Hoopa Valley Tribe

P.O. Box 1348 ♦ Highway 96 ♦ Hoopa, California 95546 ♦ (530) 625-5515

Water Quality Control Plan

Hoopa Valley Indian Reservation

Approved September 11, 2002
Amendments Approved February 14, 2008

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Prepared By

Hoopa Valley Tribe
Hoopa Valley Tribal Environmental Protection Agency

Primary Contributors:
Ken Norton, Environmental Director
Pliny McCovey Jr., Water Quality Coordinator
Curtis Miller, Environmental Planner II
Louisa McConnell, Environmental Planner II
Mike Orcutt, Fisheries Director
Nolan Colegrove, Forestry Director
Mark Higley, Wildlife Biologist
&
Clifford Lyle Marshall, Hoopa Valley Tribal Chairman
Tom Schlosser, Tribal Attorney
Grett Hurley, Tribal Attorney

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Foreword

The Hoopa Valley Tribe applied for treatment as a state with respect to the Water Pollution Control Program under Section 106 of the Clean Water Act (CWA) on July 16, 1989. The United States Environmental Protection Agency (EPA) announced formal approval of the application on July 3, 1990. Upon receiving approval, the Hoopa Valley Tribe became the first tribe in the State of California to receive such approval and qualify for grant funds under the CWA. Subsequently, the Tribe has received funding to conduct the Water Quality Planning and Management Program on the Reservation.

Comprehensive water quality planning as set forth in the Tribe's Pollutant Discharge Prohibition Ordinance (PDPO) and the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977, requires a water quality control plan (WQCP) for the waters of the Reservation as well as public review of the plan. The goal of this planning process is to provide a definitive program of actions designed to preserve and enhance water quality on the Reservation and to protect beneficial uses of water for the next 10 years. Further, the provision for change is integral to this planning process. In this regard, the WQCP shall be reviewed triennially by the Tribal Environmental Protection Agency to reflect changes in technologies, policies, and laws, and reflect physical changes within the Reservation’s waters. Any proposed amendments to the WQCP arising from the triennial review shall comply with the Hoopa Valley Tribe’s Legislative Procedures Act.

The Hoopa Valley Tribal Council adopts the WQCP, which consists of water quality criteria, standards, anti-degradation policy, and implementation plans, in accordance with the PDPO, which declares that protection of the quality of surface and ground waters for the use and enjoyment by the people of the Hoopa Tribe requires control of the discharge of waste to waters of the Reservation. It is the intent of the Tribal Council, in adopting the WQCP that the Forest Management Plan, the PDPO, Riparian Protection and Surface Mining Ordinance, and other Plans and Ordinances developed to improve the waters of the Reservation will be used as anti-degradation policies. These Tribal regulatory documents are to be used as the mechanism to identify the actions needed to protect surface and ground waters of the Reservation.

INTRODUCTION

1.0 INTRODUCTION

The Hoopa Valley Tribal Council pursuant to Title 37 of the Hoopa Tribal Code has assigned the primary responsibility for the protection and enhancement of water quality on the Hoopa Valley Indian Reservation to the Riparian Review Committee (RRC). The RRC along with the Hoopa Valley Tribal Environmental Protection Agency provides Reservation-wide coordination of the water quality control program by developing, reviewing and recommending for Tribal approval Reservation wide policies and plans for the implementation of Tribal and Federal law. This Water Quality Control Plan recognizes the unique characteristics of each watershed with regard to natural water quality, existing, potential, and historical beneficial uses, and water quality problems.

1.1 Function and Objectives of the Hoopa Valley Tribal Water Quality Control Plan

The goal of this plan is to provide a definitive program of actions designed to preserve and enhance water quality on the Reservation, and to protect the beneficial uses of water for the next 10 years to 20 years. The plan is concerned with all factors and activities that might affect water quality. However, the plan emphasizes actions to be taken by the Riparian Review Committee, the Hoopa Valley Tribal Fisheries, Forestry, Public Utility Departments, and Tribal Environmental Protection Agency, as they have responsibility for maintaining water quality on the Reservation.

The Water Quality Control Plan (WQCP) is comprehensive in scope. The WQCP describes the Hoopa Valley Reservation waters, the quality and quantity issues, and the existing, potential and historical beneficial uses of the Reservation's waters. The plan also prescribes criteria for the protection of the Reservation waters and includes plans and policies that describe the basis for the management of water quality and protection of human health. The Hoopa Valley Tribe has recognized authority for setting water quality standards for its Reservation waters, including both the Trinity and Klamath Rivers (U.S. EPA, 2002). Included in the plan are specific criteria that apply to the Lower Klamath River on the Hoopa Valley Reservation (***Figure 1.1***).

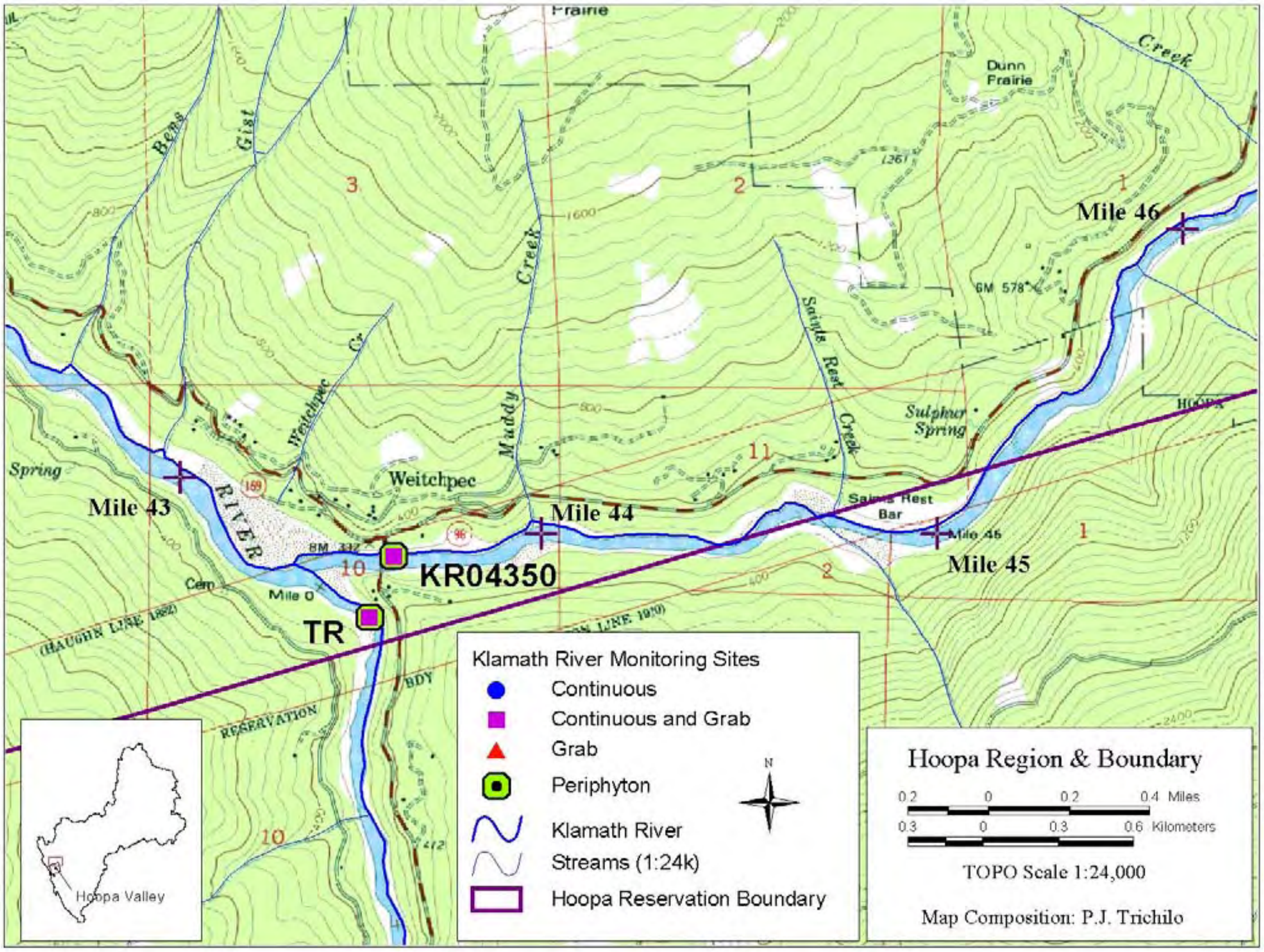
1.2 Legal Basis and Authority

The Hoopa Valley Tribe is a self-governing tribe, which possesses and exercises full control over resources within the exterior boundaries of the Reservation through the actions of various Tribal departments, including legislative and executive branches, as well as through the Tribal Court system. The Hoopa Valley Tribal Council is the governing body of the Tribe, and under Article IX of the Constitution and Bylaws, the Council is authorized to "enforce the protection of Tribal property, wildlife and natural resources" (Section 1(e)), and "safeguard and promote the safety and general welfare of the Tribe and the Reservation community" (Section 1(1)).

In protecting Tribal property, wildlife and natural resources with the adoption of this Water Quality Control Plan, the Tribe is exercising its inherent power to regulate activities that may threaten or have a direct effect on the political integrity, the economic security, and health and welfare of the Tribe.

As a sovereign power recognized by the Federal Government, as a co-manager of natural resources, and by the U.S. Environmental Protection Agency for purposes of Water Pollution Control, the Hoopa Valley Tribe maintains jurisdiction over waters that flow into and through the Reservation, regardless of the geographic origins of water sources. Furthermore, the Tribe asserts its rights to regulate non-Indians owning non-trust lands within the exterior boundaries of the Reservation. This is based in part on the legal opinion attached as Appendix A. In addition, in 1988, Congress expressly approved application of the Tribe's jurisdiction "to all lands within the confines of the Hoopa Valley Reservation boundaries." Also, congress affirmed establishment of regulations and ordinances affecting nonmembers of the Hoopa Valley Tribe pursuant to the Tribes Constitution 25 U.S.C. s 1300I-7. This Hoopa-Yurok Settlement Act confirms the Tribe's jurisdiction to safeguard the general welfare of the Tribe by regulating land "use and disposition" by all persons, including nonmembers.

Figure 1.1 *- Map showing the convergence of the Klamath and Trinity Rivers. Upstream of the confluence is a short reach known as Saints Rest, where the boundary of the Hoopa Valley Indian Reservation (purple line) intersects the mainstem of the Klamath River. The reservation is located on the southern side of the boundary.*



1.3 Reservation Setting

The Hoopa Valley Indian Reservation is the largest reservation in California. Established by Executive Order issued by President U.S. Grant on June 23, 1876, the Reservation now encompasses 93,702.73 acres. As currently surveyed, the Reservation is nearly square with sides 12 miles in length or approximately 144 square miles. This area encompasses roughly 50% of the Hupa aboriginal territory. The Reservation is located in the northeastern corner of Humboldt County in Northern California. It lies approximately 50 miles inland from the Pacific Ocean, and 300 miles north of San Francisco, California.

The 2000 U.S. Census indicated that there are 2,633 persons residing on the Hoopa Valley Indian Reservation. As a supplement to the census information, the Tribe normally uses the 1992 Bureau of Indian Affairs (BIA) Population and Labor Force Report. This report, unlike the census, utilizes a wide variety of sources including per-capita payments, medial patient records, and the Humboldt Co. Welfare Department's caseloads.

The BIA report estimated the Reservation Native American population to be 2,936. The 2000 census reported 410 non-Indian people residing on the Reservation. These two reports together estimate the total Reservation population at 3,346. By utilizing the revised population statistics, the population on the Reservation was determined to include 1,484 Hoopa, 1,452 other Native Americans, and 410 non-Indians.

Relatively wet, cool winters and dry summers characterize the climate of the Hoopa Valley. Prevailing air masses, elevations, drainage of cold dense air from higher elevations and the distance from the Pacific Ocean influence temperatures in the basin. The mean annual temperature at the Hoopa weather station, (Agency Field, 350 feet above mean sea level), is 56.9°F. The mean annual temperature in winter is 45.1°F, and in summer is 70.9°F. Mean annual upland temperature recorded at 1,700 feet is 52.4°F. A summer high of 113°F and a winter low of 7°F have also been recorded.

The mean annual precipitation at Hoopa is approximately 58.35 inches. Winter precipitation in the three-month winter period from December through February averages 30.6 inches. Mean summer precipitation is 1.32 inches. Frequency analysis of precipitation data indicates that there is only a 25% probability that the Hoopa Valley will receive less than 50 inches a year; there is a 5 percent probability of receiving less than 40 inches per year. Rainfall intensities of 2 inches per 6-hour period and 4-inches in a 24 hour period are common. Roughly three-quarters of the total annual precipitation occurs from November through March. The majority of the precipitation is associated with storms of several days duration and relatively moderate intensity. Snow occurs in moderate amounts at elevations above 2000 feet; snow remains on the ground for appreciable periods of time at elevations exceeding 4000 feet. Snowfall averages approximately 0.4 inches annually.

Reservation soils fall within the broad vegetation class referred to as the Douglas fir-White Oak prairie type, and have developed from the slate, shale and slate sandstone parent materials that predominate the underlying, consolidated rocks. Commercially important stands of Douglas fir timber dominate much of the Reservation and it is this timber resource that provides the primary economic base of the community.

The Reservation topography varies from the 3/4 mile wide by six-mile long alluvial plain adjacent to the Trinity River at an elevation of 320 feet, to the steep, mountainous terrain, which is characteristic of the balance of Reservation lands. Elevations along the eastern periphery of the Reservation range to over 5,000 feet. The relatively flat land adjacent to the Trinity River accommodates the vast majority of agricultural, municipal, and industrial development within the Reservation.

The Reservation is bisected in a north-south direction by the Trinity River. The Klamath River flows in an east-west direction through a small portion of the far-northeastern part of the Reservation referred to as Saints Rest Bar. A number of smaller streams flow into the Trinity and Klamath Rivers within the Reservation. The largest of these streams include: Mill Creek, Hostler Creek, Tish-Tang Creek, Campbell Creek, Supply Creek, and Soctish Creek. The valley floor consists of a sequence of prominent stream terrace benches that step upward in elevation and age from the active channel of the Trinity River. The terraces or benches represent ancient to modern flood plain levels. Across the valley floor, the Trinity River has formed a series of broad meanders. The broad meanders of the Trinity River naturally divide the alluvial valley into paired sets of terraces, which the Tribe defines as "fields" of the Reservation.

1.4 Field Hydrogeology

Campbell Field

Campbell Field is roughly bounded by Campbell Creek to the south, by an unnamed creek to the north, the Trinity River to the east and the valley wall to the west. ***Figure 1.2*** shows the Reservation fields along with known and suspected toxic sites. Galice bedded shale bedrock was encountered at an average depth of 45 feet. Bedrock drops to approximately 75 feet below the surface in some areas adjacent to the Trinity River. This increase in bedrock depth along the Trinity River may indicate a deeper incised ancient Trinity River channel. A few of the tributary channels appear to have graded to this ancient Trinity River channel.

Matilton Field

Captain John Gulch to the south, Ferry Gulch roughly bound Matilton Field to the north, and Trinity River to the west and the valley wall to the east. The majority of the field is bordered by the Trinity River. A relatively narrow portion of the field borders the Trinity River to the north as an eroded terrace remnant. Large boulder-gravel lag deposits approximately 10 feet thick overlie the terrace bedrock surface. The alluvial terrace deposits are overlain by colluvial deposits along the back half of the field. The thickness of the alluvial deposits is approximately 30 feet. The maximum saturated thickness of the groundwater aquifer in the primary field area is estimated at 9.4 feet from January to March. The aquifer is frequently dry during the other months of the year.

North Agency Field

For the purposes of this plan, Agency Field has been divided into North Agency and South Agency Fields. Supply Creek to the south, Brown Creek/Trinity River bound North Agency Field to the north, valley wall to the west and the Trinity River to the east. Galice schist bedrock was encountered between 21 feet and 25 feet below the ground surface. Depth to bedrock increases toward the back edge of the field indicating the presence of an ancient buried stream channel.

South Agency Field

The Trinity River, Supply Creek roughly bound South Agency Field to the south and east to the north, and the valley wall to the west. Bedded Galice slate/schist was generally encountered between 18 feet and 22 feet. Depth to bedrock increases to 48 feet along the back edge of the field, consistent with an ancient buried stream channel along the back edge of the field.

Hostler Field

Ferry Gulch, Hostler Creek roughly bound hostler Field to the south to the north, and Trinity River to the west and the valley slope to the east. Galice bedded shale bedrock was encountered at an average depth of 50 feet below the surface. The average maximum saturated thickness of the aquifer was 12 feet (1966-1974). The deposits are stratified with a westward dip of approximately 3-4% towards the Trinity River.

Chenone Field

Chenone Field is bounded by Spring Creek to the south, the valley wall and the Trinity River to the north, the Trinity River to the east, and the valley wall to the west. Galice bedded shale bedrock and South Fork Mountain Schist bedrock was encountered at an average depth of 30 feet below the ground surface. Depth to bedrock increased to 48 feet near the valley wall (back edge). The increased depth to bedrock may represent a buried scour channel (ancient Trinity River channel). Surface scour erosion has reduced the terrace alluvium to less than 20 feet thick near the Trinity River.

Meskat Field

Mill Creek is bounded to the north, Hostler Creek bound by Meskat Field to the south, and Trinity River to the west and the valley wall to the east. Galice bedded slate was generally encountered between 20 and 67 feet below the ground surface in domestic water wells. Depth to bedrock appears to increase toward the back edge of the field, consistent with an ancient buried stream channel near the valley wall. Two large colluvial fans or landslides from the eastern valley slope overlie the back edge of the field.

Soctish Field

Soctish Field is bounded to the south, north and east by the Trinity River, and to the west by the valley wall. Bedded Rattlesnake Creek Terrane schist bedrock was encountered between 23 feet and 60 feet below the ground surface. The field is generally bisected by the incised Soctish Creek.

Norton Field

Norton Field is bounded by Mill Creek to the north, Trinity River to the west and north, and by the valley wall to the east. Galice bedded schist bedrock was encountered between 37 feet and 50 feet across most of the field. The average maximum thickness for the saturated aquifer is 13 feet. A portion of the field includes alluvial deposits adjacent to Mill Creek.

***Figure 1.2 -** Known Toxic Sites on Hoopa Valley Indian Reservation 2000)*

1.5 Industrial History

Supply Creek Land Fill

The Supply Creek Landfill covered about two acres, and had been used as an unregulated dump for many years. The site received both domestic and commercial wastes. Both the BIA Complex Well and the Supply Creek Well are approximately 2 miles down gradient from the landfill. Water from Supply Creek is occasionally used for unregulated domestic drinking water. A shallow soil gas survey (Tetra Tech. 1987D) upgradient from the landfill detected low levels of trichloroethene. No testing of soil or groundwater for contamination has been done at the site, or down gradient. Three test wells were drilled to 200 feet without encountering ground water as a condition of closure for the dump in 1998. The Supply Creek Land Fill was officially encapsulated and closed in 1999.

Supply Creek Landfill Prior to Closure (1997)

Campbell Field

Past industrial uses within Campbell Field include an abandoned sawmill site most recently occupied by Cal-Pac Lumber (Simpson Paper Company), Humboldt County Department of Public Works Maintenance Yard, Kelly Tire Store, McIntosh Site, chemical storage and disposal at the Hailstone Allotment, Jackson Trucking and Hoopa Ready Mix.

The Cal-Pac Mill site was originally operated as the Sugar Pine Lumber Company. Van Fleet Lumber Company purchased the site in 1957 and the Van Fleet Mill produced rough sawn lumber for shipment to Arcata. Both Sugar Pine Lumber and Van Fleet Lumber may have used wood preservatives and other toxic chemicals on the site. The Van Fleet Lumber Mill operated until 1968, when the mill site was transferred to California Pacific Manufacturing Company (Cal-Pac). The Cal-Pac Mill operated until 1980. The mill was dismantled in 1982. The Tribe recently purchased the property.

Lumber milled at the Cal-Pac site was treated by dipping the lumber in a pentachlorophenol (PCP) solution. In 1981 and 1982, the Cal-Pac Mill site in Campbell Field was found to contain elevated levels of chromium, barium and mercury. The California Department of Health and Human Services (DHS) sampled soils in 1981 and found 435 ppm of tetrachlorophenol (TCP) in soils below the dip tank area. Soil contaminated with more than 14 ppm of TCP and 8 ppm PCP was excavated and hauled away to the Klamath, California landfill and to Grandview, Idaho. The excavated area was subsequently covered with a concrete cap. Soils remain on site that is contaminated with 8 ppm PCP and 14 ppm TCP (Registered Codicil, 1989). In 1991, water from a seep bordering the Cal-Pac site was found to contain relatively high levels of copper, arsenic, chromium, and mercury. Sediment from that seep contained levels of arsenic, chromium, lead, copper, mercury, nickel, and zinc in excess of the current regulations. In 1999, the Cal-Pac site was selected as a Brownfield Demonstration Project for reclamation and development.

Tee-Pee Burner at Abandoned Cal-Pac Mill (2000)

The Humboldt County Public Works Maintenance Yard is located off Shoemaker Road. Diesel and gasoline fuels were stored in underground fuel tanks until 1990. Investigations by LACO Associates (1990-1991) and Selvage, Heber and Nelson (1990) detected both gasoline and diesel contaminated soil. Groundwater contamination has not been verified. Waste oil was also apparently stored on site.

The Kelly Tire Store is located off Highway 96, adjacent to the Hailstone Allotment. Toxic chemicals and fuels may have been used or stored on-site.

The Hailstone Allotment site is located between the Kelly Tire Store and Cal-Gas on the western half of parcel 143. The Hoopa Valley Indian Housing Authority was informed in 1981 that pine treatment chemicals were stored on the Hailstone Allotment. DHS and Indian Health Service (IHS) collected surface samples in 1981; TCP was detected. DHS concluded that additional investigation and soil analysis was needed.

In 1981, the McIntosh Site was found to contain heavy metals above the current regulations, including arsenic, copper, iron, manganese and mercury. That study concluded the site was not suitable for industry or housing. Tetrachlorophenol was detected both at the McIntosh site and the Hailstone Allotment.

Matilton Field

Industrial uses on Matilton Field appear limited to operation of the Hoopa Community Airport. Fuels were once stored at the community care facility, but the underground fuel tanks have since been removed.

North Agency Field

Past industrial uses within the North Agency Field area include the abandoned Big Four Lumber Company Mill, Pacific Gas and Electric transformer substation and the Ieeque Trading Post. The Big Four Mill also known as the G.A. Way Lumber Mill, operated prior to 1964, but was destroyed by the flood. The site is currently used as pasture land. Wood preservative (e.g., PCP) and other toxic chemicals may have been used on site. No soil or groundwater assessment for toxics has been conducted on site. The Pacific Gas and Electric Company Transformer Substation is an active transformer station. The Ieeque Trading Post (now closed) reportedly sold gasoline in the past. The status of the underground fuel tanks is unknown. No soil or groundwater testing for contamination has been conducted.

South Agency Field

Past industrial uses of the South Agency Field consist of underground fuel storage at the Bureau of Indian Affairs Compound, Hoopa Valley High School, Hoopa Valley Elementary School, Humboldt-Trinity Unified School Corporation Yard, Tribal Fisheries and the BIA Fire Service. Other uses have included the old County Landfill (school football field), and fill material from the Celtor Chemical works mine tailings - used both at the Hoopa High School football field and the Neighborhood Facility Preschool playground.

All of the of the underground fuel tanks at the BIA Compound, Tribal Fisheries, and BIA Fire Service Facilities have been removed or upgraded and meet Federal requirements. An underground tank investigation at the Hoopa High School and the Elementary

School/Corporation yard by LACO Associates detected diesel contamination in soil. The UST was removed however; groundwater contamination has not been verified.

The old County Landfill site was used as an open dump for several years. The dump was unregulated, and may have received lumber mill and mining-related toxic chemicals and other domestic toxic refuse. The site was closed and covered with soil after the 1964 flood. Freon, trichlorethene and trichloroethane were detected at low levels during a shallow gas survey (Tetra Tech, 1987C). No soil or groundwater has been tested for toxics.

Mine tailings from the Celtor Chemical Works might have reportedly been used as fill at The Hoopa High School football field. Soils sampled at the High School football field and Neighborhood Facility Pre-school playground contained arsenic, lead, cadmium and copper (Davis, 1983). Sampling and testing in accordance with EPA Standards has not been conducted at these two sites.

Hostler Field

Past industrial uses within Hostler Field include: Trinity River Lumber Company (abandoned), Unocal Bulk Oil and Unocal Station, BP Gas Station, Wold Logging Company, Risling Lumber Mill and the Shopping Center Sewage Treatment Plant. The Trinity River Lumber Company Mill site was abandoned after the 1964 flood. The Hoopa Valley Shopping Center complex was built over the abandoned mill site in 1975. The Public Utilities District (PUD) water well supplying the shopping center and surrounding community is located in the area previously occupied by the millpond. A soil gas survey (Tetra Tech, 1987A) detected Trichloroethene (0.004 ppb) and 1,1,1-Trichloroethane (0.002 ppb). In addition, wood preservatives (e.g., PCP) and other toxic chemicals may have been used or stored on site.

The site of the Unocal 76 Station and bulk plant is on the west side of Highway 96. The site is approximately 1/4 mile north of the Trinity River Bridge and is 1700 feet east of the Trinity River. A subsurface hydrologic investigation (Applied Geo Systems, 1990) detected as much as 2.39-ppm gasoline (TPHg) in soil, and 36 ppb TPHg and 6.1 ppb benzene in groundwater. The site was registered with the California Regional Water Quality Control Board (UGT No. 1THU109) as a leaking underground fuel storage tank site. The Hoopa Valley Tribe asserted jurisdiction however, and five 10,000-gallon tanks were removed in 1998. As of 2006, the site is currently operated by a private owner.

The Union 76 Station located on the East Side of Highway 96 near the Unocal facility has been in operation for some years, and underground fuel tanks are currently in use at the site. This site meets all Federal UST standards and is equipped with double-walled tanks, vapor recovery systems, and containment systems. The Wold Logging Corp. yard is located on the East Side of Highway 96 and has been operating at this site for some years. Fuels and other toxic chemicals may have been used on site. Further, the abandoned Risling Lumber Mill site located on tribal trust land adjacent to Hostler Creek was destroyed in the 1964 flood. Wood preservative (e.g., PCP) and other toxic chemicals may have been used on site. Contamination status of soil and groundwater at these sites is unknown.

The shopping center community sewage treatment facility is located behind the shopping center, adjacent to the Trinity River. Treated sewage water is used for irrigation in the adjacent area.

Other industrial uses of the field include a Laundromat and a hardware supply store. Toxic chemicals may be stored at these facilities.

Chenone Field

Past industrial activities within the Chenone Field appear limited to the old Airport Lumber Mill site located off Pine Creek Road. According to the Hoopa Tribal Records, the mill was abandoned prior to 1970. Wood preservative (e.g., PCP) and other toxic chemicals may have been used on site. All signs of the old Airport Mill have been removed, but it was reportedly located on the lower terrace surface between the Hoopa Rodeo Grounds and the Trinity River. The entire site lies within the 100-year flood plain of the Trinity River. The site is currently used for pastureland. No soil or groundwater assessment for toxics has been conducted.

Meskat Field

Past industrial uses of the Meskat Field have included the Masonite Mill Creek Lumber Mill, Hoopa Veneer Mill Site (Masonite Meskat Field), Tsemeta Nursery (Hoopa Tribal Forestry Nursery), Big Hill Laundromat, and Hoopa Valley Development Enterprise.

The Masonite Mill Creek Lumber Mill site located on Lots 266-273 covered approximately 21 acres when it operated. The Humboldt Fir Lumber Company originally occupied the site at some time before 1958, succeeded by the Humboldt Fir Company. The Humboldt Fir Company operated between 1958 and 1964 when the company merged with the Masonite Corporation. The Mill was partially destroyed during the 1964 flood. Two wells were installed on the Squires parcel for domestic and irrigation use.

A 1981 study of the Masonite Mill Creek Mill site found levels of Pentachlorophenol and tetrachlorophenol. The site underwent partial cleanup in 1987. The tanks were removed and all that remains at the site is a 34 by 53 foot pit (excavated 25 feet down to the hardpan) and a 1,688 cubic yard mound of diesel contaminated soil stockpile adjacent to the pit. Investigations by the U.S. EPA Field Investigation Team (FIT) in 1982, Ecology & Environment, Inc. (1982) and by Cooper Consultants (1990) have determined that the site is contaminated with PCP, Polychlorinated Dibenzodioxins (Dioxin), Polychlorinated Biphenyls (PCB), Trichlorethlene, Tetrachlorethene, 1,1,1-Trichlorethane, diesel and gasoline. A 1989 study of the sediments in the Trinity River up and downstream of the Masonite Mill Creek site found iron levels in excess of the current regulations. Samples taken from a seep in the same location found both iron and manganese levels in excess of the Minimum Concentration Level (MCL). In addition, limited testing of seeps along the Trinity River in 1992 found no trace of Pentachlorophenol or tetrachlorophenol.

Hoopa Veneer and Humboldt Fir Company also previously operated the Masonite Meskat Mill site. The site appears to have encompassed Lots 283 to 297A. The majority of the lots were transferred to the Hoopa Valley Tribe in 1978. Lumber milling operations throughout the site undoubtedly involved fungicide and wood preservative use over the past 20 years. However, various operators used different portions of the site, and the exact locations of use and the identity of all the compounds used are unknown.

A 1981 investigation of the site revealed levels of the following heavy metals above the MCL: arsenic, chromium, copper, iron, manganese and zinc. A study in 1982 also found levels of mercury and lead above the MCL. A DHS study in 1984 found high levels of barium, chromium, cobalt, lead, and vanadium and in 1986 found levels of arsenic and chromium. Investigation by Ecology and Environment (1982) and Winzler & Kelly (1986, 1987) detected high levels of PCPs, TCPs, heavy metals and oil-grease on portions of Lots 291-295. Limited site remediation was conducted on Lots 291-295. Furthermore, sediment from a seep in Meskat Field contained levels of chromium, nickel, and zinc in excess of the current California Regulations for hazardous waste, (LACO Associates, 1991). No soil/groundwater testing has been conducted for toxics on the remaining portions of the Meskat Mill Site although a site assessment is scheduled for the summer of 2001.

The Tsemeta Nursery (Hoopa Tribal Forestry Nursery) located on Lot 265 has used and is currently using various compounds. The Hoopa Valley Development Enterprise is located on Lot 265A. The site uses include maintenance and repair of vehicles and heavy equipment. Gasoline, diesel, waste oil and other toxic chemicals may be used and stored on site. No soil/groundwater contamination testing appears to have been conducted at any of these sites.

Soctish Field

There are no known industrial sites or underground fuel tanks located within the Soctish Field.

Norton Field and Vicinity

The primary industrial use of Norton Field was the Celtor Chemical Works. This site was used to extract copper, zinc and other precious metals from sulfide ore mined at the Copper Bluff Mine between 1957 and 1962. After abandonment in 1962, some equipment and mine tailings remained on site. The site was targeted by the Abandoned Site Project (ASP) investigation of Humboldt County in 1981. Subsequent soil investigation revealed high levels of heavy metals and very acid conditions. In 1983, the Celtor site was approved for cleanup under the Federal Superfund Program, and was remediated in 1987-88. In addition, waste soil from the Celtor site was reportedly used as fill material at several sites throughout the valley, including a playground for pre-school and elementary school children, a high school football field, a county landfill, and housing sites.

The 1993 Five Year Review of the Celtor Chemical Works site conducted by USEPA revealed that (1) the re-vegetation and post-closure maintenance was successful at insuring that the vegetation survived; (2) the vegetation cover is in good condition and there is no evidence of erosion, (3) there is no need to impose additional operation and maintenance requirements; (4) the original cleanup objectives remain protective of human health and the environment; and (5) there are no new Applicable or Relevant and Appropriate Standards, Limitations, Criteria, and Requirements (ARARs) which would make the remedial action insufficient.

However, the Tribe has concerns with the EPA Five Year Review findings. These concerns include the omission of any comment regarding the stunted growth of the vegetation adjacent to the site or the build up of salts on the lower slope of the site. Because of the salt build up, the Tribe believes additional investigation is required. In August of 1999 the salts were sampled with 4.4 ug/g of arsenic resulting. Considering the laboratory and visual evidence from settling ponds adjacent to the river indicating excessive concentrations of heavy metals and conglomeration of solids, which have been cemented together along with the salt deposits, there remains some concern for public health and safety for this reason, a sampling event is scheduled for the summer of 2001. This site was taken off the NPL by USEPA in 2003 based on the 2001 and 2002 sampling.

The Copper Bluff Mine is located approximately 0.5 miles north of the Celtor Chemical Works, adjacent to the Trinity River. Mining operations at Copper Bluff Mine (formerly Bolivar Mine) began in the 1930's. Copper, zinc, silver, and gold were extracted from the ore. Mining operations ceased in 1962 and the mine was abandoned. A 1981 study of the Copper Bluff Mine sludge found concentrations above drinking water MCL for arsenic, cadmium, copper, iron, lead, manganese, selenium, and zinc. Soil and water were sampled at the Copper Bluff Mine by Ecology and Environment (1982), and revealed high levels of heavy metals (copper, cadmium, lead, manganese) and very acidic conditions. A 1987 study of sediment from the Trinity River both up and downstream from the effluent of the Copper Bluff Mine found the following heavy metals in excess of the current regulations: arsenic, cadmium, chromium, lead, mercury, selenium, nickel, copper and zinc. The mineshaft remains open and water discharges from the shaft directly into the Trinity River. The mine water is highly acidic, and contains high levels of arsenic, cadmium, chromium, copper, lead and zinc.

A joint funding agreement with the United States Geological Survey (USGS) has provided analyses of the Copper Bluff Mine. Results from the 1995 progress report indicate pH levels for underground mine tailings range from 2.5 to 3.2 and specific conductance ranging from 560 to 2770 mS/cm. Observed pH values from surface seeps ranged from 4.0 to 4.9. Specific conductance for seepage ranged from 320 to 550 mS/cm. Upcoming work plans for the mine include chemical analysis of underground and surface-seep samples (for Al, Cd, Ca, Cr, Cu, Fe, Pb, Mg, Mn, Ni, K, Si, Na, Zn, chloride, fluoride, and sulfate), which will be analyzed by an EPA contracted laboratory.

1.6 Water Resources and Water Use

The Hoopa Valley Indian Reservation hosts a seasonal abundance of surface water for drinking water supply while in contrast, groundwater aquifers are quite limited. The Tribe is now faced with the challenge of meeting the increase demands for drinking water supply, while maintaining quality surface water in streams to protect fish, wildlife and other beneficial uses.

Klamath and Trinity Rivers

The water resources of the Klamath and Trinity Rivers, in particular, have played a key role in the indigenous life of local people. For thousands of years, the Hupa people have depended on the abundant runs of salmon and steelhead, harvesting fish first with wooden weirs, and in recent times with gill nets. Fish have historically provided the mainstay of the Native American economy in the area. Today, however, water itself has become the commodity. The Lewiston Dam on the Trinity River was developed for agriculture and electrical power generation.

Surface Water Inventory

Any catchment that included reservation land within its boundary or any catchment (except the Trinity and Klamath Rivers) that gave rise to a stream flowing through the reservation is included and delineated in the watershed inventory (***Table 1.1***). The delineation also includes watershed areas and estimated water yields. Beneficial uses for these watersheds are further delineated in Chapter 3.

For this assessment, streams were taken directly from blue lines on USGS topographic maps. Approximately 43 percent of the watershed area drains into the Trinity River from the east side and 25 percent drains into the Trinity River from the west. Twenty percent of the watershed area drains into the Klamath River.

Stream flow information for the Trinity River Gauging Station in Hoopa measures runoff from approximately 2,855 square miles, or 96 percent of the hydrographic area. The total drainage from tributaries within the Reservation accounts for only 7 percent of the overall drainage area that discharge into the Trinity River. The flow records from this station are summarized below in ***Table 1.1***. These figures represent data from 1931 to 1992. According to the Humboldt County Contingency Plan for Floods, the flood warning stage for the Trinity River in Hoopa is 44 feet and flood stage is reached at 48 feet. The 100 year flood maximum flood depth of 52 feet and peak discharge of 212,000 cfs were exceed during the 1964 flood, which measured 231,00 cfs at a height of 57 feet. The 12.5 miles of the Trinity River located within the boundaries of the Reservation has an average channel depth of 31 feet.

Table. 1.1 *- Watershed Inventory (Hoopa Valley 305(b) Water Quality Inventory, 2000)*

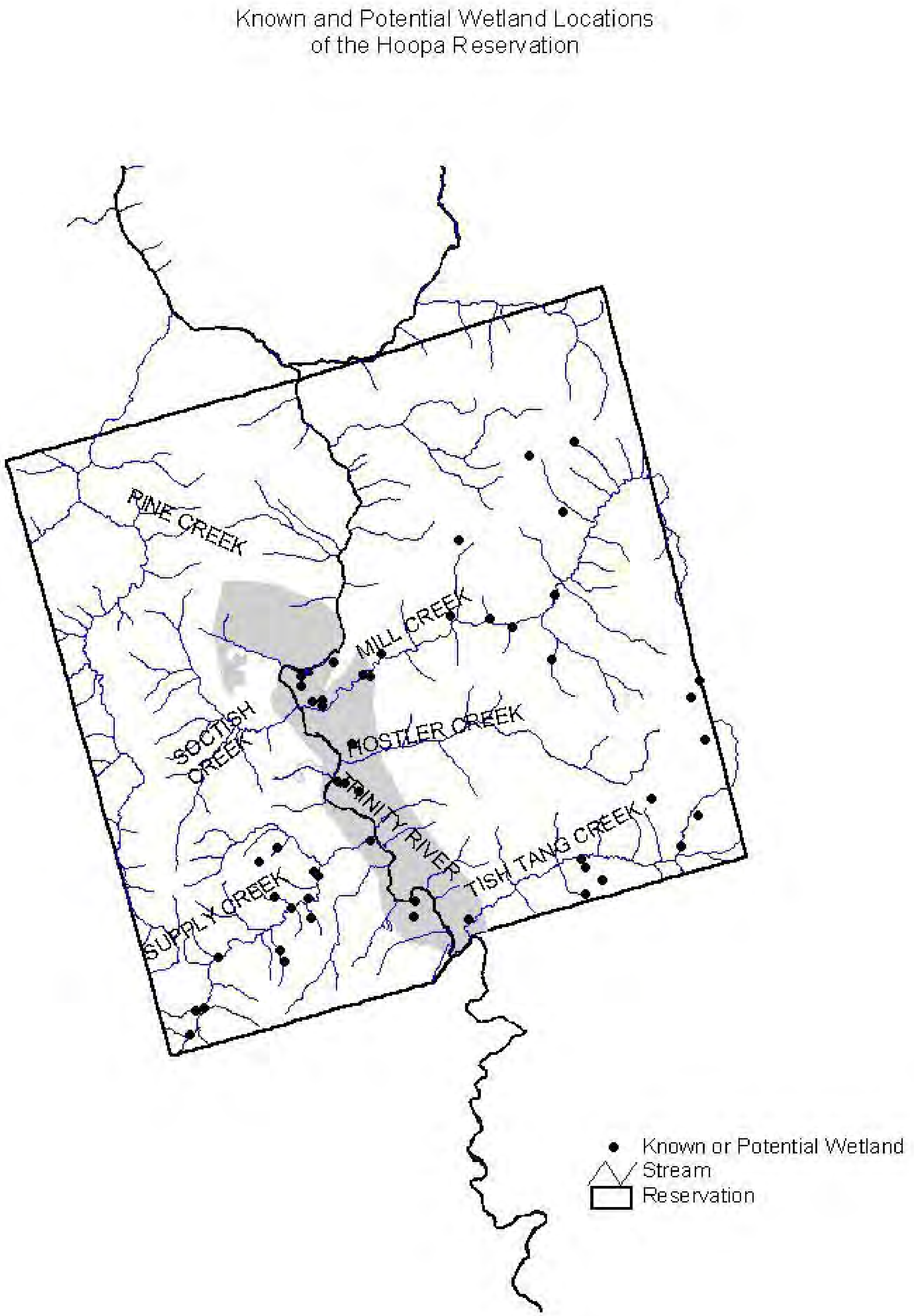
Watershed Name	Total Watershed Area(ac.)	Reservation Watershed Area (ac.)	Percent Total 0n-Reservation Watershed Area	Miles of Stream Class I / Class II	Estimated Water Yield (Acre-feet)[a]
	Trinity	**River**	**East Side**		
Tish Tang Creek	19,131	8,367	43	9.67 / 13.59	63,440
Hostler Creek	6,657	6,657	100	8.30 / 6.47	22,089
Mill Creek	30,806	16,824	55	14.24 / 28.91	102,175
Bull Creek	4,198	4,198	100	3.28 / 7.29	13,925
Captain John	881	881	100	0.33 / 2.01	2,934
Low Order / Direct Facing	9,601	9,458	98	0.98 / 7.74	31,847
Total	71,274	46,385	65	36.47 / 64.00	236,410
	Trinity	**River**	**West Side**		
Campbell Creek	4,355	423	10	1.18 / 0.00	14,435
Hospital Creek	1,617	1,617	100	0.00 / 6.46	5,357
Supply Creek	10,254	7,184	70	7.33 / 38.84	34,016
Soctish Creek	5,924	5,924	100	3.67 / 23.06	19,644
Big Creek	1,157	1,157	100	0.00 / 5.71	3,827
Beaver Creek	2,059	2,059	100	1.34 / 8.37	6,824
Low Order / Direct Facing	9,601	9,458	98	0.00 / 30.36	31,842
Total	34,967	27,822	79	13.52 / 112.80	115,945
	Klamath	**River**			
Hopkins Creek	5,762	3,781	66	3.69 / 8.45	19,113
Pine Creek	31,412	12,559	40	20.52 / 42.10	104,174
Direct Drainage	2,964	1,199	40	0.00 / 2.21	9,843
Total	40,138	17,482	44	24.21 / 52.76	133,130

a) Water Yield is estimated using a value of 2126 acre-feet per square mile.

Wetlands

In 1999 the Tribal EPA and Humboldt State University cooperated on a wetland identification project using a geographic information system (GIS) and infrared aerial photo interpretation. Data layers from the GIS were queried for attributes indicative of wetland occurrences (soil, vegetation, slope and hydrography). Air photo interpretation was then used to further validate the GIS results. The study area included Mill, Supply and Tish Tang watersheds (uplands) and the Valley floor. Fifty potential wetlands were identified: 13 on the Valley floor & 37 in the uplands (***Figure 1.3***). Six Valley floor wetlands and 3 upland wetlands were field verified. Aerial extent of these wetlands was not determined due to the site-specific nature of wetland boundaries. Delineation of wetlands will normally be conducted when a proposed project is adjacent to it. The Tribal EPA plans to repeat this process of remote identification and field verification for the Reservation and surrounding watersheds in cooperation with Humboldt State and adjacent stakeholders.

***Figure 1.3** – Known or Potential Wetlands on the Hoopa Valley Indian Reservation (1999)*



Upland Riparian and Wet Brushfield

The riparian corridors occur along most of the perennial drainages, and are characterized by dense canopy and moderately diverse hydrophytic vegetation. Approximately 200 miles of riparian corridor were delineated from photographs for tributaries to the Trinity and Klamath Rivers, in addition to 19 miles associated with the Trinity River itself. Red alder is generally dominant with varying amounts of willow, big leaf maple, Nuttal's dogwood, California bay, thimbleberry, salmonberry, spikenard, ladyfern, five-finger fern, evergreen huckleberry, streamside dogwood, and a variety of other hydrophytic trees, shrubs and herbs. Black cottonwood and western yew are occasionally present. Riparian vegetation in the southwest corner of the Reservation can also include Port-Orford cedar, western azalea, western hemlock and other species specific to either saturated ultramafic soils or the coastal Douglas fir forest. The wet brushfields differ little compositionally from riparian, other than lacking a structural tree stratum. Brushfields are often associated with former landslide features or broad hillside seeps.

Example of Valley Wetland at Mill Creek

Upland Herb Meadows

The upland meadows are mostly associated with dioritic soils at higher elevation in the southeast corner of the Reservation, and are representative of the highly developed wet meadow complex that occurs farther east in the vicinity of Trinity Summit. Meadows are normally of low gradient, with diverse vegetation dominated by various sedge, rush, grass and herb species. Steeper portions of the meadows are often covered with dense brushfield.

Valley Floor Riparian

Riparian vegetation on the valley floor is similar to upland riparian, but due to past disturbance (filling, channelization) is often dominated by exotic species. Dominant native species include many associated with upland riparian, the most important trees being red alder and black cottonwood. However, the vegetation is often dominated by invasive exotic species, including Himalaya black berry, black locust and escaped cherry.

Other Wetlands on the Valley Floor

The majority of wetlands on the valley floor, excluding riparian, are located on poorly drained flat areas adjacent to drainages. The relatively stagnant "swamp" is characterized by native species such as black cottonwood, red alder, water parsley, juncus, horsetail, and other hydrophytic or aquatic species. As with riparian vegetation in the valley, these areas have been subject to intense invasion by the three exotic species noted above. Other minor wetland types present in the valley include a small amount of cattail marsh, and an aquatic forb community present in horse pasture.

Trends

Due to the restriction of agricultural, residential and commercial development largely to the valley floor, long-term loss of wetlands in upland areas has probably been minimal. Some upland riparian wetlands undoubtedly have been lost to road construction or streamcourse alterations. Past logging practices have contributed to downcutting of drainages and sediment deposition in some areas, altering or destroying riparian vegetation. Changes in species composition have undoubtedly occurred due to logging near to or within the riparian corridors. No attempt was made to quantify change in wetland quality or loss of wetlands as a result of these factors.

In contrast, decline in amount or quality of wetlands on the valley floor has probably been significant over the past 50-60 years. Black cottonwood/alder swamp and other stagnant wetlands were probably historically widespread in the valley, associated with the mouths of some drainages. BIA agents apparently encouraged modern techniques of farming about the turn of the century. Flat, moist, and fertile land would have been desirable, since most crops required irrigation. Additional wetlands were probably lost to mill construction and related water diversions later in the first half of the century.

Finally, significant loss or decline in quality of wetlands in the valley may have occurred as a result of the 1964 flood and subsequent stream rechannelization by the Army Corps of Engineers. Those impacts may have contributed to the high occurrence of exotic species in the valley. Subsequent construction of irrigation channels serving Campbell Field and other areas of the valley probably caused additional losses. Inspection of 1962 aerial photographs indicated no significant change in non-riparian wetlands in the valley from 1990 photos. Therefore, aside from flood-related impacts on riparian vegetation after 1964, the major historical impacts to wetlands on the valley floor appear to have occurred prior to 1962.

Groundwater Resources

The groundwater basin in the Hoopa Valley is restricted to alluvial fans at the mouth of principal tributaries and the terrace and floodplain deposits adjacent to the Trinity River. Surficial deposits range in depth from a few feet along the valley floor to a maximum of about 80 feet along the terraces bordering the river. According to the Tribe's 1993 305(b) report, the valley basin is estimated to have a usable storage capacity of approximately 6,000 acre-feet per year.

Groundwater recharge is primarily from two sources: 1) precipitation and surface runoff infiltration, and 2) percolation of water through soils adjacent to perennial stream channels. The alluvial deposits are largely sand and gravel, with moderate to high permeability, allowing water to move rapidly from recharge to discharge areas. Consequently, sustained heavy withdrawals from these aquifers during the dry summer months for domestic and agricultural uses may lower water tables and affect other groundwater users.

1.7 Identification of Water Bodies Which Do Not Meet Standards

In 1990, the Hoopa Valley Tribal Council, in conjunction with the U.S. EPA, awarded LACO Associates a contract to prepare the Water Quality Assessment EPA 305(b) report for the Hoopa Valley Indian Reservation. The purpose of the study was two-fold; to complete the Water Body System 305(b) report, and to characterize water quality on the Reservation. The Hoopa Valley Tribe was granted program authorization under Section 303 of the Clean Water Act from EPA in 1996.

On August 3, 1995, the Hoopa Valley Tribal Council approved Title 37 Pollution Discharge Prohibition Ordinance. The purpose of this Ordinance was to exercise comprehensive Tribal regulatory authority over all surface and groundwater matters. The focus is to provide protection for beneficial uses of water, prohibiting all point source discharges and restricting non-point source discharges of pollutants within the exterior boundaries of the Hoopa Valley Reservation. This Ordinance established numeric and descriptive water quality standards and beneficial uses of the Hoopa Reservation's waters. The standards adopted by HVT in 1997 and current revisions to the WQCP supersede standards set forth in the Pollution Discharge Ordinance.

A waterbody that is not listed but that is a tributary to a listed waterbody is protected by the water quality standards that have been established for the nearest downstream waterbody. Water bodies within the Reservation, which do not have beneficial uses designated for them are assigned wildlife and/or aquatic habitat, or recreation designations. These designations in no way affect the presence or absence of other beneficial use designations in these water bodies. Further classification will be based on the size of the waterbody and its historic and environmental significance. Water bodies which are used for Domestic water, fisheries, or cultural purposes have the highest priority for protection and restoration.

There have also been many ground water, surface water, and point source studies to determine the water quality in Hoopa Valley Reservation. The bulk of these studies are useful in assessing surface waters on the Reservation with respect to Clean Water Act goals. A summary of the usable data shows a high level of soil and water runoff contamination above the accepted governmental standards in some cases. Non-point sources of contamination include gold and mercury mines, mine processing sites, timber processing mills, construction activities, urban runoff, underground storage tanks, landfills, leachfields, septic systems, roads, silviculture, agriculture, flow regulation, diversions, hydro modifications, land development, and the use of pesticides. The miles of streams impacted for each watershed is listed in the Tribe's 305 (b) report.

1.8 Identification of Non-Point Source Pollution

In 1991 through 1995 Hoopa Tribal Environmental Staff and LACO Associates sampled monitoring wells, surface waters, sediments and waters from seeps below a few point sources. The only contaminant that affected a designated use, (municipal), was the Total and Fecal Coliform found in surface waters and some wells. With proper treatment, the designated use would be supported. Even though no other impairment of designated uses was noted, there is much concern over the potential impairment by contamination in soil working its way into sediments and water sources. From the previous detection of contaminants, the following potential water quality problems were identified:

1. Potential for chlorophenols in certain streams.
2. Potential for dioxins and furans in certain streams.
3. Potential for silvicultural chemicals (organic pesticides) and their breakdown products in certain streams.
4. Potential for heavy metals and other byproducts of ore processing in certain streams.
5. Potential for unknown chemicals or combinations of chemicals entering Supply Creek from the Supply Creek landfill and dump.
6. Potential for contamination of the Trinity River by any of several industrial chemicals from a truck accident on Highways 96 or 299 which closely parallel the Trinity River for many miles.
7. Potential for further increases in sedimentation and degradation of spawning beds through mining activities, forest management practices, and road building within the Reservation, and by private concerns outside the control of the Reservation.

Beneficial uses of the Trinity River are affected by the decline in the Trinity River water levels due to increased demands for water diversion to other parts of the State. This decreases the potential use for water-oriented activities, such as, Indian subsistence fishing, cultural ceremonies, and other Indian fishing rights. A potential, but undocumented trend in Hoopa is an increase in failure of septic leachfields, contributing to an increase in coliform levels found in some of the surface and ground water sources. This would affect the designated municipal and domestic water uses if left untreated.

Soil contamination increases the potential for further contamination of water and stream sediments. This could increase with time or under certain conditions. Agriculture lands could also be affected however no studies have been conducted to see whether there is plant uptake of metals or other toxics by crops. This situation should be more closely studied.

1.9 Inter-Governmental Coordination

The Hoopa Valley Tribe's Legislative Procedures Act sets forth a comprehensive and systematic process for the Tribal Council to establish, amend, or modify policies, ordinances and acts, or to take other major governmental actions on behalf of the Hoopa Tribe. The Tribe's Title 37 Pollution Discharge Prohibition Ordinance states that:

> *"It shall be the policy of the Tribe and its authorized entities and departments to vigorously enforce the provisions of this Ordinance and the Water Quality Control Plan; continue technical and legal efforts pertaining to Trinity and Klamath River water rights and flow allocations; monitor off Reservation waters which flow into the Reservation for pollutants; and to coordinate with the off-reservation jurisdiction of the North Coast Regional Water Quality Control Board, State Water Quality Control Board, or the State of California or any of its agencies, with regard to matter herein regulated by the Tribal authority."*

In addition, the Tribe is mandated by the Federal Government to comply with the regulations set forth in 40 CFR Part 25 concerning public involvement.

1.10 Erosion Control and Prevention

Watershed restoration is a long-term commitment to improve fish habitat, riparian reserves, and water quality. The Hoopa Tribe is currently working to address erosion problems caused by past land management activities. From 1984 to the present, watershed rehabilitation projects have been implemented in Mill Creek, Tish Tang, Supply, and Pine Creek watersheds on the Hoopa Valley Indian Reservation. The Tribe's goals of watershed restoration projects are:

1. To improve riparian habitat by treating chronic or potentially catastrophic areas of sediment production.
2. To minimize potential of sediment from reaching anadromous spawning habitat and to encourage the return of natural ecosystems to there predisturbance condition as closely as possible (FY94 Watershed Rehabilitation Program, HVIR, 1994).
3. Reduce turbidity during high flows on Reservation domestic water supply streams, which lead to unacceptable water quality problems during the winter on Mill Creek and Tish Tang Creek.
4. To set up long term monitoring stations to measure the effectiveness of the rehabilitation projects and overall conditions of fish bearing streams.

Erosion abatement projects are designed to reduce potential sediment delivery to Reservation streams. In 1995, 157 erosion projects were designed to reduce some 66,000 cubic yards of sediment from reaching these streams (FY95 Watershed Rehabilitation Program, HVIR, 1995). Funding of erosion treatment was a conglomeration of Option 9 monies, Tribal Timber Sale, the Trinity River Restoration Program, Environmental Protection Agency support, Integrated Resource Management Plan funds, and University of California Coop Extension funds.

1.11 Irrigation Systems, Implementation of Fish Screens

The Tribal Public Utilities Department has developed irrigation diversion systems on Hostler, Mill, Soctish, and Supply Creeks as well as the Trinity River. The Tribal Fisheries Department identified that the unscreened intake pipes to these diversion systems are entraining and killing salmonid fry. In September 1997 the Tribal Fisheries installed a rotary fish screen system in Mill Creek. Interim fish screens have been installed on intake pipes located in Hostler and Soctish and Supply Creeks. Installation of fish screens resolved the problem of salmonids entering into irrigation diversion systems. Supply Creek is scheduled for installation of a rotary fish screen system in the spring of 2002. The Trinity River Water Treatment Facility, completed in 2005 is state of the art and institutes all measures to protect fish.

1.12 Water Quantity and Quality Problems

In addition to further reductions in Trinity River stream flows, the Hoopa Valley Tribe faces difficult management decisions with respect to on-reservation water use conflicts and water quality problems. As the demand for water diversion from streams within the Reservation increases, it will become difficult to avoid impacts to aquatic resources including salmon and steelhead. Water quality in wells providing domestic water must be protected against groundwater pollutants deriving from septic tanks, pesticides, leaking underground fuel tanks and industrial wastes. Timber harvest activities if not adequately managed can contribute unacceptably large amounts of suspended sediment to streams, which can degrade habitat for salmon and steelhead.

Water Projects

The diversion of Trinity River is a major water development project that involves inter-basin transfers, from northern California to central valleys of California. The Project has resulted in an average annual diversion of approximately 1,000,000 acre feet of water - substantially more than the planned design diversion of approximately 900,000 acre feet, and about double the diversion originally proposed. Exported Trinity River water, which is routed through a series of hydroelectric power plants, is used for irrigation in the Sacramento and San Joaquin Valleys and also to help improve water quality in the Sacramento River and Delta. This diversion of up to 90% of the annual flow has contributed to drastic declines in the number of salmon and steelhead migrating through the Hoopa Valley Reservation. Both the subsistence and commercial fisheries of the Hoopa Valley Tribe have been impaired. Efforts to divert additional quantities of water are expected to continue despite the clear history of serious environmental consequences.

Water Systems

The existing water systems suffer from several basic inadequacies:

The east side of the reservation generally has adequate water supply in the winter and spring months, but falls short in the late summer and fall. The major surface source supplying the east side, Captain John Gulch, tends to have reduced flow rates or occasionally dry up in the summer and fall months due to its small watershed (less then two square miles). To compensate, untreated water is pumped into the system from the Mill Creek irrigation flume.

The west side of the reservation generally has year-round surface water, but high winter and springtime turbidities in Campbell Creek preclude operation of the water treatment plant during this period. Well water normally meets winter and spring demands, but there is insufficient capacity to satisfy summer demand with wells only.

In summary, maximum water demand during summer months occurs when availability of treated water is low. Overall, water storage volume and fire hydrant locations are inadequate to meet minimum fire protection standards and maintain protection of Tribal property.

In an effort to mitigate these inadequacies, Hoopa PUD has developed a valley wide drinking water source drawing upon water from the Trinity River. This state of the art facility was completed in 2005 under a grant from USEPA and should remedy the needs of drinking water for Hoopa. The current water systems will still be utilized, however they are mostly online for emergency backup at this point. The new water treatment facility will help the Hoopa Tribe provide the community safe drinking water for future generations.

Inorganic Chemicals

Most of the inorganic chemical analyses of soil and water on the Reservation have established baseline conditions of site-specific locations throughout the Reservation. The majority of this data has provided critical information in addressing serious water quality problems.

Surface water on the Reservation can be characterized as "soft", low in hardness and alkalinity. The water is slightly basic (pH 7.7-8.3) west of the Trinity River, reflecting the ultramafic nature of the underlying rocks, and more neutral (pH 7.5-8.0) east of the river, reflecting the metamorphosed sediments (Galice) and granitic geology. The groundwater is much more acidic than surface water. Campbell Field water has the lowest pH (6.2-6.6, one 7.4 measurement), while Soctish Field has groundwater that is nearly neutral.

Soctish Field groundwater is the hardest, but all the fields have groundwater ranging from low to high corrosiveness. Campbell Field water is the most corrosive; Soctish Field groundwater is the least corrosive. The basic characteristics of Reservation water that may help in understanding the degree of risk posed by inorganic constituents are listed in Tables 8.1 and 8.2 of the Tribe’s 305(b) Report.

Drinking Water

The inorganic chemicals most often associated with health and environmental concerns are heavy metals. The earliest chemical analysis of water on the Reservation emphasizing metals was conducted in 1973 (Winzler & Kelly, 1974). Concentrations of silver, cadmium, mercury and selenium in the Moon Lane well were over the 1991 maximum concentration level (MCL). Presence of copper and zinc in the Gibbs Gulch sample is expected in systems deriving their water from heavily mineralized areas. Other results were well below the MCL.

In 1981, the HVPUD community well ("New Well") in Agency Field and the new Campbell Creek intake (surface water) were tested for an extensive array of compounds. Low levels of zinc were detected in water from the west side of the valley. Based on a 1982 study, mercury exceeds the MCL in the Mill Creek source (Meskat Field), Soctish-Chenone system and BIA system (Agency Field). Two of the HVPUD wells (the Old and New PUD Wells), exceed the MCL for iron, and the Old Well exceeds the MCL for manganese based on a 1987 study.

The North Agency Field system, Campbell Field system, and Soctish-Chenone system were tested for a limited suite of analytes in 1982. These systems all draw water from catchment areas west of the Trinity River. All the catchment areas include ultramafic geology. The levels of sulfates in all three fields, although appearing high, are well below the MCL. Of greater concern is the very high concentration of iron reported for the Soctish-Chenone system, well above the 1991 MCL. The relatively high level of zinc at Campbell Field is significant.

As part of the Field Investigation Team (FIT) investigation of hazardous sites in the Hoopa Valley Reservation in 1982, water was sampled from five wells; the Shopping Center (Hostler Field), Moon Lane and Jackson Trucking wells (Campbell Field), and the Squire and Deep Sleep wells (Meskat Field). This was the first widespread investigation of groundwater quality in the valley. All five wells showed detectable levels of cadmium, lead and zinc, with levels of cadmium in four wells and levels of lead in all five wells at or above the 1991 MCLs for drinking water. These levels constitute a serious potential health hazard.

The results of the FIT investigation led to further analyses of Reservation water supplies. In 1982, two wells and three water distribution systems were tested. The results of retesting the Shopping Center and Moon Lane wells again showed lead at levels somewhat greater than the MCL. Cadmium and zinc concentrations were considerably lower than the MCL. Tests of the three distribution systems showed all analytes undetectable or at levels well below the MCL. The consistent high levels of lead in Shopping Center and Moon Lane wells suggest a serious health hazard exists.

A further round of testing of community water systems was conducted between 1983 and 1985, concentrated on the smaller "East Side" systems. While not surpassing the 1991 MCL, zinc concentrations in the East Valley Community system and the new Norton Field well were among the highest recorded in the valley.

The "Old" and "New" HVPUD wells located near the Masonite sawmill site and next to Mill Creek were tested in 1987. The high manganese levels indicate both wells are questionable as continued sources of public drinking water. Although these levels may be "background", and people have taken water from Mill Creek for years with no apparent deleterious effects, there is potential for cumulative effects.

The Squire well and an irrigation well in the Masonite Mill Creek mill site in Meskat Field were tested in 1989 for a suite of heavy metals and other inorganics. These analyses indicate no hazard related to the inorganic target chemicals in the Squire Well existed at that time. The irrigation well is questionable as a source of drinking water, due to high barium, iron and manganese content. The high iron content may be related to the well casing.

BENEFICIAL USES

2.0 BENEFICIAL USES

Essential to this plan is a designation of beneficial uses for the Reservation waters that are to be protected. Table 2.1 identifies beneficial uses for major water bodies on the Reservation. Equal protection will be afforded to existing, potential and historical uses of the Reservation waters. The Tribe adopted the WQCP in July of 1997; the WQCP standards and criteria have been adopted as a Tribal ordinance. Further, the beneficial uses of any specifically identified water body apply to all tributaries above the beneficial use area.

Virtually all activities for both consumptive and non-consumptive uses of the Reservation waters center on satisfaction of domestic, aquatic, industrial, irrigation, recreational and cultural needs. Additional quantities of water are expected to be required for all consumptive and non-consumptive uses over the next several years. Specifically, there has been a marked increase over the last several years in concern over some of the non-consumptive uses that water can serve, notably the growing importance given to the habitat for anadromous fish, principally Chinook salmon, Coho salmon and Steelhead trout. More interest is also being shown in the benefit of water-orientated recreational activities. Other non-consumptive beneficial uses of growing concern include cultural uses, wildlife habitat, esthetics, wild rivers, and special Native American fisheries.

Several Federal and California laws establish beneficial uses for waterways that apply to waters of the Reservation. First, with the passage in 1972 of the "California Wild and Scenic Rivers Act" (Senate Bill 107), certain river systems, including the Klamath and Trinity, were established as wild and scenic river systems. This act prioritizes the beneficial uses of waters for scenic, fisheries, wildlife, and recreational purposes. Secondly, according to the 1975 Klamath River Basin plan: "The special Indian fishing rights amount to a unique non-consumptive beneficial use within the basin." Since many Native American families living along the major streams depend on fishing as an important means of providing food for their families, this "non-consumptive" beneficial use is extremely pertinent to the Reservation waters. Finally, on December 19, 2000 the Secretary of the Interior signed the Record of Decision adopting the Trinity River Mainstem Fishery Restoration Final Environmental Impact Statement. This decision mandates an increase of 42% flows out of the dam, in order to restore and maintain the Trinity River anadromous fishery and habitat. Also this decision re-affirms the federal trust responsibility to assure a viable fishery from which the Hoopa and Yurok Tribes can exercise their federally reserved fishing rights.

2.1 Use Designation

For the purpose of this plan, the following designated uses for the waters of the Reservation have been established. Water bodies within the Reservation, which do not have uses designated for them innately, maintain beneficial uses for wildlife habitat and/or aquatic life habitats. These habitat designations in no way affect the presence or absence of other beneficial uses in these water bodies. Further classification will be based on the size of the water body and its historic and environmental significance. In addition, those water bodies, which are not assigned with a beneficial use, will be assessed in accordance with the biannual Clean Water Act 305(b) report as produced by the Water Quality Coordinator. The codes used in ***Table 2.1*** are as follows:

(A) Municipal and Domestic Supply (MUN) includes usual uses in community water systems and domestic uses from individual water supply systems.

(B) Agricultural Supply (AGR) includes crop, orchard and pasture irrigation, stock watering, support of vegetation for range grazing and all uses in support of farming and ranching operations.

(C) Industrial Service Supply (IND) includes uses that do not depend primarily on water quality such as mining, cooling water supply, hydraulic conveyance, gravel washing, and fire protection.

(D) Industrial Process Supply (PROC) includes process water supply and all uses related to the manufacturing of products.

(E) Groundwater Recharge (GWR) includes natural or artificial recharge for future extraction for beneficial uses.

(F) Hydropower Generation (POW) means used for hydropower generation.

(G) Cold Freshwater Habitat (COLD) includes uses of water that support cold water ecosystems including, but not limited to, preservation, or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

(H) Water Contact Recreation (REC-1) includes all recreational uses involving actual body contact with water, such as swimming, wading, water-skiing, skin-diving, surfing, sport fishing, uses in therapeutic spas and other uses where ingestion of water is reasonably possible.

(I) Non-Contact Water Recreation (REC-2) includes recreational uses which involve the presence of water but do not require contact with water, such as picnicking, sunbathing, hiking, beach combing, camping, pleasure boating, hunting, and aesthetic enjoyment.

(J) Preservation of Areas of Special Biological Significance (BIOL) includes aquatic and wildlife refuges, ecological reserves and designated areas of special biological significance.

(K) Wildlife Habitat (WILD) provides a water supply and vegetative habitat for the maintenance of wildlife.

(L) Preservation of Threatened and Endangered Species (T&E) provides an aquatic habitat necessary, at least in part, for the survival of certain species which are Federally and/or Tribally recognized as being threatened and/or endangered species.

(M) Fish Migration (MGR) provides a migration route and temporary aquatic environment for anadromous or other fish species.

(N) Fish Spawning (SPWN) provides a high quality aquatic habitat especially suitable for fish spawning.

(O) Ceremonial and Cultural Water Use (CUL) is defined as the traditional use of a river, stream, reach, or lake for cultural purposes by members of the Hoopa Valley Tribe; such uses involves immersion, provision of adequate flows for the Boat Dance ceremony, and suitable water-temperature for ensuring the presence and consumption of anadromous salmonids for ceremonial purposes.

(P) Wild and Scenic (W&S) provides for scenic, fisheries, wildlife and recreational purposes.

Table 2.1 *- Designated Uses of the Major Drainage on Hoopa Valley Indian Reservation*

	Inter								
Unit	State	MUN	AGR	IND	PROC	GWR	POW	COLD	REC-1
Mill Creek	X	E	E	P	H	E	P	E	E
Tish Tang	X	P	P	P	P	E	P	E	E
Pine Creek	X	P	P	N/A	N/A	E	P	E	E
Campbell Creek	X	E	E	P	P	E	H/P	E	E
Supply Creek	X	E	E	P	P	E	H/P	E	E
Trinity River	X	P	P	E	E	E	P	E	E
Klamath River	X	P	P	P	P	E	N/A	E	E
Soctish Creek		P	E	P	P	E	P	E	E
Hostler Creek		P	E	P	P	E	H/P	E	E
Hospital Creek		P	E	N/A	N/A	E	N/A	E	E
Captain John		E	E	N/A	N/A	E	N/A	E	E
Big Creek		P	P	N/A	N/A	E	P	E	E
Gibb Gulch		E	E	N/A	N/A	E	N/A	E	E
Hopkins	X	P	N/A	N/A	N/A	N/A	N/A	E	E

	Inter								
Unit	State	REC-2	BIOL	WILD	T&E	MGR	SPWN	CUL	W&S
Mill Creek	X	E	N/A	E	E	E	E	H	N/A
Tish Tang	X	E	N/A	E	E	E	E	H	N/A
Pine Creek	X	E	N/A	E	E	E	E	H	N/A
Campbell Creek	X	E	N/A	E	E	E	E	H	N/A
Supply Creek	X	E	N/A	E	E	E	E	H	N/A
Trinity River	X	E	N/A	E	E	E	E	E	E
Klamath River	X	E	N/A	E	E	E	E	H	E
Soctish Creek		E	N/A	E	E	E	E	H	N/A
Hostler Creek		E	N/A	E	E	E	E	H	N/A
Hospital Creek		E	N/A	E	H	H	H	H	N/A
Captain John		E	N/A	E	N/A	N/A	N/A	H	N/A
Big Creek		E	N/A	E	N/A	N/A	N/A	H	N/A
Gibb Gulch		E	N/A	E	N/A	H	H	H	N/A
Hopkins	X	E	N/A	E	H	E	E	H	N/A

The classification key for the beneficial uses is as follows:

P = Potential Use, E = Existing Use, H = Historical Use, N/A = Not Applicable

X = Waterbodies that extend beyond Reservation boundaries.

2.2 Beneficial Use Related Activities

Current activities on the Reservation including fisheries, mining, industrial, forestry, recreational and cultural activities play a key role in protecting beneficial uses of Reservation waters. These activities and their demand on Reservation waters must be balanced along with the need to supply domestic water and irrigation water throughout the Reservation.

Fisheries

The Trinity River fishery has been a cultural and subsistence mainstay of the Hupa people for thousands of years. The Tribe has and is harvesting from the Tribal allocation of in-river salmonids runs that are headed for the upper reaches of the watershed. The vast majorities of fish migrating through the Reservation do not spawn within the Reservation, but spawn further up in the basin

However, the Pacific salmon populations, which once flourished in the Klamath-Trinity River systems, have experienced a disastrous decline in recent decades. Poor land use practices degrading water quality, thus altering stream flows and degrading riparian resources have resulted in decreased fisheries migration and reproduction. This has certainly been the case of the Trinity River system.

While on-Reservation impacts due to silviculture, road building and water diversion occur, the magnitude of cumulative off-site impacts of these same activities is far greater. It is therefore appropriate to consider current and past land use and the associated cumulative effects on all watersheds of the Klamath and Trinity Rivers which flow through the Hoopa Valley Indian Reservation and the subsequent threat to federally protected and reserved fishing rights of the Tribe.

Impacts have certainly occurred to Reservation waters yet they are moderate when compared to the magnitude of flow diversion such as occurs on the Trinity River, at Lewiston Dam, or the Klamath River above Irongate Dam. The devastation that has occurred on private, federal and state lands in the Klamath-Trinity River watershed as a whole due to water diversions greatly exceeds impacts incurred as a result of activities within the Hoopa Valley Indian Reservation.

Aquatic Biological Resources

The aquatic biological resources of the Hoopa Valley Indian Reservation are located in the lower portion of the Klamath and Trinity watersheds. The Klamath River system, including its major tributary, the Trinity River is one of the largest river systems in northern California. The headwaters of the Klamath originate in western Oregon and flows southwesterly through the northern extreme of California to the Pacific Coast. The Trinity River flows westerly from the Trinity Alps of Northern California until it joins the Klamath at Weitchpec, about 50 miles from the mouth of the Klamath.

Environmental factors most critical to anadromous fish relate to the basic hydrological and geological characteristics of the river systems. Snowmelt in the higher elevations sustains high spring and early summer flows. The flows open many of the small tributaries to spawning that normally are dry or intermittent during the summer and fall months. The high flows and newly established habitat provide protection for eggs and newly hatched young from predators.

All salmon spawn soon after winter rains begin to swell the rivers and tributaries. Because of their large size and aggressiveness, salmon have out-competed other species for first use of the gravel spawning riffles. The salmon spawn quickly so their eggs develop and hatch before winter and spring floods. They spawn in loose gravel in streambeds that have been washed down through the watershed by continuous erosion of the mountains. The gravel beds provide protection from predators for eggs and newly hatched young, and provide a continuous supply of fresh oxygenated water necessary for development.

Logging, mining, road building, and water diversions currently threaten the Klamath-Trinity River watershed and their rehabilitation. Redwood groves in the Lower Klamath watershed, not within National and State Park boundaries, are threatened with clear-cut logging. Extensive logging still takes place on private, public, and Indian reservation lands. Although logging practices have greatly improved, changes in tributary watersheds cannot be expected without protection, restoration, and rehabilitation. Road building, especially that associated with logging and forestry practices is still the single greatest threat to increased erosion if appropriate restoration and mitigation measures are not taken.

In recent years, State and Federal resource agencies, under Congressional authorization, have begun a concerted effort to restore and rehabilitate the Klamath-Trinity watershed. The goal of restoring the Trinity River is to improve habitat for migratory fish. Watershed rehabilitation programs have begun under auspices of the Trinity River Basin Fish and Wildlife Management Program. U.S. Forest Service, Hoopa Valley Tribe, California Department of Fish and Game, Trinity County, Yurok Tribe, Bureau of Land Management and private businesses are conducting stream rehabilitation programs.

The Lower Klamath and Trinity Rivers within the Reservation are important migration routes and spawning, rearing, and feeding areas for many anadromous fish. The anadromous fish include:

Green sturgeon	*Acipenser medirostris*
White sturgeon	*Acipenser transmontanus*
Chinook salmon	*Oncorhynchus tshawytscha*
Coho salmon	*Oncorhynchus kisutch*
Steelhead/rainbow trout	*Oncorhynchus mykiss*
Cutthroat trout	*Oncorhynchus clarki*
Brown trout	*Salmo trutta*
American shad	*Alosa sapidissma*
Pacific lamprey eel	*Petromyzon*

Irrigation Water Supply

Irrigation waters are currently supplied through small diversions of several Reservation streams that connect to the Trinity River as well as some limited application through wells. Additional water is available through the HVPUD for the valley, however, limited water supplies during drought years lead to a shortage during late summer and autumn. There is potentially a net area of 2578 acres of irrigable land in the Hoopa Valley. Using a unit rate of application of 5.0 acre-feet of water per acre, a requirement of 12,900 acre feet annually would be created (U.C. Davis, Hoopa Valley Soil Survey, 1974).

However, any type of diversion of the available creeks would be susceptible to yearly sedimentation and scouring, resulting in high maintenance costs or a short project life. The Trinity River's potential for irrigation waters is limited only by the cost of pumping the waters from the river up to the fields as well as the amount of water released from the dam. In addition, while groundwater could supplement water supplies for irrigation, the supply is inadequate to supply all the needs of the valley for irrigation purposes.

Domestic Water Supply

The Hoopa Valley Trinity River Water Supply Project was completed in 2005 and consists of an infiltration gallery or Ranney collector, sedimentation basins, polymer application, dual media filtration and disinfection with chlorine all located on the Trinity River. The treatment plant includes a 175,000-gallon treated storage tank and a 25,000-gallon filter backwash tank. The Trinity River intake is located approximately 0.5 mile upstream from the State Route 96 Highway Bridge and the treatment pant is located near Hoopa's Wild Land Fire Suppression Facility at mile post (16.5) adjacent to the highway. This system serves the entire Hoopa Valley community current and future domestic water demands.

Where as in the past two separate community water systems served the Hoopa Valley community. According to the Hoopa Valley Public Utilities District, as of 1988, there were a total of 539 metered service connections, with about 280 connections on the east, and 259 on the west. Approximately 2,100 people are served by the water systems. The water systems have various surface and groundwater sources, with varying manners of treatment.

Overall, about 50 percent of the annual domestic water supply is gravity fed, and the remainder pumped. Storage tanks are located along the valley benches and are connected to the systems throughout the valley. The distribution system generally includes main water trunk lines extending the length of the valley on both sides of the river, with smaller lateral pipes and some main loops. Pressure booster pump stations and water storage tanks higher on the valley benches locally serve the upper portions of the valley. A separate small water system in the Telescope area on the west side serves 15 homes from a perennial spring.

The east side generally has adequate water supply in the winter and spring months, but falls short in the late summer and fall. The major sources, Captain John Gulch, tends to have reduced flow rates or occasionally dries up in the summer and fall months due to its small watershed (less than two square miles). To compensate, untreated water is pumped into the system from the Mill Creek irrigation flume.

The west side generally has year round surface water, but high winter and springtime turbidity levels in Campbell Creek preclude operation of the water treatment plant during this period. Well water normally meets winter and spring demands, but there is insufficient capacity to satisfy summer demand with wells only.

Sources and Treatment

This entire section was drafted prior to the completion of the Trinity River Water Treatment Facility in 2005 and is basically an overview of how things operated prior to it's construction. Now that the Trinity Rivers is online and there is a valley-wide source of drinking water throughout the year, then the rest of the following sources are utilized as backup to the Trinity Source. The following is an explanation of the sites as if the Trinity Site became non-operational.

The east side water system has three sources: Captain John Gulch; Shopping Center well; and Mill Creek Diversion.

Captain John Gulch is a small stream located at Matilton Field. Flow rate is highly variable, and during late summer and fall months flow rate may fall to a point where the intake and water treatment plant must be shut down. Raw water is gravity fed to filters via a combination of self-backwashing vertical sand filters, hyperchloride and fluoridation. No coagulation, pre-sedimentation or clarification processes are used prior to filtration. The design flow rate capacity of the filters is about 120 gallons per minute (gpm); actual operation ranges from about 40 gpm in the summer-fall months (when operating) to 80 gpm. This source supplies roughly one-third of the east side yearly demand volume. Chlorine contact time is obtained in a 20,000-gallon wood stave tank at the water treatment plant (WTP) site. Treated water is gravity fed from the tank into the distribution system.

The Shopping Center well is located in downtown Hoopa, on Hostler Field near the Tribal-owned shopping center. The well is fitted with gas chlorination and fluoridation equipment, and has a pumping capacity of about 80 gpm. It is used only during peak demand periods in the summer. Considerable corrosion of the well casing and piping has occurred due to the chlorine gas cylinders being located in the same room.

The Mill Creek diversion is a pumping station that draws raw surface water from an irrigation pipeline, which is gravity fed from an intake on the bank of Mill Creek. The irrigation system is operated only in the summer; each spring the intake is excavated and cleaned and the pipeline flushed by the Hoopa Valley Public Utilities District. The pumping station is used only in the summer during irrigation operation, for domestic high demand makeup water. Pumping capacity is about 130-150 gpm. The water is not treated. Hyperchloride equipment is installed at the pumping station.

There are three water systems on the west side. The principal system, known as the "west side system" serves the vast majority of customers, and extends the length of the valley.

The principal source for the west side system is Campbell Creek for most of the year. Campbell Creek provides treated water first to Campbell Field through the valley-long main water trunkline. Water is then supplied to the rest of the valley via the trunk line, which passes over Matilton Cut-Off Pass. This pass is much higher than the system water storage tanks. When the Campbell Creek water treatment plant is shut down, the system wells must provide a majority of the water supply for the west side.

1. Campbell Field system with Moon Lane well as its sole source.

2. Matilton Cut-Off homes (about four) are served by the Telescope spring tank overflow. During the winter-spring period, the spring flow rate can increase to 60 gpm, more than the average demand of the Telescope area. The overflow is diverted through the Campbell Water Treatment Plant (WTP) and tank, being chlorinated (and fluoridated) only. The tank feeds the valley-long water main, and the line is kept charged by closing an in-line valve at the bottom of Matilton Cut-Off at Agency Field. The main line is flushed periodically.

3. The rest of the system, which includes Agency, Chenone and Soctish Fields, is served by the Supply Creek well only. Within the primary west side system, Trinity River is the principle source, supplying roughly two-thirds of West Hoopa's yearly demand volume. Campbell Creek is a small stream in the southwest portion of the Reservation. It usually flows year-round. However, due to irrigation system demands and minimum allowable flow standards, water flow availability in the summer for domestic use can be inadequate. The intake is a small concrete diversion structure located approximately 1.3 miles up from the Trinity River. The watershed drainage area above the intake is small, approximately six square miles, and lies almost entirely on U.S. Forest Service land. From the intake, water flows by gravity to the water treatment plant via a water transmission line. Treatment includes an inline prescreen, two five-foot diameter pressure sand filters, gas chlorination and fluoridation. No coagulation, pre-sedimentation or clarification processes are in place prior to filtration. Design flow rate capacity of the filters is

> about 120 gpm. Turbidities are normally very low during the summer months. Chlorine contact time is obtained in a 100,000-gallon wood stave water storage tank at the water treatment plant (WTP) site. From the tank, the treated water is gravity fed into the west side system via the valley-long trunk line.

The second source is Moon Lane well, located in the Campbell Field tank and distribution system. It is operated only in the winter and spring when the Campbell WTP is shut down and sufficient groundwater volume is available. Well capacity is about 100 gpm. This water is not treated.

The third source for the primary west side system is the Supply Creek well located near the south bank of Supply Creek in Agency Field. This well is used primarily for backup when Campbell WTP is shut down, and for high summer demand makeup water. The water is gas chlorinated and fluoridated. Maximum well capacity is about 130 gpm.

A second water system on the west side of the valley is located in the upper Telescope area, serving about 15 homes. The Telescope area system is gravity fed from a spring development and has two small wood stave storage tanks (25,000 and 12,000 gallon capacities). No water treatment facilities are used, although occasionally the tanks are batch-chlorinated manually by the Hoopa Valley PUD.

A third water system that formerly served only the BIA compound is now tapped into the primary west side system. The well should not be in service until electrical installation and chlorination-fluoridation treatment systems are completed. The well will be operated for a period before integrated fully into the system. Water is currently untreated; existing pump capacity is approximately 600 gpm.

In general, maximum water demand during summer months occurs when availability of treated water is low. Overall water storage volume, distribution main lateral sizes, and fire hydrant locations are inadequate to meet minimum fire protection standards.

The alternative of using the Trinity River for a drinking water source was approved by a ballot referendum by the voters of the Hoopa Valley Tribe on April 24, 2001. The official result of the referendum was 385 for and 288 against considering the use of the Trinity River as a domestic water source. Funding for this endeavor has been obtained from the U.S. EPA and the Indian Health Service.

This alternative involves the construction of either an infiltration gallery or a Ranney-Type collector in the Trinity River and a treatment plant near the center of the urban zone of the Hoopa Valley community. The infiltration gallery would be constructed in a gravel bar or out in the main river channel to collect subsurface river water. The infiltration gallery would be constructed beneath the gravel and sediment of the river to provide less turbid raw water than that of a surface intake and to protect against damage to the intake during storm events. Both processes would require that a backwash system be designed to correct the likelihood of silt build-up in the intake system. Either process will allow for use of existing infrastructure such as electricity to power the pump station and treatment plant, easy access to existing water distribution mains, and easy access for operation and maintenance. For both options, a metal building approximately 40′ X 30′ in size will house the water treatment equipment. Either hypo- chloride or an on-site generator of hypo-chloride will be used to treat the raw water. Two storage tanks, one containing untreated water for back-washing the intake system, and one containing treated water that is released into the water line distribution system will be needed. Additionally, a diesel back-up generator with one-day fuel supply will be required in the event of power failure. No additional fuel reservoir provided by the electrical generator will be required. All backwash operations will involve the use of untreated water. As backwash operation takes place, this water is stored in a storage tank until sediments are settled, and the raw water is then re-circulated back into the intake pipe. When sediment levels reach a certain levels within the backwash tank, the material is pumped from the tank and deposited in an approved uplands site. Approximately 0.9 cfs will be withdrawn from the Trinity River for domestic consumption.

Mining

Gold, mercury, chromium, copper and other minerals have been mined within the Hoopa Valley Reservation or surrounding Six Rivers National Forest at one time or another since 1850 (see ***Figure 2.1*** for number and types of mines). Now abandoned, these mines have resulted in toxic heavy metals contaminated water runoff. This mine runoff can adversely affect beneficial uses. The biological impacts are unknown and are subject for further study.

In addition, sand and gravel extraction occurs on the Reservation. ***Table 2.3*** lists the site locations, maximum yield, and gravel renewability. The major potential problems relating to these operations are increased turbidity resulting from wash-off or discharge of tailings. This is compounded by the effect of sand and gravel extraction from the active channel, which can have significant biological impacts to spawning redds and juvenile nursery habitats.

Figure 2.1 *- Mining Locations on the Hoopa Valley Indian Reservation (Source: USGS)*

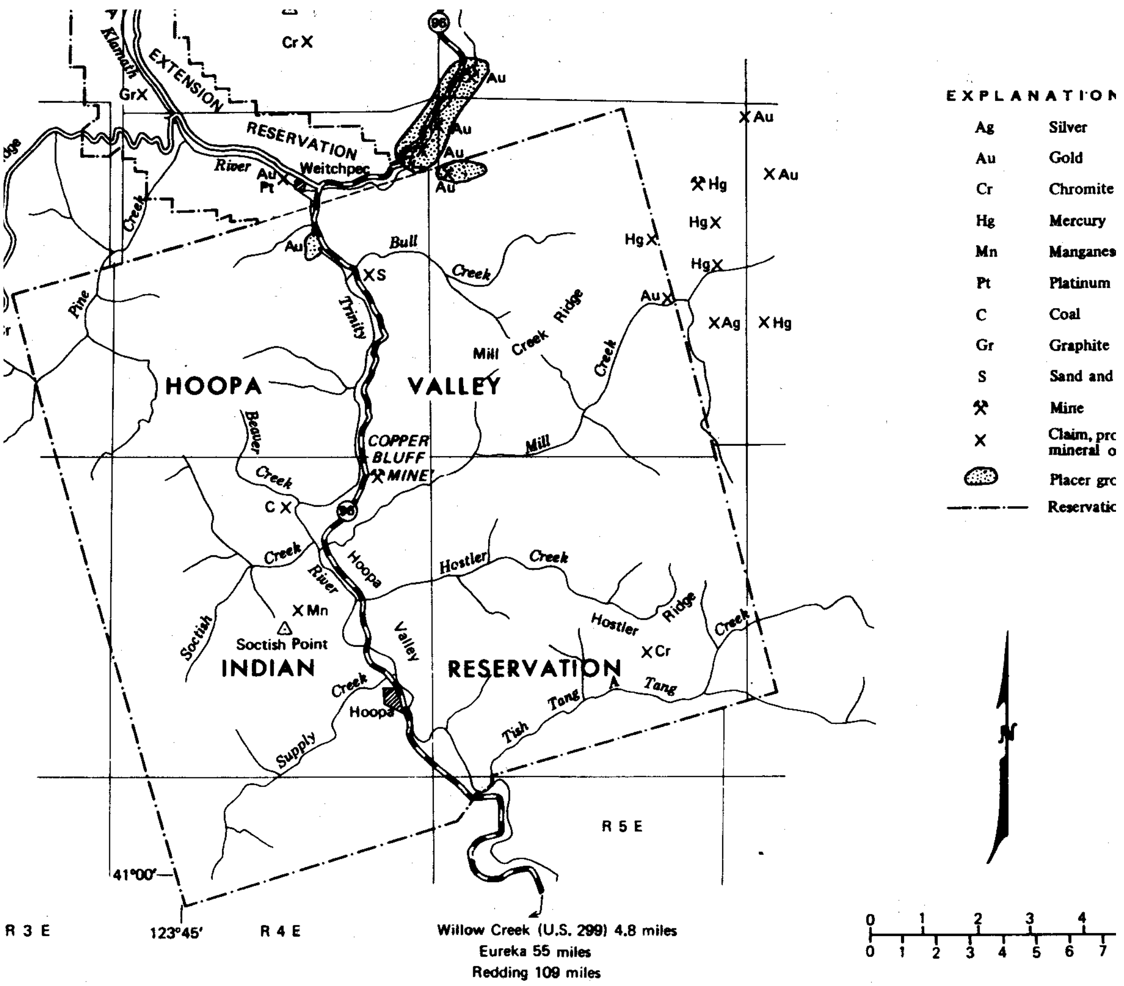


Table 2.2 - *Gravel Site Location, Maximum Yield, and Renewability (Lehre, 1993)*

Location	**Maximum Yield (yds^3)**	**Renewability**
Cal Pac Site, High Terraces		
North Terrace	200,000	Nonrenewable
South Terrace	420,000	Nonrenewable
Low Terrace/Floodplain	75,000	Limited redeposit
Low river bar	1,000	Renewable
Cal Pac Island	104,000	Partially renewed
Rowland-Security Bar	58,000	Renewable
North Agency Bar	5,000	Renewable
Sentry Bar	60,000	Renewable
Rodeo 1 Bar Complex		
Rodeo 1S	67,000	Renewable
Rodeo 1N	13,000	
Rodeo 2 Bar Complex		
Rodeo 2S	74,000	Renewable
Rodeo 2N	60,000	Renewable
Trinity		

Several river bars have been used as a source of aggregate for use in concrete for road and building construction. Removal of gravel from these areas at a faster rate than it is replenished can result in physical damage to river channel morphology. This damage can range from causing increasing channel incision or degradation, (removal or under supply of streambed material through erosion), bank erosion and reduction and elimination or siltation of gravel beds essential for spawning fish and other aquatic organisms. Removal of excess material and smoothing of channel may result in channel widening, which will allow for shallower flows and reduced velocities. This decreases the ability of the stream to transport sediments and results in a finer size distribution of bed material. Such an increase in finer materials could make the deposits unsuitable for fish spawning. It also increases potential for heat gain with detrimental effects on fishery habits especially for salmonids.

Aggregate Processing on the Reservation

Rock quarries also have the potential for delivering sediments into streams. Large boulders are excavated from upland slopes for use in riprap and are crushed for roadbed reinforcement. A total of 16 potential rock quarry sites have been identified throughout the Reservation. An environmental assessment will be completed for each site before any extraction activities are implemented.

Industrial Use

Industrial use of tribal surface waters is hampered by low to no flow conditions during drought years on some of the streams. It is possible that the surface supply could be supplemented by groundwater under such conditions. Based on known analysis of the surface and groundwater, the water would have to under go at least some treatment prior to most industrial uses. The use of agricultural chemicals in the area would also make the use of surface waters or water from shallow aquifers for any food processes questionable.

Forestry

The Hoopa Valley Reservation uses Best Management Practices (BMPs) within the Tribal forestlands. Logging roads and forestry practices are designed to minimize erosion, sediment loads and impacts on stream ecology.

Intensive forest management began on the HVIR in the mid to late 1940's. Until that time poor markets for Douglas fir coupled with the Reservations remote location inhibited development. In the decade 1946-1956 about 1,456 acres were harvested with a combination of clear cutting and selection techniques. Total harvest between 1957 and 1966 was 12,221 acres, between 1967-1976 13,593 acres, between 1977-1986, 7,057 acres and between 1987-1996 was 4,159 acres. By the late 1950's there were three sawmills on the Reservation and another four mills within 20 miles. Several natural disasters, including the floods of 1955 and 1964 resulted in substantial damage to the Hoopa forest and to the Tribe's road and stream systems. Cutting accelerated after the 1964 flood reaching a peak harvest of nearly 70 MMBF of timber on 2,938 acres in 1968, about 3.8% of the forested area. By 1999 about 39,500 acres of the 76,000 acres of forestland had been harvested, nearly all by clear-cut logging practices.

The BIA initiated Forest management in 1945 with the first timber sale. During the period between 1950 and 1980 BIA forest management practices were similar to private timber companies in the same time period. In the late 1970's however, the Tribal Council passed several resolutions prohibiting the spraying of herbicides as a result of the spraying of nearly 15,000 acres of previously cut lands in 1976 and 1977. By 1984 the Tribal Council had instituted a Tribal Forestry Department that provided input to the BIA on contemporary forest management practices, such as reducing the size of cut blocks, lowering the tractor logging limit to approximately 40% slopes, increasing soil protection practices, etc.

In 1990 the Tribe took over all forest management from the BIA. In 1994 the Tribe adopted, and the BIA approved a forest management plan that was widely regarded as state of the art within Indian country. The FMP has standards and guidelines for management of logging, silviculture, regeneration, wildlife habitat, prescribed fire and has obtained Smart Wood Certification. In addition, the FMP allocates all land to one of 27 land use zones. These zones have detailed standards and guidelines as to the management of the lands. Example of land use zones includes zones for the viewshed, riparian areas (about 20,000 acres), roads, geologically unstable areas, inaccessible areas, wilderness areas, etc. Many of the standards and guidelines contain measures to reduce water quality impacts including those dealing with tractor logging on steep slopes, water bar standards, over-story leave standards, etc. The road standards (H specifications) in particular contain numerous standards and guidelines including limitation on operations in wet weather, road gradient, culvert sizing, surfacing, road widths, drainage features, etc. The Tribe uses BMPs that are designed to minimize erosion, sediment loads and impacts on stream ecology.

Even though the FMP has detailed road standards and BMPs, the Tribe's road system is a major water quality concern. Most of the 635 miles of road on the Reservation (***Table 2.3***) were built for timber management purposes during periods where concern about water quality, fish habitat and watershed processes was not high. The majority of the road system was built in the early 1950's to the late 1960', with most of the system built after the 1964 flood. By 1999 the Reservations road system was composed of roads in the following condition:

Table 2.3 *- Road condition and road miles for the Hoopa Valley Indian Reservation (1999)*

HOOPA VALLEY TRIBE ROAD SYSTEM, 1999		
Type of road	**Miles**	**Percent of total**
Decommissioned log truck roads	35.2	5.55
Un-drivable log truck roads	158.8	29.49
Abandoned log truck roads	8.98	1.41
Subtotal Not Drivable	212.4	33.43
Paved, valley	15.63	2.46
Paved, highway 96	14.36	2.26
Arterial, gravel main log truck haul roads	127.77	20.11
Collector, dirt/gravel connecting log truck routes	156.44	24.62
Local, dirt log truck roads 2 or 4WD	108.95	17.15
Subtotal, drivable	423.15	66.60
Subtotal all roads	635.54	100.00

About half of the un-drivable and abandoned roads are closed due to brush re-growth with the remaining balance of road closures due to blown out culverts, landslides, gullies, etc. Research near the Reservation confirms that forest roads in Northwestern California deliver about 50 tons of sediment per year per mile of road to the Reservation's waters. Although watershed assessments have been completed in several of the main tributaries including Pine, Mill, Tish Tang and Supply Creeks, much of the balance of the Reservation has not been subject to a systematic analysis of which roads need to be decommissioned and those needing improvement. Of major concern is that about ½ of the Tribal road systems were built after the 1964 flood and have not been through a 100-year storm event.

The Tribal Council has considerable interest in timber harvesting activities on lands near to the Reservation. It has taken issue in several resolutions responding to USDA-Forest Service timber sales in the Trinity Summit area. This is an area that the Hoopa treat as sacred and claim as part of their aboriginal territory.

Recreation

Non-contact recreation has been increasing in popularity within the Hoopa Valley Reservation. Non-contact recreation includes boating, picnicking, sunbathing, hiking, camping, hunting and aesthetic enjoyment. Boating is popular on the Trinity River and non-existent or very limited on the smaller creeks. Boating activities range from powerboat racing to boat fishing to white water rafting. Hiking and camping activities are popular along several of the creeks still in a relatively pristine condition, such as Tish-Tang Creek and Captain John Gulch. In addition, camping is also common along some sections of the Trinity River and at the Tish-Tang Campground.

Contact recreation has also shown an increase in popularity. Contact recreation includes swimming, wading, water-skiing and sport fishing. Sport fishing is common in the area, but, the drought since 1985 and decreasing fish populations has placed limitations on sport fishing. Because of these dry conditions and the resulting reduced flows to the Trinity River, the Secretary of the Interior amended the Trinity River Restoration Act (1981) to provide increased flows to the Trinity River in 1991 and successive years, easing the problem slightly.

Swimming and wading are also popular along the Trinity River, and in some of the creeks, by visitors and tourists, but not among Tribal members. Tribal members, especially the children exhibit a distinct preference for using valley floor sections and mouths of major tributary streams for wading and swimming. Mill, Supply, Tish Tang, Hospital and Campbell Creeks are the high usage areas. While the high quality, water clarity and aesthetic beauty of these streams explain in part this preference; traditional cultural values are also a major factor. Tribal preference for certain creeks for swimming or wading can be traced to traditional and cultural beliefs. The Trinity River is sometimes viewed as inappropriate for swimming, or drinking, because it has traditionally been held as unclean by those same cultural beliefs.

Sun Shining Through the Trees in the Trinity Summit Area

Cultural

The waters of the Hoopa Valley have been culturally significant to the Indian population for thousands of years. Cultural significance includes ceremonial and traditional uses, and remains as a viable beneficial use to the Hoopa Valley Reservation today. The Boat Dance is an ancient religious ceremony that was timed to coincide with the natural flow regime of the Trinity River. The current flow regime produces flows different from the natural regime and thus makes the enactment of this ceremony impossible without a special request for altered flows from the USBOR. Every other year the Hoopa Tribe contacts USBOR to request an increase flows to at least 1,600 cfs for the enactment of this ceremony. On a bi-annual schedule, the Hoopa Tribe conducts ceremonies integral to the Hoopa's religion and culture. These ceremonies require sufficient flow in the mainstem of the Trinity River to facilitate the "Boat Dance" ceremony. This requirement is protected under the American Indian Religious Freedom Act (P.L. 95 – 341).

Water Quality Criteria

3.1. **INTRODUCTION**

In 1988, the U.S. Congress ratified and confirmed the Hoopa Valley Tribe's 1972 Constitution by Section 8 of Public Law 100-580. The Constitution established the Hoopa Valley Tribal Council as the governing body of the Tribe. Article IX of this section authorizes the Hoopa Valley Tribal Council to protect Tribal property, wildlife, and natural resources; Section 1 addresses the protocols to safeguard and promote the safety and general welfare of the Tribe and Reservation community. Pursuant to this directive, Title 37 (Pollutant Discharge Prohibition Ordinance of the Hoopa Valley Indian Reservation) establishes pollution control criteria to apply to all individuals within the Hoopa Valley Indian Reservation boundaries. As part of the Pollution Control Ordinance, the Hoopa Valley Tribal Council establishes the completion of water quality standards covering all surface waters on the Hoopa Indian Reservation. These standards shall provide a mechanism for managing and safeguarding the quality and use of all water bodies within the Hoopa Reservation boundaries by establishing water quality criteria, and providing a legal basis for regulatory controls.

The standards provided herein are established to restore, maintain and protect the chemical, physical, biological, and cultural integrity of the surface waters of the Hoopa Valley Reservation; to promote the health, social welfare, and economic well-being of the Hoopa Valley Tribe, its people, and all the residents of the Hoopa Valley Reservation; to achieve a level of water quality that provides for all potential uses; and to provide for full protection of threatened and endangered species.

These standards will provide designation of the existing and potential uses for the surface waters of the Hoopa Valley Tribe and water quality standards (narrative and numeric) to sustain the designated uses and protect existing water quality.

The water use and quality provisions set forth herein are established in conformance with present and potential water uses of the surface waters of the Hoopa Valley Indian Reservation and in consideration of the natural water quality potential and limitations of the same.

The Hoopa Valley Tribe recognizes that the Water Quality Control Plan does not contain all water quality pollutants; therefore, the Tribe shall use EPA Region IX Preliminary Remediation Goals (PRGs) guidelines (Appendix E) to evaluate risk contamination to soil and water bodies of the Reservation.

In addition, the Hoopa Valley Tribe has reviewed the California Toxics Rule (CTR) as promulgated by the U.S. Environmental Protection Agency (40 CFR Part §131.38) and has determined that for the purposes of consistency, the water quality criteria for priority pollutants in the CTR apply to waters of the Hoopa Valley Indian Reservation as outlined in Appendix F.

3.2 **DEFINITIONS**

Definitions pertaining to this chapter can be found in Appendix B.

3.3 **GENERAL CONDITIONS**

The water quality standards applicable to tribal waters are a combination of standards outlined in: the Clean Water Act as amended; North Coast Region Water Quality Control Plan; Oregon Administrative Rules Chapter 340, U. S. EPA Integrated Risk Information System (IRIS) and California Code of Regulations Title 22, U.S. EPA preliminary Remediation Goals and criteria objectives established in the California Toxics Rule.

The following conditions will apply to all water quality criteria and classifications set forth herein.

3.3.1 Any controllable factors are not allowed to degrade water quality of the Hoopa Valley Indian Reservation. In no cases may controllable water quality factors effect present and anticipated beneficial uses of water nor result in water quality less than that prescribed by the criteria contained in this document. When uncontrollable factors result in the degradation of water quality exceeding the limits set forth in this document, then controllable factors shall not contribute additional burden on the water quality. Controllable factors are those relating to the presence of human activity that may impact the quality of waters.

3.3.2. In circumstances where the natural conditions of surface waters are of lower quality than the criteria assigned, the Riparian Review Committee may determine that the natural conditions shall constitute the water quality criteria. If natural condition varies with time, the natural condition will be determined as the highest quality prevailing natural condition measured during an annual, seasonal, or shorter time period prior to influence of human-caused pollution. Natural conditions means conditions or circumstances affecting the physical, chemical, or biological integrity of a water of the HVIR that are not influences by past or present anthropogenic activities. Disturbances from wildfire, floods, earthquakes, volcanic or geothermal activity, wind, insect infestation, and diseased vegetation are considered natural conditions, except to the extent that they are exacerbated by anthropogenic activities. The Riparian Review Committee may, at its discretion, determine a natural condition for one or more seasonal or shorter time period to reflect variable ambient conditions. The Riparian Review Committee reviews and recommends changes to the WQCP.

3.3.3 The Federal Clean Water Act requires the governing entity to submit for approval to the Administrator of the U. S. Environmental Protection Agency (EPA) all new or revised water quality standards that are established for surface waters. These regulations also require the review of water quality standards at least every three years. These "Triennial Reviews" provide the opportunity to both evaluate the effectiveness of the current water quality criteria and to amend or revise water quality criteria. The Hoopa Valley Tribal Council may revise criteria on a Reservation-wide or waterbody-specific basis as needed to protect the beneficial uses and to increase the technical accuracy of the criteria being applied. The Riparian Review Committee shall formally adopt any revised criteria following public review and comment.

3.3.4. In no case shall discharge to surface waters result in a violation of standards for downstream water bodies. The water quality standards of this plan apply throughout a water body column. In situations where water bodies with differing standards mix at a confluence, no acute toxicity shall occur within mixing zones. The Riparian Review Committee shall determine where, at the confluence of water bodies, the differing standards apply. The Hoopa Valley Tribal Council may review this determination.

3.3.5. As part of the Reservation's continuing planning process, data will be collected and numerical water quality objectives will be developed for those constituents where sufficient information is presently not available for the establishment of such objectives.

3.3.6. As part of the Hoopa Valley Indian Tribes' continuing planning process, specific use designations of the water bodies within and flowing through the Hoopa Valley Indian Reservation (HVIR) are listed in section 2.1 of chapter 2. Specific use criteria for the designated uses are listed in section 3.5.1 of this chapter. The specific use designation and the specific use criteria contained within the Water Quality Control Plan has been implemented by the Hoopa Valley Tribe since 1997. The monitoring of the waterways listed below will be implemented during the next 10 years. The first waterway to be monitored will be the Trinity River. Any and all named tributaries that originate within the exterior boundaries of the HVIR or flow through the HVIR into the primary waterway, which is the Trinity River, are ranked for monitoring purposes as follows:

1. Tish Tang Creek
2. Supply Creek
3. Pine Creek
4. Mill Creek
5. Soctish Creek
6. Big Creek
7. Captain John Creek
8. Gibb Gulch
9. Campbell Creek
10. Hospital Creek
11. Klamath River
12. Hopkins Creek

Specific use criteria will be applied to the above listed tributaries as outlined in section 3.5.1 of this chapter. Appropriate water quality standards will be applied to the tributaries. As data concerning each tributary is analyzed by Hoopa Valley Tribal Environmental Protection Agency, the water quality standards may be revised with the recommendation of the Riparian Review Committee and Tribal Council consent. As the water quality data base development and monitoring allows for scientific analysis of the listed and prioritized waterways, the Specific Use Criteria may be modified in accordance with the Clean Water Act, section 303.

3.4 **NUMERIC CRITERIA**

3.4.1 TOXIC SUBSTANCES

A) Toxic substances shall not be introduced into waters within the boundaries of the Hoopa Valley Indian Reservation. Numeric criteria concentrations, which have the potential to either singularly or cumulatively adversely, affect beneficial water uses, cause acute or chronic toxicity to the most sensitive biota, or adversely affect public health. Additional criteria for toxins that cause adverse effects from bioaccumulation are listed in Appendix F.

B.) The Hoopa Valley Tribal Environmental Protection Agency (TEPA) shall employ or require chemical testing, acute and chronic toxicity testing, and biological assessments, as appropriate, to evaluate compliance with this section. Where necessary, TEPA shall establish controls to ensure that aquatic communities and the existing and characteristic beneficial uses of waters are being fully protected.

C.) Risk-based criteria for carcinogenic substances shall be applied such that the upper-bound excess cancer risk is less than or equal to one in 10^6, which means the probability of one excess cancer per million people exposed.

D.) Numeric and narrative criteria shall be applied to all surface waters of the Hoopa Valley Indian Reservation for the protection of aquatic life and human health. Selecting values for regulatory purposes will depend on the most sensitive beneficial use to be protected, and what level of protection is necessary for aquatic life and human health.

E.) Dioxins are known to be some of the most toxic manmade compounds known. Recent research has indicated that these compounds may be several orders of magnitude more toxic than was originally indicated (EPA 1985). Criteria established for such compounds are likely to be below the levels one could reasonably expect to be able to detect. No dioxin compounds will be discharged to any water within the Reservation boundaries.

F.) The pH of surface waters within the Trinity River shall be maintained at a level of **5.0 - 9.0** for (MUN) use designations and will be maintained at a level of 7.0 - 8.5 for all other beneficial uses. The pH in the Klamath River shall be maintained within 7.0 - 8.5 at all times.

G.) Ammonia: Because ammonia toxicity to fish is influenced by pH, waters designated for the purpose of protection of threatened and endangered fish species in cold freshwater habitat shall meet the following conditions for ammonia based on the pH in the waterbody:

i) The one-hour average concentration of total ammonia nitrogen (in mg N/L) does not exceed, more than once every three years on the average, the CMC (acute criterion) calculated using the following equation. Where salmonid fish are present:

$$\text{CMC} = \frac{0.275}{1 + 10^{7.204 - \text{pH}}} + \frac{39.0}{1 + 10^{\text{pH} - 7.204}}$$

Based on this equation, ammonia toxicity values for a given pH value are provided in the following table:

pH	**NH3 mg N/l**
4	38.98
5	38.76
6	36.72
7	24.10
8	5.62
9	0.88
10	0.34
11	0.28

Ammonia Toxicity Table for salmonids in fresh water at various expected pH levels.

ii) The thirty-day average concentration of total ammonia nitrogen (in mg N/L) does not exceed, more than once every three years on the average, the CCC (Chronic criterion) calculated using the following equation. When fish early life stages are present:

$$\text{CCC} = \left\{ \frac{0.0577}{1 + 10^{7.688 - \text{pH}}} + \frac{2.487}{1 + 10^{\text{pH} - 7.688}} \right\} \times \text{MIN}(2.85,\ 1.45 \times 10^{0.028 \times (25 - T)}$$

H.) Radioactivity: Radionuclides shall not be present in concentrations which are deleterious to human, plant, animal or aquatic life nor which result in the accumulation of radionuclides in the food chain to an extent which presents a hazard to human, plant, animal or indigenous aquatic life.

I.) Waters designated for use as domestic or municipal supply shall not contain concentrations of radionuclides in excess of the following:

Maximum Contaminant Level (drinking water standards based on drinking 2 liters of water/day).

Constituent	Level, pCi/l
Combined Radium-226 and Radium-228 (including Radium-226 but excluding Radon and Uranium)	5
Gross Alpha particle activity	15
Tritium	20,000
Strontium-90	8
Gross Beta particle activity	50

3.5 **SPECIFIC USES**

3.5.1 Specific Use Criteria: HVT implemented specific use attainability analysis in the development of temperature and turbidity criteria. The rest of the following water quality criteria were designated based on data and information provided in U.S. EPA Quality Criteria for Water 1986 (Gold Book).

A) Waters listed with the designated uses of Municipal and Domestic Supply (**MUN**), Cultural (**CUL**), Preservation of Threatened and Endangered Species (**T&E**), Preservation of Areas of Special Biological significance (**BIOL**), Cold Freshwater Habitat (**COLD**), Fish Spawning (**SPWN**), Wildlife habitat (**WILD**) and/or Contact Recreation (**REC-1**) shall meet the following criteria over the entire length of the stream including connecting tributaries within the jurisdiction of the HVT:

i. Bacteriological Criteria – Bacterial criteria for freshwater use a single value maximum, which shall not exceed the following for all waters on the Reservation listed with the designated uses from §3.5.1 (A):

	Geometric mean
Fecal enterococci	33 CFU/100 ml*
Escherichia coli	126 CFUs/100 ml*

- * CFUs – Coliform Forming Units

ii. Water Column Dissolved Oxygen – For the Trinity River and other Reservation Tributaries with the designated uses from §3.5.1 (A), the minimum level of dissolved oxygen shall not drop below **11.0 mg/l** in the water column. Klamath River D.O. criteria based on the designated use COLD (year-round), the 7-day moving average of the daily minimum D.O. in the water column shall not drop below **8.0 mg/L**, whereas SPWN (whenever spawning occurs, has occurred in the past or has potential to occur), the 7-day moving average of daily minimum D.O. in the water column shall not drop below **11.0 mg/L**. If dissolved oxygen standards are not achievable due to natural conditions, then the COLD and SPAWN standard shall instead be dissolved oxygen concentrations equivalent to 90% saturation under natural receiving water temperatures. If water quality monitoring indicates that dissolved oxygen levels are below the criteria listed, then an investigation of impact will be conducted.

iii. Inter-gravel Dissolved Oxygen - The inter-gravel dissolved oxygen on the Trinity River and other Reservation Tributaries with the designated uses from §3.5.1 (A), shall not be decreased below **8.0 mg/l** by any human related activity. Klamath River D.O. criteria that are based on the designated use SPWN (whenever spawning occurs, has occurred in the past or has potential to occur), where the 7-day moving average of the daily minimum D.O. in the inter-gravel water shall not drop below **8.0 mg/L**. If dissolved oxygen standards are not achievable due to natural conditions, then the COLD and SPAWN standard shall instead be dissolved oxygen concentrations equivalent to 90% saturation under natural receiving water temperatures.

iv. Periphyton - For the Klamath River only (Trinity River standards yet to be developed), the maximum annual periphyton biomass shall not exceed **150 mg chlorophyll *a*/m^2** of streambed area.

v. pH - The pH of surface waters within the Trinity River shall be maintained at a level of **5.0 – 9.0** for MUN use designations and will be maintained at a level of **7.0 – 8.5** for all other designated uses from §3.5.1 (A). The pH in the Klamath River shall be maintained within **7.0 - 8.5** at all times.

vi. Nutrients - For the Klamath River only (Trinity River standards yet to be developed), the mean nutrient concentrations in any 30-day period from May-October shall not exceed the values shown in ***Table 3.2***. There should be at least two samples per 30-day period. If total nitrogen and total phosphorus standards are not achievable due to natural conditions, then the standards shall instead be the natural conditions [1]/ for total nitrogen and total phosphorus.

Table 3.2 *– Klamath River Nutrient Criteria Standards.*

Parameter	**Standard**
Total Nitrogen (TN) (mg/L)	0.2 mg/L
Total Phosphorus (TP) (mg/L)	0.035 mg/L

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[1]/ Through consultation, the ongoing TMDL process for the Klamath River is expected to further define these natural conditions.

vii. Microcystins & Microcystis - For the Klamath River only (Trinity River standards yet to be developed), the Microcystis aeruginosa and microcystin criteria shall not exceed the values shown in ***Table 3.3***.

Table 3.3 - *Microcystis aeruginosa and microcystin criteria for the Klamath River on the HVIR.*

Parameter	**Standard**	**Rationale**
Microcystis aeruginosa cell density	<5,000 cells/mL for drinking water <40,000 cells/mL for recreational water	Combination of WHO and Oregon guidelines-- protect of public health
Microcystin toxin concentration	<1µg/L total microcystins for drinking water <8 µg/L total microcystins for recreational wa	Combination of WHO and Oregon guidelines-- protect of public health
Total potentially toxigenic blue-green algal species*	<100,000 cells/mL for recreational water	Oregon guidelines—protective of public health
Cyanobacterial scums	There shall be no presence of cyanobacterial scums	Protective of public health, see below

*Includes: *Anabaena, Microcystis, Planktothrix, Nostoc, Coelosphaerium, Anabaenopsis, Aphanizomenon, Gloeotrichia* and *Oscillatoria.*

viii. Turbidity – Turbidity Criteria for all Reservation waters has been withdrawn as they are still being evaluated and will be revised for inclusion in the next triennial review.

ix. Temperature - Tribal temperature objectives consist of two parts: 1) objectives that directly relate to the flows in the Trinity River, and 2) numeric temperature standards that deal with point and non-point source temperature management in the Trinity River. These objectives and standards agree with and support the Trinity River Flow Evaluation (TRFE) particularly with regard to the TRFE's flow regime and resultant temperatures. The Reservation Tributary Temperature standards were derived from a combination of literature review and Hoopa historical temperature data analysis to determine the biological requirements of the various salmonids life stages. We used the following literature resources and review sources to provide the basis of the proposed standards: The US EPA *Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards*, the California Regional Water Quality Control Board North Coast Region's *Biological Temperature Requirements of Salmonids by Life Stage*, TEPA laboratory temperature studies, and over nine years of Hoopa temperature data. The aim of the objectives/standards is to provide protection for the survival, growth, and reproduction of anadromous fish and other aquatic life, such that ceremonial and cultural values of the Tribe and other beneficial uses are maintained.

Trinity River Temperature Objectives

The Hoopa Valley Tribe's Trinity River temperature criteria (Table 3.1) are based on temperature-flow relationships that maintain TRFE flow regimes and protect adult salmonid holding and spawning. The approach of adopting the TRFE flow regime as an integral component of the temperature criteria recognizes the importance of temperature variation through the year to the life history stages and development of anadromous fish species. The Tribe's Trinity River temperature objectives were established by Tribal Environmental Protection Agency in cooperation with Tribal Fisheries, U.S. Fish & Wildlife Service, North Coast Regional Water Quality Control Board (NCRWQCB) and U.S. Environmental Protection Agency. In June of 1999, the Hoopa Valley Tribe and U.S. Fish and Wildlife Service published the TRFE. The TRFE represents the most thorough state-of-the-art scientific report on regulated flow releases and related actions designed to restore and maintain the riverine ecology of the upper mainstem Trinity River. Temperatures will be monitored based on water-year type as established in the TRFE by inflow into the Trinity River Reservoir each spring. The U.S. Bureau of Reclamation (USBOR) determines water-year type. The Hoopa Valley Tribe's temperature objectives agree precisely with those outlined in the TRFE preferred alternative and are consistent with temperature standards as specified in the NCRWQCB temperature standards for the Trinity River below Lewiston Dam and downstream to Douglas City and the confluence of the North Fork Trinity. The Tribe's temperature standards do not require additional flows over and above those required by TRFE. Temperatures recorded at Weitchpec will be utilized to determine compliance with the Trinity River standards. Therefore, continued evaluation of temperature information is needed to refine and revise temperature standards for the reservation over time. The Tribe recognizes that the development and implementation of control technologies and best management practices to reduce human caused warming are ongoing and the achievement of the optimal temperature standard will be an evolutionary process. The Hoopa Tribe will initiate Clean Water Act triennial review amendments, which are consistent with the Adaptive Environmental Assessment and Management (AEAM) principles, outlined in the TRFE as appropriate.

Table 3.4 Trinity River Temperature Criteria for the Hoopa Valley Indian Reservation.

Running 7-Day Average Temperature Not to Exceed					
Water-Year Type	**May 23 to June 4**	**June 5 to July 9**	**July 10 to September14**	**September 15 to October 31**	**November 1 to May 22**
Extremely Wet, Wet and Normal	≤ 59°F or 15.0°C	≤62.6°F or 17.0°C	≤ 72.0°F or 22.1°C	≤ 66.0°F or 19.0°C	≤ 55.4°F or 13.0°C
	May 23 to June 4	**June 5 to June 15**	**June 16 to September 14**	**September 15 to October 31**	**November 1 to May 22**
Dry and Critically Dry	≤ 62.6°F or 17.0°C	≤ 68°F or 20.0°C	≤ 74.0°F or 23.5 °C *	≤ 66.0°F or 19.0°C	≤ 59.0°F or 15.0°C

* For the seasonal period of June 16th through September 14th temperatures on the mainstem Trinity River at the Weitchpec gauging station were used to determine running seven-day averages.

Trinity River temperature standards have been established for the portion of the Trinity River that flows through the Hoopa Valley Indian Reservation and are adjusted according to the hydrologic conditions of the year. Temperature standards will be monitored at the Weitchpec temperature monitoring station operated and maintained by the U.S. Bureau of Reclamation.

Temperature standard violation(s) will be determined if > 10 % of seven-day running averages exceed the standard. The 10 % exceedance will be determined on the number of days exceeded for that seasonal period. For example, for the seasonal period of June 16th through September 14th (91 days), 10 % exceedance will equate to nine days. If temperature standards cannot be met due to unusually excessive ambient air temperatures coupled with TRFE level flows, enforcement action will not be pursued against USBR. Excessive air temperature will be determined if the measured 7-day average air temperature during the previous seven-day period of the year exceeds the 90th percentile of the seven-day average daily maximum air temperature calculated in a June 16th through September 14th series over the historic record available within the basin.

Point and Non-Point Temperature Objectives for Trinity River and Tributaries

Hoopa's temperature standards establish numeric criteria designed to protect beneficial uses and to provide a basis from which to initiate actions to control human-caused sources that adversely increase stream temperatures. Human-caused activities that affect surface water temperatures include, but are not limited to, discharge of heated water, widening streams, or reduction of stream shading, flows and depth. Natural surface water temperatures at times exceed the numeric criteria due to naturally high ambient air temperatures, naturally low stream flows, streamside shade, solar radiation, or other natural conditions. These exceedances are not considered water quality standard violations when the natural conditions themselves cause water temperatures to exceed the numeric criteria. In surface waters where both natural and human-caused factors are responsible for exceedances of the numeric criteria, each human-caused source will be responsible for controlling that portion of the increase caused by the human activity. This will be determined through the use of baseline data, when it exists, in conjunction with temperature monitoring upstream and down-stream of the human-caused source. The Tribal Forestry Department and Tribal Environmental Protection Agency will establish, implement, and improve forest management practices in order to reduce, achieve and maintain the surface water temperature criteria. Federal forest management agencies are required by the federal Clean Water Act to meet or exceed the substantive requirements of Tribe's non-point source program. The requirement for a surface water temperature management plan and the content of the plan will be appropriate to the contribution the permitted source makes to the temperature problem, the technologies and practices available to reduce thermal loads, and the potential for trading or mitigating thermal loads. These measures will apply to the portion of the Trinity River that flows through the Reservation to assure attainment of running 7-day average temperatures of 21°C during the July 10 – September 14 period. It is the goal of TEPA to achieve 21°C for this period within five years of adoption of these standards. If monitoring shows that temperatures continue to increase, HVT will employ adaptive management strategies until such time that the trend is toward lower temperatures. This management approach gives the Tribe a framework for improving temperature conditions in the lower Trinity while allowing the implementation of the TMDL process for the South Fork of Trinity to improve watershed conditions.

Reservation Tributary Criteria

Water temperature is a critical aspect of the freshwater habitat of anadromous salmonids and overall water quality of Reservation waters. Salmonids listed as threatened or endangered under the ESA and other coldwater salmonids need cold water to survive. Human-caused increases in river water temperatures have been identified as a factor in the decline of SA-listed salmonids in the Pacific Northwest. Adoption of Hoopa Tribal tributary temperature criteria can play an important role in helping to maintain and restore water temperatures to protect anadromous salmonids and to aid in the recovery of water quality on the Hoopa Reservation. For these reasons, the Hoopa Valley Tribe is proposing temperature criteria for Reservation tributaries to meet the biological requirements of salmonids during their various life stages.

According to the standards adopted for Trinity River Temperature above, separate criteria were adopted for the water year types, differentiating Dry and Critically Dry Years and Extremely Wet, Wet and Normal Years. ***Table 3.5*** shows the varying criteria for each life stage of salmonids for our Reservation tributaries. The proposed objectives apply when and where the given species and life stage time period exist, and when and where the species and life stage time period existed historically, and have the potential to exist again. Activities that result in an increase to water temperature must comply with the Tribal and Federal anti-degradation policies.

Table 3.5 – Reservation Tributary Temperature Criteria (MWAT) for the HVIR

Salmonid Life Stage	Timeframe	(*C)	(*F)
Dry and Critically Dry Years		**Tributaries**	
Adult Holding/Coho Incubation & Emergence/Spawning/Smoltification	May 23 to June 4	14.0	57.2
Adult Holding/Peak Temperatures Timeframe According to Hoopa Tribal Data	June 5 to July 9	17.0	62.6
Adult Holding	July 10 to September 14	20.0	68.0
Adult Holding/Spawning	September 15 to October 31	16.0	60.8
Adult Incubation & Emergence (Including Coho)/Smoltification/Spawning	November 1 to May 22	12.0	53.6
Extremely Wet, Wet, and Normal Years		**Tributaries**	
Adult Holding/Coho Incubation & Emergence/Spawning/Smoltification	May 23 to June 4	13.0	55.4
Adult Holding/Peak Temperatures Timeframe According to Hoopa Tribal Data	June 5 to July 9	16.0	60.8
Adult Holding	July 10 to September 14	18.0	64.4
Adult Holding/Spawning	September 15 to October 31	14.0	57.2
Adult Incubation & Emergence (Including Coho)/Smoltification/Spawning	November 1 to May 22	10.0	50.0
Adult Migration and Juvenile Rearing are considered All Year Life Stages			

The temperature listed in Table 3.5 are based on the maximum weekly average temperature (MWAT), which is defined as the highest 7-day moving average of equally spaced water temperature measurements for a given time period. In this application, the time period is the duration of the existing salmonid life stage. For the MWAT objective, the water temperatures in the stream may not exceed the numeric objective for every 7-day period during the given life stage.

> *The recommended metric for all of the temperature criteria is the maximum weekly average temperature (MWAT). This metric is recommended because it describes the maximum temperatures in a stream, but is not overly influenced by the maximum temperature of a single day. Thus, it reflects an average of maximum temperatures that fish are exposed to over a week-long period. Since this metric is oriented to daily maximum temperatures, it can be used to protect against acute effects, such as lethality and migration blockage conditions.*

We recognize that in some streams, the numeric objectives may not be achievable due to site specific limitations. In this case, the Hoopa Tribe may consider site specific objectives if the following conditions are met:

- The stream has been restored to its full site potential,
- The salmonid population is at a level consistent with NOAA Fisheries concept of a Viable Salmonid Population

De Minimis Temperature Increase Allowance

The Hoopa Tribal Reservation Tributary Temperature Criteria allows for a de minimis temperature increase above the numeric criteria or the natural background temperature. We choose to include a de minimis increase allowance as a way of accounting for monitoring measurement error and tolerating negligible human impacts.

If a particular tributary exceeds a temperature numeric criterion due to natural conditions (or natural conditions plus a de minimis human impact), then the waterbody need not be listed on the Tribe's 303(d) list. Such waterbodies would not be considered impaired because they would be meeting the narrative natural background provisions of the Hoopa Temperature Criteria. These tributaries should be identified as an attachment to the Tribe’s section 303(d) list submission to EPA along with the demonstration that these waters do not exceed the natural background provision.

For situations where waterbodies exceed the applicable numeric criteria due to a combination of apparent natural background conditions and known or suspected human impacts (above a de minimis impact level), it would be appropriate to list those waters on the 303(d) list because the waters would be exceeding the narrative natural background provision because of the human impacts. The TMDL process will provide the opportunity to distinguish the natural sources from the human caused sources.

3.6 NARRATIVE CRITERIA

3.6.1 Surface Waters: All surface waters of the reservation, including mixing zones, shall be free from substances attributable to human activity in accordance with the following:

3.6.1.1 Benthic Macroinvertebrate Populations: Site specific species composition shall not be degraded in both abundance and structure to a level that would threaten fish habitat conditions, water quality, and general watershed health. Bioassessment procedures for identifying macroinvertebrates in the laboratory and information analysis are set forth and standardized in the California Stream Bioassessment Procedure (CSBP) document. Biological monitoring maybe implemented to determine impacts on aquatic organisms from both point and non-point source pollution.

3.6.1.2 Biostimulatory Substances: Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.

3.6.1.3 Bottom Substrate: Suitable substrate particle size distributions shall be maintained to insure successful fish spawning as well as attachment of macroinvertebrates and algal components.

3.6.1.4 Color: Waters shall be free of unnatural coloration, which causes nuisance or impairs the designated beneficial uses.

3.6.1.5 Dioxins: Dioxins are known to be some of the most toxic manmade compounds known. Recent research has indicated that these compounds may be several orders of magnitude more toxic than was originally indicated (EPA 1985). Criteria established for such compounds are likely to be below the levels one could reasonably expect to be able to detect. No dioxin compounds will be discharged to any water within the reservation boundaries.

3.6.1.6 Floating Material: Waters shall not contain floating material, including solids, liquids, foams, and scum, in concentrations that cause nuisance or adversely affect beneficial uses.

3.6.1.7 Nitrate: Levels of Nitrates in waters with municipal or domestic supply use shall not exceed 10 mg/l. In other bodies of water the levels of nitrate shall not be increased by human related activity above the levels consistent with preservation of the specified beneficial uses.

3.6.1.8 Nitrite: Levels of nitrites shall not be increased, in any body of water, by human related activity above the levels consistent with preservation of the specified beneficial use corresponding to that water body.

3.6.1.9 Oil and Grease: Waters shall not contain oils, greases, waxes, or other materials in concentrations that result in a visible film or coating on the surface of the water or on objects in the water, that cause nuisance, or that otherwise adversely affect beneficial uses.

3.6.1.10 Pentachlorophenol: No discharge of pentachlophenol will be allowed to any water body within the boundaries of the reservation. Any existing point or non-point source causing increased levels of PCP shall be addressed as a noncompliance condition under the antidegredation plan.

3.6.1.11 Petroleum Hydrocarbons: No increase above background levels of petroleum hydrocarbons will be allowed due to human related activity in any water body within the reservation boundaries.

3.6.1.12 Pesticides: No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses. There shall be no bioaccumulation in pesticide concentrations found in bottom sediments or aquatic life.

Waters designated for use, as domestic or municipal supply shall not contain concentrations of pesticides in excess of the limiting conditions set forth in Appendix F. Any existing point or non-point source causing increased levels of pesticides shall be addressed as a noncompliance condition under the antidegredation plan.

3.6.1.13 Phosphates: In order to preserve the existing quality of water within the reservation boundaries from existing and to avoid potential eutrophication of phosphorous in any water body shall not be increased by human related activity above levels consistent with preservation of the specified beneficial uses.

3.6.1.14 Radioactivity: Radionuclides shall not be present in concentrations which are deleterious to human, plant, animal or aquatic life nor which result in the accumulation of radionuclides in the food web to an extent which presents a hazard to human, plant, animal or indigenous aquatic life.

3.6.1.15 Sediment: The suspended sediment load and suspended sediment discharge rate of waters shall not be altered in such a manner as to cause impairment or adversely affect beneficial uses.

3.6.1.16 Settable Material: Waters shall not contain substances in concentrations that result in deposition of material that causes nuisance or adversely affect beneficial uses.

3.6.1.17 Suspended Material: Waters shall not contain suspended material in concentrations that cause impairment or adversely affect beneficial uses.

3.6.1.18 Tastes and Odors: Waters shall not contain taste or odor producing substances in concentrations that impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin, or that cause nuisance or adversely affect beneficial uses.

3.6.1.19 Tetrachlorophenol: No discharge of tetrachlorophenol will be allowed to any water body within the boundaries of the reservation. Any existing point or non-point source causing increased levels of TCP shall be addressed as a non-compliant condition under the antidegredation plan.

3.6.1.20 Total Dissolved Solids: The total dissolved solids shall not exceed 100.0 mg/l unless specifically authorized by the Riparian Review Committee upon such conditions as it may deem necessary to carry out the general intent of this plan and to protect the beneficial uses specified in this document.

3.6.1.21 Toxicity: All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life. This objective applies regardless of whether the toxicity is caused by a single substance or the interactive effect of multiple substances. Compliance with this objective will be determined by analysis of indicator organisms, species diversity, population density, growth anomalies, biotoxicity tests of appropriate duration, or other methods as specified by the Riparian Review Committee.

i. The survival of aquatic life in surface waters subjected to a waste discharge, or other controllable pollution factors, shall not be less than that for the same water body in areas unaffected by the waste discharge. For other control water bodies the requirements for "experimental water" are described in Methods for Measuring Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, latest edition, and Short-Term Methods For Estimating The Chronic Toxicity of Effluents And Receiving Water To Freshwater Organisms, latest edition.

ii. Effluent limits based upon acute bioassay of effluent will be prescribed where appropriate. Additional numerical receiving water standards for specific toxicants will be established as sufficient data become available. Source control of toxic substances will be encouraged.

iii Waters designated for use as domestic or municipal supply shall not contain concentrations of toxic compounds in excess of the limiting concentrations set forth in Appendix F.

3.6.1.22 Other Chemical Constituents: Surface water used for domestic or municipal supply shall not contain concentrations of chemical constituents in excess of the limiting concentrations set forth in Appendix F.

Waters designated for use as agricultural supply shall not contain concentrations of chemical constituents in amounts that adversely affect such beneficial use.

3.6.2 Ground Waters

In general groundwater standards and criteria will be the same as those for surface waters. The designated uses specified for those waters derived from groundwater sources will dictate the specific standards that apply.

Groundwater shall not contain chemical constituents, toxicants, radionuclides, pesticides or substances which produce tastes or odors in concentrations that produce detrimental physiological responses in human, plant, animal or aquatic life associated with the beneficial uses.

Groundwater used for domestic or municipal supply shall not contain concentrations of contaminants in excess of the maximum contaminant limits set forth in EPA's Safe Drinking Water Act.

Additional groundwater protection is provided under Section 5., Wellhead Protection, of Ordinance No. 3-95 of the Hoopa Valley Tribe.

3.6.3 Wetlands

Determination of wetland jurisdiction and wetland delineation will be made in accordance with the protocols outlined in the *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* (Interagency Cooperative Publication, January 1989). The Riparian Review Committee or their respective department representatives will be responsible for wetland determination.

There shall be no net loss of wetlands on the Hoopa Valley Indian Reservation. This means that no activity shall convert a wetland to non-wetland status when a feasible alternative exists. If no feasible alternative exists, then a wetland of equal or greater size must be constructed or rehabilitated in another area (preferably within the same watershed) as mitigation.

When water is present at the surface or extracted from the subsurface in a wetland, the above criteria for surface and groundwater applies.

Vegetation removal within wetlands shall be avoided where a feasible alternative exists. If no feasible alternative exists, the wetland is to be replanted or expanded to mitigate for the area where vegetation has been removed.

Dumping waste of any kind is prohibited in wetlands. Dumping in wetlands will be considered a Class II Moderate violation.

3.7 ANTDEGRADATION POLICY

The Tribe has developed an antidegradation policy that is implemented through the Tribe's Forest Management Plan's Riparian Protection Guidelines and Pollutant Discharge Prohibition Ordinance. The Tribal Riparian Protection Guidelines and the Tribal minimum management requirements for domestic and non-domestic waters are hereby adopted as Best Management Practices to protect water quality. It is the intent of the Tribal Council, in adopting the WQCP, that the Forest Management Plan, the PDPO, Riparian Protection and Surface Mining Ordinance, and other Plans and Ordinances developed to improve the waters of the Reservation will be used as antidegradation policies. To the extent there is a conflict between a provision of the WQCP and a provision of another Tribal plan, ordinance, or policy, the more stringent provision shall apply. In the case of any conflict between either (1) the mixing zone provisions of this plan, or (2) the provisions of this plan, which states that, as a general rule, downstream standards apply to upstream tributaries when those standards are more protective.

3.7.1 The Tribe shall maintain and protect existing instream water uses and water quality so as not to degrade the subsequent instream uses for other purposes. In such cases where the designated uses of a given water body are impaired by water quality, there shall be no additional lowering of water quality with respect to the specific pollutant or pollutants which are causing or contributing to the impairment.

3.7.2 Where the quality of the waters exceeds levels necessary to support propagation of fish and wildlife and for recreation, that quality shall be maintained and protected. If however, the Tribe finds it necessary to allow a lower water quality in a specific water body to accommodate important economic or social development in the area in which the waters are located, the Tribe shall do so only after the Tribe's intra-governmental coordination provisions have been met. In allowing such degradation or lower water quality, the Tribe shall assure that water quality will protect existing uses. Further, the Tribe shall assure that the statutory and regulatory requirements for all new and existing point sources will be met. In addition, it's the objective of the Tribe that reasonable best management practices for non-point source control will be implemented.

3.7.3 The Tribal Council or designated agency may allow lower water quality on a temporary basis in order to respond to emergencies or to otherwise protect public health and welfare, but shall not allow degradation below the standards for any designated use as outlined in the WQCP.

3.7.4 In such cases where water uses justify outstanding resource designations, the designated water quality and uses shall be maintained and protected. Pollutants that will reduce the existing water quality shall not be allowed to enter such waters. To accomplish this the department may require water controls, maintenance of natural flow regimes, protection of in-stream habitats, and pursuit of land use practices protective of the watershed.

Outstanding resource waters are those, which meet one or more of the following criteria:

a) Outstanding national or Tribal resource; Waters in designated Tribal preserves and portions of the Trinity River which are recognized as Wild and Scenic;
b) Documented critical habitat for populations of threatened or endangered species and areas of cold-water refugia that provide exceptionally low summer temperatures relative to the needs of salmonid species.

c) Waters of exceptional recreational, ceremonial, cultural, or ecological significance;
d) Waters supporting priority species as determined by the Tribe.

3.7.5 In those cases where potential water quality impairments associated with thermal discharge are involved; the Antidegradation Policy and implementing methods shall be consistent with Section 316 of the Clean Water Act.

IMPLEMENTATION PLANS AND POLICIES

Implementation Plans

4.1 General Conditions

The requirements of the water quality standards set forth in this plan shall be met for all waters of the Reservation. No activity shall be permitted if that activity violates or causes the violation of these standards. All discharges from point sources, all instream activities, and all activities, which generate non-point source pollution, shall be conducted so as to comply with this plan and all other Federal and Tribal regulations. The Riparian Review Committee as established in Title 37, the Pollutant Discharge Prohibition Ordinance (PDPO), shall determine compliance.

All permits issued or reissued, and all activities undertaken by the Tribe, United States Environmental Protection Agency, Bureau of Indian Affairs, Indian Health Services, Army Corps of Engineers, Bureau of Reclamation, California Department of Forestry, United States Forest Service or any other government agencies or commissions shall be conditioned in such a manner as to authorize only activities that will not cause violations of this plan. Permits may be subject to review by the Riparian Review Committee after Tribal approval whenever it appears to the Riparian Review Committee that the activity has the potential to significantly impact water quality on the Reservation.

Best Management Practices shall be applied in combination or as individual practices as not to result in cumulative impacts, which violate water quality criteria. If a person is applying all Best Management Practices and a violation of water quality occurs, the person shall modify those existing practices or apply further water quality pollution control measures, as selected or approved by the Riparian Review Committee, to achieve compliance with water quality criteria. Best Management Practices established in permits, orders, rules or directives shall, be subject to Tribal Council approval, be reviewed and modified by the Riparian Review Committee, as appropriate, to achieve compliance with water quality standards.

4.2 Triennial Water Quality Assessment Plan

To fulfill the requirements of this plan, TEPA is primarily responsible for overseeing the Tribe's water quality monitoring, enforcement, and compliance programs, and the Tribe's point and non-point source permit review system. Most importantly, TEPA shall be responsible for conducting triennial assessments of the Tribe's Water Quality Control Plan for review by the Tribal Council and develop regulations to further the purposes of the PDPO.

TEPA triennial water quality assessment (WQA) of the Tribe’s WQCP identifies the water quality condition as good, fair, poor, impaired, or unknown. The data used to categorize water bodies in the WQA are obtained from the various monitoring programs described in the 1992 QA Manual (LACO Associates, 1992). The WQA serves many purposes. Most noticeably, the 305(b) report, also known as the National Water Quality Inventory Report, is a summary of all Reservation's water quality reports compiled for the USEPA. The report is updated biannually pursuant to Section 305(b) (1) of the CWA.

TEPA prepares the Reservation report using information taken from the WQA. The Reservation 305(b) Report includes: a) a description of the water quality of major waters in the Reservation during the preceding years; b) an analysis of the extent to which significant waters support designated beneficial uses; c) an analysis of the extent to which elimination of the discharge of pollutants has been achieved; d) an estimate of the environmental impact, the economic and social costs necessary to achieve the "no pollutant discharge" objective of the CWA, the economic and social benefits of such achievement, and the date of such achievement; and e) a description of the nature and extent of non-point sources of pollutants and recommendations as to the programs which must be taken to control them, with estimates of cost.

For the purpose of sampling water bodies for the assessment, TEPA has developed a water quality-monitoring program that incorporates the recent scientific findings and priorities of the Tribe.

In this program, sampling objectives remain, as stated in the 1992 QA Manual and the 1993 Supplement, "to provide information that can be used to determine the current quality of water within the Reservation and the extent to which it meets designated beneficial uses."

The information gathered under this program is for field analysis, to aid the determination of the water bodies' ability to support the specific beneficial uses. All analyses will take place in the field, in the TEPA Laboratory, or at a designated contract laboratory. All applicable sampling procedures as outlined in the 1992 QA Manual will be followed. Where previous data exists, the information will aid in any determination of trends for that water body.

4.3 Monitoring Plan

A program has been developed for the purpose of monitoring the Reservation waters. The Tribe's water quality monitoring program is based upon the beneficial uses assigned to each stream and the potential point and non-point source pollution, which can be attributed to the activities, which take place in each watershed. The purposes of the Tribe's water quality monitoring efforts are for the collection of data. The data collected has and will continue to be used in the development and implementation of the future water quality standards and other management programs. TEPA intends to expand the monitoring program to all of the previously listed waterways as funding and personnel become available.

The monitoring program has been separated into the priority stream, groundwater, and point source systems. The priority stream water quality-monitoring program is comprehensive in scope and is concerned with all factors and activities, which might affect water quality in streams. The priority streams on the Reservation are Mill Creek, Tish Tang Creek, Pine Creek, Campbell Creek, Hostler Creek, Soctish Creek, and Supply Creek. These streams have been determined to be of top priority for water quality monitoring and restoration as a result of the beneficial uses assigned to them (see, Table 1.4, pg 21, of the Non-Point Source Pollution Assessment).

4.4 Non-Point Source Management Program

4.4.1 Identification of Best Management Practices

Best Management Practices BMP's are those practices determined to be practical, acceptable to the public, and effective in preventing water pollution or reducing the amount of pollution generated by non-point sources. Best management practices include information and education programs, technical and financial assistance, technology transfer, demonstration projects, monitoring/evaluation systems, and regulation and enforcement. The Tribal Environmental Protection Agency and other departments within the Tribe will develop and present BMP's to the Tribal Council for approval in accordance with the Tribe's Legislative Procedures Act.

Reservation wide program objectives include current as well as proposed programs and identify activities, products, responsible agencies, and funding. Existing non-point source problem and current conditions were assessed in the Hoopa Valley Indian Reservation Water Quality Assessment. The Tribal Council is responsible for forest management activities, such as, surface mining, firewood cutting, fishing, grazing, herbicide use, wellhead protection, and road building, has approved BMP's. The following non-exhaustive lists of BMP's have been approved by the Tribal Council:

- Land Assignment and Lease Ordinance:
- Conservation /Trespass Act:
- Riparian Protection and Surface Mining Ordinance:
- Pollution Discharge Prohibition Ordinance:
- Fishing Ordinance:
- Land Use, Development Standards and Zoning Plan
- Closed Range Ordinance:
- Tribal Resolutions 81-80, 81-90, 81-91, 81-93, and 94-19 on the use of Pesticides:
- Forest Management Plan:
    - Riparian Management Practices:
    - Cumulative Effects Assessment Guidelines:
    - Guidelines for Geologically unstable (E-MEHR) /Inaccessible Lands
    - Firewood Policy and Permit:
    - Road Construction/Reconstruction H Specs:

4.4.2 Identification of Needed Implementation Programs

The following Tribal Ordinances, plans, and regulations shall be drafted and presented to The Tribal Council for adoption as Best Management Practices, and shall impose administrative responsibility and fiscal liability for monitoring, investigation, cleanup, and enforcement costs, together with damages for all resulting injuries to tribal natural resources:

- Water Quality Control Plan
- Wellhead Protection Plan
- Pesticide Control Ordinance
- Solid Waste Ordinance
- Solid Waste Management Plan
- Hazardous Waste Ordinance

- Emergency Operations Plan
- Underground Storage Tank Regulations
- Water Diversion Plan

The prioritization of the Tribe's non-point management program is as follows:

1. Inter-departmental cooperation shall support maintenance and improvement of water quality within the reservation.
2. Implement Best Management Practices for construction, mining, silviculture, grazing, agriculture, and other potential non-point source pollution areas.
    A. Monitoring Forest Management BMPs
        1. Contracts for Compliance
        2. Harvest techniques
        3. Stream above and below restoration projects
    B. Monitoring gravel mining BMPs
        1. Permit applications
        2. Extraction techniques
        3. Recontour extraction site
    C. Monitoring road construction BMPs
        1. Contracts for compliance
        2. Erosion prevention techniques
        3. Cumulative impacts
        4. Bioassessment monitoring of bentic macroinvertbrates
3. Train Tribal Environmental staff on hazardous materials handling, monitoring, and safety.
4. Upgrade the Tribal Environmental Laboratory to monitor non-point source pollution on the Reservation.
5. Implement a management plan to safeguard public water supply wells.
6. Implement a management plan to safeguard watersheds supplying public drinking water supplies.
7. Conduct a detailed survey of the abandoned mines, which flow into and through the Reservation.
8. Conduct a remedial site investigation of the Copper Bluff Mine.
9. Conduct a remedial site investigation of known and suspected contaminated soils and groundwater.
10. Finalize the remediation of the soil contaminated with petroleum hydrocarbons at Masonite Mill Creek.
11. Monitor the clean closure of the Supply Creek Landfill.
12. Locate and characterize septic tanks and leachfields throughout the valley.
13. Improve irrigation and domestic water diversion systems.
14. Initiation of restoration projects for the rehabilitation of the following non-point source problem areas
    - Wellhead protection from groundwater contamination
    - Watershed rehabilitation for surface erosion abatement
    - Stream restoration projects
    - Water Diversion Projects
    - Road rehabilitation projects
    - Mine restoration projects

- Agricultural runoff projects
- Construction runoff projects
- Urban runoff projects

4.4.3 Consistency of Programs with Tribal Non-point Source Requirements

The Tribe's Non-Point Source Management Program is consistent with the Tribe's goals and objectives. These goals and objectives have been ratified in the following Tribal Ordinance, Resolutions, Management Plans, Guidelines, and Best Management Practices:

Land Assignment and Lease Ordinance:
Conservation /Trespass Act:
Riparian Protection and Surface Mining Ordinance:
Pollution Discharge Prohibition Ordinance:
Solid Waste Ordinance:
Fishing Ordinance:
Closed Range Ordinance:
Tribal Resolutions: 81-80, 81-90, 81-91, 81-93, and 94-19.
Forest Management Plan:
    Riparian Management Practices:
    Cumulative Effects Assessment Guidelines:
    Guidelines for Geologically unstable (E-MEHR) /Inaccessible Lands
    Firewood Policy and Permit:
    Road Construction/Reconstruction H Specs:
    Guidelines for Reservation Wide Fuel Management and Prescribed Fire

4.4.4 Public Notice and Opportunity for Public Comment

The Hoopa Valley Tribe's Legislative Procedures Act (Title 6) sets forth a comprehensive and systematic process for the Tribal Council to establish, amend, or modify policies, ordinances and acts, or to take other major governmental actions on behalf of the Hoopa Tribe. The Tribe's Title 37 Pollution Discharge Prohibition Ordinance provides for coordination "with the off-reservation jurisdiction of the North Coast Regional Water Quality Control Board, State Water Quality Control Board, or the State of California or any of its agencies, with regard to matter herein regulated by the Tribal authority."

The public participation requirements are intended to foster public awareness and provide an opportunity to participate in open processes of governmental decision-making. TEPA seeks to implement public participation requirements by requesting the public's input, assimilating its viewpoints and preferences, and demonstrating that those viewpoints have been considered. In general, as specified in Tribal law, all legislation must comply with the Hoopa Valley Tribal Legislative Procedures Act.

Periodically, TEPA shall hold public hearings for the purpose of reviewing the water quality standards and, as appropriate, modifying standards for Tribal Council approval. TEPA will issue public notice of proposed changes and provide opportunity for public comment.

In the quality control planning process, a notice of the proposed action is published in area newspapers and distributed to a list of interested persons or organizations. All WQCP amendments must observe, as a minimum, the publication procedures notification in a newspaper of general circulation once, and three consecutive times when a prohibition of waste discharge is being considered.

Input from interested persons may be either through written correspondence, through public workshop sessions, or at the hearing. At the hearing all interested persons are given the opportunity to speak and respond to the material being considered, within reasonable limitations as determined by TEPA.

4.5 Pollution Prevention Plans

The Clean Water Act provides that storm water discharges associated with industrial activity from a point source (including discharges through a municipal separate storm sewer system) to waters of the United States are unlawful unless authorized by a Section 402 National Pollutant Discharge Elimination System (NPDES) permit. The terms "storm water discharge associated with industrial activity", "point source" and "waters of the United States" are critical to determining whether a facility is subject to this requirement. Section 402 requires permits for all discharges of storm water associated with industrial activity from construction sites that will result in the disturbance of one or more acres total land area.

Pollution Prevention Plans for construction projects over one acre must include the following:

1. Site description, including:
   - The type of construction activity
   - Intended sequence of major construction activities
   - The total area of the site
   - The area of the site that is expected to undergo disturbance
   - The runoff coefficient of the site before and after construction is complete
   - Existing soil and storm water data
   - A site map with:
     - Drainage patterns
     - Approximate slopes after major grading
     - Area of soil disturbance
     - Outline of areas which will not be disturbed
     - Location of major structural and non structural controls
     - Areas where stabilization practices are expected to occur
     - Surface waters
     - Storm water discharge locations
     - The name of the receiving water

2.0 A description of controls:

2.1 Erosion and sediment controls including:

- Stabilization practices for all areas disturbed by construction
- Structural practices for all drainage/discharge locations

2.2 Storm water management controls including:

- Measures used to control pollutants occurring in storm water discharges after construction activities are complete
- Velocity dissipation devices to provide non-erosive flow conditions from the discharge point along the length of any outflow channel

2.3 Other controls including:

- Waste disposal practices which prevent discharge of solid materials to waters of the Reservation
- Measures to minimize off-site tracking of sediments by construction vehicles
- Measures to ensure compliance with Federal and Tribal waste disposal, sanitary sewer, or septic system regulations

2.4 Description of the timing during the construction when measures will be implemented

- State or Local requirements incorporated into the plans
- Inspection and maintenance procedures for control measures identified in the plan
- Identification of allowable non-storm water discharges and pollution prevention measures
- Location and description of where all off-site excavation and disposal of spoils will occur
- Contractors certification
- Plan certification

All contractors and subcontractors identified in a storm water pollution prevention plan shall sign a copy of the following certification statement before conducting any professional service identified in the storm water pollution prevention plan:

I certify under penalty of law that I understand the terms and conditions of the general National Pollutant Discharge Elimination System (NPDES) permit that authorizes the storm water discharges associated with industrial activity from the construction site identified as part of this certification.

The certification must include the name and title of the person providing the signature; the name address and telephone number of the contracting firm; the address (or other identifying description) of the site; and the date the certification is made.

4.5.1 **Categorical Exclusions**

The Tribal Council in accordance with the Tribal Legislative Procedure Act (LPA) process, including an RRC review and public hearing may exclude categories of uses, activities or projects from requirements for one or more of the following reasons with USEPA approval:

(a) Naturally occurring pollution;
(b) Natural low-flow conditions;
(c) Irretrievable human-caused conditions;

(d) Substantial and widespread economic and social impacts.

Variances:
Variances to established water quality objectives will be reviewed in accordance with the LPA process and a public hearing by the RRC and forwarded, if amended or approved by the RRC, to the Tribal Council, only when the applicant satisfactorily demonstrates that:

(a) Water quality will not be permanently impaired,
(b) Public health will not be threatened,
(c) No significant adverse environmental effects will occur due to the limited size or scale of a proposed activity,
(d) A mitigation plan approved by RRC demonstrates that all discharges will be below established water quality standard as set forth in the Water Quality Control Plan before the expiration of the variance;
(e) The variance does not exceed one year from the date of issuance; and
(f) A 30-day public review period has passed with at least one public meeting.

4.6 Department of Public Safety and Emergency Services

The Department of Public Safety and Emergency Services shall enforce the provisions of this plan. Any Tribal Law Enforcement Officer, or any person officially appointed by the Hoopa Valley Tribal Council in consultation with the Director of the Department of Public Safety may issue the following for violations:

(A) Cease Orders or Citations: Upon determination that any person is discharging or causing to be discharged or is about to discharge into any Reservation waters, directly or indirectly, any pollutant which constitutes a violation of this plan, a Cease Order or Citations will be served.

(B) It shall be a civil offense, for which a fine of not less than $100.00 shall be assessed, to obstruct or otherwise interfere with investigative or other activities of any agent or officer of the Tribe carrying out this plan.

4.7 Tribal Court

The Hoopa Valley Tribal Court shall have jurisdiction of all cases and controversies arising under this plan, as provided for in Title 37, Section 3.4.

(A) Upon failure of any person to comply with provision of this plan, the Riparian Review Committee, by and through an attorney, may petition the Tribal Court for an injunction or other order requiring the person to comply herewith. In any such suit, the court shall have jurisdiction to grant a prohibitory or mandatory injunction, either preliminary or permanent, and to levy such fines as the facts may warrant and at a minimum to cover all clean-up and administrative costs;

(B) Any person who in violation of this plan discharges any pollutant into the waters of the Reservation shall be liable for all costs associated with or necessary to clean up, abate, or remove said pollutants from the waters of the Reservation and restore the quality of the waters of the Reservation to their condition as they existed immediately prior to the discharge.

Civil Penalty Schedule Matrix
In addition to any liability, duty, or other penalty provided by law, the Land Management Department Director, in accordance with Title 37 section 3.3, or the Tribal Court may assess a civil penalty for any violation of the tribal water quality standards.

Violation Matrix (Penalty per Day).

Class of Violation	**Major**	**Moderate**	**Minor**
Class I	$6,000	$3,000	$1,000
Class II	$2,000	$1,000	$500
Class III	$500	$250	$100

No civil penalty issued by the Director shall be less than $50.00 or more than $10,000 for each day of violation.

Class I Major violations:
1. Violation of a written Cease and Desist order from the Tribal Court or the Land Management Department Director.
2. Any discharge of a toxic waste that enters Tribal waters.
3. Any discharge of a waste that enters Tribal waters and results in a kill of fish or other aquatic animals.
4. Violation of a permit compliance requirement that causes major harm or poses a major risk to public health or to the environment.
5. Any violation related to water quality that causes major harm or poses a major risk to public health or to the environment.

Class I Moderate violations:
1. Any discharge of a waste that enters Tribal waters either without a waste discharge permit or from a point not authorized by a waste discharge permit.
2. Failure to comply with any statute, rule, or permit requirement regarding notification of a spill or upset which results in a non-permitted discharge to Tribal waters.
3. Violation of a permit compliance requirement that causes harm or poses a risk to public health or to the environment.

Class I Minor violations:
1. Operation of heavy equipment in the active channel.

Class II Major Violations:
1. Operation of a properly operating waste disposal system without first obtaining a permit.
2. Placing wastes such that the wastes are likely to enter Tribal waters by any means.

Class II Moderate violations:
1. Failure to submit a report or plan as required by any permit.
2. Failure to submit a pre-season monitoring report requiring cross-sections or other surveyed data on time.
3. Operating heavy equipment in an equipment exclusion zone.

Class II Minor violations
1. Any violation of water quality not otherwise classified.

Class III Major Violations:
1. Failure to submit a post-season monitoring report requiring cross-sections or other surveyed data on time.
2. Failures to submit a discharge monitoring report on time.
3. Exceeding waste discharge requirements of more than 20 percent by concentrations or of more than 10 percent by mass loading.
4. Violation of pH requirement by more than 0.5.

Class III Moderate violations:
1. Failures to submit a post-season monitoring report on time.
2. Exceeding waste discharge requirements of 20 percent or less by concentrations or of 10 percent or less by mass loading
3. Violation of pH requirement by less than 0.5 and more than 0.2

Class III Minor violations:
1. Failures to submit a complete discharge monitoring report on time.

4.8 Wellhead Protection Plan

For the purpose of this plan, wellhead protection zones were as established in the Pollutant Discharge Prohibition Ordinance (PDPO) consist of aquifers and/or groundwater recharge zones as with minimum zoning radii of 100 feet for groundwater extraction of 1,000 gallons per day (gpd); 200 feet for 5,000 gpd; 300 feet for 20,000 gpd; 400 feet for wells pumping 100,000 gpd or more. These wellhead protection areas are delineated on a map at a scale of 1 inch to 1,000 feet and are entitled "Wellhead Protection Overlays. This map is on file at the TEPA. In addition, the PDPO provides specifications regulating permitted activities within these wellhead protection areas.

Furthermore, as specified in the PDPO, if the location of the wellhead protection zone in relation to a suspected prohibited use is in doubt, resolution of boundary disputes shall be through the Hoopa Valley Land Management Department.

Disputants shall be afforded notice and an opportunity to be heard after prima facie showing by the Tribe as to the prohibited activities occurring in the wellhead protection zone, the burden of proof shall be upon the owner(s) of the land in question to show where the boundary should properly be located. At the request of the owner(s), the Hoopa Valley Tribe may engage a professional engineer (civil or sanitary), hydrologist, geologist, or surveyor to determine more accurately the boundaries of the wellhead protection zone with respect to individual parcels of land, and may charge the owner(s) for all or part of the cost of the investigation.

4.9 Policy on the Control of Water Quality with Respect to On-Site Waste Treatment and Disposal Practices

The following policy shall be implemented with respect to discharges from individual waste treatment and disposal systems. This policy sets forth uniform Reservation wide criteria and guidelines to protect water quality and to preclude health hazards and nuisance conditions arising from the subsurface discharges of waste from on-site waste treatment and disposal systems.

Site Evaluation Criteria and Methods

A. **Criteria:** The following site criteria are considered necessary for the protection of water quality and the prevention of health hazards and nuisance conditions arising from the on-site discharge of wastes. Waiver of individual criterion may be made in accordance with the "provisions of a waiver" contained in this policy.

1) Subsurface Disposal: On-site waste treatment and disposal systems shall be located, designed, constructed and operated in a manner to ensure that effluent does not surface at any time, and that percolation of effluent shall not adversely affect beneficial uses of waters of the Reservation.

2) Ground Slope and Stability: Natural ground slope in all areas to be used for effluent disposal shall not be greater than thirty (30) percent. Where less than five (5) feet of soil exists below the trench bottom ground slope shall not exceed twenty (20) percent. Natural ground slope criteria for mounds shall be as follows: for percolation rates of 3 to 60 minutes per inch the maximum allowable slope is twelve (12) percent and for percolation rates of 60 to 120 minutes per inch the maximum allowable slope is six (6) percent. In addition, steeper ground slopes may be allowed for experimental systems approved by the Riparian Review Committee and the Tribal Council. All soils to be utilized for effluent disposal shall be stable.

3) Soil Depth: Soil depth is measured vertically to the point where bedrock, hardpan, impermeable soils or saturated soils are encountered. Where ground slope is twenty (20) percent to thirty (30) percent minimum soil depth immediately below the bottom of the leaching trench shall be five (5) feet. Where ground slope is less than twenty (20) percent, a minimum soil depth of three feet immediately below the leaching trench shall be permitted. Lesser soil depths may be granted only as a waiver or for alternative systems.

4) Depth to Groundwater: Minimum depth to anticipated highest level of groundwater below the bottom of the leaching trench shall be determined according to soil texture and percolation rates as shown in Table 4.1.

5) Percolation Rates: Percolation test results in the effluent disposal area shall not be less than one inch per 60 minutes (60 MPI) for conventional leaching trenches and one inch per 30 minutes (30 MPI) for seepage pits. Percolation rates of less than one inch per 60 minutes (60 MPI) may be granted as a waiver or for Alternative Systems.

Table 4.1 *- Minimum Depth to Groundwater below Leaching Trench*

Soil Texture[1] **Percent Silt & Clay**	**Depth to Groundwater** **Below Leaching Trench (feet)**
5 OR LESS	**40**
6 TO 10	**20**
11 TO 15	**10**
Greater than 15[2]	**5**
Greater than 15	**2[3]**

1. Must exist for a minimum of three continuous feet below the bottom of the leaching trench and groundwater.

2. Or a percolation rate slower than 5 MPI

3. Granted only as a waiver or for Alternative Systems.

Setback Distances**:** Minimum setback distances for various features of individual waste treatment and disposal systems shall be as shown in **Table 4.2**.

Table 4.2 - *Minimum Setback Distances*

Facility	**Well**	**Perennially Flowing Stream[1]**	**Ephemeral Stream[2]**	**Cut Banks, Natural Bluffs and Sharp Changes in Slope**	**Unstable Land Forms**
Septic Tank	100	100	50	25	50
Leaching Field	100	100	50	25[3]	50
Seepage Pit	150	100	50	25[3]	50

1. As measured from the line, this defines the limit of ten (10) year frequency flood.

2. as measured from the edge of the watercourse.

3. Where soil depth or depth of groundwater below the leaching trench is less than five feet, a minimum set back distance of fifty (50) feet shall be required.

Replacement Area: An adequate replacement area equivalent to and separate from the initial effluent disposal area shall be identified at the time of site approval. Incompatible uses of the replacement area shall be prohibited.

B. Methods of Site Evaluation

Site evaluations are required in all instances to allow proper system design and to determine compliance with proceeding site suitability criteria prior to approving the use of on-site waste treatment and disposal systems. The Riparian Review Committee will be notified prior to conduct of site evaluations since verification by the Riparian Review Committee may be required. Site evaluation methods shall be in accordance with the following guidelines.

1) General Site Features: Site features to be determined by inspection shall include:
   - a. Land area available for primary disposal system and replacement area.
   - b. Ground slope soil type and soil depth in the effluent disposal and replacement area.
   - c. Location of cut banks, natural bluffs sharp changes in slope and unstable land forms within fifty feet of the disposal and replacement area.

    d. Location of wells, intercept drains, streams, and other bodies of water on the property in question and within 100 feet on adjacent properties.

2) Soil Profiles: Soil characteristics shall be evaluated by soil profile analysis. One backhoe excavation in the primary disposal field and one in the replacement area shall be required for this purpose. A third profile shall be required if the initial two profiles show dissimilar conditions. Augered test holes shall be an acceptable alternative, upon determination of the Riparian Review Committee: (a) where use of a backhoe is impractical because of access, (b) when necessary only to verify conditions expected on the basis of prior soil investigations, or (c) when done in connection with geologic investigations. Where this method is employed, three test holes in the primary disposal field and three in the replacement area shall be required. In evaluation of new subdivisions, an adequate number of soil profile excavations shall be made to identify a suitable disposal and replacement area on each proposed parcel. The following factors shall be observed and reported from ground surface to a depth of at least five feet below the proposed leachfield system:
    a. Thickness and coloring of soil layers and apparent United States Department of Agriculture classification.
    b. Depth to and type of bedrock, hardpan, or impermeable soil layer.
    c. Depth to observed groundwater.
    d. Depth to soil mottling.
    e. Other prominent soil features such as structure, gravel content, roots and porosity, water holding capacity, etc.

3) Depth to Groundwater Determinations: The anticipated highest level of groundwater shall be estimated:
    a. As the highest extent of soil mottling observed in the examination of soil profiles; or
    b. By direct observation of groundwater levels during wet weather conditions.

Where a conflict, in the above methods of examination exists, the direct observation shall govern. In those areas, which, because of parent materials, the soils lack the necessary iron compounds to exhibit mottling, direct observation during wet weather conditions shall be required. Guidance in defining such areas shall be provided by the Riparian Review Committee.

4) Soil Percolation Suitability: Determination of a site's suitability for percolation of effluent shall be either of the following methods:
    a. Percolation Testing

    Percolation testing shall be in accordance with methods specified by the Hoopa Valley Tribal Environmental Protection Agency and Hoopa Valley Public Utilities District, reviewed by the Riparian Review Committee and approved by the Tribal Council. Percolation testing of soils within Zone 3 and 4 shall be conducted during wet weather. Percolation testing of soils falling within Zone 1 and Zone 2 may be conducted in non-wet weather conditions provided presoaking of the test hole is accomplished with (a) a continuous 12 hour presoaking, or (b) a minimum of four complete refillings beginning during the day prior to the day the test is conducted.

b. Soil Analysis

Soil from the limiting soil layer observed within the excavated soil profile shall be obtained and analyzed for texture and bulk density according to methods prescribed by the Hoopa Valley Tribal Environmental Protection Agency, reviewed by the Riparian Review Committee and approved by the Tribal Council. The results shall be plotted on a soil texture triangle.

(1) Soils within Zone 1 shall be considered to have minimum filtration capabilities, requiring increased depths to groundwater.

(2) Soils within Zone 2 shall be considered suitable for effluent disposal without further testing.

(3) Soils within Zone 3 and 4 shall require percolation testing as per (a) above to verify suitability for effluent disposal.

(4) Wet Weather Criteria: Hoopa Valley Tribal Environmental Protection Agency (TEPA) shall determine Wet weather testing periods on a geographic base. The following criteria shall be followed:

a. Between January 1 and April 30; and

b. Following 10 inches of rain in a 30-day period or after one-half of the seasonal normal precipitation has fallen.

Extension of wet weather testing beyond the limits of above criteria may be made in accordance with a program of groundwater level monitoring approved by the Tribal Council and conducted by TEPA.

C. Provision for Waiver

Except for mounds, waiver of site suitability criteria and evaluation methods specified herein may be granted by the Riparian Review Committee, following Tribal approval, when it can be satisfactory demonstrated that water quality will not be impaired and public health will not be threatened as a result of such waivers.

Waivers may be granted for:

(1) Individual cases, or
(2) Defined geographical areas.

The TEPA shall notify the Tribal Council of the basis for each waiver and seek Tribal approval for each waiver. Prior to granting geographical area waivers, TEPA shall submit technical justification to the Riparian Review Committee for review and concurrence.

D. Waiver Prohibitions
Where surveys conducted by TEPA indicate that discharges from on-site waste treatment and disposal systems in specific geographical areas are resulting in or threatening to result in health hazards or water quality impairment, the Riparian Review Committee may prohibit the issuance of waivers in said areas. Exemptions to such prohibitions shall be granted by the Riparian Review Committee, after seeking Tribal approval, only where an authorized public agency can provide satisfactory assurance that individual systems will be appropriately designed, located, sized, shaped, constructed and maintained to provide adequate protection of beneficial uses of water and prevention of nuisance, pollution, and contamination.

4.10 Policy on the Regulation of Waste Discharges from Underground Petroleum Tank Systems

It shall be the policy of the Hoopa Valley Tribe to implement a program to investigate and cleanup groundwater pollution caused by the unauthorized releases of petroleum from underground tanks that protects water quality while at the same time minimizes the cost to responsible parties and the public in general. The following principles shall constitute the policy:

With respect to all underground petroleum tank cases in the Reservation, the highest priority will be to eliminate pollutant sources through tank removal, product removal, and removal of contaminated soil to the extent practicable. If required, the need for further remedial action will be based on impacts on the beneficial uses of affected waters as determined by reasonable monitoring or other investigation.

TEPA shall assign the highest priority to the resolution of underground petroleum tank cases where drinking water sources are being adversely impacted.

Where practical, TEPA will schedule the investigation and cleanup of petroleum pollution by responsible parties to coincide with the availability of funds.

Where practical, TEPA will recognize the use of alternative cleanup techniques such as in-situ bioremediation and passive remediation.

4.11 Underground Storage Tank Closure Procedures

General Information and Requirements

1. A complete application must be submitted to the Hoopa Valley Tribal Council or TEPA with appropriate fees at least ten (10) working days prior to closure activities. Incomplete applications will be returned.

   NOTE: All terms of the permit must be met prior to final approval. Permits are issued only to the owner or a duly authorized representative of the owner. Permits are non-transferable and non-refundable. The approved permit, with the exception of temporary closure, will expire within ninety- (90) days of approval, if the work authorized has not begun. The permit can be extended an additional ninety days, if requested in writing prior to expiration. The applicant must make the written request and a tentative closure date must be specified at that time. In the case where permits are allowed to expire without notification to the TEPA, the entire application process must be repeated (including payment of fees) before an authorized closure may begin.

2. Submit appropriate permit application fees.

3. Submit a site-specific safety plan for each tank closure application.

4. Notify the respective fire agency of the tank closure and follow any special requirements and/or restrictions that they impose.

5. Leak detection monitoring shall continue until actual tank closure. Each tank must have a valid operating permit or closure permit, issued by the TEPA.

6. TEPA staff shall inspect all closure activities. Notify TEPA a minimum of 48 hours prior to commencing work. Closure activities must not begin prior to permit approval unless authorized by TEPA, with the exception of emergency measures necessary to protect health, safety, and the environment. An approved permit must be obtained prior to scheduling an inspection.

7. All parts of the tank system(s) must be properly closed, but do not have to be closed in the same manner. The application/plan must indicate how all portions of the tank system(s), including piping, will be closed pursuant to applicable requirements.

8. The tank owner is responsible for proper closure and investigation of the underground storage tank(s). The owner or contractor shall ensure that proper procedures are followed and all necessary information is obtained and/or made available for inspection. A copy of the approved permit/plan shall be kept on site. Any changes made to the permit/plan must be approved by TEPA and shall be made known to the owner and to all persons performing the work.

9. The closure application and the laboratory chain-of-custody form must authorize the laboratory conducting the analysis to submit copies of the results directly to TEPA.

10. If field observation indicates and/or laboratory analysis confirms soil or groundwater contamination during the closure activities, an unauthorized release (leak) shall be reported to the US Environmental Protection Agency, Office of Underground Storage Tanks. Within 24 hours of discovery, the owner or operator shall report the release to TEPA, followed by a written report (unauthorized release report form) within five (5) working days.

11. Excavating small amounts of contaminated soil during the tank removal is permitted where determined appropriate by TEPA inspectors. Generally, ten (10) to twenty (20) cubic yards of soil per tank may be stockpiled on site in such a way as to prevent contamination of surface water, groundwater, and soil. Alternatively, soil may be removed for treatment and disposal at an approved off-site facility with prior approval from TEPA.

12. Receipts of manifest documents for the disposal of product, rinsate, tanks, and piping must be submitted to the TEPA within thirty days of closure activities. The State Contractors' License Law requires contractors installing or closing underground storage tanks to hold the Hazardous Waste Certification issued by the State Contractors' License Board and have either General Engineering - A classification or General Engineering - B license classification.

    A copy of the contractors' license, Hazardous Waste Certification, Workers' Compensation Certificate, and evidence of appropriate health and safety training must be on file with TEPA.

13. Persons authorized to sign the permit application include:

    a) A contractor who meets the requirements specified in 12 above.
    b) An owner who possesses a current Certificate of Workers' Compensation Insurance.
    c) An owner who is exempt from the Licensing Law and certifies, in the performance of the permitted work, no person shall be employed in any manner so as to become subject to the Workers' Compensation Law.

UST Closure Requirements - Planning and Pre-closure

1. Specify the type of tank closure (i.e., removal, in-place closure, or temporary closure) and reason for closure of each tank.

2. Provide the facility name, site address, phone number, the owner of the facility, the operator of the facility, and the contractor responsible for the proposed permit application activity.

3. Provide a description of each tank (i.e., capacity in gallons, age, contents, date last operated, and whether any product remains inside). Describe any site history and any investigation activities that may have been conducted in the past (e.g., monitoring wells and their results).

4. Submit a site plot plan, drawn to scale on 8½" X 11" paper, including the following:

    a) Draw plan to scale (e.g., 1"=10', 1"=20', 1"=40', etc.).
    b) North arrow.
    c) Street address and property boundaries.
    d) Location of tank(s), all associated piping, and dispensers, Remaining tank(s), underground and overhead utilities, wells, drainage courses, and other obstacles.
    e) Overburden-excavated soil cover area, placed on and covered by 10 mil minimum or equivalent high-density polyethylene.
    f) Sample locations with numbers and sample analysis table for anticipated sampling.

5. Provide a one-time EPA Generator's number along with the facility name. The owner may obtain a one-time hazardous waste generator number. The owner must contact the Department of Toxic Substances Control at (916) 324-1781. The contractor or consultant may obtain the number for the owner by sending a fax to the Manifest Unit, at (916) 327-4495. Include name, license, firm, address, phone, and fax of the representative, and the name and site for which the number is being requested.

6. All liquid must be removed from the tank system. If the liquid is classified as a waste, then the California Highway Patrol must license the hauler, and a Uniform Hazardous Waste Manifest must be completed. A copy of the manifest shall be submitted to TEPA within thirty - (30) days.

   The tank and the associated piping are considered hazardous waste unless rendered clean. If these items are cleaned, then the resulting rinsate is considered hazardous, unless proven otherwise by sampling.

   If the remaining liquid is to be removed as usable product, then all California Department of Transportation regulations must be met. Documentation of proper rinsate disposal, tank and piping disposal, or reuse, is required to be submitted to TEPA within thirty (30) days of tank excavation. Disposal or reuse information for the tank and piping shall include the name and address of the recipient and the final disposal/reuse location of the tank and piping.

7. Soil/water sampling must be performed for permanent tank closure. The applicant must authorize the laboratory or consultant to release any and all analytical results to TEPA within thirty days. For approval of the closure work, the following documentation shall be submitted to TEPA within thirty (30) days of tank removal:

   a) Laboratory analysis results and chain of custody record directly from the lab.
   b) Copies of hazardous waste manifests.
   c) Disposal documentation for cleaned tank(s) and piping.

UST Closure Option I - Tank Removal

1. Indicate how each tank and its associated piping will be handled and finally disposed.

   NOTE: Tanks and associated piping previously containing gasoline or diesel fuel must be free of product. Any loose scale, residue, and sludge must be inserted into the tank before removal from the ground or transportation off-site. All underground storage tank system components shall be transported and disposed of as hazardous waste. No portion of any underground storage tank system may be reused for other than compatible hazardous materials storage unless certified as being rendered non-hazardous by a California Department of Toxic Substances Control permitted Hazardous Waste Treatment Facility.

2. The excavation site shall be adequately secured to prevent entry by unauthorized persons. This may be by total enclosure with a secured, locked six-foot high chain-link fence or its equivalent.

3. Soil excavated from the tank and piping shall be placed on an impervious surface (20 mil polyethylene, or equivalent). The contractor shall attempt to segregate obviously contaminated soil and keep asphalt and concrete paving separate. Contaminated wet soils shall not be removed from the excavation or be handled in a manner that will cause surface contamination.

4. All associated piping (remote fill pipes, product, vapor recovery, and vent piping) shall be removed and disposed of unless removal will damage structures, or other pipes in use and are in a common trench. All piping to be removed must be exposed and inspected for deterioration and signs of contamination. Piping closed in-place must meet the requirements of In-Place Tank Closure of this policy. Product and vent lines shall be drained into the tank and disconnected from the tank in a manner allowing tank openings to be sealed. Care must be taken to prevent product spillage.

5. Tanks previously containing flammable liquids shall be made inert by using a minimum of 20 pounds of dry ice per 1,000 gallons of tank volume for a sufficient time prior to removal. The tank removal shall not proceed until the tank atmosphere show 6% or less oxygen by volume, or 10% or less of the lower explosive limit (LEL). The contractor/applicant shall provide portable instrumentation to verify that these conditions are obtained. Tanks must be transported under these conditions and in most cases must be transported on the same day.

6. The exterior of the tank(s) must be free of soil and debris, and inspected for signs of leakage/failure before loading onto the truck for transport.

7. Sampling is required for closure of a tank system or any portion of the entire tank system. Soil and water samples must be obtained and submitted for laboratory analysis. All soil and water samples shall be taken using appropriate sampling equipment and protocol. Samples shall have a chain of custody form and shall be immediately stored under refrigeration at 34° F. or below (an ice chest may be used if samples are to be transported to the laboratory immediately).

8. The tank excavation may be purged of water and allowed to refill before sampling. If the excavation is pumped dry and water does not return within twenty-four (24) hours, then the source may be considered not to be groundwater. The purged water must be stored, sampled, and disposed of properly.

9. If excavation reveals a previously unknown tank or any portions of a tank system, including piping, then operations may be stopped until the permit is modified and adequate information is obtained to ensure safe and proper removal.

UST Closure Option II - In-Place Closure

Underground storage tanks and/or associated piping may be closed in-place. An investigation to determine the presence of an unauthorized release from the system is required. Closure in-place should only be considered for tanks/piping that, if removed, would damage a structure such as a building foundation or when other piping is in use in a common trench. Closure by this method requires a more extensive soil and groundwater investigation.

1. The application must include a workplan prepared by a California registered geologist or engineer experienced in soil and groundwater investigations. The workplan must propose an investigation of the tank site for the presence of an unauthorized release.

   The workplan will be reviewed and a decision will be rendered on how to proceed with the closure. If closure by removal is determined appropriate based on the findings, then the permit application can be amended and a closure by removal can proceed. If closure in-place is appropriate, then the closure can proceed.

2. All residual products shall be removed and the tank/piping cleaned. Provide information to TEPA on the company cleaning the tank and hauling the rinsate including their Department of Health Services Hazardous Waste Hauler's License number.

3. These requirements do not apply to those underground storage tanks in which hazardous substances remain even though the hazardous substances are not in use. In these cases, the applicable containment and monitoring requirements of the operating permit shall continue to apply.

4. Underground storage tank systems that have emitted an unauthorized release do not qualify for temporary closure until the tank owner demonstrates to TEPA that appropriate authorized repairs have been made which would make the tank capable of storing hazardous substances in accordance with the conditions of an operating permit issued by TEPA.

5. All residual liquid, solids, or sludge shall be removed and hauled by an environmentally accredited hazardous waste hauler. Indicate the name and license number, if applicable, of the company removing and hauling the tank contents.

6. If the underground storage tank contained a hazardous substance that could produce flammable vapors as standard temperature and pressure, then the tank shall be made inert, as often as necessary to levels that will preclude an explosion or to such lower vapor levels as required by the local fire agency. Tanks may be triple-rinsed to lower vapor levels. Indicate the name and hazardous waste hauler number of the company hauling the rinsate.

7. All fill, access locations, and piping (except required vent piping) shall be sealed with locking caps or concrete. Electric service to the pumps serving the tank shall be disconnected, unless the pump serves another tank in use and/or an impressed current cathodic protection system.

8. Monitoring requirements for the temporarily closed tank may be modified or eliminated by TEPA during the period of closure. Generally, monthly or quarterly tank gauging will be required at a minimum.

9. The temporarily closed tank(s) shall be inspected at least once every three months to ensure that temporary closure measures are still in place and to monitor the tank(s). Records of inspections shall be kept and submitted at the end of the temporary closure period. An inspection plan shall be submitted with the application that includes the following:

   a) Name and phone number of the company/person performing the inspections.
   b) Schedule for site inspections.
   c) Description of the inspection procedure or observations to be made.

10. If inspection reveals the intrusion of water or any other sign of an unauthorized release, then TEPA shall be notified within twenty-four (24) hours. Permanent closure by removal may then be required.

    The owner may terminate the temporary closure and reuse the underground storage tank system(s) only if they will be upgraded to the latest standards.

4.12 Groundwater Resource Protection

The groundwater resources of the Hoopa Valley are located in a series of isolated fields. Groundwater resources in the individual field are very vulnerable and highly susceptible to contamination. Open pit mining on or adjacent to any field places the quality of the groundwater resources of that field at risk and is therefore prohibited.

TRIENNIAL REVIEW AND AMENDMENT PROCESS

Triennial Review and Amendment Process

The Pollutant Discharge Prohibition Ordinance and the Clean Water Act (Section 303(c)(1)) require periodic review of the Water Quality Control Plan (WQCP) to keep pace with changes in regulations, new technologies, policies, and physical changes within the Reservation. The Riparian Review Committee will be responsible for this review, which is to be conducted triennially, and is required to 1) identify those portions of the WQCP which are in need of modification or new additions; 2) adopt new standards as appropriate; and 3) recognize the portions of the WQCP which are appropriate as written. The review includes a public hearing process to allow the public to raise issues for the Riparian Review Committee to consider for incorporation into the WQCP.

After the triennial review has concluded, the Riparian Review Committee shall present the Tribal Council 1) a summary of those sections of the WQCP which the Riparian Review Committee has determined to be appropriate and up to date, and 2) sets forth a prioritized list of issues (priority list), to be adopted by the Tribal Council, which the Riparian Review Committee has determined are necessary for further evaluation and potential development into a WQCP revision.

The triennial review priority list directs the planning efforts concerning water quality for the Hoopa Valley Tribal Environmental Protection Agency until the next triennial review. As budget and staffing allows, and starting from the top of the list, the Hoopa Valley Tribal Environmental Protection Agency considers each of the issues identified on the priority list for potential WQCP revisions. The Hoopa Valley Tribal Environmental Protection Agency may also initiate the WQCP revisions apart from the triennial review process in response to urgent needs, which arise after completion of the triennial review.

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Appendix A
Tribal Legal Capacity

OFFICE OF TRIBAL ATTORNEY
HOOPA VALLEY TRIBE

Post Office Box 188 • Highway 96
Hoopa, California • 95546
(916) 625-4211 • FAX (916) 625-4847

SENIOR TRIBAL ATTORNEY
BRUCE J. FRIEDMAN

LEGAL ASSISTANT /
OFFICE MANAGER
WARREN L. TAMERIUS, JR.

LEGAL SECRETARY
TAMERA L. HOSTLER

July 27, 1995

Felicia Marcus
Regional Administrator - Region IX
Environmental Protection Agency
75 Hawthorne Street
San Francisco, California 94105

Subject: Tribal Jurisdiction - Water Quality
Non-Indians - Non-Trust Lands

Dear Ms. Marcus,

The intent of this letter is to clarify and to affirm the jurisdiction of the Hoopa Valley Tribe, a federally recognized Indian Tribe, 25 USC § 1300i-7, to set and to enforce water quality standards respecting non-Indians owning non-trust lands on the Hoopa Valley Indian Reservation. At the outset, your attention is drawn to an accompanying July 11, 1989 letter from the Office of the Tribal Attorney to a past Regional Administrator - Region IX. The letter is accurate still and is soundly reasoned. I'll focus on subsequently acquired information, changes in Tribal law and later federal cases.

1. Land Ownership On Reservation - the federal courts have lately analyzed land ownership quantitatively as a component of tribal jurisdiction. In Brendale v. Confederated Tribes and Bands of [the] Yakima Indian Nation, 492 U.S. 408 (1989), a crucial concurring opinion by Justice Stevens, joined by Justice O'Connor, traced tribal jurisdiction to regulate non-Indians and non-trust lands to "[tribal] power to define the essential character of the territory." In turn the presence of that tribal power is subject to a quantitative analysis of land ownership on reservation. In Brendale the fact that the "closed" sector on the Yakima reservation is held in trust by the Tribe and by Indian allottees, except for "a very small proportion" privately owned by "[a] few individuals," was found sufficient to affirm tribal jurisdiction respecting non-Indians on non-trust lands:

> Congress ... could not have intended that tribes would lose control over the character of their reservations upon the sale of a few, relatively small parcels of land. Id. p. 441
>
> the tribe has authority to prevent the few individuals who own portions of the closed area in fee from undermining its general plan to preserve the character of this unique resource by developing their isolated parcels without regard to an otherwise common scheme. Id. p. 441
>
> the fact that a very small proportion of the closed area is owned in fee does not deprive the tribe of the right to ensure that this area maintains its unadulterated character. Id. p. 444

The Court in Brendale came to a different result respecting a non-Indian privately owning land on the "open" sector on the Yakima reservation. At least half the land in the "open" sector is privately owned.

Applying the United States Supreme Court land ownership quantitative analysis to the Hoopa Valley Indian Reservation, the accompanying graphic plainly shows that just 1922.6 acres - 2.8% - of the 87948.5 acre- reservation, overlooking for the moment boundary disputes not bearing on non-Indians on privately owned lands, is held in trust by the Hoopa Valley Tribe and by Indian allottees. Scrutinizing the 1922.6 acres, I am informed that roughly 2/3 are held by the Tribe or by Tribal members.

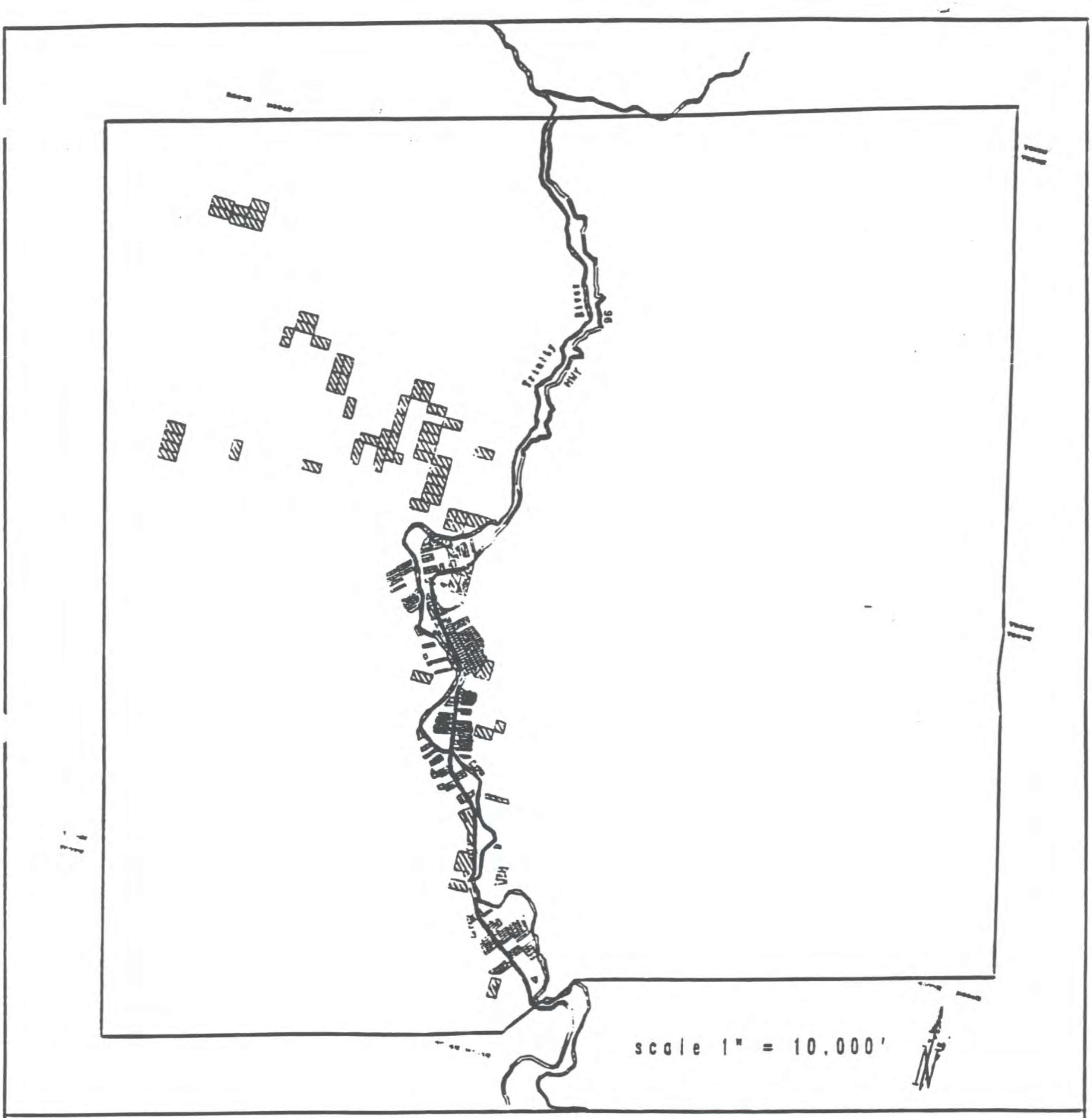
So somewhat less than 1% of the Hoopa Valley Indian reservation is privately owned by non-Indians, at least comparable to the "closed" sector Yakima facts in Brendale; far different than the facts on the Salish and Kootenai Reservation. The Hoopa Valley Tribe, as it happens, and as anticipated in Brendale, is endeavoring to assure that their reservation - their home since time immemorial - "maintains its unadulterated character."

2. Tribal Riparian Ordinance - on August 3, 1992, the Hoopa Valley Tribe passed a Riparian Protection Ordinance, no. 92-3, that is intended, inter alia, to set and to enforce water quality standards respecting surface mining throughout the Reservation "including such activities conducted by non-members of the Tribe or on privately owned lands." 35 Hoopa Tribal Code § 35.1.1

The Hoopa Valley Tribal Council, on July 7, 1995, issued a Gravel Permit, no. 95-2, to a non-Indian operating on privately owned lands. The Hoopa Valley Tribe has not "accommodated itself to the State's 'near exclusive' regulation" of water quality. Cf. Montana v. United States, 450 U.S. 544, 566 (1981). Gravel Permit no. 95-2 was issued subject to conditions pertaining to water quality.

3. Congressionally Delegated Tribal Jurisdiction - it bears repeating that the United States Supreme Court has stated clearly that Indian tribes can set and enforce water quality standards respecting non-Indians on privately owned land if Tribal jurisdiction is congressionally delegated. The Court in Brendale, by way of example, cited 33 USC §§ 1377 (e) and (h) (1), id. p. 428, tribal treatment as a state.

4. Recent Federal Cases - the Federal courts carry on a long line of authority to the effect that Indian tribes have jurisdiction to legislate and to adjudicate that non-Indians operating on non-trust lands refrain from interfering with the profound interests of tribal members on their reservations. Salish and Kootenai Tribes v. Montana, 750 F.Supp. 446 (D.Mont. 1990); FMC v. Shoshone Bannock Tribes, 905 F.2d 1311 (9th Cir. 1990); United States ex rel. Morongo Band v. Rose, 34 F.3d 813 (9th Cir. 1994); Stock West Corp. v. Taylor, 964 F.2d 912 (9th Cir. 1992).



TRUST - PRIVATE OWNERSHIP

Hoopa Valley Indian Reservation

Total Reservation Area = 87943.5 Acres
Total Private (County Fee) Ownership
Indian and Non-Indian owners = 1922.6 Acres
Percent of Reservation Privately Owned = 2.8 %

86

source: HVTC, Forestry Div., GIS Database (ownGS), 7/26/95, je.

Legal Department
Hoopa Valley Business Council
P.O. Box 1348 • Hoopa, California 95546 • (916) 625-4211

Stephen H. Suagee
Staff Attorney

MEMORANDUM

TO: Daniel McGovern, Regional Administrator
EPA - Region 9

FROM: Stephen H. Suagee
Attorney for Hoopa Valley Tribe

DATE: July 11, 1989

SUBJECT: Legal Basis of Hoopa Valley Tribe's Regulatory Authority Over Water Resources of the Hoopa Valley Reservation

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This memorandum explains the legal basis for the Hoopa Valley Tribe's regulatory authority over the water resources within the Hoopa Valley Reservation in northern California. It is presented in support of the Tribe's Petition for Treatment as a State for Section 106 funding and for authority to establish water quality standards, as required by Section 518(e)(2) of the Clean Water Act, 33 U.S.C. § 1377(e)(2), and by EPA's Interim Final Rule, Indian Tribes: Water Quality Planning and Management, published in 54 Fed. Reg. 14354-60 (April 11, 1989). Although the Hoopa Valley Tribe lacks a formally designated Attorney General, I am an analogous official and am authorized by the Hoopa Valley Business Council to submit this statement.

The Hoopa Valley Tribe is a federally recognized Tribe. The Interior Department approved the Tribe's current Constitution and Bylaws in 1972. Article III of this Constitution provides that "[t]he jurisdiction of the Hoopa Valley Tribe shall extend to all lands within the confines of the Hoopa Valley Reservation boundaries as established by Executive Order of June 23, 1876." Article V, Section (1) provides that the Hoopa Valley Business Council is the governing body of the Tribe.

Section II.A. of the Tribe's Petition for Treatment as a State acknowledges that due to protracted federal court litigation regarding the nature of Indian and tribal rights in the Hoopa Valley Reservation, some doubt once existed whether the Hoopa Valley Tribe possessed exclusive jurisdiction over Reservation territory as defined in Article III of the Tribal Constitution. <u>See</u> <u>Jessie Short, et al. v. United States</u>, Cl.Ct.

No. 102-63, and Lillian Blake Puzz, et al. v. Dept. of Interior, No. C 80-1908 TEH. Any and all doubts were conclusively laid to rest by the recent implementation of the Hoopa-Yurok Settlement Act, Pub. L. 100-580, 25 U.S.C. §§ 1300i-1300i-11. Section 2 of the Settlement Act provides that upon publication of the appropriate Federal Register Notice, the Hoopa Valley Reservation[1/] "shall thereafter be held in trust by the United States for the benefit of the Hoopa Valley Tribe." 25 U.S.C. § 1300i-1(h). The appropriate notice was published by the Interior Department on December 7, 1988, 53 Fed. Reg. 49361-62 (copy attached), and as of that date the Hoopa Valley Tribe has been the exclusive beneficial owner of the unallotted trust lands and assets that comprise over 95% of the Reservation.

More significantly for purposes of tribal jurisdiction, Section 8 of the Settlement Act provides that "the existing governing documents of the Hoopa Valley Tribe and the governing body established and elected thereunder, as heretofore recognized by the Secretary, are hereby ratified and confirmed." 25 U.S.C.§ 1300i-7. The existing governing documents of the Tribe are its 1972 Constitution and Bylaws, which provides that the Hoopa Valley Tribe has jurisdiction over Reservation territory. See footnote [1/]. Thus there can be no question that, regardless of any doubt that may have been raised by the Short and Puzz lawsuits, the Hoopa Valley Tribe is now vested by Congress and tribal law with exclusive sovereign authority to govern the territory of the Hoopa Valley Reservation.[2/]

Several provisions of the Tribal Constitution, Article IX, expressly authorize the Business Council to exercise powers that entail regulation of not only water quality for all surface and groundwater within the Reservation, but also use of all waters originating within the Reservation as well: Section 1(p) authorizes protection of tribal property and natural resources, which includes regulation of federal reserved fishing and water rights; Section 1(g) authorizes the Council to represent the Tribe in negotiations with other governments; Section 1(h) authorizes the Council to represent tribal positions in

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[1/] The Settlement Act and the Tribal Constitution both define the Hoopa Valley Reservation in the same way - as established by the 1876 Executive Order.

[2/] See attached Order in the Puzz case dismissing all claims as moot in light of the Settlement Act.

litigation; Section 1(j) authorizes the Council to exclude non-members of the Tribe from tribal lands, and otherwise regulate their activities thereon; Section 1(l) authorizes protection of the general welfare, health, and safety; and Section 1(h) authorizes establishment of the Tribal Court, which has been in existence since March 27, 1986.

These specific Constitutional provisions are interpreted broadly to achieve the protection of tribal rights and interests, and to accommodate constant developments in federal law that expand or refine the general scope of tribal jurisdiction. In addition, the Tribe is authorized to exercise any inherent sovereign power not expressly extinguished by Congress.

The Council has enacted a number of Ordinances pursuant to the above cited authority, including: the Fishing Ordinance, which comprehensively regulates fishing on the Reservation; the Law and Order Code which establishes the Tribal Court for adjudication of disputes arising on the Reservation or offenses arising under tribal law; the Exclusion Ordinance, which protects against natural resources trespass; the Use/Permit Ordinance, which regulates use of Reservation natural resources by Indians and non-Indians.

In addition, the Council is drafting Ordinances: to set forth required environmental review procedures;[3/] to provide for comprehensive zoning consistent with the Tribe's overall land use plan; to protect the special ceremonial, fisheries, recreational, environmental, and commercial values of the Trinity River riparian zone; to establish best forestry management practices for protection of watersheds. These will be implemented after a public review process.

The Tribe has been awarded grant funds for the coming year from the Administration for Native Americans to establish a Water Resources Department with in-house hydrological and legal capability. One objective of the grant funded phase of the

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[3/] The Tribe already exercises primary responsibility for NEPA compliance on the Reservation. The Bureau of Indian Affairs, in its internal Manual setting forth NEPA procedures for Indian Country, recognizes that "tribal governments have substantial authority for environmental protection within their reservations as an aspect of their <u>retained</u> tribal sovereignty." 30 BIAM, Supp. 1 § 2.6 (emphasis added).

program is development of the technical information necessary to enactment of tribal Water Use and Water Quality Codes. The activities of the Water Quality Planning and Management proposal submitted herewith to EPA will be coordinated with those of the Water Resources Department, and should yield information essential to development of such Codes.

The Tribe's main purposes in regulating the use of Reservation resources generally, and water use and quality particularly, include protection of the Tribe's federal reserved fishing and water rights from environmental degradation and unauthorized interference by outside persons and governments. Tribal authority to regulate these reserved rights necessarily entails the authority to serve the purposes for which the rights exist, which include: subsistence, ceremonial, and commercial use of the Reservation fishery; and protection of traditional cultural and ceremonial values associated with the salmon runs, the Trinity River riparian zone, and all Reservation water resources. In addition, tribal regulation of this type fulfills the Council's constitutional obligations to protect the basic health, safety, and welfare of the Tribe and the Reservation community. Ultimately, such regulation promotes the political integrity of the Hoopa Valley Tribe.

Given the fundamental tribal interests implicated by water use and quality regulation, the Tribe is approaching surface water regulation on a watershed basis: The Hoopa Valley Reservation is bisected by the Trinity River. The Hoopa Valley floor consists of 3500-4000 acres of alluvial flat land along the River, and is the principal residential and agricultural area. The remaining 85,000 acres of the Reservation consist of mountainous forest lands, drained by a number of small creeks tributary to the Trinity River. All these creeks are sources of domestic and agricultural water, and many have their headwaters within the Reservation. Some creeks are used for salmon rearing, and both the Tribe and the United States have invested heavily in restoration of salmonid habitat in these creeks. In addition, certain streams have potential for micro-hydro development, to provide power and enhance domestic and agricultural water uses. Upland forest development activities must therefore conform to the water use and quality requirements at the lower end of each drainage.

The groundwater table adjacent to the Trinity River is also a source of domestic and agricultural water. Although it underlies a variety of tribal lands, residences, and businesses on the Valley floor, as well as the tribally-owned riparian zone, the groundwater table is a unitary resource that provides runoff into the Trinity River and the lower portions of Reservation creeks. In order to protect tribal values and interests in the creeks and River, and to prevent buildup of pollutants underground, the groundwater table must be regulated as a unitary system.

Due to the extremely high percentage of tribal lands within the Reservation (95-97%), and to the fundamental tribal interests implicated by the need to comprehensively regulate all Reservation water use and quality, the Tribe must have, and does have, jurisdiction to regulate water use and quality throughout the Reservation. This Reservation-wide jurisdiction over water resources is consistent with the broad language of CWA Section 518(e)(2) and (h), which recognizes tribal primacy over "the management and protection of water resources . . . within the borders of an Indian reservation," 33 U.S.C. § 1377(e)(2), and further defines "Indian reservation" as "all land within the limits of any Indian reservation . . . notwithstanding the issuance of any patent," 33 U.S.C. § 1377(h).

This clear statutory language found in the 1987 CWA amendments confirms doctrine developed in prior federal cases, that absent express Congressional action vesting States with civil regulatory jurisdiction over Reservation resources and land use, it is tribal governments which exercise this jurisdiction. In the case of CWA Section 518, express Congressional language confirms that regulatory jurisdiction over Reservation waters inheres in Tribes.

EPA is of course no stranger to the pre-1987 federal court decisions affirming this aspect of tribal jurisdiction, inasmuch as it has successfully asserted this position against various challenges by state agencies and private interests. See Washington Dept. of Ecology v. EPA, 752 F.2d 1465 (9th Cir. 1985) (sustaining EPA's administrative policy that the Resources Conservation and Recovery Act did not authorize state jurisdiction over hazardous wastes on Indian reservations in the State of Washington); Phillips Petroleum Corp. v. EPA, 803 F.2d 545 (10th Cir. 1986); Nance v. EPA, 645 F.2d 701 (9th Cir. 1981). Accordingly, it is not necessary to engage in extended analysis of the federal cases.

It is worth nothing, however, that under Pub. L. 83-280, which transferred criminal jurisdiction and limited civil adjudicatory (not regulatory) jurisdiction over Reservations to certain States, including California, Indian tribes retain full authority to regulate rights reserved to them by treaty or federal statute. 25 U.S.C. § 1322(b). The reserved fishing and water rights of the Hoopa Valley Tribe are secured by an 1864 Act of Congress which authorized the 1876 Executive Order establishing the Reservation. See United States v. Eberhardt, 789 F.2d 1354, 1359 and -61 (9th Cir. 1986) (confirming that fishing rights on the Hoopa Valley Reservation are protected by the 1864 federal statute, which bars state regulation). Accord People v. McCovey, 205 Cal. Rptr. 643, 653, cert. denied 469 U.S. 1062 (1984). See also California v. Cabazon Band of Mission Indians, 107 S.Ct. 1083 (1987) (Public Law 83-280 did not vest California with civil regulatory jurisdiction over Indian reservations); and footnote [3] above regarding BIA recognition of retained tribal authority over environmental regulation.

EPA's implementation of CWA Section 518 seems to recognize inherent tribal authority as described above:" . . . a Tribe will ordinarily have authority to administer Clean Water Act programs within reservation boundaries." 54 Fed. Reg. 14355 (emphasis added). Supplementary information to the most recent Proposed Rule amending 40 C.F.R. Part 131, Water Quality Standards, acknowledges that both Tribes and States have inherent authority, predating CWA Section 510, to set quality standards for waters within their respective territories. Section 510, 33 U.S.C. § 1310, functions as a "savings clause," in EPA's words, to confirm that while Congress intended to require compliance with minimum federal standards, it did not intend to restrict preexisting inherent authority of Tribes and States to establish standards stricter than federal standards. See attached letter of March 2, 1988 from Hoopa Valley Tribe to David Sabock, Chief, EPA Branch of Standards, commenting on earlier draft of amended regulations.

Finally, the Federal Register Notice under which the Tribe submits its petition for primacy requests a statement regarding the Tribe's ability to exercise emergency powers comparable to those granted the EPA Administrator in CWA Section 504. 54 Fed. Reg. 14358 (Interim Revision of 40 C.F.R. § 35.260(b). First, the Hoopa Valley Business Council is authorized to initiate legal actions in the name of the Tribe, and has standing in federal district court to seek injunctive relief from water pollution emergencies that threaten tribal resources, reserved rights, or the public health and safety. 28 U.S.C.§ 1362. Under this federal jurisdictional statute, a Tribe stands in the shoes of its trustee, the United States, and therefore may assert any claim the United States would be entitled to assert. Moe v. Confederated Salish and Kootenai Tribes., 425 U.S. 463 (1976). Second, the Council may bring actions in Tribal Court under its current exclusion and natural resources trespass laws. Council enactment in the near future of expanded environmental procedures laws and comprehensive riparian zone regulation, as well as ultimate establishment of water quality standards, will expand the Tribe's ability to use its own court system to respond to water pollution emergencies.

In sum, the Hoopa Valley Tribe clearly possesses the legal authority to comprehensively regulate water quality and use within the Hoopa Valley Reservation. The Tribe also possesses emergency response authority comparable to that of the EPA Administrator under CWA Section 504. Accordingly, EPA is respectfully urged to qualify the Tribe for treatment as a state under CWA Section 518(e)(2) for purposes of its Section 106 proposal and to authorize promulgation of tribal water quality standards. If any questions should be raised about the Tribe's authority as described herein, we hereby request an opportunity to respond before EPA makes any determination regarding our eligibility for treatment as a State. Thank you for your consideration.

Stephen H. Suagee

Stephen H. Suagee
Legal Department
Hoopa Valley Tribe
Attorney for Hoopa Valley Tribe

SHS/ib
Enclosures
071189/certif/epa

Appendix B
Definitions

Definitions

For the purposes of this plan, the following words and phrases shall have the following meanings:

"Acute Conditions" are conditions in the physical, chemical, or biological environment which are expected or demonstrated to result in injury or death to an organism as a result of short-term exposure to a substance or detrimental environmental condition.

"Acute Toxicity" refers to a relatively short-term lethal or other adverse effect to an organism caused by pollutants, and usually defined as occurring within 4 days for fish and large invertebrates and shorter times for smaller organisms.

"Appropriate reference site or region" means a site on the same water body or within the same basin or eco-region that has similar habitat conditions, which is expected to represent the water quality and biological community attainable within the area(s) of concern.

"Aquatic species" means any plant or animal which lives at least part of their life cycle in water.

"Aquifer" means any geologic formation capable of yielding a significant amount of potentially recoverable water.

"Background conditions" means the biological, chemical, and physical conditions of a water body, outside and up-gradient of the area of influence of the point source discharge, nonpoint source, or in stream activity under consideration. For example, in rivers and streams background sampling locations would be upstream from the source or activity, but not upstream from other inflows. If several sources to any water body exist, background sampling would be undertaken immediately upstream from each source.

"Beneficial uses" means all lawful uses of water identified in the Water Quality Control Plan. Uses may include but are not limited to domestic, commercial, industrial, agricultural, traditional, cultural, recreational uses, and use by fish and wildlife for habitat or propagation.

"Best Management Practices" means physical, structural, and/or managerial practices that, when used singularly or in combination, prevent or reduce pollution.

"Benthic Macroinvertebrates" are organisms that, for at least a portion of their life cycle inhabit the bottom substrates of freshwater habitats. They are retained by a mesh size of >200 micrometers.

“Chronic toxicity” means a fairly long-term adverse effect to an organism (when compared to the life span of the organism) caused by or related to changes in feeding, growth, metabolism, reproduction, a pollutant, genetic mutation, etc. Short-term test methods for detecting chronic toxicity may be used.

“Council” means the Hoopa Valley Tribal Council.

“Critical conditions” means the physical, chemical, and biological characteristics of the receiving water that interact with the point source discharge, nonpoint source or in-stream activity to produce the greatest potential adverse impact on aquatic biota and existing or characteristic water uses.

“Cultural water use” means water which are used to support and maintain the way of life of the Hupa People including, but not limited to: use from in stream flow, habitat for fisheries and wildlife, and preservation of habitat for berries, roots, medicines and other vegetation significant to the values of the Hupa People.

“Damage to the ecosystem” means any demonstrated or predicted stress to aquatic or terrestrial organisms or communities of organisms which the department concludes may interfere with the health or survival success or natural structure and functioning of such populations. This stress may be due to alteration in habitat or changes in water temperature, chemistry, or turbidity or other causes. In making a determination regarding ecosystem damage, the department shall consider the cumulative effects of pollutants or incremental changes in habitat which may create stress over the long term.

“Designated use” means a use that is specified in water quality standards as a goal for a waterbody segment, whether or not it is currently being attained.

“Embeddedness” is an evaluation of the bottom substrate suitability, expressed as percent composition of rock size and/or type (fines, cobbles, boulders), needed to maintain the quality and integrity for survival of aquatic populations.

“EPA” means the United States Environmental Protection Agency.

“Escherichia coli (E. coli)” is a specific bacterial coliform used as an indicator for fecal contamination.

“Existing uses” means all uses actually attained in the waterbody on or after November 28, 1975, whether or not they are explicitly stated as designated uses in the water quality standards or presently existing uses.

“Fish Consumption” is expressed as the amount of fish in Kg consumed by residents of the Hoopa Valley Indian Reservation on a daily basis.

“Permit” means a document issued pursuant to tribal code or federal laws (such as NPDES, CWA, Section 401; CWA, Section 404) specifying the waste treatment and control requirements and waste discharge conditions.

“Persistent pollutant” means a pollutant which is slow to or does not decay, degrade, transform, volatilize, hydrolyze, or photolyze.

“Person” means any individual, corporation, partnership, association, agency, municipality, commission, or department, including the Hoopa Valley Tribe or other federally recognized tribal government.

“Pesticide” mans any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest. Also, any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant.

“Point source” means any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, culvert, well, discrete fissures, containers, rolling stock,, concentration animal feeding operation, vessel or other floating craft.

“Pollutant” means any substance that will alter the quality of the waters of the Reservation.

“Potential uses” means all uses attainable in the watebody, whether or not they are explicitly stated as designated uses in the water quality standards or presently potential uses.

“Quality of the water or waters” means any chemical, physical, biological, bacteriological, radiological, and other properties and characteristics of water which affect its use.

“Reservation” means all land, air and water located within the exterior boundaries of the Hoopa Valley Indian Reservation.

“Recharge Area” means any areas that collect precipitation or surface water which contributes to the aquifer. Recharge areas may include areas designated as wellhead protection areas.

“Resident aquatic community” means aquatic life expected to exist in a particular habitat when water quality standards for a specific eco-region, basin, or water body are met. This shall be established by accepted biomonitoring techniques.

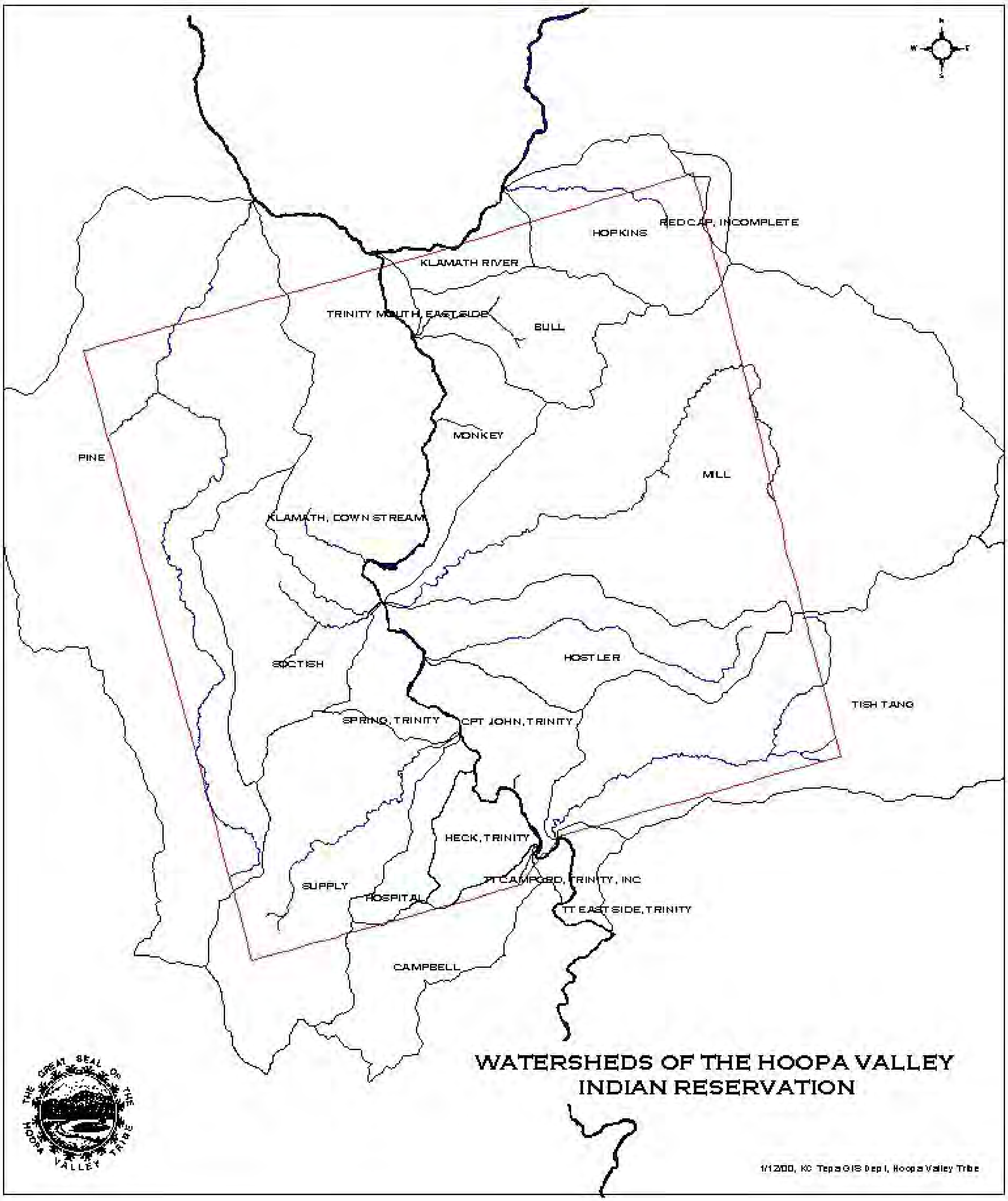
“Violations of water quality” means that when pollutants are discharged into waterways either directly or indirectly which result from human activities that were not planned, approved and/or permitted from a consortium of staff from Tribal EPA, Fisheries, Forestry and the Tribal cultural committee.

“Wellhead protection area” means the surface and subsurface area surrounding a water well or well field, supplying a domestic water system, through which contaminants are reasonably likely to move toward and reach such water well or well field.

“Wetland” means any area that is inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.

“Wildlife habitat” means the waters of the tribe used by, or that directly or indirectly provide food support to fish, other aquatic life, and wildlife for any life history stage or activity.

Appendix C
Tribal Watersheds



WATERSHEDS OF THE HOOPA VALLEY
INDIAN RESERVATION

1/12/00, KC Tepa GIS Dept, Hoopa Valley Tribe

Appendix D

Trinity River/Tributary Temperature Support Analysis

Temperature Standards 2006 Triennial Review
Supporting Analysis

The Hoopa Valley Tribe's Environmental Protection Agency (TEPA) is responsible for protecting water quality within the Hoopa Reservation. To fulfill that responsibility, TEPA sets in-stream water quality temperature standards for the Trinity River and connecting tributaries that originate and/or flow into the reservation. Temperature Standards are not proposed for the Hoopa portion of the Klamath River at this time. The standards are set with the goal of providing full protection to beneficial uses. Depending on the watershed, beneficial uses may include: drinking water, anadromous spawning and rearing, swimming, irrigation, hydropower, and other uses. Standards include narrative and numeric criteria and identification of the associated beneficial uses that they are intended to protect. The purpose of this document is to comply with the requirements of part 131.21 of the Clean Water Act as amended and provide the supporting analysis that determined the site-specific criteria development for certain constituents and temperature.

Review Process

Under Section 303 of the federal Clean Water Act, tribes must review their water quality standards every two or three years in order to incorporate the most recent scientific findings and to reflect evolving priorities within the tribe. The Hoopa Tribe, in establishing water quality standards, recognizes that new information is constantly being developed on water criteria and how water criteria affect different beneficial uses. Therefore, continued reevaluation of criteria information is needed to refine and revise water quality standards for the reservation over time. The Hoopa Tribe has adopted a triennial review process and is currently undergoing its first review in 2006. Within this review, TEPA has determined the need to update the temperature criteria for all Reservation waters with the exception of the Trinity River, where the 2002 approved standards remain unchanged. Also, temperature standards are not being proposed for the Klamath River at this time.

TEPA is the technical advisory body established for standards under review. TEPA's technical staff evaluates and revises the standards based on recent scientific advances. The process of revising standards follow the required Tribal Legislative Procedures Act and Clean Water Act, section 303(c) (1) by notifying the general public, holding public hearings, and responding to comments on the standards. Public legal notices have been published in newspapers from Southern Oregon to Fresno County~~;~~ as well as being posted on the Hoopa Tribe's website under the link http://www.hoopa-nsn.gov/documents/WQCP.pdf. Following completion of the public process, the revised standards will be submitted to EPA Region IX for Section 7 consultation with cognizant federal agencies. Under 33 U.S.C. § 1313 (a) EPA must notify the Tribe within 90 days of submission of standards whether its revised standards satisfy the Clean Water Act.

The summaries below provide a brief overview of the reasons for revising each standard, and the proposed revision. Details on the scientific and policy rational for the standard changes is provided in this document.

Introduction

Tribal temperature objectives consist of two parts, 1) objectives that directly relate to the Trinity River and 2) temperature standards that deal with Reservation tributaries and other waters on the HVIR, excluding the Klamath River system. Trinity River objectives and standards agree with and support the Trinity River Flow Evaluation (TRFE) particularly with regard to the TRFE's flow regime and resultant temperatures. Reservation Tributary standards are based upon a combination of current literature review including the USEPA document *EPA Region 10 Guidance for Pacific Northwest State and Tribal Water Quality Standards* (2003), and California Regional Water Quality Control Board North Coast Region's *Biological Temperature Requirements of Salmonids by Life Stage (2005),* and analysis of over 10 years of tributary temperature data from the Hoopa Tribe's water quality database. The aim of both parts/standards is to provide protection for the survival, growth, and reproduction of anadromous fish and other aquatic life, such that ceremonial and cultural values of the Tribe and other beneficial uses are maintained. In odd years the Hoopa Tribe conducts ceremonies integral to

the Hoopa's religion and culture. These ceremonies require sufficient flow in the mainstem of the Trinity River to facilitate the "Boat Dance" ceremony. This requirement is protected under the American Indian Religious Freedom Act (P.L. 95 – 341).

Trinity River Temperature Standards
The Hoopa Valley Tribe's Trinity River temperature criteria (Table 1) are based on temperature-flow relationship that maintains TRFE flow regimes and protects adult salmonids holding and spawning. The approach of adopting the TRFE flow regime as temperature objectives recognizes the importance of temperature variation through the year to the life history stages and development of anadromous fish species. The Tribe's Trinity River temperature objectives were established by Tribal Environmental Protection Agency in cooperation with Tribal Fisheries, U.S. Fish & Wildlife Service, North Coast Regional Water Quality Control Board (NCRWQCB) and U.S. Environmental Protection Agency. In June of 1999, the Hoopa Valley Tribe, U.S. Bureau of Reclamation (USBR), and U.S. Fish and Wildlife Service (USFWS), published the TRFE. The TRFE represents the most thorough state-of-the-art science report on regulated flow releases and related actions designed to restore and maintain the riverine ecology of the upper mainstem Trinity River. The TRFE establishes temperature objectives consistent with the NCRWQCB's temperature criteria above Douglas City. Temperatures will be monitored based on water-year type as established in the TRFE by inflow into the Trinity River Reservoir each spring. The USBR determines water-year type. The Hoopa Valley Tribe's temperature objectives agree precisely with those outlined in the TRFE preferred alternative and are consistent with temperature objectives as specified in the NCRWQCB temperature standards for the Trinity River below Lewiston Dam and downstream to Douglas City and the confluence of the North Fork Trinity. The Tribe's temperature objectives do not require additional flows over and above those required by TRFE. Temperatures recorded at Weitchpec will be utilized to determine compliance with the Trinity River standards. Therefore, continued re-evaluation of temperature information is needed to refine and revise temperature standards for the reservation over time. The Tribe also recognizes that the development and implementation of control technologies and best management practices to reduce human caused warming are ongoing and the achievement of the optimal temperature standard will be an evolutionary process.

Table 1 - *Temperature criteria are specified by seasonal time frames and water-year type.*

Running 7-Day Average Temperature Not to Exceed					
Water-Year Type	May 23 to June 4	June 5 to July 9	July 10 to September14	September 15 to October 31	November 1 to May 22
Extremely Wet, Wet and Normal	≤ 59°F or 15.0°C	≤62.6°F or 17.0°C	≤ 72.0°F or 22.1°C	≤ 66.0°F or 19.0°C	≤ 55.4°F or 13.0°C
	May 23 to June 4	June 5 to June 15	June 16 to September 14	September 15 to October 31	November 1 to May 22
Dry and Critically Dry	≤ 62.6°F or 17.0°C	≤ 68°F or 20.0°C	≤ 74.0°F or 23.5 °C *	≤ 66.0°F or 19.0°C	≤ 59.0°F or 15.0°C

* For the seasonal period of June 16th through September 14th temperatures on the mainstem Trinity River at the Weitchpec gauging station were used to determine running seven-day averages.

Tribal Trinity River temperature standards have been established for the portion of the Trinity River that flows through the Hoopa Valley Indian Reservation and are adjusted according to the hydrologic conditions of the year. Temperature standards will be monitored throughout the main-stem Trinity River on the Hoopa Reservation from the South boundary to Weitchpec.

Trinity Development Process

The development of Tribal temperature standards to address TRFE flow regimes provided a significant challenge to TEPA staff. The over riding goal of the Tribal temperature standards is to achieve compliance with flow regimes and resulting water temperatures specified in preferred alternative of the TRFE.

The TRFE and NCRWQCB recommend temperature objectives for the Trinity River at Weitchpec throughout year with the exception of the period from June 16th through October 31st. For this period, Tribal temperature criteria are derived directly from ambient temperature data recorded at the U.S. Bureau of Reclamation's Weitchpec gauging station since 1991 (**Table 2**). The recommended base flow of 450 cfs has occurred during this period since 1991. The recorded temperatures for June 16th to October 31st were used to construct an 8-year historical temperature sequence. These temperature values were calculated using a 7-day running average for each temperature period from June 16th through October 31st. Calculating the 7-day running average involves taking the average daily temperatures and averaging it with the prior six days sequentially throughout the sample period. These results were then queried for an upper temperature value that was not exceeded more than 90% within the given time period, (i.e., 10% or less of the 7-day running averages exceeded the upper temperature value). The temperatures shown in Table 2 represent the upper 7-day running averages that occurred in each sample period. Individual years were then grouped into two categories that consisted of "Dry and Critically Dry" and "Wet, Extremely Wet, and Normal" hydrologic conditions. Within each category an upper temperature mean was established. The temperature mean for each category is the standard for that time period. For the period of June 16th to September 14th during Critically Dry and Dry years, 23.7 °C was determined to be the upper temperature standard not to be exceeded. During Normal, Wet, and Extremely Wet years from July 10th through September 14th, 22.3°C was determined to be the upper temperature standard not to be exceeded. The same analytical process was used to establish temperature criteria for September 15th through October 31st in "Dry and Critically Dry" and "Wet, Extremely Wet, and Normal" hydrologic conditions. Since the seasonal time frames were refined late in the process through further consultation, the 7-day running average was re-evaluated and the final standard for the period of September 15 through October 31st in Extremely Wet, Wet, and Normal water years was adjusted from 16° C to 19° C.

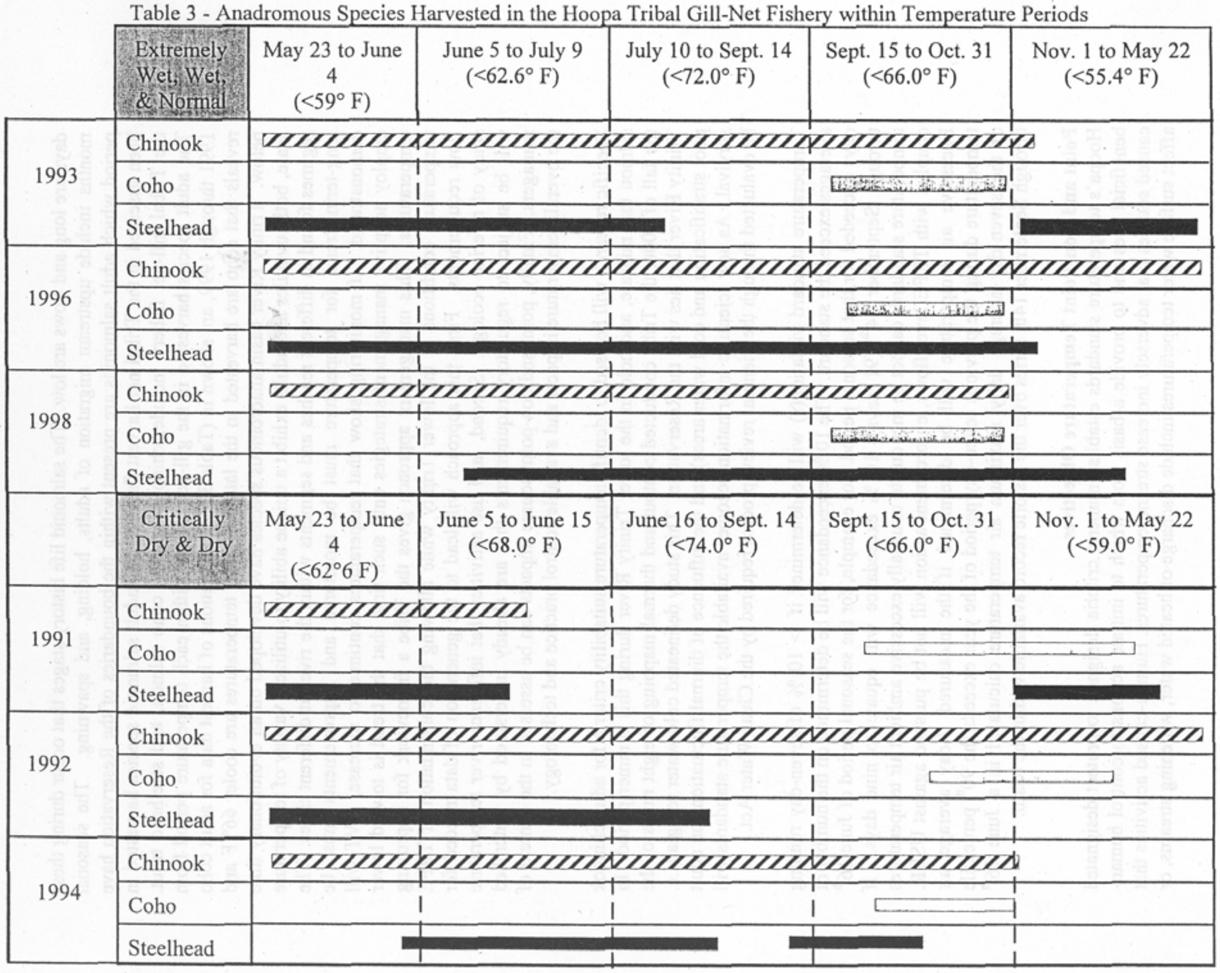
Table 2 - *7-day running average temperatures for times frames from June 16th through October 31st.*

Dry & Critically water years	June16-Sept14	Sept 15-Oct 31
91	23.6	20.2
92	23.9	19
94	23.6	ND
Average	23.7	19.6
Extremely Wet, Wet, &Normal	July10-Sept14	Sept 15-Oct 31
93	21.4	18.5
95	ND	ND
96	23.4	ND
97	23	18.5
98	22.2	19.7
99	21.4	
Average	22.28	18.9

ND = No data, the record sequence was incomplete for analysis.

Achieving the natural temperature regime for the lower Trinity River is the focus of the Tribal standard. Trinity River Basin anadromous species have developed on an evolutionary time scale, the ability to utilize the variety of temperature regimes found in different reaches and segments within the river at different seasonal periods. Historically, the Trinity River had a natural tendency to warm as flows move in a downstream direction even under natural conditions. Recorded summer temperatures for the Trinity River at Weitchpec from 1991-1999 exceed those that are optimal for cold-water species, as recommended in published literature, for a several week period each summer. Bell (1984) found the upper lethal limit for Chinook salmon to be 77ºF (25ºC). According to EPA and NMFS (1971), temperatures of 70ºF (21º) were directly lethal to more than 50 percent of the adult salmon and steelhead exposed to that temperature. Typically, maximum Trinity River temperatures recorded at Weitchpec are the warmest from July through August when incoming solar radiation levels are high, air temperature are high, days are long and flows are low. The salmonid life history stages that occur during these months include upstream migration of adults, holding, and spawning. The seasonal period which adult salmonids are present within the boundaries of the Reservation have been assessed in the Tribal net-harvest fishery. The adult salmonid species harvested in the Tribal gill-net fishery include, Chinook salmon, Coho salmon, and steelhead trout. The adult species harvested in the gill-net fishery within each temperature period from 1991 through 1999, are shown in Table 3.

Table 3 - Anadromous Species Harvested in the Hoopa Tribal Gill-Net Fishery within Temperature Periods



Examinations of harvest data for adult Coho reveals that Coho are harvested in the late fall when temperatures are cooler 66° F and below. Trinity River basin anadromous species have developed on an evolutionary time scale; both juveniles and adults exhibit a unique ability to utilize a variety of temperature regimes found in different reaches and segments within the river at different times. The long-term trend for temperature must be monitored and improvements must be demonstrated. If monitoring show that temperatures continue to increase, HVT will employ adaptive management strategies until such time that the trend is toward lower temperatures. This management approach gives the Tribe a framework for improving temperature conditions in the lower Trinity while allowing the continuation of TRFE flow requirements. First, this approach will lead to the generation of data needed for study of riverine ecology. Second, land use activities that influence river temperature will be subject to regulatory requirements that are already understood by watershed managers. Finally, point and non-point source impacts can be assessed in the context of the overall temperature impacts and available control practice and technology.

Specific research will be used to identify temperature suitability criteria for adult Chinook salmon that migrate, and hold in the lower Trinity River during this summer period. In the fall of 2000, the Tribe conducted contour and thermal mapping of eight miles of the Trinity River that lies with the Reservation. This study delineated cold-water refugia (i.e. pool stratification and cold water areas) and the influence of diurnal fluctuations on adult survival. As new scientific information becomes available the temperature standards will be evaluated through the triennial review process required by the Clean Water Act.

Trinity Temperature Exceedances

Temperature standard violation(s) will be determined if > 10 % of seven-day running averages exceed the standard. The 10 % exceedance will be determined on the number of days exceeded for that seasonal period. For example, for the seasonal period of June 16th through September 14th (91 days), 10 % exceedance will equate to nine days. If temperature standards cannot be met due to unusually excessive ambient air temperatures coupled with TRFE level flows, enforcement action will not be pursued against USBR. Excessive air temperature will be determined if the measured 7-day average air temperature during the previous seven-day period of the year exceeds the 90th percentile of the seven-day average daily maximum air temperature calculated in a June 16th through September 14th series over the historic record available within the basin.

Hoopa's temperature standards establish numeric criteria designed to protect designated beneficial uses and to provide a basis from which to initiate actions to control human-caused sources that adversely increase stream temperatures. Human-caused activities that affect surface water temperatures include discharge of heated water, widening streams, or reduction of stream shading, flows and depth. These human-caused modifications, as well as others, increase water temperatures. Natural surface water temperatures at times exceed the numeric criteria due to naturally high ambient air temperatures, naturally low stream flows, streamside shade, solar radiation, and or other natural conditions. These exceedances are not water quality standard violations when the natural conditions themselves cause water temperatures to exceed the numeric criteria. In surface waters where both natural and human-caused factors cause exceedances of the numeric criteria, each human-caused source will be responsible for controlling that portion of the increase caused by the human activity. This will be determined through the use of baseline data, when it exists, in conjunction with temperature monitoring upstream and down-stream of the human-caused source. The Tribal Forestry Department and Tribal Environmental Protection Agency will establish, implement, and improve practices in order to reduce thermal loads to achieve and maintain the surface water temperature criteria. Federal forest management agencies are required by the federal Clean Water Act to meet or exceed the substantive requirements of Tribe's non-point source program. The requirement for a surface water temperature management plan and the content of the plan will be appropriate to the contribution the permitted source makes to the temperature problem, the technologies and practices available to reduce thermal loads, and the potential for trading or mitigating thermal loads. These measures will be implemented sufficiently to assure attainment of running 7-day average temperatures of 21°C during the July 10 – September 14 period of each year (June 16 – September 14 in dry and critically dry years) within five years of adoption of these standards.

Reservation Tributary Development Process

The Hoopa Valley Tribe is proposing temperature criteria for Reservation tributaries to meet the biological requirements of salmonids during their various life stages. In addition, the tributary temperature criteria are distinguished between hydrologic year types, differentiating Dry and Critically Dry Years and Extremely Wet, Wet and Normal Years. ***Table 4*** shows the varying criteria for each life stage of salmonids in relationship to hydrologic year type.

The temperatures listed in the ***Table 5*** are based on the Maximum Weekly Average Temperature (MWAT), which is defined as the highest 7-day moving average of equally spaced water temperature measurements for a given time period. In this application, the time period is the duration of the existing salmonid life stage. For the MWAT objective, the water temperatures in the stream may not exceed the numeric objective for every 7-day period during the given life stage. This metric is recommended because it describes the maximum temperatures in a stream, but is not overly influenced by the maximum temperature of a single day. Thus, it reflects an average of maximum temperatures that fish are exposed to over a week-long period. Since this metric is oriented to daily maximum temperatures, it can be used to protect against acute effects, such as lethality and migration blockage conditions.

In considering the effect of temperature on salmonids, it is useful to have a measure of chronic (i.e. sub-lethal) and acute (i.e. lethal) temperature exposures. A common measure of chronic exposure is the maximum weekly average temperature (MWAT). The MWAT is the maximum seasonal or yearly value of the mathematical mean of multiple, equally spaced, daily temperatures over a running seven day consecutive period (Brungs and Jones 1977). In other words, it is the highest single value of the seven day moving average of temperature. The MWAT for salmonids growth is the upper temperature that allows for optimum growth of salmonids (Armour 1991). A common measure of acute effects is the instantaneous maximum (also known as the short term maximum exposure limit, upper thermal survival limit, the lethal threshold temperature, and the incipient lethal temperature). A third metric, the maximum weekly maximum temperature (MWMT) can be used as a measure of both chronic and acute effects. The MWMT (also known as the seven-day average of the daily maximum temperatures (7-DADM)) is the maximum seasonal or yearly value of the daily maximum temperatures over a running seven day consecutive period. The MWMT is useful because it describes the maximum temperatures in a stream, but is not overly influenced by the maximum temperature of a single day. In consideration of this information, freshwater temperature thresholds in this document are given as MWAT's.

A literature review was performed to evaluate temperature requirements for the various life stages of Steelhead Trout (*Oncorhynchus mykiss*), Coho Salmon (*Oncorhynchus kisutch*), and Chinook Salmon (*Oncorhynchus tschawytscha).* This review included EPA guidance, Oregons' and Washingtons' standards, reports that compiled and summarized existing scientific information, and laboratory studies. When possible, species specific requirements were summarized by the following life stages: migrating adults, spawning and incubation/emergence, and freshwater rearing and growth. Additionally, the effects of temperature on disease and lethality are also discussed. Results for Fall-run Coho Salmon, Spring/Summer, Fall-run, and Winter-run Steelhead, and Spring-run and Fall-run Chinook Salmon are summarized by life stage in **Tables 4 and 5.**

Salmon and Trout respond to temperatures during their upstream migration (Bjornn and Reiser 1991). Delays in migration have been observed in response to temperatures that were either too cold or too warm. Most salmonids have evolved with the temperature regime they historically used for migration and spawning, and deviations from the normal pattern can affect survival (Spence et al. 1996).

The USEPA document *EPA Region 10 Guidance for Pacific Northwest State and Tribal Water Quality Standards* (2003) recommends that the seven-day average of the daily maximum temperatures (7-DADM) should not exceed 18° C in waters where both adult salmonid migration and "non-core" juvenile rearing occur during the period of summer maximum temperatures. Non-core juvenile rearing is defined as moderate to low density salmon and trout rearing usually occurring in the mid or lower part of the basin, as opposed to areas of high density rearing which are termed "core" rearing areas. This criterion is derived from analysis and synthesis of past laboratory and field research. The EPA believes that this temperature recommendation will protect against lethal conditions, prevent migration blockage, provide optimal or near optimal juvenile growth conditions, and prevent high disease risk by minimizing the exposure time to temperatures which can lead to elevated disease rates.

Reservation Tributary Temperature Objectives

In September 2002, US Environmental Protection Agency (EPA) approved the Hoopa Tribe's WQCP with exception of the Reservation Tributary temperature criteria which was withdrawn. TEPA staff determined that the tributary temperature objectives did not afford adequate protection for the Listed Species in the Reservation tributaries. In order to address this, staff worked closely with North Coast Regional Water Quality Control Broad (NCRWQCB) staff in developing numeric objectives specific to salmonid life stages. The NCRWQCB and USEPA Region X have conducted extensive evaluations and revisions of temperature criteria that are beneficial to all life stages of various salmonids. Therefore to be consistent with regional efforts and strategies for temperature control, TEPA has adopted a combination of the NCRWQCB's Biological Temperature Requirements of Salmonids by Life Stage and USEPA Region X's EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards.

By adopting similar criteria for the Reservation tributaries, the Hoopa Tribe is being proactive in helping achieve mutual goals for the protection of life stages of the Listed Species. USEPA expects to be able to expedite its review of revised temperature standards for Tribe's that follow the recommendations in the Region X Temperature document because the scientific rationale in support of the State and Tribal WQS would in large part already be described and supported by EPA, and by the National Marine Fisheries Service and the U.S. Fish and Wildlife Service. Also, given that the proposed tributary criteria are consistent with the NCRWQCB's current analysis of temperature regimes for Pacific Northwest salmonid species, the Hoopa Tribe is confident that EPA will approve these criteria under the 303(c) process. States or Tribes that choose to adopt new or revised temperature WQS must submit those standards to EPA for review and approval or disapproval in accordance with CWA section 303(c)(2)(A).

Reservation Tributary Temperature Standards

There are seven major tributaries to the Trinity and Klamath Rivers that run through the Hoopa Valley Indian Reservation and provide significant habitat for resident and anadromous species. The headwaters of these streams originate off the Reservation with the exception of Hostler and Soctish Creeks. These tributaries support different uses by anadromous fish than the mainstem Trinity thus requiring a different set of temperature standards. Since the tributaries support the incubation and rearing of fishes, temperatures must be adequate to support the most sensitive life stages of salmonids. Therefore, the following standards (**Table 4**) apply to the entire length of all tributaries existing within the exterior boundaries of the Reservation.

Temperature is one of the most important factors affecting the success of salmonids. Most aquatic organisms, including salmon and steelhead, are poikilotherms. Temperature therefore, influences growth and feeding rates, metabolism, development of embryos and alevins, timing of life history events such as upstream migration, spawning, freshwater rearing, and seaward migration, and the availability of food (NCRWQCB 2005). Human-caused increases in river water temperatures have been identified as a factor in the decline of ESA-listed salmonids in the Pacific Northwest. The Hoopa Tribe's temperature WQS can play an important role in helping to maintain and restore water temperatures to protect salmonids and aid in their recovery.

Temperature changes can also cause stress and lethality (Ligon et al. 1999). Temperatures at sub-lethal levels can effectively block migration, lead to reduced growth, stress fish, affect reproduction, inhibit smoltification, create disease problems, and alter competitive dominance (Elliott 1981, USEPA 1999). Further, the stressful impacts of water temperatures on salmonids are cumulative and positively correlated to the duration and severity of exposure. The longer the salmonid is exposed to thermal stress, the less chance it has for long-term survival (Ligon et al. 1999).

The Hoopa Valley Tribe is proposing the following temperature criteria ***(Table 4)*** for Reservation tributaries to meet the biological requirements of salmonids during their various life stages. Life Stages and timeframes, which are based on the Trinity River Flow Evaluation (TRFE), differ on the Hoopa Reservation as compared to the dates outlined in the NCRWQCB and Region X documents. For comparison purposes ***Table 5*** shows the NCRWQCB and USEPA Region X proposed temperature criteria based on life stage and data summary types (MWAT, MWMT, and Instantaneous Maximum).

Table 4 –Tributary Temperature Criteria for the HVIR by Life Stage and Hydrologic Year Type

Salmonid Life Stage	**Timeframe**	**(*C)**	**(*F)**
Dry and Critically Dry Years		**Tributaries**	
Adult Holding/Coho Incubation & Emergence/Spawning/Smoltification	May 23 to June 4	14.0	57.2
Adult Holding/Peak Temperatures Timeframe According to Hoopa Tribal Data	June 5 to July 9	17.0	62.6
Adult Holding	July 10 to September 14	20.0	68.0
Adult Holding/Spawning	September 15 to October 31	16.0	60.8
Adult Incubation & Emergence (Including Coho)/Smoltification/Spawning	November 1 to May 22	12.0	53.6
Extremely Wet, Wet, and Normal Years		**Tributaries**	
Adult Holding/Coho Incubation & Emergence/Spawning/Smoltification	May 23 to June 4	13.0	55.4
Adult Holding/Peak Temperatures Timeframe According to Hoopa Tribal Data	June 5 to July 9	16.0	60.8
Adult Holding	July 10 to September 14	18.0	64.4
Adult Holding/Spawning	September 15 to October 31	14.0	57.2
Adult Incubation & Emergence (Including Coho)/Smoltification/Spawning	November 1 to May 22	10.0	50.0
Adult Migration and Juvenile Rearing are considered All Year Life Stages			

Table 5 –NCRWQCB Temperature Requirements of Salmonids (January 2005)

		NCWQCB			Region X	
Life Stage	**Time Period**	**MWAT**	**MWMT**	**Inst. Max**	**MWAT**	**MWMT**
Adult Migration	All Year	15.0	17.0	21.0	18.0	20.0
Incubation/Emergence (Coho)	Nov-Jun	10.0	12.0	22.0	12.0	14.0
Smoltification	Jan-Jun	12.0	14.0	22.0	14.0	16.0
Incubation/Emergence (Except Coho)	Jan-May	11.0	13.0	22.0	13.0	15.0
Spawning	Sept-Apr	11.0	13.0	22.0	13.0	15.0
Adult Holding	May-Dec	14.0	16.0	22.0	16.0	18.0
Juvenile Rearing	All Year	15.0	17.0	22.0	16.0	18.0

The temperatures listed in ***Table 5*** are based on the maximum weekly average temperature (MWAT) which is defined as the highest 7-day moving average of equally spaced water temperature measurements for a given time period. In this application, the time period is the duration of the existing salmonid life stage. For the MWAT objective, the water temperatures in the stream may not exceed the numeric objective for every 7-day period during the given life stage.

> *The recommended metric for all of the temperature criteria is the maximum weekly average temperature (MWAT). This metric is recommended because it describes the maximum temperatures in a stream, but is not overly influenced by the maximum temperature of a single day. Thus, it reflects an average of maximum temperatures that fish are exposed to over a week-long period. Since this metric is oriented to daily maximum temperatures, it can be used to protect against acute effects, such as lethality and migration blockage conditions.*

Reservation Temperature Exceedances

Temperature exceedances will be documented as running seven-day average for each time period and life stage. A watershed will be considered to have exceeded the temperature standard when 2 or more exceedances occur during the rearing period and/or 3 or more during adult migration and maintenance period. If a watershed is documented as having exceedances of the temperature criteria for 3 or more years within the 5-year assessment period, then it will be considered as a violation of the standard. If however, land management activities are modified in such a way as to influence a reduction in stream temperatures within the 5 year assessment period then the watershed will be placed into recovery status and will be evaluated for an additional 3 years before making a final determination of watershed impairment. In the case when natural surface water temperatures exceed the numeric criteria due to naturally high ambient air temperatures and/or with abnormally low stream flows due to drought conditions, temperatures that surpass the criteria will not be documented as "exceedances under normal conditions".

We recognize that in some streams, the numeric objectives may not be achievable due to site specific limitations. In this case, the Hoopa Tribe may consider site specific objectives if the following conditions are met:

- The stream has been restored to its full site potential,
- The salmonid population is at a level consistent with NOAA Fisheries concept of a Viable Salmonid Population

De Minimis Temperature Increase Allowance

The Hoopa Tribal Reservation Tributary Temperature Criteria allows for a de minimis temperature increase above the numeric criteria or the natural background temperature. We choose to include a de minimis increase allowance as a way of accounting for monitoring measurement error and tolerating negligible human impacts.

If a particular tributary exceeds a temperature numeric criterion due to natural conditions (or natural conditions plus a de minimis human impact), then the waterbody need not be listed on the Tribe's 303(d) list as temperature impaired. Such waterbodies would not be considered impaired because they would be meeting the narrative natural background provisions of the Hoopa Temperature Criteria. These tributaries should be identified as an attachment to the Tribe's section 303(d) list submission to EPA along with the demonstration that these waters do not exceed the natural background provision.

For situations where waterbodies exceed the applicable numeric criteria due to a combination of apparent natural background conditions and known or suspected human impacts (above a de minimis impact level), it would be appropriate to list those waters on the 303(d) list because the waters would be exceeding the narrative natural background provision because of the human impacts. The TMDL process will provide the opportunity to distinguish the natural sources from the human caused sources.

Appendix E
Preliminary Remediation Goals

USERS' GUIDE AND BACKGROUND TECHNICAL DOCUMENT
FOR
USEPA REGION 9'S PRELIMINARY REMEDIATION GOALS (PRG) TABLE

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DISCLAIMER

Preliminary remediation goals (PRGs) focus on common exposure pathways and may not consider all exposure pathways encountered at CERCLA / RCRA sites (Exhibit 1-1). PRGs do not consider impact to groundwater or address ecological concerns. The PRG Table is specifically not intended as a (1) stand-alone decision-making tool, (2) as a substitute for EPA guidance for preparing baseline risk assessments, (3) a rule to determine if a waste is hazardous under RCRA, or (4) set of final cleanup or action levels to be applied at contaminated sites.

The guidance set out in this document is not final Agency action. It is not intended, nor can it be relied upon to create any rights enforceable by any party in litigation with the United States. EPA officials may decide to follow the guidance provided herein, or act at variance with the guidance, based on an analysis of specific circumstances. The Agency also reserves the right to change this guidance at any time without public notice.

1.0 INTRODUCTION

Region 9 Preliminary Remediation Goals (PRGs) are risk-based tools for evaluating and cleaning up contaminated sites. They are being used to streamline and standardize all stages of the risk decision-making process.

The Region 9 PRG Table combines current human health toxicity values with standard exposure factors to estimate contaminant concentrations in environmental media (soil, air, and water) that are considered by the Agency to be health protective of human exposures (including sensitive groups), over a lifetime. Chemical concentrations above these levels would not automatically designate a site as "dirty" or trigger a response action. However, exceeding a PRG suggests that further evaluation of the potential risks that may be posed by site contaminants is appropriate. Further evaluation may include additional sampling, consideration of ambient levels in the environment, or a reassessment of the assumptions contained in these screening-level estimates (e.g. appropriateness of route-to-route extrapolations, appropriateness of using chronic toxicity values to evaluate childhood exposures, appropriateness of generic exposure factors for a specific site etc.).

The risk-based concentrations presented in the Table may be used as screening goals or initial cleanup goals if applicable. Generally a screening goal is intended to provide health protection without knowledge of the specific exposure conditions at a site. PRGs may also be used as initial cleanup goals when the exposure assumptions based on site-specific data match up with the default exposure assumptions in the PRG Table. When considering PRGs as cleanup goals, it is EPA’s preference to assume maximum beneficial use of a property (that is, residential use) unless a non-residential number (for example, industrial soil PRG) can be justified.

Before applying PRGs at a particular site, the Table user should consider whether the exposure pathways and exposure scenarios at the site are fully accounted for in the PRG calculations. Region 9 PRG concentrations are based on direct contact pathways for which generally accepted methods, models, and assumptions have been developed (i.e. ingestion, dermal contact, and inhalation) for specific land-use conditions and do not consider impact to groundwater or ecological receptors (see Developing a Conceptual Site Model below).

EXHIBIT 1-1
TYPICAL EXPOSURE PATHWAYS BY MEDIUM FOR RESIDENTIAL AND INDUSTRIAL LAND USES[a]

	EXPOSURE PATHWAYS, ASSUMING:	
MEDIUM	RESIDENTIAL LAND USE	INDUSTRIAL LAND USE
Ground Water	***Ingestion from drinking***	Ingestion from drinking
	Inhalation of volatiles	Inhalation of volatiles
	Dermal absorption from bathing	Dermal absorption
Surface Water	***Ingestion from drinking***	Ingestion from drinking
	Inhalation of volatiles	Inhalation of volatiles
	Dermal absorption from bathing	Dermal absorption
	Ingestion during swimming	
	Ingestion of contaminated fish	
Soil	***Ingestion***	***Ingestion***
	Inhalation of particulates	***Inhalation of particulates***
	Inhalation of volatiles	***Inhalation of volatiles***
	Exposure to indoor air from soil gas	Exposure to indoor air from soil gas
	Exposure to ground water contaminated by soil leachate	Exposure to ground water contaminated by soil leachate
	Ingestion via plant, meat, or dairy products	Inhalation of particulates from trucks and heavy equipment
	Dermal absorption	***Dermal absorption***

Footnote:

[a] Exposure pathways considered in the PRG calculations are indicated in boldface italics.

2.0 READING THE PRG TABLE

2.1 General Considerations

With the exceptions described below, PRGs are chemical concentrations that correspond to fixed levels of risk (i.e. either a one-in-one million [10^{-6}] cancer risk or a noncarcinogenic hazard quotient of 1) in soil, air, and water. In most cases, where a substance causes both cancer and noncancer (systemic) effects, the 10^{-6} cancer risk will result in a more stringent criteria and consequently this value is presented in the printed copy of the Table. PRG concentrations that equate to a 10^{-6} cancer risk are indicated by "ca". PRG concentrations that equate to a hazard quotient of 1 for noncarcinogenic concerns are indicated by "nc".

If the risk-based concentrations are to be used for site screening, it is recommended that both cancer and noncancer-based PRGs be used. Both carcinogenic and noncarcinogenic values may be obtained at the Region 9 PRG homepage at:

http://www.epa.gov/region09/waste/sfund/prg/

It has come to my attention that some users have been multiplying the cancer PRG concentrations by 10 or 100 to set "action levels" for triggering remediation or to set less stringent cleanup levels for a specific site after considering non-risk-based factors such as ambient levels, detection limits, or technological feasibility. This risk management practice recognizes that there may be a range of values that may be "acceptable" for carcinogenic risk (EPA's risk management range is one-in-a-million [10^{-6}] to one-in-ten thousand [10^{-4}]). However, this practice could lead one to overlook serious noncancer health threats and it is strongly recommended that the user consult with a toxicologist or regional risk assessor before doing this. For carcinogens, I have indicated by asterisk ("ca*") in the PRG Table where the noncancer PRGs would be exceeded if the cancer value that is displayed is multiplied by 100. Two stars ("ca**") indicate that the noncancer values would be exceeded if the cancer PRG were multiplied by 10. There is no range of "acceptable" noncarcinogenic "risk" so that under no circumstances should noncancer PRGs be multiplied by 10 or 100, when setting final cleanup criteria. In the rare case where noncancer PRGs are more stringent than cancer PRGs set at one-in-one-million risk, a similar approach has been applied (e.g. “nc**”).

In general, PRG concentrations in the printed Table are risk-based but for soil there are two important exceptions: (1) for several volatile chemicals, PRGs are based on the soil saturation equation ("sat") and (2) for relatively less toxic inorganic and semivolatile contaminants, a non-risk based "ceiling limit" concentration is given as 10^{+5} mg/kg ("max"). At the Region 9 PRG website, the risk-based calculations for these same chemicals are also available in the “InterCalc Tables” if the user wants to view the risk-based concentrations prior to the application of “sat” or “max”. For more information on why the “sat” value and not a risk-based value is presented for several volatile chemicals in the PRG Table, please see the discussion in Section 4.6.

With respect to applying a “ceiling limit” for chemicals other than volatiles, it is recognized that this is not a universally accepted approach. Some within the agency argue that all values should be risk-based to allow for scaling (for example, if the risk-based PRG is set at a hazard quotient = 1.0, and the user would like to set the hazard quotient to 0.1 to take into account multiple chemicals, then this is as simple as multiplying the risk-based PRG by 1/10th). If scaling is necessary, PRG users can do this simply by referring to the “InterCalc Tables” at our website where risk-based soil concentrations are presented for all chemicals (see soil calculations, “combined” pathways column).

In spite of the fact that applying a ceiling limit is not a universally accepted approach, we have opted to continue applying a “max”soil concentration to the PRG Table for the following reasons:

- Risk-based PRGs for some chemicals in soil exceed unity (>1,000,000 mg/kg) which is not possible.
- The ceiling limit of 10^{+5} mg/kg is equivalent to a chemical representing 10% by weight of the soil sample. At this contaminant concentration (and higher), the assumptions for soil contact may be violated (for example, soil adherence and windborne dispersion assumptions) due to the presence of the foreign substance itself.
- PRGs currently do not address short-term exposures (e.g. pica children and construction workers). Although extremely high soil PRGs are likely to represent relatively non-toxic chemicals, such high values may not be justified if in fact more toxicological data were available for evaluating short-term and/or acute exposures.

In addition to Region 9 PRG values, the PRG Table also includes California EPA PRGs ("CAL-Modified PRGs") for specific chemicals where CAL-EPA screening values may deviate significantly from the federal values (see Section 2.4) and EPA OSWER soil screening levels (SSLs) for protection of groundwater (see Section 2.5).

2.2 Toxicity Values

Hierarchy of Toxicity Values

There is a new hierarchy of human health toxicity values that replaces earlier guidance. This is important because human toxicity values known as cancer slope factors (SF) or non-cancer reference doses (RfDs) form the basis of the PRG values listed in the table. As noted in OSWER Directive 9285.7-53 (dated December 5, 2003), the updated EPA hierarchy is as follows: Tier 1 - EPA’s Integrated IRIS, Tier 2 - EPA’s Provisional Peer Reviewed Toxicity Values (PPRTVs), and Tier 3 - Other Toxicity Values. Tier 3 includes additional EPA sources (e.g. historic HEAST and NCEA provisional values) and non-EPA sources of toxicity information (e.g. California EPA toxicity values).

The PRG Table lists Tier 1 toxicity values from IRIS as “i” and Tier 2 toxicity values known as PPRTVs as “p”. Tier 3 toxicity values were obtained from various sources including California EPA databases “c”, historic HEAST tables “h” and NCEA provisional values “n”.

Inhalation Conversion Factors

As of January 1991, IRIS and NCEA databases no longer present RfDs or SFs for the inhalation route. These criteria have been replaced with reference concentrations (RfC) for noncarcinogenic effects and unit risk factors (URF) for carcinogenic effects. However, for purposes of estimating risk and calculating risk-based concentrations, inhalation reference doses (RfDi) and inhalation slope factors (SFi) are preferred. This is not a problem for most chemicals because the inhalation toxicity criteria are easily converted. To calculate an RfDi from an RfC, the following equation and assumptions may be used for most chemicals:

$$\text{RfDi}\ \frac{\text{mg}}{(\text{kg-day})} = \text{RfC}\,(\text{mg}/\text{m}^3) \times \frac{20\text{m}^3}{\text{day}} \times \frac{1}{70\text{kg}}$$

Likewise, to calculate an SFi from an inhalation URF, the following equation and assumptions may be used:

$$\text{SFi}\ \frac{(\text{kg-day})}{(\text{mg})} = \text{URF}\,(\text{m}^3\ /\text{ug}) \times \frac{\text{day}}{20\text{m}^3} \times 70\text{kg} \times \frac{10^3\ \text{ug}}{\text{mg}}$$

Route-to-Route Methods

Route-to-route extrapolations ("r") were frequently used when there were no toxicity values available for a given route of exposure. Oral cancer slope factors ("SFo") and reference doses ("RfDo") were used for both oral and inhaled exposures for organic compounds lacking inhalation values. Inhalation slope factors ("SFi") and inhalation reference doses ("RfDi") were used for both inhaled and oral exposures for organic compounds lacking oral values. Route extrapolations were not performed for inorganics due to portal of entry effects and known differences in absorption efficiency for the two routes of exposure.

An additional route extrapolation is the use of oral toxicity values for evaluating dermal exposures. In general, dermal toxicity values are not listed in EPA databases and consequently must be estimated from oral toxicity information. However, a scientifically defensible data base often does not exist for making an adjustment to the oral slope factor/RfD so that the oral toxicity value is often applied without adjustment to estimate a dermal toxicity value. For more information please refer to recent Agency guidance (USEPA 2004) entitled *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)* available on the web at: http://www.epa.gov/superfund/programs/risk/ragse/index.htm

Please note that whenever route-extrapolated values are used to calculate risk-based PRGs, additional uncertainties are introduced in the calculation.

2.3 PRGs Derived with Special Considerations

Most of the Region 9 PRGs are readily derived by referring to Equations 4-1 thru 4-8 contained in this "User's Guide/Technical Background Document" to the Region 9 PRGs. However, there are some chemicals for which the standard equations do no apply and/or adjustments to the toxicity values are recommended. These special case chemicals are discussed below.

<u>Cadmium</u> The PRGs for Cadmium are based on the oral RfD for water which is slightly more conservative (by a factor of 2) than the RfD for food. Because the PRGs are considered screening values, we elected to use the more conservative RfD for cadmium. However, reasonable arguments could be made for applying an RfD for food (instead of the oral RfD for water) for some media such as soils.

The water RfD for cadmium assumes a 5% oral absorption factor. The assumption of an oral absorption efficiency of 5% for Cadmium leads to an estimated dermal RfD of 2.5E-05. The PRG calculations incorporate these adjustments per recent guidance (USEPA 2004).

<u>Chromium 6</u> For Chromium 6 (Cr6), IRIS shows an air unit risk of 1.2E-2 per (ug/cu.m) or expressed as an inhalation cancer slope factor (adjusting for inhalation/body weight) of 42 (mg/kg-day)$^{-1}$. However, the supporting documentation in the IRIS file states that these toxicity values are based on an assumed 1:6 ratio of Cr6:Cr3. Because of this assumption, we in Region 9 prefer to present PRGs based on these cancer toxicity values as "total chromium" numbers.

In the PRG Table, we also include a Cr6 specific value (assuming 100% Cr6) that is derived by multiplying the "total chromium" value by 7, yielding a cancer potency factor of 290 (mg/kg-day)$^{-1}$. This is considered to be an overly conservative assumption by some within the Agency. However, this calculation is also consistent with the State of California's interpretation of the Mancuso study that forms the basis of Cr6's toxicity values.

If you are working on a project outside of California (and outside of Region 9), you may want to contact the appropriate regulatory officials to determine what their position is on this issue. As mentioned, Region 9 also includes PRGs for "total chromium" which is based on the same ratio (1:6 ratio Cr6:Cr3) that forms the basis of the cancer slope factor of 42 (mg/kg-day)$^{-1}$ presented in IRIS.

<u>Dioxin</u> Dioxins, furans, and some polychlorinated biphenyls are members of the same family and exhibit similar toxicological properties. Before using the dioxin PRG at an individual site, these dioxin-related compounds must be summed together. However, they differ in the degree of toxicity so that a toxicity equivalence factor (TEF) must first be applied to adjust the measured concentrations to a toxicity equivalent concentration. EPA Region 9 has adopted the 1997 World Health Organization (WHO) TEFs. For more on this, please refer to the following article (in Environmental Health Perspectives, Vol. 6, No. 12, Dec. 1998) online at: http://ehp.niehs.nih.gov/members/1998/106p775-792vandenberg/vandenberg-full.html

Lead Residential PRGs for Lead (Region 9 EPA and California EPA) are derived based on pharmacokinetic models. Both EPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model and California's LeadSpread model are designed to predict the probable blood lead concentrations for children between six months and seven years of age who have been exposed to lead through various sources (air, water, soil, dust, diet and *in utero* contributions from the mother). Run in the reverse, these models also allow the user to calculate lead PRGs that are considered "acceptable" by EPA or the State of California.

EPA uses a second Adult Lead Model to estimate PRGs for an industrial setting. This PRG is intended to protect a fetus that may be carried by a pregnant female worker. It is assumed that a cleanup goal that is protective of a fetus will also afford protection for male or female adult workers. The model equations were developed to calculate cleanup goals such that there would be no more than a 5% probability that fetuses exposed to lead would exceed a blood lead (PbB) of 10 Fg/dL. An updated screening level for soil lead at commercial/industrial (i.e., non-residential) sites of 800 ppm is based on a recent analysis of the combined phases of NHANES III that chooses a cleanup goal protective of all subpopulations.

For more information on EPA's lead models and other lead-related topics, please go to:
http://www.epa.gov/oerrpage/superfund/programs/lead/

For more information on California's LeadSpread Model and Cal-Modified PRGs for lead, please go to:
http://www.dtsc.ca.gov/ScienceTechnology/ledspred.html

Manganese The IRIS RfD (0.14 mg/kg-day) includes manganese from all sources, including diet. The author of the IRIS assessment for manganese recommends that the dietary contribution from the normal U.S. diet (an upper limit of 5 mg/day) be subtracted when evaluating non-food (e.g. drinking water or soil) exposures to manganese, leading to a RfD of 0.071 mg/kg-day for non-food items. The explanatory text in IRIS further recommends using a modifying factor of 3 when calculating risks associated with non-food sources due to a number of uncertainties that are discussed in the IRIS file for manganese, leading to a RfD of 0.024 mg/kg-day. This modified RfD is applied in the derivation of the Region 9 PRGs for soil and water. For more information regarding the Manganese RfD, you may want to contact Dr. Bob Benson at (303) 312-7070.

Nitrates/Nitrates Tap water PRGs for Nitrates/Nitrites are based on the MCL as there is no available RfD for these compounds. For more information, please see IRIS at:
http://www.epa.gov/iriswebp/iris/index.html

Thallium IRIS has many values for the different salts of thallium. However, our analytical data packages typically report "thallium". Therefore, as a practical matter it makes more sense to report a PRG for plain thallium. We have done this by making the adjustment contained in the IRIS file for thallium sulfate based on the molecular weight of the thallium in the thallium salt. The adjusted oral RfD for plain thallium is 6.6 E-05 mg/kg-day which we use to calculate a thallium PRG.

Vinyl Chloride In EPA's recent reassessment of vinyl chloride toxicity, IRIS presents two cancer slope factors for vinyl chloride (VC): one that is intended to be applied towards evaluating adult risks and a second more protective slope factor that takes into account the unique susceptibility of developing infants and young children. For residential PRGs, the Region 9 PRG Table applies the more conservative cancer potency factor that addresses exposures to both children and adults whereas for the industrial soils PRG, the adult only cancer slope factor is applied.

Because of the age-dependent vulnerability associated with vinyl chloride exposures, and due to the method that is applied in deriving the cancer slope factor for VC, an assumption of a 70 year exposure over the lifetime is assumed, consistent with the way that the toxicity value for VC was derived. Therefore, instead of the usual exposure assumption of 6 years as a child and 24 years as an adult that is assumed for carcinogenic substances, we have revised the exposure assumption for VC to 6 years as a child and 64 years as adult. Since most of the cancer risk is associated with the first 30 years of exposure to VC, there is actually little difference between a 30 year exposure assumption (typically assumed for Superfund risk assessments) and the 70 year exposure assumption that is assumed in calculating the PRG for VC.

2.4 Cal-Modified PRGs

When EPA Region 9 first came out with a Draft of the PRG Table in 1992, there was concern expressed by California EPA's Department of Toxic Substances and Control (DTSC) that for some chemicals, the risk-based concentrations that are calculated using Cal-EPA toxicity values are "significantly" more protective than the risk-based concentrations that are calculated using EPA toxicity values. Because the risk-based PRGs are order-of-magnitude estimates at best, it was agreed by both Agencies that a difference of approximately 4 or greater would be regarded as a significant difference.   For chemicals with California and EPA values that differ by a factor of 4 or more, both the EPA PRGs and the "Cal-Modified PRGs" are listed in the Table.

Please note that in the State of California, Cal-Modified PRGs should be used as screening levels for contaminated sites if they are more stringent than the Federal numbers.

2.5 Soil Screening Levels

Generic, soil screening levels (SSLs) for the protection of groundwater have been included in the PRG Table for 100 of the most common contaminants at Superfund sites. Generic SSLs are derived using default values in standardized equations presented in EPA OSWER's *Soil Screening Guidance* series, available on the web at http://www.epa.gov/superfund/resources/soil/index.htm .

The SSLs were developed using a default dilution-attenuation factor (DAF) of 20 to account for natural processes that reduce contaminant concentrations in the subsurface. Also included are generic SSLs that assume no dilution or attenuation between the source and the receptor well (i.e., a DAF of 1). These values can be used at sites where little or no dilution or attenuation of soil leachate concentrations is expected at a site (e.g., sites with shallow water tables, fractured media, karst topography, or source size greater than 30 acres).

In general, if an SSL is not exceeded for the migration to groundwater pathway, the user may eliminate this pathway from further investigation.

It should be noted that in the State of California, the California Regional Water Quality Control Board has derived “California SSLs” for a number of pathways including migration to groundwater. These are not included in the Region 9 PRG Table, but may be accessed at the following website:

http://www.swrcb.ca.gov/rwqcb2/rbsl.htm

Or, for more information on the “California SSLs”, please contact Dr Roger Brewer at: (510) 622-2374.

2.6 Miscellaneous

Volatile organic compounds (VOCs) are indicated by "y" in the VOC column of the Table and in general, are defined as those chemicals having a Henry's Law constant greater than 10^{-5} (atm-m^3/mol) and a molecular weight less than 200 g/mole). Three borderline chemicals (dibromochloromethane, 1,2-dibromochloropropane, and pyrene) which do not strictly meet these criteria of volatility have also been included based upon discussions with other state and federal agencies and after a consideration of vapor pressure characteristics etc. Volatile organic chemicals are evaluated for potential volatilization from soil/water to air using volatilization factors (see Section 4.4).

Chemical-specific dermal absorption values for contaminants in soil and dust are presented for arsenic, cadmium, chlordane, 2,4-D, DDT, lindane, TCDD, PAHs, PCBs, and pentachlorophenols as recommended in the *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim Guidance* (USEPA 2004). Otherwise, default skin absorption fractions are assumed to be 0.10 for nonvolatile organics. Please note that previous defaults of 0.01 and 0.10 for inorganics and VOCs respectively, have been withdrawn per new guidance.

3.0 USE OF PRGS AT SITES

The decision to use PRGs at a site will be driven by the potential benefits of having generic risk-based concentrations in the absence of site-specific risk assessments. The original intended use of PRGs was to provide initial cleanup goals for individual chemicals given specific medium and land-use combinations (see RAGS Part B, 1991), however risk-based concentrations have several applications. They can also be used for:

- Setting health-based detection limits for chemicals of potential concern
- Screening sites to determine whether further evaluation is appropriate
- Calculating cumulative risks associated with multiple contaminants

A few basic procedures are recommended for using PRGs properly. These are briefly described below. Potential problems with the use of PRGs are also identified.

3.1 Conceptual Site Model

The primary condition for use of PRGs is that exposure pathways of concern and conditions at the site match those taken into account by the PRG framework. Thus, it is always necessary to develop a conceptual site model (CSM) to identify likely contaminant source areas, exposure pathways, and potential receptors. This information can be used to determine the applicability of PRGs at the site and the need for additional information. For those pathways not covered by PRGs, a risk assessment specific to these additional pathways may be necessary. Nonetheless, the PRG lookup values will still be useful in such situations for focusing further investigative efforts on the exposure pathways not addressed.

To develop a site-specific CSM, perform an extensive records search and compile existing data (e.g. available site sampling data, historical records, aerial photographs, and hydrogeologic information). Once this information is obtained, CSM worksheets such as those provided in ASTM's *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites* (1995) can be used to tailor the generic worksheet model to a site-specific CSM. The final CSM diagram represents linkages among contaminant sources, release mechanisms, exposure pathways and routes and receptors. It summarizes our understanding of the contamination problem.

As a final check, the CSM should answer the following questions:

- Are there potential ecological concerns?
- Is there potential for land use other than those covered by the PRGs (that is, residential and industrial)?
- Are there other likely human exposure pathways that were not considered in development of the PRGs (e.g. impact to groundwater, local fish consumption, raising beef, dairy, or other livestock)?
- Are there unusual site conditions (e.g. large areas of contamination, high fugitive dust levels, potential for indoor air contamination)?

If any of these four conditions exist, the PRG may need to be adjusted to reflect this new information. Suggested websites for the evaluation of pathways not currently addressed by Region 9 PRG's are presented in Exhibit 3-1.

EXHIBIT 3-1
SUGGESTED WEBSITES FOR EVALUATING EXPOSURE PATHWAYS NOT CURRENTLY ADDRESSED BY REGION 9 PRGs

EXPOSURE PATHWAY	WEBSITE
Migration of contaminants to an underlying potable aquifer	EPA Soil Screening Guidance: http://www.epa.gov/superfund/resources/soil/index.htm California Water Board Guidance: http://www.swrcb.ca.gov/rwqcb2/rbsl.htm
Ingestion via plant uptake	EPA Soil Screening Guidance: http://www.epa.gov/superfund/resources/soil/index.htm EPA Fertilizer Risk Assessment: http://www.epa.gov/epaoswer/hazwaste/recycle/fertiliz/risk/
Ingestion via meat, dairy products, human milk	EPA Protocol for Combustion Facilities: http://www.epa.gov/epaoswer/hazwaste/combust/riskvol.htm#volume1 California “Hot Spots” Risk Guidelines: http://www.oehha.ca.gov/air/hot_spots/HRSguide.html
Inhalation of volatiles that have migrated into basements or other enclosed spaces.	EPA’s draft Subsurface Vapor Intrusion Guidance: http://www.epa.gov/correctiveaction/eis/vapor.htm EPA’s Version of Johnson & Ettinger Model: http://www.epa.gov/oerrpage/superfund/programs/risk/airmodel/johnson_ettinger.htm
Ecological pathways	EPA Ecological Soil Screening Guidance: http://www.epa.gov/superfund/programs/risk/ecorisk/ecossl.htm NOAA Sediment Screening Table: http://response.restoration.noaa.gov/cpr/sediment/squirt/squirt.html

3.2 Background Levels Evaluation

A necessary step in determining the applicability of Region 9 risk-based PRGs is the consideration of background contaminant concentrations. There is new EPA guidance on determining background at sites. *Guidance for Characterizing Background Chemicals in Soil at Superfund Sites* (USEPA 2001b) is available on the web at: http://www.epa.gov/superfund/programs/risk/background.pdf .

EPA may be concerned with two types of background at sites: naturally occurring and anthropogenic. Natural background is usually limited to metals whereas anthropogenic (i.e. human-made) “background” includes both organic and inorganic contaminants. Before embarking on an extensive sampling and analysis program to determine local background concentrations in the area, one should first compile existing data on the subject. Far too often there is pertinent information in the literature that gets ignored, resulting in needless expenditures of time and money.

Generally EPA does not clean up below natural background. In some cases, the predictive risk-based models generate PRG concentrations that lie within or even below typical background concentrations for the same element or compound. If natural background concentrations are higher than the risk-based PRG concentrations, then background concentrations should also be considered in determining whether further evaluation and/or remediation is necessary at a particular site. Exhibit 3-2 presents summary statistics for selected elements in soils that have background levels that may exceed risk-based PRGs.

Where anthropogenic “background” levels exceed PRGs and EPA has determined that a response action is necessary and feasible, EPA's goal will be to develop a comprehensive response to the widespread contamination. This will often require coordination with different authorities that have jurisdiction over the sources of contamination in the area.

EXHIBIT 3-2
BACKGROUND CONCENTRATIONS OF SELECTED ELEMENTS IN SOILS

TRACE ELEMENT	**U.S. STUDY DATA[1]**			**CALIFORNIA DATA[2]**		
	Range	GeoMean	ArMean	Range	GeoMean	ArMean
Arsenic	<.1-97	5.2 mg/kg	7.2 mg/kg	0.59-11	2.75 mg/kg	3.54 mg/kg
Beryllium	<1-15	0.63 “	0.92 “	0.10-2.7	1.14 “	1.28 “
Cadmium	<1-10	--	<1	0.05-1.7	0.26	0.36
Chromium	1-2000	37	54	23-1579	76.25	122.08
Nickel	<5-700	13	19	9.0-509	35.75	56.60

[1] Shacklette and Hansford, “Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States”,USGS Professional Paper 1270, 1984.

[2] Bradford et. al, “Background Concentrations of Trace and Major Elements in California Soils”, Kearney Foundation Special Report, UC-Riverside and CAL-EPA DTSC, March 1996.

3.3 Screening Sites with Multiple Pollutants

A suggested stepwise approach for PRG-screening of sites with multiple pollutants is as follows:

- Perform an extensive records search and compile existing data.

- Identify site contaminants in the PRG Table. Record the PRG concentrations for various media and note whether PRG is based on cancer risk (indicated by "ca") or noncancer hazard (indicated by "nc"). Segregate cancer PRGs from non-cancer PRGs and exclude (but don't eliminate) non-risk based PRGs ("sat" or "max").

- For cancer risk estimates, take the site-specific concentration (maximum or 95 UCL) and divide by the PRG concentrations that are designated for cancer evaluation ("ca"). Multiply this ratio by 10^{-6} to estimate chemical-specific risk for a reasonable maximum exposure (RME). For multiple pollutants, simply add the risk for each chemical:

$$Risk = [(\frac{conc_x}{PRG_x}) + (\frac{conc_y}{PRG_y}) + (\frac{conc_z}{PRG_z})]\ x\ 10^{-6}$$

- For non-cancer hazard estimates. Divide the concentration term by its respective non-cancer PRG designated as "nc" and sum the ratios for multiple contaminants. The cumulative ratio represents a non-carcinogenic hazard index (HI). A hazard index of 1 or less is generally considered “safe”. A ratio greater than 1 suggests further evaluation. **[Note that carcinogens may also have an associated non-cancer PRG that is not listed in the PRG Table. To obtain these values, the user should view or download the InterCalc Tables at the PRG website and display the appropriate sections.]**

$$Hazard\ Index = [(\frac{conc_x}{PRG_x}) + (\frac{conc_y}{PRG_y}) + (\frac{conc_z}{PRG_z})]$$

For more information on screening site risks, the reader should contact EPA Region 9's Technical Support Section.

3. 4 Potential Problems

As with any risk-based tool, the potential exists for misapplication. In most cases the root cause will be a lack of understanding of the intended use of Region 9 PRGs. In order to prevent misuse of PRGs, the following should be avoided:

- Applying PRGs to a site without adequately developing a conceptual site model that identifies relevant exposure pathways and exposure scenarios,

- Not considering background concentrations when choosing PRGs as cleanup goals,

- Use of PRGs as cleanup levels without the nine-criteria analysis specified in the National Contingency Plan (or, comparable analysis for programs outside of Superfund),

- Use of PRGs as cleanup levels without verifying numbers with a toxicologist or regional risk assessor,

- Use of antiquated PRG Tables that have been superseded by more recent publications,
- Not considering the effects of additivity when screening multiple chemicals, and
- Adjusting PRGs upward by factors of 10 or 100 without consulting a toxicologist or regional risk assessor.

4.0 TECHNICAL SUPPORT DOCUMENTATION

Region 9 PRGs consider human exposure hazards to chemicals from contact with contaminated soils, air, and water. The emphasis of the PRG equations and technical discussion are aimed at developing screening criteria for soils, since this is an area where few standards exist. For air and water, additional reference concentrations or standards are available for many chemicals (e.g. MCLs, non-zero MCLGs, AWQC, and NAAQS) and consequently the discussion of these media are brief.

4.1 Ambient Air and the Vapor Intrusion Pathway

The ambient air PRG is applicable to both indoor and outdoors and is based on a residential exposure scenario using standard Superfund exposure factors (see Exhibit 4-1 below).

The air PRG may also be used as a health-protective indoor air target for determining soil gas and groundwater screening levels for the evaluation of the subsurface vapor intrusion pathway. The “vapor intrusion pathway” refers to the migration of volatile chemicals from the subsurface into overlying buildings. Volatile chemicals in buried wastes and/or contaminated groundwater can emit vapors that may migrate through subsurface soils and into indoor air spaces of overlying buildings in ways similar to that of radon gas seeping into homes.

To derive a soil gas and/or groundwater screening level that targets the air PRG, it is necessary to divide the air PRG by an appropriate attenuation factor. The attenuation factor represents the factor by which subsurface vapor concentrations migrating into indoor air spaces are reduced due to diffusive, advective, and/or other attenuating mechanisms. The attenuation factor can be empirically determined and/or calculated using an appropriate vapor intrusion model such as the Johnson and Ettinger model available at: http://www.epa.gov/oerrpage/superfund/programs/risk/airmodel/johnson_ettinger.htm . Once the appropriate attenuation factor is determined, the following equation can be used to derive a screening level that would be protective of indoor air assuming residential land use.

For Soil Gas, the relationship is as follows:

$C_{soil\text{-}gas}[ug/m^3] = \text{Air PRG } [ug/m^3]/AF$

where

$C_{soil\text{-}gas}$ = soil gas screening level
AF = attenuation factor (ratio of indoor air concentration to soil gas concentration)

For Groundwater, the relationship is as follows:

C_{gw}[ug/L] = Air PRG [ug/m^3] x 10^{-3} m^3/L x 1/H x 1/AF

where

C_{gw} = groundwater screening level
H = dimensionless Henry's Law Constant at 25C [(mg/L - vapor)/(mg/L - water)]
AF = attenuation factor (ratio of indoor air concentration to soil gas concentration)

For more information on EPA's current understanding of this emerging exposure pathway, please refer to EPA's recent draft guidance *Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)* (USEPA 2002) available on the web at:
http://www.epa.gov/correctiveaction/eis/vapor.htm

4.2 Soils - Direct Ingestion

Calculation of risk-based PRGs for direct ingestion of soil is based on methods presented in RAGS HHEM, Part B (USEPA 1991a) and *Soil Screening Guidance* (USEPA 1996a,b, USEPA 2001a). Briefly, these methods backcalculate a soil concentration level from a target risk (for carcinogens) or hazard quotient (for noncarcinogens).

Residential Soil PRGs

A number of studies have shown that inadvertent ingestion of soil is common among children 6 years old and younger (Calabrese et al. 1989, Davis et al. 1990, Van Wijnen et al. 1990). To take into account the higher soil intake rate for children, two different approaches are used to estimate PRGs, depending on whether the adverse health effect is cancer or some effect other than cancer.

For carcinogens, the method for calculating PRGs uses an age-adjusted soil ingestion factor that takes into account the difference in daily soil ingestion rates, body weights, and exposure duration for children from 1 to 6 years old and others from 7 to 31 years old. This health-protective approach is chosen to take into account the higher daily rates of soil ingestion in children as well as the longer duration of exposure that is anticipated for a long-term resident. For more on this method, see USEPA RAGs Part B (1991a).

For noncarcinogenic concerns, the more protective method of calculating a soil PRG is to evaluate childhood exposures separately from adult exposures. In other words, an age-adjustment factor is not applied as was done for carcinogens. This approach is considered conservative because it combines the higher 6-year exposure for children with chronic toxicity criteria. In their analysis of the method, the Science Advisory Board (SAB) indicated that, for most chemicals, the approach may be overly protective. However, they noted that there are specific instances when the chronic RfD may be based on endpoints of toxicity that are specific to children (e.g. fluoride and nitrates) or when the dose-response is steep (i.e., the dosage difference between the no-observed-adverse-effects level [NOAEL] and an adverse effects level is small). Thus, for the purposes of screening, EPA Region 9 has adopted this approach for calculating soil PRGs for noncarcinogenic health concerns.

Industrial Soil PRGs

In the *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (Supplemental SSL Guidance, EPA 2001a), two different soil ingestion rates are assumed for non-construction workers: 100 mg/day is assumed for outdoor workers whereas 50 mg/day is assumed for indoor workers. The default value of 100 mg/day for outdoor workers is also recommended by EPA's Technical Review Workgroup for Lead (TRW), and it reflects increased exposures to soils for outdoor workers relative to their indoor counterparts. For more on this, please see the Supplemental SSL Guidance available at the following website:

http://www.epa.gov/superfund/resources/soil/index.htm

Because the Region 9 PRGs are generic and intended for screening sites early in the investigation process (often before site-specific information is available), we have chosen to use the 100 mg/day soil ingestion (i.e. outdoor worker) assumption to calculate industrial soil PRGs. The appropriateness of this assumption for a particular site may be evaluated when additional information becomes available regarding site conditions or site development.

4.3 Soils - Dermal Contact

Dermal Contact Assumptions

Exposure factors for dermal contact with soil are based on recommendations in *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim Guidance* (USEPA 2004). Recommended RME (reasonable maximum exposure) defaults for adult workers' skin surface areas (3300 cm^2/day) and soil adherence factors (0.2 mg/cm^2) now differ from the defaults recommended for adult residents (5700 cm^2/day, 0.07 mg/cm^2) as noted in Exhibit 4-1. This is due to differences in the range of activities experienced by workers versus residents.

Dermal Absorption

Chemical-specific skin absorption values recommended by the Superfund Dermal Workgroup were applied when available. Chemical-specific values are included for the following chemicals: arsenic, cadmium, chlordane, 2,4-D, DDT, lindane, TCDD, PAHs, PCBs, and pentachlorophenols.

The *Supplemental Guidance for Dermal Risk Assessment* (USEPA 2004) recommends a default dermal absorption factor for semivolatile organic compounds of 10% as a screening method for the majority of SVOCs without dermal absorption factors. Default dermal absorption values for other chemicals (VOCs and inorganics) are not recommended in this new guidance. Therefore, the assumption of 1% for inorganics and 10% for volatiles is no longer included in the PRG Table. This change has minimal impact on the final risk-based calculations because human exposure to VOCs and inorganics in soils is generally driven by other pathways of exposure.

4.4 Soils - Vapor and Particulate Inhalation

Agency toxicity criteria indicate that risks from exposure to some chemicals via inhalation far outweigh the risk via ingestion; therefore soil PRGs have been designed to address this pathway as well. The models used to calculate PRGs for inhalation of volatiles/particulates are based on updates to risk assessment methods presented in RAGS Part B (USEPA 1991a) and are identical to the *Soil Screening Guidance: User's Guide and Technical Background Document* (USEPA 1996a,b).

It should be noted that the soil-to-air pathway that is evaluated in the PRGs calculations is based on inhalation exposures that result from the volatilization or particulate emissions of chemicals from soil to outdoor air. **The soil PRG calculations do not evaluate potential for volatile contaminants in soil to migrate indoors. For more on the subsurface vapor intrusion pathway please see Section 4.1.**

To address the soil-to-outdoor air pathways, the PRG calculations incorporate volatilization factors (VF_s) for volatile contaminants and particulate emission factors (PEF) for nonvolatile contaminants. These factors relate soil contaminant concentrations to air contaminant concentrations that may be inhaled on-site. The VF_s and PEF equations can be broken into two separate models: an emission model to estimate emissions of the contaminant from the soil and a dispersion model to simulate the dispersion of the contaminant in the atmosphere.

The box model in RAGS Part B has been replaced with a dispersion term (Q/C) derived from a modeling exercise using meteorological data from 29 locations across the United States because the box model may not be applicable to a broad range of site types and meteorology and does not utilize state-of-the-art techniques developed for regulatory dispersion modeling. The dispersion model for both volatiles and particulates is the AREA-ST, an updated version of the Office of Air Quality Planning and Standards, Industrial Source Complex Model, ISC2. However, different Q/C terms are used in the VF and PEF equations. Los Angeles was selected as the 90th percentile data set for volatiles and Minneapolis was selected as the 90th percentile data set for fugitive dusts (USEPA 1996 a,b). A default source size of 0.5 acres was chosen for the PRG calculations. This is consistent with the default exposure area over which Region 9 typically averages contaminant concentrations in soils. If unusual site conditions exist such that the area source is substantially larger than the default source size assumed here, an alternative Q/C could be applied (see USEPA 1996a,b).

Volatilization Factor for Soils

Volatile chemicals, defined as those chemicals having a Henry's Law constant greater than 10^{-5} (atm-m^3/mol) and a molecular weight less than 200 g/mole, were screened for inhalation exposures using a volatilization factor for soils (VF_s). Please note that VF_s's and other physical-chemical data for VOCs are contained in the InterCalc Tables at the EPA Region 9 PRG website.

The emission terms used in the VF_s are chemical-specific and were calculated from physical-chemical information obtained from several sources. The priority of these sources were as follows: *Soil Screening Guidance* (USEPA 1996a,b), *Superfund Chemical Data Matrix* (USEPA 1996c), *Fate and Exposure Data* (Howard 1991), *Subsurface Contamination Reference Guide* (EPA 1990a), and *Superfund Exposure Assessment Manual* (SEAM, EPA 1988). When there was a choice between a measured or a modeled value (e.g. Koc), our default was to use modeled values. In those cases where Diffusivity Coefficients (Di) were not provided in existing literature, Di's were calculated using Fuller's Method described in SEAM. A surrogate term was required for some chemicals that lacked physico-chemical information. In these cases, a proxy chemical of similar structure was used that may over- or under-estimate the PRG for soils.

Equation 4-9 forms the basis for deriving generic soil PRGs for the inhalation pathway. The following parameters in the standardized equation can be replaced with specific site data to develop a simple site-specific PRG

- Source area
- Average soil moisture content
- Average fraction organic carbon content
- Dry soil bulk density

The basic principle of the VF_s model (Henry's law) is applicable only if the soil contaminant concentration is at or below soil saturation "sat". Above the soil saturation limit, the model cannot predict an accurate VF-based PRG. How these particular cases are handled, depends on whether the contaminant is liquid or solid at ambient soil temperatures (see Section 4.6).

Particulate Emission Factor for Soils

Inhalation of chemicals adsorbed to respirable particles (PM_{10}) were assessed using a default PEF equal to 1. 316 x 10^9 m^3/kg that relates the contaminant concentration in soil with the concentration of respirable particles in the air due to fugitive dust emissions from contaminated soils. The generic PEF was derived using default values in Equation 4-11, which corresponds to a receptor point concentration of approximately 0.76 ug/m^3. The relationship is derived by Cowherd (1985) for a rapid assessment procedure applicable to a typical hazardous waste site where the surface contamination provides a relatively continuous and constant potential for emission over an extended period of time (e.g. years). This represents an annual average emission rate based on wind erosion that should be compared with chronic health criteria; it is not appropriate for evaluating the potential for more acute exposures.

The impact of the PEF on the resultant PRG concentration (that combines soil exposure pathways for ingestion, skin contact, and inhalation) can be assessed by accessing the Region 9 PRG website and viewing the pathway-specific soil concentrations listed in the InterCalc Tables. Equation 4-11 forms the basis for deriving a generic PEF for the inhalation pathway. For more details regarding specific parameters used in the PEF model, the reader is referred to *Soil Screening Guidance: Technical Background Document* (USEPA 1996a).

Note: the generic PEF evaluates windborne emissions and does not consider dust emissions from traffic or other forms of mechanical disturbance that could lead to greater emissions than assumed here.

4.5 Soils - Migration to Groundwater

The methodology for calculating SSLs for the migration to groundwater was developed to identify chemical concentrations in soil that have the potential to contaminate groundwater. Migration of contaminants from soil to groundwater can be envisioned as a two-stage process: (1) release of contaminant in soil leachate and (2) transport of the contaminant through the underlying soil and aquifer to a receptor well. The SSL methodology considers both of these fate and transport mechanisms.

SSLs are backcalculated from acceptable ground water concentrations (i.e. nonzero MCLGs, MCLs, or risk-based PRGs). First, the acceptable groundwater concentration is multiplied by a dilution factor to obtain a target leachate concentration. For example, if the dilution factor is 10 and the acceptable ground water concentration is 0.05 mg/L, the target soil leachate concentration would be 0.5 mg/L. The partition equation (presented in the *Soil Screening Guidance* document) is then used to calculate the total soil concentration (i.e. SSL) corresponding to this soil leachate concentration.

The SSL methodology was designed for use during the early stages of a site evaluation when information about subsurface conditions may be limited. Because of this constraint, the methodology is based on conservative, simplifying assumptions about the release and transport of contaminants in the subsurface. For more on SSLs, and how to calculate site-specific SSLs versus generic SSLs presented in the PRG Table, the reader is referred to the *Soil Screening Guidance* document (USEPA 1996a,b).

4.6 Soil Saturation Limit

The soil saturation concentration “sat” corresponds to the contaminant concentration in soil at which the absorptive limits of the soil particles, the solubility limits of the soil pore water, and saturation of soil pore air have been reached. Above this concentration, the soil contaminant may be present in free phase, i.e., nonaqueous phase liquids (NAPLs) for contaminants that are liquid at ambient soil temperatures and pure solid phases for compounds that are solid at ambient soil temperatures.

Equation 4-10 is used to calculate “sat” for each volatile contaminant. As an update to RAGS HHEM, Part B (USEPA 1991a), this equation takes into account the amount of contaminant that is in the vapor phase in soil in addition to the amount dissolved in the soil’s pore water and sorbed to soil particles.

Chemical-specific “sat” concentrations must be compared with each VF-based PRG because a basic principle of the PRG volatilization model is not applicable when free-phase contaminants are present. How these cases are handled depends on whether the contaminant is liquid or solid at ambient temperatures. Liquid contaminant that have a VF-based PRG that exceeds the “sat” concentration are set equal to “sat” whereas for solids (e.g., PAHs), soil screening decisions are based on the appropriate PRGs for other pathways of concern at the site (e.g., ingestion).

4.7 Tap Water - Ingestion and Inhalation

Calculation of PRGs for ingestion and inhalation of contaminants in domestic water is based on the methodology presented in RAGS HHEM, Part B (USEPA 1991a). Ingestion of drinking water is an appropriate pathway for all chemicals. For the purposes of this guidance, however, inhalation of volatile chemicals from water is considered routinely only for chemicals with a Henry’s Law constant of 1 x 10^{-5} atm-m^3/mole or greater and with a molecular weight of less than 200 g/mole.

For volatile chemicals, an upperbound volatilization constant (VF_w) is used that is based on all uses of household water (e.g showering, laundering, and dish washing). Certain assumptions were made. For example, it is assumed that the volume of water used in a residence for a family of four is 720 L/day, the volume of the dwelling is 150,000 L and the air exchange rate is 0.25 air changes/hour (Andelman in RAGS Part B). Furthermore, it is assumed that the average transfer efficiency weighted by water use is 50 percent (i.e. half of the concentration of each chemical in water will be transferred into air by all water uses). Note: the range of transfer efficiencies extends from 30% for toilets to 90% for dishwashers.

4.8 Default Exposure Factors

Default exposure factors were obtained primarily from RAGS Supplemental Guidance Standard Default *Exposure Factors* (OSWER Directive, 9285.6-03) dated March 25, 1991 and more recent information from U.S. EPA's Office of Solid Waste and Emergency Response, U.S. EPA's Office of Research and Development, and California EPA's Department of Toxic Substances Control (see Exhibit 4-1).

Because contact rates may be different for children and adults, carcinogenic risks during the first 30 years of life were calculated using age-adjusted factors ("adj"). Use of age-adjusted factors are especially important for soil ingestion exposures, which are higher during childhood and decrease with age. However, for purposes of combining exposures across pathways, additional age-adjusted factors are used for inhalation and dermal exposures. These factors approximate the integrated exposure from birth until age 30 combining contact rates, body weights, and exposure durations for two age groups - small children and adults. Age-adjusted factors were obtained from RAGS PART B or developed by analogy (see derivations next page).

For soils only, noncarcinogenic contaminants are evaluated in children separately from adults. No age-adjustment factor is used in this case. The focus on children is considered protective of the higher daily intake rates of soil by children and their lower body weight. For maintaining consistency when evaluating soils, dermal and inhalation exposures are also based on childhood contact rates.

(1) ingestion([mg-yr]/[kg-d]:

$$IFS_{adj} = \frac{ED_c \times IRS_c}{BW_c} + \frac{(ED_r - ED_c) \times IRS_a}{BW_a}$$

(2) skin contact([mg-yr]/[kg-d]:

$$SFS_{adj} = \frac{ED_c \times AF \times SA_c}{BW_c} + \frac{(ED_r - ED_c) \times AF \times SA_a}{BW_a}$$

(3) inhalation ([m^3-yr]/[kg-d]):

$$InhF_{adj} = \frac{ED_c \times IRA_c}{BW_c} + \frac{(ED_r - ED_c) \times IRA_a}{BW_a}$$

EXHIBIT 4-1
STANDARD DEFAULT FACTORS

Symbol	Definition (units)	Default	Reference
CSFo	Cancer slope factor oral (mg/kg-d)-1	--	IRIS, PPRTV, HEAST, NCEA, or California
CSFi	Cancer slope factor inhaled (mg/kg-d)-1	--	IRIS, PPRTV, HEAST, NCEA, or California
RfDo	Reference dose oral (mg/kg-d)	--	IRIS, PPRTV, HEAST, NCEA, or California
RfDi	Reference dose inhaled (mg/kg-d)	--	IRIS, PPRTV, HEAST, NCEA, or California
TR	Target cancer risk	10^{-6}	--
THQ	Target hazard quotient	1	--
BWa	Body weight, adult (kg)	70	RAGS (Part A), EPA 1989 (EPA/540/1-89/002)
BWc	Body weight, child (kg)	15	Exposure Factors, EPA 1991 (OSWER No. 9285.6-03)
ATc	Averaging time - carcinogens (days)	25550	RAGS(Part A), EPA 1989 (EPA/540/1-89/002)
ATn	Averaging time - noncarcinogens (days)	ED*365	
SAa	Exposed surface area for soil/dust (cm^2/day)		Dermal Assessment, EPA 2004 (EPA/540/R-99/005)
	– adult resident	5700	
	– adult worker	3300	
SAc	Exposed surface area, child in soil (cm^2/day)	2800	Dermal Assessment, EPA 2004 (EPA/540/R-99/005)
AFa	Adherence factor, soils (mg/cm^2)		Dermal Assessment, EPA 2004 (EPA/540/R-99/005)
	– adult resident	0.07	
	– adult worker	0.2	
AFc	Adherence factor, child (mg/cm^2)	0.2	Dermal Assessment, EPA 2004 (EPA/540/R-99/005)
ABS	Skin absorption defaults (unitless):		
	– semi-volatile organics	0.1	Dermal Assessment, EPA 2004 (EPA/540/R-99/005)
	– volatile organics	**--**	Dermal Assessment, EPA 2004 (EPA/540/R-99/005)
	– inorganics	**--**	Dermal Assessment, EPA 2004 (EPA/540/R-99/005)
IRAa	Inhalation rate - adult (m^3/day)	20	Exposure Factors, EPA 1991 (OSWER No. 9285.6-03)
IRAc	Inhalation rate - child (m^3/day)	10	Exposure Factors, EPA 1997 (EPA/600/P-95/002Fa)
IRWa	Drinking water ingestion - adult (L/day	2	RAGS(Part A), EPA 1989 (EPA/540/1-89/002)
IRWc	Drinking water ingestion - child (L/day)	1	PEA, Cal-EPA (DTSC, 1994)
IRSa	Soil ingestion - adult (mg/day)	100	Exposure Factors, EPA 1991 (OSWER No. 9285.6-03)
IRSc	Soil ingestion - child (mg/day),	200	Exposure Factors, EPA 1991 (OSWER No. 9285.6-03)
IRSo	Soil ingestion - occupational (mg/day)	100	Soil Screening Guidance (EPA 2001a)
EFr	Exposure frequency - residential (d/y)	350	Exposure Factors, EPA 1991 (OSWER No. 9285.6-03)
EFo	Exposure frequency - occupational (d/y)	250	Exposure Factors, EPA 1991 (OSWER No. 9285.6-03)
EDr	Exposure duration - residential (years)	30[a]	Exposure Factors, EPA 1991 (OSWER No. 9285.6-03)
EDc	Exposure duration - child (years)	6	Exposure Factors, EPA 1991 (OSWER No. 9285.6-03)
EDo	Exposure duration - occupational (years)	25	Exposure Factors, EPA 1991 (OSWER No. 9285.6-03)
	Age-adjusted factors for carcinogens:		
IFSadj	Ingestion factor, soils ([mg-yr]/[kg-d])	114	RAGS(Part B), EPA 1991 (OSWER No. 9285.7-01B)
SFSadj	Dermal factor, soils ([mg-yr]/[kg-d])	361	By analogy to RAGS (Part B)
InhFadj	Inhalation factor, air ([m^3-yr]/[kg-d])	11	By analogy to RAGS (Part B)
IFWadj	Ingestion factor, water ([L-yr]/[kg-d])	1.1	By analogy to RAGS (Part B)
VFw	Volatilization factor for water (L/m^3)	0.5	RAGS(Part B), EPA 1991 (OSWER No. 9285.7-01B)
PEF	Particulate emission factor (m^3/kg)	See below	Soil Screening Guidance (EPA 1996a,b)
VFs	Volatilization factor for soil (m^3/kg)	See below	Soil Screening Guidance (EPA 1996a,b)
sat	Soil saturation concentration (mg/kg)	See below	Soil Screening Guidance (EPA 1996a,b)

Footnote:

[a] Exposure duration for lifetime residents is assumed to be 30 years total. For carcinogens, exposures are combined for children (6 years) and adults (24 years) .

4.9 Standardized Equations

The equations used to calculate the PRGs for carcinogenic and noncarcinogenic contaminants are presented in Equations 4-1 through 4-8. The PRG equations update RAGS Part B equations. The methodology backcalculates a soil, air, or water concentration level from a target risk (for carcinogens) or hazard quotient (for noncarcinogens). For completeness, the soil equations combine risks from ingestion, skin contact, and inhalation simultaneously. **Note: the InterCalc Tables available at the EPA Region 9 PRG website also includes pathway-specific concentrations, should the user decide against combining specific exposure pathways; or, the user wants to identify the relative contribution of each pathway to exposure.**

To calculate PRGs for volatile chemicals in soil, a chemical-specific volatilization factor is calculated per Equation 4-9. Because of its reliance on Henry's law, the VF_s model is applicable only when the contaminant concentration in soil is at or below saturation (i.e. there is no free-phase contaminant present). Soil saturation ("sat") corresponds to the contaminant concentration in soil at which the adsorptive limits of the soil particles and the solubility limits of the available soil moisture have been reached. Above this point, pure liquid-phase contaminant is expected in the soil. If the PRG calculated using VF_s was greater than the calculated sat, the PRG was set equal to sat, in accordance with *Soil Screening Guidance* (USEPA 1996 a,b). The equation for deriving sat is presented in Equation 4-10.

PRG EQUATIONS

<u>Soil Equations</u>: For soils, equations were based on three exposure routes (ingestion, skin contact, and inhalation).

Equation 4-1: Combined Exposures to Carcinogenic Contaminants in Residential Soil

$$C(mg/kg) = \frac{TR \times AT_c}{EF_r \left[\left(\frac{IFS_{adj} \times CSF_o}{10^6 mg/kg} \right) + \left(\frac{SFS_{adj} \times ABS \times CSF_o}{10^6 mg/kg} \right) + \left(\frac{InhF_{adj} \times CSF_i}{VF_s^a} \right) \right]}$$

Equation 4-2: Combined Exposures to Noncarcinogenic Contaminants in Residential Soil

$$C(mg/kg) = \frac{THQ \times BW_c \times AT_n}{EF_r \times ED_c \left[\left(\frac{1}{RfD_o} \times \frac{IRS_c}{10^6 mg/kg} \right) + \left(\frac{1}{RfD_o} \times \frac{SA_c \times AF \times ABS}{10^6 mg/kg} \right) + \left(\frac{1}{RfD_i} \times \frac{IRA_c}{VF_s^a} \right) \right]}$$

Equation 4-3: Combined Exposures to Carcinogenic Contaminants in Industrial Soil

$$C(mg/kg) = \frac{TR \times BW_a \times AT_c}{EF_o \times ED_o \left[\left(\frac{IRS_o \times CSF_o}{10^6 mg/kg} \right) + \left(\frac{SA_a \times AF \times ABS \times CSF_o}{10^6 mg/kg} \right) + \left(\frac{IRA_a \times CSF_i}{VF_s^a} \right) \right]}$$

Footnote:
[a] Use VF_s for volatile chemicals (defined as having a Henry's Law Constant [atm-m^3/mol] greater than 10^{-5} and a molecular weight less than 200 grams/mol) or PEF for non-volatile chemicals.

Equation 4-4: Combined Exposures to Noncarcinogenic Contaminants in Industrial Soil

$$C(mg/kg)\ '\ \frac{THQ\ x\ BW_a\ x\ AT_n}{EF_o\ x\ ED_o[(\frac{1}{RfD_o}\ x\ \frac{IRS_o}{10^6 mg/kg})\ \%\ (\frac{1}{RfD_o}\ x\ \frac{SA_a\ x\ AF\ x\ ABS}{10^6 mg/kg})\ \%\ (\frac{1}{RfD_i}\ x\ \frac{IRA_a}{VF_s^a})]}$$

Tap Water Equations:

Equation 4-5: Ingestion and Inhalation Exposures to Carcinogenic Contaminants in Water

$$C(ug/L)\ '\ \frac{TR\ x\ AT_c\ x\ 1000ug/mg}{EF_r\ [(IFW_{adj}\ x\ CSF_o)\ \%\ (VF_w\ x\ InhF_{adj}\ x\ CSF_i)]}$$

Equation 4-6: Ingestion and Inhalation Exposures to Noncarcinogenic Contaminants in Water

$$C(ug/L)\ '\ \frac{THQ\ x\ BW_a\ x\ AT_n\ x\ 1000ug/mg}{EF_r\ x\ ED_r\ [(\frac{IRW_a}{RfD_o})\ \%\ (\frac{VF_w\ x\ IRA_a}{RfD_i})]}$$

Air Equations:

Equation 4-7: Inhalation Exposures to Carcinogenic Contaminants in Air

$$C(ug/m^3)\ '\ \frac{TR\ x\ AT_c\ x\ 1000ug/mg}{EF_r\ x\ InhF_{adj}\ x\ CSF_i}$$

Equation 4-8: Inhalation Exposures to Noncarcinogenic Contaminants in Air

$$C(ug/m^3)\ '\ \frac{THQ\ x\ RfD_i\ x\ BW_a\ x\ AT_n\ x\ 1000ug/mg}{EF_r\ x\ ED_r\ x\ IRA_a}$$

Footnote:

[a] Use VF_s for volatile chemicals (defined as having a Henry's Law Constant [atm-m^3/mol] greater than 10^{-5} and a molecular weight less than 200 grams/mol) or PEF for non-volatile chemicals.

SOIL-TO-AIR VOLATILIZATION FACTOR (VF_s)

Equation 4-9: Derivation of the Volatilization Factor

$$VF_s(m^3/kg) = (Q/C) \times \frac{(3.14 \times D_A \times T)^{1/2}}{(2 \times \rho_b \times D_A)} \times 10^{-4}(m^2/cm^2)$$

where:

$$D_A = \frac{[(\Theta_a^{10/3} D_i H' + \Theta_w^{10/3} D_w)/n^2]}{\rho_B K_d + \Theta_w + \Theta_a H'}$$

Parameter	Definition (units)	Default
VF_s	Volatilization factor (m^3/kg)	--
D_A	Apparent diffusivity (cm^2/s)	--
Q/C	Inverse of the mean conc. at the center of a 0.5-acre square source (g/^{M2}-s per kg/m^3)	68.81
T	Exposure interval (s)	9.5 x 10^8
ρ_b	Dry soil bulk density (g/cm^3)	1.5
Θ_a	Air filled soil porosity (L_{air}/L_{soil})	0.28 or n-Θ_w
n	Total soil porosity (L_{pore}/L_{soil})	0.43 or 1 - (ρ_b/ρ_s)
Θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.15
ρ_s	Soil particle density (g/cm^3)	2.65
Di	Diffusivity in air (cm^2/s)	Chemical-specific
H	Henry's Law constant (atm-m^3/mol)	Chemical-specific
H'	Dimensionless Henry's Law constant	Calculated from H by multiplying by 41 (USEPA 1991a)
D_w	Diffusivity in water (cm^2/s)	Chemical-specific
K_d	Soil-water partition coefficient (cm^3/g) = $K_{oc}f_{oc}$	Chemical-specific
K_{oc}	Soil organic carbon-water partition coefficient (cm^3/g)	Chemical-specific
f_{oc}	Fraction organic carbon in soil (g/g)	0.006 (0.6%)

SOIL SATURATION CONCENTRATION (sat)

Equation 4-10: Derivation of the Soil Saturation Limit

$$sat = \frac{S}{\rho_b}\left(K_d\rho_b + \Theta_w + H'\Theta_a\right)$$

Parameter	Definition (units)	Default
sat	Soil saturation concentration (mg/kg)	--
S	Solubility in water (mg/L-water)	Chemical-specific
ρ_b	Dry soil bulk density (kg/L)	1.5
n	Total soil porosity (L_{pore}/L_{soil})	0.43 or 1 - (ρ_b/ρ_s)
ρ_s	Soil particle density (kg/L)	2.65
K_d	Soil-water partition coefficient (L/kg)	K_{oc} x f_{oc} (chemical-specific)
k_{oc}	Soil organic carbon/water partition coefficient (L/kg)	Chemical-specific
f_{oc}	Fraction organic carbon content of soil (g/g)	0.006 or site-specific
Θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.15
Θ_a	Air filled soil porosity (L_{air}/L_{soil})	0.28 or n-Θ_w
w	Average soil moisture content (kg_{water}/kg_{soil} or L_{water}/kg_{soil})	0.1
H	Henry's Law constant (atm-m^3/mol)	Chemical-specific
H'	Dimensionless Henry's Law constant	H x 41, where 41 is a units conversion factor

SOIL-TO-AIR PARTICULATE EMISSION FACTOR (PEF)

Equation 4-11: Derivation of the Particulate Emission Factor

$$PEF(m^3/kg) = Q/C \; x \; \frac{3600 s/h}{0.036 \; x \; (1-V) \; x \; (U_m/U_t)^3 \; x \; F(x)}$$

Parameter	Definition (units)	Default
PEF	Particulate emission factor (m^3/kg)	1.316×10^9
Q/C	Inverse of the mean concentration at the center of a 0.5-acre-square source (g/^{M2}-s per kg/m^3)	90.80
V	Fraction of vegetative cover (unitless)	0.5
U_m	Mean annual windspeed (m/s)	4.69
U_t	Equivalent threshold value of windspeed at 7 m (m/s)	11.32
F(x)	Function dependent on U_m/U_t derived using Cowherd (1985) (unitless)	0.194

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Key : SFo,i=Cancer Slope Factor oral, inhalation RfDo,i=Reference Dose oral, inhalation i=IRIS p=PPRTV c=California EPA n=NCEA h=HEAST x=Withdrawn r=Route-extrapolation ca=Cancer PRG nc= Noncancer PRG ca* (where: nc PRG < 100X ca PRG)
ca** (where nc PRG < 10X ca PRG) +++=Non-Standard Method Applied (See User's Guide) sat=Soil Saturation (See User's Guide) max=Ceiling limit (See User's Guide) DAF=Dilution Attenuation Factor (See User's Guide) CAS=Chemical Abstract Services

TOXICITY VALUES											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs)								SOIL SCREENING LEVELS	
												"Direct Contact Exposure Pathways"								"Migration to Ground Water"	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
8.7E-03	i	4.0E-03	i	8.7E-03	r	4.0E-03	r		0.1	30560-19-1	Acephate	5.6E+01	ca**	2.0E+02	ca*	7.7E-01	ca*	7.7E+00	ca*		
				7.7E-03	i	2.6E-03	i	y		75-07-0	Acetaldehyde	1.1E+01	ca**	2.3E+01	ca**	8.7E-01	ca*	1.7E+00	ca		
		2.0E-02	i			2.0E-02	r		0.1	34256-82-1	Acetochlor	1.2E+03	nc	1.2E+04	nc	7.3E+01	nc	7.3E+02	nc		
		9.0E-01	i			9.0E-01	r	y		67-64-1	**Acetone**	1.4E+04	nc	5.4E+04	nc	3.3E+03	nc	5.5E+03	nc	1.6E+01	8.0E-01
		8.0E-04	h			8.0E-04	r		0.1	75-86-5	Acetone cyanohydrin	4.9E+01	nc	4.9E+02	nc	2.9E+00	nc	2.9E+01	nc		
		1.7E-02	r			1.7E-02	i	y		75-05-8	Acetonitrile	4.2E+02	nc	1.8E+03	nc	6.2E+01	nc	1.0E+02	nc		
		5.0E-04	i			5.7E-06	i	y		107-02-8	**Acrolein**	1.0E-01	nc	3.4E-01	nc	2.1E-02	nc	4.2E-02	nc		
4.5E+00	i	2.0E-04	i	4.5E+00	i	2.0E-04	r		0.1	79-06-1	Acrylamide	1.1E-01	ca	3.8E-01	ca	1.5E-03	ca	1.5E-02	ca		
		5.0E-01	i			2.9E-04	i		0.1	79-10-7	Acrylic acid	2.9E+04	nc	1.0E+05	max	1.0E+00	nc	1.8E+04	nc		
5.4E-01	i	1.0E-03	h	2.4E-01	i	5.7E-04	i	y		107-13-1	Acrylonitrile	2.1E-01	ca*	4.9E-01	ca*	2.8E-02	ca*	3.9E-02	ca*		
1.0E+00	r			1.0E+00	c			y			**"CAL-Modified PRG"**	5.5E-02	ca	1.2E-01	ca	6.7E-03	ca	1.1E-02	ca		
8.1E-02	h	1.0E-02	i	8.0E-02	r	1.0E-02	r		0.1	15972-60-8	Alachlor	6.0E+00	ca	2.1E+01	ca	8.4E-02	ca	8.4E-01	ca		
		1.5E-01	i			1.5E-01	r		0.1	1596-84-5	Alar	9.2E+03	nc	9.2E+04	nc	5.5E+02	nc	5.5E+03	nc		
		1.0E-03	i			1.0E-03	r		0.1	116-06-3	Aldicarb	6.1E+01	nc	6.2E+02	nc	3.7E+00	nc	3.6E+01	nc		
		1.0E-03	i			1.0E-03	r		0.1	1646-88-4	Aldicarb sulfone	6.1E+01	nc	6.2E+02	nc	3.7E+00	nc	3.6E+01	nc		
1.7E+01	i	3.0E-05	i	1.7E+01	i	3.0E-05	r		0.1	309-00-2	Aldrin	2.9E-02	ca*	1.0E-01	ca	3.9E-04	ca	4.0E-03	ca	5.0E-01	2.0E-02
		2.5E-01	i			2.5E-01	r		0.1	74223-64-6	Ally	1.5E+04	nc	1.0E+05	max	9.1E+02	nc	9.1E+03	nc		
		5.0E-03	i			5.0E-03	r		0.1	107-18-6	Allyl alcohol	3.1E+02	nc	3.1E+03	nc	1.8E+01	nc	1.8E+02	nc		
		2.9E-04	r			2.9E-04	i		0.1	107-05-1	**Allyl chloride**	1.7E+01	nc	1.8E+02	nc	1.0E+00	nc	1.0E+01	nc		
		1.0E+00	p			1.4E-03	p			7429-90-5	Aluminum	7.6E+04	nc	1.0E+05	max	5.1E+00	nc	3.6E+04	nc		
		4.0E-04	i							20859-73-8	Aluminum phosphide	3.1E+01	nc	4.1E+02	nc			1.5E+01	nc		
		3.0E-04	i			3.0E-04	r		0.1	67485-29-4	Amdro	1.8E+01	nc	1.8E+02	nc	1.1E+00	nc	1.1E+01	nc		
		9.0E-03	i			9.0E-03	r		0.1	834-12-8	Ametryn	5.5E+02	nc	5.5E+03	nc	3.3E+01	nc	3.3E+02	nc		
		2.0E-04	n			2.0E-04	r		0.1	1321-12-6	**Aminodinitrotoluene**	1.2E+01	nc	1.2E+02	nc	7.3E-01	nc	7.3E+00	nc		
		7.0E-02	h			7.0E-02	r		0.1	591-27-5	m-Aminophenol	4.3E+03	nc	4.3E+04	nc	2.6E+02	nc	2.6E+03	nc		
		2.0E-05	h			2.0E-05	r		0.1	504-24-5	4-Aminopyridine	1.2E+00	nc	1.2E+01	nc	7.3E-02	nc	7.3E-01	nc		
		2.5E-03	i			2.5E-03	r		0.1	33089-61-1	Amitraz	1.5E+02	nc	1.5E+03	nc	9.1E+00	nc	9.1E+01	nc		
						2.9E-02	i			7664-41-7	Ammonia					1.0E+02	nc				
		2.0E-01	i						0.1	7773-06-0	Ammonium sulfamate	1.2E+04	nc	1.0E+05	max			7.3E+03	nc		
5.7E-03	i	7.0E-03	p	5.7E-03	r	2.9E-04	i		0.1	62-53-3	Aniline	8.5E+01	ca**	3.0E+02	ca*	1.0E+00	nc	1.2E+01	ca*		
		4.0E-04	i							7440-36-0	Antimony and compounds	3.1E+01	nc	4.1E+02	nc			1.5E+01	nc	5.0E+00	3.0E-01
		1.3E-02	i			1.3E-02	r		0.1	74115-24-5	Apollo	7.9E+02	nc	8.0E+03	nc	4.7E+01	nc	4.7E+02	nc		
2.5E-02	i	5.0E-02	h	2.5E-02	i	5.0E-02	r		0.1	140-57-8	Aramite	1.9E+01	ca	6.9E+01	ca	2.7E-01	ca	2.7E+00	ca		
1.5E+00	i	3.0E-04	i	1.5E+01	i				0.03	7440-38-2	Arsenic	3.9E-01	ca*	1.6E+00	ca	4.5E-04	ca	4.5E-02	ca	2.9E+01	1.0E+00
9.5E+00	c			1.2E+01	c				0.03		**"CAL-Modified PRG"**	6.2E-02	ca	2.5E-01	ca	5.6E-04	ca	7.1E-03	ca		
						1.4E-05	i			7784-42-1	Arsine (see arsenic for cancer endpoint)					5.2E-02	nc				
		9.0E-03	i			9.0E-03	r		0.1	76578-14-8	Assure	5.5E+02	nc	5.5E+03	nc	3.3E+01	nc	3.3E+02	nc		
		5.0E-02	i			5.0E-02	r		0.1	3337-71-1	Asulam	3.1E+03	nc	3.1E+04	nc	1.8E+02	nc	1.8E+03	nc		
2.2E-01	h	3.5E-02	i	2.2E-01	r	3.5E-02	r		0.1	1912-24-9	Atrazine	2.2E+00	ca	7.8E+00	ca	3.1E-02	ca	3.0E-01	ca		
		4.0E-04	i			4.0E-04	r		0.1	71751-41-2	Avermectin B1	2.4E+01	nc	2.5E+02	nc	1.5E+00	nc	1.5E+01	nc		
1.1E-01	i			1.1E-01	i				0.1	103-33-3	Azobenzene	4.4E+00	ca	1.6E+01	ca	6.2E-02	ca	6.1E-01	ca		
		7.0E-02	i			1.4E-04	h			7440-39-3	Barium and compounds	5.4E+03	nc	6.7E+04	nc	5.2E-01	nc	2.6E+03	nc	1.6E+03	8.2E+01

Key : SFo,i=Cancer Slope Factor oral, inhalation RfDo,i=Reference Dose oral, inhalation i=IRIS p=PPRTV c=California EPA n=NCEA h=HEAST x=Withdrawn r=Route-extrapolation ca=Cancer PRG nc= Noncancer PRG ca* (where: nc PRG < 100X ca PRG) ca** (where nc PRG < 10X ca PRG) +++=Non-Standard Method Applied (See User's Guide) sat=Soil Saturation (See User's Guide) max=Ceiling limit (See User's Guide) DAF=Dilution Attenuation Factor (See User's Guide) CAS=Chemical Abstract Services

TOXICITY VALUES											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs)								SOIL SCREENING LEVELS	
												"Direct Contact Exposure Pathways"								"Migration to Ground Water"	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
		4.0E-03	i			4.0E-03	r		0.1	114-26-1	Baygon	2.4E+02	nc	2.5E+03	nc	1.5E+01	nc	1.5E+02	nc		
		3.0E-02	i			3.0E-02	r		0.1	43121-43-3	Bayleton	1.8E+03	nc	1.8E+04	nc	1.1E+02	nc	1.1E+03	nc		
		2.5E-02	i			2.5E-02	r		0.1	68359-37-5	Baythroid	1.5E+03	nc	1.5E+04	nc	9.1E+01	nc	9.1E+02	nc		
		3.0E-01	i			3.0E-01	r		0.1	1861-40-1	Benefin	1.8E+04	nc	1.0E+05	max	1.1E+03	nc	1.1E+04	nc		
		5.0E-02	i			5.0E-02	r		0.1	17804-35-2	Benomyl	3.1E+03	nc	3.1E+04	nc	1.8E+02	nc	1.8E+03	nc		
		3.0E-02	i			3.0E-02	r		0.1	25057-89-0	Bentazon	1.8E+03	nc	1.8E+04	nc	1.1E+02	nc	1.1E+03	nc		
		1.0E-01	i			1.0E-01	r		0.1	100-52-7	Benzaldehyde	6.1E+03	nc	6.2E+04	nc	3.7E+02	nc	3.6E+03	nc		
5.5E-02	i	4.0E-03	i	2.7E-02	i	8.6E-03	i	y		71-43-2	**Benzene**	6.4E-01	ca*	1.4E+00	ca*	2.5E-01	ca	3.5E-01	ca	3.0E-02	2.0E-03
2.3E+02	i	3.0E-03	i	2.3E+02	i	3.0E-03	r		0.1	92-87-5	Benzidine	2.1E-03	ca	7.5E-03	ca	2.9E-05	ca	2.9E-04	ca		
		4.0E+00	i			4.0E+00	r		0.1	65-85-0	Benzoic acid	1.0E+05	max	1.0E+05	max	1.5E+04	nc	1.5E+05	nc	4.0E+02	2.0E+01
1.3E+01	i			1.3E+01	r				0.1	98-07-7	Benzotrichloride	3.7E-02	ca	1.3E-01	ca	5.2E-04	ca	5.2E-03	ca		
		3.0E-01	h			3.0E-01	r		0.1	100-51-6	Benzyl alcohol	1.8E+04	nc	1.0E+05	max	1.1E+03	nc	1.1E+04	nc		
1.7E-01	i	2.9E-03	r	1.7E-01	r	2.9E-03	n	y		100-44-7	Benzyl chloride	8.9E-01	ca*	2.2E+00	ca	4.0E-02	ca	6.6E-02	ca		
		2.0E-03	i	8.4E+00	i	5.7E-06	i			7440-41-7	Beryllium and compounds	1.5E+02	nc	1.9E+03	ca**	8.0E-04	ca*	7.3E+01	nc	6.3E+01	3.0E+00
		1.0E-04	i			1.0E-04	r		0.1	141-66-2	Bidrin	6.1E+00	nc	6.2E+01	nc	3.7E-01	nc	3.6E+00	nc		
		1.5E-02	i			1.5E-02	r		0.1	82657-04-3	Biphenthrin (Talstar)	9.2E+02	nc	9.2E+03	nc	5.5E+01	nc	5.5E+02	nc		
		5.0E-02	i			5.0E-02	r	y		92-52-4	**1,1-Biphenyl**	3.0E+03	nc	2.3E+04	nc	1.8E+02	nc	3.0E+02	nc		
1.1E+00	i			1.1E+00	i			y		111-44-4	Bis(2-chloroethyl)ether	2.2E-01	ca	5.8E-01	ca	6.1E-03	ca	1.0E-02	ca	4.0E-04	2.0E-05
7.0E-02	x	4.0E-02	i	3.5E-02	x	4.0E-02	r	y		108-60-1	Bis(2-chloroisopropyl)ether	2.9E+00	ca	7.4E+00	ca	1.9E-01	ca	2.7E-01	ca		
2.2E+02	i			2.2E+02	i			y		542-88-1	Bis(chloromethyl)ether	1.9E-04	ca	4.3E-04	ca	3.1E-05	ca	5.2E-05	ca		
7.0E-02	x	4.0E-02	i	3.5E-02	x	4.0E-02	r	y		108-60-1	Bis(2-chloro-1-methylethyl)ether	2.9E+00	ca	7.4E+00	ca	1.9E-01	ca	2.7E-01	ca		
1.4E-02	i	2.0E-02	i	1.4E-02	r	2.0E-02	r		0.1	117-81-7	Bis(2-ethylhexyl)phthalate (DEHP)	3.5E+01	ca*	1.2E+02	ca	4.8E-01	ca	4.8E+00	ca		
		5.0E-02	i			5.0E-02	r		0.1	80-05-7	Bisphenol A	3.1E+03	nc	3.1E+04	nc	1.8E+02	nc	1.8E+03	nc		
		2.00E-01	i			5.7E-03	h			7440-42-8	Boron	1.6E+04	nc	1.0E+05	max	2.1E+01	nc	7.3E+03	nc		
						2.0E-04	h			7637-07-2	Boron trifluoride					7.3E-01	nc				
7.0E-01	i	4.0E-03	i	7.0E-01	r	4.0E-03	r		0.1	15541-45-4	**Bromate**	6.9E-01	ca	2.5E+00	ca	9.6E-03	ca	9.6E-02	ca		
		2.0E-02	p			2.9E-03	p	y		108-86-1	Bromobenzene	2.8E+01	nc	9.2E+01	nc	1.0E+01	nc	2.0E+01	nc		
6.2E-02	i	2.0E-02	i	6.2E-02	r	2.0E-02	r	y		75-27-4	Bromodichloromethane	8.2E-01	ca	1.8E+00	ca	1.1E-01	ca	1.8E-01	ca	6.0E-01	3.0E-02
7.9E-03	i	2.0E-02	i	3.9E-03	i	2.0E-02	r		0.1	75-25-2	Bromoform (tribromomethane)	6.2E+01	ca*	2.2E+02	ca*	1.7E+00	ca*	8.5E+00	ca*	8.0E-01	4.0E-02
		1.4E-03	i			1.4E-03	i	y		74-83-9	Bromomethane (Methyl bromide)	3.9E+00	nc	1.3E+01	nc	5.2E+00	nc	8.7E+00	nc	2.0E-01	1.0E-02
		5.0E-03	h			5.0E-03	r		0.1	2104-96-3	Bromophos	3.1E+02	nc	3.1E+03	nc	1.8E+01	nc	1.8E+02	nc		
		2.0E-02	i			2.0E-02	r		0.1	1689-84-5	Bromoxynil	1.2E+03	nc	1.2E+04	nc	7.3E+01	nc	7.3E+02	nc		
		2.0E-02	i			2.0E-02	r		0.1	1689-99-2	Bromoxynil octanoate	1.2E+03	nc	1.2E+04	nc	7.3E+01	nc	7.3E+02	nc		
1.1E-01	r	5.7E-04	r	1.1E-01	i	5.7E-04	i	y		106-99-0	**1,3-Butadiene**	5.8E-02	ca*	1.2E-01	ca*	6.1E-02	ca*	1.0E-01	ca*		
6.0E-01	r	5.7E-03	r	6.0E-01	c	5.7E-03	c	y		106-99-0	**"CAL-Modified PRG"**	1.1E-02	ca	2.3E-02	ca	1.1E-02	ca	1.9E-02	ca		
		1.0E-01	i			2.6E-03	n		0.1	71-36-3	1-Butanol	6.1E+03	nc	6.1E+04	nc	9.5E+00	nc	3.6E+03	nc	1.7E+01	9.0E-01
		5.0E-02	i			5.0E-02	r		0.1	2008-41-5	Butylate	3.1E+03	nc	3.1E+04	nc	1.8E+02	nc	1.8E+03	nc		
		4.0E-02	n			4.0E-02	r	y		104-51-8	n-Butylbenzene	2.4E+02	sat	2.4E+02	sat	1.5E+02	nc	2.4E+02	nc		
		4.0E-02	n			4.0E-02	r	y		135-9-88	sec-Butylbenzene	2.2E+02	sat	2.2E+02	sat	1.5E+02	nc	2.4E+02	nc		
		4.0E-02	n			4.0E-02	r	y		98-06-6	tert-Butylbenzene	3.9E+02	sat	3.9E+02	sat	1.5E+02	nc	2.4E+02	nc		
		2.0E-01	i			2.0E-01	r		0.1	85-68-7	Butyl benzyl phthalate	1.2E+04	nc	1.0E+05	max	7.3E+02	nc	7.3E+03	nc	9.3E+02	8.1E+02
		1.0E+00	i			1.0E+00	r		0.1	85-70-1	Butylphthalyl butylglycolate	6.1E+04	nc	1.0E+05	max	3.7E+03	nc	3.6E+04	nc		

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TOXICITY VALUES											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs) "Direct Contact Exposure Pathways"								SOIL SCREENING LEVELS "Migration to Ground Water"	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
		5.0E-04	i	6.3E+00	i				0.001	7440-43-9	Cadmium and compounds	3.7E+01	nc	4.5E+02	nc	1.1E-03	ca	1.8E+01	nc	8.0E+00	4.0E-01
		5.0E-01	i			5.0E-01	r		0.1	105-60-2	Caprolactam	3.1E+04	nc	1.0E+05	max	1.8E+03	nc	1.8E+04	nc		
8.6E-03	h	2.0E-03	i	8.6E-03	r	2.0E-03	r		0.1	2425-06-1	Captafol	5.7E+01	ca**	2.0E+02	ca**	7.8E-01	ca**	7.8E+00	ca**		
3.5E-03	h	1.3E-01	i	3.5E-03	r	1.3E-01	r		0.1	133-06-2	Captan	1.4E+02	ca*	4.9E+02	ca	1.9E+00	ca	1.9E+01	ca		
		1.0E-01	i			1.1E-01	r		0.1	63-25-2	Carbaryl	6.1E+03	nc	6.2E+04	nc	4.0E+02	nc	3.6E+03	nc		
2.0E-02	h			2.0E-02	r				0.1	86-74-8	Carbazole	2.4E+01	ca	8.6E+01	ca	3.4E-01	ca	3.4E+00	ca	6.0E-01	3.0E-02
		5.0E-03	i			5.0E-03	r		0.1	1563-66-2	Carbofuran	3.1E+02	nc	3.1E+03	nc	1.8E+01	nc	1.8E+02	nc		
		1.0E-01	i			2.0E-01	i	y		75-15-0	Carbon disulfide	3.6E+02	nc	7.2E+02	sat	7.3E+02	nc	1.0E+03	nc	3.2E+01	2.0E+00
1.3E-01	i	7.0E-04	i	5.3E-02	i	7.0E-04	r	y		56-23-5	Carbon tetrachloride	2.5E-01	ca**	5.5E-01	ca*	1.3E-01	ca*	1.7E-01	ca*	7.0E-02	3.0E-03
		1.0E-02	i			1.0E-02	r		0.1	55285-14-8	Carbosulfan	6.1E+02	nc	6.2E+03	nc	3.7E+01	nc	3.6E+02	nc		
		1.0E-01	i			1.0E-01	r		0.1	5234-68-4	Carboxin	6.1E+03	nc	6.2E+04	nc	3.7E+02	nc	3.6E+03	nc		
		1.5E-02	i			1.5E-02	r		0.1	133-90-4	Chloramben	9.2E+02	nc	9.2E+03	nc	5.5E+01	nc	5.5E+02	nc		
4.0E-01	h			4.0E-01	r				0.1	118-75-2	Chloranil	1.2E+00	ca	4.3E+00	ca	1.7E-02	ca	1.7E-01	ca		
3.5E-01	i	5.0E-04	i	3.5E-01	i	2.0E-04	i		0.04	12789-03-6	Chlordane (technical)	1.6E+00	ca*	6.5E+00	ca*	1.9E-02	ca*	1.9E-01	ca*	1.0E+01	5.0E-01
		2.0E-02	i			2.0E-02	r		0.1	90982-32-4	Chlorimuron-ethyl	1.2E+03	nc	1.2E+04	nc	7.3E+01	nc	7.3E+02	nc		
		1.0E-01	i			5.7E-05	n			7782-50-5	Chlorine					2.1E-01	nc				
		3.0E-02	i			5.7E-05	i			10049-04-4	Chlorine dioxide					2.1E-01	nc				
		2.0E-03	h			2.0E-03	r		0.1	79-11-8	Chloroacetic acid	1.2E+02	nc	1.2E+03	nc	7.3E+00	nc	7.3E+01	nc		
		8.6E-06	r			8.6E-06	i	y		532-27-4	2-Chloroacetophenone	3.3E-02	nc	1.1E-01	nc	3.1E-02	nc	5.2E-02	nc		
		4.0E-03	i			4.0E-03	r		0.1	106-47-8	4-Chloroaniline	2.4E+02	nc	2.5E+03	nc	1.5E+01	nc	1.5E+02	nc	7.0E-01	3.0E-02
		2.0E-02	i			1.7E-02	n	y		108-90-7	Chlorobenzene	1.5E+02	nc	5.3E+02	nc	6.2E+01	nc	1.1E+02	nc	1.0E+00	7.0E-02
2.7E-01	h	2.0E-02	i	2.7E-01	h	2.0E-02	r		0.1	510-15-6	Chlorobenzilate	1.8E+00	ca	6.4E+00	ca	2.5E-02	ca	2.5E-01	ca		
		2.0E-01	h			2.0E-01	r		0.1	74-11-3	p-Chlorobenzoic acid	1.2E+04	nc	1.0E+05	max	7.3E+02	nc	7.3E+03	nc		
		2.0E-02	h			2.0E-02	r		0.1	98-56-6	4-Chlorobenzotrifluoride	1.2E+03	nc	1.2E+04	nc	7.3E+01	nc	7.3E+02	nc		
		2.0E-02	h			2.0E-03	h	y		126-99-8	2-Chloro-1,3-butadiene	3.6E+00	nc	1.2E+01	nc	7.3E+00	nc	1.4E+01	nc		
		4.0E-01	h			4.0E-01	r	y		109-69-3	1-Chlorobutane	4.8E+02	sat	4.8E+02	sat	1.5E+03	nc	2.4E+03	nc		
		1.4E+01	r			1.4E+01	i	y		75-68-3	1-Chloro-1,1-difluoroethane (HCFC-142b)	3.4E+02	sat	3.4E+02	sat	5.2E+04	nc	8.7E+04	nc		
		1.4E+01	r			1.4E+01	i	y		75-45-6	Chlorodifluoromethane	3.4E+02	sat	3.4E+02	sat	5.1E+04	nc	8.5E+04	nc		
2.9E-03	n	4.0E-01	n	2.9E-03	r	2.9E+00	i	y		75-00-3	Chloroethane	3.0E+00	ca	6.5E+00	ca	2.3E+00	ca	4.6E+00	ca		
		1.0E-02	i	8.1E-02	i	1.4E-02	n	y		67-66-3	**Chloroform**	2.2E-01	ca	4.7E-01	ca	8.3E-02	ca	1.7E-01	ca	6.0E-01	3.0E-02
3.1E-02	c			1.9E-02	c			y			"CAL-Modified PRG"	9.4E-01	ca	2.0E+00	ca	3.5E-01	ca	5.3E-01	ca		
		2.6E-02	r			2.6E-02	i	y		74-87-3	**Chloromethane (methyl chloride)**	4.7E+01	nc	1.6E+02	nc	9.5E+01	nc	1.6E+02	nc		
5.8E-01	h			5.8E-01	r				0.1	95-69-2	4-Chloro-2-methylaniline	8.4E-01	ca	3.0E+00	ca	1.2E-02	ca	1.2E-01	ca		
4.6E-01	h			4.6E-01	r				0.1	3165-93-3	4-Chloro-2-methylaniline hydrochloride	1.1E+00	ca	3.7E+00	ca	1.5E-02	ca	1.5E-01	ca		
		8.0E-02	i			8.0E-02	r	y		91-58-7	beta-Chloronaphthalene	4.9E+03	nc	2.3E+04	nc	2.9E+02	nc	4.9E+02	nc		
9.7E-03	p	1.0E-03	p	9.7E-03	r	2.0E-05	p	y		88-73-3	o-Chloronitrobenzene	1.4E+00	nc**	4.5E+00	nc**	7.3E-02	nc**	1.5E-01	nc**		
6.7E-03	p	1.0E-03	p	6.7E-03	r	1.7E-04	p	y		100-00-5	p-Chloronitrobenzene	1.0E+01	nc**	3.7E+01	nc**	6.2E-01	nc**	1.2E+00	nc**		
		5.0E-03	i			5.0E-03	r	y		95-57-8	2-Chlorophenol	6.3E+01	nc	2.4E+02	nc	1.8E+01	nc	3.0E+01	nc	4.0E+00	2.0E-01
		2.9E-02	r			2.9E-02	h	y		75-29-6	2-Chloropropane	1.7E+02	nc	5.9E+02	nc	1.0E+02	nc	1.7E+02	nc		
1.1E-02	h	1.5E-02	i	1.1E-02	r	1.5E-02	r		0.1	1897-45-6	Chlorothalonil	4.4E+01	ca*	1.6E+02	ca*	6.1E-01	ca*	6.1E+00	ca*		
		2.0E-02	i			2.0E-02	r	y		95-49-8	o-Chlorotoluene	1.6E+02	nc	5.6E+02	nc	7.3E+01	nc	1.2E+02	nc		
		2.0E-01	i			2.0E-01	r		0.1	101-21-3	Chlorpropham	1.2E+04	nc	1.0E+05	max	7.3E+02	nc	7.3E+03	nc		

Key : SFo,i=Cancer Slope Factor oral, inhalation RfDo,i=Reference Dose oral, inhalation i=IRIS p=PPRTV c=California EPA n=NCEA h=HEAST x=Withdrawn r=Route-extrapolation ca=Cancer PRG nc= Noncancer PRG ca* (where: nc PRG < 100X ca PRG)
ca** (where nc PRG < 10X ca PRG) +++=Non-Standard Method Applied (See User's Guide) sat=Soil Saturation (See User's Guide) max=Ceiling limit (See User's Guide) DAF=Dilution Attenuation Factor (See User's Guide) CAS=Chemical Abstract Services

TOXICITY VALUES											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs) "Direct Contact Exposure Pathways"								SOIL SCREENING LEVELS "Migration to Ground Water"	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
		3.0E-03	i			3.0E-03	r		0.1	2921-88-2	Chlorpyrifos	1.8E+02	nc	1.8E+03	nc	1.1E+01	nc	1.1E+02	nc		
		1.0E-02	h			1.0E-02	r		0.1	5598-13-0	Chlorpyrifos-methyl	6.1E+02	nc	6.2E+03	nc	3.7E+01	nc	3.6E+02	nc		
		5.0E-02	i			5.0E-02	r		0.1	64902-72-3	Chlorsulfuron	3.1E+03	nc	3.1E+04	nc	1.8E+02	nc	1.8E+03	nc		
		8.0E-04	h			8.0E-04	r		0.1	60238-56-4	Chlorthiophos	4.9E+01	nc	4.9E+02	nc	2.9E+00	nc	2.9E+01	nc		
				4.2E+01	i						Total Chromium (1:6 ratio Cr VI:Cr III)+++	2.1E+02	ca	4.5E+02	ca	1.6E-04	ca			3.8E+01	2.0E+00
		1.5E+00	i							16065-83-1	Chromium III	1.0E+05	max	1.0E+05	max			5.5E+04	nc		
		3.0E-03	i	2.9E+02	i	2.2E-06	i			18540-29-9	Chromium VI+++	3.0E+01	ca**	6.4E+01	ca	2.3E-05	ca	1.1E+02	nc	3.8E+01	2.0E+00
		2.0E-02	p	9.8E+00	p	5.7E-06	p			7440-48-4	Cobalt	9.0E+02	ca**	1.9E+03	ca*	6.9E-04	ca*	7.3E+02	nc		
				2.2E+00	i					8007-45-2	Coke Oven Emissions					3.1E-03	ca				
		4.0E-02	h							7440-50-8	Copper and compounds	3.1E+03	nc	4.1E+04	nc			1.5E+03	nc		
1.9E+00	h			1.9E+00	r			y		123-73-9	Crotonaldehyde	5.3E-03	ca	1.1E-02	ca	3.5E-03	ca	5.9E-03	ca		
		1.0E-01	i			1.1E-01	i	y		98-82-8	Cumene (isopropylbenzene)	5.7E+02	nc	2.0E+03	nc	4.0E+02	nc	6.6E+02	nc		
8.4E-01	h	2.0E-03	h	8.4E-01	r	2.0E-03	r		0.1	21725-46-2	Cyanazine	5.8E-01	ca	2.1E+00	ca	8.0E-03	ca	8.0E-02	ca		
		2.0E-02	i						0.1	57-12-5	Cyanide (free)	1.2E+03	nc	1.2E+04	nc			7.3E+02	nc		
		2.0E-02	i			8.6E-04	i	y		74-90-8	Cyanide (hydrogen)	1.1E+01	nc	3.5E+01	nc	3.1E+00	nc	6.2E+00	nc		
		4.0E-02	i			4.0E-02	r	y		460-19-5	Cyanogen	1.3E+02	nc	4.3E+02	nc	1.5E+02	nc	2.4E+02	nc		
		9.0E-02	i			9.0E-02	r	y		506-68-3	Cyanogen bromide	2.9E+02	nc	9.7E+02	nc	3.3E+02	nc	5.5E+02	nc		
		5.0E-02	i			5.0E-02	r	y		506-77-4	Cyanogen chloride	1.6E+02	nc	5.4E+02	nc	1.8E+02	nc	3.0E+02	nc		
		1.7E+00	r			1.7E+00	i	y		110-82-7	**Cyclohexane**	1.4E+02	sat	1.4E+02	sat	6.2E+03	nc	1.0E+04	nc		
		5.0E+00	i			5.0E+00	r		0.1	108-94-1	Cyclohexanone	1.0E+05	max	1.0E+05	max	1.8E+04	nc	1.8E+05	nc		
		2.0E-01	i			2.0E-01	r		0.1	108-91-8	Cyclohexylamine	1.2E+04	nc	1.0E+05	max	7.3E+02	nc	7.3E+03	nc		
		5.0E-03	i			5.0E-03	r		0.1	68085-85-8	Cyhalothrin/Karate	3.1E+02	nc	3.1E+03	nc	1.8E+01	nc	1.8E+02	nc		
		1.0E-02	i			1.0E-02	r		0.1	52315-07-8	Cypermethrin	6.1E+02	nc	6.2E+03	nc	3.7E+01	nc	3.6E+02	nc		
		7.5E-03	i			7.5E-03	r		0.1	66215-27-8	Cyromazine	4.6E+02	nc	4.6E+03	nc	2.7E+01	nc	2.7E+02	nc		
		1.0E-02	i			1.0E-02	r		0.1	1861-32-1	Dacthal	6.1E+02	nc	6.2E+03	nc	3.7E+01	nc	3.6E+02	nc		
		3.0E-02	i			3.0E-02	r		0.1	75-99-0	Dalapon	1.8E+03	nc	1.8E+04	nc	1.1E+02	nc	1.1E+03	nc		
		2.5E-02	i			2.5E-02	r		0.1	39515-41-8	Danitol	1.5E+03	nc	1.5E+04	nc	9.1E+01	nc	9.1E+02	nc		
2.4E-01	i			2.4E-01	r				0.03	72-54-8	DDD	2.4E+00	ca	1.0E+01	ca	2.8E-02	ca	2.8E-01	ca	1.6E+01	8.0E-01
3.4E-01	i			3.4E-01	r				0.03	72-55-9	DDE	1.7E+00	ca	7.0E+00	ca	2.0E-02	ca	2.0E-01	ca	5.4E+01	3.0E+00
3.4E-01	i	5.0E-04	i	3.4E-01	i	5.0E-04	r		0.03	50-29-3	DDT	1.7E+00	ca*	7.0E+00	ca*	2.0E-02	ca*	2.0E-01	ca*	3.2E+01	2.0E+00
		1.0E-02	i			1.0E-02	r		0.1	1163-19-5	Decabromodiphenyl ether	6.1E+02	nc	6.2E+03	nc	3.7E+01	nc	3.6E+02	nc		
		4.0E-05	i			4.0E-05	r		0.1	8065-48-3	Demeton	2.4E+00	nc	2.5E+01	nc	1.5E-01	nc	1.5E+00	nc		
6.1E-02	h			6.1E-02	r				0.1	2303-16-4	Diallate	8.0E+00	ca	2.8E+01	ca	1.1E-01	ca	1.1E+00	ca		
		9.0E-04	h			9.0E-04	r		0.1	333-41-5	Diazinon	5.5E+01	nc	5.5E+02	nc	3.3E+00	nc	3.3E+01	nc		
		2.0E-03	n			2.0E-03	r	y		132-64-9	**Dibenzofuran**	1.5E+02	nc	1.6E+03	nc	7.3E+00	nc	1.2E+01	nc		
		1.0E-02	i			1.0E-02	r		0.1	106-37-6	1,4-Dibromobenzene	6.1E+02	nc	6.2E+03	nc	3.7E+01	nc	3.6E+02	nc		
8.4E-02	i	2.0E-02	i	8.4E-02	r	2.0E-02	r	y		124-48-1	Dibromochloromethane	1.1E+00	ca	2.6E+00	ca	8.0E-02	ca	1.3E-01	ca	4.0E-01	2.0E-02
1.4E+00	h	5.7E-05	r	2.4E-03	x	5.7E-05	i	y		96-12-8	**1,2-Dibromo-3-chloropropane (DBCP)**	4.6E-01	ca**	2.0E+00	ca**	2.1E-01	nc	4.8E-02	ca**		
7.0E+00	c			7.0E+00	c			y		96-12-8	**"CAL-Modified PRG"**	3.0E-02	ca	7.6E-02	ca	9.6E-04	ca	1.6E-03	ca		
2.0E+00	i	9.0E-03	i	2.0E+00	i	2.6E-03	i	y		106-93-4	**1,2-Dibromoethane (EDB)**	3.2E-02	ca	7.3E-02	ca	3.4E-03	ca	5.6E-03	ca		
		1.0E-01	i			1.0E-01	r		0.1	84-74-2	Dibutyl phthalate	6.1E+03	nc	6.2E+04	nc	3.7E+02	nc	3.6E+03	nc	2.3E+03	2.7E+02
		3.0E-02	i			3.0E-02	r		0.1	1918-00-9	Dicamba	1.8E+03	nc	1.8E+04	nc	1.1E+02	nc	1.1E+03	nc		

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ca** (where nc PRG < 10X ca PRG) +++=Non-Standard Method Applied (See User's Guide) sat=Soil Saturation (See User's Guide) max=Ceiling limit (See User's Guide) DAF=Dilution Attenuation Factor (See User's Guide) CAS=Chemical Abstract Services

TOXICITY VALUES											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs)								SOIL SCREENING LEVELS	
												"Direct Contact Exposure Pathways"								"Migration to Ground Water"	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
		9.0E-02	i			5.7E-02	h	y		95-50-1	**1,2-Dichlorobenzene**	6.0E+02	sat	6.0E+02	sat	2.1E+02	nc	3.7E+02	nc	1.7E+01	9.0E-01
		3.0E-02	n			3.0E-02	r	y		541-73-1	**1,3-Dichlorobenzene**	5.3E+02	nc	6.0E+02	sat	1.1E+02	nc	1.8E+02	nc		
2.4E-02	h	3.0E-02	n	2.2E-02	n	2.3E-01	i	y		106-46-7	1,4-Dichlorobenzene	3.4E+00	ca	7.9E+00	ca	3.1E-01	ca	5.0E-01	ca	2.0E+00	1.0E-01
4.5E-01	i			4.5E-01	r				0.1	91-94-1	3,3-Dichlorobenzidine	1.1E+00	ca	3.8E+00	ca	1.5E-02	ca	1.5E-01	ca	7.0E-03	3.0E-04
		3.0E-02	n			3.0E-02	r		0.1	90-98-2	4,4'-Dichlorobenzophenone	1.8E+03	nc	1.8E+04	nc	1.1E+02	nc	1.1E+03	nc		
9.3E+00	r			9.3E+00	h			y		764-41-0	1,4-Dichloro-2-butene	7.9E-03	ca	1.8E-02	ca	7.2E-04	ca	1.2E-03	ca		
		2.0E-01	i			5.7E-02	h	y		75-71-8	Dichlorodifluoromethane	9.4E+01	nc	3.1E+02	nc	2.1E+02	nc	3.9E+02	nc		
		1.0E-01	h			1.4E-01	h	y		75-34-3	1,1-Dichloroethane	5.1E+02	nc	1.7E+03	nc	5.2E+02	nc	8.1E+02	nc	2.3E+01	1.0E+00
5.7E-03	c			5.7E-03	c			y			"CAL-Modified PRG"	2.8E+00	ca	6.0E+00	ca	1.2E+00	ca	2.0E+00	ca		
9.1E-02	i	2.0E-02	n	9.1E-02	i	1.4E-03	n	y		107-06-2	1,2-Dichloroethane (EDC)	2.8E-01	ca*	6.0E-01	ca*	7.4E-02	ca*	1.2E-01	ca*	2.0E-02	1.0E-03
		5.0E-02	i			5.7E-02	i	y		75-35-4	1,1-Dichloroethylene	1.2E+02	nc	4.1E+02	nc	2.1E+02	nc	3.4E+02	nc	6.0E-02	3.0E-03
		1.0E-02	p			1.0E-02	r	y		156-59-2	1,2-Dichloroethylene (cis)	4.3E+01	nc	1.5E+02	nc	3.7E+01	nc	6.1E+01	nc	4.0E-01	2.0E-02
		2.0E-02	i			2.0E-02	r	y		156-60-5	1,2-Dichloroethylene (trans)	6.9E+01	nc	2.3E+02	nc	7.3E+01	nc	1.2E+02	nc	7.0E-01	3.0E-02
		3.0E-03	i			3.0E-03	r		0.1	120-83-2	2,4-Dichlorophenol	1.8E+02	nc	1.8E+03	nc	1.1E+01	nc	1.1E+02	nc	1.0E+00	5.0E-02
		8.0E-03	i			8.0E-03	r		0.1	94-82-6	4-(2,4-Dichlorophenoxy)butyric Acid (2,4-DB)	4.9E+02	nc	4.9E+03	nc	2.9E+01	nc	2.9E+02	nc		
		1.0E-02	i			1.0E-02	r		0.05	94-75-7	2,4-Dichlorophenoxyacetic Acid (2,4-D)	6.9E+02	nc	7.7E+03	nc	3.7E+01	nc	3.6E+02	nc		
6.8E-02	h	1.1E-03	r	6.8E-02	r	1.1E-03	i	y		78-87-5	1,2-Dichloropropane	3.4E-01	ca*	7.4E-01	ca*	9.9E-02	ca*	1.6E-01	ca*	3.0E-02	1.0E-03
		2.0E-02	p			2.0E-02	r	y		142-28-9	**1,3-Dichloropropane**	1.0E+02	nc	3.6E+02	nc	7.3E+01	nc	1.2E+02	nc		
1.0E-01	i	3.0E-02	i	1.4E-02	i	5.7E-03	i	y		542-75-6	1,3-Dichloropropene	7.8E-01	ca	1.8E+00	ca	4.8E-01	ca	4.0E-01	ca	4.0E-03	2.0E-04
		3.0E-03	i			3.0E-03	r		0.1	616-23-9	2,3-Dichloropropanol	1.8E+02	nc	1.8E+03	nc	1.1E+01	nc	1.1E+02	nc		
2.9E-01	i	5.0E-04	i	2.9E-01	r	1.4E-04	i		0.1	62-73-7	Dichlorvos	1.7E+00	ca*	5.9E+00	ca*	2.3E-02	ca*	2.3E-01	ca*		
4.4E-01	x			4.4E-01	r				0.1	115-32-2	Dicofol	1.1E+00	ca	3.9E+00	ca	1.5E-02	ca	1.5E-01	ca		
		3.0E-02	h			5.7E-05	x	y		77-73-6	Dicyclopentadiene	5.4E-01	nc	1.8E+00	nc	2.1E-01	nc	4.2E-01	nc		
1.6E+01	i	5.0E-05	i	1.6E+01	i	5.0E-05	r		0.1	60-57-1	Dieldrin	3.0E-02	ca	1.1E-01	ca	4.2E-04	ca	4.2E-03	ca	4.0E-03	2.0E-04
		1.0E-02	p			5.7E-03	p		0.1	112-34-5	Diethylene glycol, monobutyl ether	6.1E+02	nc	6.2E+03	nc	2.1E+01	nc	3.6E+02	nc		
		6.0E-02	p			8.6E-04	p		0.1	111-90-0	Diethylene glycol, monoethyl ether	3.7E+03	nc	3.7E+04	nc	3.1E+00	nc	2.2E+03	nc		
		4.0E-04	p			4.0E-04	r		0.1	617-84-5	Diethylformamide	2.4E+01	nc	2.5E+02	nc	1.5E+00	nc	1.5E+01	nc		
1.2E-03	i	6.0E-01	i	1.2E-03	r	6.0E-01	r		0.1	103-23-1	Di(2-ethylhexyl)adipate	4.1E+02	ca	1.4E+03	ca	5.6E+00	ca	5.6E+01	ca		
		8.0E-01	i			8.0E-01	r		0.1	84-66-2	Diethyl phthalate	4.9E+04	nc	1.0E+05	max	2.9E+03	nc	2.9E+04	nc		
4.7E+03	h			4.7E+03	r				0.1	56-53-1	Diethylstilbestrol	1.0E-04	ca	3.7E-04	ca	1.4E-06	ca	1.4E-05	ca		
		8.0E-02	i			8.0E-02	r		0.1	43222-48-6	Difenzoquat (Avenge)	4.9E+03	nc	4.9E+04	nc	2.9E+02	nc	2.9E+03	nc		
		2.0E-02	i			2.0E-02	r		0.1	35367-38-5	Diflubenzuron	1.2E+03	nc	1.2E+04	nc	7.3E+01	nc	7.3E+02	nc		
		1.1E+01	r			1.1E+01	i	y		75-37-6	1,1-Difluoroethane					4.2E+04	nc	6.9E+04	nc		
		2.0E-02	n			2.0E-02	r		0.1	28553-12-0	Diisononyl phthalate	1.2E+03	nc	1.2E+04	nc	7.3E+01	nc	7.3E+02	nc		
						1.1E-01	p			108-20-3	**Diisopropyl ether**					4.0E+02	nc				
		8.0E-02	i			8.0E-02	r		0.1	1445-75-6	Diisopropyl methylphosphonate	4.9E+03	nc	4.9E+04	nc	2.9E+02	nc	2.9E+03	nc		
		2.0E-02	i			2.0E-02	r		0.1	55290-64-7	Dimethipin	1.2E+03	nc	1.2E+04	nc	7.3E+01	nc	7.3E+02	nc		
		2.0E-04	i			2.0E-04	r		0.1	60-51-5	Dimethoate	1.2E+01	nc	1.2E+02	nc	7.3E-01	nc	7.3E+00	nc		
1.4E-02	h			1.4E-02	r				0.1	119-90-4	3,3'-Dimethoxybenzidine	3.5E+01	ca	1.2E+02	ca	4.8E-01	ca	4.8E+00	ca		
		5.7E-06	r			5.7E-06	x	y		124-40-3	Dimethylamine	6.7E-02	nc	2.5E-01	nc	2.1E-02	nc	3.5E-02	nc		
		2.0E-03	i			2.0E-03	r		0.1	121-69-7	N-N-Dimethylaniline	1.2E+02	nc	1.2E+03	nc	7.3E+00	nc	7.3E+01	nc		
7.5E-01	h			7.5E-01	r				0.1	95-68-1	2,4-Dimethylaniline	6.5E-01	ca	2.3E+00	ca	9.0E-03	ca	9.0E-02	ca		

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TOXICITY VALUES											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs) "Direct Contact Exposure Pathways"								SOIL SCREENING LEVELS "Migration to Ground Water"	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
5.8E-01	h			5.8E-01	r				0.1	21436-96-4	2,4-Dimethylaniline hydrochloride	8.4E-01	ca	3.0E+00	ca	1.2E-02	ca	1.2E-01	ca		
2.3E+00	p			2.3E+00	r				0.1	119-93-7	**3,3'-Dimethylbenzidine**	2.1E-01	ca	7.5E-01	ca	2.9E-03	ca	2.9E-02	ca		
		1.0E-01	h			8.6E-03	i		0.1	68-12-2	N,N-Dimethylformamide	6.1E+03	nc	6.2E+04	nc	3.1E+01	nc	3.6E+03	nc		
		1.0E-03	n			1.0E-03	r		0.1	122-09-8	Dimethylphenethylamine	6.1E+01	nc	6.2E+02	nc	3.7E+00	nc	3.6E+01	nc		
		2.0E-02	i			2.0E-02	r		0.1	105-67-9	2,4-Dimethylphenol	1.2E+03	nc	1.2E+04	nc	7.3E+01	nc	7.3E+02	nc	9.0E+00	4.0E-01
		6.0E-04	i			6.0E-04	r		0.1	576-26-1	2,6-Dimethylphenol	3.7E+01	nc	3.7E+02	nc	2.2E+00	nc	2.2E+01	nc		
		1.0E-03	i			1.0E-03	r		0.1	95-65-8	3,4-Dimethylphenol	6.1E+01	nc	6.2E+02	nc	3.7E+00	nc	3.6E+01	nc		
		1.0E+01	h			1.0E+01	r		0.1	131-11-3	Dimethyl phthalate	1.0E+05	max	1.0E+05	max	3.7E+04	nc	3.6E+05	nc		
		1.0E-01	i			1.0E-01	r		0.1	120-61-6	Dimethyl terephthalate	6.1E+03	nc	6.2E+04	nc	3.7E+02	nc	3.6E+03	nc		
		1.0E-04	p			1.0E-04	r		0.1	534-52-1	**4,6-Dinitro-o-cresol**	6.1E+00	nc	6.2E+01	nc	3.7E-01	nc	3.6E+00	nc		
		2.0E-03	i			2.0E-03	r		0.1	131-89-5	4,6-Dinitro-o-cyclohexyl phenol	1.2E+02	nc	1.2E+03	nc	7.3E+00	nc	7.3E+01	nc		
		1.0E-04	p			1.0E-04	r		0.1	528-29-0	1,2-Dinitrobenzene	6.1E+00	nc	6.2E+01	nc	3.7E-01	nc	3.6E+00	nc		
		1.0E-04	i			1.0E-04	r		0.1	99-65-0	1,3-Dinitrobenzene	6.1E+00	nc	6.2E+01	nc	3.7E-01	nc	3.6E+00	nc		
		1.0E-04	p			1.0E-04	r		0.1	100-25-4	1,4-Dinitrobenzene	6.1E+00	nc	6.2E+01	nc	3.7E-01	nc	3.6E+00	nc		
		2.0E-03	i			2.0E-03	r		0.1	51-28-5	2,4-Dinitrophenol	1.2E+02	nc	1.2E+03	nc	7.3E+00	nc	7.3E+01	nc	3.0E-01	1.0E-02
6.8E-01	i			6.8E-01	r				0.1	25321-14-6	Dinitrotoluene mixture	7.2E-01	ca	2.5E+00	ca	9.9E-03	ca	9.9E-02	ca	8.0E-04	4.0E-05
		2.0E-03	i			2.0E-03	r		0.1	121-14-2	2,4-Dinitrotoluene (also see Dinitrotoluene mixture)	1.2E+02	nc	1.2E+03	nc	7.3E+00	nc	7.3E+01	nc	8.0E-04	4.0E-05
		1.0E-03	h			1.0E-03	r		0.1	606-20-2	2,6-Dinitrotoluene (also see Dinitrotoluene mixture)	6.1E+01	nc	6.2E+02	nc	3.7E+00	nc	3.6E+01	nc	7.0E-04	3.0E-05
		1.0E-03	i			1.0E-03	r		0.1	88-85-7	Dinoseb	6.1E+01	nc	6.2E+02	nc	3.7E+00	nc	3.6E+01	nc		
		4.0E-02	p			4.0E-02	r		0.1	117-84-0	di-n-Octyl phthalate	2.4E+03	nc	2.5E+04	nc	1.5E+02	nc	1.5E+03	nc	1.0E+04	1.0E+04
1.1E-02	i			1.1E-02	r				0.1	123-91-1	1,4-Dioxane	4.4E+01	ca	1.6E+02	ca	6.1E-01	ca	6.1E+00	ca		
1.5E+05	h			1.5E+05	h				0.03	1746-01-6	Dioxin (2,3,7,8-TCDD)+++	3.9E-06	ca	1.6E-05	ca	4.5E-08	ca	4.5E-07	ca		
		3.0E-02	i			3.0E-02	r		0.1	957-51-7	Diphenamid	1.8E+03	nc	1.8E+04	nc	1.1E+02	nc	1.1E+03	nc		
		2.5E-02	i			2.5E-02	r		0.1	122-39-4	Diphenylamine	1.5E+03	nc	1.5E+04	nc	9.1E+01	nc	9.1E+02	nc		
		3.0E-04	p			3.0E-04	r		0.1	74-31-7	N,N-Diphenyl-1,4 benzenediamine (DPPD)	1.8E+01	nc	1.8E+02	nc	1.1E+00	nc	1.1E+01	nc		
8.0E-01	i			8.0E-01	i				0.1	122-66-7	1,2-Diphenylhydrazine	6.1E-01	ca	2.2E+00	ca	8.4E-03	ca	8.4E-02	ca		
		3.0E-03	p			3.0E-03	r		0.1	127-63-9	Diphenyl sulfone	1.8E+02	nc	1.8E+03	nc	1.1E+01	nc	1.1E+02	nc		
		2.2E-03	i			2.2E-03	r		0.1	85-00-7	Diquat	1.3E+02	nc	1.4E+03	nc	8.0E+00	nc	8.0E+01	nc		
8.6E+00	h			8.6E+00	r				0.1	1937-37-7	Direct black 38	5.7E-02	ca	2.0E-01	ca	7.8E-04	ca	7.8E-03	ca		
8.1E+00	h			8.1E+00	r				0.1	2602-46-2	Direct blue 6	6.0E-02	ca	2.1E-01	ca	8.3E-04	ca	8.3E-03	ca		
9.3E+00	h			9.3E+00	r				0.1	16071-86-6	Direct brown 95	5.2E-02	ca	1.9E-01	ca	7.2E-04	ca	7.2E-03	ca		
		4.0E-05	i			4.0E-05	r		0.1	298-04-4	Disulfoton	2.4E+00	nc	2.5E+01	nc	1.5E-01	nc	1.5E+00	nc		
		1.0E-02	i			1.0E-02	r		0.1	505-29-3	1,4-Dithiane	6.1E+02	nc	6.2E+03	nc	3.7E+01	nc	3.6E+02	nc		
		2.0E-03	i			2.0E-03	r		0.1	330-54-1	Diuron	1.2E+02	nc	1.2E+03	nc	7.3E+00	nc	7.3E+01	nc		
		4.0E-03	i			4.0E-03	r		0.1	2439-10-3	Dodine	2.4E+02	nc	2.5E+03	nc	1.5E+01	nc	1.5E+02	nc		
		1.0E-01	n							7429-91-6	Dysprosium	7.8E+03	nc	1.0E+05	max			3.6E+03	nc		
		6.0E-03	i			6.0E-03	r		0.1	115-29-7	Endosulfan	3.7E+02	nc	3.7E+03	nc	2.2E+01	nc	2.2E+02	nc	1.8E+01	9.0E-01
		2.0E-02	i			2.0E-02	r		0.1	145-73-3	Endothall	1.2E+03	nc	1.2E+04	nc	7.3E+01	nc	7.3E+02	nc		
		3.0E-04	i			3.0E-04	r		0.1	72-20-8	Endrin	1.8E+01	nc	1.8E+02	nc	1.1E+00	nc	1.1E+01	nc	1.0E+00	5.0E-02
9.9E-03	i	2.0E-03	h	4.2E-03	h	2.9E-04	i	y		106-89-8	Epichlorohydrin	7.6E+00	nc	2.6E+01	nc	1.0E+00	nc	2.0E+00	nc		

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TOXICITY VALUES											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs) "Direct Contact Exposure Pathways"								SOIL SCREENING LEVELS "Migration to Ground Water"	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
8.00E-02	r			8.00E-02	c			y			**"CAL-Modified PRG"**	1.3E+00	nc	2.9E+00	nc	8.4E-02	nc	1.4E-01	nc		
		5.7E-03	r			5.7E-03	i		0.1	106-88-7	1,2-Epoxybutane	3.5E+02	nc	3.5E+03	nc	2.1E+01	nc	2.1E+02	nc		
		2.5E-02	i			2.5E-02	r		0.1	759-94-4	EPTC (S-Ethyl dipropylthiocarbamate)	1.5E+03	nc	1.5E+04	nc	9.1E+01	nc	9.1E+02	nc		
		5.0E-03	i			5.0E-03	r		0.1	16672-87-0	Ethephon (2-chloroethyl phosphonic acid)	3.1E+02	nc	3.1E+03	nc	1.8E+01	nc	1.8E+02	nc		
		5.0E-04	i			5.0E-04	r		0.1	563-12-2	Ethion	3.1E+01	nc	3.1E+02	nc	1.8E+00	nc	1.8E+01	nc		
		4.0E-01	h			5.7E-02	i		0.1	110-80-5	2-Ethoxyethanol	2.4E+04	nc	1.0E+05	max	2.1E+02	nc	1.5E+04	nc		
		3.0E-01	h			3.0E-01	r		0.1	111-15-9	2-Ethoxyethanol acetate	1.8E+04	nc	1.0E+05	max	1.1E+03	nc	1.1E+04	nc		
		9.0E-01	i			9.0E-01	r	y		141-78-6	Ethyl acetate	1.9E+04	nc	3.7E+04	sat	3.3E+03	nc	5.5E+03	nc		
4.8E-02	h			4.8E-02	r			y		140-88-5	Ethyl acrylate	2.1E-01	ca	4.5E-01	ca	1.4E-01	ca	2.3E-01	ca		
		1.0E-01	i			2.9E-01	i	y		100-41-4	**Ethylbenzene**	4.0E+02	sat	4.0E+02	sat	1.1E+03	nc	1.3E+03	nc	1.3E+01	7.0E-01
2.9E-03	n	4.0E-01	n	2.9E-03	r	2.9E+00	i	y		75-00-3	Ethyl chloride	3.0E+00	ca	6.5E+00	ca	2.3E+00	ca	4.6E+00	ca		
		3.0E-01	h			3.0E-01	r		0.1	109-78-4	Ethylene cyanohydrin	1.8E+04	nc	1.0E+05	max	1.1E+03	nc	1.1E+04	nc		
		9.0E-02	p			9.0E-02	r		0.1	107-15-3	**Ethylene diamine**	5.5E+03	nc	5.5E+04	nc	3.3E+02	nc	3.3E+03	nc		
		2.0E+00	i			2.0E+00	r		0.1	107-21-1	Ethylene glycol	1.0E+05	max	1.0E+05	max	7.3E+03	nc	7.3E+04	nc		
		5.0E-01	i			3.7E+00	i		0.1	111-76-2	Ethylene glycol, monobutyl ether	3.1E+04	nc	1.0E+05	max	1.4E+04	nc	1.8E+04	nc		
1.0E+00	h			3.5E-01	h			y		75-21-8	Ethylene oxide	1.4E-01	ca	3.4E-01	ca	1.9E-02	ca	2.4E-02	ca		
1.1E-01	h	8.0E-05	i	1.1E-01	r	8.0E-05	r		0.1	96-45-7	Ethylene thiourea (ETU)	4.4E+00	ca**	1.6E+01	ca**	6.1E-02	ca**	6.1E-01	ca**		
		2.0E-01	i			2.0E-01	r	y		60-29-7	Ethyl ether	1.8E+03	sat	1.8E+03	sat	7.3E+02	nc	1.2E+03	nc		
		9.0E-02	h			9.0E-02	r	y		97-63-2	Ethyl methacrylate	1.4E+02	sat	1.4E+02	sat	3.3E+02	nc	5.5E+02	nc		
		1.0E-05	i			1.0E-05	r		0.1	2104-64-5	Ethyl p-nitrophenyl phenylphosphorothioate	6.1E-01	nc	6.2E+00	nc	3.7E-02	nc	3.6E-01	nc		
		3.0E+00	i			3.0E+00	r		0.1	84-72-0	Ethylphthalyl ethyl glycolate	1.0E+05	max	1.0E+05	max	1.1E+04	nc	1.1E+05	nc		
		8.0E-03	i			8.0E-03	r		0.1	101200-48-0	Express	4.9E+02	nc	4.9E+03	nc	2.9E+01	nc	2.9E+02	nc		
		2.5E-04	i			2.5E-04	r		0.1	22224-92-6	Fenamiphos	1.5E+01	nc	1.5E+02	nc	9.1E-01	nc	9.1E+00	nc		
		1.3E-02	i			1.3E-02	r		0.1	2164-17-2	Fluometuron	7.9E+02	nc	8.0E+03	nc	4.7E+01	nc	4.7E+02	nc		
		6.0E-02	i						0.1	16984-48-8	Fluorine (soluble fluoride)	3.7E+03	nc	3.7E+04	nc			2.2E+03	nc		
		8.0E-02	i			8.0E-02	r		0.1	59756-60-4	Fluoridone	4.9E+03	nc	4.9E+04	nc	2.9E+02	nc	2.9E+03	nc		
		2.0E-02	i			2.0E-02	r		0.1	56425-91-3	Flurprimidol	1.2E+03	nc	1.2E+04	nc	7.3E+01	nc	7.3E+02	nc		
		6.0E-02	i			6.0E-02	r		0.1	66332-96-5	Flutolanil	3.7E+03	nc	3.7E+04	nc	2.2E+02	nc	2.2E+03	nc		
		1.0E-02	i			1.0E-02	r		0.1	69409-94-5	Fluvalinate	6.1E+02	nc	6.2E+03	nc	3.7E+01	nc	3.6E+02	nc		
3.5E-03	i	1.0E-01	i	3.5E-03	r	1.0E-01	r		0.1	133-07-3	Folpet	1.4E+02	ca*	4.9E+02	ca	1.9E+00	ca	1.9E+01	ca		
1.9E-01	i			1.9E-01	r				0.1	72178-02-0	Fomesafen	2.6E+00	ca	9.1E+00	ca	3.5E-02	ca	3.5E-01	ca		
		2.0E-03	i			2.0E-03	r		0.1	944-22-9	Fonofos	1.2E+02	nc	1.2E+03	nc	7.3E+00	nc	7.3E+01	nc		
		1.5E-01	i	4.6E-02	i				0.1	50-00-0	Formaldehyde	9.2E+03	nc	1.0E+05	nc	1.5E-01	ca	5.5E+03	nc		
		2.0E+00	h			8.6E-04	p		0.1	64-18-6	**Formic Acid**	1.0E+05	max	1.0E+05	max	3.1E+00	nc	7.3E+04	nc		
		3.0E+00	i			3.0E+00	r		0.1	39148-24-8	Fosetyl-al	1.0E+05	max	1.0E+05	max	1.1E+04	nc	1.1E+05	nc		
		3.0E+01	i			8.6E+00	h	y		76-13-1	Freon 113	5.6E+03	sat	5.6E+03	sat	3.1E+04	nc	5.9E+04	nc		
		1.0E-03	i			1.0E-03	r	y		110-00-9	Furan	2.5E+00	nc	8.5E+00	nc	3.7E+00	nc	6.1E+00	nc		
3.8E+00	h			3.8E+00	r				0.1	67-45-8	Furazolidone	1.3E-01	ca	4.5E-01	ca	1.8E-03	ca	1.8E-02	ca		
		3.0E-03	i			1.4E-02	h		0.1	98-01-1	Furfural	1.8E+02	nc	1.8E+03	nc	5.2E+01	nc	1.1E+02	nc		
5.0E+01	h			5.0E+01	r				0.1	531-82-8	Furium	9.7E-03	ca	3.4E-02	ca	1.3E-04	ca	1.3E-03	ca		
3.0E-02	i			3.0E-02	r				0.1	60568-05-0	Furmecyclox	1.6E+01	ca	5.7E+01	ca	2.2E-01	ca	2.2E+00	ca		
		4.0E-04	i			4.0E-04	r		0.1	77182-82-2	Glufosinate-ammonium	2.4E+01	nc	2.5E+02	nc	1.5E+00	nc	1.5E+01	nc		

Key : SFo,i=Cancer Slope Factor oral, inhalation RfDo,i=Reference Dose oral, inhalation i=IRIS p=PPRTV c=California EPA n=NCEA h=HEAST x=Withdrawn r=Route-extrapolation ca=Cancer PRG nc= Noncancer PRG ca* (where: nc PRG < 100X ca PRG)
ca** (where nc PRG < 10X ca PRG) +++=Non-Standard Method Applied (See User's Guide) sat=Soil Saturation (See User's Guide) max=Ceiling limit (See User's Guide) DAF=Dilution Attenuation Factor (See User's Guide) CAS=Chemical Abstract Services

TOXICITY VALUES											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs) "Direct Contact Exposure Pathways"								SOIL SCREENING LEVELS "Migration to Ground Water"	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
		4.0E-04	i			2.9E-04	h		0.1	765-34-4	Glycidaldehyde	2.4E+01	nc	2.5E+02	nc	1.0E+00	nc	1.5E+01	nc		
		1.0E-01	i			1.0E-01	r		0.1	1071-83-6	Glyphosate	6.1E+03	nc	6.2E+04	nc	3.7E+02	nc	3.6E+03	nc		
		5.0E-05	i			5.0E-05	r		0.1	69806-40-2	Haloxyfop-methyl	3.1E+00	nc	3.1E+01	nc	1.8E-01	nc	1.8E+00	nc		
		1.3E-02	i			1.3E-02	r		0.1	79277-27-3	Harmony	7.9E+02	nc	8.0E+03	nc	4.7E+01	nc	4.7E+02	nc		
4.5E+00	i	5.0E-04	i	4.6E+00	i	5.0E-04	r		0.1	76-44-8	Heptachlor	1.1E-01	ca	3.8E-01	ca	1.5E-03	ca	1.5E-02	ca	2.3E+01	1.0E+00
9.1E+00	i	1.3E-05	i	9.1E+00	i	1.3E-05	r		0.1	1024-57-3	Heptachlor epoxide	5.3E-02	ca*	1.9E-01	ca*	7.4E-04	ca*	7.4E-03	ca*	7.0E-01	3.0E-02
		2.0E-03	i			2.0E-03	r		0.1	87-82-1	Hexabromobenzene	1.2E+02	nc	1.2E+03	nc	7.3E+00	nc	7.3E+01	nc		
1.6E+00	i	8.0E-04	i	1.6E+00	i	8.0E-04	r		0.1	118-74-1	Hexachlorobenzene	3.0E-01	ca	1.1E+00	ca	4.2E-03	ca	4.2E-02	ca	2.0E+00	1.0E-01
7.8E-02	i	3.0E-04	n	7.8E-02	i	3.0E-04	r		0.1	87-68-3	Hexachlorobutadiene	6.2E+00	ca**	2.2E+01	ca**	8.6E-02	ca*	8.6E-01	ca*	2.0E+00	1.0E-01
6.3E+00	i	5.0E-04	n	6.3E+00	i	5.0E-04	r		0.04	319-84-6	HCH (alpha)	9.0E-02	ca	3.6E-01	ca	1.1E-03	ca	1.1E-02	ca	5.0E-04	3.0E-05
1.8E+00	i	2.0E-04	n	1.8E+00	i	2.0E-04	r		0.04	319-85-7	HCH (beta)	3.2E-01	ca	1.3E+00	ca	3.7E-03	ca	3.7E-02	ca	3.0E-03	1.0E-04
1.3E+00	h	3.0E-04	i	1.3E+00	r	3.0E-04	r		0.04	58-89-9	HCH (gamma) Lindane	4.4E-01	ca*	1.7E+00	ca	5.2E-03	ca	5.2E-02	ca	9.0E-03	5.0E-04
1.8E+00	i			1.8E+00	i				0.04	608-73-1	HCH-technical	3.2E-01	ca	1.3E+00	ca	3.8E-03	ca	3.7E-02	ca	3.0E-03	1.0E-04
		6.0E-03	i			5.7E-05	i		0.1	77-47-4	Hexachlorocyclopentadiene	3.7E+02	nc	3.7E+03	nc	2.1E-01	nc	2.2E+02	nc	4.0E+02	2.0E+01
1.4E-02	i	1.0E-03	i	1.4E-02	i	1.0E-03	r		0.1	67-72-1	Hexachloroethane	3.5E+01	ca**	1.2E+02	ca**	4.8E-01	ca**	4.8E+00	ca**	5.0E-01	2.0E-02
		3.0E-04	i			3.0E-04	r		0.1	70-30-4	Hexachlorophene	1.8E+01	nc	1.8E+02	nc	1.1E+00	nc	1.1E+01	nc		
1.1E-01	i	3.0E-03	i	1.1E-01	r	3.0E-03	r		0.1	121-82-4	Hexahydro-1,3,5-trinitro-1,3,5-triazine	4.4E+00	ca*	1.6E+01	ca	6.1E-02	ca	6.1E-01	ca		
		2.9E-06	r			2.9E-06	i		0.1	822-06-0	1,6-Hexamethylene diisocyanate	1.7E-01	nc	1.8E+00	nc	1.0E-02	nc	1.0E-01	nc		
		1.1E+01	p			5.7E-02	i	y		110-54-3	**n-Hexane**	1.1E+02	sat	1.1E+02	sat	2.1E+02	nc	4.2E+02	nc		
		3.3E-02	i			3.3E-02	r		0.1	51235-04-2	Hexazinone	2.0E+03	nc	2.0E+04	nc	1.2E+02	nc	1.2E+03	nc		
		5.0E-02	i			5.0E-02	r		0.1	2691-41-0	HMX	3.1E+03	nc	3.1E+04	nc	1.8E+02	nc	1.8E+03	nc		
3.0E+00	i			1.7E+01	i				0.1	302-01-2	Hydrazine, hydrazine sulfate	1.6E-01	ca	5.7E-01	ca	3.9E-04	ca	2.2E-02	ca		
3.0E+00	n			1.7E+01	n				0.1	60-34-4	Hydrazine, monomethyl	1.6E-01	ca	5.7E-01	ca	4.0E-04	ca	2.2E-02	ca		
3.0E+00	n			1.7E+01	n				0.1	57-14-7	Hydrazine, dimethyl	1.6E-01	ca	5.7E-01	ca	4.0E-04	ca	2.2E-02	ca		
						5.7E-03	i			7647-01-0	Hydrogen chloride					2.1E+01	nc				
		2.0E-02	i			8.6E-04	i	y		74-90-8	Hydrogen cyanide	1.1E+01	nc	3.5E+01	nc	3.1E+00	nc	6.2E+00	nc		
		3.0E-03	i			2.9E-04	i			7783-06-4	Hydrogen sulfide					1.0E+00	nc	1.1E+02	nc		
5.6E-02	p	4.0E-02	p	5.6E-02	r	4.0E-02	r		0.1	123-31-9	**p-Hydroquinone**	8.7E+00	ca	3.1E+01	ca	1.2E-01	ca	1.2E+00	ca		
		1.3E-02	i			1.3E-02	r		0.1	35554-44-0	Imazalil	7.9E+02	nc	8.0E+03	nc	4.7E+01	nc	4.7E+02	nc		
		2.5E-01	i			2.5E-01	r		0.1	81335-37-7	Imazaquin	1.5E+04	nc	1.0E+05	max	9.1E+02	nc	9.1E+03	nc		
		4.0E-02	i			4.0E-02	r		0.1	36734-19-7	Iprodione	2.4E+03	nc	2.5E+04	nc	1.5E+02	nc	1.5E+03	nc		
		3.0E-01	n							7439-89-6	Iron	2.3E+04	nc	1.0E+05	max			1.1E+04	nc		
		3.0E-01	i			3.0E-01	r	y		78-83-1	Isobutanol	1.3E+04	nc	4.0E+04	sat	1.1E+03	nc	1.8E+03	nc		
9.5E-04	i	2.0E-01	i	9.5E-04	r	2.0E-01	r		0.1	78-59-1	Isophorone	5.1E+02	ca*	5.1E+02	ca*	7.1E+00	ca	7.1E+01	ca	5.0E-01	3.0E-02
		1.5E-02	i			1.5E-02	r		0.1	33820-53-0	Isopropalin	9.2E+02	nc	9.2E+03	nc	5.5E+01	nc	5.5E+02	nc		
		1.0E-01	i			1.1E-01	r		0.1	1832-54-8	Isopropyl methyl phosphonic acid	6.1E+03	nc	6.2E+04	nc	4.0E+02	nc	3.6E+03	nc		
		5.0E-02	i			5.0E-02	r		0.1	82558-50-7	Isoxaben	3.1E+03	nc	3.1E+04	nc	1.8E+02	nc	1.8E+03	nc		
8.0E+00	p	2.0E-04	p	8.0E+00	r	2.0E-04	r		0.1	143-50-0	Kepone	6.1E-02	ca	2.2E-01	ca	8.4E-04	ca	8.4E-03	ca		
		2.0E-03	i			2.0E-03	r		0.1	77501-63-4	Lactofen	1.2E+02	nc	1.2E+03	nc	7.3E+00	nc	7.3E+01	nc		
www.epa.gov/superfund/programs/lead/ieubk.htm										7439-92-1	**Lead+++**	4.0E+02	nc	8.0E+02	nc						
www.dtsc.ca.gov/ScienceTechnology/ledspred.html											"CAL-Modified PRG"+++	1.5E+02	nc								
		1.0E-07	i						0.1	78-00-2	Lead (tetraethyl)	6.1E-03	nc	6.2E-02	nc			3.6E-03	nc		

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TOXICITY VALUES											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs)								SOIL SCREENING LEVELS	
												"Direct Contact Exposure Pathways"								"Migration to Ground Water"	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		V O C	skin abs. soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
		2.0E-03	i			2.0E-03	r		0.1	330-55-2	Linuron	1.2E+02	nc	1.2E+03	nc	7.3E+00	nc	7.3E+01	nc		
		2.0E-02	x							7439-93-2	Lithium	1.6E+03	nc	2.0E+04	nc			7.3E+02	nc		
		2.0E-01	i			2.0E-01	r		0.1	83055-99-6	Londax	1.2E+04	nc	1.0E+05	max	7.3E+02	nc	7.3E+03	nc		
		2.0E-02	i			2.0E-02	r		0.1	121-75-5	Malathion	1.2E+03	nc	1.2E+04	nc	7.3E+01	nc	7.3E+02	nc		
		1.0E-01	i			1.0E-01	r		0.1	108-31-6	Maleic anhydride	6.1E+03	nc	6.2E+04	nc	3.7E+02	nc	3.6E+03	nc		
		5.0E-01	i			5.0E-01	r	y		123-33-1	Maleic hydrazide	1.7E+03	nc	2.4E+03	sat	1.8E+03	nc	3.0E+03	nc		
		1.0E-04	p			1.0E-04	r		0.1	109-77-3	**Malononitrile**	6.1E+00	nc	6.2E+01	nc	3.7E-01	nc	3.6E+00	nc		
		3.0E-02	h			3.0E-02	r		0.1	8018-01-7	Mancozeb	1.8E+03	nc	1.8E+04	nc	1.1E+02	nc	1.1E+03	nc		
6.0E-02	o	5.0E-03	i	6.0E-02	r	5.0E-03	r		0.1	12427-38-2	Maneb	8.1E+00	ca*	2.9E+01	ca	1.1E-01	ca	1.1E+00	ca		
		2.4E-02	i			1.4E-05	i			7439-96-5	Manganese and compounds+++	1.8E+03	nc	1.9E+04	nc	5.1E-02	nc	8.8E+02	nc		
		9.0E-05	h			9.0E-05	r		0.1	950-10-7	Mephosfolan	5.5E+00	nc	5.5E+01	nc	3.3E-01	nc	3.3E+00	nc		
		3.0E-02	i			3.0E-02	r		0.1	24307-26-4	Mepiquat chloride	1.8E+03	nc	1.8E+04	nc	1.1E+02	nc	1.1E+03	nc		
2.9E-02	n	1.0E-01	n	2.9E-02	r	1.0E-01	r		0.1	149-30-4	2-Mercaptobenzothiazole	1.7E+01	ca	5.9E+01	ca	2.3E-01	ca	2.3E+00	ca		
		3.0E-04	i							7487-94-7	Mercury and compounds	2.3E+01	nc	3.1E+02	nc			1.1E+01	nc		
						8.6E-05	i			7439-97-6	Mercury (elemental)					3.1E-01	nc				
		1.0E-04	i						0.1	22967-92-6	Mercury (methyl)	6.1E+00	nc	6.2E+01	nc			3.6E+00	nc		
		3.0E-05	i			3.0E-05	r		0.1	150-50-5	Merphos	1.8E+00	nc	1.8E+01	nc	1.1E-01	nc	1.1E+00	nc		
		3.0E-05	i			3.0E-05	r		0.1	78-48-8	Merphos oxide	1.8E+00	nc	1.8E+01	nc	1.1E-01	nc	1.1E+00	nc		
		6.0E-02	i			6.0E-02	r		0.1	57837-19-1	Metalaxyl	3.7E+03	nc	3.7E+04	nc	2.2E+02	nc	2.2E+03	nc		
		1.0E-04	i			2.0E-04	h	y		126-98-7	Methacrylonitrile	2.1E+00	nc	8.4E+00	nc	7.3E-01	nc	1.0E+00	nc		
		5.0E-05	i			5.0E-05	r		0.1	10265-92-6	Methamidophos	3.1E+00	nc	3.1E+01	nc	1.8E-01	nc	1.8E+00	nc		
		5.0E-01	i			5.0E-01	r		0.1	67-56-1	Methanol	3.1E+04	nc	1.0E+05	max	1.8E+03	nc	1.8E+04	nc		
		1.0E-03	i			1.0E-03	r		0.1	950-37-8	Methidathion	6.1E+01	nc	6.2E+02	nc	3.7E+00	nc	3.6E+01	nc		
		2.5E-02	i			2.5E-02	r	y		16752-77-5	Methomyl	4.4E+01	nc	1.5E+02	nc	9.1E+01	nc	1.5E+02	nc		
		5.0E-03	i			5.0E-03	r		0.1	72-43-5	Methoxychlor	3.1E+02	nc	3.1E+03	nc	1.8E+01	nc	1.8E+02	nc	1.6E+02	8.0E+00
		1.0E-03	h			5.7E-03	i		0.1	109-86-4	2-Methoxyethanol	6.1E+01	nc	6.2E+02	nc	2.1E+01	nc	3.6E+01	nc		
		2.0E-03	h			2.0E-03	r		0.1	110-49-6	2-Methoxyethanol acetate	1.2E+02	nc	1.2E+03	nc	7.3E+00	nc	7.3E+01	nc		
4.6E-02	h			4.6E-02	r				0.1	99-59-2	2-Methoxy-5-nitroaniline	1.1E+01	ca	3.7E+01	ca	1.5E-01	ca	1.5E+00	ca		
		1.0E+00	h			1.0E+00	r	y		79-20-9	Methyl acetate	2.2E+04	nc	9.2E+04	nc	3.7E+03	nc	6.1E+03	nc		
		3.0E-02	h			3.0E-02	r	y		96-33-3	Methyl acrylate	7.0E+01	nc	2.3E+02	nc	1.1E+02	nc	1.8E+02	nc		
2.4E-01	h			2.4E-01	r				0.1	95-53-4	2-Methylaniline (o-toluidine)	2.0E+00	ca	7.2E+00	ca	2.8E-02	ca	2.8E-01	ca		
1.8E-01	h			1.8E-01	r				0.1	636-21-5	2-Methylaniline hydrochloride	2.7E+00	ca	9.6E+00	ca	3.7E-02	ca	3.7E-01	ca		
		5.0E-04	i			5.0E-04	r		0.1	94-74-6	2-Methyl-4-chlorophenoxyacetic acid	3.1E+01	nc	3.1E+02	nc	1.8E+00	nc	1.8E+01	nc		
		1.0E-02	i			1.0E-02	r		0.1	94-81-5	4-(2-Methyl-4-chlorophenoxy) butyric acid	6.1E+02	nc	6.2E+03	nc	3.7E+01	nc	3.6E+02	nc		
		1.0E-03	i			1.0E-03	r		0.1	93-65-2	2-(2-Methyl-4-chlorophenoxy) propionic acid	6.1E+01	nc	6.2E+02	nc	3.7E+00	nc	3.6E+01	nc		
		1.0E-03	i			1.0E-03	r		0.1	16484-77-8	2-(2-Methyl-1,4-chlorophenoxy) propionic acid	6.1E+01	nc	6.2E+02	nc	3.7E+00	nc	3.6E+01	nc		
		8.6E-01	r			8.6E-01	h	y		108-87-2	Methylcyclohexane	2.6E+03	nc	8.7E+03	nc	3.1E+03	nc	5.2E+03	nc		
2.5E-01	h			2.5E-01	r				0.1	101-77-9	4,4'-Methylenebisbenzeneamine	1.9E+00	ca	6.9E+00	ca	2.7E-02	ca	2.7E-01	ca		
1.3E-01	h	7.0E-04	h	1.3E-01	h	7.0E-04	r		0.1	101-14-4	4,4'-Methylene bis(2-chloroaniline)	3.7E+00	ca*	1.3E+01	ca*	5.2E-02	ca*	5.2E-01	ca*		
4.6E-02	i			4.6E-02	r				0.1	101-61-1	4,4'-Methylene bis(N,N'-dimethyl)aniline	1.1E+01	ca	3.7E+01	ca	1.5E-01	ca	1.5E+00	ca		
		1.0E-02	h			1.0E-02	r	y		74-95-3	Methylene bromide	6.7E+01	nc	2.3E+02	nc	3.7E+01	nc	6.1E+01	nc		
7.5E-03	i	6.0E-02	i	1.6E-03	i	8.6E-01	h	y		75-09-2	Methylene chloride	9.1E+00	ca	2.1E+01	ca	4.1E+00	ca	4.3E+00	ca	2.0E-02	1.0E-03

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ca** (where nc PRG < 10X ca PRG) +++=Non-Standard Method Applied (See User's Guide) sat=Soil Saturation (See User's Guide) max=Ceiling limit (See User's Guide) DAF=Dilution Attenuation Factor (See User's Guide) CAS=Chemical Abstract Services

TOXICITY VALUES											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs)								SOIL SCREENING LEVELS	
												"Direct Contact Exposure Pathways"								"Migration to Ground Water"	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
		1.7E-04	r			1.7E-04	i		0.1	101-68-8	4,4'-Methylene diphenyl diisocyanate	1.0E+01	nc	1.0E+02	nc	6.2E-01	nc	6.2E+00	nc		
		6.0E-01	i			1.4E+00	i	y		78-93-3	**Methyl ethyl ketone (2-Butanone)**	2.2E+04	nc	1.1E+05	nc	5.1E+03	nc	7.0E+03	nc		
		8.0E-02	h			8.6E-01	i	y		108-10-1	**Methyl isobutyl ketone**	5.3E+03	nc	4.7E+04	nc	3.1E+03	nc	2.0E+03	nc		
		5.7E-04	r			5.7E-04	n		0.1	74-93-1	Methyl Mercaptan	3.5E+01	nc	3.5E+02	nc	2.1E+00	nc	2.1E+01	nc		
		1.4E+00	i			2.0E-01	i	y		80-62-6	Methyl methacrylate	2.2E+03	nc	2.7E+03	sat	7.3E+02	nc	1.4E+03	nc		
3.3E-02	h			3.3E-02	r				0.1	99-55-8	2-Methyl-5-nitroaniline	1.5E+01	ca	5.2E+01	ca	2.0E-01	ca	2.0E+00	ca		
		2.5E-04	i			2.5E-04	r		0.1	298-00-0	Methyl parathion	1.5E+01	nc	1.5E+02	nc	9.1E-01	nc	9.1E+00	nc		
		5.0E-02	i			5.0E-02	r		0.1	95-48-7	2-Methylphenol	3.1E+03	nc	3.1E+04	nc	1.8E+02	nc	1.8E+03	nc	1.5E+01	8.0E-01
		5.0E-02	i			5.0E-02	r		0.1	108-39-4	3-Methylphenol	3.1E+03	nc	3.1E+04	nc	1.8E+02	nc	1.8E+03	nc		
		5.0E-03	h			5.0E-03	r		0.1	106-44-5	4-Methylphenol	3.1E+02	nc	3.1E+03	nc	1.8E+01	nc	1.8E+02	nc		
		2.0E-02	p			2.0E-02	r		0.1	993-13-5	Methyl phosphonic acid	1.2E+03	nc	1.2E+04	nc	7.3E+01	nc	7.3E+02	nc		
		6.0E-03	h			1.1E-02	h	y		25013-15-4	Methyl styrene (mixture)	1.3E+02	nc	5.4E+02	nc	4.2E+01	nc	6.0E+01	nc		
		7.0E-02	h			7.0E-02	r	y		98-83-9	Methyl styrene (alpha)	6.8E+02	sat	6.8E+02	sat	2.6E+02	nc	4.3E+02	nc		
1.8E-03	c	8.6E-01	**r**	9.1E-04	c	8.6E-01	i	y		1634-04-4	**Methyl tertbutyl ether (MTBE)**	3.2E+01	ca	7.0E+01	ca	7.4E+00	ca	1.1E+01	ca		
		1.5E-01	i			1.5E-01	r		0.1	51218-45-2	Metolaclor (Dual)	9.2E+03	nc	9.2E+04	nc	5.5E+02	nc	5.5E+03	nc		
		2.5E-02	i			2.5E-02	r		0.1	21087-64-9	Metribuzin	1.5E+03	nc	1.5E+04	nc	9.1E+01	nc	9.1E+02	nc		
1.8E+00	x	2.0E-04	i	1.8E+00	r	2.0E-04	r		0.1	2385-85-5	Mirex	2.7E-01	ca*	9.6E-01	ca	3.7E-03	ca	3.7E-02	ca		
		2.0E-03	i			2.0E-03	r		0.1	2212-67-1	Molinate	1.2E+02	nc	1.2E+03	nc	7.3E+00	nc	7.3E+01	nc		
		5.0E-03	i							7439-98-7	Molybdenum	3.9E+02	nc	5.1E+03	nc			1.8E+02	nc		
		1.0E-01	i			1.0E-01	r		0.1	10599-90-3	Monochloramine	6.1E+03	nc	6.2E+04	nc	3.7E+02	nc	3.6E+03	nc		
		2.0E-03	i			2.0E-03	r		0.1	300-76-5	Naled	1.2E+02	nc	1.2E+03	nc	7.3E+00	nc	7.3E+01	nc		
		1.0E-01	i			1.0E-01	r		0.1	15299-99-7	Napropamide	6.1E+03	nc	6.2E+04	nc	3.7E+02	nc	3.6E+03	nc		
		2.0E-02	i							7440-02-0	Nickel (soluble salts)	1.6E+03	nc	2.0E+04	nc			7.3E+02	nc	1.3E+02	7.0E+00
				8.4E-01	i						Nickel refinery dust					8.0E-03	ca				
				1.7E+00	i					12035-72-2	Nickel subsulfide			1.1E+04	ca	4.0E-03	ca				
Tap Water PRG Based on Infant NOAEL (see IRIS)										14797-55-8	Nitrate+++							1.0E+04	nc		
Tap Water PRG Based on Infant NOAEL (see IRIS)										14797-65-0	Nitrite+++							1.0E+03	nc		
		3.0E-03	p			3.0E-05	p		0.1	88-74-4	**2-Nitroaniline**	1.8E+02	nc	1.8E+03	nc	1.1E-01	nc	1.1E+02	nc		
2.1E-02	p	3.0E-04	p	2.1E-02	r	3.0E-04	p		0.1	99-09-2	**3-Nitroaniline**	1.8E+01	nc	8.2E+01	ca**	3.2E-01	ca**	3.2E+00	ca**		
2.1E-02	p	3.0E-03	p	2.1E-02	r	1.0E-03	p		0.1	100-01-6	**4-Nitroaniline**	2.3E+01	ca**	8.2E+01	ca*	3.2E-01	ca*	3.2E+00	ca*		
		5.0E-04	i			5.7E-04	h	y		98-95-3	Nitrobenzene	2.0E+01	nc	1.0E+02	nc	2.1E+00	nc	3.4E+00	nc	1.0E-01	7.0E-03
		7.0E-02	h			7.0E-02	r		0.1	67-20-9	Nitrofurantoin	4.3E+03	nc	4.3E+04	nc	2.6E+02	nc	2.6E+03	nc		
1.5E+00	h			1.5E+00	r				0.1	59-87-0	Nitrofurazone	3.2E-01	ca	1.1E+00	ca	4.5E-03	ca	4.5E-02	ca		
1.4E-02	n			1.4E-02	r				0.1	55-63-0	Nitroglycerin	3.5E+01	ca	1.2E+02	ca	4.8E-01	ca	4.8E+00	ca		
		1.0E-01	i			1.0E-01	r		0.1	556-88-7	Nitroguanidine	6.1E+03	nc	6.2E+04	nc	3.7E+02	nc	3.6E+03	nc		
9.4E+00	r	5.7E-03	r	9.4E+00	h	5.7E-03	i	y		79-46-9	2-Nitropropane					7.2E-04	ca	1.2E-03	ca		
5.4E+00	i			5.6E+00	i			y		924-16-3	N-Nitrosodi-n-butylamine	2.4E-02	ca	5.8E-02	ca	1.2E-03	ca	2.0E-03	ca		
2.8E+00	i			2.8E+00	r				0.1	1116-54-7	N-Nitrosodiethanolamine	1.7E-01	ca	6.2E-01	ca	2.4E-03	ca	2.4E-02	ca		
1.5E+02	i			1.5E+02	i				0.1	55-18-5	N-Nitrosodiethylamine	3.2E-03	ca	1.1E-02	ca	4.5E-05	ca	4.5E-04	ca		
5.1E+01	i	8.0E-06	p	4.9E+01	i	8.0E-06	r		0.1	62-75-9	**N-Nitrosodimethylamine**	9.5E-03	ca*	3.4E-02	ca	1.4E-04	ca	1.3E-03	ca		
4.9E-03	i	2.0E-02	p	4.9E-03	r	2.0E-02	r		0.1	86-30-6	**N-Nitrosodiphenylamine**	9.9E+01	ca*	3.5E+02	ca*	1.4E+00	ca*	1.4E+01	ca*	1.0E+00	6.0E-02
7.0E+00	i			7.0E+00	r				0.1	621-64-7	N-Nitroso di-n-propylamine	6.9E-02	ca	2.5E-01	ca	9.6E-04	ca	9.6E-03	ca	5.0E-05	2.0E-06

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TOXICITY VALUES											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs) "Direct Contact Exposure Pathways"								SOIL SCREENING LEVELS "Migration to Ground Water"	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
2.2E+01	i			2.2E+01	r				0.1	10595-95-6	N-Nitroso-N-methylethylamine	2.2E-02	ca	7.8E-02	ca	3.1E-04	ca	3.1E-03	ca		
2.1E+00	i			2.1E+00	i				0.1	930-55-2	N-Nitrosopyrrolidine	2.3E-01	ca	8.2E-01	ca	3.1E-03	ca	3.2E-02	ca		
		2.0E-02	p			2.0E-02	r	y		99-08-1	**m-Nitrotoluene**	7.3E+02	nc	1.0E+03	sat	7.3E+01	nc	1.2E+02	nc		
2.3E-01	p	1.0E-02	h	2.3E-01	r	1.0E-02	r	y		88-72-2	**o-Nitrotoluene**	8.8E-01	ca	2.2E+00	ca	2.9E-02	ca	4.9E-02	ca		
1.7E-02	p	1.0E-02	p	1.7E-02	r	1.0E-02	r	y		99-99-0	**p-Nitrotoluene**	1.2E+01	ca*	3.0E+01	ca*	4.0E-01	ca*	6.6E-01	ca*		
		4.0E-02	i			4.0E-02	r		0.1	27314-13-2	Norflurazon	2.4E+03	nc	2.5E+04	nc	1.5E+02	nc	1.5E+03	nc		
		7.0E-04	i			7.0E-04	r		0.1	85509-19-9	NuStar	4.3E+01	nc	4.3E+02	nc	2.6E+00	nc	2.6E+01	nc		
		3.0E-03	i			3.0E-03	r		0.1	32536-52-0	Octabromodiphenyl ether	1.8E+02	nc	1.8E+03	nc	1.1E+01	nc	1.1E+02	nc		
		2.0E-03	h			2.0E-03	r		0.1	152-16-9	Octamethylpyrophosphoramide	1.2E+02	nc	1.2E+03	nc	7.3E+00	nc	7.3E+01	nc		
		5.0E-02	i			5.0E-02	r		0.1	19044-88-3	Oryzalin	3.1E+03	nc	3.1E+04	nc	1.8E+02	nc	1.8E+03	nc		
		5.0E-03	i			5.0E-03	r		0.1	19666-30-9	Oxadiazon	3.1E+02	nc	3.1E+03	nc	1.8E+01	nc	1.8E+02	nc		
		2.5E-02	i			2.5E-02	r		0.1	23135-22-0	Oxamyl	1.5E+03	nc	1.5E+04	nc	9.1E+01	nc	9.1E+02	nc		
		3.0E-03	i			3.0E-03	r		0.1	42874-03-3	Oxyfluorfen	1.8E+02	nc	1.8E+03	nc	1.1E+01	nc	1.1E+02	nc		
		1.3E-02	i			1.3E-02	r		0.1	76738-62-0	Paclobutrazol	7.9E+02	nc	8.0E+03	nc	4.7E+01	nc	4.7E+02	nc		
		4.5E-03	i			4.5E-03	r		0.1	4685-14-7	Paraquat	2.7E+02	nc	2.8E+03	nc	1.6E+01	nc	1.6E+02	nc		
		6.0E-03	h			6.0E-03	r		0.1	56-38-2	Parathion	3.7E+02	nc	3.7E+03	nc	2.2E+01	nc	2.2E+02	nc		
		5.0E-02	h			5.0E-02	r		0.1	1114-71-2	Pebulate	3.1E+03	nc	3.1E+04	nc	1.8E+02	nc	1.8E+03	nc		
		4.0E-02	i			4.0E-02	r		0.1	40487-42-1	Pendimethalin	2.4E+03	nc	2.5E+04	nc	1.5E+02	nc	1.5E+03	nc		
2.3E-02	h			2.3E-02	r				0.1	87-84-3	Pentabromo-6-chloro cyclohexane	2.1E+01	ca	7.5E+01	ca	2.9E-01	ca	2.9E+00	ca		
		2.0E-03	i			2.0E-03	r		0.1	32534-81-9	Pentabromodiphenyl ether	1.2E+02	nc	1.2E+03	nc	7.3E+00	nc	7.3E+01	nc		
		8.0E-04	i			8.0E-04	r		0.1	608-93-5	Pentachlorobenzene	4.9E+01	nc	4.9E+02	nc	2.9E+00	nc	2.9E+01	nc		
2.6E-01	h	3.0E-03	i	2.6E-01	r	3.0E-03	r		0.1	82-68-8	Pentachloronitrobenzene	1.9E+00	ca*	6.6E+00	ca	2.6E-02	ca	2.6E-01	ca		
1.2E-01	i	3.0E-02	i	1.2E-01	r	3.0E-02	r		0.25	87-86-5	Pentachlorophenol	3.0E+00	ca	9.0E+00	ca	5.6E-02	ca	5.6E-01	ca	3.0E-02	1.0E-03
		1.0E-04	n							7601-90-3	Perchlorate	7.8E+00	ca/nc	1.0E+02	ca/nc			3.6E+00	ca/nc		
		5.0E-02	i			5.0E-02	r		0.1	52645-53-1	Permethrin	3.1E+03	nc	3.1E+04	nc	1.8E+02	nc	1.8E+03	nc		
		2.5E-01	i			2.5E-01	r		0.1	13684-63-4	Phenmedipham	1.5E+04	nc	1.0E+05	max	9.1E+02	nc	9.1E+03	nc		
		3.0E-01	i			3.0E-01	r		0.1	108-95-2	**Phenol**	1.8E+04	nc	1.0E+05	max	1.1E+03	nc	1.1E+04	nc	1.0E+02	5.0E+00
		2.0E-03	n			2.0E-03	r		0.1	92-84-2	Phenothiazine	1.2E+02	nc	1.2E+03	nc	7.3E+00	nc	7.3E+01	nc		
		6.0E-03	i			6.0E-03	r		0.1	108-45-2	m-Phenylenediamine	3.7E+02	nc	3.7E+03	nc	2.2E+01	nc	2.2E+02	nc		
4.7E-02	h			4.7E-02	r				0.1	95-54-5	**o-Phenylenediamine**	1.0E+01	ca	3.7E+01	ca	1.4E-01	ca	1.4E+00	ca		
		1.9E-01	h			1.9E-01	r		0.1	106-50-3	p-Phenylenediamine	1.2E+04	nc	1.0E+05	max	6.9E+02	nc	6.9E+03	nc		
		8.0E-05	i			8.0E-05	r		0.1	62-38-4	Phenylmercuric acetate	4.9E+00	nc	4.9E+01	nc	2.9E-01	nc	2.9E+00	nc		
1.9E-03	h			1.9E-03	r				0.1	90-43-7	2-Phenylphenol	2.5E+02	ca	8.9E+02	ca	3.5E+00	ca	3.5E+01	ca		
		2.0E-04	h			2.0E-04	r		0.1	298-02-2	Phorate	1.2E+01	nc	1.2E+02	nc	7.3E-01	nc	7.3E+00	nc		
		2.0E-02	i			2.0E-02	r		0.1	732-11-6	Phosmet	1.2E+03	nc	1.2E+04	nc	7.3E+01	nc	7.3E+02	nc		
		3.0E-04	i			8.6E-05	i		0.1	7803-51-2	Phosphine	1.8E+01	nc	1.8E+02	nc	3.1E-01	nc	1.1E+01	nc		
						2.9E-03	i			7664-38-2	Phosphoric acid					1.0E+01	nc				
		2.0E-05	i							7723-14-0	Phosphorus (white)	1.6E+00	nc	2.0E+01	nc			7.3E-01	nc		
		1.0E+00	h			1.0E+00	r		0.1	100-21-0	p-Phthalic acid	6.1E+04	nc	1.0E+05	max	3.7E+03	nc	3.6E+04	nc		
		2.0E+00	i			3.4E-02	h		0.1	85-44-9	Phthalic anhydride	1.0E+05	max	1.0E+05	max	1.2E+02	nc	7.3E+04	nc		
		7.0E-02	i			7.0E-02	r		0.1	1918-02-1	Picloram	4.3E+03	nc	4.3E+04	nc	2.6E+02	nc	2.6E+03	nc		
		1.0E-02	i			1.0E-02	r		0.1	29232-93-7	Pirimiphos-methyl	6.1E+02	nc	6.2E+03	nc	3.7E+01	nc	3.6E+02	nc		

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TOXICITY VALUES											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs)								SOIL SCREENING LEVELS	
								V	skin			"Direct Contact Exposure Pathways"								"Migration to Ground Water"	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		O C	abs. soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
8.9E+00	h	7.0E-06	h	8.9E+00	r	7.0E-06	r		0.1		Polybrominated biphenyls	5.5E-02	ca**	1.9E-01	ca*	7.6E-04	ca*	7.6E-03	ca*		
											Polychlorinated biphenyls (PCBs, see IRIS)										
7.0E-02	i	7.0E-05	i	7.0E-02	i	7.0E-05	r		0.14	12674-11-2	PCBs (unspeciated mixture, low risk, e.g. Aroclor 1016)	3.9E+00	nc	2.1E+01	ca**	9.6E-02	ca**	9.6E-01	ca**		
2.0E+00	i	2.0E-05	i	2.0E+00	i	2.0E-05	r		0.14	11097-69-1	PCBs (unspeciated mixture, high risk, e.g. Aroclor 1254)	2.2E-01	ca**	7.4E-01	ca*	3.4E-03	ca*	3.4E-02	ca*		
4.5E+00	n			4.5E+00	r				0.1	61788-33-8	Polychlorinated terphenyls	1.1E-01	ca	3.8E-01	ca	1.5E-03	ca	1.5E-02	ca		
											Polynuclear aromatic hydrocarbons (PAHs)										
		6.0E-02	i			6.0E-02	r	y		83-32-9	Acenaphthene	3.7E+03	nc	2.9E+04	nc	2.2E+02	nc	3.7E+02	nc	5.7E+02	2.9E+01
		3.0E-01	i			3.0E-01	r	y		120-12-7	Anthracene	2.2E+04	nc	1.0E+05	max	1.1E+03	nc	1.8E+03	nc	1.2E+04	5.9E+02
7.3E-01	n			7.3E-01	r				0.13	56-55-3	Benz[a]anthracene	6.2E-01	ca	2.1E+00	ca	9.2E-03	ca	9.2E-02	ca	2.0E+00	8.0E-02
7.3E-01	n			7.3E-01	r				0.13	205-99-2	Benzo[b]fluoranthene	6.2E-01	ca	2.1E+00	ca	9.2E-03	ca	9.2E-02	ca	5.0E+00	2.0E-01
7.3E-02	n			7.3E-02	r				0.13	207-08-9	Benzo[k]fluoranthene	6.2E+00	ca	2.1E+01	ca	9.2E-02	ca	9.2E-01	ca	4.9E+01	2.0E+00
1.2E+00	c			3.9E-01	c				0.13	207-08-9	"CAL-Modified PRG"	3.8E-01	ca	1.3E+00	ca	1.7E-02	ca	5.6E-02	ca		
7.3E+00	i			7.3E+00	r				0.13	50-32-8	Benzo[a]pyrene	6.2E-02	ca	2.1E-01	ca	9.2E-04	ca	9.2E-03	ca	8.0E+00	4.0E-01
7.3E-03	n			7.3E-03	r				0.13	218-01-9	Chrysene	6.2E+01	ca	2.1E+02	ca	9.2E-01	ca	9.2E+00	ca	1.6E+02	8.0E+00
1.2E-01	c			3.9E-02	c				0.13		"CAL-Modified PRG"	3.8E+00	ca	1.3E+01	ca	1.7E-01	ca	5.6E-01	ca		
7.3E+00	n			7.3E+00	r				0.13	53-70-3	Dibenz[ah]anthracene	6.2E-02	ca	2.1E-01	ca	9.2E-04	ca	9.2E-03	ca	2.0E+00	8.0E-02
		4.0E-02	i			4.0E-02	r		0.13	206-44-0	Fluoranthene	2.3E+03	nc	2.2E+04	nc	1.5E+02	nc	1.5E+03	nc	4.3E+03	2.1E+02
		4.0E-02	i			4.0E-02	r	y		86-73-7	Fluorene	2.7E+03	nc	2.6E+04	nc	1.5E+02	nc	2.4E+02	nc	5.6E+02	2.8E+01
7.3E-01	n			7.3E-01	r				0.13	193-39-5	Indeno[1,2,3-cd]pyrene	6.2E-01	ca	2.1E+00	ca	9.2E-03	ca	9.2E-02	ca	1.4E+01	7.0E-01
		2.0E-02	i			8.6E-04	i	y		91-20-3	Naphthalene	5.6E+01	nc	1.9E+02	nc	3.1E+00	nc	6.2E+00	nc	8.4E+01	4.0E+00
1.2E-01	r			1.2E-01	c						**"CAL-Modified PRG"**	1.7E+00	ca	4.2E+00	ca	5.6E-02	ca	9.3E-02	ca		
		3.0E-02	i			3.0E-02	r	y		129-00-0	Pyrene	2.3E+03	nc	2.9E+04	nc	1.1E+02	nc	1.8E+02	nc	4.2E+03	2.1E+02
1.5E-01	i	9.0E-03	i	1.5E-01	r	9.0E-03	r		0.1	67747-09-5	Prochloraz	3.2E+00	ca	1.1E+01	ca	4.5E-02	ca	4.5E-01	ca		
		6.0E-03	h			6.0E-03	r		0.1	26399-36-0	Profluralin	3.7E+02	nc	3.7E+03	nc	2.2E+01	nc	2.2E+02	nc		
		1.5E-02	i			1.5E-02	r		0.1	1610-18-0	Prometon	9.2E+02	nc	9.2E+03	nc	5.5E+01	nc	5.5E+02	nc		
		4.0E-03	i			4.0E-03	r		0.1	7287-19-6	Prometryn	2.4E+02	nc	2.5E+03	nc	1.5E+01	nc	1.5E+02	nc		
		7.5E-02	i			7.5E-02	r		0.1	23950-58-5	Pronamide	4.6E+03	nc	4.6E+04	nc	2.7E+02	nc	2.7E+03	nc		
		1.3E-02	i			1.3E-02	r		0.1	1918-16-7	Propachlor	7.9E+02	nc	8.0E+03	nc	4.7E+01	nc	4.7E+02	nc		
		5.0E-03	i			5.0E-03	r		0.1	709-98-8	Propanil	3.1E+02	nc	3.1E+03	nc	1.8E+01	nc	1.8E+02	nc		
		2.0E-02	i			2.0E-02	r		0.1	2312-35-8	Propargite	1.2E+03	nc	1.2E+04	nc	7.3E+01	nc	7.3E+02	nc		
		2.0E-03	i			2.0E-03	r		0.1	107-19-7	Propargyl alcohol	1.2E+02	nc	1.2E+03	nc	7.3E+00	nc	7.3E+01	nc		
		2.0E-02	i			2.0E-02	r		0.1	139-40-2	Propazine	1.2E+03	nc	1.2E+04	nc	7.3E+01	nc	7.3E+02	nc		
		2.0E-02	i			2.0E-02	r		0.1	122-42-9	Propham	1.2E+03	nc	1.2E+04	nc	7.3E+01	nc	7.3E+02	nc		
		1.3E-02	i			1.3E-02	r		0.1	60207-90-1	Propiconazole	7.9E+02	nc	8.0E+03	nc	4.7E+01	nc	4.7E+02	nc		
										98-82-8	Isopropylbenzene (see Cumene)										
		4.0E-02	n			4.0E-02	r	y		103-65-1	n-Propylbenzene	2.4E+02	sat	2.4E+02	sat	1.5E+02	nc	2.4E+02	nc		
		5.0E-01	p			8.6E-04	p		0.1	57-55-6	Propylene glycol	3.0E+04	nc	1.0E+05	max	3.1E+00	nc	1.8E+04	nc		
		7.0E-01	h			7.0E-01	r		0.1	52125-53-8	Propylene glycol, monoethyl ether	4.3E+04	nc	1.0E+05	max	2.6E+03	nc	2.6E+04	nc		
		7.0E-01	h			5.7E-01	i		0.1	107-98-2	Propylene glycol, monomethyl ether	4.3E+04	nc	1.0E+05	max	2.1E+03	nc	2.6E+04	nc		
2.4E-01	i	8.6E-03	r	1.3E-02	i	8.6E-03	i	y		75-56-9	Propylene oxide	1.9E+00	ca*	6.6E+00	ca*	5.2E-01	ca*	2.2E-01	ca		
		2.5E-01	i			2.5E-01	r		0.1	81335-77-5	Pursuit	1.5E+04	nc	1.0E+05	max	9.1E+02	nc	9.1E+03	nc		
		2.5E-02	i			2.5E-02	r		0.1	51630-58-1	Pydrin	1.5E+03	nc	1.5E+04	nc	9.1E+01	nc	9.1E+02	nc		

Key : SFo,i=Cancer Slope Factor oral, inhalation RfDo,i=Reference Dose oral, inhalation i=IRIS p=PPRTV c=California EPA n=NCEA h=HEAST x=Withdrawn r=Route-extrapolation ca=Cancer PRG nc= Noncancer PRG ca* (where: nc PRG < 100X ca PRG)
ca** (where nc PRG < 10X ca PRG) +++=Non-Standard Method Applied (See User's Guide) sat=Soil Saturation (See User's Guide) max=Ceiling limit (See User's Guide) DAF=Dilution Attenuation Factor (See User's Guide) CAS=Chemical Abstract Services

TOXICITY VALUES											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs) "Direct Contact Exposure Pathways"								SOIL SCREENING LEVELS "Migration to Ground Water"	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
		1.0E-03	i			1.0E-03	r		0.1	110-86-1	Pyridine	6.1E+01	nc	6.2E+02	nc	3.7E+00	nc	3.6E+01	nc		
		5.0E-04	i			5.0E-04	r		0.1	13593-03-8	Quinalphos	3.1E+01	nc	3.1E+02	nc	1.8E+00	nc	1.8E+01	nc		
3.0E+00	i			3.0E+00	r				0.1	91-22-5	Quinoline	1.6E-01	ca	5.7E-01	ca	2.2E-03	ca	2.2E-02	ca		
1.1E-01	i	3.0E-03	i	1.1E-01	r	3.0E-03	r		0.1	121-82-4	RDX (Cyclonite)	4.4E+00	ca*	1.6E+01	ca	6.1E-02	ca	6.1E-01	ca		
		3.0E-02	i			3.0E-02	r		0.1	10453-86-8	Resmethrin	1.8E+03	nc	1.8E+04	nc	1.1E+02	nc	1.1E+03	nc		
		5.0E-02	h			5.0E-02	r		0.1	299-84-3	Ronnel	3.1E+03	nc	3.1E+04	nc	1.8E+02	nc	1.8E+03	nc		
		4.0E-03	i			4.0E-03	r		0.1	83-79-4	Rotenone	2.4E+02	nc	2.5E+03	nc	1.5E+01	nc	1.5E+02	nc		
		2.5E-02	i			2.5E-02	r		0.1	78587-05-0	Savey	1.5E+03	nc	1.5E+04	nc	9.1E+01	nc	9.1E+02	nc		
		5.0E-03	i						0.1	7783-00-8	Selenious Acid	3.1E+02	nc	3.1E+03	nc			1.8E+02	nc		
		5.0E-03	i							7782-49-2	Selenium	3.9E+02	nc	5.1E+03	nc			1.8E+02	nc	5.0E+00	3.0E-01
		5.0E-03	h						0.1	630-10-4	Selenourea	3.1E+02	nc	3.1E+03	nc			1.8E+02	nc		
		9.0E-02	i			9.0E-02	r		0.1	74051-80-2	Sethoxydim	5.5E+03	nc	5.5E+04	nc	3.3E+02	nc	3.3E+03	nc		
		5.0E-03	i							7440-22-4	Silver and compounds	3.9E+02	nc	5.1E+03	nc			1.8E+02	nc	3.4E+01	2.0E+00
1.2E-01	h	5.0E-03	i	1.2E-01	r	5.00E-03	r		0.1	122-34-9	Simazine	4.1E+00	ca*	1.4E+01	ca	5.6E-02	ca	5.6E-01	ca		
		4.0E-03	i							26628-22-8	Sodium azide										
2.7E-01	h	3.0E-02	i	2.7E-01	r	3.0E-02	r		0.1	148-18-5	Sodium diethyldithiocarbamate	1.8E+00	ca	6.4E+00	ca	2.5E-02	ca	2.5E-01	ca		
		2.0E-05	i			2.0E-05	r		0.1	62-74-8	Sodium fluoroacetate	1.2E+00	nc	1.2E+01	nc	7.3E-02	nc	7.3E-01	nc		
		1.0E-03	h			1.0E-03	r		0.1	13718-26-8	Sodium metavanadate	6.1E+01	nc	6.2E+02	nc	3.7E+00	nc	3.6E+01	nc		
		6.0E-01	i							7440-24-6	Strontium, stable	4.7E+04	nc	1.0E+05	max			2.2E+04	nc		
		3.0E-04	i			3.0E-04	r		0.1	57-24-9	Strychnine	1.8E+01	nc	1.8E+02	nc	1.1E+00	nc	1.1E+01	nc		
		2.0E-01	i			2.9E-01	i	y		100-42-5	Styrene	1.7E+03	sat	1.7E+03	sat	1.1E+03	nc	1.6E+03	nc	4.0E+00	2.0E-01
		5.0E-03	p			5.0E-03	r			80-07-9	**1,1'-Sulfonylbis (4-chlorobenzene)**	3.9E+02	nc	5.1E+03	nc	1.8E+01	nc	1.8E+02	nc		
		2.5E-02	i			2.5E-02	r		0.1	88671-89-0	Systhane	1.5E+03	nc	1.5E+04	nc	9.1E+01	nc	9.1E+02	nc		
1.5E+05	h			1.5E+05	h				0.03	1746-01-6	2,3,7,8-TCDD (dioxin)	3.9E-06	ca	1.6E-05	ca	4.5E-08	ca	4.5E-07	ca		
		7.0E-02	i			7.0E-02	r		0.1	34014-18-1	Tebuthiuron	4.3E+03	nc	4.3E+04	nc	2.6E+02	nc	2.6E+03	nc		
		2.0E-02	h			2.0E-02	r		0.1	3383-96-8	Temephos	1.2E+03	nc	1.2E+04	nc	7.3E+01	nc	7.3E+02	nc		
		1.3E-02	i			1.3E-02	r		0.1	5902-51-2	Terbacil	7.9E+02	nc	8.0E+03	nc	4.7E+01	nc	4.7E+02	nc		
		2.5E-05	h			2.5E-05	r		0.1	13071-79-9	Terbufos	1.5E+00	nc	1.5E+01	nc	9.1E-02	nc	9.1E-01	nc		
		1.0E-03	i			1.0E-03	r		0.1	886-50-0	Terbutryn	6.1E+01	nc	6.2E+02	nc	3.7E+00	nc	3.6E+01	nc		
		3.0E-04	i			3.0E-04	r		0.1	95-94-3	1,2,4,5-Tetrachlorobenzene	1.8E+01	nc	1.8E+02	nc	1.1E+00	nc	1.1E+01	nc		
2.6E-02	i	3.0E-02	i	2.6E-02	i	3.0E-02	r	y		630-20-6	1,1,1,2-Tetrachloroethane	3.2E+00	ca	7.3E+00	ca	2.6E-01	ca	4.3E-01	ca		
2.0E-01	i	6.0E-02	p	2.0E-01	i	6.0E-02	r	y		79-34-5	1,1,2,2-Tetrachloroethane	4.1E-01	ca	9.3E-01	ca	3.3E-02	ca	5.5E-02	ca	3.0E-03	2.0E-04
5.4E-01	c	1.0E-02	i	2.1E-02	c	1.0E-02	c	y		127-18-4	**Tetrachloroethylene (PCE)**	4.8E-01	ca*	1.3E+00	ca	3.2E-01	ca	1.0E-01	ca	6.0E-02	3.0E-03
		3.0E-02	i			3.0E-02	r		0.1	58-90-2	2,3,4,6-Tetrachlorophenol	1.8E+03	nc	1.8E+04	nc	1.1E+02	nc	1.1E+03	nc		
2.0E+01	h			2.0E+01	r				0.1	5216-25-1	p,a,a,a-Tetrachlorotoluene	2.4E-02	ca	8.6E-02	ca	3.4E-04	ca	3.4E-03	ca		
2.4E-02	h	3.0E-02	i	2.4E-02	r	3.0E-02	r		0.1	961-11-5	Tetrachlorovinphos	2.0E+01	ca*	7.2E+01	ca	2.8E-01	ca	2.8E+00	ca		
		5.0E-04	i			5.0E-04	r		0.1	3689-24-5	Tetraethyldithiopyrophosphate	3.1E+01	nc	3.1E+02	nc	1.8E+00	nc	1.8E+01	nc		
7.6E-03	n	2.1E-01	n	6.8E-03	n	8.6E-02	n	y		109-99-9	Tetrahydrofuran	9.4E+00	ca	2.1E+01	ca	9.9E-01	ca	1.6E+00	ca		
		6.6E-05	i							7440-28-0	Thallium and compounds+++	5.2E+00	nc	6.7E+01	nc			2.4E+00	nc		
		1.0E-02	i			1.0E-02	r		0.1	28249-77-6	Thiobencarb	6.1E+02	nc	6.2E+03	nc	3.7E+01	nc	3.6E+02	nc		
		5.0E-02	n			5.0E-02	r		0.1	N/A	Thiocyanate	3.1E+03	nc	1.0E+05	max	1.8E+02	nc	1.8E+03	nc		
		3.0E-04	h			3.0E-04	r		0.1	39196-18-4	Thiofanox	1.8E+01	nc	1.8E+02	nc	1.1E+00	nc	1.1E+01	nc		

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ca** (where nc PRG < 10X ca PRG) +++=Non-Standard Method Applied (See User's Guide) sat=Soil Saturation (See User's Guide) max=Ceiling limit (See User's Guide) DAF=Dilution Attenuation Factor (See User's Guide) CAS=Chemical Abstract Services

TOXICITY VALUES											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs)								SOIL SCREENING LEVELS	
												"Direct Contact Exposure Pathways"								"Migration to Ground Water"	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		V O C	skin abs. soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
		8.0E-02	i			8.0E-02	r		0.1	23564-05-8	Thiophanate-methyl	4.9E+03	nc	4.9E+04	nc	2.9E+02	nc	2.9E+03	nc		
		5.0E-03	i			5.0E-03	r		0.1	137-26-8	Thiram	3.1E+02	nc	3.1E+03	nc	1.8E+01	nc	1.8E+02	nc		
		6.0E-01	h							7440-31-5	Tin (inorganic, also see tributyltin oxide)	4.7E+04	nc	1.0E+05	max			2.2E+04	nc		
		4.0E+00	n			8.6E-03	n			7440-32-6	Titanium	1.0E+05	max	1.0E+05	max	3.1E+01	nc	1.5E+05	nc		
		2.0E-01	i			1.1E-01	i	y		108-88-3	Toluene	5.2E+02	sat	5.2E+02	sat	4.0E+02	nc	7.2E+02	nc	1.2E+01	6.0E-01
3.2E+00	h			3.2E+00	r				0.1	95-80-7	Toluene-2,4-diamine	1.5E-01	ca	5.4E-01	ca	2.1E-03	ca	2.1E-02	ca		
		6.0E-01	h			6.0E-01	r		0.1	95-70-5	Toluene-2,5-diamine	3.7E+04	nc	1.0E+05	max	2.2E+03	nc	2.2E+04	nc		
		2.0E-01	h			2.0E-01	r		0.1	823-40-5	Toluene-2,6-diamine	1.2E+04	nc	1.0E+05	max	7.3E+02	nc	7.3E+03	nc		
1.9E-01	i			1.9E-01	r				0.1	106-49-0	p-Toluidine	2.6E+00	ca	9.1E+00	ca	3.5E-02	ca	3.5E-01	ca		
1.1E+00	i			1.1E+00	i				0.1	8001-35-2	Toxaphene	4.4E-01	ca	1.6E+00	ca	6.0E-03	ca	6.1E-02	ca	3.1E+01	2.0E+00
		7.5E-03	i			7.5E-03	r		0.1	66841-25-6	Tralomethrin	4.6E+02	nc	4.6E+03	nc	2.7E+01	nc	2.7E+02	nc		
		1.3E-02	i			1.3E-02	r		0.1	2303-17-5	Triallate	7.9E+02	nc	8.0E+03	nc	4.7E+01	nc	4.7E+02	nc		
		1.0E-02	i			1.0E-02	r		0.1	82097-50-5	Triasulfuron	6.1E+02	nc	6.2E+03	nc	3.7E+01	nc	3.6E+02	nc		
		5.0E-03	i			5.0E-03	r		0.1	615-54-3	1,2,4-Tribromobenzene	3.1E+02	nc	3.1E+03	nc	1.8E+01	nc	1.8E+02	nc		
9.2E-03	p	2.0E-01	p	9.2E-03	r	2.0E-01	r		0.1	126-73-8	**Tributyl phosphate**	5.3E+01	ca	1.9E+02	ca	7.3E-01	ca	7.3E+00	ca		
		3.0E-04	i						0.1	56-35-9	Tributyltin oxide (TBTO)	1.8E+01	nc	1.8E+02	nc			1.1E+01	nc		
3.4E-02	h			3.4E-02	r				0.1	634-93-5	2,4,6-Trichloroaniline	1.4E+01	ca	5.1E+01	ca	2.0E-01	ca	2.0E+00	ca		
2.9E-02	h			2.9E-02	r				0.1	33663-50-2	2,4,6-Trichloroaniline hydrochloride	1.7E+01	ca	5.9E+01	ca	2.3E-01	ca	2.3E+00	ca		
		1.0E-02	i			1.0E-03	p	y		120-82-1	**1,2,4-Trichlorobenzene**	6.2E+01	nc	2.2E+02	nc	3.7E+00	nc	7.2E+00	nc	5.0E+00	3.0E-01
		2.8E-01	n			6.3E-01	p	y		71-55-6	1,1,1-Trichloroethane	1.2E+03	sat	1.2E+03	sat	2.3E+03	nc	3.2E+03	nc	2.0E+00	1.0E-01
5.7E-02	i	4.0E-03	i	5.6E-02	i	4.0E-03	r	y		79-00-5	1,1,2-Trichloroethane	7.3E-01	ca*	1.6E+00	ca*	1.2E-01	ca	2.0E-01	ca	2.0E-02	9.0E-04
4.0E-01	n	3.0E-04	n	4.0E-01	n	1.0E-02	n	y		79-01-6	Trichloroethylene (TCE)	5.3E-02	ca	1.1E-01	ca	1.7E-02	ca	2.8E-02	ca	6.0E-02	3.0E-03
1.3E-02	c			7.0E-03	c	1.7E-01	c	y		79-01-6	**"CAL-Modified PRG"**	2.9E+00	ca	6.5E+00	ca	9.6E-01	ca	1.4E+00	ca		
		3.0E-01	i			2.0E-01	h	y		75-69-4	Trichlorofluoromethane	3.9E+02	nc	2.0E+03	sat	7.3E+02	nc	1.3E+03	nc		
		1.0E-01	i			1.0E-01	r		0.1	95-95-4	2,4,5-Trichlorophenol	6.1E+03	nc	6.2E+04	nc	3.7E+02	nc	3.6E+03	nc	2.7E+02	1.4E+01
1.1E-02	i	1.0E-04	n	1.1E-02	i	1.0E-04	r		0.1	88-06-2	2,4,6-Trichlorophenol	6.1E+00	nc**	6.2E+01	nc**	3.7E-01	nc**	3.6E+00	nc**	2.0E-01	8.0E-03
7.0E-02	c			7.0E-02	c				0.1	88-06-2	"CAL-Modified PRG"	6.9E+00	ca	2.5E+01	ca	9.6E-02	ca	9.6E-01	ca		
		1.0E-02	i			1.0E-02	r		0.1	93-76-5	2,4,5-Trichlorophenoxyacetic Acid	6.1E+02	nc	6.2E+03	nc	3.7E+01	nc	3.6E+02	nc		
		8.0E-03	i			8.0E-03	r		0.1	93-72-1	2-(2,4,5-Trichlorophenoxy) propionic acid	4.9E+02	nc	4.9E+03	nc	2.9E+01	nc	2.9E+02	nc		
		5.0E-03	i			5.0E-03	r	y		598-77-6	**1,1,2-Trichloropropane**	7.1E+01	nc	2.7E+02	nc	1.8E+01	nc	3.0E+01	nc		
2.0E+00	n	6.0E-03	i	2.0E+00	r	1.4E-03	n	y		96-18-4	**1,2,3-Trichloropropane**	3.4E-02	ca	7.6E-02	ca	3.4E-03	ca	5.6E-03	ca		
		1.0E-02	p			3.0E-04	p	y		96-19-5	**1,2,3-Trichloropropene**	5.2E+00	nc	1.7E+01	nc	1.1E+00	nc	2.2E+00	nc		
		3.0E-03	i			3.0E-03	r		0.1	58138-08-2	Tridiphane	1.8E+02	nc	1.8E+03	nc	1.1E+01	nc	1.1E+02	nc		
		2.0E-03	r			2.0E-03	i	y		121-44-8	Triethylamine	2.3E+01	nc	8.6E+01	nc	7.3E+00	nc	1.2E+01	nc		
7.7E-03	i	7.5E-03	i	7.7E-03	r	7.5E-03	r		0.1	1582-09-8	Trifluralin	6.3E+01	ca**	2.2E+02	ca*	8.7E-01	ca*	8.7E+00	ca*		
		1.4E-04	r			1.4E-04	n		0.1	552-30-7	Trimellitic Anhydride (TMAN)	8.6E+00	nc	8.6E+01	nc	5.1E-01	nc	5.1E+00			
		5.0E-02	p			1.7E-03	p	y		95-63-6	1,2,4-Trimethylbenzene	5.2E+01	nc	1.7E+02	nc	6.2E+00	nc	1.2E+01	nc		
		5.0E-02	p			1.7E-03	p	y		108-67-8	1,3,5-Trimethylbenzene	2.1E+01	nc	7.0E+01	nc	6.2E+00	nc	1.2E+01	nc		
3.7E-02	h			3.7E-02	r				0.1	512-56-1	Trimethyl phosphate	1.3E+01	ca	4.7E+01	ca	1.8E-01	ca	1.8E+00	ca		
		3.0E-02	i			3.0E-02	r		0.1	99-35-4	1,3,5-Trinitrobenzene	1.8E+03	nc	1.8E+04	nc	1.1E+02	nc	1.1E+03	nc		
		1.0E-02	h			1.0E-02	r		0.1	479-45-8	Trinitrophenylmethylnitramine	6.1E+02	nc	6.2E+03	nc	3.7E+01	nc	3.6E+02	nc		
3.0E-02	i	5.0E-04	i	3.0E-02	r	5.0E-04	r		0.1	118-96-7	2,4,6-Trinitrotoluene	1.6E+01	ca**	5.7E+01	ca**	2.2E-01	ca**	2.2E+00	ca**		

Key : SFo,i=Cancer Slope Factor oral, inhalation RfDo,i=Reference Dose oral, inhalation i=IRIS p=PPRTV c=California EPA n=NCEA h=HEAST x=Withdrawn r=Route-extrapolation ca=Cancer PRG nc= Noncancer PRG ca* (where: nc PRG < 100X ca PRG)
ca** (where nc PRG < 10X ca PRG) +++=Non-Standard Method Applied (See User's Guide) sat=Soil Saturation (See User's Guide) max=Ceiling limit (See User's Guide) DAF=Dilution Attenuation Factor (See User's Guide) CAS=Chemical Abstract Services

TOXICITY VALUES											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs)								SOIL SCREENING LEVELS	
												"Direct Contact Exposure Pathways"								"Migration to Ground Water"	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
		2.0E-02	p			2.0E-02	r		0.1	791-28-6	**Triphenylphosphine oxide**	1.2E+03	nc	1.2E+04	nc	7.3E+01	nc	7.3E+02	nc		
1.4E-02	p	3.1E-01	p	1.4E-02	r	3.1E-01	r		0.1	115-96-8	**Tris(2-chloroethyl) phosphate**	3.5E+01	ca	1.2E+02	ca	4.8E-01	ca	4.8E+00	ca		
3.2E-03	p	1.0E-01	p	3.2E-03	r	1.0E-01	r		0.1	78-42-2	**Tris(2-ethylhexyl) phosphate**	1.5E+02	ca*	5.4E+02	ca	2.1E+00	ca	2.1E+01	ca		
		2.0E-04	n							7440-61-1	Uranium (chemical toxicity only)	1.6E+01	nc	2.0E+02	nc			7.3E+00	nc		
		1.0E-03	n							7440-62-2	Vanadium and compounds	7.8E+01	nc	1.0E+03	nc			3.6E+01	nc	6.0E+03	3.0E+02
		1.0E-03	i			1.0E-03	r		0.1	1929-77-7	Vernam	6.1E+01	nc	6.2E+02	nc	3.7E+00	nc	3.6E+01	nc		
		2.5E-02	i			2.5E-02	r		0.1	50471-44-8	Vinclozolin	1.5E+03	nc	1.5E+04	nc	9.1E+01	nc	9.1E+02	nc		
		1.0E+00	h			5.7E-02	i	y		108-05-4	Vinyl acetate	4.3E+02	nc	1.4E+03	nc	2.1E+02	nc	4.1E+02	nc	1.7E+02	8.0E+00
1.1E-01	r	8.6E-04	r	1.1E-01	h	8.6E-04	i	y		593-60-2	Vinyl bromide (bromoethene)	1.9E-01	ca*	4.2E-01	ca*	6.1E-02	ca*	1.0E-01	ca*		
1.5E+00	i	3.0E-03	i	3.1E-02	i	2.9E-02	i	y		75-01-4	Vinyl chloride (child/adult)+++	7.9E-02	ca			1.1E-01	ca	2.0E-02	ca	1.0E-02	7.0E-04
7.5E-01	i	3.0E-03	i	1.6E-02	i	2.9E-02	i	y		75-01-4	Vinyl chloride (adult)			7.5E-01	ca						
		3.0E-04	i			3.0E-04	r		0.1	81-81-2	Warfarin	1.8E+01	nc	1.8E+02	nc	1.1E+00	nc	1.1E+01	nc		
		2.0E-01	i			2.9E-02	i	y	0.1	1330-20-7	**Xylenes**	2.7E+02	nc	4.2E+02	sat	1.1E+02	nc	2.1E+02	nc	2.1E+02	1.0E+01
		3.0E-01	i							7440-66-6	Zinc	2.3E+04	nc	1.0E+05	max			1.1E+04	nc	1.2E+04	6.2E+02
		3.0E-04	i							1314-84-7	Zinc phosphide	2.3E+01	nc	3.1E+02	nc			1.1E+01	nc		
		5.0E-02	i			5.0E-02	r		0.1	12122-67-7	Zineb	3.1E+03	nc	3.1E+04	nc	1.8E+02	nc	1.8E+03	nc		

Appendix F
California Toxics Rule

A		B Freshwater (Aquatic Life)		C Human Health (10^{-6} risk for carcinogens) For consumption of:	
# Compound	CAS Number	Criterion Maximum Conc. (µ/L) [d] B1	Criterion Continuous Conc. (µ/L) [d] B2	Water & Organisms (µg/L) D1	Organisms Only (µg/L) D2
1. Antimony	7440360			14 a,q	4300 a,q
2. Arsenic	7440382	340 i,m,w	150 i,m,w		
3. Beryllium	7440417			n	n
4. Cadmium	7440439	1.0 e,i,m,w $e^{(1.0166[\ln(\mathrm{hardness})]-3.924}$)	0.15 e,i,m,w $e^{(.7409[\ln(\mathrm{hardness})]-4.719}$	n	n
5a. Chromium (III)	16065831	550 e,i,m,	180 e,i,m,	n	n
5b. Chromium (VI)	18540299	16 i,m,w	11 i,m,w	n	n
6. Copper	7440508	13 e,i,m,w	9.0 e,i,m,w	1300q	
7. Lead	7439921	65 e,i,m	2.5 e,i,m	n	n
8. Mercury	7439976	[Reserved]	[Reserved]	0.050 a,q	0.051 a,q
9. Nickel	7440020	470 e,i,m,w	52 e,i,m,w	610 a,q	4600 a,q
10. Selenium	7782492	[Reserved] p	5.0 q	n	n
11. Silver	7440224	3.4 e,i,m			
12. Thallium	7440280			1.7 a,q	6.3 a,q
13. Zinc	7440666	120 e,i,m,w	120 e,i,m,w		
14. Cyanide	57125	22	5.2	700 a	220,000 a,j
15. Asbestos	1332214			7,000,000 fibers/L k	
16. 2,3,7,8-TCDD (Dioxin)	1746016			0.000000013 c	0.000000014 c
17. Acrolein	107028			320	780
18. Acrylonitrile	107131			0.059 a,c	0.66 a,c
19. Benzene	71432			1.2 a,c	71 a,c
20. Bromoform	75252			4.3 a,c	360 a,c
21. Carbon Tetrachloride	56235			0.25 a,c	4.4 a,c
22. Chlorine (Total Residual)	77822505	19	11	n	n
23. Chlorobenzene	108907			680 a	21,000 a,j
24. Chlorodibromomethane	124481			0.41 a,c	34 a,c
25. Chloroethane	75003				
26. 2-Chloroethylvinyl Ether	110758				
27. Chloroform	67663			[Reserved]	[Reserved]
28. Dichlorobromomethane	75274			0.56 a,c	46 a,c

29. 1,1-Dichloroethane	75343				
30. 1,2-Dichloroethane	107062			0.38 a,c	99 a,c
31. 1,1-Dichloroethylene	75354			0.057 a,c	3.2 a,c
32. 1,2-Dichloropropane	78875			0.52 a	39 a
33. 1,3-Dichloropropylene	542756			10 a	1,700 a
34. Ethylbenzene	100414			3,100 a	29,000 a
35. Methyl Bromide	74839			48 a	4,000 a
36. Methyl Chloride	74873			n	n
37. Methylene Chloride	75092			4.7 a,c	1,600 a,c
38. 1,1,2,2-Tetrachloroethane	79345			0.17 a,c	11 a,c
39. Tetrachloroethylene	127184			0.8 c	8.85 c
40. Toluene	108883			6,800 a	200,000 a
41. 1,2-Trans-Dichloroethylene	156605			700 a	140,000 a
42. 1,1,1-Trichloroethane	71556			n	n
43. 1,1,2-Trichloroethane	79005			0.60 a,c	42 a,c
44. Trichloroethylene	79016			2.7 c	81 c
45. Vinyl Chloride	75014			2 c	525 c
46. 2-Chlorophenol	95578			120 a	400 a
47. 2,4-Dichlorophenol	120832			93 a	790 a
48. 2,4-Dimethylphenol	105679			540 a	2,300 a
49. 2-Methyl-4,6-Dinitrophenol	534521			13.4	765
50. 2,4-Dinitrophenol	51285			70 a	14,000 a
51. 2-Nitrophenol	88755				
52. 4-Nitrophenol	100027				
53. 3-Methyl-4-Chlorophenol	59507				
54. Pentachlorophenol	87865	19 f,w	15 f,w	0.28 a,c	8.2 a,c,j
55. Phenol	108952			21,000 a	4,600,000 a,j
56. 2,4,6-Trichlorophenol	88062			2.1 a,c	6.5 a,c
57. Acenaphthene	83329			1,200 a	2,700 a
58. Acenaphthylene	208968				
59. Anthracene	120127			9,600 a	110,000 a
60. Benzidine	92875			0.00012 a,c	0.00054 a,c
61. Benzo(a)Anthracene	56553			0.0044 a,c	0.049 a,c
62. Benzo(a)Pyrene	50328			0.0044 a,c	0.049 a,c
63. Benzo(b)Fluoranthene	205992			0.0044 a,c	0.049 a,c

64. Benzo(ghi)Perylene	191242				
65. Benzo(k)Fluoranthene	207089			0.0044 a,c	0.049 a,c
66. Bis(2-Chloroethoxy)Methane	111911				
67. Bis(2-Chloroethyl)Ether	111444			0.031 a,c	1.4 a,c
68. Bis(2-Chloroisopropyl)Ether	108601			1,400 a	170,000 a
69. Bis(2-Ethylhexyl)Phthalate	117817			1.8 a,c	5.9 a,c
70. 4-Bromophenyl Phenyl Ether	101553				
71. Butylbenzyl Phthalate	85687			3,000 a	5,200 a
72. 2-Chloronaphthalene	91587			1,700 a	4,300 a
73. 4-Chlorophenyl Phenyl Ether	7005723				
74. Chrysene	218019			0.0044 a,c	0.049 a,c
75. Dibenzo(a,h)Anthracene	53703			0.0044 a,c	0.049 a,c
76. 1,2 Dichlorobenzene	95501			2,700 a	17,000 a
77. 1,3 Dichlorobenzene	541731			400	2,600
78. 1,4 Dichlorobenzene	106467			400	2,600
79. 3,3'-Dichlorobenzidine	91941			0.04 a,c	0.077 a,c
80. Diethyl Phthalate	84662			23,000 a	120,000 a
81. Dimethyl Phthalate	131113			313,000	2,900,000
82. Di-n-Butyl Phthalate	84742			2,700 a	12,000 a
83. 2,4-Dinitrotoluene	121142			0.11 c	9.1 c
84. 2,6-Dinitrotoluene	606202				
85 Di-n-Octyl Phthalate	117840				
86. 1,2-Diphenylhydrazine	122667			0.040 a,c	0.54 a,c
87. Fluoranthene	206440			300 a	370 a
88. Fluorene	86737			1,300 a	14,000 a
89. Hexachlorobenzene	118741			0.00075 a,c	0.00077 a,c
90. Hexachlorobutadiene	87683			0.44 a,c	50 a,c
91. Hexachlorocyclopentadiene	77474			240 a	17,000 a,j
92. Hexachloroethane	67721			1.9 a,c	8.9 a,c
93. Indeno(1,2,3-cd) Pyrene	193395			0.0044 a,c	0.049 a,c
94. Isophorone	78591			8.4 c	600 c
95. Naphthalene	91203				
96. Nitrobenzene	98953			17 a	1,900 a,j
97. N-Nitrosodimethylamine	62759			0.00069 a,c	8.1 a,c
98. N-Nitrosodi-n-Propylamine	621647			0.005 a	1.4 a

99. N-Nitrosodiphenylamine	86306			5.0 a,c	16 a,c
100. Phenanthrene	85018				
101. Pyrene	129000			960 a	11,000 a
102. 1,2,4-Trichlorobenzene	120821				
103. Aldrin	309002	3 g		0.00013 a,c	0.00014 a,c
104. alpha-BHC	319846			0.0039 a,c	0.013 a,c
105. beta-BHC	319857			0.014 a,c	0.046 a,c
106. gamma-BHC	58899	0.95 w		0.019 c	0.063 c
107. delta-BHC	319868				
108. Chlordane	57749	2.4 g	0.0043 g	0.00057 a,c	0.00059 a,c
109. 4,4'-DDT	50293	1.1 g	0.001 g	0.00059 a,c	0.00059 a,c
110. 4,4'-DDE	72559			0.00059 a,c	0.00059 a,c
111. 4,4'-DDD	72548			0.00083 a,c	0.00084 a,c
112. Dieldrin	60571	0.24 w	0.056 w	0.00014 a,c	0.00014 a,c
113. alpha-Endosulfan	959988	0.22 g	0.056 g	110 a	240 a
114. beta-Endosulfan	33213659	0.22 g	0.056 g	110 a	240 a
115. Endosulfan Sulfate	1031078			110 a	240 a
116. Endrin	72208	0.086 w	0.036 w	0.76 a	0.81 a,j
117. Endrin Aldehyde	7421934			0.76 a	0.81 a,j
118. Heptachlor	76448	0.52 g	0.0038 g	0.00021 a,c	0.00021 a,c
119. Heptachlor Epoxide	1024573	0.52 g	0.0038 g	0.00010 a,c	0.00011 a,c
120-125. Polychlorinated biphenyls (PCBs)			0.014 u	0.00017 c,v	0.00017 c,v
126. Toxaphene	8001352	0.73	0.0002	0.00073 a,c	0.00075 a,c
Total Number of Criteria [h]		22	21	92	90

Footnotes:

a. Criteria revised to reflect the Agency q1* or RfD, as contained in the Integrated Risk Information System (IRIS) as of October 1, 1996. The fish tissue bioconcentration factor (BCF) from the 1980 documents was retained in each case.

b. [reserved]

c. Criteria are based on carcinogenicity of 10^{-6} risk.

d. Criteria Maximum Concentration (CMC) equals the highest concentration of a pollutant to which aquatic life can be exposed for a short period of time without deleterious effects. Criteria Continuous Concentration (CCC) equals the highest concentration of a pollutant to which aquatic life can be exposed for an extended period of time (4 days) without deleterious effects. µg/L equals micrograms per liter.

e. Freshwater aquatic life criteria for metals are expressed as a function of total hardness (mg/L) in the water body. The equations are provided in matrix on page 43 of this section. Values displayed above in the matrix correspond to a total hardness of 100 mg/l.

f. Freshwater aquatic life criteria for pentachlorophenol are expressed as a function of pH, and are calculated as follows: Values displayed above in the matrix correspond to a pH of 7.8. CMC = exp(1.005(pH) - 4.869). CCC = exp(1.005(pH) - 5.134).

g. This criterion is based on 304(a) aquatic life criterion issued in 1980, and was issued in one of the following documents: Aldrin/Dieldrin (EPA 440/5-80-019), Chlordane (EPA 440/5-80-027), DDT (EPA 440/5-80-038), Endosulfan (EPA 440/5-80-046), Endrin (EPA 440/5-80-047), Heptachlor (440/5-80-052), Hexachlorocyclohexane (EPA 440/5-80-054), Silver (EPA 440/5-80-071). The Minimum Data Requirements and derivation procedures were different in the 1980 Guidelines than in the 1985 Guidelines. For example, a “CMC” derived using the 1980 Guidelines was derived to be used as an instantaneous maximum. If assessment is to be done using an averaging period, the values given should be divided by 2 to obtain a value that is more comparable to a CMC derived using the 1985 Guidelines.

h. These totals simply sum the criteria in each column. For aquatic life, there are 23 priority toxic pollutants with some type of freshwater acute or chronic criteria. For human health, there are 92 priority toxic pollutants with either "water + organism" or "organism only" criteria. Note that these totals count chromium as one pollutant even though EPA has developed criteria based on two valence states. In the matrix, EPA has assigned numbers 5a and 5b to the criteria for chromium to reflect the fact that the list of 126 priority pollutants includes only a single listing for chromium.

i. Criteria for these metals are expressed as a function of the water-effect ratio, WER, as defined in 40 CFR 131.38(c). CMC = column B1 or C1 value x WER; CCC = column B2 or C2 value x WER. To use a WER other than the default of 1, the WER must be determined as set forth in interim Guidance on Determination and Use of Water effect Ratios, U.S. EPA Office of Water, EPA-823-B-94-011, February 1994, or alternatively, other scientifically defensible methods adopted by the Tribe as part of its water quality standards program and approved by EPA.

j. No criterion for protection of human health from consumption of aquatic organisms (excluding water) was presented in the 1980 criteria document or in the 1986 Quality Criteria for Water. Nevertheless, sufficient information was presented in the 1980 document to allow a calculation of a criterion, even though the results of such a calculation were not shown in the document.

k. The criterion for asbestos is the MCL (56 FR 3526, January 30, 1991).

l. [reserved]

m. These criteria for metals are expressed in terms of the dissolved fraction of the metal in the water column. Criterion values were calculated by using EPA's Clean Water Act 304(a) guidance values (described in the total recoverable fraction) and then applying the conversion factors in 40 CFR 131.36(b)(1) and (2).

n. EPA is not promulgating human health criteria for these contaminants. However, permit authorities should address these contaminants in NPDES permit actions using the Tribe's existing narrative criteria for toxics.

o. [reserved]

p. [reserved]

q. This criterion is expressed in the total recoverable form.

r. [reserved]

s. [reserved]

t. [reserved]

u. PCBs are a class of chemicals which include aroclors 1242, 1254, 1221, 1232, 1248, 1260, and 1016, CAS numbers 53469219, 11097691, 11104282, 11141165, 12672296, 11096825, and 12674112, respectively. The aquatic life criteria apply to the sum of this set of seven aroclors.

v. This criterion applies to total PCBs, e.g., the sum of all congener or isomer or homolog or aroclor analyses.

w. This criterion has been recalculated pursuant to the 1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water, Office of Water, EPA-820-B-96-001, September 1996. See also Great Lakes Water Quality Initiative Criteria Documents for the Protection of Aquatic Life in Ambient Water, Office of Water, EPA-80-B-95-004, March 1995.

General Notes:

1. This chart lists all of EPA's priority toxic pollutants whether or not criteria guidance are available. Blank spaces indicate the absence of national section 304(a) criteria guidance. Because of variations in chemical nomenclature systems, this listing of toxic pollutants does not duplicate the listing in Appendix A to 40 CFR Part 423 - 126 Priority Pollutants. EPA has added the Chemical Abstracts Service (CAS) registry numbers, which provide a unique identification for each chemical.

2. The following chemicals have organoleptic-based criteria recommendations that are not included on this chart: zinc, 3-methyl-4-chlorophenol.

(2) Factors for Calculating Metals Criteria. Final CMC and CCC values should be rounded to two significant figures**.**

(i) $$CMC = WER \times (Acute\ Conversion\ Factor) \times \left(\exp\left\{m_A\left[\ln(hardness)\right] + b_A\right\}\right)$$

(ii) $$CCC = WER \times (Chronic\ Conversion\ Factor) \times \left(\exp\left\{m_C\left[\ln(hardness)\right] + b_C\right\}\right)$$

(iii) Table 1 to paragraph (b)(2) of this section:

Metal	mA	bA	mC	bC
Cadmium	1.128	-3.6867	0.7852	-2.715
Copper	0.9422	-1.700	0.8545	-1.702
Chromium (III)	0.8190	3.688	0.8190	1.561
Lead	1.273	-1.460	1.273	-4.705
Nickel	0.8460	2.255	0.8460	0.0584
Silver	1.72	-6.52	---	---
Zinc	0.8473	0.884	0.8473	0.884

Note to Table 1: The term "exp" represents the base e exponential function.

(iv) Table 2 of this section:

Metal	Conversion Factor (CF) for freshwater acute criteria	CF for freshwater chronic criteria
Antimony	(d)	(d)
Arsenic	1.000	1.000
Beryllium	(d)	(d)
Cadmium	0.944(b)	0.909(b)
Chromium (III)	0.316	0.860
Chromium (VI)	0.982	0.962
Copper	0.960	0.960
Lead	0.791(b)	0.791(b)
Mercury	---	---
Nickel	0.998	0.997
Selenium	---	(c)
Silver	0.85	(d)
Thallium	(d)	(d)
Zinc	0.978	0.986

Footnotes:

a. [reserved]

b. Conversion Factors for these pollutants in freshwater are hardness dependent. CFs are based on a hardness of 100 mg/l as calcium carbonate ($CaCO_3$). Other hardness can be used; CFs should be recalculated using the equations in table 3 to paragraph (b)(2) of this section.

c. Bioaccumulative compound and inappropriate to adjust to percent dissolved.

d. EPA has not published an aquatic life criterion value.

The term "Conversion Factor" represents the recommended conversion factor for converting a metal criterion expressed as the total recoverable fraction in the water column to a criterion expressed as the dissolved fraction in the water column. See 'Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria', October 1, 1993, by Martha G. Prothro, Acting Assistant Administrator for Water available from Water Resource Center, USEPA, Mailcode RC4100, M Street SW, Washington, DC, 20460 and the note to §131.36(b)(1).

(v) Table 3 to paragraph (b)(2) of this section:

	Acute	Chronic
Cadmium	CF = 1.136672 - [(ln {hardness})(0.041838)]	CF = 1.101672 - [(ln {hardness})(0.041838)]
Lead	CF = 1.46203 - [(ln {hardness})(0.145712)]	CF = 1.46203 - [(ln {hardness})(0.145712)]

(c) Applicability.

(1) The criteria in [Table X paragraph (b) whatever it's called...] of this section apply to the Tribe's designated uses cited in [Chapter 2? paragraph (d)(or whatever it's called in the HVTWQCP)] and apply concurrently with any other criteria adopted by the Tribe.

(2) The criteria established in this section are subject to the Tribe's general rules of applicability in the same way and to the same extent as are other Federally-adopted and Tribal-adopted numeric toxics criteria when applied to the same use classifications including low flow values below which numeric standards can be exceeded in flowing fresh waters.

(3) Application of metals criteria.

(i) For purposes of calculating freshwater aquatic life criteria for metals from the equations in [paragraph (b)(2) of this section, for waters with a hardness of 400 mg/l or less as calcium carbonate, the actual ambient hardness of the surface water shall be used in those equations. For waters with a hardness of over 400 mg/l as calcium carbonate, a hardness of 400 mg/l as calcium carbonate shall be used with a default Water-Effect Ratio (WER) of 1, or the actual hardness of the ambient surface water shall be used with a WER.

(ii) The criteria for metals (compounds #1 - #13 in paragraph (b) of this section) are expressed as dissolved except where otherwise noted. For purposes of calculating aquatic life criteria for metals from the equations in footnote i in the criteria matrix in paragraph (b)(1) of this section and the equations in [paragraph (b)(2) of this section, the water effect ratio is generally computed as a specific pollutant's acute or chronic toxicity value measured in water from the site covered by the standard, divided by the respective acute or chronic toxicity value in laboratory dilution water. To use a water effect ratio other than the default of 1, the WER must be determined as set forth in Interim Guidance on Determination and Use of Water Effect Ratios, U.S. EPA Office of Water, EPA-823-B-94-001, February 1994, or alternatively, other scientifically defensible methods adopted by the State as part of its water quality standards program and approved by EPA.

Appendix G
Klamath River Nutrient Criteria

NUTRIENT CRITERIA FOR THE KLAMATH RIVER ON THE HOOPA VALLEY INDIAN RESERVATION

PREPARED FOR THE

HOOPA VALLEY TRIBAL ENVIRONMENTAL PROTECTION AGENCY

BY

KIER ASSOCIATES, FISHERIES AND WATERSHED PROFESSIONALS
MILL VALLEY AND ARCATA, CALIFORNIA

NOVEMBER, 2006

INTRODUCTION

The Hoopa Valley Tribe has recognized authority for setting water quality standards for its Reservation waters, including both the Trinity and Klamath Rivers (U.S. EPA 2002a). This draft nutrient criteria and standards plan presented here is part of the updating of the *Hoopa Valley Indian Reservation Water Quality Control Plan* (Hoopa TEPA 2001). It applies to the lower Klamath River on the Hoopa Valley Reservation (Figures 1 and 2). The Tribe is concerned with the health of Pacific salmon species that use the Reservation reach of the Klamath River.

These Pacific salmon have requirements that need to be met at upstream locations on the Klamath River if beneficial uses are to be maintained on the Reservation. Although the Tribe is also concerned about water quality in the Klamath River Hydroelectric Project reservoirs because of its apparent impact on nutrients in the lower river (Kier Associates 2004, Kann and Asarian 2005), water quality standards for those water bodies are not addressed here.

The Hoopa Valley Tribe recognizes that it shares authority over Klamath River water quality with other agencies and Tribes and it will be working with those parties toward adoption of similar nutrient standards.

The U.S. Environmental Protection Agency (EPA 2000a) describes the need for Tribes and States to set water quality standards as follows:

> "Ambient water quality criteria associated with specific waterbody uses when adopted as State or Tribal water quality standards under Section 303 define the level of a pollutant (or, in the case of nutrients, a condition) necessary to protect designated uses in ambient waters. Quantified water quality criteria contained within State or Tribal water quality standards are essential to a water quality-based approach to pollution control. Whether expressed as numeric criteria or quantified translations of narrative criteria within State or Tribal water quality standards, quantified criteria serve as a critical basis for assessing attainment of designated uses and measuring progress toward meeting the water quality goals of the Clean Water Act."

U.S. EPA (2001) recommended that authorized Tribes develop a "Nutrient Criteria Plan" to outline the process for how and when they intend to adopt nutrient criteria into their water quality standards. Nutrient Criteria Plans are meant to ensure that the EPA and Tribes agree on an approach early in the process, well before criteria development is completed, in order to increase the speed and effectiveness of final criteria approval. In September 2005, a preliminary draft nutrient criteria plan was circulated to various water quality experts, agencies, and other participants in Klamath River water quality co-management.

This document contains proposed nutrient-related water quality criteria and it documents the process that was used to develop them. It follows logical steps to define nutrient standards for the lower Klamath River on the Hoopa Valley Indian Reservation that were set out clearly in a *Draft Nutrient Criteria Plan for the Klamath River* (Kier Associates, 2005).

Figure 1. Map showing the location of the Hoopa Valley Indian Reservation within the Klamath Basin.

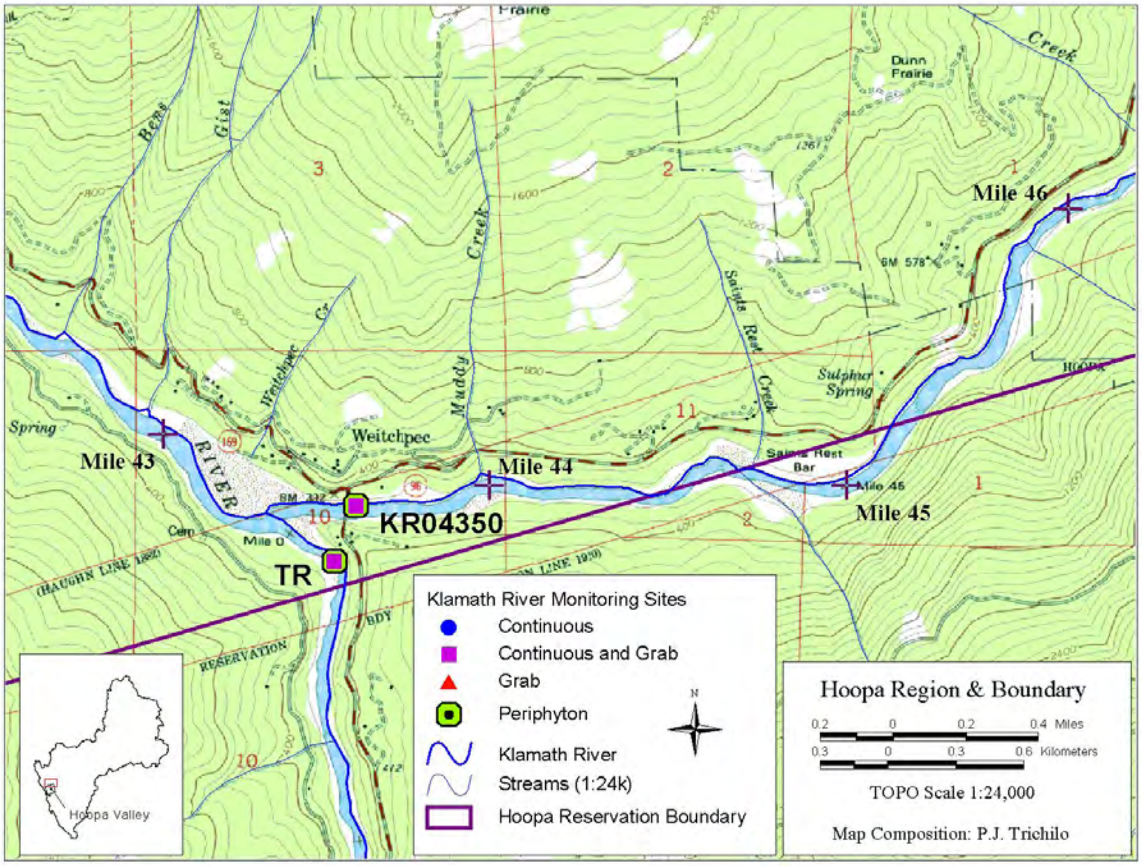


Figure 2. Map showing the convergence of the Klamath and Trinity Rivers. Upstream of the confluence is a short reach known as Saints Rest, where the boundary of the Hoopa Valley Indian Reservation (purple line) intersects the mainstem of the Klamath River. The reservation is located on the southern side of the boundary. Note that the reservation boundary on the topographic map does not correspond perfectly with GIS-determined locations of the reservation boundary. It is not known which is the more accurate.

TIMELINE AND PROCESS

Kier Associates, with assistance from Aquatic Ecosystem Sciences of Ashland, Oregon, was hired to assist the Hoopa Valley Tribe in developing water quality criteria. To provide the opportunity for comment early in the criteria development process, a preliminary Nutrient Criteria Plan (Kier Associates 2005) was submitted to the EPA in late September 2005 for review and dissemination to the Regional Technical Assistance Group (RTAG) and any other applicable Tribes and agencies.

Subsequent to Kier Associates' submittal to the Tribe of the draft nutrient criteria and supporting analysis contained herein, the Tribe began a 45-day public review process in which the draft criteria and supporting analysis were made available for Tribal, agency, and public comment. A public comment session was held, and written and oral comments were accepted. In response to comments, Tribe responded to comments and revised the proposed criteria as appropriate. The revised criteria will then be submitted to the EPA for final approval.

BENEFICIAL USES TARGETED FOR PROTECTION

Conserving Pacific salmon populations is of critical cultural importance to the Hoopa Valley Tribe as well as other Tribes in the Klamath River Basin. Consequently, nutrient criteria will focus on the beneficial uses associated with supporting cold water fish (COLD) and cold water fish spawning (SPAWN). The beneficial use associated with surface contact, generally recognized as recreational use (REC-1) under the Clean Water Act, will also be considered with regard to cyanobacteria and cyanobacterial toxins. For Tribes, surface water contact can be associated with continuing traditional cultural uses of the river, including fishing and consumption of fish (Hoopa TEPA 2001).

WATER QUALITY PARAMETERS SELECTED FOR NEW AND REVISED CRITERIA

Nutrient pollution can manifest itself in many different ways because it stimulates plant growth that in turn drives chemical reactions that change several water quality parameters.

Dissolved Oxygen

Photosynthetic activity during the day may cause supersaturated dissolved oxygen (D.O.) conditions and respiration of aquatic plant life at night can cause D.O. declines. Both conditions are potentially injurious to salmonids; therefore, both minimum D.O. and supersaturation are reviewed here.

pH

Photosynthesis also increases pH as OH^- ions go into suspension as part of the associated chemical reactions. pH is discussed and standards are proposed. Studies have shown that pH can be directly stressful to salmonids. An important concern is that elevated pH increases ammonia toxicity by converting ammonium ions to unionized or dissolved ammonia that is lethal to salmonids at very low levels. Although ammonia data with appropriate detection limits are sparse, and existing Hoopa water quality standards are appropriate (Hoopa TEPA 2001), ammonia is discussed below because of the substantial risk it poses to fish health in the Klamath River.

Periphyton and Nutrients

U.S. EPA (2000b) and Tetra Tech (2004) suggest that criteria can be set for the nitrogen to phosphorous ratio (N:P), for density of aquatic macrophytes, and for the amount of chlorophyll *a* in benthic algae. Various forms of phosphorous or nitrogen can also be used as criteria if there are patterns or statistical relationships between N or P and other water quality parameters of concern (i.e. pH or dissolved oxygen).

The ratio of nitrogen to phosphorus in the water column is an indication of which nutrient is limiting algal growth in a waterbody (U.S. EPA 2000b). When the molar ratio of N:P is higher than 16 a waterbody is likely phosphorus-limited; conversely, when the N:P ratio is less than 16 a waterbody is likely nitrogen-limited (Tetra Tech 2004). Algal growth in streams is more often limited by nitrogen than by phosphorus (U.S. EPA 2000b). Tetra Tech (2004) found that streams in Ecoregion 6, encompassing the central California coast and foothills, were likely nitrogen-limited. The Klamath River is generally recognized as nitrogen-limited (PacifiCorp 2004). We queried the Klamath TMDL database to calculate molar nitrogen:phosphorus ratios for sites in the Klamath River from Iron Gate Dam down to the estuary. With a summer mean of 13.9, the ratios of total nitrogen (TN) to total phosphorus (TP) indicate that the Klamath River is likely nitrogen-limited (Figure 3). Ratios of total inorganic nitrogen (TIN) to orthophosphorus (PO_4), the forms of nutrients immediately available for algal growth, show an even stronger nitrogen limitation with a summer mean of 8.1 (Figure 4). The figures indicate that while nitrogen is often limiting, phosphorus is likely to be limiting or at least co-limiting at times. Additionally, if restoration efforts are effective in decreasing nitrogen levels, then phosphorus may become more limiting over time; hence, we proposed criteria for both nitrogen and phosphorus.

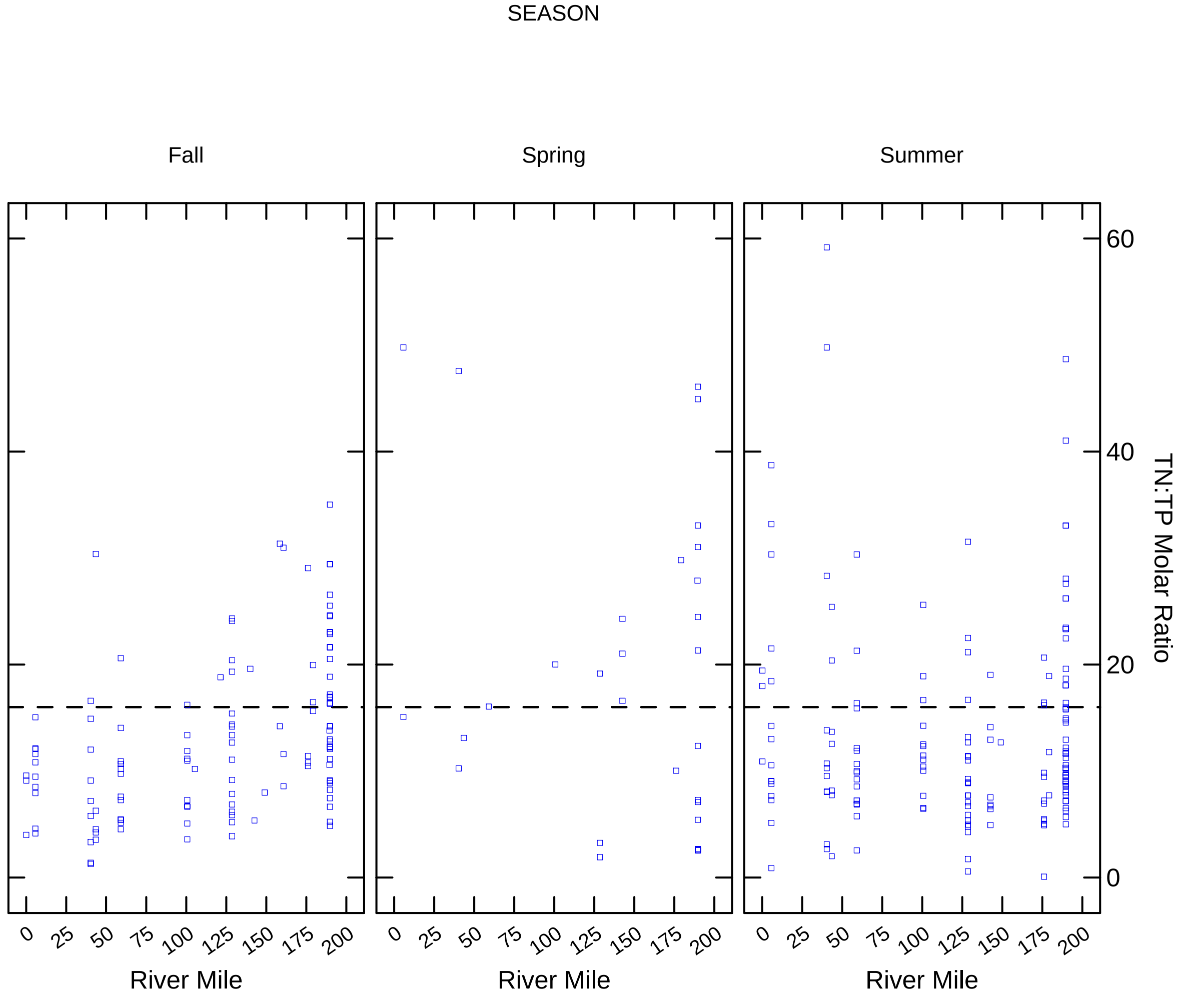


Figure 3. Calculated ratios of total nitrogen (TN) to total phosphorus (TP) indicating that the Klamath River is likely nitrogen-limited, based on all available samples from 2000-2004. The horizontal line at 16 indicates the ratio below which a waterbody is expected to be nitrogen-limited (Tetra Tech, 2004). Some outliers are not included in this graph.

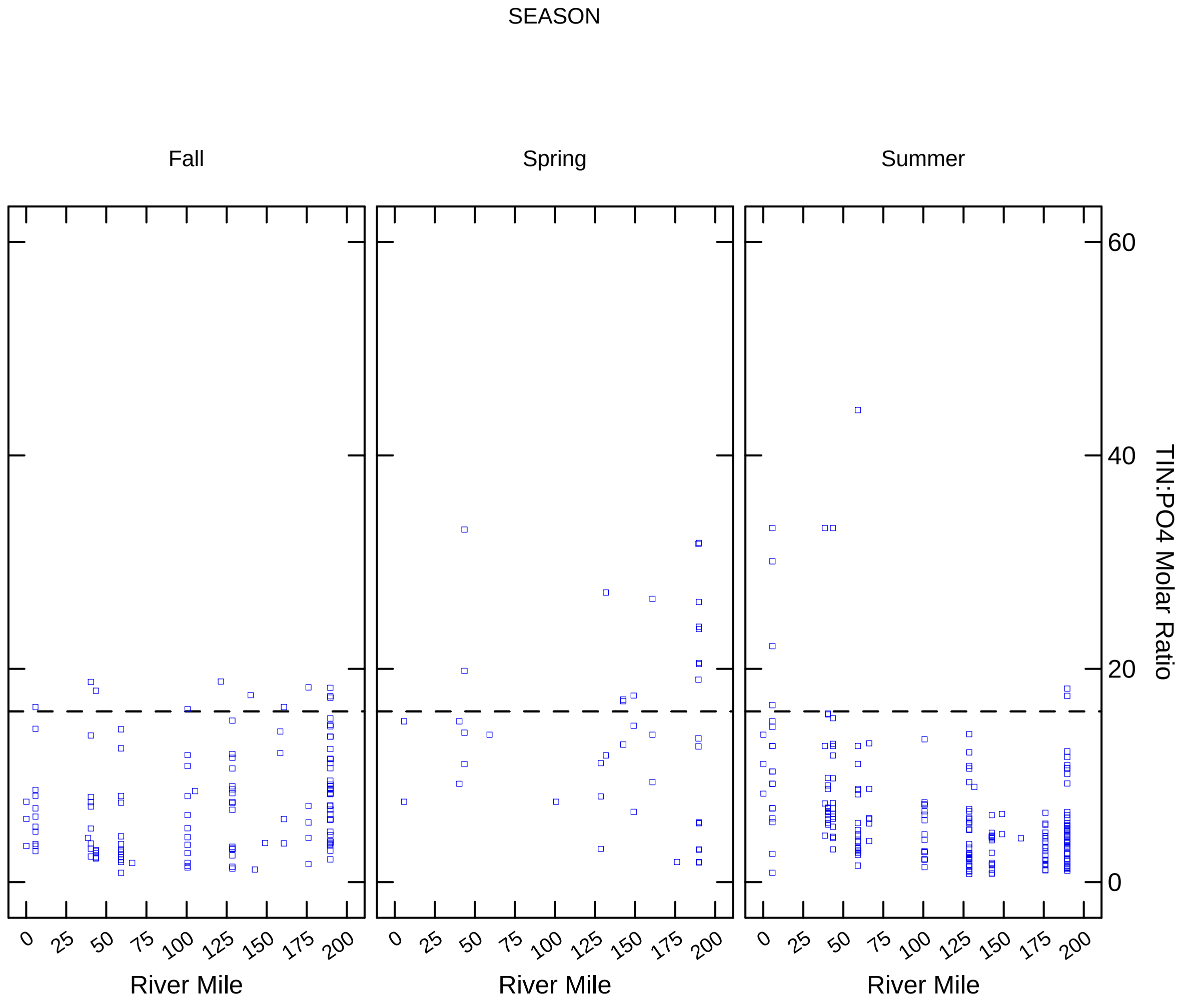


Figure 4. Calculated ratios of total inorganic nitrogen (TIN) to orthophosphorus (PO_4) indicating that algal growth in the Klamath River is likely nitrogen-limited, based on all available samples from 2000-2004. The horizontal line at 16 indicates the ratio below which a waterbody is expected to be nitrogen-limited (Tetra Tech, 2004). Some outliers are not included in this graph.

Chlorophyll *a* per streambed area is typically the best indicator of periphyton biomass, although ash-free dry weight (AFDW) is also sometimes used (U.S. EPA 2000b). While chlorophyll *a* showed relationships with pH and D.O. in the Klamath River (see below), AFDW did not exhibit any discernable relationships. The lack of a discernable relationship may be because AFDW does not distinguish between actively photosynthesizing benthic algae, other members of the periphyton community such as bacteria and fungi, and organic detritus. In contrast, chlorophyll *a* is a direct indication of biomass of benthic algae only.

Cyanobacteria and Associated Toxins

Microcystis aeruginosa, a blue-green algal species (cyanobacteria) capable of producing the potent liver toxin (hepatotoxin) microcystin, was recently detected in the lower reservoirs of the Klamath River Hydroelectric Project (Kann 2005, Kann and Corum 2006). Also in 2005, Klamath River samples as far downstream as the estuary indicated that algal cells are being washed from the reservoirs into the river below and are maintaining viability (Kann 2006a, Fetcho 2006). Detection of the presence of both cells and toxin well downstream of Iron Gate Reservoir has implications for human and aquatic ecosystem health; therefore, criteria for *Microcystis* and microcystin toxins are recommended.

CLASSIFICATION

The Klamath River is located in Aggregate Ecoregion II, and its watershed is composed of portions of four different Level III ecoregions (Figure 5): Coast Range (1) , Cascades (4), Eastern Cascade Slopes and Foothills (9), Klamath Mountains (78). For descriptions of the characteristics of the ecoregions, refer to U.S. EPA (2000a).

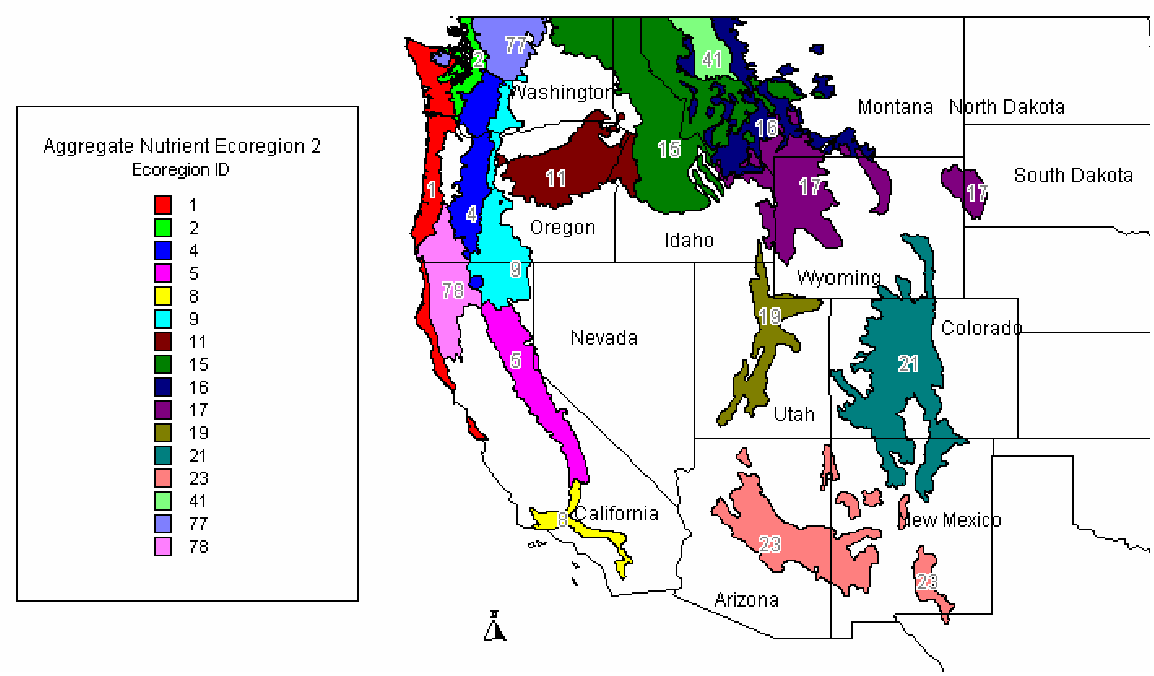


Figure 5. Location of Level III ecoregions within Aggregate Ecoregion II. Figure from U.S. EPA (2000a).

In its recent guidance for developing nutrient numeric endpoints for California, Tetra Tech (2006a) proposed classifying waterbodies using three Beneficial Use risk classification categories:

I. Presumptive unimpaired (use is supported)
II. Potentially impaired (may require an impairment assessment)
III. Presumptive impaired (use is not supported or highly threatened)

The purpose of the classification is to determine the degree of risk that a waterbody is impaired. There has been extensive monitoring and analysis of the Klamath River to confirm its impairment (for instance, it is 303d listed as impaired, and is undergoing the TMDL process).

Based on the proposed risk-category boundaries presented in Table 3-2 of Tetra Tech (2006a) for SPWN and COLD beneficial uses, Hoopa Valley Tribe's portion of the Klamath

River is in Category III for benthic algal biomass, Category II for dissolved oxygen, and Category I for pH.

Given that evidence from laboratory studies indicates that any pH over 8.5 is stressful to salmonids and 9.6 is lethal (Wilkie and Wood 1995), it is our opinion that the Tetra Tech (2006a) Category I/II boundary should be revised to be pH 8.5, and the Category II/III boundary should be pH 9.0 (or perhaps 9.5), rather than the current pH boundaries of 9.0 and 9.5, respectively.

CONCEPTUAL APPROACH TO STANDARD SETTING

The Hoopa Valley Tribe development of nutrient criteria follows methods contained in the guidance documents published by the U.S. EPA for the nation (U.S. EPA 2000b and 2001) and Region 9 (Tetra Tech 2004) on how to develop nutrient criteria. In the months since Kier Associates' initial development of recommended draft nutrient criteria for the Hoopa Valley Tribe in fall 2005, EPA Region 9 and Tetra Tech issued new guidance for developing nutrient numeric endpoints in California (Tetra Tech 2006a). We have reviewed this updated guidance document and have determined that although we did not utilize new tools such as the Benthic Biomass Spreadsheet Tool, our recommended criteria are generally consistent with the approach outlined in Tetra Tech (2006a). The text herein has been revised to incorporate elements from Tetra Tech (2006a) where appropriate.

In a memo to states and Tribes, U.S. EPA (2001) recommends following one of these three approaches:

> 1) Wherever possible, develop nutrient criteria that fully reflect localized conditions and protect specific designated uses, using the process outlined in the technical guidance manuals;
>
> 2) Adopt EPA's recommended section 304(a) criteria for nutrients, either as numeric criteria or as a translator for a state or Tribal narrative criterion; or
>
> 3) Use other scientifically defensible methods and appropriate water quality data to develop criteria protective of designated uses.

Because of the extensive amount of existing data available for the Klamath River, we will follow a combination of approaches 1 and 3 applied to beneficial uses associated with cold water fish and fish spawning, as well as surface contact recreation (cyanobacterial toxins only).

The U.S. EPA (2000b) guidance document proposes three methods for developing nutrient and algal criteria ranges, which can also be used in coordination with each other:

> 1) Identification of reference reaches for each established stream class based on either best professional judgment (BPJ) or percentile selections of data plotted as frequency distributions.

2) Refinement of trophic classification systems, use of models, and/or examination of system biological attributes to assess the relationships among nutrient and algal variables.

3) Use (or modify for use) published nutrient/algal thresholds as criteria.

The large size of the Klamath River basin and a long history of land use with widespread associated water quality degradation prevent use of the reference reach approach (method 1), although assumptions related to reference conditions are discussed below. Instead, the second approach will be followed, where quantitative relationships between variables in Klamath River datasets are examined to discern cause and response variables to help set nutrient criteria. Applicable scientific literature is also used to set values for thresholds and end points necessary to maintain beneficial uses.

U.S. EPA (2000) proposes following nine iterative steps in the process of criteria development:

1. Identify water quality needs and goals with regard to managing nutrient enrichment problems.

2. Classify rivers and streams first by type, and then by trophic status.

3. Select variables for monitoring nutrients, algae, macrophytes, and their impacts.

4. Design sampling program for monitoring nutrients and algal biomass in rivers and streams.

5. Collect data and build database.

6. Analyze data.

7. Develop criteria based on reference condition and data analyses.

8. Implement nutrient control strategies.

9. Monitor effectiveness of nutrient control strategies and reassess the validity of nutrient criteria.

The recent crisis in river health as manifest in the September 2002 adult salmon die off (CDFG 2003; Guillen 2003) has prompted increased participation of agencies and Tribes in coordinated monitoring of Klamath River water quality. There has also been substantial data collection and analysis in response to the potential relicensing of the Klamath River Hydroelectric Project. The cumulative result of these efforts is equivalent to the performance of many of the steps recommended above.

The Hoopa Valley Tribe recognizes that water quality management is shared with numerous other states, agencies and Tribes. Consequently, it is the intention of the Hoopa Valley Tribe Environmental Protection Agency (TEPA) to provide scientifically justified nutrient criteria and then to work with other entities to adopt similar criteria. The Hoopa Valley

Tribe also looks forward to working cooperatively on pollution control strategies and effectiveness monitoring.

REFERENCE CONDITIONS AND ENDPOINTS

The U.S. EPA (2000) recommends use of reference reaches to determine unimpaired conditions, but most reaches of the Klamath River have been degraded as a result of human-caused pollution and no reference reaches remain. The uniqueness and vast watershed of the Klamath River also makes it inappropriate to expect that water in the Klamath River was historically as clean as its large tributaries such as the Salmon River. For example, the latter is an oligotrophic basin, whereas the Klamath itself was likely mesotrophic. Although in nutrient criteria development below, we do compare data from the Klamath River with data from the Trinity and Salmon Rivers, we recognize their differences in historic trophic status.

An "endpoint" is the level of a nutrient or related condition (i.e. algal biomass) below which negative effects on beneficial uses are avoided (Tetra Tech, 2004). Some endpoints here (e.g., D.O. and pH) are derived from the literature because studies have determined thresholds for salmonid stress and lethality. Endpoints for chlorophyll *a* and nitrogen were derived by determining relationships to other parameters using Klamath River data.

The Klamath River historically drew much of its richness from Upper Klamath Lake. This large, shallow lake was formed by plate tectonics, where a large area dropped as a result of the crust being pulled apart creating what geologists term a graben. Slow transit time through this shallow waterbody would have allowed enrichment of the Klamath River and helped fuel its tremendous salmon runs. The reference conditions for Upper Klamath Lake and the Klamath River in the pre-contact period cannot be completely reconstructed or accurately modeled because of lack of data; however, two types of historic data that do shed considerable light on pre-contact condition are fossil algae and fish distribution and diversity.

Paleolimnological analyses were performed on sediment cores taken from Upper Klamath Lake and were analyzed for historic trends in the algal community (diatoms, *Pediastrum*, and *Aphanizomenon flos-aquae* resting cells or akinetes). Prior to approximately 100 years ago no *Aphanizomenon flos-aquae* akinetes were discernable in the sediment record, yet today this nitrogen fixing blue green alga comprises as much as 99% of the summer phytoplankton in Upper Klamath Lake (Eilers et al 2004; Bradbury et al. 2004). Cope (1879) and Gilbert (1898) provide field data and descriptions of the distribution and diversity of fish species prior to habitat destruction. Various other sources indicate widespread ability of the Klamath River and most of its tributaries to support all life history phases of salmonid species throughout the year (Gilbert 1898, Snyder 1931, Hamilton et al. 2004).

In assessing lower Klamath River reaches on the Hoopa Reservation and those upstream to Iron Gate Dam, it is assumed that water quality conditions were likely supportive of all life history phases of Pacific salmon species and likely within optimal ranges for most of the year. Consequently, where conditions in the Klamath River today exceed highly stressful or lethal conditions for salmonids, those conditions are considered outside the normal range of variability and as indicative of water pollution.

U.S. EPA (2000b) "believes that State and Tribal water quality standards need to include quantified endpoints for casual and response variables to provide sufficient protection of uses and to maintain downstream uses." The quantified end points recommended here are those that support healthy conditions for salmonids, including spawning and egg incubation, as well as those that allow cultural uses that require surface water contact.

PATHWAYS FOR KLAMATH RIVER WATER QUALITY IMPAIRMENT

Numerous studies have recognized water quality impairment of the Klamath River and its tributaries (NRC 2004, Kier Associates 1991 and 1999, CH2Mhill 1985, Gwynne 1993, Winchester et al. 1995, Halstead 1997), including Upper Klamath Lake (Kann and Smith 1999, ODEQ 2002). The Klamath River is recognized as polluted by nutrients and increased water temperature (NCRWQCB 2001). Major tributaries are also recognized as impaired including the Shasta, Scott, Salmon, and Lost Rivers as well as Tule and Lower Klamath Lakes (NCRWQCB 2001). Table 1 shows the type of impairment for each Klamath River tributary. Pollution from all these source areas is transported down the Klamath River to the Hoopa Valley Indian Reservation and beyond. Pathways for impairment of water quality and effects on salmonids are described below.

Table 1. Klamath River reaches and tributaries basins and water quality parameters for which they are recognized as impaired.

Watershed	**Temperature**	**Nutrients**	**Dissolved Oxygen**	**Sediment**	**pH**
Klamath River	X	X	X		
Upper Klamath Lake	X	X	X		
Shasta River	X	X	X		
Scott River	X			X	
Salmon River	X				
Tule Lake/Lower Klamath Refuge	X	X			X
Lower Lost River	X	X			

ODEQ (2002) describes non-point source pollution problems in tributaries to Upper Klamath Lake and noted their contribution to water quality in the lake itself:

> The water quality conditions in the Upper Klamath Lake, and the streams that drain to the lake, range from high quality to seriously impaired. There is no question that water quality standards are being violated and that beneficial uses are compromised in the 303(d) listed portions of the drainage and in the lake itself.

Upper Klamath Lake is dominated by the nitrogen fixing alga *Aphanizomenon flos-aquae* (*A. flos-aquae*). Due to *A. flos-aquae* and other internal loads, the outflow total nitrogen load from the lake was about 3.5 times the load entering the lake for the period 1992-1998 (Kann and Walker 1999). Klamath Hydroelectric Project reservoirs inundate 62 miles of free flowing Klamath River reaches and set up an ideal environment for additional blooms of *A. flos-aquae* and other phytoplankton (Kier Associates 2004). The National Research Council (NRC 2004) noted that a major contributing factor to nutrient enrichment of reservoirs was that in summer, 50% of the Klamath Rivers flow into Keno Reservoir may be agricultural drain water:

> "Thus, source waters of diverse quality influence the quality of water in the reservoirs. The waters of Upper Klamath Lake often bring large amounts of algal biomass to the upper end of the system, along with large amounts of soluble and total phosphorus. When Upper Klamath Lake is experiencing senescence of its algal population, the entering waters also may have low concentrations of dissolved oxygen and an abundance of decomposing organic matter. Irrigation tailwater and other drainage would carry abundant nutrients and could carry organic matter."

The return flow of the Lost River, Tule Sump and Lower Klamath Lake enters the Klamath River in an impounded reach just above Keno through the Straits Drain. Water quality in the Straits Drain is severely impaired and it has been shown to be a source of nutrient pollution by NCRWQCB 104b sampling results from 1996 and 1997. Unionized ammonia grab samples for three days in 1996 show values as high as 0.125 mg/L, but in August of 1997 a value of 0.35 mg/L was measured (Figure 6), indicating significant nutrient pollution and lethal conditions for many species of fish, plants and macroinvertebrates.

The Oregon Water Resources Department (ODWR 2004) described Keno Reservoir and J.C. Boyle Reservoir as impaired and noted a particular lack of biological diversity in the former.

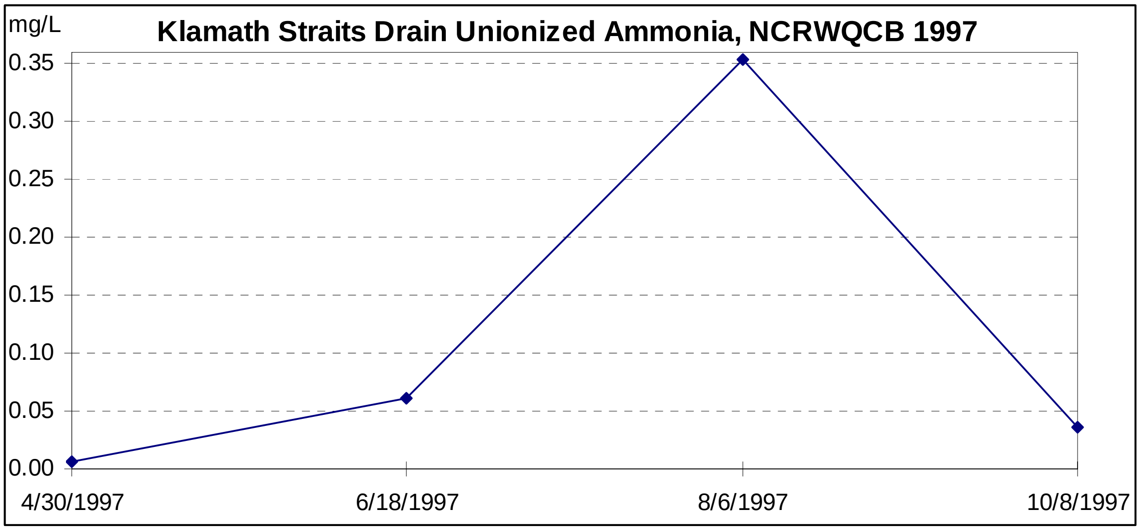


Figure 6. The dissolved or unionized ammonia levels at the Straits Drain in 1997 indicate that it is likely sometimes a significant source of nutrient pollution. Data are from NCRWQCB 104 b grab samples.

Kann and Asarian (2005) used water quality data collected by PacifiCorp and the USFWS to calculate nutrient budgets for Copco and Iron Gate Reservoirs. These budgets showed that during the April-November 2002 period, the reservoirs functioned as both sinks and sources of nutrients. At times during the June through September period, nutrient concentrations in reservoir outflows were substantially higher than in reservoir inflows, making nutrients available downstream growth of algae and macrophytes (Kann and Asarian 2005).

Since most tributaries below the Scott River are oligotrophic is should be expected that indications of algal and macrophyte production would decrease progressively downstream; however, Kier Associates (2004) noted that Klamath River water quality data from the mid 1990's showed major fluctuation of pH, D.O. and unionized ammonia as far downstream as Ike's Falls below Sommes Bar. This indicates that a phenomenon known as nutrient spiraling is likely occurring, where nutrients are absorbed and then are released (such as when periphyton is scoured or senesces), cascade downstream, break down, and then become available again for growth.

Kier Associates (1991) described pollution of the lower Klamath River from nutrients from KHP reservoirs: "The impoundment of water in the reservoirs contributes to algal blooms and nuisance conditions (e.g., attached algae) downstream. Nutrient levels of the reservoir inflow are also quite high, with contributions coming from natural, agricultural, and industrial sources."

Figure 7 shows a schematic of pathways for potential Klamath River pollution based on the reports cited above. Sources begin in the headwaters of the Sprague River and other Upper Klamath Lake tributaries (ODEQ, 2002; ODA, 2004). The Upper Klamath Lake TMDL (ODEQ, 2002) specifically cites the City of Chiloquin sewage facilities as a point source of pollution. The City of Klamath Falls is also a point source to the Klamath River in the Keno reach. Each reservoir is not only inoculated with *A. flos-aquae* and nutrient rich waters from Upper Klamath Lake, but also with nutrients from the Lost River, Tule Sump and Lower Klamath Lake through the Straits Drain. Middle Klamath tributaries such as the Shasta, Scott and Salmon are also shown as sources.

The pathways for nutrient pollution related impairment of COLD and SPAWN beneficial uses are displayed in Figure 8. The Klamath River is generally nitrogen limited, so increased nitrogen levels are of the greatest concern. Nutrients can only be taken up biologically when they are in inorganic forms (NO_3, NO_2, NH_3, and PO_4). When dissolved, these inorganic forms can stimulate excess growth of macrophytes, periphyton, phytoplankton, and bacteria in the lower Klamath River. In KHP reservoirs, high levels of nutrients stimulate planktonic algae blooms that can add more nutrients through nitrogen fixation. Stimulated by warm nutrient-rich water, the high amount of photosynthetic activity in the lower Klamath River gives rise to changes in water chemistry that are acutely stressful and sometimes lethal for salmonids.

In developing these nutrient criteria we will focus on the direct impacts of pH and D.O. on salmonids; however, nutrients may be affecting other factors that have indirect but substantial negative consequences for salmonids such as increased fish disease. For example, *Ceratomyxa shasta* is a myxozoan parasite that causes major problems for the health of juvenile salmonids in the Klamath River. Infection rates are extremely high and in many years results in the death of significant portion of the juvenile salmonids in the Klamath River. Nichols and Foott (2005) estimated that in 2004, 45% of juvenile fall-run chinook salmon were infected with *C. Shasta* and that the majority of those fish would not survive, and that impact of a loss of that many fish could rival the 2002 adult fish-kill where over 33,000 adult salmon died.

High nutrient levels may be stimulating luxuriant growth of *Cladophora*, a filamentous green algal species. *Cladophora* beds are a favored habitat for polychaete worms that are a host for *C. Shasta* (Stocking and Bartholomew, 2004). The high incidence of *C. Shasta* in the Klamath River may be due to an increase in polychaete populations caused by an increase in polychaete habitat (Stocking and Bartholomew, 2004). Foott (pers. comm.) noted that *C. Shasta* parasite loads are so high in the Klamath River that even healthy fish with active immune systems can be overwhelmed. To reduce the incidence of *C. Shasta* infection in the Klamath River, it may be insufficient to improve pH and D.O. alone to reduce fish stress. It also may require reduction in parasite loads by reducing nutrients to reduce the prevalence of *Cladophora* and hence *C. Shasta*'s polychaete host. Mapping the distribution and abundance of *Cladophora* in the Klamath River and its tributaries should be a research priority.

The most acute water quality problems in the Klamath River are located far upstream of the Hoopa Valley reservation, yet because of *Cladophora* and *C. Shasta* the water quality in those locations is important to the Hoopa Tribe. It may be the case that making major improvements in nutrients levels far upstream would have a far greater beneficial impact on the Hoopa Valley Tribe's fisheries than making smaller improvements to water quality on the Hoopa reservation.

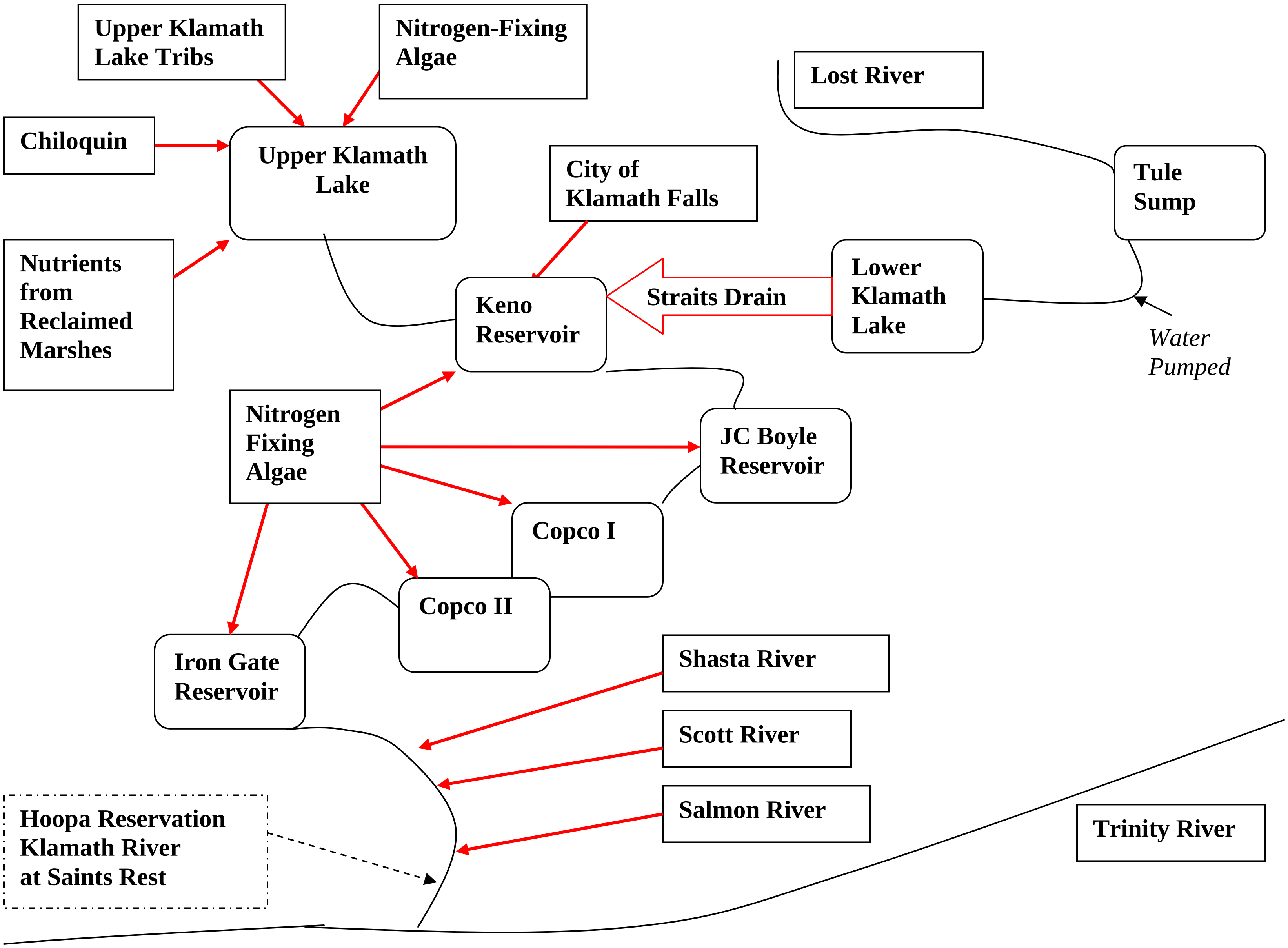


Figure 7. Spatial sequence of sources of water pollution, including nutrients, to the Klamath River above the Trinity River.

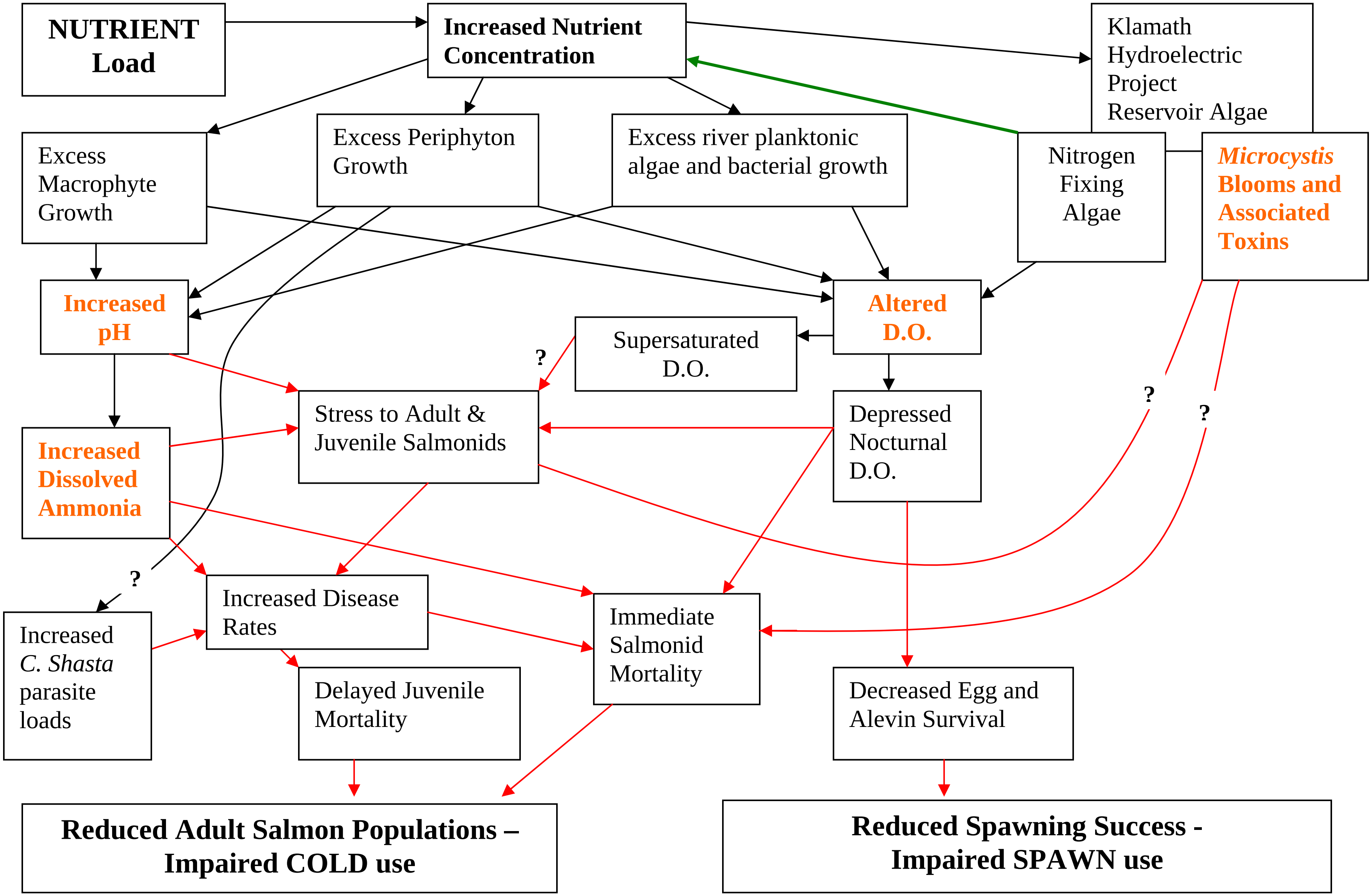


Figure 8. Klamath River conceptual flow chart of pathways for nutrient enrichment and water quality impairment of COLD and SPAWN beneficial uses. Orange = water quality stressors, red arrows = direct effects on salmonids, green arrow = blue green algae are N source, and ? = possible impairment but no available data.

LITERATURE REVIEW AND ASSESSMENT OF PATTERNS IN KLAMATH WATER QUALITY DATA

In this section, we review the literature for each water quality parameter that we are proposing a standard for, and then provide a brief illustrated summary of Klamath River data for each parameter.

Extensive amounts of nutrient data have been collected in the Klamath River and its tributaries, especially in the period 2000-2004. Agencies involved in data collection include PacifiCorp, U.S. Geologic Survey (USGS), U.S. Fish and Wildlife Service (USFWS) Arcata Office, U.S. Bureau of Reclamation (USBR), U.S. Bureau of Land Management (BLM), U.S. Environmental Protection Agency (U.S. EPA), Karuk Tribe, the North Coast Regional Water Quality Control Board, the California Department of Water Resources, and various private companies and their consultants.

As part of the Federal Energy Regulatory Commission Klamath Hydroelectric Project relicensing process, PacifiCorp's consultants assembled a large database of historical water quality data for the Klamath River basin. In preparation for the developing the Total Maximum Daily Load (TMDL) plan for the Klamath River, Tetra Tech (2004) added to PacifiCorp's water quality database. Significant additional data were recently added by Kier Associates under contract to the Karuk Tribe, in order to analyze the effect of Iron Gate and Copco reservoir operations on river nutrients. The database is available online at: http://www.krisweb.com/ftp/KlamWQdatabase/KR_TMDL_database_with_PCorp_USFWS_CDWR_data.zip

That same database also contains data from an extensive number of automated continuous water quality probes measuring temperature, D.O., pH, and conductivity that were deployed by the City of Klamath Falls, the Karuk Tribe, the Oregon Department of Environmental Quality (ODEQ), PacifiCorp, U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service (USFWS), U.S. Geological Survey (USGS), and the Yurok Tribe. The result of these efforts is an excellent database that provided the basis for nutrient criteria development. Figure 9 shows the location of water quality monitoring stations in the Klamath Basin, and Table 2 provides a key site codes.

PacifiCorp's nutrient data for the year 2004 has not yet been integrated into the TMDL database, but was included in our analyses to develop nutrient criteria.

While there are abundant nutrient and continuous probe data, periphyton data are relatively scarce with only one year of detailed collection (see periphyton section below for details).

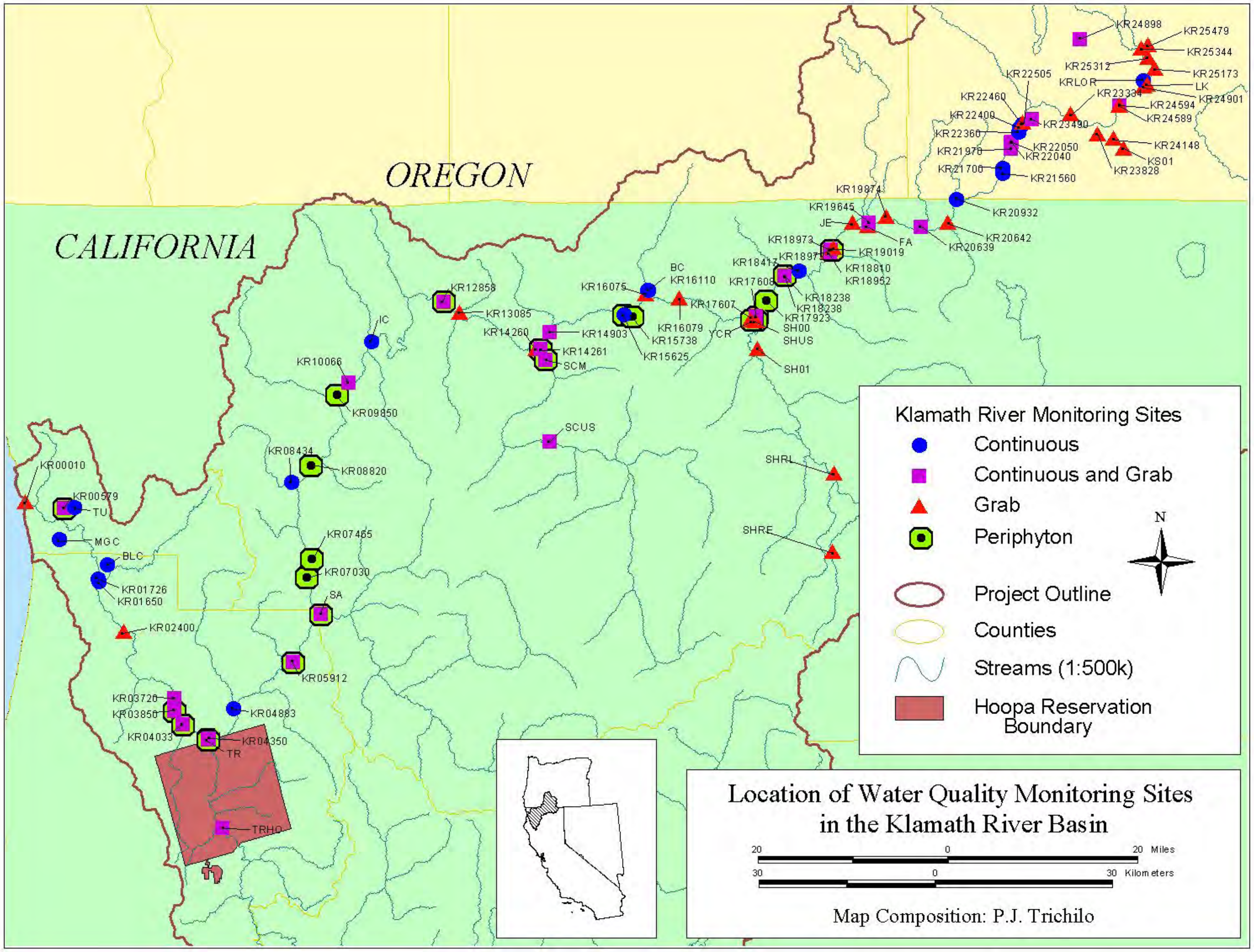


Figure 9. Map showing the location of water quality monitoring sites in the Klamath River in the years 2000-2004. Data are from Yurok Tribe, Karuk Tribe, U.S. Fish and Wildlife Service, PacifiCorp, NCRWQCB, USGS, City of Klamath Falls, CDWR, and U.S. Bureau of Reclamation.

Table 2. Description of Klamath River water quality monitoring stations and key to site codes. Site ID code for mainstem Klamath stations begin with KR, followed by river mile. For instance, KR18952 is river mile 189.52. Some that some continuous stations are only temperature some are multi-probe (temperature, pH, D.O., conductivity).

Site ID	Site Name	Contin-uous	Grab	Peri-phyton	Latitude	Longitude
BC	Beaver Creek	x			41.870830	-122.815830
BLC	Blue Creek near Mouth	x			41.448611	-123.911110
FA	FALL CREEK		x		41.968100	-122.365300
IC	INDIAN C AT MOUTH	x			41.792220	-123.378060
JE	JENNY CREEK		x		41.972200	-122.395800
KR00010	Klamath River Estuary Mainstem		x		41.543610	-124.078890
KR00579	KLAMATH RIVER AT KLAMATH GLEN	x	x	x	41.535000	-123.998890
KR01650	Klamath River above Blue Creek	x			41.423333	-123.927780
KR01726	Klamath River at Blue Hole	x			41.426940	-123.929170
KR02400	Klamath River at Johnson's Point		x		41.347630	-123.876000
KR03720	Klamath River at Young's Bar	x	x		41.246600	-123.773300
KR03850	Klamath River above Tully Creek	x	x	x	41.228060	-123.772220
KR04033	Klamath River at Martins Ferry	x	x	x	41.207220	-123.755280
KR04350	Klamath River at Weitchpec	x	x	x	41.186111	-123.703056
KR04883	Klamath River at Aikens Hole	x			41.231389	-123.652778
KR05912	KLAMATH RIVER AT ORLEANS	x	x	x	41.303330	-123.533330
KR06608	KLAMATH R AB SALMON RIVER			x		
KR07030	Klamath River several miles u/s Salmon River			x	41.432200	123.506233
KR07465	Klamath River below Irving Creek			x	41.461370	-123.496790
KR08434	KLAMATH R AB DILLON C	x			41.576940	-123.539170
KR08820	Klamath River at Cottage Grove			x	41.603260	-123.499990
KR09850	Klamath Above Clear Creek			x	41.711317	123.448150
KR10066	Klamath River below Happy Camp	x	x		41.729720	-123.424440
KR12858	Klamath River at Seiad Valley	x	x	x	41.854170	-123.230280
KR13085	Klamath River at Seiad Valley (2.25 mi above gage)		x		41.837333	-123.197500
KR14260	KLAMATH RIVER D/S SCOTT RIVER		x		41.782200	-123.042100
KR14261	Klamath River above Scott River	x	x	x	41.781530	-123.033110
KR14903	Klamath River below Everill Creek	x	x		41.808133	-123.014067
KR15625	Klamath River at Walker Bridge	x		x	41.833779	-122.863530
KR15738	Klamath River at Barkhouse Creek			x	41.831960	-122.847290
KR16075	KLAMATH RIVER D/S BEAVER CREEK		x		41.865800	-122.819300
KR16079	Klamath River at Gottsville River Access		x		41.858450	-122.750220
KR16110	Klamath River above Beaver Creek	x			41.869720	-122.814170
KR17607	KLAMATH RIVER D/S SHASTA RIVER		x		41.828700	-122.603600
KR17608	Klamath River above Shasta River	x	x	x	41.831280	-122.593467
KR17923	Klamath River at Collier Rest Area			x	41.854933	122.573350
KR18238	KLAMATH RIVER U/S COTTONWOOD CREEK	x	x	x	41.892730	-122.535400
KR18417	KLAMATH RIV AT KLAMATHON BR	x			41.899170	-122.506670
KR18810	Klamath River 2 mi. below Iron Gate Dam		x		41.927780	-122.443900
KR18952	Klamath River below Iron Gate Dam (USGS Gage)	x	x		41.928056	-122.443056
KR18973	Klamath River below Iron Gate Dam (Hatchery Br.)	x	x	x	41.931600	-122.440000
KR19019	Irongate Res nr Hornbrook		x		41.934200	-122.435000
KR19645	COPCO DAM OUTFLOW	x	x		41.973250	-122.363580
KR19874	Copco Lake nr Copco		x		41.981100	-122.327500

Site ID	Site Name	Contin-uous	Grab	Peri-phyton	Latitude	Longitude
KR20639	Klamath River above Copco Reservoir	x	x		41.965920	-122.256500
KR20642	KLAMATH RIVER U/S SHOVEL CREEK		x		41.972100	-122.201600
KR20932	KR4 Klamath River near Stateline	x			42.006738	-122.183122
KR21560	Klamath River at Frain Ranch	x			42.045515	-122.089234
KR21700	Klamath River several miles below Boyle powerhouse	x			42.053470	-122.089110
KR21970	Klamath River below Boyle powerhouse at USGS gage	x	x		42.083112	-122.071746
KR22040	Klamath River at J.C. Boyle Powerhouse	x	x		42.093060	-122.070830
KR22050	Klamath River above J.C. Boyle Powerhouse	x	x		42.093610	-122.069170
KR22360	Klamath River at spring in Bypass Reach	x			42.107586	-122.055593
KR22400	Klamath River above Springs in Bypass Reach	x			42.113571	-122.053956
KR22460	Klamath River D/S of J.C. Boyle Dam	x			42.118836	-122.048108
KR22505	JC Boyle Reservoir at Deepest Point		x		42.123400	-122.045400
KR23334	Klamath River below Keno Dam		x		42.135300	-121.947220
KR23490	KLAMATH RIVER AT KENO BRIDGE (HWY 66)	x	x		42.128056	-122.027778
KR23828	KLAMATH RIVER DIRECTLY SOUTH OF HILL 4315		x		42.103610	-121.892780
KR24148	Klamath River u/s of Klamath Strait		x		42.096400	-121.859970
KR24589	KLAMATH RIVER AT MILLER ISLAND BOAT RAMP	x	x		42.147000	-121.848400
KR24594	Klamath River at Miller Island Boat Ramp		x		42.147220	-121.847600
KR24898	KLAMATH RIVER AT HWY 97 BRIDGE	x	x		42.249444	-121.927222
KR24901	Klamath River at Hwy 95 Br NE		x		42.176400	-121.797720
KR25079	Klamath River at South-Side Bypass Bridge	x	x		42.273889	-121.916944
KR25173	Lake Ewauna at Railroad Bridge Drawspan		x		42.203140	-121.774080
KR25200	LAKE EWAUNA BETWEEN STPS	x			42.324167	-121.875000
KR25312	Link River at Mouth		x		42.218900	-121.788300
KR25344	Link River at top of fish ladder		x		42.233520	-121.801120
KR25479	Link River at Fremont St Bridge		x		42.238300	-121.788060
KRLOR	Klamath River above Log Rafts	x			42.184167	-121.799444
KS01	PUMPING PLANT F		x		42.081110	-121.840700
LK	Lost River Diversion Canal at Klamath River		x		42.178400	-121.790700
MGC	McGarvey Creek	x			41.486111	-124.009444
SA	Salmon River at Somes Bar	x	x	x	41.376900	-123.477200
SCM	Scott River at Mouth	x	x	x	41.765830	-123.022800
SCUS	Scott River at USGS Gage	x	x		41.640500	-123.014500
SH00	Shasta River at Mouth	x	x	x	41.825000	-122.595100
SH01	SHASTA RIVER D/S HWY 5		x		41.781390	-122.591940
SH02260	Shasta River at A12 Bridge			x		
SHRE	Shasta River near Edgewood		x		41.470830	-122.440870
SHRG	Shasta River at Montague Grenada			x		
SHRL	Shasta River at Louie Rd Crossing		x		41.590830	-122.436940
SHUS	Shasta River at USGS Gage		x		41.823167	-122.595000
TR	Trinity River at Weitchpec	x	x	x	41.183889	-123.704167
TRHO	Trinity River at Hoopa	x	x		41.050400	-123.673300
TU	Turwar Creek	x			41.535000	-123.978611
YCR	Yreka Creek at Anderson Road		x	x	41.825000	-122.603890

pH

Literature Review:
Evidence from laboratory studies indicates that any pH over 8.5 is stressful to salmonids and 9.6 is lethal (Wilkie and Wood 1995). Studies show that as water reaches a pH of 9.5, salmonids are acutely stressed and use substantial energy to maintain pH balance in their bloodstream (Wilkie and Wood 1995), while pH in the range of 6.0 to 8.0 is normative.

Wilkie and Wood (1995) note that when the gill membranes of bony fishes, including salmonids "are exposed to alkaline water there is an immediate reduction in ammonia excretion rate and a corresponding increase in plasma ammonia concentration." The direct stress effects of increased pH in the Klamath River are compounded by increasing unionized ammonia, which is triggered by increasing pH in conjunction with typically warm water conditions in summer (see below).

Prolonged exposure to pH levels of 8.5 or greater may exhaust ion exchange capacity at gill membranes and lead to increased alkalinity in the bloodstream of salmonids (Wilkie and Wood 1995). This internal shift in chemistry facilitates conversion of internal ammonium to dissolved ammonia (Heisler 1990). In case of extreme pH swings "NH_3 and NH_4^+ concentrations rise too rapidly and/or approach toxic levels, internal ammonia can ultimately contribute to high pH induced mortality" (Wilkie and Wood 1995). Dissolved ammonia causes a similar diffusion pressure on the gills to high pH as salmonids try to convert NH_3 into more benign NH_4^+, thus causing loss of H^+ ions at the gill membrane. This compounds problems in maintaining pH balance in the bloodstream of juvenile and adult salmonids exposed to both stressors.

Patterns in Klamath River Data
Although the NCRWQCB (2001) suggests a maximum upper limit of pH in the Klamath River of 8.5, that limit is frequently exceeded. Figure 10 shows the average maximum pH during the month of August at all locations monitored on the Klamath River from 2000-2004. The pH rises above levels known to be stressful to salmonids at locations immediately below Iron Gate Dam (RM 189.13) downstream to the mouth of the Shasta River (RM 176.08). The data show considerable variability between sites and between years. The variability of pH between years is reflective of changes in flows, climatological conditions, and other factors, but the consistent exceedance of the NCRWQCB pH standard of 8.5 is an indication of pervasive nutrient pollution and consequently a high probability of problems for fish health.

The pH results for 2004 (Figures 10 and 11) show a rise in pH at the gauge location just above the Trinity River. The increased pH is a reflection of increased photosynthetic activity that would also likely be representative of the reach of the Klamath River crossing the Hoopa Indian Reservation about 1.5 miles upstream. The pH of 8.5 indicates that pH in the stressful range for salmonids was occurring, compromising beneficial uses for juvenile salmonids (COLD).

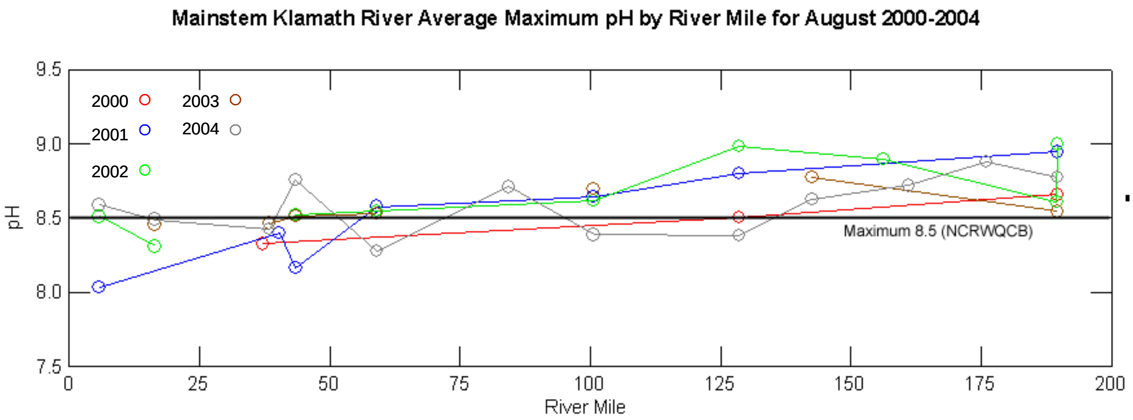


Figure 10. Average maximum pH of the Klamath River by river mile showing patterns for the years 2000-2004. The horizontal line shown on the graph is the NCRWQCB (2001) standard for pH. Data are from the USFWS, Karuk Tribe, Yurok Tribe and USGS.

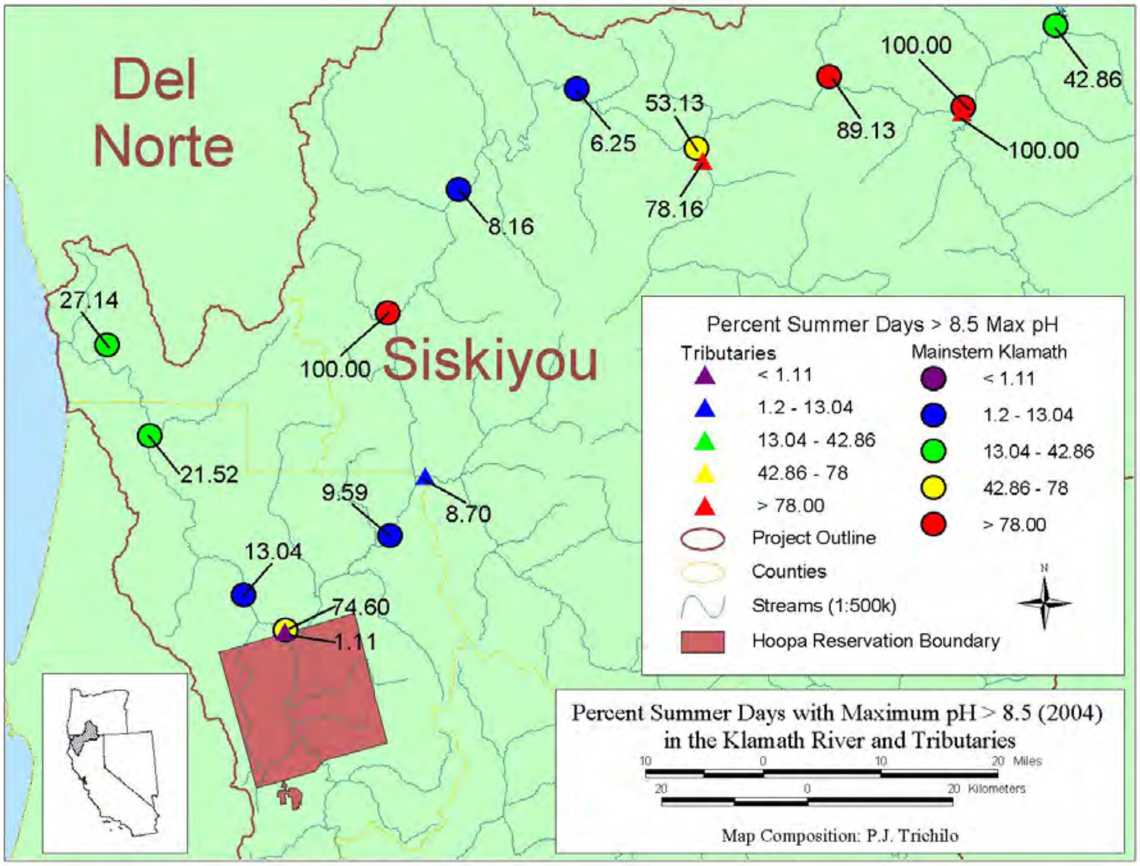


Figure 11. Map showing the percent of summer days in 2004 where maximum pH exceeded 8.5. Data are from Yurok Tribe, Karuk Tribe, and U.S. Fish and Wildlife Service.

Dissolved ammonia (also known as unionized ammonia) is discussed here because of its strong relationship to pH and its potential harm to fish life in the Klamath River that crosses the Hoopa Valley Indian Reservation. Current criteria for unionized ammonia set by the Hoopa Valley Tribe EPA (2001) are sufficient for protection of fish so is not proposed for revision.

Because ammonia criteria are not proposed for revision, we did not perform the specific calculations required to query available data to determine if the ammonia criteria are being exceeded, as the upcoming Mainstem Klamath TMDL will include ammonia toxicity analysis (St. John. pers. comm.).

Extreme variations in pH and presence of dissolved ammonia in the lower Klamath River suggest that criteria may be periodically violated in the reaches in Hoopa Tribal ownership. Goldman and Horne (1983) explained that conversion of ammonium to dissolved ammonia is prompted by increasing pH with greater than 38% converted at a pH of 9.0 and a water temperature of 25 ^{O} C (Figure 12). Mainstem Klamath River water temperature data from proximate reaches indicate that the reach crossing the Hoopa Square typically exceeds 25^{O} C in most years (Figure 13). The maximum floating weekly average temperature shown indicates that 25^{O} C was exceeded as a weekly average, which means that maximum temperatures were much higher. Although water temperature is not the subject of this report, they are highly stressful to salmonids as indicated by the exceedance of reference for salmonid growth shown on Figure 13 from Sullivan et al. (2000).

The results of North Coast Regional Water Quality Control Board 104b water quality data from 1996 and 1997 show that maximum dissolved ammonia can reach levels well above those recognized as acutely stressful to salmonids (Heisler 1990). Maximum levels of dissolved ammonia for 1996 and 1997 by Klamath River location indicate that problems with this substance may be more pronounced in reaches further downstream from Iron Gate Dam (Figure 14).

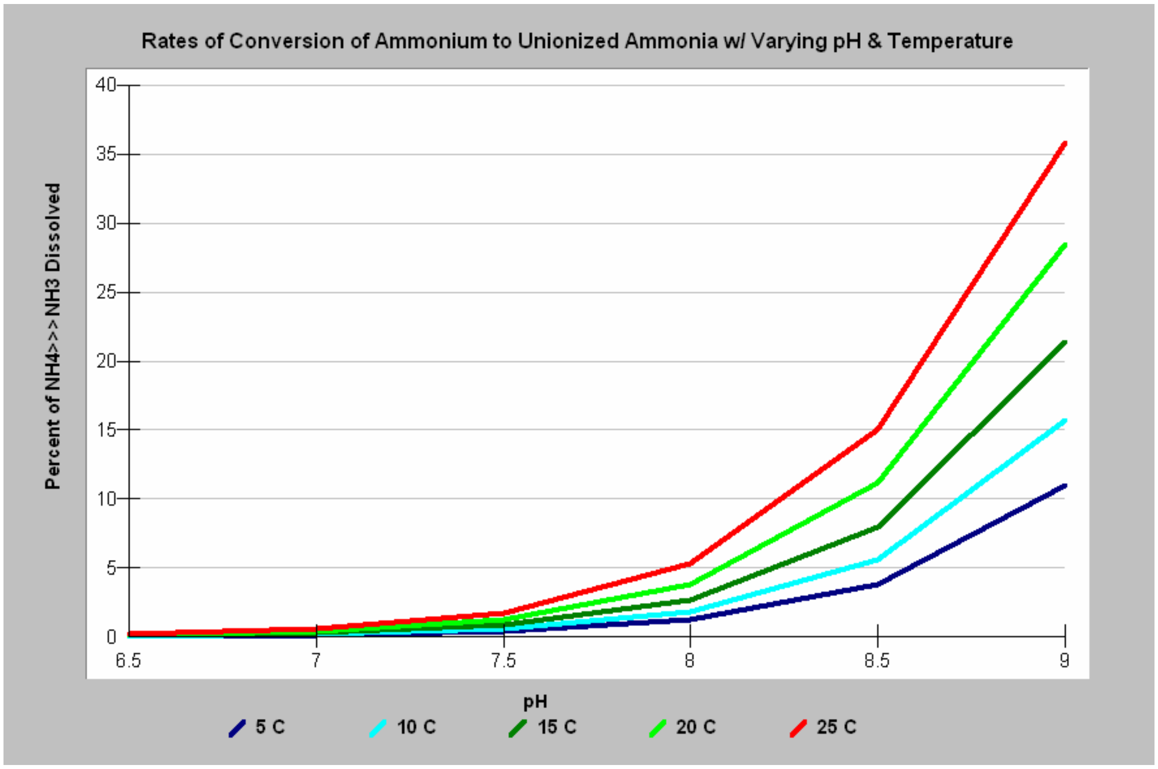


Figure 12. Chart showing the percent conversion of ammonium to dissolved ammonia with increasing pH and water temperature. Data from Goldman and Horne (1983).

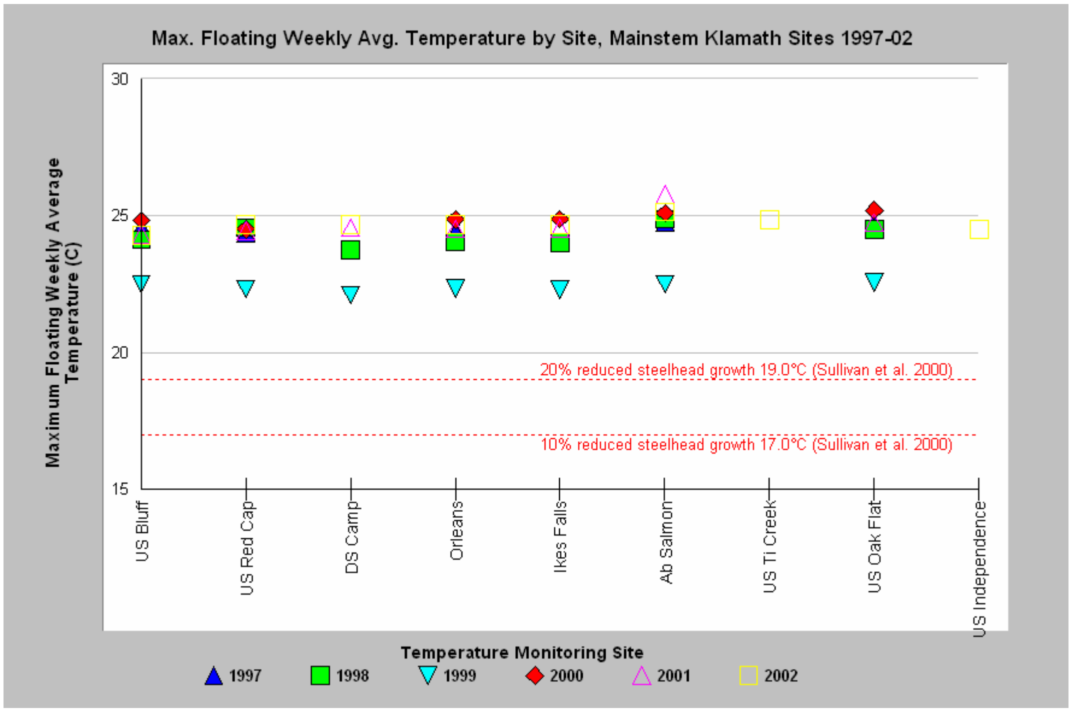


Figure 13. Maximum floating weekly average water temperature of Klamath River locations upstream of the reach on the Hoopa Indian Reservation show and MWAT of 25° C upstream of Bluff Creek in 2000. Data from the Karuk Tribe and Klamath National Forest.

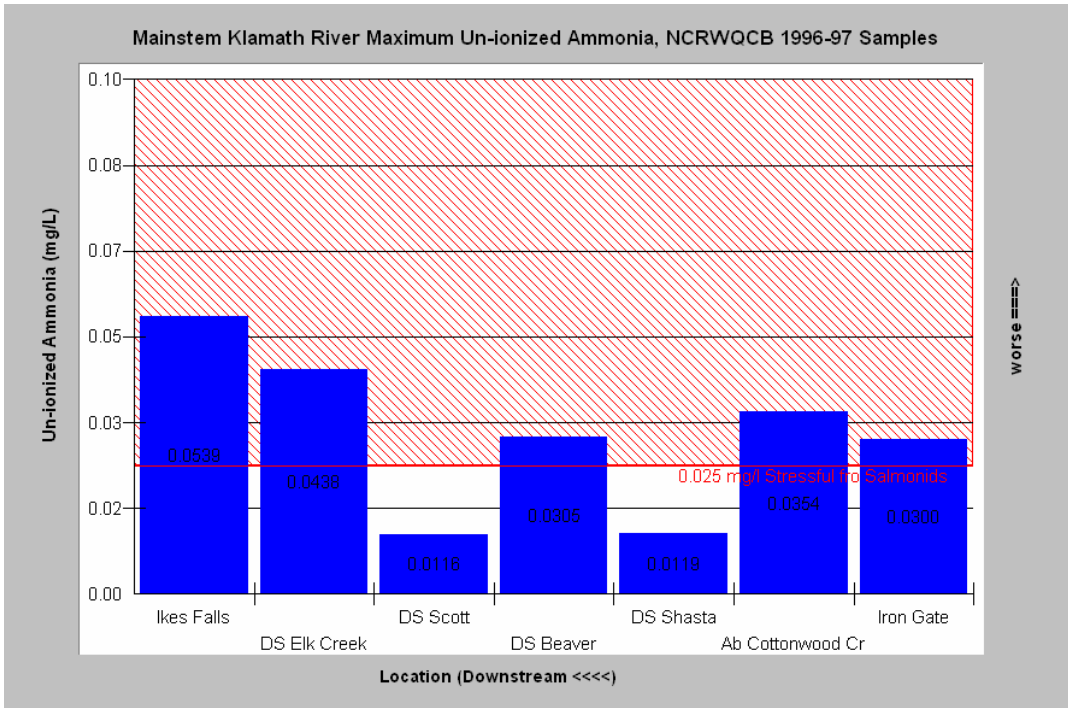


Figure 14. The maximum dissolved ammonia levels measured in grab samples collected in 1996 and 1997 show levels in the highly stressful to lethal range for salmonids as far downstream as Ikes Falls (RM 65.93) about 20 miles upstream of the Hoopa Reservation reach. Data were collected by the North Coast Regional Water Quality Control Board as part of the 104b program.

Dissolved Oxygen

Literature Review
The State of Washington revised dissolved oxygen (D.O.) standards for its waters in 2002 (White 2002) and provides an extensive literature review and research findings. We draw on their document *Evaluating Criteria for the Protection of Aquatic Life in Washington's Surface Water Quality Standards: Dissolved Oxygen* (WDOE, 2002) extensively in this section. They describe the pervasive nature of dissolved oxygen problems and aquatic health:

> "Of all water quality parameters, D.O. is possibly the most affected by the actions of humans. Human actions increase the biological oxygen demand by contributing organic and inorganic materials that are metabolized by stream organisms (who use available oxygen to process the waste), and by actions that raise the temperature of the waterbodies (increasing water temperature reduces the ability of the water to hold oxygen in saturation)."

The effect of dissolved oxygen on Pacific salmon varies by life history phase. WDOE (2002) found that egg survival was only minimally effected in laboratory experiments by dissolved oxygen depression at 10º Celsius (C), but that mortality from similar drops increased dramatically as temperatures rose (Figure 15). Although survival of eggs was undiminished by depressed D.O. at 10º C (Eddy 1971 as cited in WDOE 2002), the size of alevins and emerging fry were significantly reduced (Figure 16).

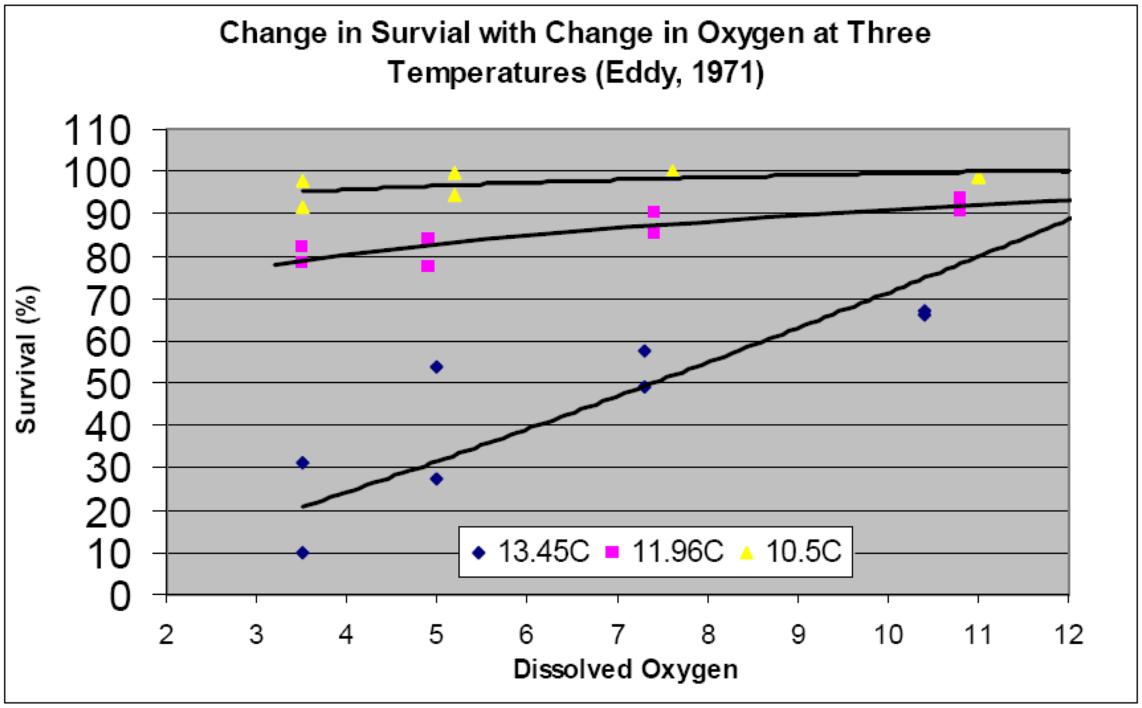


Figure 15. Incubation survival of chinook salmon eggs is shown here in relationship to dissolved oxygen and three water temperatures. This figure is taken from WDOE (2002) and is based on data from Eddy (1971).

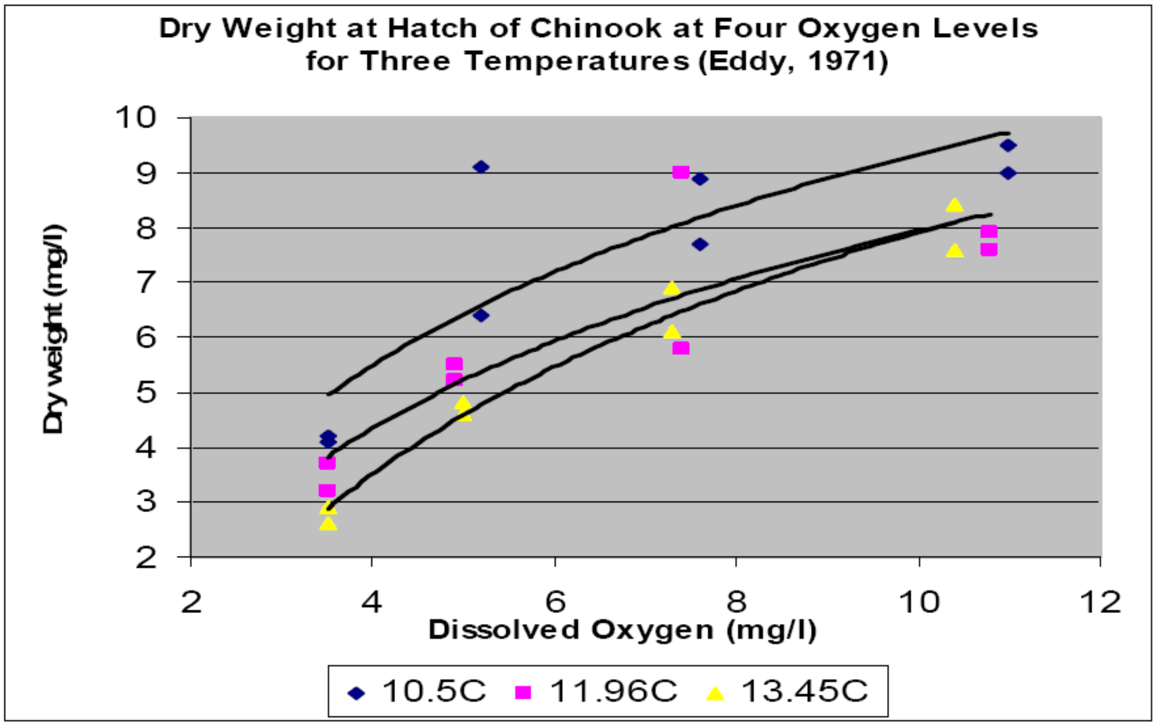


Figure 16. Dry weight of chinook salmon fry where eggs and alevin were exposed to varying levels of temperature and dissolved oxygen. This figure is taken from WDOE (2002) and is based on data from Eddy (1971).

Laboratory experiments measuring D.O. in gravels and relating it to egg survival to emergence "suggest that average intragravel oxygen concentrations of 6-6.5 mg/L and lower can cause significant stress and mortality in developing embryos and alevin" (WDOE 2002). WDOE (2002) concluded that field experiments indicate that egg survival drops significantly at a D.O. of less than 8 mg/L. WDOE (2002) cautioned that laboratory experiments might not give indications of survival of fry in the wild because any size reduction might decrease ability to emerge from redds. The difference between D.O. in the water column and in redds may also be affected by fine sediment that blocks percolation through gravels (Barnard and McBain 1994).

Alevins of chinook salmon moved toward D.O. levels of 10 mg/L from 8.0 mg/L in laboratory experiments and WDOE (2002) used this as an indication that redd D.O. levels should not be allowed to go below 8.0 mg/L.

With regard to D.O. needs of juvenile salmonids, WDOE (2002) found that:

> "Median lethality (50% mortality) of juvenile salmonids would be likely to occur with constant exposure to mean concentrations below 3-3.3 mg/L for periods of 20-30 days. Adding a 1.3 mg/L adjustment to this estimated lethal range would be expected to convert the effects from 50% mortality to no-mortality based in part on the results of Herrmann et al. (1962). Thus, a mean concentration of 4.6 mg/L would seem most likely needed to prevent lethality over a 3-4 week period of time."

Juvenile salmonids show avoidance of areas or reaches with dissolved oxygen of 5.0 mg/L and juvenile chinook showed avoidance of D.O. levels of 6.0 mg/L (WDOE 2002). WDOE

(2002) noted that all laboratory experiments show increased growth in environments with stable D.O. levels and slower growth with higher D.O. variability.

Swimming speeds of Pacific salmon juveniles were reduced at D.O. levels of 6.5-7.0 mg/L (Reiser and Bjornn 1979). WDOE (2002) noted that decreased swimming ability could lead to higher susceptibility to predation in the wild. Although laboratory experiments have focused on juvenile salmonids, it is likely that reduced D.O. effects have similar, if not greater impact, on adult fish because of the metabolic needs associated with larger body size.

Downing and Merkens (1955 as cited in WDOE 2002) found that resistance of rainbow trout to dissolved ammonia was greatly hampered by depressed D.O. levels. This relationship is important because increased levels of photosynthesis can create water chemistry shifts that cause simultaneous increases in dissolved ammonia and depressed D.O., though fortunately low D.O. tends to occurs at night and high pH tends to occur during the day.

Photosynthesis can cause supersaturation of D.O. diurnally as well as decreased D.O. due to plant respiration at night. Although most concern about gas supersaturation and salmonids is related to water spilling over dams, some studies have shown that conditions associated with algae blooms can also raise D.O. saturation to levels of concern (Boyd et al. 1994). Mesa and Warren (1997) found that 112% total dissolved gasses led to gas bubble trauma in rainbow trout and total dissolved gasses 130% lead to acute responses.

Larger fish are more susceptible to problems associated with supersaturated dissolved oxygen, but can escape effects by sounding to depth to adjust gas pressures, if deep pools are available (Jensen et al., 1986). The ratio of oxygen to nitrogen is an important factor in the effects of supersaturated gas levels on salmonids and effects may be low if nitrogen is not also above 100% saturation (Jensen et al. 1986).

Patterns in Klamath River Data

Dissolved oxygen (D.O.) data for the Klamath River are less robust than for temperature and pH because of the challenges associated with collecting data that meet quality assurance criteria and encompass critical periods. Instantaneous hand held measurements may miss critical periods if samples are collected during the day and D.O. sags driven by plant respiration are occurring at night or during early morning hours (Gwynne 1993). D.O. data from continuous recorders can have problems resulting from fouling of probes that may cause incorrect readings of low or supersaturated conditions. Continuous data from 2004 are the most reliable because it is the only year in which data were post-processed to correct for bio-fouling of the probes (see notes in D.O. criteria development section for more details).

Data collected for the Klamath River at various locations from below Iron Gate Reservoir (RM 189.13) to the river mouth (RM 0) between the years 2000 and 2004 show a wide range of conditions. Locations proximate to the reach of the river crossing the Hoopa Indian Reservation indicate impairment for juvenile salmonid growth and rearing during August. Figure 17 shows the mean daily minimum D.O. for 2000-2004 by river mile and the reference line of 7.0 mg/L on the chart above reflects research showing reduced swimming ability of juvenile chinook salmon (WDOE 2002). Only one location near the mouth of the river at Terwer Creek (RM 5.73) meets the proposed NCRWQCB (2005) standards for D.O., which is a minimum of 8.0 mg/L. All locations near Iron Gate Reservoir show significantly depressed D.O. in 2001 and 2004. The 2004 D.O. daily average minimum for August 2004 shows depressed levels all the way down to the Scott River with average daily minimum D.O. dipping below 6.0 mg/L, well into the stressful ranges for salmonids (Reiser and Bjornn 1979).

While monthly mean minimum D.O. levels indicate chronic stress for juvenile salmonids, daily minimum data from some mainstem Klamath River locations show levels dipping more toward acutely low D.O. levels of 5 mg/L. Figure 18 shows daily minimum, average and maximum D.O. above the Scott River. Minimums continue under 6 mg/L into October, which raises concerns about D.O. levels needed for spawning. NCRWQCB proposed D.O. standards for spawning are 8.0 mg/L in redds and 11 mg/L in the water column, values clearly not met according to gauge results. The NCRWQCB (2005) indicates that "The natural potential dissolved oxygen concentration of a waterbody shall not be altered unless it can be demonstrated, to the satisfaction of the Regional Board, that such alteration does not adversely affect beneficial uses." As discussed above, decreasing D.O. may have side effects on salmonid ability to cope with increased ammonia levels. This is a concern with the co-occurrence of high dissolved ammonia and daily minimum D.O. levels dropping consistently below 6.0 mg/L and sometimes under 5.0 mg/L.

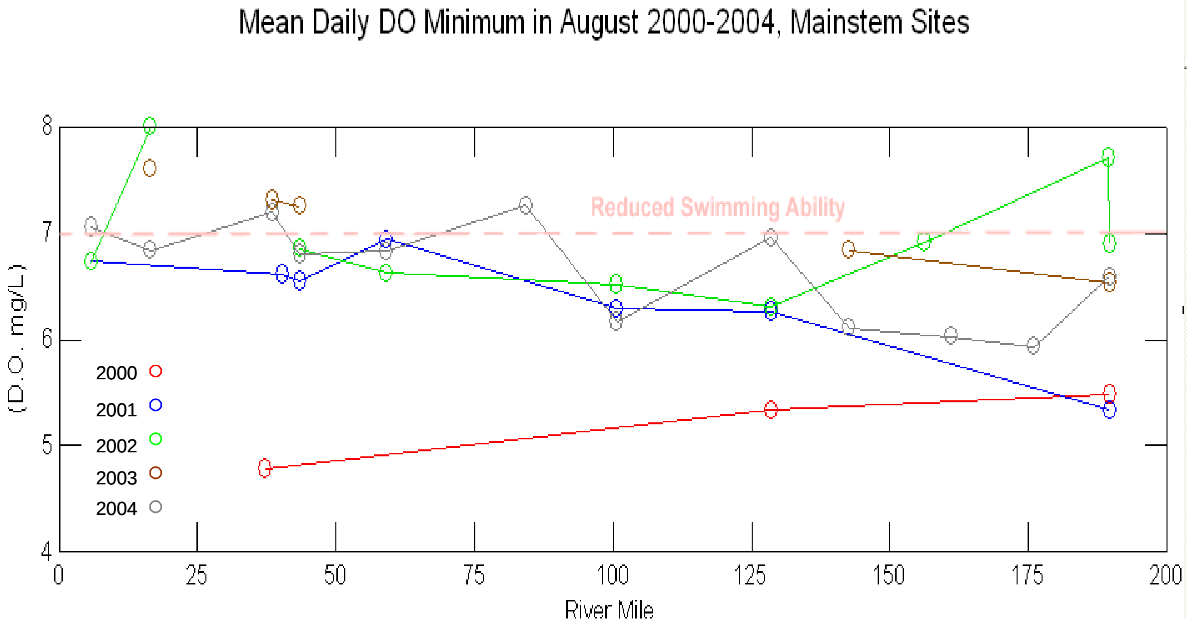


Figure 17. The mean daily minimum D.O. for August in various years from 2000-2004 are displayed here with river miles (RM) for location reference. River miles from the outlet of Iron Gate Reservoir at River Mile (RM) 189.73 to the mouth at RM 0. Data are from the USFWS, Karuk Tribe, Yurok Tribe and USGS.

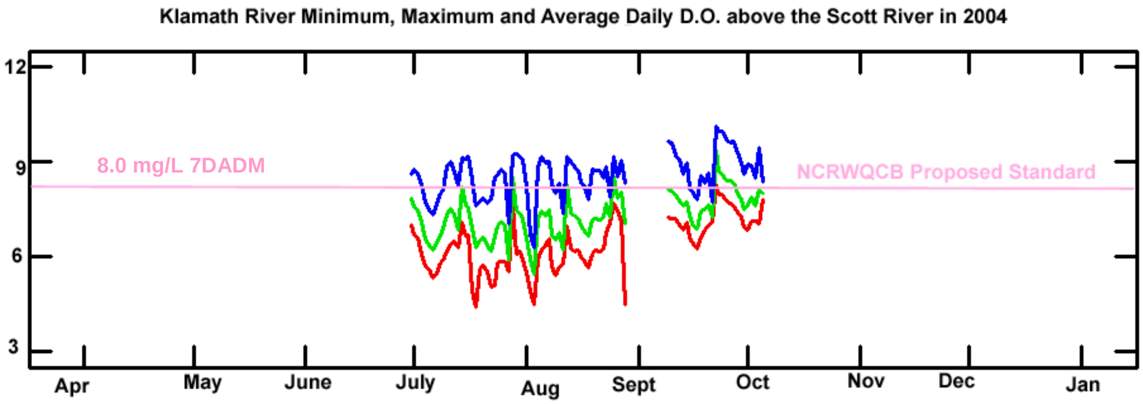


Figure 18. This chart shows minimum (red), average (green) and maximum (blue) D.O. values for the Klamath River above the Scott River (RM 142.61) with a threshold that reflects the NCRWQCB (2005) proposed standard for Klamath River D.O. Data are from the USFWS, Karuk Tribe, Yurok Tribe and USGS.

While data collected by the U.S. Fish and Wildlife Service Arcata Fisheries Office in August of 1997 was anomalous, it bears mention because it likely represents extreme conditions that sometimes occur. WDOE (2002) set acute lethal D.O. limits for warm water species at 3.5-4.0. USFWS crews measured Klamath River D.O. of 3.1 during nocturnal swings on August 9-10, 1997 (Figure 19) and mortality of Klamath smallscale suckers and speckled dace both confirm that conditions at that time had reached acute lethality. Other limnological conditions such as pH and dissolved ammonia were not measured, but may have been cumulatively adding to fish stress and mortality.

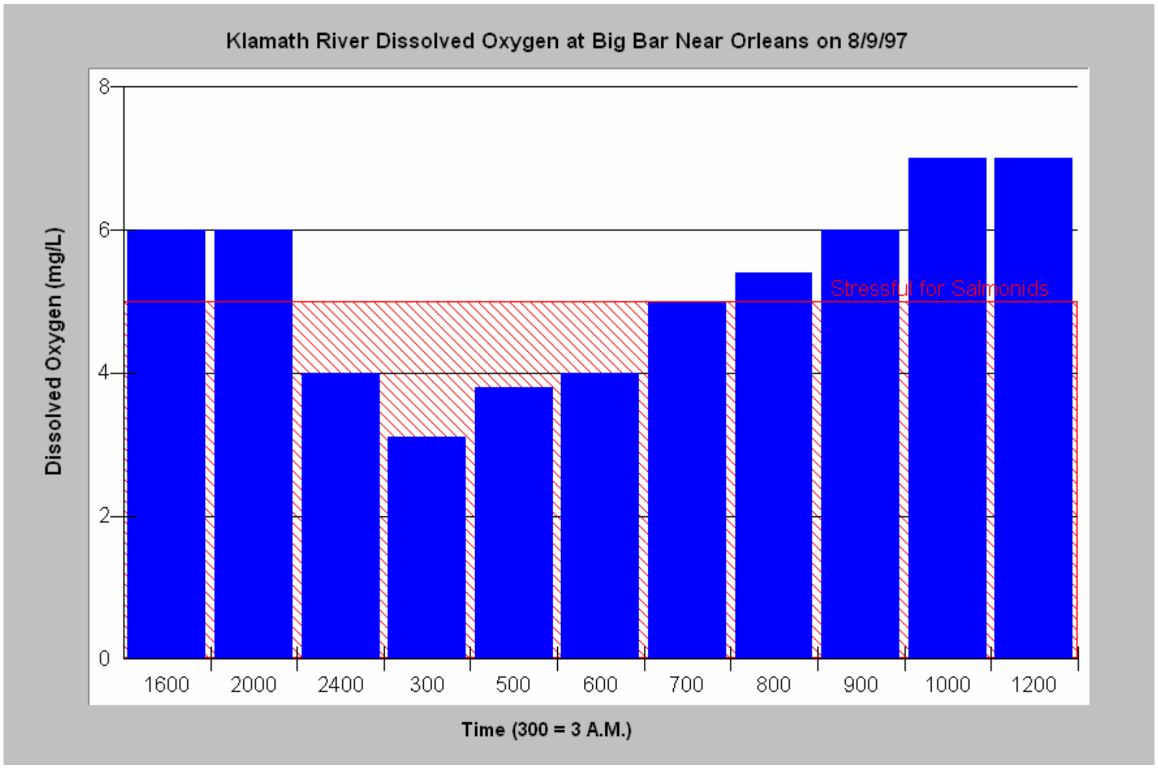


Figure 19. USFWS Arcata Fisheries Office measured D.O. levels at night and in early morning hours of August 9-10, 1997 and discovered minimum nocturnal levels of 3.1 mg/L, which are lethal for salmonids (WDOE 2002).

Periphyton

Literature Review
Discussed below at "Review of Existing Standards" (see, especially, Table 4).

Patterns in Klamath River Data
There have been two efforts to sample periphyton in the Klamath River, the U.S. EPA Environmental Monitoring Program (EMAP) program in 2000-2003, and a collaborative study in 2004. Sampling results are shown in Figures 20-22, and summarized below.

In 2000, 2001, and 2003, the U.S. EPA Environmental Monitoring Program (EMAP) collected limited samples at 7 sites in the Klamath River basin, including two on tributaries above Upper Klamath Lake. The number of samples was limited, ranging from one to three per site. The month in which sites were sampled varied, and no site was sampled more than once each year, hence it is not possible to determine maximum annual chlorophyll a levels (an important metric). Periphyton data included chlorophyll *a* biomass, ash-free dry weight (AFDW), and algal species composition. The periphyton sampling was part of a larger nationwide effort that includes macroinvertebrates, fish tissue toxin analysis, and chemical and physical water quality. The sampling methodologies are described in detail in U.S. EPA (2002b).

In 2004 there was a collaborative study between the North Coast Regional Water Quality Control Board, the Yurok Tribe, and PacifiCorp. They collected periphyton samples in the Klamath River at sites between Iron Gate Dam and Weitchpec, including tributary streams. Samples were collected once a month from June through September. The number of stations sampled varied from 9 to 15. Although this dataset spans only one algal growing season, and hence is relatively limited in that respect, it is the best data currently in existence. All parties used similar sampling methodologies (Eilers 2005, NCRWQCB et al. 2005) and the same laboratory. Parameters analyzed included chlorophyll *a*, AFDW, and phaeophytin, but varied between sampling events. For instance, the Yurok Tribe did not obtain chlorophyll *a* or phaeophytin and only some of the NCRWQCB samples had phaeophytin.

Periphyton biomass (as measured by chlorophyll *a* in mg/m^2) was much lower in 2000 and 2003 than 2004, although with only one sample at each of three sites for 2000 and 2003, sampling may not have occurred during the period of peak biomass. This indicates that inter-annual variability is likely substantial. The early July, early August, and early September 2004 samples show interesting spatial and temporal patterns. For example, in early July 2004 all sites sampled had chlorophyll *a* values of 82 mg/m^2 or less, except for the Klamath River above the Scott River (river mile 142.61), which was 353 mg/m^2. For the August samples, periphyton biomass increased at most sites, exceeding 150 mg/m^2 at 5 of 9 sites sampled with the highest biomass of 706 mg/m^2 at river mile 183.28 (Klamath River above Cottonwood Creek). In late August, the flow released from Iron Gate Dam increased from 615 cfs to a peak of 1320 cfs, before declining to 913 cfs. The flow increase likely caused significant scour of periphyton because biomass decreased from 706 mg/m^2 at river mile 183.28 in August to 9 mg/m^2 at river mile 179.23 on September 1, and biomass also declined substantially at river mile 142.61. Biomass held stable at river mile 98.5, and increased in the lower river at river miles 70.30 and 43.50. Biomass may not have declined in the lower river because the Klamath River's channel generally widens as it flows downstream, and so the flow likely had less scouring affect and algae continued to grow. It is also possible that the scouring of periphyton in the reaches between rivers miles 189 and 98.5 may have led to an increase in available nutrients downstream if periphyton cells stayed in the river long enough to decay rather than being flushed out to sea. It is difficult to generalize from one year of data, and it is unknown if similar patterns occur in other years.

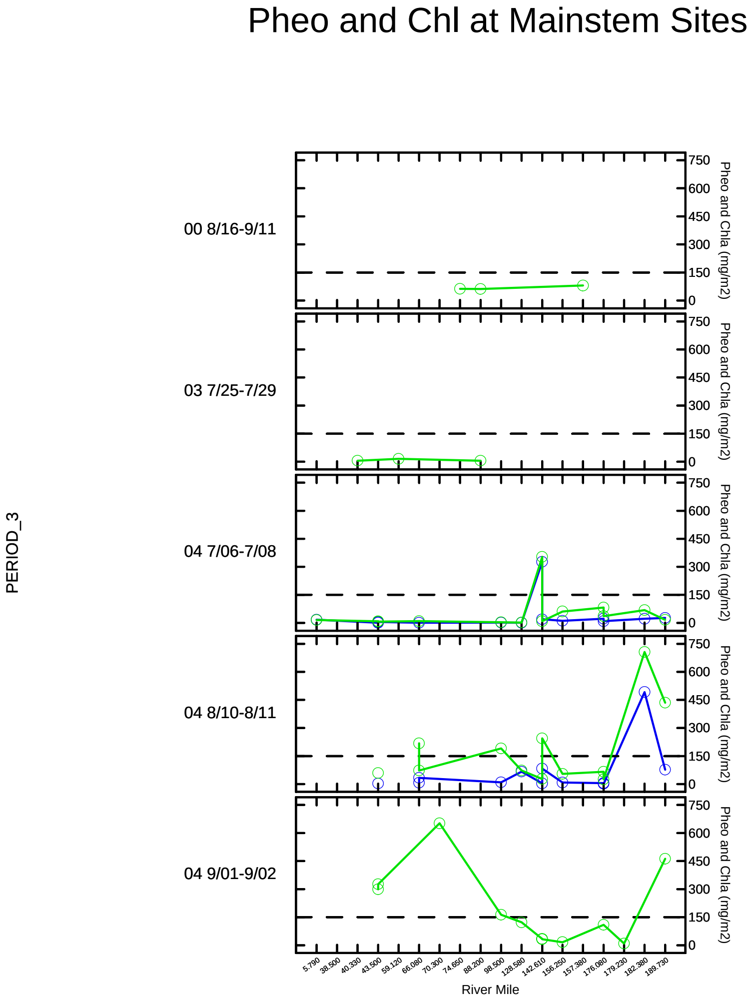


Figure 20. Periphyton data for the mainstem of the Klamath River, grouped by sampling period and sorted by river mile. The y-axis units are mg/m^2, with chlorophyll in green and phaeophytin in blue. Sampling periods begin with year, followed by month-day range (i.e. 00 8/16-9/11 is 8/16/2000-9/11/2000). A 150 mg/m^2 reference value is shown as a horizontal line on the charts.

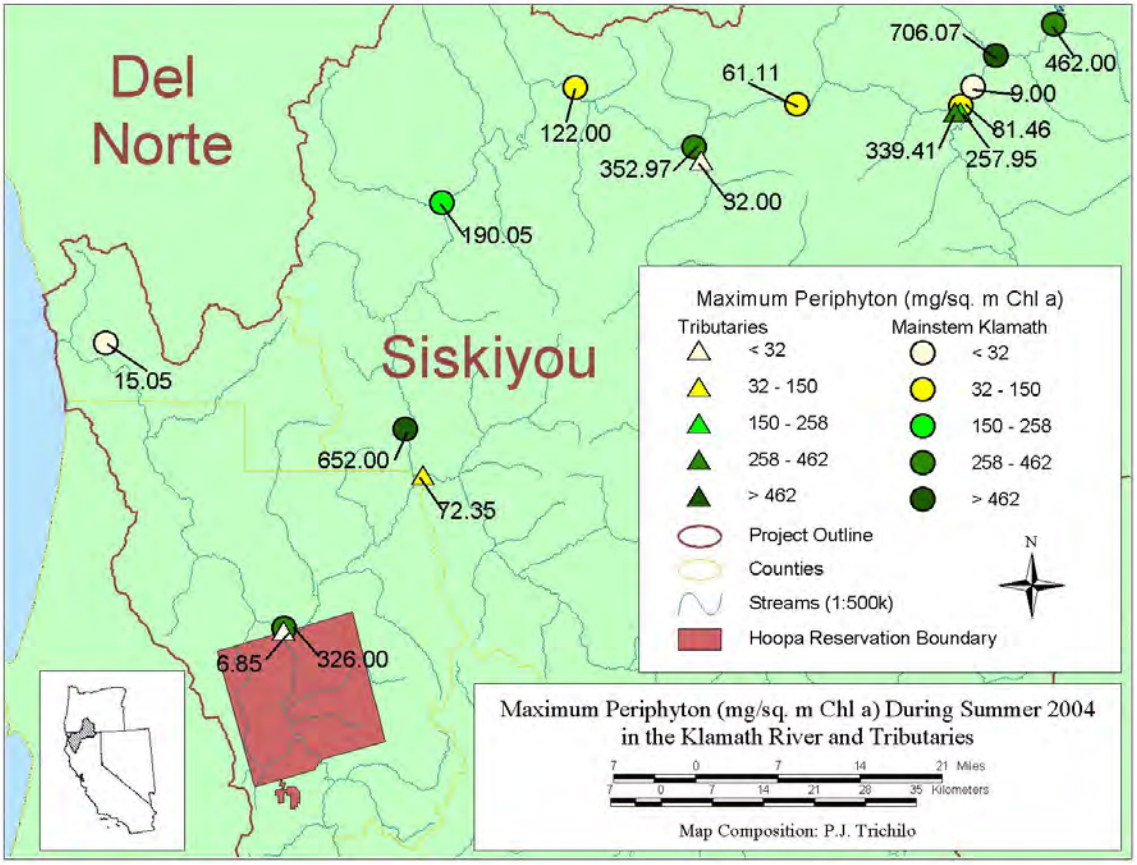


Figure 21. Map showing the maximum periphyton biomass observed in summer 2004. Data are from NCRWQCB and PacifiCorp.

The most common species identified in 2004 samples were *Cymbella affinis* (CMAF), *Cocconeis placentula* (COPC), *Diatoma vulgare* (DTVL), *Epithemia sorex* (EPSX), *Navicula cryptocephala veneta* (NVCV), and *Nitzschia frustulum* (NZFR). Figure 22 illustrates spatial and temporal patterns in the species composition. NCRWQCB et al. (2005) briefly summarized the habits of these species using information from Wehr and Shealth et al. (1996), Patrick and Reimer (1966), Patrick and Reimer (1975), Fore and Grafe (2002), Carpenter (2003), and Anderson and Carpenter (1998). All six of these species are classified by the US Geological Survey as eutrophic and alkalophilic (NCRWQCB et al. 2005).

Interestingly, *Epithemia sorex* (EPSX), the species that was most common at the mouth of the Trinity, the mouth of the Salmon River, and in the lower Klamath River between river mile 100 and the estuary, is capable of fixing nitrogen. These reaches all have low nitrogen concentrations relative to the rest of the Klamath River, which may provide a competitive advantage to *Epithemia sorex*. Because it can fix its own nitrogen, relationships between water column nitrogen concentration and periphyton biomass at sites dominated by *Epithemia sorex* may not be the same as in other places in the Klamath River. It is unknown if *Epithemia sorex* is fixing nitrogen in the Klamath River, and if so, how much.

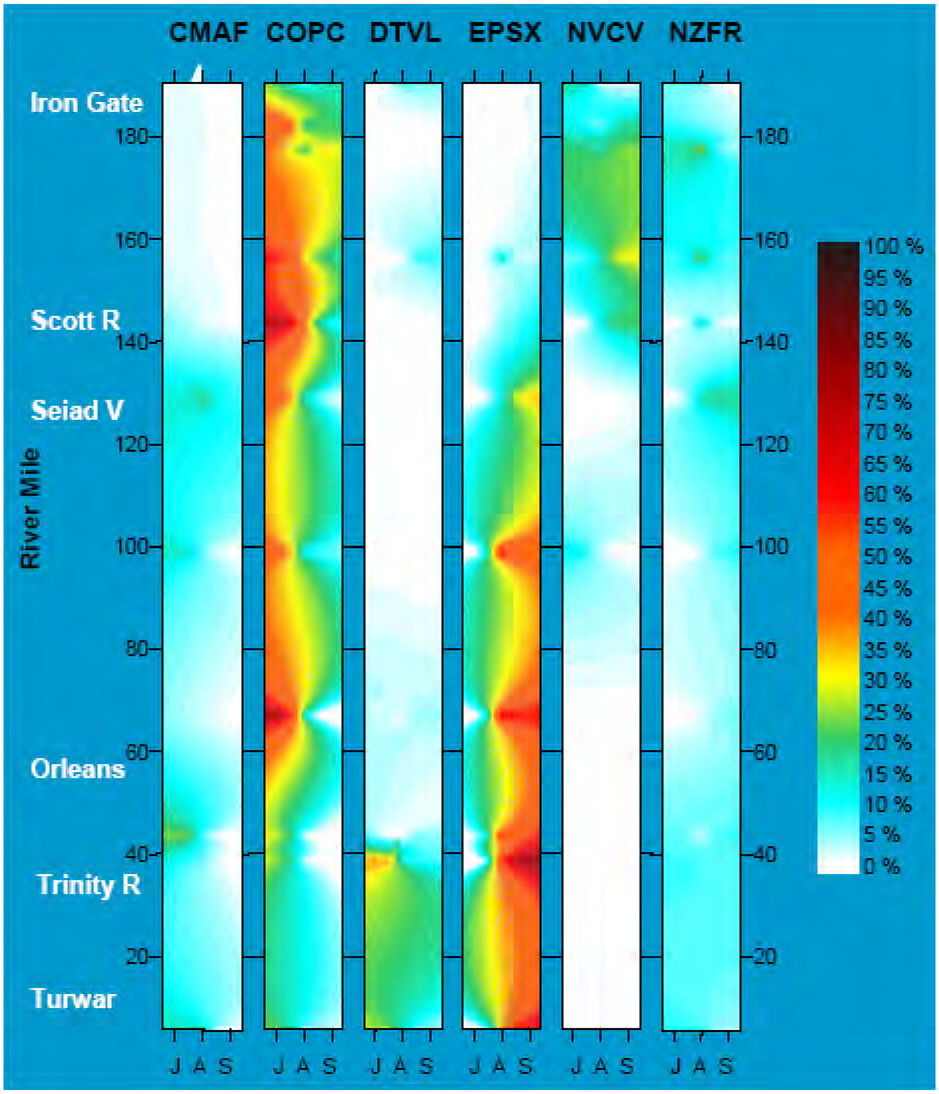


Figure 22. Species composition from Klamath River periphyton sampling in July (J), August (A) and September (S) 2004. Keys to four-letter species codes are provided in text above. Figure is adapted from NCRWQCB et al. (2005) and does not include samples collected by the Yurok Tribe in June between Weitchpec and Turwar.

Nutrients

Literature Review

Nutrients do not directly affect salmonids, but impact them indirectly by stimulating the growth of algae and aquatic macrophytes to nuisance levels that can adversely impact dissolved oxygen and pH levels in streams. The concentration of nutrients required to cause nuisance levels of periphyton varies widely from one stream to another. Detailed data analysis is required to determine relationships. U.S. EPA (2000b) and Tetra Tech (2004) provide excellent summaries of the literature that will not be repeated here.

Patterns in Klamath River data

The quality of water coming out of Upper Klamath Lake in the summer is extremely poor and often full of algae. Nutrient concentrations generally decline as the Klamath River flows downstream. There are three reasons for this:

A. Dilution by springs and clean tributaries
B. Periphyton growing on the bed of the river removes nutrients from the water column
C. Micro-organisms in the hyporheic zone below the river denitrify nitrate into inert atmospheric nitrogen

A. Dilution

Even if the river did not have the capacity to assimilate nutrients, nutrient concentration would still decline as the river flows downstream from Keno to Iron Gate due solely to dilution of low-quality Klamath River water with high-quality water from tributary and spring flow inputs. These inputs include springs in the J.C. Boyle bypass reach (225 cfs) and tributaries between Link River dam and Iron Gate dam. The tributaries are Spencer Creek (approximately 20 to 200 cfs), Shovel Creek (10 to 100 cfs), Fall Creek (30 to 100 cfs) and Jenny Creek (30 to 500 cfs). Spencer, Shovel, and Jenny creeks all have irrigation diversions, so the actual quantity of water entering the Project may be less than stated here (PacifiCorp, 2004). The sum of these inputs ranges from 315 to 1125 cfs.

As demonstrated in a comparison of flow at USGS gages from Iron Gate Dam down to Turwar near the mouth of the river (Figure 23), the river picks up many substantial tributaries on its path to the ocean. With the exception of the Shasta, and perhaps the Scott, nearly all these tributaries are cleaner and cooler than the mainstem Klamath, greatly increasing the likelihood of improved water quality.

B. Assimilative Capacity of Periphyton

Benthic algae, also know as periphyton or attached algae, can take nutrients dissolved in water and assimilate them into their cells as they grow. This can enhance water quality by removing nutrients from the water, but it can also release nutrients when the algae decompose, causing diurnal D.O. and pH swings by photosynthesis/respiration cycles.

C. Denitrification in River Reaches

Denitrification is a process in which certain organisms can convert nitrate (NO_3) to atmospheric nitrogen (N_2). The result is enhanced water quality, due to the reduction in productivity that occurs because a form of nitrogen readily available to organisms (nitrate) is converted into a stable form of nitrogen that is essentially unusable by most organisms (atmospheric nitrogen). For denitrification to occur, adequate nitrate levels and low levels of dissolved oxygen must be present.

Denitrification is known to occur in the hyporheic zones of rivers and streams (Sjodin et al., 1997 and Holmes, 1996). The hyporheic zone is the area of water-saturated sediment beneath and beside streams where ground water and surface water mix (Edwards, 1998). Denitrification most often occurs with the following conditions: low hydraulic conductivity, long flow path, reduced oxygen supply, adequate nitrate supply, and adequate supply of labile organic carbon (Edwards, 1998). The amount of nitrogen removed from some rivers due to denitrification can be extraordinary, especially those with a high rate of interchange between surface water and gravel alluvium. In Colorado's South Platte River, denitrification rates varied between 2 and 100 mg of nitrogen per square meter per hour. During mid-summer, a 90% reduction of nitrate was achieved in a 6 km long reach. On an annual basis, close to half the nitrate input to a 100-km reach was removed by denitrification (Sjodin et al., 1997).

It is unknown how much denitrification is currently occurring in the Klamath River, or how that amount compares with the amount of nitrogen assimilated by periphyton.

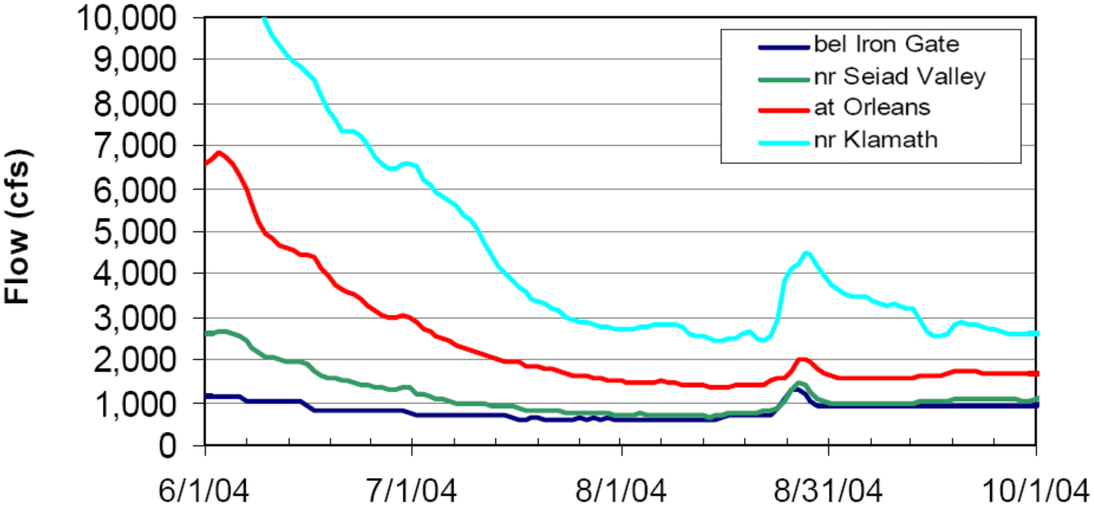


Figure 23. A comparison of discharge at USGS gages from Iron Gate Dam down to Turwar in summer and early fall of 2004. Adapted from NCRWQCB et al. (2005).

Figure 24 shows a typical example of the longitudinal gradient in nitrogen concentrations in the peak of the summer months. Only inorganic forms of nitrogen (nitrate and ammonia) are immediately available to fuel growth of periphyton and aquatic plants, organic nitrogen must first decay into ammonia before it can be utilized. Organic nitrogen is the most common form of nitrogen across the Klamath River. High levels of inorganic nitrogen are present throughout the upper reaches of the Klamath River. Beginning at the outlet of Iron Gate Dam (river mile 189.73), dense mats of periphyton and aquatic plants cover the river bed during summer. They are extremely efficient at removing nutrients, and within approximately 40 miles, above the Scott River at river mile 146.12, most inorganic nitrogen has been removed from the water column.

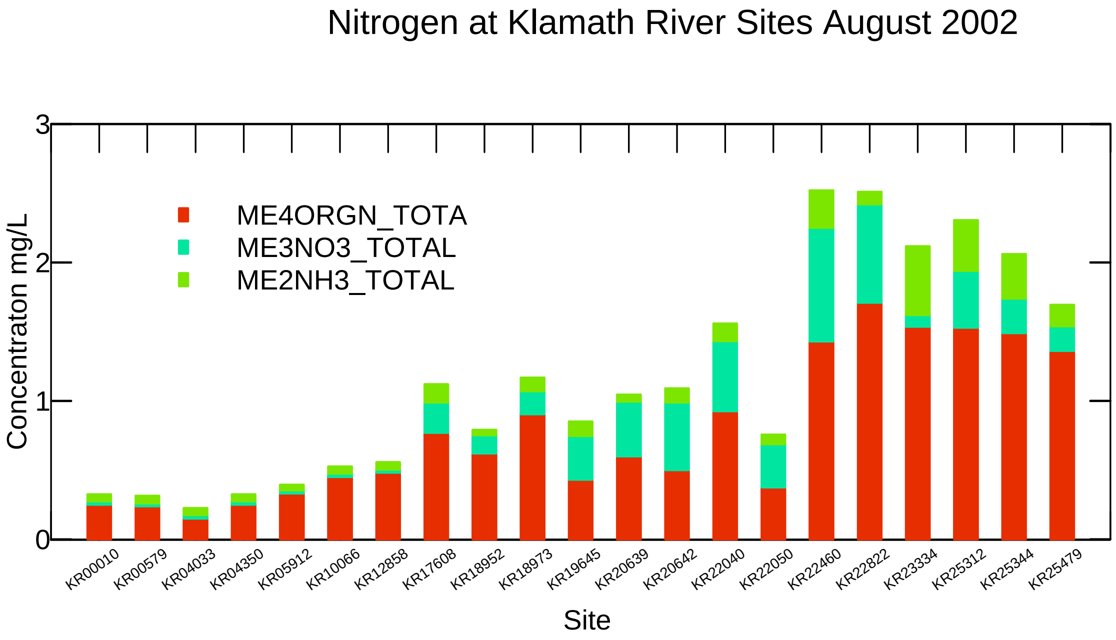


Figure 24. This graph shows the longitudinal gradient in average nitrogen concentrations in the Klamath River from Link River to the estuary in August 2002. The total height of the bars is total nitrogen concentration, and the colors represent the three major forms of nitrogen: organic (ME4ORGN_TOTA), nitrate (MENO3_TOTAL), and ammonia (MENH3_TOTAL).

There is substantial variation in nutrient concentration between years (Figures 25 and 26). The year with the highest nutrient concentrations at most sites was 2001. Both TN and TP generally decrease as the river flows downstream, though the pattern varies among years.

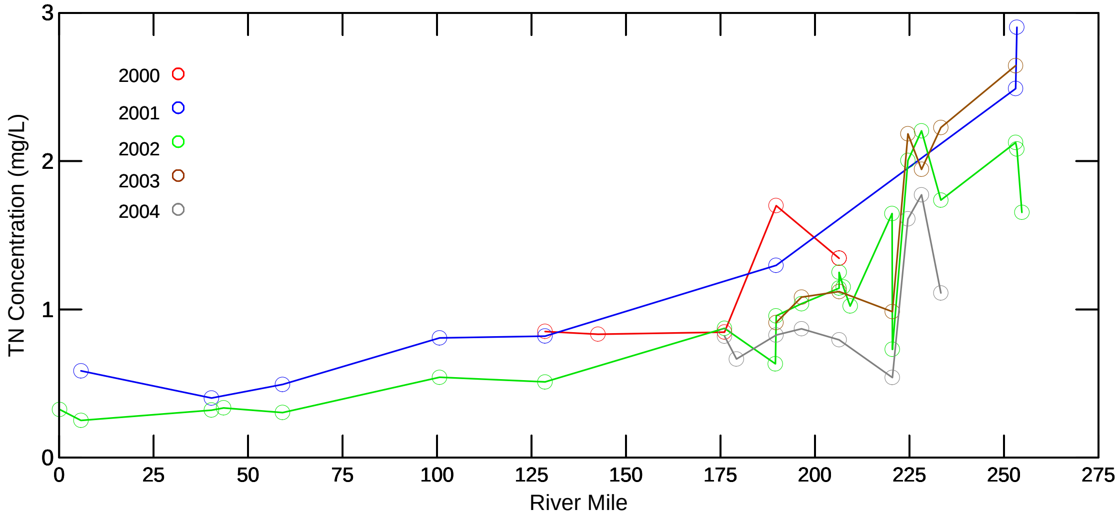


Figure 25. Longitudinal profile of mean summer total nitrogen concentrations in Klamath River mainstem sites for the year 2000-2004 (reservoirs excluded). Sites with less than three measurements in a summer were excluded from this graph.

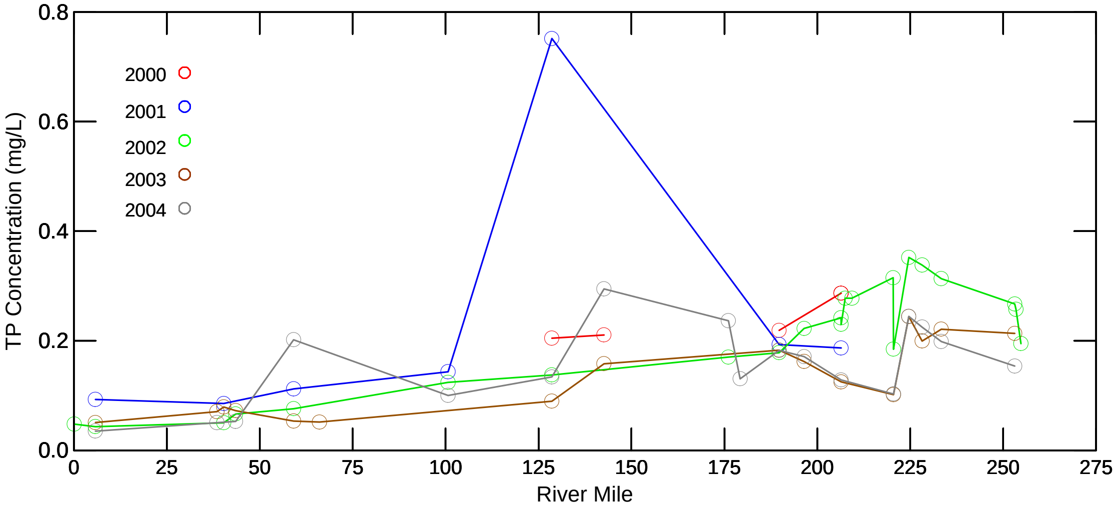


Figure 26. Longitudinal profile of mean summer total phosphorus concentrations in Klamath River mainstem sites for the year 2000-2004 (reservoirs excluded). Sites with less than three measurements in a summer were excluded from this graph.

Microcystins and *Microcystis*

Literature Review:

Cyanobacteria, also known as blue-green algae, are a diverse group of single-celled aquatic organisms found in surface waters worldwide. Lakes, reservoirs, ponds, and slow-moving rivers are especially well suited to cyanobacteria, and given the right conditions – calm water, light, and abundant nutrients – these organisms can reproduce at a high rate, forming vast blooms in the water. The resulting high cyanobacterial algal concentrations are not only aesthetically unpleasing, but often produce toxins that have been implicated in human health problems ranging from skin irritation and gastrointestinal upset, to death from liver or respiratory failure (Chorus and Bartram 1999, Chorus 2001). *Microcystis aeruginosa* produces the potent hepatotoxin microcystin and has been demonstrated to occur in the Klamath River system (Kann 2005, 2006a, 2006b).

These hepatotoxins (liver toxins) are powerful cyclical peptides which disrupt the structure of liver cells, causing cell destruction, liver hemorrhage, liver necrosis, and death (Carmichael 1994). In addition to hepatotoxicity, long-term laboratory animal studies indicate that microcystins act as liver tumor promoters and teratogens (Falconer et al. 1988). Microcystin poisoning has been implicated in the largest number of cyanobacteria-associated animal deaths worldwide, and enough work has been done, both with rodents and pigs, on microcystin effects at various levels of exposure, that the World Health Organization (WHO) has issued a provisional guideline of 1 µg/L for microcystin concentration in drinking water. With actual microcystin concentration data frequently unavailable, alert level guidelines based on cell counts have been established for *Microcystis* (as well as other cyanobacteria) blooms in drinking and recreational waters (Yoo et al. 1995, Chorus and Bartram 1999).

Although human health effects of toxins from the blue-green algae *Microcystis aeruginosa* are better studied (WHO, 1998), fish health effects have also been recently researched (Zambrano and Canelo 1995, Wiegland and Pflugmacher 2005), including effects on salmonids (Tencalla et al. 1994, Bury et al. 1996; Fischer et al. 2000, Best et al. 2003). We do not propose to set limits for protection of salmonids from microcystin toxins because there are currently insufficient data to understand the threat in the Klamath River. Nonetheless, these effects are discussed here because there is evidence that hepatotoxins created by *Microcystis* are a threat to fish health independently, and may also act synergistically with other water quality problems (i.e. pH) in causing cumulative stress or in contributing to immunosuppression and subsequent outbreaks of fish disease epidemics.

Microcystin toxins accumulate in the liver where they disrupt many different liver enzymes and ultimately cause the liver to break down (Fischer et al., 2000). Algae grazing fish species may be the most susceptible to microcystin poisoning, but other fish may ingest whole *Microcystis* cells or breakdown products from the water column (Wiegland and Pflugmacher 2005). In laboratory experiments, rainbow trout were found to excrete microcystin toxins in bile fluids when exposed to them orally. The toxins caused increased drinking in this species and increased water in the gut, which was a sign of osmoregulatory imbalance and could promote diffusion of toxins into the blood (Best et al., 2003).

Tencalla et al. (1994) noted that large scale fish kills around the world have resulted from microcystin poisoning. They postulated that a 60 g rainbow trout would only have to ingest 0.1-0.4 g of algae (wet weight) or 0.2-0.6% of its body weight to experience massive liver damage. Bury et al. (1996) studied brown trout exposed to sublethal levels of microcystin toxins and found greatly altered blood cortisol levels indicating acute stress and reduced immunosuppression. This is a concern in the mainstem Klamath River because of the recognized fish health problems (Foott and Stone, 2003; Nichols and Foott, 2005), and the potential for additional diminishment of resistance to disease caused by microcystin exposure of juvenile salmonids.

Patterns in Klamath River Data

Microcystis aeruginosa cell density and microcystin toxin concentration were monitored in the Klamath River system in 2005 and 2006 by the Karuk Tribe in the hydropower reservoir area (Fig. 27a)(Kann and Corum 2006, Kann 2006b), and by the Yurok Tribe and USFWS between the reservoirs and the mouth (Fig. 27b)(Kann 2006a, Fetcho 2006). Concentrations were compared to moderate probability of adverse health effect levels (MPAHEL thresholds) for recreational waters as published in documents for the World Health Organization (WHO) and U.S. EPA (Falconer el al. 1999, Chorus and Cavalieri 2000). The MPAEL is 100,000 cells/ml or 20 µg/L microcystin in the top 4 meters of surface waters and the Tolerable Daily Intake (TDI: 0.04 µg kg bw^{-1} WHO 1998) for a 40 lb (18kg) child accidentally ingesting 100 ml of reservoir water on that date.

Copco and Iron Gate Reservoir data clearly show the occurrence of large and widespread blooms of *Microcystis aeruginosa* (MSAE) and microcystin toxin levels in 2005 (Fig 28). During the August-September period cell density and toxin levels exceeded the MPHAEL often by 10-100's of times; likewise, the TDI was commonly exceeded by more than 10-100 times throughout the August-September period (Fig. 28).

During the same sample dates when in-reservoir data (the boxes in Fig 28) showed substantial MSAE cell density and toxin concentration, the station KRAC had non-detects for both parameters (red circles in Fig 28). Thus, for the sampled dates both cell density and toxin data indicate that neither toxin nor MSAE cells were detectable in the Klamath River directly above the reservoirs in 2005. These same in-reservoir and downstream transport patterns were also observed in 2006 (Kann 2006b).

These data are consistent with literature showing that MSAE and other buoyant cyanobacteria do not dominate in conditions of turbulent mixing such as that known to occur in the Klamath River above Copco and Iron Gate Reservoirs. For example, Huisman et al. (2004) demonstrate that potentially toxic MSAE dominate at low turbulent diffusivity (calm-stable conditions) when their flotation velocity exceeds the rate of turbulent mixing. Such conditions are more likely to occur in lakes and reservoirs as velocity and turbulence are reduced.

The non-detects at KRAC (above Copco reservoir) even when reservoir stations showed substantial concentrations of both toxin and MSAE cell density, clearly indicate the role of the reservoirs in providing ideal habitat conditions for MSAE. Moreover, as indicated by cell count and toxin data at KRBI (below Iron Gate Dam), the potential exists for export of both cells and toxin to downstream environments (Fig 28). In areas where turbulent diffusivity may decrease as the river widens or such as would occur in backwater areas, the potential exists for high concentrations to occur downstream. In fact, MSAE cell concentration exceeded 1.3 million cells/ml in a backwater area near the confluence of Coon Creek nearly 100 miles downstream from Iron Gate Dam (Kann 2006a), and microcystin levels were as high as 47 µg/L (written communication Yurok Tribe).

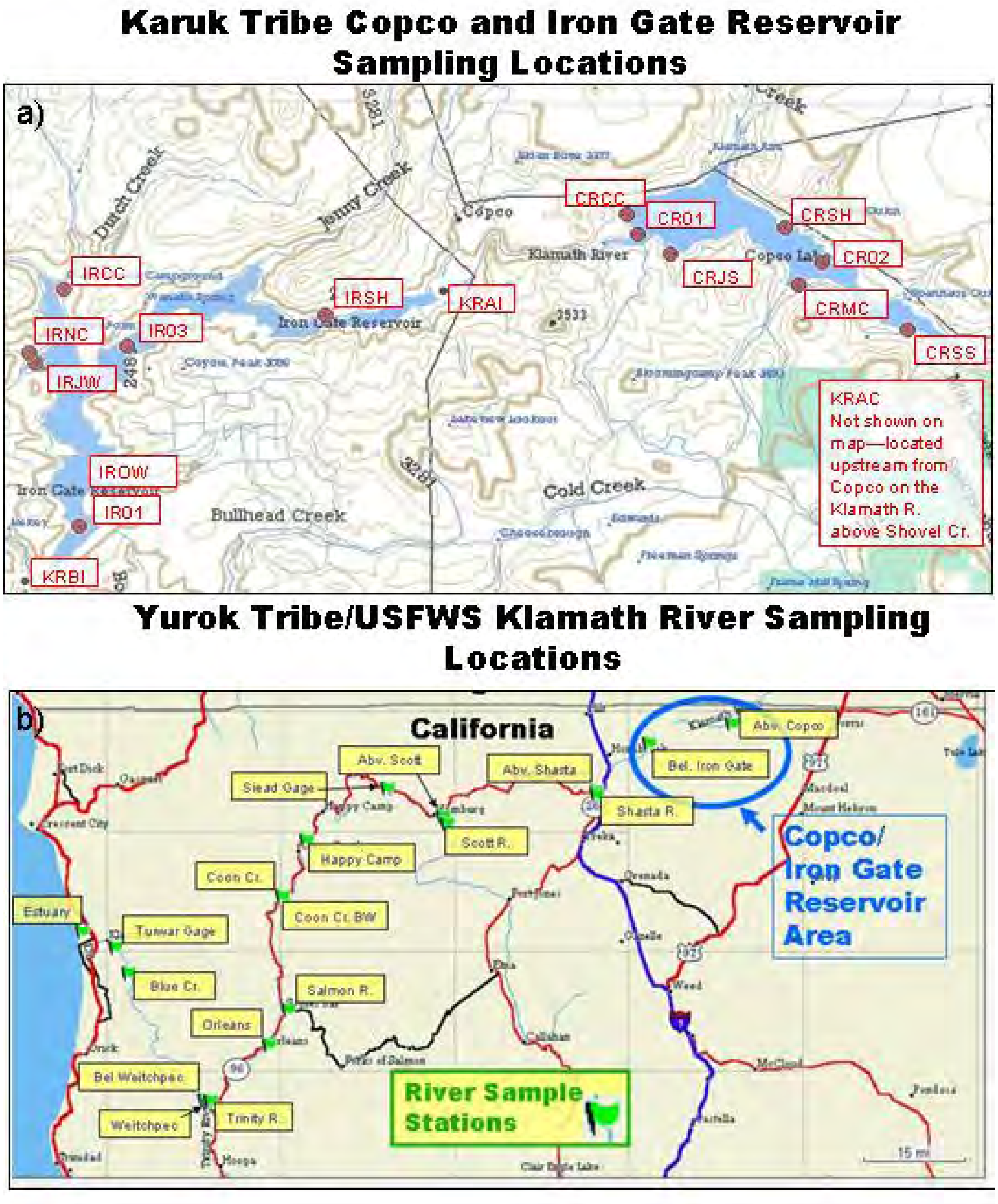


Figure 27. Location of Karuk Copco and Iron Gate Reservoir toxic cyanobacteria sampling stations (a) and Yurok/FWS Klamath River sampling stations (b), 2005.

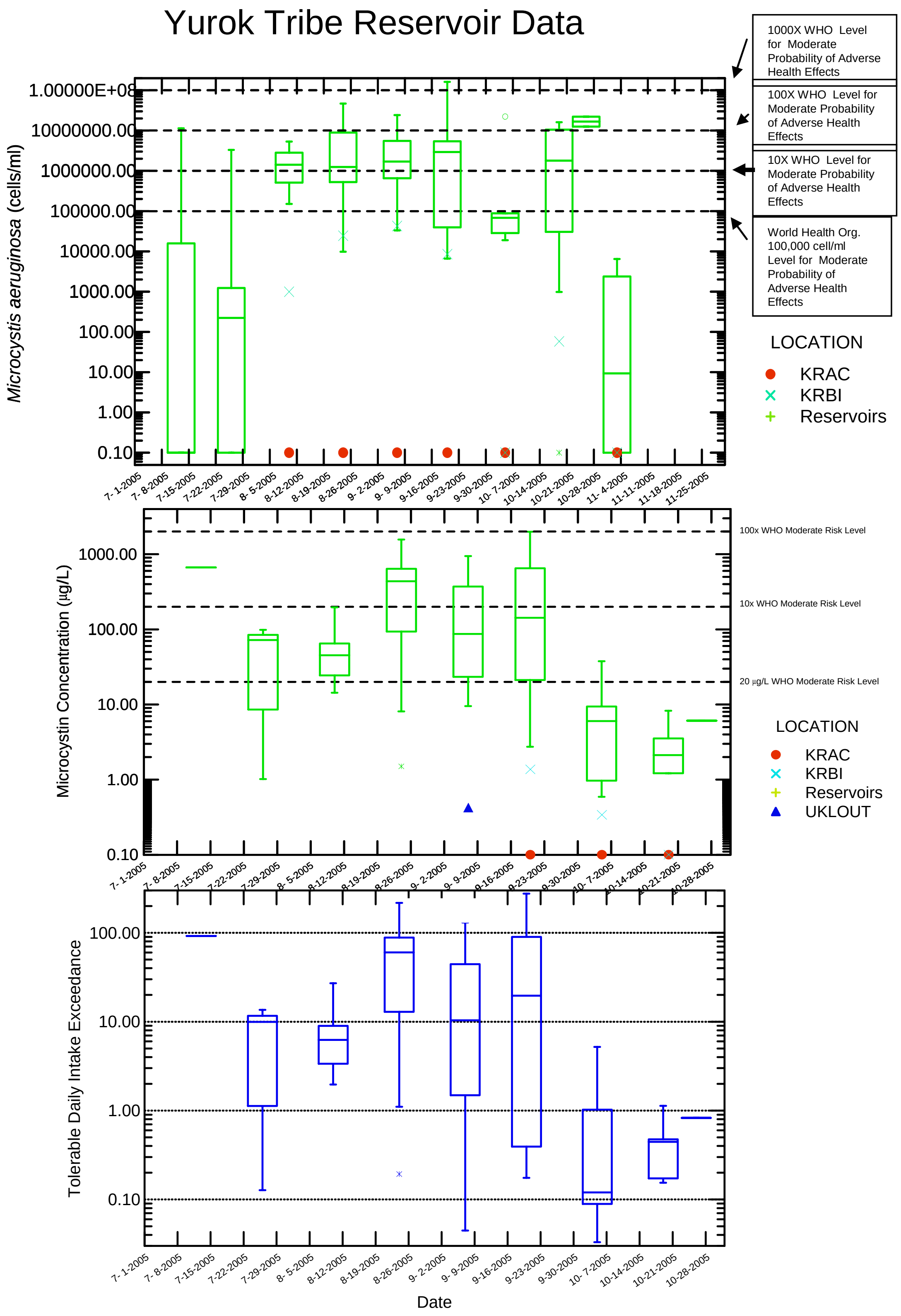


Figure 28. Yurok Tribe *Microcystis aeruginosa* cell density (a), microcystin concentration (b), and TDI (c) in Copco and Iron Gate Reservoirs, July-October, 2005. Note y-axis is log scaled and for graphing purposes all values have 0.1 added to them; Reservoirs=Copco and Iron Gate, KRAC=Klamath R. above Copco Reservoir, KRBI=Klamath R. below Iron Gate Reservoir.

STANDARD SETTING

This section reviews existing nutrient-related water quality standards, recommends standards for the Hoopa Valley Tribe's reach of the Klamath River, and provides justification for each standard

pH

Review of Existing Standards: Table 3 shows various standards for pH set by States (WDOE 2002, ODEQ 2002) Tribes (Hoopa TEPA, 2001) and California Regional Water Quality Control Boards (Tetra Tech, 2004) with regard to COLD and SPAWN beneficial uses. Hoopa TEPA (2001) set a minimum pH of 6.0 and a maximum of 9.0, but the NCRWQCB *Basin Plan* (2001) standard for the Klamath River is that the pH shall not be depressed below 7.0 nor raised above 8.5, and "Changes in normal ambient pH levels shall not exceed ……0.5 units within the range specified above in fresh waters with designated COLD or WARM beneficial uses."

Recommended Standard: The pH in the Klamath River shall be maintained within 7.0 and 8.5 at all times.

Justification for Recommended Standard: This standard is based on the literature reviewed above and is the same as the standard in the NCRWQCB *Basin Plan* (2001).

Dissolved Oxygen

Review of Existing Standards: In setting D.O. standards for the Klamath River, it is useful to compare standards from other agencies, Tribes and authorities (Table 3). The periodicity and duration of D.O. conditions that create stressful or lethal conditions for salmonids must be reflected in standards that must cover both long-term thresholds to prevent chronic stress as well as acute daily minimum levels to prevent acute stress or mortality (WDOE 2002). For example, the U.S. EPA (1986b) suggests that:

> "For embryonic, larval, and early life stages, the averaging period should not exceed 7 days. This short time is needed to adequately protect these often short duration, most sensitive life stages. Other life stages can probably be adequately protected by 30-day averages. Regardless of the averaging period, the average should be considered a moving average rather than a calendar-week or calendar-month average."

Table 3. Agency, Tribe or authority and various standards set for dissolved oxygen and pH. Standards for California Regional Water Quality Control Boards shown here were taken from the *Development of Nutrient Criteria in California: 2003-2004* (Tetra Tech 2004). The North Coast Regional Water Quality Control Board Basin Plan (2001) criteria for D.O. is currently under revision (NCRWQCB 2005). Both old and revised standards are included in this table.

Source	**Dissolved Oxygen**	**pH**
Hoopa TEPA (2001)	11.0 mg/L min. in water column for COLD 8.0 mg/L intragravel for spawning SPAWN	6.5 minimum 9.0 maximum
NCRWQCB (2001)	For Middle Klamath Hydrologic Area: 8.0 mg/L Minimum 10.0 mg/L 50% Lower Limit	7.0 minimum 8.5 maximum Not altered from normal more that 0.5 units due to human actions
NCRWQCB 2005 (In Review)	8.0 mg/L 7-DAMin COLD 8.0 mg/L 7DAMin in gravel beds SPAWN 11 mg/L 7-DAMin in water column for SPAWN	
WDOE (2000)	7.0 mg/L one day minimum for salmon, steelhead and trout rearing 9.5 mg/L as 90 day average of daily min. (90-DADMin)	7.0 mg/L one day minimum for salmon, steelhead and trout rearing 9.5 mg/L as 90 day average of daily min.
Central Coast RWQCB	5.0 mg/L for WARM uses 8.0 mg/L for COLD and SPAWN uses 85% saturation median value	7.0 for COLD uses 8.0 for WARM uses 8.5 for General Uses
Tulare Lake RWQCB	5.0 mg/L for WARM uses 8.0 mg/L for COLD uses 85% saturation or >75% saturation 95% of the time	6.5-8.3 for all uses No more than 0.3 human induced variation
Colorado River RWQCB	5.0 mg/L for WARM uses 8.0 mg/L for COLD uses	
San Francisco RWQCB	5.0 mg/L for WARM uses 8.0 mg/L for COLD uses 80% saturation median for 3 months	7.0 minimum 8.5 maximum Not altered from normal more that 0.5 units due to human actions
ODEQ (1996)	8.0 mg/L as 30 day mean minimum 6.5 mg/L as 7-day minimum mean 6.0 absolute min.	

Chronic stress criteria for juvenile and adult salmonids have led to 30 day or 90 day daily average minimum standards, while spawning criteria are for 7 day periods as recommended by U.S. EPA (1986b). The most conservative standards are those reflected by daily minimums, where even a single day's exceedance of acute stress or lethal D.O. levels would be a violation of standards. D.O. standards may also set maximum levels of D.O. fluctuation that can be caused by human impacts and for upper limits to gas supersaturation.

In setting D.O. criteria for salmonid spawning (SPAWN), one must take into account the difference between surface water D.O. and that in the intragravel spaces where the eggs reside (WDOE, 2002). Although salmonid spawning streams in healthy or intact conditions may have little or no loss of D.O. saturation, Maret et al. (1993) found decreases of 1.6 mg/L to 7.2 mg/L in streams effected by varying levels of non-point source pollution. U.S. EPA (1986b) recommends using an average difference between surface waters and redds of 3 mg/L. The magnitude and frequency of salmon spawning in Klamath River on the Hoopa Valley Indian Reservation is unknown. Fall chinook spawn timing in the mainstem Klamath River below Iron Gate Dam is recognized by Leidy and Leidy (1984) as beginning on September 15, with emergence from gravels complete by April 15.

D.O. values considered in this exercise are only those for protection of cold water fisheries (COLD), including special consideration for periods of spawning (SPAWN).

Recommended Standards:
COLD (year-round):
The 7-day moving average of daily minimum D.O. (7-DAMin) in the water column of the Klamath River shall not drop below 8.0 mg/L

SPAWN (shall be met during times of year when the spawning life stage occurs, or has occurred historically and has the potential to occur again):
The 7-day moving average of daily minimum D.O. (7-DAMin) in gravel beds of the Klamath River shall not drop below 8.0 mg/L
The 7-day moving average of daily minimum D.O. (7-DAMin) in the water column of the Klamath River shall not drop below 11.0 mg/L

Natural conditions clause:
If dissolved oxygen standards are not achievable due to natural conditions, then the COLD and SPAWN standard shall instead be dissolved oxygen concentrations equivalent to 90% saturation under natural receiving water temperatures.

Justification for Recommended Standard: The proposed standard is based on the literature reviewed above and is the same as the recently proposed NCRWQCB D.O. standards. The standards are equivalent or superior to criteria set in Oregon, Washington and other California RWQCB and reflect best current available science.

Due to the influence of water temperature on the solubility of oxygen, high water temperatures alone (even in the absence of biologically-driven oxygen dynamics) could cause violations of the recommended standards for D.O. If the water temperatures were naturally high, then the D.O. standard could be violated even under natural conditions. Thus, we recommend the inclusion of the natural conditions clause to make the standard more realistic, achievable, and enforceable.

Periphyton

Review of Existing Standards

EPA (2000b) presents an excellent review of literature on recommended periphyton criteria that will not be repeated here. The summary of that review is included here as Table 4. The literature is fairly consistent in recommending a maximum chlorophyll a concentration of 100-200 mg/m^2, centering around 150 mg/m^2. Horner et al. (1983) conducted a literature review of 19 case studies and concluded that biomass levels greater than 150 mg/m^2 often occurred with enrichment and when filamentous forms were more prevalent. Welch et al. (1988) noted that percent coverage by filamentous forms was less than 20 percent at 150 mg/m^2, but increased as biomass increased, noticeably affecting aesthetic quality (Welch et al. 1988). Additional discussions regarding setting periphyton standards are included in Tetra Tech (2006a). Tetra Tech (2006a) proposed 150 mg/m^2 as the boundary between Beneficial Use Categories II (Potentially impaired) and III (Presumptively impaired), and Tetra Tech (2006b) recommended a standard of 150 mg/m^2 for the Klamath River on the Hoopa Valley Tribe Reservation.

Table 4. Nutrient (as µg/L) and algal biomass criteria limits recommended to prevent nuisance conditions and water quality degradation in streams based either on nutrient-chlorophyll a relationships or preventing risks to stream impairment as indicated. Adapted from U.S. EPA (2000b).

PERIPHYTON Maximum in mg/m^2						
TN	**TP**	**DIN**	**SRP**	**Chlorophyll *a***	**Impairment Risk**	**Source**
				100-200	nuisance growth	Welch et al. 1988, 1989
275-	38-90			100-200	nuisance growth	Dodds et al. 1997
650						
1500	75			200	eutrophy	Dodds et al. 1998
300	20			150	nuisance growth	Clark Fork River Tri-State Council, MT
	20				*Cladophora* nuisance growth	Chetelat et al. 1999
	10-20				*Cladophora* nuisance growth	Stevenson unpubl. data
		430	60		eutrophy	UK Environ. Agency 1988
		100[1]	10[1]	200	nuisance growth	Biggs 2000
		25	3	100	reduced invertebrate diversity	Nordin 1985
			15	100	nuisance growth	Quinn 1991
		1000	10[2]	~100	eutrophy	Sosiak pers. comm.
PLANKTON Mean in µg/L						
TN	**TP**	**DIN**	**SRP**	**Chlorophyll *a***	**Impairment Risk**	**Source**
300[3]	42			8	eutrophy	Van Nieuwenhuyse and Jones 1996
	70			15	chlorophyll action level	OAR 2000
250[3]	35			8	eutrophy	OECD 1992 (for lakes)

[1] 30-day biomass accrual time

[2] Total Dissolved P

[3] Based on Redfield ratio of 7.2N:1P (Smith et al. 1997)

Recommended Standard

The maximum annual periphyton biomass shall not exceed 150 milligrams of chlorophyll *a* per square meter of streambed area.

Justification for Recommended Standard:

We developed quantitative relationships between benthic algal biomass (as measured by g/m^2 of chlorophyll *a*) and various metrics of pH and D.O., using correlation and regression methods; however; because our periphyton dataset was limited to one year, we also relied on criteria recommended in the literature.

To guide the setting of periphyton criteria, we attempted to answer four questions:
- *What level of periphyton chlorophyll* a *is recommended in the literature to protect water quality?*
- *What level of periphyton chlorophyll* a *is likely to cause a violation of the proposed pH standard?*
- *What level of periphyton chlorophyll* a *is likely to cause a violation of the proposed D.O. standard?*
- *How do levels of periphyton chlorophyll* a *in the Klamath compare to the Salmon and Trinity Rivers?*

Periphyton chlorophyll a limits recommended in scientific literature

As noted in the review of existing standards above, there is considerable agreement that 100-200 mg/m^2 periphyton chlorophyll *a* is the level at which periphyton reaches nuisance levels that cause aesthetic and water quality problems. Tetra Tech (2006b) recommended a standard of 150 mg/m^2 in the Klamath River. Given the Klamath River's historically mesotrophic status, we chose a criterion of 150 mg/m^2, rather than a lower value such as 100 mg/m^2.

Relationships between algal biomass and pH

There were only six sites with enough periphyton data and continuous water quality data to use in the regression analyses. Despite the low number of sites, significant relationships were found between maximum summer periphyton biomass and both mean summer daily maximum pH (Figure 29) and mean summer daily pH range (Figure 30). The regression analyses indicate that pH can be negatively impacted at periphyton biomass at concentrations as low as 100 mg/m^2. The ability to set a standard based on so few data points is limited; however, so we instead rely on the 150 mg/m^2 value recommended in the literature. Future studies encompassing greater inter-annual and spatial variability may necessitate revision of the proposed 150 mg/m^2 standard. As such, additional years of periphyton data would be very beneficial, increasing the sample size and providing information on variability among years.

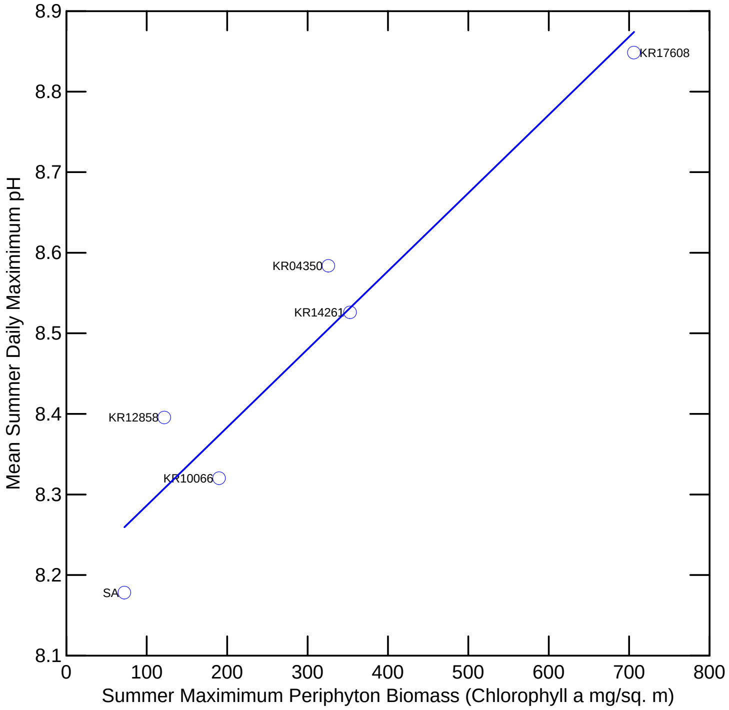


Figure 29. Mean summer daily maximum pH versus maximum summer periphyton biomass, for the year 2004. The relationship is statically significant (p=0.0030, r^2=0.8895), with maximum pH increasing as periphyton biomass increases. The data in the graph indicate that maintaining maximum biomass of 100 mg/m^2 should keep maximum pH below 8.3, and that a maximum biomass of 150 mg/m^2 would keep maximum pH below 8.4.
Regression equation: MeanDailyMax_pH = 8.189281 + 0.00097 Max_Chl

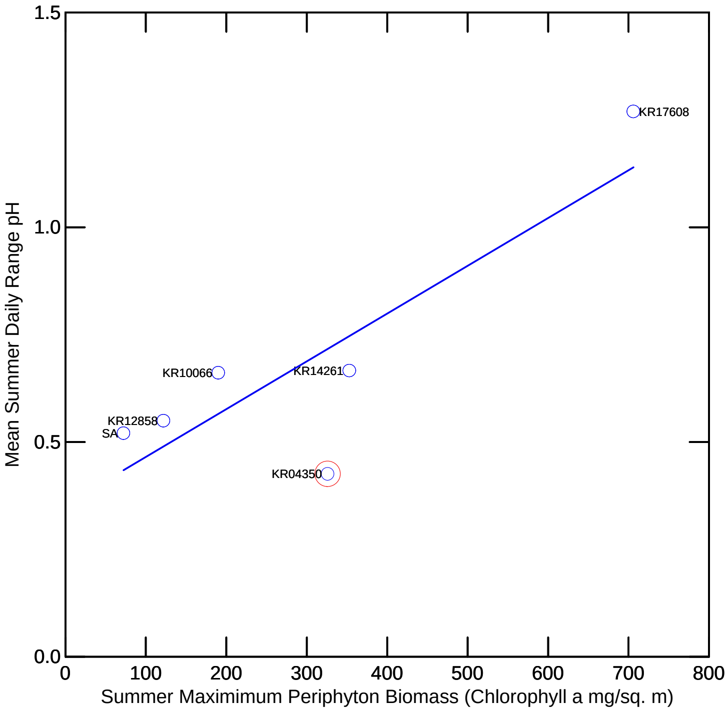


Figure 30. Mean summer daily pH range versus maximum summer periphyton biomass for the year 2004. Excluding an outlier at KR04350 (Klamath River above the Trinity River, shown circled in ref on the graph), there was a statistically significant relationship ($p=0.0079$, $r^2=0.9074$), although with so few data points it is not possible to know the shape of the curve between 350 mg/L and 700 mg/L, and the upper site KR17608 exerts substantial influence on the regression line. The data in this graph indicate that a maximum biomass of 100 mg/m^2 should hold daily pH range at approximately 0.5, and that a maximum biomass of 150 mg/m^2 should hold daily pH range under 0.6. A possible explanation for why Site KR04350 does not fit the same pattern as the rest of the sites shown in this graph is that it reached peak biomass in early September, whereas the other sites reached peak biomass in early August and then were scoured out by a late August pulse flow.
Regression equation: MeanDailyRange_pH = 0.399971 + 0.001154 log10(Max_Chl)

Relationships between algal biomass and D.O.

Mean summer daily D.O. range had a significant relationship with maximum summer periphyton biomass, for the year 2004 (figure 31).

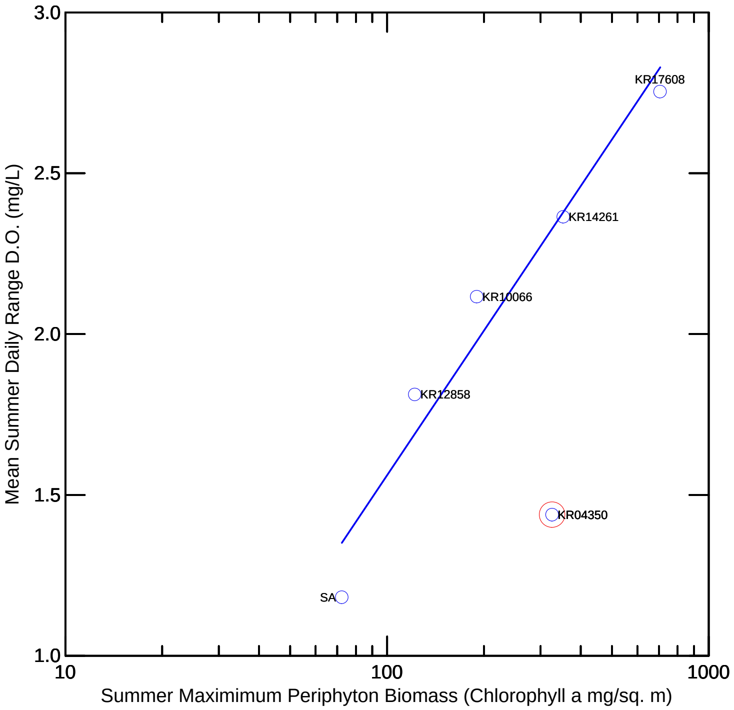


Figure 31. Mean summer daily D.O. range versus maximum summer periphyton biomass, for the year 2004. Excluding an outlier at site KR04350, the relationship is highly significant (p: 0.0046 r^2: 0.9349). Results indicate that substantial diurnal swings of D.O. occur at relatively low periphyton biomass. For instance, max biomass at KR12858 is approximately 125 mg/m^2, yet the D.O. range is approximately 1.8 mg/L. In contrast, the Salmon River's maximum biomass was only 60 mg/m^2 and had D.O. range of 1.2 mg/L, indicating that a criterion of 100 mg/m^2 would likely keep the D.O. range below 1.5 mg/L, and that a criterion of 150 mg/m^2 would keep D.O. range below 2.0 mg/L. Regression equation: MeanDailyRange_DO = -1.4280 – 1.4945 / Max_Chl

Nutrients

Review of Existing Standards

There are currently no EPA-approved nutrient standards for rivers or streams in California, Oregon, Idaho, and Washington to protect the COLD beneficial use. The Water Quality Control Plan (CCRWQCB 1994) for the Central Coast set a monthly mean objective for nitrate of 0.25 mg/L (as $N0_3$), but this standards was rescinded in 2003.

There are some nitrate standards set to protect municipal drinking water. For instance, the Water Quality Control Plan (CCRWQCB 1994) for the Central Coast sets a standard of 10 mg/L (as N).

U.S. EPA has provided guidance but does not intend for these values to be directly translated into standards. Using 25th percentiles, U.S. EPA (2000a) calculated reference conditions for the Level III subecoregions (1, 2, 4, 5, 8, 9, 11, 15, 16, 17, 19, 21, 23, 41, 77, and 78) in Aggregated Ecoregion II. EPA also calculated references conditions for the Aggregated Ecoregion 2 as a whole (Table 5) and subecoregion 78 (Table 6).

Table 5. Reference conditions for nutrient-related parameters for streams in subecoregions in Aggregated Ecoregion 2, and references conditions for Aggregated Ecoregion 2 as a whole. From U.S. EPA (2000a).

Nutrient Parameters	**Aggregate Nutrient Ecoregion II Reference Conditions**	**Range of Level III Subecoregions Reference Conditions**
Total phosphorus (µg/L)	10.0 µg/L	3.0-32.5 µg/L
Total nitrogen (mg/L)	0.12 mg/L	0.0-0.53 mg/L
Chlorophyll *a*(µg/L) (Fluorometric method)	1.08 µg/L	0.7-2.95 µg/L
Turbidity (FTU)	1.3 NTU	0.25-5.5 NTU

Table 6. Reference conditions for nutrient-related parameters for streams in Level III subecoregion 78 (Klamath Mountains), where the Hoopa Valley Indian Reservation is located. From U.S. EPA (2000a).

Parameter	No. of Streams N ++	Reported values		25thPercentiles based on all seasons data for the Decade
		Min	Max	**P25-all seasons+**
TKN (mg/L)	53	0.05	1.28	**0.14**
NO2+ NO3(mg/L)	56	0	5.1	**0.04**
TN (mg/L) - calculated	NA	0.05	6.38	**0.18**
TN (mg/L) - reported	1	0.53	0.53	**0.53**
TP (*u*g/L)	68	5.63	455	**32.5**
Turbidity (NTU)	15 W	4	20	**5.5**
Turbidity (FTU)	50	0.68	33.81	**1.5**
Turbidity (JCU)	0	--	--	**--**
Chlorophyll *a*(*u*g/L) -F	18	0.75	6.3	**1.15**
Chlorophyll *a*(*u*g/L) -S	0	--	--	**--**
Chlorophyll *a*(*u*g/L) -T	–	–	–	--
Periphyton Chl *a*(mg/m2)				

Tetra Tech (2004) advocated using a tiered approach where instead of establishing a single regional standard, three tiers are set:

Tier I. Impacts unlikely (use is supported)
Tier II. Probably sustaining (but potentially threatened)
Tier III. Impacts likely (use is not supported or highly threatened)

Tier II waterbodies then need detailed data analysis to determine site-specific targets. Tetra Tech (2004) also provided draft criteria, presented as preliminary and not intended to be directly used for regulation (Table 7). Tetra Tech (2006a), in an update to Tetra Tech (2004) renamed "tiers" as "beneficial use risk categories" and did not include exposure variables such as TP and TN in their recommendations.

Tetra Tech (2006b) applied the Benthic Biomass Spreadsheet Tool to the Klamath River, including a site near the Hoopa Reservation. A benthic algal biomass target of 150 mg chl-a/m^2 yielded a TN goal 0.3 mg/L with an algal biomass accrual adjustment and a TN goal of 0.17 mg/L without an algal biomass accrual adjustment.

Table 7. Draft nutrient criteria for protecting the cold water beneficial use in streams (adapted from Tetra Tech, 2004).

Parameter	**Tier I Range**	**Tier II Range**	**Tier III Range**	**Rationale**
Exposure variables				
Total Nitrogen (TN) (mg/l)	<0.5	0.5-2.0	>2.0	Background concentrations through modeling; data from Ecoregion 6; stream benthic chlorophyll model
Total Phosphorus (TP) (mg/l)	<0.05	0.05-0.2	>0.2	Background concentrations through modeling; Land-use nutrient relationships from Ecoregion 6; stream benthic chlorophyll model
Nitrate (NO3) (mg/l)	<0.2	0.2-2.0	>2.0	Ecoregion 6 data; Land-use nutrient relationships; background concentrations in modeling; drinking water criteria
Ammonia (NH3) (mg/l)	<0.5[1]	0.5-2.0[2]	>2.0	Ecoregion 6 data and CCC and CMC for ammonia[1,2]
Response Variables				
Benthic Chlorophyll a (mg/m^2)	<50	50-200	>200	Literature sources; Data from Regional Water Board 6
Planktonic Chlorophyll a (μg/l)	<10	10-20	>30	Literature sources

[1] The criterion continuous concentration (CCC) for ammonia at pH 8.5 and 26°C when early life stages of fish are present is selected as the Tier I/II boundary (value = 0.52 mg/L). Source: U.S. EPA 1999 Update of Ambient Water Quality Criteria for Ammonia.

[2] The criterion maximum concentration (CMC) for ammonia when salmonids are present is 5.62 mg/L at pH 8; because this is higher than the total nitrogen value, the total nitrogen concentration is proposed as the Tier II/III boundary. Source: U.S. EPA 1999 Update of Ambient Water Quality Criteria for Ammonia.

***Recommended Standards*:**

The mean nutrient concentrations in any 30-day period from May-October shall not exceed the values shown in Table 8. There should be at least two samples per 30-day period.

Table 8. Proposed nutrient criteria for the Klamath River on the Hoopa Valley Indian Reservation, and justification for criteria.

Parameter	**Proposed Standard**	**Rationale for Proposed**
Total Nitrogen (TN) (mg/L)	0.2	D.O. range vs. TN 2000-2004 (Figure 35) Minimum D.O. vs. TN 2001-2004 (Figure 37) Maximum pH vs. TN 2000-2004 (Figure 39) pH range vs TN 2000-2004 (Figure 41) D.O. range vs. TN 2000-2004 (Figure 43)
Total Phosphorus (TP) (mg/L)	0.035	D.O. range vs. TP 2000-2004 (Figure 36)

Justification for Recommended Standard:

Using correlation and regression analyses, we developed quantitative relationships between nutrients, algal biomass, pH, and D.O. Using a weight of evidence approach, these relationships were used to choose criteria.

The analyses used to derive the nutrient criteria were based on summer (June through August) mean nutrient concentrations, but to provide a conservative safety factor the final standards are 30-day averages from May-October. A 30-day period was chosen because it is the time scale at which nutrient concentrations can be expected to have biological effects (uptake by growing periphyton, which then affect pH and D.O. in the water column). For instance, data from 2004 shows that most of the periphyton growth in 2004 occurred between early July and early August (Figure 20). The standard is to be calculated on a 30-day period rather than by calendar month because calendar months are artificial and biologically arbitrary. The standard spans from May through October because those are the months expected to have sufficient water temperature and solar input to facilitate periphyton growth.

The basic geographic unit of analysis was the most commonly monitored stations located longitudinally along the mainstem Klamath River from Iron Gate Dam down to the Turwar Creek gage at the Klamath estuary. The final number of sites used in the analyses varied between approximately 6 and 10, depending on the year and parameter.

Data for sites upstream of Iron Gate Dam were excluded from the analyses, as those sites are quite different because they are located in reservoirs or in reaches of the Klamath River subject to irregular flow regimes such has hydropower peaking.

Data from the sites immediately below Iron Gate Dam (site codes KR18973 and KR18952) exhibited characteristics dominated by reservoir outputs rather than instream processes. For instance, they showed diminished diurnal range of pH and D.O; therefore, these two sites were excluded from analyses that included pH and D.O. KR18973 and KR18952 were included in analyses to determine the relationship between nutrient concentrations and algal biomass, as diurnal cycles of nutrient concentrations are thought to be relatively minor.

The Trinity River and Salmon River exhibit characteristics of larger rivers, similar to the Klamath River, and therefore were included in the analyses. Moreover, the Salmon and Trinity have water quality that is much better than the Klamath, and hence represent a reference that the Klamath can be compared to. As discussed above, it is important to note that the Salmon and Trinity were historically oligotrophic while the Klamath was historically mesotrophic, so it is unreasonable to expect that water quality in the Klamath River should better than in the Trinity and Salmon Rivers.

The Shasta River, Scott River, and other smaller tributaries were excluded from the analyses because their summer flows are substantially lower than Salmon, Trinity, and Klamath (Table 9).

Table 9. Mean August flows at USGS flow gages on the Klamath River and its tributaries for the years 2001-2003.

USGS Gaging Station	2001	2002	2003
Klamath River at Iron Gate	1023	666	996
Klamath River at Seiad Valley	1046	787	1218
Klamath River at Orleans	1209	1263	2088
Klamath River at Terwer	2713	2327	3463
Shasta River near mouth	19	24	68
Scott River at mouth	6	15	88
Indian Creek	25	46	60
Salmon River near mouth	92	171	300
Trinity River at Weitchpec	717	696	1151

Where multiple years of data were available, sites have a data point in the regression for each year. In general, relationships between sites varied substantially between years and relationships that were strong in some years were weak or non-existent in others. The proposed standards are intended to be conservative to protect beneficial uses in years of poorer-than-average water quality, yet still generally reasonable and achievable.

Of all the nutrient parameters, total nitrogen (TN) appeared to have the strongest relationship with the metrics of D.O. and pH. TN is the sum of total inorganic nitrogen (TIN) and organic nitrogen. Organic nitrogen, which is typically the most abundant form of nitrogen present in the Klamath River, is not available for growth until it decays into ammonia.

Unfortunately, there were less data points available for TN than the other parameters because TN could only be computed when NO_3 and TKN were both available. Because CDWR did not analyze for TKN, TN could not be computed from their data. Moreover, in 2004 USFWS/Yurok/Karuk reporting limits for TKN were unacceptably high (0.5 mg/L), such that non-detect TKN samples had to be excluded from the analysis. Thus, there are relatively few TN data points for 2004.

The relatively high reporting limits given by the laboratories where the Klamath River samples were processed increased the difficulty in developing the nutrient standards. In most of the lower river (below approximately river mile 100), NH_3 and NO_3 are often only present at levels near or below the detection limit provided by the laboratories, yet periphyton growth at those locations is still high enough to impair water quality. Hence, for these low nutrient concentrations it is not possible to use currently available data to precisely determine the shape of relationship curves between nutrients and other parameters (e.g., pH, dissolved oxygen, and periphyton). Existing data are adequate to establish that when high levels (i.e. >0.2 mg/L) of available nutrients (NH_3 and NO_3) occur, water quality is typically extremely impaired during the summer months. However, the data cannot accurately indicate the maximum level of available nutrients that will not result in impaired water quality; therefore we do not propose a TIN standard. In the Suggestions for Future Studies and Criteria Refinement section below, we recommend nutrient detection limits that would be more appropriate for nutrient criteria development in the Klamath River.

The recommended nutrient criteria are in between the concentrations generally observed in the Klamath River, and the low concentrations the Salmon and Trinity Rivers. It makes sense to set a standard that is lower than the currently observed values because water quality in the Klamath River is impaired even in the most downstream reaches, and improvements are needed if fisheries are to be protected and restored. For instance, daily maximum pH exceeds 8.5 frequently at nearly all sites in summer 2004 (Figure 11). Fish health problems in the Klamath River are substantial and are likely related to poor water quality. Nichols and Foott (2005) estimated that in 2004, 45% of juvenile fall-run chinook salmon were infected with *C. Shasta* and would not likely survive. Foott et al. (2002) found that juvenile salmonids in the Salmon and Trinity Rivers (where water quality is excellent) had low rates of disease, while juvenile salmonids in the Klamath River (where water quality is poor) had high rates of disease.

The recommended nutrient criteria are higher than concentrations typically observed in the Trinity and Salmon Rivers. This makes sense because it is not reasonable to expect that nutrient concentrations in the Klamath River should be as low as they are in the Trinity and Salmon, as those rivers were historically oligotrophic and the Klamath was historically mesotrophic.

To guide the setting of nutrient criteria we attempted to answer these four questions:
- *What nutrient criteria are recommended in the literature?*
- *What concentration of nutrients is likely to cause violation of the proposed benthic chlorophyll a standard?*
- *What concentration of nutrients is likely to cause violation of the proposed pH standard?*
- *What concentration of nutrients is likely to cause a violation of the proposed D.O. standard?*
- *How do levels of nutrients, D.O., pH, and periphyton in the Klamath compare to nutrient levels in the Salmon and Trinity Rivers?*

Recommended nutrient criteria in the literature

The Review of Existing Standards section above provides details on recommended nutrient criteria from the literature. The proposed standards fall within ranges suggested in the literature (Table 10). The proposed TP and TN standards are lower than the Tier I range (Tetra Tech 2004), are higher than the Ecoregion II reference conditions (U.S. EPA 2000a), and are almost identical to the Level III subecoregion 78 reference conditions (U.S. EPA 2000a). The proposed TN and TP standards are intermediate between Tetra Tech's (2006b) two methods of applying the Benthic Biomass Spreadsheet Tool, one with an algal biomass accrual adjustment, and one without. As noted above, Tetra Tech (2006a), in an update to Tetra Tech (2004) renamed "tiers" as "beneficial use risk categories" and did not include exposure variables such as TN and TP in their recommendations.

Table 10. Comparison of the Hoopa Valley Tribe's proposed nutrient criteria with Tetra Tech (2006b), Tetra Tech (2004) draft nutrient criteria for California, and U.S. EPA (2000a) statistically-based calculations of reference conditions in Ecoregion II, range of Level III Subecoregions, and Subecoregion 78 (Klamath Mountains).

Source	Total Nitrogen (TN) (mg/L)	Total Phosphorus (TP) (mg/L)
Hoopa Valley Tribe's Proposed Standard for Klamath River	0.20	0.035
Benthic Biomass Spreadsheet Tool, with algal biomass accrual adjustment, for Klamath (Tetra Tech 2006b)	0.30	0.042*
Benthic Biomass Spreadsheet Tool, no algal biomass accrual adjustment, for Klamath (Tetra Tech 2006b)	0.17	0.024*
Tier I Range (Tetra Tech 2004)	<0.50	<0.050
Tier II Range (Tetra Tech 2004)	0.5-2.0	0.05-0.2
Aggregate Nutrient Ecoregion II Reference Conditions (EPA 2000a)	0.12	0.010
Range of Level III Subecoregions Reference Conditions (EPA 2000a)	0.00 - 0.53	0.0030 - 0.0325
Level III Subecoregion 78 Reference Conditions (EPA 2000a)	0.18	0.0325

*Derived from TN using Redfield ratio of 7.2

Relationships between nutrients and algal biomass

There were no statistically significant relationships between mean summer nutrient concentrations and maximum summer periphyton biomass (as measured by mg/m^2 chlorophyll *a*). Figure 32-34 show the results. In the figures, sites are labeled by their Site ID code. For a map and key to site locations, see Figure 9 and Table 2.

One likely reason that patterns were difficult to distinguish and not statistically significant was the small sample size. Several of the periphyton sampling sites (KR00579 and TR) could not be used for this analysis because they had only one sample, taken in early July before peak biomass developed. That left only 8 sites for the analysis, a number much lower than ideal for conducting regression analyses. Had more data had been available, statistically significant patterns may have emerged.

The relationship between maximum summer periphyton biomass and NO_3 is not shown in this report due to its similarity to TIN; most of the inorganic nitrogen in the Klamath River below Iron Gate is NO_3 and only a small portion is NH_3 (ammonia). Due to high detection limits for Kjeldahl nitrogen in 2004 (see discussions above) there were only a few data points for TN, making it impossible to evaluate relationship between TN and other parameters in 2004.

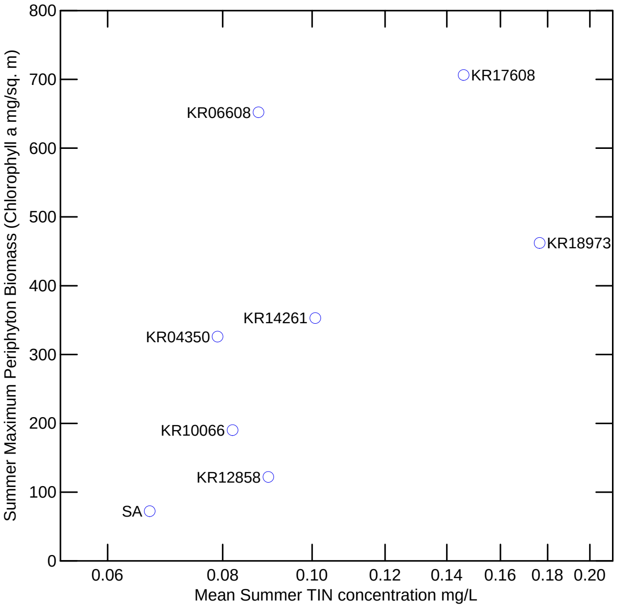


Figure 32. Maximum summer periphyton biomass (as measured by mg/m^2 chlorophyll *a*) versus mean summer total inorganic nitrogen concentration, for the year 2004. Some pattern appear to be evident, but it is not statistically significant ($p=0.1005$ and $r^2= 0.2830$). Site with the lowest periphyton biomass also had low the lowest TIN concentration, and the sites with the highest TIN concentrations also had high periphyton biomass; however, from TIN 0.06-0.10 mg/L, there is no relationship between the two parameters.

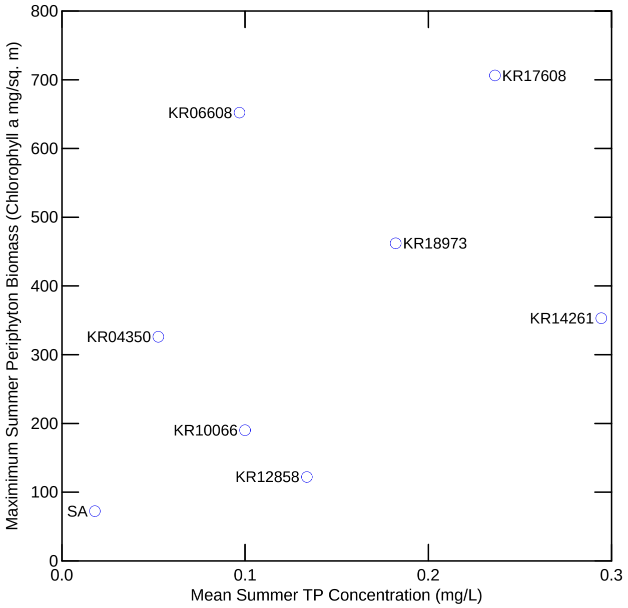


Figure 33. Maximum summer periphyton biomass (as measured by mg/m^2 chlorophyll *a*) versus mean summer total phosphorus concentration. As with TIN, some pattern appears to be evident, but there is a lot of scatter and it is not statistically significant ($p = 0.0797$ and $r^2 = 0.2520$). The sites with the lowest periphyton biomass also had a low TP concentration, and the sites with the highest TP concentrations also had high periphyton biomass; however, from TP 0.05-0.15 mg/L, there is no relationship between the two parameters.

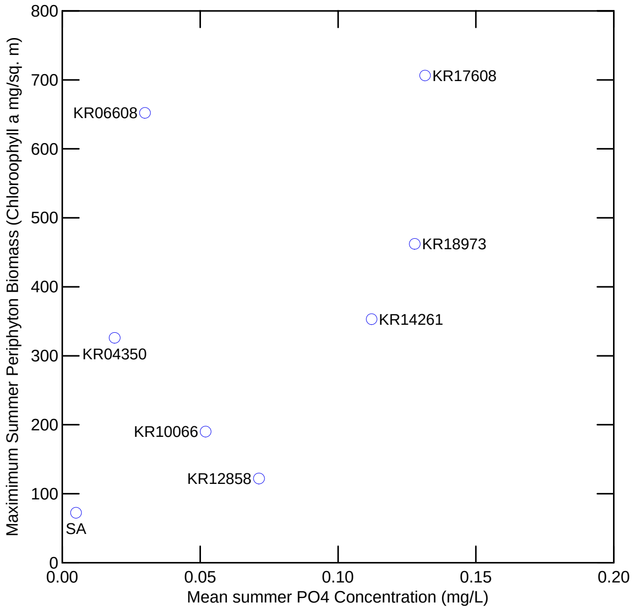


Figure 34. Maximum summer periphyton biomass (as measured by mg/m^2 chlorophyll *a*) versus mean summer orthophosphorus (PO_4) concentration, for the year 2004. There was no statistically significant relationship between the parameters ($p = 0.2446$ and $r^2 = 0.0866$), although an interesting pattern is apparent. Looking at the graph from right to left, mean PO_4 concentrations rank nearly perfectly by river mile.

Relationships between nutrients and D.O.

Significant relationships were found between mean summer TN and mean summer daily D.O. minimum and mean summer daily D.O. range. Significant relationships were also found between mean summer TP and mean summer daily D.O. minimum, and also between TIN and the percent of summer days with minimum D.O. less than 8.0. The results are shown in figures 35-38, and interpretations are discussed in the figure captions.

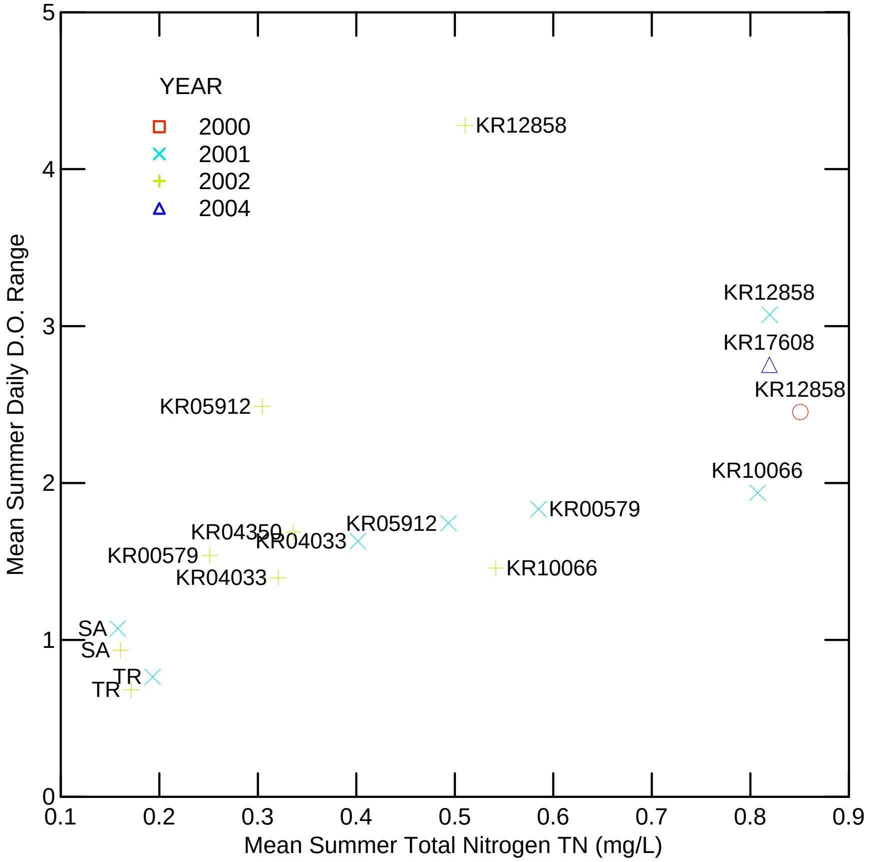


Figure 35. Mean summer daily D.O. range versus mean summer total nitrogen (TN) for 2000-2004. Although r^2 was low, the relationship was statistically significant ($p=0.0067$, $r^2=0.3566$). The relationship dramatically improved when the outlier KR12858 2002 was removed ($p=0.0002$, $r^2=0.6207$). It is unclear why KR12858 2002 is does not fit the same pattern as the rest of the data. Three distinct groups of points are visible on the graph: 1) the Salmon and Trinity sites (site codes SA and TR, respectively) have the lowest TN and pH values, 2) there is a group of points with TN concentrations of 0.25-0.6 mg/L, and D.O. ranges of approximately 1.4 mg/L to 1.9 mg/L, with D.O. range increasing slightly as TN concentration increases, and 3) sites with TN concentrations over 0.8 mg/L which have D.O. ranges near or greater than 2 mg/L. Although the relationship is relatively weak with high variability, the grouping of data points indicates that TN values less than 0.2 mg/L may protect water quality.
Regression equation: MeanDailyRange_DO = 0.813 + 2.3174 Mean_TN

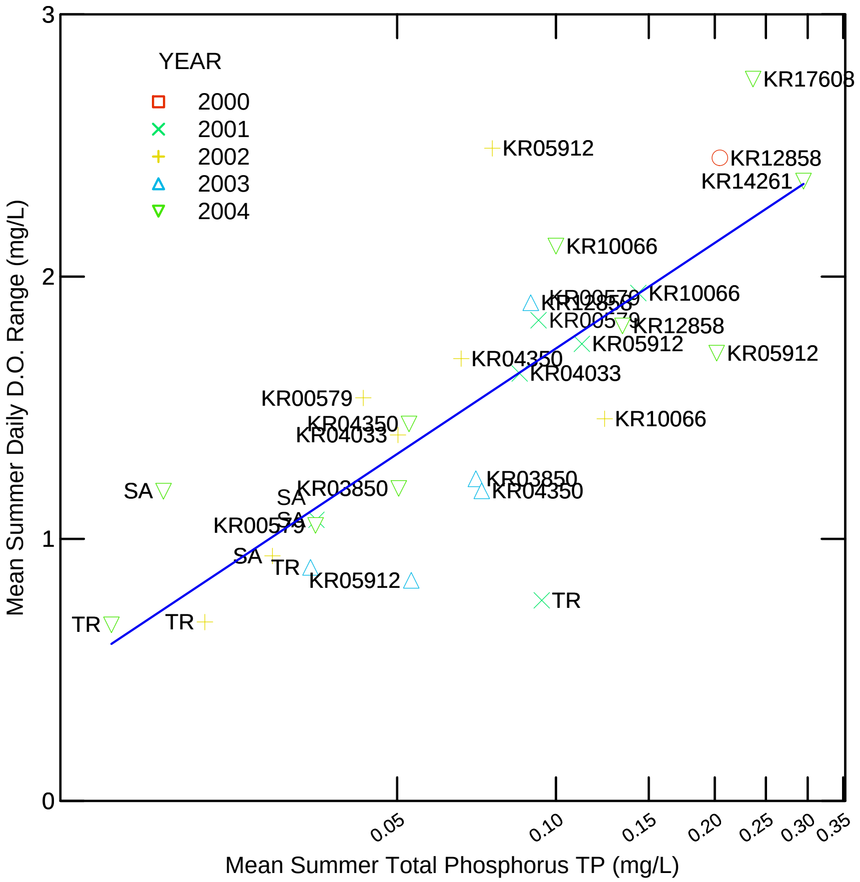


Figure 36. Mean summer daily D.O. range versus mean summer total phosphorus (TP) concentration for the years 2000-2004 and shown with a logged x-axis. Two outliers, site KR12858 in 2001 and 2002, were excluded from this graph (in 2001 TP of approximately 0.75 mg/L and D.O. range of 3.2 mg/L, and in 2002 TP of approximately 0.15 mg/L and D.O. range of 4.3 mg/L) because they were so far away from the other points it made the graph hard to read. Excluding the two outliers, the relationship is statistically significant ($p< 0.0001$, $r^2=0.5898$) though there is substantial scatter. Only 1 of 7 TP concentrations 0.035 mg/L or less had a mean D.O. range greater than approximately 1 mg/L. For TP concentrations less than 0.05 mg/L, mean daily D.O. ranges over 1.5 mg/L did not occur.
The regression equation is: MeanDailyRange_DO = 3.0626 + 1.3364 log10(Mean_TP).

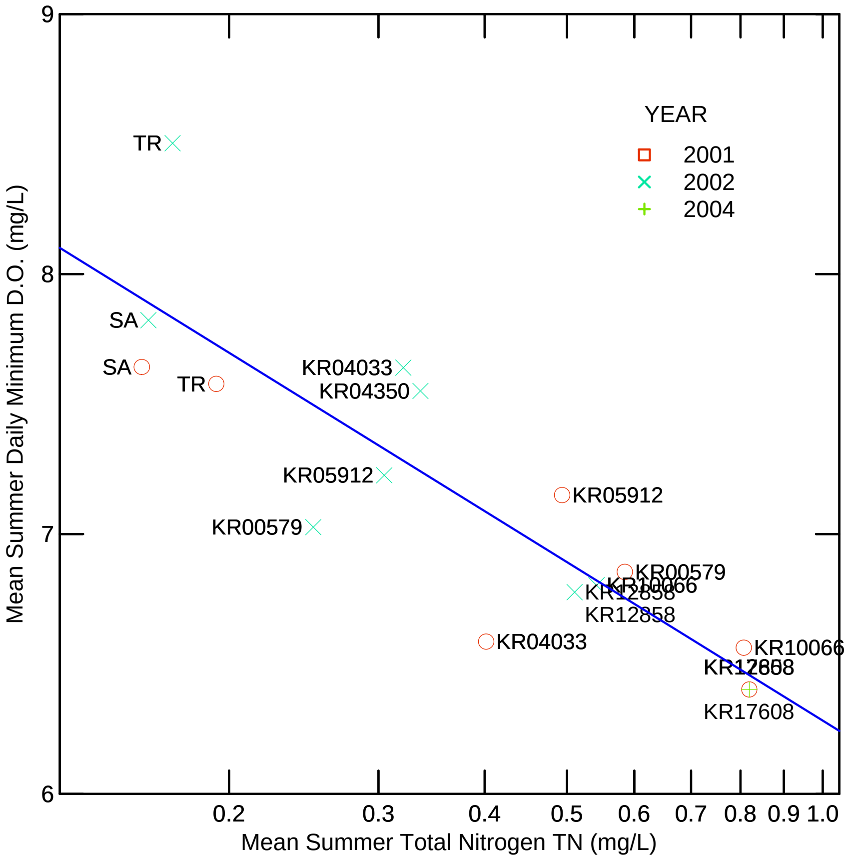


Figure 37. Mean summer minimum D.O. versus mean summer total nitrogen (TN) concentration for the years 2001-2004 shown with a logged x-axis. The relationship shown in this graph is statistically significant ($p=<0.0001$, $r^2=0.7259$) with daily minimum D.O. decreasing as TN concentrations increase. Mean daily minimum D.O. concentrations below 7.5 did not occur with TN concentrations less than 0.2 mg/L and mean daily minimum D.O. concentrations below 7.5 did not occur with TN concentrations less than 0.35 mg/L.
Regression equation: MeanDailyMin_DO = 6.2827 - 2.023 log10(Mean_TN).

It should be noted that D.O. data for 2000-2003 were not adjusted to correct for biofouling of the probes over the course of a deployment; the only year of D.O. data that have been adjusted to correct for biofouling is 2004. The USFWS (Zedonis 2005), who distributed these data collected by the USFWS, Karuk Tribe, and Yurok Tribe, notes that “the adjusted dissolved oxygen data periodically display a trend of decay through the course of deployment suggesting that the correction was inadequate to account for all bias.” Despite potentially substantial errors due to biofouling, the relationship between TN and minimum D.O. is relatively strong. Minimum D.O. data for the year 2000 were excluded from the final analyses presented in this report, including this figure, as they were substantially lower than other years, indicating potential data quality problems.

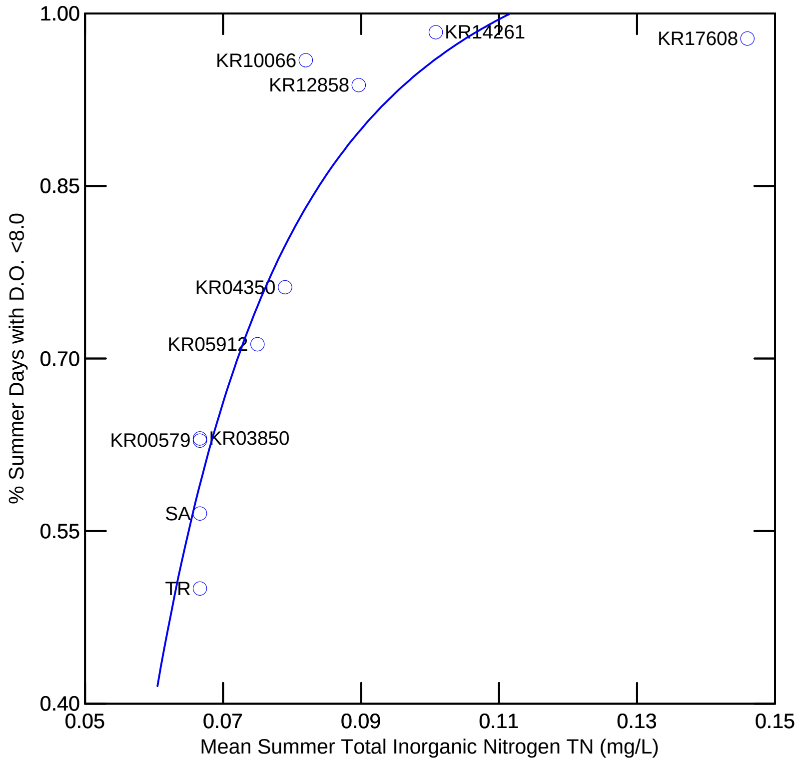


Figure 38. Fractional percentage of summer days with minimum D.O. less than 8.0 mg/L versus mean summer total inorganic nitrogen concentration for the year 2004. Total inorganic nitrogen concentration is the sum of NH_3 and NO_3. With a negative inverse cubed transformation of TN, there is a statistically significant relationship ($p<0.0001$, $r^2=0.855810$). With no transformation, the relationship was still significant ($p<0.0001$, $r^2=0.6770$), but the transformation was used because it improved linearity. Note that the mean TN concentration for the four points with the lowest TN concentration is 0.067 mg/L, which is equal to the sum of half the reporting limits for NO_3 and NH_3 (when a sample was non-detect, calculations were made by assuming the concentration was one half the reporting limit). This is an example of why lower detection limits should be used so that relationships at the low nutrient concentrations can be discerned. Therefore, a TIN standard is not proposed. The data presented in this graph indicate that decreasing the frequency of days with minimum D.O. concentrations less than 8.0 mg/L to less than 50% requires a mean TIN concentration less than 0.067 mg/L. Given that even in the Salmon and Trinity Rivers, the reference systems for the Klamath basin, 8.0 mg/L was exceeded on 50-60% of the days, it may be difficult to meet that criteria in the mainstem Klamath River.
Regression equation: PctDays_Max_DO_less8 = 1.1106 + 0.000154 - ($1/\text{Mean\_TIN}^3$)

Due to high detection limits for Kjeldahl nitrogen, no TN values could be calculated from the USFWS/Yurok/Karuk dataset for 2004. Thus, there are very few TN values below Iron Gate Dam in 2004 and relationships between TN and other parameters in 2004 could not be explored.

Relationships between nutrients and pH

Significant relationships were found between mean summer TN and mean summer daily pH maximum, mean summer daily pH range, and percent of summer days with maximum pH over 8.5. The results are shown in figures 39-43, and interpretations are discussed in the figure captions.

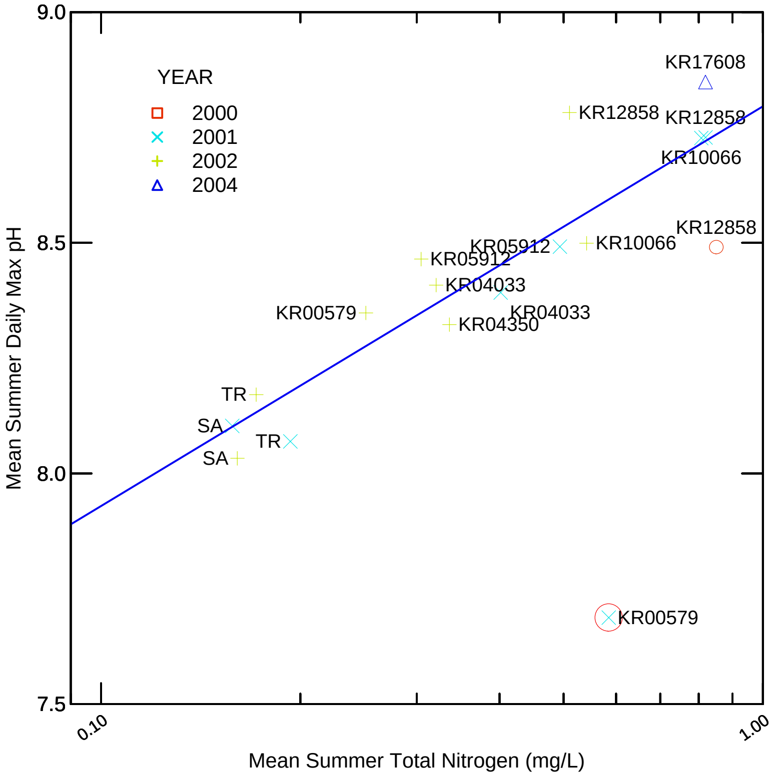


Figure 39. Mean summer daily maximum pH versus mean summer total nitrogen (TN) for 2000-2004 plotted with a logged x-axis. With the exclusion of an outlier at site KR00579 (Klamath River at Turwar, circled in red in the figure) in 2001, the data show a significant ($p= <0.0001$, $r^2= 0.7949$) relationship. While a clear trend is visible and the regression line fits well, the relationship is not entirely linear, with approximately three distinct groups of points visible on the graph. With mean TN concentrations less than 0.2 mg/L, the Salmon and Trinity sites (site codes SA and TR, respectively) have pH values of 8.0-8.2 mg/L, substantially lower than any of the Klamath mainstem sites. Points with mean TN concentrations of 0.2-0.4 mg/L have pH values of 8.3-8.5, and are located between river miles 5.79 and 59.12. For points with TN concentrations of 0.5 mg/L and above, all located between river mile 100.66 and 176.08, pH values range approximately from 8.5-8.8 with no apparent pattern visible within the cluster. The relationships shown in this chart suggest that the TN standard for the Hoopa Valley Tribe's portion of the Klamath should be set at somewhere between 0.2-0.3 mg/L, as pH reduction from the current condition is necessary. Regression equation: MeanDailyMax_pH = 8.738 + 0.751 log10(Mean_TN)

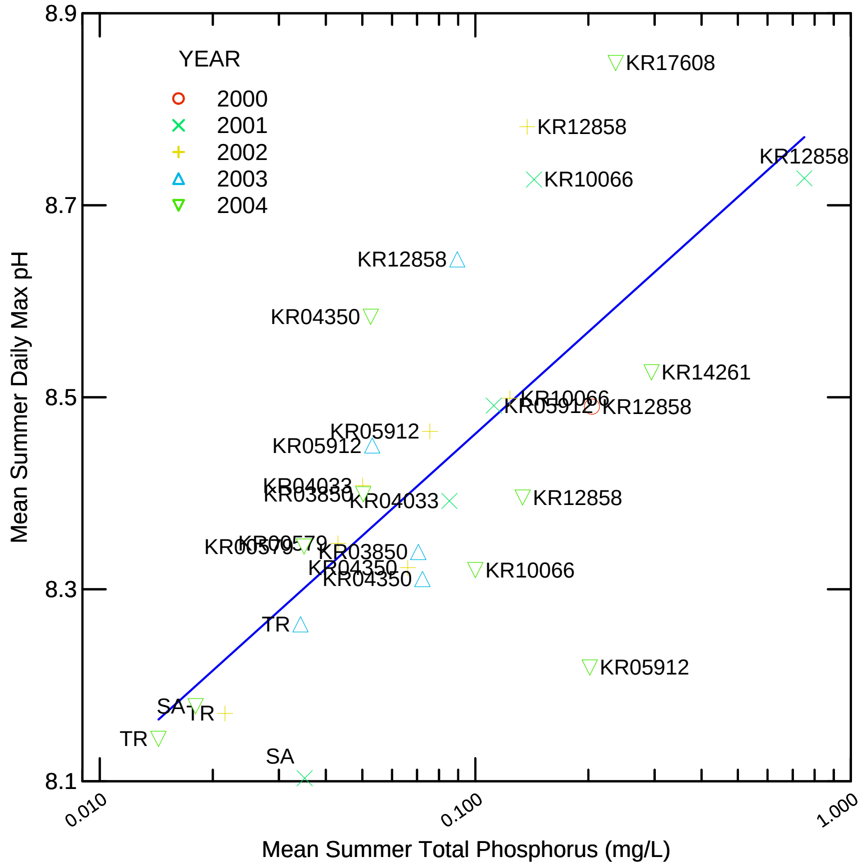


Figure 40. Mean summer daily maximum pH versus mean summer total phosphorus (TP), plotted on a logged x-axis. While the relationship is statistically significant, there is a lot of scatter and a relatively low r² value ($p<0.0009$, $r^2= 0.4208$), indicating that TP explains only a moderate portion of the variation in pH range. This relationship was not used in setting the TP standard because it was weak; instead, the relationship of D.O. range to TP was used (see Figure 36).
Regression equation: MeanDailyMax_pH = 8.8117 + 0.368694 log(TP)

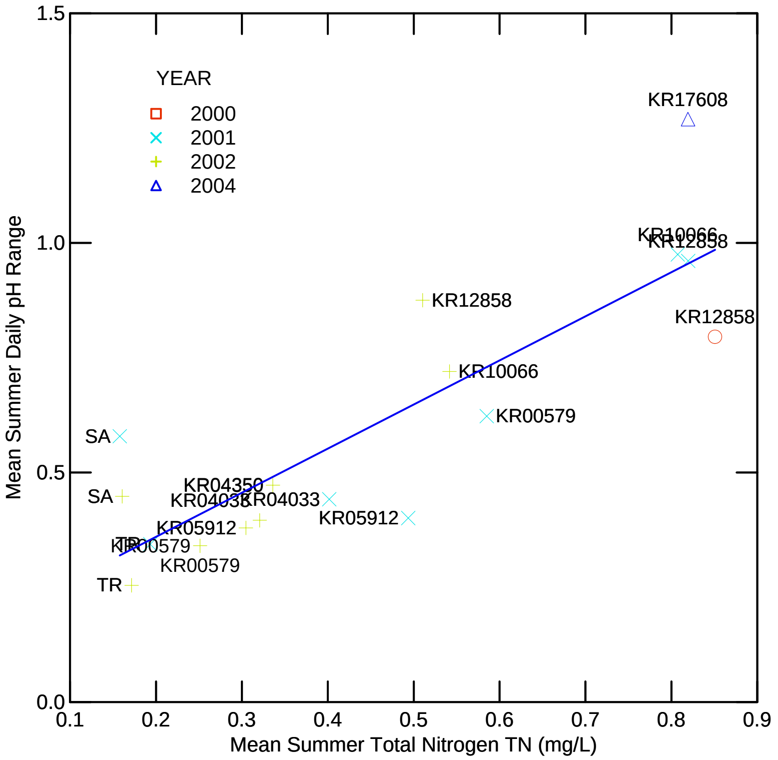


Figure 41. Mean summer daily pH range versus mean summer total nitrogen (TN) for 2000-2004. While there is some scatter, these data show a statistically significant linear relationship (p=<0.0001, r^2=0.6921). The Salmon River site (site code SA) shows a higher pH range than other sites with low TN concentrations. The data in this chart suggest that a mean TN concentration of 0.2 mg/L would hold mean daily pH range to 0.3 or less (Salmon River cite excepted), and a mean TN concentration of 0.5 mg/L or lower would hold mean daily pH range to less than 0.5.
Regression equation: MeanDailyRange_pH = 0.1679 + 0.9604 Mean_TN

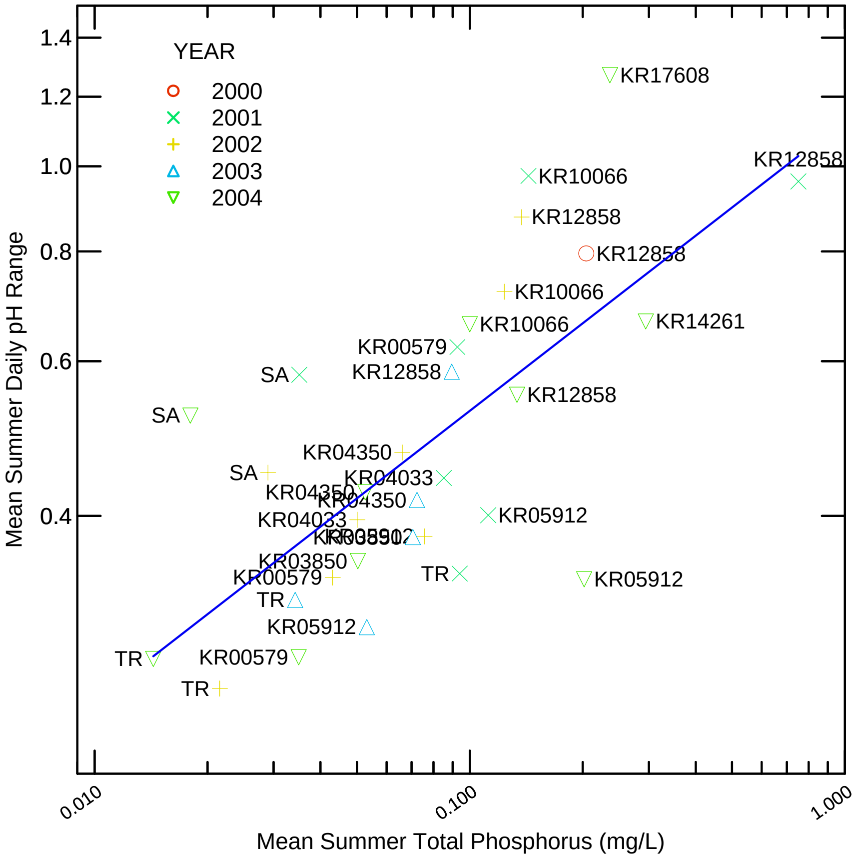


Figure 42. Mean summer daily pH range versus mean summer total phosphorus (TP), plotted on logged x and y axes. This relationship is statistically significant but with a low r^2 value ($p=0.0019$, $r^2= 0.2614$), indicating that TP explains only a small portion of the variation in pH range. This relationship was not used in setting the TP standard because it was weak; instead, the relationship of D.O. range to TP was used (see Figure 36).
Regression equation: log(MeanDailyRange_pH) = 0.943192 + 0.018207 log(TP)

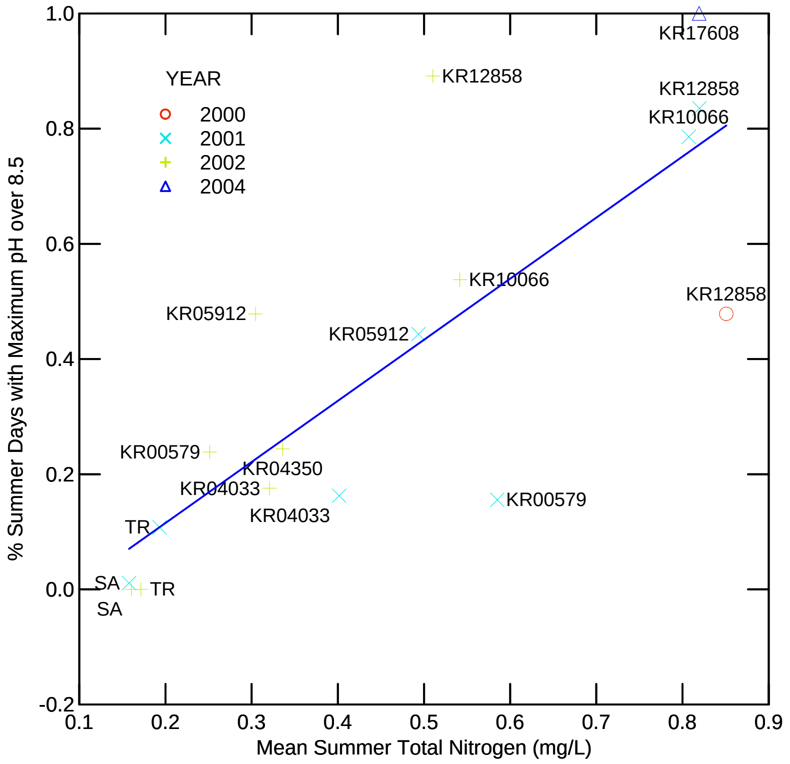


Figure 43. The fractional percent of summer days where daily pH exceeded 8.5 versus mean summer total nitrogen (TN) for 2000-2004. While there is considerable scatter, these data show a statistically significant linear relationship ($p=0.0001$, $r^2=0.6207$). It is worthy of note that with the exception of KR05912 in 2002, all the points with an exceedance percentage over 0.5 occurred with a TN concentration of over 0.4 mg/L. Sites with a TN concentration of 0.2 mg/L or less did not exceed 10% of days with max pH over 8.5.
Regression equation: PctDays_Max_pH_greater8.5 = -0.097 + 1.0606 Mean_TN

Microcystins and *Microcystis*

Review of Existing Standards:

U.S. EPA currently has no standards for *Microcystis aeruginosa* cell density or microcystin toxin concentration although cyanobacteria and their toxins are currently on EPA's Contaminant Candidate List 2 (http://www.epa.gov/ogwdw000/ccl/ccl2_list.html). However, the World Health Organization (WHO) as well as certain states and international countries provide threshold guidelines for MSAE and microcystin. Guidelines from the WHO, Australia, and the State of Oregon are summarized here. The Australian guidelines are the most recently updated and comprehensive

Microcystin poisoning has been implicated in the largest number of cyanobacteria-associated animal deaths worldwide, and enough work has been done, both with rodents and pigs, on microcystin effects at various levels of exposure, that the World Health Organization (WHO) has issued a provisional guideline of 1 µg/L for microcystin concentration in drinking water. With actual microcystin concentration data frequently unavailable, alert level guidelines based on cell counts have been established for *Microcystis* (as well as other cyanobacteria) blooms in drinking and recreational waters (Yoo et al. 1995; Chorus and Bartram 1999).

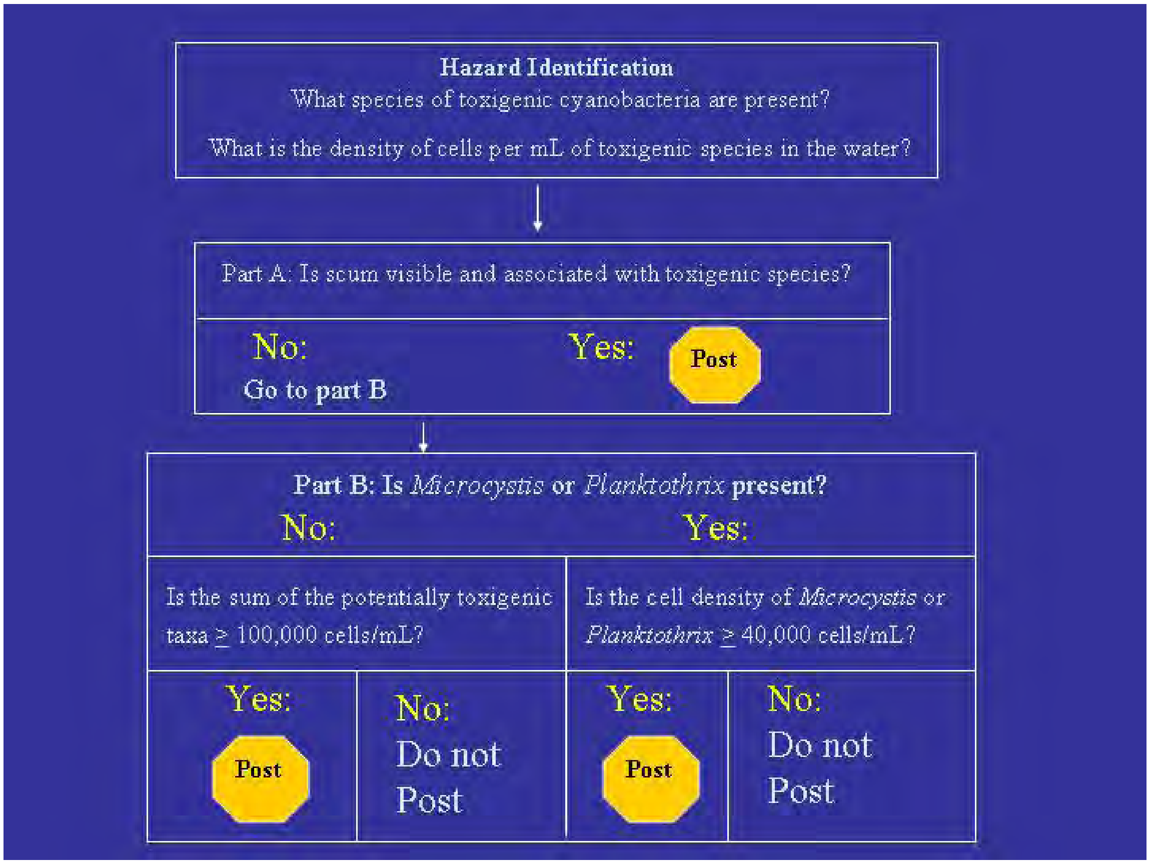
A Tolerable Daily Intake (TDI) was calculated for microcystin-LR, since this variant has sufficient information to derive a guideline value and is thought to be one of the most toxic variants. A TDI is a level of exposure below which it is thought that no adverse health effects will occur. It is important to note that simply exceeding a TDI does not imply that a health effect is likely. Rather, the duration of exposure and concentration of toxin will be major determinants of toxicity. The basis for the TDI was a 13-week mouse study with observed liver changes (Fawell et al. 1994). The no observed adverse effect level (NOAEL), which was the basis for determining a guidance value, was 40μg microcystin per kg body weight per day. To calculate a TDI, the NOAEL was divided by a series of uncertainty factors to include potential for intraspecies variation (factor of 10), interspecies variation (factor of 10) and for a less-than-lifetime study (factor of 10). The equation is:

$$\mathrm{TDI} = \frac{40\ \mu\mathrm{g/kg{\bullet}day^{-1}}}{1000} = 0.04\ \mu\mathrm{g}\ \text{microcystin-LR per kg body weight per day}$$

The TDI is instrumental in determining guidance for taxa such as *Microcystis* or *Planktothrix* that are known to produce microcystins at high intracellular concentrations. Based on this information the WHO guideline for microcystin is 1 μg/L for drinking water.

For accumulations of MSAE in recreational waters, microcystins at subacute levels may be ingested or inhaled by swimmers, skiers, windsurfers or kayakers. The WHO considers cell densities of 100,000 cells/ml and higher as likely to produce microcystin concentrations of 20 times the WHO 1 μg/L guideline for drinking water. Scum formation is likely at this density, as the concentration of buoyant cells rises and covers the surface. Thus, in documents published for the U.S. EPA and WHO (Falconer el al. 1999, Chorus and Cavalieri 2000) a moderate probability of adverse health effect level (MPAEL) is designated when cell density exceeds 100,000 cells/ml or there is 20 μg/L microcystin in the top 4 meters of surface water. The presence of scums indicates a high probability of adverse health effects. However, microcystin toxins can be released into the water, remaining even after the *Microcystis* bloom has visually dissipated either from natural senescence or treatment by algaecides (e.g., copper sulfate); thus, caution should be exercised for drinking and recreational water sources even when no scum or cells may be visible (Lam, et al. 1995).

The Sate of Oregon provides a flow chart for determining management action relative to cyanobacteria cell density threshold levels (Stone 2005, Stone and Bress 2006). In a figure excerpted from Stone (2005) a MSAE cell density of 40,000 cells per mL is given as a level to post a water body for recommendation against water contact (Fig. 44), based on the risk of exceeding a microcystin concentration of 8 μg/L. Oregon's posting guidelines (Stone 2005, Stone and Bress 2006) have also been preliminarily adopted by the posting-subcommittee of the Klamath Blue-Green Algae Working Group at its August 29, 2006 meeting (KBGAWG 2006).



Hazard Identification

What species of toxigenic cyanobacteria are present?

What is the density of cells per mL of toxigenic species in the water?

Part A: Is scum visible and associated with toxigenic species?

No: Go to part B

Yes: Post

Part B: Is *Microcystis* or *Planktothrix* present?

No: Is the sum of the potentially toxigenic taxa ≥ 100,000 cells/mL?

- Yes: Post
- No: Do not Post

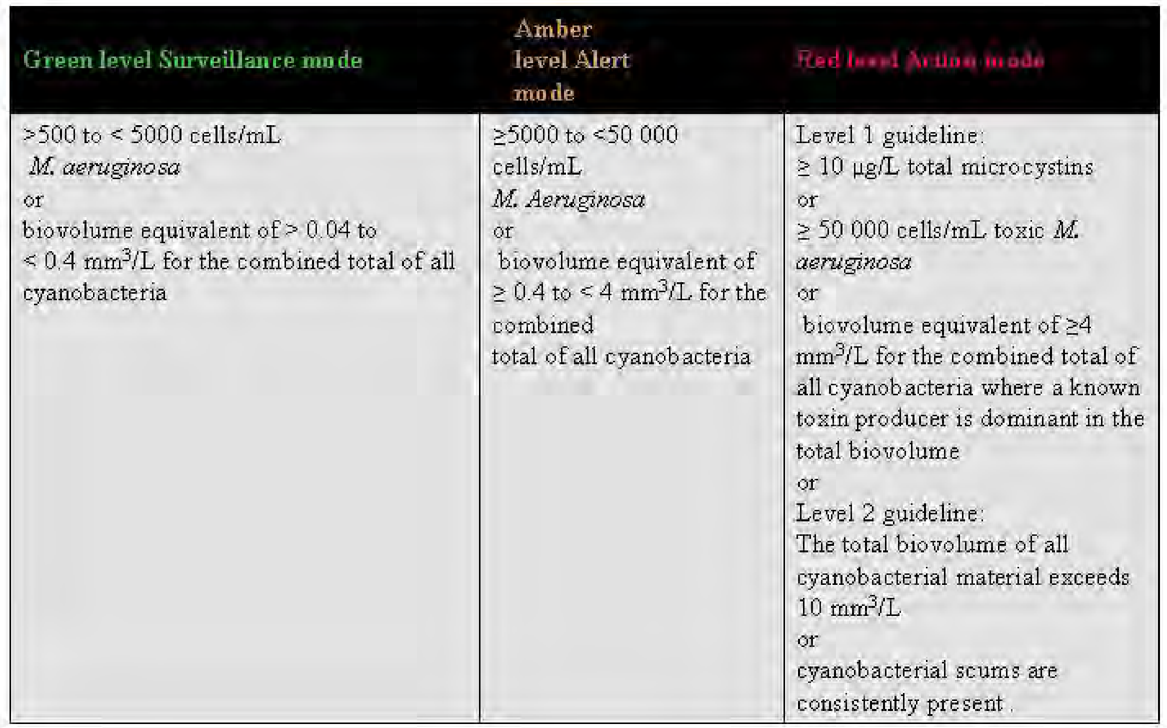
Yes: Is the cell density of *Microcystis* or *Planktothrix* ≥ 40,000 cells/mL?

- Yes: Post
- No: Do not Post

Figure 44. Proposed Oregon Guidance for Recreational Contact with Cyanobacteria

Note that Oregon makes a distinction between MSAE and other cyanobacteria due to relatively higher toxin production at a lower cell count for MSAE than for other cyanobacteria.

A recent Australian document entitled Managing Risks in Recreational Waters (National Health and Medical Research Council [NHMRC] 2005) provides a recent compilation and derivation of recreational guidelines for MSAE. Similar to Oregon, they distinguish between MSAE and other cyanobacterial species (Figure 45).



Green level Surveillance mode	Amber level Alert mode	Red level Action mode
>500 to < 5000 cells/mL *M. aeruginosa* or biovolume equivalent of > 0.04 to < 0.4 mm^3/L for the combined total of all cyanobacteria	≥5000 to <50 000 cells/mL *M. Aeruginosa* or biovolume equivalent of ≥ 0.4 to < 4 mm^3/L for the combined total of all cyanobacteria	Level 1 guideline: ≥ 10 µg/L total microcystins or ≥ 50 000 cells/mL toxic *M. aeruginosa* or biovolume equivalent of ≥4 mm^3/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume or Level 2 guideline: The total biovolume of all cyanobacterial material exceeds 10 mm^3/L or cyanobacterial scums are consistently present.

Figure 45. Australian Guidance for Recreational Contact with Cyanobacteria

Thus, for Australia the "Red Level Action Mode" is where water contact avoidance is recommended and occurs at 50,000 cells/ml of MSAE and 10 µg/L of microcystin. Similar to WHO and Oregon, the presence of cyanobacterial scums also warrants a water contact advisory.

***Recommended Standard*(s)**

Recommended standards are as follows:

Table 11. Proposed *Microcystis aeruginosa* and microcystin criteria for the Klamath River on the Hoopa Valley Indian Reservation.

Parameter	**Proposed Standard**	**Rationale for Proposed**
Microcystis aeruginosa cell density	<5,000 cells/mL for drinking water <40,000 cells/mL for recreational water	Combination of WHO and Oregon guidelines--protective of public health
Microcystin toxin concentration	<1µg/L total microcystins for drinking water <8 µg/L total microcystins for recreational water	Combination of WHO and Oregon guidelines--protective of public health
Total potentially toxigenic blue-green algal species*	>100,000 cells/mL for recreational water	Oregon guidelines--protective of public health
Cyanobacterial scums	There shall be no presence of cyanobacterial scums	Protective of public health, see below

*Includes: *Anabaena, Microcystis, Planktothrix, Nostoc, Coelosphaerium, Anabaenopsis, Aphanizomenon, Gloeotrichia* and *Oscillatoria.*

Justification for Recommended Standard

The above recommended standards for MSAE and microcystin are based upon animal toxicity data for microcystins and incorporate the estimated risk for short term repeated exposure for recreationists (Stone 2005, Stone and Bress 2006) and TDI values for drinking water (Falconer at al 1999). As noted above, Oregon's posting guidelines (Stone 2005, Stone and Bress 2006) have also been adopted by the Klamath Blue-Green Algae Working Group, which includes the NCRWQCB, Yurok Tribe, Karuk Tribe, and Humboldt County, at its August 29, 2006 meeting (KBGAWG 2006). Thus, Hoopa Valley Tribe's proposed standard will be consistent with other public health agencies in the region. The efficacy of these standards is further confirmed by data specific to the Klamath River system, which shows that either the Australian or Oregon microcystin toxin threshold of 8 or 10 μg/L is likely to be exceeded at the MSAE cell density thresholds of 40,000 or 50,000 cells/ml (Kann and Corum 2006).

The cyanobacterial scum standard is necessary because when a scum is visually evident, cell densities have already exceed 100,000 cells/mL. If there is no monitoring/sampling program in place, then the visual presence of a scum is often the first indication of hazardous conditions.

SUGGESTIONS FOR FUTURE STUDIES AND CRITERIA REFINEMENT

Klamath River nutrient standards can be refined and improved in the future by collecting additional data and conducting additional analyses. In this section we provide some ideas as guidance to the Hoopa Valley Tribe as they refine the proposed standards, as well as to other agencies and Tribes as they develop their own nutrient standards for the Klamath River and beyond. These ideas can also be used to guide monitoring that will gauge if the proposed criteria are being met, or if further improvements to water quality are needed.

Data analysis

In developing these proposed standards we have focused on analyzing data at a seasonal scale, primarily summer. It would also be beneficial to analyze data at other time scales, such as monthly, and other time periods, such as fall when fish are spawning.

Multiple regression analyses could be used to see how other parameters that we did not explore here, such as flow, temperature, and weather, combine with nutrients to affect periphyton, pH, and dissolved oxygen.

A complimentary approach to the linear regression analyses of seasonal data that we have conducted here would be to do finer-scale analyses on individual data points rather than averages. For instance, empirical models could be developed to predict the percent likelihood of exceeding a given critical value for pH and D.O, based on varying algal biomass levels. Kann and Smith (1999) developed this type of model for Upper Klamath Lake. This method is good for examining data that are non-linear and that may not be normally distributed.

U.S. EPA (2000b) cites several references for developing periphyton algal species composition metrics. These approaches would likely be applicable to the Klamath River, but were not pursued during the current nutrient criteria development process. In the future, the Hoopa Valley Tribe and/or others may wish to apply the algal species composition metrics to the Klamath River, and set algal species composition criteria. Additional periphyton sampling would be beneficial in assessing inter-annual variability, but there is likely enough existing data to develop algal species composition metrics.

Data collection

No water quality data exist for the Klamath River on the Hoopa Valley Indian Reservation at Saints Rest, located at approximately river mile 45. The proposed criteria in this document are based on relationships developed from water quality measurements taken from other points on the Klamath River and its tributaries. The closest monitoring station is KR04350 (Klamath River at Weitchpec), located approximately 1.5 miles downstream at river mile 43.5. Given the close proximity, it is highly likely that water quality at Weitchpec is very similar to Saints Rest, but samples need be taken to confirm whether or not this is true.

As discussed previously in this document, most of the nutrient samples in the Klamath River have been processed by labs with inadequate reporting limits for many parameters. For instance, many ammonia samples have reporting limits of 0.1 or 0.2 mg/L, yet ammonia can be lethal to salmonids at concentrations several times lower than that. With regard to nutrient criteria development, data with inadequate reporting limits have made it difficult to establish quantitative relationships between nutrients and other parameters (D.O., pH, periphyton, etc.) at low nutrient concentrations. If future studies are to contribute to establishment and refinement of water quality standards, they should meet or exceeded the reporting limits listed in Table 12.

Table 12. Recommended reporting limits for nutrient samples to be used in development of water quality standards on the Klamath River.

Abbreviation	Parameter	Reporting Limit (mg/L)
NH_3	Ammonia	0.01
$NO_3 + NO_2$	Nitrate + Nitrite as N	0.01
TKN	Total Kjeldahl Nitrogen	0.05
PO_4	Orthophosphate	0.01
TP	Total Phosphorus	0.01

Periphyton are clearly a major driver of water quality in the Klamath River and merit further study. The only year in which intensive periphyton sampling has occurred in the Klamath River was 2004. U.S. EPA (2002b) collected some samples at a limited number of sites in 2000, 2001, and 2003. Relationships between periphyton and other parameters (nutrients, D.O., pH) likely vary between years, so having more than one year of data to develop relationships would help to improve the proposed standards. Including large tributaries with relatively unimpaired water quality such as the Trinity and the Salmon River provides an important reference comparison to the Klamath River. Periphyton data are most useful when several samples are collected at the same sites over the growing season, so that peak biomass can be quantified, and insight gained into temporal patterns of growth, senescence, and scour. In 2004, monthly samples were collected from July through September. Extending sampling for another a month or two into the fall would be beneficial. In addition, all periphyton samples collected in the Klamath River should be analyzed for the amount of chlorophyll *a* in samples, as this parameter is critical for nutrient criteria development yet was not analyzed for all 2004 samples.

Little data or no data have been collected on aquatic macrophytes in the Klamath River. Below the Scott River macrophytes are present only in quiet backwater areas (PacifiCorp, 2005). They are known to be common in the Klamath River between the Iron Gate Dam and the Scott River, likely due to the stable nature of the channel in that reach (PacifiCorp, 2005). In that reach, studies should be conducted on the spatial and temporal distribution of aquatic macrophytes to determine how they affect D.O., pH, and nutrients.

IMPLEMENTATION OF NUTRIENT CONTROL STRATEGIES

The Hoopa Valley Tribe is currently participating in two policy processes with major implications for the future of water quality in the Klamath River, and Hoopa Valley Tribe's proposed water quality standards can be used as a tool in both of them. These processes are the Klamath Basin TMDLs and the relicensing/decommissioning of the Klamath Hydroelectric Project.

Klamath Basin TMDLs

The Oregon Department of Environmental Quality (DEQ) and California North Coast Regional Water Quality Control Board (NCRWQCB) are working cooperatively to develop Total Maximum Daily Loads (TMDLs) for the impaired waterbodies in the Klamath Basin, including the Lost River, Klamath Straits Drain and Klamath River from Link River to the Pacific Ocean (St. John, 2004). The TMDL will quantify the natural and human-related sources of the pollutants or stressors that are causing impairment, determine how much of the pollutants or stressors the waterbody can handle while still supporting the designated uses, and it determines how much, if any, the identified sources need to be reduced in order to achieve the target conditions. The Hoopa Tribe has been actively participating in this process and will continue to do so. If Hoopa Valley Tribe's proposed nutrient standards are approved by the Tribal council before the draft Klamath TMDL is completed (currently scheduled for June 2006), the standards will be taken into account as an advisory. If Hoopa Valley Tribe's standards are also approved by the U.S. EPA in time, the TMDL is obligated to take them into account in a mandatory fashion.

Relicensing/Decommissioning of the Klamath Hydroelectric Project

The Klamath Hydroelectric Project (KHP) is operated by PacifiCorp and includes 6 dams on the mainstem Klamath River: Iron Gate, Copco 1, Copco 2, J.C. Boyle, Keno, and Link Dam (listed in upstream order). PacifiCorp's license to operate the KHP expires in March 2006, and in April 2004 PacifiCorp filed its Final License Application (FLA) with the Federal Energy Regulatory Commission (FERC) to apply for a new 30-50 year license. This began a multi-year process in which FERC will write an Environmental Impact Statement and then decide whether to grant PacifiCorp a new license or require that the dams be decommissioned (removed). To obtain a new license, PacifiCorp also needs not only FERC's approval but also Clean Water Act "401" certifications from the states of California and Oregon. If the Hoopa Valley Tribe's water quality standards are approved by the U.S. EPA in time, the state of California will have to take them into account when deciding whether to issue a 401 certification for the project.

CONCLUSION

We recognize the limitations of the available data upon which these standards are based, as well as the variability of the relationships, and expect that these standards may be refined over time. Nonetheless, these proposed criteria were derived using the best available data, followed a logical analytical approach, and provide a reasonable starting point for nutrient criteria for the Klamath River.

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