FINAL 2006
Nutrient Summary Report

Yurok Tribe Environmental Program:
Water Division

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I. Introduction

This report summarizes the presence and concentration of commonly occurring nutrients on the Klamath River and Trinity River within the Yurok Indian Reservation boundaries during water year 2006. The Yurok Tribe Environmental Program (YTEP) collected water samples at several monitoring sites at the mouth of the Trinity River near Weitchpec and from in the Klamath River near Weitchpec to the Klamath River Estuary starting at the end of May and ending in mid-October. This work was performed as part of an effort to track both nutrient temporal and spatial patterns of the Lower Klamath River during the period of time in which water quality is degraded. This data was added to previous years' nutrient data as part of an endeavor to build a multi-year database on the Lower Klamath River. This nutrient summary is part of YTEP's comprehensive program of monitoring and assessment of the chemical, physical, and biological integrity of the Klamath River and its tributaries in a scientific and defensible manner.

II. Background

The Klamath River Watershed

The Klamath River system drains much of northwestern California and south-central Oregon (Figure 1). Thus, even activities taking place on land hundreds miles off the Yurok Indian Reservation (YIR) can affect water conditions within YIR boundaries. For example, upriver hydroelectric and diversion projects have altered natural flow conditions for decades. The majority of water flowing through the YIR is derived from scheduled releases of impounded water from the Upper Klamath Basin that is often of poor quality with regards to human needs as well as the needs of fish and wildlife.

Some historically perennial streams now have ephemeral lower reaches and seasonal fish migration blockages which may be influenced by inadequate dam releases from water diversion projects along the Klamath and Trinity Rivers. The releases contribute to lower mainstem levels and excessive sedimentation which in turn causes subsurface flow and aggraded deltas. Additionally, the lower slough areas of some of the Lower Klamath tributaries that enter the estuary experience eutrophic conditions during periods of low flow. These can create water quality barriers to fish migration when dissolved oxygen levels are inadequate for migrating fish. The Klamath River is on California State Water Resource Control Board's (SWRCB) 303(d) List as impaired for temperature, dissolved oxygen, and nutrients and portions of the Klamath River were recently listed as impaired for microcystin and sedimentation.

The basin's fish habitat has also been greatly diminished in area and quality during the past century by accelerated sedimentation from mining, timber harvest practices, and road construction, as stated by Congress in the Klamath River Act of 1986. Management of private lands in the basin (including fee land within Reservation boundaries) has been, and continues to be, dominated by timber harvest.

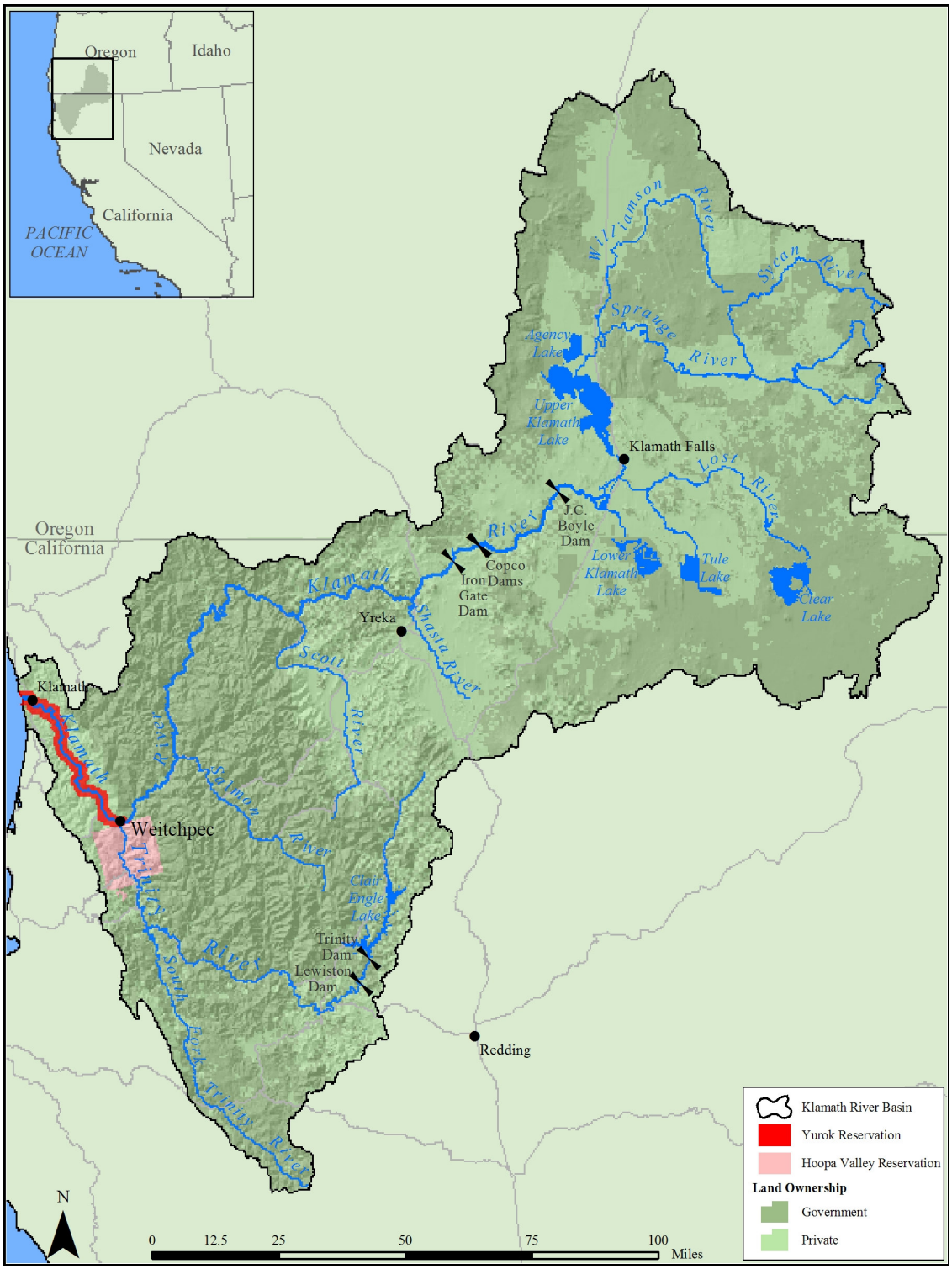

Figure 1. Klamath River Basin Map

The Klamath River

The health of the Klamath River and associated fisheries has been central to the life of the Yurok Tribe since time immemorial fulfilling subsistence, commercial, cultural, and ceremonial needs. Yurok oral tradition reflects this. The Yurok did not use terms for north or east, but rather spoke of direction in terms of the flow of water (Kroeber 1925). The Yurok word for salmon, *nepuy*, refers to "that which is eaten". Likewise, the local waterways and watershed divides have traditionally defined Yurok aboriginal territories. Yurok ancestral land covers about 360,000 acres and is distinguished by the Klamath and Trinity Rivers, their surrounding lands, and the Pacific Coast extending from Little River to Damnation Creek.

The fisheries resource continues to be vital to the Yurok today. The September 2002 Klamath River fish kill, where a conservative estimate of 33,000 fish died in the lower Klamath before reaching their natal streams to spawn, was a major tragedy for the Yurok people.

The Yurok Indian Reservation

The current YIR consists of a 59,000-acre corridor extending for one mile from each side of the Klamath River from just upstream of the Trinity River confluence to the Pacific Ocean, including the channel and the bed of the river (Figure 2). There are approximately two dozen major anadromous tributaries within that area. The mountains defining the river valley are as much as 3,000 feet high. Along most of the river, the valley is quite narrow with rugged steep slopes.

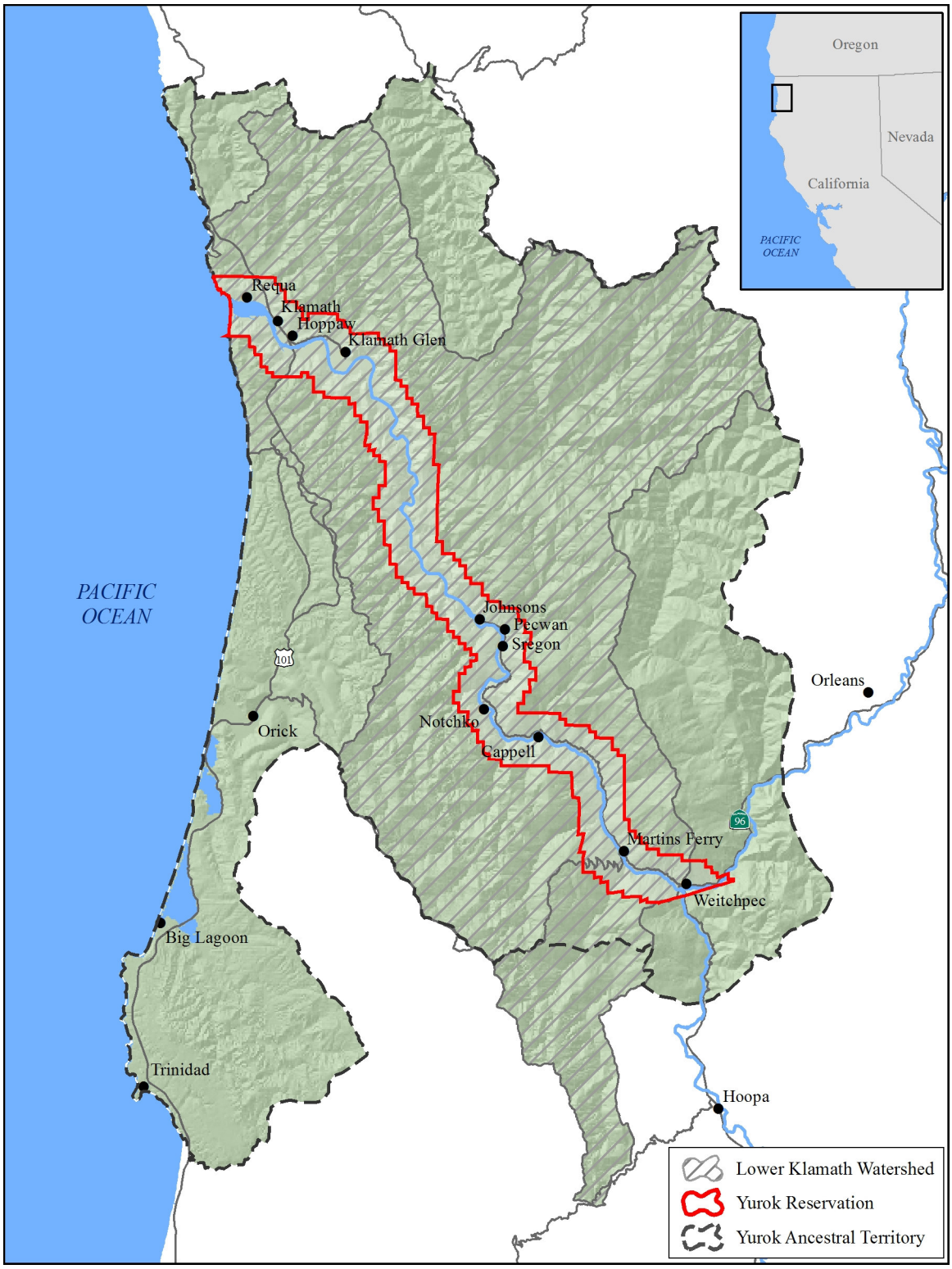

Figure 2. Yurok Indian Reservation and Yurok Ancestral Territory Map

The vegetation is principally redwood and Douglas fir forest with little area available for agricultural development. Historically, prevalent open prairies provided complex and diverse habitat.

At this time within the reservation, 3,653 acres are held in trust status, 115 acres are Tribal Housing, 4,222 acres are Tribal fee lands and 3,499 acres are allotments (Yurok Tribal Planning Department). The majority of the remaining lands in the YIR are fee lands, (mostly owned by Green Diamond Resource Company), which are managed intensively for timber products. A small portion of the YIR consists of public lands managed by Redwood National/State Parks (RNSP), the United States Forest Service (USFS) and private landholdings.

Yurok Tribe Water Monitoring Division

In 1998, YTEP was created to protect and restore tribal natural resources through high quality scientific practices. YTEP is dedicated to improving and protecting the natural and cultural resources of the Yurok Tribe through collaboration and cooperation with local, private, state, tribal, and federal entities such as the Yurok Tribe Fisheries Program (YTFP), US Fish and Wildlife Service (USFWS), the United States Environmental Protection Agency (USEPA), Green Diamond Resource Company, the NCRWQCB, and the United States Geological Survey (USGS). A USEPA General Assistance Program (GAP) Grant and funding allocated under the Clean Water Act Section 106 and funding from the State of California primarily fund YTEP's water monitoring activities.

III. Methods

Grab samples, discreet surface water samples, were collected during the sampling season twice a month beginning in May and ending in October. Samples were delivered to the same lab during the 2006 season in an effort to maintain consistency in laboratory methods. Samples were delivered to Aquatic Research Inc. in Seattle, WA. The parameters sampled are shown in Table 1.

Upon arrival at each site, a sampling churn was rinsed three times with distilled water. After rinsing with distilled water, the churn was rinsed three times with stream water. The churn was then fully submerged into the stream and filled to the lid with sample water. Completely filling the churn allowed for all samples to be filled from one churn; thereby minimizing differences in water properties and quality between samples.

Proper use of the churn guaranteed the water was well mixed before the sample was collected. The churn was stirred at a uniform rate by raising or lowering the splitter at approximately 9 inches per second. This mixing continued while the bottles were being filled. If filling had stopped for some reason, the stirring rate was resumed before the next sample was drawn from the churn.

The sample bottles and chemical preservatives used were provided by the contract lab and were considered sterile prior to field usage. Sample bottles without chemical preservatives were rinsed with stream water from the churn once before filling with sample water. In the case of bottles that contained chemical preservatives, bottles were not rinsed before sample collection and care was taken to avoid over-spillage that would result in chemical preservative loss. Collected samples were placed in coolers on wet ice for transport to the contract lab for analysis.

Additional quality control measures were included in the sampling. At one site per sampling event a duplicate split sample and a blank sample were sent to the laboratory to assess laboratory precision and to gain improved confidence in the data.

Table 1. Parameters sampled on the Klamath River during WY06

Analytes
Nitrate + Nitrite
Total Nitrogen
Ammonia
Total Phosphorus
Soluble Reactive Phosphorous
Total Alkalinity
Calcium
Chlorophyll-a
Pheophytin-a
Magnesium
Non-Filterable Residue
Total Dissolved Solids
Total Organic Carbon

Environmental information was also recorded at the time water samples were collected. The data included water temperature, pH, specific conductance, dissolved oxygen and other observational notes. Chain-of-custody (COC) sheets were also filled out to document the handling of the samples from the time of collection to the time of laboratory analysis. This is a standard procedure for handling samples.

IV. Site Selection

In general, the various sampling locations were chosen in order to represent the average ambient water conditions throughout the water column. The sites listed below in bold indicate established sampling locations for the collection of water samples for nutrient analysis May through October.

YTEP collected water samples for nutrient analysis at the following mainstem Klamath River locations (Figure 3) (river miles are approximate):

- **WE - Klamath River at Weitchpec (upstream of Trinity River) – RM 43.5**
- **KBW - Klamath River below Weitchpec RM 42.5**
- **TG - Klamath River at Turwar Boat Ramp – RM 6**
- **LES - Lower Estuary Surface – RM 0.5**
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YTEP collected water samples for nutrient analysis at the following major tributary locations:

- **TR - Trinity River near mouth (above Klamath River confluence) – RM 0.5**

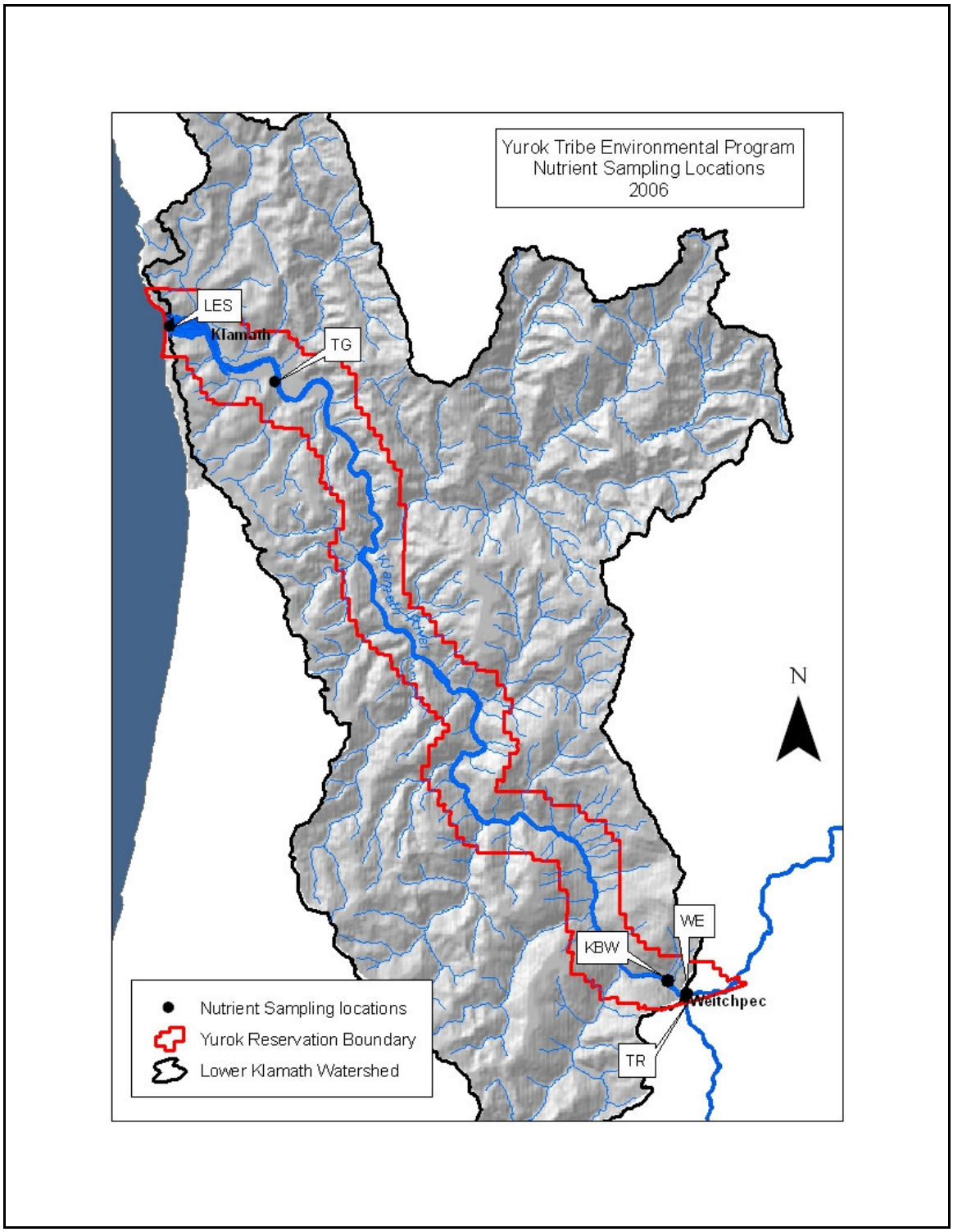

Figure 3. Map of Nutrient Sampling Sites for WY06

V. Quality Assurance

During this study, many quality assurance and quality control (QA/QC) measures were undertaken to ensure the grab sample data that was collected was of the highest quality. YTEP performs all surface water quality monitoring activities consistent with its Quality Assurance Program Plan that was approved by the USEPA in April 2001. Quality control of the collection, preparation and analysis of water samples for presence of nutrients and related analytes was achieved by following a standard water sample collection protocol using a churn sampler and submitting samples to labs that follow strict protocol that have QA/QC measures.

All field personnel that were involved in collection of water samples have been trained appropriately by the Water Division Program Manager and are properly supervised to ensure proper protocol is followed consistently throughout the monitoring season. Each field visit requires that staff fill out field data sheets and label samples appropriately in the field. Sampling is always conducted by at least two staff for safety reasons and to maintain consistency. Field crews collecting samples ensured representativeness of samples by selecting sites that have free-flowing water from established sampling locations and using a churn splitter to mix sample water once collected. All samples were transported to the appropriate laboratories following chain of custody procedures to ensure proper handling of the samples.

The collection and analysis of field replicate samples were performed on a monthly basis to determine the labs' precision of data. Field replicates were collected by splitting samples in the field using the churn splitter. One of the split samples was sent with its' associated split with a different ID code for analysis of both nutrients and related analytes so as to not alert lab staff of the fact that the samples were replicates.

Blank results from the 2006 sampling season indicate that there is no significant issue with contamination of samples in the field or laboratory. It is not believed that cross contamination between sites influences results because the stream sample will overwhelm any minute presence of nutrients and related analytes that could be present after the churn is rinsed three times with distilled water and with stream water at the next sampling site.

Data is thoroughly reviewed once received from the laboratory. YTEP is the primary organization responsible for data review, although the professional laboratories analyzing water quality samples will also note potential problems with outliers or other anomalies in sample results. Information regarding QA/QC procedures for the laboratory is available upon request. One hundred percent of laboratory-generated data was checked on receipt by the Project Manager for consistency and acceptability, including whether replicates are within specified targets and meet data quality objectives. Outliers will be identified and removed from the dataset if deemed necessary by the QA Officer. Water temperature, conductivity, pH and dissolved oxygen are measured in the field when samples are collected and values of these hand-held measurements can be used to check field conditions at the time of sampling.

The data manager will visually inspect all entered data sets to check for inconsistencies with original field or laboratory data sheets. Where inconsistencies are encountered, data will be re-entered and re-inspected until the entered data is found to be satisfactory or results will be discarded. The Project Manager will maintain field

datasheets and notebooks in the event that the QA Officer needs to review any aspect of sampling for QA/QC purposes.

The Yurok Tribe received a grant under the Environmental Information Exchange Network Program and used it to develop the Yurok Tribe Environmental Data Storage System (YEDSS). Nutrient data covered in this report have been entered in YEDSS and will be uploaded into USEPA's STORET database via the internet using the Water Quality Exchange.

VI. Results

Nitrite + Nitrate

The Klamath River at Weitchpec (WE), the Klamath River below Weitchpec (KBW), the Klamath River at the Turwar boat ramp (TG), and the Trinity River near the mouth (TR) sites nitrite plus nitrate results show a trend of falling concentrations from mid-May to mid-July, at which time results for WE, KBW, and TR were below reporting limits (Table 3, Figure 4). Concentrations for TG, while above reporting limits, continued to fall into late August, at which time results generally rose until sampling was suspended in mid-October. Concentrations at WE and KBW held steady at, or near, reporting limits until mid-October, at which time concentrations rose sharply. TR returned results below reporting limits from mid-July until sampling was suspended for the season. Sampling at the Lower Estuary Surface (LES) occurred three times from September 6th to October 4th. All three sampling events showed concentrations holding steady, ranging from 0.012 to 0.016 mg/L. Overall, TR returned the lowest concentrations throughout the year, with TG returning the highest concentrations throughout a majority of the sampling period.

Nitrite plus nitrate concentrations at the 2006 monitoring sites ranged from less than 0.010 mg/L to 0.116 mg/L. The site with the lowest concentration yet still above reporting limits was KBW on September 20, 2006. The site that yielded the highest concentration was WE on October 18, 2006. The reporting limit for nitrate plus nitrite was 0.010 mg/L. If a site generated a reading below this number, ND (No Detect) was entered into the database for this date and parameter, indicating that the results were below the reporting limit. For graphing purposes, ½ of the reporting limit (0.005 mg/L) was used when this occurred.

Total Nitrogen

WE, KBW, and TG exhibited a similar pattern of falling concentrations of total nitrogen from mid-May to mid-July, at which time concentrations rose until late August/early September (Table 3, Figure 5). At that time there was a slight decrease in concentrations, however, by late September concentrations were on the rise and continued in this way until sampling was suspended in mid-October. The exception was TR, which exhibited falling concentrations from mid-May to mid-July, at which time results were below the reporting limit of 0.100 mg/L for the rest of the sampling season. LES was sampled three times from September 6th to October 4th. The results for LES show a sharp spike during the second sampling event in mid-September. At the end of the field season; WE and KBW had rising concentrations, while TG and TR's results

were holding steady. During peak concentrations from early to mid-October, the upriver sites yielded higher concentrations of total nitrogen than lower reaches, with the WE site exhibiting the highest concentrations and TG the lowest concentrations. Again, the exception was TR, which consistently tested below the reporting limits from mid-July until mid-October.

Total nitrogen concentrations at the 2006 monitoring sites ranged from less than 0.100 mg/L to 0.492 mg/L. The site with the lowest concentration above reporting limits was TR on July 18, 2006. The site with the highest concentration was WE on October 18, 2006. If a site generated a reading below the reporting limit, ND (No Detect) was entered into the database for this date and parameter, indicating that the results were below the minimum reporting value. For graphing purposes, ½ of the reporting limit (0.050 mg/L) was used when this occurred.

Ammonia

Ammonia results for all sites exhibited falling concentrations from mid-May to mid-July, at which time WE, KBW, and TR returned results below the reporting limit of 0.010 mg/L for the rest of the sampling season (Table 3, Figure 6). TG exhibited a spike in mid-September, but returned to concentrations below reporting limits by early October. LES was sampled three times from September 6th to October 4th, showing falling concentrations throughout this period.

Ammonia concentrations for the 2006 monitoring season ranged from less than 0.010 mg/L to 0.040 mg/L. The site with the lowest concentration above the reporting limit was WE on May 23, 2006. The site with the highest concentrations was TR on May 23, 2006 and LES on September 6, 2006. If a site generated a reading below the reporting limit, ND (No Detect) was entered into the database for this date and parameter, indicating that the results were below the reporting limit. For graphing purposes, ½ of the reporting limit (0.005 mg/L) was used when this occurred.

Total Phosphorous

Total phosphorous trends were similar for all sites except LES, with falling concentrations from mid-May to mid-July, and rising concentrations throughout the rest of the season (Table 3, Figure 7). LES was sampled three times from September 6th to October 4th, exhibiting a rise in concentrations similar to all other sites during this period. Total Phosphorus followed a similar trend as total nitrogen, upriver sites tended to generate higher concentrations of total phosphorous than downriver sites, with WE generally returning the highest concentrations and TG the lowest concentrations.

Total phosphorous concentrations for the 2006 monitoring season ranged from 0.007 mg/L to 0.126 mg/L. The site with the lowest concentration was TR on August 23, 2006. The site with the highest concentration was TR on May 23, 2006. No sites yielded total phosphorous concentrations below the reporting limit of 0.002 mg/L for the 2006 sampling season.

Soluble Reactive Phosphorous (SRP)

SRP for all sites except LES showed comparable trends with falling concentrations occurring from mid-May to mid-July, followed by rising concentrations until late August. At this time there was a small decrease in concentrations until early

September, with rising concentrations for the rest of the sampling season (Table 3, Figure 8). LES was sampled three times from September 6th to October 4th, exhibiting an overall increase in SRP concentration during this period. As with total nitrogen and total phosphorous concentrations, the upriver sites generally yielded higher SRP concentrations than downriver sites.

SRP concentrations for the 2006 monitoring season ranged from 0.001 mg/L to 0.076 mg/L. The site with the lowest concentration was TR on July 18, 2006, while WE yielded the highest concentration on October 18, 2006. No sites exhibited soluble reactive phosphorous concentrations below the reporting limit of 0.001 mg/L for the 2006 sampling season.

Alkalinity

Trends and results for alkalinity concentrations during the 2006 monitoring season were very similar throughout the entire sampling season (Table 4, Figure 9). All sites except TR returned rising concentrations from sampling inception in mid-May until sampling suspension in mid-October. TR's results for this time period indicate it was holding steady near 76.0 mg/L $CaCO_3$. As with total nitrogen, total phosphorous, and SRP concentrations, the upriver sites generally yielded higher alkalinity concentrations than downriver sites.

WE produced the highest concentration of the 2006 monitoring season with a reading of 90.2 mg/L $CaCO_3$ on October 18, 2006. The lowest concentration recorded during the 2006 sampling season was 46.6 mg/L $CaCO_3$ at TR on May 23, 2006. No sites exhibited alkalinity concentrations below the reporting limit of 1.0 mg/L $CaCO_3$ for the 2006 monitoring season. LES was not tested for alkalinity concentrations during the 2006 monitoring season.

Calcium

Trends and results for calcium concentrations at all sites were similar throughout the 2006 sampling season (Table 4, Figure 10). Results for calcium concentrations during the 2006 sampling season were very different from other parameters tested with TR exhibiting the highest concentrations throughout the season and downriver sites returning higher concentrations than upriver sites. The lowest concentrations were displayed at the beginning of the monitoring season with low readings of 8.94 mg/L recorded at WE on May 23, 2006. The highest calcium concentrations were exhibited in late August, with the highest concentration of 16.6 mg/L recorded at TR on August 23, 2006. No sites exhibited calcium concentrations below the reporting limit of 0.1 mg/L for the 2006 monitoring season. LES was not tested for calcium concentrations during the 2006 monitoring season.

Chlorophyll-a

Chlorophyll-*a* trends were broadly similar for all sites except TR and LES, with the largest peaks occurring mid to late August (Table 4, Figure 11). This peak was following by falling concentrations until late September, at which time concentrations rose until sampling was suspended in mid-October. TR exhibited falling concentrations from mid-May to mid-July, after which, concentrations slowly rose until sampling was

suspended for the season. LES was sampled three times from September 6th to October 4th. It exhibited a trend very similar to WE, KBW, and TG during this period.

Chlorophyll-*a* concentrations for the 2006 monitoring season ranged from 0.8 µg/L to 9.9 µg/L. The site with the lowest concentration was TR on July 18, 2006. The site with the highest concentration was WE on August 23, 2006. No site exhibited chlorophyll-*a* concentrations below the reporting limit of 0.1 µg/L for the 2006 sampling season.

Pheophytin-a

Pheophytin-*a* trends for WE, KBW, and TG were broadly similar during the 2006 season. Concentrations fell from mid-May to mid-July, followed by an increase in concentrations until early September (Table 4, Figure 12). At this time concentrations fell until late September, at which time they generally increased until sampling was suspended in mid-October. Concentrations at TR fell from mid-May until mid August, at which time results were below the reporting limit of 0.1 µg/L. Concentrations at TR stayed at these levels until sampling was suspended in mid-October. LES was sampled three times from September 6th to October 4th. Results for all three sampling events at LES were steady at 1.9 µg/L.

Pheophytin-*a* concentrations for the 2006 monitoring season ranged from less than 0.1 µg/L to 7.6 µg/L. The site with the lowest concentration above the reporting limit was 0.5 µg/L at TR and TG on July 18, 2006. The site with the highest concentration was WE on October 18, 2006. The reporting limit for pheophytin-*a* was 0.1 µg/L. If a site generated a reading below this number, ND (No Detect) was entered into the database for this date and parameter, indicating that the results were below the reporting limit. For graphing purposes, ½ of the reporting limit (0.05 µg/L) was used when this occurred.

Magnesium

Trends and results for magnesium concentrations during the 2006 monitoring season were similar among all sites yielding results between a low of 4.93 mg/L at WE on May 23, 2006 and a high of 8.22 mg/L at WE on August 23, 2006 (Table 4, Figure 13). Peak concentrations for all sites occurred in late August. No site exhibited magnesium concentrations below the reporting limit of 0.1 mg/L for the 2006 monitoring season. LES was not sampled for magnesium concentrations during the 2006 monitoring season.

Non-Filterable Residue (TSS)

Non-filterable residue, also known as total suspended solids (TSS), trends and results were similar for all sites tested during the sampling season (Table 4, Figure 14). Concentrations fell from season highs in mid-May until mid-July, fluctuating very little after mid-July. All sites exhibited slight increases at the end of the sampling season.

TSS concentrations for the 2006 monitoring season ranged from less than 0.50 mg/L to 101.0 mg/L. The site with the lowest concentration above the reporting limit was TR on October 18, 2006. The site with the highest concentration was TR on May 23, 2006. The reporting limit for TSS was 0.50 mg/L. If a site generated a reading below this number, ND (No Detect) was entered into the database for this date and parameter,

indicating that the results were below the reporting limit. For graphing purposes, ½ of the reporting limit (0.25 mg/L) was used when this occurred. LES was not sampled for TSS during the 2006 monitoring season.

Total Dissolved Solids (TDS)

TDS trends for all sites were similar throughout the sampling season (Table 4, Figure 15) with all sites except TR generally increasing in concentration throughout the season. TR experienced a small decrease in concentration in mid-August, but continued to rise after this until sampling was suspended in mid-October.

TDS concentrations for the 2006 monitoring season ranged from 77.0 mg/L to 143.0 mg/L. The lowest concentration was at TR on May 23, 2006 while the highest concentration was at WE on October 18, 2006. No site exhibited concentrations less than the reporting limit of 5.0 mg/L for the 2006 monitoring season. LES was not sampled for TDS during the 2006 monitoring season.

Total Organic Carbon (TOC)

TOC concentrations for all sites varied throughout the sampling season. WE concentrations rose from mid-May to mid-September, after which concentrations fell until mid-October. KBW concentrations fell from mid-May to mid-July, but thereafter rose until mid-October. TG concentrations rose from mid-May to mid-July, dropped slightly until late August, and then rose until mid-October. TR concentrations dropped from mid-May to mid-July, rose until late August, and then fell until mid-October. LES was only sampled once for TOC, returning the highest concentration of TOC recorded for the season in late September.

TOC concentrations for the 2006 monitoring season ranged from 0.93 mg/L to 4.22 mg/L. The lowest concentration was recorded at TR on October 18, 2006. The highest concentration was recorded at LES on September 20, 2006. No site exhibited concentrations less than the reporting limit of 0.250 mg/L during the 2006 monitoring season.

VII. Discussion

Spatial Patterns

In a large watershed such as the Klamath Basin, in which water coming out of Upper Klamath Lake and that being released from upriver dams in the summer is very low quality, full of algae, and high in nutrients; nutrient concentrations decline as the river flows downstream. This decline occurs for three reasons: dilution, periphyton growth, and denitrification.

Dilution

This process has the largest affect on the concentration of nutrients in the Klamath River. Even if nutrients were not being used by other components of the river system, nutrient concentrations would still decline as the river flows downstream due to an influx of cleaner, cooler, higher-quality water from tributaries into low-quality Klamath River water (Water Quality Control Plan: Hoopa Valley Reservation, 2008).

Periphyton Growth

Periphyton, also known as benthic or attached algae, removes nutrients dissolved in water and uses them to facilitate biochemical processes involved in cellular growth. While periphyton can improve water quality by removing nutrients from the water, it can also contribute to water quality degradation by re-releasing the nutrients into the river system during decomposition (Water Quality Control Plan: Hoopa Valley Reservation, 2008). Luxuriant periphyton growth also causes large swings in pH and dissolved oxygen over the course of the day as biochemical processes increase and decrease in accordance with the rise and fall of the sun. Such small-scale changes, however, are out of the scope of this report due to two week, and not hourly, sampling intervals.

Denitrification

Denitrification occurs when certain organisms convert nitrate (NO_3) to atmospheric nitrogen (N_2). This change from a usable form of nitrogen (nitrate) into an unusable form (atmospheric nitrogen) limits and reduces productivity for organisms that require the usable form of nitrogen for growth and reproduction (Water Quality Control Plan: Hoopa Valley Reservation).

Temporal Patterns

The Klamath River's nutrient concentrations also vary by time of year. During winter and spring, concentrations are low due to high flows from Upper Klamath Lake, and subsequently, released water from upriver dams; and high flows in the tributaries that feed the Klamath River throughout its course to the ocean. These concentrations rise throughout the summer and peak in the fall as flows decrease throughout the summer and rainfall is at it lowest in the late summer/early fall.

Nutrient Criteria

In order to determine when water quality has reached detrimental levels, agreed upon baseline criteria must be established by those involved in the analysis of the collected data. To address this need, the Hoopa Valley Indian Reservation Riparian Review Committee, in conjunction with the Hoopa Valley Tribal EPA, has established nutrient criteria standards (Table 2) for surface waters on the Hoopa Valley Reservation. This includes the Klamath River, which intersects the northwest corner of the reservation. In this report, these nutrient criteria standards are applied to the information collected in 2006. The Hoopa Valley Tribe has not set standards for all nutrients analyzed by YTEP, therefore, nutrient standards to be discussed will be limited to total nitrogen and total phosphorous.

Total Nitrogen

The Hoopa Valley Tribe EPA has set the proposed standard for total nitrogen at 0.2 mg/L (Table 2, red line in Figure 5). As can be seen in Table 2 and Figure 5, all sites but TR exceeded this standard for most of the year. During peak concentrations, most sites were yielding results that were 1.5 to 2.5 times greater than the minimum standard set by the Hoopa Tribe. The three exceptions are TG on July 18, 2006; KBW on July 18, 2006; and KBW on September 20, 2006. TR concentrations were below the standard set by the Hoopa Tribe for the entire monitoring season.

Total Phosphorous

The Hoopa Valley Tribe EPA has set the proposed standard for phosphorous at 0.035 mg/L (Table 2, red line in Figure 7). As can be seen in Table 2 and Figure 7, most sites, except TR, tested above this standard for most of the year. During peak concentrations sites were returning results that were 1.5 to 3 times greater than the minimum standard of 0.035 mg/L set by the Hoopa Valley Tribe. The two exceptions are TG on July 18, 2006, and KBW on July 18, 2006. TR concentrations were below the standards set by the Hoopa Tribe for most of the season except mid-May, when TR yielded the highest concentration of total phosphorous out of all sites for the entire sampling season.

Table 2. Nutrient Standards for the Klamath River (based on data from Hoopa Tribe EPA, 2008)

Parameter	Water Quality Standard (mg/L)
Total Nitrogen	0.2
Total Phosphorous	0.035

The results from total nitrogen and total phosphorous indicate that nutrient levels in the Lower Klamath River are much higher than water quality standards recognized as acceptable levels to meet beneficial uses.

Table 3. Nutrient Results for Yurok Reservation, 2006

Nutrients

Nitrate +Nitrite mg/L; Report Limit: 0.010	Site	Date 5/23/2006	6/20/2006	6/27/2006	7/18/2006	8/23/2006	9/6/2006	9/20/2006	10/4/2006	10/18/2006
	WE	0.056	DNS	DNS	ND	ND	ND	ND	ND	0.116
	KBW	0.042	DNS	DNS	ND	ND	ND	0.01	ND	0.085
	TG	0.042	DNS	DNS	0.024	0.020	0.034	0.026	0.040	0.043
	LES	DNS	DNS	DNS	DNS	DNS	0.012	0.016	0.015	DNS
	TR	0.018	DNS	DNS	ND	ND	DNS	ND	DNS	ND

Total Nitrogen mg/L; Report Limit 0.100	Site	5/23/2006	6/20/2006	6/27/2006	7/18/2006	8/23/2006	9/6/2006	9/20/2006	10/4/2006	10/18/2006
	WE	0.300	DNS	DNS	0.208	0.347	0.228	0.286	0.350	0.492
	KBW	0.297	DNS	DNS	0.161	0.266	0.219	0.198	0.296	0.384
	TG	0.281	DNS	DNS	0.120	0.243	0.297	0.264	0.273	0.272
	LES	DNS	DNS	DNS	DNS	DNS	0.257	0.453	0.278	DNS
	TR	0.175	DNS	DNS	ND	ND	DNS	ND	DNS	ND

Ammonia Nitrogen mg/L; Report Limit: 0.010	Site	5/23/2006	6/20/2006	6/27/2006	7/18/2006	8/23/2006	9/6/2006	9/20/2006	10/4/2006	10/18/2006
	WE	0.016	DNS	DNS	ND	ND	ND	ND	ND	ND
	KBW	0.019	DNS	DNS	ND	ND	ND	ND	ND	ND
	TG	0.023	DNS	DNS	ND	ND	ND	0.020	ND	ND
	LES	DNS	DNS	DNS	DNS	DNS	0.040	0.035	ND	DNS
	TR	0.040	DNS	DNS	ND	ND	DNS	ND	DNS	ND

Table 3 (contd.) Nutrient Results for Yurok Reservation, 2006

Total Phosphate Phosphorous	**Site**	5/23/2006	6/20/2006	6/27/2006	7/18/2006	8/23/2006	9/6/2006	9/20/2006	10/4/2006	10/18/2006
mg/L; Report Limit: 0.002	WE	0.059	DNS	DNS	0.037	0.072	0.081	0.081	0.092	0.099
	KBW	0.065	DNS	DNS	0.029	0.056	0.055	0.060	0.081	0.075
	TG	0.07	DNS	DNS	0.024	0.043	0.049	0.047	0.055	0.056
	LES	DNS	DNS	DNS	DNS	DNS	0.049	0.051	0.058	DNS
	TR	0.126	DNS	DNS	0.008	0.007	DNS	0.008	DNS	0.012

Soluble Reactive Phosphorous	**Site**	5/23/2006	6/20/2006	6/27/2006	7/18/2006	8/23/2006	9/6/2006	9/20/2006	10/4/2006	10/18/2006
mg/L; Report Limit: 0.001	WE	0.023	DNS	DNS	0.023	0.063	0.059	0.063	0.073	0.076
	KBW	0.017	DNS	DNS	0.011	0.043	0.040	0.046	0.052	0.056
	TG	0.016	DNS	DNS	0.010	0.028	0.026	0.030	0.032	0.038
	LES	DNS	DNS	DNS	DNS	DNS	0.029	0.038	0.036	DNS
	TR	0.007	DNS	DNS	0.001	0.004	DNS	0.003	DNS	0.003

Table 4. Other Analytes Results, Yurok Reservation, 2006

Other Analytes										
		Date								
Alkalinity	**Site**	5/23/2006	6/20/2006	6/27/2006	7/18/2006	8/23/2006	9/6/2006	9/20/2006	10/4/2006	10/18/2006
mg/L CaCO3; Report Limit: 1.0	WE	49.0	DNS	DNS	76.2	85.1	DNS	90.1	DNS	90.2
	KBW	48.4	DNS	DNS	73.3	83.0	DNS	84.7	DNS	87.0
	TG	50.0	DNS	DNS	74.8	83.9	DNS	86.2	DNS	88.0
	LES	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS
	TR	46.6	DNS	DNS	68.0	78.3	DNS	76.2	DNS	76.1
Calcium	**Site**	5/23/2006	6/20/2006	6/27/2006	7/18/2006	8/23/2006	9/6/2006	9/20/2006	10/4/2006	10/18/2006
mg/L; Report Limit: 0.1	WE	8.94	DNS	DNS	13.2	14.0	DNS	13.7	DNS	14.1
	KBW	9.11	DNS	DNS	13.5	15.1	DNS	14.1	DNS	14.3
	TG	9.86	DNS	DNS	14.1	14.8	DNS	14.3	DNS	14.7
	LES	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS
	TR	9.86	DNS	DNS	14.1	16.6	DNS	14.6	DNS	15.0
Chlorophyll a	**Site**	5/23/2006	6/20/2006	6/27/2006	7/18/2006	8/23/2006	9/6/2006	9/20/2006	10/4/2006	10/18/2006
µg/L; Report Limit: 0.1	WE	3.2	DNS	DNS	4.3	9.9	3.5	2.4	3.7	8.8
	KBW	3.7	DNS	DNS	3.2	4.5	2.7	1.9	3.5	5.9
	TG	3.2	DNS	DNS	3.7	7.7	3.7	2.7	4.0	4.5
	LES	DNS	DNS	DNS	DNS	DNS	1.9	1.1	2.4	DNS
	TR	3.7	DNS	DNS	0.8	1.1	DNS	1.1	DNS	2.4
Pheophytin a	**Site**	5/23/2006	6/20/2006	6/27/2006	7/18/2006	8/23/2006	9/6/2006	9/20/2006	10/4/2006	10/18/2006
µg/L; Report Limit: 0.1	WE	3.2	DNS	DNS	1.1	1.3	1.6	1.3	3.4	7.6
	KBW	2.6	DNS	DNS	0.9	1.0	1.3	1.0	2.7	4
	TG	4.3	DNS	DNS	0.5	1.6	2.6	1.8	3.8	2.6
	LES	DNS	DNS	DNS	DNS	DNS	1.9	1.9	1.9	DNS
	TR	4.1	DNS	DNS	0.5	ND	DNS	ND	DNS	ND

Table 4(contd.). Other Analytes Results, Yurok Reservation, 2006

Magnesium	**Site**	5/23/2006	6/20/2006	6/27/2006	7/18/2006	8/23/2006	9/6/2006	9/20/2006	10/4/2006	10/18/2006
mg/L; Report Limit: 0.1	WE	4.93	DNS	DNS	5.35	8.22	DNS	5.90	DNS	6.29
	KBW	5.18	DNS	DNS	5.28	8.04	DNS	5.75	DNS	6.22
	TG	5.60	DNS	DNS	5.26	7.84	DNS	5.91	DNS	6.21
	LES	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS
	TR	6.09	DNS	DNS	5.22	7.97	DNS	5.38	DNS	5.65

Non-Filterable Residue (TSS)	**Site**	5/23/2006	6/20/2006	6/27/2006	7/18/2006	8/23/2006	9/6/2006	9/20/2006	10/4/2006	10/18/2006
mg/L; Report Limit: 0.50	WE	33	DNS	DNS	3.2	5.0	DNS	2.3	DNS	5.0
	KBW	49	DNS	DNS	8.7	4.7	DNS	1.8	DNS	4.5
	TG	45	DNS	DNS	2.3	5.0	DNS	3.5	DNS	7.3
	LES	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS
	TR	101	DNS	DNS	2.5	0.63	DNS	ND	DNS	0.50

Total Dissolved Solids (TDS)	**Site**	5/23/2006	6/20/2006	6/27/2006	7/18/2006	8/23/2006	9/6/2006	9/20/2006	10/4/2006	10/18/2006
mg/L; Report Limit: 5	WE	82.0	DNS	DNS	127	140	DNS	133	DNS	143
	KBW	83.5	DNS	DNS	112	125	DNS	134	DNS	132
	TG	81.5	DNS	DNS	128	126	DNS	135	DNS	130
	LES	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS
	TR	77.0	DNS	DNS	103	121	DNS	102	DNS	126

Total Organic Carbon	**Site**	5/23/2006	6/20/2006	6/27/2006	7/18/2006	8/23/2006	9/6/2006	9/20/06	10/4/06	10/18/06
mg/L; Report Limit: 0.250	WE	2.75	DNS	DNS	2.97	3.07	DNS	3.27	DNS	3.10
	KBW	2.48	DNS	DNS	2.14	2.45	DNS	2.56	DNS	3.40
	TG	1.84	DNS	DNS	2.03	1.83	DNS	2.21	DNS	3.90
	LES	DNS	DNS	DNS	DNS	DNS	DNS	4.22	DNS	DNS
	TR	1.59	DNS	DNS	1.00	1.17	DNS	1.13	DNS	0.93

DNS = Did not Sample ND=No Detect FLAG = Outlier was removed

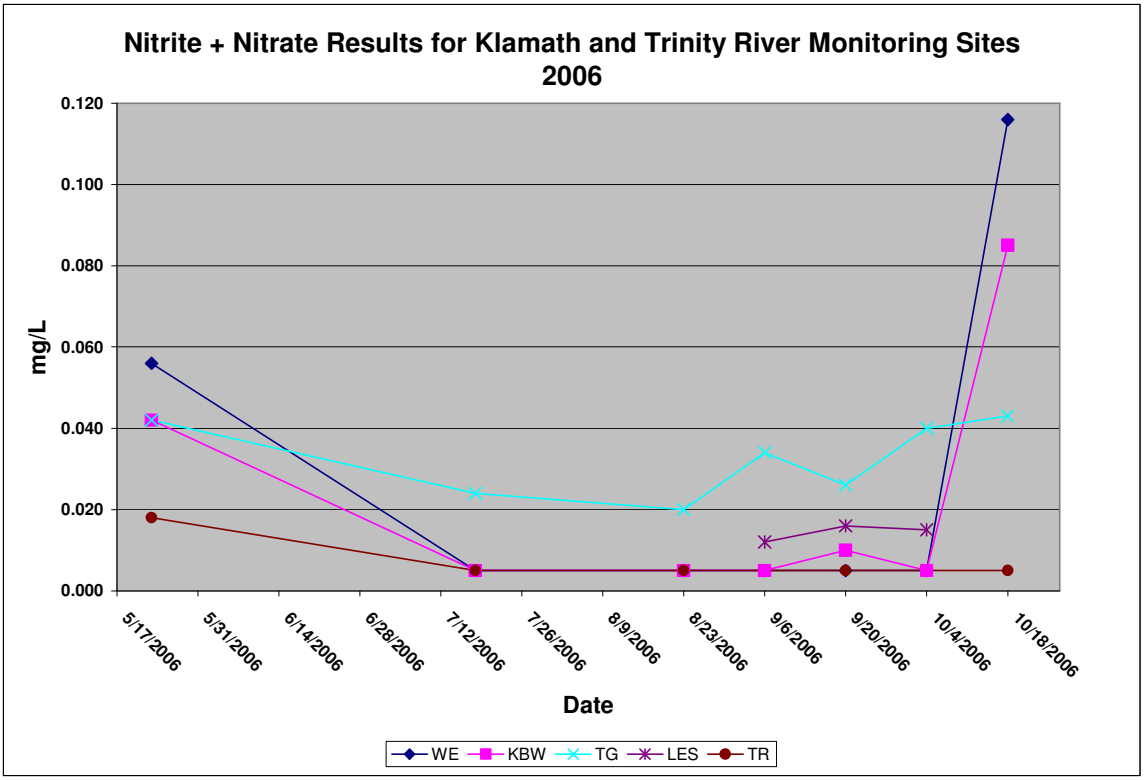

Figure 4. Nitrite and Nitrate Results 2006

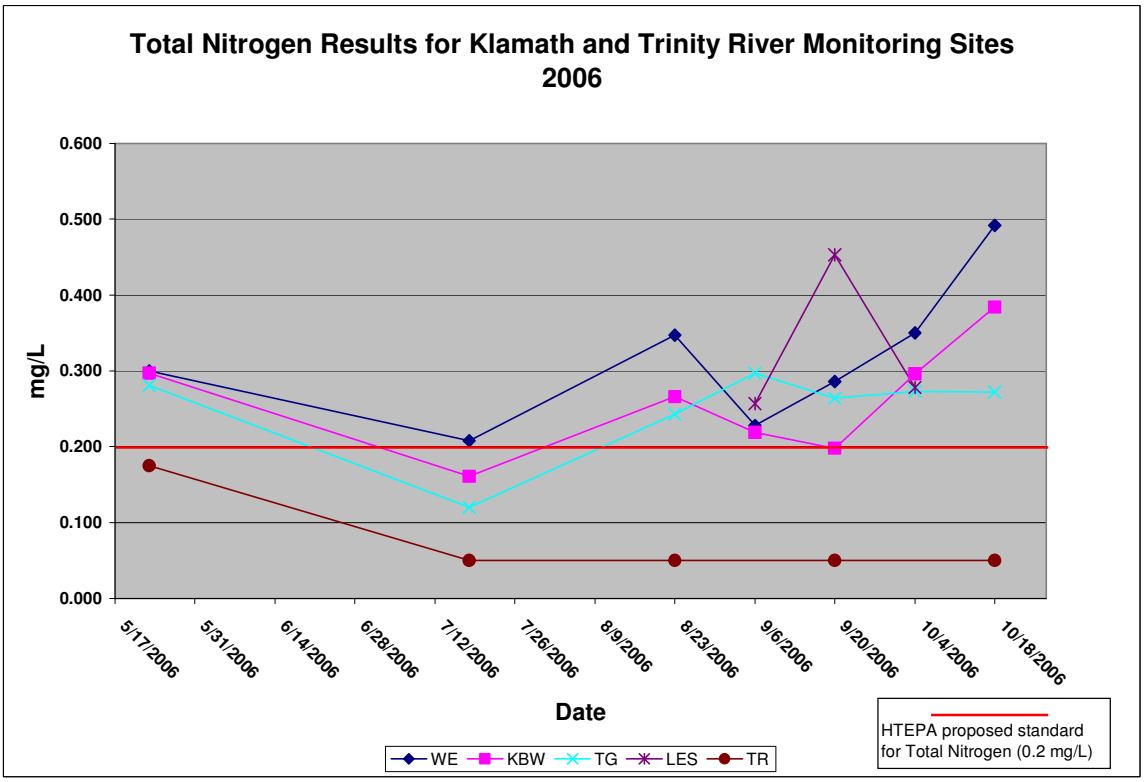

Figure 5. Total Nitrogen Results 2006

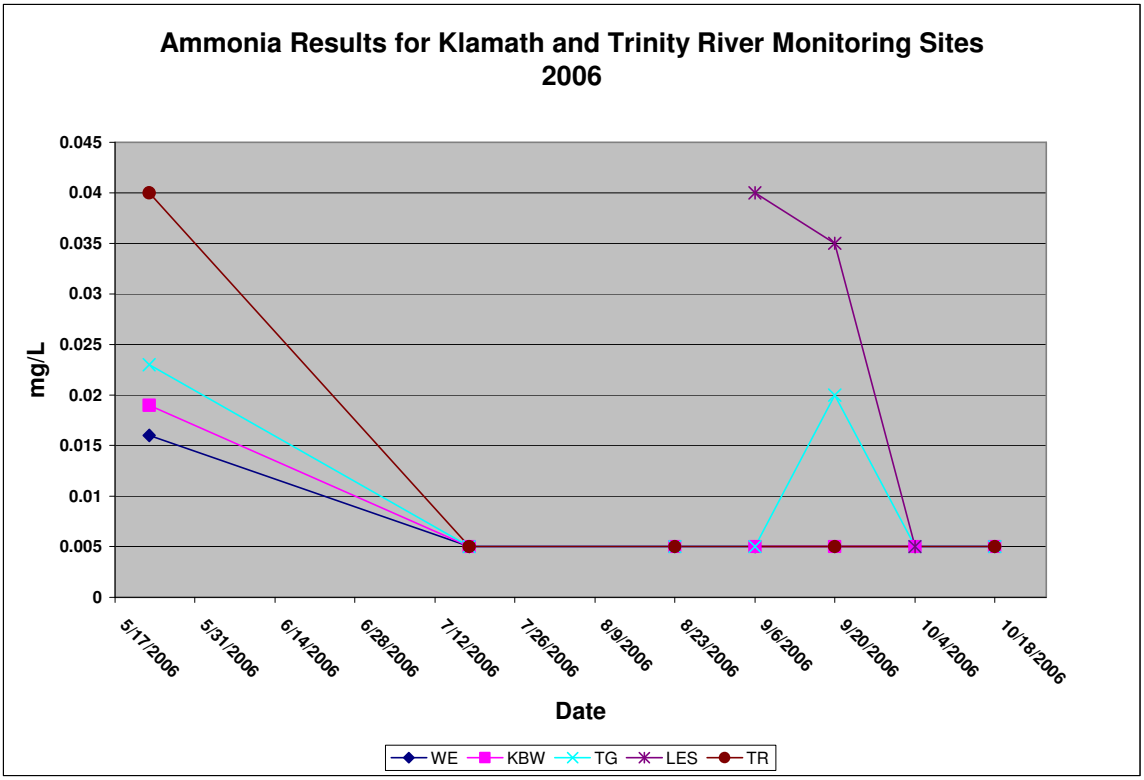

Figure 6. Ammonia Results 2006

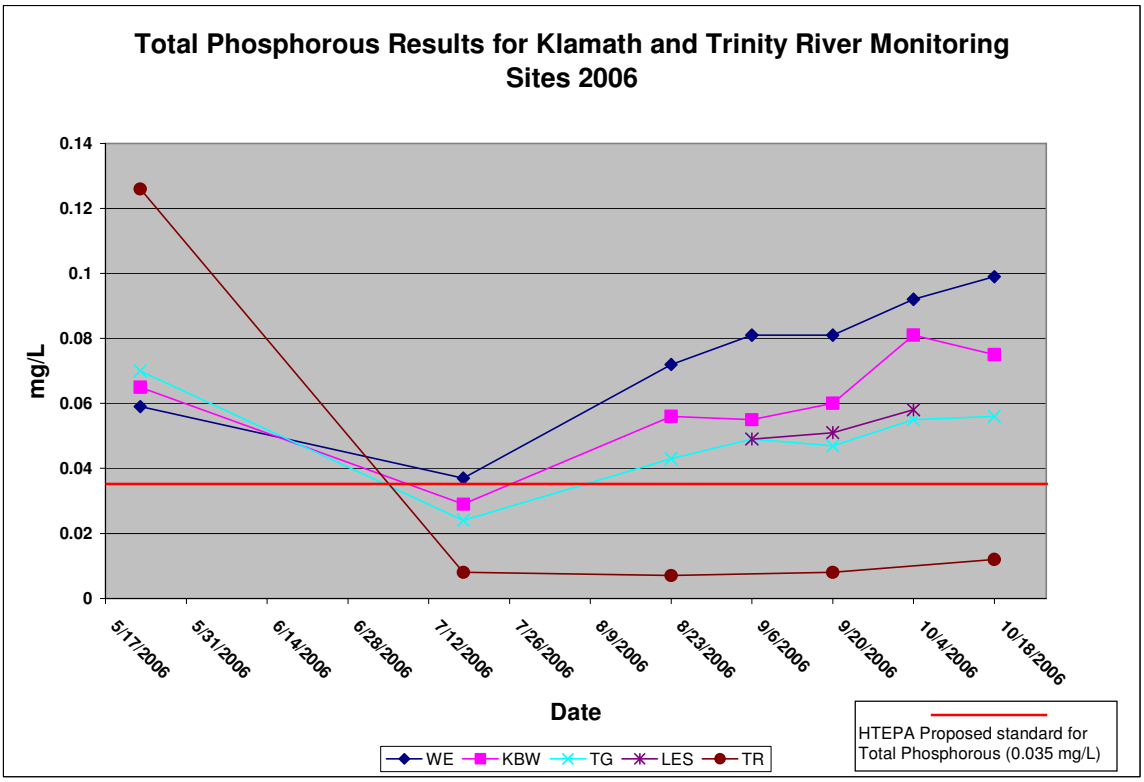

Figure 7. Total Phosphorous Results 2006

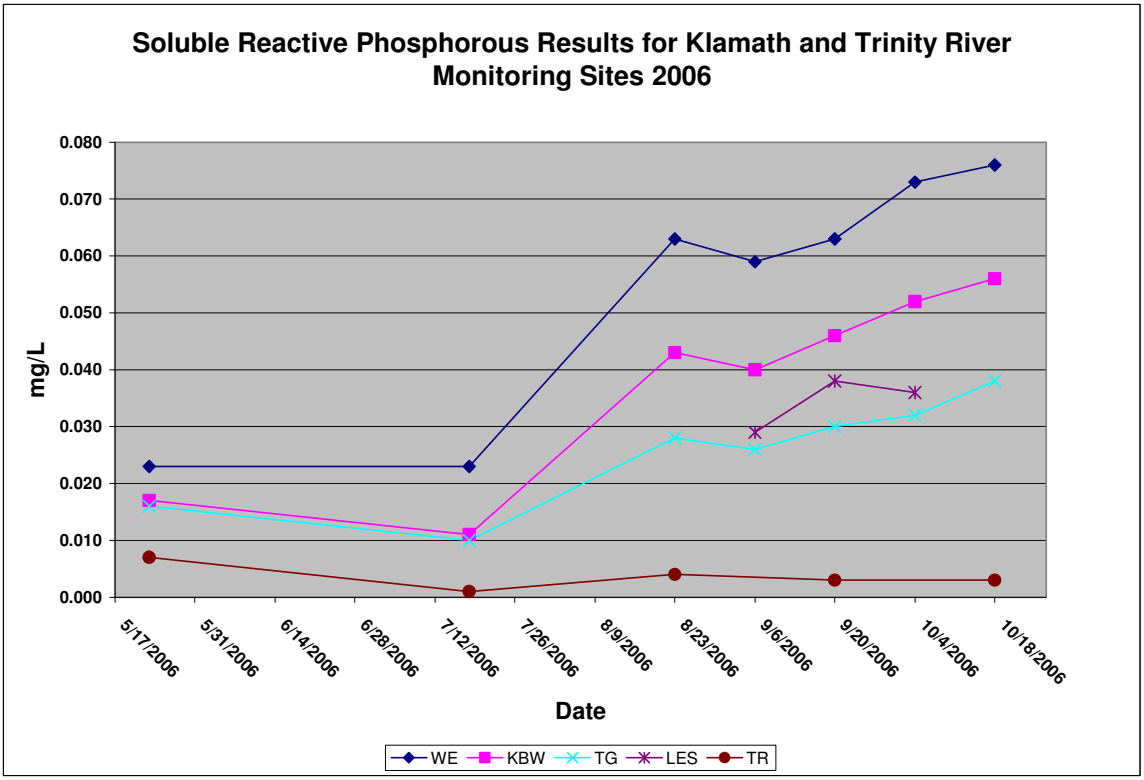

Figure 8. Soluble Reactive Phosphorous Results 2006

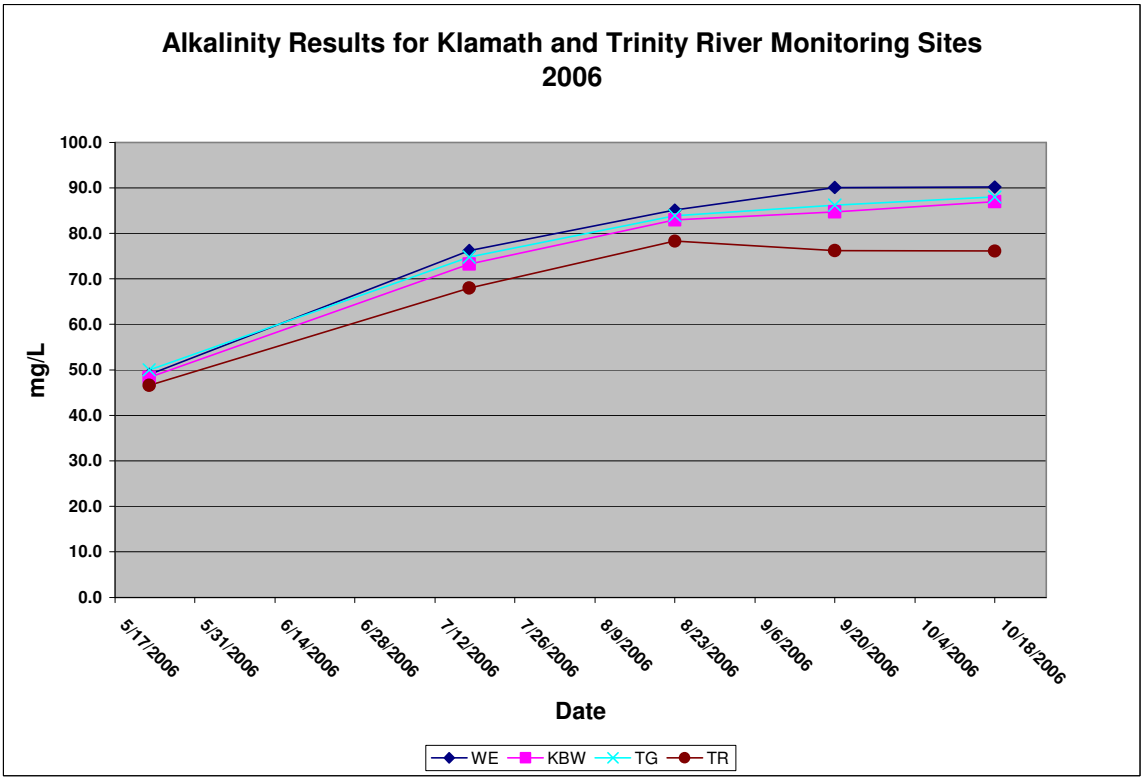

Figure 9. Alkalinity Results 2006

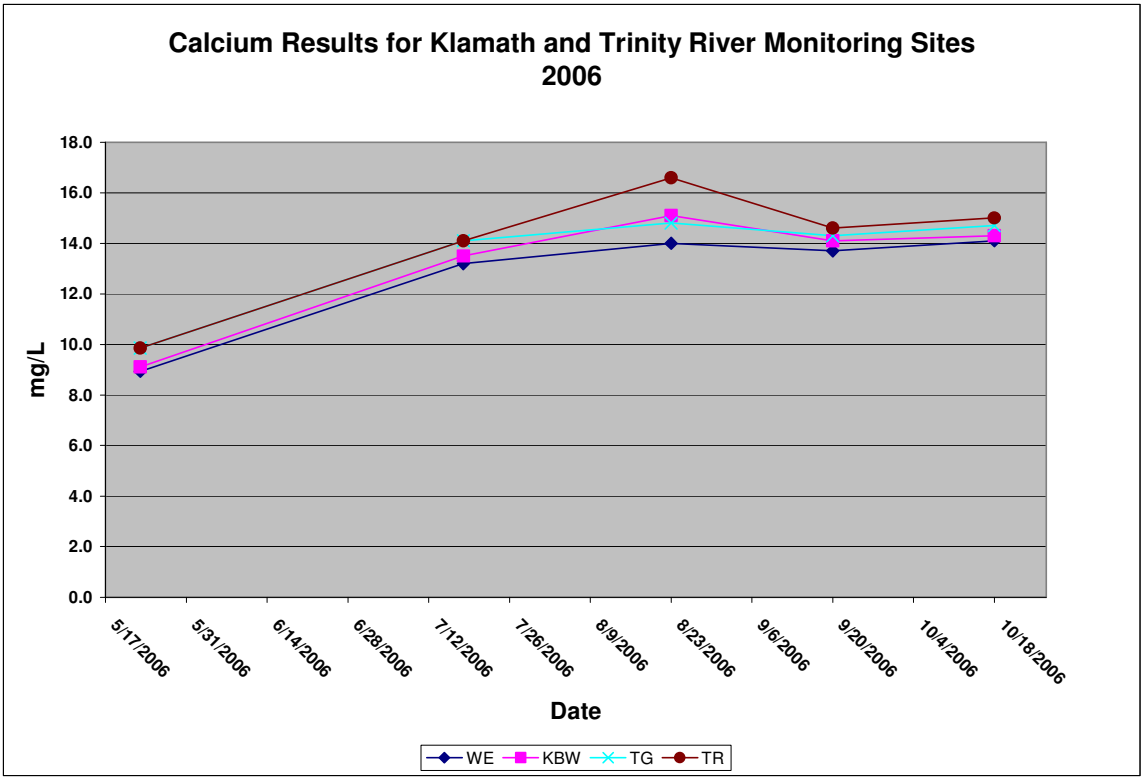

Figure 10. Calcium Results 2006

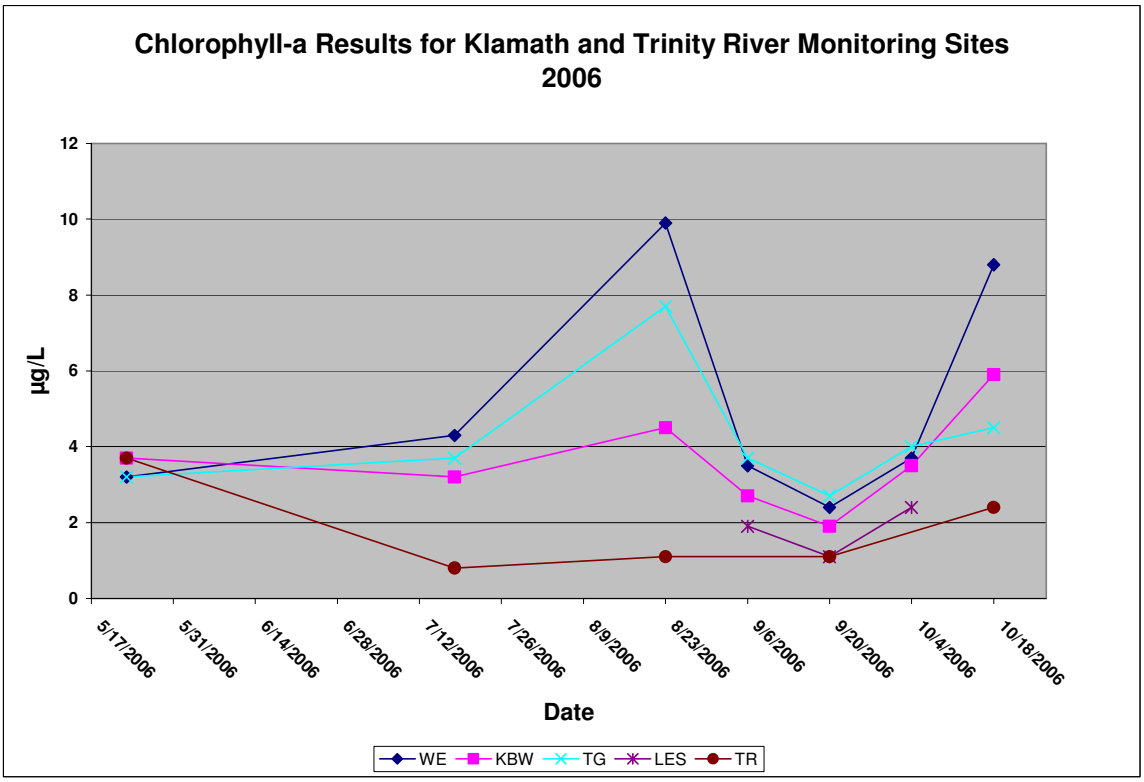

Figure 11. Chlorophyll-*a* Results 2006

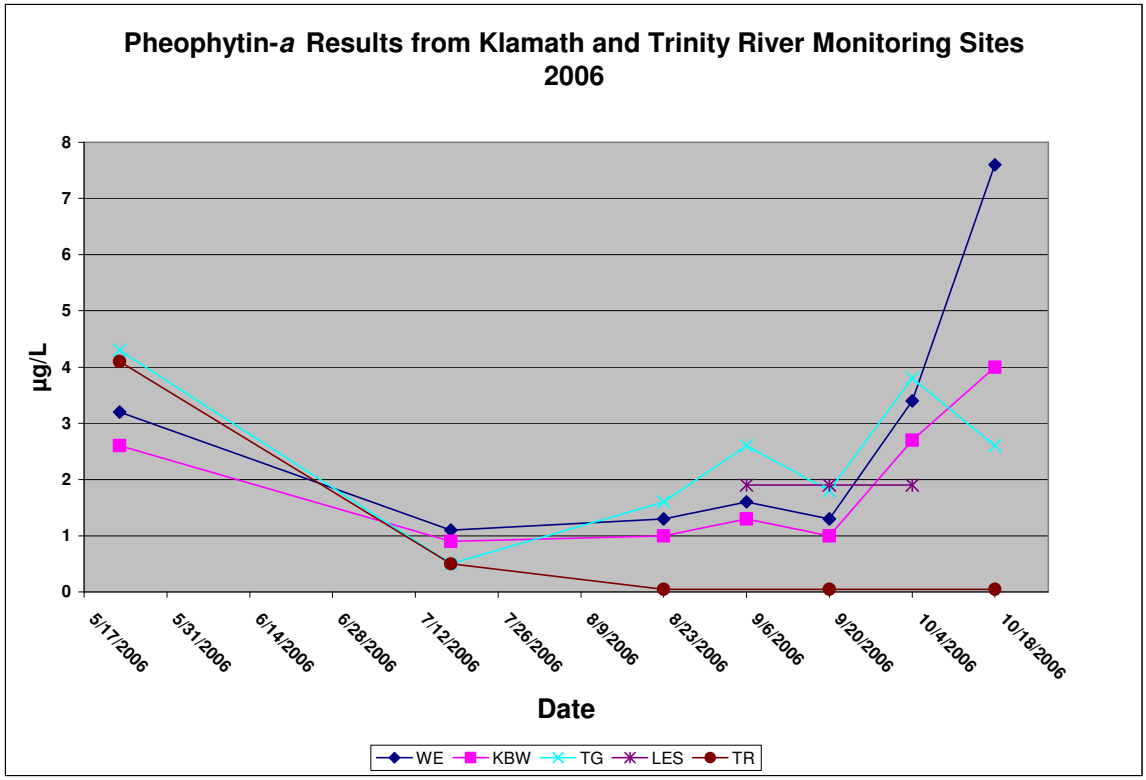

Figure 12. Pheophytin-*a* Results 2006

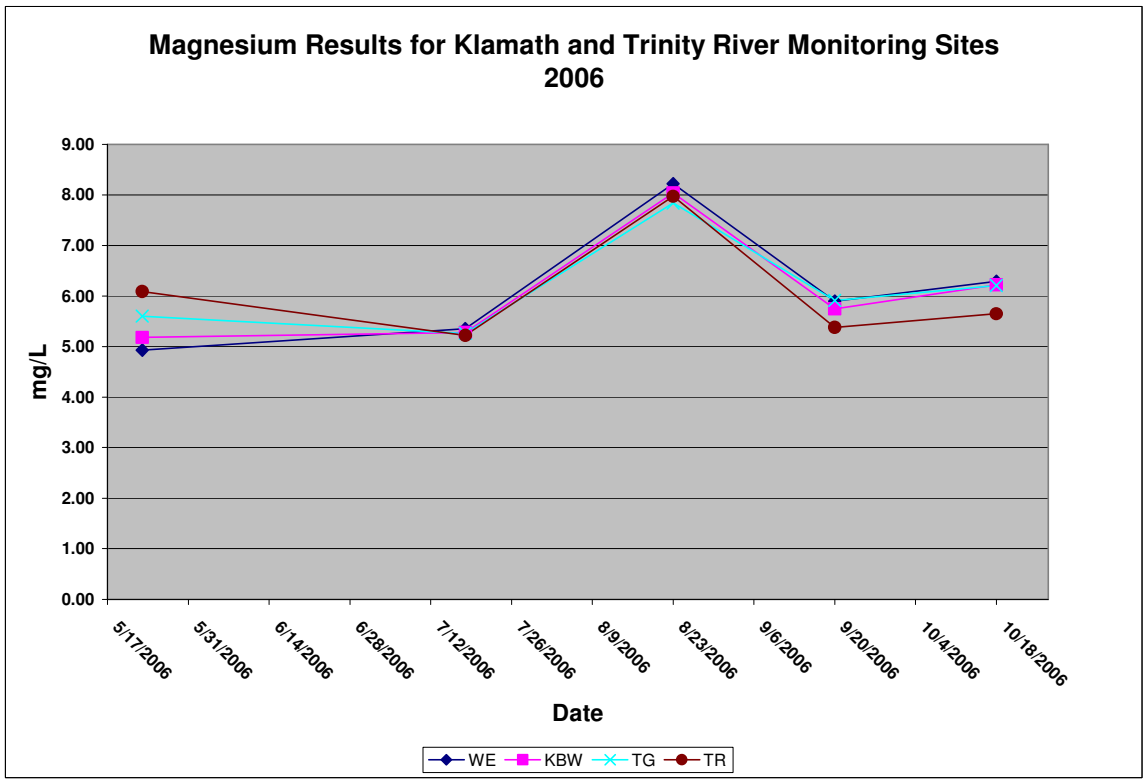

Figure 13. Magnesium Results 2006

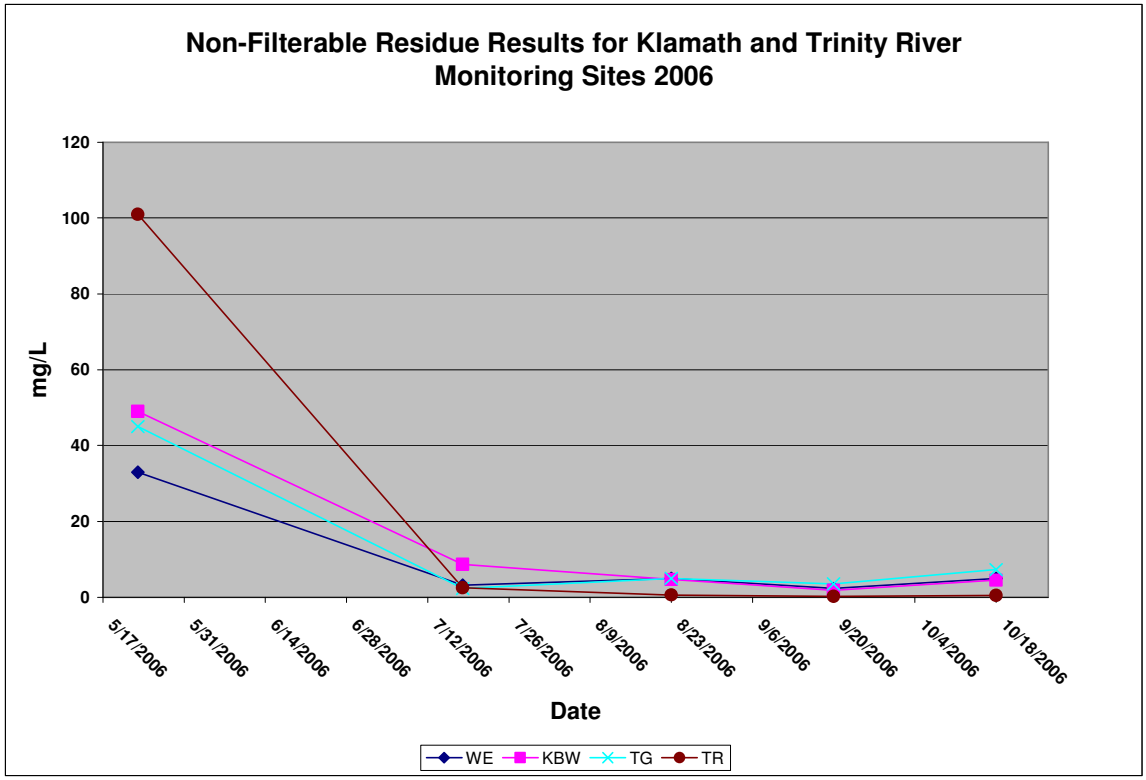

Figure 14. Non-Filterable Residue Results 2006

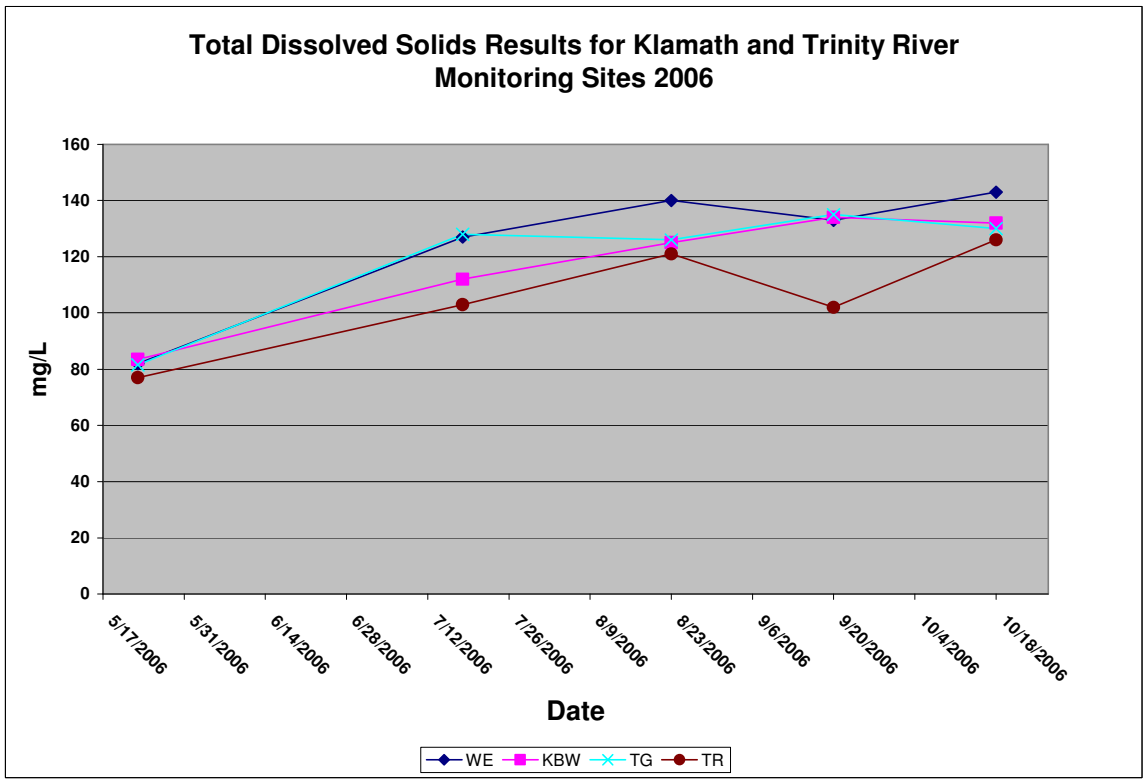

Figure 15. Total Dissolved Solids Results 2006

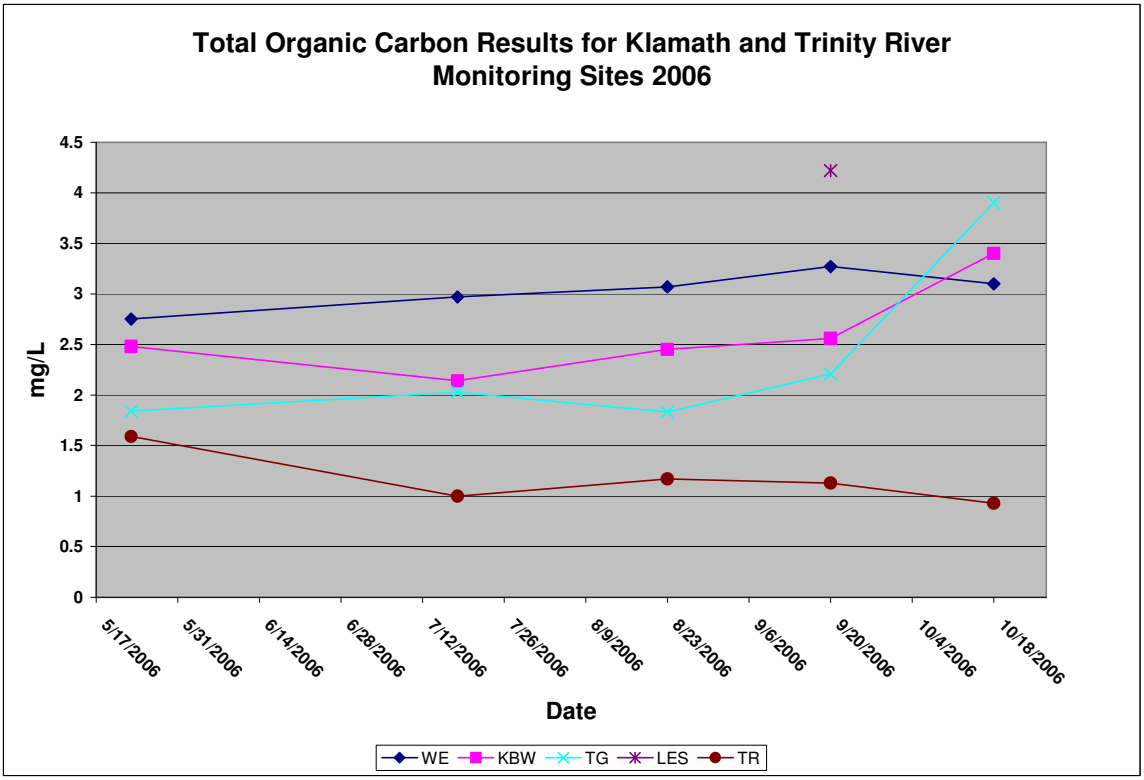

Figure 16. Total Organic Carbon Results 2006

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Appendix

Grab Sample Protocol

'Grab sampling' refers to water samples obtained by dipping a collection container into the upper layer of a body of water and collecting a water sample (USGS File Report -00213). For quality assurance/quality control (QA/QC) purposes replicate, and blank bottle sets will be prepared and collected for one site each sampling period. These additional bottle sets will be handled, prepared and filled following the same protocol used for regular bottle sets and samples. General water quality parameters will also be measured with a freshly calibrated portable multi-probe water quality instrument during grab samples and recorded onto data sheets.

Upon arrival at each site, the sampling churn will be rinsed three times with distilled water. The goal of rinsing is 'equipment decontamination – the removal from equipment, residues from construction and machining and the removal of substances adhering to equipment from previous exposure to environmental and other media' (USGS Open File Report 00213). After rinsing with D.I. water, the churn will be rinsed three times with stream water. The churn is then fully submerged into the stream and filled to the lid with sample water. Completely filling the churn allows for all samples to be filled from one churn; thereby minimizing differences in water properties and quality between samples.

Proper use of the churn guarantees the water is well mixed before the sample is collected. The churn should be stirred at a uniform rate by raising or lowering the splitter at approximately 9 inches per second (Bel-Art Products, 1993). This mixing must continue while the bottles are being filled. If filling is stopped for some reason, the stirring rate must be resumed before the next sample is drawn from the churn. As the volume of water in the churn decreases, the round trip frequency increases as the velocity of the churn splitter remains the same. Care must be taken to avoid breaking the surface of the water as the splitter rises toward the top of the water in the churn.

Sample bottles and chemical preservatives used were provided by associated laboratories and were considered sterile prior to field usage. Sample bottles without chemical preservatives were rinsed with stream water from the churn 2-3 times before filling with sample water. In the case of bottles that contained chemical preservatives, bottles were not rinsed before sample collection and care was taken to avoid over-spillage that would result in chemical preservative loss. Collected samples will be placed in coolers on ice or dry ice for transport to contracted laboratories for analysis.

QA/QC – Duplicate and Blank Bottle Sets

To ensure laboratory and sampling accuracy, one site every sampling period was randomly selected to receive two additional QA/QC bottle sets. These bottle sets contains duplicate and blank water samples. Duplicate samples are obtained using the same process as regular samples. This information is used to assure the laboratory maintains precision within results. These are disguised so the lab does not know which samples are duplicates. Blank samples in 2006 were collected in two separate ways to evaluate field crew and lab contamination potential. Equipment blanks were collected by pouring distilled water into the sampling churn after it was rinsed three times with distilled water. Sample bottles were filled with distilled water from the sampling churn using the same process as regular samples. True blank samples were collected by pouring distilled water straight into the sample bottles. These are disguised so the lab does not know which samples are blank samples. All bottle sets are then placed on ice and are transported to the associated laboratories by mailing a cooler via Fed Ex. All grab samples were processed within 24 hours or within known laboratory holding periods.

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