Field Monitoring Guide

Visitor Experience and Resource Protection Program

United States Department of the Interior
National Park Service
Yosemite National Park
California

2007

Yosemite National Park

National Park Service
U.S. Department of the Interior

FIELD MONITORING GUIDE
VISITOR EXPERIENCE AND RESOURCE PROTECTION PROGRAM

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

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SECTION A: INTRODUCTION

A.1 BACKGROUND

The National Park Service is charged to protect the quality of park resources while providing for their enjoyment by this and future generations. This is the essential mission outlined in the 1916 Organic Act (Public Law 16 U.S.C. 1) establishing the National Park Service and it suggests that a balance be maintained between resource protection and visitor use. Today, there are hundreds of National Park units accommodating millions of visitors each year. This poses increasing challenges for area managers trying to achieve this balance. Managers must increasingly rely on scientific data and up-to-date information as to the extent of visitor use and related impacts so that they may make informed decisions that ensure that the resources and visitor opportunities they are charged to protect remain in tact for future generations to enjoy.

The Visitor Experience and Resource Protection (VERP) framework was developed to address visitor use and related issues in National Park units. VERP is a visitor use planning and management process designed to: 1) plan for desired resource and experiential conditions; 2) establish a monitoring program to track the status of these desired conditions; and 3) implement management strategies to maintain desired conditions (NPS 1997, Hof et al.1997).

Overall, the VERP process helps the National Park Service to address a variety of visitor use-related issues including user capacity. The National Parks and Recreation Act of 1978 (P.L. 95-625) stipulates that National Park units "identify and implement commitments for visitor carrying capacities for all areas of the unit". Originally, the carrying capacity concept referred to the level of use by a particular species that a particular land area could effectively accommodate. As applied to visitor use in national parks and other protected areas this concept is known as "user capacity" and refers to the types and levels of visitor use that a given protected area can accommodate before the values for which the area had been established are unacceptably affected (NPS 1997; Manning 1999; Manning et al. 2006).

Since the early 1990s, the VERP process has been initiated and / or implemented in several national park units across the country. In Yosemite, the VERP process has been applied to develop plans for the future of Yosemite Valley and the Merced River Corridor (YOSE 2000; 2001; 2004). It represents a significant effort of the park in tackling user capacity and other visitor-related issues through a systematic and adaptive management framework (NPS 1997). Currently, the park is also applying VERP to the Tuolumne Wild and Scenic River.

The objective of the VERP monitoring program is to provide park managers with up-to-date, scientific data and information on visitor use and related impacts. The VERP monitoring program is a key component of a cyclical process of adaptive visitor use management in the park. It also provides a means to inform park partners and the public as to the current status of resource and visitor use conditions.

A.2 INDICATORS AND STANDARDS

In the VERP process *indicators* are measurable, manageable variables that reflect the condition of park resources and the quality of visitors' experiences. *Standards* reflect the desired condition of these variables (Manning 2007). The User Capacity Management Program for the Merced Wild and Scenic River defined a suite of 8 selected indicators. (YOSE 2001; YOSE 2004). These indicators were first monitored in 2004. However, after several iterative evaluations and marked improvements this original set of indicators has evolved into the current list as follows:

INDICATOR 1: Water Quality
Visitor impacts include pollutants into the rivers are known to create resource degradation. Such constituents are monitored to identify potential changes over time.
Standards: Anti-degradation for each segment, for *E. coli,* nutrients (total dissolved nitrogen, nitrate and nitrite, total dissolved phosphorous, and total phosphorus), and total petroleum hydrocarbons. Absolute minimum for all segments: State *E. coli* standard for recreational contact. Yosemite-specific standards, which will be much more protective than available state and federal standards, will be established once sufficient data has been obtained through this sampling protocol.

INDICATOR 2: Riverbank Erosion
Use along riverbanks present vegetation trampling and erosion related impacts. Understanding this relationship is important to protecting these aquatic ecosystems.
Standards: A peer review of the existing monitoring protocol revealed the need for a more rigorous approach to riverbank condition monitoring and assessment. As a result, standards are being developed that take into account a new protocol under development in late 2007.

INDICATOR 3: Wildlife Exposure to Human Food
Wildlife impacts are heavily caused by access to food. Understanding visitors' abilities to comply with food storage regulation has been developed as a proxy for these wildlife impacts.
Standards: 95% or greater compliance with food storage regulations in selected campgrounds and parking areas.

INDICATOR 4: Extent and Condition of Informal Trails
Informal trail monitoring has been applied to both river corridors to identify trampling related impacts to Yosemite unique meadow habitat.
Standards: No net increase in density of informal trails when compared with baseline (for Yosemite Valley). Baseline established in 2004 and 2005. In Tuolumne Meadows, 2007 mapping will add to data collected in 2005 and 2006 to increase baseline dataset. Baseline will be updated as restoration actions are implemented and data are re-collected to reflect restoration efforts.

INDICATOR 5: Number of Encounters with Other Parties in Wilderness
Monitoring Wilderness encounters focuses primarily in the Upper Merced River Corridor beyond Nevada Falls. Tuolumne River Corridor monitoring has been initiated with Wilderness staff and volunteers.
Standards: **Zone Un-trailed—**No more than one encounter with another party per four hour period, 80% of the time.
Zone Trailed Travel—No more than one encounter with another party per hour, 80% of the time.

INDICATOR 6: Visitor Use Monitoring
Pedestrian simulation models are being developed in 2007 to provide outputs for people-one-time (PAOT) and people-per-viewscape (PPV), commonly applied metrics used to monitor crowding and congestion in protected areas.
Standard: Methods alteration due to increased information: developing baseline for river, trail and attraction site use.

INDICATOR 7: Archeological Resource Integrity
This work explored the applicability of the National Park Service's Archeological Site Monitoring Information System (ASMIS) to monitor visitor use impacts to archeological resources.
Standard: no deterioration in site stability or condition related to visitor threats or disturbances. No new visitor related (including park management actions related to visitor use) threats or disturbances to archeological sites that have the potential to degrade stability or condition. No change in condition from baseline to current as a result of visitor use.

INDICATOR 8: Parking Availability
In addition to the typical monitoring collection with parking, transportation studies were conducted throughout Yosemite Valley, entrance stations and key intersections to develop a simulation model of the transportation system in the park. The intent of this study is to outline other aspects of this system that are key to the visitor experience and measurable.
Standard: A standard for parking availability has yet to be determined.

Monitoring Requirements

Monitoring these indicator variables requires the development of protocols that allow NPS staff to collect data in order to understand current use, impact, and trends. Creating a robust and accurate measurement strategy requires a good sampling plan. Sampling is a systematic approach to collecting data. A good sample will accurately represent estimates of population values. Watson et al (2000) outlined seven components of a good sampling strategy.

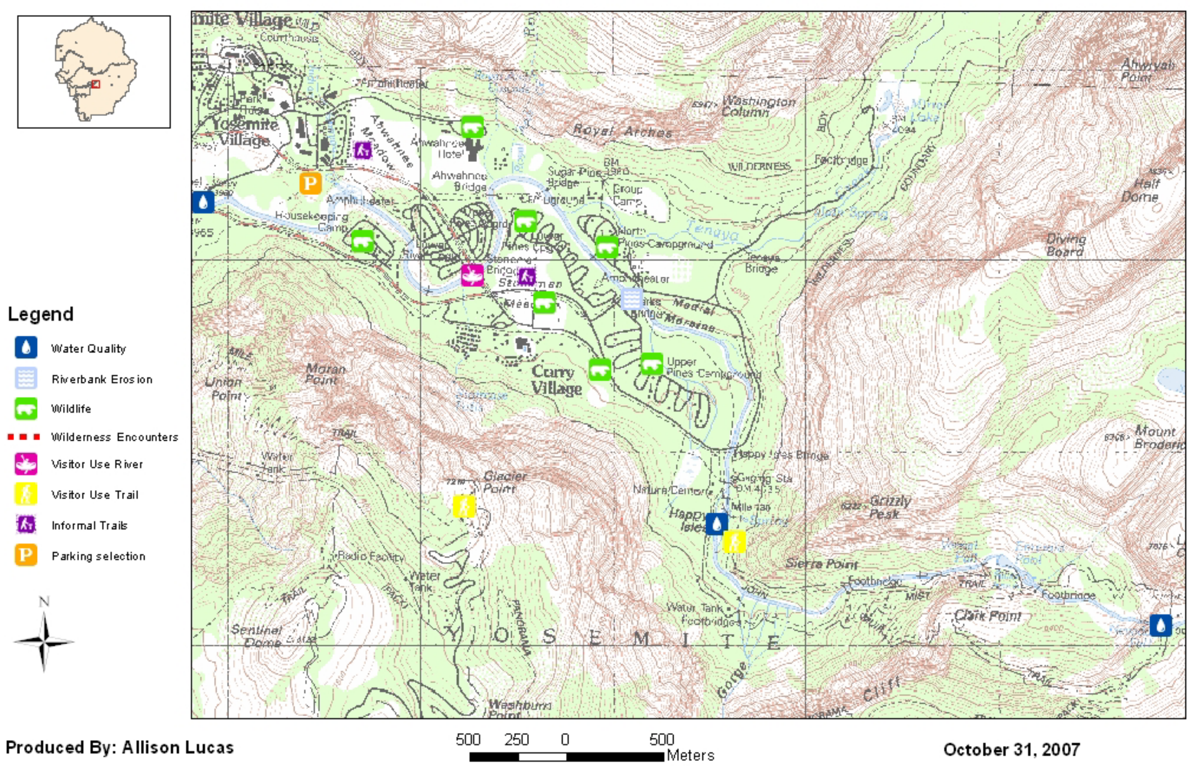
- Bias in the sampling can be eliminated by randomization.
- Probability sampling can be used to measure precision sample results.
- Patterns and landscape characteristics of wilderness use usually do not allow for census measurements in a field season.
- Good sampling strategies require fewer personnel hours.
- Well designed sampling leads to higher accuracy in the data.
- Flexibility is very important to managers who are challenged to multi-task and maximize productivity with minimal personnel resources.
- Sampling should not burden visitors.

These sampling strategy components can be generalized to all indicators measured. However, as with all monitoring programs some constraints exist including time, limited budgets, or other stochastic events such as weather, medical emergencies, and unforeseen circumstances. Therefore, NPS staff should know the standard error associated with the number of days or times that an indicator is measured. Generally, the higher the sample size, the lower the standard error. For several of the indicators, the standard error can be calculated to help NPS staff be informed about such conditions. All of these components of a good sampling strategy were incorporated into development of this field guide. Sampling strategies were developed for each indicator that will be efficient yet provide the data required to address whether a standard has been exceeded.

Although all of these considerations were incorporated into the development of this field guide, it is understood that it takes time to develop monitoring protocols that truly address changes in the natural or social environment. Recent research by United States Geological Survey and National Park Service staff concluded that long-term monitoring protocols take several years of field work and revisions to develop the level of confidence in the data for long-term monitoring (Oakley, et al, 2003).

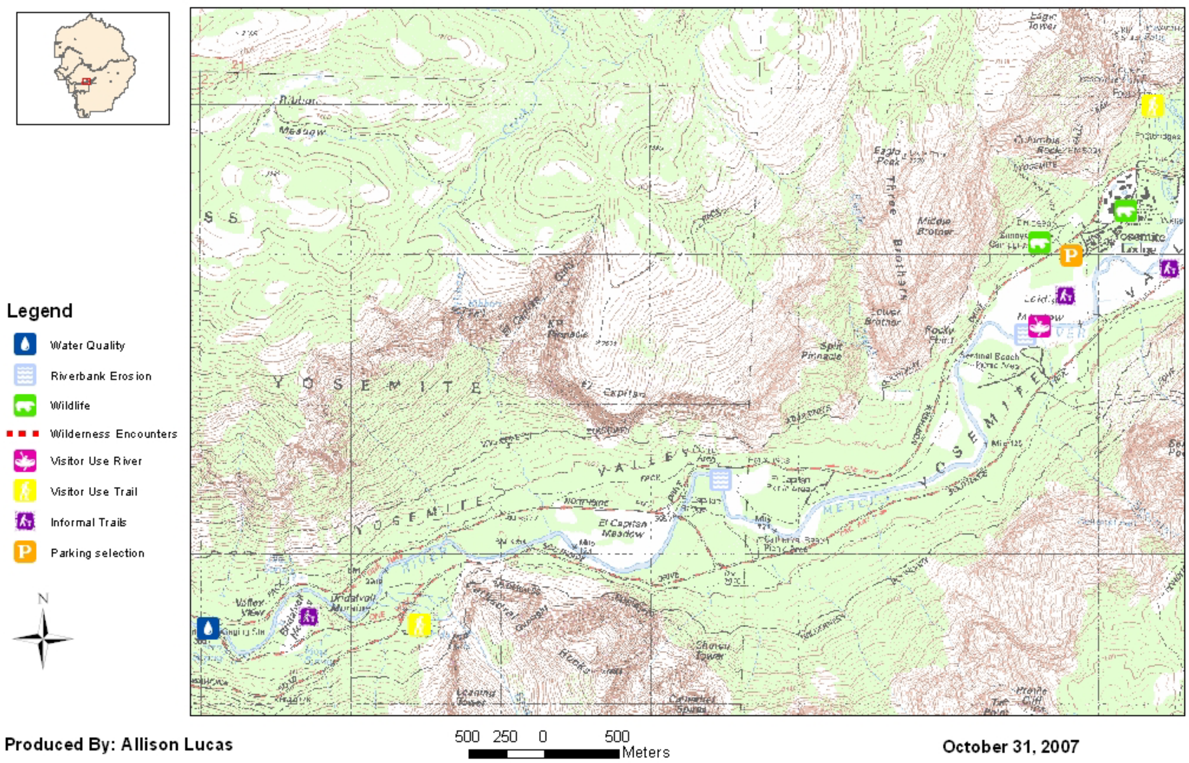
The following maps present the various sampling sites for each indicator variable monitored in 2007:

Figure A.2.1 VERP Monitoring Sites in East Yosemite Valley



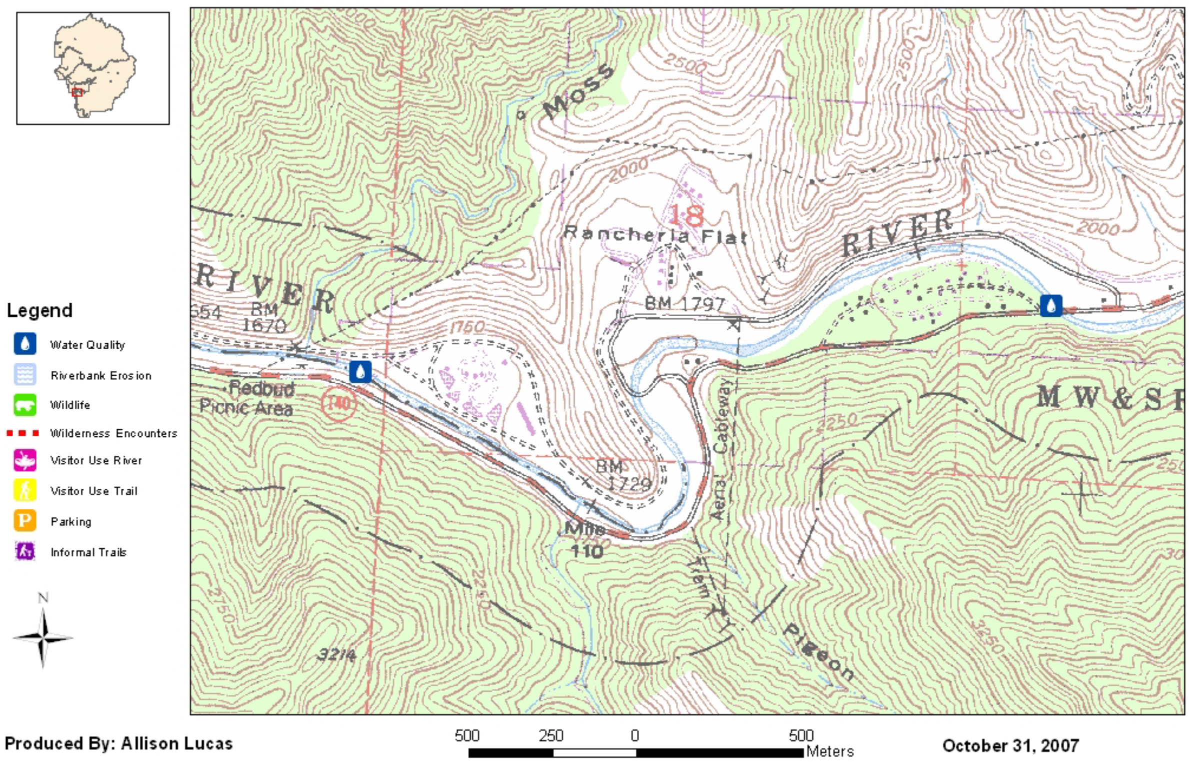
Note: "The Cultural resource information contained herein is protected from public disclosure under 16 U.S.C. section 470w-3, of the National Historic Preservation Act of 1966, as amended, and 16 U.S.C. section 470hh, of the Archaeological Resources Protection Act of 1979."

Figure A.2.2 VERP Monitoring Sites in West Yosemite Valley



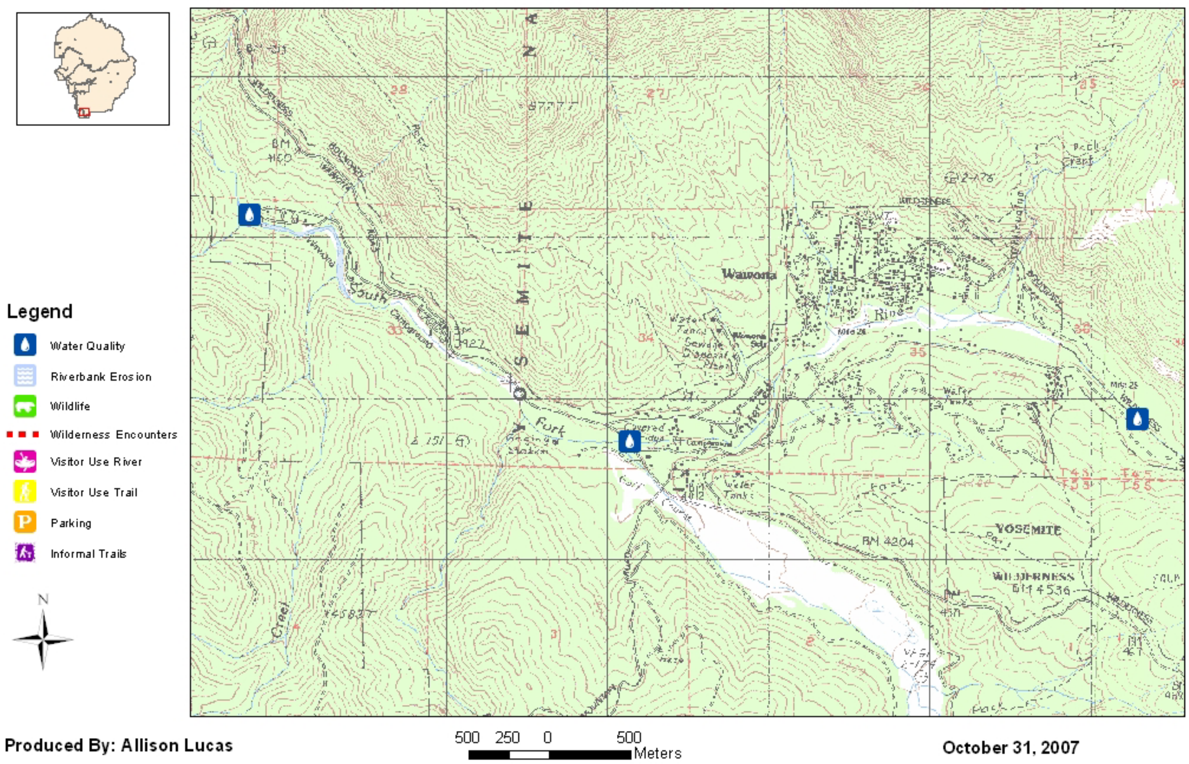
Note: "The Cultural resource information contained herein is protected from public disclosure under 16 U.S.C. section 470w-3, of the National Historic Preservation Act of 1966, as amended, and 16 U.S.C. section 470hh, of the Archaeological Resources Protection Act of 1979."

Figure A.2.3 VERP Monitoring Sites in El Portal



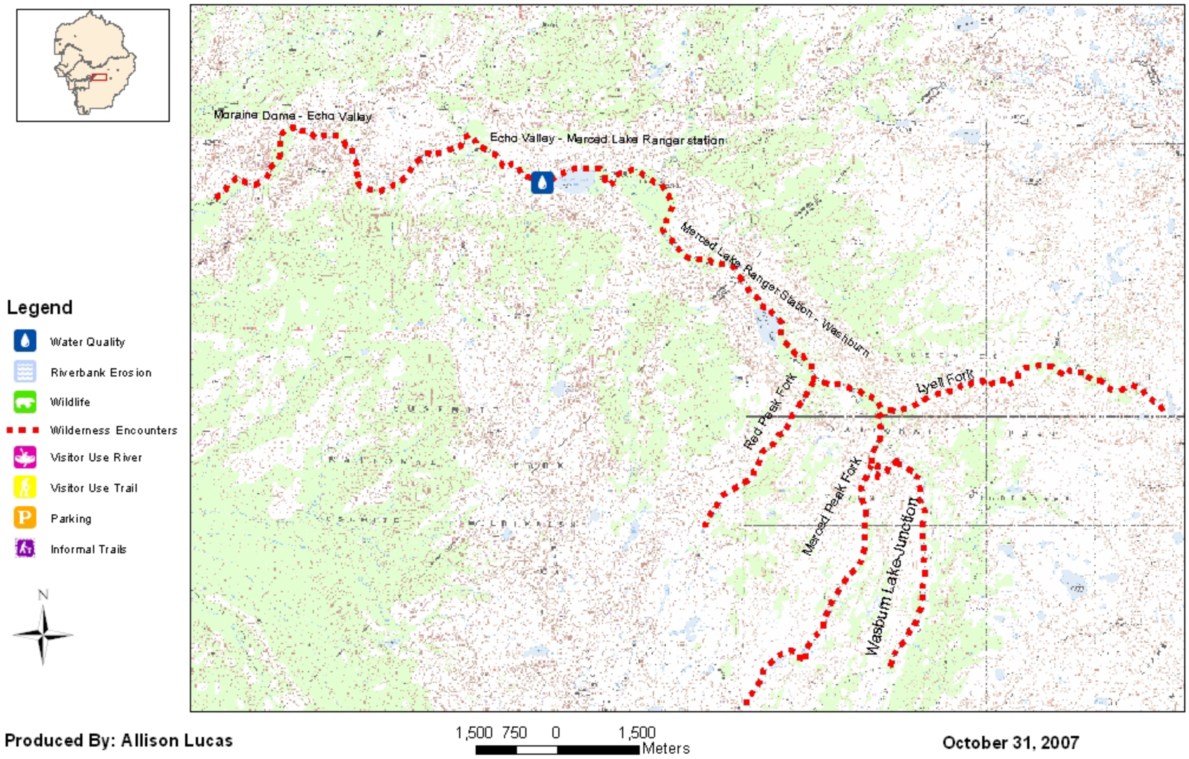
Note: "The Cultural resource information contained herein is protected from public disclosure under 16 U.S.C. section 470w-3, of the National Historic Preservation Act of 1966, as amended, and 16 U.S.C. section 470hh, of the Archaeological Resources Protection Act of 1979."

Figure A.2.4 VERP Monitoring Sites in Wawona



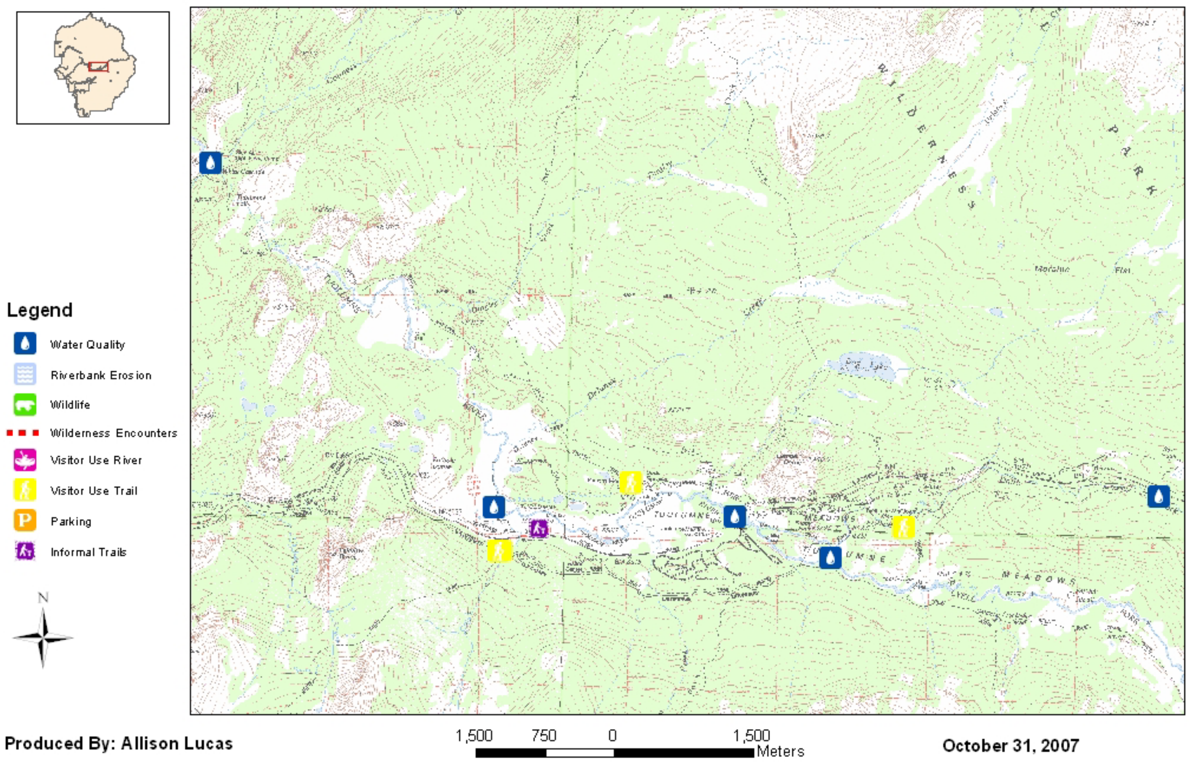
⅄ **Note:** "The Cultural resource information contained herein is protected from public disclosure under 16 U.S.C. section 470w-3, of the National Historic Preservation Act of 1966, as amended, and 16 U.S.C. section 470hh, of the Archaeological Resources Protection Act of 1979."

Figure A.2.5 VERP Monitoring Sites in the Merced Lake Area



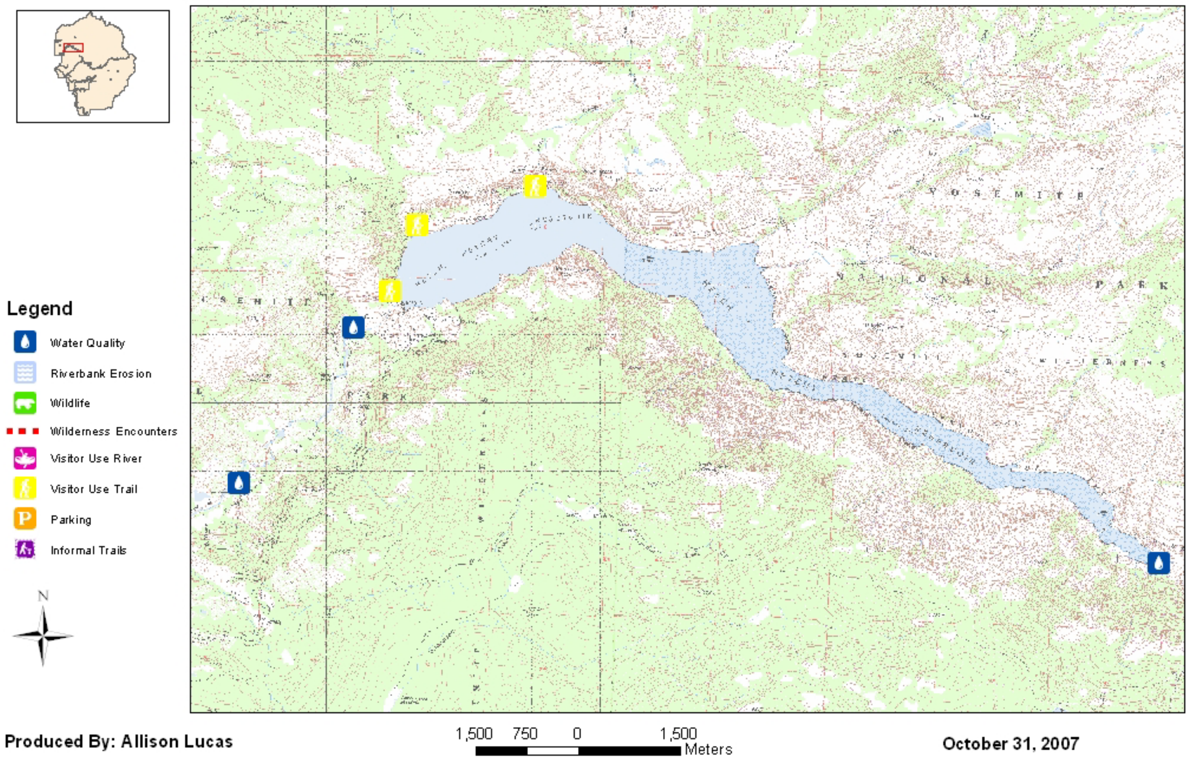
Note: “The Cultural resource information contained herein is protected from public disclosure under 16 U.S.C. section 470w-3, of the National Historic Preservation Act of 1966, as amended, and 16 U.S.C. section 470hh, of the Archaeological Resources Protection Act of 1979.”

Figure A.2.6 VERP Monitoring Sites in the Tuolumne Meadows Area



Note: "The Cultural resource information contained herein is protected from public disclosure under 16 U.S.C. section 470w-3, of the National Historic Preservation Act of 1966, as amended, and 16 U.S.C. section 470hh, of the Archaeological Resources Protection Act of 1979."

Figure A.2.7 VERP Monitoring Sites in the Hetch Hetchy Reservoir Area



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A.3 THE 2007 FIELD SEASON

Summary: This version of the field guide was prepared for use during the 2007 season. Readers will note that improvements have been made in the protocols from the 2005 and 2006 seasons. In some cases we have moved from the inventorying of baseline conditions to sampling-based strategies. Still in other cases we have refined measurement techniques. Further development of these and additional indicators continue as additional information and technology expands. This process of improvement and refinement is essential to an on-going monitoring program and will continue in subsequent years.

This field guide is organized into the following sections:

Section A — Introduction. Provides background on the VERP monitoring program and introduces the indicators monitored in 2007.

Section B — Monitoring Protocols. Describes the field monitoring protocols employed for each indicator for the 2007 season.

Appendices — The appendices section includes a glossary and a list of acronyms.

Compliance Statement: Compliance with institutional requirements and regulatory processes was completed for the 2007 VERP field monitoring effort. National Park Service research permits were obtained to comply with institutional requirements for conducting field research and monitoring activities in a National Park unit. Two permits were obtained as follows: 1) General monitoring activities permit #YOSE-2007-SCI-0044); and 2) Water quality sampling (permit #YOSE-2007-SCI-0032). Both permits are detailed and accessible at the National Park Service Research Permit and Reporting System site at https://science1.nature.nps.gov/research/ac/ResearchIndex.

Additionally, the 2007 field monitoring season also included a number of activities that required the National Park Service to demonstrate compliance with the National Environmental Protection Act (NEPA). The specific types of data collected for the Tuolumne Wild and Scenic River Comprehensive Management Plan, as part of the VERP monitoring program, included water quality sampling of the Tuolumne Wild and Scenic River and documentation of social trails in the Tuolumne Meadows area.

For example, collection of water samples from the Dana Fork of the Tuolumne Wild and Scenic River requires an identification of where those sampling locations will be, and the amount of water expected to be removed from the river for each sample. The use of Geographic Information Systems (GIS) equipment to document the location of social trails required staff traversing through sensitive habitats (i.e., places the NPS would like to see people avoid). Because of the scale and duration of these types of monitoring activities were considered to be at a negligible (i.e., non detectable) level of intrusion into the "human environment," a Categorical Exclusion (CE) was the appropriate level of NEPA compliance.

The types of activities covered under the CE received for VERP data collection included: (1) Non-destructive data collection by fewer than 5 people together at one time in one area; and (2) The temporary installation of small, unobtrusive data collection devises in and adjacent to the Tuolumne River and its tributaries.

Work Plan: The following work plan (Figure A.3.1) provides an overview of the activities associated with carrying out the monitoring of VERP indicators during the 2007 field season.

Figure A.3.1. VERP Field Monitoring Work Plan 2007

ID	Task	Deliverable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.0	**Planning and Development Phase**	**Field Monitoring Guide**												
1.1	Monitoring protocol development													
1.2	Conduct development workshop													
1.3	Obtain data collection permits and conduct appropriate compliance													
1.4	Acquire data collection instruments													
1.5	Select and prepare sampling locations													
1.6	Field test data collection methods and instruments													
1.7	Conduct public meeting on indicator planning and development													
2.0	**Implementation Phase**	**Data and Information**												
2.1	Conduct field data collection													
2.2	Conduct quality control checks of data collection													
2.3	Enter data including quality control check													
2.4	Conduct public meeting on data collection efforts													
3.0	**Reporting Phase**	**Annual Report**												
3.1	Data analysis													
3.2	Prepare annual report													
3.3	Conduct evaluation workshop													
3.4	Conduct public meeting on monitoring results													

A.4 REFERENCES

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SECTION B:
MONITORING PROTOCOLS

B.1. Water Quality

B.1.1 Background

Purpose of the Merced River Water Quality Monitoring Protocol: Human use has the potential to affect water quality. Horse manure (at 70701stables or on trails) or people swimming in the river can increase fecal coliform (i.e. bacteriological) levels; people bathing in the river with soap can increase phosphorus/phosphate (i.e. nutrients) levels; and surface water runoff from campgrounds and stables can affect both fecal coliform and nutrient levels. These activities, as well as hydrocarbon pollution associated with roads and other development, all may occur in Yosemite Valley.

The goal of this plan is to collect baseline water quality data along the Merced River corridor. Specific objectives are to sample backcountry sections of river downstream of heavy use areas and above and below heavy use areas in Yosemite Valley, El Portal, and Wawona. A final objective is to collect high quality data that is comparable to data collected in other parks and in the Sierra Region as a means to protect water resources from human-use impacts.

Water quality standards have been established by the State of California, in accordance with the Clean Water Act, for surface waters in the San Joaquin River Basin, which includes the Merced River. Similar standards that are much more restrictive for certain indicators such as fecal coliforms have been established for Lake Tahoe under the Clean Water Act's anti-degradation policy that mandates protection of waters with existing high quality (see Lahontan Region Basin Plan). The NPS currently monitors water quality above and below the treated water discharge points for the wastewater treatment plants in El Portal (monthly) and Wawona (weekly), to assure attainment with state standards and to carry out the requirements of the operating permits. In the event of a sewage spill or direct discharge of treated water to the river, the monitoring is more frequent (potentially daily).

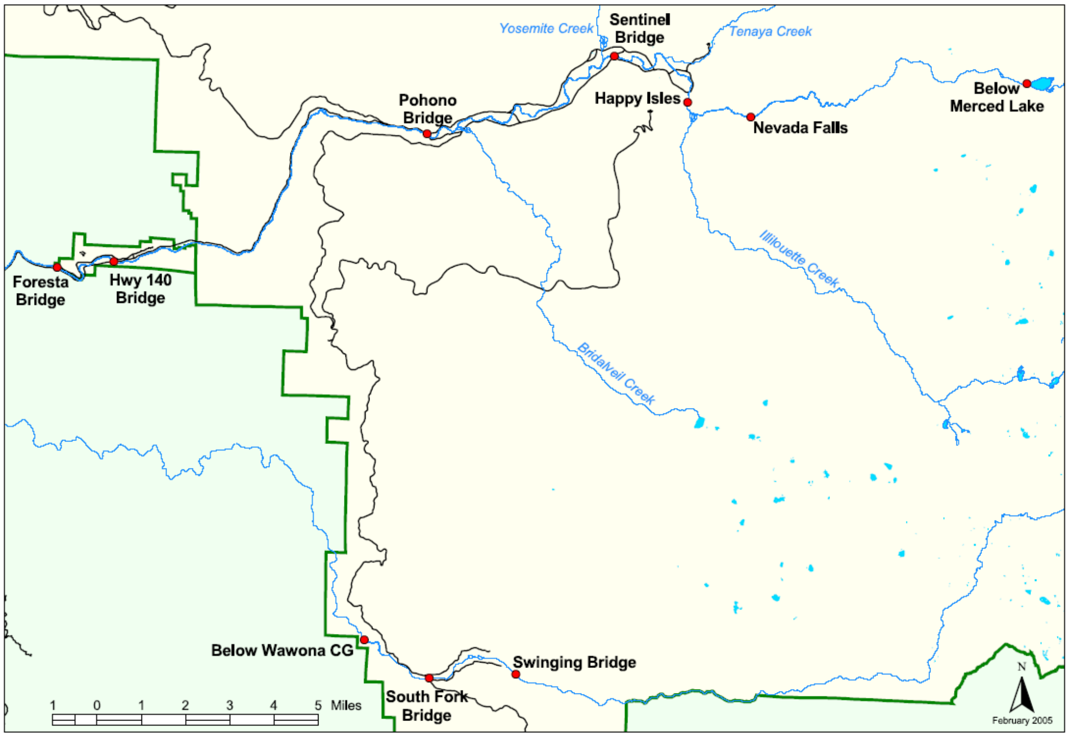
Description of indicator and standard
Indicator: Water quality as measured by the following constituents: *E. coli,* nutrients (total dissolved nitrogen, nitrate and nitrite, total dissolved phosphorous, and total phosphorus), and total petroleum hydrocarbons.
Standard: Anti-degradation for each segment, for *E. coli,* nutrients (total dissolved nitrogen, nitrate and nitrite, total dissolved phosphorous, and total phosphorus), and total petroleum hydrocarbons. Absolute minimum for all segments: State *E. coli* standard for recreational contact. Yosemite-specific standards, which will be much more protective than available state and federal standards, will be established once sufficient data has been obtained through this sampling protocol.

B.1.2 Sampling Design

Rationale for sampling design: The initial sampling regime has been designed to inventory spatial and temporal water quality conditions on the Merced River with an emphasis on areas of the river adjacent to the heaviest development. Intensive sampling will take place for at least three years before standards of quality will be established. Until such time, applicable state and federal water quality standards will apply as minimum acceptable water quality standards.

Site selection (selection criteria and procedures): Sample locations are depicted in Figure B.1.1 and listed in Table 3. Sites were selected based on location, co-location with other sampling efforts, and existing water quality data. In general, locations were selected to be upstream and downstream of developed areas, in order to better isolate impacts. Ongoing water quality sampling by the U.S. Geological Survey at Happy Isles Bridge, top of Nevada Falls, and below Merced Lake make these good sites for collocation of sampling. Similarly, the waste water treatment plants in El Portal and Wawona sample regularly at the Highway 41 South Fork Bridge, the Highway 140 Bridge, and the Foresta Bridge. Finally, sample sites where sampling could take place in the middle of the channel even at high flow were more desirable for accurate sampling.

Figure B.1.1 Water Quality Sampling Locations for the Merced River



Sampling schedule: In order to understand seasonal variations in water quality, monthly sampling is conducted at all sites accept the two wilderness sites (Below Merced Lake and Above Nevada Falls). The latter are sampled monthly during the summer and fall months. In addition, intense weekly sampling is conducted at five sites (Happy Isles, Pohono Bridge, Foresta Bridge, Swinging Bridge, and below Wawona Campground) during spring runoff. Finally, sampling is conducted during or following a storm event that causes a major change in flow conditions on the river. A sampling schedule and available personnel is scheduled well in advance each spring runoff season. Fixed interval sampling generally takes place on the same days each week or month, but these times can be adjusted to accommodate schedule conflicts or personnel availability. An attempt is made to sample storms during the rising limb of the hydrograph.

B.1.3 Field Methods

The field methods described in the following section assures the collection of quality data that meets the purpose of monitoring described in the previous section. The components include data quality objectives, instrument calibration procedures, sampling procedures, and quality control procedures. Special "Quick Guides" that encapsulate specific operational instructions are included in this section.

Data Quality Objectives: High data quality will be achieved through proper training of field technicians and adherence to the foregoing discussion of accuracy, precision, representativeness, and completeness.

> Chemical and Physical Parameters: Accuracy describes how close the measurement is to its true value. Accuracy is the measurement of a sample of known concentration compared with a measured value. The accuracy of field measurements will be checked by performing tests on standard check solutions as a part of calibration procedures. Standard calibration and check solutions will be purchased from commercial labs. In addition, the accuracy of chemical measurements should be verified through use of blind audit samples. Check standards and audit samples should be in the mid-range of typical values for the Merced River.

Biological Parameters: Accuracy for bacteria will be determined by analyzing a positive control sample twice annually. A positive control is similar to a standard, except that a specific discreet value is not assigned to the bacterial concentrations in the sample. This is due to the fact that bacteria are alive and capable of mortality and reproduction. Instead of a specific value, an approximate target value of the bacterial concentration is assigned to the sample by the laboratory preparing the positive control sample. In general, these checks are performed as a part of a certified laboratory routine quality control.

Chemical and Physical Parameters: The precision objectives apply to duplicate and split samples taken as part of normal sampling and repeated field parameter measurements on the same sample. Precision describes how well repeated measurements agree. Duplicate or split samples prepared in the lab or field will comprise at least 5% of the samples or one set per sampling day (about 10%). Repeated field measurements on a single sample will be conducted once per sampling day.

Biological Parameters: Precision for bacterial parameters will be determined by having the same analyst complete the procedure for laboratory duplicates of the same sample. At a minimum this should be done once per day, or run duplicates on a minimum of 5% of the samples if there are over 20 samples run per day. The results of the duplicates should be within the confidence limits supplied by the manufacturer.

Comparability: Comparability is the degree to which data can be compared directly to similar studies. Sample collection methods and field parameter measurements outlined in this protocol are derived from the USGS National Field Manual and the Surface Water Ambient Monitoring Program of the California State Water Resources Control Board. Laboratory analyses will be conducted by the USGS National Water Quality Laboratory or similar USGS approved contact laboratory or, at minimum, a National Environmental Laboratory Accreditation Program (NELAP) approved laboratory. These measures should ensure broad data comparability, particularly with the National Park Service Inventory and Monitoring and Vital Signs Programs (National Park Service- Freshwater Workgroup Subcommittee 2002).

Method Detection Limit and Sensitivity: The Method Detection Limit (MDL) is the lowest possible concentration the instrument or equipment can detect. This is important to record because we can never determine that a pollutant was not present, only that we could not detect it. Sensitivity is the ability of the instrument to detect one concentration from the next. Detection Limits and Sensitivities are noted in Tables B.1.1 and B.1.2. Some labs use reporting limits in addition to the method detection limits. A reporting limit is typically 2-5 times the MDL.

Table B.1.1. Water Quality Parameter Measurement

Parameter	Method/ Range	Units	Detection Limit	Sensitivity	Precision	Accuracy	Complete-ness
Temp.	Electronic thermometer (-5 to 50)	°C	-5	0.01 °C	± 0.01 °C	± 0.15 °C	80%
Dissolved Oxygen	Electronic meter/probe	mg/l	0.1	0.01 mg/l	± 0.01 mg/l	± 0.2 mg/l	80%
pH	pH meter	pH units	0	0.01 unit	+ 0.01 units	+ 0.2 units	80%
Conductivity	Conductivity meter	µS/cm	1	1 µS/cm	± 0.5%	± 5%	80%

Table B.1.2. Water Quality Laboratory Parameters

Parameter	Method	Units	Detection Limit	Reporting Limit	Completeness
Total Dissolved Nitrogen	USGS/NWQL 2754	mg/l	0.015	0.03	80%
Nitrate and Nitrite	USGS/NWQL 1979	mg/l	0.008	0.016	80%
Total Phosphorous	USGS/NWQL 2333	mg/l	0.002	0.004	80%
Total Dissolved Phosphorous	USGS/NWQL 2331	mg/l	0.002	0.004	80%
E. coli	SM9221F	MPN/100 ml	2	2	80%
Total Petroleum Hydrocarbons	306 MEPA SW 846	µg/l	13.0		80%

Representativeness: Representativeness describes how relevant the data are to the actual environmental condition. Problems can occur if:

- Samples are taken in a non-standard collection area such as downstream of a bridge
- Samples are not representative of the entire flow due to sampling in a backwater area, or not properly assuring an integrated sample
- Samples are not analyzed or processed appropriately; causing conditions in the sample to change (e.g. water chemistry measurements are not taken immediately).

Sampling locations have been selected to minimize local impacts due to a bridge or other adjacent structure. Foresta Bridge is the only location where samples are collected downstream of the bridge both for safety reasons and to sample at the same location as El Portal Waste Water treatment plant personnel. Integrated sampling has been done when possible from bridges or by wading using a centroid sample. Otherwise, grab samples are collected as close to the main flow as possible to minimized backwater effects. Side-by-side comparison of grab sampling and centroid sampling or equal-width interval sampling has been and continues to be conducted to characterize the variability associated with grab sampling alone. All field parameter measurements are conducted at the sampling sites. All samples are to be held at 4°C and analyzed within the specified hold times.

Completeness: Completeness reflects the ratio of valid laboratory results to number of samples actually sampled. The goal is 80% sample validity. This ratio may be increased as this program matures.

Before modifying these methods, or developing alternative or additional methods, technical advisors will evaluate and review the effects of the potential modification. It will be important to address their concerns about data quality before proceeding with the monitoring program.

Instrument Calibration Procedures: Instrument calibration and checks should be conducted at least twice per day, including a check of the calibration following collection of the last sample. Calibration checks are intended to verify the calibration of the instrument. The following table specifies post calibration check error limits. If the instrument does not read within these limits, perform the calibration sequence again.

Post Calibration Check Error Limits:

Parameter	Value
Dissolved oxygen	± 0.5 mg/L, ± 6% saturation
pH	± 0.2 standard units
Specific conductance	± 5%
Temperature	± 0.2 °C, annual calibration check

Instruments to calibrate will be the multi-parameter probe for measuring temperature, pH, specific conductivity, and dissolved oxygen and the smaller packable unit for temperature and conductivity. Calibration procedures will vary by instrument but the following provides a general outline of the procedure and a form to record calibration results.

Temperature: Conductivity, pH, and dissolved oxygen are all temperature compensated qualities and therefore it is critical that temperature be measured accurately. Temperature accuracy should be verified periodically via a side-by-side comparison with a NIST-traceable thermometer every three months during regular field measurements and then document in the notes section on the calibration form.

Both the multi-parameter probe and the NIST-traceable thermometer should be sent to the manufacturer once per year to verify or adjust calibration. All calibration certificates should be filed with field data for the period that the calibration was valid.

Specific Conductivity: Calibration should be performed once per sampling day. The calibration should be checked after the last sample has been collected to ensure the instrument has maintained its calibration.

- If the probe has been in storage, soaking in deionized (DI) water may be necessary to ensure the probe is thoroughly wetted prior to use. Equilibrating the probe in DI water for 10 minutes is recommended. Consider immersing the probe in DI water in a clean durable container before heading to the field.
- To calibrate the meter for specific conductivity, use a conductivity standard solution of around 1000 µS/cm. A single point calibration will be adequate.
- Immerse the probe into the standard and agitate vertically to ensure there are no air bubbles trapped. Allow time for the reading to stabilize.
- Record the value of the calibration standard, the manufacturer and lot number, and the expiration date.
- Triple rinse the probe with DI water and then with the check solution This solution should be another conductivity standard around 750 µS/cm.
- Record the manufacturer's value for the check solution, the solution temperature, the manufacturer and lot number, and the expiration date.
- Immerse the probe in the check solution and record the measured value. This is the Initial Calibration Check (ICC).
- Record Continuing Calibration Checks (CCC) at the end of the day and record this value and the time. The difference should be less than 5%.

pH: Calibrate the pH meter before the start of sampling. In addition, the meter accuracy should be verified using a check standard close in value to the river water. A final check of the instrument should be done after the last sample is taken.

- Triple rinse electrode with DI water.
- Calibrate and operate in temperature-compensation mode using pH = 4.00 and 7.00 buffer solutions. Record the value of each buffer standard, the manufacturer and lot number, and the expiration date.
- Rinse the probe with DI water and blot the excess.
- Check using a buffered check solution of pH 5-6. Immerse the electrode into the solution and stir briefly.
- Record the manufacturer's value, the measured value (ICC or CCC), temperature, the manufacturer and lot number, and expiration date.
- Rinse the probe with DI water, blot dry, and make field measurement.

Dissolved Oxygen: Clean the sonde and stirrer under running tap water to remove debris. Swab the DO membrane and pH probe with a cotton ball soaked in Alconox or methanol. This removes surface films that may cause the calibration to drift. Check the condition of the membrane. Ensure the membrane is intact; free of wrinkles, bubbles, and surface films; and not discolored below the membrane.

- Fill the calibration cup with water to just below the O-ring, securing the DO membrane.
- Carefully remove any water droplets from the membrane with a Kimwipe or soft towel.
- Cap the calibration cup and allow it to stabilize for about five minutes.
- Select Calibrate, (%) Saturation, and then enter the correct barometric pressure (mm-Hg) and hit Enter.

Data Collection, Measurement, and Post-collection Processing:

Table 3 lists sampling locations and analytes to be sampled. Eight front-country (accessible by vehicle) sites will be sampled monthly. Five of these eight sites will be sampled following major storm events and weekly during the peak spring runoff period. An additional two backcountry sites will be sampled seasonally on a monthly basis. Each sampling event will take place over 1-2 days. Sample collection at two backcountry sites will require one technician two days per event. Sampling should also be coordinated with more comprehensive sampling conducted at Happy Isles by the USGS as part of the Hydrologic Benchmark program to provide a quality control check.

Nutrients (dissolved nitrogen species, total phosphorous and total dissolved phosphorous) will be sampled at all sites. Petroleum hydrocarbons will be sampled quarterly at three downstream locations only (Pohono Bridge, Foresta Bridge, and Below Wawona Campground). Additional petroleum hydrocarbon sampling will take place on a monthly basis during spring runoff sampling. *Escherichia coli* (*E. coli)* bacteria will only be sampled at the eight front-country sites due to the short 6-hour hold time on these samples. All sampling and sample hold times will conform to published USGS and EPA procedures. Storm and spring runoff sampling will be conducted at five sites only, to facilitate delivery and processing of samples at the El Portal Waste Water Treatment Plant. Storm event sampling should take place for each precipitation event that causes a doubling of discharge at the USGS Happy Isles Gage. In the case where a storm follows an extended dry period, one may wish to collect a sample prior to the point at which the discharge has doubled. During large storm events that last many days, two sample sets should be collected as the discharge increases.

At each sampling location, field measurements will also be recorded. These include water and air temperature, pH, specific conductivity, and dissolved oxygen. River stage or discharge will also be recorded where feasible. Nutrients will be sampled at the flow centroid when and where possible. Otherwise, a grab sample taken from the bank where the thalweg is accessible will suffice.

Table B.1.3. Water Quality Sampling Locations for Merced River

Sampling Location [Latitude, Longitude, Elevation, (NAD27 Datum)]	Sampling Schedule
Merced River at Merced Lake, below High Sierra Camp 37° 44' 17'' 119° 25' 07'' 7,200 ft	Monthly between June 15 and October 15
Merced River at top of Nevada Fall (below Little Yosemite Valley 37° 43' 29'' 119° 31' 55'' 5,920 ft	Monthly between June 15 and October 15
Merced River in Yosemite Valley at Happy Isles Gaging Station 37° 43' 54'' 119° 33' 28'' 4,016 ft	Monthly, weekly during snowmelt runoff, and during rainfall-generated high flows (e.g. summer thunderstorms)
Merced River in Yosemite Valley at Sentinel Bridge 37° 44' 36'' 119° 35' 20'' 3,950 ft	Monthly
Merced River in Yosemite Valley at Pohono Bridge 37° 43' 01'' 119° 39' 55'' 3,862 ft	Monthly, weekly during snowmelt runoff, and during rainfall-generated high flows (e.g. summer thunderstorms)
Merced River in El Portal at SR140 Bridge 37° 40' 17'' 119° 47' 33'' 1,825 ft	Monthly
Merced River in El Portal at Foresta Bridge 37° 40' 10'' 119° 48' 58'' 1,640 ft	Monthly, weekly during snowmelt runoff, and during rainfall-generated high flows (e.g. summer thunderstorms)
South Fork Merced River in Wawona at Swinging Bridge 37° 32' 19'' 119° 37' 11'' 4,180 ft	Monthly, weekly during snowmelt runoff, and during rainfall-generated high flows (e.g. summer thunderstorms)
South Fork Merced River in Wawona at South Fork Bridge 37° 32' 19'' 119° 39' 28'' 3,950 ft	Monthly
South Fork Merced River in Wawona below Wawona campground 37° 33' 02'' 119° 37' 11'' 3,860 ft	Monthly, weekly during snowmelt runoff, and during rainfall-generated high flows (e.g. summer thunderstorms)

Hydrocarbons and *E. coli* will be sampled as grab samples due to sampling requirements. Field replicates and blanks will be prepared according the requirements for each analyte.

Field staff will properly store and ship water samples within 24 hours or as soon as possible such that the samples remain below 4°C until analysis takes place. All field forms, calibration forms, and chain of custody forms will be photocopied and stored according to protocol. All equipment problems should be documented and addressed immediately.

What follows is a detailed description of monthly sampling. Event sampling is much smaller in scope due to time restrictions. At the end of this section are two Quick Guides to sampling: 1) monthly and 2) event. Once the more detailed information is learned, one can simply take the quick guide to the field as a reference.

<u>Before Going to the Field</u>:

- Confirm with the El Portal Waste Water Treatment Plant laboratory that they will be expecting to receive samples that day. Ideally, all sampling trips should be scheduled at least one month ahead of time.

- Calibrate and check pH, conductivity, and dissolved oxygen (DO) meters according to the calibration methods discussed above. Record this data on the Calibration/Check form and place in binder. Calibrating the conductivity and pH meters once per sample day is sufficient. The DO meters should be calibrated and checked at each sample site. This procedure will be reviewed as sampling progresses to assure proper meter calibration.

- Gather bottle sets, gloves, collection device, meters, forms, cooler, and blue ice. Use at least one blue ice block per sample set to assure the samples remain at or below 4°C.

Sampling Technique Overview: For each site, there should be a designated sampling location. The sample should be representative of the whole river at this location so collect the sample from water moving downstream, possibly in a location where the thalweg impacts the river's edge. Time constraints dictate the collection of a centroid sample (depth-integrated) where possible and a grab sample in other locations. When possible, dual sets of samples (centroid or Equal-Width Interval and grab) should be collected to assess their relative differences.

In general, collect the samples before making field measurements to avoid contamination of the site. Also, when possible, collect samples starting at the most downstream location and working upstream to avoid contamination due to sampling activities. Wear a new set of gloves at each site. Sample upstream of bridges to avoid contamination from the bridge. (Except in the case of Foresta Bridge, where grab samples are more safely collected below the bridge.) For each grab sample, open the bottle and plunge beneath the water surface about 1.0 feet and move the mouth upstream until the container is nearly full. If wading, collect the sample upstream of you. If water depth is less than 1.5 feet deep immerse the sample bottle one third of the depth. Cap the bottle and label properly. Once the samples have been collected, place the pH, conductivity, temperature, and DO probes (or multi-probe) in the water to equilibrate. Take field readings. In order to expedite *E. coli* sample transport to the laboratory and to minimize the potential for contamination, sample processing (acidification, filtration, documentation) should be delayed until back in the laboratory.

Sample Processing Requirements: Table B.1.4

Bottle Number	Analyte(s)	Collection Method	Container	Preservation
1	Dissolved Nitrogen and Phosphorous Species	Grab	125 ml brown plastic (FCC)	Filter within 2-3 hours using 0.45 μm filter; chill to 4°C. Hold time = Ship as soon as possible
2	Total Phosphorous	Grab	125 ml clear plastic (WCA)	Acidify with 1 ml 4.5 N H_2SO_4; chill to 4°C Hold time = 28 days
3	*E. coli*	Grab	Container provided by lab	Chill to 4°C Hold time = 6 hours
4	Total Petroleum Hydrocarbons	Grab	Baked borosilicate glass 1000ml	Chill to 4°C Hold time = Ship as soon as possible

Specific Tasks for Each Sample Site:

A. Collect *E. coli* sample
B. Collect dissolved nitrogen sample
C. Collect total phosphorous sample
D. Collect total petroleum hydrocarbon sample (at Pohono, Foresta, and below Wawona Campground only) on a quarterly basis. See operational plan.
E. Collect quality control sample(s)
F. Collect field measurements

A. *E. coli* Sampling Protocol (USGS National Field Manual for the Collection of Water-Quality Data (NFM), Chapter 7). Never pre-rinse the sample container. When submerging the sample container, take care to avoid contamination by surface scums. The surface film is enriched with particles and bacteria not representative of the water mass. *E. coli* samples will always be collected as grab samples**.**

1. Establish a consistent sampling location at each site, preferably where there is a consistent downriver current and enough depth to avoid collecting any sediment.
2. For each sample set, wear a new pair of exam (latex, nitrile, vinyl or similar) gloves.
3. Open the sample container and collect a sample from the surface, moving the bottle forward upstream until full. Always hold the mouth of the sample container upstream of the sampler and any disturbed sediments. Avoid contact with the sediment.
4. Place sample immediately in cooler. Fill out sample form.

B. Nutrient Sample - Total Dissolved Nitrogen Sampling Protocol (NFM, Chapter 5.2.1.A):

1. Collect a grab sample at a location where the thalweg impacts the bank.
2. For each sample set, wear a new pair of gloves.
3. Collect sample in a 1-liter Nalgene bottle that had been rinsed 3 times with deionized (not distilled) water. Rinse the bottle 3 times with river water before collecting the sample.
4. Filter the sample using a 0.45 μm filter. Note that filtering may take place in the field or back in the laboratory. Keep samples cold and in the dark.
5. Place samples immediately in cooler. Fill out sample form.

(Note that the nitrogen and the phosphorous samples may be derived from the same 1-liter sample)

C. Nutrient Sample - Total Phosphorous Sampling Protocol (NFM, Chapter 5.2.1.A):

1. Collect a grab sample at a location where the thalweg impacts the bank.
2. For each sample set, wear a new pair of gloves.
3. Collect sample in a 1-liter Nalgene bottle that had been rinsed 3 times with deionized (not distilled) water. Rinse the bottle 3 times with river water before collecting the sample.
4. Acidify the sample per directions from the laboratory.
5. Place sample immediately in cooler. Fill out sample form.

(Note that the nitrogen and the phosphorous samples may be derived from the same 1-liter sample)

D. Hydrocarbon/Petroleum Sampling Protocol (NFM, Chapter 5.4.2):

1. Sample at the same location as the *E. coli* sample. This sample will always be collected as a grab sample.
2. For each sample set, wear a new pair of gloves.
3. Open the sample bottle not touching the opening. Do not pre-rinse bottle. Plunge the bottle into the river fully below the surface facing the opening upstream. Move the bottle slowly forward under the surface until nearly full. Leave a small amount of head space.
4. Place sample immediately in cooler. Fill out sample form.

E. Quality Control Samples:

Field Replicate (Collect one replicate per sampling trip).

1. Collect two separate nutrient samples at one location. Rotate sites at which a replicate is collected.
2. Filter or acidify as appropriate.

Field Equipment Blank (Collect one blank per trip).

1. Rinse a 1-L sample bottle with DI water 3 times. Fill with DI water. This is the 'blank' nutrient sample. Transport bottle as you would other samples in the cooler.
2. Once back at the laboratory, filter and acidify as if the sample were being processed for nitrogen and phosphorous species.

F. Field Measurements:

Measure temperature (air and water), specific conductivity, pH, and dissolved oxygen (DO). In addition make an estimate of the discharge (NFM Chapter 6). Record all calibration information on calibration forms and place in notebook.

<u>Temperature:</u>

- Measure the temperature at 5-10 cm beneath the water surface, approximately the same location where the samples were collected.
- Report the value to the nearest 0.2 °C.

<u>Specific Conductivity:</u>

- Immerse probe into the water at approximately the same location as where the samples were taken.
- Once it has stabilized, record the specific (temperature compensated) conductivity values to nearest tenth µS/cm.

<u>pH:</u>

- Immerse probe into the water at approximately the same location as where the samples were taken. Agitate the probe continuously.
- Once it has stabilized, record value to the nearest tenth of a pH unit.

Dissolved Oxygen:

- Calibrate the probe at each sample location.
- Immerse probe into the water at approximately the same location as where the samples were taken. Agitate the probe continuously.
- Once it has stabilized, record value to the nearest 0.1 mg/L.

Discharge Estimate:

- At Happy Isles and Pohono Bridge use the USGS gaged flows. Note the time of your site visit and find the discharge later via the USGS web-sites: Happy Isles: http://nwis.waterdata.usgs.gov/nwis/uv/?site_no=11264500&agency_cd=USGS and Pohono Bridge: http://nwis.waterdata.usgs.gov/nwis/uv/?site_no=11266500 &agency_cd=USGS
- At Foresta Bridge, use the wire-weight gage to determine stage. Use the stage-discharge table for this site to determine discharge.
- At Sentinel Bridge, record the stage. No stage-discharge relation yet exists for this gage.
- For the Wawona sites, record the stage on the staff gage across from the golf course. Determine the discharge using the stage-discharge table for this site.

QUICK GUIDE TO VERP WATER QUALITY SAMPLING
(MONTHLY SAMPLING)

Before Field Day:

1) Charge MiniSonde Controller (turn on to assure charging; leave power on)
2) Print and copy on waterproof paper: field forms (12).and calibration forms (3). Make sure you have a chain of custody form (1) and Sampling Log (1). All forms are at MS01/EP Commons/VERP/Field Activities Commons/Water Quality/Forms. Note that some field forms have a back side with reference codes.
3) Assure you have 12 NWQL bottle sets (2 FCC, 1 WCA each), 3 1-L amber bottles, and at least 8 *E. coli* sample bottles. One bottle set is for Merced Lake.
4) Fill 5-gal DI bottle at El Portal Waste Water Treatment Plant (call El Portal Waste Water Treatment Plant @ 379-1828).
5) Verify with Jim Allen (379-1039) that the waste water treatment plant is prepared to receive and process samples.
6) Fill a 1-L bottle with DI water for calibrating the DO when in the field.
7) Assure adequate supply of all calibration and check solutions standards.

Day 1—Main Stem Merced (First Tuesday of the Month):

Before going into field:

1) One person needs to go to Nevada Fall. This person should take the calibrated handheld conductivity meter and a clean 1-L Nalgene bottle to collect the sample. Record the specific conductivity, water temperature, and time of collection. Process back at lab.
2) Assemble 5 *E. coli* sample bottles, 2 TPH brown glass bottles. Prepare cooler with blue ice in which to store 6 1-L bottles each in a zip-lock bag. You may want to prelabel these bottles for each site. One will be a replicate.
3) Clipboard with field forms, chain of custody form, calibration forms, and sample log form.
4) Calibrate multiprobe in laboratory. Calibrate pH (pH 7 and 4, check at pH 5.00), and conductivity (1000 uS/cm and check at 750 uS/cm). **Record all information on calibration form.**
5) Pack large monthly sample bin, DI Water, Hydrolab with cord and controller.

In the field:

1) Calibrate DO. Record on calibration form.
2) Collect grab sample for nutrient analysis. Cap sample bottle, label, and store for processing later. Collect one *E. coli* sample. Collect one TPH sample at specified sites on a quarterly basis. **Record TPH samples on TDI Chain of Custody Form.**
3) Measure pH, water and air temperatures, DO (mg/l), and conductivity at each site. **Fill out field form.**
4) Collect samples indicated in the following table. Following collection of the samples deliver *E. coli* samples to the El Portal Waste Water Treatment Plant.

Site	NWQL Sample	Total Pet Sample	*E. coli* Sample	Measure Stage
Happy Isles	**1**	**0**	**1**	**Online or in field.**
Sentinel Bridge	**1**	**0**	**1**	**Use gage on bridge.**
Pohono Bridge	**1**	**1 (per quarter)**	**1**	**Online or in field.**
SR140 Bridge	**1**	**0**	**1**	**Use same value as Foresta.**
Foresta Bridge	**1**	**1 (per quarter)**	**1**	**Wire weight gage on bridge.**

Site	NWQL Sample	Total Pet Sample	*E. coli* Sample	Measure Stage
Replicate (any site)	**1**	**0**		

5) **Fill out the Sampling Log Form as you go.**
6) Back at the lab, process NWQL Samples. Filter the sample for the 2 FCC bottles (125 ml brown bottle). Acidify an unfiltered sample in the WCA (125 ml clear bottle). Rinse bottles three times before filling. Label and chill immediately. **Change filters between samples. On the Field form check the VERP (Schedule 2027) and the alkalinity, pH, and SC analyses.**
7) Process the replicate sample as above.
8) Process one blank sample (use DI water for 2 FCC and 1 WCA).
9) Check the multimeter pH probe using pH 5.00 solution. Check conductivity probe using 750 uS/cm solution. **Record these values and solution temperature on the Calibration Form.**
10) Rinse multimeter. Place a small amount of *tap water* in the calibration cup for storage. Unplug cord and cap conductors for protection.
11) Make copies of all field forms and calibration forms. Verify that each sample bag has the proper field form. Include calibration forms in a separate plastic bag.
12) Store all equipment properly. Rinse all filtering equipment and bottles and allow to air dry before storage.

Day 2—South Fork Merced (First Wednesday of the Month):

<u>Before going to the field</u>:
1) Assemble 3 NWQL bottle sets, 3 *E. coli* sample bottles, 1 TPH brown glass bottle. Place all in cooler with ample blue ice.
2) Clipboard with field forms, chain of custody form, calibration forms, and sample log form.
3) Calibrate the Hydrolab in laboratory. Calibrate pH (pH 7 and 4, check at pH 5.00), and conductivity (1000 uS/cm and check at 750 uS/cm). **Record all information on calibration form.**
4) Pack large monthly sampling bin, DH-81, binoculars, DI water, Hydrolab with cord and controller.

<u>In the field</u>:
1) Calibrate DO. Record on calibration form.
2) Measure pH, water and air temperatures, DO (mg/l), and conductivity at each site.
3) Collect grab sample for nutrient analysis about 100 yards downstream of campground at outlet of large pool. Cap sample bottle, label, and store for processing later. Collect one *E. coli* sample. Collect one TPH sample at specified sites on a quarterly basis (no rinsing). **Record TPH samples on TDI Chain of Custody Form.** Read stage on river near golf course. **Fill out field form.**

4) Collect remaining samples as follows:

Site	NWQL Sample	Total Pet Sample	*E. coli* Sample	Measure Stage
Below Wawona Campground	**1**	**1 (per quarter)**	**1**	**Same as below.**
South Fork Bridge	**1**	**0**	**1**	**Gage in river near golf course (use binoculars).**
Swinging Bridge	**1**	**0**	**1**	**Same as above.**

5) **Fill out the Sampling Log Form as you go.**
6) Deliver *E. coli* samples to the El Portal Waste Water Treatment Plant.
7) Process NWQL samples back in the laboratory. Filter the sample for the two FCC bottles (125 ml brown bottle). Acidify an unfiltered sample in the WCA (125 ml clear bottle). Rinse bottles three times before filling. Label and chill immediately. **Change filters between samples. On the Field form check the VERP (Schedule 2007) and the alkalinity, pH, and SC analyses.**
8) Ship NWQL samples as soon as possible using overnight FedEx to Dave Clow (forms are in lab). Use plenty of blue ice. Ship TPH samples as soon as possible using overnight FedEx to Dr. Thomas McDonald at TDI Brooks.

QUICK GUIDE TO VERP WATER QUALITY SAMPLING
(EVENT OR SNOWMELT RUNOFF SAMPLING)

1) Weekday: Call the El Portal Waste Water Treatment Plant 379-1828 to tell them you are coming with 5 *E. coli* samples. Tell them approximately what time you will arrive.

   Weekend: Do not collect *E. coli* samples.

2) Gather bottles sets, forms, two coolers, and blue ice:

   a. 7 WCA (clear 125 ml bottles + acid)
   b. 7 FCC (brown 125 ml bottles)
   c. 5 *E. coli* sample bottles
   d. 3 amber glass bottles (total petroleum hydrocarbons) + 1 spare in case one is broken
   e. Forms: 1 chain of custody TDI form, 1 sample log form, 1 calibration form, 7 field forms (all on waterproof paper)

3) Collect field items:

   a. Big black Tuff box : orange vests, towels, lifejacket, grab sample bottles (1-liter) with labels (6), ziplock bags, *E.coli* sample bottles, gloves, conductivity meter
   b. One cooler and blue ice for samples
   c. Clipboard – all forms, example forms, calibration instructions
   d. Binoculars – for the Wawona staff gage by the golf course

4) Calibrate meter – use simple Oakton meter for specific conductivity and temperature only. Calibrate with 1000 uS/cm solution or equivalent and check using 750 uS/cm solution or equivalent.

5) Sample sequence:

   a. Swinging Bridge— *E. coli*, FCC, and WCA (collect 2 1-L bottles of river water, 1 sample and 1 replicate)
   b. Wawona Campground— *E. coli*, TPH, FCC, and WCA
   c. Happy Isles Bridge— *E. coli*, FCC, and WCA
   d. Pohono Bridge— *E. coli*, TPH, FCC, and WCA
   e. Foresta Bridge— *E. coli*, TPH, FCC, and WCA

   [*E. coli* = Sample bottle for *E. coli*, TPH = Total Petroleum Hydrocarbon (1L bottle), FCC = Filtered Chilled (125 ml brown), and WCA = Whole water acidified (125 ml clear)]
   For spring runoff sampling, see sampling schedule for which days to sample TPH. It is no longer sampled every week.

6) At each site:

   a. Note stage **(try to collect sample at location in main current where it is safe to do so)**
   b. Collect *E. coli* sample - (no rinsing!)
   c. Collect TPH using 1-L amber bottle— (no rinsing!)
   d. Collect one liter of water in plastic bottle for FCC and WCA (rinse 3 times)
   e. Label bottles with date, time, sample location
   f. Measure temperature, conductivity
   g. Finish field form(s)
   g. Store samples in cooler

Immediately following collection of last sample at Foresta Bridge, take *E. coli* samples to the El Portal Waste Water Treatment Plant.

7) Back at the lab:

   a. Filter samples for FCC bottles
   b. Acidify sample for WCA bottles
   c. Label all bottles with site name, number, date, time
   d. Finish field form
   e. Process replicate sample as others, label as such, fill out separate field form, place sample in separate bag
   f. Process field equipment blank as others, label as such, fill out separate field form, place sample in separate bag
   g. Copy field forms
   h. Place original waterproof field forms with their respective samples
   i. Check calibration of the meter using 750 uS/cm solution or equivalent
   j. Copy calibration form. Place a copy with the samples (in a separate bag). Mail with samples sent to Dave Clow at the USGS.
   k. Complete sample log form
   l. Refrigerate samples
   m. Place all copies of forms in the VERP Drawer at the Rancheria Office.

8) Mail nutrient samples to Dave Clow and total petroleum hydrocarbons to Dr. Thomas McDonald as soon as possible. Send in a cooler with plenty of blue ice. If after 12:00 p.m. on Thursday, mail the following Monday so samples don't sit over the weekend.

Quality Control:

Quality control (QC) of field measurements and sample integrity are outlined in this section. In general, at least one set of QC samples and one set of duplicate field measurements should be taken per sampling trip (one per the eight front-country sites and two back-country sites). In addition, one field blank should be processed per sampling trip.

Sample Replicates (Once per Sampling Trip): For nutrients (nitrogen species and total phosphorous) collect sample replicates at one site per sampling event. Process both samples as normal, labeling one as the replicate sample.

For the *E. coli* sample, a replicate will be prepared in the laboratory. This should be the same sample location as the replicate sample for the other analysis. Standard laboratory positive and negative tests should be reported for each sample batch.

For the total petroleum hydrocarbon sample, the laboratory conducting the analysis will perform quality assurance.

Field Equipment Blanks (One per Trip): Process one sample set using DI water in exactly the same way as a normal river water sample. Rinse a 1 L bottle with DI water three times. Fill with DI water. Fill the total phosphorous bottle from this "sample" bottle. Acidify the sample and store as normal. Filter the "sample" water into a dissolved nitrogen species bottle following normal filtration protocols. Store and label as normal.

Repeated Field Measurements (Once per Trip): Repeat field measurements of temperature, pH, conductivity, and dissolved oxygen once per sampling trip. If taking measurements from a bridge, take the first set of readings as normal. Remove sensors from the water and rinse thoroughly with DI water and return to the same location as the first set of readings. Record these readings in the space provided on the field form.

External Audit Samples: None scheduled at this time.

Equipment Maintenance: The following is a schedule and procedural guide to maintenance of water monitoring field equipment.

Daily (After Sampling):

Buffers and Standards Solutions:

- Store buffers and standards solutions according to manufacturer's directions. Some solutions may have to be refrigerated when not in use.
- Check the expiration dates and order new solutions well in advance. Do not use expired solutions.

Sample Bottles and Collection Devices:

- Rinse all sampling devices (bottles, caps, nozzles, filtering systems, and tubing) with DI water after each sampling day. ***Do not use soap.*** Store in clean zip-lock bags or a clean dust-free container.
- Inspect sampling bottles regularly for scratches or other damage. Do not use bottles that are excessively scratched as these may be difficult to clean.
- Inspect the sampling ports of the DH-81 and DH-95 devices for scratches or damage. Order replacement parts if necessary.

Annually (January or February):

Buffers, Standards Solutions, and Other Chemicals:

- Order sufficient buffer and standards solutions for the coming year. This includes pH 4.00, 7.00, and check solution, and conductivity standard and check solutions.
- Order sufficient acid and methanol.

Sample Bottles and Collection Devices:

- Inspect sampling bottles regularly for scratches or other damage. Do not use bottles that are excessively scratched as these may be difficult to clean.
- Order new sample bottles if necessary.
- Inspect the sampling ports of the DH-81 and DH-95 devices for scratches or damage. Order replacement parts if necessary.

Hydrolab MiniSonde 4a: Follow this schedule for minimum maintenance. This schedule has been developed from the record of instrument performance and consultation with the manufacturer.

After Each Sampling Trip: These are important steps in preventive maintenance that are done each day the instrument is used.

- Post-calibrate the instrument before general cleaning and maintenance.
- Following post-calibration, rinse off the sensors and store them in tap water. Do not use deionized or distilled water for storage.
- Keep the water-tight rubber cable connectors well lubricated and dry on the inside. The best procedure is to store the instrument with all connectors separated and open to the air until dry.
- Check rubber cable connectors regularly to ensure that the mated surfaces are covered with a thin film of white silicone.
- As necessary, use some tissue paper to remove old traces of silicone and dirt and then reapply the silicone.

Before Calibrating: Clean off the sensors. Use a cotton pad and methanol. Cotton swabs or gauze pads are the only materials that will not scratch the soft glass of the pH probes. Paper, including lens paper, is not suitable.

Conductivity: Every two months or once every 15 field trips clean the conductivity sensor with a Q-tip soaked with methanol.

pH: Every two months or once every 15 field trips:

- Wipe the pH probe with a Q-tip soaked in methanol.
- Replace the solution in the pH reference sleeve with a standard electrolyte (3.5 molar KCl saturated with silver chloride).
- Clean the plastic reference probe sleeve and fitted end piece inside and out with a Q-tip soaked in methanol.
- Rinse everything with deionized water before filling and reassembling.
- Always apply a thin layer of silicone to the O-rings.
- When replacing the sleeve, point the sensor down and push the sleeve up until it just covers the O-ring, then point the sensor up and continue to push the sleeve all the way to the base of the probe. This will purge air out of the sleeve and force electrolyte through the Teflon junction.
- Inspect the reference sleeve for air bubbles by observing the sensor while inverting the Sonde. If bubbles are present, repeat the filling procedure.
- Place the instrument sensor upright and fill the reference sleeve with solution until overflowing. As the Teflon junction is screwed in place observe electrolyte coming through.

Every 12 Months:

- Replace Teflon junctions on pH reference sleeve.
- Store spare junctions in a 2 to 5 molar (> 50,000 µmhos/cm) KCl solution.
- Inspect the O-ring at the bottom of the Teflon junction and at the base of the reference sleeve. Replace them if they appear flattened or have small nicks or cuts.

pH Trouble Shooting: If pH still doesn't calibrate correctly, do the following:

Evaluate the condition of the Teflon junction on the terminal end of the pH reference sleeve. The sleeve should slide on easily with some force applied. If the sleeve is difficult to apply, then the junction may have become clogged. In contrast, if the sleeve slides on too easily with little resistance, the junction is too porous. In both instances the junction must be replaced.

If replacing the junction does not solve pH problems, then clean the probe by alternately soaking it in 0.1 N HCl (hydrochloric acid), and then in 0.1 N NaOH (sodium hydroxide) for five minutes in each solution. Use the small black caps that protect display unit terminals to isolate the probes for soaking with these solutions.

Safety Note: Wear safety glasses and gloves when working with the corrosive chemicals.

Batteries: Every two months or once every 15 field trips:

- Review the calibration and replacement schedule for batteries.
- Recharge the 6-volt NiCad Gelcell batteries (nickel-cadmium or nickel-metal hydride) for 12 to 24 hours, regardless of the voltage displayed by the instrument. Ensure that NiCad batteries are recycled or disposed of properly. They should not be put in the regular trash.

Stirrer: Every two months or once every 15 field trips:

- Remove the magnetic metal wheel from the stirrer post.
- Thoroughly clean all lubricant, dirt, and debris from the inside of the wheel and stirrer post with a paper towel and Q-tip.
- Reapply a very small amount of white silicone lubricant to the tip of the stirrer post.

Dissolved Oxygen: Every six months or once every 15 field trips:

- Change the DO membrane and add fresh KCl solution.
- Invert the Sonde on a ring stand.
- Remove the guard, the O-ring, and the membrane. Shake out old electrolyte.
- Rinse DO cavity twice with deionized water and twice with DO electrolyte.
- Fill the cell with DO electrolyte and gently tap the side to release any trapped air bubbles.
- Replace the membrane and secure with the O-ring.
- Inspect the membrane for wrinkles or trapped air bubbles.

Whenever there is anything but a rapid and stable oxygen calibration, replace the membrane as a first step in troubleshooting. The new Teflon membrane is stretched during the replacement procedure. This affects the rate of diffusion for oxygen through the membrane to the internal sensing components. As the membrane relaxes, the rate of diffusion changes in an unpredictable manner. It is preferable to allow the membrane to relax overnight before calibrating. A minimum of 30 minutes must be allowed before the initial calibration.

If the gold cathode ring is discolored or tarnished, polish lightly with a lint free cloth or pencil eraser.

If the white ceramic post in the DO sensor is discolored (ages from white to gray to black):

- Clean with a 1:1 solution of household ammonia and deionized water.
- Remove the membrane from the sensor and pour out the electrolyte.
- Rinse with deionized water. Invert the Sonde on a ring stand and with a small eye dropper fill the cell with the ammonia solution until the white ceramic post is covered. Be careful not to get the solution on the gold anode ring. Have a moist towel close by when conducting this procedure so that the solution can be quickly wiped from the gold ring.
- Let stand for 10 minutes.
- Rinse twice with deionized water and refill according to the standard procedure described above.
- If it is necessary to use the DO probe before the new membrane has 12 ours to relax, carefully recalibrate the dissolved oxygen immediately before each set of measurements.
- **Sonde:** Every 12 months:
- Replace desiccant inside the display and Sonde units.

B.1.4 Data Management

Each sampling trip will generate field forms, calibrations forms, and chain-of-custody forms. In addition, there will be laboratory analysis results. All this information must be stored in a convenient and secure manner.

Sample Site Files: Each sample site will have its own folder that will contain site metadata and all field forms. Field forms will likely be required to accompany the samples to the laboratory. Therefore, make copies of each before sending samples.

File the following items in the sample site file:

- Copy of field form
- Copy of the instrument calibration form that corresponds to field measurements taken at that location
- Copy of the corresponding chain-of-custody file(s)
- Copy of laboratory analysis results

These files should be stored in a secure fireproof location.

Instrument Calibration Notebook: All instrument calibration sheets should be stored in a 3-ring binder that is stored in the lab.

Instruments Maintenance Notebook: All notes regarding instruments maintenance should be stored in a 3-ring binder kept in the lab. This binder should be organized by instrument. Notes to be included are battery changes, maintenance performed in-house, and any manufacturer servicing of the devices.

Forms:

1) USGS Field Form (Figures B.1.2 and B.1.3)
2) Instrument Calibration Form (Figure B.1.4)
3) Water Quality Sampling Log (Figure B.1.5)
4) Sample Site Information Form (Figure B.1.6)

Figure B.1.2 USGS Field Form (front)

AHRG Lab number (entered at login)		
SITE INFO		Unit (circle)
Site Code (see list)		
Site Name (see list)		
New site (y / n)?	if yes, enter new site info below	
DATE INFO		
Collection date		
Collection time		
Field Filtered?		
If no, date/time filtered		
BULK PRECIPITATION DATA		
Begin date		
Begin time		
Precip volume		L / ml
SNOWPACK OR LAKE DATA		
Sampling depth		ft / in / m / cm
NEW SITE INFO (complete only for new sites)		
Latitude/Longitude		
Elevation		ft / m
Datum, method (GPS, digitizer)		
Accuracy		ft / m
County, State		

FIELD DATA		Unit (circle)
Sample Type (see list)	If blank, note water lot#	
Sample Method (see list)		
Sampler type (see list)		
Staff gage		ft / in / m / cm
Description		
Tape down		ft / in / m / cm
Description		
Depth of water at weir		ft / in / m / cm
Inner gage		ft / in / m / cm
Discharge		cfs / cms
Air temp.		°C / °F
Water temp.		°C / °F
Field S.C.		µS/cm
Field D.O.		mg/L
Susp. sediment collected?		y / n
If yes, volume filtered		L / ml
PERSONNEL		
Sampling team		
Team lead signature		
Date signed		

BOTTLES	# of each	**Preservation**	**Acid lot**
250 ml FA		filter; acidify in lab (1 ml Ultrex HNO_3)	
250 ml RU		none	
250 ml FU		filter	
125 ml FCC		filter, chill	
60 ml		filter, chill	
125 ml DOC		filter, chill	
15 ml vial (^{18}O)		none	
125 ml WCA		acidify in field (1 ml 5N H_2SO_4)	
Septum (dissolved gas)		none	
Mercury		acidify in field (5 ml Omnitrace HCl)	
1L or 2L RU (circle)		none	

ISOTOPES	Check		Check
^{18}O-water		Tritium	
^{34}S / ^{32}S		^{87}Sr / ^{86}Sr	
^{35}S		CFCs	
^{15}N-NO_3		^{18}O-NO_3	

PROJECT NAME	**ACCOUNT # (if known)**
VERP	8582-AWR19

ANALYSES	
AHRG Lab	Check
ICP	
IC Anions	
IC Cations	
alkalinity, pH, SC	
DOC	
DON	
NWQL	
HB-N (schedule 1671)	
VERP (schedule 2027)	
TDN (lab code 2754) (FCC)	
Total N (lab code 2756) (WCA)	
Nitrate (lab code 1979) (FCC)	
Ammonia (lab code 1980) (FCC)	
ortho-P (lab code 1978) (FCC)	
TDP (lab code 2331) (FCC)	
Total P (lab code 2333) (WCA)	
Other (specify lab codes below)	

NOTES

Figure B.1.3 USGS Field Form (back)

Sample Type	Description
S	Streamwater
R	Springwater (eg., talus springs)
G	Groundwater (eg., wells)
B	Bulk precipitation
W	Wet-only precipitation
P	Snowpack
O	Lake Outflow
E	Lake Epilimnion
H	Lake Hypoliminion
F	Field Blank
K	Lab Blank

Site Info

Site Code	Site Name
HB259	Merced River below Merced Lake
HB201	Merced River above Nevada Fall
HB204	Merced River above Happy Isles Bridge
NP182	Merced River above Sentinel Bridge
HB317	Merced River above Pohono Bridge
NP183	Merced River above SR140 Bridge
NP184	Merced River above Foresta Bridge
NP185	S. Fork Merced River above Swinging Bridge
NP186	S. Fork Merced River above South Fork Bridge
NP187	S. Fork Merced River below Wawona Campground

Sample Method	Description
M	Grab
E	EWI
A	Autosampler
R	Replicate
B	Blank
W	Weir
G	Gage
C	Composite
30	Centroid

Sampler Type
(surface water samples)

1L or 2L bottle
DH81
Autosampler

(precipitation samples)

Carboy
Funnel
Aerochem
Shovel/scoop

Figure B.1.4 Instrument Calibration Form

Date: ____________________
Analysts: ____

Instrument (circle one):

Hydrolab MiniSonde 4a serial# 040900071937

Oakton Con400 serial# 161539

Other:____

pH

Time ____________
1st Level Calibration: **pH 7.0** @ _____°C; Mfr/Lot# __________________Exp. Date______

2nd Level Calibration: **pH 4.0** @ _____°C; Mfr/Lot# __________________Exp. Date______

Calibration Check: (true value) **pH 5.0**; Mfr/Lot# ____________________Exp. Date_____
Initial Calibration Check (measured): pH _____ @ ______°C
Diff <0.2 units? Cal. accepted by (initials/date/time): ________________
Continuing Calibration Check (measured): pH _____ @ ______°C
Diff <0.2 units? Cal. accepted by (initials/date/time): ________________

Conductivity

Time ____________
1st Level Calibration: **991 µS/cm** @ _____°C; Mfr/Lot#________________Exp.Date______

Calibration Check: (true value) **717 µS/cm**; Mfr/Lot#_________________Exp.Date______
Initial Calibration Check (measured): ________ µS/cm @ ______°C
Diff <5%? Cal. accepted by (initials/date/time): _______________
Continuing Calibration Check (measured): ________ µS/cm @ ______°C
Diff <5%? Cal. accepted by (initials/date/time): _______________

Dissolved Oxygen

Calibrations at each site:
Time _______ Barometric Pressure _____________ (mm Hg) Temperature ___________°C
Time _______ Barometric Pressure _____________ (mm Hg) Temperature ___________°C
Time _______ Barometric Pressure _____________ (mm Hg) Temperature ___________°C
Time _______ Barometric Pressure _____________ (mm Hg) Temperature ___________°C
Time _______ Barometric Pressure _____________ (mm Hg) Temperature ___________°C

Notes:

Figure B.1.5 Water Quality Sampling Log

Site Name	Site Code	Date	Time	Samples Collected (Number)			
				FCC	WCA	1-L TPH	Fecal Coliform
Merced River Above Happy Isles Gaging Station	HB204						
Merced River Above Sentinel Bridge	NP182						
Merced River Above Pohono Bridge	HB317						
Merced River Above SR140 Bridge	NP183						
Merced River Foresta Bridge	NP184						
S. Fork Merced River Above Swinging Bridge	NP185						
S. Fork Merced River Above SR41 Bridge	NP186						
S. Fork Merced River Below Wawona C.G.	NP187						

FCC - Filtered, Chilled,
Integrated
WCA - Unfiltered, Acidified,
Integrated
1-L TPH - Amber Glass Bottle, Acidified, Total Petroleum
Hydrocarbons, Grab Sample
Fecal Coliform - 100ml Whirl Pak,
Grab Sample

Figure B.1.6 Sample Site Information Form

Site Name: ____

Date: _________________________

Site Location: UTM ____________ E ______________N Datum NAD27 NAD83

Lat/Long ______ N ______ W

Site Elevation: _______________ meters feet

USGS Site Number: ____________________________

Other Relevant Site Numbers ____

Site Description:

Sketch Map:

Data entry: As soon as is feasible, a record of the sampling event should be recorded in the VERP water quality database. Enter one new record for each sample location as well as one record for the duplicate sample and one record for the field blank. Once laboratory data becomes available, this too should be entered into these records.

Data analysis: Data analysis consists of first checking data against all hard copy field forms and laboratory results. Once this is complete, data should be censored to exclude duplicates, blanks, and values below detection limits. For each site, prepare a summary plot of all concentrations of each analyte (total dissolved nitrogen, nitrate plus nitrite, total dissolved phosphorous, total phosphorous, E. coli, and total petroleum hydrocarbon) or report in the form of a table. Summary statistics (mean, standard deviation, maximum, and minimum) should be prepared for field parameters such as water temperature, specific conductivity, pH, and dissolved oxygen. This summary data will be reported as a part of the VERP Annual Report. In the annual report, notable findings should be mentioned as well as any exceedances of existing water quality standards.

B.1.5 Personnel Requirements and Training

Roles and Responsibilities (tasks and time commitments): Yosemite National Park, through the Division of Resource Management and Science will be responsible for the administration of this monitoring plan. Management of this project will be conducted by the branch chief of Physical Sciences and GIS within the division of Resources Management and Science. Responsibilities are:

- Preparation of an annual implementation plan and budget
- Training of field personnel
- Purchase and maintenance of field equipment
- Review of data and procedures
- Maintenance of data, field forms, equipment repair and maintenance logs, and updating protocols

Preparation of an Annual Implementation Plan and Budget: The annual plan should include a sampling schedule, the laboratory(s) used, anticipated personnel needs and time. There should be a comprehensive list of equipment, repair or calibration needs, and a list of disposables such as calibration and check solutions. A budget should be included. If possible, there should also be a summary of the previous season’s problems and possible solutions. This plan provides a record of data gathering activities.

As each new or returning technician enters on duty, they should receive comprehensive training on field and office water sampling procedures. The project manager should document this training for each technician for each season.

The project manager or a designated technician should be responsible for ordering new equipment and consumables, repairing or calibrating existing equipment (beyond routine actions), maintaining a supply of fresh buffers and calibration solutions, and maintaining a log of all equipment repairs.

Every couple of months, the project manager should review the laboratory data and the QC sample data in particular. This information, coupled with discussions with field staff, should be used to review or modify procedures to improve data quality.

All field data forms should be photocopied and stored as office copies or archive copies. Office copies are photocopies of the originals and are intended as an operational reference. Original data forms, chain-of-custody forms, and calibration forms should be stored as archives in a fire-safe location. Each instrument should have a logbook to document calibrations, repairs, and factory calibrations. As sampling protocols are modified, former protocols should be archived with the dates that they were in effect.

Training procedures: Each technician collecting water samples and field data associated with this project must have demonstrated the following:

- The ability to calibrate and operate conductivity, pH, and dissolved oxygen (DO) meters.
- Proper sample collection, preservation, and handling.
- A safety conscious approach to field work around rivers.
- Knowledge of proper documentation procedures.

These skills may be verified through assisting a qualified technician or by a means deemed satisfactory to the branch chief for Physical Sciences and GIS. This training should be documented at least once a year for each technician.

B.1.6 Operational Requirements

Work plan: Monthly sampling will be conducted on the first Tuesday and Wednesday of the month except December and February. Event samples should be collected as soon as is feasible. Spring runoff samples are to be collected weekly for a period of 8-10 weeks following that start of spring runoff.

Safety: A job hazard analysis (JHA) has been completed**.** See job hazard analysis table below (Table B.1.5).

Table B.1.5 Job Hazard Analysis for Water Quality Data Collection

United States Department of Interior **NATIONAL PARK SERVICE**	**1. WORK PROJECT/ACTIVITY**	**2. LOCATION**	
	VERP Water Quality Sampling	Main Stem and South Fork Merced River	
Job Hazard Analysis (JHA)	**3. NAME OF ANALYST**	**4. JOB TITLE**	**5. DATE PREPARED**
	Laura Clor	Technician	April, 2005

6. TASKS/PROCEDURES	**7. HAZARDS**	**8. ABATEMENTS ACTIONS** ENGINEERING CONTROLS – SUBSTITUTION – ADMINISTRATIVE CONTROLS – PPE
a. Driving to, from, and around sampling sites.	a. Collision resulting in damage, injury, or death.	a. Drive defensively, obey traffic laws, lights on, seatbelt on, be alert for pedestrians, wildlife, and distracted drivers. Know procedures for installing snow chains. Always carry and know how to use a Park radio.
b. Using bridge board and leaning out over bridge railings to lower/retrieve sampler.	b. Back injury due to lifting heavy DH-95 sampler, falling from bridges into water, injury due to loss of control of bridge board as heavy sampler drops from bridge into a suspended position.	b. Use proper lifting techniques to prevent back strain, employ a second person to aid in lifting or to serve as a spotter for the lifter, a third person should stand on the bridge board foot pegs to anchor it firmly to the ground.
c. Carrying DH-95 sampling device to and from bridge locations.	c. Back strain or other injury.	c. Stop to rest, lift with legs rather than back, use two people to carry for longer distances.
d. Working on bridges.	d. Accidents and injury resulting from being hit by a car.	d. Wear orange safety vests, be cautious of traffic.
e. Wading in river to collect samples.	e. Tripping, falling or being swept away due to slippery, uneven river bottom surfaces and strong currents.	e. Use extreme caution in watching footing, wear life vest, only wade if the water level/current strength is low enough to permit it, collect sample from river edge if water is too high and/or swift.
f. Working and walking along riverbanks.	f. Tripping and/or falling due to wet and slippery rocks or sloping ground surfaces, contact with poison oak, etc.	f. Watch footing, know how to identify and avoid all poison oak, rinse immediately in stream if contact occurs.
g. Acidifying water samples with sulfuric acid.	g. Skin or eye contact resulting in irritation, rashes or chemical burns.	g. Use dropper bottle to minimize potential for contact, acidify samples at counter level, rather than holding up to eye level, flush immediately in lab sink if contact occurs.
h. Working outdoors in cold and/or wet weather.	h. Hypothermia, reduced resistance to illness.	h. Stay dry. Use rubberized raingear if possible. Stay hydrated preferably with warm liquids. Stop work to warm up if necessary. Snack often.
10. SUPERVISORS SIGNATURE	**11. TITLE**	**12. DATE**

Equipment and materials: All equipment and materials are stored with the Branch of Physical Sciences and GIS. The lead technician and the park hydrologist are responsible for making sure that adequate supplies are available and in working order prior to each sample event.

B.1.7 References:

Clesceri L.S., Greenberg A.E., and Eaton A.D. Editors (1998). Standard Methods for the Examination of Water and Wastewater (20th Edition). American Public Health Association, the American Water Works Association, and the Water Environment Federation.

National Park Service- Freshwater Workgroup Subcommittee (2002). Recommendations for core water quality monitoring parameters and other key elements of the NPS Vital Signs program, water quality monitoring component. Fort Collins, CO, National Park Service.

United States Geological Survey, variously dated, National Field Manual for the Collection of Water Quality data: United States Geological Survey Techniques of Water-Resources Investigations, Book 9, Chapters A1-A9, available online at: http://pubs.water.usgs.gov/twri9A.

B.2. Riverbank Condition

B.2.1. Background

Riverbank condition has been selected as an indicator because soils and the vegetation that stabilizes them are integral to the integrity of riparian ecosystems. Although soil erosion occurs along the river as a result of natural river processes, such erosion can be accelerated and exacerbated by visitor use. Increasing visitor use on susceptible substrates often results in increased soil erosion. Therefore, this indicator is valuable for assessing a site's ability to sustain varying types and levels of visitor use.

Riverside soils and vegetation affect water quality by regulating the entry of groundwater, surface runoff, nutrients, sediments and other particulates, and fine and coarse organic matter to rivers and streams. Accelerated erosion associated with trampling and visitor access can alter these processes, leading to changes in hydrology and water quality.

In addition to indicating loss of soil, erosion may affect cultural Outstandingly Remarkable Values. The amount of riverbank erosion associated with visitor use will be used as an indicator of changes that may be occurring to any cultural resources—namely to archeological sites—that may exist along the river corridor. Riverbank soil erosion that occurs at archeological sites would suggest a potential loss of site stability and loss of intact archeological artifacts and features, critical components of archeological site integrity. Once artifacts and features are displaced from their original context or lost, the information inherent to those deposits is also lost.

Description of indicator and standard
Indicator: Degree of riverbank erosion along the Merced River. This will be assessed through a combination of vegetative cover condition and substrate erosion condition characteristics.
Standard: A peer review of the existing monitoring protocol revealed the need for a more rigorous approach to riverbank condition monitoring and assessment. As a result, standards are being developed that take into account a new protocol under development in late 2007.

Rationale for indicator: Vegetation and erosion conditions of the banks of the Merced River will be monitored because the conditions of riverbanks are an important indicator of potential impacts to Outstandingly Remarkable Values of the river corridor.

Objectives: To document the extent of human-caused riverbank erosion along the Merced River in Yosemite Valley by assessing bank and river morphological characteristics, erosion features, riparian vegetation condition, and human use impact. Through comparison of existing conditions to standards, problem areas can be identified and management actions, such as restoration or access limitations, can be taken to ameliorate riverbank erosion impacts to the Merced River ecosystem.

2007 Riverbank Condition Workshop: A peer review of the 2005 and 2006 monitoring protocols took place in 2007. The review combined with a workshop on the subject revealed the need for a more quantitative approach to monitoring riverbanks due to the complexity of the system and the need to be able to quantitatively describe conditions with statistical rigor. The following monitoring protocol is a description of the monitoring activities that were piloted in late 2007 following recommendations from the workshop.

B.2.2. Sampling Design

Rationale for sampling design: The Riverbank Condition indicator is designed to monitor human-caused riverbank erosion in Yosemite Valley via a stratified sampling approach. The river will be stratified by geomorphic characteristics such as slope and width and by visitor use or management zoning. 200 meter sample reaches will be randomly selected from within each stratum. This design allows comparisons of riverbank condition as measured by vegetation condition and cross-sectional area of the channel among like areas of river. It will also allow comparison of heavily used areas with other areas along the river.

The above methodology may be complemented by continuous digital photographs of each bank of the river from Happy Isles Bridge to the former site of the Cascades Dam. This qualitative data would assure that emerging impacts not captured by sampling are caught and addressed early.

Measurement: At each sample reach, vegetation condition along 100 meters of bank (both sides of the river) will be evaluated as well as channel cross-sectional area. The condition of vegetation will be assessed through a point-intercept sampling of functional vegetation groups (see field methods). Channel cross-sectional area will be assessed by surveying at least 3 river cross-sections within the 200 meter reach. All monitoring locations will be marked with permanent site markers in order to accurately relocate and evaluate the same location every 3-5 years or following major flood events.

Continuous bank photography would involve using a high resolution digital camera and taking photos approximately every 50 meters along each bank or at such spacing as to allow stitching photos together without edge distortion. The resulting product would essentially be a long strip photo of the entire length of riverbank in Yosemite Valley.

Site selection (selection criteria and procedures): To reduce the variance between sites, site selection will be based on a stratified random approach using available geomorphic and soils data. This methodology will be developed during the winter of 2007-2008. In order to pilot this new protocol several locations were chosen deliberately in the fall of 2007 based on assumed visitor use levels and the availability of pre-existing data.

Sampling Schedule: Field work for this indicator will be conducted in mid-August to mid-September, depending on accessibility due to river level.

B.2.3 Field Methods

Channel Geometry monitoring

Preparation:

The following is a description of documenting and monitoring channel geometry using cross-sections and ground-based LiDAR. Documenting channel geometry involves the following steps:

1. Location of sample reach and any nearby benchmarks
2. Placement of permanent cross-section endpoints
3. Survey of endpoints and river cross-section

To locate the sample reach, obtain accurate maps and air photos and use a GPS unit if necessary. Also obtain a map and list of available benchmarks that may be nearby. Locate the site and nearby benchmarks in the field. Install or relocate at least 3 cross-sections within the reach. Cross-sections should be approximately equally spaced along the 200 meter reach and extend to the top of the river terraces on either side of the river. Cross-section endpoints are marked using rebar with aluminum caps that are labeled with the reach name, cross-section number, and which side of the river it represents. An example would be EC 2LX, for El Cap, Cross-section #2 on river left. Survey the cross-section endpoints using a total survey station if possible. At minimum, the cross-section endpoints need to be located using GPS. Each cross-section will require a field sheet (see Forms) to help relocate the point in the future.

Data collection:

The profile survey procedure for cross-section surveys is based on Harrelson et al. (1994), Section 6 (pp. 26-32) and Section 8 (pp. 37-41). Please refer to the reference for surveying basics. If using total station surveying equipment, survey data (such as in the examples depicted below) may not be necessary. Below are concise steps for cross-section surveys:

<u>Cross-Sectional Profile</u>

- Figures B.2.1 and B.2.2 provide a graphical representation and sample data of a cross-section profile.

- Establish the benchmark to set up elevation and survey controls. Existing benchmarks or permanent natural or artificial features can be used if available. Record the exact location of each endpoint (permanent marker) based on its distance and direction to the corresponding benchmark. Draw a site map to indicate location of benchmark, endpoints, and other important features and record measurements.
- Set up a taut tape across the cross section, with the zero-end of the tape at the end point where elevation measurements will be taken. Starting on the left side of river is suggested for easier plotting of profiles later.
- Begin the total station survey. Be sure to record the correct height of the survey rod and instrument. Start with the endpoint stake as zero. Begin shooting points with the total station. Along the tape (cross-section), shoot a point at each change in elevation and at each important feature, on all slope breaks and at the edge of water.
- Total station data should be downloaded upon return to office.

<u>LiDAR scanning of sample reaches:</u>

- Each reach will be scanned using a ground-based LiDAR system.
- A total surveying station is used to locate and orient the LiDAR unit in space. Set up the total station in a location where most/all of the reach is visible.
- Set up the LiDAR station at the upstream end of the reach, level it, and turn it on. Backsight the LiDAR unit to the total station.
- Use the LiDAR unit to scan the area.
- Move the LiDAR unit downstream. Repeat the steps above for setting up the unit (including backsight to the total station).
- Scan both sides of the bank by moving from one bank to the other in a zig-zag pattern.

Figure B.2.1. Diagram of a cross-section survey (Harrelson et al. 1994).

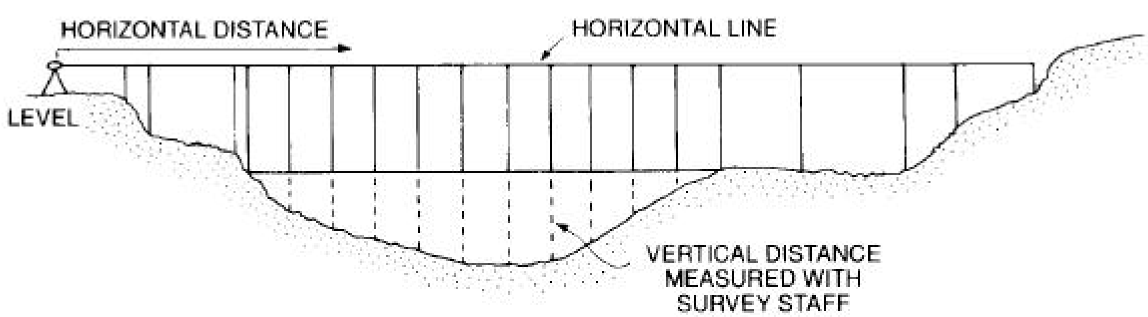
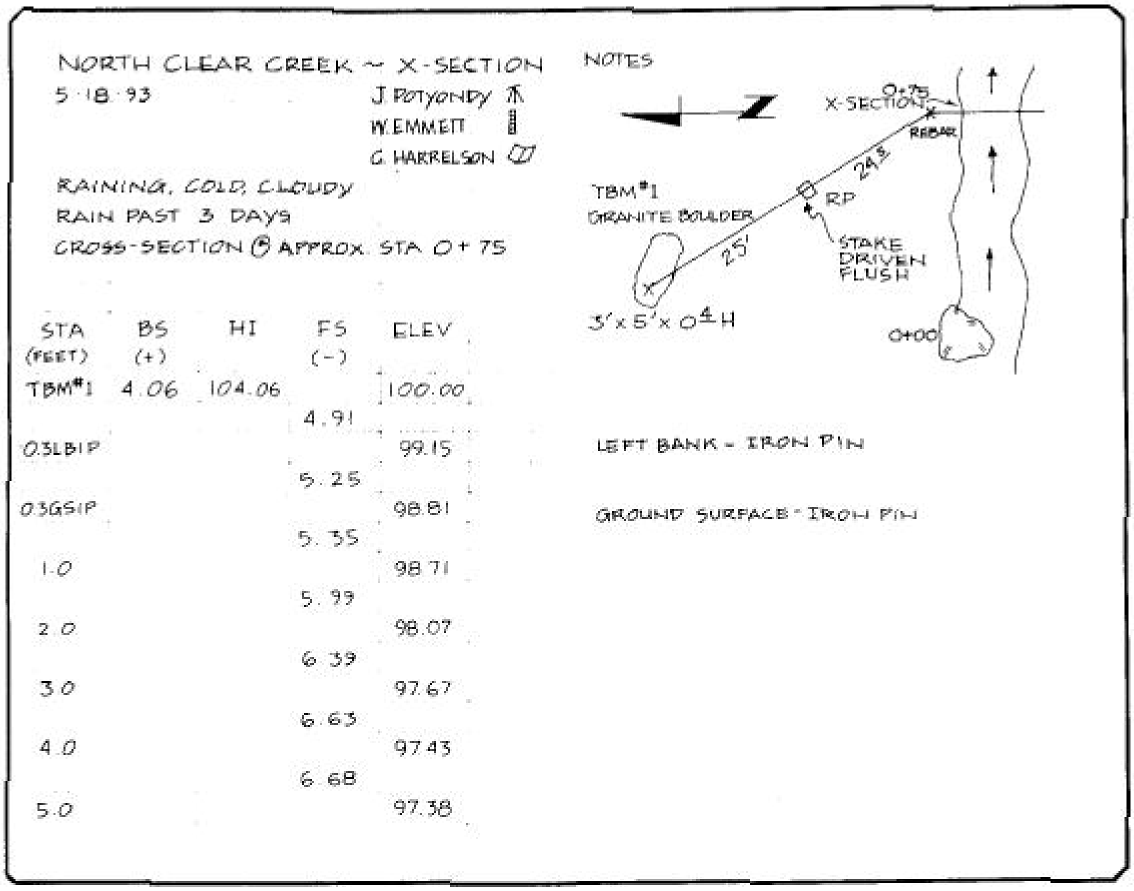


Figure B.2.2. Sample notes for cross-section survey (Harrelson et al. 1994).


NORTH CLEAR CREEK ~ X-SECTION
5·18·93
J. POTYONDY
W. EMMETT
C. HARRELSON

RAINING, COLD, CLOUDY
RAIN PAST 3 DAYS
CROSS-SECTION @ APPROX. STA 0+75

STA (FEET)	BS (+)	HI	FS (−)	ELEV
TBM#1	4.06	104.06		100.00
			4.91	
0.3LBIP				99.15
			5.25	
0.3GSIP				98.81
			5.35	
1.0				98.71
			5.99	
2.0				98.07
			6.39	
3.0				97.67
			6.63	
4.0				97.43
			6.68	
5.0				97.38

NOTES

LEFT BANK - IRON PIN

GROUND SURFACE - IRON PIN

Vegetation Condition Assessment
Preparation: Field personnel should be trained (see Training, below) and the following required tools and supplies should be acquired.

- One 100-meter tape
- One 50-meter tape
- 4 chaining pins
- Pin flags
- Densitometer
- Point intercept device
- Ladder (accessing steep banks)
- Extender for densitometer
- Weighted rope with 1m markings
- Pens/pencils/clipboard
- Data sheets
- Site description sheets
- Compass
- GPS unit (for plot installation)
- Hand drawn map forms for triangulating permanent monuments (for plot installation)
- Rebar, monument caps, mallet, and die set (for plot installation)
- Metal detector (to find existing plots)

- Hand drawn and GIS maps (to find existing plots)
- Sunscreen/water/lunch/personal gear
- Protocol and Field Instructions

Timing of sampling
Sampling should be done late in the growing season, before herbs die back and before deciduous trees and shrubs lose their leaves. Plants are not identified to species, thus, phenology is not critical.

Locate Plots
Use river cross-section maps and directions to locate the following 6 locations:

1. North Pines RX11
2. North Pines RX13
3. Sentinel Beach RX71
4. Sentinel Beach LX71
5. El Capitan Dump RX30
6. El Capitan Dump LX30

Use the descriptions below to locate the following 3 locations.

7. Pohono Bridge left
8. Pohono Bridge right
9. Cook's Meadow right

Pohono Bridge left and right:

Park at the dirt pullout west (downstream) of Pohono Bridge, and East (upstream) of the El Portal Road/Big Oak Flat Road intersection; located on the north bank of the Merced River.

Pohono Bridge right:

Establish the upstream endpoint 20 meters from the west end of the dirt pullout. Establish the downstream endpoint 100-meters downstream of the upstream endpoint. Follow the previously mentioned rules for setting up endpoints. Midpoints should not be needed.

Pohono Bridge left:

Establish the upstream endpoint directly across from the right bank upstream endpoint. Establish the downstream endpoint 100-meters downstream of the upstream endpoint. Follow the previously mentioned rules for setting up endpoints. Midpoints should not be needed.

Cook's Meadow right:

Select the Cook's Meadow plot location downstream of Sentinel Bridge, near the restoration area closest to the bridge, and on the right bank. Establish the upstream endpoint, where the restoration fence ends. Establish the downstream endpoint 100-meters downstream of the upstream endpoint. Follow the previously mentioned rules for setting up endpoints. Midpoints should not be needed.

Data collection:

Site Description
Record a description of the site by entering information in the Site Description Sheet. See figure under Data Sheets. (figure)

Plot Setup
Set up the BASELINE tape: Regularly Shaped Plots

1. Previously established river cross section monuments will be used to determine plot location.
2. Using the river cross section monument map and directions, locate the monument.
3. Locate the top of the bank terrace.
   (When several bank terraces are visible, the one including the conifer line should be chosen. This will insure ample sampling of hydrophytic vegetation.)
4. In line with the river cross section monument, measure 3 meters perpendicular and upland from the top of the bank. Place a chaining pin here. This is the upstream corner of the plot.
5. Next, stretch a 100-meter baseline tape downstream, parallel to the river flow.
6. Locate the top of the bank terrace.
7. In line with the 100-meter mark, measure 3 meters perpendicular and upland from the top of the bank. Place a chaining pin here and secure the 100-meter tape to the chaining pin. This is the downstream corner of the plot.

Set up the BASELINE tape: Irregular Shaped Plots/Setting up Mid-Points

1. In some instances, due to the natural irregular shape of the river, a regularly shaped plot will miss large portions of the bank, or put the observer into the river bed. In this case, a "midpoint" must be installed to move the plot in a location that will capture the full extent of the river bank. *(For the purposes of clarification, the term "midpoint" is used to refer to the point between the two endpoints that will be used to facilitate creating a plot that captures the full extent of the river bank. Furthermore, more than one midpoint may need to be used for the previously mentioned reasoning.)*
2. First, determine the general location for the downstream endpoint, by stretching a 100-meter tape downstream from the upstream endpoint. Place a chaining pin here, but do not secure the 100-meter tape at this point.
3. Next, determine the best location for the midpoint placement.
4. Locate the top of the bank terrace.
5. Measure 3 meters perpendicular and upland from the top of the bank. Install a chaining pin here.
6. Now stretch the 100-meter tape downstream, parallel to river flow.
7. Insert the tape through the eye of the midpoint chaining pin and continue to stretch the tape downstream until you reach the 100-meter mark.
8. In line with the 100-meter mark, measure 3 meters perpendicular and upland from the top of the bank. Place a chaining pin here and secure the 100-meter tape to the chaining pin. This is the downstream corner of the plot.

Set up the BASELINE tape: Irregular Shaped Plots/Capturing Terrace Points

1. In some instances, due to the natural irregular shape of the river, the plot will miss the terrace in few locations. To keep the setting up of the plot efficient, apply the following rule:
   a. First, establish the transect lines.
   b. If the transect falls on a scalloped area, move the transect upland, until at least one terrace point is captured.
   c. Continue to record the transect start point in reference to the distance from baseline. In this instance, the first transect point will be a negative number.

Set up the TRANSECT lines

1. Transect lines will be placed every 10 meters along the baseline tape, and extend perpendicular to the baseline tape in the direction of the river, ending at the bottom of the river bank and top of the riverbed.
2. To select the starting point for the transect line, use a random number generator (such as hundredths of a second on a stopwatch) to select a number between 0 and 9. *For example, if the random number selected is 2, then transects will start at 2 meters, 12 meters, 22 meters, etc., up to 92 meters (10 transects total) along the baseline tape.*
3. Mark the starting point for each of the transect line by placing pin flags along the baseline tape.

Plot Set Up: Rules and Reasoning

- Endpoints and midpoints are installed 3 m from the top of the bank. This is an arbitrary number that captures the importance of terrace vegetation in preventing riverbank erosion.
- Midpoints can be installed as needed to facilitate plot setup on irregular or curving banks.
- The initial distance of the baseline is 100m.
- <u>200 points must be recorded for each plot</u>. If needed, the baseline can be lengthened to facilitate this rule. If 200 points are reached before the transect line ends, continue to collect point until you reach the end of the transect line. *See discussion below on selection of 200 as minimum.*
- Points are not considered permanent. When plots are revisited, a new transect starting point will be chosen.
- Transects are set up perpendicular to baseline, and extend to the bottom of the bank.
- The bottom of the bank is not determined by the waterline, but by the break in slope. There is no need to sample the actual river bed.
- Transect lengths are determined by geomorphology. There is no standard transect length.

- Transects start on a random number between 1 and 10, and then are set up in 10 m intervals. Pin flags marking the beginning and end of the transect will help the observer keep the transect line straight. Intermediate pin flags may be helpful on long or heavily vegetated transects. Precise point placement is not critical.
- Each transect should measure at least one terrace point. If the baseline covers a scalloped area and does not capture the terrace, any transect in that area should move upland, incorporating negative points, so at least one terrace point is captured.

Data collection

Determine Data Collection Point locations

1. Data will be collected at points along the transect lines.
2. The transect lines are located ON the ground, along the grounds contour.
    a. On level terrain, this may seem obvious.
    b. However, on steep terrain one could mistakenly set up a horizontal-mid-air transect line- DO NOT DO THIS.
3. The first point will be taken at 0 meters from the baseline. *Or, if the transect is moved upland to capture at least one terrace point, the first transect point will be a negative number distance from baseline.*
4. Points will be equally spaced apart, as follows:
    a. 1 meter apart, for straight reaches, with transect lines of a reasonable length (approximately less than 100 meters)
    b. 2 meters apart, for plots with transect lines approximately 100-meters long or more.
5. Use a measuring device to determine spacing. For example, a 50-meter tape or a one-meter stick.

Collect Data

For efficiency, two people will work together to collect data. One person will be the OBSERVER and the other the RECORDER. To lessen bias, rotate roles.

1. OBSERVER: place an objective point-intercept device on the transect point.
2. OBSERVER: look through the scope on the point-intercept device.
3. OBSERVER: use the cross-hairs to determine the exact point location. *The point is theoretically as small as possible, extending from the ground to the canopy.*
4. Observer: observe all layers at the point; *this may result in more than 100% cover in some places.*
5. OBSERVER: dictate observations to RECORDER
6. RECORDER: record the following observations on the data sheet:
    a. bank/terrace
    b. substrate size
    c. litter size
    d. presence or absence of bare ground
    e. exposed roots
    f. nonvascular plants
    g. annual or biennial plants
    h. fibrous-rooted perennials
    i. tap rooted perennials
    j. shrubs
    k. woody plants under 0.5 m tall
    l. evergreen trees
    m. deciduous trees
7. Use a densitometer to observe canopy.
    a. It should be in line with the ground point.
    b. It can also be used to observe the shrub layer.
    c. It may only be able to hit one canopy type.
8. RECORDER: Once the point-intercept device is in place, the recorder may move the one-meter stick to the next data collection point location. Or for even more efficiency, pin flags may be placed (using the one-meter stick for measuring) at each point.
9. OBSERVER: When all attributes for the point are recorded, move along the transect line toward the river and to the next data collection point.

Steep banks

Steep banks present accessibility problems. First and foremost, each slope should be assessed for worker safety. Do not work on a bank where a fall could produce an injury. Rocky deposits, riprap, and logjams must be carefully considered. Second, the potential for resource damage is high when working on steep slopes. It is NOT acceptable to negatively impact bank stability while collecting data. Various solutions have been put forth:

1. Collect data from the river bed.
2. Use a secured ladder to minimize foot traffic on the bed. Secure and climb the ladder starting at the bottom of the bank, never from the top.
3. In some cases an extension may work for the densitometer, but this has limited application, mainly due to its short reach and difficulty in leveling.
4. In many places a less objective method of data collecting is warranted:
    a. A weighted rope with 1-meter markings on it can be strewn along the bank, with point data collected as best as possible.
    b. Many of the steep banks lack vegetation. Hence, this is not the worst case scenario for collecting accurate data.
    c. Canopy data will probably need to be eliminated; unless a reasonable method and appropriate equipment are discovered.

Figure B.2.3 . Blank form used to document permanent monument locations.

Cross Section: ___________ **Date:**__________________

Right **Left** Bank Monument

RIVER CROSS SECTION SKETCH MAP

KEY

MONUMENT ⊗(I.E. ⊗34L)

Reference **Rx** (i.e. Rxii)

Photo Station ↑**(i.e. ↑2)**

MONUMENT DESCRIPTION:

x:

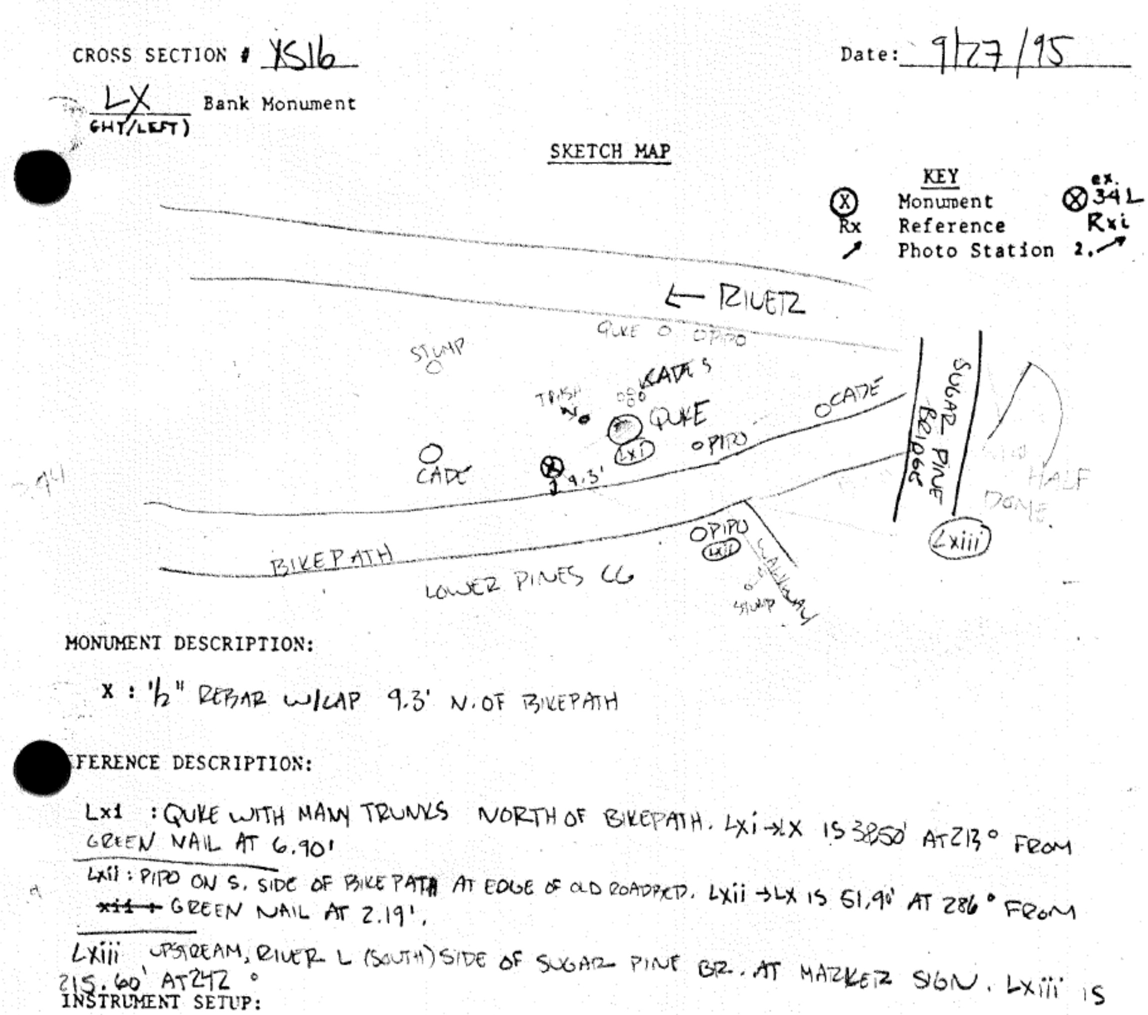
REFERENCE DESCRIPTION:

xi:

xii:

xiii:

Figure B.2.4 An example of a hand drawn map.



*Note inclusion of three reference points with distance and azimuth to monument. This information is critical in relocating permanent monuments. Bearings are usually set to magnetic north (no declination), and this should be explicitly stated on each map.

Figure B.2.5 A sample blank datasheet

VERP riverbank condition data sheet (draft)

Site: ____________ Bank side: L or R Date: ________ Observers: ______________________ Monument number: _________

Strata: Human Use: Vulnerability:

In gray boxes, select appropriate class; in white boxes, record presence: Yes = 1, No = 0.

Transect start point*	Distance from baseline toward river	Bank /terrace	Subst-rate size, 1-5**	litter/LWD, 1-4***	bare ground	Exposed roots****	Non-vascular plant	annual/biennial	perennial	shrub	woody plant <0.5 m tall	evergreen tree	deciduous tree	Objective?
	0													
	1													
	2													
	3													
	4													
	5													
	6													
	7													
	8													
	9													
	0													
	1													
	2													
	3													
	4													
	5													
	6													
	7													
	8													
	9													

*based on random number 1-10

**Substrate class 1 < 2mm; class 2 2.0mm < 16mm; class 3 16 < 64 mm; class 4 64mm < 256mm; class 5 256mm+

***LWD class 1 < 1m, class 2 1 < 10 m; class 3 10m+ length; R = rootwad > 3m diameter

****Woody root seemingly attached to live plant

Figure B.2.6 A sample blank site description sheet

VERP Riverbank Condition Monitoring
Pilot Study 2007
Site Notes

Site name:
Observers:
Date:

Total time at site:
Time setting up plot:
Time collecting data:
Plot location and shape, i.e., directions for setting up next year:

Visitor Use Comments:

Bank Description:
Height, steepness, substrate, etc.

Plot shape description/how was plot shape and location determined?

Difficulties of site:

Post-collection and processing:

Prepare detailed site maps using the LiDAR and cross-section data. Compute cross-sectional areas from cross-section data and LiDAR data. If previous cross-sectional data is available, compute the change in cross-sectional area. The cross-sectional area is the area below a line drawn between the cross-section endpoints. If previous LiDAR data is available, compute changes in bank geometry and report in volume of bank material gained or lost.

B.2.4. Data Management

Data entry: Collected data will be entered into a database, and digital photographs will be labeled and filed electronically. Field notes will be transferred into digital form (i.e. word processed).

Data analysis: Total station surveys will be converted into detailed profiles/maps of monitoring sites. GPS points delineating monitoring sites will also be displayed on a map. The data analysis of cross-section data consists of calculating the channel cross-sectional area and comparing this value to past values. The cross-sectional area is the area below a line drawn between the cross-section endpoints. In the case of LiDAR data, a reach volume would be calculated in a similar manner and the amount of volume change from the previous monitoring effort calculated. The data analysis methods for the vegetation condition assessment will be developed during the winter of 2007-2008.

Data reporting: Reach locations and associated cross-sectional data including cross-sectional area will be reported in the 2007 VERP Annual Report, as will the data associated with the vegetation condition assessment.

Data storage: All collected data and compiled documentation will be stored on the YOSE NPS network (ms01\EP Resources\Restoration Program Common\VERP\VERP 2007\Riverbank Erosion). Original datasheets associated with the vegetation condition assessment will be stored in the office of Vegetation and Restoration. Original datasheets associated with the reach locations and associated cross-sectional data including cross-sectional area will be stored in the office of Physical Science.

B.2.5. Personnel Requirements and Training

Roles and responsibilities (tasks and time commitments): A Resources Management and Science GS-11 will be responsible for the oversight and refinement of the indicator and data analysis. They will train and support the GS-7 technician with implementation of the protocol and field work. The GS-7 technician will be responsible for conducting field work and training of personnel not familiar with indicator protocol, total station surveying and conducting the vegetation assessment. The GS-7 and GS-6 technicians will work cooperatively to conduct total station mapping, and the tasks involved with piloting the protocol for the vegetation assessment. Other field staff will assist, as needed, in total station mapping.

Preparation and implementation of LiDAR mapping conducted on three segments of the Merced River will require 8-12 field staff over a course of 6 weeks. The piloting of the vegetation assessment protocol will require 2 field technicians over a course of two weeks, with one day allotted per plot for setting up and monitoring procedures.

Qualifications:

- A GS-11 will be responsible for the oversight of the Riverbank Condition indicator. This includes both the vegetation assessment and river morphology components. The duties will include: training, managing and supporting field technicians; attending monthly VERP team meetings; coordinating, and facilitating consultation workgroups involving academic, agency and other experts to further this indicator; conducting data analysis; writing reports; establishing work plans; creating a budget and making any changes necessary to further this indicator. They will also be responsible for supervising the implementation of the standard operating procedures for preparing for and assisting with LiDAR mapping and riverbed surveying. They should be familiar with river geomorphology and ecology principles; have experience in natural resource monitoring, including river geomorphology and vegetation monitoring; have experience in training and supervising personnel; have experience creating budgets and work plans; posses the ability to conduct data analysis; and be versed in GPS, GIS, and total station technologies. They will serve as the point-of-contact, directly under the branch chief, for this indicator.

- A GS-7 biological science technician will be responsible for the oversight of the vegetation assessment component of this indicator. Their main duty will be to establish a science-based, repeatable, efficient, and relevant protocol that can be used long into the future for monitoring this indicator. They will be an active participant in the growth of this indicator through attending workgroups with academic, agency and other experts; they will test the data collection methods and alter such methods based on statistical integrity, efficiency, safety and resource protection. They should be familiar with general river geomorphology and ecology principles; have some experience in natural resource monitoring, including river geomorphology and vegetation monitoring; be comfortable training and supervising personnel; posses the ability to conduct data analysis; and be versed in GPS, GIS, and total station technologies. They will also be responsible for supervising the implementation of the standard operating procedures for preparing for and assisting with LiDAR mapping and riverbed surveying. They will serve as the point-of-contact for the vegetation assessment component of this indicator, directly under the
- GS-11 and the Branch Chief.
- A GS-6 biological science technician will be responsible for collaborating with other personnel on the development of the vegetation assessment component of this indicator. Their main duty will be to assist in the establishment of a science-based, repeatable, efficient, and relevant protocol that can be used long into the future for monitoring this indicator. They will be an active participant in the growth of this indicator through attending workgroups with academic, agency and other experts; they will test the data collection methods and alter such methods based on statistical integrity, efficiency, safety and resource protection. They should be familiar with general river geomorphology and ecology principles; have some experience in natural resource monitoring, including river geomorphology and vegetation monitoring; be comfortable training and supervising personnel in the absence of the assigned supervisor; posses the ability to discuss data analysis; and be versed in GPS, GIS, and total station technologies. They will also be responsible for assisting with the implementation of the standard operating procedures for preparing for and assisting with LiDAR mapping and riverbed surveying. They will serve as the second point-of-contact for the vegetation assessment portion of this indicator, directly under the GS-7 technician.
- Other field staff will assist in conducting field work. They should posses the ability to follow instructions; collect and record data accurately; and be willingly and able to learn how to operate the total station. Ideally, they should be familiar with general river geomorphology and ecological principals, although this is not required.

Training procedures: The GS-11 will brief the GS-7 on the standard operating procedures for preparing for and assisting with LiDAR mapping and riverbed surveying. The GS-7 will then train the GS-6 and other staff on these procedures and specifically, how to use the total station.

B.2.6. Operational Requirements

Field work plan: Riverbank LiDAR mapping and riverbed surveying will be conducted mid-August through September- when river flows are low enough to permit safe crossing. Piloting of the vegetation assessment protocol will be conducted in September through October- when it is more likely to detect impediment of vegetation growth due to trampling. Analysis will be conducted November through December. Reporting will be conducted December through February. The following is an outline of the field work schedule:

- Week 1: Workgroup and follow-up meeting (All)
- Week 2 : LiDAR mapping preparation/ Locating benchmark and river cross section monuments (GS 6 and one assistant as needed)
- Week 3 - 5: Surveying benchmarks and river cross section monuments (GS-7, GS-6, and one assistant: at least 2 people every day)
- Week 6-7: LiDAR mapping and riverbed surveying (GS-11, GS-7, GS-6, plus one assistant: at least 3 people every day)
- Week 8-9: Data collection for Riverbank Condition Vegetation Assessment Protocol (GS-7 and GS-6)
- Week 10: Data Analysis (GS-11 and GS-7)
- Week 11: Report Writing (GS-11 and GS-7)

*Projections of time requirements are based on a 10hr workday

Safety: A job hazard analysis has been completed and appears below (Table B.2.1).

Table B.2.1 Job Hazard Analysis for VERP Riverbank Erosion indicator.

United States Department of Interior NATIONAL PARK SERVICE	**1. WORK PROJECT/ACTIVITY**	**2. LOCATION**	
	VERP Riverbank Erosion Monitoring	Merced River, Yosemite Valley, YNP	
Job Hazard Analysis (JHA)	**3. NAME OF ANALYST**	**4. JOB TITLE**	**5. DATE PREPARED**
	Christal Niederer	Technician	July, 2005
6. TASKS/PROCEDURES	**7. HAZARDS**	**8. ABATEMENTS ACTIONS** ENGINEERING CONTROLS – SUBSTITUTION – ADMINISTRATIVE CONTROLS – PPE	
a. Driving to, from, and around sampling sites.	a. Collision resulting in damage, injury, or death.	a. Drive defensively, obey traffic laws, lights on, seatbelt on, be alert for pedestrians, wildlife, and distracted drivers. Know procedures for installing snow chains. Always carry and know how to use a Park radio.	
b. Walking, hiking and other physical exertion.	b. Exhaustion, muscle strain, dehydration and fatigue.	b. Drink plenty of fluids, bring snacks and/or meals if out during lunch hours, Take periodic rests and stretch before and after physical activity.	
c. Wading in river to assess riverbank conditions.	c. Tripping, falling or being swept away due to slippery, uneven river bottom surfaces and strong currents.	c. Use extreme caution in watching footing, wear life vest, only wade if the water level/current strength is low enough to permit it, collect sample from river edge if water is too high and/or swift.	
d. Working and walking along riverbanks.	d. Tripping and/or falling due to wet and slippery rocks or sloping ground surfaces, contact with poison oak, etc.	d. Watch footing, know how to identify and avoid all poison oak, rinse immediately in stream if contact occurs.	
e. Working outdoors in cold and/or wet weather.	e. Hypothermia, reduced resistance to illness.	e. Wear appropriate clothing and carry extra layers. Stay dry. Use rubberized raingear if possible. Stay hydrated preferably with warm liquids. Stop work to warm up if necessary. Snack often.	
f. Working outdoors in hot / extreme heat weather.	f. Fatigue, exhaustion, dehydration and heat stroke.	f. Wear appropriate clothing and use sunscreen. Drink fluids and snack throughout the day. Carry extra water and dehydration salts along with first aid kit.	
10. SUPERVISORS SIGNATURE	**11. TITLE**	**12. DATE**	

Equipment and materials: see “Preparation” in the Field Methods section

B.2.7. References

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B.3. Wildlife Exposure to Human Food

B.3.1 Background

The most direct and prevalent way visitors adversely affect wildlife in Yosemite is by purposely feeding animals, leaving food improperly stored, or leaving food debris on the ground or picnic tables. This leads to alteration in the animals' behavior and roles in the ecosystem, as animals exposed to human food continue to seek it out. In extreme cases, fed animals become aggressive and dangerous, and must be killed to protect human safety. This modification of wildlife behavior and ecological roles adversely affects the biological outstanding remarkable value (ORV) and that of recreation quality.

There is a likely correlation between the number of visitors in Yosemite Valley and the opportunities for wildlife to be exposed to human food. More visitors means more people feeding wildlife, more people improperly storing food, and more food debris left behind, if the proportion of visitors engaging in these behaviors remains constant over the range of visitor numbers. Also, trash cans and dumpsters are more likely to overflow, allowing animals access to garbage. The number of staff dispensing information about park regulations through personal contact, and frequency of garbage removal remains relatively constant at a given times of year, and among years, regardless of the number of visitors. Therefore, as the number of visitors goes up, the proportion of them who receive information and warnings likely goes down, the chance of overflowing trash receptacles increases, and intentional feeding of wildlife increases resulting in higher human-wildlife conflicts.

Description of indicator and standard:
Indicator: Number of instances wildlife could be exposed to human food.
Standard: 95% or greater compliance with food storage regulations in selected campgrounds and parking areas.

Rationale for indicator: Current management of human-wildlife conflicts call for "zero tolerance" for allowing animals access to human food. This is especially true for black bears, which quickly become conditioned to human food and, as a result, can become dangerously aggressive and must be killed. The severity of this problem requires the expenditure of considerable funding and staff time to provide visitor education, patrol to look for food left available to animals, enforce food storage regulations, and haze bears out of developed areas. Despite these extensive efforts, and the zero tolerance policy, it is unrealistic to believe that *all* availability of human food to wildlife can be controlled. It was, therefore, decided that steady progress in removing human food from the diets of wildlife would be a reasonable measure of the effect of visitation level on wildlife exposure to human food.

Objectives: Provide accurate assessment of food storage compliance rates and food storage violations in campgrounds and parking lots.

B.3.2 Sampling Design

Currently, statistics on the availability of human food to wildlife is documented through the park's Bear Patrol Log Database (BPLD). The BPLD was developed for the Human-Bear Management Program in 2005 to ensure accountability with bear-funded employees and to collect data on bear monitoring and management activities in the field. In Yosemite Valley, there are an average of 15 bear funded employees that spend a minimum 80% of their time on bear related issues between the months of May and October. These employees include Protection, Campground and Interpretation Rangers, and Wildlife Technicians. While the primary duties differ among work units, all employees share the common goal of mitigating human-bear conflicts and protecting wildlife from exposure to human food. This is accomplished through proactive patrols between the hours of 5 p.m. and 6 a.m. when bear activity is the greatest. During patrols, visitors are educated about proper food storage through one-on-one interpretive contacts, campsites and vehicles are checked for food storage compliance, and food storage regulations are enforced through verbal or written warnings and citations. For this indicator, average compliance rates are determined by inspecting either a certain number of campsites or vehicles. Non-compliance is defined as an incident in which *a violation of human food-related park regulations is observed by the field staff that necessitates immediate management action such as issuing verbal or written warning*.

Non-compliance includes the following violations:

B.1. Feeding human food to wildlife – Knowingly offering human food or baiting wildlife.

B.2. Improper food storage – Human food stored in locations that are considered inappropriate, such as inside vehicles after dark or in containers that are not approved by the park as wildlife resistant;

B.3. Improper use of food locker – Food is put in food locker but the locker is wide open, unlocked, or not latched in a way consistent with the instructions provided and the visitors are either away from their site or asleep.

B.4. Leaving food unattended – Food left in open locker, out in campsite, or other location where the food is out of arms reach, is not actively being prepared or eaten, and/or the food is not visible to any of the camp occupants.

Campground inspections to determine compliance rates are generally conducted after 10 p.m. when most visitors are finished eating dinner and food is put away. Inspections conducted earlier than 10 p.m. often result in a very low compliance rate because most people preparing dinner have their food lockers open and food items out of arms reach. These incidents are documented in the BPLD as educational contacts rather than violation or inspection records.

Parking lot inspections are conducted throughout the night, but because food stored inside vehicles during daylight hours is legal, compliance checks on vehicles can only be performed after dark.

On many occasions, especially when responding directly to bear activity, food storage violations are found, corrected and documented, but are not calculated in the average compliance rate for an area because they are not part of an inspection. In the BPLD, food storage violation records can either stand alone or be part of an inspection record.

Site Selection: Inspections will take place in the following Yosemite Valley locations: Upper Pines Campground (C.G.), North Pines C.G., Lower Pines C.G., Camp 4 C.G., Housekeeping Camp (campsites only), Curry Village Parking Lots, Curry Orchard Parking Lot, Ahwahnee Parking Lot, Yosemite Lodge Parking Lot, Wilderness Lot, and Camp 4 Parking Lot.

Sampling Schedule: Inspections will be performed as time permits, but no less than once a week for each location, from May 15, 2007 through November 10, 2007. Inspections will occur during weekdays and weekends.

B.3.3 Field Methods

Preparation: Gather all datasheets or the handheld computer (PDA).

Data collection and measurement: Procedures listed below are taken from the Bear Patrol Log Database Manual on collecting and entering data.

INSPECTIONS

- All inspections will be entered into the Bear Patrol Log Database. Data will include the date, location, start and end time, number of campsites or vehicles checked, and the number of campsites or vehicles that are non-compliant.
- Inspections of campsites and Housekeeping Camp units should occur only after the dinner hour when visitors are not preparing food.
- Inspections of vehicles must be completed after dark.
- Inspections of concessions facilities except Housekeeping Camp units may be completed at any time of day or night.

- If non-compliant vehicles, campsites, facilities or trashcans are found, a food storage detail record must be completed for those violations. For example if 300 cars are checked and 4 are found with food in them and the visitors are woken up because of food in their cars, an inspection detail would be completed along with a food storage detail. The food storage detail would list the 4 violations of unattended food in vehicle and the action would be a verbal warning.

FOOD STORAGE VIOLATIONS

- Spot checks for food storage violations occur on a nightly basis during patrols. All violations will be entered into the Bear Patrol Log Database. Data will include the date, location, time violation was found, type of violation, number of violations if more than one, and the type of warning issued.

- Violation Types:

  - **Baiting -** Knowingly offering or leaving human food for wildlife.
  - **Bear Box/Improperly Locked -** Food is put in food locker but the locker is not latched in a way consistent with the instructions. The visitors may be either away from their site, inside a tent or vehicle (RV) or asleep.
  - **Bear Box/Left Open -** Food is put in food locker, but the locker is wide open or completely unlatched **and** the visitors are either away from their site, inside a tent or vehicle (RV) or asleep.
  - **Bear Locker Deficiency -** Anything that makes a locker not bear proof, difficult to operate, or otherwise requiring repair. Example: latch does not operate properly.
  - **Unattended/Food or Attractant -** Food left out in campsite, or other location and the visitor is not in the campsite or asleep. Example: Camper at Upper Pines is no where to be found (i.e. in bathroom or sleeping) and there is a bag of marshmallows on his picnic table.
  - **Visitors Too Far From Food -** Visitor is in site and awake. Food left in open locker, out in campsite, or other location where the food is out of arms reach, is not actively being prepared or eaten. Example: Campers in Upper Pines are sitting around fire with their back turned to their food and are 10 feet away.
  - **Unattended/Food or Attractant in Vehicle.**
  - **OB Camper w/Food in Vehicle**
  - **Unsecured Recycling Container.** Container is not closed properly.
  - **Unsecured Trash Can**. Container is not closed properly.
  - **Recycling Container Deficiency.** Anything that makes it not bear proof, difficult to operate, or otherwise requiring repair.
  - **Trash Can Deficiency.** Anything that makes it not bear proof, difficult to operate, or otherwise requiring repair.
  - **Trash Can/Overflowing**

Figure B.3.1 Datasheet- Wildlife Exposure to Human Food

2006 BEAR MANAGEMENT PATROL LOG

DATE:

Name(s):

INSPECTIONS (CARS, CAMPSITES, CONCESSION FACILITIES)

Location	Start Time	End Time	Number Checked	# Non-Compliant

VISITOR CONTACTS

Location	Number of Contacts
Upper Pines	
Lower Pines	
North Pines	
Camp 4	
Housekeeping	

FOOD STORAGE VIOLATIONS

Location	Site	Time	Violation	Warning Type	Number of Violations

B.3.4 Data Management

Data entry: Patrol data will be recorded on PDA's or datasheets. Data will then be entered into the Bear Patrol Log Database at the end of each patrol shift, or at the beginning of the next patrol shift.

Data analysis: Data for this indicator will be queried and analyzed each November for the summary report. Quality control will be performed by the Wildlife Management Office at least once a week in May and June and once a month for the remainder of the season. Food storage compliance rates will be determined by taking the average compliance rate each month from May through October. Compliance rates will be analyzed for each monitoring site.

Data reporting: Results will be compiled and presented in the VERP Annual Report. Additionally, information will be presented at a public meeting and made available on the park's website.

Data storage: The Bear Patrol Log Database is stored on the park's network and can be accessed through Citrix. Hard copies of completed datasheets will remain on file with the Wildlife Office and copies sent to the Integrated Resources Analysis Branch in El Portal.

B.3.5 Personnel Requirements and Training

Roles and responsibilities (tasks and time commitments): Monitoring efforts and data collection will be performed by the Yosemite Interdivisional Bear Team. This team is comprised of employees from several different work units including Campground, Interpretation and Protection Rangers, and Wildlife Technicians. An average of 15+ individuals will be involved in the data collection. The Wildlife Management Branch is responsible for the Bear Patrol Log Database including maintenance, quality control, improvements, and training.

Qualifications: Before data is collected, all employees, volunteers, and interns on the Interdivisional Bear Team will be trained in bear management and patrol activities, black bear biology, the Bear Patrol Log Database, and data collection methods.

Training: Wildlife Management staff with experience surveying and monitoring non-compliance of food storage will be responsible for training any NPS staff or volunteers without prior monitoring experience. NPS staff and volunteers will be required to demonstrate the ability to:

- Navigate to inspection sites.
- Identify and differentiate various types of non-compliance.
- Make appropriate recordings for non-compliance and related attributes.
- Enter field data into the Bear Patrol Log Database.

These skills will be verified through field training and assistance of qualified Wildlife Management staff. In addition, all members of the bear team using the database will be given a copy of the Bear Patrol Log Database Manual.

B.3.6 Operational Requirements

Safety: Particular attention will need to be given to collecting data in a safe manner as personnel will be working at night, alone in some occasions and within high use bear activity areas. A job hazard analysis has been completed and appears below (Table B.3.1).

Table B.3.1 Job Hazard Analysis for Wildlife Exposure to Human Food

United States Department of Interior NATIONAL PARK SERVICE	1. WORK PROJECT/ACTIVITY	2. LOCATION	
	VERP Wildlife Monitoring	**Yosemite Valley, YNP**	
Job Hazard Analysis (JHA)	3. NAME OF ANALYST	4. JOB TITLE	5. DATE PREPARED
	Tori Seher	**Wildlife Biologist**	**July, 2006**
6. TASKS/PROCEDURES	7. HAZARDS	8. ABATEMENTS ACTIONS **ENGINEERING CONTROLS – SUBSTITUTION – ADMINISTRATIVE CONTROLS – PPE**	
a. Driving to, from, and around sampling sites.	**a. Collision resulting in damage, injury, or death.**	**a. Drive defensively, obey traffic laws, lights on, seatbelt on, be alert for pedestrians, wildlife, and distracted drivers. Know procedures for installing snow chains. Always carry and know how to use a Park radio.**	
b. Walking, hiking and other physical exertion.	**b. Exhaustion, muscle strain, dehydration and fatigue.**	**b. Drink plenty of fluids, bring snacks and/or meals if out during lunch hours, Take periodic rests and stretch before and after physical activity.**	
c. Encountering / managing wildlife.	**c. Bite, attack or other injury resulting from incidental or violent interaction with wildlife or the use of wildlife management tools such as firearms.**	**c. Work in coordination with trained wildlife staff, use caution when dealing with wildlife and follow appropriate safety procedures for the use of management tools such as firearms. Carry first-aid kit and radio during patrols.**	
d. Working outdoors in cold and/or wet weather.	**d. Hypothermia, reduced resistance to illness.**	**d. Wear appropriate clothing and carry extra layers. Stay dry. Use rubberized raingear if possible. Stay hydrated preferably with warm liquids. Stop work to warm up if necessary. Snack often.**	
e. Working during nighttime hours.	**e. Injury resulting from over-tired or exhausted condition due to late night working hours and working in the dark.**	**e. Maintain healthy sleeping habits. Eat and drink appropriate meals for consistent energy (coffee is not an appropriate food source). If overly tired, take breaks and rest. Always carry charged flashlights with extra batteries.**	
10. SUPERVISORS SIGNATURE	11. TITLE	12. DATE	

Equipment and supplies:

1 Flashlights and headlamps with extra batteries
3 Park radio
4 PDA or Field forms: Data sheets
5 Clipboard/pencils
6 Warning flyers/notices
7 Manual counter

B.3.7 References:

Graber, D.M. (1982) Ecology and management of black bears in Yosemite National Park. Coop. Parks Studies Unit, Univ. of Calif. Davis, Tech. Report No. 5. 206 pp.

Harms, D.R. (1980) Black bear management in Yosemite National Park. Int. Conf. Bear Res. and Manage. 4:205-212.

Matthews, S.M., B.K. Lackey, S.S. Greenleaf, H.M. Leithead, J.J. Beecham, S.H. Ham, H.B. Quigley. (2003) Final Report: Human-bear interactions in Yosemite National Park. Hornocker Wildlife Institute/Wildlife Conservation Society.

Thompson, S.C., and K.E. McCurdy. (1995) Black bear management in Yosemite National Park: more a people management problem. Proceedings of the Fifth Western Black Bear Workshop. pp 105 – 115.

B.4. Extent and Condition of Informal Trails

B.4.1 Background

Informal trails (or visitor-created "social" trails) may be defined as discernible and continuous trail segments that were created by visitors and which do not follow a park's formal trail system (Leung et al. 2002). Since informal trails are not planned or constructed they are usually poorly located with respect to terrain. These trails also receive very little or no maintenance. These factors substantially increase their potential for degradation in comparison to formal trails. The proliferation of informal trails may increase habitat fragmentation and can directly threaten sensitive habitats when crossed or accessed by unplanned trails (Tylser and Joghson 2004). From a social perspective, a web of informal trails creates a visually scarred landscape and may lead to safety and liability concerns. Due to their ecological and social significance, informal trails are a common indicator selected in different implementations of NPS's VERP planning framework and Vital Signs monitoring program.

Monitoring can provide timely information on the extent, distribution and condition of informal trail segments. The findings from data collection combined with established minimum acceptable conditions can serve as warning signs of resource degradation and habitat intrusion. In turn, such information can trigger management action.

Most previous informal trail monitoring studies focused on their proliferation (number of places they occurred) throughout the park landscape. These studies did not include any added information about the trail. For example, trail length, width, or classification was not recorded. This approach made it difficult to asses the affect the trails may have on the resources. Fortunately, three main monitoring approaches have been developed specifically for informal trails. One approach is to include informal trails as part of an overall visitor impact study. In this type of study, the level of informal trail proliferation is assessed by tallying the occurrence of informal trail segments extending from formal trail networks or recreation sites (Marion 1994; Leung et al. 2002). Another approach is to inventory and map the entire informal trail network of a park or selected portions of a park (Cole et al. 1997; Leung et al. 2002). Yet another approach, used to enable temporal evaluation and used in a few studies, is to actually monitor informal trail networks more than one time (YOSE 2005). Condition class ratings and assessments were incorporated into most of the studies using these approaches.

Due to the extensive nature of some informal trail networks, the efficiency of field assessments is a particular concern. The advent of geospatial techniques seems to provide potential solutions to this challenge. Major developments are currently occurring with the rapid advancements of geospatial technologies, such as geographic information systems (GIS), global positioning system (GPS), remotely sensing and the digital spatial data. These technologies are particularly relevant to informal trail monitoring due to their dispersed spatial distribution. In 2004, Witztum and Stow demonstrated the utility of multi-spectral imagery and digital image processing techniques in extracting informal trails in a coastal sage scrub community (Witztum and Stow 2004).

This field protocol presents the data requirements and data collection procedures for surveying the extent and condition of informal trails in selected sites in Yosemite Valley and Tuolumne Meadows, an indicator that was first implemented in 2004. The User Capacity Management Program identified two zones to be monitored in Yosemite Valley, 2B Discovery and 2C Day Use. The meadows to be monitored in those zones are: Stoneman, Ahwahnee, Cooks, Sentinel, Woskey Pond, Leidig, El Capitan, and Bridalveil. In 2005, the User Capacity Management Program added Tuolumne Meadows as an area of interest for informal trail monitoring. This was in part driven by the need to collect baseline data to be used in conjunction with the Tuolumne Meadows Concept Plan. Thus, in 2005, mapping began in the main sections of Tuolumne Meadow, north of Tioga Road. In 2006, monitoring included meadows on the South side of Tioga Road, and other areas encompassed by the Tuolumne Wild and Scenic corridor and the Tuolumne Concept Plan. In 2007, baseline data was further expanded with monitoring conducted in the high use areas between the Lyell and Dana forks of the Tuolumne River.

The standards presented in the User Capacity Management Program were based on 1990 data. It was decided that data on current conditions should be used as the basis for future monitoring. This methodology described will be used to determine current conditions and to monitor them in the future. The standards were revised to develop a more rigorous data set from which future monitoring efforts will be measured.

Original methodology was refined and repeated in 2005 to confirm 2004 mapping results. Particular attention was placed on clarifying condition class definitions. Resulting from workgroups in 2005 through 2007, it has been decided that the *extent* of informal trails (as represented by density of informal trails) is a more meaningful parameter than solely *length* of informal trails because it is relative and allows for cross-meadow comparisons. In 2007, condition classes will again be assigned to all mapped trails. However, “barely discernible trail” and “flattened vegetation” will be eliminated and the remaining condition classes will include stunted vegetation, some bare ground, barren and braided. Rutted and braided will also remain as condition class attributes. Disturbed areas will be delineated as polygon shapes so that an integrated parameter of “density of disturbed area” can also be achieved. Otherwise, most methodologies will remain consistent with 2006 protocol.

Description of indicator and standard

Indicator: Extent (density) and condition of informal trails in the meadows of Yosemite Valley and in the meadows and high use areas of Tuolumne Meadows. These are specific areas of concern due to their location within the corridors of the Merced and Tuolumne Rivers, which have been given the congressional status of “Wild and Scenic”, thereby requiring compliance with the regulations protecting rivers of this designation.

Standard: No net increase in density of informal trails when compared with baseline (for Yosemite Valley). Baseline established in 2004 and 2005. In Tuolumne Meadows, 2007 mapping will add to data collected in 2005 and 2006 to increase baseline dataset. Baseline will be updated as restoration actions are implemented and data are re-collected to reflect restoration efforts. In addition, a range of density threshold values of disturbed areas and trailing will be developed through consultation with professionals specializing in recreation and meadow ecology. The resulting standard will be developed through a combined effort from scientists and park management/planning specialists and will be based on desired conditions associated with particular management zones designed to protect Wild and Scenic River ORV’s.

Rationale for indicator: Monitoring the extent and condition of informal trails in the meadow contributes to the protection and enhancement of many of the Outstandingly Remarkable Values of the Merced River Corridor. The biological Outstandingly Remarkable Value is represented through the following rationale: the extent and condition of informal trails is indicative of the contiguity and ecological health of meadows and wetland areas, and impacts to wildlife habitat, including special-status species. The cultural Outstandingly Remarkable Values is represented through the fact that archaeological sites and traditional gathering areas used by American Indian groups exist in some meadows, and could be affected by the proliferation and length of informal trails in meadows. The recreation Outstandingly Remarkable Value is represented through the belief that informal trails in meadows may affect visitor experience, as meadows are enjoyable areas in which to engage in a variety of recreational opportunities—including nature study, photography, etc. And lastly, but not finally, the scenic Outstandingly Remarkable Value is represented by the extent to which informal trails may impact the scenic interface of river, rock, meadow, and forest.

Objectives
To document the extent and condition of informal trails in meadows of Yosemite Valley and Tuolumne Meadows; to further establish baseline data on these impacts; and to compare results (where applicable) to data collected in 2004 through 2007. Results will be used to inform management decisions regarding protection of meadow health.

B.4.2 Sampling Design

Rationale for sampling design: In 2004, a GPS inventory of informal trails in the meadows of Yosemite Valley was undertaken. Monitoring was repeated in 2005 to verify results and explore potential factors that could cause variation in collected data (e.g. monitoring post-deer rut, which potentially skewed results; weather variability influencing soil moisture and trailing patterns, etc.). In 2006, four Yosemite Valley meadows were chosen to be monitored: El Capitan, Cooks, Stoneman and Woskey. El Capitan, Cooks, and Stoneman meadows exhibited an increase in trail length between 2004 and 2005, so they were monitored to confirm trends in informal trail development. Woskey Pond was chosen randomly. In 2007, five meadows will be monitored: Stoneman, Leidig, Sentinel, Ahwahnee, and Bridalveil. Stoneman exhibited a slight increase in trail length so it will be monitored to confirm trends in informal trail development. Leidig was chosen using a random table. Sentinel, Ahwahnee and Bridalveil were selected since they were last monitored in 2005.

In the future, meadows to be chosen will be based on those that exhibit trends towards informal trail increase, as well as, on a rotational schedule. These sampling methods should prove to be useful in capturing the range of long and short-term impacts caused by the many activities in these two very busy areas of the park.

In Tuolumne Meadows, no data existed on informal trails until mapping was conducted in the main meadow area (north of Highway 120, east of Pothole Dome, and west of Lembert Dome) in 2005. In 2006, monitoring efforts focused on expanding this baseline data in high use areas to the east of the Highway 120 Bridge. In 2007, additional baseline data will be collected in the high use areas between the Dana and Lyell forks of the Tuolumne River. This inventory of informal trails in the Tuolumne Meadows area is needed to create a baseline to which data from subsequent monitoring efforts can be compared. It will also be used in the Tuolumne Meadows Concept Plan planning efforts. Later, assessments may involve monitoring selected meadow areas via a sampling scheme similar to the one described above for Yosemite Valley.

Site selection: In Yosemite Valley, five meadows will be monitored: Stoneman, Leidig, Sentinel, Ahwahnee, and Bridalveil. In Tuolumne Meadows, additional baseline data will be collected in the high use areas between the Dana and Lyell forks of the Tuolumne River.

Sampling schedule: In Yosemite Valley, monitoring will be conducted over a four-week period, between mid-July and mid-August (before the fall deer rut). In Tuolumne Meadows, monitoring will be conducted between September and October, weather and road conditions permitting.

B.4.3 Field Methods

Preparation: Field personnel should be trained (see Training, below) and the following required tools and supplies should be acquired:
- GPS
- Clipboard and pencils
- Notebook
- Measuring tape
- Copy of indicator protocol
- Map of area of interest
- Digital camera
- Photo-documentation sheets (on waterproof paper)

- Pin flags
- Radio
- Water
- Lunch

Data collection and measurement: Field technicians should travel to the meadow to be monitored, and turn on GPS, so that it can begin to acquire satellites. Follow "Field Instructions" for complete, step-by-step data dictionary procedures.
Disturbed areas, regardless of size, should be entered as a polygon feature. Informal trail classifications should be entered into the GPS as a line feature. Additionally, the appropriate condition class and any subsequent features should be recorded for each trail segment. When choosing the appropriate condition class, use the following list of characteristics and photo examples as a guide. See figure below (Figure B.4.1).

Figure B.4.1 Informal Trails: Condition Class Characteristics and Photo Examples

Condition Class: **Stunted Vegetation**
Data Dictionary field: **Line Feature**
Photo Examples:

General Characteristics:
- *Distinct trail* feature present
- Trail boundary *present*
- *Moderate* repeated human use evident
- *Trampled and matted* vegetation
- Noticeably *impeded* vegetation growth

Condition Class: **Some Bare Ground**
Data Dictionary field: **Line Feature**
Photo Examples:

General Characteristics:

- *Distinct trail* feature present
- Trail boundary present and *distinct in some* areas
- *Heavy* repeated human use evident
- *Trampled and matted* vegetation
- *Noticeably impeded* vegetation growth
- *Some bare ground* present in trail tread

Condition Class: **Barren**
Data Dictionary Field: **Line Feature**
Photo Examples:

General Characteristics:

- *Distinct trail* feature present
- Trail boundary present and *distinct in most* areas
- *Extensive* repeated human use evident
- *No vegetation* present
- *Bare ground* present in trail tread *throughout*

Condition Class: **Disturbed Area**
Data Dictionary Field: **Polygon Feature**
Photo Examples:

General Characteristics:

- Polygon-type shape
- High use area
- Stunted vegetation, some bare ground and/or barren

Condition Class: **Braided**
Data Dictionary Field: **Line Feature**
Photo Examples:

General Characteristics:

- Two or more adjacent trails (5 feet apart maximum)
- Must be a minimum of 25 feet in length
- Can be: Stunted Vegetation, Some Bare Ground and/or Barren

Condition Class: **Rutted**
Data Dictionary Field: **Line Feature**
Photo Examples:

General Characteristics:

- Trail with depth greater than 6 inches
- Must be a minimum of 25 feet in length
- Can be: Stunted Vegetation, Some Bare Ground and/or Barren

General Mapping Plan:

1 Using the field maps you brought with you, orientate yourself and make a plan for data collection.

B.7.1 Informal Trails:

1.1.1 If in the first or fifth year of data collection, map meadow boundary/area of study first.
1.1.2 Next, map perimeter trails- placing pin flags at the beginning of side trails.
1.1.3 Then, map the longest trails- again placing pin flags at the beginning of side trails.
1.1.4 Next, map the side trails- removing the pin flag when you begin to map said trail. Additionally, if there is a sub-side trail, place pin flags at the beginning of said trail.
1.1.5 Continue in this fashion until all main trails and side trails are mapped.

B) Disturbed Areas:

1. Map the trail leading to the disturbed area first.
2. If a trail bisects a disturbed area, map the trail through the disturbed area. Either immediately resume mapping the disturbed area, or mark it with a pin flag and return later.
3. When walking the disturbed area boundary, always walk in the same direction and place a pin flag at the starting point- or at least take note of a distinguishing feature.

Note: For large meadows, you may want to break it into segments. Mark the segments on the map with a pen and on the ground by using pin flags.
Note: Use the map to keep track of the trails/disturbed areas you have mapped, by writing directly on the map.

Mapping Instructions:

Informal Trails:

1. DO NOT MAP FORMAL TRAILS (i.e. the Valley Loop trail, and formal hiking trails in Tuolumne).
2. Map the meadow boundary/area of study when it is in the first year of data collection (establishing a baseline) and then repeat every 5 years or if there has been a noticeable change in meadow boundary.
   Note: There is no need to GPS meadow edges that abut a road or formal trail.
3. Map all informal trails, regardless of size/length.
4. Map all informal trail classifications from beginning to end.
5. If a trail changes in classification (and/or in width) -*__for at least 25 feet__- end/store the feature and start a new one.
   ***Note**: The trail classification (and/or width) must change for at least 25 feet, otherwise, keep the original classification/width.

5. Make sure you **collect at least one point at each bend/vertex** in the trail, as well as, at the start and end of the trail.
6. Map trails through disturbed areas and return later to map the disturbed area.
7. Refer to "Mapping Plan" for supplemental instructions.

Disturbed Area:

- A disturbed area is: A polygon-shaped high use area as opposed to a trail. The condition class can be either: stunted vegetation, some bare ground, barren or any combination of said classes.
- Map all disturbed areas, regardless of size.
- You only need to collect points at the vertexes, not along the entire boundary line.
- Refer to "Mapping Plan" for supplemental instructions.

GPS Instructions:

1. Turn on GPS
2. Open TerraSync (double click)
3. Create a new File (create a new file at the beginning of each day)
   1. Open the "Skyplot" (default) screen
   2. Select "Status", from the drop-down menu.
   3. Select "Data"
   4. Hit "New" button
   5. Leave file type as Rover
   6. Use the keypad to name the new file
      1. verp yv mm/dd/yy
      2. verp tm mm/dd/yy
   7. Choose the appropriate data dictionary
      1. 2007 Valley Social trails
      2. 2007 Tuolumne Social trails
4. Log features
   1. Once the file and data dictionary are open, Hit "Create".
   2. Enter the meadow name (from a drop-down list)
   3. Select the appropriate feature
      1. Meadow boundary (use this for "study area" in Tuolumne)
      2. Trail
      3. Disturbed Area
   4. Select the appropriate classification
   5. Enter the trail width
   6. Select braiding,or rutted if applicable
      1. enter the number of braids
      2. enter the total braiding width (combination)
   7. Select rutted, if applicable
      1. enter the rutting depth
   8. Enter any notes necessary.

9. Hit “Log”
10. Walk the feature, making sure the GPS is collecting points at least every 10m and at all vertexes. If not, **you must wait** until the point is collected.
    a) The GPS unit will beep and the point-count (in the upper right hand corner) will increase.

Note: If satellite coverage is sparse, and it is taking a long time to get points, you can <u>start logging and then enter</u> the feature fields as you are waiting in between points.

<u>Editing GPS Data</u>

1. Open Terra Sync.
2. Select and open the main file.
3. From the first tier, upper-left, drop-down menu, select “Data”.
4. From the second tier, upper-left, drop-down menu, select “update features”.
5. A list of all the features associated with the file will appear. Highlight and select (click once) the feature to be edited.
6. Click on the “begin” button.
7. When you have finished editing attributes, click “ok”.
8. The list of features will again appear. Either edit more features, or click on the “update” button (on the top left).
9. To resume collecting data, select “collect”

<u>Deleting GPS Data</u>

1. Open Terra Sync.
2. Select and open the main file.
3. From the first tier, upper-left, drop-down menu, select “Data”.
4. From the second tier, upper-left, drop-down menu, select “update features”.
5. A list of all the features associated with the file will appear. Highlight and select (click once) the feature to be deleted.
6. Click on the “options” button.
7. Select “delete”.
8. When you have finished deleting attributes, click “ok”.
9. The list of features will again appear. Either delete more features, or click on the “update” button (on the top left).
10. To resume collecting data, select “collect”

<u>Data Dictionary Fields</u>

1. **Meadow Name**
    a) Choose from a drop-down list
2. **Classification**
    a) Stunted Vegetation
    b) Some Bare Ground
    c) Barren
    d) Rutted
    e) Braided
3. **Width:**
    a) (width of trail) to the <u>nearest 6 inches</u>
4. **Rutting Depth**:
    a) (depth of rutted trail) to the <u>nearest 6 inches</u>
5. **Braiding Number**
    a) Total number of trails in the braided complex
6. **Braiding Width**
    a) Width of the <u>entire braided complex</u> at its <u>widest point</u>
    b) <u>IN FEET</u>
7. Trail or Disturbed Area **identifier**
    a) <u>Do not change</u>
    b) Automatically generated
8. **Date and Time**

a) Do not change
b) Automatically generated

Post-collection and processing: Each day following field work, technicians will return to the Vegetation and Restoration office to download the GPS (see "Downloading GPS" instructions), download photos, update photo-documentation and time spent records, and charge camera batteries.

End of season procedures: Following completion field work, data will be managed properly (see Data Management section), and a report will be compiled.

B.4.4 Data Management

Data entry:

- GPS data will be downloaded at the end of each day. No later than one week after downloading, GPS files will be differentially corrected. Corrected files will then be exported and converted to GIS shapefiles. The shapefiles will then be used to create maps and for analyzing purposes.
- Photos shall be downloaded and labeled following the photo documentation protocol as outlined in the "ThumbsPlus Step-By-Step User's Guide. Photos will be stored following the "Photo Library File Structure Organizational Chart". All photos shall follow the "Standard Operating Procedures for Assigning Image File Names". The brief description, as part of the file name, should include the meadow name and the condition class. (e.g. YOSE-LeidigMeadowBarren-20070721.tif). Keywords and notes should also be assigned to all photos.
- Time spent will be entered into the "time spent" word file, with a description of the work completed that day.

Data analysis: GIS data will be converted into maps depicting informal trails in the areas being monitored. Calculations in ArcGIS 9 on informal trail features and meadow polygons will be completed to achieve informal trail density results.

Data reporting: Maps, informal trail density, and other data will be formalized in the 2007 VERP Report.

Data storage (meta-data): All GPS data (Trimble files) will be stored in ms01/EP Resources/Restoration Program Commons/GPS Data/VERP/2007/Informal Trails/Valley or Tuolumne. All GIS shapefiles will be stored in ms01/EP Resources/Restoration Program Commons/GIS Data/VERP/2007/Informal Trails/Valley or Tuolumne. All photos will be stored in ms01/EP Resources/00.Photo Library_RMS/Projects and Programs/Vegetation and Restoration/VERP. To follow the Resources Management and Science photo library file structure, all photos previously stored in ms01/EP Resources/Restoration Program Commons/VERP/2006/Informal Trails/Valley or Tuolumne/Photos will be moved to the aforementioned location.

B.4.5 Personnel Requirements and Training

Roles and responsibilities (tasks and time commitments):

- A Supervisory GS-7 will be responsible for the oversight of the Yosemite Valley and Tuolumne Meadows Informal Trails indicator. The duties will include: training of, managing, and supporting field technicians; attending monthly VERP team meetings; consulting with academic, agency, and other experts to further this indicator; assisting in analysis; and writing reports. They will serve as the point-of-contact, directly under the Branch Chief for this indicator.
- Assistant Supervisory GS-6 will be responsible for supporting the Supervisory GS-7. The duties will include: assisting the GS-7 with training of, managing, and supporting field technicians; attending monthly VERP team meetings; consulting with academic, agency, and other experts to further this indicator; assisting in analysis; and writing reports. They will serve as the point-of-contact, directly under the GS-7 for this indicator. They will also serve as the point-of-contact and support person for the field technician.

- Field Technician will be responsible for data collection and some data entry. The duties will include: mapping the informal trails; downloading GPS files; creating maps; and maintaining accurate and complete records of field work.

Projected time commitments are as follows:

- Supervisory GS-7: one week for training assistant supervisor and field personnel; one week for refining protocol; three to four weeks for mapping trails in Tuolumne Meadows; 2.5 hours per month for team meetings; one week for participating in workgroups; and one to two weeks for report writing.
- Supporting GS-6: total of 4-6 hours per week of oversight of field technician; three to four weeks for monitoring informal trails in selected areas in Yosemite Valley; 2.5 hours per month for team meetings; one week for participating in workgroups; and one to two weeks for report writing.
- Field technician (i.e. Americorp intern): one week for monitoring informal trails in selected areas of Tuolumne Meadows; and one to two weeks for creating maps.

Qualifications:

- Supervisory GS-7 should be knowledgeable of the overall VERP program; the protocol specifics of the VERP Informal Trails Indicator; and condition class characteristics. They should be comfortable in a supervisory role and should have background in the natural sciences or resources/recreation management.
- The supporting GS-6 should have experience in the fields mentioned above, be able to communicate well, and be comfortable in a leadership position. They should also be prepared to assist and fill-in with the duties assigned to the Supervisory GS-7.
- The field technician should also have experience in the fields mentioned above, as well as, posses the ability to pay attention to detail, follow instructions, work independently, and be computer savvy. Ideally, they will have experience operating a GPS unit and related GIS computer software.

Training procedures: Experienced Vegetation and Restoration management staff, with professional knowledge of informal trail protocol and procedures, will be will be responsible for training non-experienced NPS staff, interns, and/or volunteers to bring their skills, ability and knowledge to a level that will allow them to monitor informal trails independently. NPS staff and volunteers will be required to demonstrate the ability to:

- Navigate to target sites at meadows
- Operate a GPS device
- Assign proper condition class and other trail attributes
- Download GPS data (see attached instructions)
- Document time spent and photos using the proper forms

These skills will be verified through field training and assistance from qualified Vegetation and Restoration Management staff.

B.4.6 Operational Requirements

Work plan: Protocol refinements conducted prior to field season in April, May, and June over a one-week total time period. Field work conducted Mid-July through mid-August in Yosemite Valley and in August in Tuolumne Meadows on the following schedule:

Yosemite Valley:

- Week 1 (field technician, GS-7 term, GS-6 seasonal): training and quality assurance
- Week 2-4 (GS-6 seasonal): mapping and assessments of informal trails and disturbed areas in Sentinel, Leidig, Stoneman, Ahwahnee, and Bridalveil meadows.

- Technician (AmeriCorps Intern): Creating maps conducted over a two-week time period following field work.
- GS-6 seasonal: Mapping and data reporting conducted over a two-week time period following field work.

Tuolumne Meadows:

- Week 1-2 (GS-7 term): mapping and assessments of informal trails between the Dana and Lyell forks of the Tuolumne River, near the high use zones and encompassed by the Tuolumne Development Concept Plan.
- Technician (AmeriCorps Intern): Creating maps conducted over a one-week time period following field work.
- GS-6 seasonal: Mapping and reporting will be conducted over a one-week time period following field work.

Safety: A job hazard analysis has been completed for this indicator. See table below (Table B.4.1).

Table B.4.1 Job Hazard Analysis for VERP Extent and Condition of Informal Trails

United States Department of Interior NATIONAL PARK SERVICE	1. WORK PROJECT/ACTIVITY	2. LOCATION	
	VERP Informal Trail Monitoring	Yosemite Valley and Tuolumne Meadows, YNP	
Job Hazard Analysis (JHA)	3. NAME OF ANALYST	4. JOB TITLE	5. DATE PREPARED
	Crystal Elliot	Technician	June, 2006
6. TASKS/PROCEDURES	7. HAZARDS	8. ABATEMENTS ACTIONS ENGINEERING CONTROLS – SUBSTITUTION – ADMINISTRATIVE CONTROLS – PPE	
a. Driving to, from, and around sampling sites.	a. Collision resulting in damage, injury, or death.	a. Drive defensively, obey traffic laws, lights on, seatbelt on, be alert for pedestrians, wildlife, and distracted drivers. Know procedures for installing snow chains. Always carry and know how to use a Park radio.	
b. Hiking through and working in meadows.	b. Inclement weather, heat, dehydration; poison oak; insects and snakes.	b. Dress appropriately, drink plenty of fluids, bring snacks and/or meals if out during lunch hours, carry first-aid kit including snake-bite kit and Tecnu, in case of contact with poison oak. An Epy pen may be necessary to carry as well.	
c. Working and walking along riverbanks.	c. Tripping and/or falling due to wet and slippery rocks or sloping ground surfaces, contact with poison oak, etc.	c. Watch footing, know how to identify and avoid all poison oak, rinse immediately in stream if contact occurs.	
d. Working outdoors in hot, dry conditions.	d. Dehydration, heat exhaustion.	d. Stay hydrated. Take frequent breaks if weather is uncomfortably warm. Use sun protection (e.g. hat).	
e. Working outdoors in cold and/or wet weather.	e. Hypothermia, reduced resistance to illness.	e. Stay dry. Use rubberized raingear if possible. Stay hydrated preferably with warm liquids. Stop work to warm up if necessary. Snack often.	
10. SUPERVISORS SIGNATURE	11. TITLE	12. DATE	

Equipment and materials: see ”Preparation” in the Field Methods section

B.4.7. References

Cole, D.N., A.E. Watson, T.E. Hall, and D.R. Spildie. 1997. *High-Use Destinations in Wilderness: Social and Biophysical Impacts, Visitor Responses, and Management Options*. Research Paper INT-RP-496. Ogden, UT: USDA Forest Service, Intermountain Research Station.

Leung, Y.-F., N. Shaw, K. Johnson, and R. Duhaime. 2002. More than a database: Integrating GIS data with the Boston Harbor Islands carrying capacity study. *George Wright Forum* 19(1), 69-78.

Marion, J. L. 1994. *An Assessment of Trail Conditions in Great Smoky Mountains National Park (Research/Resources Management Report).* Atlanta, GA: USDI National Park Service, Southeast Region.

Tyser, R.W., and C.A. Christopher. 1992. Alien flora in grasslands adjacent to road and trail corridors in Glacier National Park, Montana (U.S.A.). *Conservation Biology* 6(2), 253-262.

Witztum, E.R., and D.A. Stow. 2004. Analyzing direct impacts of recreation activity on coastal sage scrub habitat with very high resolution multi-spectral imagery. *International Journal of Remote Sensing* 25(17), 3477-3496.

YOSE (Yosemite National Park). 2005. *Merced River Monitoring 2005 Annual Report: User Capacity Management Program for the Merced Wild and Scenic River Corridor*. USDI National Park Service, Yosemite National Park.

B.5. WILDERNESS ENCOUNTERS

B.5.1. Background

The Wilderness Act of 1964 mandates that designated wilderness will have "outstanding opportunities for solitude". While there is some disagreement about the value of monitoring encounters as a measure of wilderness experience quality (Stewart 2001; Cole, 1996), historically, wilderness managers have considered inter-group encounters as a primary threat to solitude (Watson 1998). In the most comprehensive study of visitor experience in the Yosemite Wilderness, Newman (Newman 2002) found encounters with other parties to be the second most important attribute affecting the quality of experience in a trade-off analysis.

This field protocol presents the procedures, data requirements and data collection sheets for the number of encounters Yosemite NP rangers or volunteers have with visitors on trails. The User Capacity Management Program identified two zones that should be monitored. A more detailed description of this indicator is presented on page 49 of the User Capacity Management Program.

DESCRIPTION OF INDICATOR AND STANDARD:
Encounters with other parties gauges the density levels and flow rates of visitor use in designated wilderness areas.

Zones: Un-trailed; Trailed Travel

Standards:

- Zone 1A: Un-trailed—No more than one encounter per four hour period, 80 percent of the time.
- Zone 1B: Trailed Travel— No more than one encounter per hour, 80 percent of the time.

Rationale for indicator: Crowding and solitude are important components of wilderness experience. Numerous studies explore the effect of encounters in wilderness settings as they affect the nature of visitor's experiences. Encounter rates are one vital part of the decision making matrix that would be used to review and possibly modify Yosemite's current overnight wilderness use limits.

Objectives: To assess crowding and opportunities for solitude as a component of wilderness experience quality in the upper Merced River corridor.

B.5.2. Sampling Design

This data will be collected primarily by the Merced Lake Ranger. Sampling will attempt to mimic, as much as possible, the visitor's experience, while recording the number of groups encountered. Data will be collected as part of routine patrols. Sampling times and locations will be dictated by patrol priorities rather than data needs. Temporal and spatial variation in data collection will be attained by combining several years' data and filtering for a variety of spatial and temporal characteristics. If more people can be devoted to data collection, they will be assigned to mitigate any deficiencies that result from this type of opportunistic sampling.

Rationale for sampling design: Most research on wilderness encounters considers encounters per day. A minority of visitors stay in the river corridor the entire day, however, so encounters are recorded by trail segment, with sampling time in the segment noted. While a more robust schedule based on sampling priorities would obviously be preferable, funding and other operational limitations dictate that sampling must be coincident with ranger patrols.

Site selection: The sampling area includes all zone 1A (un-trailed) and 1B (trailed) areas of the river corridor. A map of all indicator sampling locations is provided in the introduction to this field guide.

Trail segments sampled:

On trail (zone 1B):

- Moraine-Echo
- Echo-MLRS
- MLRS-Washburn
- Washburn-Junction

Off trail (zone 1A):

- Red Peak Fork
- Merced Peak Fork
- Lyell Fork
- South Fork

Sampling Schedule: The Merced Lake Ranger typically patrols the upper Merced Drainage from late May (depending on snowpack) to early October, and performs eight to nine day patrols during each two week period. Much of June is spent training in the frontcountry. Encounters will be recorded during regularly scheduled ranger patrols.

B.5.3 Field Methods

Data collection and measurement

- Data collectors should attempt to match their travel speed to that of a typical visitor, approximately two miles per hour.

- Whenever a data collector enters a new trail segment, the time will be recorded on the data sheet/index card. Any encounters within that zone will then be recorded. Staff should record an end time at the end of the zone or each time one needs to leave the trail to perform administrative duties.

- Data collectors will only count parties that are close enough to establish verbal or eye contact without leaving the trail. Parties camped close to the trail that can be seen and talked to from the trail will count. Each party will be counted only once, even if encountered multiple times. Parties found by leaving the trail to specifically look for campers or to perform other administrative tasks will not count. Other administrative parties (rangers, concession employees, etc.) will not be counted.

- If the data collector is unsure about whether individuals hiking separately are part of the same party, they will ask. This is already done as part of routine patrol.

When encounters with parties occur along a trail or are visible from the trail, record the following data on the data sheet provided:

- **Field Monitor Name(s):** Record field monitor name(s).

- **Date:** Day/Month/Year (August 8, 2007 = 08/08/07).

- **Start Time:** Record time entering trail segment or following a side trip off the trail.

- **End Time:** Record time leaving trail segment or when leaving trail.

- **Segment:** Record the trail segment number.

- **Number of Parties Encountered:** Record the number of parties encountered along segment of trail monitored.

- **Notes:** Record any information pertinent to the collection of data on that day in that particular site (i.e., weather, access issues, special events, etc.)

Figure B. 5.1 Data Sheet – Wilderness Encounters

Field Monitor Name:
Date:

Trail Segment*	Start Time	End Time	# of Parties Encountered

***Segments:**			
1B Zone		**1A Zone**	
Moraine-Echo	1	Red Peak Fork	5
Echo-MLRS	2	Merced Peak Fork	6
MLRS-Washburn	3	Lyell Fork	7
Washburn-Jct.	4	South Fork	8
		Triple Peak Fork	9

Post-collection and processing

- At the conclusion of the hike, the data should be transposed onto an Encounter Record Sheet, which should be filed until the end of the data collection period.
- Return data sheet/index cards to the wilderness management office and enter information in the Number of Encounters with other Parties database.

End of season procedures

- Data collectors should meet with the VERP Program Manager and Wilderness Specialist at the end of the season to discuss potential program improvements.

B.5.4. Data Management

Data entry: All data will be entered into the Number of Encounters with other parties database.

Data analysis: Questions remain on the best method of analysis for this indicator. Most of these concerns the difference between the units (encounters/day) used in most studies on the subject and the visitor use patterns found in zones 1A and 1B of the Merced River corridor: Most visitors spend only part of the day traveling in the sampling area. The best way to analyze the data to represent a visitor day across all temporal and spatial variables still needs to be decided.

Data reporting: Results from data analysis will be reported in the VERP annual report, at public meetings, and on the park website.

Data storage (meta data): Data will be stored in the wilderness patrol database.

B.5.5. Personnel Requirements and Training

Roles and responsibilities (tasks and time commitments): The Merced Lake Ranger will be the primary data collector. Other volunteers may be able to supplement this effort as available. Because this sampling occurs only during routine patrols; time commitment is minimal; training (1hour), data transfer (10 minute/day), data entry (2-3 hours for the season), and debriefing (1 hour).

The Wilderness Specialist and VERP Program Staff will be responsible for training data collectors (1 hour), providing logistics for any volunteers (3 hours each), quality control (1 3 day visit to the sampling area), debriefing (1 hour), and data analysis (1 day).

Qualifications: Data collectors must be competent at living and traveling in a remote wilderness setting. They also need to be able to record data accurately and maintain records accordingly.

Training procedures: The Wilderness Specialist, VERP Manager, or Wilderness Rangers with experience in recording encounters with parties will be responsible for training any NPS staff or volunteers without prior monitoring experience. NPS staff and volunteers will be required to demonstrate the ability to:

- Adjust hiking speed to approximate the typical speed of a visitor. Typical hiking speed would be approximately 2 miles per hour.
- Make appropriate recordings of encounter data on ranger patrol card.
- Enter data into the Number of Encounters database.

B.5.6 Operational Requirements

Work plan: Sampling will take place during the summer season, approximately mid June through mid October.

Safety: The job hazard analysis for this indicator is the same as for routine wilderness patrol.

Table B.5.1 Job Hazard Analysis

United States Department of Interior NATIONAL PARK SERVICE	1. WORK PROJECT/ACTIVITY	2. LOCATION	
	VERP Wilderness Encounters Monitoring	Yosemite Wilderness, YNP	
Job Hazard Analysis (JHA)	3. NAME OF ANALYST	4. JOB TITLE	5. DATE PREPARED
	Mark Fincher	Wilderness Mgr.	July, 2005
6. TASKS/PROCEDURES	7. HAZARDS	8. ABATEMENTS ACTIONS ENGINEERING CONTROLS – SUBSTITUTION – ADMINISTRATIVE CONTROLS – PPE	
a. Driving to, from, and around sampling sites.	a. Collision resulting in damage, injury, or death.	a. Drive defensively, obey traffic laws, lights on, seatbelt on, be alert for pedestrians, wildlife, and distracted drivers. Know procedures for installing snow chains. Always carry and know how to use a Park radio.	
b. Walking, hiking and other physical exertion.	b. Exhaustion, muscle strain, dehydration and fatigue.	b. Drink plenty of fluids, bring snacks and/or meals if out during lunch hours, Take periodic rests and stretch before and after physical activity.	
c. Hiking and camping in Wilderness.	c. Bite or attack from snakes, bees and or wildlife. Exposure to poison oak.	c. Use appropriate backcountry hiking and camping techniques. Use appropriate backcountry gear and clothing. Carry park radio and first aid kit. Leave travel itinerary with supervisor.	
d. Working outdoors in cold and/or wet weather.	d. Hypothermia, reduced resistance to illness.	d. Wear appropriate clothing and carry extra layers. Stay dry. Use rubberized raingear if possible. Stay hydrated preferably with warm liquids. Stop work to warm up if necessary. Snack often.	
e. Working outdoors in hot / extreme heat weather.	e. Fatigue, exhaustion, dehydration and heat stroke.	e. Wear appropriate clothing and use sunscreen. Drink fluids and snack throughout the day. Carry extra water and dehydration salts along with first aid kit.	
10. SUPERVISORS SIGNATURE	11. TITLE	12. DATE	

Equipment and materials:
- Pencils / sharpener
- Watch
- Datasheet

B.5.7. References

Cole, David N.; Stewart, William P. 2002. Variability of user-based evaluative standards for backcountry encounters. Leisure Sciences 24: 313-324

Cole, David N.; Watson, Alan E.; Hall, Troy E.; Spildie, David R. 1996. High-use destinations in wilderness: social and biophysical impacts, visitor responses, and management options. INT-RP-496. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 30 p.

Newman, Peter. 2002. Integrating social, ecological, and managerial indicators of quality into carrying capacity decision making in Yosemite national Park wilderness.

Stewart, William P.; Cole, David N. 2001. Number of encounters and experience quality in Grand Canyon backcountry; consistently negative and weak relationships. Journal of Leisure Research 33(1): 106-120

Watson, Alan E.; Cronn, Rich; Christensen, Neal A. 1998. Monitoring inter-group encounters in wilderness. Res. Pap. RMRS-RP-14. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 20 p.

B.6. Extent of Visitor Use

B.6.1 Background

The visitor use monitoring indicator will allow managers to assess use densities, durations, and activity types along the Merced and Tuolumne Rivers and high use trails. This indicator directly represents both the Recreation and Scenic Outstandingly Remarkable Value (ORV) but has correlation to all other values established for the river corridors. This indicator has been developed to assist in computer simulation outputs of people-at-one-time (PAOT) and people-per-viewscape (PPV) metrics. The rationale behind this change stemmed from the park's ability to gain more robust monitoring data through the implementation of a variety of methods to monitor visitor use while continuing to monitor PAOT/PPV through these established relationships.

Description of indicator and standard
Indicator: For the Merced River, visitor use monitoring serves as an extensive gauge of human use activity along the river. This indicator reflects human use levels and behaviors that may potentially cause negative impacts such as crowding, user conflict, noise and others visitor caused disturbances on both resources and the visitor experience. Visitor counts measures overall human use in the river corridor and helps to protect the Merced River's Outstandingly Remarkable Values.
River Standard: Methods alteration: Developing baseline
Trail Standard: Methods alteration: developing baseline

Rationale for indicator: Documenting visitor use levels and their activities is an essential component of user capacity and related monitoring programs. Visitor Use monitoring serves as an indicator of overall use levels at points of interest including trails and in-river recreational users. Crowding and congestion have been shown to degrade the quality of visitor experiences (Manning 1999; Manning 2007) and can have a negative impact on park resources (Hammit and Cole 1998).

Trail and Attraction Site Use Monitoring
The 2007 field season is integrating additional ways of looking at this indicator. With the assistance from researchers at Colorado State University and Virginia Tech, aggregate counts, mode of travel (personal bike, rental bike, foot, rental raft, etc.) and travel routes are being monitored in the Happy Isles, Mirror Lake, Yosemite Falls, Bridalveil Fall, Tuolumne Meadows and Wapama Falls areas. On the trails, this allows for an increase understanding of overall use levels occurring along trail segments as opposed to the previously applied PAOT (People-At-One-Time) counts. However, PAOT is being continued along trail locations that are unable to be monitored using TrailMaster instrumentation. This was applied to areas where low use occurs as a way to substantiate trail selection for this season's installation of the monitoring devices.

River Use Monitoring
In river use was documented during the height of the rafting season in the Merced River. Documenting on-river use allows the park to understand the river experience atmosphere. The locations where data was collected was at the raft put-in (Stoneman Bridge) and the take-out (Sentinel Beach). Aggregate counts of floaters will be complimented by DNC (Delaware North Company) data pertaining to raft rentals.

Objectives: To document the levels and types of visitor use at key areas in the river, on trails, and at attraction sites within the Merced and Tuolumne River Corridors.

The overall change in methods for this indicator was determined to initiate a park-wide GIS layer documenting visitor use levels. This in turn, can inform the entire VERP program where the park is receiving specific levels of visitation. As VERP is a framework that outlines visitor-caused impacts on park resources, sampling locations for every indicator's data collection should span across use levels. Such sampling methods identify how resources are impacted by these various levels.

B.6.2 Sampling Design

Trail Sample: The benefit received by using trail monitoring equipment this year is the depth of peak-season sample that can be obtained versus staffing this type of data collection. Except for uncontrollable equipment errors, sampling started on May 17th through September 30th.

River Sample: Raft rentals ran from May 18th to July 9th this year. Randomized sampling was conducted from May 31st through June 24th.

Rationale for sampling design: The visitor use indicator is designed to estimate the extent of visitors along trails, at attraction sites, and along the two river corridors in the park. Since the number of people within a trail corridor and the number of people in the river influences Outstandingly Remarkable Values, both of these factors are addressed in this protocol. Monitoring will be conducted using a variety of sampling methodologies to obtain a representative and complete sample of visitor use across the days of the week and months during peak season from May through September. Two river sampling locations are selected for the Merced River, Stoneman Bridge (the raft rental put-in site) and Sentinel Beach (the raft rental take-out site). Six trails throughout Yosemite Valley, Tuolumne Meadows and Hetch Hetchy will be monitored. At each monitoring site the number of people floating the river or hiking the trails will be analyzed. Counting periods for the river will be between 10:00 am to 6:00 pm, the time period where rafts are rented. Counting periods for the high use trails will be stratified by time of day between 8:00 a.m. and 8:00 p.m. Trail monitor instrumentation allows for a continuous count of use regardless of time of day.

Measurement:
The measurement for visitor use along the river will be the number of vessels and people beginning their raft trip at Stoneman Bridge and the number of vessels and people finishing the rafting trip at Sentinel Beach. This will allow us to determine the total number of people floating the river for a specific day as these two locations dominate the rafting and floating locations as a result of their accessibility and use by the concessionaire raft rentals.

The measurement for visitor use along the trail will be the total number of people using the selected trails. These instruments are able to estimate the overall amount of use that the trail receives. Combined with calibration days (observation counts to determine a percent error due to shoulder-to-shoulder walking, fast-paced walking, stopping on or near the infrared beam, etc), the park is able to identify time specific use levels over a longer period of time than manual counts requiring extensive labor hours. In locations where counters are not able to be used, staff and volunteers performed manual counts to capture use levels.

Site selection (selection criteria and procedures):

1) River PAOT monitoring has shifted from the riverbank or attraction site approach to visitor use that identifies rafters and floater levels in the river exclusively. The scope of this indicator will broaden this season as a result of the focus placed on recreation activities taking place in the Merced River. Additionally, little understanding of “in river” use during the high-use times of the summer has been emphasized. Monitoring times will vary from season to season depending on water levels within the Merced River.

2) Monitoring Sites (Trail) – Trail selection was made as a result of the high use of these trails. The goal is to achieve a representative sample of a high use trails allowing for an estimate to be derived from this work. Additionally, many of these sites in Yosemite Valley were used in a visitor study conducted in 1998 (Manning et al. 1998) exploring for visitor’s normative evaluations of PAOT encounters.

Sampling Schedule: Field work for this indicator will be conducted on mornings and afternoons for weekdays, weekends and holidays during peak season from May through September. Sampling should capture early and late day visitors utilizing the Merced and Tuolumne River corridors. Monday-Thursday constitutes weekdays, while Friday-Sunday constitutes weekend days. Sampling on the river will be every fifteen minutes throughout the day (10:00 am – 6:00 pm). Efforts should be made to sample early and late daily and seasonally, this will depend on water levels within the Merced River. Trail use monitoring instrument validation will be rotated throughout the summer; this will consist of monitoring for four hours during each sample period. Sampling with the instrument are continuous throughout the season ensure a large sample to understand differences in hourly, daily, weekly, and seasonality in visitor use patterns.

B.6.3 Field Methods

Preparation: Field personnel should be trained (see Training guidelines section below) and the following required tools and supplies should be acquired.

- Map with location, photos and directions to monitoring sites
- Field Forms: Data sheets on waterproof paper
- Clipboard/pencils/pens
- Watch with second hand
- Counter
- Sunscreen/insect repellant/first aid kit
- Water

Training outline: YOSE data collection staff training form

- Supplies from shipped boxes
- Study overview
    - Purpose
    - Study sites
    - Types of information
    - Modeling
- Sampling schedule
    - NPS and VPI staff
    - 7 hours of sampling, morning and evening study administration
- Logistics
    - Research supplies storage
    - Computer access
    - Transportation to and from study sites
    - Daily meeting time and location
        - With VPI too, after July 17
    - SCA housing?
    - VPI camping location
    - NPS research permit
- Survey instruments
    - Route surveys and survey logs, by location
    - Visitor counts forms, by location
    - Bridalveil Fall regression counts form
    - Site schematics
- Pocket PC's
    - Operation of each model
    - Name of each unit
    - Battery installation, battery life, and battery charging
    - Data entry
        - Event button and Pocket PC site legends
        - Naming files on Pocket PC
    - Data entry error log? (Make photocopies if more logs are needed)
    - Hardcopy forms for backup
        - Battery capacity, event counter capacity, mechanical issues
    - Data download and file organization
        - My Documents (Event Counter data files)
        - Program Files (Event Counter program)
        - Organizing and naming files on computer
- Daily routine
    - See handout
    - Organization is everything!
- Survey research
    - Consistency of administration is critical!
    - Response rates reflect data quality
        - Develop a good "come-on"
    - Clear, legible data recording key for data entry by other people
    - Observant to "problems" early in the study is important
        - Consult before revising methodology!
    - Organization is everything!
- Site visits and trials, Vernal Falls counts, Mirror Lake counts, Bridalveil Falls delays

Data collection: Data collection procedures for visitor use along the Merced River and high use trails and their methods are described below:

1) **Monitoring (River)**
   - Locate monitoring site using map, directions and photos.
   - The data collector will then station himself or herself in a position that permits vision of the complete viewscape in the river segment and low visitor interaction levels.
   - The data collector should record the amount of people visible in the viewscape. Counting floaters will be every 15 minutes throughout the day. Figure b.6.1 illustrates a field data sheet.
   - This data should be collected on weekdays and weekends.
   - When the monitoring is complete, return all datasheets to the VERP Monitoring office.

2) **Monitoring (Trail)**
   - Locate the trail monitor using map, directions and photos.
   - Download the current data log from the monitor before initiating the calibration.
   - Calibration of the trail monitor should take place in a location where arrivals and departures are clearly visible.
   - The calibration should be hourly by intervals of 15 minutes.
   - Record the proportions of inbound and outbound arrivals
   - When the monitoring is complete, return all datasheets to the VERP Monitoring office.

3) **Data Sheet**

Figure B.6.1 PAOT (People at One time) and Aggregate Counts datasheet from the Twin Bridges-Tuolumne River (2007)

PAOT (People At One Time) And Aggregate Counts								
	DATE:				NAME:			
	TIME	**From Campground**	**To Campground**	**From Trailhead**	**To Trailhead**	**From Backcountry**	**To Backcountry**	**PAOT-Twin Bridges**
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								

Monitor Calibration Protocol:

1) Calibrations are set up as hour-long sampling periods, broken into four 15-minute sections. Each hour of calibration takes up four rows on the form. The “time start” and “time end” correlate with the four fifteen minute sections (ex. 8:00-8:15, 8:15-8:30, 8:30-8:45, 8:45-9:00). See figure B.6.2.

2) The unit number and date are recorded in their respective columns. Bridalveil is unit #5.

3) At the start and end of each 15 minute section, the monitor number displayed is recorded into the “monitor start” and “monitor end” columns respectively.

4) The “monitor count” column is “monitor end” minus “monitor start”.

5) For Bridalveil, use a single tally-clicker and count the number of people who hike the trail, both up and down. At the beginning of each 15 minute section, start the tally at zero and record the total count of that 15 minute section in the “total count” column.

6) When tallying with your clicker, count each person a total of two times, only once on the way up and once on the way down. This is important to know because if you see a person who checks out either of the monitor components and you notice that they trigger multiple monitor counts, you do not want to record on your clicker each count they make, only once on the way up and once down. Also, it is not necessary to stop the person from making multiple counts, as this is part of the natural error process, *unless* they are being destructive with the monitor.

7) *Calculating the R is not necessary*, as they are processed much easier in Excel, but for your understanding, the “R” column stands for rate of error and is found by dividing the total count by the monitor count. (ex. 75 total counts divided by 50 monitor counts equals 1.5, so for each monitor count there is actually 1.5 people passing)

Figure B.6.2 Visitor Monitoring Calibration Form

Monitor Number	Date	Start Time	End Time	Monitor Start	Monitor End	Total Count	Monitor Count	R = Rate of Error

Post-collection and processing: Datasheets in electronic form will be e-mailed to the VERP Office. Original datasheets (if manually completed) will then be copied and stored in the VERP program office in El Portal.

B.6.4 Data Management

Data Entry: Collected data will be downloaded or transferred into the appropriate computer software (e.g. StatPack, Excel, etc).

Data analysis: Visitor use will be statistically analyzed via Statistical Package for the Social Sciences (SPSS) and incorporated into summary tables. Data should be presented by sampling location, date and time.

Data reporting: Visitor use along the two river corridors and trails within will be presented in the 2007 VERP Annual Report. More detailed reporting will be provided by the Cooperative Ecosystem Studies Unit as stated in the final agreements. Additionally, results will be applied to other aspects of park management.

Data storage: All collected data and compiled documentation will be stored on the YOSE NPS network (ms01/EP Commons/VERP/VERP Indicators/Visitor Use/Data). GIS maps and project files can be found at (ms01/ EP Commons/VERP/VERP Indicators/General/VERP Site Maps Compiled). Datasheets can be found at (ms01/ EP Commons/VERP/VERP Indicators/Visitor Use/Visitor Use Trail/Visitor Use Datasheet) and originals will be stored in the VERP office in El Portal.

B.6.5 Personnel Requirements and Training

Roles and responsibilities (tasks and time commitments): Supervisory GS-7 responsible for oversight of field work and training of personnel not familiar with protocol and surveying. GS-7 field technician in charge of tasks associated with visitor use surveys and training and supervising other field staff. Other field staff will assist in surveying visitor use.

Projected personnel needs for visitor use monitoring locations are two to three personnel for 12 weeks including training throughout the summer. Additional time will be contributed by CESU The river sites will require a total of six days and each day requiring six to eight hours to monitor. A total of 10 days and four hours will be needed to validate the trail monitors.

Qualifications: Data collectors must demonstrate the ability to accurately count the number of visitors, download data using the TrailMaster equipment, and efficiently conduct brief interviews with visitor groups. All data collectors will be required to work outdoors during inclement weather, stand for extended periods of time and may be required to hike or walk for long distances.

Staff Training: Two days will be dedicated to familiarizing field staff with data collection procedures and the overall purpose of the study. Formalizing this process ensures interviewer/data collector accuracy.

B.6.6 Operational Requirements

Work plan: Sampling will take place during the summer season from mid May to mid August. River monitoring days will depend on water levels. Trail data collection will continue throughout the summer and instrument calibration with rotate throughout this time.

Safety: A job hazard analysis has been completed and appears below (Table B.6.1)

Table B.6.1 Job Hazard Analysis for Extent of Visitor Use Data Collection

United States Department of Interior NATIONAL PARK SERVICE	1. WORK PROJECT/ACTIVITY	2. LOCATION	
	Visitor use Monitoring	Yosemite Valley, YNP	
Job Hazard Analysis (JHA)	3. NAME OF ANALYST	4. JOB TITLE	5. DATE PREPARED
	Bret Meldrum	Technician	May, 2007
6. TASKS/PROCEDURES	7. HAZARDS	8. ABATEMENTS ACTIONS ENGINEERING CONTROLS – SUBSTITUTION – ADMINISTRATIVE CONTROLS – PPE	
a. Driving to, from, and around sampling sites.	a. Collision resulting in damage, injury, or death.	a. Drive defensively, obey traffic laws, lights on, seatbelt on, be alert for pedestrians, wildlife, and distracted drivers. Know procedures for installing snow chains. Always carry and know how to use a Park radio.	
b. Walking, hiking and other physical exertion.	b. Exhaustion, muscle strain, dehydration and fatigue.	b. Drink plenty of fluids, bring snacks and/or meals if out during lunch hours, Take periodic rests and stretch before and after physical activity.	
c. Hiking through and working in meadows.	c. Inclement weather, heat, dehydration; poison oak; insects and snakes.	c. Dress appropriately, drink plenty of fluids, bring snacks and/or meals if out during lunch hours, carry first-aid kit including snake-bite kit and Tecnu, in case of contact with poison oak. An Epy pen may be necessary to carry as well.	
d. Working and walking along riverbanks.	d. Tripping and/or falling due to wet and slippery rocks or sloping ground surfaces, contact with poison oak, etc.	d. Watch footing, know how to identify and avoid all poison oak, rinse immediately in stream if contact occurs.	
e. Working outdoors in cold and/or wet weather.	e. Hypothermia, reduced resistance to illness.	e. Wear appropriate clothing and carry extra layers. Stay dry. Use rubberized raingear if possible. Stay hydrated preferably with warm liquids. Stop work to warm up if necessary. Snack often.	
f. Working outdoors in hot / extreme heat weather.	f. Fatigue, exhaustion, dehydration and heat stroke.	f. Wear appropriate clothing and use sunscreen. Drink fluids and snack throughout the day. Carry extra water and dehydration salts along with first aid kit.	
g. Hiking in Wilderness.	g. Bite or attack from snakes, bees and or wildlife. Exposure to poison oak.	g. Use appropriate backcountry hiking and camping techniques. Use appropriate backcountry gear and clothing. Carry park radio and first aid kit. Leave travel itinerary with supervisor.	
10. SUPERVISORS SIGNATURE	11. TITLE	12. DATE	

Equipment and materials:

- Map with location, photos and directions to monitoring sites
- Field Forms: Data sheets, route surveys, and smiley stickers
- Data Collectors-when downloading
- Clipboard/pencils/pens
- Watch with second hand (stopwatch optional)
- Hand Counter/PDA
- Sunscreen/insect repellant/first aid kit
- Water

Project Requirements:

Data was collected by a variety of staff, interns and cooperative research groups.
Virginia Tech Cooperative Agreement - Modeling and use counts at: ▪ Mirror Lake ▪ Vernal Fall ▪ Bridalveil Fall ▪ Yosemite Falls ▪ El Capitan Meadow
Colorado State University Cooperative Agreement - Visitor use estimation (trails) locations: ▪ Yosemite Falls ▪ Bridalveil Fall ▪ Vernal Fall ▪ Glacier Point ▪ Hetch Hetchy ▪ Lyell Canyon ▪ Cathedral Lakes ▪ Glen Aulin
Assistant Program Coordinator GS-7 ▪ One seasonal staff member to provide oversight ▪ Occasionally this position needed to collect data
Student Conservation Association-Interns ▪ Two interns from June to mid-September ▪ Responsibilities included conducting interviews, aggregate counts, data downloading, and instrument calibration.

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B.7. Archeology Condition and Stability

B.7.1 Background

Archeological sites have been selected as an indicator because the National Park Service (NPS) has a responsibility to protect non-renewable resources important to our nations' heritage such as archeological sites (see Directors Order # 28, National Historic Preservation Act, National Environmental Policy Act), and their status as cultural components in the Merced and Tuolumne Wild & Scenic River Corridors. These resources are also sensitive to visitor use, as such use can negatively impact the stability and condition of archeological sites leading to a loss of archeological site significance, integrity, and the irretrievable loss of important data.

Despite the abundant applications of the VERP framework to natural resources, there is virtually no current application of the VERP process on non-renewable resources such as archeological sites (see NPS 2000a, 2001; Fairley and Downum 2000). The VERP process and the limits of acceptable change concept are not neatly compatible with current legislation relating to the management of cultural resources such as National Historic Preservation Act (NHPA), the National Environmental Policy Act (NEPA), NPS Directors Order 28, and more. Fundamentally, no decline in the condition of the data potential, significance, or integrity of cultural resources on the National Register of Historic Places (NRHP) or those eligible for inclusion in the NRHP is acceptable without working through a planning process such as the NEPA process.

The goal of this indicator monitoring is to collect visitor impact data at a sample of archeological sites. The specific objectives for this project are to select a random sample of archeological sites, stratified by use level zone, complete site visits and collect visitor use impact data.

This field guide presents the procedures, data requirements, and data collection sheets for conducting use impact monitoring on archeological sites throughout Yosemite National Park.

Description of indicator and standard

Indicator: Archeological Sites

Standard: Not yet developed; however we propose a single standard: no deterioration in site stability or condition related to visitor threats or disturbances. No new visitor related (including park management actions related to visitor use) threats or disturbances to archeological sites that have the potential to degrade stability or condition. No change in condition from baseline to current as a result of visitor use.

Zone(s): Low Use and High Use, Merced and Tuolumne River corridors

Rationale for indicator: Archeological sites are important park resources that are sensitive to visitor use and other types of impacts. These resources exist throughout the park and generally are present on the ground surface in areas not restricted from public use. These resources are sensitive to trampling, soil compaction, vegetation loss, unauthorized collection, and a myriad of other results of visitor use activities. Given the non-renewable nature of archeological resources, the VERP process requires some adaptation to provide a meaningful framework to address standards and monitoring protocols for these resources. We propose supplementing traditional VERP parameters (those geared toward daily wear and tear from use) with parameters that represent serious and real threats and disturbances to the integrity and significance of archeological resources (including episodic abuse). We propose to develop protocols specifically geared toward the collection and analysis of visitor use data.

Objectives:

To document the extent of visitor use impacts at a sample of archeological sites. Through comparison of visitor caused disturbances and deterioration/change from base line data, problem areas can be identified and management actions, such as, but not limited to: stabilization, data recovery, restoration, and/or access limitations (trail obliteration etc.), can be taken to prevent further site destabilization.

B.7.2 Sampling Design

Rationale for sampling design:

This pilot sampling regime is being designed to inventory percent change in archeological site stability and condition. Since this is a pilot study, sampling will take place for the 2007 field season, and the suitability of this system will be evaluated. Until such time as a more appropriate minimum standard is established, no visitor use caused change in archeological site condition will be the minimum acceptable standard used.

Sample locations will be based on a random sample stratified by use level zones (high and low) within the Tuolumne and Merced Wild and Scenic River corridors. The sample will be drawn from the population of all previously recorded archeological sites within the two river corridors.

Sampling Schedule:

Sampling will take place during July and August of the 2007 summer field season.

Site selection (selection criteria and procedures):

Current site documentation is conducted on an opportunistic basis, as provided for by non-routine and special funded projects; it is impossible to visit all sites regularly due to the lack of funding for this activity. Therefore, a sample of sites will be chosen stratified by use level zones along the Merced and Tuolumne Wild and Scenic River corridors. A list of sites selected is listed in Table X. The objectives for the 2007 field season are to collected base line data and develop long-term protocols for quantitative, systematic, and regularly-scheduled site condition assessments focused on visitor use impacts to archeological sites.

B.7.3 Field Methods

Preparation: Field personnel should be trained (see Training, below) and the following required tools and supplies should be acquired.

- Copy of the most current ASMIS site report
- Most current site forms and map with location/directions to target sites
- Compass
- Blank ASMIS field form and cheatsheet
- Graph paper for mapping and blank paper for notes.
- Clipboard/pencils
- GPS Unit
- Camera
- Visitor Use Impact Monitoring field form and user guide

Data collection and measurement:

Complete the Visitor Use Impact Site Monitoring field form (Figure B.7.1) at every archeological site in the project area. Impact data to be collected include artifact collection piles, presence of indicators of camping on site, trails on or near site boundaries, etc. Additionally, some collateral indicators (such as soils compaction, vegetation damage, and erosion) will be monitored that can give crucial information for determining archeological resource condition before there is inherent damage to archeological resources.

Data from these field monitoring forms will be entered into a standard relational use database using the protocol outlined below upon return to the Yosemite Archeology Office. Original field forms will be stored with individual projects and archived upon project completion.

Figure B.7.1: Yosemite Visitor Use Impact Site Monitoring Field Form.

Park Management / Basics

Trinomial: CA-
Temp No. YOSE 2007
Recorder:
Monitor Date:
Last Date Monitored:

Photo Point

UTM Zone 11 mN mE
Photo Number(s):
Description of Photo Point:
Photo Caption:

Public Access

Public Access	Score
Nearest Public Access: *(describe)*	
How close is the nearest Access Point? ☐< 100m = 3 points ☐100-500 m = 2 points ☐500-1000m = 1 point ☐> km = 0 points	
How visible is site from public access: ☐Not visible at all = 0 ☐visible from 10-50m = 1 ☐visible from over >50m = 2	
Is site near an est. formal campground or lodging? ☐Within 100 m = 2 ☐ from 100m to 1 km = 1 ☐ > 1km = 0	
Total Score:	

Visible Features

Does site have rock art? ☐Yes = 1 ☐No = 0 Visible Features? ☐Yes = 1 ☐No = 0 Total Score:
Describe:

Natural Impacts

Use the following scores to evaluate Natural Impacts at site:

0 = none
1 = Minor: < 10 % of site area
2 = Moderate: 10 – 50% of site area
3= Extensive: > 50 % of site area

Evidence of:	Score	Describe/Comments
Erosion		
Natural Animal Caused Impacts		
Rock Fall		
Tree Fall		
Vegetation Growth		
Flooding		
Other		

15 total possible points	Total Score:

Natural Impact Condition Class

Using the natural impact total score, evaluate the Condition Class with the following scores:

☐ 0 points: **No Impact** = total score is 0
☐ 1 point: **Minimum** = total score is 1-3
☐ 2 points: **Moderate** = total score is 4-6
☐ 3 points: **High** = total score is 7-10
☐ 4 points: **Severe** = total score is 10-15

Condition Class Score:

Comments: Describe anything of note, address the depositional stability of the site (sediment type, landform, vegetation), as it relates to natural impacts

Human/Visitor Use Impacts

Artifact Collection Piles: use the following scores

0 = None
1 = One pile
2 = Multiple piles **Total Score:**

Describe:

Social (informal) Trails present on site:

0 = None
2= One or two trails
3 = > two trails **Total Score:**

Characterize each trail as follows:

1=faint (not compacted) 2=distinct (bare ground visible, compacted) 3=eroding channeling water

Trail 1	Trail 2	Trail 3	Trail 4	**Total Score:**

Evidence of recent camping: If you notice any of these on the site but not as a result of camping, score anyway and notate

Use the following scores to evaluate impacts at the site:

0 = none
1 = Minor: < 10 % of site area
2 = Moderate: 10 – 50% of site area
3= Extensive: > 50 % of site area

Evidence of:	Score:	Describe/Comments
Fire ring, scar, pit, or charcoal		
Obvious soil compaction		
Vegetation damage		
Rearrangement of rocks		
Trash – camp		
Rearrangement/modification of features		
Other		**Total Score:**

Evidence of Facilities Impacts *as a result of visitor use:*

Use the following scores to evaluate impacts at the site:

0=none, 1=Minor <10% of site, 2=Moderate 10-50%, 3 = Severe > 50% of site

Evidence of:	Score	
Wilderness Restoration		
Stock Use		
Trails work		**Total Score:**

Other:

Evidence of *deliberate* vandalism/ARPA violation? (not just missing artifacts)

☐0=none, ☐2=slight, minor graffiti, shallow test hole, ☐4=substantial rock art vandalism, major digging

Is Vandalism new: ☐no=0 ☐yes=1

Total Score:

Total Score:

Sum All Total Scores:

Human Impact Condition Class

Using the Human Impact Sum of all Total Scores, evaluate the Condition Class with the following scores:

☐ 0 points: **No Impact**, Total Score is 0
☐ 1 point: **Minimal**, Total Score is 1-3
☐ 2 points: **Moderate**, Total Score is 4-6
☐ 3 points: **High**, Total Score is 7-9
☐ 4 points: **Severe**, Total Score is 10-12
☐ 5 points: **Extreme**, Total Score is >13

Comments: (*Describe impacts since last visit*):

Condition Class Total Score:

Please account for your own disturbances: 0=none 1=present

New Trail	Score	Damage to vegetation	Score
Movement of Rocks	Score	Movement of artifacts	Score
Other	Score		

Management Assessment and Recommendations

Recommended Actions/Prescriptions

☐ Set up regular monitoring schedule
☐ Re-trail or define existing trail
☐ Plant vegetation
☐ Stabilize slopes
☐ Surface collect site
☐ Detailed map – total station
☐ Close site
☐ Discontinue monitoring
☐ Obliterate trails
☐ Wilderness restoration
☐ Stabilize features or site
☐ Test for significance/subsurface deposits
☐ Data Recovery
☐ Other

Elaborate/Justify your recommendations:

Monitoring Priority

List Total Scores From	Score
Natural Impact Condition Class	
Human Impact Condition Class	
Public Access Total Score	
Visible Features Total Score	

Total Score:

Use the above Total Score to evaluate the Monitoring Priority Schedule:

	Score	Schedule
☐	1-3 points	Monitor every 10 years
☐	4-9 points	Monitor every 5-7 years
☐	10-13 points	Monitor every 2-5 years

☐ >13 points Monitor one time or twice per year

Give a brief overview narrative of the site, disturbances, condition, and recommendations:

Continuation section: (please use this area for continuation of any information above)

Please attach a site sketch map of features, disturbances, photopoints, etc.

Post-collection and processing:

Data gathered in the field will be entered into the appropriate databases, digital photographs will be processed according to Yosemite Archeology Office standards, a summary report will be written (to be included in the 2007 VERP Summary Report), and the entirety of the project will be archived according to Yosemite Museum standards.

B.7.4 Data Management

Each archeological site visit will generate field forms. All this information must be stored in a convenient and secure manner. All of the metadata will be stored in the Visitor Use Impact Monitoring database. Field forms will be archived at the end of each project.

Data entry:

Upon return to the Yosemite Archeology office, each field form will be entered into the appropriate database. Existing ASMIS records will be updated accordingly. New records will be entered as is consistent with NPS ASMIS guidelines and procedures (see NPS 2005b), and visitor use impact data will be entered according to established guidelines. Photographs will be downloaded according to office standards and site sketch maps will be digitized.

Data analysis and reporting:

Summary statistics (mean, standard deviation, min, max) will be prepared for the impact categories measured, such as collection piles. The summary data will be reported as a part of the VERP annual report. Preliminary recommendations will be made where field data indicate the draft standard has been exceeded. Additionally, a Yosemite Archeology Office-specific report will be completed and archived according to the standards and guidelines provided in the *Yosemite Archeology Office Guidelines For Survey and Reporting* (NPS 2002d).

Data storage:

All collected data will be stored in the Visitor Use Monitoring database located on NPS servers. Original datasheets will be archived with other original paperwork from this project. Printed ASMIS reports for each visited site will be kept on file with each site record at the Yosemite Archeology Office.

B.7.5 Personnel Requirements and Training

Roles and Responsibilities (tasks and time commitments):
Yosemite National Park, through the Division of Resource Management and Science will be responsible for the administration of this pilot monitoring plan. Management of this project will be conducted by the Branch Chief (or designated project lead) of Anthropology and Archeology within the Division of Resources Management and Science. Responsibilities are:

- Training of field personnel
- Review of data and procedures
- Maintenance of data, field forms, equipment repair and maintenance logs, and updating protocols

Data collection will be performed by qualified archeologists and archeological technicians, meeting OPM standards. Individuals will be trained in archeological site documentation, ASMIS condition assessments, and the resources and material types common to archeological sites in the park.

As each new or returning technician enters on duty, they should receive comprehensive training on field and office procedures, including both Visitor Use Impact and ASMIS databases.

At the end of each fiscal year, the project manager should review the data and procedures. This will be done in conjunction to ASMIS federal reporting requirements. This information, coupled with discussions with field staff, will be used to review or modify procedures, reevaluate the system, and to improve data quality.

Training procedures:

Each technician collecting monitoring field data must have demonstrated the following:

- The ability to prepare complete and accurate field forms.
- The ability to enter in field form information into the ASMIS and Visitor Use databases.
- A safety conscious approach to field work.
- Knowledge of proper archeological documentation procedures.
- Proficiency with identifying and recording archeological sites

Volunteers:

Volunteers can not be currently used for ASMIS documentation due to requirements of the ASMIS/Archeology program. However, some aspects of site monitoring and visitor use data collection may be accomplished using volunteers, similar to site stewardship programs in other NPS units and state programs.

B.7.6 Operational Requirements

Work plan:
A sample of archeological sites previously recorded within both river corridors will be drawn. Once the sample of sites is selected, site assessments will begin. A visitor use impact site monitoring field form will be filled out at each site, as well as a current ASMIS condition assessment. This data will be entered into the visitor use impact database and the ASMIS database, and analyzed according to the guidelines in the VERP Archeological Resources indicator Research Design (Middleton 2007).

Safety:
A job hazard analysis (JHA) has been completed for front and back country archeological survey and monitoring (on file at Yosemite Archeology Office). This document will be reviewed and discussed with all project participants prior to start of fieldwork, and periodically throughout the field season. Similarly, the JHA for data entry and general office work will be reviewed prior to the start of data input, processing and reporting.

Equipment and materials:
All equipment and materials are stored with the Yosemite Archeology Office, Branch of Anthropology and Archeology. Each project archeologist is responsible for making sure that adequate supplies are available and in working order prior to each field recording.

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n.d. "Potential Indicators for YOSE Merced River Corridor"

n.d. "ASMIS-Archeological Site Monitoring and Condition Assessments and Carrying Capacity in the Merced Wild and Scenic River Corridor"

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n.d. "Addressing Carrying Capacity for Cultural Outstandingly Remarkable Values in the Merced Wild and Scenic River Corridor"

B.8. Parking Availability

B.8.1. Background

Traffic congestion in Yosemite Valley has been a well documented issue for many years. In fact, the reduction of traffic congestion was one of the primary goals of the 1980 General Management Plan (YOSE 1980). The number of vehicles in activity areas directly affects visitor experience (part of the recreational Outstandingly Remarkable Value) (Littlejohn et al. 2006, White et al. 2006). When the number of vehicles exceeds the supply of appropriate parking, drivers often resort to parking along the roadside and in other inappropriate areas (Thomas et al. 2005; Elliot et al. 2006). As a result, resources may be adversely affected. Therefore, it is important to define the point when these values become most at risk of degradation. It has been determined that these risks occur significantly when designated parking areas fill to capacity and staff perform Alternative Parking Measures (APM) to alleviate congestion and stopped traffic flows. Alternative parking actions are defined as the point when the Camp 6/Day Use parking lot is full and traffic staff begins directing people to park along the roadside or other alternative areas. Monitoring day use parking capacity provides park management with an indication that visitor use levels and corresponding vehicular use have reached unacceptable levels that may be causing unacceptable impacts to park resources and the quality of visitors' experiences.

Description of indicator and standard:

Indicator: This indicator is used to identify the conditions of the transportation system in Yosemite Valley. Parking lots monitored to identify the amount of time that they are at full capacity, forcing them to be shut down to incoming visitors.

Standard: A standard has yet to be determined

Zone(s): 2C Day Use; 3B Visitor Base and Lodging

Rationale for indicator: Transportation has long played an important role in the National Park system (Percival 1999). Transportation issues have recently been studied at such parks as Yellowstone (Mings et al. 1992), Smoky Mountains (Sims et al. 2005), Blue Ridge Parkway (Vallier et al. 2003) as well as in Yosemite (Nelson and Tumlin 2000, YOSE 1999, White et al. 2006). Traffic congestion was identified in the Yosemite Valley Plan as one of the principal human use impacts to mitigate (YOSE 2000).

Thousands of vehicles enter Yosemite Valley each year, resulting in significant traffic congestion. Traffic congestion can cause a variety of impacts to natural and cultural resources as well as the quality of the visitor experience. Specific impacts include increased travel and waiting times, wildlife depredation, air pollution, noise, vegetation loss, and others. Parking availability serves as an indicator of overall traffic congestion in Yosemite Valley and, therefore, serves as an early warning sign suggestive of the extent to which human vehicular use is negatively affecting the park.

Objective: Provide expedient and accurate assessment of parking capacity at the Camp 6/Day Use parking area as an indicator of overall human vehicular use levels in Yosemite Valley.

B.8.2. Sampling Design

Two sampling strategies will be employed to monitor parking availability in 2007. First, a daily log will be kept documenting the instances that the Camp 6/Day Use parking area fills to capacity and is closed. This will provide information as to the frequency and duration of parking area closures. In addition, vehicular use at the Yosemite Lodge bus lot will be monitored. Collectively, these areas, along with Camp 6/Day Use parking represent the principal parking areas in Yosemite Valley. Measuring and monitoring their use will provide a more comprehensive view of overall parking capacity.

Sampling schedule: The following is a sampling schedule for the parking behaviors data collection. All other data collection will be conducted on a daily basis using a log as shown in the data sheets section below.

Figure B.8.1 Example of Sampling Schedule for Parking Availability

July						
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20 Weekday Sample	21 Weekday Sample	22	23
24	25	26	27	28	29 Weekend Sample	30 Weekend Sample
31						

August						
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17 Weekday Sample	18 Weekend Sample	19	20
21	22	23	24	25	26 Weekend Sample	27 Weekend Sample
28	29 Weekday Sample	30 Weekday Sample	31			

B.8.3. Field Methods

Data collection and measurement: The following list describes the variables for which data will be collected at all parking locations.

- **ID:** Enter case identification number in ascending order beginning with “1”.
- **Date:** Enter date of sample as follows (e.g. 10/21/07)
- **Weekday / Weekend:** Enter “WD” for weekday or “WE” for weekend. For the purposes of this monitoring effort weekdays are considered to be Monday through Thursday and weekends are considered to be Friday, Saturday and Sunday.
- **Holiday:** Record “Y” for yes if it is a holiday or “N” if it is not a holiday.
- **Directed:** Record a “Y” for yes if parking was directed on the day of sampling or “N” for no, it was not directed on the sampling day.
- **Time Initiated:** Record the time Alternative Parking Measure (APM) was initiated (e.g. 0900)
- **Time Terminated:** Record the time Alternative Parking Measure (APM) was terminated (e.g. 1032)
- **Time In:** Enter the time the bus entered the loading area at Yosemite Lodge (e.g. 0830)
- **Time Out:** Enter the time the bus left the loading area at Yosemite Lodge (e.g. 1130)
- **Bus Company Name:** Enter the name of the bus company
- **License Plate #:** Enter the license plate number of the vehicle / bus
- **State:** Record the state from the license plate on the bus
- **# of Passengers:** Record the number of passengers on the bus
- **Closure VOG**: Record the number of Vehicles on the Ground (VOG) at the time the Alternative Parking Measure (APM) was initiated.
- **Record other Factors**: Record other factors that may have lead to APM (gate back-ups, road closures due to accidents or fire, back ups at the entrance gate, etc.)
- **Total Vehicles In**: Record the total number of vehicles that entered the parking area from the traffic counter at the parking area entrance.
- **Vehicles Parked at Sampling Times:** Record the total number of vehicles by type – Motorcycle, Automobile, or Campers / Trailers
- **Comments:** Record any field notes or observations pertinent to data collection on day of sampling.

Figure B.8.2. Parking Availability Datasheets

Yosemite National Park
VERP Parking Capacity Indicator 2007

Camp 6/Day Use Parking

ID	Date	Weekday / Weekend	Holiday	Directed	Closure Start Time	Closure End Time	Closure VOG	Comments
		(WD / WE)	(Y / N)	(Y / N)				
e.g.	5/4/07	WD	N	N	14:00	17:00	540	rain

Yosemite National Park
VERP Parking Capacity Indicator 2007

Yosemite Lodge Bus Lot

ID	Date	Time	Weekday / Weekend (WD / WE)	Holiday (Y / N)	Directed (Y / N)	Total Buses In	Comments
e.g.	5/4/07	11:00	WD	N	N	540	rain

B.8.4. Data Management

Data entry: Data will be entered into a database by traffic management staff on a monthly basis. VERP Monitoring Program staff will re-code a selected sample of datasheets to ensure quality of data entry. Discrepancies between data coding will be reconciled using the completed datasheets.

Data analysis: Data will be analyzed using statistical software (either Statistical Package for the Social Sciences – SPSS or JMP). Descriptive statistics will be used to present frequency distributions of the data. The length of time of parking area closures should be analyzed using both the mean and median of the distribution.

Data reporting: Results will be compiled and presented in the VERP Annual Report. Additionally, information will be presented at a public meeting and made available on the park's website.

Data storage (metadata): Data will be stored electronically on the MS10 server in the Yosemite National Park computer directory. Hard copies of completed datasheets will remain on file with the Visitor Use and Social science branch in El Portal. These copies should be stored in a fire-safe area. The life cycle should be 3 years for printed materials after which time all data and report should be physically and electronically archived to allow for future longitudinal analysis and documentation.

B.8.5. Personnel Requirements and Training

Roles and responsibilities (tasks and time commitments): VERP monitoring program personnel will work collaboratively with traffic management staff in the Protection Division to conduct monitoring activities. Daily logs will be kept by traffic management staff and the detailed sampling of parking areas will be conducted by VERP program staff.

Qualifications: Data collection personnel should be capable of working outdoors for extended periods of time. They should be able to carryout basic mathematical exercises and document results accordingly. Personnel should also exhibit the ability to conduct activities in a varied and complex setting where multiple tasks may be required at the same time.

Training: Monitoring personnel will be trained jointly by the traffic manager and VERP monitoring program staff on the procedures and methods of data collection. Training will consist of an explanation of data collection procedures and a trial run-through collecting mock data. Once personnel have been trained and data are being collected, VERP monitoring program staff will conduct field visits to ensure that data continue to be collected properly and to conduct additional training or troubleshoot problems should they arise over the course of the data collection effort.

Safety: Particular attention will need to be given to collecting data in a safe manner as personnel will be working in close proximity to moving vehicles. A job hazard analysis has been completed and appears below (Table B.8.1.).

Table B.8.1. Job Hazard Analysis for Parking Availability Data Collection

United States Department of Interior NATIONAL PARK SERVICE	**1. WORK PROJECT/ACTIVITY**	**2. LOCATION**	
	VERP Transportation Monitoring	Yosemite Valley, YNP	
Job Hazard Analysis (JHA)	**3. NAME OF ANALYST**	**4. JOB TITLE**	**5. DATE PREPARED**
	Dave Henderson	Facilities Mgr.	June, 2006
6. TASKS/PROCEDURES	**7. HAZARDS**	**8. ABATEMENTS ACTIONS** ENGINEERING CONTROLS – SUBSTITUTION – ADMINISTRATIVE CONTROLS – PPE	
a. Driving to, from, and around sampling sites.	a. Collision resulting in damage, injury, or death.	a. Drive defensively, obey traffic laws, lights on, seatbelt on, be alert for pedestrians, wildlife, and distracted drivers. Know procedures for installing snow chains. Always carry and know how to use a Park radio.	
b. Standing, walking, hiking and other physical exertion.	b. Exhaustion, muscle strain, dehydration and fatigue from prolonged standing or physical exertion.	b. Drink plenty of fluids, bring snacks and/or meals if out during lunch hours, Take periodic rests and stretch before and after physical activity.	
c. Working outdoors in cold and/or wet weather.	c. Hypothermia, reduced resistance to illness.	c. Wear appropriate clothing and carry extra layers. Stay dry. Use rubberized raingear if possible. Stay hydrated preferably with warm liquids. Stop work to warm up if necessary. Snack often.	
d. Working outdoors in hot / extreme heat weather.	d. Fatigue, exhaustion, dehydration and heat stroke.	d. Wear appropriate clothing and use sunscreen. Drink fluids and snack throughout the day. Carry extra water and dehydration salts along with first aid kit.	
10. SUPERVISORS SIGNATURE	**11. TITLE**	**12. DATE**	

B.8.6 Operational Requirements

Work plan: Monitoring efforts associated with the parking capacity indicator should follow a general work plan as presented in Table A.3.1 in the introduction to this field guide. Generally, two traffic management seasonal staff (wage grade) will be used to collect data. Data will need to be collected between May and October, or the peak season of visitor use in the park.

Equipment and materials:

- Clipboard
- Pencils / sharpener
- Data sheet
- Instructions for data sheet
- Watch
- Hand counter(s)

B.8.7 References

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APPENDIX A:
GLOSSARY OF TERMS AND ACRONYMS

TERMS

Azimuth: This is the direction of a celestial object, measured clockwise around the observer's horizon from north. So an object due north has an azimuth of 0°, one due east 90°, south 180° and west 270°. Azimuth and altitude are usually used together to give the direction of an object in the topocentric coordinate system.

Carrying Capacity: As it applies to parks, carrying capacity is the type and level of visitor use that can be accommodated while sustaining the desired resource and social conditions that complement the purpose of a park unit and its management objectives.

Geographic Information System (GIS): A computer system for capturing, storing, checking, integrating, manipulating, analyzing and displaying data related to positions on the Earth's surface. Typically, a Geographical Information System (or Spatial Information System) is used for handling maps of one kind or another. These might be represented as several different layers where each layer holds data about a particular kind of feature. Each feature is linked to a position on the graphical image of a map.

Global Positioning System (GPS): The Global Positioning System (GPS) is a satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defense. GPS was originally intended for military applications, but in the 1980s, the government made the system available for civilian use. GPS works in any weather conditions, anywhere in the world, 24 hours a day. There are no subscription fees or setup charges to use GPS.

Indicator: Indicators are specific, measurable physical, ecological, or social variables that reflect the overall condition of a management zone. Resource indicators measure visitor impacts on the biological, physical, and/or cultural resources of a park; social indicators measure visitor impacts on the park visitor experience.

Management zone (zone): A geographical area for which management directions or prescriptions have been developed to determine what can and cannot occur in terms of resource management, visitor use, access, facilities or development, and park operations.

Outstandingly Remarkable Values (ORVs): Those resources in the corridor of a Wild and Scenic River that are of special value and warrant protection. ORVs are the "scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values…that shall be protected for the benefit and enjoyment of present and future generations" (16 USC 1272).

River corridor: The area within the boundaries of a Wild and Scenic River (e.g., the Merced River corridor).

Standard: Standards define the desired condition of each indicator variable. A standard does not define an intolerable condition, but rather the minimum acceptable condition.

User capacity: As it applies to parks, user capacity is the type and level of visitor use that can be accommodated while sustaining the desired resource and social conditions based on the purpose and objectives of a park unit.

Visitor experience: The perceptions, feelings, and reactions a park visitor has in relationship with the surrounding environment.

Visitor Experience Resource Protection (VERP): A process developed by the National Park Service to manage the impacts of visitor use on the visitor experiences and resource conditions in units of the national park system.

Wetland: Wetlands are defined by the U.S. Army Corps of Engineers (CFR, Section 328.3[b], 1986) as those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

Wild and Scenic Rivers: Those rivers receiving special protection under the Wild and Scenic Rivers Act.

Wilderness: Those areas protected by the provisions of the 1964 Wilderness Act. These areas are characterized by a lack of human interference in natural processes.

Wilderness Impact Monitoring System (WIMS): An inventory process that monitors campsite and trail conditions in Yosemite National Park backcountry and Wilderness.

ACRONYMS

C	Centigrade
CA	California
CCC	Continuing Calibration Check
CD	Compact Disc
cfs	cubic feet per second
cm	centimeter
CMP	Comprehensive Management Plan
DH-81	Standard USGS wading sediment / water sampling device
DH-95	Standard USGS suspended sediment / water sampling device
DO	Dissolved Oxygen
DI	Deionized Water
DOQs	Digital Orthophotos
EPA	Environmental Protection Agency
EDI	Equal Discharge Increment
EWI	Equal Width Interval
GIS	Geographic Information System
GPS	Global Positioning System
HCl	Hydrochloric Acid
Hg	Mercury
ICC	Initial Calibration Check
KCl	Potassium Chloride
L	Liter
mg/l	Milligram per Liter
ml	Milliliter
MDL	Method Detection Limit
mm	Millimeter

MPN	Most Probable Number
NAD27	North American Datum 27
NAD83	North American Datum 83
NELAP	National Environmental Laboratory Accreditation Program
NFM	National Field Manual
NIST	National Institute of Standards and Technology
NPS	National Park Service
PDA	Personal Data Assistant
pH	Potential Hydrogen
QAPP	Quality Assurance Project Plan
QC	Quality Control
SOP	Standard Operating Procedure
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
μS	Micro-Siemens (a measure of electrical conductivity)
μmhos	Micro-mhos (inverse of micro-ohms, a measure of electrical resistance)
VERP	Visitor Experience and Resource Protection
WIMS	Wilderness Impacts Monitoring System

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