The sample size and panel design will allow sufficient power to detect most trends in water quality in the basin and relatively precise standard errors around status estimates. These numbers are currently being estimated in pilot work being conducted by NPS and FLBS in the North Fork basin in Glacier National Park.

Sampling variables: A suite of biological, physical habitat and physiochemical variables are measured at all Survey Sites. Water chemistry variables should match the core set collected at FB Sentinel Sites as discussed above. Table 3 presents a summary of data to be collected. Detailed methods and SOPs are in the EMAP Wadeable or Non-wadeable stream Protocols (Peck et al 2003; Lazorchak et al 2000) and/or the in production NPS Stream Ecological Integrity Protocol (Schweiger et al 2007).

EPA, GNP and MT DEQ are developing reference conditions and multivariate and multimetric indices that allow assessment of benthos, periphyton, other assemblages and some habitat attributes. Data from the Survey Sites will be analyzed with these indices to generate synthetic measures of ecological condition.

Table 3: Summary of indicators measured at Survey Sites

Indicator Name	***Example* Measures**	**SOP**	**Key Summary Metrics**
Water Chemistry and Physical Attributes	Alkalinity, Chlorophyll a, Conductivity, Dissolved oxygen, Hardness, Major anions and cations, Nutrients, Silica, Dissolved inorganic and organic carbon, pH, True color, Dissolved metals, Temperature, Total suspended solids, Turbidity, Acid neutralizing capacity	**EMAP Wadeable / Non-wadeable**	Multivariate
Physical Habitat	Thalweg Profile; Woody Debris Tally; Channel and Riparian Characterization (channel dimensions, substrate quantification, fish cover, riparian vegetation, human influence); Assessment of Channel Constraint, Debris Torrents, and Major Floods; Discharge; Visual Assessment (RBP) of anthropogenic impacts;	**EMAP Wadeable / Non-wadeable**	Stream power; Physical habitat integrity
Periphyton Assemblages	Hard and soft substrate samples	**EMAP Wadeable / Non-wadeable**	IBI
Benthic Macro-invertebrate Assemblages	Kick or FLBS net samples in both targeted habitat (usually riffles) and a reach-wide habitat (systematic transect array) sample	**EMAP Wadeable / Non-wadeable**	IBI; O:E
OPTIONAL: Fish Assemblages	Electrofishing (or stream size based alternative) of a 40 channel width length of stream around each design point	**EMAP Wadeable / Non-wadeable**	IBI

Monitoring Partner: NPS, FLBS, MT DEQ
Current Funding Sources: NPS, FLBS, USGS, MT DEQ

D. SWAN AND WHITEFISH LAKES

Sites pertaining to Swan and Whitefish Lakes are described below. The Montana DEQ is finalizing Sampling and Analysis Plans (SAP) for Swan and Whitefish Lakes and respective tributaries. The Swan and Whitefish Lake plans are short-term and designed to meet the objectives of TMDL development in the Flathead Basin and to fulfill Phase II of the 2001 Flathead Lake nutrient TMDL. These plans will be referenced in Appendices IV and V once they are finalized.

The following sites are the objective long-term monitoring sites of the FBC (all of these sites are included in the MT DEQ Whitefish and Swan Lakes SAP's).

Note: * indicates FLBS monitoring and research site since 1985
** indicates FLBS monitoring and research site since 1989

Swan Lake at South Swan Lake Deep**

Site justification: Swan Lake was first demonstrated to be impaired and having low oxygen and high organic levels in the deep, southern end of the lake in 1989. Swan Lake is experiencing significant population growth around its shoreline and in its headwaters.
This site is fundamental to any Swan Lake monitoring effort and is critical to assessing trends in nutrient loading, cycling, and ecological response.

Sampling frequency: 15 times per year
Sampling variables: Q, T/phys, Nuts, Cat, An, M, Hg, TSS
Monitoring partners: FLBS
Current funding sources: currently unfunded

Swan River above Swan Lake (Porcupine Creek Bridge)**

Site justification: This site is important for measuring and calculating the total loads of nutrients and sediment that enter Swan Lake. There is no continuous flow measurement taken at this site, as it is located in backwater from Swan Lake when the lake is full. Discharge calculations for this site are determined by inference between USGS gage at Condon and the USGS gage below the lake.

Sampling frequency: 15 times per year
Sampling variables: Q, T/phys, Nuts, Cat, An, M, Hg, TSS
Monitoring partners: FLBS
Current funding source: currently unfunded

Whitefish Lake Site at E Mid Lake Deep*

Site justification: Whitefish Lake is considered impaired and is experiencing significant population growth around the lake and in its headwaters. This site is fundamental to a

monitoring effort on Whitefish Lake. Site is critical in assessing trends in nutrient loading, cycling, and ecological response.

Sampling frequency: 15 times per year
Sampling variables: Q, T/phys, Nuts, Cat, An, M, Hg, TSS
Monitoring partners: FLBS
Current funding sources: currently unfunded

Swift Creek*

Site justification: This site is important for measuring and calculating the total loads of nutrients and sediment that enter Whitefish Lake. There is no continuous flow measurement taken at this site, which should be added.

Sampling frequency: 15 times per year
Sampling variables: Q, T/phys, Nuts, Cat, An, M, Hg, TSS
Monitoring partners: FLBS
Current funding source: currently unfunded

Lazy Creek*

Site justification: This site is important for measuring and calculating the total loads of nutrients and sediment that enter Whitefish Lake. There is no continuous flow measurement taken at this site, which should be added.

Sampling frequency: 15 times per year
Sampling variables: Q, T/phys, Nuts, Cat, An, M, Hg, TSS
Monitoring partners: FLBS
Current funding source: currently unfunded

VII. Other Monitoring and Research Efforts

Confederated Salish and Kootenai Tribes

[PLACEHOLDER: Pending Submission by CSKT]

Flathead Lake Biological Station

The ecology of Flathead Lake has been the focus of study at the Flathead Lake Biological Station (FLBS) for over one hundred years. Continuous long-term monitoring of the lake began in the late 1970's as part of the research program and continues today. At the outset, the emphasis of that study was to monitor water quality in the lake which required an understanding of those physical, biological and chemical factors that influence algal productivity. Thus, an essential component of the program is the measurement of nutrient flux through the lake and subsequent in-lake biological responses. For the current funding year (July 1, 2006 through June 30, 2007) the monitoring effort is being funded by the Montana Legislature, the Montana Department

of Environmental Quality and FLBS to achieve a common goal of maintaining a long-term record of those chemical and biological variables necessary for critically evaluating the long-term trends in water quality.

During the current funding year the Flathead Lake Biological Station is scheduled to collect water quality samples 15 times at a midlake site in Flathead Lake, 5 tributary sites in the upper Flathead Valley and the lake outlet at Polson. A minimum of 15 samples per year is needed for accurate determination of nutrient loads and water quality trend analysis. In addition, approximately 30 bulk precipitation samples will be collected at Yellow Bay Point. Bulk precipitation samples are collected after every major wet precipitation event. Sample analysis may include quantification of nutrients, sediments, chlorophyll a, dissolved oxygen, temperature, and other water quality variables (see Table 4). The FLBS Freshwater Research Lab (FRL) was specifically designed for low level detection limits necessary for analysis of the waters of the Flathead Basin. Continuous flows are measured using data loggers at a number of sites. Reference Appendix VI for a summary of methodology.

Table 4. Summary of the Flathead Lake Biological Station's Work Plan for the funding period July 1, 2006 to June 30, 2007.

Monitoring Components	Site(s)	Parameters	Sampling Frequency
Collecting chemical, biological and physical data from Flathead Lake for long-term trend analysis	Flathead Lake @ Mid Lake Deep station	total phosphorus, soluble reactive phosphorus, total nitrogen, nitrite + nitrate nitrogen, ammonium nitrogen, total organic carbon, dissolved organic carbon, dissolved inorganic carbon, sulfate, silica, carbonate alkalinity, turbidity, total suspended solids, chlorophyll a, phytoplankton primary productivity, phytoplankton biomass, zooplankton abundance, relative fluorescence, photosynthetically active radiation, temperature, dissolved oxygen, specific conductance, pH, oxidation reduction potential, secchi depth	15 times per year
Collecting chemical, and physical data from major and select minor Flathead Lake tributaries and the outlet for long-term trend analysis	Flathead River @ Holt, Swan River @ Bigfork, Stillwater River @ Conrad Drive, Ashley Creek @ hwy 93, Stoner Creek @ Flathead Lake, Flathead River @ Polson	total phosphorus, soluble reactive phosphorus, total nitrogen, nitrite + nitrate nitrogen, ammonium nitrogen, total organic carbon, dissolved organic carbon, dissolved inorganic carbon, sulfate, silica, turbidity, total suspended solids, temperature, dissolved oxygen, specific conductance, pH, oxidation reduction potential	15 times per year

Collecting chemical data from bulk aeresol deposition to Flathead Lake	Yellow Bay Point	total phosphorus, soluble reactive phosphorus, total nitrogen, nitrite + nitrate nitrogen, ammonium nitrogen, sulfate, silica, chloride, pH	after major precipitation events (approximately 30 times per year)

NPS Vital Signs

Knowing the condition of natural resources in national parks is fundamental to the National Park Service's (NPS) ability to manage park resources. National Park managers across the country are confronted with increasingly complex and challenging issues that require a broad-based understanding of the status and trends of park resources as a basis for making decisions, working with other agencies, and communicating with the public to protect park natural systems and native species. Vital signs monitoring is a key component in the Service's strategy to provide scientific data and information needed for management decision-making and education. Vital sign monitoring also contributes information needed to understand and to measure performance regarding the condition of watersheds, landscapes, and biological communities.

Streams and rivers are fundamental components of nearly every Rocky Mountain Network (ROMN) park and their ecology is both intimately linked with and reflective of the watersheds they drain. Streams support a broad spectrum of ecological services including critical habitat for facultative and obligate aquatic species, nutrient processing, hydrologic cycling and multiple socioeconomic functions for humans (e.g., water sources, fisheries). Streams are also typically highly sensitive to stressors at both local and landscape scales. Finally, streams are central to the fundamental purposes of ROMN parks, either directly (e.g., as fisheries) or as general indicators of overall park ecological condition. Therefore, stream ecological integrity is one the highest priorities for long term monitoring within ROMN parks.

ROMN long term stream monitoring will be guided by a detailed Stream Ecological Integrity (SEI) Protocol. The protocol will describe an integrated approach to understanding stream ecological status and trend in ROMN parks, capturing the strengths of both fixed-site water quality-based approaches and probability survey bioassessments. Stream monitoring field methods are relatively well established for Colorado and Montana streams and we will draw upon this wealth of knowledge for the protocol. Sources of methods include the EPA Environmental Monitoring and Assessment Program (EMAP), Flathead Lake Biological Station (FLBS) procedures, NPS Water Resource Division (WRD) protocols, multiple United States Geological Survey (USGS) approaches, and methods from both state water monitoring agencies (in Colorado, the Department of Public Health and Environment (CO DPHE) and in Montana, the Department of Environmental Quality (MT DEQ).

Stormwater Sampling Sites
Increasing development in the Flathead Basin can increase pollutant loads to streams, rivers and lakes from stormwater runoff. Localized impacts from stormwater runoff may be severe (e.g., see Stanford et al. 1997 TMDL study results). Stormwater sampling should be added to the monitoring plan, but will need a subplan development separate from this Monitoring Plan. Stormwater samples should be collected during three to four major storm events at locations and for variables previously sampled for the TMDL study by FLBS.

United States Geological Survey
The basic monitoring constituents of the USGS are nutrients and suspended sediment. Nutrients samples are analyzed for dissolved ammonia, dissolved nitrite, dissolved nitrite plus nitrate, total nitrogen, dissolved orthophosphate and total phosphorous. Onsite determinations also are made for streamflow, water temperature, specific conductance, pH and dissolved oxygen. Samples are collected using standard USGS depth-integration methods and quality-assurance practices.

Water samples are analyzed for nutrients by the USGS National Water Quality Laboratory in Denver, CO. and for suspended sediment concentration and particle-size distribution (sand-silt break) by the USGS Montana District sediment laboratory in Helena, MT.

Historical water quality data are accessible to the public at the USGS website; http://waterdata.usgs.gov/nwis/mt. Analytical results for samples collected during a current year are available electronically upon request after receipt of results from the laboratory and preliminary quality-assurance review.

For 8 samples per year, samples should be be taken twice during the rising limb of the hydrograph, at peak discharge, twice during the falling limb of the hydrograph, once during late summer base flow, once in the winter base flow and the last sample during unusual drought or flood events.

Whitefish Lake Institute Monitoring
The Whitefish Lake Water Quality Monitoring Program Master Plan was drafted by the Whitefish Lake Institute in March 2006. The program outlined in the plan is designed to build upon past monitoring and data collection efforts and implement a long-term water quality monitoring program for Whitefish Lake. Objectives of the program include coordination of monitoring efforts, implementation of a long-term synoptic approach to provide data for trend analysis and conformity with TMDL reporting standards.

VIII. RECOMMENDATIONS

1) Develop a Memorandum of Understanding (MOU)
An MOU should be developed between the Flathead Basin Commission, Flathead Lake Biological Station, the Confederated Salish and Kootenai Tribes, U.S. Forest Service, National Park Service, the US Geological Survey, MT DNRC, DFWP and DEQ and other governmental entities on the development and implementation of the Flathead River Basin monitoring program. The MOU will spell out priority sites to be monitored, acceptable protocols for collecting and analyzing samples, procedures for disseminating data to the public, and funding mechanisms.

2) Enhance Monitoring Committee
An effective Monitoring Committee composed of technical representatives of organizations active in monitoring is critical to implementation of the plan. It is the responsibility of the Monitoring Committee to guide the development of a strategy to implement and maintain the monitoring plan.

Recommendations for proper functioning of the monitoring committee are:

- Solicit members from all organizations that fund and/or collect monitoring data within the Flathead River Basin.
- Formalize committee membership list and establish contact list for distribution of communications.
- Formalize committee organizational structure.
- Identify responsibilities of members including committee leaders.
- Identify ways to ensure continuity of leadership.

The goals of the monitoring plan and the purpose of the core monitoring sites is to provide long-term collection of data. This requires consistently adequate funding. FBC should work with agencies and others to develop and implement a funding strategy to ensure continued funding and additional funding for identified needs.

3) Establish Protocols and Methods for Data Sharing
Currently there are a dozen or more agencies/organizations collecting monitoring data within the Flathead Basin. These agencies dedicate large amounts of time and money to collecting monitoring data. In order to facilitate data sharing, it is recommended that FBC develop agreements with agencies for data access and data sharing. Priority should be given to agreements with CSKT, FLBS and USGS for the sharing of data from Sentinel monitoring sites on Flathead Lake and its tributaries and core CSKT sites.

FBC recommends that a formal MOU/Agreement be developed among all those agencies that are funding and collecting monitoring data, especially for the Sentinel monitoring sites. In addition, all analytical laboratories participating in sample analysis must obtain an updated Laboratory Quality Assurance Plan (LQAP), that meets the requirements of the EPA document “Guidance On Preparation of Laboratory Quality Assurance Plans, EPA 910/9-92-032” available at http://www.epa.gov/r10earth/offices/oea/r10lqa.pdf.

4) Objective for Data Management:
The goal is to effectively manage data and information about the data (metadata) generated by monitoring in the Flathead Basin. To be effective, all of the data and metadata must be routinely quality controlled and archived in a web-accessible data management system. FLBS is currently developing a management system for data it generates with a view to integrate the system with National Park Service Rocky Mountain Monitoring Network and other data archival systems such as Natural Resources Information Systems. All FLBS data will be web accessible by July 1, 2007. The USGS data flow data is available on the USGS website on a real time basis and water quality data within 6 months.

Each monitoring partner should be responsible for maintaining its own database; however, all data should be accessible through web sites following posting, through official reports and bulletins (or similar short-format information documents), and through written summaries and synthesized reports.

The management, interpretation and reporting of the information and data generated by monitoring in the basin will meet the following requirements (basis for the MOU):

a. Quality Assurance/Quality Control – Build in controls and procedures to reduce errors related to transcription, logic, and omission. QA/QC will include detailed standard operating procedures for data collection and designing databases that mimic the field forms, reduce the likelihood of transcription error through pull down menus and picklists, and have built-in analyses to check for logical errors.

b. Documentation – Ensure the correct amount of documentation is available so that the data can be distributed and used in the future. Metadata will be created for all datasets and reports, and will follow the standard scientific structure (e.g., include data and methods description) and be citable.

c. Data Sensitivity and Ownership – Ensure that sensitive information, including detailed information about threatened and endangered species, not be released to the public without partner approval.

d. Archiving – Protect the information, including the field sheets, voucher specimens, databases and final reports from degradation and disaster. Data will be secured, backed up, and regularly checked to ensure that data formats do not become obsolete.

All original documents and reports relating to the collection and generation of data will be retained by the source funding entity, including, but not limited to work plans, field sheets, and LIMS reports.

e. Cataloging – Ensure the information is searchable through the databases, including NP Species, NatureBib, and the GIS Metadata Store. The Network will regularly update catalogs regarding information collected.

f. Reporting – Provide the information, from the data to the final reports, promptly, and in a usable and accessible format. Data will be regularly distributed, ranging from raw data to synthesized reports. Hard copy reports will also be mailed to the partners and the reports will typically be on an annual basis, but will vary with the cycle of revisits to sites for the monitoring in the basin.

5) Optimize Monitoring Methods and Comparability

It is recommended that the Monitoring Committee further evaluate the existing monitoring data and the proposed sentinel (core) monitoring sites to optimize monitoring and to ensure the comparability of data. Specific items to be addressed include the adequacy and comparability of monitoring methods and measurement parameters.

6) Establish Long-term Funding and Accessibility of the Monitoring Data

The Monitoring Committee will work with FBC members, other monitoring agencies and organizations, and other partners to develop a long-term funding strategy for the monitoring plan, including funding for data reporting and dissemination. It will develop an annual implementation work plan to assure continuous, adequate funding for the monitoring plan, and report to the full FBC on the status of the monitoring plan and its funding on a regular basis (at least annually).

7) Add Biological Assessment (Bioassessment) Parameters to Monitoring Plan by Implementing Biological Measures at Gauging Stations

The FBC recognizes the importance of providing a quantitative description of biological assemblages, physical habitat and physiochemistry of the Sentinel monitoring sites identified in the plan. This would include benthic macroinvertebrate assemblages, periphyton assemblages, fish, and a survey for nonnative species.

Biological measurements reflect current water quality conditions (as do chemical measurements) but also capture temporal changes in water quality parameters- and hydrologic impacts, as well as cumulative and synergistic effects of mixtures of chemicals. Biological monitoring provides an assessment of the receiving environment's long-term assimilation of disturbances. The FBC Monitoring Committee will work with partners to develop bioassessment parameters to present to the full FBC for approval by January, 2008.

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Appendix I: Map of the Monitoring Sites

Appendix II: [PLACEHOLDER: Flathead Basin Commission Strategic Plan 2007 – 2012]

Appendix III: [PLACEHOLDER: Flathead Basin Commission Monitoring and Data Assessment Committee 2007-2008 Draft Action Plan Goals I, III, V]

Appendix IV: [PLACEHOLDER: MT DEQ CE-QUAL-W2 Model Development for Whitefish Lake in Northwestern Montana, Sampling and Analysis Plan]

Appendix V: [PLACEHOLDER: MT DEQ CE-QUAL-W2 Model Development for Swan Lake in Northwestern Montana, Sampling and Analysis Plan]

Appendix VI: [PLACEHOLDER: Reference methodology for Flathead Lake Biological Station Sentinel Site Standard Operating Procedures (SOP)]

Appendix VII [PLACEHOLDER: Reference methodology for the United States Geological Survey Sentinel Site Standard Operating Procedures (SOP)]

Appendix VIII [PLACEHOLDER: Reference methodology for the National Park Service, Rocky Mountain Monitoring Network, Stream Ecological Integrity North Fork Standard Operating Procedures (SOP)]

Appendix IX: [PLACEHOLDER: Environmental Cooperation Arrangement, 2003 British Columbia and Montana]