— Is this report a result of, + does it logically follow, the report by Johnson + Knudson (1985), or does it have some other use?

— Where is Appendix A? See pg. 4 + 7

A COMPREHENSIVE EVALUATION OF WATER QUALITY ISSUES AND RECLAMATION OPPORTUNITIES-- CLARK FORK RIVER BASIN, MONTANA

A proposal prepared for:
The United States Environmental Protection Agency

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I. INTRODUCTION

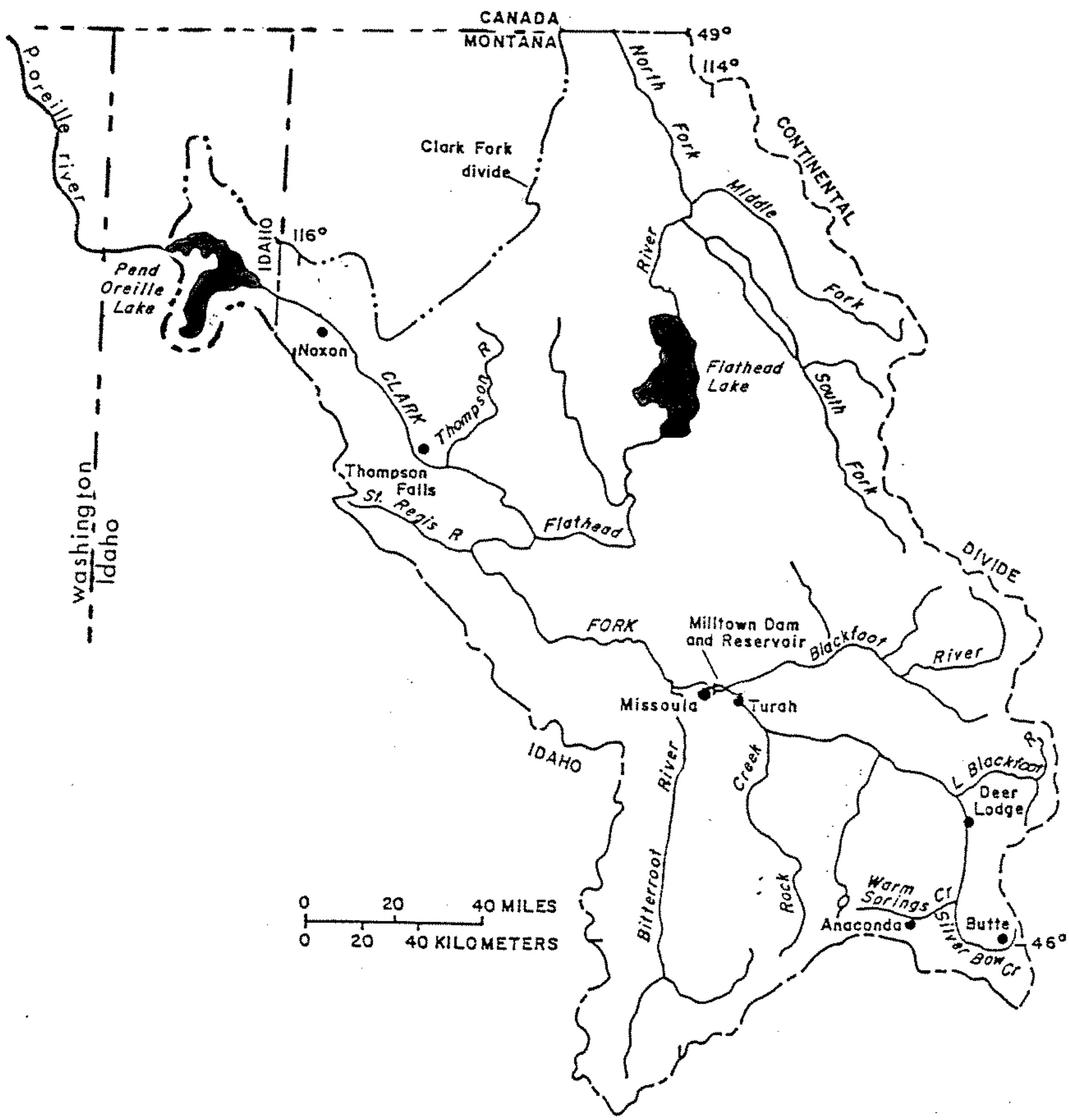
The Clark Fork River/Lake Pend Oreille ecosystem is a primary environmental feature of western Montana, northern Idaho and eastern Washington (Figure 1). Although it is often been described as the most seriously abused stream in the Pacific Northwest, the Clark Fork/Pend Oreille system remains as a highly valued recreational resource and the central focus of nearly every major urban, industrial and agricultural activity of the region.

Concerns about environmental problems in the basin are not new, but recent events have focused public attention on water quality degradation and the increasing need for a basin-wide approach to water quality management. In recent years, public interest groups, local governments, universities, industries and state and federal agencies have committed funds and other valuable resources to the goal of maintaining and enhancing the resource potential of the Clark Fork River/Lake Pend Oreille Basin.

The problems of the basin are complex and diverse. At the headwaters, three "Superfund" sites are under investigation due to severe contamination of water and agricultural lands by arsenic and heavy metals. In the lower river, nutrients and sediment from point and non-point sources are believed to be responsible for algae blooms and other signs of pollution in Lake Pend Oreille. Sediments derived from various non-point sources in the basin have been identified as one of the most serious pollutants affecting the Clark Fork River Basin. Logging, agriculture, placer mining, subdivision development, road construction and natural erosion are all important sources of sediment loading.

Only limited and sporadic monitoring of water quality has

FIGURE 1. CLARK FORK/LAKE PEND OREILLE BASIN



occurred in the past, but new investigations started within the past few years are providing an improved data base.

In 1984, the Governor of Montana created a Clark Fork River Basin Project within his office to coordinate agency programs and to assist the efforts of all public interest groups working in the basin. The project was initiated with funding from the Anaconda Minerals Company. During the past year, the Clark Fork Project's staff has worked with state and federal agency representatives from Montana and Idaho, a Citizen's Advisory Council, industry and various public interest groups to prepare a coordinated work plan. The Clark Fork/Pend Oreille Work Plan (Johnson and Knudson, 1985) describes the basin's aquatic resource problems and outlines the additional information needed to develop a comprehensive water quality management plan (Appendix 1).

This proposal presents a conceptual outline and estimated budgets for three high priority projects selected because of their importance to future water quality management decisions and their value for improving water quality of the basin. Each project has been developed to integrate with and strengthen existing programs within the basin.

Project 1--provides for a continuation of the Clark Fork Project coordination activities and the development of a comprehensive water quality management plan. This project will be conducted by staff in the Montana Governor's Office working in cooperation with advisory groups.

Project 2--addresses nutrients and eutrophication, the major water quality issue jointly affecting Montana and Idaho and one for which the least amount of predictive information exists. This project will be conducted by the Montana Department of Health and Environmental Sciences and/or their contractors.

Project 3--an action oriented project designed to demonstrate reclamation of toxic mine tailings in the river's flood plain. Completion of this project will be a major step forward in reducing heavy metal impacts on drinking water, agriculture and aquatic life. The project has several phases requiring work by different agencies (Department of Health and Environmental Sciences, the University of Montana, Montana Bureau of Mines, Department of Fish, Wildlife and Parks) and/or their contractors.

II. PROJECT 1

DEVELOPMENT OF A COMPREHENSIVE WATER QUALITY MANAGEMENT PLAN

The Clark Fork/Lake Pend Oreille hydrologic system extends over a broad area including parts of three states. Resource management responsibilities within the basin are shared by a multitude of state, federal and local authorities. More than thirty different aquatic resource studies or projects are now underway in the basin and additional new efforts are being proposed. Each of these efforts address important resource issues, but the entities conducting the studies do not have the statutory authority or the funding necessary to effectively utilize the extensive data base.

Several important studies conducted during the early 1970's have provided useful background information on the Clark Fork River Basin (US Department of Agriculture, 1977; MWQB, 1975, 1976; US Environmental Protection Agency, 1972; Brosten and Jacobsen, 1985). These studies, coupled with the biennial assessment of water quality ("305 B Reports") by the Montana Water Quality Bureau, provide a historical framework for developing a comprehensive water quality management plan.

Major investigations initiated in recent years will significantly improve the existing aquatic resource data base. The "Superfund" investigations on Silver Bow Creek, the Anaconda Smelter site and the Milltown Reservoir will define the sources and options for mitigation of heavy metals and arsenic that contaminate the headwaters streams and the upper Clark Fork River. Another major study initiated in 1984 is evaluating the impact of direct discharges of pulp and paper mill wastes to the Clark Fork River below Missoula (MWQB, 1985). The Montana Water Quality Bureau has conducted monitoring of water quality in the lower river for the past year and a half and the Champion International Corporation has funded a fish population study in the same area. A one-year continuation and expansion of the water quality monitoring was approved by the Montana Legislature in 1985. The Montana Department of Fish, Wildlife and Parks plans to continue the fishery study (with state funds) for several more years.

Various efforts have been initiated to gain information on non-point source pollution. The U.S. Forest Service has outlined various monitoring efforts to assess sediment loading due to timber harvest and road construction on public lands (Munther, 1985). Some of these monitoring programs will address the impact of sediments on fishery resources of the streams while others will only monitor the impact of timber sales at specific sites. Various activities, eg. placer mining and construction are permitted by the Montana Water Quality Bureau, but monitoring and quantification of sediment loading is very limited.

Many other on-going or recently completed projects are listed in the Clark Fork River/Pend Oreille Work Plan prepared by the Clark Fork River Basin Project (Appendix 1).

This project will develop and implement a comprehensive coordinated plan to maintain and enhance the aquatic resources of the Clark Fork River Basin. Water quality issues and pollution sources will be evaluated for their effects in Montana and in the downstream states of Idaho and Washington. Major components of this project include 1) compilation and evaluation of all existing water quality data for the basin 2) establishment of reclamation and monitoring priorities 3) a preliminary evaluation of non-point sources of sediment and 4) development of a comprehensive water quality management plan for the basin.

A. DATA COMPILATION AND EVALUATION

Purpose: Analyze the quality and trends in quality of the Clark Fork River's aquatic resources.

Preliminary Study Design: The project staff working in conjunction with the advisory groups will compile the pertinent data from all appropriate sources to establish a Clark Fork River Basin data base. The data on flow volumes, water quality, fisheries and other aquatic parameters will be organized by stream segment or project areas as described in the Clark Fork/Pend Oreille Work Plan (Johnson & Knudson, 1985).

The data will be reviewed and analyzed to determine the types, sources and extent of specific water pollutants entering the Clark Fork River Basin. Specific pollutants or water quality parameters that exceed existing water quality standards will be identified. The reduction in pollutant loading necessary to mitigate existing water quality problems will be determined. Water-related issues and problems for all reaches of the Clark Fork River Basin will be identified and prioritized.

B. RECLAMATION AND MONITORING PROGRAM PRIORITIES

Purpose: Determine feasible methods to maintain and enhance the quality of the Clark Fork River Basin.

Preliminary Study Design: The project staff will work with its advisory groups and individual agencies to identify and evaluate opportunities to reclaim specific sites or sections of the river basin affected by environmental damage. This will include stabilization of stream banks and erodible mine wastes in the upper river and protection of riparian zones affected by construction, mining, forestry and agriculture.

The minimum water quality monitoring program needed to assess changes in the aquatic resources on the basin will be identified. Interagency agreements and cooperation in implementing such programs will be encouraged and actively promoted.[1]

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[1] As an example of the latter, the Clark Fork Project is presently working with Region 1 of the US Forest Serivce to establish a coordinated and integrated sediment monitoring program for all National Forests within the basin.

C. SEDIMENT IMPACT EVALUATION

Purpose: Organize the existing information on sediments and develop a coordinated effort for monitoring and mitigation of these impacts.

Preliminary Study Design: A consultant will be hired for an eighteen month period by the Clark Fork Project to conduct a thorough review of all appropriate data to define the extent of sediment loading problems in Clark Fork River Basin. This review will provide, where possible, a ranked list and description of specific locations and streams most seriously impacted (or potentially impacted) by sediments and other non-point source pollutants. Using appropriate data from resource management agencies and census data, maps of impacted areas of the basin will be constructed showing primary land uses, soils and geologic features, and ownership (public or private). Following a review of the technical literature and consultations with technical personnel, the most effective and useful techniques for assessing the impact of sediments on water quality and fisheries in the Clark Fork River Basin will be identified.

This consultant will work with state and federal biologists to identify specific tributary streams which are known to be or are potentially critical for spawning and recruitment of game fish populations. He/she will also work with technical personnel from land and water resource management agencies and the Clark Fork Project to develop a coordinated interagency program to monitor sediment loading in the basin and implement appropriate mitigation measures.

D. WATER QUALITY MANAGEMENT PLAN

Purpose: Develop a comprehensive data base and a Water Quality Management Plan that can be implemented by government and industry leaders.

Preliminary Study Design: Using all existing water quality data, the project staff will work with its advisory groups and the general public to outline a plan to maintain and improve water quality of the basin. Conditions for each river segment that will optimize the biological, social and economic values of the aquatic resource will be identified. The plan will consider such factors as water quantity, critical fish and wildlife habitat, channel integrity, waste load allocations, protection of riparian zones, surface and ground water quality, aesthetics and other resource values.

During the development of the plan, the project staff will actively participate in agency and interagency activities to encourage and promote active communication and cooperation on matters pertaining to the Clark Fork River Basin. The staff will facilitate progress on specific programs, minimize duplication of agency actions and coordinate interagency and interstate efforts.

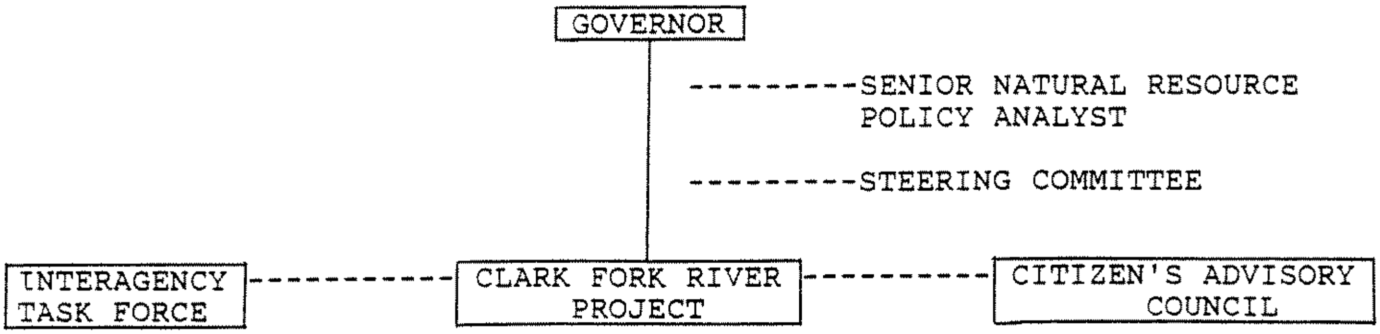
E. PROJECT PERSONNEL

The project structure (Table 1) provides for two technical staff in the Governor's Office to conduct the project. The staff are responsible for compiling and evaluating data from all existing sources and preparing a comprehensive water quality management report. These tasks will be accomplished through a close coordination with the Interagency Task Force, interagency agreements and review and comment by the Citizen's Council and the general public.

The Interagency Task Force is composed of technical personnel from state and federal resource agencies and the Montana University System who are charged with oversight of fisheries and water quality projects within the Clark Fork River Basin. In addition to Montana representatives, government resource agencies in Idaho and Washington are asked to participate in the planning process. Meetings of the Interagency Task Force are held at quarterly intervals, and individual members are consulted more frequently on an ad hoc basis. Agreements between federal and state agencies will be used to formalize the management plans.

The Steering Committee consists of seven state agency directors listed on Table 1. The Steering Committee will collectively provide final review and approval of project activities. The Steering Committee will meet semi-annually or more frequently when requested.

TABLE 1. CLARK FORK RIVER BASIN ORGANIZATION



STEERING COMMITTEE: DIRECTORS MONTANA NATURAL RESOURCE AGENCIES

Natural Resources and Conservation
Health and Environmental Sciences
Environmental Quality Council
Fish, Wildlife and Parks
State Lands
Commerce

(6) Agriculture is missing

INTERAGENCY TASK FORCE

Montana Department of Health and Environmental Sciences
Montana Department of Fish, Wildlife and Parks
US EPA (Montana and Idaho Operations Offices)
Idaho Department of Health and Welfare
Montana Environmental Quality Council
Montana Bureau of Mines and Geology
Idaho Department of Fish and Game
Washington Department of Ecology
Montana University System
US Geological Survey
Industry

CITIZEN'S ADVISORY COUNCIL

Thirteen member committee appointed by the Governor.

F. PROJECT BUDGET

WATER QUALITY MANAGEMENT PLAN

	Year 1	Year 2	Year 3*
Personnel (Salary/Benefits)	$ 94,000	$94,000	$47,000
Technical Personnel (2)			
Clerical Personnel (1)			
Supplies	1,100	1,200	600
Communications	3,000	3,300	1,700
Travel	7,000	7,000	3,500
Contracted Services			
Consultant (Sediment Study)	25,000	25,000	-0-
Printing	1,000	4,300	2,200
Computer Programmer	10,000	10,000	5,000
Per Year Totals	$141,100	$144,800	$60,000
TOTAL PROJECT COST			$345,900

*Funding for six months in final year.

IV. PROJECT 2
CLARK FORK BASIN NUTRIENT LOADING EVALUATION

Lake Pend Oreille is the aquatic crown jewel of the Rocky Mountains. One of the largest oligothrophic lakes in western North America, it is highly valued because of its clear, near pristine water quality. But, like Lake Tahoe, California, and Flathead Lake in Montana, this large system appears to be threatened by cultural eutrophication. Evidence of localized algal blooms, declining light penetration, and complaints of bacterial slimes are all early signs of declining water quality. These subtle, but definitive characteristics of eutrophication are cause for concern. If Lake Pend Oreille is receiving excessive nutrient loading we can eventually expect irreversible changes in water quality, the loss of desirable fish species and diminished recreational and property values.

The future of Lake Pend Oreille is an interstate issue. More than 90 percent of the water annually entering Lake Pend Oreille originates in Montana. The State of Idaho is proposing a limnological investigation (Woods, et al, 1985) to determine the trophic status of the lake and the limitation on nutrient loading necessary to reduce the threat of eutrophication. Montana must identify the sources and quantities of pollutants entering the Clark Fork River to determine the necessary control for point and non-point sources of pollutants. Together, these two investigations will form a basis for interstate agreements and cooperation necessary for protecting and managing the resource value of the lower river and Lake Pend Oreille.

In the 22,000 square mile basin that drains into Lake Pend Oreille, there are hundreds of human-caused (or cultural) sources of nutrients. These include municipal and industrial "point" sources and "non-point" runoff and seepage from agricultural, suburban and recently harvested forest lands. Even the most recent nutrient investigations (MWQB, 1985; IWQB, 1985) do not adequately assess the annual amount of nutrients entering Lake Pend Oreille from Montana.[2] Earlier investigations (Brosten and Jacobsen, 1985; Knudson and Hill, 1978; MWQB, 1975) were similarly limited in their sampling frequency, the extent of the basin covered and/or their duration. None of these studies have identified the relative contribution of various nutrient sources.

The recent controversy over nutrient discharges from Champion International's pulp and paper mill underscores the need for a more complete understanding of nutrient loading in the basin. Just how significant is the impact of this one major industrial discharge upon the quality of Lake Pend Oreille? Can the river assimilate even more nutrients before discharging "excess" amounts to the lake? What is the relative contribution of point versus non-point sources? Which sources are most easily controlled? Which, if any, need to be better controlled?

Although studies associated with renewal of Champion's Waste Discharge Permit (MWQB, 1985) collected valuable background information regarding nutrient loading in the Clark Fork/Lake Pend Oreille Basin, these questions remain largely unanswered.

This proposed evaluation will build upon the preliminary nutrient information recently collected by the States of Montana and Idaho,[3] so a basin-wide nutrient "budget" can be calculated. This nutrient budget would provide the basis for a waste load allocation, if needed. Major components of this proposal are 1) determination of annual nutrient contributions of all MPDES-permitted point source discharges 2) increased sampling frequency

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[2] Due to budget limitations, these studies were unable to sample their stations frequently enough to allow calculation of an annual nutrient load for the basin.

[3] The State of Idaho is also proposing to expand their present nutrient monitoring efforts to include an evaluation of shoreline and Idaho tributary sources. (Woods, et al, 1985)

at certain mainstem and major tributary stations presently being sampled by the Montana Water Quality Bureau, and 3) intensive surveys of subbasins found (under component 2) to be major contributions to the total nutrient load of the basin.

A. POINT SOURCE EVALUATION

Purpose: Quantify the contribution of MPDES-permitted point sources to the total, annual nutrient[4] load of the Clark Fork Basin.

Preliminary Study Design: There are thirty MPDES-permitted waste discharges in the Clark Fork Basin (excluding those above Flathead Lake). Twenty seven of these permits are for domestic waste discharges. Nutrient loads originating from these facilities will be calculated, based upon the sewered population that they serve. To confirm these calculations, three selected discharges will be monitored twice monthly for two years. Any existing compliance or self monitoring data will also be utilized.

Champion International is the only permitted industrial facility contributing measurable amounts of nutrients to the Clark Fork/Lake Pend Oreille system. A considerable amount of background nutrient data is available for this facility's discharge (MWQB, 1985). More precise loading information will be gathered by sampling this effluent twice monthly for two years.

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[4] Nutrient parameters to be analyzed in this and all other components of this evaluation include total phosphorus, orthophophorus, nitrate, ammonia and kjeldahl nitrogen.

B. CLARK FORK MAINSTEM AND MAJOR TRIBUTARY MONITORING

Purpose: Quantify loads of nutrients from the three major tributaries; quantify changes in nutrient loads along the mainstem; and, ultimately, determine the annual load of nutrients entering Lake Pend Oreille from Montana.

Preliminary Study Design: Sampling frequencies will be increased for one year at eleven existing[5] Montana Water Quality Bureau stations:

1. Primary nutrient loading stations (to be sampled twice weekly from April through September and weekly from October through March): Clark Fork River at Cabinet Gorge; above Thompson Falls; near St. Regis; and the Flathead River at its mouth.

2. Secondary nutrient loading stations (to be sampled weekly from April through September and twice monthly from October through March): Clark Fork River at Deer Lodge; Turah, above Missoula; below Missoula (Harper's Bridge); below Champion International (Huson); and the Blackfoot and Bitterroot Rivers at their mouths.

During year two, the above sampling frequency will be halved at all stations. During the third year, a total of six stations will be sampled twice per month. (These stations will be established as long-term monitoring stations for the Clark Fork Basin). All samples will be composited from cross-sectional, depth-integrated samples.

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[5] In March, 1984, the Montana Water Quality Bureau began collecting monthly nutrient samples at fourteen mainstem and major tributary stations. In August, 1985, the number of stations was doubled, but the sampling frequency remained the same. This investigation is funded until June, 1987.

Increased monitoring at the primary stations will determine a) if the lower river reservoirs are acting as nutrient "sinks", i.e. do they remove nutrients that would otherwise enter Lake Pend Oreille and b) establish the relative nutrient contributions of the Flathead versus the Clark Fork River systems. Monitoring of secondary stations will determine which tributaries or segments of the Clark Fork Basin above St. Regis are the largest nutrient contributors. This information will be used to select subbasins for intensive surveys (see next section).

C. SUBBASIN SURVEYS

Purpose: Survey subbasins or river segments found to be contributing the largest percentage of nutrients to the Clark Fork System; quantify the relative contribution of various sources; suggest, if needed, land use changes or waste treatment improvements.

Preliminary Study Design: Subbasins or river segments to be surveyed will be selected after a review of all existing nutrient data for the Clark Fork Basin and after at least six months of mainstem and major tributary monitoring. The total annual monitoring effort for these basin-specific surveys (sampling frequencies and number of sampling stations) will be similar to the first year of the aforementioned basin-wide effort.

Examples of possible basin-specific surveys (one or a combination of which may be evaluated) include 1) the Missoula area, the basin's largest population center; 2) the upper Clark Fork, where a relatively small stream is receiving domestic wastes from three large communities; 3) a major tributary like the Bitterroot River, which is influenced by an wide variety of nutrient inputs; or 4) other, as yet unidentified subbasins that contribute a significant amount of nutrients per unit land area.

The survey(s) will be designed to proportion out the relative contributions of various nutrient sources, i.e. point versus non-point, industrial versus domestic, agricultural versus silvicultural, etc. Based on these findings, land use changes or waste treatment improvements will be suggested if the combined Montana and Idaho (Woods et al, 1985) evaluations determine that nutrient reduction are needed in Montana to protect the water quality of Lake Pend Oreille.

Subbasin surveys will be conducted for two years. The attached budget reflects six months of effort during years one and three and a full twelve months of work during year two.

D. PROJECT PERSONNEL

A project leader/water quality specialist will be employed full time for three years to assemble all past and current nutrient information in the basin. This person will also be responsible for a portion of the collection and all of the interpretation of the data and for all report writing. the project leader will be assisted during field seasons by a technician, who will be responsible for water sampling and streamflow measurements, to include the installation, calibration and maintenance of staff-gauged stream discharge stations (during the subbasin surveys). This person will be employed for six months per year.

Sample collection at the primary nutrient loading stations on the lower river will require hiring a part time technician/ water sampler to be located in the Thompson Falls or Plains area. This person will be employed for at least half time during the first year of the project. Employment during the second and third year of the project will vary, depending upon sampling needs.

It is anticipated that the work associated with this project will be implemented by the Montana Department of Health and Environmental Sciences, Water Quality Bureau and/or their selected contractor(s) as a supplement to their lower river monitoring program.

E. PROJECT BUDGET

	YEAR 1	YEAR 2	YEAR 3
POINT SOURCE EVALUATION			
Personnel	$ 12,000	$ 12,000	$ 6,000
Travel	3,000	3,000	-0-
Analytical	7,000	7,000	-0-
Supplies	2,000	1,000	-0-
Equipment	-0-	-0-	-0-
MAJOR RIVER MONITORING			
Personnel	30,000	24,000	30,000
Travel	15,000	10,000	5,000
Analytical	44,000	22,000	11,000
Supplies	2,000	2,000	2,000
Equipment	8,000	-0-	-0-
SUBBASIN SURVEYS			
Personnel	24,000	30,000	30,000
Travel	10,000	10,000	5,000
Analytical	22,000	44,000	22,000
Supplies	3,000	3,000	1,000
Equipment	5,000	-0-	-0-
PER YEAR TOTAL	$187,000	$168,000	$112,000
TOTAL PROJECT COST			$467,000

IV. PROJECT 3

UPPER CLARK FORK RIVER RECLAMATION FEASIBILITY PROJECT

Hard rock mining has left a legacy of hazardous wastes in the Clark Fork River Basin above Milltown Reservoir. For over a century, toxic metal wastes, originating primarily from "the Richest Hill on Earth," were deposited along the river's floodplain. During periods of high stream discharge, metals that have been deposited within flood channels and eroding streambanks are resuspended, causing impacts to both agriculture and aquatic resources.

Schafer (1985) estimates that as many as 27,000 acres of irrigated hay and alfalfa lands have been contaminated to some degree[6] by mining wastes. Diversion of metal-laden river water, particularly as exists during high flow periods, has spread this contamination to croplands above the river's floodplain (Rice and Ray, 1984). Production losses of alfalfa and hay due to soils contaminated by tailings in the upper Clark Fork Basin have been estimated to be $2.5 million annually (Schafer, 1985).

Impacts to aquatic resources are also severe. During high flow periods, copper concentrations fifty times higher than criteria to protect aquatic life have been measured (Phillips, 1985). These elevated metal levels are believed to be the major reason why the trout fishery of the upper river is depressed.[7]

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6 This study ranked contaminated soils into four classes, based upon degrees of impact to potential agricultural production--ranging from 100 percent (Class I) to 15 percent (Class IV).

7 Only about 300 trout/mile are found in the mainstem of the Clark Fork River (the lowest value being 25/mile) compared to 1500-2500/mile in Rock Creek and the Blackfoot River. Trout numbers in the mainstem, therefore, range from only one to twenty percent of those found in Clark Fork's adjacent, major tributaries (Knudson, 1984).

The paucity of trout in the upper Clark Fork River has had concurrent impact upon water-based recreational industries like floating, outfitting and guide fishing, as well as associated service business like motels, cafes, tackle shops and gas stations. Potential losses to these recreation-related industries is at least $2.0 million annually (Knudson, 1984).

The existence of mine tailings along the upper Clark Fork's floodplain may also be impacting the river's aquifer. This is particularly true in suspected depositional areas such as the Deer Lodge and Drummond Valleys. Very little information is available concerning toxic metal concentrations in drinking water, irrigation and stock-watering wells. Nor is it known whether groundwater recharge adds measurable quantities of toxic metals to the surface water of the Clark Fork River.

If the agricultural, recreational and clean water resources of the upper Clark Fork Basin are to be significantly improved, reclamation of erodible and exposed heavy metal deposits must be undertaken. There are thousands of acres of floodplain between Warm Springs and Milltown Dam. Yet preliminary observations and measurements suggest that most of the deposits causing impacts to agricultural and aquatic resources are concentrated in "hot spots" near or within the river's active and abandoned channels. For Example, in the river reach from Warm Springs to Deer Lodge, eroded streambanks, containing blue-green "lenses" of tailings are readily observable. The existence of completely barren areas or "slickens" as described by Ray (1983) are also easily identified and do not appear to be wide spread in the portion of the basin below the Little Blackfoot River (Schafer, 1985). Even buried tailing deposits as observed in the Gold Creek area by Schafer (1985) can likely be traced to the existence of an old river channel or irrigation water source.

This proposed project will determine the feasibility and cost of reclaiming the heavy metal deposits that are most damaging to the agricultural and aquatic resources of the upper Clark Fork Basin. Central to this effort will be actual streambank[8] reclamation demonstration projects. Sites to be reclaimed will be determined by first conducting a thorough mapping of floodplain/stream channel heavy metal deposits. To properly assess the efficacy of the various streambank treatments, necessary water chemistry and biological information will also be collected prior to and after construction.[9] Using a combination of the above information, the feasibility and cost of reclaiming the upper river's heavy metal impacts will be determined.

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[8] The feasibility of reclaiming agricultural lands contaminated by tailing deposits is being evaluated by Dodge et al (1985).

[9] As proposed herein, monitoring will occur before, during and one year after construction. To properly assess changes in the river resulting from the projects, additional years of monitoring will be required, albeit at a reduced level.

A. ANALYSIS, DESIGN AND CONSTRUCTION OF STREAMBANK DEMONSTRATION PROJECTS

Purpose: Map flood plain/streambank neavy metal deposits; determine their erodibility; analyze soils for heavy metal content; select, design and construct streambank reclamation sites.

Preliminary Study Design: Reconnaissance level mapping of stream deposited mine tailings will be conducted, utilizing aerial photographs recently taken by the U.S. EPA (Wardell, 1985). This will be followed by ground surveys of obvious barren areas, suspected depositional zones and eroding streambanks. Core samples will be collected for heavy metal analyses. In areas with large localized tailing deposits, grid sampling along transects will be necessary. Areas of active erosion, head cutting and deposition will be identified, utilizing a combination of present field data and historical photographs and maps.[10]

Sites for streambank reclamation will be determined by using map overlays prepared from data collected in the above surveys. (Although landowner approval and ease of access will also influence section of sites). Site-specific engineering designs will be prepared, using combinations of five general categories of streambank treatments: vegetative, heavy armoring (riprap), light armoring (riprapping the toe of the bank, followed by back-sloping of the bank and vegetative cover), artificial structures (gabions, jetties, buried logs, etc.) and fencing.

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[10] During the last century, the banks and channel of the upper river have been altered by the construction of two major railroads and highways. This has had a measureable impact upon sediment transport and deposition, which must be analyzed before commencing with any streambank treatments.

Streambank treatments will be constructed by local contractors under the part-time supervision of a professional hydrologist/sedimentologist. All altered or contaminated streambanks within 2 to 6 one-mile demonstration sections will be treated. The actual number of sections will depend upon 1) the severity of contamination, i.e. the number of feet/mile of erodible tailing deposits, and 2) the ease of access to the project sites.

B. WATER QUALITY MONITORING

Purpose: Before, during and after construction of the reclamation projects, sample surface and groundwater stations for heavy metal and common ion concentrations. Monitor the heavy metal content of selected irrigation, drinking water and stock-watering wells.

Preliminary Study Design: Fifteen mainstem and tributary surface water stations will be monitored for dissolved, and total recoverable copper, zinc, iron and arsenic concentrations and for selected "common" parameters, i.e. specific conductivity, pH, alkalinity and hardness. These stations will be located throughout the basin above Milltown, with special emphasis given to segments immediately above and below the reclamation sites. Twenty four[11] ground water stations, located along transects within the reclamation project sites, will be monitored for the same metals (but for the dissolved fraction only) and common parameters.

All stations will be synopticly sampled during seven distinct flow regimes: pre-irrigation season, ascending runoff, peak runoff, descending runoff, summer low-flow, post irrigation season and winter low-flow. Water levels will be recorded monthly at all groundwater monitoring stations. Two hundred domestic wells will be tested for their heavy metal content.

Concurrent sampling of surface and groundwater stations will determine the influence of recharge upon the concentration and solubility of metals in surface water. Collection of

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11 Three monitoring well transect sites, each with four sets of paired wells will be establihsed. Two sets of paired wells will be located on either side of the river, with one pair in the deeper water-bearing zone and one pair in the upper portion of the "saturated zone."

common parameters will determine changes in the buffering capacity of the river and allow for calculation of chemical forms or "species" of metals. These data will be useful in determining the proportion of metals that are present in species most toxic to plants and animals. As a basis to judge the success of the reclamation projects, it is just as important to evaluate such changes in chemical equilibria as it is to measure reductions in total metal loading. Both will be evaluated simultaneously in this proposed monitoring program.

C. BIOLOGICAL MONITORING

Purpose: Before, during and after construction of the reclamation projects, evaluate the condition of fish, macroinvertebrate and algae populations near and within the project sites.

Preliminary Study Design: Mainstem fish population study sections will be established above, within and below the reclamation project sites. The abundance, age structure, condition coefficients and growth rates of these populations will be monitored annually during the spring for three years. The species diversity, abundance and biomass of aquatic macroinvertebrates and algae will be evaluated seasonally at locations within the fish population study sections.

Biological monitoring detects insidious changes in water quality, like uneven or sporadic releases of toxic substances, which may go unnoticed during discontinuous water sampling programs. Changes in the quality of the Clark Fork River resulting from the reclamation demonstration projects (and reclamation at the upstream Superfund sites) will, therefore, be best evaluated in the long term, by this suggested biological monitoring program.

D. PROJECT PERSONNEL

Analysis, Design and Construction

The floodplain mapping/river mechanics evaluation will be conducted by a professional geologist, hydrologist or sedimentologist, employed approximately three-quarter time for one year. This person will be assisted during the mapping surveys by part-time field assistants(s). During the construction phase (year 2), a professional engineer will be employed approximately half time to design and oversee the construction projects.

Water Quality Monitoring

A water quality specialist will be employed at approximately half time for three years to assemble and analyze all past and present heavy metal data on the upper Clark Fork River. This person will also collect all surface and groundwater data during this project. During year one, a part-time water quality technician will assist in the collection of the domestic well samples.

Biological Monitoring

A fisheries biologist will be employed for four months per year for three years to collect and analyze the fish population data. This person will be assisted by two part-time fisheries field workers--one for three months/year and another for one month/year. An aquatic biologist will be employed for four months per year for three years to collect and analyze the invertebrate/periphyton data. A laboratory technician will be employed for one month/year to assist with sample sorting.

It is anticipated that various portions of this project will be conducted by the University of Montana, the Montana

Department of Health and Environmental Sciences, the Montana Bureau of Mines and Geology, the Montana Department of Fish, Wildlife and Parks and /or their selected contractors.

E. PROJECT BUDGET

	Year 1	Year 2	Year 3
Analysis, Design and Construction			
Personnel (professional)	$ 48,000	$ 27,000	$ 4,000
Personnel (construction)	-0-	160,000[12]	-0-
Travel	10,000	4,000	1,000
Analytical	45,000	5,000	2,000
Supplies	5,000	2,000	-0-
Water Quality Monitoring			
Personnel (professional)	$ 21,000	$ 17,000	$17,000
Personnel (construction)	20,000[13]	-0-	-0-
Travel	7,000	5,000	5,000
Analytical	30,000	20,000	20,000
Supplies	3,000	2,000	2,000
Equipment	5,000	-0-	-0-
Biological Monitoring			
Personnel	$ 33,000	$ 33,000	$33,000
Travel	9,000	9,000	9,000
Supplies	7,000	5,000	5,000
Equipment	15,000	-0-	-0-
PER YEAR TOTAL	$258,000	$289,000	$98,000
TOTAL PROJECT COST			$645,000

[NOTE: "Supplies" include postage, communications and expendable materials.]

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[12] Also includes construction materials, i.e. riprap, fence, topsoil, willow shoots, etc.

[13] Well drilling costs.

V. BUDGET SUMMARY

	Year 1	Year 2	Year 3
Project 1			
Water Quality Management Plan	$141,000	$144,800	$ 60,000
Project 2			
Nutrient Evaluation			
Point Source	$ 24,000	$ 23,000	$ 6,000
Major River Monitoring	99,000	58,000	48,000
Subbasin Surveys	64,000	87,000	58,000
Project 3			
Upper River Reclamation			
Analysis, Design and Construction	$108,000	$198,000	$ 58,000
Water Quality Monitoring	86,000	44,000	44,000
Biological Monitoring	64,000	47,000	47,000
PER YEAR TOTAL	$586,100	$601,800	$270,000
THREE YEAR TOTAL			$1,457,900
15% CONTINGENCY			218,685
TOTAL PROJECT COST			$1,676,585

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