



IN REPLY REFER TO

## United States Department of the Interior

BUREAU OF RECLAMATION  
Reclamation Service Center  
P.O. Box 25007  
Building 67, Denver Federal Center  
Denver, Colorado 80225-0007

D-8220

July 20, 1997

CALFED Bay-Delta Program Office  
Category III Proposal Administrator  
1416 Ninth Street, Suite 1155  
Sacramento, California 95814

Enclosed please find 10 copies of the proposal "Enhancement of a Fish Friendly Pumping System for Fish Protection Facilities in the Central Valley, California", submitted in response to your CALFED BAY-DELTA PROGRAM Request for Proposals: 1997 Category III. I understand that all proposals need to be submitted by July 28, 1997, so this should hopefully make the deadline by several days. CALFED's recommended proposal format has been carefully followed, and page limitations adhered to as advised in pages 13-18 of your RFP.

We believe development of "fish friendly" pumping systems would result in major benefits to CALFED's programs, and are pleased to submit this proposal. If any clarification or further information is needed on this proposal, I would be happy to respond and can be reached at 303/236-6007, ext 226; FAX = 236-6008; or, Email: CListon@do.usbr.gov.

Sincerely,

Charles R. Liston  
Research Aquatic Scientist

## EXECUTIVE SUMMARY

ENHANCEMENT OF A "FISH FRIENDLY" PUMPING SYSTEM  
FOR FISH PROTECTION FACILITIES IN THE CENTRAL VALLEY, CALIFORNIA

CHARLES R. LISTON

**Description and Objectives.** Modifications to the Red Bluff Research Pumping Plant (RBRPP) internal helical pump (Hydrostal) outlet and variable frequency drive motor, with fisheries and hydraulic evaluations, are proposed to assist development of "fish friendly" pumping technology for CALFED programs. Fish friendly pumps and lifts would be of high value in new fish screen facilities (i.e., Hood, CA) and for upgrading existing technology (i.e., Tracy, CA). Present pump outlet configurations and non-variable pumping speeds restrict evaluations necessary for acceptance of this technology. Fish survival through the helical pump has been high, though somewhat less than tests show for larger Archimedes pumps. Unnecessary stressful conditions from present pump outlet configurations and higher than optimal pump flows would be remedied with this project, and critical evaluations would be done. Evaluations would be carried out using existing research facilities and protocols accepted by regulatory agencies responsible for endangered species concerns. Species focus would be juvenile chinook salmon and steelhead, though studies would be made on 18 other species entrained at Red Bluff. There are additional major applications for other Central Valley priority species including Delta smelt, longfin smelt, splittail, sturgeon, and striped bass. The project objective is to "Demonstrate, refine, and develop "fish friendly" pumping technology to a level acceptable to regulatory agencies for major application at CALFED-related facilities and programs in the Central Valley, California".

**Approach/Tasks/Schedules.** This project would capitalize on existing "fish friendly" pumping programs, trained staff, and research facilities. A fisheries-engineering approach would be applied. The three-year project would be done in five "Phases": I) Feasibility Study with Report for Pump Outlet Modification - 10/1/97-12/15/97; II) Design, Specifications, Drawings, Peer Review, for Pump Outlet - 12/1/97-2/15/98; III) Assessment and Improvement of the Variable Frequency Drive - 10/1/97-9/30/98; IV) Acquisition of Materials and Construction of Modified Pump Outlet - 4/1/98-8/31/98; and, V) Hydraulic and Fisheries Testing and Evaluations with Final Report - 9/1/98-9/31/2000.

**Justification for Project and Funding by CALFED.** New technologies are needed by CALFED under all future water management scenarios for fish screens and associated bypasses. Refined testing with proof of "fish friendly" pump systems is required for acceptance by regulatory agencies. Acceptance requires demonstrating that species such as juvenile salmon and steelhead, Delta smelt, longfin smelt, American shad, splittail, sturgeon, and striped bass, can be bypassed successfully away from screens and back into source waters in a healthy condition. The Red Bluff site, associated research facilities, trained staff, and accumulated experience and data afford an economically and scientifically attractive opportunity to advance this technology. Support of this project would be in line with recent recommendations from the CALFED Fish committee to seriously consider "fish friendly" pumping technology, based on the early results from the RBRPP Program.

Budget Costs and Third Party Impacts. The three year budget is estimated at \$442,059. Budgets associated with the five Phases are as follows: I) \$43,124; II) \$18,961; III) \$122,440; IV) \$82,738; V) 174,798. By Fiscal Year, budgets are: FY98, \$267,261; FY99, \$79,324; FY2000, \$95,474. No impact will occur to water users; construction is scheduled for July and August when water deliveries are made from Red Bluff Dam. Ongoing research will be impacted minimally; evaluations will continue on the Archimedes pumps during construction. All modifications must meet with agency approval, requiring communication and coordination. Since we are improving an existing system for fish passage, no problem impacts are anticipated.

Applicant Qualifications. The fisheries and engineering team is eminently qualified for completing this project. Many decades of fisheries, aquatic science and engineering experience with fish-related facilities is represented, with experience gained from academia and government, and from many parts of the country and overseas. All staff have intimate knowledge and experience with the RBRPP, and most are involved in present evaluations and analysis of RBRPP data. Principals are involved with many Central Valley fishery issues and are leading technology development for other Central Valley fish facilities.

Monitoring and Data Evaluation. An extensive engineering and fisheries evaluation is planned for the two years following plant modifications, using existing research facilities and established peer-reviewed protocols. Excellent pre-project data exists for direct comparison. Publications containing methods and early results are noted in the proposal. Frequent hydraulic monitoring of pump effluents, forebays and screens will be done. Monitoring of pump operation and conditions will be continuous. Weekly fish entrainment evaluations will be made (20 species), noting fish condition and injury. Experimental pump "pass throughs" using juvenile salmon of various sizes will be carried out with replication using treatment and control groups. Extensive observations on fish survival and post-passage condition will be done. Fish are held for 96 hr following pump passage to observe any potential delayed effects. All data will be analyzed with established statistical methods, and a final report will be submitted September 30, 2000. Data updates and progress reports will be prepared on request.

Local Support/Coordination with Other Programs/Compatibility with CALFED Objectives. Support for the RBRPP has been very high from all cooperating agencies (CF&G; CDWR; NMFS; USFWS; Reclamation), and all programs have been coordinated with agencies and water users from the beginning. This project would enter into a high support environment, with much interest by all parties in "fish friendly" pumping technology. This project would integrate with other programs such as USFWS local river fisheries studies, the Red Bluff Fish Passage Program, GCID fish screen developments, the Tracy Fish Facility Improvement Program (TFFIP) in the south Delta, Contra Costa screen developments, and others. The project is most compatible with CALFED objectives for addressing factors that negatively impact the Bay-Delta ecosystem such as unscreened diversions. Further, this project is right for Category III funding as it directs activities towards reducing conflicts in the Bay-Delta Ecosystem, focuses on high risk species, and, through higher survival of entrained fish, can provide broad ecosystem benefits.

ENHANCEMENT OF A "FISH FRIENDLY" PUMPING SYSTEM  
FOR FISH PROTECTION FACILITIES IN THE CENTRAL VALLEY, CALIFORNIA

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GOVERNMENT

PARTICIPATING AND COLLABORATING WITH:

Warren Frizell, Research Hydraulic Engineer, Reclamation, D-8560, Denver  
Sandra Borthwick, Fishery Biologist, Reclamation, NC-102, Red Bluff, CA  
Max Stodolski, Civil Engineer, Reclamation, NC-102, Red Bluff, CA  
Louis Helfrich, Professor of Fisheries, on Sabbatical with Reclamation, DTSC  
Clarence McNabb, Retired Professor of Aquatic Sciences - Consultant  
Steve Atkinson, Mechanical Engineer, Reclamation, NC-102, Red Bluff, CA  
Rick Christensen, Mechanical Engineer, Reclamation, D-8410, Denver  
Bob Zelenka, Mechanical Engineer, Reclamation, D-8420, Denver

RFP Project Group Type: Public Works/Construction  
Services

Note: Project Involves Minor Structural Modifications to a "Fish  
Friendly" Pumping System and Includes Evaluations  
and Monitoring

## PROJECT DESCRIPTION

a. Project Description and Approach. The Red Bluff Research Pumping Plant (RBRPP) is providing unique new technology for delivering water while minimizing fish injury and loss (Frizell et al 1996; Liston et al, 1997; Figures 1-5). This technology has extensive application for future fish facilities required under all CALFED water management options in the Central Valley. Fish friendly lifts, or pumps, will be needed for both water diversions and bypasses associated with fish screens. Construction of RBRPP was completed in 1995. Two Archimedes and one centrifugal-helical pump were installed for evaluation. Higher pump speeds are required for the Helical pump, however the pump is much smaller than Archimedes pumps for a given volume, and purchase and installation costs are significantly lower. Pump size and simplicity facilitate maintenance and repair, and proven fish passage success would make the helical pump economically attractive and feasible for CALFED-related fish facilities. Early tests on fish passage show high survival rates for both pump types (Liston et al. 1997). However, survival through the helical system is somewhat lower than the Archimedes because of incorrect outfall configuration (see figure 5, outlet for the helical pump) and pump speeds and flows outside of "best efficiency" criteria. This project would significantly enhance the success of the helical pump system through modifications and evaluations of the outlet works and use of variable speed motors. The outlet would be modified to provide gentle flows leading to the fish screens, and to create less stress within the pump by eliminating four feet of head. The present outlet was retrofitted into a bay initially designed for the Archimedes pump, and water unnecessarily plunges into the fish screen forebay from heights of about four feet. Improvements in the variable speed capabilities would assure the pump operates within design criteria and allow fish survival evaluations over various pump flows and RPM's. In summary, these modifications would allow us to test pump effects more directly and fairly by eliminating unnecessary sources of stress.

This project would be approached in five phases as outlined in section "e" below, under "Proposed Scope of Work". The project takes advantage of pumping and evaluation facilities that do not exist anywhere else. Extensive pre-project data will assist comparisons of "before and after modification" pump operations. All modifications and evaluations would be carried out to provide critical data and technology for future Central Valley fish facilities and water diversions requiring water lifts, as well as ensuring acceptable salmon survival in pumps at Red Bluff.

b. Location and/or Geographic Boundaries of Project. This project is on the Sacramento River, Tehama County, California (upper Sacramento River watershed; Figure 1). The project is at Red Bluff Diversion Dam, approximately 243 river miles above Golden Gate Bridge.

c. Expected Benefits. The primary stressors addressed are direct fish losses and injury at water diversions and fish screen facilities (existing and future). Major primary benefits to fish survival would result from application of refined "fish friendly" pumping technology wherever fish screen facilities need to be improved (i.e., Tracy) or developed (i.e. at Hood, CA) in the Central Valley. Fish friendly pumps will enable fish bypasses to be developed wherever hydraulic head is needed for transporting fish back into source waters. This is typically everywhere in the Bay-Delta system where fish screens are installed. New concepts for fish screening may result. Secondary benefits relate to more opportunities for fish protection systems at more sites

previously considered unfeasible for screens (i.e., the many small diversions in the Delta may develop small "fish friendly" pumps for water delivery, backed up by screens with "mini" portable bypasses). Further, small diversion dams in tributaries to the Bay-Delta that are serious impediments to fish passage may be seasonally replaced with "fish friendly" pumps to deliver water.

The primary species focus with this project are juvenile chinook salmon and steelhead, but development of refined "fish friendly" pumping systems has wide implications for other Central Valley priority species such as Delta smelt, longfin smelt, splittail, sturgeon and striped bass.

d. Background and Biological/Technical Justification. Refinements are needed for the internal helical pumping system to demonstrate the potential of this pump for broad application in fish protection in the Central Valley. Present high fish survival rates are still less than with the Archimedes, although the playing field for pump comparisons is not level at present (Liston et al 1997). This is due to unnecessary rigorous and stressful conditions created by the pump outlet (Figure 5) and inoperative variable speed motors needed to assure efficient pump operating ranges (the helical pump now runs at 380 RPM, and pumps 113 CFS; the pump, screen and bypass systems were designed for about 100 CFS; Archimedes pumps deliver around 90 CFS).

Benefits are expected for enhanced fish survival and health following pump passage because proposed modifications will significantly lower stressful conditions. We further expect less fish disorientation, and greater immediate predator escapement ability. Increased survival of native species in the Central Valley will contribute positively towards ecosystem health.

Benefits will be long-lasting and durable because refined facilities will continue to function for fish protection throughout the life of the fish screening facilities. Populations of priority fish species will be enhanced annually through increased survival and health of individuals that become entrained, then bypassed back into source waters, at water delivery operations.

The current status and accomplishments of the RBRPP program have been outlined in recent publications (Frizell et al. 1996; Liston et al. 1997). Hydraulic, fish entrainment, and fish pump-passage evaluations have been on-going since 1995, following completion of the major construction in 1995. Approximately \$15 million has been expended on construction of the RBRPP including excellent fish research facilities (two aquaculture-type, controlled environment labs) required for delicate fish experimentation and hydraulic monitoring. Facilities to perform the necessary evaluations for the proposed project are available, and are of highest scientific quality. Invited papers and presentations have been presented since 1995 at national scientific forums and regional scientific and non-technical forums. In addition, interagency coordination and cooperation has been a significant accomplishment. Fisheries and engineering staff from NMFS, USFWS, CF&G, CDWR, BOR, and water authorities have met regularly since 1991 developing project designs and evaluation plans in a collegial atmosphere resulting in a high professional and technical approach, and acceptance of the RBRPP work.

The RBRPP interacts extensively with the overall Red Bluff fish passage program, and was developed to assess the potential of using "fish friendly" pumps to provide water to the

Tehama-Colusa Canal while gates are raised at Red Bluff Dam. Results have been so encouraging that this technology has been recommended by the CALFED fish facility committee for further development. More recently, the Tracy Fish Facility Improvement Program (TFFIP; a large activity aimed at upgrading this south Delta fish salvage system) is planning to incorporate tests with "fish friendly" pumps based on the optimistic results at Red Bluff.

Documents related to the RBRPP program and this proposal are listed in the attached bibliography.

e. Proposed Scope of Work: This project will be carried out under the following phases and tasks: Phase I. Feasibility Study with Report, Pump Outlet, 10/1/97 - 12/15/97

\*Will include flume studies in the lab to optimize the pump outfall-channel entrance interface; this will involve fine tuning the outfall shape to minimize the formation of eddies in the outlet channel and ensure adequate velocities to move fish through the system.

Phase II. Design, Specs, Drawings, Peer Review, Pump Outlet, 12/1/97 - 2/15/98

\*The pump outlet system will be designed and specification drawings and paragraphs prepared by the DTSC, Reclamation. The specifications will be issued by the Mid-Pacific Region. Major features include: 1) Removal of existing pump outlet pipe, pipe transition and pipe supports; 2) Saw cut and removal of a portion of the upstream end of the existing concrete flume; 3) Furnish a steel plate frame and attach to the concrete flume; 4) Furnish a new pump outlet pipe with pipe transition and pipe supports, and install between pump outlet and concrete flume; and, 5) Furnish and install new, adjustable transition walls in concrete flume.

Phase III. Assessment and Improvement of the Variable Frequency Drive (VFD), 10/1/97- 9/ 30/98 (Overlaps with Phases I and II)

\*Will include thorough study of the present VFD system, including electrical supply, with a report of improvement recommendations by 2/1/98; improvements will be made so pump can operate effectively at variable rates by 9/30/98;

Phase IV. Construction of New Pump Outlet, 4/1/98-8/31/98

\*Award to Construct expected by 4/1/98; time prior to 7/1/98 devoted to acquisition and fabrication of materials; actual construction planned during 7/15-8/31/97, when disruption of on-going evaluations and water deliveries would be minimal and not significant.

Phase V. Testing and Evaluations with Final Report, 9/1/98-9/31/2000

\*Hydraulic and fisheries testing will be carried out with established protocols, and replicated using pre-modification techniques for valid comparisons; fish entrainment studies will involve all 20 species (Liston et al. 1997); fish pass-through tests will focus on juvenile chinook

salmon.

Quarterly financial reports including costs broken down by labor, non-labor, and services (contracts) will be provided to appropriate CALFED staff using Reclamation's automated computer system. The financial status and details are available at any time, however, and printouts can be made available on request during any phase of the project. The principal investigator works closely with our Mid-Pacific Client Liaison, Mr. Al Bourland, on all financial aspects.

**f. Monitoring and Data Evaluation.** Monitoring and evaluations for RBRPP are on-going and would be tied in with this project, beginning 9/1/98. Established, peer-reviewed protocols for hydraulic and fisheries evaluations would be continued (Frizell et al., 1996; Liston and Johnson 1992b; McNabb et al. 1997). Hydraulic evaluations will consist of measuring velocity profiles in the channel leading up to the wedge-wire "Vee" screens as well as a reevaluation of the sweeping and approach velocity conditions on the screens themselves. Shear forces at the pump outfall-channel interface will be evaluated through velocity and current-direction measurements. Hydraulic evaluations of the channel will be done prior to extensive biological testing, including any adjustments to the screen baffles that may be required. Monitoring of pump operating conditions will be done continuously. Comparisons with the present operating conditions should show improved efficiency due to lower head requirements. Variations in flowrate through the adjustment of motor speed will further enhance pump comparisons.

Fish evaluations will consist of both regular entrainment observations and experimental pump-passage tests using juvenile chinook salmon. During pump operation, weekly 24-hour entrainment studies will provide data on numbers and condition of fish coming in from the Sacramento River. Fish are collected from downstream holding tanks and identified to species, measured (length), inspected for condition and external injuries, and returned to the River. All data will be compared directly to earlier entrainment data (1995-1997). For pump-passage tests, fish are transported from Coleman Hatchery (two groups: 30-44 mm, and 45-70 mm) and held in flow-through well water at Red Bluff. Fish are dyed with bismark brown prior to a test, and are sorted into control and treatment groups. Fish are then moved to the river lab and acclimated to River water. During passage tests, fish are released (32 per release) into intake pipes of pumps (treatment) and at pump outfalls (controls). Samples of pre-test fish are used to compare with post-test fish for possible external damage and scale loss. Following each test, fish are recovered and held in the river lab with Sacramento River water for 96 hours to assess any delayed effects. Sub-lethal stress will also be evaluated on pump-passed fish and compared to controls. Observations on behavioral stress indicators, such as respiratory rates, swimming ability, current orientation, cover response and predator avoidance will be made. In addition, blood chemical indicators of stress will be observed (blood glucose levels). All experiments will be done with appropriate statistical design.

All RBRPP data are integrated with on-going USFWS local Sacramento River fisheries studies, and with other Central Valley fish protection/screening studies such as Tracy, GCID, and Contra Costa. Data will be presented to the CALFED Fish Facility committee on request. NMFS receives all RBRPP data monthly, and uses information for reports and assessments of other sites.

Peer review of all RBRPP methods and research reports has been an integral part of the program from the start. Key technical staff from all interested and cooperating agencies have been identified and serve as technical reviewers. We also include reviews by Universities. Articles submitted for journal publication will ensue, and will undergo the established review processes for national technical journals.

**g. Implementability.** Existing environmental compliance agreements, permits, and interagency cooperation intended to conform with relevant state and federal regulations at RBRPP can be extended or modified (rather than developed) to maximize implementability. Ongoing fisheries research efforts are coordinated (since 1992) with an interagency group from Reclamation, NMFS, USFWS, CF&G, CDWR, Central Valley Water Users, and the Tehama-Colusa Canal Authority. Current cooperative agreements, biological opinions, and scientific collection permits for state- and federally-listed species can be extended or modified. The broad participation, continuous information exchange, and wide support expressed by agencies, industry, and the general public at annual technical and public meetings will continue to be promoted in this project effort.

#### COSTS AND SCHEDULE TO IMPLEMENT PROPOSED PROJECT

##### a. Budget Costs/Table

Project Phase/ Tasks	Direct Labor Hours	Direct Salary & Benefits	Overhead Labor	Service Contracts	Material & Acquisition Contracts	Misc. & Other DC (T&PDiem)	Total Cost
Phase I <sup>1</sup> 10/1-12/15/97	375	\$19,684	\$18,336		\$1,000	\$4,104	\$43,124
Phase II <sup>1</sup> 12/1/97-2/15/98	240	\$9,860	\$9,101				\$18,961
Phase III <sup>1</sup> 10/1/97-9/30/98	600	\$23,712	\$21,888		<u>\$70,000</u> <sup>2</sup>	\$6,840	\$122,440
Phase IV <sup>1</sup> 4/1-8/31/98				\$40,000	\$40,000	\$2,736	\$82,736
Phase V <sup>1</sup> 10/1/98-9/30/99	400	\$18,179	\$16,781	\$25,000	\$5,000	\$14,364	\$79,324
10/1/99-9/30/20	600	\$28,954	\$26,438	\$25,000		\$15,082	\$95,474
Total (3 years)							\$442,059

<sup>1</sup>Phase I=Feasibility Study and Report, Pump Outlet; Phase II=Design, Specs, Drawings, Peer Review, for Pump Outlet; Phase III=Assess and Improve Variable Frequency Drive; Phase IV=Construction of Pump Outlet; Phase V=Testing/Evaluations and Final Report.

<sup>2</sup>\$70 K needed if present system of motor and VFD needs replaced for single Hydrostral pump

CALFED funding is needed for this project for refined testing and development of fish protection technology of high value for all CALFED options in the Bay-Delta. Without support, it is likely that internal hydrostol pumps will not be given enough appropriate scientific assessments for acceptance by regulatory agencies in the Bay-Delta. This would be unfortunate for the advantages of a compact, yet "fish friendly", pump to all future fish bypass needs, and many direct water delivery systems, would be enormous.

Evaluation costs requested for this project are modest and reflect cost sharing through on-going Reclamation support of the overall RBRPP and Red Bluff Fish Passage Program. Requested budgets would allow greater focus on the internal pump, and would expand evaluations to include more tests under variable RPM conditions. Costs for a start-up scientific evaluation of "fish friendly" pumps for CALFED would be enormous. We propose to provide a multi-million dollar research facility with high quality labs and experienced technical staff to assist CALFED technology development needs. Beyond this project, we see a great potential for another "fish friendly" program: we anticipate using the fourth bay at RBRPP (figure 2) to install and test another pumping system further applicable to CALFED needs. We wish to explore this latter possibility through proposals during the second round of RFP's from CALFED.

The hydrostol pump's service and repair needs are being underwritten and met beyond warranty requirements by Envirotech of Salt Lake City. This company is committed to appropriate assessments of the hydrostol system, and has made verbal assurances that it will continue this if the proposed modifications and evaluations are continued.

b. Schedule Milestones.

<u>Project Milestone</u>	<u>Start Date</u>	<u>End Date</u>
Feasibility Study, with Report, Pump Outlet	10/1/97	12/15/97
Design, Specs, Drawings, and Review, Pump Outlet	12/1/97	2/15/98
Assess and Improve Variable Frequency Drive	10/1/97	9/30/98
Construction of New Pump Outlet	4/1/98	8/31/98
Testing and Evaluation; Final Report	9/1/98	9/31/2000

c. Third Party Impacts. Alteration of the helical pump outlet will require close coordination with the National Marine Fisheries Service. Any alteration, however minor, of RBRPP must meet with NMFS approval because of the sensitive issues surrounding the endangered winter-run salmon. Past coordination with NMFS on alterations (i.e., trashrack configurations) has been most successful, and we anticipate no problems. Electrical supply to Variable Frequency Drives may be altered and could affect other operations at RBRPP. Careful coordination with Reclamation plant managers should alleviate problems. No impact will result on water deliveries, as construction is planned when Red Bluff Dam gates are in, and ample water is supplied through gravity diversion. On-going research and monitoring will be impacted to some extent, although studies will continue during construction with the Archimedes pumps.

## APPLICANT QUALIFICATIONS

This project would involve a team of nine fishery and engineering professionals, all intimately familiar with the RBRPP program. The project would be managed by Dr. Charles Liston, Research Aquatic Scientist, who has had extensive experience in managing large, interdisciplinary research projects both in academia and government. Dr. Liston is presently directing research for the RBRPP and is also technical team leader for Reclamation's Tracy Fish Facility Improvement Program (TFFIP) in the south Delta. He has a thorough understanding of the fisheries and fish protection technology needs throughout the Central Valley, and has worked extensively with all involved federal and state agencies for nine years.

Engineering designs and feasibility activities for the pump outlet would be handled mainly by Warren Frizell, Rick Christensen, and Bob Zelenka, Engineers with Reclamation. On-site engineering needs and coordination would be handled by Max Stodolski, Engineer and Manager of the overall Red Bluff Fish Passage Program, and Steve Atkinson, on-site engineer for the RBRPP. Evaluation programs would be carried out under the direction of C. Liston and Sandy Borthwick (fisheries) and W. Frizell (Research Hydraulic Engineer), with further academic in-put and assistance from Dr. Louis Helfrich and Dr. Cal McNabb. Pump outlet retrofit and variable frequency drive activities (bidding process if needed; construction) would be coordinated by Max Stodolski and Reclamation's Willows construction office, California.

### Brief "Biosketches" of Technical Staff

Charles R. Liston, Research Aquatic Scientist, GS-14, Bureau of Reclamation

BS, MS, Ph.D. - Biology and Aquatic Sciences

Prior to Reclamation (1989), Tenured Associate Professor, Michigan State University

32 years experience in applied research related to water resource development and fisheries and aquatic habitat interactions; directed multi-million dollar fisheries programs both in academia and government; numerous publications and technical reports; presently directing technical program for the Tracy Fish Facility Improvement Program (TFFIP) and Red Bluff Research Pumping Plant Project (RBRPP).

K. Warren Frizell, Research Hydraulic Engineer, GS-13, Bureau of Reclamation

BS, MS - Mechanical and Civil Engineering

With Reclamation since 1976

Specialties include: hydraulics of fluid machinery, gates and valves; data acquisition techniques; instrumentation; and prototype field evaluations. Currently serves as technical lead for Red Bluff engineering evaluations, and performs hydraulic studies at the Tracy Fish Facility in the south Delta.

Sandra Borthwick, Fisheries Biologist, GS-12, Bureau of Reclamation

BS, MS - Biology and Fisheries Science

With Reclamation since 1994, before with National Park Service

Specialties include: development of fisheries techniques for assessing fish screens and "fish friendly" pumping systems; fisheries ecology, river ecology and aquatic

invertebrates; on-site management of complex interdisciplinary research programs and staff.

Max Stodolski, Civil Engineer and Manager, Bureau of Reclamation

BS - Civil Engineering

With Reclamation over thirty years

Specialties include: construction supervision and inspection; administration; development of interagency coordination for complex programs; technical advisor and reviewer of engineering evaluations for RBRPP; budget development and management; interactions with water users and districts; planning activities. Currently serves as Manager of Reclamation's Red Bluff Fish Passage Program, and of the Red Bluff Office.

Rick Christensen, Senior Mechanical Engineer, Bureau of Reclamation

BS - Mechanical Engineering

With Reclamation since 1981

Specialties include: preparation of designs, computations, layouts, drawings, reports, manuals, specifications, operational procedures, procurement procedures, fabrication techniques, and installation procedures for mechanical equipment; responsible for designs, specs, and construction support for trash rakes, conveyors, selective withdrawal structures, fish screening equipment, screen cleaning systems, fish bypasses, flow measurement equipment, engine generators, temperature sensors and dredging equipment. Has extensive experience and special expertise in engineering studies and designs associated with fish facilities.

Robert L. Zelenka, P.E., Senior Mechanical Engineer, Bureau of Reclamation

BS - Ocean Engineering

With Reclamation since 1979

Specialties and current responsibilities include: analysis, design, and specifications of hydraulic turbines, pump-turbines, pumps, and associated auxiliary equipment and related sub-systems for Reclamation powerplants, irrigation pumping plants, and pump-storage generating plants. Has had extensive involvement in the analysis and modification of the archimedes and internal helical pumps for the RBRPP.

Steve Atkinson, Civil Engineer, Bureau of Reclamation

BS - Civil Engineering

With Reclamation since 1994

Currently serves as the on-site engineer for the RBRPP; duties include assisting with operations and maintenance, and engineering evaluations (with W. Frizell) for RBRPP. Specializes in all mechanical and operational details for the RBRPP.

Louis Helfrich, Professor of Fisheries and IPA assignment with Reclamation

BS, M.Ed, MS, and Ph.D., Biology and Fisheries Science

Presently Tenured Professor at Virginia Tech, on detail to RBRPP and Tracy Program

Specialties in aquaculture, fisheries conservation biology, endangered species recovery, fish behavior, fish passage, water quality management and research design. Numerous

technical and popular articles on aquatic sciences, and specialist in university extension activities including award winning videos. Currently assisting in research design and implementation for Reclamation fisheries projects including RBRPP, Tracy Fish Facility Improvement Program, and fish passage around low-head irrigation dams on the Yellowstone River, Montana.

Clarence McNabb, Professor of Fisheries and Aquatic Sciences (Retired, Michigan State Univ.)

IPA Scientist and Consultant to Reclamation since 1991

BA, MS, Ph.D., Biology and Aquatic Sciences/Limnology

Broad experience in many aspects of fisheries and limnology, decades of undergraduate and graduate teaching and research at major universities prior to detailing to Reclamation; joined Reclamation on IPA assignment in 1991 as western zebra mussel expert; began as manager of on-site fisheries research at RBRPP in 1993, and responsible for development of many unique pump/screen/bypass evaluation techniques now used at RBRPP. Also responsible for design and development of present research facilities at RBRPP; numerous scientific publications and international experience; currently serves as expert consultant and scientific writer for Reclamation, focusing on the RBRPP program.

#### COMPLIANCE WITH STANDARD TERMS AND CONDITIONS

It is understood that Reclamation, as a federal agency, would submit specific documents prior to or at signing of a final contract. These documents, as understood, would be documents 3 (Standard Clauses-Interagency Agreements) and 6 (Standard California Nondiscrimination Construction Contract Specifications), as noted in Attachment D of the 1997 CALFED Category III RFP document. Reclamation would also comply with all the "Terms and Conditions", as detailed in Attachment D.

## DOCUMENTS SUPPORTING THE CALFED "FISH FRIENDLY" PROPOSAL

Bigelow, J. And R. Johnson. 1996. Estimates of survival and condition of juvenile salmonids passing through the downstream migrant fish protection facilities at Red Bluff Diversion Dam on the Sacramento River, spring and summer, 1994. U.S. Fish and Wildlife Service, Northern Central Valley Fish and Wildlife Office, Red Bluff, California. Red Bluff Pumping Plant Report Series, Bureau of Reclamation. Volume 1, 50 pp.

EnviroTech Pump Systems. 1997. Status and technical assessment, including recommendations for improvements, of the Red Bluff Internal Screw Pump. Report to Bureau of Reclamation, D-8220, July 8, 1997. 10 pp. + figures.

Frizell, W., C. Liston, and S. Atkinson. 1996. Engineering features of the Red Bluff Research Pumping Plant. Proceedings 1996 North American Water and Environment Congress, American Society of Civil Engineers. 6 pp.

Liston, C. And P. Johnson. 1992a. Design criteria and environmental setting for a pilot pumping plant installation at Red Bluff Diversion Dam on the Sacramento River, California. Bureau of Reclamation, DTSC, Ecological Research and Investigations Group (D-8220)/Water Resources Research Laboratory (D-8560), Denver, Colorado. 66pp. + append.

Liston, C. And P. Johnson. 1992b. Biological and engineering evaluation plan for a pilot pumping plant at Red Bluff Diversion Dam on the Sacramento River, California. Bureau of Reclamation, DTSC, Ecological Research and Investigation Group (D-8220)/Water Resources Research Laboratory (D-8560), Denver, Colorado. 54 pp.

Liston, C., C. McNabb, S. Borthwick, W. Frizell, and S. Atkinson. 1997a. Status and early results of the Red Bluff Research Pumping Plant Program on the Sacramento River, California. Presented at the EPRI sponsored 1997 National Fish Passage Workshop, Milwaukee, May 6-8, 1997. 10 pp. + figures and tables.

Liston, C., C. McNabb, S. Borthwick, W. Frizell, and S. Atkinson. 1997b. Use of "fish friendly" pumps for fish passage on the upper Sacramento River: Early experiments at Red Bluff Research Pumping Plant (USA). To be presented and published with the American Fisheries Symposium "Advances in Fish Passage Technology", 1997 Annual Meeting, AFS, Monterey, CA. August 27-28, 1997.

McNabb, C., C. Liston, and S. Borthwick. 1997. In-plant biological evaluation of the Red Bluff Research Pumping Plant (RBRPP) on the Sacramento River in Northern California: a summary of information obtained during 1995 and 1996. Annual Report of biological evaluations of RBRPP. Bureau of Reclamation, DTSC (D-8220) and Mid-Pacific Region, Northern California Area Office. In Preparation.

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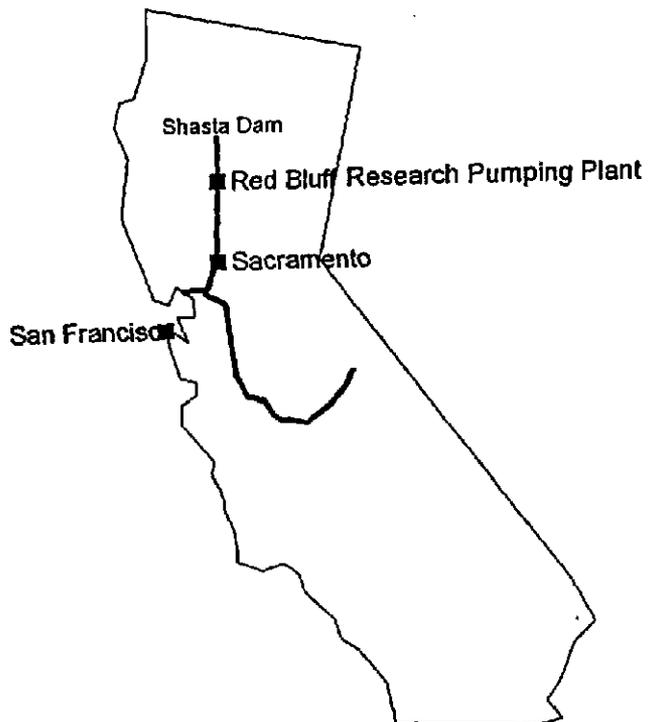


Figure 1: Location of Red Bluff Research Pumping Plant, Sacramento River, California.

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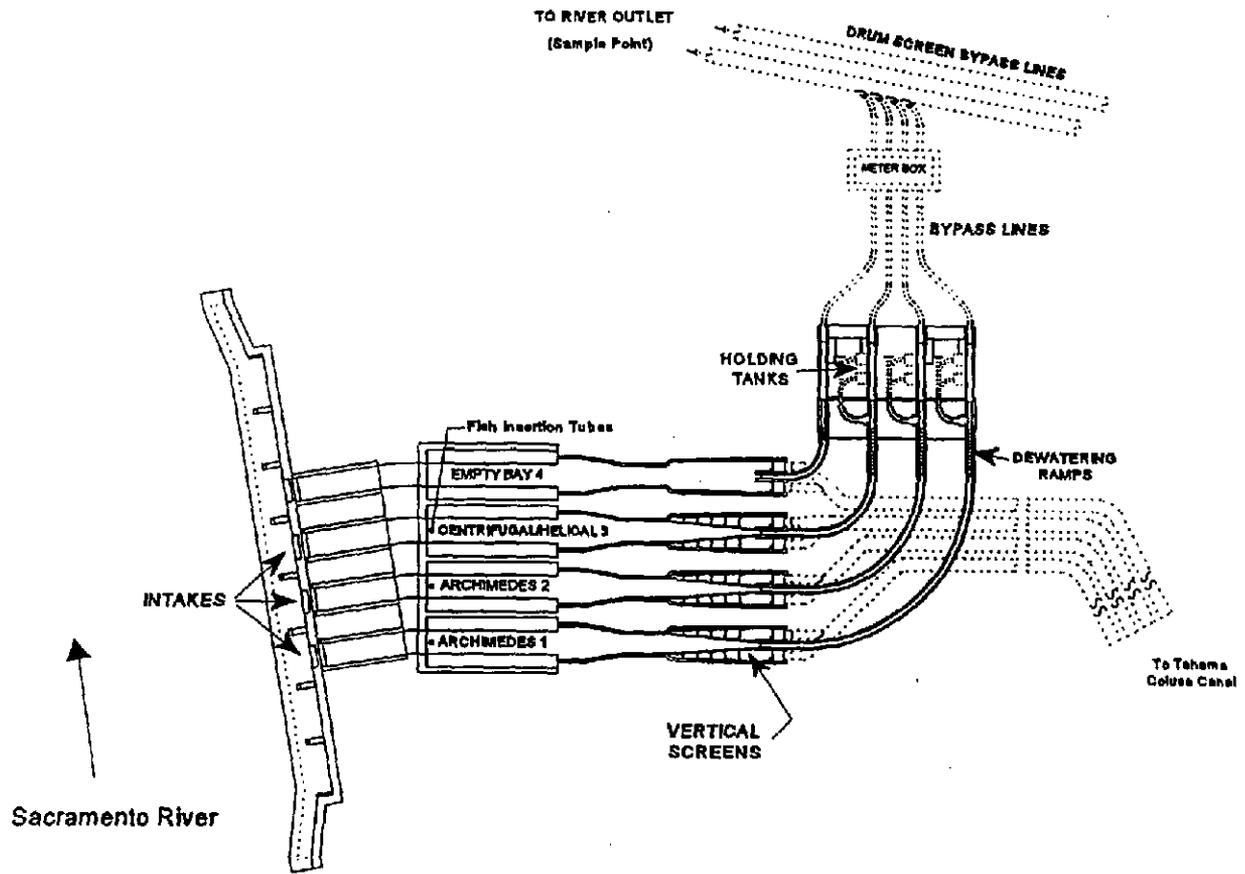


Figure 2: Schematic of Red Bluff Research Pumping Plant.

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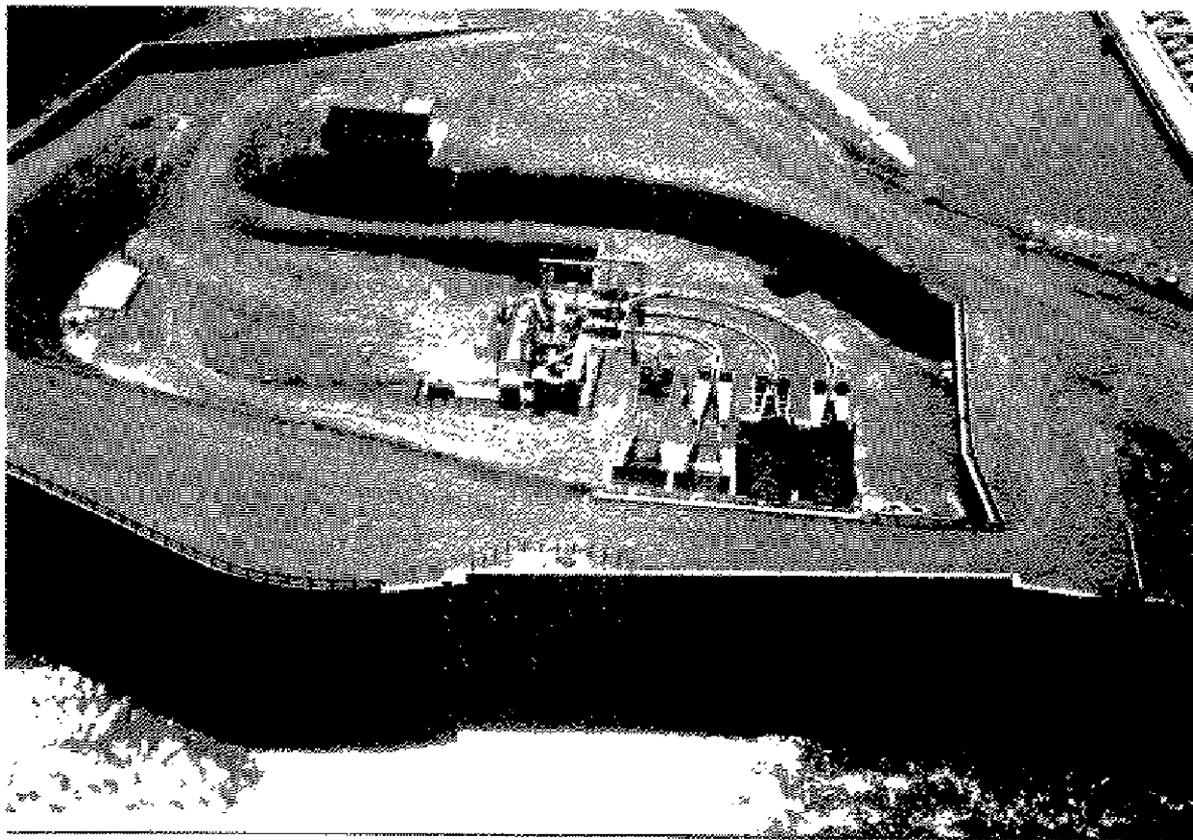


Figure 3 - Aerial View of Red Bluff Research Pumping Plant on West Side of the Sacramento River, California

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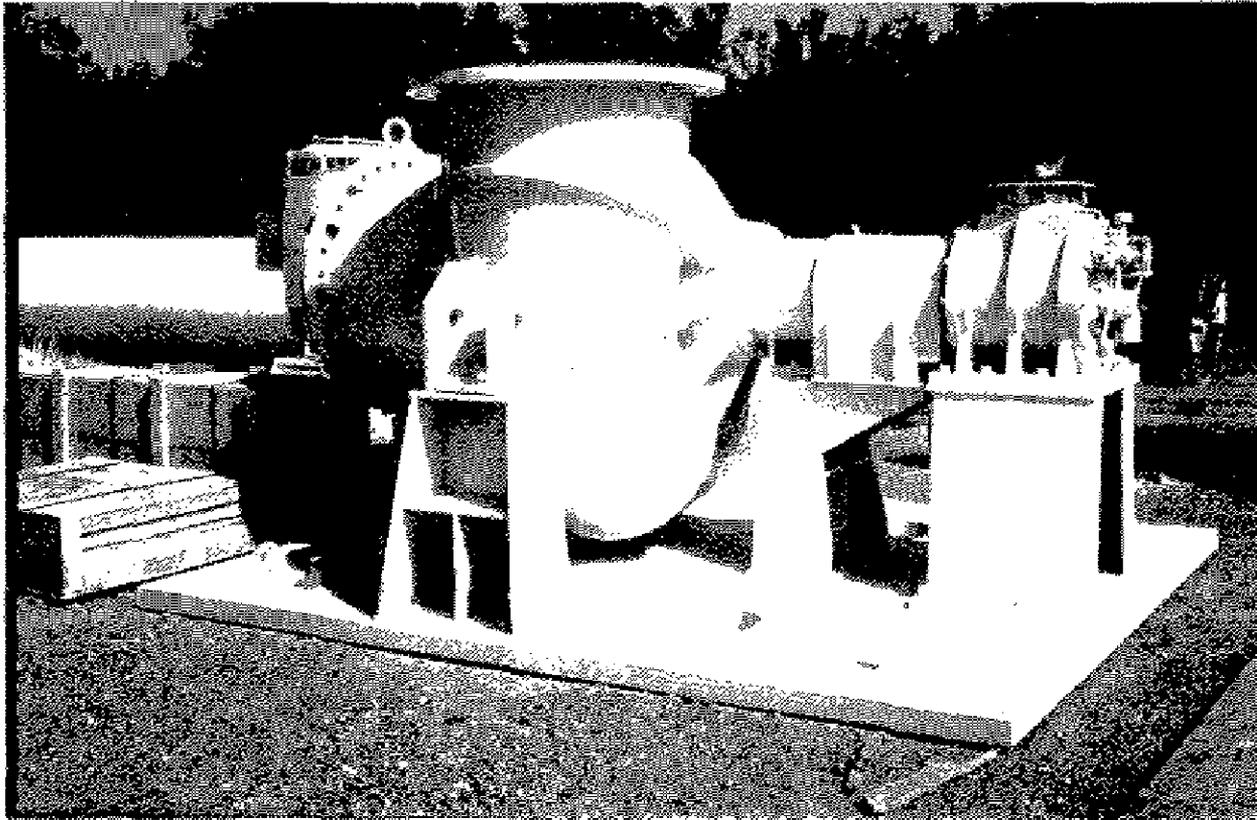


Figure 4 Picture of the Internal Helical Pump Prior to Installation

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*Figure 5 Close-up View of the Two Archimedes Pumps and Outfall Structure for the Internal Helical Pump*

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