F1-020

I. EXECUTIVE SUMMARY

REMOVAL OF SELENIUM FROM DRAINAGE WATER USING IN-SITU ELECTOKINETIC TREATMENT

Proposed by Panoche Drainage District

Project Description and Primary Biological / Ecological Objectives

The project will show the benefits of a selenium removal based on an electrokenetic process. Electrode sumps (with anodes and cathodes), will be installed along one of Panoche Drainage District's interceptor drains.
The first phase of the project was completed in the Fall of 1996 at Panoche's expense, and showed positive results. The treatment process is expected to remove significant amounts of Se from 900 GPM flowing water resulting in improved water quality.

Panoche Drainage District, as a signatory member of the Grassland By-Pass Use Agreement, is obligated to reduce selenium loading into the San Joaquin River (River). Selenium, in high concentrations, has shown negative impacts towards the ecological health of the River and the Bay Delta. The primary objective is reducing the contaminant load of the Agricultural Drainage Affluent before it leaves the District boundaries and enters the River.

Approach / Tasks / Schedule

The two parties plan to develop a ½ mile stretch of one of the District's drains into a fully integrated treatment site that will operate for fourteen months. A system of low maintenance dams and weir structures will be designed and installed within the existing ditch to create to proper flow demand. This will allow the electrodes to successfully remove the selenium from the drainage and cause it to change to a form that will stay in the soil profile.

Tasks with approximate start dates.

Task 1: Construction Phase: 30 days (Nov. 1, 1997)
Task 2: Installation and Start Up of Technical Equipment: 15 days (Dec. 1, 1997)
Task 3: Full Start allowing for flow adjustments: 15 days (Dec. 16, 1997)
Task 4: Operation with Monitoring and Quarterly reporting: 12 months (12-31-98)

Justification for Project and Funding by CALFED

Westside agriculture has a history of discharging agricultural drainage into the San Joaquin River in order to maintain it's crop production cycle. With the selenium targets that must be met for tributary flows, Panoche must continue to search for a beneficial selenium removal process. CALFED has maintained their stance of reducing contaminant loads not only in the San Joaquin River but also in the Delta, and this project will be a good fit in this long-term goal.

Budget Costs and Third Party Impacts

The full cost of the project is expected to be $240,000. The breakdown is included in the report. There will be no third party impacts due to the fact that the treatment process is

taking place on District grounds with its' own discharge water. Any water that passes through the system untreated will continue to flow out the normal discharge site.

Applicant Qualifications

Panoche Drainage District has been discharging drain water since it's inception in the 1950's. They realize the importance of maintaining a drainage outlet to maintain the viability of the agricultural production within its boundaries. Salt and selenium concerns, as they related to aquatic habitat and other land species, have always been a concern of the District. They have been involved with various projects over the years trying to find a treatment solution. Some of the projects include:

HARZA ENGINEERING 1985-87
MMRV ION EXCHANGE 1991-92
BOYLE ENGINEERING ION EXCHANGE 1994
ALGAE BACTERIAL U.C. BERKELY LAB 1996- CURRENTLY RUNNING

ETS President and CEO Walter W. Loo will be responsible for the system design and technical expertise necessary to the project. Walter Loo is qualified by experience, education and professional registration. He is the author of many published articles and has prepared and presented over 100 technical reports and papers nationwide and internationally in the field of environmental remediation.

ETS Regulatory Compliance Director and Project Manager John W. Lovelady will be responsible for the installation and implementation of the project. He has more than 23 years of experience in environmental systems construction and operation and in the collection and analysis of data. He served as an educator for more than 10 years, developing and teaching courses of study ranging from natural resources conservation to agricultural management. He has wide experience in the field of environmental studies and, particularly, in electrokenetic technology and its application and operation.

Monitoring and Data Evaluation

There will be extensive monitoring for the first month of full operation (Jan 1- Jan. 31). After the flow is stabilized, and all equipment is properly adjusted, daily checks and maintenance will occur by District staff. Data will be analyzed and formatted in file forms and be available to Cal-Fed on a Quarterly basis. An annual report will be published at the end of the fourteen month period.

Program Support and Compatibility with CALFED Objectives

Panoche plans to work cohesively with E.T.S. to make selenium reductions in the drainage water in order to meet the flow targets to the San Joaquin River. Cal-Fed is committed to improving the water quality of the River and also the Bay Delta. These tributaries serve as a water supply for not only agriculture, but also municipal, industrial, and environmental concerns. A treated water supply entering the San Joaquin River will benefit all stakeholders in the Bay Delta.

II. TITLE PAGE

REMOVAL OF SELENIUM FROM DRAINAGE WATER USING IN-SITU ELECTROKINETIC TREATMENT

PROJECT GROUP TYPE: OTHER SERVICE: WATER QUALITY

Proposed by

PANOCHE DRAINAGE DISTRICT
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In Collaboration with
ENVIRONMENT AND TECHNOLOGY SERVICES (ETS)

PANOCHE DRAINAGE DISTRICT:

Chase Hurley
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Mr. Walter Loo
Mr. John Lovelady
(Technical Contacts)
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III. PROJECT DESCRIPTION

A. Project Description and Approach

The project shall consist of a 12 month demonstration of previously proven innovative technology (electrokinetics) in the removal of Selenium from agricultural drainage water. The project will monitor the rates of Se removal and collect data which will be used to optimize the efficiency of the Se removal system. The operation of the system will provide information necessary to evaluate the feasibility of electrokinetic technology in the treatment of agricultural drainage for the removal of Se under dynamic flow conditions.

The project's approach will be to install the electrokinetic treatment system and closely monitor the system operation and adjust the technology as needed to enhance the amount of Se removed per the volume of drainage water treated.

The electrokenetic (EK) selenium (Se) treatment system will be installed on one of eight drains for drainage water from the District. The system will consist of three stations 500' apart along the interceptor drain to monitor and manage water flow rates and water quality. Electrode sumps will be installed at each of these stations. Electrode wells will be installed along the interceptor drain banks between the three stations, spaced 50' apart. DC power stations will be designed and constructed as needed to operate the system, after evaluation of the soil and groundwater at the specific sites. The EK treatment system will be operated and closely monitored to optimize Se removal rates for a 12 month period beginning in fall 1997.

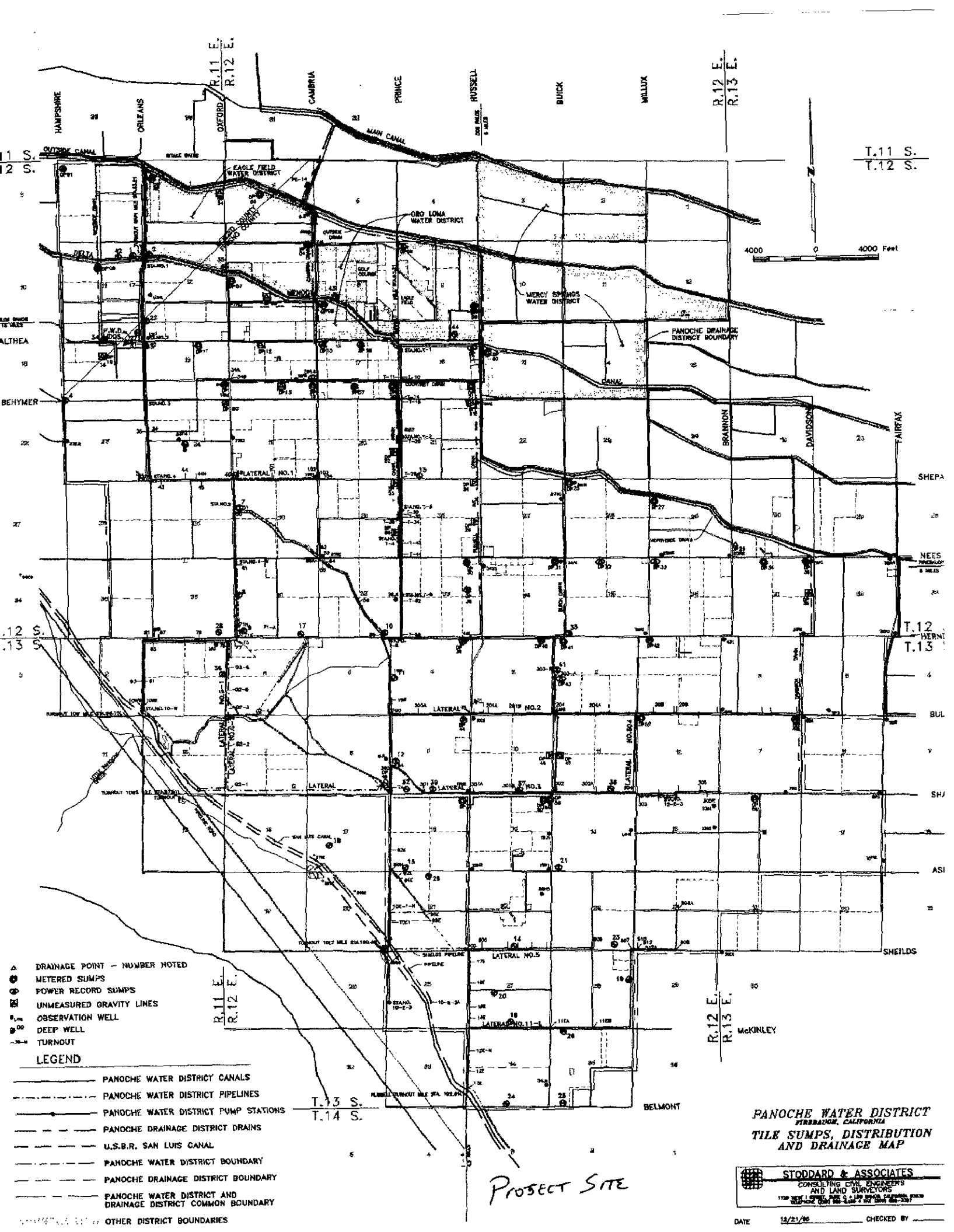
B. Location and/or Geographic Boundaries of Project

The project will take place in Western Fresno County in the lower San Joaquin River watershed. The drainage water currently is discharged through District delivery channels north through the Grassland Bypass Project into Mud and Salt Slough and then the San Joaquin River. The equipment will be installed along the northern end of the interceptor drain known as the Buick Drain as it flows to the Northside Drain in T12S.R12E between sections 26 and 27 (See Map).

C. Expected Benefits

The primary stressor addressed by the project is contaminants entering the lower San Joaquin River by way of subsurface agricultural drainage water. The project should determine the efficiency of the electrokinetic treatment process in treating agricultural drainage water to reduce the Se load that is now entering the lower San Joaquin River and Bay-Delta. Species and species groups benefiting from reductions in contaminants entering the Bay-Delta include delta smelt, longfin smelt, splittail, white and green sturgeon, striped bass, marine and estuary fishes, large invertebrates, Bay-Delta aquatic foodweb organisms, and waterfowl.

The specific problem to be addressed by the project is the Selenium (Se) loaded irrigation drainage water which enters the San Joaquin River via discharges from the Panoche Water Drainage District (PDD). Based upon research and an initial demonstration already completed, Se loading can be reduced by 75% by electrokinetic treatment. The expected benefit of this project, and its primary goal, will be an overall improvement in the San Joaquin River water quality by reduction of Se in water discharged by PDD. In addition, other factors important to water quality, such as high Total Dissolved Solids (TDS) and boron in irrigation drainage water will be addressed.



- △ DRAINAGE POINT – NUMBER NOTED
- METERED SUMPS
- POWER RECORD SUMPS
- UNMEASURED GRAVITY LINES
- OBSERVATION WELL
- DEEP WELL
- TURNOUT

LEGEND

- PANOCHE WATER DISTRICT CANALS
- PANOCHE WATER DISTRICT PIPELINES
- PANOCHE WATER DISTRICT PUMP STATIONS
- PANOCHE DRAINAGE DISTRICT DRAINS
- U.S.B.R. SAN LUIS CANAL
- PANOCHE WATER DISTRICT BOUNDARY
- PANOCHE DRAINAGE DISTRICT BOUNDARY
- PANOCHE WATER DISTRICT AND DRAINAGE DISTRICT COMMON BOUNDARY
- OTHER DISTRICT BOUNDARIES

PANOCHE WATER DISTRICT
FIREBAUGH, CALIFORNIA

TILE SUMPS, DISTRIBUTION AND DRAINAGE MAP

STODDARD & ASSOCIATES
CONSULTING CIVIL ENGINEERS AND LAND SURVEYORS

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water quality, such as high Total Dissolved Solids (TDS) and boron in irrigation drainage water will be addressed.

The result of the reduction in Se loading and reduction in TDS will be an improvement in the water quality for agricultural, municipal, industrial, and recreational beneficial uses and a reduction in danger to various Bay-Delta species, shore and wading birds in particular.

Confirmation of electrokinetic technology's value in Se removal will benefit agricultural drainage managers who must evaluate costs, performance, and requirements of various Se removal treatment processes and who must reduce or maintain Se levels to below compliance objectives. Any improvement in water quality to the San Joaquin River and, ultimately the Bay-Delta, benefits all stakeholders.

D. Background and Biological/Technical Justification

In the subsurface agricultural drainage water of the west side of the San Joaquin Valley, Se occurs predominately as highly soluble selenate. The Panoche Water and Drainage District (PDD) covers a service area of 44,000 acres in western Fresno county along the Interstate 5 corridor. Within the PDD boundaries are 38 miles of open drains which move seepage water and developed tile drainage water from irrigated land. These tile drains are necessary to keep boron and high concentrations of salts from lodging in the root zone of agricultural crops and killing the plants. As the shallow underground aquifer develops, it picks up naturally occurring Se from the soil profile, concentrating it in the drainage water. PDD must find a way to reduce Se load in its drainage water in order to maintain water quality standards in the San Joaquin River while maintaining a viable drainage outlet for part of California's valuable agricultural industry.

Electrokinetic (EK) processes are recognized by the US Department of Defense, US Department of Energy, and U.S. EPA as potential cost-effective treatment of hazardous wastes (US Army 1992). In 1995, USEPA collected a list of EK treatment processes that are in research, demonstration, and commercial application (USEPA 1995). Recently, EK has attracted the attention of DuPont, GE, and Monsanto for waste treatment (Initiatives, 1996). ETS has been successfully using EK in the remediation of hazardous wastes since 1991. The first application of EK processes to the removal of SE from irrigation drainage water was accomplished in 1996 (Loo, W.W., Field Demonstration of In-Situ Electrokinetic Treatment of Selenium and Boron, Environment & Technology Services Technical Report to Panoche Drainage District, December, 1996).

The above cited field demonstration of in-situ electrokinetic (EK) treatment of irrigation drainage water at DP 25 and Area 27 in the Panoche Water and Drainage District (PDD) was conducted in 1996. The project results indicated that the selenium load at the project site would be reduced by 75% from the current Se loading of 785 lbs. per year to 197 lbs. per year. Given the PDD's annual discharge of 6,200 lbs per year (1995), the proposed project would result in a 9% reduction in annual Se discharge from PDD.

The long term goal of the District is to install EK treatment at all points of discharge from the District to effect an overall reduction in Se discharge by 75%, (from 6,200 lbs. per year to 1,730 lbs. per year) with a substantial improvement to overall water quality in the lower San Joaquin River and the Bay-Delta.

In 1996, PDD and Environment & Technology Services, Inc. (ETS) collaborated in an initial demonstration project in which boreholes were drilled, logged geophysically and tested to establish the lithology and electrical properties of the soil and groundwater at the site known as DP 25 and Area 27. Initial baseline data was collected and the electrokenetic (EK) treatment points were established in August 1996. The system was operated for a 10 week period. Data collected indicated the following results:

Dissolved Se was attracted to the anode portion of the system (removed from water) and Se was attracted to the cathode portion of the system where it precipitated from the drainage water and was fixed in place below the drainage systems ability to dissolve the Se. In addition, the Total Dissolved Solids (TDS) concentration in the drainage water was reduced by the removal of significant amounts of sodium, calcium and magnesium salts and boron load was reduced along with the Se load of the treated drainage water.
A complete report of findings of the initial demonstration project is available from PDD.

The proposed EK treatment system will continue to reduce Se loading as long as it is operational. The system is planned to remain operational as long as Se is present in drainage water planned for discharge from the PDD. The system's monitoring program allows for adjustment to changing hydrologic conditions and is not affected by climatic changes. As long as water is in the drain being treated, the system will continue to reduce Se loading of that water. Operating and maintenance costs associated with the electrokinetic treatment system are projected to be very low and the simplicity of operation makes electrokinetic treatment a viable process for wide use in areas where it is desirable to improve water quality by removal of Se.

Expenditures for the initial project were shared by PDD and ETS. The total costs were:

PDD		**ETS**	
Construction	$12,000	Engineering & Consultation	$12,000
Water Quality Testing	$18,000	Administration & Travel	$ 4,000
Labor	$ 3,000	Total	$16,000
Administration	$ 1,000		
Total	$34,000		

The ETS contribution was for design services, technical personnel necessary to install and operate the demonstration system, professional expertise necessary to evaluate and report the data gained from the project and consultation and engineering services.

E. Proposed Scope of Work

The project feasibility has been verified by the initial project completed in December 1996 by the PDD and ETS and described earlier. ETS will be retained to design and implement a dynamic irrigation drainage water quality improvement and management program that can be duplicated at different locations within the PDD. The project consists of a network of EK systems which are designed to remove Se from the water as it passes through the drain channel; a dynamic system of removal. The system is described in section III.a. above. At design capacity, the project will treat 2 cubic feet per second (900 gpm).

It is expected that construction will commence as soon as materials arrive at the site and a suitable drilling contractor is arranged. The construction phase of the project will be completed in approximately 30 days. Installation and start up of technical equipment needed for the project will be accomplished within an additional 15 days and full operation of the system is expected within another 15 days, making the time from initial construction to full operation 60 days. Data collection will be ongoing and the system optimization will be the priority. Data will be analyzed and reported in narrative and graphic form each three month period. The data will show the amount of Se reduction accomplished over the 12 month demonstration period. Financial accounting will be accomplished on an ongoing basis and will be reported each quarter beginning January 1998 according to the usual accounting practice of the Panoche District.

F. Monitoring and Data Evaluation

Reports of monitoring and data analysis will be compiled monthly and reported quarterly beginning January 1998. Data collected throughout the project will be submitted to CAL-FED Bay Delta Program and consultation will occur between existing University programs doing research on Se removal and appropriate water resource agencies. A final project report will be submitted to CALFED at the end of the project period. No other projects of the type and scope proposed herein are known to be active at this time.

Project staff shall be available to provide briefings on project activities and accomplishments to interested parties.

G. Implementability

The proposed project will be operated in accordance will all applicable laws and regulations. No special permits or authorizations will be required by the project at this site. No hazardous materials are to be used or are anticipated to be generated by the project. Access has been granted and allowed by landowners in the area and no changes to land or water conveyances are necessary to implement the project. University of California, Berkeley is currently operating an experimental Se removal project near the site. The project will not infringe on the University project nor will the University operated experiment interfere with the EK project. The hydrologic conditions at the Buick Drain site make it an exceptional location for this project since it has favorable flow rates and very high Se loading as the drainage water goes from drain tiles to District owned open channels and into the lower San Joaquin River.

IV. COSTS AND SCHEDULE TO IMPLEMENT PROPOSED PROJECT

A. Budget Costs

The costs are summarized in **TABLE 1**. A contract will be in place between E.T.S. and Panoche Drainage District so that those particular services and material costs can be reimbursed between the two parties.

As mentioned previously, there are four tasks in the project, and for budget purposes Tasks 1 and 2 will be grouped together and Tasks 3 & 4 together. Numbers one and two will concentrate on all the engineering and construction costs, while tasks three and four will be for monitoring, quality control, and laboratory analysis.

B. Schedule Milestones

Work on Task 1 would begin upon approval and final signatures of the Cal-Fed contract with Panoche Drainage District. The other tasks, and the corresponding payments from Cal-Fed, would follow according to the schedule listed below. The dates listed below are assuming a start date of November 1st. 1997. If the start date is different, the same intervals of completion will apply.

Task	Completion Date	Payment Amount
1	11-30-97	$80,000
2	12-15-97	$25,000
3	04-30-97	$56,250
3a	10-31-97	$56,250
4	12-31-98	$22,500

C. Third Party Impacts

No third parties will be negatively impacted as a result of any operations involved with this project.

TABLE 1

PROJECT PHASE and TASK	DIRECT LABOR HOURS	DIRECT SALARY & BENEFITS	OVERHEAD LABOR (GENERAL, ADMIN AND FEE)	SERVICE CONTRACTS	MATERIAL AND ACQUISITION CONTRACTS	MISSELANEOUS & OTHER DIRECT COSTS	TOTAL COST
TASK 1							
design				4200			$ 4,200
construction	200	$ 5,000		30000	40800		$ 75,800
TASK 2							
installation			5000	20000			$ 25,000
TASK 3							
operation	400	10000	5000	95000		2500	$ 112,500
TASK 4							
data analysis	100	2500	5000	7500			$ 15,000
data reporting			2500	5000			$ 7,500
						GRAND TOTAL	$ 240,000

V. APPLICANT QUALIFICATIONS

PDD has successfully operated since the 1950s, providing water and drainage services to clients with it's 44,000 acre service area. PDD will be responsible for the overall project budget control and will provide expertise in District operations.

Mr. Chase Hurley is the administrative assistant at the District. Having graduated with a Management / Marketing degree from Cal Poly San Luis Obispo, he has attained valuable experience in accounting and water management in his responsibilities with the District and previous employers.

ETS President and CEO Walter W. Loo will be responsible for the system design and technical expertise necessary to the project. Walter Loo is qualified by experience and education (BS and MS from Oklahoma State University) and by professional registration; (Certified Hydrogeologist, California #72; Certified Engineering Geologist, California #1207; Registered Geologist, California #3856; Registered Environmental Assessor, California #REA-01207; Certified Environmental Manager, Nevada #1305). Mr. Loo is owner of the proprietary technology used in part of this project and is widely recognized as the foremost expert in electrokinetic development and commercial application of the technology (US EPA 1995). He is the author of many published articles and has prepared and presented over 100 technical reports and papers nationwide and internationally in the field of environmental remediation.

ETS Regulatory Compliance Director and Project Manager John W. Lovelady will be responsible for the installation and implementation of the project. He has more than 23 years of experience in environmental systems construction and operation and in the collection and analysis of data. He is qualified by education (BA, CSU,Long Beach - Education/Health and Human Services; Certifications in Environmental Health and Safety Management, Environmental Auditing from UC,Davis, Advanced Environmental Law and Management from UC, Berkeley;qualified Paralegal from NW Calif. Univ., School of Law, where he is currently a candidate for his JD degree; professional registration; (Registered Environmental Assessor, CAL EPA #REA-06107). He served as an educator for more than 10 years, developing and teaching courses of study ranging from natural resources conservation, mechanized agriculture and agricultural management and holds lifetime credentials in several areas. He has wide experience in the field of environmental studies and, particularly, in electrokenetic technology and its application and operation.

All other ETS personnel who will be involved with the project are qualified engineering and environmental professionals.

VI. COMPLIANCE WITH STANDARD TERMS AND CONDITIONS

Panoche Drainage District will comply with all terms and conditions as they apply for Cal-Fed funding. Appropriate compliance paperwork will be provided upon signatory of the contract.