GROUNDWATER BANKING JOINT POWERS AUTHORITY (GBJPA)

KERN FAN GROUNDWATER STORAGE PROJECT

REQUEST FOR PROPOSALS (RFP)

PROFESSIONAL SERVICES FOR ENGINEERING DESIGN

Description:

The Groundwater Banking Joint Powers Authority (GBJPA) is requesting proposals for engineering design services associated with five phases of the Kern Fan Groundwater Storage Project. These include:

1. Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie; Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures

2. Phase I Well Drilling and Equipping; Phase II Well Drilling and Equipping

3. Aqueduct Turnout Facility

4. Conveyance Facilities including Turnout(s) & Pump Stations

5. SCADA and PLC Programming

The Kern Fan Groundwater Storage Project is located in western Kern County, west of the City of Bakersfield. The proposed recharge and recovery facilities will be constructed on approximately 1,280 acres of agricultural or vacant land within or near the Rosedale-Rio Bravo Water Storage District service area. The proposed project will include the acquisition of easements, rights-of-way, and permits for the design and construction of the Kern Fan conveyance facilities and turnouts from the California Aqueduct to the Phase I and Phase II Recharge & Recovery properties as well as other facilities owned and operated by the Rosedale-Rio Bravo Water Storage District Conjunctive Use Program.

Pre-Proposal Conference:

A proposal conference will be held **September 29th, 2021** at the office of Rosedale-Rio Bravo Water Storage District located at 849 Allen Road, Bakersfield, Ca, 93314 at **10:00 am**. This will be an opportunity to ask questions regarding the Request for Proposals and to visit the project area.

Proposal Deadline:

One (1) unbound original and four (4) copies of the Engineering Proposal shall be received no later than: **5:00 pm on October 20th, 2021**. In addition, an electronic copy of the proposal shall be uploaded to the link provided on the GBJPA website by the bid submission deadline. Proposals received after the time and date stated above shall be returned unopened to the proposer.

Proposal Instructions:

Sealed proposals shall be addressed to the following:

Groundwater Banking Joint Powers Authority
Attn: Dan Bartel, GM
849 Allen Road
Bakersfield, CA 93314

The sealed proposals shall be marked as follows:

Proposer's Name & Mailing Address

RFP for Kern Fan Groundwater Storage Project
Professional Services for Engineering Design

Identification of the Design Packages Proposed On

Inquiries:

Interested Proposers may obtain an electronic copy of the RFP from Rosedale-Rio Bravo Water Storage District (661) 589-6045 or by emailing a request to Dan Bartel at dbartel@rrbwsd.com.

Questions or clarifications with respect to this RFP shall be addressed in writing to Dan Bartel, General Manager of the GBJPA at Rosedale-Rio Bravo Water Storage District, dbartel@rrbwsd.com. Questions may be asked at any time prior to, but no later than **5:00 pm on October 7th, 2021**.

Public Works Project:

Notice is hereby given that this is a Public Works Project (Design Phase). In compliance with SB854 and Labor Code Section 1725.5, all contractors and subcontractors (including Consultants and Sub-Consultants) proposing and performing work on Public Works Projects must be currently registered with the California Department of Industrial Relations (DIR) and furnish electronic payroll records to the Labor Commissioner if Proposer employs or subcontracts workers to perform any trade that has a prevailing wage designation (i.e., surveying or materials testing).

The GBJPA also hereby affirmatively ensures that Minority Business Enterprises and Disadvantaged Business Enterprises (DBE), as defined in 49 CFR, Part 26, shall have the maximum opportunity to participate in the performance of contracts financed, in whole or in part, with Federal Funds under this agreement and will be afforded full opportunity to submit proposals in response to this notice and will not be discriminated against on the basis of race, color, national origin, ancestry, disability, gender, or religion in any consideration leading to the award of contract. No qualified disabled person shall, on the basis of disability, be excluded from participating in, be denied the benefits of, or otherwise be subjected to discrimination under any program or activity leading to the award of a contract.

The right is reserved by the GBJPA to reject any or all responses, to waive any irregularities or informalities not affected by law, to evaluate the proposals submitted and to award the contract according to the proposal which best serves the interests of said GBJPA.

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Appendices

I. Introduction/Background

The Kern Fan Groundwater Storage Project consists of a regional water bank in the Kern County Groundwater Sub-basin of the San Joaquin Groundwater Basin in Kern County, California that will provide water supply, groundwater and ecosystem benefits. Project facilities will be planned, designed, constructed, owned, and operated by the Groundwater Banking Joint Powers Authority (GBJPA) that consists of representatives from the Irvine Ranch Water District (IRWD) and the Rosedale-Rio Bravo Water Storage District (RRBWSD). IRWD and RRBWSD share a ten-year history of implementing successful water banking projects in Kern County. The Project concept, sizing, location, features and operations are based on the experience and knowledge gained from IRWD's and RRBWSD's existing water banking projects.

The total storage capacity to be developed by the Kern Fan Groundwater Storage Project is anticipated to be 100,000 acre-feet.

The project objectives are to cost-efficiently recharge and store groundwater for subsequent recovery to address the following:

- Enhance water supply reliability;
- Reduce imported water demands on the San Francisco Bay/Sacramento –San Joaquin Delta Estuary (Delta) to benefit spring and winter-run Chinook salmon;
- Provide water supply during drought conditions;
- Provide water supply for emergency response benefits;
- Establish temporary wetlands through intermittent recharge events that will attract migratory and other waterfowl in Kern County;
- Benefit the water levels in the Kern County Groundwater Sub-basin;
- Provide sustainable water supply for local agricultural use; and
- Potential to be integrated into other water storage projects and storage reservoirs to provide greater statewide benefits.

The Kern Fan Groundwater Storage Project consists of the development of a regional water bank in the Kern County Groundwater Sub-basin of the San Joaquin Groundwater Basin in Kern County, California. The project will construct conveyance, recharge, and recovery facilities as necessary to develop a fully functioning water banking project. It includes approximately 1,280 acres of land to be developed as recharge facilities as part of two project phases involving multiple sites potentially. The Phase I and Phase II recharge areas are anticipated to contain approximately 640-acres of land each. It includes up to twelve (12) proposed new extraction wells and associated pipelines, and conveyance of up to 500 cfs from the California Aqueduct to the recharge facilities, see proposed items in Figure 1 below and in Appendix A.

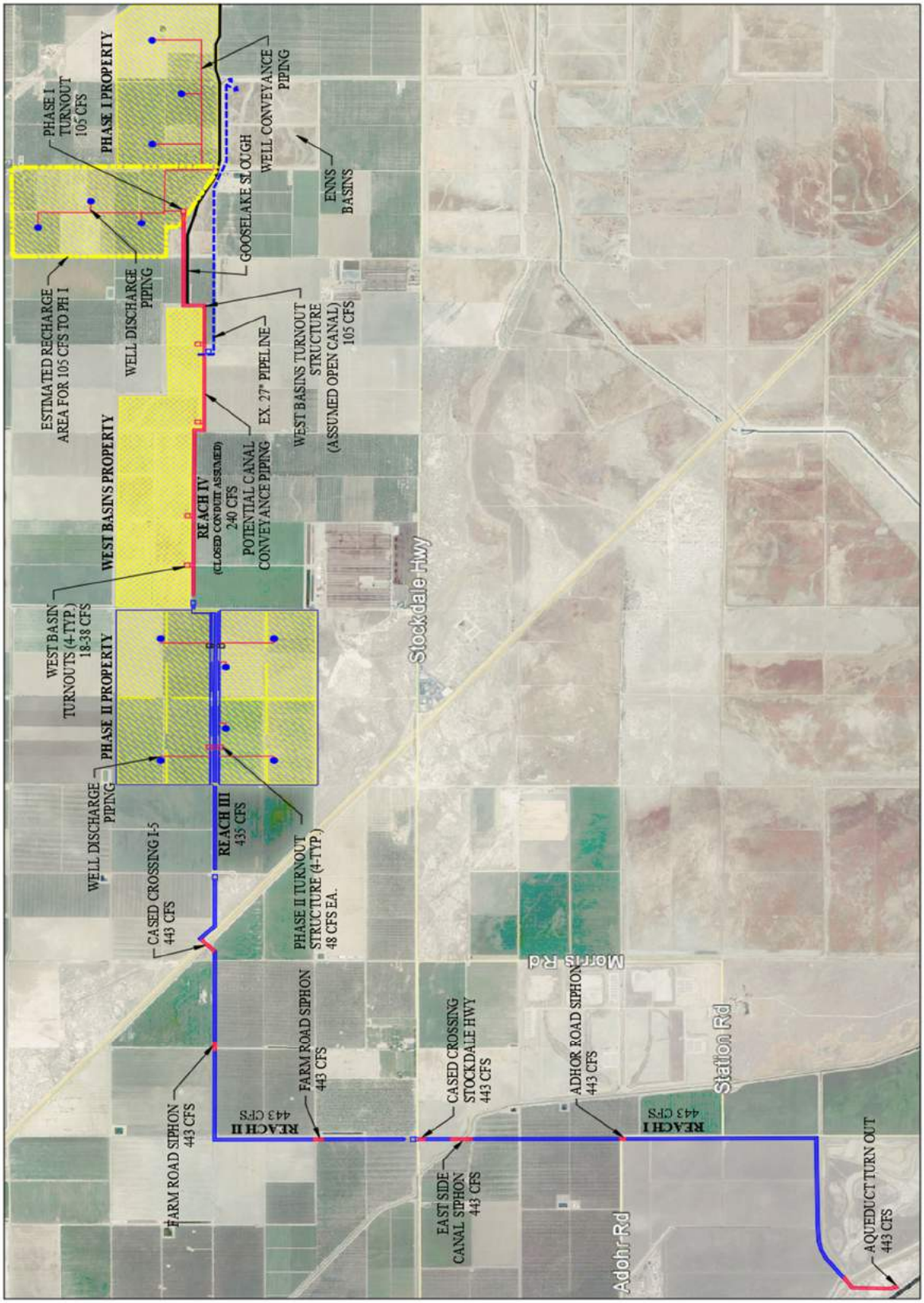


Figure 1 – Project Site Map

The Kern Fan Groundwater Storage Project is planned to have multiple packages for the design and the construction of the project. This approach will divide the project into subsets that will lead to the most qualified firms and contractors working on those phases as well as break the project down into more manageable sizes.

The project duration is anticipated to be six to eight years from start to finish. The GBJPA is currently working on land acquisition, environmental documents, funding options, and preliminary engineering design in the form of technical memoranda. The technical memoranda are attached as appendices to this RFP and are to provide further clarification and definition to the project scope of work. These memoranda are not intended to function as the design for the project, but rather are intended to provide a basis and direction for the design and implementation of the project.

It is envisioned that there may be up to five different design packages as outlined below:

1. <u>Design Package #1 (Recharge Basins & Infrastructure)</u>
   Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie; Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures

2. <u>Design Package #2 (Recovery Wells)</u>
   Phase I Well Drilling and Equipping; Phase II Well Drilling and Equipping

3. <u>Design Package #3 (Aqueduct Turnout)</u>
   Aqueduct Turnout Facility

4. <u>Design Package #4 (Conveyance Facilities)</u>
   Conveyance Facilities including Turnouts & Pump Stations

5. <u>Design Package #5 (SCADA)</u>
   SCADA and PLC Programming

Engineering firms may be selected for a single design package or multiple design packages at the discretion of the GBJPA. Engineering firms shall provide cost proposals for the design packages they are interested in.

The design will include multiple project bid and construction packages. It is envisioned that there will be ten project bid packages as outlined below:

Item 1 Design Package (above)

1. Phase I Recharge Basins

2. Phase I Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie

3. Phase II Recharge Basins

4. Phase II Well Pipelines and Interbasin Structures

Item 2 Design Package (above)

5. Phase I Well Drilling and Equipping

6. Phase II Well Drilling and Equipping

Item 3 Design Package (above)

7. Aqueduct Turnout Facility

Item 4 Design Package (above)

8. Conveyance Facilities including Turnouts & Pump Stations

9. Pump Station Equipping

Item 5 Design Package (above)

10. SCADA and PLC Programming

II. Schedule

RFP Issued…….September 2nd, 2021
Pre-Proposal Conference…….. September 29th, 2021
Deadline for Written Questions…… October 7th, 2021
Proposals Due at …… October 20th, 2021
Interviews /Presentations (if required)…….. November 1st – 17th, 2021
Award of Contract…… December 2021
Contract Begins…… January 1, 2022

Estimated Schedule for Design Packages

1. Design Package 1 (Recharge Basins & Infrastructure): Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie; Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures

   January 1, 2022 – October 1, 2022 (9 month duration)

2. Design Package 2 (Recovery Wells): Phase I Well Drilling and Equipping; Phase II Well Drilling and Equipping

   May 1, 2022 – January 1, 2023 (8 month duration)

3. Design Package 3 (Aqueduct Turnout): Aqueduct Turnout Facility

   January 1, 2023 – June 31, 2023 (6 month duration)

4. Design Package 4 (Conveyance Facilities): Conveyance Facilities including Turnouts & Pump Stations

   April 1, 2023 – August 1, 2024 (16 month duration)

5. Design Package 5 (SCADA): SCADA and PLC Programming

   January 1, 2022 – August 1, 2024 (Intermittent over 31 month duration)

III. Scope of Services

The detailed scope of work presented herein shall be used to establish the minimum requirements for the project. The Proposer shall review the scope of work and attached technical memoranda and provide a comprehensive scope of work that reflects all the efforts necessary to complete the project.

In general, the work includes preliminary engineering design and value engineering, final design services, bid phase assistance, and construction phase assistance as outlined herein, with each phase being authorized by a separate Notice to Proceed. The scope of work and budget proposal submitted by the selected firm are to be standalone documents that will become contract exhibits. In preparing this proposal, the Proposer needs to thoroughly identify and discuss any and all issues relevant to the proposed project rather than simply repeating the scope of work discussed herein.

A. Task #1 Engineering Design

The design firm shall perform all work necessary to prepare the engineering design and construction bid documents for the project. All contract documents shall be developed in accordance with all building, plumbing, electrical and other applicable codes and regulations. All contract documents shall be developed by individuals appropriately licensed for the work they are designing. All documents, at a minimum, shall provide adequate detail and information to provide clear guidance for bidding and for construction purposes. Regular project meetings will be held to review project progress, answer questions, and provide design decisions.

Design Package #1 (Recharge Basins & Infrastructure):

- Review Preliminary Work and Technical Memoranda and provide feedback, questions, concerns, suggestions, and/or alternatives
- Review and Incorporation of Environmental Mitigation Measures
- Provide Geotechnical Investigation and Report
- Provide Topographic Surveying
- Provide Preliminary Engineering Design & Value Engineering
- Attendance and Participation in Monthly Project Design Meetings
- Preparation of 30% Level Design Drawings for Review and Comment
- Preparation of 60% Level Design Drawings for Review and Comment
- Preparation of 90% Level Design Drawings, Specifications, and Engineer's Estimate for Review and Comment
- Preparation of 100% Level Design Drawings, Specifications, and Engineer's Estimate for Review and Comment
- Issue Bid Documents

Design Package #2 (Recovery Wells):

- Review Preliminary Work and Technical Memoranda and provide feedback, questions, concerns, suggestions, and/or alternatives

- Review and Incorporation of Environmental Mitigation Measures
- Provide Topographic Surveying
- Provide Preliminary Engineering Design & Value Engineering
- Attendance and Participation in Monthly Project Design Meetings
- Preparation of 30% Level Design Drawings for Review and Comment
- Preparation of 60% Level Design Drawings for Review and Comment
- Preparation of 90% Level Design Drawings, Specifications, and Engineer's Estimate for Review and Comment
- Preparation of 100% Level Design Drawings, Specifications, and Engineer's Estimate for Review and Comment
- Issue Bid Documents

Design Package #3 (Aqueduct Turnout):

- Review Preliminary Work and Technical Memoranda and provide feedback, questions, concerns, suggestions, and/or alternatives
- Review and Incorporation of Environmental Mitigation Measures
- Provide Geotechnical Investigation and Report
- Provide Topographic Surveying
- Provide Preliminary Engineering Design & Value Engineering
- Attendance and Participation in Monthly Project Design Meetings
- Permit Assistance with DWR
- Coordination with Department of Water Resources (DWR)
- Coordination with the Kern County Water Agency (KCWA)
- Preparation of 30% Level Design Drawings for Review and Comment
- Preparation of 60% Level Design Drawings for Review and Comment
- Preparation of 90% Level Design Drawings, Specifications, and Engineer's Estimate for Review and Comment
- Preparation of 100% Level Design Drawings, Specifications, and Engineer's Estimate for Review and Comment
- Issue Bid Documents

Design Package #4 (Conveyance Facilities):

- Review Preliminary Work and Technical Memoranda and provide feedback, questions, concerns, suggestions, and/or alternatives
- Review and Incorporation of Environmental Mitigation Measures
- Provide Geotechnical Investigation and Report
- Provide Topographic Surveying
- Provide Preliminary Engineering Design & Value Engineering
- Attendance and Participation in Monthly Project Design Meetings
- Permit Assistance with Caltrans and County of Kern
- Provide Hec-Ras Modeling
- Provide Physical Hydraulic Modeling
- Preparation of 30% Level Design Drawings for Review and Comment
- Preparation of 60% Level Design Drawings for Review and Comment

- Preparation of 90% Level Design Drawings, Specifications, and Engineer's Estimate for Review and Comment
- Preparation of 100% Level Design Drawings, Specifications, and Engineer's Estimate for Review and Comment
- Issue Bid Documents

Design Package #5 (SCADA):

- Review Preliminary Work and Technical Memoranda and provide feedback, questions, concerns, suggestions, and/or alternatives
- Coordination with other Design Firms and Project Phases
- Provide Preliminary Engineering Design & Value Engineering
- Attendance and Participation in Monthly Project Design Meetings
- Preparation of a Control Narrative for the Overall Project as well as Specific Phases
- Preparation of 30% Level Design Drawings for Review and Comment
- Preparation of 60% Level Design Drawings for Review and Comment
- Preparation of 90% Level Design Drawings, Specifications, and Engineer's Estimate for Review and Comment
- Preparation of 100% Level Design Drawings, Specifications, and Engineer's Estimate for Review and Comment
- Issue Bid Documents

B. Task #2 Bid Assistance

The GBJPA will be responsible for advertising for bids, facilitating pre-bid job walks, and administering the bid opening. The design firm shall provide assistance during the bid phase as outlined below.

Design Package #1 (Recharge Basins & Infrastructure):

- Provide written responses to Bid Requests for Information (RFI's). Estimate twenty (20) RFI's documents.
- Provide written addendum as necessary during bidding phase. Estimate three (3) addenda.
- Assistance with power service application to PG&E for Goose Lake Channel Pump Station
- Provide Conformed Documents issued for construction.

Design Package #2 (Recovery Wells):

- Provide written responses to Bid Requests for Information (RFI's). Estimate twenty (20) RFI's documents.
- Provide written addendum as necessary during bidding phase. Estimate three (3) addenda.
- Assistance with power service application to PG&E for up to twelve wells.
- Provide Conformed Documents issued for construction.

Design Package #3 (Aqueduct Turnout):

- Provide written responses to Bid Requests for Information (RFI's). Estimate twenty (20) RFI's documents.
- Provide written addendum as necessary during bidding phase. Estimate three (3) addenda.
- Assistance with power service application to PG&E for Aqueduct Turnout.
- Coordination with DWR and KCWA, as necessary.
- Provide Conformed Documents issued for construction.

Design Package #4 (Conveyance Facilities):

- Provide written responses to Bid Requests for Information (RFI's). Estimate forty (40) RFI's documents.
- Provide written addendum as necessary during bidding phase. Estimate five (5) addenda.
- Assistance with power service application to PG&E for Pump Stations and Turnouts.
- Provide Conformed Documents issued for construction.

Design Package #5 (SCADA):

- Provide written responses to Bid Requests for Information (RFI's). Estimate twenty (20) RFI's documents.
- Provide written addendum as necessary during bidding phase. Estimate three (3) addenda.
- Provide Conformed Documents issued for construction.

C. Task #3 Construction Assistance

The GBJPA will be responsible for the construction management and inspection services. The design firm shall provide assistance during the construction phase as outlined below.

Design Package #1 (Recharge Basins & Infrastructure):

- Provide submittal and shop drawing review. Estimate fifty (50) initial submittals plus twenty-five (25) re-submittals.
- Provide written responses to construction Requests for Information (RFI's). Estimate ten (10) RFI's documents.
- Assistance with power service application to PG&E for Goose Lake Channel Pump Station
- Provide Project As-Built Drawings.

Design Package #2 (Recovery Wells):

- Provide submittal and shop drawing review. Estimate seventy (70) initial submittals plus thirty-five (35) re-submittals.
- Provide written responses to construction Requests for Information (RFI's). Estimate fifteen (15) RFI's documents.
- Assistance with power service application to PG&E for recovery wells.
- Provide Project As-Built Drawings.

Design Package #3 (Aqueduct Turnout):

- Provide submittal and shop drawing review. Estimate fifty (50) initial submittals plus twenty-five (25) re-submittals.
- Provide written responses to construction Requests for Information (RFI's). Estimate twenty (20) RFI's documents.
- Assistance with power service application to PG&E for Aqueduct Turnout.
- Provide Project As-Built Drawings.

Design Package #4 (Conveyance Facilities):

- Provide submittal and shop drawing review. Estimate two-hundred (200) initial submittals plus one-hundred (100) re-submittals.
- Provide written responses to construction Requests for Information (RFI's). Estimate fifty (50) RFI's documents.
- Assistance with power service application to PG&E for Pump Stations and Turnouts.
- Provide Project As-Built Drawings.

Design Package #5 (SCADA):

- Provide submittal and shop drawing review. Estimate fifty (50) initial submittals plus twenty-five (25) re-submittals.
- Provide written responses to construction Requests for Information (RFI's). Estimate twenty (20) RFI's documents.
- Provide Project As-Built Drawings.

D. GBJPA Responsibilities

The GBJPA will provide a "Technical Representative(s)" who will represent the GBJPA and who will work with the Design Firm in carrying out the provisions of the project. They shall have the option to examine documents, review plans, and participate in design decisions in a timely manner throughout the duration of the project. They will also have the option to perform "peer reviews" of the plans, specifications, and estimates of the appropriate project deliverables and have the discretion to require changes.

The Technical Representatives serving on the Engineering Team for the GBJPA include the following:

Dan Bartel – Rosedale Rio-Bravo Water Storage District
TBD – Irvine Ranch Water District
Markus Nygren – Rosedale Rio-Bravo Water Storage District
Curtis Skaggs – Consultant with Dee Jaspar & Associates, Inc.

The Technical Representative will facilitate regular project meetings and maintain sufficient communication with the Design Firm.

- The GBJPA will provide the project environmental document(s) in the form of an EIR and any other applicable environmental coverage documents, along with the environmental mitigation monitoring and reporting requirements. The selected firm shall be responsible for familiarizing themselves with these documents and for incorporating the applicable mitigation monitoring and reporting requirements into the bid documents.

- The GBJPA will perform preliminary survey work and establish a survey control grid for horizontal and vertical control that will be utilized for each design phase to ensure that all project components are on the same survey control and datum. A project survey map will be furnished to the design firm that identifies found section corners and survey monuments, field bearing and distances, record bearing and distances, and elevation benchmarks within the project area from the California Aqueduct to the recharge facilities. Each design phase will utilize the specified horizontal and vertical control identified on the project survey map as their control for field surveying to ensure all project facilities are on the same datum.

- The GBJPA will initiate project correspondence with PG&E for electrical service to the project and facilitate PG&E communication. The GBJPA will ensure PG&E's understanding of the comprehensive project and overall electrical loads. The selected firm will be expected to provide technical information as required and to assist with the electrical service application process.

- The GBJPA or its designated representative will handle land procurement, right-of-way acquisition, and negotiations with landowners. The selected firm will be responsible for providing land survey information, right-of-way plats, and property legal descriptions for land purchased in-fee, permanent easements, and temporary easements.

IV. Proposal Contents and Format Requirements

Proposers are requested to organize their responses into sections with tabs corresponding to the listed criteria below.

A. General Information

1. Firm name, address, telephone number, fax number, and email address.
2. Firm Representative or other person to contact for clarification of any item contained in the proposal and to coordinate interviews. Include telephone number, fax number, and email address if different from above.
3. Specify type of organization (individual, partnership, or corporation) and if applicable indicate whether you are a Small Business, Disadvantaged Business, or Minority and/or Women-Owned Business.
4. Provide your Federal Tax ID Number, City of Bakersfield Business License, and Department of Industrial Relations (DIR) Registration Number.
5. Provide names of the Firm's Owners or Officers.
6. Provide names of the Project Team to be employed on this project and roles.
7. Provide names of any firms being included as a Joint Venture. Provide same information above for any firm involved as a Joint Venture.
8. Provide names of any sub-consultants to be utilized.
9. Provide surety information for all sureties – General and Automobile Liability, E/O and Worker's Compensation
10. List of References and Referrals.

B. Project Staff

1. This section shall outline the project team, team structure, and staff that will be assigned to each design package. This shall include personnel such as the project manager(s), principal(s), design engineer(s), surveyor(s), draftsperson(s), and sub-consultants. The Design Firm may not substitute any member of the project team without prior written approval from the GBJPA. An organizational chart shall be provided for all project team members, staff, and any sub-consultants.

2. Demonstrate the qualifications of all professional personnel to be assigned to this project by providing resumes and experience summaries describing their education, credentials, related experience, and their proposed roles for this project.

3. If your firm intends to subcontract any of the services required under this RFP it should be discussed in this section. Detailed information for each sub-consultant or subcontractor must be provided. For Design Package #4 (Conveyance Facilities), the Design Firm shall provide information and qualifications for the firm or laboratory that will provide the physical hydraulic modeling.

C. Related Project Experience

1. Provide descriptive information concerning the experience of the firm. Include information about previous projects which are similar in nature, size, scope, and delivery method.

2. Provide specific project experience for a minimum of three (3) comparable projects for each Design Package you are proposing on. List the projects in reverse chronological order and provide the following information for each project:

    - Name of Project
    - Project Location
    - Construction Value
    - Brief Description (Type of Construction, Functional Components, Special Design Consideration)
    - Name of Owner
    - Owner's Contact Person and Telephone Number
    - Your Firm's Specific Involvement (i.e. Engineer, Subconsultant, etc.)
    - Outline of Project Team Involved
    - Year Started and Completed
    - Engineering Proposal Cost versus Actual Cost

3. It is important that the related experience provided include as many of the proposed Project Team Members outlined in Section B above.

4. Provide a detailed list of project references that will be contacted as part of the selection process. This is in addition to the project experience listed above. Provide Owner's Name, Contact Name, Contact Number, Contact Email Address, Project Name, Brief Description, and years worked on.

D. Proposed Project Approach

1. Outline which Design Packages are being proposed on for the project and the proposed approach to the project. The approach and scope of work shall consist of:

    - Design Package Number
    - Objectives
    - Tasks and Brief Description
    - Work Products
    - Meeting(s)
    - Timeline
    - Completion Date

2. Summarize the approach and understanding of the project and any special considerations of which the GBJPA should be aware. Indicate clearly, the levels of participation you will expect from the GBJPA, beyond those described herein, in the fulfillment of the contract. The contents of this section shall be determined by the

proposer, but should demonstrate an understanding of the special characteristics of this project.

3. Exceptions to any requirements of the RFP should be clearly delineated in this section.

E. Project Schedule and Ability to Provide Requested Services

1. Discuss your ability to provide the desired services herein.

2. Provide a detailed project schedule for the performance of the work listed herein.

F. Cost Proposal

1. A cost proposal for engineering design services shall be provided under a separate sealed envelope as part of this proposal as outlined herein in Section VI "Cost Proposal".

2. Design firms may propose on any of the Design Packages including any combination of packages or may provide a proposal for all five.

3. The cost proposal shall be provided on the Proposal Form included herein. In addition, a detailed cost breakdown identifying the project staff, hourly rate, work task, estimated hours, and estimated costs shall be submitted for each Design Package that is proposed on. Sample worksheets are attached hereto. These worksheets do not have to be utilized but the format provided shall be similar.

V. General Conditions

A. General Notice

The GBJPA will not be responsible for oral representations or interpretations given by a District employee, representative, or others. Proposers are cautioned that any statements made that materially change any portion of the proposal documents shall not be relied upon unless subsequently ratified by a formal written amendment to the proposal document. The issuance of a written addendum is the only official method whereby interpretation, clarification, or additional information can be given. If any addenda are issued to this Request for Proposals, the GBJPA will attempt to notify all prospective proposers who have secured RFP's. However, it will ultimately be the responsibility of each proposer to ensure they have copies of all the addenda prior to submitting their proposal.

B. Contracting Entity

The contract resulting from this Request for Proposals will be administered by the Groundwater Banking Joint Powers Authority.

C. DIR Requirements

Notice is hereby given that this is a Public Works Project. All contractors and subcontractors, consultants, and sub-consultants bidding and performing work on Public Works Projects must:

1. Register on an annual basis with the California Department of Industrial Relations (DIR)
2. Furnish electronic payroll records for new projects to the Labor Commissioner

This includes Professional Architectural, Engineering, or Planning Firms that employ or subcontract workers that are covered under the prevailing wage laws such as surveyors, material testers, and inspectors. No contract will be awarded unless contractor and subcontractors are registered with the California Department of Industrial Relations (DIR). Proposals submitted by unregistered contractors or list unregistered subcontractors will be rejected as non-responsive.

A contractor or subcontractor shall not be qualified to bid on, be listed in a bid proposal, subject to the requirements of Section 4104 of the Public Contract Code, or engage in the performance of any contract for public work, as defined in this chapter, unless currently registered and qualified to perform public work pursuant to Section 1725.5. It is not a violation of this section for an unregistered contractor to submit a bid that is authorized by Section 7029.1 of the Business and Professions Code or by Section 10164 or 20103.5 of the Public Contract Code, provided the contractor is registered to perform public work pursuant to Section 1725.5 at the time the contract is awarded.

Consultant and sub-consultants shall fulfill requirements of Department of Industrial Relations and California Labor Codes by complying with the project Labor Compliance Manual.

D. Legal Responsibilities

All proposals must be submitted, filed, made, and executed in accordance with State of California and Federal laws relating to proposals for contracts of this nature whether the same or expressly referred to herein or not. By submitting a proposal, Consultant certifies that he or she will comply with all Federal laws and requirements, including but not limited to Equal Employment Opportunity, Disadvantaged Business Enterprise, Labor Protection and other laws and regulations applicable to contracts utilizing Federal Funds.

E. Permits and Licenses

Consultant shall be licensed in accordance with the California Business and Professions Code and is to possess the necessary current professional registrations for the project and be licensed to perform work in the State of California.

In addition, the Consultant shall have a valid and current City of Bakersfield Business Tax Certificate prior to commencing any work. For additional information contact the City of Bakersfield at (661) 326-3762.

Consultant shall be required to obtain and maintain at his/her own expense, any and all permits, licenses, and certifications issued by any federal, state, or local governmental agency, pertaining to, and necessary for providing the services required in this Request for Proposals.

F. Insurance

As respects acts, errors, or omissions in the performance of services, the Consultant agrees to indemnify and hold harmless the GBJPA, its elected and appointed officers, employees, representatives, and designated volunteers from and against any and all claims, demands, losses, defense costs, liability or consequential damages arising directly out of Consultant's negligent acts, errors, or omissions in the performance of his/her services under the terms of this Agreement; except to the extent those arise out of the negligence of the GBJPA.

The GBJPA agrees to indemnify and hold harmless the Consultant, its officers, employees, and designated volunteers from and against any and all losses, defense costs, liability or consequential damages to the extent arising out of the GBJPA's negligent acts, errors, or omissions in the performance of this Agreement.

As respects all acts or omissions which do not arise directly out of the performance of services, including but not limited to those acts or omissions normally covered by

general and automobile liability insurance, Consultant agrees to indemnify, defend (at GBJPA's option), and hold harmless the GBJPA, its elected and appointed officers, agents, employees, representatives, and volunteers from and against any and all claims, demands, defense costs, liability, or consequential damages of any kind or nature arising out of or in connection with Consultant's (or Consultant's subcontractor's, if any) performance or failure to perform, under the terms of this Agreement; except to the extent those which arise out of the negligence of the GBJPA.

Without limiting the GBJPA's right to indemnification, it is agreed that Consultant shall secure prior to commencing any activities under this Agreement, and maintain during the term of this Agreement, insurance coverage as follows:

- Workers' Compensation Insurance as required by California statutes

- Comprehensive General Liability insurance with a combined single limit of not less than One Million Dollars ($1,000,000) per occurrence. Such insurance shall include coverage for Premises and Operations, Contractual Liability, Personal Injury Liability, Products and Completed Operations Liability, Broad Form Property Damage (if applicable), Independent Contractor's Liability (if applicable)

- Business Automobile Liability coverage with a combined single limit of not less than One Million Dollars ($1,000,000) per occurrence. Such insurance shall include coverage for owned, hired, and non-owned automobiles and shall be provided by a business automobile policy.

- Professional Liability (E&O) coverage for liability arising out of, or in connection with, the performance of all required services under this Agreement, with coverage equal to the policy limits, which shall not be less than One Million Dollars ($1,000,000) per occurrence and Two Million Dollars ($2,000,000) aggregate.

Each insurance policy required by this Agreement shall contain the following clause:

"This insurance shall not be canceled, limited in scope or coverage, or non-renewed until after thirty (30) days prior written notice has been given to the GBJPA, 849 Allen Road, Bakersfield, CA 93314, with the exception of cancellation for non-payment of premium, in which case ten (10) days' notice shall be given"

In addition, the Comprehensive General Liability and Business Automobile Liability policies required by this Agreement shall contain the following clauses:

"It is agreed that any insurance maintained by the GBJPA shall apply in excess of and not contribute with insurance provided by this policy."

"The GBJPA, its officers, agents, employees, representatives, and volunteers are added as additional insureds as respects operations and activities of, or on behalf of the named insured, performed under contract with the GBJPA."

The successful Consultant shall maintain the insurance for the life of the Agreement. Endorsements are to be received and approved by the GBJPA before work commences. Should Consultant cease to have insurance as required during any time, all work by Consultant pursuant to the Agreement shall cease until insurance acceptable to the GBJPA is provided.

G. Withdrawal of Proposals

Before submitting a proposal, the proposer shall satisfy themselves by personal examination of the proposal requirements and other contract documents, and by any other means as they may believe necessary, as to the actual conditions, requirements, and difficulties under which the work must be performed and to verify any representations made by the GBJPA.

The submission of a proposal shall be considered conclusive evidence that the proposer has carefully investigated all conditions that affect, or may at some future date affect, the performance of services covered by this solicitation, and is satisfied as to the character, quality, and quantities of work to be performed and as to the requirements of the proposal. Submission of a proposal shall also be evidence that the proposer is familiar with directives that in any way affect prosecution of the work or persons engaged or employed in the work. No proposer shall at any time after submission of a proposal make any claim or assertion that there was any misunderstanding or lack of information regarding the nature or amount of work necessary for satisfactory performance under the contract.

Any proposal may be withdrawn at any time prior to the time fixed in the public notice for the receipt of proposals, but only by written request for the withdrawal of the proposal filed with the GBJPA. The request shall be executed by the proposer or his duly authorized representative. The withdrawal of a proposal does not prejudice the right of the proposer to file a new proposal. No proposal may be withdrawn after the time fixed in the public notice for the receipt of proposals.

H. Rejection of Proposals

Failure to meet the requirements of the Request for Proposals may be cause for rejection of the proposal. The GBJPA may reject the proposal if it is deemed incomplete, contains irregularities of any kind or is offered conditionally. The GBJPA reserves the right to reject any and all proposals without cause.

The proposal is to be prepared in such a way as to provide a straightforward, concise delineation of the information requested. Proposals which contain false or misleading statements, or which do not support an attribute or condition claimed by the proposer, may be cause for rejection of the proposal. If, in the opinion of the GBJPA, such information was intended to mislead the GBJPA in its evaluation of the proposal, it will be cause for rejection of the proposal.

I. Evaluation and Award of Contract

Evaluation and selection of proposals will be based on the information called for in this RFP. Brochures or other promotional materials beyond that sufficient to submit a complete and effective proposal are not desired.

Proposals will be reviewed by the GBJPA Technical Committee and other representatives as deemed appropriate by the GBJPA. The selection of the firm will be at the sole discretion of the GBJPA and will include factors such as qualifications, experience, local knowledge, past performance, schedule, and cost.

As part of the evaluation process, the GBJPA may, at its discretion, invite one or more proposers for an interview and oral presentation.

The award, if made, will be made within ninety (90) days from the proposal closing date. The Proposer agrees and so stipulates in submitting this proposal, as though stated therein, and in any subsequent award of contact that:

1. Proposer is an independent consultant/contractor, not an employee, agent, or officer of the GBJPA.
2. Contract, should it be awarded, shall be interpreted, construed, and given effect in all respects according to the laws of the State of California.
3. Should proposer be awarded contract, proposer shall not assign contract, or any part thereof, or any moneys due or to become due thereunder, without prior consent of the GBJPA.
4. Proposer shall indemnify and hold harmless the GBJPA, its officers, officials, employees, representatives, and agents from and against all claims, damages, losses, and expenses caused in whole or in part by any negligent act or omission of the proposer, its Consultants, sub-consultants, anyone directly or indirectly employed by any of them, or anyone for whose acts any of them may be liable, except where caused by the active negligence, sole negligence, or willful misconduct by the GBJPA.
5. Proposer shall hold the GBJPA and its representatives harmless from liability of any nature or kind, including cost and expenses for infringement or use of any copyrighted composition, secret process, patented or unpatented invention, article or appliance furnished or used in connection with the contract.
6. Proposer warrants that no gratuities, in the form of gifts, entertainment, or otherwise, were offered or given by the proposer, to any officer or employee or

representative of the GBJPA with a view toward securing the contract or securing favorable treatment with respect to any determination concerning the performance of the contract. For breach or violation of this warranty, the GBJPA shall have the right to terminate the contract, either in whole or in part. The rights and remedies of the GBJPA provided in this clause shall not be exclusive, and are in addition to any other rights and remedies provided by law or under the contract.

J. Assignment of Contract

No assignment of the contract or any part hereof, or of funds to be received thereunder, will be binding upon the GBJPA unless such assignment had prior written approval and consent of the GBJPA. In the event the GBJPA gives such consent, the terms and conditions of the agreement shall apply to, and bind the party or parties to whom such work is assigned, sublet, or transferred.

K. Right to Require Performance

The failure of the GBJPA at any time to require performance by the proposer of any provisions hereof shall in no way affect the right of the GBJPA thereafter to enforce the same. Nor shall waiver by the GBJPA of any breach of any provision hereof be taken or held to be a waiver of any succeeding breach of such provision or as a waiver of any provision itself.

L. Ethics in Public Contracting

Each proposer, by submitting a proposal, certifies that it is not a party to any collusive action or any action that may be in violation of the Sherman Antitrust Act. By submitting a proposal, the proposer certifies that its proposal was made without fraud; that it has not offered or received any kickbacks or inducement from any other proposer in connection with the request for proposals; and that it has not conferred on any employee, member or official having responsibility for this procurement transaction, any payment, loan, subscription, advance, deposit of money, services, or anything of more than nominal value. The proposer further certifies that no relationship exists between itself and the GBJPA or another person or organization that interferes with fair competition or constitutes a conflict of interest with respect to a contract with the GBJPA.

More than one proposal from an individual, firm, partnership, corporation or association under the same or different names may be rejected. Reasonable grounds for believing that a proposer has interest in more than one proposal for the work solicited may result in rejection of all proposals in which the proposer is believed to have an interest.

The proposer shall disclose any financial, business, or other relationship with the GBJPA or any member of the District staff that may have an impact on the outcome of the project. Provide a list of any current clients who may have a financial interest in the outcome of the project.

M. Equal Employment Opportunity

During the performance of the contract, the proposer agrees to the following:

1. Proposer shall comply with all the requirements, when applicable, of the California Fair Employment Practice Commission and provisions of, when applicable, all Federal, State of California, and County of Kern laws and ordinances related to employment practices.

2. Proposer shall not discriminate against any employee or applicant for employment on the basis of race, religion, color, gender, age, handicap, national origin or ancestry, except when such a condition is a bona fide occupational qualification reasonably necessary for the normal operations of the proposer. The proposer agrees to post in conspicuous places, visible to the employees and applicants for employment, notices setting forth the provisions of this nondiscrimination clause.

3. Proposer, in all solicitations or advertisements for employees, placed by, or on behalf of the proposer, shall state that proposer is an Equal Opportunity Employer.

N. Sample Agreement

1. No agreement with the GBJPA is in effect until a contract has been signed by both parties.

2. A sample agreement for Professional Services between the selected Proposer and the Groundwater Banking Joint Powers Authority is attached for reference in Appendix L. The final agreement may include the contents of the RFP, any addenda to this RFP, portions of the successful proposer's proposal and any other modifications determined by the GBJPA to be necessary prior to its execution by the parties.

3. The sample agreement is included in Appendix L for informational purposes only and should not be returned with a Proposal; however, the Proposal shall include a statement that the proposer has reviewed the sample agreement and either i) will agree to and accept the terms and conditions of that agreement if selected, or ii) indicate those specific provisions of the sample agreement to which the proposer takes exception and why. The raising of significant exceptions in a Proposal, as determined in the sole discretion of the GBJPA, may be cause for rejection of the Proposal.

4. The selected Proposer will be required to execute an agreement with the GBJPA for the services requested within sixty (60) days of the award. If agreement on the terms and conditions of the contract that are acceptable to the GBJPA , including, but not limited to, compensation, cannot be achieved within that timeframe, the GBJPA reserves the right to continue negotiations or to award the bid to another proposer and begin negotiations with that proposer.

VI. Cost Proposal

The proposed project fee, rate structure, and schedule must be submitted under separate, sealed cover as a part of the RFP.

Provide proposed fees and cost information on the proposal/fee schedule form provided.

- Proposers should review the requirements of this RFP and address all services in this fee schedule that are required to support the project. The fees provided shall be considered not-to-exceed amounts and shall include hard copy prints, meetings, travel expenses, etc. that are expected with this project. All work will be invoiced and paid for on an hourly basis for the actual work performed.

- Proposers may propose on all five design packages or they may propose on select design packages at their discretion. Design packages that are not proposed on shall be noted accordingly.

- Proposers shall provide the most current rate schedule. These shall be the unit rates paid for the duration of the contract and will not be subject to cost increases.

- The fee proposal submitted under separate, sealed cover, along with the proposed project schedule, will be used as a basis for any contract negotiations. The actual scope of serves and fees included in the contract may be negotiated and may vary to satisfy the GBJPA's actual needs.

The GBJPA may award the five design packages in any fashion as they deem appropriate and best for the project, i.e. award to one single firm, award to five different firms, or award to some other combination(s) of firms.

The GBJPA is not liable for any costs incurred by proposers in responding to this Request for Proposals.

Proposal Form

Design Package #1 (Recharge Basins & Infrastructure)

Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines & Intertie; Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures.

Engineering Design Proposal (Not-to-Exceed)	$_____
Bid Assistance Proposal (Not-to-Exceed)	$_____
Construction Assistance Proposal (Not-to-Exceed)	$_____
Total Proposal (Not-to-Exceed)	*$*_____

Design Package #2 (Recovery Wells)

Phase I Well Drilling and Equipping; Phase II Well Drilling and Equipping.

Engineering Design Proposal (Not-to-Exceed)	$_____
Bid Assistance Proposal (Not-to-Exceed)	$_____
Construction Assistance Proposal (Not-to-Exceed)	$_____
Total Proposal (Not-to-Exceed)	*$*_____

Design Package #3 (Aqueduct Turnout)

Aqueduct Turnout Facility.

Engineering Design Proposal (Not-to-Exceed)	$_____
Bid Assistance Proposal (Not-to-Exceed)	$_____
Construction Assistance Proposal (Not-to-Exceed)	$_____
Total Proposal (Not-to-Exceed)	*$*_____

Design Package #4 (Conveyance Facilities)

Conveyance Facilities including Turnouts & Pump Stations.

Engineering Design Proposal (Not-to-Exceed)	$_____
Bid Assistance Proposal (Not-to-Exceed)	$_____
Construction Assistance Proposal (Not-to-Exceed)	$_____
Total Proposal (Not-to-Exceed)	*$*_____

Design Package #5 (SCADA)

SCADA and PLC Programming.

Engineering Design Proposal (Not-to-Exceed)	$_____
Bid Assistance Proposal (Not-to-Exceed)	$_____
Construction Assistance Proposal (Not-to-Exceed)	$_____
Total Proposal (Not-to-Exceed)	*$*_____

Notes:

1. Submit proposal worksheets for each design package proposed on above that includes the detailed breakdown of tasks, staff, hourly rate, estimated hours, and estimated costs.

2. Submit copy of current Rate Schedule to be utilized for the duration of the project.

Dee Jaspar Associates
Consulting Civil Engineers

Groundwater Banking Joint Powers Authority (GBJPA)
Kern Fan Groundwater Storage Project

Professional Services for Engineering Design Worksheet

Design Package No. 1: Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie; Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures	Principal Engineer	Registered Engineer / Project Manager	Staff Engineer	Surveyor	Survey Crew	Draftsperson	Secretary	Other Staff	Sub-Consultant	Sub-Consultant	Miscellaneous Costs, Mileage, Copies, etc.	
	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Cost ($)	Estimated Cost ($)	Estimated Cost ($)	Estimated Cost ($)	Total
Task #1 - Engineering Design	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	
Review preliminary work and provide comments, suggestions, and questions.												
Site topographic surveying.												
Geotechnical investigation and report.												
Phase I Recharge Basins Earthwork Design												
Phase I Recharge Basins Earthwork 60% Level Design Plans												
Phase I Recharge Basins Earthwork 90% Level Design Plans												
Phase I Recharge Basins Earthwork 100% Level Design Plans												
Phase I Recharge Basin Specifications and Bid Documents												
Phase I Recharge Basins Engineer's Estimate												
Goose Lake Channel Pump Station Preliminary Design												
Goose Lake Channel Pump Station 60% Level Design Plans												
Goose Lake Channel Pump Station Physical Modeling												
Goose Lake Channel Pump Station Final Design												
Goose Lake Channel Pump Station 90% Level Design Plans												
Goose Lake Channel Pump Station 100% Level Design Plans												
Goose Lake Channel Check Structure Design												
Goose Lake Channel Check Structure 60% Level Design Plans												
Goose Lake Channel Check Structure 90% Level Design Plans												
Goose Lake Channel Check Structure 100% Level Design Plans												
Phase I Recharge Basin Interbasin Structure Design												
Phase I Recharge Basin Interbasin Structure 60% Level Design Plans												
Phase I Recharge Basin Interbasin Structure 90% Level Design Plans												
Phase I Recharge Basin Interbasin Structure 100% Level Design Plans												
Phase I Recharge Basin Well Pipeline & Intertie to RRB Intake Canal Design												
Phase I Recharge Basin Well Pipeline & Intertie to RRB Intake Canal 60% Level Design Plans												
Phase I Recharge Basin Well Pipeline & Intertie to RRB Intake Canal 90% Level Design Plans												
Phase I Recharge Basin Well Pipeline & Intertie to RRB Intake Canal 100% Level Design Plans												
Phase I Pump Station, Check Structure, & Recharge Basin Infrastructure Specifications and Bid Documents												
Phase I Pump Station, Check Structure, & Recharge Basin Infrastructure Engineer's Estimate												
Phase II Recharge Basins Earthwork Design												
Phase II Recharge Basins Earthwork 60% Level Design Plans												
Phase II Recharge Basins Earthwork 90% Level Design Plans												
Phase II Recharge Basins Earthwork 100% Level Design Plans												
Phase II Recharge Basin Specifications and Bid Documents												
Phase II Recharge Basins Engineer's Estimate												
Phase II Recharge Basin Interbasin Structure Design												
Phase II Recharge Basin Interbasin Structure 60% Level Design Plans												
Phase II Recharge Basin Interbasin Structure 90% Level Design Plans												
Phase II Recharge Basin Interbasin Structure 100% Level Design Plans												
Phase II Recharge Basin Well Pipeline Design												
Phase II Recharge Basin Well Pipeline 60% Level Design Plans												
Phase II Recharge Basin Well Pipeline 90% Level Design Plans												
Phase II Recharge Basin Well Pipeline 100% Level Design Plans												
Phase II Recharge Basin Infrastructure Specifications and Bid Documents												
Phase II Recharge Basin Infrastructure Engineer's Estimate												
Project Meetings and General Project Correspondence												
Subtotal Task No. 1:												
Task #2 - Bid Assistance												
Phase I Recharge Basins RFI Responses (Estimate 20 RFI Documents)												
Phase I Recharge Basins Addenda (Estimate 3 Addenda)												
Phase I Recharge Basins Conformed Documents												
Phase I Pump Station, Check Structure, & Recharge Basin Infrastructure RFI Responses (Estimate 20 RFI Documents)												
Phase I Pump Station, Check Structure, & Recharge Basin Infrastructure Addenda (Estimate 3 Addenda)												
Phase I Pump Station, Check Structure, & Recharge Basin Infrastructure assistance with power service application												
Phase I Pump Station, Check Structure, & Recharge Basin Infrastructure Conformed Documents												
Phase II Recharge Basins RFI Responses (Estimate 20 RFI Documents)												
Phase II Recharge Basins Addenda (Estimate 3 Addenda)												
Phase II Recharge Basins Conformed Documents												
Phase II Recharge Basin Infrastructure RFI Responses (Estimate 20 RFI Documents)												
Phase II Recharge Basin Infrastructure Addenda (Estimate 3 Addenda)												
Phase II Recharge Basin Infrastructure Conformed Documents												
Subtotal Task No. 2:												
Task #3 - Construction Assistance												
Phase I Recharge Basins RFI Responses (Estimate 10 RFI Documents)												
Phase I Recharge Basins Submittal and Shop Drawing Review (Estimate 50 Submittals and 25 Re-Submittals)												
Phase I Recharge Basins As-Built Documents												
Phase I Pump Station, Check Structure, & Recharge Basin Infrastructure RFI Responses (Estimate 10 RFI Documents)												
Phase I Pump Station, Check Structure, & Recharge Basin Infrastructure Submittal and Shop Drawing Review (Estimate 50 Submittals and 25 Re-Submittals)												
Phase I Pump Station, Check Structure, & Recharge Basin Infrastructure assistance with power service application												
Phase I Pump Station, Check Structure, & Recharge Basin Infrastructure As-Built Documents												
Phase II Recharge Basins RFI Responses (Estimate 10 RFI Documents)												
Phase II Recharge Basins Submittal and Shop Drawing Review (Estimate 50 Submittals and 25 Re-Submittals)												
Phase II Recharge Basins As-Built Documents												
Phase II Recharge Basin Infrastructure RFI Responses (Estimate 10 RFI Documents)												
Phase II Recharge Basin Infrastructure Submittal and Shop Drawing Review (Estimate 50 Submittals and 25 Re-Submittals)												
Phase II Recharge Basin Infrastructure As-Built Documents												
Subtotal Task No. 3:												
Total Hours Estimated:	0	0	0	0	0	0	0	0	0	0	0	
Total Engineering Estimate:	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Dee Jaspar Associates
Consulting Civil Engineers

Groundwater Banking Joint Powers Authority (GBJPA)
Kern Fan Groundwater Storage Project

Professional Services for Engineering Design Worksheet

Design Package No. 2: Phase I Well Drilling and Equipping; Phase II Well Drilling and Equipping	Principal Engineer	Registered Engineer / Project Manager	Staff Engineer	Surveyor	Survey Crew	Draftsperson	Secretary	Other Staff	Sub-Consultant	Sub-Consultant	Miscellaneous Costs, Mileage, Copies, etc.	
	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Cost ($)	Estimated Cost ($)	Estimated Cost ($)	Estimated Cost ($)	Total
Task #1 - Engineering Design	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	
Review preliminary work and provide comments, suggestions, and questions.												
Site topographic surveying.												
Phase I Well Drilling and Equipping Design												
Phase I Well Drilling and Equipping 60% Level Design Plans												
Phase I Well Drilling and Equipping 90% Level Design Plans												
Phase I Well Drilling and Equipping 100% Level Design Plans												
Phase I Well Drilling and Equipping Specifications and Bid Documents												
Phase I Well Drilling and Equipping Engineer's Estimate												
Phase II Well Drilling and Equipping Design												
Phase II Well Drilling and Equipping 60% Level Design Plans												
Phase II Well Drilling and Equipping 90% Level Design Plans												
Phase II Well Drilling and Equipping 100% Level Design Plans												
Phase II Well Drilling and Equipping Specifications and Bid Documents												
Phase II Well Drilling and Equipping Engineer's Estimate												
Project Meetings and General Project Correspondence												
Subtotal Task No. 1:												
Task #2 - Bid Assistance												
Phase I Well Drilling and Equipping RFI Responses (Estimate 20 RFI Documents)												
Phase I Well Drilling and Equipping Addenda (Estimate 3 Addenda)												
Phase I Well Drilling and Equipping assistance with power service application												
Phase I Well Drilling and Equipping Conformed Documents												
Phase II Well Drilling and Equipping RFI Responses (Estimate 20 RFI Documents)												
Phase II Well Drilling and Equipping Addenda (Estimate 3 Addenda)												
Phase II Well Drilling and Equipping assistance with power service application												
Phase II Well Drilling and Equipping Conformed Documents												
Subtotal Task No. 2:												
Task #3 - Construction Assistance												
Phase I Well Drilling and Equipping RFI Responses (Estimate 15 RFI Documents)												
Phase I Well Drilling and Equipping Submittal and Shop Drawing Review (Estimate 70 Submittals and 35 Re-Submittals)												
Phase I Well Drilling and Equipping assistance with power service application												
Phase I Well Drilling and Equipping As-Built Documents												
Phase II Well Drilling and Equipping RFI Responses (Estimate 15 RFI Documents)												
Phase II Well Drilling and Equipping Submittal and Shop Drawing Review (Estimate 70 Submittals and 35 Re-Submittals)												
Phase II Well Drilling and Equipping assistance with power service application												
Phase II Well Drilling and Equipping As-Built Documents												
Subtotal Task No. 3:												
Total Hours Estimated:	0	0	0	0	0	0	0	0	0	0	0	
Total Engineering Estimate:	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Dee Jaspar Associates
Consulting Civil Engineers

Groundwater Banking Joint Powers Authority (GBJPA)
Kern Fan Groundwater Storage Project

Professional Services for Engineering Design Worksheet

Design Package No. 3: Aqueduct Turnout Facility	Principal Engineer	Registered Engineer / Project Manager	Staff Engineer	Surveyor	Survey Crew	Draftsperson	Secretary	Other Staff	Sub-Consultant	Sub-Consultant	Miscellaneous Costs, Mileage, Copies, etc.	
	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Cost ($)	Estimated Cost ($)	Estimated Cost ($)	Estimated Cost ($)	Total
Task #1 - Engineering Design	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	
Review preliminary work and provide comments, suggestions, and questions.												
Site topographic surveying.												
Geotechnical investigation and report.												
Aqueduct Turnout Design												
Aqueduct Turnout 60% Level Design Plans												
Aqueduct Turnout 90% Level Design Plans												
Aqueduct Turnout 100% Level Design Plans												
Aqueduct Turnout Facility Specifications and Bid Documents												
Aqueduct Turnout Facility Engineer's Estimate												
Permit Assistance and Coordination with the Department of Water Resources												
Project Meetings and General Project Correspondence												
Subtotal Task No. 1:												
Task #2 - Bid Assistance												
Aqueduct Turnout Facility RFI Responses (Estimate 20 RFI Documents)												
Aqueduct Turnout Facility Addenda (Estimate 3 Addenda)												
Aqueduct Turnout Facility assistance with power service application												
Aqueduct Turnout Facility Conformed Documents												
Subtotal Task No. 2:												
Task #3 - Construction Assistance												
Aqueduct Turnout Facility RFI Responses (Estimate 20 RFI Documents)												
Aqueduct Turnout Facility Submittal and Shop Drawing Review (Estimate 50 Submittals and 25 Re-Submittals)												
Aqueduct Turnout Facility assistance with power service application												
Aqueduct Turnout Facility As-Built Documents												
Subtotal Task No. 3:												
Total Hours Estimated:	0	0	0	0	0	0	0	0	0	0	0	
Total Engineering Estimate:	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Dee Jaspar Associates
Consulting Civil Engineers

Groundwater Banking Joint Powers Authority (GBJPA)
Kern Fan Groundwater Storage Project

Professional Services for Engineering Design Worksheet

Design Package No. 4: Conveyance Facilities including Turnouts & Pump Stations	Principal Engineer	Registered Engineer / Project Manager	Staff Engineer	Surveyor	Survey Crew	Draftsperson	Secretary	Other Staff	Sub-Consultant	Sub-Consultant	Miscellaneous Costs, Mileage, Copies, etc.	
	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Cost ($)	Estimated Cost ($)	Estimated Cost ($)	Estimated Cost ($)	Total
Task #1 - Engineering Design	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	
Review preliminary work and provide comments, suggestions, and questions.												
Site topographic surveying.												
Geotechnical investigation and report.												
Conveyance Facilities including Turnouts & Pump Stations Design												
Hec-Ras Hydraulic Modeling of Conveyance Facilities												
Conveyance Facilities including Turnouts & Pump Stations 60% Level Design Plans												
Conveyance Facilities including Turnouts & Pump Stations 90% Level Design Plans												
Conveyance Facilities including Turnouts & Pump Stations 100% Level Design Plans												
Conveyance Facilities including Turnouts & Pump Stations Specifications and Bid Documents												
Conveyance Facilities including Turnouts & Pump Stations Engineer's Estimate												
Right-of-Way and Easement Plats												
Right-of-Way and Easement Legal Descriptions												
In-Line Pump Station Equipping Preliminary Design												
In-Line Pump Station Equipping 60% Level Design Plans												
In-Line Pump Station Physical Modeling												
In-Line Pump Station Equipping Final Design												
In-Line Pump Station Equipping 90% Level Design Plans												
In-Line Pump Station Equipping 100% Level Design Plans												
Pump Station Equipping Specifications and Bid Documents												
Pump Station Equipping Engineer's Estimate												
Project Meetings and General Project Correspondence												
Subtotal Task No. 1:												
Task #2 - Bid Assistance												
Conveyance Facilities including Turnouts & Pump Stations RFI Responses (Estimate 40 RFI Documents)												
Conveyance Facilities including Turnouts & Pump Stations Addenda (Estimate 5 Addenda)												
Conveyance Facilities including Turnouts & Pump Stations assistance with power service application												
Conveyance Facilities including Turnouts & Pump Stations Conformed Documents												
In-Line Pump Station Equipping RFI Responses (Estimate 40 RFI Documents)												
In-Line Pump Station Equipping Addenda (Estimate 5 Addenda)												
In-Line Pump Station Equipping assistance with power service application												
In-Line Pump Station Equipping Conformed Documents												
Subtotal Task No. 2:												
Task #3 - Construction Assistance												
Conveyance Facilities including Turnouts & Pump Stations RFI Responses (Estimate 50 RFI Documents)												
Conveyance Facilities including Turnouts & Pump Stations Submittal and Shop Drawing Review (Estimate 200 Submittals and 100 Re-Submittals)												
Conveyance Facilities including Turnouts & Pump Stations assistance with power service application												
Conveyance Facilities including Turnouts & Pump Stations As-Built Documents												
In-Line Pump Station Equipping RFI Responses (Estimate 50 RFI Documents)												
In-Line Pump Station Equipping Submittal and Shop Drawing Review (Estimate 200 Submittals and 100 Re-Submittals)												
In-Line Pump Station Equipping assistance with power service application												
In-Line Pump Station Equipping As-Built Documents												
Subtotal Task No. 3:												
Total Hours Estimated:	0	0	0	0	0	0	0	0	0	0	0	
Total Engineering Estimate:	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Dee Jaspar Associates
Consulting Civil Engineers

Groundwater Banking Joint Powers Authority (GBJPA)
Kern Fan Groundwater Storage Project

Professional Services for Engineering Design Worksheet

Design Package No. 5: SCADA and PLC Programming	Principal Engineer	Registered Engineer / Project Manager	Staff Engineer	Surveyor	Survey Crew	Draftsperson	Secretary	Other Staff	Sub-Consultant	Sub-Consultant	Miscellaneous Costs, Mileage, Copies, etc.	
	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Cost ($)	Estimated Cost ($)	Estimated Cost ($)	Estimated Cost ($)	Total
Task #1 - Engineering Design	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	$/hr	
Review preliminary work and provide comments, suggestions, and questions.												
Coordination with other design firms and project phases.												
Preparation of a control narrative for the overall project as well as specific phases.												
Perform radio survey.												
SCADA and PLC Programming 60% Level Design Plans												
SCADA and PLC Programming 90% Level Design Plans												
SCADA and PLC Programming 100% Level Design Plans												
SCADA and PLC Programming Specifications and Bid Documents												
SCADA and PLC Programming Engineer's Estimate												
Project Meetings and General Project Correspondence												
Subtotal Task No. 1:												
Task #2 - Bid Assistance												
SCADA and PLC Programming RFI Responses (Estimate 20 RFI Documents)												
SCADA and PLC Programming Addenda (Estimate 3 Addenda)												
SCADA and PLC Programming Conformed Documents												
Subtotal Task No. 2:												
Task #3 - Construction Assistance												
SCADA and PLC Programming RFI Responses (Estimate 20 RFI Documents)												
SCADA and PLC Programming Submittal and Shop Drawing Review (Estimate 100 Submittals and 50 Re-Submittals)												
SCADA and PLC Programming As-Built Documents												
Subtotal Task No. 3:												
Total Hours Estimated:	0	0	0	0	0	0	0	0	0	0	0	
Total Engineering Estimate:	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

APPENDIX A

Technical Memorandum #1
Project Phasing and Contractor Selection

DEE JASPAR & ASSOCIATES, INC.
CONSULTING CIVIL ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CA 93308
PHONE (661) 393-4796
FAX (661) 393-4799

KERN FAN GROUNDWATER STORAGE PROJECT

TECHNICAL MEMORANDUM NO. 1
(Project Phasing and Design/Contractor Selection)

PREPARED FOR: Groundwater Banking Joint Powers Authority (JPA)
PREPARED BY: Curtis Skaggs, P.E., Dee Jaspar & Associates, Inc.
DATE: August 15, 2020

SUBJECT: ***Project Phasing and Design/Contractor Selection***

I. Executive Summary

The Kern Fan Groundwater Storage Project is planned to have multiple phases for the design and the construction of the project with the goal of lean project management. This effort will divide the project into subsets that will lead to the most qualified firms and contractors working on those phases as well as break the project down into more manageable sizes.

The project duration is anticipated to be six to eight years from start to finish. The JPA is currently working on land acquisition, environmental documents, funding options, and preliminary engineering design in the form of technical memoranda. The technical memoranda will be incorporated into requests for proposals (RFP's) or requests for qualifications (RFQ's) in the selection of engineering design firms.

It is envisioned that there may be up to five different design firms and potentially multiple construction administration and inspection contracts for the following project phases:

1. Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie; Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures

2. Phase I Well Drilling and Equipping; Phase II Well Drilling and Equipping

3. Aqueduct Turnout Facility

4. Conveyance Facilities including Turnouts & Pump Stations

5. SCADA and PLC Programming

The design will include multiple project construction packages. These construction packages are outlined below and describe the type of work to be completed, the typical Contractor licensing requirements, the minimum contents of the bid packages, and sample front-end contract documents. The licensing requirements, bid packages, and sample contract documents outlined herein are not intended to be comprehensive, but provide a framework and understanding of the work involved in the engineering design and preparation of bid packages. It is envisioned that there will be ten project bid packages as outlined below:

1. Phase I Recharge Basins

2. Phase I Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie

3. Phase I Well Drilling and Equipping

4. Phase II Recharge Basins

5. Phase II Well Drilling and Equipping

6. Phase II Well Pipelines and Interbasin Structures

7. Aqueduct Turnout Facility

8. Conveyance Facilities including Turnouts & Pump Stations

9. Pump Station Equipping

10. SCADA and PLC Programming

The projects will be competitively bid in order to comply with all grant funding requirements, however a pre-qualification process may be implemented for more unique project phases.

II. Project Schedule

A preliminary project schedule has been prepared based on the JPA formation date of August 25th, 2020. The schedule includes timeframes for land acquisition, environmental work, project rights-of-way, permitting, engineering design, the bid process, and construction.

A compressed project schedule is illustrated in Figure 1 below and a more detailed schedule is attached in Appendix A. The project is shown to begin on August 26, 2020 after the formation of the JPA and is completed and operational by May 5, 2028.

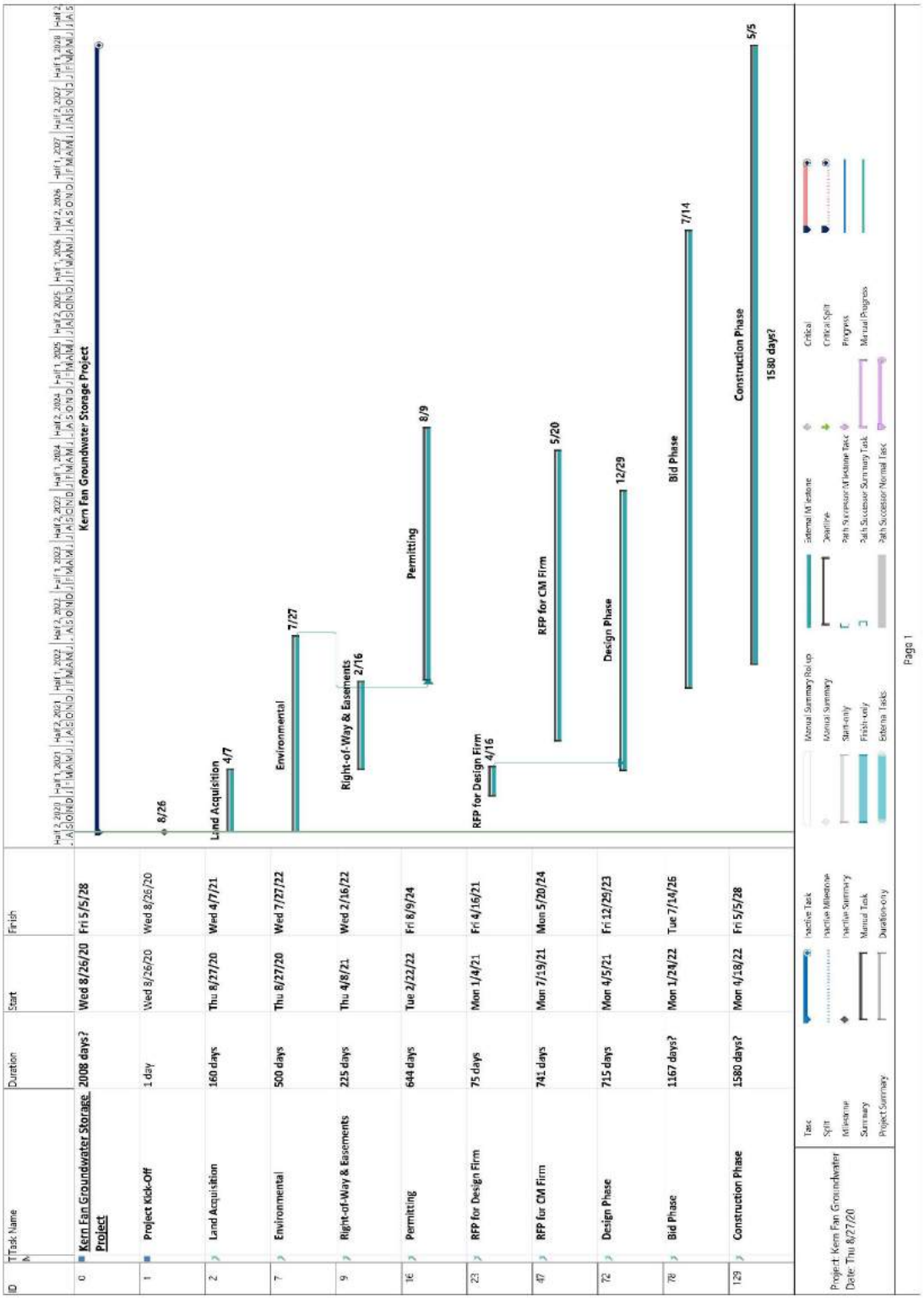


Figure 1: Project Schedule

III. Project Phasing (Construction Bid Packages)

A. Phase I Recharge Basins

- Type of Work

  The Recharge Basin work will consist primarily of earthwork and earth moving activities. This will include, but not be limited to, crop removal, utility and underground locating work as well as utility/facility removal or relocation, clearing and grubbing, over-excavation and re-compaction, obtaining borrow material, hauling, filling and compacting levee embankments, ramps, and islands, fine grading, and slope grading. In addition, this may include the placement of all-weather surfacing on levee embankment roads as well as ripping/slip plowing of recharge basin bottoms.

- Contractor Licensing

  Contractors for this work shall be licensed with the State of California for a Class A General Engineering Contractors License or a C-12 Earthwork and Paving Contractors License.

- Bid Package

  1. Cover Sheet
  2. Demolition Plan for Tree Removal, Oil/Gas/Irrigation Line Removal or Relocation, Power Line Relocations, etc.
  3. Site Plan
  4. Plan Sheets illustrating Levee Embankment Layouts, Dimensions, Grades, Borrow Areas, & Well Pads
  5. Embankment Cross-Sections
  6. Earthwork Details – Embankment Over-Ex and Re-Compact, Keyways, Slopes, etc.
  7. Fence Plan, if applicable
  8. Project Specifications including Earthwork Volumes and Geotechnical Report

- Design Standards/Project Specification Format

  See attached boiler plate specifications in Appendix B for reference. The boiler plate front-end specifications shall be reviewed and revised as a joint effort between the engineering design firm and the JPA at the time of design.

  The technical specifications will be developed to be project specific. Sample technical specifications are provided in subsequent technical memoranda.

B. Phase I Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie

- Type of Work

  This work will include, but not be limited to, the installation of interbasin structures through the Phase I Recharge Basin levee embankments, the installation of underground well conveyance pipelines through the basins with a connection to the RRBWSD Intake Canal, construction of a check structure in the Goose Lake Channel, and construction of a pump station in the Goose Lake Channel.

- Contractor Licensing

  Contractors for this work shall be licensed with the State of California for a Class A General Engineering Contractors License.

- Bid Package

  1. Cover Sheet
  2. Site Plan
  3. Interbasin Structure Plan View Layout
  4. Interbasin Structure & Piping Elevation
  5. Interbasin Details
  6. Existing Well & Irrigation Lateral Plan
  7. Well Conveyance Piping Layout Plan including modifications to existing irrigation lines
  8. Well Conveyance Plan & Profile Sheets

9. Well Conveyance In-Lieu Service Turnouts
10. Well Conveyance Details
11. Goose Lake Channel Check Structure Site Plan
12. Check Structure Elevation Views
13. Check Structure Details
14. Goose Lake Channel Pump Station Site Plan
15. Pump Station Elevation Views
16. Pump Station Structural Details
17. Pump Station Pump & Motor Details
18. Pump Station Discharge Piping Plan & Profile Sheets
19. Pump Station Recharge Basin Outlet Plan & Elevation Views
20. Pump Station Security & Remote Monitoring
21. Pump Station Fencing, if applicable
22. Pump Station Detail Sheets
23. Pump Station Electrical & Controls
24. PG&E Electrical Supply Plan
25. Project Specifications

- Design Standards/Project Specification Format

  See attached boiler plate specifications in Appendix B for reference. The boiler plate front-end specifications shall be reviewed and revised as a joint effort between the engineering design firm and the JPA at the time of design.

  The technical specifications will be developed to be project specific. Sample technical specifications are provided in subsequent technical memoranda.

C. Phase I Well Drilling and Equipping

- Type of Work

  The Phase I Well Drilling and Equipping work will consist primarily of well drilling and well equipping work for up to six wells in the Phase I Recharge area as well as constructing monitoring wells. This work will include, but not be limited to, drilling reverse rotary pilot holes, performing geophysical logging, water depth sampling, reaming of the pilot holes,

casing installation, gravel installation, cement annular seal placement, well development, and testing. In addition, the work will include site development and well equipping with a deep well vertical turbine pump, vertical hollowshaft electric motor, discharge piping, appurtenances, well motor enclosure, concrete foundations, electrical and controls, shade structure, site lighting, site security, remote monitoring, and all-weather surfacing.

- Contractor Licensing

  Contractors for this work shall be licensed with the State of California for the following:

  1. Class C57 Well Drilling Contractors License
  2. Class C10 Electrical Contractors License

- Bid Package

  1. Cover Sheet
  2. Site Plan showing Existing and Proposed Well Locations
  3. Well Rehabilitation and Equipping Plan for Existing Wells
  4. Well Destruction Plan for Existing Wells
  5. Well Drilling Cross Section
  6. Well Drilling Details
  7. Monitoring Well Construction
  8. Well Site Plan Layout
  9. Well Pump & Motor Cross Section
  10. Well Discharge Piping Plan & Elevation
  11. Well Pump Foundation
  12. Well Motor Enclosure
  13. Well Electrical Foundation
  14. Well Electrical Shade Structure
  15. Well Site Details
  16. Well Site Security & Remote Monitoring
  17. Well Site Fencing, if applicable
  18. Well Electrical and Controls
  19. PG&E Electrical Supply Plan
  20. Project Specifications

- Design Standards/Project Specification Format

See attached boiler plate specifications in Appendix B for reference. The boiler plate front-end specifications shall be reviewed and revised as a joint effort between the engineering design firm and the JPA at the time of design.

The technical specifications will be developed to be project specific. Sample technical specifications are provided in subsequent technical memoranda.

D. Phase II Recharge Basins

- Type of Work

  The Recharge Basin work will consist primarily of earthwork and earth moving activities. This will include, but not be limited to, crop removal, utility and underground locating work as well as utility removal or relocation, clearing and grubbing, over-excavation and re-compaction, obtaining borrow material, hauling, filling and compacting levee embankments, ramps, and islands, fine grading, and slope grading. In addition, this may include the placement of all-weather surfacing on levee embankment roads as well as ripping/slip plowing of recharge basin bottoms.

- Contractor Licensing

  Contractors for this work shall be licensed with the State of California for a Class A General Engineering Contractors License or a C-12 Earthwork and Paving Contractors License.

- Bid Package

  1. Cover Sheet
  2. Demolition Plan for Tree Removal, Oil/Gas/Irrigation Line Removal or Relocation, Power Line Relocations, etc.
  3. Site Plan
  4. Plan Sheets illustrating Levee Embankment Layouts, Dimensions, Grades, Borrow Areas, & Well Pads
  5. Embankment Cross-Sections

6. Earthwork Details – Embankment Over-Ex and Re-Compact, Keyways, Slopes, etc.
7. Fence Plan, if applicable
8. Project Specifications including Earthwork Volumes and Geotechnical Report

- Design Standards/Project Specification Format

  See attached boiler plate specifications in Appendix B for reference. The boiler plate front-end specifications shall be reviewed and revised as a joint effort between the engineering design firm and the JPA at the time of design.

  The technical specifications will be developed to be project specific. Sample technical specifications are provided in subsequent technical memoranda.

E. Phase II Well Drilling and Equipping

- Type of Work

  The Phase II Well Drilling and Equipping work will consist primarily of well drilling and well equipping work for up to six wells in the Phase II Recharge area as well as constructing monitoring wells. This work will include, but not be limited to, drilling reverse rotary pilot holes, performing geophysical logging, water depth sampling, reaming of the pilot holes, casing installation, gravel installation, cement annular seal placement, well development, and testing. In addition, the work will include site development and well equipping with a deep well vertical turbine pump, vertical hollowshaft electric motor, discharge piping, appurtenances, well motor enclosure, concrete foundations, electrical and controls, shade structure, site lighting, site security, remote monitoring, and all-weather surfacing.

- Contractor Licensing

  Contractors for this work shall be licensed with the State of California for the following:

  1. Class C57 Well Drilling Contractors

License
2. Class C10 Electrical Contractors License

- Bid Package

1. Cover Sheet
2. Site Plan showing Existing and Proposed Well Locations
3. Well Rehabilitation and Equipping Plan for Existing Wells
4. Well Destruction Plan for Existing Wells
5. Well Drilling Cross Section
6. Well Drilling Details
7. Monitoring Well Construction
8. Well Site Plan Layout
9. Well Pump & Motor Cross Section
10. Well Discharge Piping Plan & Elevation
11. Well Pump Foundation
12. Well Motor Enclosure
13. Well Electrical Foundation
14. Well Electrical Shade Structure
15. Well Site Details
16. Well Site Security & Remote Monitoring
17. Well Site Fencing, if applicable
18. Well Electrical and Controls
19. PG&E Electrical Supply Plan
20. Project Specifications

- Design Standards/Project Specification Format

See attached boiler plate specifications in Appendix B for reference. The boiler plate front-end specifications shall be reviewed and revised as a joint effort between the engineering design firm and the JPA at the time of design.

The technical specifications will be developed to be project specific. Sample technical specifications are provided in subsequent technical memoranda.

F. Phase II Well Pipelines and Interbasin Structures

- Type of Work

This work will include, but not be limited to, the installation of interbasin structures through the Phase

II Recharge Basin levee embankments and the installation of underground well conveyance pipelines through the basins with connections to the Conveyance Canal.

- Contractor Licensing

  Contractors for this work shall be licensed with the State of California for a Class A General Engineering Contractors License.

- Bid Package

  1. Cover Sheet
  2. Site Plan
  3. Interbasin Structure Plan View Layout
  4. Interbasin Structure & Piping Elevation
  5. Interbasin Details
  6. Existing Well & Irrigation Lateral Plan
  7. Well Conveyance Piping Layout Plan including modifications to existing irrigation lines
  8. Well Conveyance Plan & Profile Sheets
  9. Well Conveyance In-Lieu Service Turnouts
  10. Well Conveyance Details
  11. Project Specifications

- Design Standards/Project Specification Format

  See attached boiler plate specifications in Appendix B for reference. The boiler plate front-end specifications shall be reviewed and revised as a joint effort between the engineering design firm and the JPA at the time of design.

  The technical specifications will be developed to be project specific. Sample technical specifications are provided in subsequent technical memoranda.

G. Aqueduct Turnout Facility

- Type of Work

  This work will include, but not be limited to, the installation of the aqueduct turnout which shall involve coordination with the Department of Water

Resources, mobilization/installation/demobilization of a cofferdam, earthwork, reinforced concrete construction, installation of miscellaneous steel, installation of a sluice gate, installation of electrical and controls, site security, remote monitoring, installation of the turnout piping, and the restoration of all-weather surfacing on the Aqueduct embankment road.

- Contractor Licensing

  Contractors for this work shall be licensed with the State of California for the following:

  1. Class A General Engineering Contractors License.
  2. Class C10 Electrical Contractors License

- Bid Package

  1. Cover Sheet
  2. Aqueduct Cofferdam Plan
  3. Aqueduct Turnout Site Plan
  4. Aqueduct Turnout Grading Plan
  5. Aqueduct Turnout Elevation Views
  6. Aqueduct Turnout Structural Details
  7. Aqueduct Turnout Pipe Plan & Profile
  8. Aqueduct Turnout Trashrack
  9. Aqueduct Turnout Details
  10. Aqueduct Turnout Electrical and Controls
  11. Aqueduct Turnout Security & Remote Monitoring
  12. PG&E Electrical Supply Plan
  13. Project Specifications

- Design Standards/Project Specification Format

  See attached boiler plate specifications in Appendix B for reference. The boiler plate front-end specifications shall be reviewed and revised as a joint effort between the engineering design firm and the JPA at the time of design.

The technical specifications will be developed to be project specific. Sample technical specifications are provided in subsequent technical memoranda.

H. Conveyance Facilities including Turnouts & Pump Stations

- Type of Work

  This work will include, but not be limited to, crop removal, utility and underground locating work as well as utility removal or relocation, the installation of the conveyance canal facility, siphon crossings, road crossings, utility crossings, highway cased crossings, pump station facilities, pump station forebays, pump station afterbays, in-lieu service turnouts, turnout facilities to the Phase II Recharge Basins, turnout facilities to the West Recharge Basins, site security, and remote monitoring.

  The pump station facility work will need to be coordinated with the pump station equipping work. Pump station hydraulic design and modeling will be performed and recommended design features and mitigation measures will need to be incorporated into the structure design and pump design.

- Contractor Licensing

  Contractors for this work shall be licensed with the State of California for the following:

  1. Class A General Engineering Contractors License.
  2. Class C10 Electrical Contractors License

- Bid Package

  1. Cover Sheet
  2. Site Plan
  3. Utility Plan & Utility Relocation/Removal Plan
  4. Conveyance Canal Plan & Profile Sheets
  5. Conveyance Canal Cross Sections
  6. Conveyance Canal Transition Structure Plan & Elevation

7. Conveyance Canal Forebay Plan & Elevation
8. Conveyance Canal Afterbay Plan & Elevation
9. Conveyance Canal Details
10. Conveyance Canal In-Lieu Service Turnouts
11. Conveyance Canal Fencing Site Plan, if applicable
12. Conveyance Canal Fence Details, if applicable
13. Adohr Road Crossing Site Plan
14. Adohr Road Crossing Plan & Elevation
15. Adohr Road Crossing Details
16. East Side Canal Crossing Site Plan
17. East Side Canal Crossing Plan & Elevation
18. East Side Canal Crossing Details
19. Stockdale Hwy Site Plan
20. Stockdale Hwy Plan & Elevation
21. Stockdale Hwy Crossing Details
22. Road Crossing/Bridge Site Plan
23. Road Crossing/Bridge Plan & Elevation
24. Road Crossing/Bridge Details
25. Interstate 5 Fwy Site Plan
26. Interstate 5 Fwy Plan & Elevation
27. Interstate 5 Fwy Crossing Details
28. Phase II Property Turnout Site Plan
29. Phase II Property Turnout Grading Plan
30. Phase II Property Turnout Plan & Elevations
31. Phase II Property Turnout Structural Details
32. Phase II Property Turnout Pipe Profile
33. Phase II Property Turnout Details
34. Phase II Property Turnout Electrical and Controls
35. Phase II Property Turnout Security & Remote Monitoring
36. West Basins Turnout Site Plan
37. West Basins Turnout Grading Plan
38. West Basins Turnout Plan & Elevation
39. West Basins Turnout Structural Details
40. West Basins Turnout Pipe Profile
41. West Basins Turnout Details
42. West Basins Turnout Electrical and Controls

43. West Basins Turnout Security & Remote Monitoring
44. Pump Station Site Plan Layout
45. Pump Station Grading Plans
46. Pump Station Elevation Views
47. Pump Station Structural Details
48. PG&E Electrical Supply Plan
49. Project Specifications

- Design Standards/Project Specification Format

  See attached boiler plate specifications in Appendix B for reference. The boiler plate front-end specifications shall be reviewed and revised as a joint effort between the engineering design firm and the JPA at the time of design.

  The technical specifications will be developed to be project specific. Sample technical specifications are provided in subsequent technical memoranda.

I. Pump Station Equipping

It is recommended that the pump station equipment be bid as a separate project from the "Conveyance Facilities including Turnouts and Pump Stations". The reinforced concrete pump station, miscellaneous steel embeds such as ladder rungs, stop log slots, grating, and handrailing, and steel trashracks will be installed as part of the Conveyance Facilities scope of work along with the conveyance canal earthwork and lining work. The "Pump Station Equipping" scope of work will begin at the pump sole plates and include the pump assembly, pump discharge head, pump sole plate and anchorage, motor, discharge piping, electrical, control building, site lighting, and site development.

The advantage to separating the project in this fashion is it allows the District to include small and medium size Contractors in the "Pump Station Equipping" work and potentially utilize local Contractors and vendors for mechanical and electrical equipment that will require on-going service and maintenance.

- Type of Work

  This work will include, but not be limited to, the procurement, testing, and installation of the conveyance canal pump station pumps and motors, the pump discharge piping and appurtenances, site electrical and controls, electrical control building and appurtenances, site security, remote monitoring, and site development. This work shall be coordinated with the pump station design and structural concrete construction.

  The pump station equipping work will need to be coordinated with the pump station structure work. Pump station hydraulic design and modeling will be performed and recommended design features and mitigation measures will need to be incorporated into the structure design and pump design.

- Contractor Licensing

  Contractors for this work shall be licensed with the State of California for the following:

  1. Class A General Engineering Contractors License.
  2. Class C10 Electrical Contractors License

- Bid Package

  1. Cover Sheet
  2. Site Plan
  3. Pump Station Site Plans
  4. Pump Station Elevation Views
  5. Pump & Motor Cross Section Views
  6. Pump & Motor Details
  7. Pump Station Pump & Motor Base Plate Details
  8. Pump Station Discharge Piping Plan & Profile Sheets
  9. Pump Station Detail Sheets
  10. Pump Station Control Building Foundation
  11. Pump Station Control Building Plan & Elevation Exterior Views
  12. Pump Station Control Building Plan &

Elevation Interior Views

13. Pump Station Control Building Details
14. Pump Station Electrical & Controls
15. Cathodic Protection Details
16. Pump Station Site Security & Remote Monitoring
17. Pump Station Fence Plan, if applicable
18. Return Water Pump Station Site Plan
19. Return Water Pump Station Grading Plan
20. Return Water Pump Station Elevation Views
21. Return Water Pump Station Structural Details
22. Return Water Pump Station Pump & Motor Base Plate Details
23. Return Water Pump Station Discharge Piping Plan & Profile Sheets
24. Return Water Pump Station Detail Sheets
25. Return Water Pump Station Electrical Foundation
26. Return Water Pump Station Electrical Shade Structure/Control Building
27. Return Water Pump Station Electrical & Controls
28. Return Water Pump Station Site Security & Remote Monitoring
29. Return Water Pump Station Fence Plan, if applicable
30. PG&E Electrical Supply Plan
31. Project Specifications

- Design Standards/Project Specification Format

  See attached boiler plate specifications in Appendix B for reference. The boiler plate front-end specifications shall be reviewed and revised as a joint effort between the engineering design firm and the JPA at the time of design.

  The technical specifications will be developed to be project specific. Sample technical specifications are provided in subsequent technical memoranda.

J. SCADA and PLC Programming

- Type of Work

  This work will include, but not be limited to, the preparation of a control narrative and preparation of programmable logic for the PLC units at all pump stations, turnouts, and wells for the project as well as radio surveys. In addition, this work will include furnishing and installing all SCADA equipment including all hardware and software for each facility and the master headquarters.

  This work shall be coordinated with the design and construction of the well sites, pump stations, and turnouts. The SCADA work and PLC programming will be implemented in conjunction with each phase of the work described above.

- Contractor Licensing

  Contractors for this work shall be licensed with the State of California for a Class C-7 or C-10 Contractors License.

- Bid Package

  1. Cover Sheet
  2. Site Plan
  3. Control Narrative
  4. PLC Diagrams
  5. SCADA Block Diagrams
  6. P&ID Drawings
  7. Electrical Details
  8. Project Specifications including Control Logic/Philosophy

- Design Standards/Project Specification Format

  See attached boiler plate specifications in Appendix B for reference. The boiler plate front-end specifications shall be reviewed and revised as a joint effort between the engineering design firm and the JPA at the time of design.

The technical specifications will be developed to be project specific. Sample technical specifications are provided in subsequent technical memoranda.

IV. Design Firm Selection

A. Design Effort Groupings

a. Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures

Once property acquisition is finalized, the priority will be to design the Phase I and Phase II recharge basins along with the necessary infrastructure to take advantage of available water if the opportunity presents itself. This work is outlined above under Item III. A, B, D, and F and includes the following:

- Phase I Recharge Basins
- Goose Lake Channel Pump Station
- Goose Lake Channel Check Structure
- Phase I Interbasin Structures
- Phase I Well Pipelines & Intertie
- Phase II Recharge Basins
- Phase II Interbasin Structures
- Phase II Well Pipelines

The scope of work for engineering design shall include:

- Review of Preliminary Engineering documents including Technical Memorandums
- Provide Feedback on Technical Memorandum and any suggested value engineering alternatives or suggested changes
- Attendance and Participation in

monthly Project Design meetings
- Hydraulic Analysis and Design
- Site and Topographic Surveying
- Preparation of 60% Level Drawings and Engineer's Estimate for Review and Comment
- Preparation of 90% Level Drawings, Specifications, and Engineer's Estimate for Review and Comment
- Incorporation of Environmental Mitigation Measures into Bid Documents (Measures provided by District)
- Preparation of 100% Level Drawings, Specifications, and Engineer's Estimate for Bidding Purposes
- Bid Assistance with Responses to RFI's and Addenda
- Assistance with Power Service to Pump Station
- Preparation of Conformed Documents
- Construction Phase Services for responses to RFI's (Est. 10), shop drawing review (Est. 50 plus 25 resubmittals), and preparation of Record Drawings

b. Phase I Well Drilling and Equipping
Phase II Well Drilling and Equipping

Upon completion of the recharge basins, it is planned to drill and construct the water recovery wells and monitoring wells. This work will include the equipping of the water wells with pumps, motors, discharge piping, and electrical and connection to the underground well conveyance pipelines. The work is outlined above under Item III. C and E.

- Phase I Well Drilling
- Phase I Well Equipping
- Phase II Well Drilling
- Phase II Well Equipping

The scope of work for engineering design shall include:

- Review of Preliminary Engineering documents including Technical Memorandums
- Provide Feedback on Technical Memorandum and any suggested value engineering alternatives or suggested changes
- Attendance and Participation in monthly Project Design meetings
- Incorporation of Well Design and Specification information from Thomas Harder & Associates, Inc.
- Hydraulic Analysis and Design
- Site and Topographic Surveying
- Preparation of 60% Level Drawings and Engineer's Estimate for Review and Comment
- Preparation of 90% Level Drawings, Specifications, and Engineer's Estimate for Review and Comment
- Incorporation of Environmental Mitigation Measures into Bid Documents (Measures provided by District)
- Preparation of 100% Level Drawings, Specifications, and Engineer's Estimate for Bidding Purposes
- Bid Assistance with Responses to RFI's and Addenda
- Assistance with Power Service to Wells
- Preparation of Conformed Documents
- Construction Phase Services including responses to RFI's (Est. 15), shop drawing review (Est. 70 plus 35 resubmittals), and preparation of Record Drawings

c. Aqueduct Turnout Facility

It is planned for the Aqueduct turnout facility to be one package as outlined above under Item III. G.

The scope of work for engineering design shall include:

- Review of Preliminary Engineering documents including Technical Memorandums
- Provide Feedback on Technical Memorandum and any suggested value engineering alternatives or suggested changes
- Attendance and Participation in monthly Project Design meetings
- Hydraulic Analysis and Design
- Site and Topographic Surveying
- Preparation of 60% Level Drawings and Engineer's Estimate for Review and Comment
- Preparation of 90% Level Drawings, Specifications, and Engineer's Estimate for Review and Comment
- Incorporation of Environmental Mitigation Measures into Bid Documents (Measures provided by District)
- Preparation of 100% Level Drawings, Specifications, and Engineer's Estimate for Bidding Purposes
- Permit Assistance
- Coordination with Department of Water Resources
- Bid Assistance with Responses to RFI's and Addenda
- Assistance with Power Service to Turnout
- Preparation of Conformed Documents
- Construction Phase Services including responses to RFI's (Est. 50), shop drawing review (Est. 200

plus 100 resubmittals), and preparation of Record Drawings

d. Conveyance Facilities including Turnouts & Pump Stations

It is planned for the conveyance facilities, pump stations, and turnout facilities to be one package as outlined above under Item III. H and I.

The scope of work for engineering design shall include:

- Review of Preliminary Engineering documents including Technical Memorandums and Hydraulic Analysis
- Provide Feedback on Technical Memorandum and any suggested value engineering alternatives or suggested changes
- Attendance and Participation in monthly Project Design meetings
- Site and Topographic Surveying
- Hydraulic Modeling, Analysis, and Design
- Preparation of 60% Level Drawings and Engineer's Estimate for Review and Comment
- Preparation of 90% Level Drawings, Specifications, and Engineer's Estimate for Review and Comment
- Incorporation of Environmental Mitigation Measures into Bid Documents (Measures provided by District)
- Preparation of 100% Level Drawings, Specifications, and Engineer's Estimate for Bidding Purposes
- Permit Assistance
- Bid Assistance with Responses to RFI's and Addenda
- Assistance with Power Service to Pump Stations and Turnouts
- Preparation of Conformed

Documents
- Construction Phase Services including responses to RFI's (Est. 50), shop drawing review (Est. 200 plus 100 resubmittals), and preparation of Record Drawings

e. SCADA and PLC Programming

It is planned for the SCADA and PLC Programming to be one package as outlined above under Item III. J. This work will need to be coordinated with the design of the electrical and controls for each of the other design packages. This work will be implemented and installed with each of the construction phases and then coordinated to add additional communications and remote monitoring as the rest of the overall project is constructed.

The scope of work for engineering design shall include:

- Review of Preliminary Engineering documents including Technical Memorandums and Hydraulic Analysis
- Provide Feedback on Technical Memorandum and any suggested value engineering alternatives or suggested changes
- Attendance and Participation in monthly Project Design meetings
- Preparation of a Control Narrative for the Overall Project as well as for Specific Phases of Project
- Coordination with other Design Firms and Project Phases
- Preparation of 60% Level Drawings and Engineer's Estimate for Review and Comment
- Preparation of 90% Level Drawings, Specifications, and Engineer's Estimate for Review and Comment
- Incorporation of Environmental

Mitigation Measures into Bid Documents (Measures provided by District)

- Preparation of 100% Level Drawings, Specifications, and Engineer's Estimate for Bidding Purposes
- Permit Assistance
- Bid Assistance with Responses to RFI's and Addenda
- Preparation of Conformed Documents
- Construction Phase Services including responses to RFI's (Est. 20), shop drawing review (Est. 50 plus 25 resubmittals), and preparation of Record Drawings

B. Selection Process – Qualifications vs Contract Amount

It is anticipated that there may be up to five engineering design firms selected as divided up above. The Item A "Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie; Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures" and Item B "Phase I Well Drilling and Equipping; Phase II Well Drilling and Equipping" will be selected based upon a traditional proposal process.

A traditional proposal process or pre-qualification process may be administered for all interested engineering firms for Item C above "Turnout Facility", Item D above "Conveyance Facilities including Turnouts and Pump Stations", and Item E above "SCADA and PLC Programming". The firm selection process will be at the discretion of the JPA. The pre-qualification process may require the presentation of the Engineering Team to the District in proposal format including not only the partnering of firms (joint ventures), but also the proposed staff that will lead the design efforts and perform the actual work.

The pre-qualification process would evaluate the experience and capabilities of the Engineering Teams

and result in the selection of a short-list of Engineering Teams that would be asked to submit a project proposal. The final firm selection may not necessarily be made based upon cost as all aspects of the qualifications will be considered.

C. Firm Qualifications

Engineering Team: Provide a description of the Engineering Team for this project and include an outline and organizational chart of the personnel that will be assigned to this project. Include a description and location of where the primary engineering work will be performed.

The proposal shall describe the specific experience and capabilities of each project staff member along with an outline of their responsibilities on this project. Include a schedule showing the percentage of time each member will contribute to the project.

The proposal shall include a project understanding and approach and describe how the work product will be performed and the level of quality control to be provided.

The proposal shall include a schedule showing the critical path with milestones for deliverables as outlined herein. The schedule shall provide an assurance of the firm's ability to complete all work with consideration given to current and future workload and include a list of outside factors that could affect the schedule. All assumptions shall be clearly identified.

D. Firm Reputation

Firm reputation will be a critical component of this evaluation. The proposal shall include a list of recent projects of a similar nature that the proposed Engineering Team and Project Staff were involved with. If this is a first time partnership for the Engineering Team then each respective firm may submit independent lists, however these should be lists that the proposed project staff was intimately involved in.

The recent project list shall include project details, project costs, Contractor name, project timeframe, contact information for the Owner's Representative, and any other pertinent information.

E. Firm Experience

The proposal shall include a list of similar projects that have been completed in the last ten (10) years by the Engineering Team. This experience shall only include projects that the proposed project staff were intimately involved in. Include a discussion of such factors as control of costs, quality of work, and ability to meet project schedule.

V. <u>Construction Administration Firm Selection</u>

A. Construction Administration Effort Groupings

a. Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures

The priority will be to construct the Phase I and Phase II recharge basins along with the necessary infrastructure to take advantage of available water if the opportunity presents itself. This work is outlined above under Item III. A, B, D, and F and includes the following:

- Phase I Recharge Basins
- Goose Lake Channel Pump Station
- Goose Lake Channel Check Structure
- Phase I Interbasin Structures
- Phase I Well Pipelines & Intertie
- Phase II Recharge Basins
- Phase II Interbasin Structures
- Phase II Well Pipelines

The scope of work for construction administration and inspection shall include:

- Facilitate a Pre-Construction Kick-off Meeting.
- Coordinate Submittal Reviews
- Coordinate RFI Responses
- Review & Evaluate Change Orders
- Perform Daily Site Inspections and Quality Control
- Perform Materials Testing
- Monitor Permit Compliance
- Monitor Environmental Compliance
- Prepare Inspection Reports with Photo Log
- Provide Labor Compliance Monitoring
- Monitor Buy American Affidavits
- Monitor MBE/WBE/DBE Compliance
- Review & Approve Progress Payments and Quantities
- Facilitate Weekly Project Meetings
- Facilitate Conflict Resolutions
- Coordinate Power Service
- Maintain Construction Records
- Perform Start-up & Testing
- Facilitate Project Close-Out and Preparation of Record Drawings

b. Phase I Well Drilling and Equipping
Phase II Well Drilling and Equipping

Upon completion of the recharge basins, it is planned to drill and construct the water recovery wells. This work will include the equipping of the water wells with pumps, motors, discharge piping, and electrical and connection to the underground well conveyance pipelines. The work is outlined above under Item III. C and E.

- Phase I Well Drilling
- Phase I Well Equipping
- Phase II Well Drilling
- Phase II Well Equipping

The scope of work for engineering design shall include:

- Facilitate a Pre-Construction Kick-off Meeting.
- Coordinate Submittal Reviews
- Coordinate RFI Responses
- Review & Evaluate Change Orders
- Perform Daily Site Inspections and Quality Control
- Perform Materials Testing
- Monitor Environmental Compliance
- Prepare Inspection Reports with Photo Log
- Provide Labor Compliance Monitoring
- Monitor Buy American Affidavits
- Monitor MBE/WBE/DBE Compliance
- Review & Approve Progress Payments and Quantities
- Facilitate Weekly Project Meetings
- Facilitate Conflict Resolutions
- Coordinate Power Service
- Maintain Construction Records
- Perform Start-up & Testing
- Facilitate Project Close-Out and
- Preparation of Record Drawings

c. Aqueduct Turnout Facility

It is planned for the Aqueduct turnout facility to be one package as outlined above under Item III. G.

The scope of work for engineering design shall include:

- Facilitate a Pre-Construction Kick-off Meeting.
- Coordinate Submittal Reviews
- Coordinate RFI Responses
- Review & Evaluate Change Orders
- Perform Daily Site Inspections and Quality Control
- Perform Materials Testing
- Monitor Permit Compliance
- Monitor Environmental Compliance

- Prepare Inspection Reports with Photo Log
- Provide Labor Compliance Monitoring
- Monitor Buy American Affidavits
- Monitor MBE/WBE/DBE Compliance
- Review & Approve Progress Payments and Quantities
- Facilitate Weekly Project Meetings
- Facilitate Conflict Resolutions
- Coordinate Power Service
- Maintain Construction Records
- Perform Start-up & Testing
- Facilitate Project Close-Out and
- Preparation of Record Drawings

d. Conveyance Facilities including Turnouts & Pump Stations

It is planned for the conveyance facilities, pump stations, and turnout facilities to be one package as outlined above under Item III. H and I.

The scope of work for engineering design shall include:

- Facilitate a Pre-Construction Kick-off Meeting.
- Coordinate Submittal Reviews
- Coordinate RFI Responses
- Review & Evaluate Change Orders
- Perform Daily Site Inspections and Quality Control
- Perform Materials Testing
- Monitor Permit Compliance
- Monitor Environmental Compliance
- Prepare Inspection Reports with Photo Log
- Provide Labor Compliance Monitoring
- Monitor Buy American Affidavits
- Monitor MBE/WBE/DBE Compliance
- Review & Approve Progress Payments and Quantities

- Facilitate Weekly Project Meetings
- Facilitate Conflict Resolutions
- Coordinate Power Service
- Maintain Construction Records
- Perform Start-up & Testing
- Facilitate Project Close-Out and
- Preparation of Record Drawings

e. SCADA and PLC Programming

It is planned for the SCADA and PLC Programming to be one package as outlined above under Item III. J, however it will be implemented as each of the above phases of the project are constructed and completed.

The scope of work for engineering design shall include:

- Facilitate a Pre-Construction Kick-off Meeting.
- Coordinate Submittal Reviews
- Coordinate RFI Responses
- Review & Evaluate Change Orders
- Perform Daily Site Inspections and Quality Control
- Perform Materials Testing
- Prepare Inspection Reports with Photo Log
- Provide Labor Compliance Monitoring
- Monitor Buy American Affidavits
- Monitor MBE/WBE/DBE Compliance
- Review & Approve Progress Payments and Quantities
- Facilitate Weekly Project Meetings
- Facilitate Conflict Resolutions
- Coordinate with other Construction Contracts
- Maintain Construction Records
- Perform Start-up & Testing
- Facilitate Project Close-Out and
- Preparation of Record Drawings

B. Selection Process – Qualifications vs Contract Amount

It is anticipated that there may be up to five construction management firms selected as divided up above. The Item A "Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie; Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures" and Item B "Phase I Well Drilling and Equipping; Phase II Well Drilling and Equipping" will be selected based upon a traditional proposal process.

A traditional proposal process or pre-qualification process may be administered for all interested construction management firms for Item C above "Aqueduct Turnout Facility, Item D above "Conveyance Facilities including Turnouts and Pump Stations", and Item E above "SCADA and PLC Programming". The firm selection process will be at the discretion of the JPA. The pre-qualification process may require the presentation of the Construction Management Team to the District in proposal format including not only the partnering of firms (joint ventures), but also the proposed staff that will lead the construction management efforts and perform the actual work.

The pre-qualification process would evaluate the experience and capabilities of the Construction Management Teams and result in the selection of a short-list of CM Teams that would be asked to submit a project proposal. The final firm selection may not necessarily be made based upon cost as all aspects of the qualifications will be considered.

C. Firm Qualifications

Construction Management Team: Provide a description of the CM Team for this project and include an outline and organizational chart of the personnel that will be assigned to this project.

The proposal shall describe the specific experience and capabilities of each project staff member along with an

outline of their responsibilities on this project. Include a schedule showing the percentage of time each member will contribute to the project.

The proposal shall include a project understanding and approach and describe how the work product will be performed and the level of quality control to be provided.

The proposal shall include a schedule showing the critical path with milestones for deliverables as outlined herein. The schedule shall provide an assurance of the firm's ability to complete all work with consideration given to current and future workload and include a list of outside factors that could affect the schedule. All assumptions shall be clearly identified.

D. Firm Reputation

Firm reputation will be a critical component of this evaluation. The proposal shall include a list of recent projects of a similar nature that the proposed Construction Management Team and Project Staff were involved with. If this is a first time partnership for the CM Team then each respective firm may submit independent lists, however these should be lists that the proposed project staff was intimately involved in.

The recent project list shall include project details, project costs, Contractor name, project timeframe, contact information for the Owner's Representative, and any other pertinent information.

E. Firm Experience

The proposal shall include a list of similar projects that have been completed in the last ten (10) years by the Construction Management Team. This experience shall only include projects that the proposed project staff were intimately involved in. Include a discussion of such factors as control of costs, quality of work, and ability to meet project schedule.

VI. Contractor Selection

A. Selection Process – Qualifications vs Contract Amount

The Contractor selection may be made based upon a competitive bid process or may include a combination pre-qualification and competitive bid process at the discretion of the JPA.

The pre-qualification process may require the presentation of the Construction Team to the District including not only the General Contracting Firm but also all subcontractors or vendors that will be responsible for greater than 10% of the work (cost wise).

The pre-qualification process would evaluate the experience and capabilities of the Construction Teams and result in the selection of a short-list of Construction Teams that would be asked to submit a project proposal.

The proposals will be evaluated based upon competitive bid and the lowest responsive and responsible bidder selected. Bids will include the following requirements:

- Prevailing Wage and Certified Payroll
- Labor Compliance Monitoring
- American Steel & Iron Compliance
- MBE/WBE/DBE Good Faith Effort

B. Company Qualifications

Construction Team: Provide a description of the Construction Team for this project and include an outline and organizational chart of the personnel that will be assigned to this project.

The proposal shall describe the specific experience and capabilities of key construction staff along with an outline of their responsibilities on this project. Include a schedule showing the percentage of time each member will contribute to the project.

The proposal shall include a project understanding and approach and describe how the work product will be

performed and the level of quality control to be provided.

The proposal shall include a list of similar projects that have been completed in the last ten (10) years by the Construction Team. This experience shall only include projects that the proposed project staff were intimately involved in. Include a discussion of such factors as control of costs, number of change orders and reason for, quality of work, and ability to meet project schedule.

The recent project list shall include project details, project costs, project timeframe, contact information for the Owner's Representative, and any other pertinent information.

The proposal shall include a schedule showing the critical path with milestones for deliverables as outlined herein. The schedule shall provide an assurance of the firm's ability to complete all work with consideration given to current and future workload. Clearly identify all third-party aspects that could affect the project schedule.

VII. Related Work Specified Elsewhere

A. TM 2 – Conveyance Capacity Requirements
B. TM 3 – Pipeline Requirements
C. TM 4 - Pump Station Requirements
D. TM 5 – Geotechnical Investigation
E. TM 6 – Canal Liner and Turnout Requirements
F. TM 7 – Well Drilling and Equipping Requirements
G. TM 8 – Right of Way Acquisition
H. TM 9 – Recharge Basin Requirements
I. TM 10 – Facility Operation and SCADA Requirements
J. TM 11 – Engineer's Estimates

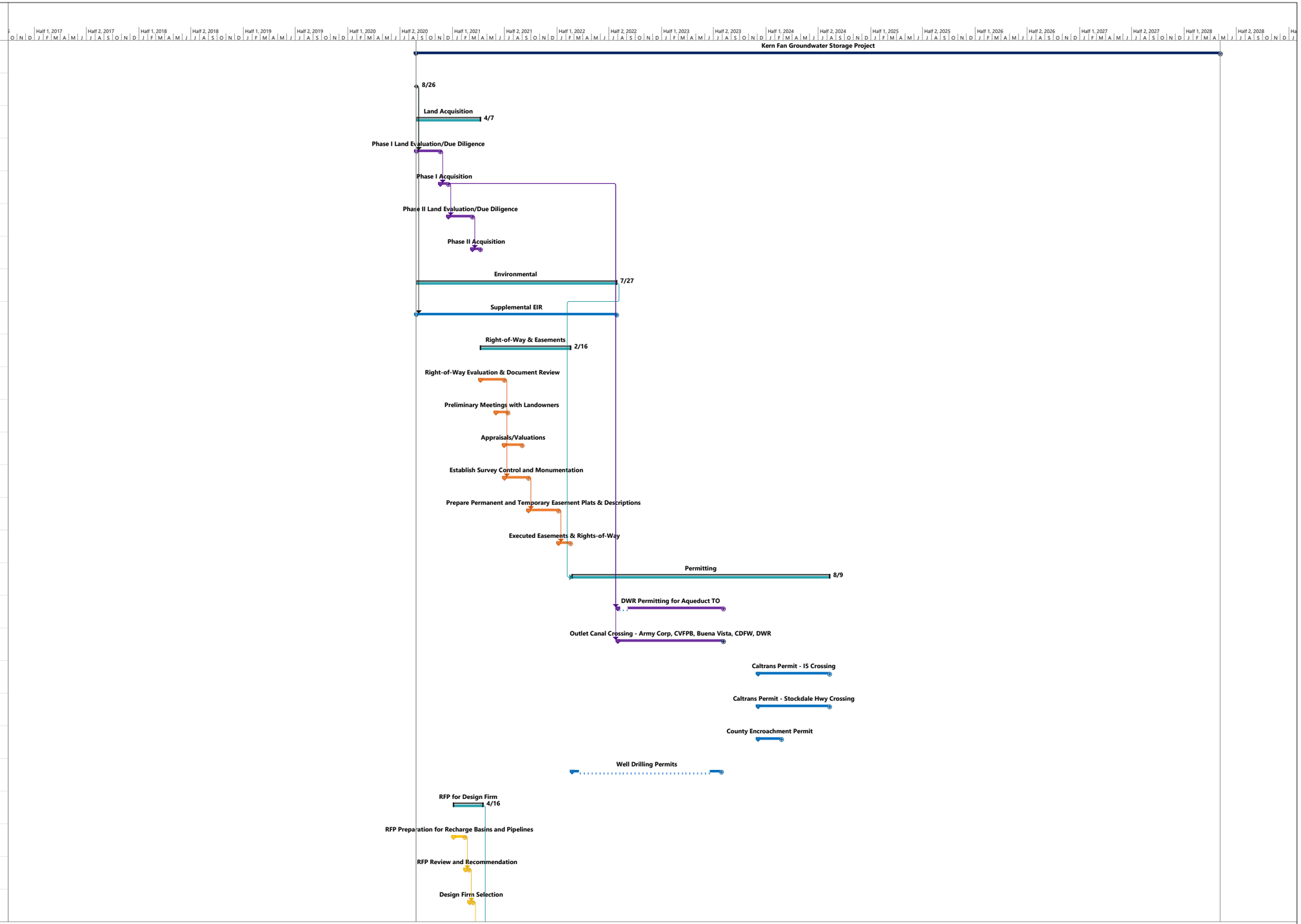
Appendices

Appendix A – Project Schedule 11 x 17
Appendix B – Sample Front End Specifications

APPENDIX A

Project Schedule 11 x 17

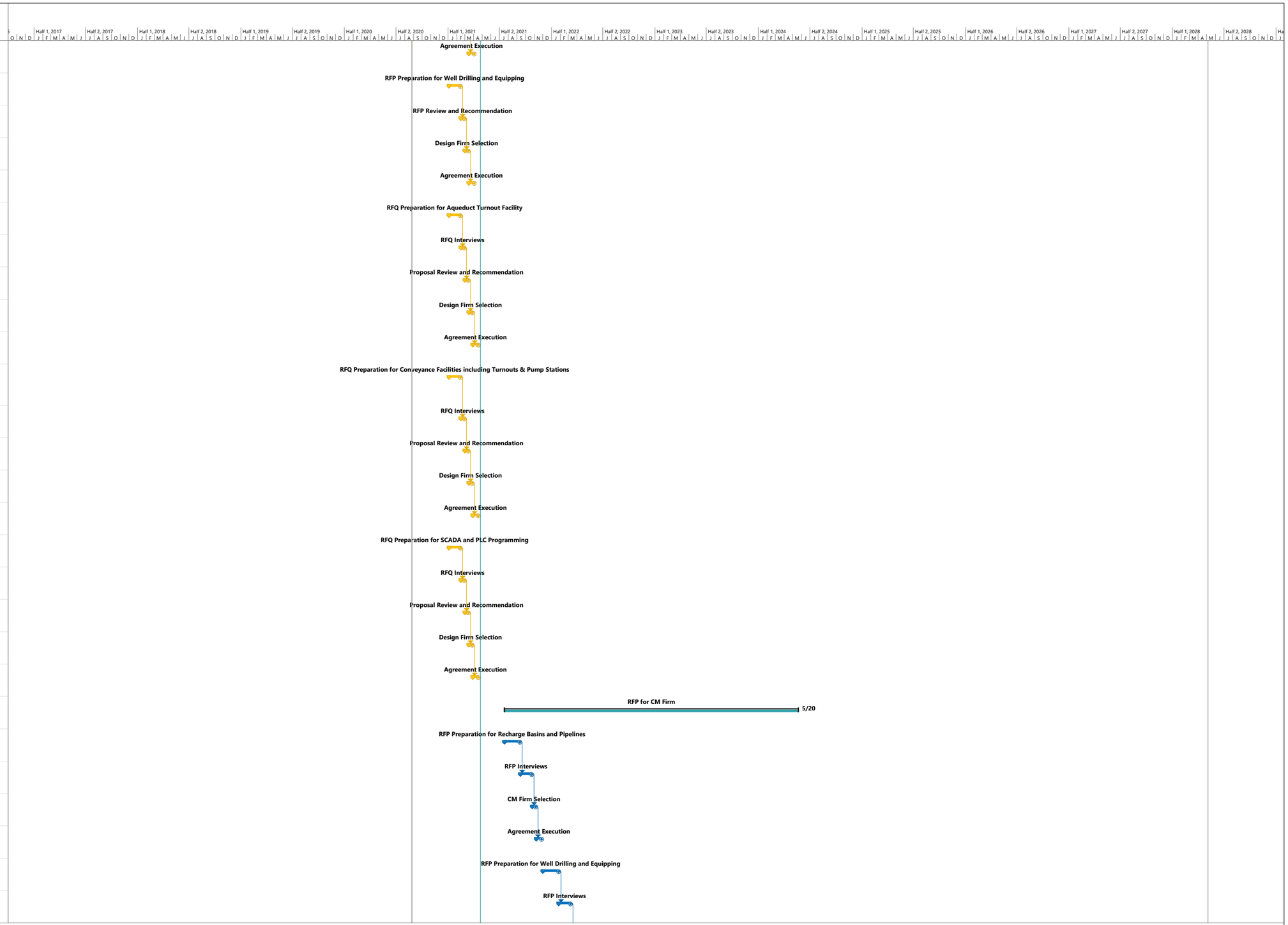
ID	Task Name	Duration	Start	Finish
0	**Kern Fan Groundwater Storage Project**	**2008 days?**	**Wed 8/26/20**	**Fri 5/5/28**
1	**Project Kick-Off**	1 day	Wed 8/26/20	Wed 8/26/20
2	**Land Acquisition**	**160 days**	**Thu 8/27/20**	**Wed 4/7/21**
3	Phase I Land Evaluation/Due Diligence	60 days	Thu 8/27/20	Wed 11/18/20
4	Phase I Acquisition	20 days	Thu 11/19/20	Wed 12/16/20
5	Phase II Land Evaluation/Due Diligence	60 days	Thu 12/17/20	Wed 3/10/21
6	Phase II Acquisition	20 days	Thu 3/11/21	Wed 4/7/21
7	**Environmental**	**500 days**	**Thu 8/27/20**	**Wed 7/27/22**
8	Supplemental EIR	500 days	Thu 8/27/20	Wed 7/27/22
9	**Right-of-Way & Easements**	**225 days**	**Thu 4/8/21**	**Wed 2/16/22**
10	Right-of-Way Evaluation & Document Review	60 days	Thu 4/8/21	Wed 6/30/21
11	Preliminary Meetings with Landowners	30 days	Tue 6/1/21	Mon 7/12/21
12	Appraisals/Valuations	45 days	Wed 6/30/21	Tue 8/31/21
13	Establish Survey Control and Monumentation	60 days	Thu 7/1/21	Wed 9/22/21
14	Prepare Permanent and Temporary Easement Plats & Descriptions	75 days	Thu 9/23/21	Wed 1/5/22
15	Executed Easements & Rights-of-Way	30 days	Thu 1/6/22	Wed 2/16/22
16	**Permitting**	**644 days**	**Tue 2/22/22**	**Fri 8/9/24**
17	DWR Permitting for Aqueduct TO	245 days	Mon 8/1/22	Fri 8/4/23
18	Outlet Canal Crossing - Army Corp, CVFPB, Buena Vista, CDFW, DWR	265 days	Mon 8/1/22	Fri 8/4/23
19	Caltrans Permit - I5 Crossing	180 days	Mon 12/4/23	Fri 8/9/24
20	Caltrans Permit - Stockdale Hwy Crossing	180 days	Mon 12/4/23	Fri 8/9/24
21	County Encroachment Permit	60 days	Mon 12/4/23	Fri 2/23/24
22	Well Drilling Permits	47 days	Tue 2/22/22	Fri 7/28/23
23	**RFP for Design Firm**	**75 days**	**Mon 1/4/21**	**Fri 4/16/21**
24	RFP Preparation for Recharge Basins and Pipelines	30 days	Mon 1/4/21	Fri 2/12/21
25	RFP Review and Recommendation	10 days	Mon 2/15/21	Fri 2/26/21
26	Design Firm Selection	10 days	Mon 3/1/21	Fri 3/12/21



Project: Kern Fan Groundwater
Date: Thu 8/27/20

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Path Successor Milestone Task | Path Successor Summary Task | Path Successor Normal Task | Critical | Critical Split | Progress | Manual Progress

ID	Task Name	Duration	Start	Finish
27	Agreement Execution	15 days	Mon 3/15/21	Fri 4/2/21
28	RFP Preparation for Well Drilling and Equipping	30 days	Mon 1/4/21	Fri 2/12/21
29	RFP Review and Recommendation	10 days	Mon 2/15/21	Fri 2/26/21
30	Design Firm Selection	10 days	Mon 3/1/21	Fri 3/12/21
31	Agreement Execution	15 days	Mon 3/15/21	Fri 4/2/21
32	RFQ Preparation for Aqueduct Turnout Facility	30 days	Mon 1/4/21	Fri 2/12/21
33	RFQ Interviews	10 days	Mon 2/15/21	Fri 2/26/21
34	Proposal Review and Recommendation	10 days	Mon 3/1/21	Fri 3/12/21
35	Design Firm Selection	10 days	Mon 3/15/21	Fri 3/26/21
36	Agreement Execution	15 days	Mon 3/29/21	Fri 4/16/21
37	RFQ Preparation for Conveyance Facilities including Turnouts & Pump Stations	30 days	Mon 1/4/21	Fri 2/12/21
38	RFQ Interviews	10 days	Mon 2/15/21	Fri 2/26/21
39	Proposal Review and Recommendation	10 days	Mon 3/1/21	Fri 3/12/21
40	Design Firm Selection	10 days	Mon 3/15/21	Fri 3/26/21
41	Agreement Execution	15 days	Mon 3/29/21	Fri 4/16/21
42	RFQ Preparation for SCADA and PLC Programming	30 days	Mon 1/4/21	Fri 2/12/21
43	RFQ Interviews	10 days	Mon 2/15/21	Fri 2/26/21
44	Proposal Review and Recommendation	10 days	Mon 3/1/21	Fri 3/12/21
45	Design Firm Selection	10 days	Mon 3/15/21	Fri 3/26/21
46	Agreement Execution	15 days	Mon 3/29/21	Fri 4/16/21
47	**RFP for CM Firm**	**741 days**	**Mon 7/19/21**	**Mon 5/20/24**
48	RFP Preparation for Recharge Basins and Pipelines	40 days	Mon 7/19/21	Fri 9/10/21
49	RFP Interviews	30 days	Mon 9/13/21	Fri 10/22/21
50	CM Firm Selection	10 days	Mon 10/25/21	Fri 11/5/21
51	Agreement Execution	15 days	Mon 11/8/21	Fri 11/26/21
52	RFP Preparation for Well Drilling and Equipping	40 days	Wed 12/1/21	Tue 1/25/22
53	RFP Interviews	30 days	Wed 1/26/22	Tue 3/8/22



Project: Kern Fan Groundwater
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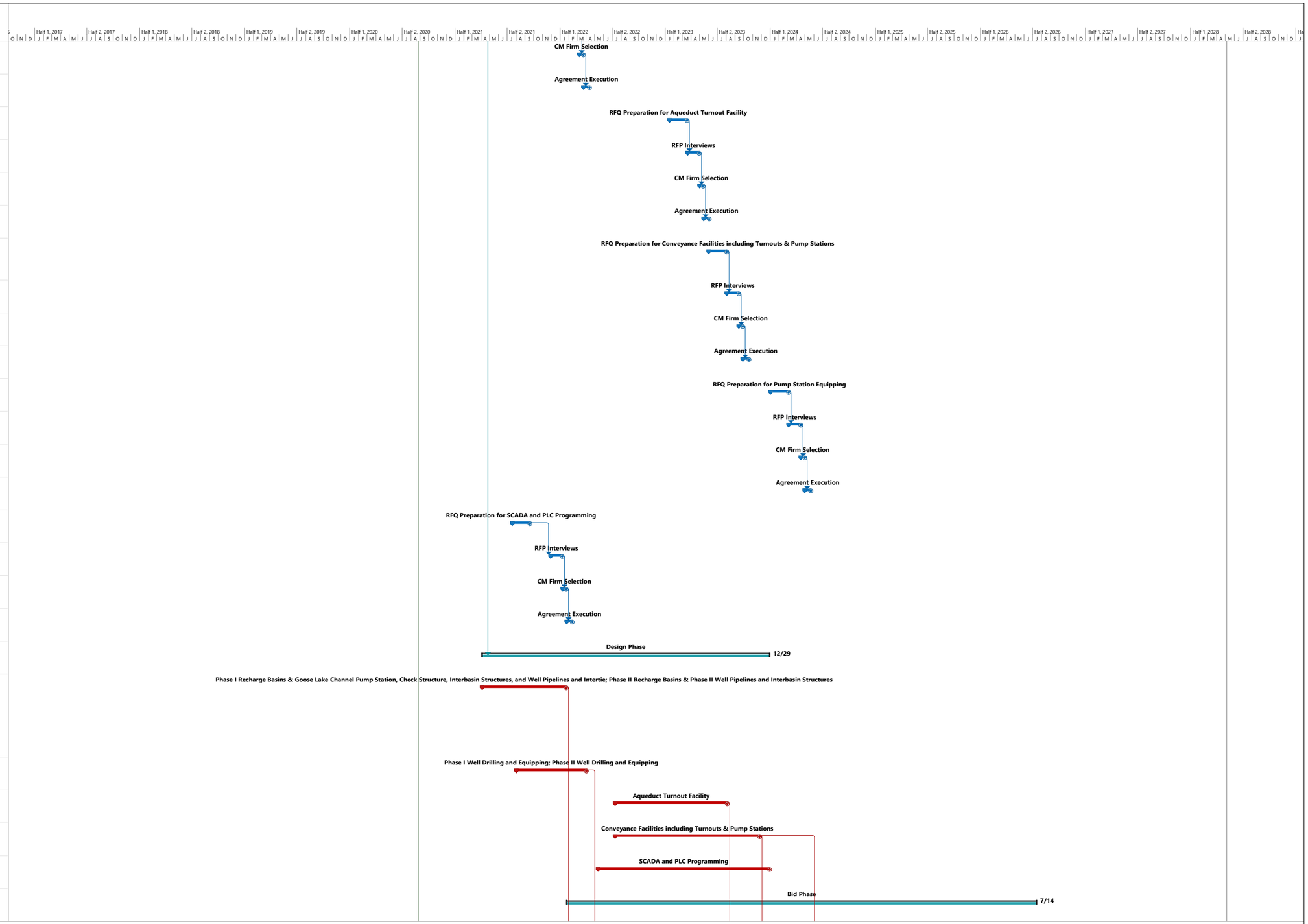
Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Path Successor Milestone Task | Path Successor Summary Task | Path Successor Normal Task | Critical | Critical Split | Progress | Manual Progress

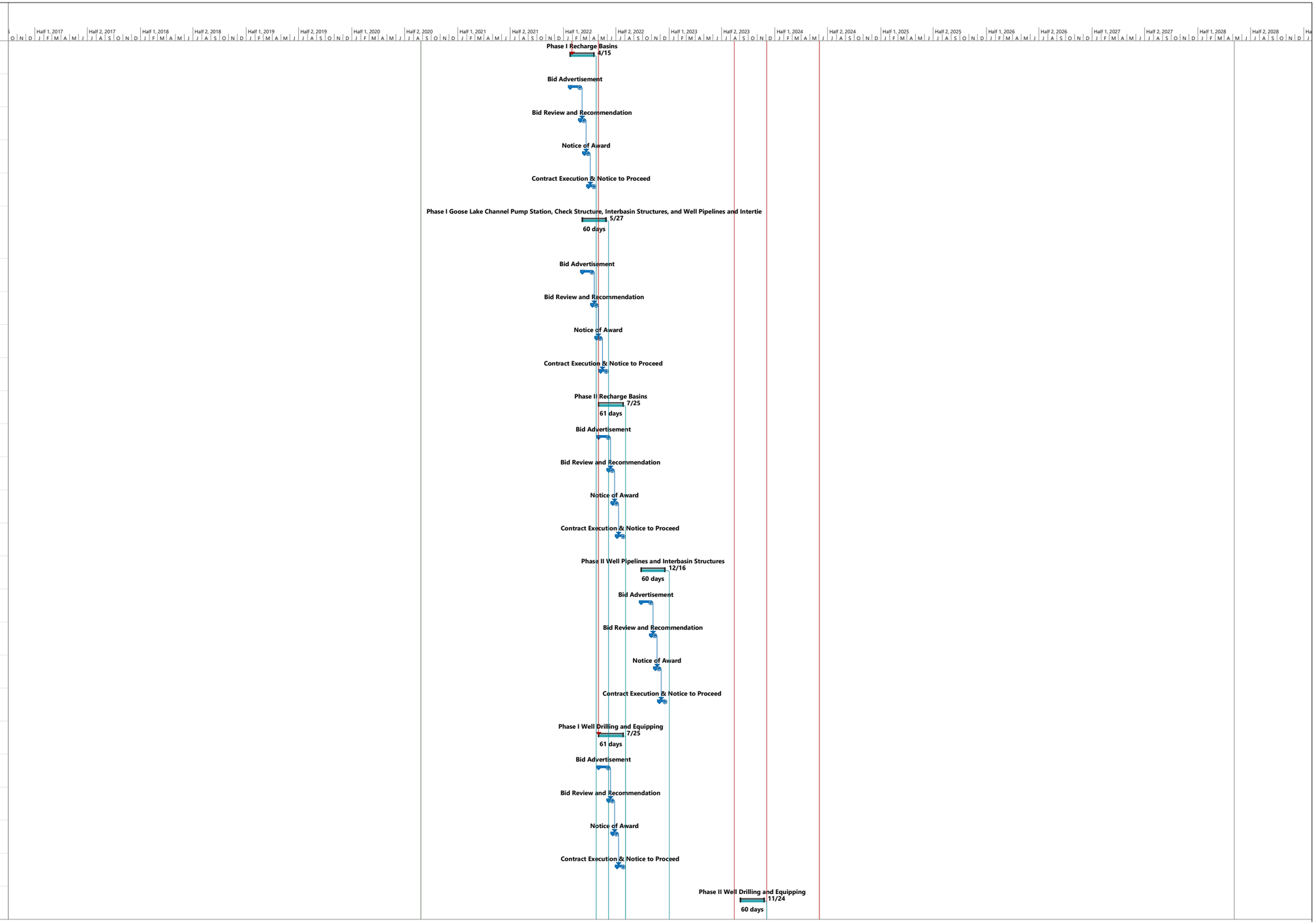
ID	Task Name	Duration	Start	Finish
54	CM Firm Selection	10 days	Wed 3/9/22	Tue 3/22/22
55	Agreement Execution	15 days	Wed 3/23/22	Tue 4/12/22
56	RFQ Preparation for Aqueduct Turnout Facility	45 days	Mon 1/16/23	Fri 3/17/23
57	RFP Interviews	30 days	Mon 3/20/23	Fri 4/28/23
58	CM Firm Selection	10 days	Mon 5/1/23	Fri 5/12/23
59	Agreement Execution	15 days	Mon 5/15/23	Fri 6/2/23
60	RFQ Preparation for Conveyance Facilities including Turnouts & Pump Stations	45 days	Thu 6/1/23	Wed 8/2/23
61	RFP Interviews	30 days	Thu 8/3/23	Wed 9/13/23
62	CM Firm Selection	10 days	Thu 9/14/23	Wed 9/27/23
63	Agreement Execution	15 days	Thu 9/28/23	Wed 10/18/23
64	RFQ Preparation for Pump Station Equipping	45 days	Tue 1/2/24	Mon 3/4/24
65	RFP Interviews	30 days	Tue 3/5/24	Mon 4/15/24
66	CM Firm Selection	10 days	Tue 4/16/24	Mon 4/29/24
67	Agreement Execution	15 days	Tue 4/30/24	Mon 5/20/24
68	RFQ Preparation for SCADA and PLC Programming	45 days	Mon 7/19/21	Fri 9/17/21
69	RFP Interviews	30 days	Mon 11/29/21	Fri 1/7/22
70	CM Firm Selection	10 days	Mon 1/10/22	Fri 1/21/22
71	Agreement Execution	15 days	Mon 1/24/22	Fri 2/11/22
72	**Design Phase**	**715 days**	**Mon 4/5/21**	**Fri 12/29/23**
73	Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie; Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures	210 days	Mon 4/5/21	Fri 1/21/22
74	Phase I Well Drilling and Equipping; Phase II Well Drilling and Equipping	8.75 mons	Mon 8/2/21	Fri 4/1/22
75	Aqueduct Turnout Facility	14 mons	Mon 7/11/22	Fri 8/4/23
76	Conveyance Facilities including Turnouts & Pump Stations	18 mons	Mon 7/11/22	Fri 11/24/23
77	SCADA and PLC Programming	21.3 mons	Fri 5/13/22	Fri 12/29/23
78	**Bid Phase**	**1167 days?**	**Mon 1/24/22**	**Tue 7/14/26**



Project: Kern Fan Groundwater
Date: Thu 8/27/20

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Path Successor Milestone Task | Path Successor Summary Task | Path Successor Normal Task | Critical | Critical Split | Progress | Manual Progress

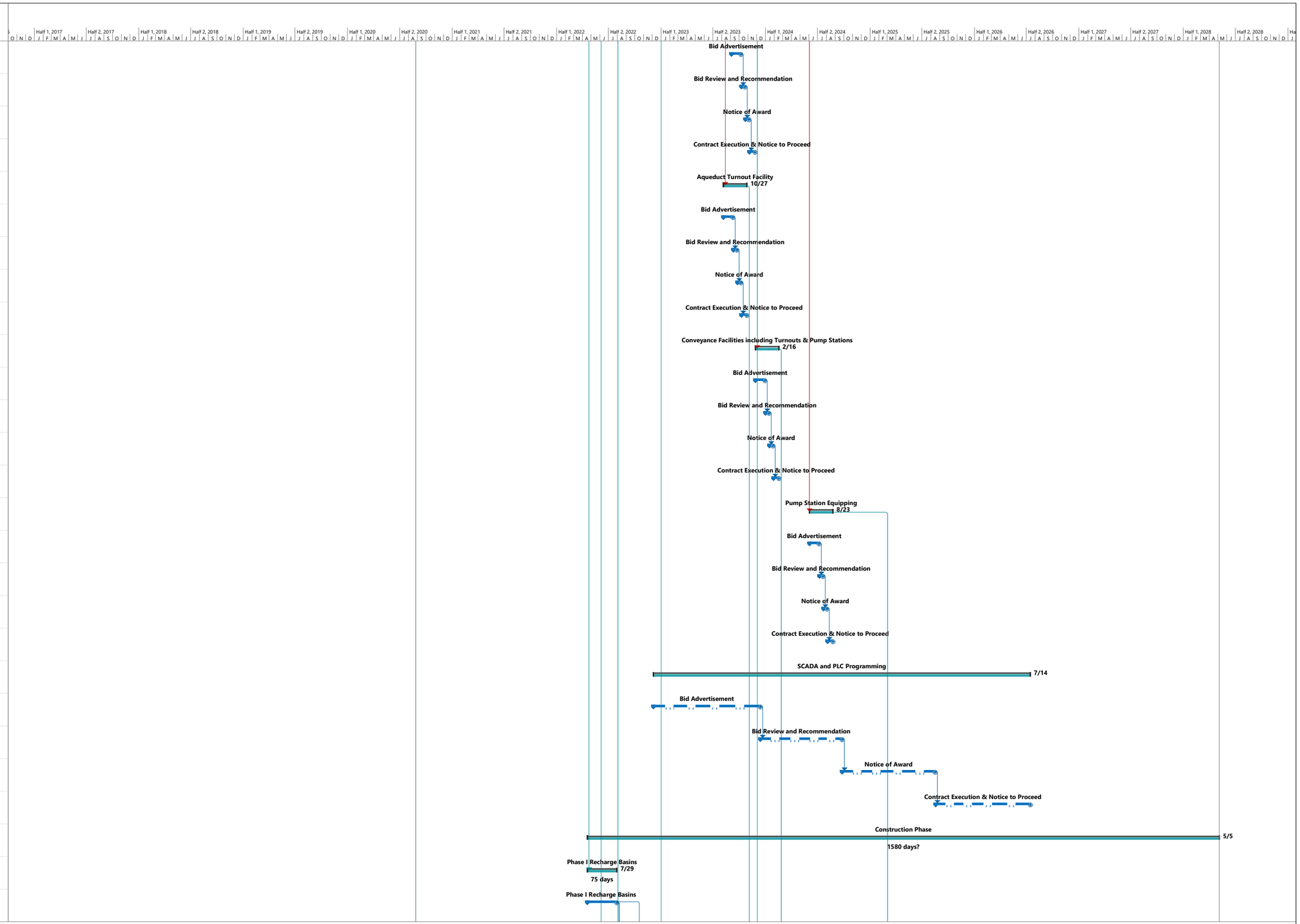
ID	Task Name	Duration	Start	Finish
79	**Phase I Recharge Basins**	**60 days?**	**Mon 1/24/22**	**Fri 4/15/22**
80	Bid Advertisement	25 days	Mon 1/24/22	Fri 2/25/22
81	Bid Review and Recommendation	10 days	Mon 2/28/22	Fri 3/11/22
82	Notice of Award	10 days	Mon 3/14/22	Fri 3/25/22
83	Contract Execution & Notice to Proceed	15 days	Mon 3/28/22	Fri 4/15/22
84	**Phase I Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie**	**60 days**	**Mon 3/7/22**	**Fri 5/27/22**
85	Bid Advertisement	25 days	Mon 3/7/22	Fri 4/8/22
86	Bid Review and Recommendation	10 days	Mon 4/11/22	Fri 4/22/22
87	Notice of Award	10 days	Mon 4/25/22	Fri 5/6/22
88	Contract Execution & Notice to Proceed	15 days	Mon 5/9/22	Fri 5/27/22
89	**Phase II Recharge Basins**	**61 days**	**Mon 5/2/22**	**Mon 7/25/22**
90	Bid Advertisement	25 days	Mon 5/2/22	Fri 6/3/22
91	Bid Review and Recommendation	10 days	Mon 6/6/22	Fri 6/17/22
92	Notice of Award	10 days	Mon 6/20/22	Fri 7/1/22
93	Contract Execution & Notice to Proceed	15 days	Tue 7/5/22	Mon 7/25/22
94	**Phase II Well Pipelines and Interbasin Structures**	**60 days**	**Mon 9/26/22**	**Fri 12/16/22**
95	Bid Advertisement	25 days	Mon 9/26/22	Fri 10/28/22
96	Bid Review and Recommendation	10 days	Mon 10/31/22	Fri 11/11/22
97	Notice of Award	10 days	Mon 11/14/22	Fri 11/25/22
98	Contract Execution & Notice to Proceed	15 days	Mon 11/28/22	Fri 12/16/22
99	**Phase I Well Drilling and Equipping**	**61 days**	**Mon 5/2/22**	**Mon 7/25/22**
100	Bid Advertisement	25 days	Mon 5/2/22	Fri 6/3/22
101	Bid Review and Recommendation	10 days	Mon 6/6/22	Fri 6/17/22
102	Notice of Award	10 days	Mon 6/20/22	Fri 7/1/22
103	Contract Execution & Notice to Proceed	15 days	Tue 7/5/22	Mon 7/25/22
104	**Phase II Well Drilling and Equipping**	**60 days**	**Mon 9/4/23**	**Fri 11/24/23**



Project: Kern Fan Groundwater
Date: Thu 8/27/20

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Path Successor Milestone Task | Path Successor Summary Task | Path Successor Normal Task | Critical | Critical Split | Progress | Manual Progress

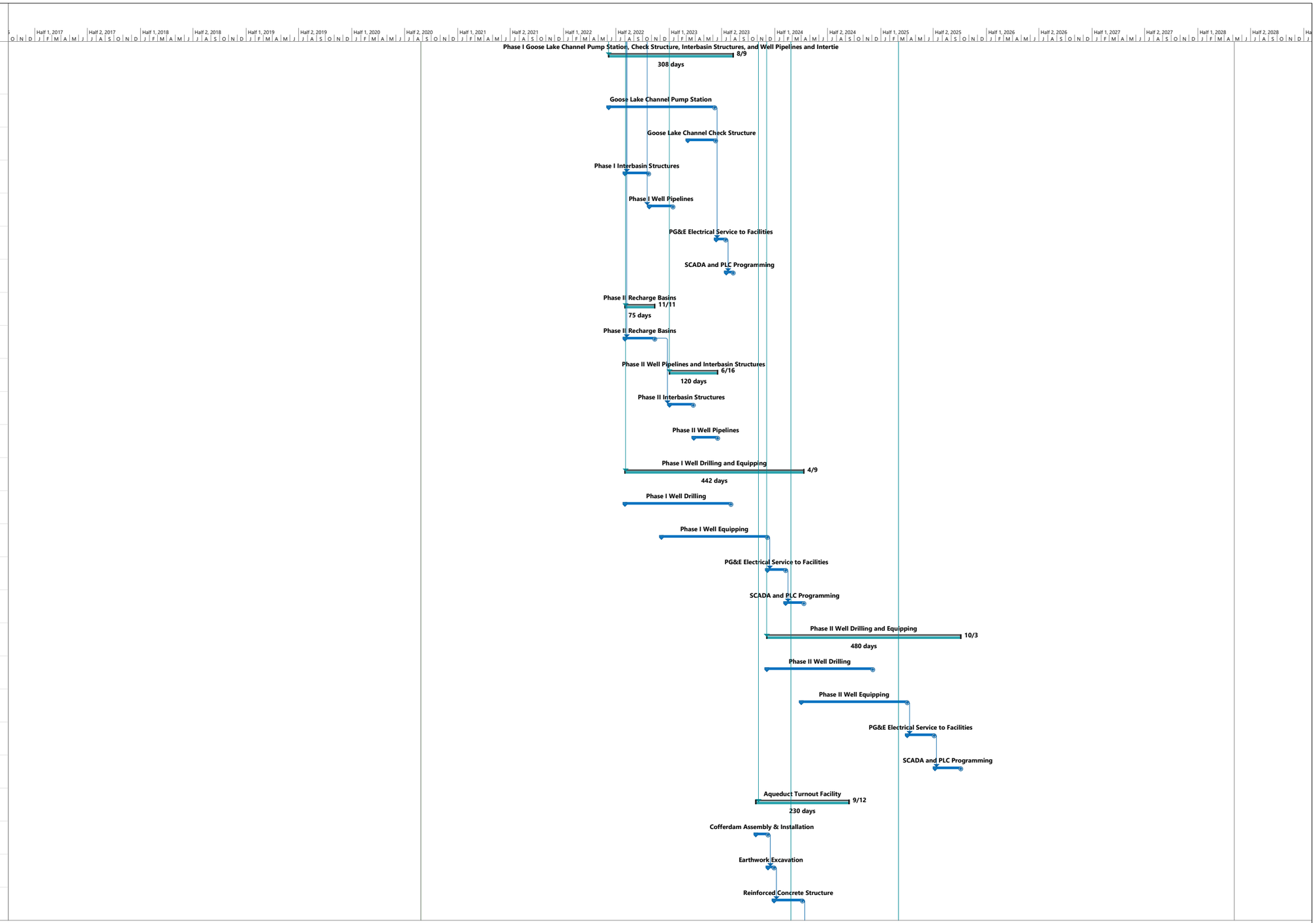
ID	Task Name	Duration	Start	Finish
105	Bid Advertisement	25 days	Mon 9/4/23	Fri 10/6/23
106	Bid Review and Recommendation	10 days	Mon 10/9/23	Fri 10/20/23
107	Notice of Award	10 days	Mon 10/23/23	Fri 11/3/23
108	Contract Execution & Notice to Proceed	15 days	Mon 11/6/23	Fri 11/24/23
109	**Aqueduct Turnout Facility**	**60 days**	**Mon 8/7/23**	**Fri 10/27/23**
110	Bid Advertisement	25 days	Mon 8/7/23	Fri 9/8/23
111	Bid Review and Recommendation	10 days	Mon 9/11/23	Fri 9/22/23
112	Notice of Award	10 days	Mon 9/25/23	Fri 10/6/23
113	Contract Execution & Notice to Proceed	15 days	Mon 10/9/23	Fri 10/27/23
114	**Conveyance Facilities including Turnouts & Pump Stations**	**60 days**	**Mon 11/27/23**	**Fri 2/16/24**
115	Bid Advertisement	25 days	Mon 11/27/23	Fri 12/29/23
116	Bid Review and Recommendation	10 days	Mon 1/1/24	Fri 1/12/24
117	Notice of Award	10 days	Mon 1/15/24	Fri 1/26/24
118	Contract Execution & Notice to Proceed	15 days	Mon 1/29/24	Fri 2/16/24
119	**Pump Station Equipping**	**60 days**	**Mon 6/3/24**	**Fri 8/23/24**
120	Bid Advertisement	25 days	Mon 6/3/24	Fri 7/5/24
121	Bid Review and Recommendation	10 days	Mon 7/8/24	Fri 7/19/24
122	Notice of Award	10 days	Mon 7/22/24	Fri 8/2/24
123	Contract Execution & Notice to Proceed	15 days	Mon 8/5/24	Fri 8/23/24
124	**SCADA and PLC Programming**	**942 days**	**Mon 12/5/22**	**Tue 7/14/26**
125	Bid Advertisement	180 days	Mon 12/5/22	Wed 12/13/23
126	Bid Review and Recommendation	115 days	Thu 12/14/23	Tue 9/24/24
127	Notice of Award	145 days	Wed 9/25/24	Fri 8/15/25
128	Contract Execution & Notice to Proceed	150 days	Mon 8/18/25	Tue 7/14/26
129	**Construction Phase**	**1580 days?**	**Mon 4/18/22**	**Fri 5/5/28**
130	**Phase I Recharge Basins**	**75 days**	**Mon 4/18/22**	**Fri 7/29/22**
131	Phase I Recharge Basins	75 days	Mon 4/18/22	Fri 7/29/22



Project: Kern Fan Groundwater
Date: Thu 8/27/20

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Path Successor Milestone Task | Path Successor Summary Task | Path Successor Normal Task | Critical | Critical Split | Progress | Manual Progress

ID	Task Name	Duration	Start	Finish
132	**Phase I Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie**	**308 days**	**Mon 6/6/22**	**Wed 8/9/23**
133	Goose Lake Channel Pump Station	262 days	Mon 6/6/22	Tue 6/6/23
134	Goose Lake Channel Check Structure	70 days	Mon 3/6/23	Fri 6/9/23
135	Phase I Interbasin Structures	60 days	Mon 8/1/22	Fri 10/21/22
136	Phase I Well Pipelines	60 days	Mon 10/24/22	Fri 1/13/23
137	PG&E Electrical Service to Facilities	25 days	Mon 6/12/23	Fri 7/14/23
138	SCADA and PLC Programming	18 days	Mon 7/17/23	Wed 8/9/23
139	**Phase II Recharge Basins**	**75 days**	**Mon 8/1/22**	**Fri 11/11/22**
140	Phase II Recharge Basins	75 days	Mon 8/1/22	Fri 11/11/22
141	**Phase II Well Pipelines and Interbasin Structures**	**120 days**	**Mon 1/2/23**	**Fri 6/16/23**
142	Phase II Interbasin Structures	60 days	Mon 1/2/23	Fri 3/24/23
143	Phase II Well Pipelines	60 days	Mon 3/27/23	Fri 6/16/23
144	**Phase I Well Drilling and Equipping**	**442 days**	**Mon 8/1/22**	**Tue 4/9/24**
145	Phase I Well Drilling	262 days	Mon 8/1/22	Tue 8/1/23
146	Phase I Well Equipping	262 days	Mon 12/5/22	Tue 12/5/23
147	PG&E Electrical Service to Facilities	45 days	Wed 12/6/23	Tue 2/6/24
148	SCADA and PLC Programming	45 days	Wed 2/7/24	Tue 4/9/24
149	**Phase II Well Drilling and Equipping**	**480 days**	**Mon 12/4/23**	**Fri 10/3/25**
150	Phase II Well Drilling	262 days	Mon 12/4/23	Tue 12/3/24
151	Phase II Well Equipping	262 days	Mon 4/1/24	Tue 4/1/25
152	PG&E Electrical Service to Facilities	67 days	Wed 4/2/25	Thu 7/3/25
153	SCADA and PLC Programming	65 days	Mon 7/7/25	Fri 10/3/25
154	**Aqueduct Turnout Facility**	**230 days**	**Fri 10/27/23**	**Thu 9/12/24**
155	Cofferdam Assembly & Installation	30 days	Fri 10/27/23	Thu 12/7/23
156	Earthwork Excavation	15 days	Fri 12/8/23	Thu 12/28/23
157	Reinforced Concrete Structure	70 days	Fri 12/29/23	Thu 4/4/24



Project: Kern Fan Groundwater
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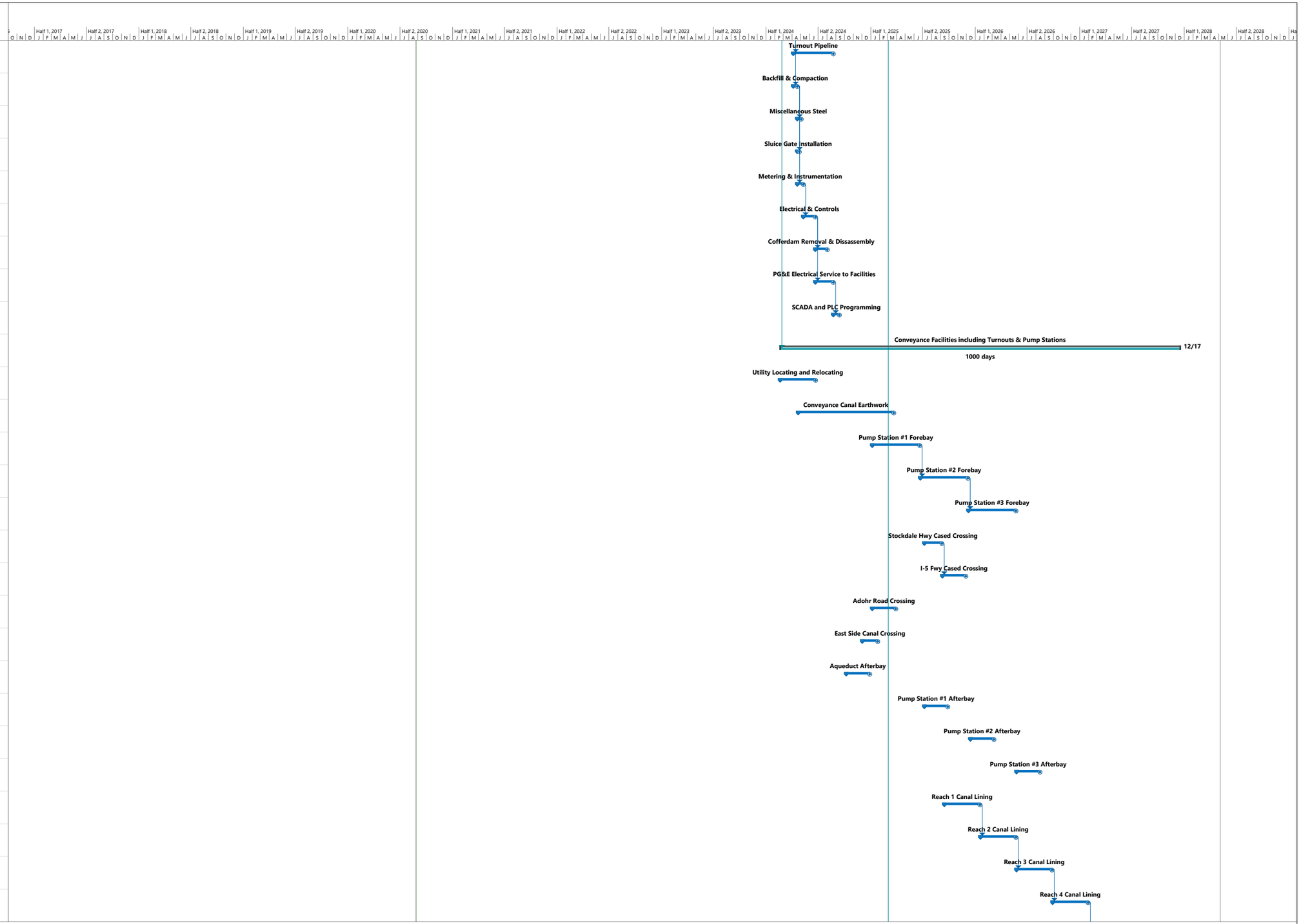
ID	Task Name	Duration	Start	Finish
158	Turnout Pipeline	100 days	Fri 4/5/24	Thu 8/22/24
159	Backfill & Compaction	10 days	Fri 4/5/24	Thu 4/18/24
160	Miscellaneous Steel	10 days	Fri 4/19/24	Thu 5/2/24
161	Sluice Gate Installation	5 days	Fri 4/19/24	Thu 4/25/24
162	Metering & Instrumentation	15 days	Fri 4/19/24	Thu 5/9/24
163	Electrical & Controls	30 days	Fri 5/10/24	Thu 6/20/24
164	Cofferdam Removal & Dissassembly	30 days	Fri 6/21/24	Thu 8/1/24
165	PG&E Electrical Service to Facilities	45 days	Fri 6/21/24	Thu 8/22/24
166	SCADA and PLC Programming	15 days	Fri 8/23/24	Thu 9/12/24
167	**Conveyance Facilities including Turnouts & Pump Stations**	**1000 days**	**Mon 2/19/24**	**Fri 12/17/27**
168	Utility Locating and Relocating	90 days	Mon 2/19/24	Fri 6/21/24
169	Conveyance Canal Earthwork	240 days	Mon 4/22/24	Fri 3/21/25
170	Pump Station #1 Forebay	120 days	Mon 1/6/25	Fri 6/20/25
171	Pump Station #2 Forebay	120 days	Mon 6/23/25	Fri 12/5/25
172	Pump Station #3 Forebay	120 days	Mon 12/8/25	Fri 5/22/26
173	Stockdale Hwy Cased Crossing	45 days	Mon 7/7/25	Fri 9/5/25
174	I-5 Fwy Cased Crossing	60 days	Mon 9/8/25	Fri 11/28/25
175	Adohr Road Crossing	60 days	Mon 1/6/25	Fri 3/28/25
176	East Side Canal Crossing	40 days	Mon 12/2/24	Fri 1/24/25
177	Aqueduct Afterbay	60 days	Mon 10/7/24	Fri 12/27/24
178	Pump Station #1 Afterbay	60 days	Mon 7/7/25	Fri 9/26/25
179	Pump Station #2 Afterbay	60 days	Mon 12/15/25	Fri 3/6/26
180	Pump Station #3 Afterbay	60 days	Mon 5/25/26	Fri 8/14/26
181	Reach 1 Canal Lining	90 days	Mon 9/15/25	Fri 1/16/26
182	Reach 2 Canal Lining	90 days	Mon 1/19/26	Fri 5/22/26
183	Reach 3 Canal Lining	90 days	Mon 5/25/26	Fri 9/25/26
184	Reach 4 Canal Lining	90 days	Mon 9/28/26	Fri 1/29/27



Project: Kern Fan Groundwater
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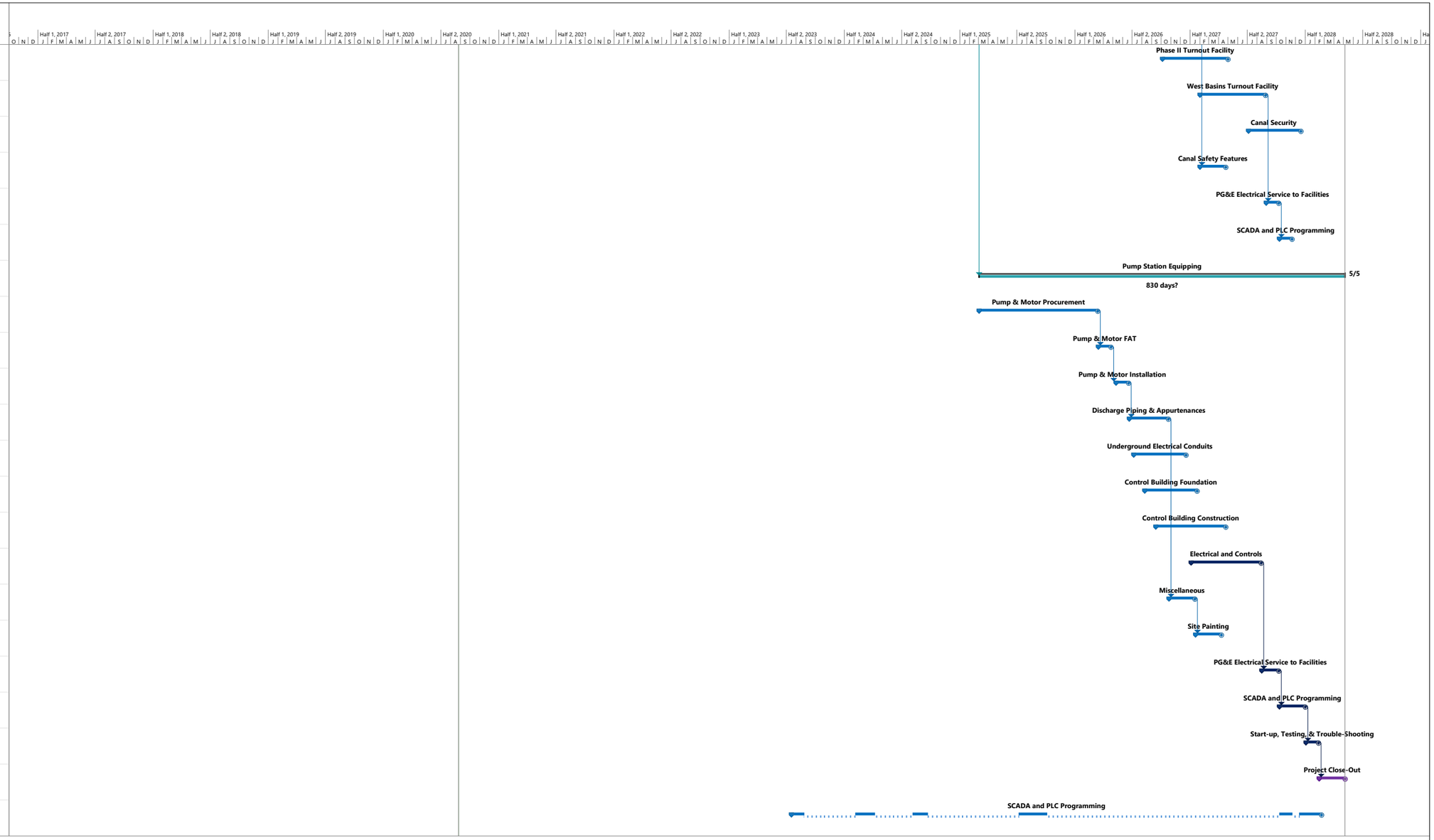
ID	Task Name	Duration	Start	Finish
185	Phase II Turnout Facility	150 days	Mon 10/5/26	Fri 4/30/27
186	West Basins Turnout Facility	150 days	Mon 2/1/27	Fri 8/27/27
187	Canal Security	120 days	Mon 7/5/27	Fri 12/17/27
188	Canal Safety Features	60 days	Mon 2/1/27	Fri 4/23/27
189	PG&E Electrical Service to Facilities	30 days	Mon 8/30/27	Fri 10/8/27
190	SCADA and PLC Programming	30 days	Mon 10/11/27	Fri 11/19/27
191	**Pump Station Equipping**	**830 days?**	**Mon 3/3/25**	**Fri 5/5/28**
192	Pump & Motor Procurement	270 days	Mon 3/3/25	Fri 3/13/26
193	Pump & Motor FAT	30 days	Mon 3/16/26	Fri 4/24/26
194	Pump & Motor Installation	30 days	Mon 5/11/26	Fri 6/19/26
195	Discharge Piping & Appurtenances	90 days	Mon 6/22/26	Fri 10/23/26
196	Underground Electrical Conduits	120 days	Mon 7/6/26	Fri 12/18/26
197	Control Building Foundation	120 days	Mon 8/10/26	Fri 1/22/27
198	Control Building Construction	160 days	Mon 9/14/26	Fri 4/23/27
199	Electrical and Controls	160 days	Mon 1/4/27	Fri 8/13/27
200	Miscellaneous	60 days	Mon 10/26/26	Fri 1/15/27
201	Site Painting	60 days	Mon 1/18/27	Fri 4/9/27
202	PG&E Electrical Service to Facilities	40 days	Mon 8/16/27	Fri 10/8/27
203	SCADA and PLC Programming	60 days	Mon 10/11/27	Fri 12/31/27
204	Start-up, Testing, & Trouble-Shooting	30 days	Mon 1/3/28	Fri 2/11/28
205	Project Close-Out	3 mons	Mon 2/14/28	Fri 5/5/28
206	SCADA and PLC Programming	255.38 days	Mon 7/17/23	Mon 2/21/28



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APPENDIX B

Sample Front End Specifications

PROJECT MANUAL

FOR

_____

_____

_____

PROJECT NO. XXXXX

CODE XXXX

MONTH 20XX

GROUNDWATER BANKING
JOINT POWERS AUTHORITY (JPA)

PROJECT MANUAL

FOR

_____

_____

_____

PROJECT NO. XXXXX

MONTH 20XX

Insert Engineer's Stamp and Signature Here

_____

JPA Engineering Manager Date

PROJECT MANUAL

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BID DOCUMENTS

Contents

NOTICE INVITING SEALED PROPOSALS (BIDS)

FOR THE

_____

_____

PROJECT NO. XXXXX

GROUNDWATER BANKING JOINT POWERS AUTHORITY

NOTICE IS HEREBY GIVEN that the Groundwater Banking Joint Powers Authority ("JPA") invites and will receive electronically submitted proposals ("Bids") up to the hour of 2:00 PM on the ___ day of _____, 20__, at the PlanetBids website, for furnishing to JPA all transportation, materials, equipment, labor, services, and supplies necessary to construct the Work for JPA. At the time specified above the Bids will be electronically opened, and Bidders may view the bid opening online at the PlanetBids website.

Prospective bidders must be on the Bidders List accompanying this Notice. Bids will not be accepted from bidders that are not on the Bidders List. Prequalification to be placed on the Bidders List for this project is closed. Bids must be submitted to JPA through the PlanetBids website as given below.

https://www.planetbids.com/portal/portal.cfm?CompanyID=39499

Bids shall conform to and be responsive to all of the Contract Documents for the Work as heretofore approved by JPA and must be accompanied by the security referred to in the Instructions to Bidders.

The Contract Documents consist of the IRWD Construction Manual, the Project Manual, and the Plans, and may be downloaded free of charge at the PlanetBids website. Complete hard copy sets of the Project Manual and Plans may be purchased from _____.

Under the provisions of the California Labor Code, the Director of the Department of Industrial Relations has determined the prevailing rate of wages for the locality in which the Work is to be performed and JPA has adopted said prevailing rate of wages. A copy of the prevailing wage rates can be found online with the State of California at http://www.dir.ca.gov/dlsr/pwd. A copy of such prevailing wage rates shall be posted on the jobsite by CONTRACTOR.

It shall be mandatory for the bidder to whom the Work is awarded, and upon any subcontractor under the successful bidder, to pay not less than the specified rates to all workers employed by them in the execution of the Work. The project is subject to compliance monitoring and enforcement by the Department of Industrial Relations.

The Contractor and subcontractors, require proof of current registration. A bid shall not be accepted nor any contract or subcontract entered into without proof of the contractor's and subcontractor's current registration.

The Contractor to whom this project is awarded must possess a class _____ contractor's license, issued by the State of California, which is current and full.

The Contractor will be permitted to substitute securities for moneys withheld under this Agreement to ensure performance. Such substitution shall be subject to the provisions of Article 11.8 of the General Provisions of the Agreement. A payment bond and performance bond are required to be provided by the Contractor.

A pre-bid meeting and site visit will be held at the hour of ___:00 _M on the ___ day of _____, 20__, at _____.

SUBSTANTIALLY COMPLEX PROJECT FINDING

_____

_____

PROJECT NO. XXXXX

(Delete this page unless the Board has made a finding on the project complexity.)

JPA's Board of Directors on _____ approved the following finding during a properly noticed and normally scheduled public hearing and prior to bid: "That this project is substantially complex and therefore requires a higher retention amount than five (5) percent, and that the actual retention amount of _____ percent be established for this project." All references in the Contract Documents indicating a five (5) percent retention amount are hereby superseded and replaced with the higher retention amount specified in the preceding sentence. The basis of the finding, including a description of the project and why it is a unique project that is not regularly, customarily or routinely performed by JPA or licensed contractors, is set forth below.

Insert information from the Board write-up on the basis of the finding, including a description of the project and why it is a unique project that is not regularly, customarily or routinely performed by JPA or licensed contractors.

BIDDERS LIST

_____

_____

PROJECT NO. XXXXX

BIDDERS LIST

_____

_____

PROJECT NO. XXXXX

*Delete the names of the **Mechanical** firms not to be invited to bid on this project.*

BIDDERS LIST

_____

_____

PROJECT NO. XXXXX

Contractor categories other than Pipeline or Mechanical:

1. *Insert contractor names from JPA's Prequalified Contractor List*
2.
3.
4.
5.

INSTRUCTIONS TO BIDDERS

Table of Contents

INSTRUCTIONS TO BIDDERS

ARTICLE 1 PROPOSAL REQUIREMENTS AND CONDITIONS

1.1 Contract Documents

The documents that comprise the Contract Documents are set forth in the Agreement and the definition of "Contract Documents" in Article 1 of the General Provisions.

1.2 Contractor's License

No bid will be accepted from a Bidder who is not a licensed contractor in the State of California for the contracting class indicated in the Notice Inviting Sealed Proposals.

1.3 Proposals

1.3.1 Bids shall be made in accordance with the following: Bids shall be submitted electronically through JPA's PlanetBids website. The electronically submitted bid is a part of the Contract Documents. All bids shall be properly executed and with all items filled in; the signatures of all persons signing shall be in longhand. Erasures, interlineations, or other corrections shall be authenticated by affixing in the margin immediately adjacent to the correction the initials of a person signing the bid.

1.3.2 Bids shall not contain any additional description or summaries of the work to be done. Alternative proposals will not be considered, except as called for. No paper copy, oral, telegraphic, or telephonic proposals or modifications will be considered.

1.3.3 The Bid Security Declaration and proposal guarantee in the form of cash, a cashier's or a certified check, or bidder's bond, in an amount not less than ten (10) percent of the amount of bid, made payable to or for the benefit of JPA shall be submitted in paper form in a sealed envelope to JPA prior to the bid opening. The envelope exterior shall indicate "Bid Security" and the project title. The check or bond shall be given as a guarantee that the Bidder will enter into a contract if awarded the Work, and in case of refusal or failure to enter into said contract and furnish the required bonds and insurance certificates and endorsements within fifteen (15) calendar days after Notice of Award by JPA in writing, the check and the money represented by the check shall be forfeited to JPA, or in the event that a bond is deposited, said bond shall be deemed to be forfeited. Forfeiture does not preclude JPA from seeking all other remedies provided by law to recover losses sustained as a result of Bidder's failure to enter into the contract or to furnish the required bonds, insurance certificates and endorsements.

1.3.4 Bids shall be submitted on or before the day and hour set for the opening of bids in the Notice Inviting Sealed Proposals. It is the sole responsibility of the Bidder to see that their bid is submitted and received in proper time.

1.3.5 Prospective bidders must be on the Bidders List accompanying the Notice Inviting Sealed Proposals. Bids will not be accepted from bidders that are not on the Bidders List. Prequalification to be placed on the Bidders List for this project is closed.

1.4 Withdrawal of Bid

A Bidder may withdraw their bid electronically through PlanetBids any time prior to the scheduled time for opening of the bids.

1.5 Bidders Interested in More Than One Bid

No person, partnership, or corporation shall be allowed to make or file or be interested in more than one bid for the Work, unless alternative bids are called for. A person, partnership, or corporation submitting a subproposal to a Bidder, or who has quoted prices on material to a Bidder, is not disqualified from submitting a subproposal or quoting prices to other Bidders.

1.6 Interpretation of Plans and Other Documents

If any prospective Bidder is in doubt as to the true meaning of any part of the plans, specifications, or other Contract Documents, or finds discrepancies in, or omissions from the Plans and specifications or other Contract Documents, they may submit to JPA through PlanetBids a written request for an interpretation or correction. An interpretation or correction of the documents will be made solely at JPA's discretion and only by addendum duly issued by JPA; a copy of such addendum will be made available to Bidders through PlanetBids. JPA and the Engineer will not be responsible for any other explanation or interpretation of the documents.

1.7 Substitute and Or Equivalent Items

The contract, if awarded, will be on the basis of materials and equipment shown or specified in the Contract Documents without consideration of possible substitute or "or equivalent" items. Application for acceptance of a substitute or "or equivalent" item of material or equipment will not be considered by JPA until after the effective date of the Agreement except as may be specified for major items of equipment in the Special Provisions. The procedure for submission of a request for substitution is set forth in the general provisions.

1.8 Engineer's Opinion of Probable Cost

The quantities of work to be done and materials to be furnished are approximate as shown in the Contract Documents and are given as a basis for comparison of bids only. JPA does not expressly or by implication agree or represent that the actual amount of work will correspond with the engineer's opinion of probable cost.

1.9 Addenda

Addenda issued through PlanetBids before the time in which to submit bids expires shall be covered in the bid and shall form a part of the Contract Documents.

1.10 Registration To Perform Public Work

Contractor and subcontractors, if required in Article 1.11, require proof of current registration. A bid shall not be accepted nor any contract or subcontract entered into without proof of the contractor’s or subcontractor’s current registration.

1.11 Subcontractors

The bidder shall provide the name, State of California license number, Department of Industrial Relations registration number, location of place of business, type of work which will be done, and percentage of work of each subcontractor who will perform work or labor or render service to the bidder in or about the construction of the Work in an amount in excess of 1/2 of 1 percent (0.5%) of the bidder's total Bid on the PlanetBids website.

ARTICLE 2 EXISTING CONDITIONS AND EXAMINATION OF CONTRACT DOCUMENTS

2.1 General

2.1.1 Any investigations and reports related to the Work are listed in the Special Provisions and are available for review at JPA's office. Bidder should visit the project site prior to submitting a bid in order to confirm soil and groundwater conditions in the project area at the time of bidding. If additional information is required, it is recommended that it be obtained from a qualified soils engineer.

2.1.2 The Bidder shall examine the Contract Documents and the site where the Work is to be performed. The submittal of a bid shall be conclusive evidence that the Bidder has investigated and has determined to their satisfaction the conditions to be encountered and the character, quality, and scope of the Work.

2.1.3 The plans for the Work show conditions as they are supposed or believed by JPA to exist; but it is not represented or intended to be inferred that the conditions are actually existent. JPA and the Engineer will not be liable for any loss sustained by CONTRACTOR as a result of any variance between the conditions as shown on the plans and the actual conditions revealed during the progress of the Work or otherwise.

2.1.4 Where JPA or the Engineer or their consultants have made investigations of subsurface conditions in areas where the Work is to be performed, such investigations were made only for the purpose of study and design. The conditions indicated by such investigations apply only at the specific location of each boring or excavation at the time the borings or excavations were made. Where such investigations have been made, the records as to such investigations are available for inspection at the office of JPA.

2.1.5 The records of such investigations are not a part of the Contract Documents and are available solely for the convenience of the Bidder or CONTRACTOR. It is expressly understood and agreed that JPA, the Engineer, and their consultants assume no responsibility whatsoever in respect to the sufficiency or accuracy of the investigations, the records, or of the interpretations set forth or made by JPA, the Engineer or their consultants. There is no warranty or guarantee, either expressed or implied, that the conditions indicated by such investigations or records are representative of those existing throughout the area, or any part of an area, or that unlooked for developments may not occur, or that materials other than, or in proportions different from, those indicated may not be encountered.

2.1.6 When a log of test borings showing a record of the data obtained by the investigation of subsurface conditions by JPA, the Engineer, or their consultants is included with the Contract Documents it is expressly understood and agreed that said log of test borings does not constitute a part of the Agreement, that it represents only the opinion of JPA or the Engineer or their consultants as to the character of the materials encountered by them in the test borings at the time they were made, that it is included in the plans only for the convenience of Bidders, and that their use is subject to all of the conditions and limitations set forth in this Article.

2.1.7 The availability or use of information described in this Article is not to be construed in any way as a waiver of the provisions of subparagraph 2.1.2 and a Bidder or CONTRACTOR is cautioned to make such independent investigations and examination as they deem necessary to satisfy themselves as to conditions to be encountered in the performance of the Work.

2.1.8 No information derived from such inspection of records of investigations or compilation of records made by JPA, the Engineer, or their consultants will in any way relieve the Bidder or CONTRACTOR from any risk or from properly fulfilling the terms of the Agreement.

ARTICLE 3 AWARD OF CONTRACT OR REJECTION OF BIDS

3.1 Award

3.1.1 The award of the Agreement, if it is awarded, will be to the lowest responsive and responsible Bidder complying with the instructions contained in the Contract Documents. JPA, however, reserves the right to reject any and all bids and to waive any informality in bids received. If, in the judgment of JPA, a bid is unbalanced or if the Bidder is not responsive and responsible, it shall be considered sufficient grounds for rejection of the entire bid.

3.1.2 JPA shall have sixty (60) days, unless otherwise specified in the Special Provisions, after the opening of bids within which to accept or reject the bids. No Bidder may withdraw their bid during said period. JPA will return the proposal guarantees, except Bidders' bonds and any guarantees that have been forfeited, to the respective Bidders whose proposals they accompanied within ten (10) days after the execution of the Agreement by the successful Bidder or rejection of all bids.

3.1.3 Before award of the contract, any Bidder upon request shall furnish a recent statement of their financial condition and previous construction experience or such other evidence of their qualifications as may be requested by JPA. Failure to do so upon request shall constitute grounds for rejection of the bid.

3.1.4 If the schedule of work items includes bid items or schedule(s) of bid items that may be added to (“Additive Items”) or deducted from (“Deductive Items”) the bids, the lowest responsive and responsible Bidder will be determined by adding all Additive Items to, and deducting all Deductive Items from, the total of the base bid, unless another method is provided in the Special Provisions. JPA reserves the right to award the Work to the lowest responsive and responsible bidder based on any single schedule or combination of schedules of bid items deemed by JPA, in its sole discretion, to be in JPA's best interest.

3.2 Agreement and Bonds

3.2.1 The form of Agreement, bonds, and other documents that the successful Bidder, as CONTRACTOR, shall be required to execute are included in the Contract Documents and should be carefully examined by the Bidder.

3.2.2 The successful Bidder, simultaneously with the execution of the Agreement, will be required to furnish a payment bond and a performance bond, each in an amount equal to one hundred (100) percent of the Contract Price. Said bonds shall be secured from a surety company satisfactory to JPA and who is admitted and authorized to transact business in California. A certified copy of Power of Attorney must be attached to each bond. Said bonds shall continue in full force and effect for the guarantee period.

3.2.3 Should any surety or sureties be deemed unsatisfactory at any time by JPA, notice will be given CONTRACTOR to that effect, and CONTRACTOR shall substitute a new surety or sureties satisfactory to JPA. No further payment shall be deemed due or will be made under the Agreement until the new sureties qualify and are accepted by JPA.

3.2.4 All alterations, time extensions, extra and additional work, and other changes authorized by the Specifications, or any part of the Agreement, may be made without securing consent of the surety or sureties on the contract bonds.

3.3 Insurance Requirements

The successful Bidder will be required to furnish JPA proof of full compliance with all insurance requirements as specified in the Articles on CONTRACTOR's Insurance in the General and Special Provisions. The form of certificates of insurance and endorsements which the successful Bidder, as CONTRACTOR, shall be required to furnish are included in the Contract Documents and should be carefully examined by the Bidder. No alteration or substitution of said forms will be allowed.

3.4 Execution of Agreement

The Agreement shall be signed by the successful Bidder and returned to JPA, together with the contract bonds and certificates of insurance coverage and endorsements, within fifteen (15) calendar days after the mailing date of the Notice of Award. The date of commencement stated in the Notice of Award will constitute the beginning of the Contract Time. The Agreement, bonds, certificates of insurance and endorsements, and other documents to be executed by CONTRACTOR shall be executed and submitted in original-triplicate, two of which shall be filed with JPA and one returned to CONTRACTOR after execution by JPA. Following receipt and approval of the executed Contract Documents, JPA will issue a Notice to Proceed. The receipt of the Notice to Proceed will be authorization for CONTRACTOR to begin work in the field and to start ordering of equipment and material.

3.5 Failure to Execute Agreement or Submit Insurance

3.5.1 Failure by a Bidder to whom the Work is awarded to execute the Agreement and file acceptable bonds and certificates of insurance coverage and endorsements as provided herein shall be just cause for the annulment of the award and the forfeiture of the proposal guarantee, and shall make the Bidder liable to JPA for all damages resulting from the failure, including reasonable attorneys' fees. The value of the proposal guarantee shall not be a limitation of damages.

3.5.2 The insurance certificates and endorsements included in the Contract Documents shall be completed, without alteration, to the satisfaction of JPA, and submitted to JPA by CONTRACTOR or CONTRACTOR's insurance company within fifteen (15) calendar days of the date of the Notice of Award. JPA shall be allotted seven (7) calendar days for review of insurance documents. Additional time as may be required for transmittal and review of follow-up insurance submittals shall not result in an extension of the Contract Time. The insurance certificates and endorsements shall reflect coverage that complies with all insurance requirements in the general provisions and Special Provisions.

ARTICLE 4 ASSIGNMENT OF ANTITRUST ACTIONS

4.1 General

In entering into a public works contract or subcontract to supply goods, services, or materials pursuant to a public works contract, CONTRACTOR or Subcontractor offers and agrees to assign to the awarding body all rights, title, and interest in and to all causes of action it may have under Section 4 of the Clayton Act (15 U.S.C. Section 15) or under the Cartwright Act (Chapter 2, commencing with Section 16700, of Part 2 of Division 7 of the Business and Professions Code), arising from purchases of goods, services, or materials pursuant to the public works

contract or the subcontract. This assignment shall be made and become effective at the time the awarding body tenders final payment to CONTRACTOR, without further acknowledgment by the parties.

ARTICLE 5 MISCELLANEOUS

5.1 Bid Breakdown

Lump-sum and unit-price bid items shall be broken down as indicated on the Schedule of Work. CONTRACTOR may be directed to provide greater detail of the items making up the Contract Price prior to submission of the first Progress Payment Request as indicated in the General Provisions.

5.2 Contract Time

The Contract Time shall be as set forth in the Agreement.

5.3 Liquidated Damages

Liquidated damages shall be as set forth in the Agreement.

5.4 Unit Price Bid Item Quantities

It is understood that the unit price bid item quantities listed in the Schedule of Work are approximate only and are solely for the purpose of facilitating the comparison of bids, and that CONTRACTOR's compensation will be computed upon the basis of the actual quantities in the completed Work whether they be more or less than those shown in the bid.

SCHEDULE OF WORK

_____

_____

PROJECT NO. XXXXX

Base Bid Items

Item No.	Approx. Quantity	Description	Unit Price Dlrs./Cts.	Total Amount Dlrs./Cts.
1-N		(PROJECT BID ITEMS AS REQUIRED)	ENTER AMOUNTS ON PLANETBIDS	
N+1		Trench Safety Measures		
N+2		Startup Testing		
N+3		Final Record Drawings		
		SUBTOTAL, Base Bid Items		

Additive and Deductive Bid Items

Item No.	Approx. Quantity	Description	Unit Price Dlrs./Cts.	Total Amount Dlrs./Cts.
A-1		Builder's Risk Insurance	ENTER AMOUNTS ON PLANETBIDS	
A-2		Additive Bid Item No. 2		
D-1		Deductive Bid Item No. 1		
		SUBTOTAL, Additive/Deductive Bid Items		
		SUBTOTAL, Base Bid and Additive/Deductive Bid Items		
		ADDITION (+) OR		
		DEDUCTION (-)*		
		TOTAL AMOUNT OF BID		

Fill in total amounts for specified Bid Item numbers N+1, N+2, N+3, etc. in blanks above; leave remaining blank for CONTRACTOR to fill in. Only CONTRACTOR entered bid amounts should be greyed out.

*Provision is made here for the bidder to include an addition or deduction in their Bid, if bidder wishes, to reflect any last-minute adjustments in price. The addition or deduction, if made, will be proportionately applied to all of the base bid items.

BID PROPOSAL

DOCUMENT CHECKLIST

_____

_____

PROJECT NO. XXXXX

Bid proposals shall include the following information entered electronically on PlanetBids:

☐ Schedule of Work

Bid proposals shall include the Bid Form and all contents provided therein as listed below that shall be completed by hand and uploaded to PlanetBids as a compiled single document:

☐ Bid Form

- ☐ Statements by Bidder
- ☐ Certification of Bidder and Qualifications
- ☐ Safety Program Certification
- ☐ Non-Collusion Declaration

Bid proposals shall include the following documents that shall be submitted in a sealed envelope to JPA prior to Bid Opening in accordance with the Article 1.3.3 of the Instructions to Bidders:

- ☐ Bid Security Declaration
- ☐ Bid Bond, Cash, or Certified Check

BID FORM

PROPOSAL TO

GROUNDWATER BANKING JOINT POWERS AUTHORITY (JPA)

_____

_____

PROJECT NO. XXXXX

Name of Bidder:_____

TO: BOARD OF DIRECTORS, JPA

Pursuant to and in compliance with your notice inviting sealed proposals (the "Bids") and the other documents relating thereto, the bidder, having familiarized himself with the terms of the Contract Documents, local conditions affecting the performance of the Work, and the cost of the Work at the place where the Work is to be done, hereby proposes and agrees to perform the Work within the Contract Time stipulated in the Agreement, including all of its component parts and everything required to be performed, and to provide and furnish any and all of the labor, material, tools, expendable equipment, and all utility and transportation services necessary to perform and complete in a workmanlike manner, all of the Work required by the Contract Documents, including Addenda, for the prices hereinafter set forth.

The bidder declares that the only persons or parties interested in this proposal as principals are those named herein; that this proposal is made without collusion with any person, firm, or corporation; and bidder proposes and agrees, if the proposal is accepted, that bidder will execute an Agreement with JPA in the form set forth in the Contract Documents and that bidder will accept in full payment thereof the prices submitted electronically on PlanetBids.

Signed this ____ day of _____, 20 __

_____
Name of Bidder

_____
Signature of Bidder

_____
Title of Signatory

STATEMENTS BY BIDDER

_____

_____

PROJECT NO. XXXXX

Bidder shall indicate opposite each item listed by JPA below the name of the manufacturer or supplier proposed to be used under the Agreement. Award of an Agreement under this proposal (bid) will not imply approval by JPA of a manufacturer or supplier listed by the bidder. However, if a manufacturer or supplier is acceptable to JPA, the successful bidder shall furnish the items from the manufacturer or supplier indicated. Any manufacturer or supplier listed in the Agreement may be substituted, changed, or omitted by the successful bidder, subject to the approval of JPA, without subjecting JPA to any liability for the substitution, change or omission.

The listing of any manufacturer or supplier in the Agreement does not, and is not intended to, grant any right, title, or interest in the Agreement for the benefit of the named manufacturer or supplier. Each bidder shall inform in writing each named manufacturer or supplier that the so named manufacturer or supplier is listed for information purposes only and they may be substituted, changed, or omitted by the successful bidder, subject to the approval of JPA, without subjecting JPA to any liability for the substitution, change or omission. The successful bidder shall reimburse JPA for any expenses incurred by JPA as a result of the successful bidder's failure to so notify each named manufacturer or supplier.

A. For each item listed by JPA below, the bidder intends to furnish materials supplied by the following manufacturers: (Bidder to list one manufacturer only for each item.)

Item	Manufacturer
Insert "None" if no items are going to be listed	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Signed this ____ day of _____, 20 __

_____
Name of Bidder

_____
Signature of Bidder

_____
Title of Signatory

CERTIFICATION OF BIDDER AND QUALIFICATIONS

_____

_____

PROJECT NO. XXXXX

The undersigned bidder certifies that bidder is, at the time of bidding, and shall be, throughout the period of the Contract, licensed by the State of California to do the type of work required under the terms of the Contract Documents. Bidder further certifies that bidder is skilled and regularly engaged in the general class and type of work called for in the Contract Documents.

The undersigned bidder certifies that it is not an ineligible contractor for the purposes of California Labor Code Section 1777.1 or 1777.7. The undersigned further certifies that no subcontractor to be used for the performance of the Work is an ineligible contractor for the purposes of Labor Code Section 1777.1 or 1777.7.

The bidder represents that bidder is competent, knowledgeable and has special skills regarding the nature, extent and inherent conditions of the Work to be performed. Bidder further acknowledges that there are certain peculiar and inherent conditions existent in the construction of the Work which may create, during the Work, unusual or peculiar unsafe conditions hazardous to persons and property.

Bidder expressly acknowledges that bidder is aware of such peculiar risks and that they have the skill and experience to foresee and to adopt protective measures to adequately and safely perform the Work with respect to such hazards.

Furthermore, Bidder hereby certifies to JPA that all representations, certifications, and statements made by Bidder, as set forth in this bid, are true and correct and are made under penalty of perjury.

Signed this ____ day of _____, 20 __

_____
Name of Bidder

_____
Signature of Bidder

_____
Title of Signatory

SAFETY PROGRAM CERTIFICATION

_____

_____

PROJECT NO. XXXXX

CONTRACTOR acknowledges that CONTRACTOR has read Section 01410 of Division 1 – General Requirements, Construction Safety Procedures.

CONTRACTOR certifies to JPA that CONTRACTOR's SAFETY PROGRAM includes the following elements:

Safety Policy
Incident Investigation Program
Safety Meeting Program
Statistical Injury and Illness Data
Safety Training Program and Records
Disciplinary Procedures
Safety Inspection Program
OSHA T1 Annual Trench Excavation Permit: Permit No. _____

Signed this ____ day of _____, 20 __

_____
Name of Bidder

_____
Signature of Bidder

_____
Title of Signatory

NON-COLLUSION DECLARATION

_____

_____

PROJECT NO. XXXXX

The undersigned declares:

I am the _____ of _____, the party making the foregoing bid.

The bid is not made in the interest of, or on behalf of, any undisclosed person, partnership, company, association, organization, or corporation. The bid is genuine and not collusive or sham. The bidder has not directly or indirectly induced or solicited any other bidder to put in a false or sham bid. The bidder has not directly or indirectly colluded, conspired, connived, or agreed with any bidder or anyone else to put in a sham bid, or to refrain from bidding. The bidder has not in any manner, directly or indirectly, sought by agreement, communication, or conference with anyone to fix the bid price of the bidder or any other bidder, or to fix any overhead, profit, or cost element of the bid price, or of that of any other bidder. All statements contained in the bid are true. The bidder has not, directly or indirectly, submitted his or her bid price or any breakdown thereof, or the contents thereof, or divulged information or data relative thereto, to any corporation, partnership, company association, organization, bid depository, or to any member or agent thereof to effectuate a collusive or sham bid, and has not paid, and will not pay, any person or entity for such purpose.

Any person executing this declaration on behalf of a bidder that is a corporation, partnership, joint venture, limited liability company, limited liability partnership, or any other entity, hereby represents that he or she has full power to execute, and does execute, this declaration on behalf of the bidder.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct and that this declaration is executed on _____ [date], at _____ [city], _____ [state].

_____
Name of Bidder

_____
Signature of Bidder

_____
Title of Signatory

BID SECURITY DECLARATION

_____

_____

PROJECT NO. XXXXX

THIS PROPOSAL INCLUDES _____
(Insert the words "cash", "bidder's bond", “cashier’s check”, or "certified check", as the case may be) in an amount equal to at least ten percent (10%) of the total amount of the bid, payable in lawful money of the United States of America to the JPA.

Prior to bid opening, the Bid Security Declaration and the bid security must be received in a sealed envelope by mail or hand delivery to JPA at _____, Attention: _____.

The undersigned deposits the security in the form set forth above as a proposal guarantee and agrees that it shall be forfeited to JPA in case this is accepted by JPA and the undersigned fails to execute an Agreement with JPA as specified in the Contract Documents accompanied by the required payment and faithful performance bonds with sureties satisfactory to JPA, and accompanied by the required certificates of insurance coverage and endorsements. Should JPA be required to engage the services of an attorney(s) in connection with the enforcement of this Bid, bidder promises to pay all of JPA's reasonable attorneys' fees and costs incurred with or without suit. The bidder's liability to JPA for failure to do any of the foregoing shall not be limited to the amount of the deposited security in the form set forth above.

The names of all persons interested in the foregoing proposal as principals are as follows:

(NOTICE: If bidder or other interested person is a **corporation**, state legal name of corporation also names of the president, secretary, treasurer and manager thereof; if a **general partnership**, state true name of firm, also names of all individual partners and limited partners; if bidder or other interested person is an **individual**, state first and last names in full; if the bidder is a **joint venture**, state the complete name of each venture; if the bidder is a **limited liability company**, state the complete name of each manager and each member, and if the manager or member is a corporation, its president, secretary and treasurer, and state the complete name of the chief executive officer, if any, of the limited liability company).

_____

_____

_____

_____

_____

BID BOND

KNOW ALL MEN BY THESE PRESENTS, that we

_____

_____

as Principal, and _____ as Surety, are held and

firmly bound unto the

GROUNDWATER BANKING JOINT POWERS AUTHORITY (JPA)

hereinafter called JPA, in the penal sum of

_____

_____ Dollars ($_____),

lawful money of the United States of America, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, assigns, and successors, jointly and severally, firmly by these presents. The condition of this obligation is such that whereas the Principal has submitted a Bid for the construction of:

_____

_____

PROJECT NO. XXXXX

NOW THEREFORE, if the Principal shall not withdraw said Bid within the period of time set forth in the Contract Documents, and shall within fifteen (15) calendar days after the prescribed forms are presented to the Principal for signature enter into a written contract with JPA in accordance with the Bid as accepted, and if the Principal shall give the required bonds with good and sufficient sureties for the faithful performance and proper fulfillment of such contract, and for the protection of laborers and material men, or in the event of the withdrawal of the Bid within the period specified, or the failure to enter into the Agreement, and give such bonds within the time specified, if the Principal shall within sixty (60) days after request by JPA pay to JPA the difference between the amount specified in the Bid and the amount for which JPA may procure the required work, if the latter amount be in excess of the former, then the above obligation shall be void and of no effect, otherwise it shall remain in full force and virtue.

Forfeiture of this bond shall not preclude JPA from seeking any or all other remedies provided by law to cover losses sustained as a result of the Principal's failure to do any of the foregoing, and this bond shall not be a limitation on Principal's liability therefor.

It is further agreed that if JPA is required to initiate legal proceedings to recover on this bond, it may also recover its costs relating thereto including a reasonable amount for attorneys' fees incurred with or without suit.

IN WITNESS WHEREOF the above-bounded parties have executed this instrument this day of _____, 20___, the name and corporate seal for each corporate party being hereto affixed and these presents duly signed by its undersigned representative pursuant to authority of its governing body.

Two Witnesses (if individual)

_____

_____

_____
PRINCIPAL

By _____

Title _____

ATTEST: (if corporation, or limited liability company with officers)

_____

_____
Title

Corporate Seal

Attach acknowledgments of authorized representative of Principal.

Any claims under this bond may be addressed to:

_____ (name and address of Surety)

_____

_____

_____ (name and address of agent or representative in California, if different from above)

_____

_____

_____ (telephone number of Surety and agent of representative in California)

_____
SURETY

By _____

Title _____

ATTEST: (if corporation)

_____

_____
Title

Corporate Seal

Attach acknowledgments of authorized representatives of Surety.

AGREEMENT, BONDS, AND INSURANCE

Contents

AGREEMENT

THIS AGREEMENT, made and entered into by and between the GROUNDWATER BANKING JOINT POWERS AUTHORITY hereinafter referred to as "JPA" and _____ a corporation organized and existing under the laws of the State of _____; a partnership consisting of _____; a joint venture consisting of _____; a limited liability company consisting of _____; or an individual trading as _____; in the City of _____, County of _____, State of _____, hereinafter referred to as "CONTRACTOR".

WITNESSETH: That JPA and CONTRACTOR, for the consideration hereinafter named, agree as follows:

1. SCOPE OF WORK: CONTRACTOR will furnish all materials and will perform all of the work for the construction of:

   (PROJECT NAME)
   PROJECT NO. XXXXX (XXXX)

   in accordance with the Contract Documents therefor.

2. CONTRACT TIME:

2.1 The work shall be substantially completed within one hundred eighty (180) calendar days from the date of the Notice of Award.

3. CONTRACT PRICE: JPA will pay CONTRACTOR in accordance with the prices shown in the bid form.

4. PAYMENTS: Monthly progress payments and the final payment will be made in accordance with the General Provisions. The filing of the notice of completion by JPA shall be preceded by final acceptance of the Work by JPA.

5. LIQUIDATED DAMAGES:

5.1 Liquidated Damages shall be assessed at the rate of $XXX.00 per calendar day, in accordance with the General Provisions.

6. COMPLIANCE WITH PUBLIC CONTRACTS LAW: JPA is a public agency in the State of California and is subject to provisions of law relating to public contracts. It is agreed that all applicable provisions of law related to public contracts are a part of this Agreement to the same extent as though set forth herein and will be complied with by CONTRACTOR.

7. CONTRACT DOCUMENTS: The complete contract includes all the contract documents set forth herein, to wit: Project Manual, Construction Manual, Plans, Addenda, and supplemental agreements.

IN WITNESS WHEREOF, this agreement is executed by the Executive / General Manager and the Secretary of JPA pursuant to Minutes of the meeting of the Board of Directors held on _____, authorizing the same, and CONTRACTOR has caused this agreement to be executed.

Dated: _____

GROUNDWATER BANKING
JOINT POWERS AUTHORITY
Owner

By _____
General Manager

ATTEST:_____
Secretary to the Board

(SEAL)

Dated: _____

_____
Contractor

By _____

APPROVED:

Title_____

_____
Attorney for JPA

(SEAL)

CORPORATE CERTIFICATE

I, _____, certify that I am the _____

Secretary of _____, a _____corporation;

That said corporation executed the foregoing Agreement as *(check only one):*

☐ CONTRACTOR,

☐ venturer of the joint venture named as CONTRACTOR in the foregoing Agreement,

☐ partner of the partnership named as CONTRACTOR in the foregoing Agreement,

☐ manager or member of the limited liability company named as CONTRACTOR in the foregoing Agreement;

that _____, who signed said agreement on behalf of CONTRACTOR was then _____ of said corporation; and that said corporation is in good standing; and that said contract was duly signed for and in behalf of CONTRACTOR by said corporation by express authority of its governing body and is within the scope of its corporate powers; and that if CONTRACTOR is a joint venture, partnership or limited liability company that includes said corporation, said corporation is CONTRACTOR's duly authorized signatory.

By _____

Bond No._____

Premium $_____

PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS: THAT

WHEREAS, THE Board of Directors of the

GROUNDWATER BANKING JOINT POWERS AUTHORITY

by Minute Order at the meeting held the ___ day of _____, 20__, has awarded to

_____ hereinafter designed as the "Principal", a contract for the construction of:

(PROJECT NAME)
PROJECT NO. XXXX (XXXX)

WHEREAS, said Principal is required under the terms of the Contract to furnish a bond for the faithful performance of the Contract,

NOW, THEREFORE, we the Principal and

_____

as Surety, and held firmly bound unto the

GROUNDWATER BANKING JOINT POWERS AUTHORITY

hereinafter called the "Obligee", in the penal sum of _____

_____

_____Dollars ($_____), lawful money of the United States of America, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, and firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH that if the above-bounded Principal, his or its heirs, executors, administrators, successors, or assigns shall in all things stand to and abide by, and well and truly keep and perform the covenants, conditions, and agreements in the Contract and any alteration thereof made as therein provided, on his or their part to be kept and performed at the time and in the manner therein specified, and in all respects according to their true intent and meaning, and shall indemnify and save harmless the Obligee, the Obligee's Representative, the

Engineer/Architect and their consultants and each of their officers, directors, agents and employees, as therein stipulated, this obligation shall become null and void, otherwise, it shall be and remain in full force and virtue inclusive of the entire Contract guarantee period. And the said Surety, for value received, hereby stipulates and agrees that no change, extension of time, alteration, or addition to the terms of the Contract, or to the Work to be performed thereunder, or the plans or specifications accompanying the same, shall in any way affect its obligation on this bond, and it does hereby waive notice by JPA of any such change, extension of time, alteration or addition to the terms of the Contract, or to the work or to the plans or specifications. Principal and Surety agree that if Obligee is required to engage the services of an attorney(s) in connection with the enforcement of this bond, each shall also pay Obligee's reasonable attorneys' fees incurred with or without suit.

IN WITNESS WHEREOF, three counterparts of this instrument, each of which shall for all purposed be deemed an original hereof, have been duly executed by the Principal and Surety above named, on the ___ day of _____ 20___.

APPROVED:

_____
(Attorney for the JPA)

_____
Principal
By _____

Title _____

Any Claims under this bond may be addressed to:

_____
_____
_____
_____
_____
_____
_____
_____
_____

(Name and address of Surety)

(Name and Address of Agent or Representative in California, if different from above)

(Telephone Number of Surety and Agent or Representative in California)

_____
Surety

(Attach Acknowledgment)

By_____

Title _____

<u>NOTICE</u>: No substitution or revision to this bond form will be accepted. Sureties must be admitted and authorized to do business in and have an agent for service of process in California. A certified copy of Power of Attorney must be attached.

PAYMENT BOND

We,_____

as Principal, and _____

as Surety, jointly and severally, bind ourselves, our heirs, representatives, successors and assigns,

as set forth herein, to the Joint Powers Authority (herein called Owner) for payment of the

penal of sum of _____ Dollars ($_____), lawful

money of the United States of America. Owner has awarded Principal a contract for the

construction of:

(PROJECT NAME
PROJECT NO. XXXXX (XXXX)

If Principal or any of his subcontractors fails to pay any of the persons named in Section 3181 of the California Civil Code, or amounts due under the California Unemployment Insurance Code with respect to work or labor performed under the Contract or during the one-year guarantee period, or for any amounts required to be deducted, withheld, and paid over to the Employment Development Department Franchise Tax Board from wages of employees of the Contractor and his subcontractors pursuant to Section 13020 of the California Unemployment Insurance Code, with respect to such work and labor, then Surety will pay the same in an amount not exceeding the sum specified above, and also will pay, in case suit is brought upon this bond, such reasonable attorney's fees as shall be fixed by the court.

This bond shall inure to the benefit of any of the persons named in Section 3181 of the California Civil Code, so as to give a right of action to them or their assigns in any suit brought upon this bond.

Surety agrees that no change, extension of time, alteration, or addition to the terms of the Contract, or the work to be performed thereunder, or the plans and specifications shall in any way affect its obligation on this bond, and it does hereby waive notice by JPA thereof.

Principal and Surety agree that should Owner become a party to any action on this bond that each will also pay Owner reasonable attorneys' fees incurred therein in addition to the sum above set forth.

Executed in three original counterparts on

_____, 20___.

_____
Principal

(Seal of Corporation)

By _____

Title _____

Any claims under this bond may be addressed to:

_____ (Name and Address of Surety)

_____

_____

_____ (Name and Address of Agent or Representative in California, if different from above)

_____

_____

_____ (Telephone Number of Surety's Agent in California)

(Attach Acknowledgment)

_____
Surety

By _____
Attorney-in-Fact

APPROVED:

_____
Attorney for JPA

NOTICE: No substitution or revision to this bond form will be accepted. Sureties must be admitted and authorized to do business in and have an agent for service of process in California. Certified copy of Power of Attorney must be attached.

CONTRACTOR'S CERTIFICATE
REGARDING WORKER'S COMPENSATION

Description of Contract:

(PROJECT NAME
PROJECT NO. XXXXX (XXXX)

California Labor Code Section 3700 provides:

> "Every employer, except the state shall secure the payment of compensation in one or more of the following ways:
>
> (a) By being insured against liability to pay compensation in one or more insurers duly authorized to write compensation insurance in this state.
>
> (b) By securing from the Director of Industrial Relations a certificate of consent to self-insure, which may be given upon furnishing proof satisfactory to the Director of Industrial Relations of ability to self-insure and to pay any compensation that may become due to his employees...."

I am aware of the provisions of Section 3700 of the California Labor Code which require every employer to be insured against liability for workers' compensation or to undertake self-insurance in accordance with the provisions of the Labor Code, and I will comply with such provisions before commencing the performance of any and all work required under the terms and conditions of this Contract.

Dated:_____, 20___ _____
Contractor

By _____

_____

(SEAL)

(In accordance with Article 5 commencing at Section 1860, Chapter 1, Division 2, Part 7, of the California Labor Code, the above certificate must be signed and filed with the JPA (the awarding body) prior to performing any work under this contract.)

GENERAL REQUIREMENTS

SECTION 1

(PROJECT NAME)

PROJECT NO. XXXXX (XXXX)

SECTION 1
GENERAL REQUIREMENTS

Table of Contents

SECTION 01000

INITIAL SUBMITTAL REQUIREMENTS

1.01 SUBMITTALS:

A. Initial Submittals shall be made in accordance with General Provisions Article GP 2.

B. Shop drawings shall be submitted in accordance with Article 9 of the General Provisions.

C. Shop drawings related to instrumentation shall be submitted with two (2) additional copies. (i.e. 10 sets instead of 8 sets of drawings.)

   a. Section 9.1.3 of Article 9 of the General Provisions shall be modified to reflect that the JPA will return three (3) sets of shop drawings with comments.

   b. If the CONTRACTOR desires more than three (3) sets of shop drawings, then the number of drawings shall be incremented by the number of additional shop drawings desired. For example, if the CONTRACTOR would like to have four (4) copies returned, then his initial submittal shall have nine (9) sets rather than the specified eight (8) sets.

1.02 SHOP DRAWING TRANSMITTAL FORM:

A. The Shop Drawing Submittal Form, a copy of which is included in the appendix, shall accompany all shop drawing submittals. Submittals shall be returned "unreviewed" if not accompanied by a submittal form or if the form is not completed in full.

1.03 REVISION OR RESUBMITTAL OF SHOP DRAWINGS:

A. Please insert the following revision to the wording at the lower portion of Section 9.2.5 after this sentence:

   CONTRACTOR shall make corrections required by the GROUNDWATER BANKING JOINT POWERS AUTHORITY (JPA), and shall return the required number of corrected copies of Shop Drawings and submit new samples as required for review and approval. Corrected Shop Drawings shall retain the number assigned to it upon the first submittal and shall be given an R (for revision) and the number of revision of that Shop Drawing. For example: Submittal No. 15-R1 (Submittal No. 15, Revision 1). CONTRACTOR shall direct specific attention in writing to revisions other than the corrections called for by the JPA on previous submittals.

END OF SECTION

SECTION 01100

CONSTRUCTION SURVEY STAKING

1.01 SURVEY STAKING FOR CLEARING LANDS AND RIGHTS-OF-WAY:

A. JPA shall provide field markers along both sides of the construction right-of-way (except where a side is contiguous with an improved road, street, or property) at horizontal curve BCs and ECs, at angle points, and at 100-foot-maximum intervals in horizontal curves and 500-foot-maximum intervals along horizontal tangent runs.

B. Markers will be wooden laths in open terrain and painted marks on structures and pavements.

1.02 SURVEY STAKING FOR CONSTRUCTING PIPELINES

A. For use in constructing pipelines, construction stakes and grade sheets shall be provided by JPA as follows based upon the CONTRACTOR'S pipeline installation drawings:

B. For pipelines not installed in tunnels or casings, one stake will be set at 50-foot intervals , for water lines, 25-foot intervals for sewer lines, and at all angle points and grade breaks. One additional reference stake and/or witness lath will be provided for each pipeline appurtenance. Stakes will be set at the surface of the ground or painted on the paved surface of the ground or painted on the paved surface along a mutually acceptable offset to the centerline of the pipeline. The offset shall be constant both as to side and distance from centerline for runs of not less than 2,000 feet where physically practicable with the provided easements. Station, offset, and cut/fill to flow line will appear on these stakes. The elevation of each point and the cut/fill to the pipe invert will be given on grade sheets. The Contractor shall exercise care in determining what offset is to be used, if sloping of the trench is anticipated. In no instance will the JPA'S Representative stake safety sloping. It shall be the CONTRACTOR'S responsibility to accurately transfer the line and grade for the facility to the trench bottom. Pavement scoring, cutting, and removal shall be accomplished from this same set of construction stakes. No additional stakes will be set for such purpose.

C. For pipe inside tunnels, two benchmarks and principal control monuments shall be provided for line and grade inside the tunnel or casing. The exact location of these benchmarks and monuments will be dictated by conditions at the site.

1.03 SURVEY STAKING FOR CONSTRUCTING STRUCTURES AND APPURTENANCES

A. JPA shall provide survey staking and reference points.

B. Major structures will be controlled by two lines set at right angles to each other, along two faces of the structure, the ends of each line to be beyond the limits of the work, and with elevations only marked on at least two of these control points.

C. Minor structures, manways, and appurtenances will have a stake set along the pipeline construction offset, with the respective pipeline station for its centerline shown.

D. Stakes will be provided after site rough grading has been completed.

1.04 SURVEY STAKING FOR CONSTRUCTING JACKING PITS AND RECEIVING PITS

A. The Contractor shall submit to the JPA'S Representative a separate diagram for each jacking and receiving pit showing the desired control and offset. No more than six (6) stakes will be set for each such pit. Grade sheets (with diagram) will show the stake elevations and the pipeline elevations calculated from the elevations and grades shown on the construction drawings.

B. JPA shall provide survey staking and reference points.

1.05 CONSTRUCTION STAKING PROVIDED BY THE JPA SHALL BE SUBJECT TO THE FOLLOWING CONDITIONS

A. The request for construction stakes shall be received in writing at least three (3) working days in advance of needed staking on the form provided in the Appendix.

B. The stakes, reference markers, and other survey points shall be carefully preserved. Otherwise, the Contractor will be charged for their replacement and will assume any expense resulting from their loss or disturbance. Should the JPA'S Representative be required to reset construction stakes, the cost for such resetting will be at the then current per diem rates. The full charges will include additional administrative and supervisory time charges as billed to the JPA and will be deducted by the JPA from the progress payments to the Contractor for the month in which the surveying work is done, and thereon paid to the JPA'S Representative.

C. Unless otherwise specified, the construction staking provided by the JPA'S Representative will be only for those items specified to be constructed or reconstructed on the plans or in the specifications. Any additional construction stakes required for the replacement of existing improvements that have been

removed or disturbed at the CONTRACTOR'S option shall be the CONTRACTOR'S responsibility.

1.06 COMMENCEMENT OF WORK

A. Work shall not proceed until construction stakes, which constitute instructions from the JPA'S representative, are provided.

END OF SECTION

SECTION 01110

COMPACTION TESTING

1.01 REQUIREMENTS

A. The JPA shall perform all compaction tests on backfill.

B. The request for compaction testing shall be made to the JPA in writing at least forty-eight (48) hours before the Contractor is ready for compaction tests to be taken.

C. The Contractor shall make available construction equipment necessary to assist the JPA'S Representative in taking the tests.

D. If the backfill should fail the compaction test, the Contractor shall pay the cost of retesting.

E. If the Contractor is not ready to have compaction tests taken at the time and in the locations indicated on the written request, the Contractor shall be responsible for all standby charges and/or return visit costs to take the requested tests.

F. If the Contractor plans to use imported sand or other imported material for backfill, a sample of the material to be used for the backfill shall be delivered to the JPA for testing, prior to the commencement of backfilling. If the test fails, the Contractor shall pay the cost of retesting.

END OF SECTION

SECTION 01120

EROSION CONTROL

1.01 REQUIREMENTS

A. The Contractor shall employ methods and approved devices for the control of erosion within the project construction area during the contract period.

B. All work shall be in accordance with the grading code of Kern County and any special requirements of the California Regional Water Quality Control Board, Central Valley Region.

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C. Erosion Control Plans are required from October 15 to May 15, and shall be submitted to the JPA for approval prior to September 25. If plans are not submitted by September 25, or within 21 days from Notice of Award for projects that commence work after September 25, JPA will withhold 30 percent of progress payment amount until plans are submitted and approved.

D. Loose excavated material shall not be placed or stored in waterways or storm drain channels.

E. All excess excavated soil and materials shall be removed and disposed of in a proper and legal manner by the Contractor.

F. All disturbed surface areas shall be shaped to facilitate drainage and avoid ponding and restored to near natural or preconstruction conditions. Work under this section shall also extend to include those erosion control measures indicated on the plans.

G. In the event that erosion control repairs or corrections are required, if CONTRACTOR does not initiate erosion control repair or corrective action within four (4) hours of notification by JPA, JPA may take action it deems necessary to prevent erosion. CONTRACTOR shall be responsible for all costs of repairs performed by JPA.

END OF SECTION

SECTION 01130

DEWATERING

1.01 GENERAL

A. No excavation shall take place below the water level until the area has been dewatered. Dewatering shall be done in such a manner as to protect adjacent structures.

B. Dewatering shall consist of furnishing all permits, plans, labor, equipment and materials, and performing all work to design, construct, and operate dewatering systems, dispose of the water from the operation and maintain in a safe and dewatered condition the areas on which the construction work will be performed, and remove the dewatering system upon completion of the work. If CONTRACTOR is unable to obtain a permit with a project specific monitoring and reporting program in a timely manner from the Regional Water Quality Control Board, CONTRACTOR may request and on approval be allowed to perform dewatering under JPA dewatering permit and monitoring and reporting program.

C. Dewatering systems shall be equipped with meters that register in gallons in order to measure dewatering volumes.

1.02 DEWATERING PLAN

A. CONTRACTOR shall submit for the JPA'S review, drawings and data showing proposed plan for dewatering of all work areas, which shall include the planned method of dewatering, excavation plan, location and capacity of such facilities as dewatering wells, well points, pumps, sumps, collection and discharge lines, standby units proposed, receiving streams, and protective fills and ditches required for control of ground-water and surface water. The plan for dewatering shall be submitted within fifteen (15) days after the date of receipt of the Notice to Proceed. CONTRACTOR shall furnish such other information as may be required for the complete under-standing and analysis of the dewatering and excavation plan by JPA. Information on groundwater conditions may be found in the Soil Investigation Reports listed in Section 00210, Investigations and Reports of the Special Provisions. CONTRACTOR is advised that the reports present conditions which existed at the time of the investigation.

B. Review by JPA will not relieve CONTRACTOR of the responsibility for the adequacy of the dewatering and excavation plan, compliance with dewatering permit requirements or for furnishing all equipment, labor, and materials necessary for performing the various parts of the work. If, during the progress of the work, it is determined by JPA that the dewatering system and excavation plan are inadequate, not in compliance with discharge requirements, or

CONTRACTOR'S plan of construction is inoperative, CONTRACTOR shall, at CONTRACTOR'S expense, furnish, install, and operate such additional dewatering equipment and make such changes in other features of the plan or operation as may be necessary to perform the work in a manner satisfactory to the JPA. CONTRACTOR shall, at CONTRACTOR'S expense, pay any fines or penalties assessed against CONTRACTOR, JPA, Owner, ENGINEER, or their affiliates by the Regional Water Quality Control Board and other applicable agencies as a result of noncompliance with dewatering discharge requirements under CONTRACTOR'S or JPA'S permit (whichever permit CONTRACTOR is performing dewatering under). In addition, CONTRACTOR shall be subject to, at JPA's discretion, a fee by JPA as compensation for JPA administrative costs associated with each non-compliance occurrence. The fee shall be in an amount to pay JPA's actual costs, or $2,000, whichever is greater.

1.03 DEWATERING REPORTING

CONTRACTOR shall comply with all permit and monitoring and reporting requirements for the permit under which CONTRACTOR is operating. Specifically, CONTRACTOR shall:

A. Prepare a report which shall include the following:
   1. Characterization of the proposed wastewater discharge
   2. The estimated average and maximum daily flow rates
   3. A schedule detailing the frequency and duration of the planned discharge(s)
   4. The affected receiving water(s)
   5. A description of the proposed treatment system (if appropriate)
   6. A map showing the path from the point of initial discharge to the ultimate location of the discharge

B. Submit report from Paragraph A to: (1) the RWQCB and copy JPA five (5) days prior to the planned discharge if CONTRACTOR is operating under CONTRACTOR'S permit, or (2) JPA for submittal to the RWQCB ten (10) days prior to the planned discharge if CONTRACTOR is operating under JPA's permit.

C. Not commence work until receiving written acknowledgement on the information provided to JPA from paragraph A.

D. CONTRACTOR shall be responsible for conducting monitoring required under the permit and any additional monitoring requested by the RWQCB. All monitoring and report preparation shall be conducted as specified in the permit under which dewatering is occurring. If CONTRACTOR is operating under the JPA permit, reports shall be forwarded to JPA by the 20th of the month for submittal by JPA to the RWQCB. This report shall include a cover letter noting any violations and stating what action was taken to correct these violations. If CONTRACTOR is operating under CONTRACTOR'S

permit, copies of reports that CONTRACTOR submits to the RWQCB shall be provided to JPA.

END OF SECTION

SECTION 01200

REQUESTS FOR INFORMATION (RFI)

1.01 GENERAL

A. CONTRACTOR shall submit a Request for Instruction (RFI) to JPA if CONTRACTOR:

1. requires instruction pursuant to General Provision Article 6.15, Errors or Discrepancies Noted by CONTRACTOR,

2. raises a question requiring clarification,

3. requests product or material changes,

4. requests design changes, or

5. requires other information from JPA.

1.02 RFI SUBMITTAL PROCEDURE

All RFIs shall be submitted on JPA Forms and shall include all backup information. Backup information shall include, but not be limited to, CONTRACTOR verified field measurements, quantities, dimensions, installation requirements, materials, catalog number, and any other information that will assist the JPA in reviewing the RFI. A copy of RFI form can be found in Appendix.

1.03 JPA RESPONSE

Within seven (7) days of receipt of RFI, JPA will either return a response to the RFI or notify CONTRACTOR when a response will be issued.

1.04 COMMENCEMENT OF RFI-RELATED WORK

No portion of the work requiring instruction from JPA shall begin until RFI has been reviewed by JPA and returned to CONTRACTOR with instruction or with notation indicating JPA response is not necessary.

END OF SECTION

SECTION 01300

TRAFFIC REGULATION

1.01 GENERAL

A. Traffic shall be maintained at those locations indicated and in conformance with the plans and specifications.

B. Furnish, construct, maintain, and remove detours, road closures, lights, signs, barricades, fences, flares, miscellaneous traffic devices, flagmen, drainage facilities, paving, and such other items and services as are necessary to adequately safeguard the public from hazard and inconvenience. All such work shall comply with the ordinances, directives, permits, and regulations of authorities with jurisdiction over the public roads in which the construction takes place and over which detoured traffic is routed by the Contractor.

C. Prior to the start of construction operations, notification shall be given to the police and fire departments in whose jurisdiction the project lies, giving the expected starting date, completion date, and the name and telephone number of the responsible person who may be contacted at any hour in the event of a condition requiring immediate correction.

1.02 CONSTRUCTION SIGNING

A. Construction signing used for handling traffic and public convenience shall conform to the latest edition of the State of California, Department of Transportation, "Manual of Traffic Controls for Construction and Maintenance Work Zones" and "Work Area Traffic Control Hand-book" (WATCH) published by Buildings News Incorporated. In case of conflict between the two previously referenced manuals with regard to recommended sign spacing, the manual, which is more stringent, shall be used.

B. Signs shall be illuminated or reflectorized when they are used during hours of darkness. Cones, pylons, barricades, or posts used in the diversion of traffic shall be provided with flashers or other illumination if in place during hours of darkness.

C. A 24-hour emergency service shall be maintained to remove, install, relocate, and maintain warning devices. The names and telephone numbers of three persons responsible for this emergency service shall be furnished to the agency having jurisdiction over traffic control for the project. If any of these persons do not promptly respond or the jurisdictional agency deems it necessary to call out other forces to accomplish emergency service, the Contractor will be held responsible for the cost of such emergency service.

1.03 VEHICULAR TRAFFIC CONTROL

A. If necessary traffic control within the area along Stockdale Highway or Enos Lane shall conform to the ordinances and regulations of the California Department of Transportation (Caltrans) and the County of Kern Roads Departments.

B. The failure of the Contractor to maintain construction signing, delineators, or barricading at all times to the satisfaction of the California Department of Transportation (Caltrans) shall be sufficient cause for closing down the work until such equipment is in satisfactory condition. All costs associated with the stoppage of work, loss of production, costs of restart, etc., shall be borne by the Contractor.

C. A minimum 2-foot clearance between the curb face or edge of pavement, and a 5-foot clearance between the edge of excavation and the edge of any traffic lane shall be maintained at all times. Shoring members, beams, or other obstructions shall not be permitted within the 2-foot clearance between the edge of excavation and the edge of any traffic lane. Any projections or activity within 2 feet to 5 feet from the adjacent traffic lane must be protected by a solid concrete barrier (K-rail). "NO PARKING" signs shall be placed as necessary.

D. Work areas adjacent to the existing traffic lane shall be delineated in accordance with the requirements for the normal posted speed limit. The Contractor shall post signing, barricades, and delineators to provide clear guidance to traffic as approved by the jurisdictional agency having authority over traffic control.

1.04 PEDESTRIAN TRAFFIC CONTROL AND SAFETY

A. Fencing or other means of securement shall be provided to preclude unauthorized entry to any excavation during all nonworking hours on a 24-hour basis including weekends and holidays. Fencing shall be a minimum of 6 feet high around the entire excavation, and shall consist of a minimum 9-gage chain link type fence sturdy enough to prohibit toppling by children or adults. There shall be no openings under the wire large enough for any child to crawl through. Gates shall be locked if no adult is in attendance. Warning signs shall be placed at 50-foot centers on the outside of the fence with the statement "DEEP HOLE DANGER."

1.05 ACCESS TO ADJACENT PROPERTIES

A. Reasonable access from public streets to all adjacent properties shall be maintained at all times during construction. Prior to restricting normal access from public streets to adjacent properties, each property owner or responsible person shall be informed of the nature of the access restriction, the approximate duration of the restriction, and the best alternate access route for that particular property.

1.06 PERMANENT TRAFFIC CONTROL DEVICES

A. Existing permanent traffic control signs, barricades, and devices shall remain in effective operation unless a substitute operation is arranged for and approved as a portion of vehicular traffic control above. Replacement work shall be in accordance with the ordinances and regulations of the California Department of Transportation (Caltrans).

B. Restriping of Streets

Any permanent restriping that is required shall be done by the Contractor. The Contractor is cautioned to check with the California Department of Transportation (Caltrans) and County of Kern Roads Department to ascertain the extent and specifications for restriping. Full compensation for restriping within the right of way shall be included in the contract unit price for which such work is appurtenant thereto. Temporary striping required for traffic control during construction shall also be done by the Contractor with full compensation to be included in the contract unit price for which such work is appurtenant, and no additional allowance shall be given. Temporary striping includes any striping required on any pavement replaced prior to the final surface course. The Contractor shall remove any permanent striping that conflicts with the detour plan and all detour striping completely, prior to replacement of any final striping, by sandblasting only. Painting out existing striping shall not be permitted. Any damaged or obliterated raised pavement markers shall also be replaced in accordance with the appropriate standard with compensation for such work and materials included in the unit contract price for which such work is appurtenant.

C. Traffic Control Wire Loops

Traffic control wire loops which are cut, removed, or otherwise disturbed for construction of the pipeline shall be replaced to the exact original position. Replacement work shall be in accordance with Section 86-5.01A of the State of California, Department of Transportation, Standard Specifications. The number of turns in the loop shall be in accordance with the manufacturer's specifications for the vehicle detector.

Detector lead-in conductors, cable, inductive loop conductor, and epoxy shall conform to the provisions of Section 86 of the State of California, Department of Transportation, Standard Specifications. The cable shall not be spliced. Splices to lead-in conductors shall be made in pull boxes and soldered, wrapped, and waterproofed after sensitivity check at tuning turn on. Inductive loop wires shall be labeled in the pull box, identifying the loop and the direction of current flow. Saw cuts for inductive loop wire shall be of a width such that the loop wires will fit within the cut snugly but without need for forcing of the wire.

Damaged traffic signal conduits shall be replaced to the nearest pull box, including new wire, back to the terminal, and/or back to the signal controller to the satisfaction of the agency having jurisdiction over the equipment.

Damaged traffic loops or signal conduit shall be repaired before proceeding to the construction phase. Two traffic signal vehicle heads shall be visible at all times to vehicular traffic at signalized intersections during construction.

1.07 PAYMENT

Payment for conforming to all of the traffic control and pedestrian safety requirements of these specifications shall be considered to be included in the contract unit or lump-sum price paid for the various items of work wherein maintenance of traffic control and detours is required. No additional allowance will be given for maintenance of traffic control and detours.

END OF SECTION

SECTION 01400

PRECONSTRUCTION AND POST CONSTRUCTION CONFERENCES

1.01 PRECONSTRUCTION CONFERENCE

A. Upon issuance of Notice to Proceed, or earlier when mutually agreeable, JPA will arrange a preconstruction conference.

B. CONTRACTOR'S superintendent, JPA, Engineer/Architect representatives of utilities, major subcontractors and others involved in performance of the Work, and others necessary to agenda shall attend Preconstruction Conference.

C. JPA will preside at conference.

D. Purpose of Conference: To establish working understanding between parties and to discuss Construction Schedule, shop drawing and other submittals, cost breakdown of major lump sum items, processing of submittals and applications for payment, and other subjects pertinent to execution of the Work.

E. Agenda will include:

1. Adequacy of distribution of Contract Documents.

2. Distribution and discussion of list of major subcontractors and suppliers.

3. Proposed progress schedules and critical construction sequencing.

4. Major equipment deliveries and priorities.

5. Project coordination.

6. Permits and Permit Conditions.

7. Environmental (CEQA) Mitigation Requirements.

8. Designation of responsible personnel.

9. Procedures and Processing of:

a. Field decisions

b. Proposal requests

c. Submittals
d. Change Orders

e. Applications for Payment

f. Record Documents

10. Use of Premises:

a. Office, construction, and storage areas

b. JPA'S requirements

11. Construction facilities, controls, and construction aids

12. Coordination of construction with JPA operations and others

13. Temporary utilities

14. Safety and first aid procedures

15. Security procedures

16. Housekeeping procedures

F. JPA will record minutes of meeting and distribute copies of minutes within seven (7) days of meeting to participants and interested parties.

1.02 POST CONSTRUCTION MEETING

A. Meet with JPA and inspect the Work eleven (11) months after the date of recording by the County of the Notice of Completion of the Work.

B. Arrange meeting at least seven (7) days before meeting.

C. Meet in JPA'S office or other mutually agreed upon place.

D. Inspect the Work and draft list of items to be completed or corrected.

E. Review service and maintenance contracts, and take appropriate corrective action when necessary.

F. Complete or correct defective work and extend correction period accordingly.

G. Require attendance of Superintendent, appropriate manufacturers and installers of major units of constructions, and affected subcontractors.

END OF SECTION

SECTION 01410

CONSTRUCTION SAFETY PROCEDURES

1.01 GENERAL

A. CONTRACTOR shall assure that each employee is trained in the work practices necessary to safely perform his/her job.

B. CONTRACTOR shall assure that each employee is instructed in the known potential hazards related to his/her job and the process, and the applicable provisions of the emergency action plan for the plant or facility as covered during CONTRACTOR safety orientation.

C. CONTRACTOR shall document that each employee has received and understood the training required. The documentation shall contain the identity of the employee, the date of training, and the means used to verify that the employee understood the training. Documentation shall be submitted to JPA upon request.

D. CONTRACTOR shall advise JPA of any unique hazards presented by the CONTRACTOR'S work.

E. CONTRACTOR shall immediately notify JPA of any hazards found or discovered during the course of the work.

F. CONTRACTOR shall submit copy of OSHA T1 Annual Trench Excavation Permit upon request.

1.02 CONSTRUCTION SAFETY

A. CONTRACTOR shall submit a Construction Safety Plan detailing the methods and procedures for complying with California Labor Code Section 6401.7, Federal, and local health and safety laws, rules and requirements for the duration of the contract time. The plan shall include the following:

1. Identification of the Safety Officer (or Consultant), who will prepare, initiate, maintain and supervise safety programs, and procedures.

2. Procedures for providing workers with an awareness of safety and health hazards expected to be encountered in the course of construction.

3. Safety equipment appropriate to the safety and health hazards expected to be encountered during construction.

4. Methods for minimizing employees' exposure to safety and health hazards expected during construction.

5. Procedures for reporting safety or health hazards.

6. Procedures to follow to correct a recognized safety and health hazard.

7. Procedures for investigation of accidents, injuries, illnesses and unusual events that have occurred at the construction site.

8. Periodic and scheduled inspections of general work areas and specific workstations.

9. Training for employees and workers at the jobsite.

10. Methods of communication of safe working conditions, work practices and required personal protection equipment.

B. CONTRACTOR shall assume responsibility for every aspect of Health and Safety on the jobsite, including the health and safety of Subcontractors, suppliers, and other persons on the jobsite.

C. CONTRACTOR'S Safety Officer shall periodically review job safety information and reports and make recommendations concerning worker health and safety at the jobsite.

D. CONTRACTOR shall employ health and safety measures specified by the Safety Officer, as necessary, for workers in accordance with OSHA guidelines.

E. CONTRACTOR shall transmit to JPA copies of reports and other documents related to accidents or injuries encountered during construction.

1.03 SAFETY PROCEDURES

A. Accident Prevention:

1. Exercise precautions throughout construction for protection of persons and property.

2. Observe safety provisions of applicable Laws and Regulations.

3. Guard machinery and equipment, and eliminate other hazards.

4. Make reports required by authorities having jurisdiction, and permit safety inspections of the Work.

5. Before commencing construction Work, take necessary action to comply with provisions for safety and accident prevention.

B. Barricades:

1. Place barriers at ends of excavations and along excavations to warn pedestrian and vehicular traffic of excavations.

2. Provide barriers with flashing lights after dark.

3. Keep barriers in place until excavations are entirely backfilled and compacted.

4. Barricade excavations to prevent persons from entering excavated areas in streets, roadways, parking lots, treatment plants, or other public or private areas.

C. Warning Devices and Barricades: Adequately identify and guard hazardous areas and conditions by visual warming devices and, where necessary, physical barriers.

1. Devices shall conform to minimum requirements of OSHA and State agency which administers OSHA regulations where Project is located.

D. Hazards in Public Right-of-Way:

1. Mark at reasonable intervals, trenches and other continuous excavations in public right-of-way, running parallel to general flow of traffic, with traffic cones, barricades, or other suitable visual markers during daylight hours.

a. During hours of darkness, provide markers with torches, flashers, or other adequate lights.

2. At intersections or for pits and similar excavations, where traffic may reasonably be expected to approach head on, protect excavations by continuous barricades.

a. During hours of darkness, provide warning lights at close intervals.

E. Hazards in Protected Areas: Mark or guard excavations in areas from which public is excluded, in manner appropriate for hazard.

F. Above Grade Protection: On multi-level structures, provide safety protection that meets requirements of OSHA and State agency which administers OSHA regulations where Project is located.

G. Protect existing structures, trees, shrubs, and other items to be preserved on Project site from injury, damage or destruction by vehicles, equipment, worker or other agents with substantial barricades or other devices commensurate with hazards.

H. Fences: Enclose site of the Work with fence adequate to protect the Work against acts of theft, violence and vandalism.

END OF SECTION

SECTION 01420

CONFINED SPACES

1.01 GENERAL

A. Attention is directed to the provisions of :

1. Article 108 of the General Industry Safety Orders, Title 8, California Code of Regulations.

2. Article 4 of the Construction Safety Orders, Title 8, California Code of Regulations.

B. The General Industry Safety Orders define a confined space as a space that: (1) is large enough and so configured that a person can bodily enter and perform work, and (2) has limited or restricted means for entry and exit, and (3) is not designed for continuous occupancy.

C. Confined spaces shall be as described above, and shall include the interior of storm drains, sewers, vaults, utility pipelines, manholes, reservoirs, and any other such structure which is similarly surrounded by confining surfaces so as to permit an oxygen deficient atmosphere or the accumulation of dangerous gases or vapors.

D. A Permit Required Confined Spaces is defined as a confined space that has one or more of the following characteristics:

1. Contains a hazardous atmosphere,

2. Contains a liquid or solid materials that can engulf an entrant,

3. A configuration that can trap and suffocate an entrant,

4. Mechanical or electrical hazards, or

5. Contains any other recognized serious safety and health hazard.

6. Contains unknown atmospheric environment.

The general industry regulations define a Non-Permit Required Confined Space as a confined space that does not contain or, with respect to atmospheric hazards, have the potential to contain any hazard capable of causing death or physical harm.

E. Confined spaces shall be considered permit-required confined spaces (PRCS) until proven safe from atmospheric hazards by testing and ventilation; and until evaluated as safe from any other serious safety or health hazards.

1.02 CONFINED SPACE OPERATING PROCEDURES

A. CONTRACTOR shall submit confined space operating and rescue procedures to the JPA for record keeping purposes. Procedures shall conform to the applicable provisions of Article 108, General Industry Safety Orders, Title 8, California Code of Regulations.

B. CONTRACTOR shall test for the presence of combustible or dangerous gases and/or oxygen deficiency in confined spaces using an approved device immediately prior to a worker entering the confined space, and at intervals frequent enough to ensure a safe atmosphere during the time a worker is in such a structure. A record of such tests shall be kept at the jobsite.

C. Employees shall not be permitted to enter a confined space, where tests indicate the presence of a hazardous atmosphere, unless the employee is wearing suitable and approved respiratory equipment, or until such time that continuous forced air ventilation has removed the hazardous atmosphere from the confined space.

D. Confined spaces that contain or that have last been used as containers of toxic gases, light oils, hydrogen sulfide, corrosives, or poisonous substances, shall, in every case, be tested by means of approved devices or chemical analysis before being entered without wearing approved respiratory equipment.

E. Sources of ignition shall be prohibited in any confined space until after the atmosphere within the confined space has been tested and found safe.

F. Reservoirs, vessels, or other confined spaces having openings or manholes in the side as well as in the top shall be entered from the side openings or manholes when practicable.

G. CONTRACTOR shall coordinate entry operations with JPA when both CONTRACTOR personnel and JPA personnel will be working together as authorized entrants into a permit-required confined space.

H. CONTRACTOR shall submit to JPA a photocopy of the canceled permit at the conclusion of the entry operation. This information is for record-keeping purposes only, and is not intended to provide enforcement of confined space regulations.

END OF SECTION

SECTION 01430

HAZARDOUS SUBSTANCES COMMUNICATION

1.01 REFERENCE

A. General Requirements Section 01430

1.02 GENERAL

A. The following hazardous substances are known to be present or will be encountered during performance of the work.

1. None know at this time.

B. Material Safety Data Sheets (MSDS) for each known hazardous substance can be found in the Appendix.

1.03 PROCESS OVERVIEW

A. If a hazardous substance is found or identified the CONTRACTOR shall immediately stop work in the area and notify the JPA'S Representative.

B. If asbestos-containing materials are uncovered during project construction, work at the project site shall immediately halt and a qualified hazardous materials professional shall be contacted and brought to the project site to make a proper assessment of the suspect materials. All potentially friable asbestos-containing material shall be removed in accordance with Federal, State, and local laws and the National Emission Standards for Hazardous Air Pollutants guidelines prior to ground disturbance that may disturb such material. All demolition activities shall be undertaken in accordance with California Occupational Safety and Health Administration standards, as contained in Title 8 of the CCR, Section 1529, to protect workers from exposure to asbestos. Material containing more than one percent asbestos shall also be subject to San Joaquin Valley Air Pollution Control District regulations. Demolition shall be performed in conformance with Federal, State, and location laws and regulations so that construction workers and or the public avoid significant exposure to asbestos-containing materials.

END OF SECTION

SECTION 01435

HAZARDOUS SUBSTANCE PROCEDURES

1.01 REFERENCES

A. California Health and Safety Code, Section 25117.

B. United States Code of Federal Regulation (CFR), Title 29 and Title 40.

C. State of California Code of Regulations (CCR), Title 8 and Title 22.

D. Steel Structure Painting Council – PA Guide 3.

E. 29 CFR 1910.1000.

F. 29 CFR 1910.134.

G. Steel Structure Painting Council:

1. Guide 61 – Guide for Containing Debris Generated During Paint Removal Operations.

2. Guide 71 – Guide for the Disposal of Lead-Contaminated Surface Preparation Debris.

1.02 GENERAL

A. CONTRACTOR shall inform JPA and other affected persons of hazardous substances that are brought onto the jobsite or suspected hazardous substances which are encountered during performance of the work. CONTRACTOR shall notify such agencies as required to be notified by law or by regulation of the presence of hazardous substances.

B. Definitions

1. Hazardous substance: Defined as any substance included in the list (Director's List) of hazardous substances prepared by the Director, California Department of Industrial Relations, pursuant to Labor Code Section 6382. Includes hazardous waste as defined herein.

2. Hazardous waste: A waste or combination of wastes as defined in 40 CFR 261.3, or regulated as hazardous waste in California pursuant to Chapter 11, Division 4.5, Title 22, California Code of Regulations, and Chapter

6.5, Division 20, California Health and Safety Code, or those substances defined as hazardous wastes in 49 CFR 171.8.

C. CONTRACTOR shall provide plans, procedures, and controls to be used when encountering hazardous substances during performance of the work.

D. Prior to commencing work, and where it is known or suspected that hazardous substances will be encountered, CONTRACTOR shall submit a copy of its hazard communication program to JPA. Program shall describe CONTRACTOR'S communication procedures and shall give evidence of employees training for complying with procedures.

E. CONTRACTOR shall designate a Certified Industrial Hygienist to issue instructions and recommendations for worker safety in the event a hazardous substance is encountered.

F. CONTRACTOR shall file request for adjustment of Contract Price or Time due to the finding of hazardous materials at the work-site, in accordance with Article 14 of the General Provisions.

1.03 HAZARDOUS SUBSTANCE PROCEDURES

A. For work where hazardous substances will be present or encountered, CONTRACTOR shall:

1. Submit to JPA a Site Safety and Health Plan. A copy of the plan shall be made available to the jobsite while work is being performed.

2. Submit to JPA a Materials Disposal Plan.

3. Submit to JPA a Material Safety Data Sheet (MSDS) for each hazardous substance proposed to be used or encountered at the jobsite. MSDS shall be submitted prior to commencing work.

4. Exercise extreme care when handling or disposing of materials or substances that are listed as hazardous substances in Section 8-339 of California Occupational Safety and Health Regulations, Title 8, California Code of Regulations, or in Title 26 (Toxics) of the California Code of Regulations, or as evidenced by the manufacturer's MSDS.

5. Immediately notify JPA of any spill of material that is, or contains, a hazardous substance, including, but not limited to, motor oil, hydraulic fluid, or other petroleum products and hazardous materials or wastes used or generated on site. JPA personnel will notify the proper

authorities of the spill and will specify the necessary measures to be taken by the CONTRACTOR to neutralize and/or remove the hazardous substance.

B. For work where materials suspected of containing hazardous substances are encountered, CONTRACTOR shall immediately comply with the requirement set forth above in Paragraph A, as well as the following:

1. Sampling and Testing

Contractor shall sample and test all materials suspected of containing hazardous substances to determine if they are classifiable as hazardous wastes that must be disposed of at a Class I disposal site, or non-hazardous wastes that must be disposed of at a Class II or Class III disposal site. All sampling and testing shall be performed by a laboratory that complies with and is certified under the Environmental Laboratory Accreditation Program (ELAP) of the California Department of Health Services.

2. Hazardous Substances that may be Encountered

All the materials listed below that are to be disposed of from the site shall be sampled and analyzed for hazardous constituents. Analytical reports shall be submitted to the JPA prior to disposing of each material.

a. Sandblast Media, sealant, soil

b. Wastewater, sediments

c. Metals analyses will include the following 17 metals:

Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Copper, Cobalt, Lead, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Vanadium and Zinc

3. Handling Samples

a. Each sample shall have an identifying sample number assigned by the CONTRACTOR when the sample is taken. Sample number shall be included on the sampling chain of custody and in all reports, correspondence, and other documentation related to the sample. Each sample shall have a sampling chain of custody. Chain of custody shall show the name and organization of each person having custody of the sample, and shall also show the sample number, job name and location, time of day and date sample taken, material sampled, and tests to be performed.

JPA's Representative will witness sampling and may take samples for JPA records and for additional analyses if required. Notify the JPA at least 24 hours prior to sampling.

b. JPA's Representative will witness sampling and may take samples for JPA records and for additional analyses if required.

c. JPA's Representative will review laboratory analysis results and will obtain a Hazardous Waste Generator's EPA ID Number if required.

4. Disposal

a. JPA's Representative will give CONTRACTOR written notice to dispose of all or a portion of material at a Class I disposal site if the JPA's Representative determines that such disposal is required based on review of analytical results of samples collected in accordance with sampling plan. Non-hazardous waste shall be disposed of in either a Class II or Class III facility dependent on material composition and landfill requirements.

b. Remove and handle the material as hazardous until the JPA's Representative has reviewed the required laboratory analysis and determined the appropriate classification. Materials from different sites shall not be transported or mixed until the material is determined to be non-hazardous. Excavation materials shall be stored or stockpiled at each site until classified.

c. Transport materials in accordance with all local, state, and federal laws, rules, and regulations. Submit hazardous waste shipping manifests to the JPA'S Representative within five (5) days of offhaul. Include the name, address, EPA Identification Number and Hauler License Number of the transport company and the EPA Identification Number of the disposal site.

1.04 SUBMITTALS

A. Site Safety and Health Plan

1. Plan shall be approved by a Certified Industrial Hygienist and shall comply with all applicable requirements of the Federal Resource

Conservation and Recovery Act, Title 8, Title 22, and Title 26 of the California Code of Regulations, and all applicable regulations of all local, state, and federal agencies having jurisdiction over the safety and health hazards of all phases of the work to be performed.

2. Submit name of individual who has been designated as the site safety and health supervisor.

B. Materials Disposal Plan

1. Prepare a materials disposal plan that complies with all applicable requirements of the Federal Resource Conservation and Recovery Act, Title 8, Title 11, and Title 26 of the California Code of Regulations; and all applicable regulations of all local, state and federal agencies having jurisdiction over the disposal of removed materials, and other waste, whether hazardous or non-hazardous. Submit a copy of the plan for the JPA'S Representative prior to disposing of any material.

2. Submit permission to dispose of material from disposal site owner prior to disposing of any material. Include name, address, and telephone number of disposal site and of owner.

3. Hazardous wastes:

a. CONTRACTOR shall prepare and JPA shall accept all hazardous waste manifests prior to use.

b. Submit manifests, Bill of Lading, land disposal restriction, or other documentation required by applicable regulations governing transport and disposal of hazardous wastes for disposal of hazardous substances within five (5) days of transport. Manifests or Bill of Lading (or other listed documentation) shall identify disposed material and source, show quantity of disposed material in pounds or tons, and show method used for final disposition as buried, incinerated, chemically treated and/or other means.

c. Submit proof that the transporter and disposal site are regulated by the State to handle and dispose of hazardous wastes.

D. Sampling and Analysis, Laboratory Designation, and Test Results

1. Submit project sampling plan prior to any sampling. Include collection methods, locations, and frequencies. Include analytical methods for each material sampled.

2. Submit name and Environmental Laboratory Accreditation Program Certificate number of laboratory that will sample and test suspected hazardous substances. Include statement of laboratory's certified testing areas and analyses that laboratory is qualified to perform. Submit prior to any laboratory testing.

3. Submit laboratory analysis results of samples taken per sampling plan. Specify any deviations from original sampling plan.

END OF SECTION

SECTION 01440

TEMPORARY FACILITIES AND CONTROLS

1.01 CONSTRUCTION WATER

A. The Contractor shall be responsible for bringing construction water to the site as necessary. Water usage and location of water supply shall be coordinated with and approved by the JPA. The Contractor shall be responsible for furnishing, installing, and operating all necessary pumps, standtanks, piping, appurtenances, and necessary connections.

1.02 CONSTRUCTION POWER

A. The Contractor shall be responsible for bringing power to the site as necessary.

1.03 DUST CONTROL

A. Submit a plan detailing the means and methods for controlling dust generated by work on the site at or below ambient dust levels for the JPA'S acceptance. The plan shall also make provision for the control of paint overspray generated during painting operations. The plan shall detail equipment and methods for monitoring compliance with the plan.

B. One or more operable street sweeping machines with vacuums in combination with a water truck for dust abatement purposes shall be maintained on the jobsite.

C. All soil excavated or graded shall be sufficiently watered to prevent excessive dust. Watering shall occur as needed with complete coverage of disturbed areas. Watering shall be a minimum of twice daily on unpaved/untreated roads and on soil areas with active operations.

D. All clearing, grading, earth moving, and excavation activities shall cease during periods of high winds greater than 20 mph (averaged over one hour), if disturbed material is easily windblown, or when dust plumes of twenty percent (20%) or greater opacity impact public roads, occupied structures, or neighboring properties.

E. All fine material transported offsite shall be either sufficiently watered or securely covered to prevent excessive dust.

F. Areas disturbed by clearing, earth moving, or excavation activities shall be minimized at all times.

G. Stockpiles of soil or other fine loose material shall be stabilized by watering or other appropriate method to prevent wind-blown fugitive dust.

H. Once initial grading has ceased, all inactive soil areas within the construction site shall be treated with a dust palliative or watered twice daily until soil has sufficiently crusted to prevent fugitive dust emission.

I. All active disturbed soil areas shall be sufficiently watered to prevent excessive dust, but no less than twice a day.

J. Onsite vehicle speed shall be limited to 15 mph.

K. All areas with vehicle traffic shall be paved, treated with dust palliatives, or watered a minimum of twice daily.

L. Streets adjacent to the project site and construction activity shall be kept clean and accumulated silt removed.

M. Contractor shall properly maintain and tune all internal combustion engine powered equipment.

N. Contractor shall require employees and subcontractors to comply with California's idling restrictions for compression ignition engines.

O. Contractor shall use low sulfur (CARB) diesel fuel.

1.04 NOISE ABATEMENT

A. The CONTRACTOR shall comply with all local sound control and noise level rules, regulations, and ordinances which apply to any work pursuant to the Contract. The CONTRACTOR is responsible to provide noise abatement to limit noise levels to less than 55 dBA and is responsible for all associated costs. If surrounding land owners complain or the CONTRACTOR exceeds allowable noise levels, the CONTRACTOR shall provide a sound abatement protocol to the complete satisfaction of the JPA.

B. The CONTRACTOR shall place all stationary construction equipment so that emitted noise is directed away from sensitive receptors nearest the project site.

C. The CONTRACTOR shall locate equipment staging in areas that create the greatest possible distance between construction-related noise sources and noise-sensitive receptors nearest the project site during all project construction.

D. The Contractor shall ensure proper maintenance and working order of equipment and vehicles, and that all construction equipment is equipped with manufacturers approved mufflers and baffles.

E. The Contractor shall install sound-control devices in all construction equipment and impact equipment, no less effective than those provided on the original equipment.

1.05 DISPOSAL OF EXCESS EXCAVATED SOIL MATERIALS

A. The CONTRACTOR shall dispose of any hazardous materials, pipe, electrical, etc. that is encountered that is not to be incorporated into the project scope of work. Organic material for project clearing and grubbing shall be removed and stockpiled in a manner that it is not incorporated into the engineered fill, however it shall be spread evenly and uniformly in the basin bottoms after the completion of all work to the satisfaction of the JPA.

1.06 TEMPORARY FACILITIES

A. The CONTRACTOR shall be responsible for furnishing and installing any temporary facilities that are deemed necessary. CONTRACTOR shall be responsible for furnishing and maintaining suitable portable sanitary facilities along with sanitary hand washing facilities.

1.07 CULTURAL RESOURCES

A. In the event that prehistoric or historic subsurface cultural resources are discovered during ground-disturbing activities, all work within 50 ft of the resources shall be halted and the JPA notified. The JPA will consult with a qualified archaeologist to assess the significance of the find according to CEQA Guidelines Section 15064.5. If any find is determined to be significant, then the JPA and the archeologist will meet to determine avoidance measures or other appropriate mitigation. The JPA will make the final determination and notify the CONTRACTOR of the necessary mitigation measures.

B. In the event that paleontological resources are discovered all work in the immediate area shall be halted and the JPA notified. The JPA will notify a qualified paleontologist depending upon the project component. The paleontologist will document the discovery as needed, evaluate the potential resource, and assess the significance of the find under the criteria set forth in CEQA Guidelines Section 15064.5. If fossil or fossil bearing deposits are discovered during construction, excavation within 50 feet of the find will be temporarily halted or diverted until the discovery is examined by a qualified paleontologist. The paleontologist will notify the appropriate agencies to determine procedures that would be followed before construction is allowed to resume at the location of the find. The JPA will make the final determination and notify the CONTRACTOR of the necessary mitigation or avoidance measures.

C. If human remains are uncovered during project construction all work in the immediate area shall be halted and the JPA notified. The JPA shall immediately contact the Kern County Coroner to evaluate the remains, and follow the procedure and protocols set forth in Section 15064.4 (e) (1) of the California Environmental Quality Act Guidelines. If the Coroner determines the remains are Native American in origin, the Coroner shall contact the Native American Heritage Commission (NAHC). As provided in Public Resources Code Section 5097.98, the NAHC shall identify the person or persons believed to be most likely descended from the deceased Native American. The most likely descendent shall be

afforded the opportunity to provide recommendations concerning the future disposition of the remains and any associates grave goods as provided in PRC 5097.98.

1.08 BIOLOGICAL RESOURCES

A. (*Description of biological surveys and requirements*)

END OF SECTION

SECTION 01500

EQUIPMENT AND EQUIPMENT SYSTEMS OPERATION

1.01 GENERAL

This section describes the intended function and operation of equipment and equipment systems.

1.02 EQUIPMENT FUNCTIONS

A. (*Description of the function of key equipment*)

1.03 EQUIPMENT SYSTEM FUNCTIONS

(*Description of how the entire system being constructed works*)

END OF SECTION

SECTION 01510

TESTING, TRAINING, AND FACILITY START-UP

1.01 SUMMARY

A. Section Includes: Equipment and system testing and start-up, services of manufacturer's representatives, training of JPA'S personnel, and final testing requirements for the complete facility.

1.02 CONTRACT REQUIREMENTS

A. Testing, training, and start-up are requisite to the satisfactory completion of the Contract.

B. Complete testing, training, and start-up within the Contract Time.

C. Allow realistic durations in the Progress Schedule for testing, training, and start-up activities.

D. Furnish labor, power, chemicals, tools, equipment, instruments, and services required for and incidental to completing functional testing, performance testing, and operational testing.

E. Provide competent, experienced technical representatives of equipment manufacturers for assembly, installation and testing guidance, and operator training.

1.03 START-UP/TESTING PROCESS OVERVIEW

A. This specification describes a process. The following definitions are provided for terms that are used in this specification and which describe the steps of the process.

B. Start-up Plan: A complete outline and schedule of the work that will be performed to meet the requirements of this specification.

C. Factory/Source Performance Testing: Testing which takes place at the supplier's facility to test equipment performance prior to shipment of the equipment to the job site. Factory pump test, or a control panel test, for example.

D. General Start-up and Testing: Initial adjustments, alignments, inspections, testing, etc., which are performed to confirm equipment is installed correctly and ready to be operated. Line flush, lubrication check, electrical integrity tests, instrument calibrations, for example.

E. Individual Equipment Functional Testing: Individual equipment operating tests which verify proper operation of the equipment. An individual pump functional test would include testing flow, pressure, amps, vibration, motor controls, associated instrument loops, and remote controls, for example.

F. Certification of Proper Installation: A written report from the equipment supplier and the equipment installer which certifies that the equipment tests are complete and the equipment performs satisfactorily.

G. Equipment/System Operational Testing: A test of the entire facility which demonstrates the individual equipment operates as a system and meets the operational requirements of the facility design. Operational requirements to test shall include system control features, station performance requirements such as flow and pressure for example.

1.04 START-UP PLAN

A. Submit start-up plan for each piece of equipment and each system not less than sixty (60) days prior to planned initial equipment or system start-up. Plan shall address all operating requirements set forth in Section 01500, Equipment and Equipment System Operation.

B. Provide a Schedule with the Following Activities Identified:

1. Manufacturer's services

2. Installation certifications

3. Operator training

4. Submission of Operation and Maintenance Manual

5. Performance testing

6. Functional testing

7. Operational testing

C. Provide testing plan with test logs for each item of equipment and each system when specified. Include testing of alarms, control circuits, capacities, speeds, flows, pressures, vibrations, sound levels, and other parameters.

D. Provide summary of shutdown requirements for existing systems, which are necessary to complete start-up of new equipment, and systems.

E. Revise and update start-up plan based upon review comments, actual progress, or to accommodate changes in the sequence of activities.

1.05 FACTORY/SOURCE PERFORMANCE TESTING

A. Test equipment for proper performance at point of manufacture or assembly when specified.

B. Equipment that is to be tested includes, but is not limited to:

Slide gates and electrical actuator require a witnessed factor test.

1. Demonstrate equipment meets specified performance requirements.

2. Provide certified copies of test results.

3. Do not ship equipment until certified copies have received written acceptance from JPA. Written acceptance does not constitute final acceptance.

1.06 FACTORY WITNESSED PUMP TESTS

A. Pumps having a motor drive of 100 horsepower or greater shall undergo factory witnessed pump testing. Each pumping unit, complete with the actual job motor drive, shall be tested at the factory in the presence of the JPA Representative. Tests shall be performed in accordance with the applicable provisions of AWWA E101 or the standards of the Hydraulic Institute. To successfully pass a laboratory performance test, a pumping unit shall meet all performance requirements specified.

B. JPA shall pay all costs for JPA'S Representative to travel to and from the location of the laboratory performance test, and all costs incurred during testing. Should results of the tests indicate, in the opinion of the JPA's Representative that the pumps fail to meet any of the specified requirements, the JPA's Representative will notify the CONTRACTOR of such failure. The manufacturer shall thereupon, at no expense to the JPA, make such modifications and perform additional testing as may be necessary to comply with these specifications. Any additional costs for travel and subsistence shall be reimbursed to the JPA by the CONTRACTOR.

1.07 GENERAL START-UP AND TESTING

A. Mechanical Systems:

1. Remove rust preventatives and oils applied to protect equipment during construction.

2. Flush lubrication systems and dispose of flushing oils. Recharge lubrication system with lubricant recommended by manufacturer.

3. Flush fuel system and provide fuel for testing and start-up. At completion of test, fill fuel tank.

4. Install and adjust packing, mechanical seals, O-rings, and other seals. Replace defective seals.

5. Remove temporary supports, bracing, or other foreign objects installed to prevent damage during shipment, storage, installation and construction.

6. Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting driver.

7. Perform cold alignment and hot alignment to manufacturer's tolerances.

8. Adjust V-belt tension and variable pitch sheaves.

9. Inspect hand and motorized valves for proper adjustment. Tighten packing glands to insure no leakage, but permit valve stems to rotate without galling. Verify valve seats are positioned for proper flow direction.

10. Tighten leaking flanges or replace flange gasket. Inspect screwed joints for leakage.

11. Install gratings, safety chains, handrails, shaft guards, and sidewalks prior to operational testing.

B. Electrical Systems:

1. Perform insulation resistance tests on wiring except 120-volt lighting, wiring, and control wiring inside electrical panels.

2. Perform continuity tests on grounding systems.

3. Test and set switchgear and circuit breaker relays for proper operation.

4. Perform direct current high potential tests on all cables that will operate at more than 2,000 volts. Obtain services of an approved, certified independent testing lab to perform tests.

5. Check motors for actual full load amperage draw. Compare to nameplate value.

C. Instrumentation Systems:

1. Bench or field calibrate instruments and make required adjustments and control point settings. Provide data on JPA's calibration sheets.

2. Leak test pneumatic controls and instrument air piping.

3. Energize transmitting and control signal systems, verify proper operation, ranges and settings.

1.08 INDIVIDUAL EQUIPMENT FUNCTIONAL TESTING

A. Functionally test mechanical and electrical equipment for proper operation after general start-up and testing tasks have been completed.

B. Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration. Perform initial checks in the presence of and with the assistance of the manufacturer's representative.

C. Demonstrate proper operation of each instrument loop function including alarms, local and remote controls, instrumentation and other equipment functions. Generate signals with test equipment to simulate operating conditions in each control mode.

D. Conduct continuous 8-hour test under full load conditions. Replace parts which operate improperly.

1.09 CERTIFICATE OF PROPER INSTALLATION

A. At Completion of Functional Testing, Furnish Written Report Prepared and Signed by Manufacturer's Authorized Representative, Certifying Equipment:

1. Has been properly installed, adjusted, aligned, and lubricated.

2. Is free of any stresses imposed by connecting piping or anchor bolts.

3. Is suitable for satisfactory full-time operation under full load conditions.

4. Operates within the allowable limits for vibration.

5. Controls, protective devices, instrumentation, and control panels furnished as part of the equipment package are properly installed, calibrated, and functioning.

6. Control logic for start-up, shutdown, sequencing, interlocks, and emergency shutdown have been tested and are properly functioning.

B. Furnish Written Report Prepared and Signed by the Electrical and/or Instrumentation Subcontractor Certifying:

1. Motor control logic that resides in motor control centers, control panels, and circuit boards furnished by the electrical and/or instrumentation subcontractor has been calibrated and tested and is properly operating.

2. Control logic for equipment start-up, shutdown, sequencing, interlocks and emergency shutdown has been tested and is properly operating.

C. Co-sign the reports along with the manufacturer's representative and subcontractors.

1.10 TRAINING OF OWNERS PERSONNEL

A. Provide operations and maintenance training for items of mechanical, electrical and instrumentation equipment. Utilize manufacturer's representatives to conduct training sessions. Coordinate with JPA to develop content for training sessions.

B. Coordinate training sessions to prevent overlapping sessions. Arrange sessions so that individual operators and maintenance technicians do not attend more than 2 sessions per week.

C. Provide Operation and Maintenance Manual for specific pieces of equipment or systems one month prior to training session for that piece of equipment or system.

D. Satisfactorily complete functional testing before beginning operator training.

E. CONTRACTOR shall coordinate the training periods with JPA personnel and manufacturer's representatives, and shall submit a training schedule for each piece of equipment or system for which training is to be provided. Such training schedule shall be submitted not less than 21 calendar days prior to the time that the associated training is to be provided and shall be based on the current plan of operation.

1.11 EQUIPMENT/SYSTEM OPERATIONAL TESTING

A. CONTRACTOR and JPA shall jointly develop and coordinate equipment system operational testing. Operation shall comply with requirements set forth in Section 01500, Equipment and Equipment Systems Operation.

B. Conduct operational test of the entire facility after completion of operator training. Demonstrate satisfactory operation of equipment and systems in actual operation.

C. Conduct operational test for continuous 7-day period.

D. JPA will provide operations personnel, power, fuel, and other consumables for duration of operational test.

E. Immediately correct defects in material, workmanship, or equipment which became evident during operational test.

F. Repeat operational test when malfunctions or deficiencies cause shutdown or partial operation of the facility or results in performance that is less than specified.

G. In the event an item of equipment cannot be tested continuously for seven (7) days, provide information for an alternative test, or modify the seven (7) day test period. For high horsepower equipment where testing will impact Time of Use (TOU) energy limitations, describe an intermittent test procedure. Identify TOU constraints.

1.12 RECORD KEEPING

A. Maintain and Submit Following Records Generated During Start-up and Testing Phase of Project:

1. Daily logs of equipment testing identifying all tests conducted and outcome.

2. Logs of time spent by manufacturer's representatives performing services on the job site.

3. Equipment lubrication records.

4. Electrical phase, voltage, and amperage measurements.

5. Insulation resistance measurements.

6. Data sheets of control loop testing including testing and calibration of instrumentation devices and set points.

END OF SECTION

SECTION 01520

CLOSEOUT PROCEDURES

1.01 FINAL CLEANING

A. Perform final cleaning prior to inspections for Final Acceptance.

B. Use cleaning materials which are recommended by manufacturers of surfaces to be cleaned.

C. Prevent scratching, discoloring, and otherwise damaging surfaces being cleaned.

D. Clean roofs, gutters, downspouts, and drainage systems.

E. Broom clean exterior paved surfaces and rake clean other surfaces of sitework. Police yards and grounds to keep clean.

F. Remove dust, cobwebs, and traces of insects and dirt.

G. Clean grease, mastic, adhesives, dust, dirt, stains, fingerprints, paint, blemishes, sealants, plaster, concrete, and other foreign materials from sight-exposed surfaces, and fixtures and equipment.

H. Remove non-permanent protection and labels.

I. Polish glossy surfaces to clear shine.

J. Vacuum carpeted and soft surfaces.

K. Clean light fixtures and replace burned-out or dim lamps.

1.02 WASTE DISPOSAL

A. Surplus materials, waste products, and other debris shall be disposed off-site

1.03 TOUCH-UP AND REPAIR

A. Touch-up, repair, or replace finished surfaces on structures, equipment and installation that have been damaged prior to inspection for final acceptance.

1.04 CLOSEOUT DOCUMENTS

A. Submit following closeout documents upon completion of the Work, and at least 7 days prior to application for Final Payment:

1. Project Record Documents, including:

   Record drawings
   Testing reports
   Survey data
   Instrument calibration sheets

2. Operation and Maintenance Manuals

3. Warranties and Bonds.

4. Spare Parts

END OF SECTION

SECTION 01600

JPA FURNISHED EQUIPMENT

1.01 EQUIPMENT FURNISHED BY JPA

The JPA will not furnish any materials for this project.

1.02 JPA RESPONSIBILITIES

A. Arrange for and deliver necessary shop drawings, installation instructions, product data and samples to CONTRACTOR.

B. Arrange and pay for product delivery to site in accordance with construction schedule.

C. Deliver supplier's bill of materials to CONTRACTOR.

D. Inspect deliveries jointly with CONTRACTOR.

E. Submit claims for transportation damage.

F. Arrange for replacement of damaged, defective, or missing items.

G. Arrange for manufacturer's warranties, bonds, service, and inspections, as required.

1.03 CONTRACTOR RESPONSIBILITIES

A. Designating required delivery date for each JPA furnished product.

B. Reviewing shop drawings, product data and samples.

C. Submitting notification of discrepancies or anticipated problems.

D. Receiving and unloading products at site.

E. Promptly inspecting products jointly with JPA and recording shortages, damaged or defective items.

F. Handling products at site, including uncrating and storage.

G. Protecting products from damage.

H. Installing, including assembly, connections, adjustments, tests, and finish products in accordance with Contract Documents.

I. Providing operating oils, lubricants, and incidental materials required for complete installation.

J. Repairing or replacing items damaged after receipt until Date of Acceptance of the Work by JPA.

1.04 DELIVERY

A. If JPA fails to deliver products in accordance with approved Construction Schedule, adjustments will be made to Contract Time and Contract Price as stipulated in General Provisions.

END OF SECTION

SECTION 01700

EARLY OCCUPANCY OF PORTIONS OF WORK

1.01 PORTIONS OF WORK SCHEDULED FOR EARLY OCCUPANCY

A. CONTRACTOR shall complete following portions of Work for JPA'S utilization including specified testing, training of JPA'S personnel, and other preparations necessary for JPA'S occupancy or use:

No portion of the project is scheduled for early occupancy.

1.02 SUBSTANTIAL COMPLETION CERTIFICATIONS

A. Certificates of Substantial Completion will be executed for each designated portion of Work prior to JPA occupancy. Such certificate of substantial completion will describe the portion of the Work to be occupied by JPA, items that may be incomplete or defective, date of occupancy by JPA, and other information required by JPA and CONTRACTOR.

1.03 FOLLOWING OCCUPANCY

A. Occupancy by JPA will relieve CONTRACTOR of responsibility for injury or damage to the above-listed completed portions of the Work resulting from use by JPA or from the action of the elements, or from other cause, except CONTRACTOR operations or negligence.

B. After JPA occupancy, allow access for JPA'S personnel, access for others authorized by JPA, and access by JPA for operation of equipment and systems.

C. Following Occupancy, JPA will provide power to operate equipment and systems, and repair damage caused by JPA occupancy.

D. CONTRACTOR will not be required to reclean early occupied portions of Work prior to final acceptance, except for cleanup made necessary by CONTRACTOR's operations.

E. Guarantee period for portions of the Work occupied by JPA shall commence with date of Certificate of Substantial Completion of portions of Work for use by JPA. Progress payment retentions for portions of the Work occupied by JPA will be released as part of the retention for the total Work.

F. JPA'S use of occupied facilities shall not relieve CONTRACTOR from responsibility for correcting defective work or materials.

G. No partial acceptance of the Work will be made and no acceptance other than the final acceptance of the completed Work will be made except for those portions of Work designated for early occupancy by JPA.

END OF SECTION

SECTION 01800

TESTING AND LABORATORY SERVICES

1.01 GENERAL

A. Requirements:

1. The JPA shall perform all concrete and compaction testing for the project.

2. The request for compaction and concrete testing shall be made to the JPA in writing at least forty-eight (48) hours before the CONTRACTOR is ready for tests to be taken.

3. The CONTRACTOR shall make available construction equipment and materials as necessary to assist the JPA'S Representative in taking the tests.

4. If the backfill shall fail the compaction tests, the CONTRACTOR shall pay the cost of restesting. If the concrete cylinders do not reach the design 28-day compressive strength, the CONTRACTOR shall be responsible for any additional testing such as concrete cores and any remedial work.

5. If the CONTRACTOR is not ready to have compaction or concrete tests taken at the time and in the locations indicated on the written request, the CONTRACTOR shall be responsible for all standby charges and/or return visit costs to take the requested tests.

6. If the CONTRACTOR elects to use any imported materials or imported sand for backfill, a sample of the material to be used for the backfill shall be delivered to the JPA Representative for testing, prior to the commencement of backfilling. If the test fails, the CONTRACTOR shall pay the cost of retesting.

7. The JPA will witness factory testing of slide gates and actuators. The CONTRACTOR shall make arrangements for all slide gates and actuators be tested in a single location during a single visit. The CONTRACTOR shall be responsible for any cost incurred by the JPA for retesting of failed equipment or need for additional visits.

END OF SECTION

SECTION 01810

SPECIAL MEETINGS

1.01 GENERAL

A. The JPA or the JPA'S Representative may schedule a Special Meeting to discuss project related activities or issues. The CONTRACTOR shall be readily available for these meetings and ensure that any project subcontractors attend when so requested by the JPA. The time and place for such meeting will be established by the JPA or the JPA'S Representative.

B. Project Meetings: The JPA may elect to administer weekly or bi-weekly project meetings to discuss project activities, review the project schedule, and to discuss any project related issues or concerns. The CONTRACTOR shall have its Project Manager and/or Project Superintendent attend each of these meetings as well as any necessary subcontractors and provide a project look ahead schedule at each meeting. The time and place for project meetings will be established at a mutually agreeable time and place prior to the commencement of work.

END OF SECTION

SECTION 01820

SPECIAL CONTRACT CLOSE OUT

(*Description of final clean up and expected job site conditions at completion of project*)

SECTION 01840

BASIS OF MEASUREMENT FOR PAYMENT

1.01 WORK LISTED IN THE SCHEDULE OF WORK ITEMS

A. Work under this contract will be paid on a unit price or lump-sum basis as outlined on the Bid Form for the quantity of work installed.

B. The unit prices and lump-sump prices include full compensation for furnishing the labor, materials, tools, and equipment and doing all the work involved to complete the work included in the Contract Documents.

C. The application for payment will be for a specific item based on the percentage completed or quantity installed. The percentage complete will be based on the value of the partially completed work relative to the value of the item when entirely completed and ready for service.

1.02 BID ITEMS

(Provide Description of each bid item)

1. ITEM NO. 1 – MOBILIZATION, DEMOBLIZATION, AND CLEANUP

Work under this item shall include all labor, tools, equipment and transportation of personnel, equipment, and operating supplies to and from the site, establishment of portable sanitary facilities, site electrical, and site communications, obtaining an adequate supply of fresh water if necessary, trench safety measures, SWPPP, Dust Control Plan, final cleanup work and all bonds, insurance, overhead, permits, shop drawings, close-out documents, and costs of work not specifically included in any other contract item.

During the progress of the work, the Contractor shall maintain the site and related equipment in a clean, orderly condition, free from unsightly accumulation of rubbish. Upon completion of the work and before the final estimate is submitted, the Contractor shall at his own expense remove from the vicinity of the work all weeds, rubbish, uninstalled materials and other like materials, belonging to him or used under his direction during construction. In the event of his failure to do so, the same may be removed by the JPA after ten days written notice to the Contractor. Such removal shall be at the expense of the Contractor and will be deducted from the final payment due him. Where construction crosses public or private property, it shall be restored by the Contractor to the complete satisfaction of the JPA, at the Contractor's expense.

1.02 WORK NOT LISTED IN THE SCHEDULE OF WORK ITEMS

A. The General Provisions and items in the Special Provisions, general requirements, and specifications which are not listed in the schedule of work items of the Bid Form are, in general, applicable to more than one listed work item, and no separate work item is provided therefore. Include the cost of work not listed but necessary to complete the project designated in the Contract Documents in the various listed work items of the Bid Form.

B. The bids for the work are intended to establish at total cost for the work in its entirety. Should the CONTRACTOR feel that the cost for the work has not been established by specific items in the Bid Form, include the cost for that work in some related bid item so that the Proposal for the project reflects the total cost for completing the work in its entirety.

1.03 MOBILIZATION

Payment for mobilization shall be made at the time of the first progress payment after the CONTRACTOR has purchased bonds and insurance and established a Contractor's site office with telephone service and a temporary field office for the JPA'S Representative.

1.04 TRENCH SAFETY MEASURES

Payment for sheeting, shoring, and bracing for the protection of life and limb, in conformance with all applicable safety orders, shall be provided for in the applicable bid items and will be paid for in accordance with the provisions outlined herein.

1.05 STORM WATER POLLUTION CONTROL / DUST CONTROL PLAN

Payment for storm water pollution control and air quality control shall be provided for in the applicable bid items and will be paid for in accordance with the provisions outlined herein.

END OF SECTION

SECTION 01900

GENERAL DESIGN REQUIREMENTS

1.01 GENERAL

(*Description of permits to be obtained, requirement to comply with all permit requirements, necessary notifications when working on other person's land, identification of time sensitive work and allowable time to complete work, etc.*)

1.02 EXISTING UTILITIES / STRUCTURES

Prior to construction, the CONTRACTOR shall perform a U.S.A. Locate and shall expose all known utility crossings and facilities in order to construct the project without damaging existing facilities or encountering a conflict with said facilities. CONTRACTOR shall be responsible for all associated costs with identifying and exposing existing utilities.

1.03 PERMITS

The JPA will submit a Notice of Intent to Discharge, along with appurtenant fee, under the Construction Activities Storm Water General Permit (99-08-DWQ). Under this permit the CONTRACTOR must prepare and submit a Storm Water Pollution Prevention Plan. CONTRACTOR shall be responsible for operating in accordance with the SWPPP.

The CONTRACTOR shall be responsible for preparing, obtaining, and complying with a SJVAPCD Dust Control Plan and Permit and be responsible for all associated costs.
See also Section 00600 herein.

END OF SECTION

SECTION 02000

MITIGATION MEASURES

1.01 GENERAL

The CONTRACTOR shall be responsible for complying with mitigation measurements listed in Table S-1 herein. Below is a summary list of items that pertain to the CONTRACTOR:

- (*List of required mitigation measure for this specific project*)

END OF SECTION

SECTION 0

SPECIAL PROVISIONS

(PROJECT NAME)

PROJECT NO. XXXXX (XXXX)

SECTION 0
SPECIAL PROVISIONS

Table of Contents

SECTION 00100

BID MODIFICATIONS

1.01 BASIS FOR DETERMINING LOWEST RESPONSIBLE BIDDER

See Paragraph 3.1.4 of Instructions to Bidders.

1.02 BIDDING ON SUBSTITUTE ITEMS

See language in Instruction to Bidders IB 1.7

1.03 TIME ALLOWED FOR ACCEPTANCE OF BIDS

See Instructions to Bidders IB 3.1.2.

END OF SECTION

SECTION 00110

DEFINITIONS

1.01 DEFINITIONS

Owner	Groundwater Banking Joint Powers Authority (JPA)
Engineer	

(*Any other agencies involved*)

END OF SECTION

SECTION 00200

THE WORK

1.01 GENERAL

The work to be done by the Contractor under these Specifications shall consist of performing all operations necessary for the construction of the (*Project Name*) at the locations, in the positions, to the elevations and dimensions and conforming to the design shown on the plans and in accordance with these specifications.

The Contractor shall furnish all transportation, materials (except where stipulated otherwise), equipment, labor, and supplies to complete installation of the (*Project Name*) together with all appurtenant work necessary or incidental to complete in a workmanlike manner the improvements as contemplated and as intended by the plans and these specifications.

1.02 LOCATION OF PROJECT SITE

The project site is located in Sections X & X, Township XX South, Range XX East and is (*description of project location relative to known landmarks, highways, roads, etc.*).

1.03 DESCRIPTION OF THE WORK

(*General Description of project as a whole and major components*)

1.04 ORDER OF WORK

Contractor will be responsible for complying with the Environmental Commitments included in these specifications. The Contractor shall submit a construction schedule within fifteen (15) calendar days of the date of the Notice to Proceed from the JPA. The schedule shall outline the various phases of work, estimate the dates of commencement and completion for each phase.

1.05 WORK BY OTHERS

The CONTRACTOR shall coordinate work with the JPA or the JPA'S Representative at all times. Work by others may be taking place in the project vicinity by (*list other possible agency's that may be working in the vicinity*) and the CONTRACTOR shall not interfere with their activities or maintenance operations.

1.06 WORKING HOURS AND HOLIDAYS

Normal working hours are from 7:00 am to 3:30 pm, Monday through Friday, excluding holidays. JPA inspection hours are from 7:00 a.m. to 3:30 p.m., Monday through Friday. No work shall be performed on Saturdays, Sundays, or JPA holidays. See appendix for list of JPA holidays. In instances where contract time extends past the year's list of JPA holidays, regularly observed holidays shall be followed.

The Contractor shall be responsible for all costs associated with inspection services outside JPA inspection hours at the rate of $150.00 per hour.

1.07 OBSTRUCTIONS AND COORDINATION WITH OTHER WORK

At least forty-eight (48) hours prior to construction and prior to any operations involving existing JPA or RRBWSD facilities, the Contractor shall notify the JPA's Representative.

Prior to construction, the Contractor shall expose all known utility crossings in order to provide for grade and alignment adjustments, if necessary.

END OF SECTION

SECTION 00210

INVESTIGATIONS AND REPORTS

1.01 INVESTIGATIONS AND REPORTS

A. The following investigations and reports are included herewith in Appendix:

1. (*List investigations and reports*)

B. The following investigations and reports are available at JPA for review:

1. (*List investigations and reports*)

END OF SECTION

SECTION 00220

LANDS AND RIGHTS-OF-WAY

1.01 LANDS AND RIGHTS-OF-WAY

See General Provisions GP 5.4.

END OF SECTION

SECTION 00300

CONTRACTOR'S INSURANCE

1.01 GENERAL

A. Contractor's insurance coverage shall be as specified in the General Provisions, shall provide the following amounts of coverage, shall include additional insureds, and shall include additional information as set forth below.

1.02 COMMERCIAL GENERAL LIABILITY INSURANCE

A. Bodily injury and property damage coverage shall be for not less than one million dollars ($1,000,000) for each occurrence and for not less than three million dollars ($3,000,000) per project aggregate.

B. Products/Completed Operations coverage shall be for not less than three million dollars ($3,000,000) aggregate.

1.03 AUTOMOBILE LIABILITY

A. Contractor shall carry and maintain a business automobile policy or equivalent coverage for bodily injury and property damage on all owned, non-owned and hired automobiles or other licensed highway vehicles used in the performance of the Contract. The limit shall be for not less than two million ($2,000,000) for each accident.

1.04 WORKER'S COMPENSATION INSURANCE AND EMPLOYER'S LIABILITY INSURANCE

A. Worker's Compensation Insurance coverage shall comply with statutory limits.

B. Employer's Liability Insurance shall be for not less than:

$1,000,000 Each Accident
$1,000,000 Each Disease – Policy Limit
$1,000,000 Each Disease – Each Employee

C. State Compensation Insurance Fund: Notwithstanding the requirements of General Provisions Section 4.2, JPA will accept Workers Compensation Insurance from the State Compensation Fund (State Fund) that is not rated and that is evidenced on the State Fund's certificate form. Except as provided above with respect to State Fund, all other insurance shall comply with all requirements of the General and Special Provisions.

1.05 ADDITIONAL INSUREDS

A. Commercial General Liability Insurance shall include as additional insureds: JPA, (List all other applicable) _____

_____

1.06 ADDITIONAL INFORMATION

A. Certificates of Insurance shall:

1. List all Endorsement forms that are part of said policy.
2. List all entities required to be named as additional insureds.
3. Include a statement that no less than 30 days written notice will be provided by certified mail to the JPA prior to any material change or cancellation of said policy.

END OF SECTION

SECTION 00400

SHOP DRAWINGS

1.01 SHOP DRAWING SUBMITTALS

A. Shop drawings shall be submitted in accordance with Article 9 of the General Provisions and Section 01210 of the General Requirements.

END OF SECTION

SECTION 00500

CONSTRUCTION SCHEDULE

1.01 CONSTRUCTION SCHEDULE

A. The Contractor shall submit a construction progress schedule in compliance with Article 10 of the General Provisions. The schedule shall be a Gantt Chart, and shall show the various parts of the work in sufficient detail so as to identify the beginning and end of each of the various construction activities. The schedule shall include the following at the minimum:

Submittal milestones
All construction activities
Equipment/material procurement and deliveries
Permit imposed work times
Partial, substantial, and final completion milestones
Critical path activities

1.02 SCHEDULE CONSTRAINTS

A. No construction activities shall be allowed at the project site prior to receiving the Notice to Proceed, including any mobilization activities.

B. (List any other constraints)

END OF SECTION

SECTION 00500A

CONSTRUCTION SCHEDULE

1.01 CONSTRUCTION SCHEDULE

A. CONTRACTOR shall submit a construction progress schedule in compliance with Article 10 of the General Provisions. The schedule shall show the various parts of the work in detail so as to identify the beginning and end of each of the various construction activities. The schedule shall include the following at the minimum:

Submittal milestones
All construction activities
Equipment/material procurement and deliveries
Permit imposed work times
Partial, substantial, and final completion milestones
Critical path activities

B. Within ten (10) days after Notice of Award, JPA will schedule and conduct a Preconstruction Scheduling Conference to commence development of the required project schedule. At this meeting, scheduling requirements will be reviewed with CONTRACTOR. CONTRACTOR shall be prepared to review and discuss methodology for the schedule and sequence of operations plus cost and manpower loading methodology.

C. CONTRACTOR shall submit Construction Schedule to JPA for review within thirty (30) days after Notice of Award. CONTRACTOR's Construction Schedule shall be comprised of a detailed Network Diagram as described in Paragraph F. All on site construction activities shall be cost loaded. The cost value of all on site construction activities shall equal the Contract value.

D. Time extensions shall not be granted nor delay damages paid until a delay occurs which is beyond the control and without the fault or negligence of CONTRACTOR and its SUBCONTRACTORS or SUPPLIERS, at any tier and which extends actual performance of the work beyond the current Contract Completion Date. If the delay occurs along a path which the current approved Construction Schedule update projects late completion prior to addition of any JPA caused delay, then the time extension allowed will be only for the additional delay demonstrated by the approved Time Impact Analysis. Time extensions shall be granted only if they are clearly demonstrated by CONTRACTOR through the submittal of a Time Impact Analysis which demonstrates the estimated impact on the end date of the work; is based upon the updated Construction Schedule current as of the month the delay occurred; and demonstrates that the delay cannot be mitigated, offset, or eliminated through such actions as revising the intended sequence of work or other means. Since float time within the Construction Schedule is jointly owned, it is acknowledged that JPA caused delays on the project may be offset by JPA caused time savings (*e.g.* critical path submittals returned in less time than allowed by the Contract, approval of substitution requests which result in a savings of time to CONTRACTOR). In such an event, CONTRACTOR shall not be entitled to receive a time extension or delay damages until all JPA caused time savings are exceeded and the Contract completion date is also exceeded.

E. Upon JPA's request, CONTRACTOR shall participate in the review of CONTRACTOR's Construction Schedule submissions (including the original

material, all update submittals, and any resubmittals). All revisions shall be submitted within fifteen (15) calendar days after JPA's review.

F. The Detailed Network Diagram shall provide a workable plan for performing the work, establish and clearly display the critical elements of the work, forecast completions of the construction, and match the Contract duration in time. Exclusive of those activities for submittal review and material fabrication and delivery, activity durations shall not be less than one (1) nor more than thirty (30) calendar days, unless otherwise approved by JPA. In addition to the detailed network diagram, CONTRACTOR shall submit the following reports with the original submittal:

1. Predecessor/ Successor Report or a list showing the predecessor activities and successor activities for each activity in the schedule sorted by Early Start.
2. Activity Report sorted by activity number or a list showing each activity in the schedule.

G. An updated Construction Schedule shall be submitted to JPA with the submittal of CONTRACTOR's monthly payment request. For those activities started but not yet completed at the time of submittal, the updated schedule shall reflect the percentage complete, as agreed between CONTRACTOR and JPA, and an estimate of the remaining duration. The monthly update of the construction schedule shall include a copy of the following:

1. A bar chart diagram showing target versus actual dates for each activity remaining to be completed.
2. The Predecessor/Successor report sorted by Early Start.
3. The Activity Report sorted by activity number.
4. The updated network diagram or the data necessary to produce such a diagram on computer diskette(s), as agreed with JPA.

H. Upon approval of a change order or issuance of a notice to proceed with a change, the approved change shall be reflected in the next schedule update submittal by CONTRACTOR.

I. If completion of any part of the work, the delivery of equipment or materials, or submittal of CONTRACTOR submittals is behind the updated Construction Schedule, and will impact the end date of the work past the contract completion date, CONTRACTOR shall submit in writing, a recovery plan acceptable to JPA for completing the work by the current Contract completion date, if requested by JPA.

1.02 SCHEDULE CONSTRAINTS

A. None at this time.

END OF SECTION

SECTION 00600

PERMITS

1.01 PERMITS OBTAINED BY JPA

A. The JPA has obtained or applied for and not yet received the following permits required to construct the project. Proper notification to the agencies affected is the responsibility of the Contractor. The Contractor shall conform to the requirements of the permits and all costs therefor shall be included in the contract prices bid for the items involved. Copies or sample copies of these permits are included in the Appendix of these specifications.

1. The JPA will have submitted a Notice of Intent to Discharge, along with appurtenant fee, under the Construction Activities Storm Water General Permit (99- 08-DWQ). Under this permit the Contractor must prepare and submit Storm Water Pollution Prevent Plan per Section 01120 of the General Requirements.

1.02 PERMITS TO BE OBTAINED BY CONTRACTOR

A. Prepare and comply with a Storm Water Pollution Prevention Plan (SWPPP).

B. Prepare and comply with a San Joaquin Valley Air Pollution Control District Dust Control Plan.

C. (*List all other applicable permits*)

1.03 PERMIT-REQUIRED INSPECTION COSTS

CONTRACTOR shall pay the cost of inspection by Permit Issuer for work that is required by permit conditions to be performed on weekends or outside normal working hours. See individual permits for information on weekend work.

END OF SECTION

SECTION 00700

CONNECTIONS TO EXISTING SERVICES

1.01 COSTS OF CONNECTION TO EXISTING SERVICES

General Provisions Article GP 6.24 calls for Contractor to make connections to existing services at no additional expense to JPA.

END OF SECTION

SECTION 00800

SPECIAL STORAGE REQUIREMENTS

1.01 SPECIAL STORAGE REQUIREMENTS

General Provisions Article GP 7.10.2 indicates special methods may be required for storing excavated materials and materials and equipment in general.

END OF SECTION

APPENDIX B

Technical Memorandum #2
Conveyance Capacity Requirements

DEE JASPAR & ASSOCIATES, INC.
CONSULTING CIVIL ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CA 93308
PHONE (661) 393-4796
FAX (661) 393-4799

KERN FAN GROUNDWATER STORAGE PROJECT

TECHNICAL MEMORANDUM NO. 2
(*Conveyance Capacity Requirements)*

PREPARED FOR: Groundwater Banking Joint Powers Authority (JPA)
PREPARED BY: Curtis Skaggs, P.E., Dee Jaspar & Associates, Inc.
DATE: August 15, 2020

SUBJECT: ***Conveyance Capacity Requirements***
(90% Draft)

I. Executive Summary

This technical memorandum serves to evaluate the potential project water demands and identify the capacity requirements for the Conveyance Canal and the associated Pump Stations.

The memorandum addresses these primary questions:

1. What demand estimates should be utilized for project recharge areas?

2. What is the proper application of these demands in order to size the conveyance facilities?

Appendix A provides a brief project description for reference. This project description was used throughout the grant application process and is based upon the thirty-percent (30%) design. Therefore, the capacities, recharge rates, acreages, etc. may be outdated. It anticipated the recharge rates for the Phase I and Phase II properties at approximately 0.35 feet per day to 0.70 feet per day. The purpose of this memorandum is to more closely evaluate the Phase I and Phase II property locations and estimated recharge rates in an effort to design more closely to actual conditions.

The recharge areas have been evaluated based on soil survey maps, available tTEM geophysical survey information, and historical recharge rates for existing nearby recharge basins. An average recharge rate of 0.6 feet per day has been utilized for the Phase I Recharge Property and an average recharge rate of 0.5 feet per day has been utilized for the Phase II Recharge Property. The initial fill rate for these facilities is estimated at

1.5 times the average recharge rate. This affords the most aggressive filling rate for ponds of three (3) to seven (7) days and is still manageable by system operators. A 1.25 fill rate factor would be considered adequate and reduces the conveyance capacity requirement by 72 cfs. The 1.5 versus the 1.25 factor would provide approximately 1,000 AF additional recharge per Article 21 startup (72 cfs x 7 days). The 1.5 fill rate factor would also provide redundant conveyance capacity in terms of pump outages, aquatic restrictions, and subsidence.

The demands that will be served by the Conveyance Canal consist primarily of the Phase II Property and the West Basins Property. The canal diversion points include:

- In-Lieu Agricultural Demands

  The "in-lieu" agricultural lands include areas west of the I-5 Freeway and north of Stockdale Highway within the service area of the Rosedale-Rio Bravo Water Storage District. In addition, there are "in-lieu" agricultural lands adjacent to the conveyance canal that are east of the I-5 Freeway as well as surrounding the existing West Basins property.

  These demands are for lands that are considered adjacent to the conveyance canal and require relatively little infrastructure to be served.

  In addition, the peak "in-lieu" agricultural demand (June, July, August) is not anticipated to overlap with the peak recharge events (December, January, February, March) which will likely occur in the winter or early spring. An analysis of the Kern Fan Groundwater Storage Project for the Water Storage Investment Program by MBK Engineers dated February 23, 2018 evaluated the availability of Article 21 supply. In wet years and above normal water years, Article 21 supply has been available during the months of December, January, February, March, April, and May. In below normal water years, Article 21 supply has been available in the month of March.

  However, while a small portion of Article 21 supply may be utilized for "in-lieu" during recharge events, the canal will be capable of supplying one-hundred percent (100%) of the average "in-lieu" agricultural demand. The canal capacity is based upon the average "in-lieu" agricultural demand plus the recharge basin fill rate of 1.5 times the average recharge rate. In the event the peaking demand for "in-lieu" agricultural demand plus the fill rates of the recharge basins exceeds the canal capacity, the "in-lieu" water will be prioritized above recharge water.

- Phase II Recharge Property. Location of this property has been assumed at this time and is estimated as approximately 640 gross acres with approximately 508 wetted acres.

- West Basins Recharge Property. This is an existing recharge facility with approximately 388 gross acres and approximately 280 wetted acres. This property will be supplied water from the California Aqueduct in return for freeing up capacity from the east (Kern River or CVC) to supply the Phase I Recharge Property.

- West Basins Pipeline Intertie to Enns Basins. There is an existing 27-inch pipeline that can be utilized to convey water from the canal to the existing Enns Basins in order to free up additional capacity from the east (Kern River or CVC) to supply the Phase I Recharge Property. This will require a small pump station to convey the water through the 27-inch pipeline to the Enns Basins. If a Reach 5 is constructed to convey water to the Phase I Recharge Property (105 cfs Exchange Capacity) it may make more sense to deliver water to the Enns Basins from Reach 5 and forego the use of the existing 27-inch pipeline (24 cfs capacity). Rather than construct two small pump stations (Pump Station No. 4 and 27-inch Pipeline Pump Station) it may make more sense to simply construct Pump Station No. 4 and increase the amount of water to the Phase I Recharge Property through Reach 5 to 130 cfs.

- Phase I Recharge Property. Location of this property has been assumed at this time and is estimated as approximately 640 gross acres with approximately 530 wetted acres. This property has originally been assumed to not be served by the new conveyance canal, however this property could ultimately be acquired in close proximity to the conveyance canal or there is a disparity in the water exchange between the West Basins and the Phase I property that must be accounted for. The West Basins exchange currently estimates 135 cfs that can be supplied from the east via the Kern River and Goose Lake Channel (105 cfs + 24 cfs in WB Pipe Intertie + 6 cfs In-Lieu). The Phase I Property initial fill rate demand is approximately 240 cfs. This is a disparity of approximately 105 cfs that may need to be supplied by the conveyance canal from the California Aqueduct.

The table below summarizes the design criteria for flow capacities.

Capacity may also be considered for future projects such as supply for future recharge basins, Stockdale West, and Strand Ranch, however the scope of this memorandum does not evaluate future projects.

Table 1

Kern Fan Groundwater Banking Project

		Reach 1	Reach 2		Reach 3			Reach 4						
Conveyance Canal	Maximum Aqueduct Capacity	Aqueduct To Stockdale Hwy	Pump Station No. 1	Divert to In-Lieu Adjacent to Canal	Pump Station No. 2	Divert to In-Lieu Adjacent to Canal	Divert to Phase II	Pump Station No. 3	Divert to In-Lieu Adjacent to West Basins	Divert to WB Pipe Intertie with Enns	Divert to West Basins	Phase I Exchange Capacity[1]	Divert to Phase I	Balance
Conveyance Canal Demand Summary	500 cfs	443	443	8	435	3	192	240	6	24	105	105	105	57 cfs

[1]Water to Phase I is by an exchange with the West Basins and In-Lieu properties. However a disparity in demand exists whereby the demand for the West Basins, In-Lieu, and the WB Pipeline Intertie to the Enns Basins is 135 cfs (105 cfs + 6 cfs + 24 cfs Demand) and the Phase I Property is 240 cfs (240 cfs Initial Fill Rate). This is a disparity of 105 cfs to be accounted for by the Phase II conveyance canal.

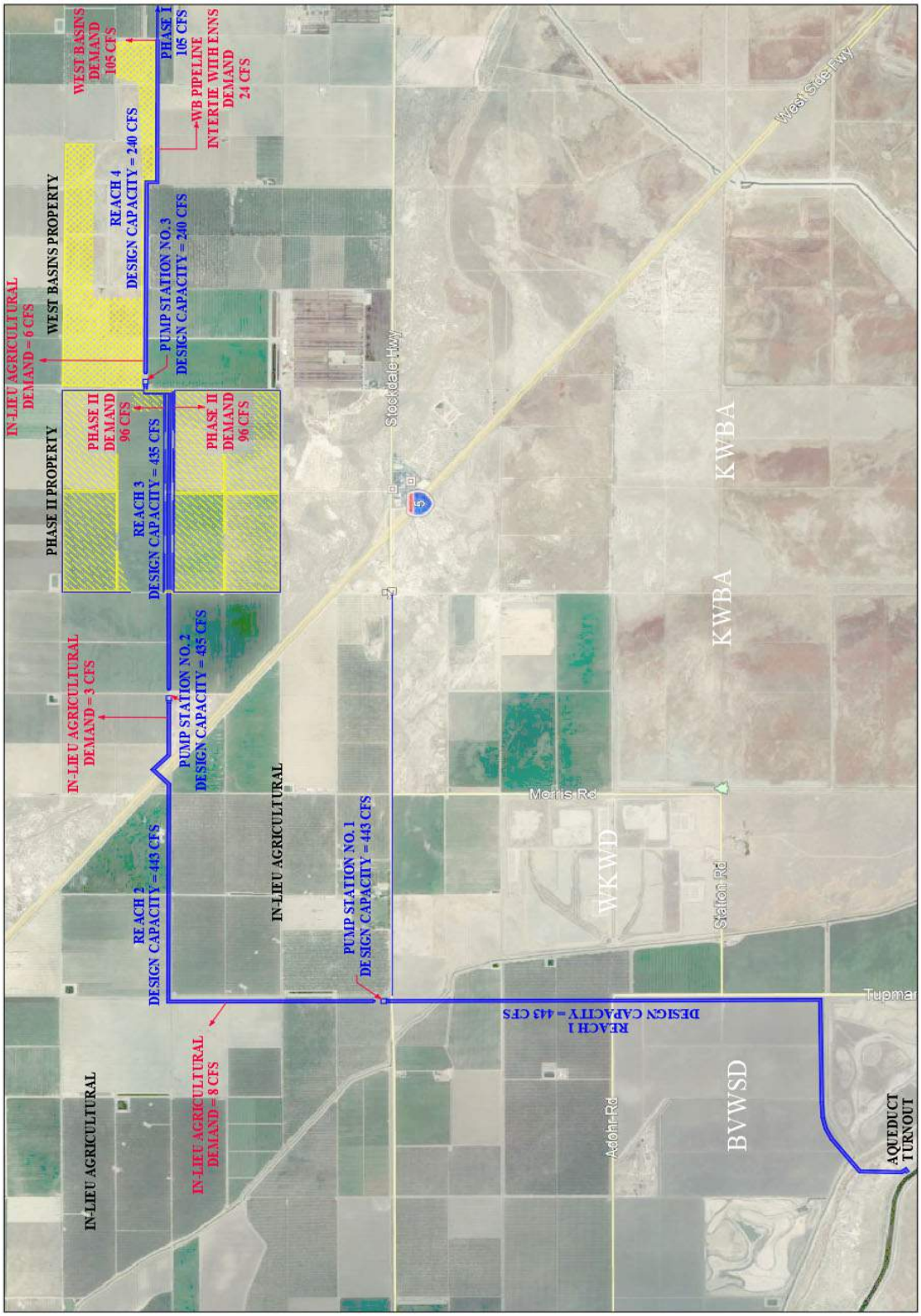


Figure 1: Conveyance Canal Demands and Capacities

It should be noted that the estimates herein are preliminary and subject to change in the event that the actual Phase I and Phase II recharge locations change or the conveyance canal alignment changes. In addition, physical geotechnical work, and perhaps tTEM geophysical work, will need to be performed at the Phase I and Phase II recharge locations during the engineering design to confirm the soil types and permeabilities.

I. Recharge Pond Infiltration and Filling Rates

A. Phase I Recharge Property

The proposed Phase I property is located west of Enos Lane and north of Stockdale Highway in Sections 26 and 27 of T29S, R25E, M.D.B.&M.

The property consists of approximately 630 acres as illustrated in Figure 2 below.

Figure 2: Phase I Property

The United States Department of Agriculture Soil Conservation Service Soil Survey Maps for the northwestern part of Kern County were reviewed in the area of the proposed Phase I property. The proposed property consists of the following soil types, generally speaking, in the top five-feet of the soil:

- Garces Silt Loam (SCS-156) +/- 20 acres
- Wasco Sandy Loam (SCS-243) +/- 30 acres
- Wasco Fine Sandy Loam (SCS-244) +/- 210 acres

- Westhaven Fine Sandy Loam (SCS-245) +/- 200 acres
- Cajon Loamy Sand (SCS-125) +/- 170 acres

The acreages noted above are estimates of the soil type across the property. The majority of the soil is:

- Wasco Fine Sandy Loam (+/- 33% of Property)
  Moderately Rapid Permeability

- Westhaven Fine Sandy Loam (+/- 33% of Property)
  Moderately Slow Permeability

- Cajon Loamy Sand (+/- 27% of Property)
  Rapid Permeability

The Rosedale-Rio Bravo Water District existing Enns Basins are located in the closest proximity to this property. The soil types for that area are predominantly:

- Cajon Loamy Sand (+/- 50% of Property)
  Rapid Permeability

- Wasco Fine Sandy Loam (+/- 45% of Property)
  Moderately Rapid Permeability

- Westhaven Fine Sandy Loam (+/- 5% of Property)
  Moderately Slow Permeability

The soil types for the Enns Basins are very similar to the soil types for the proposed Phase I property. The historic recharge rates for the Enns Basins were reviewed. An average recharge capacity for the Enns Basins is approximately 0.6 feet per day.

In addition, Rosedale-Rio Bravo Water Storage District had Ramboll, an engineering firm out of Emeryville, California, perform a tTEM geophysical survey of a portion of the proposed Phase I property. The transient electromagnetic (tTEM) method is a geophysical exploration technique in which electric and magnetic fields are induced by transient pulses of electric current and the subsequent decay response measured. This allows for a non-intrusive method of obtaining subsurface resistivity-conductivity data in an effort to identify the subsurface lithology.

The tTEM method measures the electrical resistivity of the earth. To assess the lithology below the ground surface, the resistivities measured by the receivers must be translated to lithologies. Translating resistivities to lithology is based on a general correlation between resistivity and type of sediments. Impermeable clay has a low resistivity. Sandy clay typically results in a resistivity ranging from 30 to 100 ohm-m, while sand to coarse sand has a resistivity above 50 ohm-m.

The average resistivity to an approximate depth of 200-feet for the southern half of Section 27 is approximately 25.1 ohm-m. This is illustrated in Figure 3 below. The average resistivity is comparable to the Stockdale East Recharge Facility property.

Figure 3: Average Resistivity for McCaslin Property (Portion of Phase I)

Figure 4 below illustrates the lithology vertically based on elevation and shows how the top 90-feet to 100-feet has coarser material (purple) well suited for groundwater recharge. A more detailed analysis of the tTEM survey in the area of the Phase I property is attached in Appendix B.

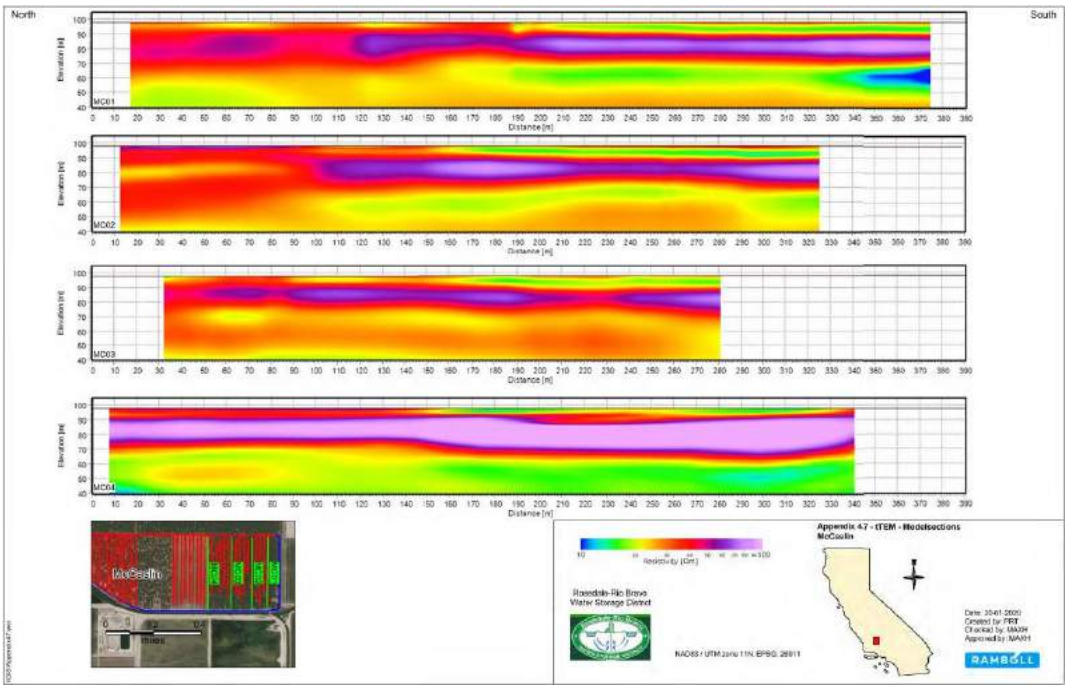


Figure 4: Model Sections of Southern Half of Section 27

The proposed Phase I Recharge property is anticipated to encompass approximately 630 acres. This may result in approximately 530 wetted acres of recharge basins. Based on the information above it is recommended that an average recharge rate of 0.6 feet per day be utilized for the proposed Phase I Recharge Basins. At the above described recharge rates, the following capacities will be required:

Average Maintenance Rate = 530 acres * 0.6 ft/day = 318 ac-ft/d = 160 cfs

Initial Fill Rate = 1.5 * 160 cfs = 240 cfs

This results in a flowrate of approximately 160 cfs. The initial fill rate is estimated as 1.5 * average flow rate which equates to a fill rate of approximately 240 cfs.

B. Phase II Recharge Property

The proposed Phase II property is located west of Bussell Road and north of Stockdale Highway in Sections 30 and 31, T29S, R25E, M.D.B.&M.

The property consists of approximately 640 acres as illustrated in Figure 5 below.

Figure 5: Phase II Property

The United States Department of Agriculture Soil Conservation Service Soil Survey Maps for the northwestern part of Kern County were reviewed in the area of the proposed Phase II property and the proposed property consists of the following soil types:

- Garces Silt Loam (SCS 156) +/- 20 acres
- Kimberlina Fine Sandy Loam (SCS 174) +/- 190 acres
- Westhaven Fine Sandy Loam (SCS 245) +/- 380 acres
- Cajon Loamy Sand (SCS 125) +/- 50 acres

The acreages noted above are estimates of the soil type across the property. The majority of the soil is:

- Kimberlina Fine Sandy Loam (+/- 30% of Property)
  Moderately Rapid Permeability

- Westhaven Fine Sandy Loam (+/- 60% of Property)
  Moderately Slow Permeability

The tTEM information did not exist for any properties in the vicinity of the Phase II property. It is recommended that this work be performed for the Enns Basins and the West Basins in an effort to correlate with actual average recharge rates and for comparison with the proposed Phase II property. The cost for these tTEM surveys is approximately $30,000 to $35,000. It is also recommended that tTEM surveys be performed on the eventual Phase I and Phase II recharge properties. The estimated cost for those surveys is approximately $60,000 to $65,000.

The Rosedale-Rio Bravo Water District existing West Basins are located in the closest proximity to this property. The historic recharge rates for the West Basins were reviewed. An average recharge capacity for the West Basins is approximately 0.5 feet per day.

Based on the information above it is recommended that an average recharge rate of 0.5 feet per day be utilized for the proposed Phase II Recharge Basins similar to that of the West Basins.

The proposed Phase II Recharge property is anticipated to encompass approximately 640 acres. This may result in approximately 508 wetted acres of recharge basins. At the above described recharge rates, the following capacities will be required:

Average Maintenance Rate = 508 acres * 0.5 ft/day = 254 ac-ft/d = 128 cfs

Initial Fill Rate = 1.5 * 128 cfs = 192 cfs

This results in a flowrate of approximately 128 cfs. The initial fill rate is estimated as 1.5 * average flow rate which equates to a fill rate of approximately 192 cfs.

C. West Basin Property

The West Basin property is already developed and utilized by the Rosedale-Rio Bravo Water Storage District. However, it is planned to provide recharge capacity for this property from the California Aqueduct and thus this recharge capacity must be accounted for in the conveyance facilities. The proposed West Basin property is located north of Stockdale Highway and is bisected by Bussell Road in Sections 28 and 29, T29S, R25E, M.D.B.&M.

The property consists of approximately 388 acres as illustrated in Figure 6 below.

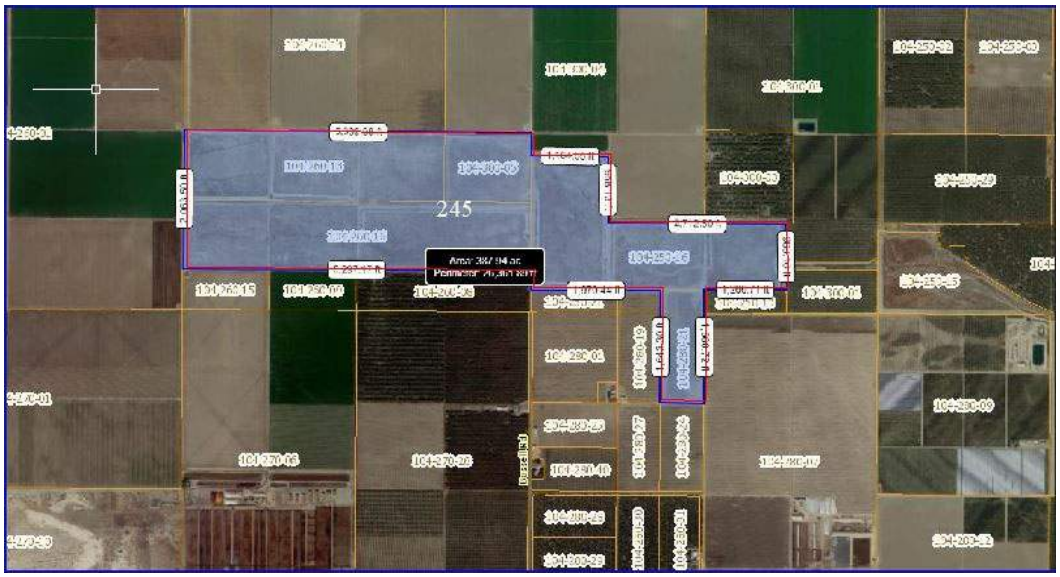


Figure 6: West Basins Property

The United States Department of Agriculture Soil Conservation Service Soil Survey Maps for the northwestern part of Kern County were reviewed in the area of the West Basin property and the property consists of the following soil type:

- Westhaven Fine Sandy Loam (SCS 245) +/- 388 acres

The acreages noted above are estimates of the soil type across the property. The majority of the soil is:

- Westhaven Fine Sandy Loam (+/- 100% of Property)
  Moderately Slow Permeability

The historic recharge rates for the West Basins were reviewed. An average recharge capacity for the West Basins is approximately 0.5 feet per day.

The existing West Basins Recharge property encompasses approximately 388 acres. It is estimated that there are approximately 280 wetted acres of recharge basins.

It has been demonstrated for the West Basins that an average recharge rate of 0.5 feet per day can be achieved. At the above described recharge rates, the following capacities will be required:

Average Maintenance Rate = 280 acres * 0.5 ft/day = 140 ac-ft/d = 70 cfs

Initial Fill Rate = 1.5 * 70 cfs = 105 cfs

This results in a flowrate of approximately 70 cfs. The initial fill rate is estimated as 1.5 * average flow rate which equates to a fill rate of approximately 105 cfs.

II. <u>In-Lieu (Agricultural) Demands</u>

The Rosedale-Rio Bravo Water Storage District boundary is illustrated in Figure 7 below.

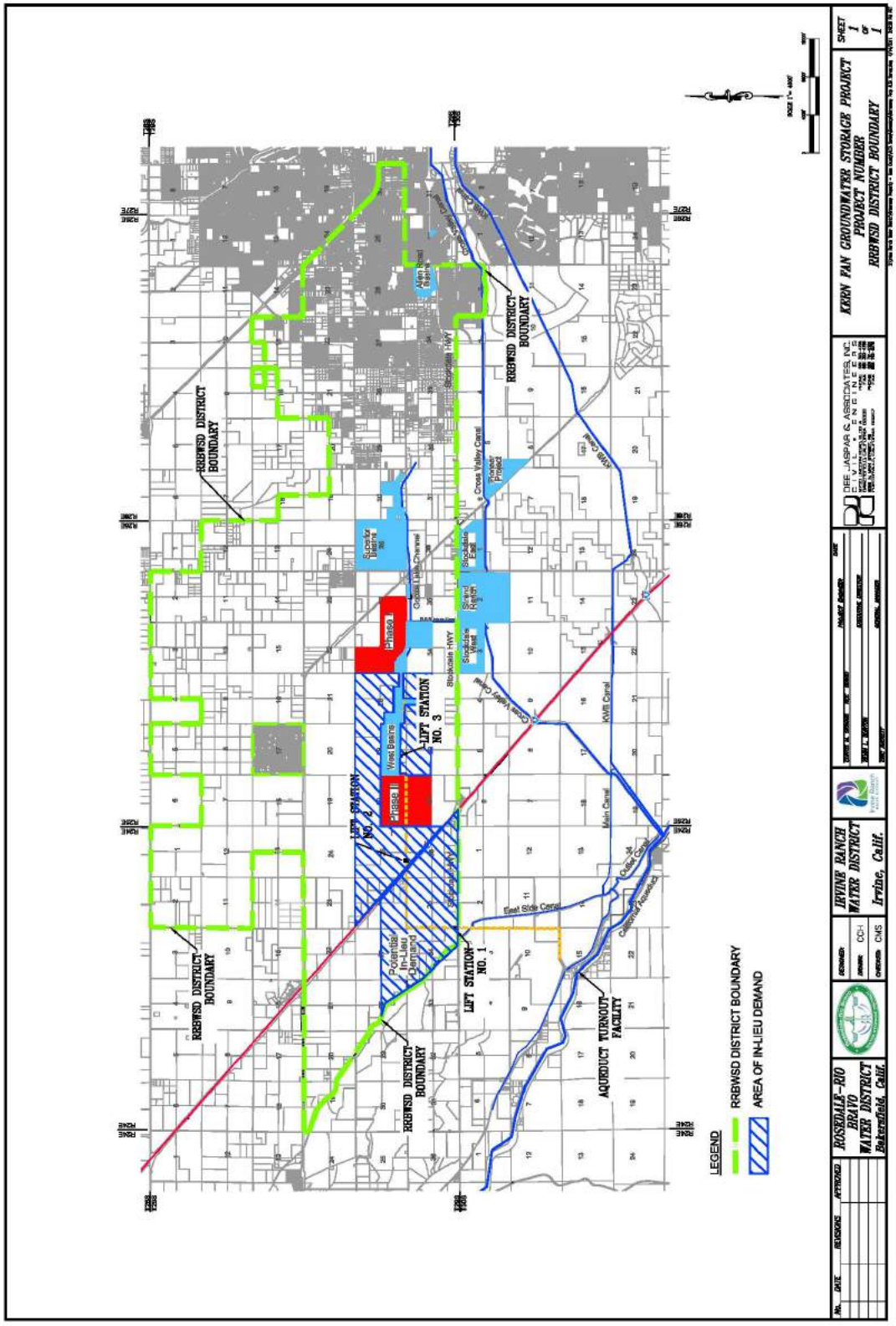


Figure 7: Potential In-Lieu Area

There are approximately 4,889 acres of farmland in the western region of the District, on the west and east sides of Interstate 5, that currently have limited access to surface water.

Due to this lack of infrastructure, these properties rely heavily on groundwater pumping. Implementing in-lieu service areas would enable the District to expand its area of surface water supply. This would achieve the following objectives:

- Allow the District to make greater use of high flow water supplies
- Reduce groundwater pumping
- Improve groundwater levels in the western region of the District

The lands identified herein for in-lieu water are considered adjacent to the proposed conveyance canal and are illustrated in Figure 7 above. The properties west of the I-5 Freeway considered adjacent to the conveyance canal consist of portions of Sections 26, 27, 28, 34, 35, and 36 in T29S, R24E. In addition, the cropping pattern has been estimated as of July 2020, see Table 2 below.

Table 2
Cropping Pattern Adjacent to Canal

Lands West of I-5 Freeway			
Crop	Acreage (acres)	Annual Demand (ac-ft)	Peak Demand (cfs)
Alfalfa	263.2	1174	5.86
Almonds	482.1	1745	10.74
Grape	64.8	172	1.44
Fallow	6.7	24	0.15
Pistachio	1400.1	4746	31.20
Totals:	2216.9	7862	49.39

[1]Water Demand for fallow lands estimated at 3.61 ac-ft/ac to account for development of these lands with surface water supply in future.
[2]Peak demand estimated as 10 gpm/acre.

There are also agricultural properties east of the I-5 Freeway and surrounding the existing West Basins that would likely receive water from the conveyance canal for in-lieu recharge. These lands are in portions of Sections 28, 29, 30, 31, 32, and 33 in T28S, R25E and are shown in Table 3 below.

Table 3
Cropping Pattern Adjacent to Canal

Lands East of I-5 Freeway			
Crop	Acreage (acres)	Annual Demand (ac-ft)	Peak Demand (cfs)
Alfalfa	258.4	1152.2	5.76
Almonds	814.1	2947.0	18.14
Carrots	280.0	700.0	6.24
Corn	600.6	1681.5	13.38
Cotton	249.6	773.6	5.56
Grape	360.0	957.6	8.02
Fallow	109.6	395.7	2.44
Totals:	2672.2	8608	59.54

[1]Water Demand for fallow lands estimated at 3.61 ac-ft/ac to account for development of these lands with surface water supply in future.
[2]Peak demand estimated as 10 gpm/acre.

This is a total in-lieu demand of 109 cfs (49.39 cfs + 59.54 cfs) for lands adjacent to the canal. However, high flow water supplies such as Article 21 water are typically available in wet years around the months of December through May. There is some overlap with the irrigation season noted above, however it avoids overlap with the peak irrigation months of June, July, August, and September as shown below in Table 4. Table 4 has been included to estimate the water demand for agriculture throughout the course of the year and demonstrates how the water demand drops off in the months of November through April.

During the months of January, February, March, and April when the Kern Fan Project would be receiving high flow water supplies and recharging under initial recharge rates, the in-lieu water demand would be a fraction (14% to 41%) of the peak month demands of July and August. Accounting for this limited irrigation demand equates to the need for additional conveyance capacity of approximately 17 cfs (109 cfs x 16%).

Table 4

Estimate of Seasonal Irrigation Demand

Month	*Alfalfa*		*Almonds*		*Carrots*		*Corn*		*Cotton*		*Grapes*		*Pistachios*		*Totals*		*Estimate of Peak Water Demand Based on 10 gpm/ac*
	ETc (in)	*Water Use (ac-ft)*	*ETc (in)*	*Water Use (ac-ft)*	*ETc (in)*	*Water Use (ac-ft)*	*ETc (in)*	*Water Use (ac-ft)*	*ETc (in)*	*Water Use (ac-ft)*	*ETc (in)*	*Water Use (ac-ft)*	*ETc (in)*	*Water Use (ac-ft)*	*Water Use (ac-ft)*	*% of Peak Month*	
Jan	1.11	48.25	1.05	113.42	1.11	25.90	1.11	55.56	1.11	23.09	1.06	37.52	1.05	122.51	400.34	14%	16 cfs
Feb	2.45	106.49	1.15	124.22	0.92	21.47	0.92	46.05	0.92	19.14	0.94	33.28	0.95	110.84	440.01	16%	17 cfs
Mar	4.32	187.78	1.30	140.42	1.20	28.00	1.20	60.06	0.12	2.50	0.52	18.41	0.12	14.00	423.16	15%	17 cfs
Apr	6.19	269.06	4.41	476.35	1.84	42.93	1.83	91.59	1.39	28.91	1.94	68.68	1.69	197.18	1131.77	41%	44 cfs
May	7.55	328.17	6.78	732.35	2.82	65.80	2.84	142.14	1.68	34.94	4.52	160.01	2.75	320.86	1718.48	62%	67 cfs
Jun	7.86	341.65	7.00	756.12	7.94	185.27	7.68	384.38	5.26	109.41	6.46	228.68	6.59	768.89	2589.13	93%	101 cfs
Jul	7.53	327.30	7.32	790.68	8.15	190.17	8.83	441.94	8.92	185.54	6.35	224.79	8.95	1044.24	3014.49	108%	109 cfs
Aug	6.57	285.58	6.00	648.10	2.76	64.40	5.96	298.30	8.10	168.48	5.06	179.12	7.75	904.23	2483.81	89%	97 cfs
Sept	5.13	222.98	4.45	480.67	0.02	0.47	0.46	23.02	5.74	119.39	2.58	91.33	5.73	668.55	1605.95	58%	63 cfs
Oct	2.10	91.28	2.03	219.27	0.33	7.70	0.33	16.52	1.57	32.66	0.51	18.05	3.10	361.69	739.47	27%	29 cfs
Nov	1.40	60.85	0.82	88.57	0.86	20.07	0.86	43.04	0.86	17.89	0.83	29.38	0.87	101.51	341.25	12%	13 cfs
Dec	1.27	55.20	1.10	118.82	1.14	26.60	1.14	57.06	1.14	23.71	1.11	39.29	1.10	128.34	422.43	15%	17 cfs
Totals:	53.48	2324.60	43.41	4689.00	29.09	678.77	33.16	1659.66	36.81	765.65	31.88	1128.55	40.65	4742.84	15310.30		
Average (AC-FT/AC):		4.46		3.62		2.42		2.76		3.07		2.66		3.39			

[1]ETc values used from Table 11 for Zone 15 in a Typical Year from the ITRC California Crop and Soil Evapotranspiration Report

The peak irrigation demand has been estimated as 109 cfs during the month of July. As stated above it is anticipated that high flow supplies will be available beginning around the months of December, January, February, or March. Therefore, an estimated irrigation demand of 17 cfs (Month of February) has been added to the conveyance canal capacity. It is assumed that even if the District is still recharging water through the summer months, that the average maintenance rates will be more appropriate than the fill rates, therefore there will be capacity in the canal for in-lieu recharge.

III. Enns Basins utilizing WB Pipeline Intertie

There is also an existing 27-inch well lateral that connects the West Basin wells to the RRBWSD Intake Canal directly adjacent to the Enns Basins. This pipeline could be utilized during recharge events to convey water to the Enns Basins via pumping from the conveyance canal. The Enns Basins include approximately 175 wetted acres of recharge area. The historic average recharge rate for these basins is 0.62 feet per day which results in a recharge flow rate of 55 cfs. The initial fill rate is estimated as 1.5 * average flow rate which equates to a fill rate of approximately 83 cfs.

Average Maintenance Rate = 175 acres * 0.62 ft/day = 109 ac-ft/d = 55 cfs

Initial Fill Rate = 1.5 * 55 cfs = 83 cfs

However, this conveyance is limited by the carrying capacity of the existing 27-inch well lateral or pipeline intertie. Since a pump station will be required at the conveyance canal, pipeline velocities could be designed to exceed 5 fps in an effort to increase the capacity of the pipeline.

WB Pipeline Capacity = at 5 fps = 20 cfs

WB Pipeline Capacity = at 6 fps = 24 cfs

WB Pipeline Capacity = at 7 fps = 28 cfs

WB Pipeline Capacity = at 8 fps = 32 cfs

In the event a Reach 5 is constructed to supply the Phase I Recharge Property, then it may make more sense to forego the use of the existing 27-inch pipeline and simply supply the Enns Basins from the Reach 5 Facilities or increase the overall reach capacity to the Phase I Property from 105 cfs to 129 cfs so that there is only one additional pump station.

IV. Other Potential Opportunities

There is the potential for other cooperative projects or future projects that could benefit RRBWSD and IRWD, however these have not been evaluated herein. Potential projects could include, but are not limited too:

- Recharge Area Expansion within RRBWSD District Boundary
- Cooperative Projects with the Buena Vista Water Storage District, the Kern Water Bank Authority, or the West Kern Water District

- Conveyance of Aqueduct Water to Stockdale West
- Conveyance of Aqueduct Water to Strand Ranch

V. Pump Stations and Reach Capacities

Three pump stations are currently planned for the conveyance canal which would divide the canal into four reaches.

- Reach One (1) of the conveyance canal begins at the California Aqueduct and ends at Pump Station No. 1 located just north of Stockdale Highway.

  Reach One Capacity is approximately 443 cfs which accounts for the following demands.

  - Phase II Property Initial Fill Rate 192 cfs
  - West Basins Initial Fill Rate 105 cfs
  - In-Lieu Agricultural Recharge 17 cfs
  - Enns Basins -WB Pipeline Intertie 24 cfs
  - Phase I Exchange Capacity 105 cfs

- Reach Two (2) of the conveyance canal begins at Pump Station No. 1 on the north side of Stockdale Highway and ends at Pump Station No. 2 on the east side of the Interstate 5 Freeway.

  Reach Two Capacity and Pump Station No. 1 Capacity is approximately 443 cfs which accounts for the following demands.

  - Phase II Property Initial Fill Rate 192 cfs
  - West Basins Initial Fill Rate 105 cfs
  - In-Lieu Agricultural Recharge 17 cfs
  - Enns Basins -WB Pipeline Intertie 24 cfs
  - Phase I Exchange Capacity 105 cfs

- Reach Three (3) of the conveyance canal begins at Pump Station No. 2 located on the east side of the Interstate 5 Freeway and ends at Pump Station No. 3 near the west end of the West Basins.

  Reach Three Capacity and Pump Station No. 2 Capacity is approximately 435 cfs which accounts for the following demands:

  - Phase II Property Initial Fill Rate 192 cfs
  - West Basins Initial Fill Rate 105 cfs
  - In-Lieu Agricultural Recharge 9 cfs
  - Enns Basins -WB Pipeline Intertie 24 cfs
  - Phase I Exchange Capacity 105 cfs

- Reach Four (4) of the conveyance canal begins at Pump Station No. 3 located near the west end of the West Basins and ends at the West Basins Turnout at the east end of the West Basins.

  Reach Four Capacity and Pump Station No. 3 Capacity is approximately 240 cfs which accounts for the following demands:

  - West Basins Initial Fill Rate 105 cfs
  - In-Lieu Agricultural Recharge 6 cfs
  - Enns Basins -WB Pipeline Intertie 24 cfs
  - Phase I Exchange Capacity 105 cfs

VI. Summary

The conveyance canal will need to provide capacity for the following uses:

- In-Lieu Agricultural Demand 17 cfs
- Phase II Property Recharge 192 cfs
- West Basins Property Recharge 105 cfs
- Enns Basins – WB Pipeline Intertie 24 cfs
- Phase I Exchange Capacity (Potential Reach 5) 105 cfs

The conveyance capacity and associated pump station capacity would decrease as these demands are accounted for. These reach capacities are summarized in Table 5 and illustrated in Figure 11.

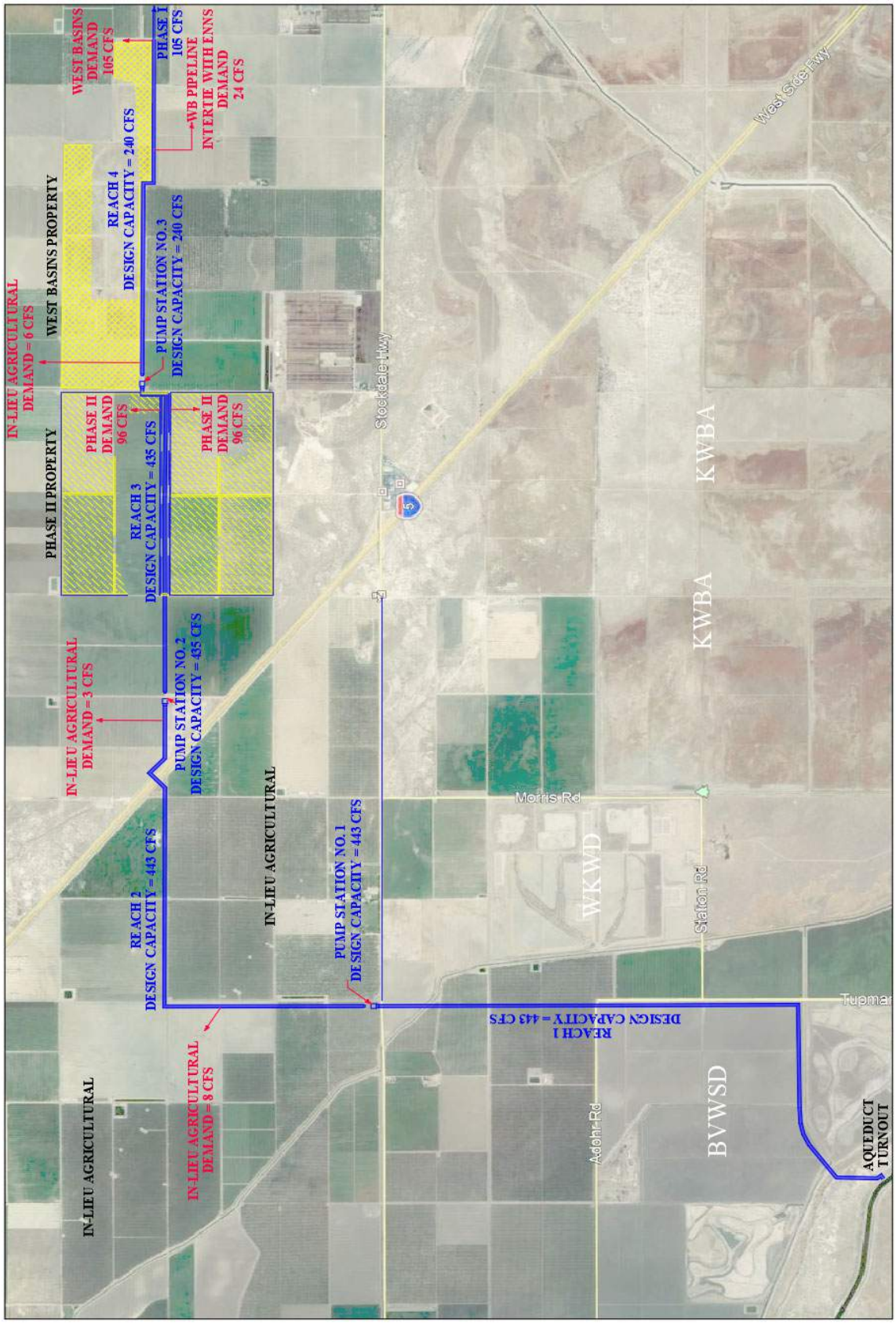


Figure 8: Conveyance Canal Demands and Capacities

A summary of the conveyance capacities is shown below in Table 5:

Table 5
Conveyance Canal Design Capacity

Conveyance Canal Facility	Design Canal Capacity	Design Pump Station Capacity
Reach 1	443 cfs	
Reach 2	443 cfs	443 cfs
Reach 3	435 cfs	435 cfs
Reach 4	240 cfs	240 cfs
Reach 5, if necessary	129 cfs	129 cfs

As described herein, Article 21 water supply is typically available in the months of December, January, February, March, April and May. Beyond these months of the year it is anticipated that the recharge areas would be at the maintenance rates rather than the initial fill rates.

The agricultural demands are typically the highest during the months of June, July, August, and September.

Table 6 illustrates the conveyance canal demands throughout the year for a 1) wet year or above normal year, 2) below normal wet year, and 3) for a dry or critical year. The anticipated peak flow of the conveyance canal is 443 cfs.

In wet years and above normal years, the conveyance canal is able to supply 100% of the average "in-lieu" agricultural demand as the recharge decreases to the estimated maintenance rates. While in below normal years and dry or critical years, the conveyance canal is able to supply 100% of the average "in-lieu" agricultural demand as water is available.

Table 6

Estimated Maximum Conveyance Canal Capacity by Month

Demand Description	January	February	March	April[2]	May	June	July	August	September	October	November	December
Recharge Operations (Wet Year or Above Normal Year)[3]	426	426	426	354	282	282	282	282	282	282	282	426
In-Lieu Agricultural[1]	16	17	17	44	67	101	109	97	63	29	13	17
Monthly Totals (Wet Year or Above Normal Year):	**442**	**443**	**443**	**398**	**349**	**383**	**391**	**379**	**345**	**311**	**295**	**443**
Recharge Operations (Below Normal Year)[3]	0	0	426	0	0	0	0	0	0	0	0	0
In-Lieu Agricultural[1]	16	17	17	44	67	101	109	97	63	29	13	17
Monthly Totals (Below Normal Year):	**16**	**17**	**443**	**44**	**67**	**101**	**109**	**97**	**63**	**29**	**13**	**17**
Recharge Operations (Dry or Critical Year)	0	0	0	0	0	0	0	0	0	0	0	0
In-Lieu Agricultural[1]	16	17	17	44	67	101	109	97	63	29	13	17
Monthly Totals (Dry or Critical Year):	**16**	**17**	**17**	**44**	**67**	**101**	**109**	**97**	**63**	**29**	**13**	**17**

[1]The "In-Lieu" agricultural demand is the average demand based upon land area, cropping pattern, and monthly Et_c.

[2]The recharge demand for the month of April is an interpolation between the fill rate of 426 cfs in March and the maintenance rate of 282 cfs in May.

[3]The months of December through April are based upon Article 21 supplies being available for recharge up to the estimated filling rate. The months of May through November are the maintenance rates and are based on other water supplies besides Article 21 water.

VII. Related Work Specified Elsewhere

A. TM 3 – Pipeline Requirements
B. TM 4 – Pump Station Requirements
C. TM 5 – Geotechnical Investigation
D. TM 6 - Canal Liner and Turnout Requirements
E. TM 8 - ROW Acquisitions
F. TM 11 – Facility Operation and SCADA Requirements
G. TM 12- Engineer's Estimates

Appendices

Appendix A – Original Project Description
Appendix B - tTEM Results on portion of Phase I Property

Appendix A
Project Description

The Kern Fan Groundwater Storage Project (Project) consists of a regional water bank in the Kern County Groundwater Sub-basin of the San Joaquin Groundwater Basin in Kern County, California that will provide water supply, groundwater and ecosystem benefits. Project facilities will be planned, designed, constructed, owned, and operated by the Kern Fan Joint Powers Authority (JPA) that consists of representatives from the Irvine Ranch Water District (IRWD) and the Rosedale-Rio Bravo Water Storage District (RRBWSD). IRWD and RRBWSD share a ten-year history of implementing successful water banking projects in Kern County. The Project concept, sizing, location, features and operations are based on the experience and knowledge gained from IRWD's and RRBWSD's existing water banking projects.

The total storage capacity to be developed by the Project is anticipated to be 100,000 acre-feet. The Project will be supplied primarily by the State Water Project's supplies that exceed the SWP Contractors allocation during a wet year (Article 21 supplies) and also by other wet-year water supplies as available, including Kern River water. In wet years, when it is declared available by the California Department of Water Resources (DWR), the JPA will take delivery of Article 21 supplies to store in the Project. IRWD and RRBWSD will equally share 75 percent of the Article 21 water delivered into storage for water supply and groundwater benefits. The remaining 25 percent of the stored Article 21 water will be held as State Water Project (SWP) system water that will be used for ecosystem benefit purposes. The ecosystem benefits will be derived by exchanging water from the Kern Fan Project to Oroville Reservoir where they will be released as needed for short term pulse flows. This exchange will be coordinated through a separate agreement.

Other water supplies that could be available for the Project include other SWP supplies diverted from the California Aqueduct, as well as other supply sources including Central Valley Project Section 215 flood water and high-flow Kern River water.

The Project objectives are to cost-efficiently recharge and store groundwater for subsequent recovery to address the following:

- Enhance water supply reliability;
- Reduce imported water demands on the San Francisco Bay/Sacramento –San Joaquin Delta Estuary (Delta) to benefit spring and winter-run Chinook salmon;
- Provide water supply during drought conditions;
- Provide water supply for emergency response benefits;
- Establish temporary wetlands through intermittent recharge events that will attract migratory and other water fowl in Kern County;
- Benefit the water levels in the Kern County Groundwater Sub-basin;
- Provide sustainable water supply for local agricultural use; and
- Be integrated into other water storage projects and storage reservoirs to provide greater statewide benefits.

The Project involves purchasing approximately 640 acres of land mostly within the Rosedale Rio Bravo Water Storage District (RRBWSD) boundary and within the limits of the Stockdale Integrated Banking Project Environmental Impact Report (EIR). Water will be conveyed to this property for recharge from the Friant-Kern Canal or the Kern River by exchange via the Goose Lake Channel or from the Cross Valley Canal (CVC) via the RRBWSD Intake Canal. An interconnection pipeline will be constructed from the RRBWSD Intake Canal to the proposed property to connect the two. A new check structure will be required in the Goose Lake Channel with a reinforced concrete turnout structure constructed behind it to convey water from the Goose Lake Channel to the Phase I property. This turnout structure will include a lift station with four 60 cfs pumps each equipped with 200 hp vertical motors to lift the water up to the Phase I property for recharge and include discharge piping, metering, appurtenances, lighting, electrical, controls, and SCADA communication. The anticipated recharge at this proposed property will initially be 230 cfs (0.7 ft/d of recharge) and then drop to an approximate maintenance rate of 115 cfs (0.35 ft/d of recharge).

The Phase I property will be developed for recharging ground water and the construction work will include site clearing and grubbing, installation of site fencing and gates, construction of earthen levees, construction of inter-basin structures and conveyance facilities, rip-rap, and existing well abandonments. In addition the property will be equipped with up to six recovery wells with an approximate capacity of 5 to 6 cfs each. These will be 20-inch diameter wells cased to approximately 930-ft. The wells will be equipped with vertical turbine pumps, 400 hp vertical hollowshaft motors, discharge piping, appurtenances, electrical and controls, and site improvements. The underground well conveyance piping will be PVC pipe ranging in size from 12-inch to 30-inch diameter. The recovery wells will return water through a conveyance pipeline that crosses the Goose Lake Channel and discharges into the RRBWSD Intake Canal whereby the water is returned to the Cross Valley Canal (CVC) for delivery or exchange to the California Aqueduct.

In order to have capacity in the Goose Lake Channel to recharge water to the Phase I property it is proposed to supply water to the existing RRBWSD West Basins by an alternate means. Due to limited capacity in the Goose Lake Channel and the CVC it is planned to construct a new reinforced concrete turnout at the California Aqueduct and convey 500 cfs approximately 9.0 miles to the easterly end of the RRBWSD West Basins. The 500 cfs capacity will account for initial recharge to the West Basins of approximately 120 cfs, initial recharge to the Phase II Property of approximately 230 cfs, and potential in lieu recharge water to District farmlands. The approximate water surface elevation at the California Aqueduct is 305-ft. The approximate elevation at the east end of the West Basins is 315-ft therefore requiring an approximate static lift of 10-feet. This water supply will be conveyed in a new canal with the approximate dimensions of a 20-ft wide bottom, 8-ft depth, and 1.5:1 side slopes. A habitat conservation plan (HCP) and mitigation credit for the conveyance easement equal to approximately 100 acres is included. The canal will be concrete lined and have siphon crossings at the following major locations:

- Outlet Canal & West Side Canal
- Adohr Road
- East Side Canal
- Stockdale Highway
- Interstate 5 Freeway
- Miscellaneous Levee Roads and Farm Roads

The canal is planned to be concrete lined in an effort to minimize weeds, debris, and sediment in the siphon crossings and the lift station forebays. Furthermore the concrete lining has the longest useful life. The canal will have three lift stations along the alignment to lift water to the recharge basins. It is estimated that the first lift station will consist of a reinforced concrete pump station with two 30 cfs low lift pumps with 100 hp motors, two 60 cfs low lift pumps with 200 hp motors, and four 80 cfs low lift pumps with 300 hp vertical motors, discharge piping and appurtenances, electrical and controls in order to convey 500 cfs to the east side of the I-5 Freeway. The second lift station will consist of a reinforced concrete pump station with two 30 cfs low lift pumps with 100 hp motors, two 60 cfs low lift pumps with 200 hp motors, and four 80 cfs low lift pumps with 300 hp vertical motors, discharge piping and appurtenances, electrical and controls in order to convey 500 cfs to the west end of the West Basins and to the Phase II Recharge Property. The third lift station will consist of a reinforced concrete pump station with two 30 cfs low lift pumps with 100 hp motors, two 60 cfs low lift pumps with 200 hp motors, and four 80 cfs low lift pumps with 300 hp vertical motors, discharge piping and appurtenances, electrical and controls in order to convey 500 cfs to the east end of the West Basins and the Goose Lake Channel. Each lift station will also include a gravity bypass line with slide gate into the lift station structure for the reverse flow of recovered water back to the California Aqueduct.

A reinforced concrete turnout structure for approximately 420 cfs will be constructed at the east end of the West Basins to convey recharge water to the West Basins and to the Goose Lake Channel if necessary. This structure will be equipped such that recovered water from the WB wells can be returned through the canal conveyance facility to the California Aqueduct.

In addition, the Project involves purchasing approximately 640 acres of Phase II land located within the Rosedale Rio Bravo Water Storage District boundary but outside of the limits of the Stockdale Integrated Banking Project EIR. Water will then be conveyed to this property from the California Aqueduct via the new canal.

The Phase II property will be developed for the recharge and recovery of ground water. The anticipated recharge at this property will initially be approximately 230 cfs (0.7 ac-ft/d) and then drop to an approximate maintenance rate of 115 cfs (0.35 ac-ft/d). The scope of work for construction will include site clearing and grubbing, installation of site fencing and gates, construction of earthen levees, construction of inter-basin structures and conveyance facilities, rip-rap, and existing well abandonments. In addition the property will be equipped with six recovery wells with an approximate capacity of 5 to 6

cfs each. These will be 20-inch diameter wells cased to approximately 930-ft. The wells will be equipped with vertical turbine pumps, 400 hp vertical hollowshaft motors, discharge piping, appurtenances, electrical and controls, and site improvements. The underground well conveyance piping will be PVC pipe ranging in size from 12-inch to 30-inch diameter. The recovery wells will pump water through conveyance pipelines back to the new canal and reverse flow water in the canal by gravity to return water to the California Aqueduct. At the California Aqueduct turnout afterbay facility, a small lift station will be constructed to lift water into the turnout pipeline and convey the water back to the California Aqueduct.

The proposed Project will also include the construction of a SCADA system to aid in the operations of the Aqueduct turnout, the canal lift stations, the turnout facilities to the groundwater banking properties, and the recovery water well facilities. This will include PLC's, radio communication, computer station at a central headquarters, and control programming.

Appendix B
tTEM Results on portion of Phase I Property

The tTEM method measures the electrical resistivity of the earth. To assess the lithology below the ground surface, the resistivities measured by the receivers must be translated to lithologies. Translating resistivities to lithology is based on a general correlation between resistivity and type of sediments. Impermeable clay has a low resistivity. Sandy clay typically results in a resistivity ranging from 30 to 100 ohm-m, while sand to coarse sand has a resistivity above 50 ohm-m. This correlation is a general assumption and can vary between locations. For purposes of the figures below, from the Ramboll study, the resistivities are color coded, see Figure 2.

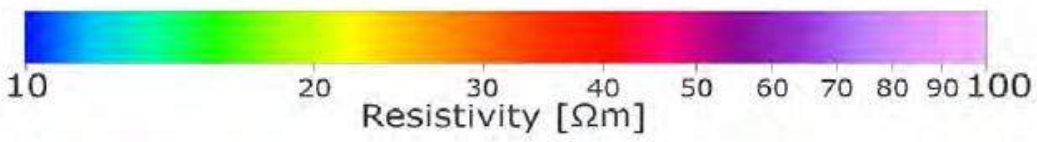


Figure 1: Resistivity Color Scale

It is estimated that clays are typically below 15 ohm-m (blue, light blue), silt layers are found to vary significantly from 10 – 40 ohm-m (green, yellow, orange, red), and sands and/or gravels are typically above 40 ohm-m (pink, purple). The large variations for the silt layers are interpreted to reflect the clay content, either as thin interbedded clay sequences or as a mixture of silt and clay.

The data surveyed indicates the southern half of Section 27 is interpreted mostly as clay and silts at depths to 13-feet below ground surface. See figures 2 and 3 below.

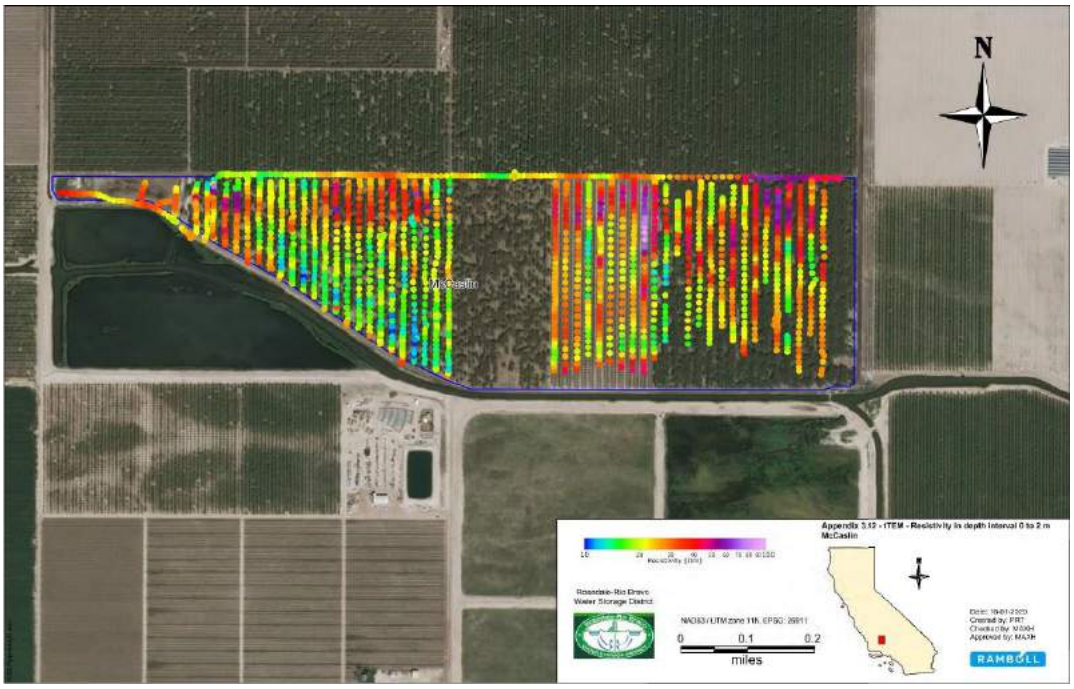


Figure 2: Depths of 0-feet to 6.5-feet

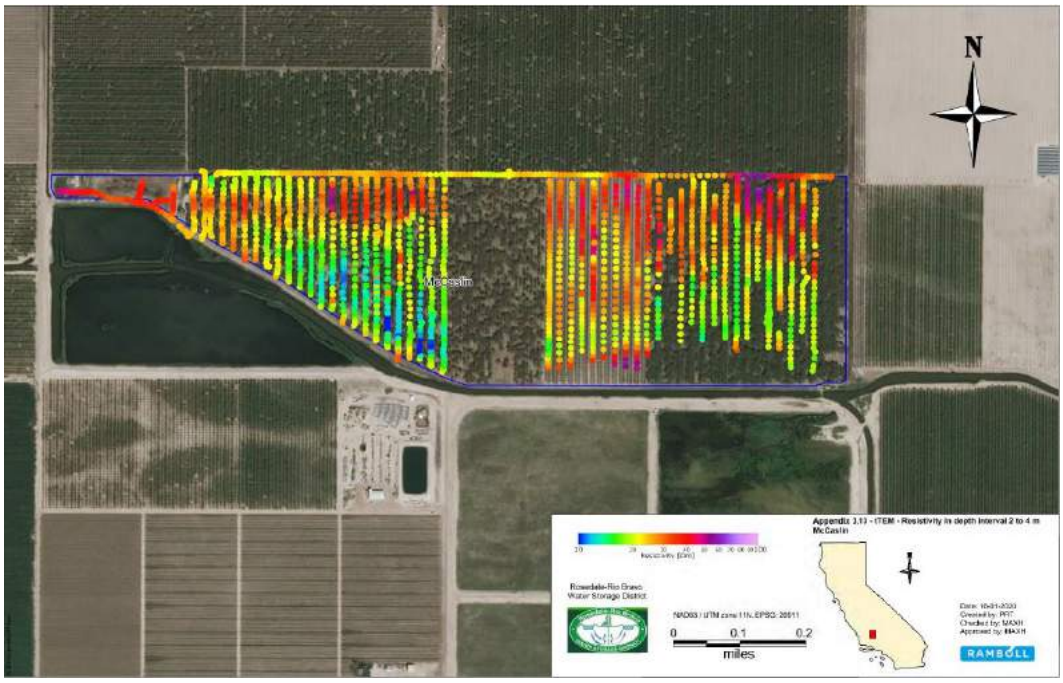


Figure 3: Depths of 6.5-feet to 13-feet

The depth interval from 13-feet to approximately 32-feet begins to transition from the silt and clays to coarser material, see Figures 4 and 5.

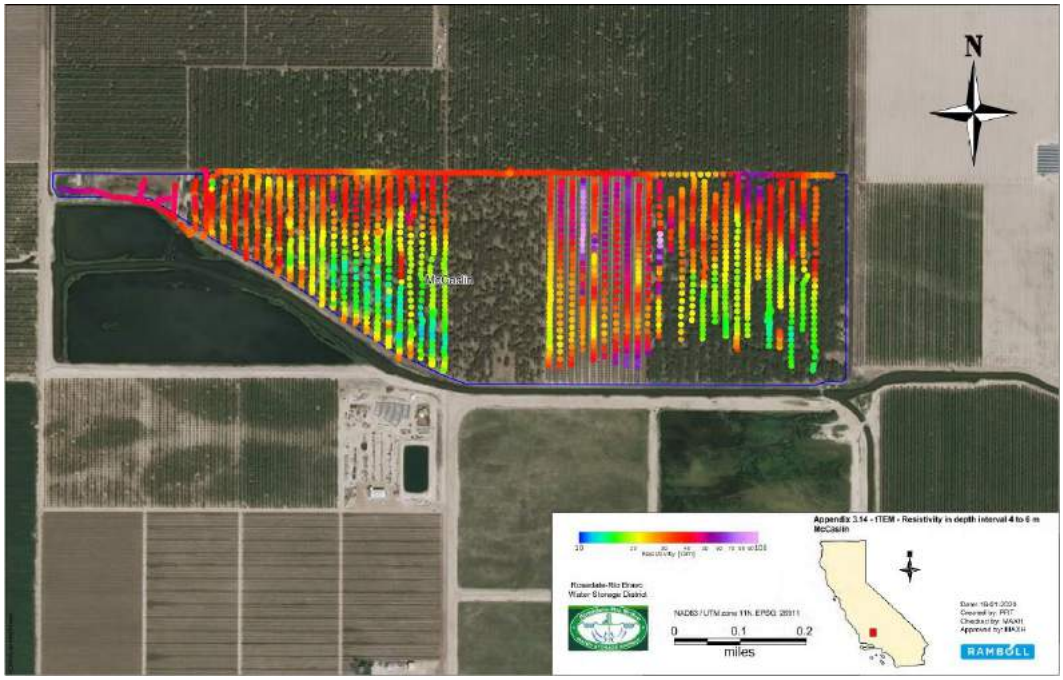


Figure 4: Depths of 13-feet to 20-feet

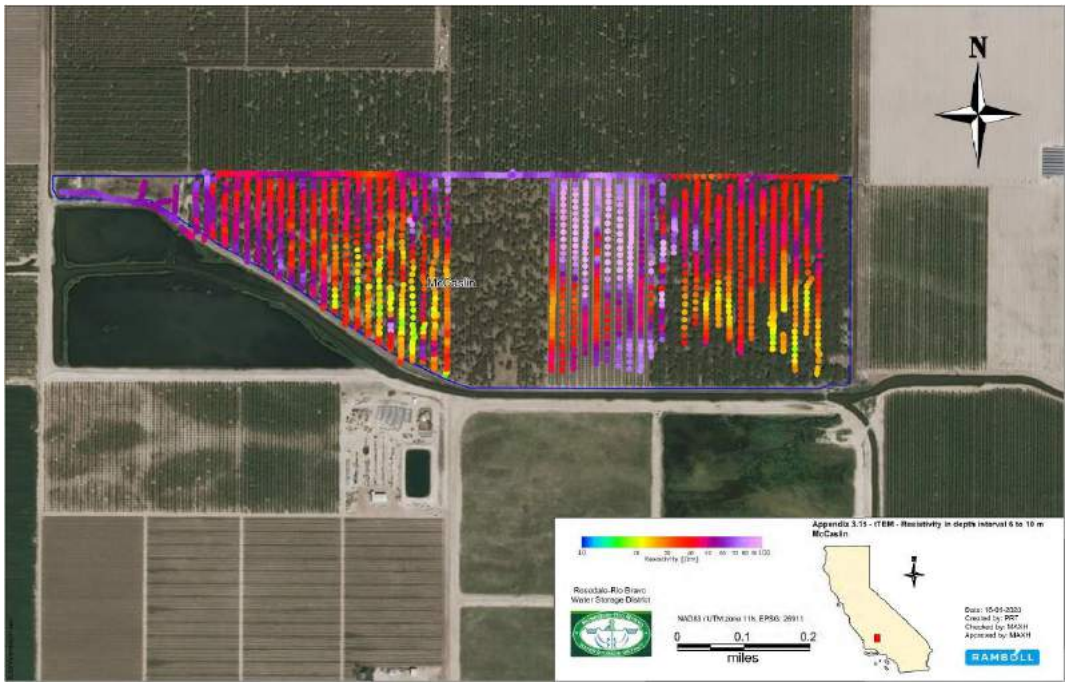


Figure 5: Depths of 20-feet to 32-feet

The depth interval from 32-feet to 65-feet illustrates coarse sands and gravels throughout the majority of the southern half of Section 27 as shown in Figures 6 and 7.

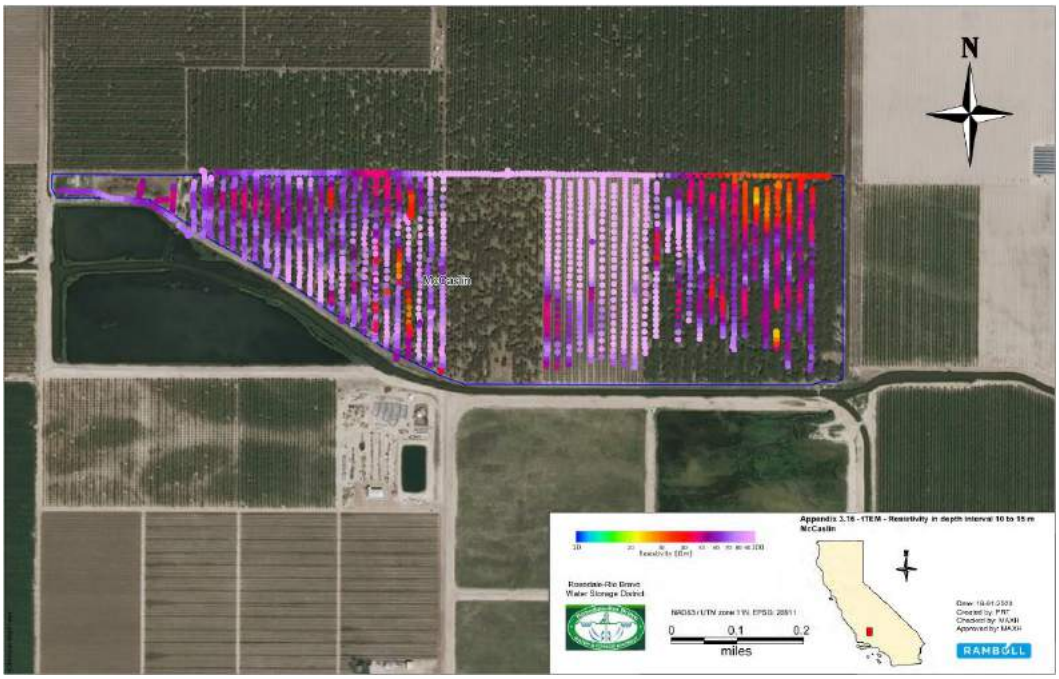


Figure 6: Depths of 32-feet to 49-feet

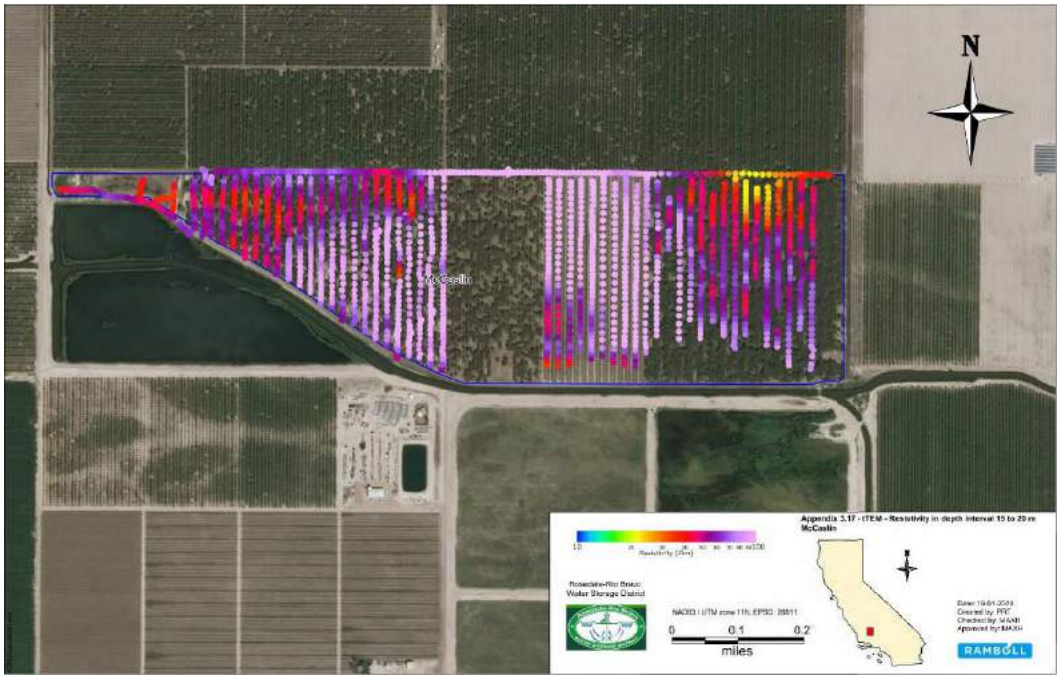


Figure 7: Depths of 49-feet to 65-feet

The depth interval from 65-feet to 82-feet below ground surface shows a large area in the central part as being coarse sand material. To the northwest and eastern parts of the south half of Section 27, the resistivities tend to be slightly lower, indicating finer material, see Figure 8.

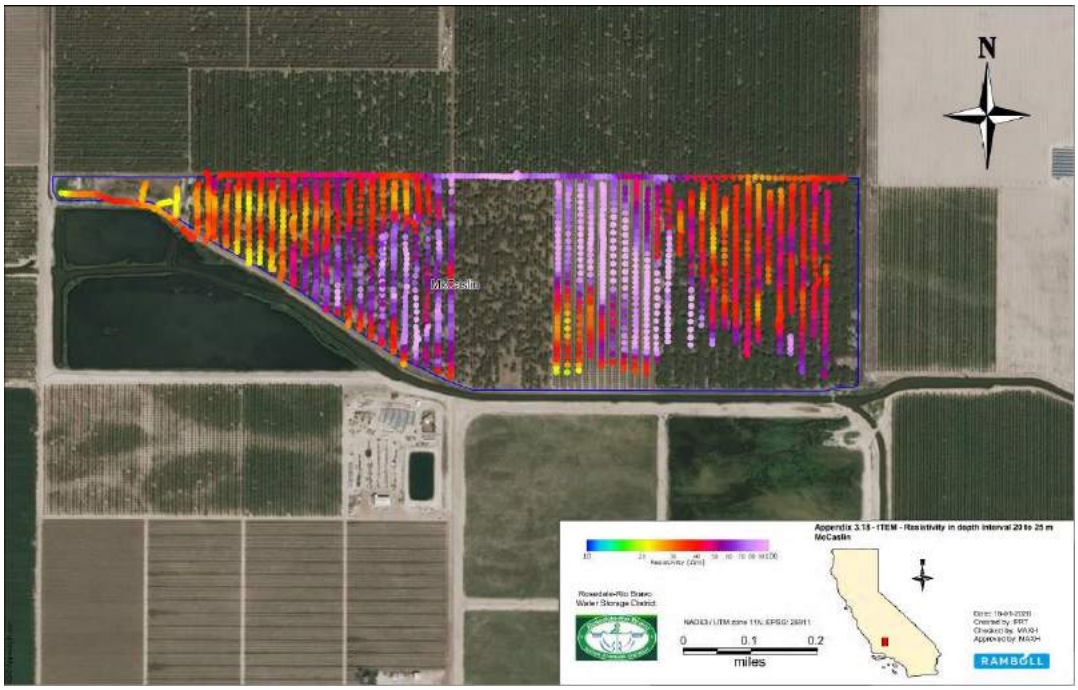


Figure 8: Depths of 65-feet to 82-feet

Beyond a depth of approximately 82-feet the material begins to transition back to a finer, siltier material with some clay, see Figures 9 through 12.

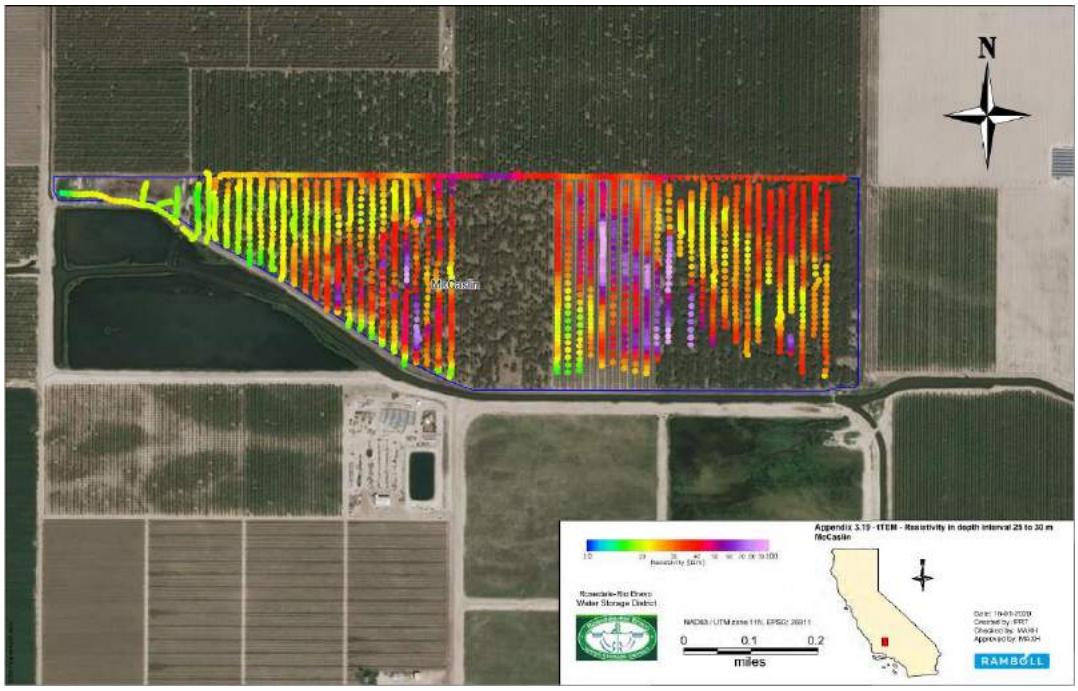


Figure 9: Depths of 82-feet to 98-feet

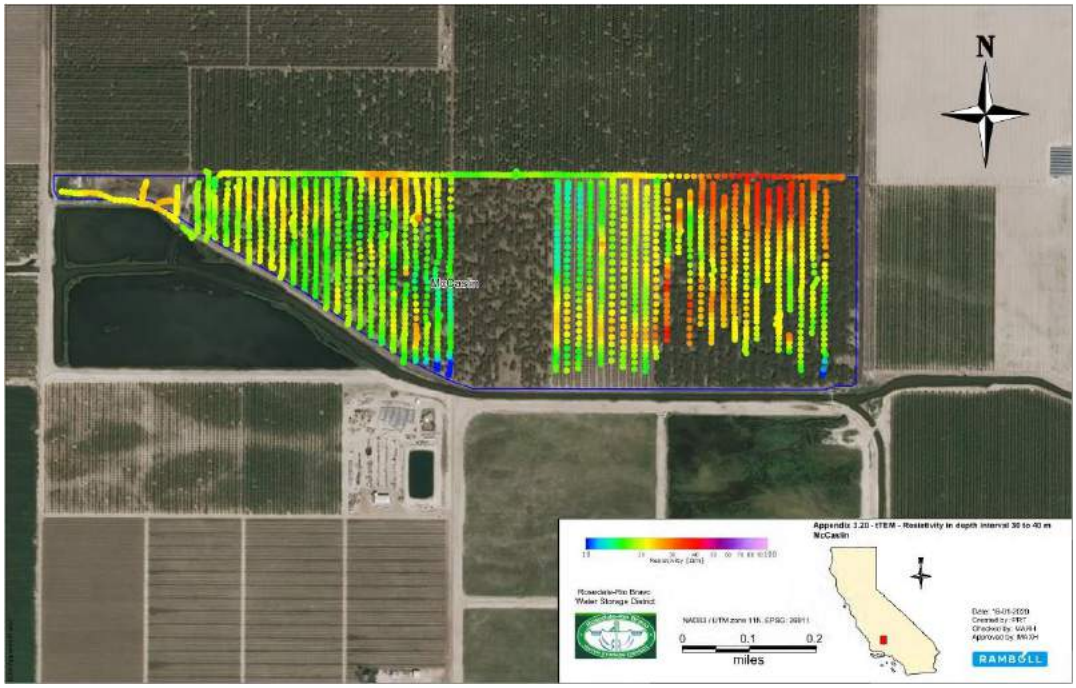


Figure 10: Depths of 98-feet to 131-feet

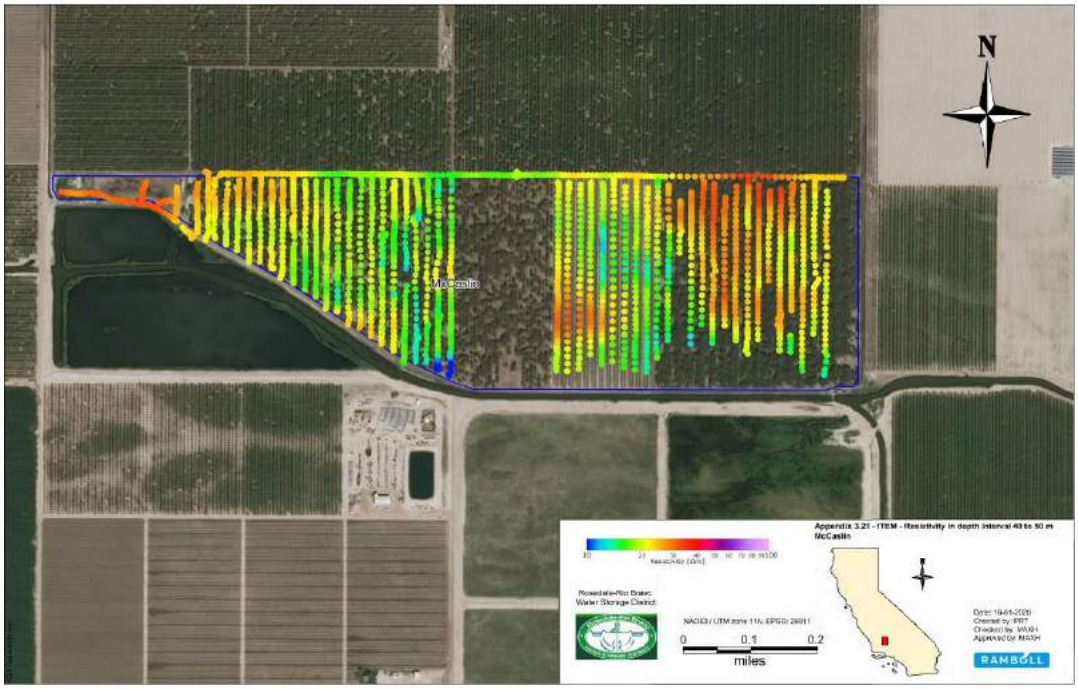


Figure 11: Depths of 131-feet to 164-feet

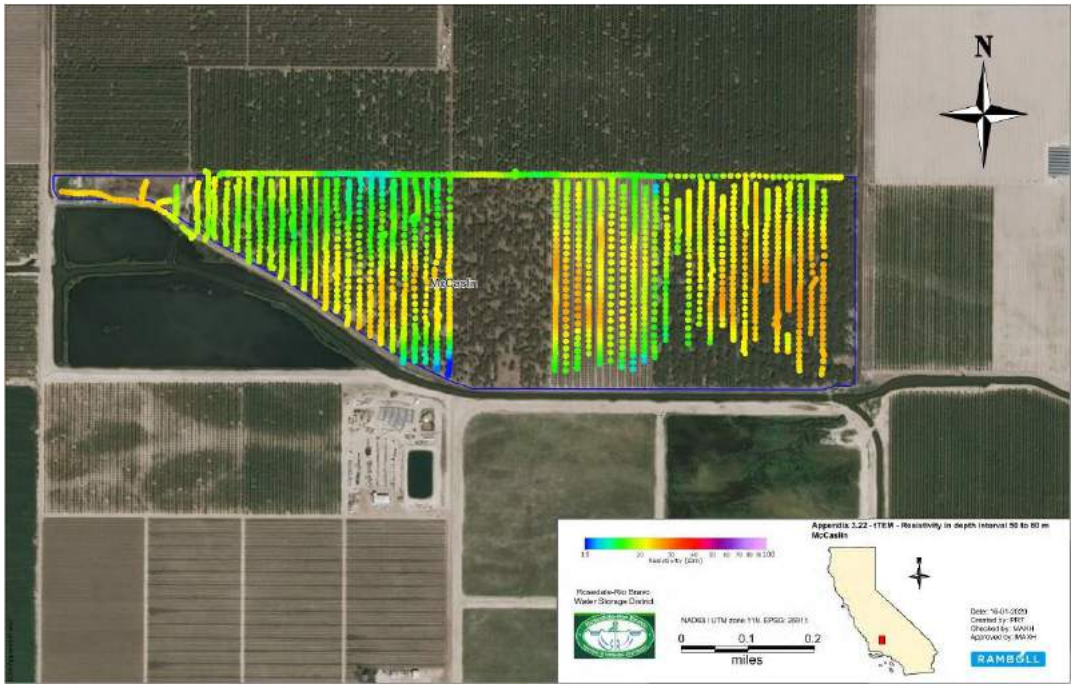


Figure 12: Depths of 164-feet to 197-feet

The average resistivity for the southern half of Section 27 is approximately 25.1 ohm-m. Figure 13 below illustrates the lithology vertically based on elevation and shows how the top 90-feet to 100-feet has coarser material well suited for groundwater recharge.

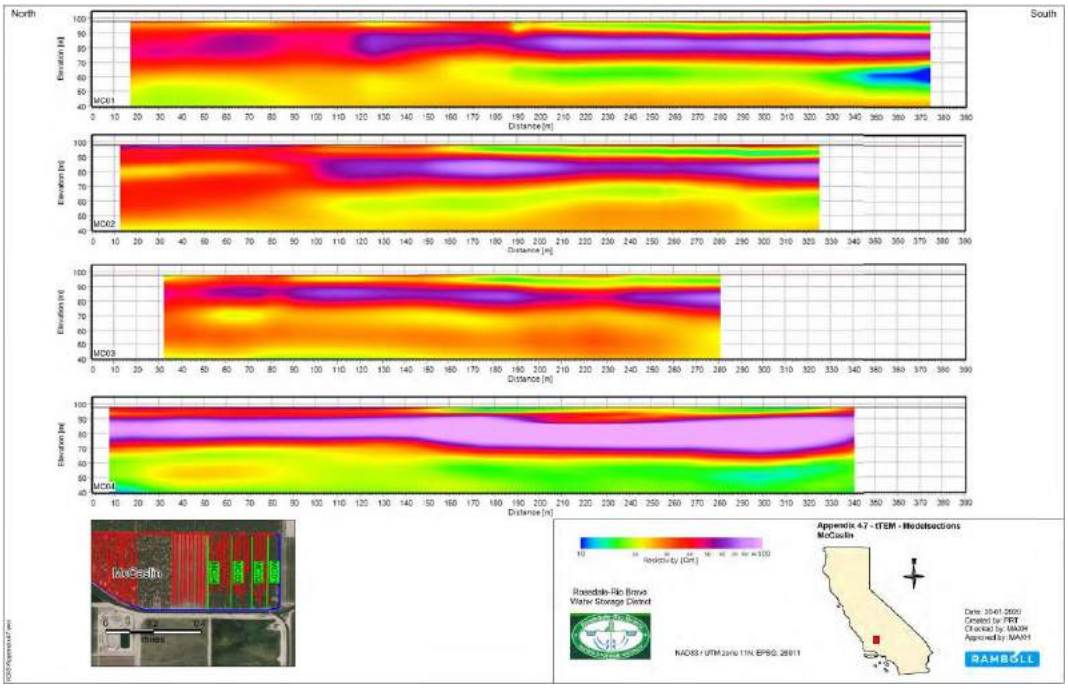


Figure 13: Model Sections of Southern Half of Section 27

APPENDIX C

Technical Memorandum #3
Pipeline Requirements

DEE JASPAR & ASSOCIATES, INC.
CONSULTING CIVIL ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CA 93308
PHONE (661) 393-4796
FAX (661) 393-4799

KERN FAN GROUNDWATER STORAGE PROJECT

TECHNICAL MEMORANDUM NO. 3
(Pipeline Requirements)

PREPARED FOR: Groundwater Banking Joint Powers Authority (JPA)
PREPARED BY: Curtis Skaggs, P.E.
DATE: November 23, 2020

SUBJECT: ***Pipeline Requirements***

I. Executive Summary

The successful performance of any pipe generally depends on:

1) proper selection of the type of pipe and class of pipe for the application
2) proper sizing of the pipeline for the hydraulic conditions
3) type of bedding and backfill material
4) proper installation and care of bedding, backfill, and compaction
5) pipeline venting to protect the pipeline system and maintain its efficiency
6) corrosion implications and protection

This memorandum serves to address some of the items above and provide the basis for the pipeline design and the preliminary Engineer's Estimate. The type of pipe and sizes of pipe recommended herein are preliminary and subject to change. The project designer shall review and evaluate the findings herein and will ultimately be responsible for the final design thereof.

The table below summarizes the project facility, the type of pipe recommended, and the estimated pipe size. The pipeline installation, bedding, backfill, and compaction will be addressed during the engineering design phase as part of the detailed project technical specifications.

Project Facility	Nominal Pipe Size	Pipe Type
Aqueduct Turnout	108-inch	D50 Dry Cast RCP
Adohr Road Siphon	120-inch	C25 Dry Cast RCP
East Side Canal Siphon	120-inch	C25 Dry Cast RCP
Reach 2 Farm Road Siphon	120-inch	C25 Dry Cast RCP
Reach 3 Farm Road Siphon	120-inch	C25 Dry Cast RCP
Reach 4 Farm Road Siphon	90-inch	C25 Dry Cast RCP
Stockdale Hwy Cased Crossing Carrier Pipe	120-inch	D25 Dry Cast RCP
I-5 Fwy Cased Crossing Carrier Pipe	120-inch	D25 Dry Cast RCP
Reach 4 Conveyance Piping	63-inch and 54-inch	DR41 HDPE
Phase II Turnout	48-inch	ADS N12 WT HDPE
West Basins Turnout (Open Channel Design)	48-inch (2 Barrels)	ADS N12 WT HDPE
West Basins Turnout (Closed Conduit Design)	36-inch	DR41 HDPE
Phase I Turnout (Open Channel Design)	48-inch (2 Barrels)	ADS N12 WT HDPE
Phase I Turnout (Closed Conduit Design)	54-inch	DR41 HDPE
Well Conveyance Pipelines	15-inch to 27-inch	SDR51 PIP PVC
Well Conveyance Pipelines	30-inch to 36-inch	DR51 C900 PVC or DR41 HDPE
Interbasin Piping	36-inch and 48-inch	ADS N12 WT HDPE
In-Lieu Turnout Piping	24-inch	ADS N12 WT HDPE

1. *The "D" class of pipe is a conservative assumption at this stage in the design. The RCP pipe classification shall be re-evaluated during detailed design and be based on actual design elevations, earth cover, and operating conditions.*
2. *The project shall prepare for bid alternatives for pipe sizes and structures where more than one alternative is an option and close in pricing such as for the Reach 4 Conveyance Canal Piping, the Well Conveyance Pipelines, and Road Crossings and Bridges or Box Culverts.*

Pipeline venting is not addressed herein, however it will need to be considered during the engineering design. The pipeline must have the ability to vent large volumes of air during filling or startup, release accumulations of air during operation, and allow air back into the pipeline at times to prevent negative pressures. Similarly, corrosion protection is not addressed in detail herein, but shall be considered during the engineering design where steel pipelines and appurtenances are installed below ground.

Section II of this memorandum discusses the different types of pipe materials:

Section III then briefly discusses the types of crossings such as trenchless pipe installations, siphon or road pipe crossings, box culverts, or bridges

Section IV evaluates the pipe types and pipe sizes for the primary project components as outlined below:

Cost estimates utilized herein are preliminary and only for purposes of the preliminary engineering work. Budgetary pipe material costs have been obtained as of September and October 2020 and installation cost estimates utilized from previous projects similar in nature. It is understood that these costs are subject to change based on the actual project conditions and engineering design, actual quantities to be installed, external global impacts to material pricing, and other unforeseen circumstances. Therefore, it is recommended to verify pipeline material costs in the design phase and to consider bidding multiple pipe material options for those close in cost.

II. PIPE MATERIALS

A. PVC Pipe

PVC pipe is an ideal pipe material for certain aspects of this project as it is a corrosion resistant material, is suitable for these water temperatures and water quality parameters, and is easy to install.

There are many types of PVC pipe, however for water pressure pipe the most common types of pipe are AWWA pressure pipe and ASTM pressure pipe. A roughness coefficient of 0.010 and a Hazen-Williams coefficient of 150 was used for PVC pipe per the McGraw-Hill Hydraulic Design Handbook.

AWWA pressure pipe is governed by the standards, AWWA C900 and C909, and use cast-iron pipe size outside diameters. This diameter regimen is compatible with both cast-iron pipe and ductile-iron pipe.

ASTM pressure pipe is governed by the standard, ASTM D2241, and is also referred to as plastic irrigation pipe (PIP). This diameter regimen is compatible with iron pipe sizes or steel pipe.

The above noted types of pipe have varying pressure classes, pipe wall thicknesses, and available diameters. For purposes of cost comparison, it has been assumed that a pressure class of 80 psi will be adequate for the applications that PVC pipe would be installed in, i.e. turnouts, well conveyance pipelines, etc. Specific pipe classes and costs however, are discussed in greater detail under Section IV Facility Piping.

a) Size Ranges and Availability

Plastic Irrigation Pipe (PIP)

Plastic Irrigation Pipe (PIP) is available in size ranges from 12-inch diameter to 27-inch diameter. The size chart below is for a standard dimension ratio (SDR) of 51. The dimension ratio defines a constant ratio between the outer pipe diameter and the pipe wall thickness thus providing a simple means of specifying product dimensions to maintain constant mechanical properties regardless of pipe size. The pressure class for ASTM D2241 SDR51 pipe is 80 psig.

Table 1

Kern Fan Project				
PIP Pipe Data (SDR51 PC 80)				
Nominal Diameter (in)	O.D.	I.D.	Capacity at Velocity = 5 fps	Capacity at Velocity = 6 fps
12	12.24	11.73	3.8	4.5
15	15.30	14.66	5.9	7.0
18	18.70	17.92	8.8	10.5
21	22.05	21.13	12.2	14.6
24	24.80	23.77	15.4	18.5
27	27.95	26.79	19.6	23.5
30	NA	NA	NA	NA
36	NA	NA	NA	NA
42	NA	NA	NA	NA
48	NA	NA	NA	NA

The PIP pipe size availability will likely mean that this pipe is not a suitable alternative for turnout piping. However, it would work for the well conveyance pipelines that are 27-inch diameter and smaller. Assuming, 6 cfs per well, it is likely that this pipe would work for connecting up to 3 wells maximum.

The PIP pipe is also advantageous as it is readily available locally since it is the typical pipe used by agricultural contractors in the area and most contractors are experienced with its installation.

The PIP pipe fittings used by the District are typically Gheen or Morrill stainless steel fittings, or equivalent. This is a result of past experience with coating issues on the Gheen fittings.

C900 PVC Pipe

AWWA C900 PVC pipe is available in size ranges from 12-inch diameter to 60-inch diameter. The largest size available in the previous C905-10 standard was 48-inch, however the revised C900-16 standard added two larger pipe sizes – 54-inch and 60-inch. The size chart below is for a dimension ratio (DR) of 41 and 51. The dimension ratio defines a constant ratio between the outer pipe diameter and the pipe wall thickness thus providing a simple means of specifying product dimensions to maintain constant mechanical properties regardless of pipe size. The pressure class for AWWA C900 DR41 pipe is 100 psig and is for the 54-inch and 60-inch pipe. The AWWA C900 DR51 pipe is 80 psig and is for the 30-inch through 48-inch pipe.

Table 2

Kern Fan Project				
PVC Pipe Data (DR51 PC 80)				
Nominal Diameter (in)	O.D.	I.D.	Capacity at Velocity = 5 fps	Capacity at Velocity = 6 fps
30	32.00	30.67	25.6	30.8
36	38.30	36.71	36.7	44.1
42	44.50	42.65	49.6	59.5
48	50.80	49.69	67.3	80.8

Table 2A

Kern Fan Project				
PVC Pipe Data (DR41 PC 100)				
Nominal Diameter (in)	O.D.	I.D.	Capacity at Velocity = 5 fps	Capacity at Velocity = 6 fps
54	57.56	54.02	79.6	95.5
60	61.61	57.82	91.2	109.4

The C900 PVC pipe availability allows for capacities upwards of 90 to 110 cfs. This piping is an option for recharge facility turnouts, interbasin structures, "in-lieu" turnouts, and well conveyance pipelines.

The C900 PVC pipe fittings are typically ductile iron fittings and film wrapped below grade to prevent corrosion.

b) Limitations/Concerns

PVC pipe is often a cost effective, corrosion resistant, and trouble-free option for pipeline projects. Limitations or concerns for the use of PVC pipe would include:

- Water temperatures greater than 73°F require the pressure de-rating of the pipe.
- Pipe installation requires adequate compaction and support around the pipe haunches and springline.
- Heavy equipment shall not be placed over the pipe until the pipe zone is backfilled and compacted to specifications.
- Pipe not recommended to be exposed to the environment due to concerns with damage from impact or UV exposure.

c) Capital Cost Estimate

As demonstrated in Tables 3 and 4 below, ASTM D2241 PIP PVC pipe is the most economical pipe material in the available pipe sizes of 27-inches and smaller.

Plastic Irrigation Pipe (PIP)

Table 3

Kern Fan Project PIP Pipe Data (SDR51 PC 80) - Cost Estimate		
Nominal Diameter (in)	Material Pipe Cost ($/LF)	Material + Install Pipe Cost ($/LF)
12	$14.64	$54.64
15	$18.17	$62.17
18	$19.98	$77.98
21	$28.76	$89.76
24	$36.53	$95.53
27	$50.56	$111.56
30	NA	NA
36	NA	NA
42	NA	NA
48	NA	NA

C900 PVC Pipe

Table 4

Kern Fan Project PVC Pipe Data (DR51 PC 80) - Cost Estimate		
Nominal Diameter (in)	Material Pipe Cost ($/LF)	Material + Install Pipe Cost ($/LF)
30	$68.31	$132.31
36	$99.14	$187.14
42	$131.23	$223.73
48	$165.80	$263.80

Table 4A

Kern Fan Project PVC Pipe Data (DR41 PC 100) - Cost Estimate		
Nominal Diameter (in)	Material Pipe Cost ($/LF)	Material + Install Pipe Cost ($/LF)
14	$19.42	$77.42
16	$20.04	$78.04
18	$21.92	$79.92
20	$37.80	$98.80
24	$49.68	$110.68
30	$70.45	$134.45
36	$106.89	$194.89
42	$144.54	$237.04
48	$200.18	$298.18
54	$266.35	$390.35
60	$316.45	$448.45

Pipe cost estimates based on approximately 1,200-ft of pipe.
Increases in quantity may affect pricing.

B. HDPE Pipe

HDPE pipe is an ideal pipe material for certain aspects of this project as it is a corrosion resistant material, is suitable for these water temperatures and water quality parameters, and is easy to install. A roughness coefficient of 0.009 and a Hazen-Williams coefficient of 160 was used for HDPE pipe per the McGraw-Hill Hydraulic Design Handbook.

HDPE is a high-density polyethylene structure wall thermal winding pipe. It is made from high-density polyethylene resin. HDPE pipe can be joined by butt welding, electrofusion welding, socket welding, or extrusion welding. These joints heat the pipe during the joining process, creating a completely homogenous joint so the weld becomes as strong, or stronger, than the existing pipe on either side of the weld.

HDPE pipe can be manufactured to AWWA C906, ASTM F714, and ASTM D3035 standards for use with cast-iron or iron pipe size outside diameters. This diameter regimen is compatible with both cast-iron pipe and ductile-iron pipe or with iron pipe sizes and steel pipe sizes.

Corrugated dual wall HDPE pipe with a smooth wall interior is also an option for the recharge basin interbasin structures and turnouts. This pipe can be provided with a water-tight joint per ASTM D3212 and has a roughness coefficient of 0.012 per the published Advanced Drainage Systems, Inc. (ADS) data.

a) Size Ranges and Availability

AWWA C906 HDPE pipe is available in size ranges from 12-inch diameter to 63-inch diameter. The size chart below is for a dimension ratio (DR) of 32.5 and of 41. The dimension ratio defines a constant ratio between the outer pipe diameter and the pipe wall thickness thus providing a simple means of specifying product dimensions to maintain constant mechanical properties regardless of pipe size. The pressure class for AWWA C906 DR32.5 pipe is 63 psig and is suitable for pipe diameters from 14-inches to 63-inches. The DR41 pipe is rated for 50 psig and is suitable for pipe diameters from 36-inches to 63-inches.

Table 5

Kern Fan Project				
HDPE Pipe Data (DR32.5 PC 63)				
Nominal Diameter (in)	O.D.	I.D.	Capacity at Velocity = 5 fps	Capacity at Velocity = 6 fps
14	14.00	13.09	4.7	5.6
16	16.00	14.96	6.1	7.3
18	18.00	16.83	7.7	9.3
20	20.00	18.70	9.5	11.4
22	22.00	20.57	11.5	13.8
24	24.00	22.44	13.7	16.5
26	26.00	24.30	16.1	19.3
28	28.00	26.17	18.7	22.4
30	30.00	28.04	21.4	25.7
32	32.00	29.91	24.4	29.3
34	34.00	31.78	27.5	33.0
36	36.00	33.65	30.9	37.0
42	42.00	39.26	42.0	50.4
48	48.00	44.87	54.9	65.9
54	54.00	50.48	69.5	83.3
63	63.00	58.89	94.5	113.4

Table 5A

Kern Fan Project				
HDPE Pipe Data (DR41 PC 50)				
Nominal Diameter (in)	O.D.	I.D.	Capacity at Velocity = 5 fps	Capacity at Velocity = 6 fps
36	36.00	34.14	31.8	38.1
42	42.00	39.83	43.2	51.9
48	48.00	45.52	56.5	67.8
54	54.00	51.21	71.5	85.8
63	63.00	59.74	97.3	116.7

The HDPE pipe availability allows for capacities upwards of 95 to 116 cfs. This piping is an option for recharge facility turnouts, interbasin structures, "in-lieu" turnouts, and well conveyance pipelines.

It is also possible that a combination of PVC pipe and HDPE pipe could be installed together such as for the well conveyance pipelines. However, consideration will need to be given to the amount of HDPE pipe to be installed and the cost to mobilize and demobilize pipe fusing equipment.

The ADS N-12 Dual Wall HDPE is anticipated to be used for recharge basin turnouts, farmer or "in-lieu" turnouts, and interbasin structures. This pipe is available in pipe diameters from 4-inches to 60 inches. The pipe is a watertight joint per ASTM D3212.

Table 6

Kern Fan Project ADS N-12 Pipe Data (WT IB)				
Nominal Diameter (in)	O.D.	I.D.	Capacity at Velocity = 5 fps	Capacity at Velocity = 6 fps
24	28.00	24.00	15.7	18.8
30	36.00	30.00	24.5	29.4
36	42.00	36.00	35.3	42.4
42	48.00	42.00	48.1	57.7
48	54.00	48.00	62.8	75.4
60	67.00	60.00	98.1	117.8

b) Limitations/Concerns

HDPE pipe is often a cost effective, corrosion resistant, and trouble-free option for irrigation pipeline projects. Limitations or concerns for the use of HDPE pipe would include:

- Water temperatures greater than 73°F require the pressure de-rating of the pipe.
- Pipe installation and repairs require special equipment and specialized contractors.
- Pipe subject to greater temperature expansion and contraction during installation.
- Pipe installation, in larger sizes, typically needs to be filled with water prior to performing backfill and compaction.
- Pipe installation requires adequate compaction and support around the pipe haunches and springline.

c) Capital Cost Estimate

Table 7

Kern Fan Project HDPE Pipe Data (DR32.5 PC 63) - Cost Estimate		
Nominal Diameter (in)	Material Pipe Cost ($/LF)	Material + Install Pipe Cost ($/LF)
14	$14.58	$64.58
16	$17.24	$67.24
18	$19.92	$71.92
20	$24.03	$82.03
22	$28.60	$86.60
24	$34.34	$96.34
26	$42.61	$113.61
28	$49.84	$127.84
30	$54.35	$142.35
32	$63.11	$159.11
34	$72.77	$178.77
36	$78.30	$204.30
42	$92.40	$230.40
48	$108.00	$260.00
54	$124.20	$297.20
63	$148.37	$352.37

Table 7A

Kern Fan Project HDPE Pipe Data (DR41 PC 50) - Cost Estimate		
Nominal Diameter (in)	Material Pipe Cost ($/LF)	Material + Install Pipe Cost ($/LF)
36	$58.30	$184.30
42	$72.40	$210.40
48	$88.00	$240.00
54	$104.20	$277.20
63	$128.37	$332.37

Pipe cost estimates based on approximately 1,200-ft of pipe.
Increases in quantity may affect pricing.

The costs for the ADS N-12 Dual Wall HDPE pipe are shown below.

Table 8

Kern Fan Project		
ADS N-12 Pipe Data (WT IB) - Cost Estimate		
Nominal Diameter (in)	Material Pipe Cost ($/LF)	Material + Install Pipe Cost ($/LF)
24	$28.57	$89.57
30	$41.04	$105.04
36	$56.50	$144.50
42	$70.18	$162.68
48	$93.15	$191.15
60	$130.41	$262.41

C. Wet Cast RCP

Wet or centrifugally cast RCP shall be manufactured in accordance with ASTM C361 for water-tight pressure joints. A roughness coefficient of 0.013 and a Hazen-Williams coefficient of 130 was used for concrete pipe per the McGraw-Hill Hydraulic Design Handbook.

The wet cast process is a flowable form of concrete which may be poured from a mixer, hopper, or truck and cast into forms where it is then stripped, finished, and marked prior to shipping. This process normally contains concrete with a slump less than 4-inches and is used on the production of large diameter pipe.

Wet cast is also used for non-standard joints and custom pipe or fittings.

RCP pipe shall have a watertight joint utilizing a confined gasket of the O-ring type.

a) Size Ranges and Availability

Table 9

Kern Fan Project				
RCP Pipe Data (ASTM C361) - Wet Cast				
Nominal Diameter (in)	O.D.	I.D.	Capacity at Velocity = 5 fps	Capacity at Velocity = 6 fps
36	44.00	36.00	35.3	42.4
42	51.00	42.00	48.1	57.7
48	58.00	48.00	62.8	75.4
54	65.00	54.00	79.5	95.4
60	72.00	60.00	98.2	117.8
66	80.50	66.00	118.8	142.5
72	87.50	72.00	141.4	169.6
78	94.50	78.00	165.9	199.1
84	101.50	84.00	192.4	230.9
90	108.50	90.00	220.9	265.1
96	115.50	96.00	251.3	301.6
102	121.00	102.00	283.7	340.5
108	128.00	108.00	318.1	381.7
114	133.00	114.00	354.4	425.3
120	140.00	120.00	392.7	471.2
126	147.00	126.00	433.0	519.5
132	157.50	132.00	475.2	570.2
144	168.00	144.00	565.5	678.6

b) Limitations/Concerns

- Lower compressive strength than dry cast pipe.
- Typically takes longer to manufacturer than dry cast pipe (approximately 12-14 joints/day).
- Higher cost (higher labor costs in manufacturing)

c) Capital Cost Estimate

Table 10

Kern Fan Project D50 RCP Pipe Data (ASTM C361) - Cost Estimate (Wet Cast)		
Nominal Diameter (in)	Material Pipe Cost ($/LF)	Material + Install Pipe Cost ($/LF)
36	$300.00	$386.60
42	$390.00	$480.00
48	$486.18	$580.62
54	$617.90	$717.90
60	$749.61	$857.55
66	$896.42	$1,036.42
72	$1,043.22	$1,225.47
78	$1,184.25	$1,414.25
84	$1,327.25	$1,612.00
90	$1,470.36	$1,805.36
96	$1,608.89	$2,002.58
102	$1,808.95	$2,263.95
108	$2,009.00	$2,531.57
114	$2,231.16	$2,901.16
120	$2,453.32	$3,271.02
126	$2,565.69	$3,535.69
132	$2,678.06	$3,775.23
144	$2,775.00	$4,141.46

Pipe cost estimates based on approximately 1,200-ft of pipe.
Increases in quantity may affect pricing.

D. Dry Cast RCP

Dry cast RCP shall be manufactured in accordance with ASTM C361 for water-tight pressure joints. A roughness coefficient of 0.013 and a Hazen-Williams coefficient of 130 was used for concrete pipe per the McGraw-Hill Hydraulic Design Handbook.

The dry cast process has a low water to cement ratio and a zero slump. This method uses low frequency-high amplitude vibration to distribute and densely compact the dry mix in the form. This process allows for the concrete to be stripped sooner and for the forms to be re-used.

Dry cast pipe is poured with a drier mix than wet cast pipe and the barrel of the joint can be stripped immediately after pouring. The bell and spigot ends remain in the forms for 24 hours while a plastic bag is normally placed over the barrel immediately after stripping the forms.

a) Size Ranges and Availability

Table 11

Kern Fan Project				
RCP Pipe Data (ASTM C361) - Dry Cast				
Nominal Diameter (in)	O.D.	I.D.	Capacity at Velocity = 5 fps	Capacity at Velocity = 6 fps
36	44.00	36.00	35.3	42.4
42	51.00	42.00	48.1	57.7
48	58.00	48.00	62.8	75.4
54	65.00	54.00	79.5	95.4
60	72.00	60.00	98.2	117.8
66	80.50	66.00	118.8	142.5
72	87.50	72.00	141.4	169.6
78	94.50	78.00	165.9	199.1
84	101.50	84.00	192.4	230.9
90	108.50	90.00	220.9	265.1
96	115.50	96.00	251.3	301.6
102	121.00	102.00	283.7	340.5
108	128.00	108.00	318.1	381.7
114	133.00	114.00	354.4	425.3
120	140.00	120.00	392.7	471.2
126	147.00	126.00	433.0	519.5
132	157.50	132.00	475.2	570.2
144	168.00	144.00	565.5	678.6

b) Limitations/Concerns

- Surface of pipe may be a little rougher due to the manufacturing process.
- Important to ensure form vibrators are effectively imparting energy to the concrete and not just the forms.
- Dry cast RCP can have difficulty meeting watertight requirements at joint when pressure tested. Testing needs to be implemented to confirm ability of manufacturer to meet this requirement and joints shall be of double gasket construction.

c) Capital Cost Estimate

Costs are estimated below in Table 12 for D25 Dry Cast RCP as well as D50 Dry Cast RCP.

Table 12

Kern Fan Project D25 RCP Pipe Data (ASTM C361) - Cost Estimate (Dry Cast)		
Nominal Diameter (in)	Material Pipe Cost ($/LF)	Material + Install Pipe Cost ($/LF)
36	$111.78	$198.38
42	$142.83	$232.83
48	$173.88	$268.32
54	$204.93	$304.93
60	$235.98	$343.92
66	$267.03	$407.03
72	$298.08	$480.33
78	$329.13	$559.13
84	$360.18	$644.93
90	$391.23	$726.23
96	$422.28	$815.97
102	$453.33	$908.33
108	$484.38	$1,006.95
114	$515.43	$1,185.43
120	$546.48	$1,364.18
126	$577.53	$1,547.53
132	$608.58	$1,705.75
144	$639.63	$2,006.09

Table 12A

Kern Fan Project D50 RCP Pipe Data (ASTM C361) - Cost Estimate (Dry Cast)		
Nominal Diameter (in)	Material Pipe Cost ($/LF)	Material + Install Pipe Cost ($/LF)
36	$175.12	$261.72
42	$202.45	$292.45
48	$229.77	$324.21
54	$257.72	$357.72
60	$285.66	$393.60
66	$312.98	$452.98
72	$340.31	$522.56
78	$367.63	$597.63
84	$394.96	$679.71
90	$422.28	$757.28
96	$450.85	$844.54
102	$479.41	$934.41
108	$509.22	$1,031.79
114	$540.27	$1,210.27
120	$571.32	$1,389.02
126	$602.37	$1,572.37
132	$639.63	$1,736.80
144	$683.10	$2,049.56

Pipe cost estimates based on approximately 1,200-ft of pipe.
Increases in quantity may affect pricing.

E. Fusion Bonded Epoxy Lined and Coated Steel Pipe (FBEL&C)

Fusion Bonded Epoxy Lined and Coated Steel Pipe (FBEL&C) is a steel cylinder pipe per AWWA C200 that is internally and externally lined with a fusion bonded epoxy. A roughness coefficient of 0.011 and a Hazen-Williams coefficient of 145 was used for epoxy lined pipe per the McGraw-Hill Hydraulic Design Handbook.

a) Size Ranges and Availability

The fusion bonded epoxy lined and coated steel pipe comes in a wide range of pipe sizes, however it is typically more competitive price wise with plastic pipes and other pipe types in pipe sizes greater than 42-inch diameter.

Table 13

Kern Fan Project FBEL Steel Pipe Data (1/4" Wall)				
Nominal Diameter (in)	O.D.	I.D.	Capacity at Velocity = 5 fps	Capacity at Velocity = 6 fps
36	36.00	35.50	34.4	41.2
42	42.00	41.50	46.9	56.3
48	48.00	47.50	61.5	73.8
54	54.00	53.50	78.0	93.6
60	60.00	59.50	96.5	115.8
66	66.00	65.50	116.9	140.3
72	72.00	71.50	139.3	167.2
84	84.00	83.50	190.0	228.1
90	90.00	89.50	218.3	262.0
96	96.00	95.50	248.6	298.3
102	102.00	101.50	280.8	337.0
108	108.00	107.50	315.0	378.0
114	114.00	113.50	351.1	421.4
120	120.00	119.50	389.2	467.1
126	126.00	125.50	429.3	515.2
132	132.00	131.50	471.3	565.6
138	138.00	137.50	515.3	618.4
144	144.00	143.50	561.3	673.5

b) Limitation/Concerns

Fusion bonded epoxy steel pipe is often a cost effective and trouble-free option for pipeline projects and is preferred in above ground installations where it is subject to inclement weather, UV exposure, seismic events, or nearby to traffic and vehicular access. Limitations or concerns for the use of FBE pipe would include:

- Corrosion protection required typically in order to prevent corrosion in the event of coating holidays. Typically a sacrificial or passive system is adequate for cathodic protection and an impressed current system can be added in the future if necessary.
- Pipe installation requires adequate compaction and support around the pipe haunches and springline.
- Installation requires inspection of fusion bonded epoxy lining and coating for damage and holidays. Surface preparation and application need to be inspected to prevent delamination and other coating defects.
- Cutting or welding of the pipe will damage the epoxy lining and coating. Repairs typically made with a two-part epoxy repair kit.

c) Capital Cost Estimate

Table 14

Kern Fan Project FBEL Steel Pipe (AWWA C200) - Cost Estimate		
Nominal Diameter (in)	Material Pipe Cost ($/LF)	Matrial + Install Pipe Cost ($/LF)
36	$161.00	$287.83
42	$190.00	$321.00
48	$220.00	$356.38
54	$255.00	$431.00
60	$330.00	$524.24
66	$400.00	$620.00
72	$500.00	$767.86
78	$550.00	$880.00
84	$600.00	$997.09
90	$650.00	$1,110.00
96	$700.00	$1,303.36
102	$750.00	$1,450.00
108	$810.00	$1,612.71
114	$1,007.37	$1,877.37
120	$1,205.00	$2,197.48
126	$1,320.00	$2,470.00
132	$1,570.00	$2,856.00
144	$1,710.00	$3,282.00

Pipe cost estimates based on approximately 1,200-ft of pipe.
Increases in quantity may affect pricing.

F. Cement Mortar Lined and Coated Steel Pipe (CMLC)

Cement Mortar Lined and Coated (CMLC) Steel pipe is a steel cylinder pipe per AWWA C200 that is internally lined with a cement mortar lining that is centrifugally spun and a brush or spray applied cement mortar coating exterior in accordance with AWWA C205. A roughness coefficient of 0.013 and a Hazen-Williams coefficient of

130 was used for cement mortar lined pipe per the McGraw-Hill Hydraulic Design Handbook.

a) Size Ranges and Availability

The cement mortar lined and coated steel pipe comes in a wide range of pipe sizes, however it is typically more competitive price wise with plastic pipes and other pipe types in pipe sizes greater than 42-inch diameter.

Table 15

Kern Fan Project CMLC Steel Pipe Data (1/4" Wall, 1/2" Lining, 3/4" Coating)				
Nominal Diameter (in)	O.D.	I.D.	Capacity at Velocity = 5 fps	Capacity at Velocity = 6 fps
36	37.50	34.50	32.5	39.0
42	43.50	40.50	44.7	53.7
48	49.50	46.50	59.0	70.8
54	55.50	52.50	75.2	90.2
60	61.50	58.50	93.3	112.0
66	67.50	64.50	113.5	136.1
72	73.50	70.50	135.5	162.7
84	85.50	82.50	185.6	222.7
90	91.50	88.50	213.6	256.3
96	97.50	94.50	243.5	292.2
102	103.50	100.50	275.4	330.5
108	109.50	106.50	309.3	371.2
114	115.50	112.50	345.1	414.2
120	121.50	118.50	382.9	459.5
126	127.50	124.50	422.7	507.2
132	133.50	130.50	464.4	557.3
138	139.50	136.50	508.1	609.7
144	145.50	142.50	553.8	664.5

b) Limitations/Concerns

CMLC steel pipe is often a cost effective and trouble-free option for pipeline projects. Limitations or concerns for the use of CMLC pipe would include:

- Corrosion protection required. Typically a sacrificial or passive system is adequate for cathodic protection and an impressed current system can be added in the future if necessary.
- Pipe installation requires adequate compaction and support around the pipe haunches and springline.
- Installation requires inspection of cement mortar lining and coating for damage and cracks.
- Personnel must have confined space training to repair & inspect interior joint lining repairs.

c) Capital Cost Estimate

Table 16

Kern Fan Project CMLC Steel Pipe (AWWA C200) - Cost Estimate		
Nominal Diameter (in)	Material Pipe Cost ($/LF)	Matrial + Install Pipe Cost ($/LF)
36	$171.00	$257.83
42	$194.00	$305.00
48	$220.00	$336.38
54	$255.00	$411.00
60	$340.00	$514.24
66	$450.00	$650.00
72	$550.00	$797.86
78	$600.00	$910.00
84	$650.00	$1,027.09
90	$700.00	$1,160.00
96	$810.00	$1,363.36
102	$936.00	$1,586.00
108	$1,070.00	$1,872.71
114	$1,152.00	$2,022.00
120	$1,205.00	$2,197.48
126	$1,320.00	$2,470.00
132	$1,580.00	$2,866.00
144	$1,760.00	$3,332.00

Pipe cost estimates based on approximately 1,200-ft of pipe.
Increases in quantity may affect pricing.

G. Cost Summary

The Table 17 below summarizes the costs of the different pipe materials and highlights the pipe sizes that are the most economical.

Table 17

Kern Fan Project

Linear Pipeline Material and Cost Summary - Recommended

Pipe Capacity at 5-6 fps	SDR51 PIP PVC Pipe			DR41 & DR51 C900 PVC Pipe			DR32.5 & DR41 HDPE Pipe			ADS N-12 HDPE Pipe[1]			CMLC Pipe			FBEL&C Pipe			D50 Wet Cast RCP Pipe			D25 Dry Cast RCP Pipe		
	Pipe Size	Material Cost ($/LF)	Material + Install Cost ($/LF)	Pipe Size	Material Cost ($/LF)	Material + Install Cost ($/LF)	Pipe Size	Material Cost ($/LF)	Material + Install Cost ($/LF)	Pipe Size	Material Cost ($/LF)	Material + Install Cost ($/LF)	Pipe Size	Material Cost ($/LF)	Material + Install Cost ($/LF)	Pipe Size	Material Cost ($/LF)	Material + Install Cost ($/LF)	Pipe Size	Material Cost ($/LF)	Material + Install Cost ($/LF)	Pipe Size	Material Cost ($/LF)	Material + Install Cost ($/LF)
5 cfs	15	$18.17	$62.17	14	$19.42	$77.42	14	$14.58	$64.58															
10 cfs	18	$19.98	$77.98	18	$21.92	$79.92	20	$24.03	$82.03															
15 cfs	24	$36.53	$95.53	24	$49.68	$110.68	24	$34.34	$96.34															
20 cfs	27	$50.56	$111.56	24	$49.68	$110.68	28	$49.84	$127.84															
25 cfs				30	$68.31	$132.31	30	$54.35	$142.35															
30 cfs				30	$68.31	$132.31	34	$72.77	$178.77															
35 cfs				36	$99.14	$187.14	36	$58.30	$184.30	36	$56.50	$116.53	36	$171.00	$257.83	36	$161.00	$287.83	36	$300.00	$386.60	36	$111.78	$198.38
40 cfs				36	$99.14	$187.14	42	$72.40	$210.40	36	$56.50	$116.53	42	$194.00	$305.00	42	$190.00	$321.00	36	$300.00	$386.60	36	$111.78	$198.38
45 cfs				42	$131.23	$223.73	42	$72.40	$210.40	42	$70.18	$133.85	42	$194.00	$305.00	42	$190.00	$321.00	42	$390.00	$480.00	42	$142.83	$232.83
50 cfs				42	$131.23	$223.73	42	$72.40	$210.40	42	$70.18	$133.85	42	$194.00	$305.00	42	$190.00	$321.00	42	$390.00	$480.00	42	$142.83	$232.83
55 cfs				42	$131.23	$223.73	48	$88.00	$240.00	42	$70.18	$133.85	48	$220.00	$336.38	48	$220.00	$356.38	42	$390.00	$480.00	42	$142.83	$232.83
60 cfs				48	$165.80	$263.80	48	$88.00	$240.00	48	$93.15	$161.19	48	$220.00	$336.38	48	$220.00	$356.38	48	$486.18	$580.62	48	$173.88	$268.32
70 cfs				48	$165.80	$263.80	54	$104.20	$277.20	48	$93.15	$161.19	48	$220.00	$336.38	48	$220.00	$356.38	48	$486.18	$580.62	48	$173.88	$268.32
80 cfs				48	$165.80	$263.80	54	$104.20	$277.20	48	$93.15	$161.19	54	$255.00	$411.00	54	$255.00	$431.00	54	$617.90	$717.90	54	$204.93	$304.93
90 cfs				54	$266.35	$390.35	63	$128.37	$332.37	60	$130.41	$203.78	54	$255.00	$411.00	54	$255.00	$431.00	54	$617.90	$717.90	54	$204.93	$304.93
100 cfs				60	$316.45	$448.45	63	$128.37	$332.37	60	$130.41	$210.46	60	$340.00	$514.24	60	$330.00	$524.24	60	$749.61	$857.55	60	$235.98	$343.92
150 cfs													72	$550.00	$797.86	72	$500.00	$767.86	72	$1,043.22	$1,225.47	72	$298.08	$480.33
200 cfs													84	$650.00	$1,027.09	84	$600.00	$997.09	84	$1,327.25	$1,612.00	84	$360.18	$644.93
250 cfs													90	$700.00	$1,160.00	90	$650.00	$1,110.00	90	$1,470.36	$1,805.36	90	$391.23	$726.23
300 cfs													102	$936.00	$1,586.00	102	$750.00	$1,450.00	96	$1,608.89	$2,002.58	96	$422.28	$815.97
350 cfs													108	$1,070.00	$1,872.71	108	$810.00	$1,612.71	108	$2,009.00	$2,531.57	108	$484.38	$1,006.95
400 cfs													114	$1,152.00	$2,022.00	114	$1,007.37	$1,877.37	114	$2,231.16	$2,901.16	114	$515.43	$1,185.43
450 cfs													120	$1,205.00	$2,197.48	120	$1,205.00	$2,197.48	120	$2,453.32	$3,271.02	120	$546.48	$1,364.18
500 cfs													126	$1,320.00	$2,470.00	126	$1,320.00	$2,470.00	126	$2,565.69	$3,535.69	126	$577.53	$1,547.53

Represents most economical pipe material based upon costs estimates and information available in October 2020.

Represents secondary pipe material alternatives that may be more economical depending on actual design and project timing.

[1]The ADS N-12 HDPE pipe is not applicable to a linear, pressurized pipeline design, but is anticipated to be used at recharge facility turnouts, "in-lieu" turnouts, and interbasin structures.

III. Crossings

The conveyance canal will involve crossings at the following locations, at a minimum:

- Adhor Road (County Road)
- East Side Canal
- Stockdale Highway (Caltrans R/W)
- Interstate 5 Freeway (Caltrans R/W)
- Farm Roads/Dirt Roads

These crossings may be completed by a bore and jack operation, micro-tunnel operation, open cut, or remain an open channel utilizing a bridge crossing to maintain farm road access. These are discussed in greater detail below.

The trenchless pipe installation will require specific soils investigation to be performed at each of the proposed crossings. The soils work will need to identify depth to groundwater, type of soils, ability of soil to maintain arching until grouting, need for soil stabilization, and potential settlement.

Siphon or road crossings may be a siphon pipe, box culvert, or open channel with a bridge crossing.

The casing pipes at Stockdale Highway and the I-5 Freeway shall be designed for H20 traffic loadings and conform to the minimum wall thicknesses as required by the California Department of Transportation (Caltrans). The casing pipe shall be sloped to one end to drain, shall have end seals, and shall have a minimum diameter of the carrier pipe outside diameter plus 12-inches. The casing shall extend a minimum of three-feet (3-ft) outside the Caltrans right-of-way plus the distance from the bottom of casing to the finish grade. The minimum cover above the casing pipe shall be 3.5-feet. All casing joints shall be butt welded and watertight and shall be welded by welder's qualified per ANSI/AWS D1.1. All welds shall be visually and radiographically tested per ANSI/AWS D1.1. The carrier pipe shall have casing spacers installed at the appropriate frequency and be the bolt-on type. It is anticipated that the annulus between the casing pipe and carrier pipe will be filled with a two-sack cement slurry.

a) Bore and Jack

The trenchless installation using the bore and jack is a method for installing a steel casing or liner plate that will be used to install a carrier pipe. It is a multi-stage process consisting of constructing a temporary horizontal jacking platform and a starting alignment track in an entrance pit (boring pit) at a desired elevation. The casing pipe is then jacked by manual control along the starting alignment track with simultaneous excavation of the soil being accomplished by a rotating cutting head in the leading edge of the product's annular space. The ground up soil (spoil) is transported back to the entrance pit by helical wound auger flights rotating inside the casing pipe.

The jack and bore method typically provides limited tracking and steering as well as limited support to the excavation face.

The jack and bore method is suitable for steel casing pipes or liner plates.

b) Micro tunnel

The trenchless installation using the micro tunneling method is conducted similar to the above described jack and bore method with the exception that it is remotely controlled, guided pipe jacking process that provides continuous support to the excavation face.

The guidance system usually consists of a laser mounted in the tunneling drive shaft which communicates a reference line to a target mounted inside the micro tunneling machine's articulated steering head. The micro tunneling process provides the ability to control the excavation face stability by applying mechanical or fluid pressure to counterbalance the earth and hydrostatic pressures.

The micro tunneling method is suitable for casing pipes that are steel, ductile iron, reinforced concrete cylinder pipe, or RCP.

c) Bridges

Bridges allow for the conveyance channel to be installed across farm roads or dirt roads without alteration or disturbance necessarily to the road grade. In addition, the elimination of a siphon crossing or box culvert eliminates headlosses and improves the hydraulic conditions of the conveyance canal.

The bridges shall be clear-span bridges that do not require infilling or restrict the area of water flow within the conveyance canal.

The bridges shall include guardrailing and/or fencing to protect against the entrance of vehicles or equipment into the canal.

IV. Facility Piping

This analysis serves to evaluate turnout pipes, siphon pipes, interbasin pipes, pump station discharge pipes, well pipes, and conveyance pipelines. These include the following:

- Aqueduct Turnout
- Adohr Road Siphon
- East Side Canal Siphon
- Farm Road Siphons
- Cased Crossings – Stockdale Hwy and I-5 Fwy
- Canal Conveyance Piping
- Pump Station Discharge Piping
- Phase II Turnout
- West Basins Turnout
- Phase I Turnout
- Well Discharge Piping
- Well Conveyance Piping
- Interbasin Piping

Figure 1 illustrates the approximate locations of the above described facilities.

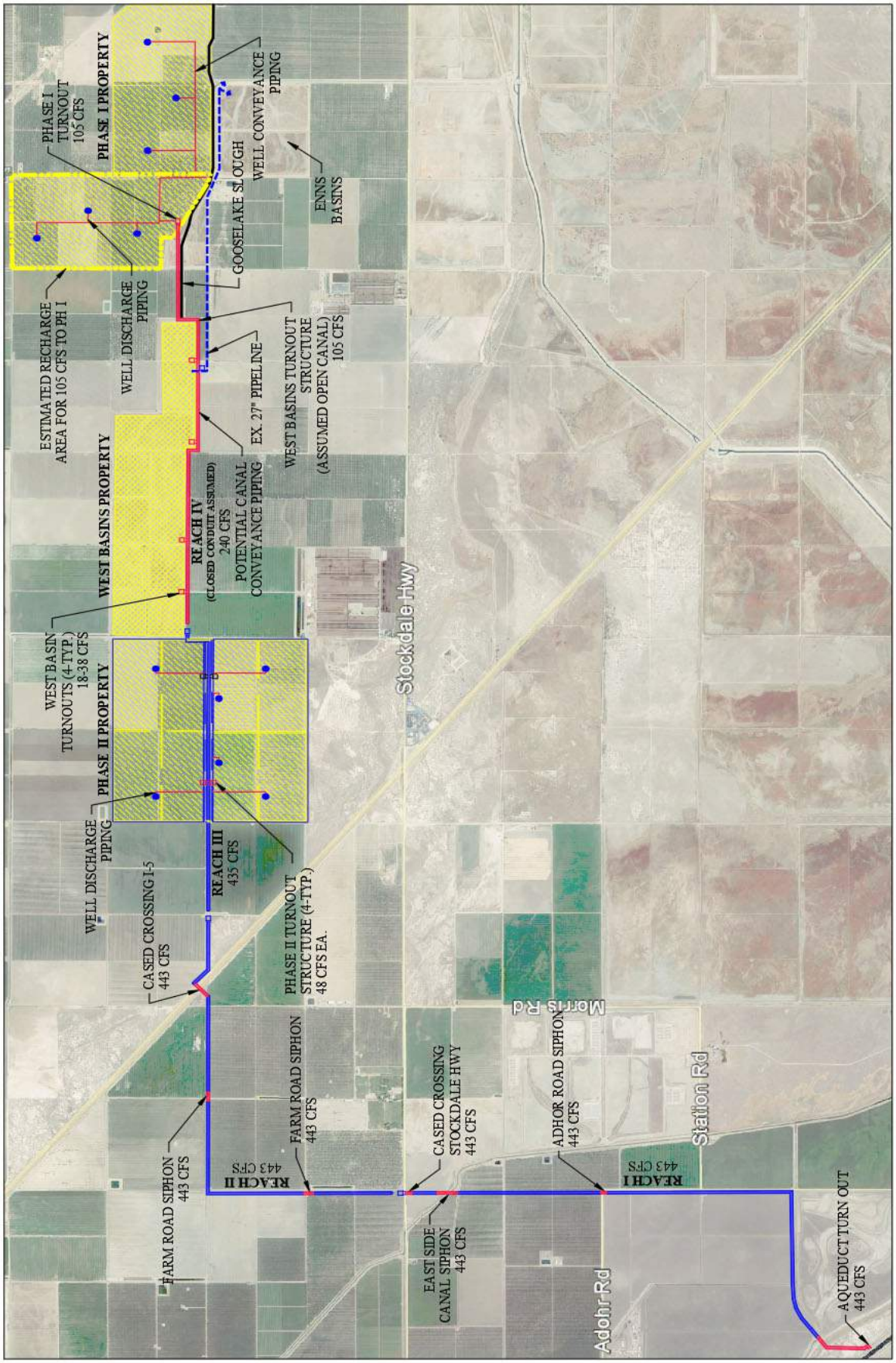


Figure 1: Project Map

The sizing and headloss calculations herein are based upon conceptual layouts and design and are subject to change during the detailed engineering design phase. However, this analysis shall provide a basis for the pipe sizes, materials, and value engineering.

A. Aqueduct Turnout

a) Sizing Criteria

The design flow for the conveyance canal from the California Aqueduct is 443 cfs.

- Flowrate = 443 cfs
- Maximum Velocity = 5 fps. This is typical for pipe turnouts, however Reach 1 of the canal is well below the Aqueduct in this location and there is excess head, therefore a higher velocity has been considered.
- Recommended Maximum Velocity = 7 fps
- Pipe Diameter = Approximate 108-in (9.0-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$A = Q/V$

The headloss through the turnout piping was calculated using the velocity head of the pipe for minor entrance and exit losses and the Manning's Equation for the friction loss through the pipe. In addition, the turnout piping will be installed well below the canal operating surface and will be submerged at all times, therefore the hydraulic calculations were also reviewed using the Hazen-Williams Equation.

Manning's Equation: $V = (1.49/n)*R^{2/3}*S^{1/2}$

Hazen-Williams Equation: $h_f = (3.022 * V^{1.85} * L) / (C^{1.85} * D^{1.17})$

<u>Where</u>:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
n = Material Coefficient (Used 0.013 for new concrete pipe)
C = Roughness Coefficient (Used 130 for new concrete pipe)
L = Pipe Length (Estimated as 2,100-ft)

<u>Results</u>:

A = 443 cfs / 7 fps = 63.3 sf
D = 8.98 ft < 9.0 ft (108-in)

$A = (3.14*D^2)/4 = 63.59$ sf
V = 443 cfs / 63.59 sf = 6.97 fps
Velocity Head = $h_v = v^2/2g = 0.75$ ft

Wetted Perimeter = P = 34.54 ft
Hydraulic Radius = R = A/P = 94.99 sf / 34.54 ft = 2.75 ft
Entrance Loss = 0.5 * $v^2/2g$ = 0.38 ft
H_L= 0.95 ft / 1,000 ft
Exit Loss = 1.0 * $v^2/2g$ = 0.75 ft

Total Estimated Headloss = 3.13-ft

Design the turnout piping so that the control water surface submerges the pipe at the headwall structure a minimum 1.78 times h_v plus 3-inches or approximately 20-inches.

b) Pipe Materials

The Aqueduct Turnout piping is large diameter pipe in the approximate size of 9-ft diameter. The pipe material options consist of FBE steel pipe, CMLC steel pipe, wet cast RCP, and dry cast RCP. It is standard practice for the pipe deflection to be limited to 2% for CMLC steel pipe and 5% for FBE steel pipe. Assuming an earth cover of 15-ft, the deflection for a 5/8" wall FBE steel pipe is approximately 4.5%. However, the use of CMLC in this application with such a large diameter and a significant earth cover while maintaining pipe wall deflections of less than 2% is difficult. The wet cast and dry cast RCP pipe would be ASTM C361 pipe, D50 double gasketed pipe. The "D" designation signifies that the pipe is suitable for earth cover over the top of the pipe up to 20-ft. The "50" designation signifies that the pipe can handle hydrostatic heads up to 50-ft above the centerline of the pipe. The hydrostatic head under normal gravity flow operations will likely be approximately 35-ft to 40-ft and potentially a little higher when pumping in a return water condition back to the Aqueduct.

c) Material Recommendations

The Aqueduct Turnout piping is estimated to be approximately 2,100-ft in length. The FBE steel pipe is estimated as $810 per lineal foot for material cost and $1,613 per lineal foot for material and installation. The wet cast RCP is estimated as $2,009 per lineal foot for material cost and $2,532 per lineal foot for material and installation while the dry cast D50 RCP is estimated as $585 per lineal foot for material cost and $1,400 per lineal foot for material and installation.

Steel pipe is not recommended in this application due to excessive pipe deflections of 4-inches to 5-inches even if it is within acceptable percentages. The dry cast RCP is the most economical pipe in this pipe diameter. Provided DWR does not require wet cast RCP, it is recommended that dry cast RCP pipe be used for the Aqueduct Turnout piping. In addition, RCP is a preferred pipe material for this application since it is corrosion resistant, more suitable to resist flotation, and a rigid pipe.

If DWR does require the use of wet cast RCP, then it is anticipated that the District will install wet cast RCP within the Aqueduct right-of-way and then utilize dry cast RCP outside of the right-of-way.

B. Road Crossings

Adhor Road

a) Sizing Criteria

The design flow for the road crossing at Adohr Road is 443 cfs.

- Flowrate = 443 cfs
- Maximum Velocity = 6 fps
- Pipe Diameter = Approximate 120-in (10-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$A = Q/V$

The headloss through the crossing piping was calculated using the velocity head of the pipe for minor entrance and exit losses and the Manning's Equation for the friction loss through the pipe.

Manning's Equation: $V = (1.49/n)*R^{2/3}*S^{1/2}$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
n = Material Coefficient (Used 0.013 for new concrete pipe)
L = Pipe Length (Estimated as 100-ft)

Results:

A = 443 cfs / 6 fps = 73.8 sf
D = 9.70 ft < 10.0 ft (120-in)

$A = (3.14*D^2)/4 = 78.5$ sf
V = 443 cfs / 78.5 sf = 5.64 fps
Velocity Head = $h_v = v^2/2g = 0.49$ ft
Wetted Perimeter = P = 31.4 ft
Hydraulic Radius = R = A/P = 78.5 sf / 31.4 ft = 2.50 ft
Entrance Loss = $0.5 * v^2/2g = 0.25$ ft
H_L= 0.71 ft / 1,000 ft
Exit Loss = $1.0 * v^2/2g = 0.49$ ft

Total Estimated Headloss = 0.81-ft

Design the road crossing piping so that the control water surface submerges the pipe at the headwall structure a minimum 1.78 times h_v plus 3-inches or approximately 14-inches.

Another option for the Adohr Road crossing is a box culvert if the grade allows for it. The hydraulic properties for a 8' x 12' box culvert are noted below:

The continuity equation was used to solve for the cross-sectional area of the box culvert and the culvert dimensions given the design flow and maximum velocity.

$A = Q/V$

The headloss through the box culvert was calculated using the velocity head of the culvert for minor entrance and exit losses and the Manning's Equation for the friction loss through the culvert.

Manning's Equation: $V = (1.49/n)*R^{2/3}*S^{1/2}$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Culvert Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
n = Material Coefficient (Used 0.013 for precast concrete)
L = Culvert Length (Estimated as 100-ft)

Results:

A = 443 cfs / 6 fps = 73.8 sf
D = 9.7 ft < 10.0 ft (120-in)

A = 8' x 12' = 96.0 sf
V = 443 cfs / 96 sf = 4.61 fps
Velocity Head = $h_v = v^2/2g = 0.33$ ft
Wetted Perimeter = P = 40.0 ft
Hydraulic Radius = R = A/P = 96 sf / 40 ft = 2.40 ft
Entrance Loss = $0.5 * v^2/2g = 0.17$ ft
H_L = 0.50 ft / 1,000 ft
Exit Loss = $1.0 * v^2/2g = 0.33$ ft

Total Estimated Headloss = 0.55-ft

Design structure to minimize headloss at maximum flow and closely match culvert invert with canal invert to avoid material buildup in the box culvert during low flow conditions.

b) Pipe Materials

The Adohr Road crossing piping is large diameter pipe in the approximate size of 10-ft diameter. The pipe material options consist of FBE steel pipe, CMLC steel pipe, wet cast RCP, and dry cast RCP. It is standard practice for the pipe deflection to be limited to 2% for CMLC steel pipe and 5% for FBE steel pipe. Assuming an earth cover of 10-ft, the deflection for a 3/8" wall FBE steel pipe is approximately 3%. However, the use of CMLC in this application with such a large diameter and a significant earth cover while maintaining pipe wall deflections of less than 2% is difficult. The wet cast and dry cast RCP pipe would be ASTM C361 pipe, C25 double gasketed pipe. The "C" designation signifies that the pipe is suitable for earth cover over the top of the pipe up to 15-ft. The "25" designation signifies that the pipe can handle hydrostatic heads up to 25-ft

above the centerline of the pipe. The hydrostatic head under normal gravity flow operations will likely be less than 10-ft.

c) Material Recommendations

The Adohr Road crossing piping is estimated to be approximately 100-ft in length. The FBE steel pipe is estimated as $1,205 per lineal foot for material cost and $2,197 per lineal foot for material and installation. The wet cast RCP is estimated as $2,453 per lineal foot for material cost and $3,271 per lineal foot for material and installation while the dry cast RCP is estimated as $546 per lineal foot for material cost and $1,364 per lineal foot for material and installation.

Steel pipe is not recommended in this application due to excessive pipe deflections of 3-inches to 4-inches even if it is within acceptable percentages. The dry cast RCP is the most economical pipe in this pipe diameter. Therefore, it is recommended that dry cast RCP pipe be used for the Adhor Road siphon piping. In addition, RCP is a preferred pipe material for this application since it is corrosion resistant, more suitable to resist flotation, and a rigid pipe.

The box culvert is also an economical alternative provided the grades work and do not require an inverted siphon.

East Side Canal

a) Sizing Criteria

The design flow for the siphon crossing at the East Side Canal is 443 cfs. This crossing is anticipated to be an inverted siphon due to dropping down to cross beneath the East Side Canal prism and provide proper clearances. Therefore, a box culvert is not anticipated as an option at this location.

- Flowrate = 443 cfs
- Maximum Velocity = 6 fps
- Pipe Diameter = Approximate 120-in (10-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$$A = Q/V$$

The headloss through the inverted siphon piping was calculated using the velocity head of the pipe for minor entrance and exit losses and the Manning's Equation for the friction loss through the pipe.

Manning's Equation: $V = (1.49/n)*R^{2/3}*S^{1/2}$

Where:

Q = Flow (cfs)

V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
n = Material Coefficient (Used 0.013 for new concrete pipe)
C = Roughness Coefficient (Used 130 for new concrete pipe)
L = Pipe Length (Estimated as 250-ft)

Results:

A = 443 cfs / 6 fps = 73.8 sf
D = 9.70 ft < 10.0 ft (120-in)

$A = (3.14*D^2)/4 = 78.5$ sf
V = 443 cfs / 78.5 sf = 5.64 fps
Velocity Head = $h_v = v^2/2g = 0.49$ ft
Wetted Perimeter = P = 31.4 ft
Hydraulic Radius = R = A/P = 78.5 sf / 31.4 ft = 2.50 ft
Entrance Loss = $0.5 * v^2/2g = 0.25$ ft
H_L= 0.71 ft / 1,000 ft
Exit Loss = $1.0 * v^2/2g = 0.49$ ft

Total Estimated Headloss = 0.92-ft

Design the siphon piping so that the control water surface submerges the pipe at the headwall structure a minimum 1.78 times h_v plus 3-inches or approximately 14-inches.

b) Pipe Materials

The East Side Canal crossing piping is large diameter pipe in the approximate size of 10-ft diameter. The pipe material options consist of FBE steel pipe, CMLC steel pipe, wet cast RCP, and dry cast RCP. It is standard practice for the pipe deflection to be limited to 2% for CMLC steel pipe and 5% for FBE steel pipe. Assuming a maximum earth cover of 10-ft, the deflection for a 3/8" wall FBE steel pipe is approximately 3%. However, the use of CMLC in this application with such a large diameter and a significant earth cover while maintaining pipe wall deflections of less than 2% is difficult. The wet cast and dry cast RCP pipe would be ASTM C361 pipe, C25 double gasketed pipe. The "C" designation signifies that the pipe is suitable for earth cover over the top of the pipe up to 15-ft. The "25" designation signifies that the pipe can handle hydrostatic heads up to 25-ft above the centerline of the pipe. The hydrostatic head under normal gravity flow operations will likely be less than 10-ft.

c) Material Recommendations

The East Side Canal crossing piping is estimated to be approximately 250-ft in length. The FBE steel pipe is estimated as $1,205 per lineal foot for material cost and $2,197 per lineal foot for material and installation. The wet cast RCP is estimated as $2,453 per lineal foot for material cost and $3,271 per lineal foot for material and installation while the dry cast RCP is estimated as $546 per lineal foot for material cost and $1,364 per lineal foot for material and installation.

Steel pipe is not recommended in this application due to excessive pipe deflections of 3-inches to 4-inches even if it is within acceptable percentages.

The dry cast RCP is the most economical pipe in this pipe diameter. Therefore, it is recommended that dry cast RCP pipe be used for the East Side Canal siphon piping. In addition, RCP is a preferred pipe material for this application since it is corrosion resistant, more suitable to resist flotation, and a rigid pipe.

Reach 2 Farm Road

a) Sizing Criteria

The design flow for the crossing at a Reach 2 Farm Road crossing is 443 cfs.

- Flowrate = 443 cfs
- Maximum Velocity = 6 fps
- Pipe Diameter = Approximate 120-in (10-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$A = Q/V$

The headloss through the crossing piping was calculated using the velocity head of the pipe for minor entrance and exit losses and the Manning's Equation for the friction loss through the pipe.

Manning's Equation: $V = (1.49/n)*R^{2/3}*S^{1/2}$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
n = Material Coefficient (Used 0.013 for new concrete pipe)
L = Pipe Length (Estimated as 60-ft)

Results:

A = 443 cfs / 6 fps = 73.8 sf
D = 9.70 ft < 10.0 ft (120-in)

$A = (3.14*D^2)/4 = 78.5$ sf
V = 442 cfs / 78.5 sf = 5.64 fps
Velocity Head = $h_v = v^2/2g = 0.49$ ft
Wetted Perimeter = P = 31.4 ft
Hydraulic Radius = R = A/P = 78.5 sf / 31.4 ft = 2.50 ft
Entrance Loss = $0.5 * v^2/2g = 0.25$ ft
H_L= 0.71 ft / 1,000 ft
Exit Loss = $1.0 * v^2/2g = 0.49$ ft

Total Estimated Headloss = 0.78-ft

Design the road crossing piping so that the control water surface submerges the pipe at the headwall structure a minimum 1.78 times h_v plus 3-inches or approximately 14-inches.

Other options for the Farm Road crossing include a pre-cast box culvert or a precast bridge. The hydraulic properties for a 8' x 12' box culvert are noted below:

The continuity equation was used to solve for the cross-sectional area of the box culvert and the culvert dimensions given the design flow and maximum velocity.

$A = Q/V$

The headloss through the box culvert was calculated using the velocity head of the culvert for minor entrance and exit losses and the Manning's Equation for the friction loss through the culvert.

Manning's Equation: $V = (1.49/n)*R^{2/3}*S^{1/2}$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Culvert Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
n = Material Coefficient (Used 0.013 for precast concrete)
L = Culvert Length (Estimated as 60-ft)

Results:

A = 443 cfs / 6 fps = 73.8 sf
D = 9.7 ft < 10.0 ft (120-in)

A = 8' x 12' = 96.0 sf
V = 443 cfs / 96 sf = 4.61 fps
Velocity Head = $h_v = v^2/2g = 0.33$ ft
Wetted Perimeter = P = 40.0 ft
Hydraulic Radius = R = A/P = 96 sf / 40 ft = 2.40 ft
Entrance Loss = $0.5 * v^2/2g = 0.17$ ft
H_L = 0.50 ft / 1,000 ft
Exit Loss = $1.0 * v^2/2g = 0.33$ ft

Total Estimated Headloss = 0.53-ft

Design structure to minimize headloss at maximum flow and closely match culvert invert with canal invert to avoid material buildup in the box culvert during low flow conditions.

b) Pipe Materials

The Farm Road crossing piping is large diameter pipe in the approximate size of 10-ft diameter. The pipe material options consist of FBE steel pipe, CMLC steel pipe, wet cast RCP, and dry cast RCP. It is standard practice for the pipe

deflection to be limited to 2% for CMLC steel pipe and 5% for FBE steel pipe. Assuming an earth cover of 10-ft, the deflection for a 3/8" wall FBE steel pipe is approximately 3%. However, the use of CMLC in this application with such a large diameter and a significant earth cover while maintaining pipe wall deflections of less than 2% is difficult. The wet cast and dry cast RCP pipe would be ASTM C361 pipe, C25 double gasketed pipe. The "C" designation signifies that the pipe is suitable for earth cover over the top of the pipe up to 15-ft. The "25" designation signifies that the pipe can handle hydrostatic heads up to 25-ft above the centerline of the pipe. The hydrostatic head under normal gravity flow operations will likely be less than 10-ft.

c) Material Recommendations

The Farm Road crossing piping is estimated to be approximately 60-ft in length. The FBE steel pipe is estimated as $1,205 per lineal foot for material cost and $2,197 per lineal foot for material and installation. The wet cast RCP is estimated as $2,453 per lineal foot for material cost and $3,271 per lineal foot for material and installation while the dry cast RCP is estimated as $546 per lineal foot for material cost and $1,364 per lineal foot for material and installation.

Steel pipe is not recommended in this application due to excessive pipe deflections of 3-inches to 4-inches even if it is within acceptable percentages. The dry cast RCP is the most economical pipe in this pipe diameter. Therefore, it is recommended that dry cast RCP pipe be used for the Farm Road crossing piping. In addition, RCP is a preferred pipe material for this application since it is corrosion resistant, more suitable to resist flotation, and a rigid pipe.

The box culvert is also an economical alternative provided the grades work and do not require an inverted siphon. It is envisioned that a 8' x 12' box culvert could be installed and the farm road built up over the box culvert so that it did not require an inverted siphon.

<u>Reach 3 Farm Road</u>

a) Sizing Criteria

The design flow for the crossing at a Reach 3 Farm Road crossing is 435 cfs.

- Flowrate = 435 cfs
- Maximum Velocity = 6 fps
- Pipe Diameter = Approximate 120-in (10-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$$A = Q/V$$

The headloss through the crossing piping was calculated using the velocity head of the pipe for minor entrance and exit losses and the

Manning's Equation for the friction loss through the pipe.

Manning's Equation: $V = (1.49/n)*R^{2/3}*S^{1/2}$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
n = Material Coefficient (Used 0.013 for new concrete pipe)
L = Pipe Length (Estimated as 60-ft)

Results:

A = 435 cfs / 6 fps = 72.5 sf
D = 9.61 ft < 10.0 ft (120-in)

$A = (3.14*D^2)/4 = 78.5$ sf
V = 435 cfs / 78.5 sf = 5.54 fps
Velocity Head = $h_v = v^2/2g = 0.48$ ft
Wetted Perimeter = P = 31.4 ft
Hydraulic Radius = R = A/P = 78.5 sf / 31.4 ft = 2.50 ft
Entrance Loss = $0.5 * v^2/2g = 0.24$ ft
H_L = 0.68 ft / 1,000 ft
Exit Loss = $1.0 * v^2/2g = 0.48$ ft

Total Estimated Headloss = 0.78-ft

Design the road crossing piping so that the control water surface submerges the pipe at the headwall structure a minimum 1.78 times h_v plus 3-inches or approximately 14-inches.

Other options for the Farm Road crossing include a pre-cast box culvert or a precast bridge. The hydraulic properties for a 8' x 12' box culvert are noted below:

The continuity equation was used to solve for the cross-sectional area of the box culvert and the culvert dimensions given the design flow and maximum velocity.

$A = Q/V$

The headloss through the box culvert was calculated using the velocity head of the culvert for minor entrance and exit losses and the Manning's Equation for the friction loss through the culvert.

Manning's Equation: $V = (1.49/n)*R^{2/3}*S^{1/2}$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Culvert Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope

n = Material Coefficient (Used 0.013 for precast concrete)
L = Culvert Length (Estimated as 60-ft)

Results:

A = 435 cfs / 6 fps = 72.5 sf
D = 9.6 ft < 10.0 ft (120-in)

A = 8' x 12' = 96.0 sf
V = 435 cfs / 96 sf = 4.53 fps
Velocity Head = $h_v = v^2/2g = 0.32$ ft
Wetted Perimeter = P = 40.0 ft
Hydraulic Radius = R = A/P = 96 sf / 40 ft = 2.40 ft
Entrance Loss = $0.5 * v^2/2g = 0.16$ ft
H_L = 0.48 ft / 1,000 ft
Exit Loss = $1.0 * v^2/2g = 0.32$ ft

Total Estimated Headloss = 0.51-ft

Design structure to minimize headloss at maximum flow and closely match culvert invert with canal invert to avoid material buildup in the box culvert during low flow conditions.

b) Pipe Materials

The Farm Road crossing piping is large diameter pipe in the approximate size of 10-ft diameter. The pipe material options consist of FBE steel pipe, CMLC steel pipe, wet cast RCP, and dry cast RCP. It is standard practice for the pipe deflection to be limited to 2% for CMLC steel pipe and 5% for FBE steel pipe. Assuming an earth cover of 10-ft, the deflection for a 3/8" wall FBE steel pipe is approximately 3%. However, the use of CMLC in this application with such a large diameter and a significant earth cover while maintaining pipe wall deflections of less than 2% is difficult. The wet cast and dry cast RCP pipe would be ASTM C361 pipe, C25 double gasketed pipe. The "C" designation signifies that the pipe is suitable for earth cover over the top of the pipe up to 15-ft. The "25" designation signifies that the pipe can handle hydrostatic heads up to 25-ft above the centerline of the pipe. The hydrostatic head under normal gravity flow operations will likely be less than 10-ft.

c) Material Recommendations

The Farm Road crossing piping is estimated to be approximately 60-ft in length. The FBE steel pipe is estimated as $1,205 per lineal foot for material cost and $2,197 per lineal foot for material and installation. The wet cast RCP is estimated as $2,453 per lineal foot for material cost and $3,271 per lineal foot for material and installation while the dry cast RCP is estimated as $546 per lineal foot for material cost and $1,364 per lineal foot for material and installation.

Steel pipe is not recommended in this application due to excessive pipe deflections of 3-inches to 4-inches even if it is within acceptable percentages. The dry cast RCP is the most economical pipe in this pipe diameter. Therefore, it is recommended that dry cast RCP pipe be used for the Farm Road crossing piping. In addition, RCP is a preferred pipe material for this application since it is corrosion resistant, more suitable to resist flotation, and a rigid pipe.

The box culvert is also an economical alternative provided the grades work and do not require an inverted siphon. It is envisioned that a 8' x 12' box culvert could be installed and the farm road built up over the box culvert so that it did not require an inverted siphon.

Reach 4 Farm Road

a) Sizing Criteria

The design flow for the crossing at a Reach 4 Farm Road crossing is 240 cfs.

- Flowrate = 240 cfs
- Maximum Velocity = 6 fps
- Pipe Diameter = Approximate 90-in (7.5-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$A = Q/V$

The headloss through the crossing piping was calculated using the velocity head of the pipe for minor entrance and exit losses and the Manning's Equation for the friction loss through the pipe.

Manning's Equation: $V = (1.49/n)*R^{2/3}*S^{1/2}$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
n = Material Coefficient (Used 0.013 for new concrete pipe)
L = Pipe Length (Estimated as 60-ft)

Results:

A = 240 cfs / 6 fps = 40.0 sf
D = 7.14 ft < 7.5 ft (90-in)

$A = (3.14*D^2)/4 = 44.2$ sf
V = 240 cfs / 44.2 sf = 5.43 fps
Velocity Head = $h_v = v^2/2g = 0.46$ ft
Wetted Perimeter = P = 23.6 ft
Hydraulic Radius = R = A/P = 44.2 sf / 23.6 ft = 1.87 ft
Entrance Loss = $0.5 * v^2/2g = 0.23$ ft
H_L= 0.97 ft / 1,000 ft
Exit Loss = $1.0 * v^2/2g = 0.46$ ft

Total Estimated Headloss = 0.75-ft

Design the road crossing piping so that the control water surface submerges the pipe at the headwall structure a minimum 1.78 times h_v plus 3-inches or approximately 13-inches.

Other options for the Farm Road crossing include a pre-cast box culvert or a precast bridge. The hydraulic properties for a 8' x 8' box culvert are noted below:

The continuity equation was used to solve for the cross-sectional area of the box culvert and the culvert dimensions given the design flow and maximum velocity.

$A = Q/V$

The headloss through the box culvert was calculated using the velocity head of the culvert for minor entrance and exit losses and the Manning's Equation for the friction loss through the culvert.

Manning's Equation: $V = (1.49/n)*R^{2/3}*S^{1/2}$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Culvert Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
n = Material Coefficient (Used 0.013 for precast concrete)
L = Culvert Length (Estimated as 60-ft)

Results:

A = 240 cfs / 6 fps = 40.0 sf

A = 8' x 8' = 64.0 sf
V = 240 cfs / 64 sf = 3.75 fps
Velocity Head = $h_v = v^2/2g = 0.22$ ft
Wetted Perimeter = P = 32.0 ft
Hydraulic Radius = R = A/P = 64 sf / 32 ft = 2.00 ft
Entrance Loss = $0.5 * v^2/2g = 0.11$ ft
H_L = 0.42 ft / 1,000 ft
Exit Loss = $1.0 * v^2/2g = 0.22$ ft

Total Estimated Headloss = 0.36-ft

Design structure to minimize headloss at maximum flow and closely match culvert invert with canal invert to avoid material buildup in the box culvert during low flow conditions.

b) Pipe Materials

The Farm Road crossing piping is large diameter pipe in the approximate size of 7.5-ft diameter. The pipe material options consist of FBE steel pipe, CMLC steel pipe, wet cast RCP, and dry cast RCP. It is standard practice for the pipe deflection to be limited to 2% for CMLC steel pipe and 5% for FBE steel pipe. Assuming an earth cover of 10-ft, the deflection for a 3/8" wall FBE steel pipe is approximately 3%. However, the use of CMLC in this application with such a

large diameter and a significant earth cover while maintaining pipe wall deflections of less than 2% is difficult. The wet cast and dry cast RCP pipe would be ASTM C361 pipe, C25 double gasketed pipe. The "C" designation signifies that the pipe is suitable for earth cover over the top of the pipe up to 15-ft. The "25" designation signifies that the pipe can handle hydrostatic heads up to 25-ft above the centerline of the pipe. The hydrostatic head under normal gravity flow operations will likely be less than 10-ft.

c) Material Recommendations

The Farm Road crossing piping is estimated to be approximately 60-ft in length. The FBE steel pipe is estimated as $650 per lineal foot for material cost and $1,110 per lineal foot for material and installation. The wet cast RCP is estimated as $1,470 per lineal foot for material cost and $1,805 per lineal foot for material and installation while the dry cast RCP is estimated as $391 per lineal foot for material cost and $726 per lineal foot for material and installation.

Steel pipe is not recommended in this application due to excessive pipe deflections of 3-inches to 4-inches even if it is within acceptable percentages. The dry cast RCP is the most economical pipe in this pipe diameter. Therefore, it is recommended that dry cast RCP pipe be used for the Farm Road crossing piping. In addition, RCP is a preferred pipe material for this application since it is corrosion resistant, more suitable to resist flotation, and a rigid pipe.

The box culvert is also an economical alternative provided the grades work and do not require an inverted siphon. It is envisioned that a 8' x 8' box culvert could be installed and the farm road built up over the box culvert so that it did not require an inverted siphon.

C. Highway Cased Crossings

a) Sizing Criteria

The design flow for the cased crossing at Stockdale Highway in Reach 1 and the cased crossing at the Interstate 5 Freeway in Reach 2 is 443 cfs.

- Flowrate = 443 cfs
- Maximum Velocity = 6 fps
- Pipe Diameter = Approximate 120-in (10-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$$A = Q/V$$

The headloss through the carrier piping was calculated using the velocity head of the pipe for minor entrance and exit losses and the Manning's Equation for the friction loss through the pipe.

Manning's Equation: $V = (1.49/n)*R^{2/3}*S^{1/2}$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
n = Material Coefficient (Used 0.013 for new concrete pipe)
L = Pipe Length (Stockdale Hwy estimated as 150-ft)
(I-5 Fwy estimated as 280-ft)

Results:

A = 443 cfs / 6 fps = 73.8 sf
D = 9.70 ft < 10.0 ft (120-in)

$A = (3.14*D^2)/4 = 78.5$ sf
V = 442 cfs / 78.5 sf = 5.64 fps
Velocity Head = $h_v = v^2/2g = 0.49$ ft
Wetted Perimeter = P = 31.4 ft
Hydraulic Radius = R = A/P = 78.5 sf / 31.4 ft = 2.50 ft
Entrance Loss = $0.5 * v^2/2g = 0.25$ ft
H_L= 0.71 ft / 1,000 ft
Exit Loss = $1.0 * v^2/2g = 0.49$ ft

Total Estimated Headloss = 0.85-ft for Stockdale Hwy
0.94-ft for I-5 Fwy

Design the cased crossing piping so that the control water surface submerges the pipe at the headwall structure a minimum 1.78 times h_v plus 3-inches or approximately 14-inches.

b) Pipe Materials

The casing pipe material for these crossings is estimated to be a minimum of 168" diameter bare steel pipe or steel liner plate with an approximate wall thickness of 3/4" per the requirements of the California Department of Transportation.

The cased crossing carrier piping is large diameter pipe in the approximate size of 10-ft diameter. The annulus between the casing pipe and the carrier pipe will be filled with a cement slurry. For this reason, RCP pipe is recommended for the carrier piping. The wet cast and dry cast RCP pipe would be ASTM C361 pipe, D25 double gasketed pipe with an approximate O.D. of 142".

c) Material Recommendations

The estimated cost for the cased crossings includes installation of the 168" diameter liner plate by the tunnel boring machine method and soil stabilization and is approximately $2,000 per lineal foot material cost and approximately $4,000 per lineal foot for material and installation. The carrier pipe is estimated as 10-ft diameter ASTM C361 D25 double gasketed RCP and the annulus filled with a cement slurry. The estimated cost to install the carrier piping is approximately $585 per lineal foot material cost and $2,500 per lineal foot for material and installation.

D. Reach 4 Conveyance Piping

a) Sizing Criteria

The Reach 4 of the conveyance canal may be an open channel or a closed conduit design. The design flow for a closed conduit in Reach 4 is 240 cfs. However, this 240 cfs demand is for the initial filling of the recharge basins and is expected to be a short-term event. Therefore, it is more desirable to design the closed conduit system for the average rates (approximately 160 cfs) rather than the short-term peak fill rates. Furthermore, it is anticipated that a closed conduit design could reduce in pipeline size as water is conveyed through turnouts along the pipeline to the West Basins, see Figure 2.

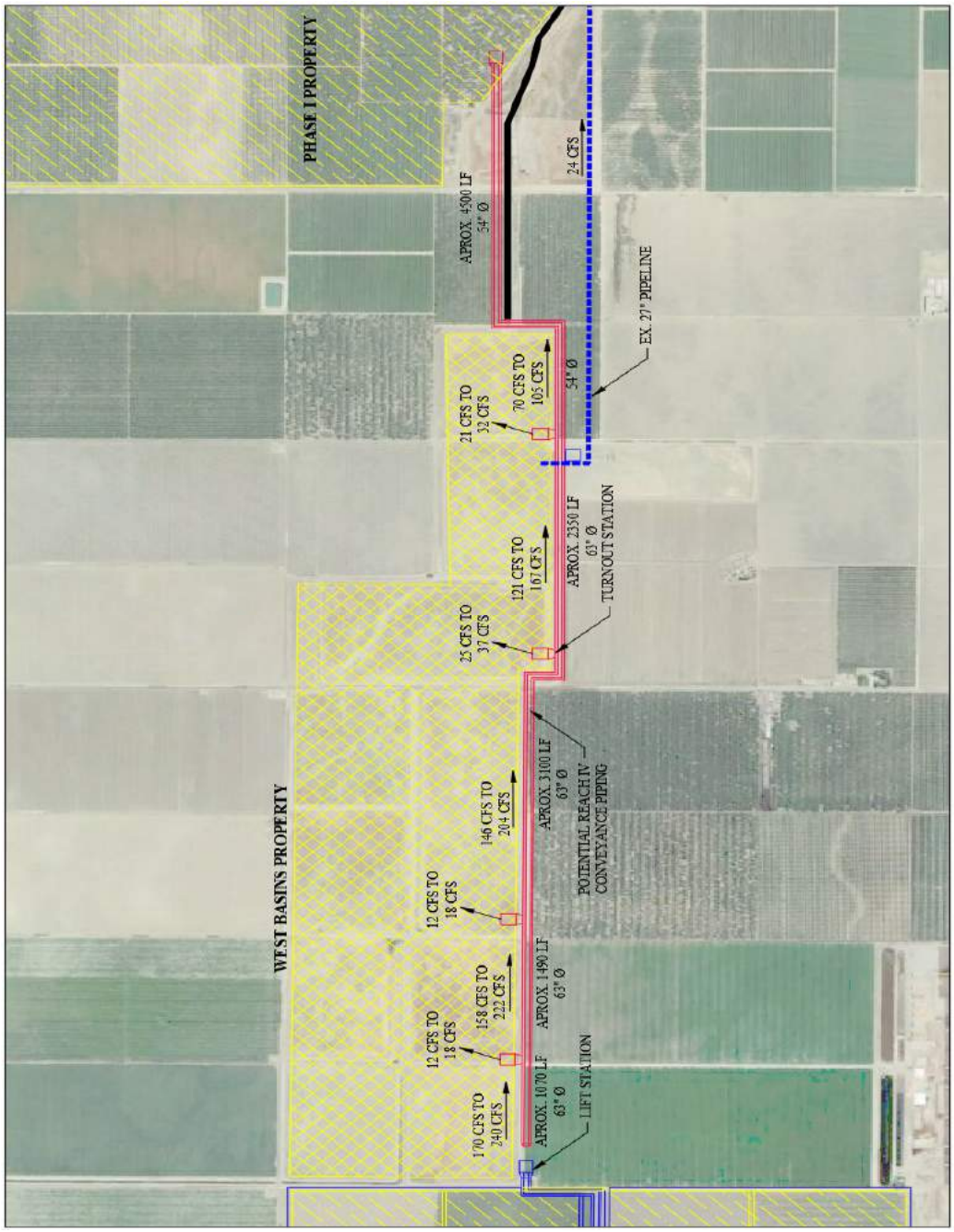


Figure 2: West Basin Turnouts

Alternative 1a: Fill Rate – Max Velocity 7 fps

The first alternative targets maintaining pipeline velocities below 7 fps during the initial filling operations and below 5 fps during average recharge conditions.

- Flowrate = 240 cfs
- Maximum Velocity at Initial Fill = 7.0 fps
- Pipe Diameter = Approximate 84-in (7-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$A = Q/V$

The headloss through the conveyance piping was calculated using the velocity head of the pipe for minor entrance and exit losses and the Hazen-Williams Equation for the friction loss through the pipe.

Hazen-Williams Equation: $h_f = (3.022 * V^{1.85} * L) / (C^{1.85} * D^{1.17})$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Material Coefficient (Used 130 for Dry Cast RCP pipe)
L = Pipe Length (Estimated as 1,070-ft)

Results:

A = 240 cfs / 7.0 fps = 34.3 sf
D = 6.6 ft < 7.0 ft (84-in)

$A = (3.14*D^2)/4 = 38.47$ sf
V = 240 cfs / 38.47 sf = 6.24 fps
Velocity Head = $h_v = v^2/2g = .60$ ft
Wetted Perimeter = P = 22.0 ft
Hydraulic Radius = R = A/P = 38.5 sf / 22.0 ft = 1.75 ft
Entrance Loss = $0.5 * v^2/2g = 0.30$ ft
H_L= 1.21 ft
Minor Loss = $0.2 * v^2/2g = 0.60$ ft

Total Estimated Headloss = 2.11-ft

The flow then decreases to approximately 222 cfs after the first turnout to the West Basins. The pipeline remains a 84" Dry Cast RCP pipe with an approximate 84" I.D.

Where:

Q = Flow (cfs)
V = Velocity (fps)

D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Material Coefficient (Used 130 for Dry Cast RCP pipe)
L = Pipe Length (Estimated as 1,490-ft)

Results:

A = 222 cfs / 7.0 fps = 31.71 sf
D = 6.4 ft < 7.0 ft (84-in)

$A = (3.14*D^2)/4 = 38.47$ sf
V = 222 cfs / 38.47 sf = 5.77 fps
Velocity Head = $h_v = v^2/2g = 0.52$ ft
Wetted Perimeter = P = 22.0 ft
Hydraulic Radius = R = A/P = 38.5 sf / 22.0 ft = 1.75 ft
H_L= 1.45 ft
Minor Loss = $0.2 * v^2/2g = 0.10$ ft

Total Estimated Headloss = 1.55-ft

The flow then decreases to approximately 204 cfs after the first and second turnouts to the West Basins. The pipeline then reduces to a 72" Dry Cast RCP pipe with an approximate 72" I.D.

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Material Coefficient (Used 130 for Dry Cast RCP pipe)
L = Pipe Length (Estimated as 3,100-ft)

Results:

A = 204 cfs / 7.0 fps = 29.1 sf
D = 6.1 ft $\leq$ 6 ft (72-in)

$A = (3.14*D^2)/4 = 28.3$ sf
V = 204 cfs / 28.3 sf = 7.2 fps
Velocity Head = $h_v = v^2/2g = 0.81$ ft
Wetted Perimeter = P = 18.8 ft
Hydraulic Radius = R = A/P = 28.3 sf / 18.8 ft = 1.51 ft
H_L= 5.45 ft
Minor Loss = $0.2 * v^2/2g = 0.16$ ft

Total Estimated Headloss = 5.61-ft

The flow then decreases to approximately 167 cfs after the first, second, and third turnouts to the West Basins. The pipeline then reduces to a 66" Dry Cast RCP pipe with an approximate 66" I.D.

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)

A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Material Coefficient (Used 130 for Dry Cast RCP pipe)
L = Pipe Length (Estimated as 2,350-ft)

Results:

A = 167 cfs / 7.0 fps = 23.9 sf
D = 5.5 ft $\leq$ 5.5 ft (66-in)

A = $(3.14*D^2)/4$ = 23.7 sf
V = 167 cfs / 23.7 sf = 7.05 fps
Velocity Head = $h_v = v^2/2g$ = 0.77 ft
Wetted Perimeter = P = 17.3 ft
Hydraulic Radius = R = A/P = 23.7 sf / 17.3 ft = 1.37 ft
H_L= 4.40 ft
Minor Loss = $0.2 * v^2/2g$ = 0.15 ft

Total Estimated Headloss = 4.55-ft

The flow then decreases to approximately 135 cfs after the fourth and final turnout to the West Basins. In addition, approximately 24 cfs is conveyed to the existing 27-inch West Basin pipeline and 6 cfs to "in-lieu" turnout demands leaving approximately 105 cfs to be conveyed to the Phase I Property. The pipeline reduces to a 54" Dry Cast RCP pipe with an approximate 54" I.D.

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Material Coefficient (Used 130 for Dry Cast RCP pipe)
L = Pipe Length (Estimated as 4,500-ft)

Results:

A = 105 cfs / 7.0 fps = 15.0 sf
D = 4.37 ft < 4.5 ft (54-in)

A = $(3.14*D^2)/4$ = 15.9 sf
V = 105 cfs / 15.9 sf = 6.6 fps
Velocity Head = $h_v = v^2/2g$ = 0.68 ft
Wetted Perimeter = P = 14.1 ft
Hydraulic Radius = R = A/P = 15.9 sf / 14.1 ft = 1.13 ft
H_L= 9.43 ft
Exit Loss = $1.0 * v^2/2g$ = 0.68 ft

Total Estimated Headloss = 10.11-ft

The estimated headloss above (23.93-ft) would need to be added to the static lift which is estimated as 13-ft for a total TDH (excluding Pump Station losses for sake of comparison) of approximately 36.93-ft. The total dynamic head (TDH) for the Pump Station No. 3 under the open channel design is approximately 13-ft (excluding Pump Station losses for sake of comparison). The closed conduit design results in an approximate increase of 1,000 bhp to convey the water

through Reach 4. This results in cost increases to the pumps, motors, VFD's, and electrical equipment.

This also results in higher operational costs. The higher pump station lift is approximately 23.93-ft than an open channel design. This equates to approximately 37.70 kwh/ac-ft. In a wet year it is estimated that approximately 7,140 ac-ft could be pumped through this reach during the initial fill over an approximate two-week duration. This equates to approximately 269,170 kwh per year. Assuming an average energy rate of $0.14/kwh equates to an increased operational cost in wet years of approximately $37,684.00.

Alternative 1b: Avg. Recharge Rate – Max Velocity 7 fps

The same calculations as above were performed accounting for the average recharge rates:

- Flowrate = 170 cfs
- Maximum Velocity = 7.0 fps
- Pipe Diameter = Approximate 84-in (7-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$A = Q/V$

The headloss through the conveyance piping was calculated using the velocity head of the pipe for minor entrance and exit losses and the Hazen-Williams Equation for the friction loss through the pipe.

Hazen-Williams Equation: $h_f = (3.022 * V^{1.85} * L) / (C^{1.85} * D^{1.17})$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Material Coefficient (Used 130 for Dry Cast RCP pipe)
L = Pipe Length (Estimated as 1,070-ft)

Results:

A = 170 cfs / 7.0 fps = 24.3 sf
D = 5.6 ft < 7 ft (84-in)

$A = (3.14*D^2)/4 = 38.47$ sf
V = 170 cfs / 38.47 sf = 4.42 fps
Velocity Head = $h_v = v^2/2g = 0.30$ ft
Wetted Perimeter = P = 22.0 ft
Hydraulic Radius = R = A/P = 38.5 sf / 22.0 ft = 1.75 ft
Entrance Loss = $0.5 * v^2/2g = 0.15$ ft
H_L= 0.64 ft

Minor Loss = 0.2 * $v^2/2g$ = 0.06 ft

Total Estimated Headloss = 0.85-ft

The flow then decreases to approximately 158 cfs after the first turnout to the West Basins. The pipeline remains a 84" Dry Cast RCP pipe with an approximate 84" I.D.

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Material Coefficient (Used 130 for Dry Cast RCP pipe)
L = Pipe Length (Estimated as 1,490-ft)

Results:

A = 158 cfs / 7.0 fps = 22.6 sf
D = 5.36 ft < 7.0 ft (84-in)

A = $(3.14*D^2)/4$ = 38.47 sf
V = 158 cfs / 38.47 sf = 4.11 fps
Velocity Head = $h_v = v^2/2g$ = 0.26 ft
Wetted Perimeter = P = 22.0 ft
Hydraulic Radius = R = A/P = 38.5 sf / 22.0 ft = 1.75 ft
H_L= 0.78 ft
Minor Loss = 0.2 * $v^2/2g$ = 0.05 ft

Total Estimated Headloss = 0.83-ft

The flow then decreases to approximately 146 cfs after the first and second turnouts to the West Basins. The pipeline reduces to a 72" Dry Cast RCP pipe with an approximately 72" I.D.

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Material Coefficient (Used 130 for Dry Cast RCP pipe)
L = Pipe Length (Estimated as 3,100-ft)

Results:

A = 146 cfs / 7.0 fps = 20.9 sf
D = 5.15 ft < 6.0 ft (72-in)

A = $(3.14*D^2)/4$ = 28.26 sf
V = 146 cfs / 28.26 sf = 5.17 fps
Velocity Head = $h_v = v^2/2g$ = 0.41 ft
Wetted Perimeter = P = 18.8 ft
Hydraulic Radius = R = A/P = 28.3 sf / 18.8 ft = 1.51 ft
H_L= 2.95 ft
Minor Loss = 0.2 * $v^2/2g$ = 0.08 ft

Total Estimated Headloss = 3.04-ft

The flow then decreases to approximately 121 cfs after the first, second, and third turnouts to the West Basins. The pipeline further reduces to a 66" Dry Cast RCP pipe with an approximate 66" I.D.

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Material Coefficient (Used 130 for Dry Cast RCP pipe)
L = Pipe Length (Estimated as 2,350-ft)

Results:

A = 121 cfs / 7.0 fps = 17.29 sf
D = 4.69 ft < 5.5 ft (66-in)

$A = (3.14*D^2)/4 = 23.75$ sf
V = 121 cfs / 23.75 sf = 5.09 fps
Velocity Head = $h_v = v^2/2g = 0.40$ ft
Wetted Perimeter = P = 17.3 ft
Hydraulic Radius = R = A/P = 23.8 sf / 17.3 ft = 1.38 ft
H_L= 2.41 ft
Minor Loss = $0.2 * v^2/2g = 0.08$ ft

Total Estimated Headloss = 2.49-ft

The flow then decreases to approximately 100 cfs after the fourth and final turnout to the West Basins. In addition, approximately 24 cfs is conveyed to the existing 27-inch West Basin pipeline and 6 cfs to "in-lieu" turnout demands leaving approximately 70 cfs to be conveyed to the Phase I Property. The pipeline reduces to a 54" Dry Cast RCP pipe with an approximate 54" I.D.

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Material Coefficient (Used 130 for Dry Cast RCP pipe)
L = Pipe Length (Estimated as 4,500-ft)

Results:

A = 70 cfs / 7.0 fps = 10.0 sf
D = 3.57 ft < 4.5 ft (54-in)

$A = (3.14*D^2)/4 = 15.9$ sf
V = 70 cfs / 15.9 sf = 4.40 fps
Velocity Head = $h_v = v^2/2g = 0.30$ ft
Wetted Perimeter = P = 14.1 ft
Hydraulic Radius = R = A/P = 15.9 sf / 14.1 ft = 1.13 ft
H_L= 4.46 ft

Exit Loss = 1.0 * $v^2/2g$ = 0.30 ft

Total Estimated Headloss = 4.76-ft

The estimated headloss above (11.97-ft) would need to be added to the static lift which is estimated as 13-ft for a total TDH (excluding Pump Station losses for sake of comparison) of approximately 24.97-ft.

This also results in higher operational costs that must be considered. The higher pump station lift is approximately 11.97-ft. This equates to approximately 18.86 kwh/ac-ft. In a wet year it is estimated that approximately 42,860 ac-ft could be pumped through this reach during the average recharge operations to bank the total 50,000 ac-ft goal. This equates to approximately 808,226 kwh per year. Assuming an average energy rate of $0.14/kwh equates to an increased operational cost in wet years of approximately $113,152.00.

This equates to a total operating cost in a wet year of approximately $150,836.00 more than would be experienced with an open channel facility. The approximate capital cost for the 84" Dry Cast RCP closed conduit design would be roughly $5.5M. In addition, the increased pump station horsepower is anticipated to add approximately $800,000 in cost for a total capital cost of approximately $6.3M.

Alternative 2a: Fill Rate – Max Velocity 12.5 fps

The second alternative evaluates using HDPE pipe and pushing the velocities higher during the initial filling period with the understanding that the majority of the time the system will be operating under average recharge rates and lower pipeline velocities.

- Flowrate = 240 cfs
- Maximum Velocity at Initial Fill = 12.5 fps
- Pipe Diameter = Approximate 60-in (5-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$A = Q/V$

The headloss through the conveyance piping was calculated using the velocity head of the pipe for minor entrance and exit losses and the Hazen-Williams Equation for the friction loss through the pipe.

Hazen-Williams Equation: $h_f = (3.022 * V^{1.85} * L) / (C^{1.85} * D^{1.17})$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope

C = Material Coefficient (Used 160 for HDPE pipe)
L = Pipe Length (Estimated as 1,070-ft)

Results:

A = 240 cfs / 12.5 fps = 19.2 sf
D = 4.95 ft < 5 ft (60-in)

$A = (3.14*D^2)/4 = 19.46$ sf
V = 240 cfs / 19.46 sf = 12.34 fps
Velocity Head = $h_v = v^2/2g = 2.36$ ft
Wetted Perimeter = P = 15.6 ft
Hydraulic Radius = R = A/P = 19.5 sf / 15.6 ft = 1.25 ft
Entrance Loss = $0.5 * v^2/2g = 1.18$ ft
H_L= 4.32 ft
Minor Loss = $0.2 * v^2/2g = 0.47$ ft

Total Estimated Headloss = 5.97-ft

The flow then decreases to approximately 222 cfs after the first turnout to the West Basins. The pipeline remains a 63" HDPE pipe with an approximately 60" I.D.

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Material Coefficient (Used 160 for HDPE pipe)
L = Pipe Length (Estimated as 1,490-ft)

Results:

A = 222 cfs / 12.5 fps = 17.8 sf
D = 4.76 ft < 5 ft (60-in)

$A = (3.14*D^2)/4 = 19.46$ sf
V = 222 cfs / 19.46 sf = 11.41 fps
Velocity Head = $h_v = v^2/2g = 2.02$ ft
Wetted Perimeter = P = 15.6 ft
Hydraulic Radius = R = A/P = 19.5 sf / 15.6 ft = 1.25 ft
H_L= 5.20 ft
Minor Loss = $0.2 * v^2/2g = 0.40$ ft

Total Estimated Headloss = 5.60-ft

The flow then decreases to approximately 204 cfs after the first and second turnouts to the West Basins. The pipeline remains a 63" HDPE pipe with an approximately 60" I.D.

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope

C = Material Coefficient (Used 160 for HDPE pipe)
L = Pipe Length (Estimated as 3,100-ft)

Results:

A = 204 cfs / 12.5 fps = 16.3 sf
D = 4.56 ft < 5 ft (60-in)

$A = (3.14*D^2)/4 = 19.46$ sf
V = 204 cfs / 19.46 sf = 10.48 fps
Velocity Head = $h_v = v^2/2g = 1.71$ ft
Wetted Perimeter = P = 15.6 ft
Hydraulic Radius = R = A/P = 19.5 sf / 15.6 ft = 1.25 ft
H_L= 9.26 ft
Minor Loss = $0.2 * v^2/2g = 0.34$ ft

Total Estimated Headloss = 9.60-ft

The flow then decreases to approximately 167 cfs after the first, second, and third turnouts to the West Basins. The pipeline remains a 63" HDPE pipe with an approximately 60" I.D.

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Material Coefficient (Used 160 for HDPE pipe)
L = Pipe Length (Estimated as 2,350-ft)

Results:

A = 167 cfs / 12.5 fps = 13.4 sf
D = 4.13 ft < 5 ft (60-in)

$A = (3.14*D^2)/4 = 19.46$ sf
V = 167 cfs / 19.46 sf = 8.58 fps
Velocity Head = $h_v = v^2/2g = 1.14$ ft
Wetted Perimeter = P = 15.6 ft
Hydraulic Radius = R = A/P = 19.5 sf / 15.6 ft = 1.25 ft
H_L= 4.82 ft
Minor Loss = $0.2 * v^2/2g = 0.23$ ft

Total Estimated Headloss = 5.05-ft

The flow then decreases to approximately 135 cfs after the fourth and final turnout to the West Basins. In addition, approximately 24 cfs is conveyed to the existing 27-inch West Basin pipeline and 6 cfs to "in-lieu" turnout demands leaving approximately 105 cfs to be conveyed to the Phase I Property. The pipeline reduces to a 54" HDPE pipe with an approximately 51" I.D.

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius

S = Slope
C = Material Coefficient (Used 160 for HDPE pipe)
L = Pipe Length (Estimated as 4,500-ft)

Results:

A = 105 cfs / 12.5 fps = 8.4 sf
D = 3.27 ft < 4.5 ft (54-in)

$A = (3.14*D^2)/4 = 14.30$ sf
V = 105 cfs / 14.30 sf = 7.34 fps
Velocity Head = $h_v = v^2/2g = .84$ ft
Wetted Perimeter = P = 13.4 ft
Hydraulic Radius = R = A/P = 14.3 sf / 13.4 ft = 1.07 ft
H_L= 8.32 ft
Exit Loss = $1.0 * v^2/2g = 0.84$ ft

Total Estimated Headloss = 9.16-ft

The estimated headloss above (35.38-ft) would need to be added to the static lift which is estimated as 13-ft for a total TDH (excluding Pump Station losses for sake of comparison) of approximately 48.38-ft. The total dynamic head (TDH) for the Pump Station No. 3 under the open channel design is approximately 13-ft (excluding Pump Station losses for sake of comparison). The closed conduit design results in an approximate increase of 1,480 bhp to convey the water through Reach 4. This results in cost increases to the pumps, motors, VFD's, and electrical equipment.

This also results in higher operational costs. The higher pump station lift is approximately 35.38-ft more than an open channel design. This equates to approximately 55.74 kwh/ac-ft. In a wet year it is estimated that approximately 7,140 ac-ft could be pumped through this reach during the initial fill over an approximate two-week duration. This equates to approximately 397,963 kwh per year. Assuming an average energy rate of $0.14/kwh equates to an increased operational cost in wet years of approximately $55,715.00.

Alternative 2b: Avg. Recharge Rate – Max Velocity 12.5 fps

The same calculations as above were performed accounting for the average recharge rates:

- Flowrate = 170 cfs
- Maximum Velocity = 12.5 fps
- Pipe Diameter = Approximate 60-in (5-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$A = Q/V$

The headloss through the conveyance piping was calculated using the velocity head of the pipe for minor entrance and exit losses and the Hazen-Williams Equation for the friction loss through the pipe.

Hazen-Williams Equation: $h_f = (3.022 * V^{1.85} * L) / (C^{1.85} * D^{1.17})$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Material Coefficient (Used 160 for HDPE pipe)
L = Pipe Length (Estimated as 1,070-ft)

Results:

A = 170 cfs / 12.5 fps = 13.6 sf
D = 4.16 ft < 5 ft (60-in)

$A = (3.14*D^2)/4 = 19.46$ sf
V = 170 cfs / 19.46 sf = 8.74 fps
Velocity Head = $h_v = v^2/2g = 1.19$ ft
Wetted Perimeter = P = 15.6 ft
Hydraulic Radius = R = A/P = 19.5 sf / 15.6 ft = 1.25 ft
Entrance Loss = $0.5 * v^2/2g = 0.59$ ft
H_L= 2.28 ft
Minor Loss = $0.2 * v^2/2g = 0.24$ ft

Total Estimated Headloss = 3.11-ft

The flow then decreases to approximately 158 cfs after the first turnout to the West Basins. The pipeline remains a 63" HDPE pipe with an approximately 60" I.D.

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Material Coefficient (Used 160 for HDPE pipe)
L = Pipe Length (Estimated as 1,490-ft)

Results:

A = 158 cfs / 12.5 fps = 12.6 sf
D = 4.01 ft < 5 ft (60-in)

$A = (3.14*D^2)/4 = 19.46$ sf
V = 158 cfs / 19.46 sf = 8.12 fps
Velocity Head = $h_v = v^2/2g = 1.02$ ft
Wetted Perimeter = P = 15.6 ft
Hydraulic Radius = R = A/P = 19.5 sf / 15.6 ft = 1.25 ft
H_L= 2.77 ft
Minor Loss = $0.2 * v^2/2g = 0.20$ ft

Total Estimated Headloss = 2.97-ft

The flow then decreases to approximately 146 cfs after the first and second turnouts to the West Basins. The pipeline remains a 63" HDPE pipe with an approximately 60" I.D.

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Material Coefficient (Used 160 for HDPE pipe)
L = Pipe Length (Estimated as 3,100-ft)

Results:

A = 146 cfs / 12.5 fps = 11.7 sf
D = 3.86 ft < 5 ft (60-in)

$A = (3.14*D^2)/4 = 19.46$ sf
V = 146 cfs / 19.46 sf = 7.50 fps
Velocity Head = $h_v = v^2/2g = 0.87$ ft
Wetted Perimeter = P = 15.6 ft
Hydraulic Radius = R = A/P = 19.5 sf / 15.6 ft = 1.25 ft
H_L= 4.99 ft
Minor Loss = $0.2 * v^2/2g = 0.17$ ft

Total Estimated Headloss = 5.16-ft

The flow then decreases to approximately 121 cfs after the first, second, and third turnouts to the West Basins. The pipeline remains a 63" HDPE pipe with an approximately 60" I.D.

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Material Coefficient (Used 160 for HDPE pipe)
L = Pipe Length (Estimated as 2,350-ft)

Results:

A = 121 cfs / 12.5 fps = 9.7 sf
D = 3.51 ft < 5 ft (60-in)

$A = (3.14*D^2)/4 = 19.46$ sf
V = 121 cfs / 19.46 sf = 6.22 fps
Velocity Head = $h_v = v^2/2g = .60$ ft
Wetted Perimeter = P = 15.6 ft
Hydraulic Radius = R = A/P = 19.5 sf / 15.6 ft = 1.25 ft
H_L= 2.67 ft
Minor Loss = $0.2 * v^2/2g = 0.12$ ft

Total Estimated Headloss = 2.79-ft

The flow then decreases to approximately 100 cfs after the fourth and final turnout to the West Basins. In addition, approximately 24 cfs is conveyed to the existing 27-inch West Basin pipeline and 6 cfs to "in-lieu" turnout demands leaving approximately 70 cfs to be conveyed to the Phase I Property. The pipeline reduces to a 54" HDPE pipe with an approximately 51" I.D.

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Material Coefficient (Used 160 for HDPE pipe)
L = Pipe Length (Estimated as 4,500-ft)

Results:

A = 70 cfs / 12.5 fps = 5.6 sf
D = 2.67 ft < 4.5 ft (54-in)

$A = (3.14*D^2)/4 = 14.30$ sf
V = 70 cfs / 14.30 sf = 6.99 fps
Velocity Head = $h_v = v^2/2g = .76$ ft
Wetted Perimeter = P = 13.4 ft
Hydraulic Radius = R = A/P = 14.3 sf / 13.4 ft = 1.07 ft
H_L= 3.93 ft
Exit Loss = $1.0 * v^2/2g = 0.76$ ft

Total Estimated Headloss = 4.69-ft

The estimated headloss above (18.72-ft) would need to be added to the static lift which is estimated as 13-ft for a total TDH (excluding Pump Station losses for sake of comparison) of approximately 31.72-ft.

This also results in higher operational costs that must be considered. The higher pump station lift is approximately 18.72-ft. This equates to approximately 29.49 kwh/ac-ft. In a wet year it is estimated that approximately 42,860 ac-ft could be pumped through this reach during the average recharge operations to bank the total 50,000 ac-ft goal. This equates to approximately 1,263,905 kwh per year. Assuming an average energy rate of $0.14/kwh equates to an increased operational cost in wet years of approximately $176,947.00.

This equates to a total operating cost in a wet year of approximately $232,662.00 as opposed to designing the closed conduit piping system closer to a more conventional velocity of 5 to 7 fps. This is an approximate increase of $81,826.00 in operating expenses per wet year as a result of utilizing a smaller diameter piping system. The approximate capital cost for the 63" HDPE closed conduit design would be roughly $4.0M. In addition, the increased pump station horsepower is anticipated to add approximately $1.5M in cost for a total capital cost of approximately $5.5M. Therefore, the increased capital cost for the difference between 63" HDPE and 84" Dry Cast RCP in a closed conduit design would be approximately $0.8M ($6.3M - $5.5M). However, the increased pipe size saves approximately $81,826.00 annually in wet years ($232,662 - $150,836). This requires approximately 10 wet years to pay for the increased

capital cost which is a great deal of time when considering that wet years typically occur only about two years out of every ten which would equate to an approximate payback period of 50 years.

Value engineering during the design phase may also consider possible parallel pipelines, more detailed pump station costs, rights-of-way and crop take, etc. when evaluating the Reach 4 design.

b) Pipe Materials

The conveyance piping is large diameter pipe in the approximate size of 5-ft diameter. The pipe material options consist of PVC, HDPE, FBE steel pipe, CMLC steel pipe, wet cast RCP, and dry cast RCP. The PVC pipe would be DR41 pipe and the HDPE would be 63" DR41 pipe. It is anticipated that a 3/8-inch steel pipe wall thickness would be utilized for the FBE steel pipe and CMLC steel pipe. The wet cast and dry cast RCP pipe would be ASTM C361 pipe, C50 double gasketed pipe. The "C" designation signifies that the pipe is suitable for earth cover over the top of the pipe up to 15-ft which is anticipated when crossing levee embankments. The "50" designation signifies that the pipe can handle hydrostatic heads up to 50-ft above the centerline of the pipe.

c) Material Recommendations

The conveyance piping is estimated to be approximately 12,510-ft in length. The PVC pipe is estimated as $316 per lineal foot for material cost and $448 per lineal foot for material and installation. The HDPE pipe is estimated as $128 per lineal foot for material cost and $332 per lineal foot for material and installation. The FBE steel pipe is estimated as $330 per lineal foot for material cost and $524 for material and installation. The CMLC steel pipe is estimated as $340 per lineal foot for material cost and $514 per lineal foot for material and installation. The wet cast RCP is estimated as $750 per lineal foot for material cost and $858 per lineal foot for material and installation while the dry cast RCP is estimated as $236 per lineal foot for material cost and $344 per lineal foot for material and installation.

The DR41 HDPE pipe is the most economical pipe in this pipe diameter. Therefore, 63" DR41 HDPE pipe is the recommended pipe material for the Reach 4 canal conveyance piping if a closed conduit design is selected. The pipe size could also be reduced as the closed conduit system turns out water to each recharge basin.

The pipe pressure class will need to be re-evaluated upon completion of the pump station design to ensure the pipe is designed for the appropriate working pressures, potential surge pressures, and pump shut-off head, if applicable.

E. Pump Station Discharge Piping

a) Sizing Criteria

The design flow for Pump Station No. 1 located near Stockdale Highway is 443 cfs. The design flow for Pump Station No. 2 located near the Interstate 5 Freeway is 435 cfs. The design flow for Pump Station No. 3 near the West Basins is 240 cfs. Each of these pump stations will consist of multiple pumps. The calculations below are for various sizes of pump discharge piping. Technical Memorandum No. 4 (Pump Station Requirements) will evaluate the different combinations of pumps.

- Flowrate = 240 cfs to 443 cfs
- Flowrate varies for each pump discharge line
- Maximum Velocity = 10 fps

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$A = Q/V$

The headloss through the discharge piping was calculated using the velocity head of the pipe for minor losses and the Hazen-Williams Equation for the friction loss through the pipe.

Hazen-Williams Equation: $h_f = (3.022 * V^{1.85} * L) / (C^{1.85} * D^{1.17})$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
C = Roughness Coefficient (Used 145 for lined steel pipe)
L = Pipe Length (Estimated as 150-ft)

Results:

125 cfs Pumps

A = 125 cfs / 10 fps = 12.5 sf
D = 3.99 ft < 4.0 ft (48-in)

$A = (3.14*D^2)/4 = 12.6$ sf
V = 125 cfs / 12.6 sf = 9.92 fps
Velocity Head = $h_v = v^2/2g = 1.53$ ft
Wetted Perimeter = P = 12.6 ft
Hydraulic Radius = R = A/P = 12.6 sf / 12.6 ft = 1.0 ft
Entrance Loss = $0.5 * v^2/2g = .77$ ft
H_L= 0.63 ft
Check Valve = 0.50-ft
Flow Meter = 0.01-ft
Butterfly Valve = 0.55-ft
Exit Loss = $1.0 * v^2/2g = 1.53$ ft

Total Estimated Headloss = 3.99-ft

100 cfs Pumps

A = 100 cfs / 10 fps =10.00 sf
D = 3.56 ft < 4.0 ft (48-in)

A = $(3.14*D^2)/4$ = 12.6 sf
V = 100 cfs / 12.6 sf = 7.94 fps
Velocity Head = $h_v = v^2/2g$ = 0.98 ft
Wetted Perimeter = P = 12.6 ft
Hydraulic Radius = R = A/P = 12.6 sf / 12.6 ft = 1.0 ft
Entrance Loss = 0.5 * $v^2/2g$ = 0.49 ft
H_L= 0.51 ft
Check Valve = 0.35-ft
Flow Meter = 0.01-ft
Butterfly Valve = 0.35-ft
Exit Loss = 1.0 * $v^2/2g$ = 0.98 ft

Total Estimated Headloss = 2.69-ft

90 cfs Pumps

A = 90 cfs / 10 fps = 9.00 sf
D = 3.39 ft < 3.5 ft (42-in)

A = $(3.14*D^2)/4$ = 9.62 sf
V = 90 cfs / 9.6 sf = 9.38 fps
Velocity Head = $h_v = v^2/2g$ = 1.36 ft
Wetted Perimeter = P = 11.0 ft
Hydraulic Radius = R = A/P = 9.6 sf / 11.0 ft = 0.87 ft
Entrance Loss = 0.5 * $v^2/2g$ = 0.68 ft
H_L= 0.66 ft
Check Valve = 0.45-ft
Flow Meter = 0.01-ft
Butterfly Valve = 0.50-ft
Exit Loss = 1.0 * $v^2/2g$ = 1.36 ft

Total Estimated Headloss = 3.66-ft

80 cfs Pumps

A = 80 cfs / 10 fps = 8.0 sf
D = 3.19 ft < 3.5 ft (42-in)

A = $(3.14*D^2)/4$ = 9.62 sf
V = 80 cfs / 9.6 sf = 8.33 fps
Velocity Head = $h_v = v^2/2g$ = 1.08 ft
Wetted Perimeter = P = 11.0 ft
Hydraulic Radius = R = A/P = 9.6 sf / 11.0 ft = 0.875 ft
Entrance Loss = 0.5 * $v^2/2g$ = 0.54 ft
H_L= 0.53 ft
Check Valve = 0.35-ft
Flow Meter = 0.01-ft
Butterfly Valve = 0.40-ft
Exit Loss = 1.0 * $v^2/2g$ = 1.08 ft

Total Estimated Headloss = 2.91-ft

65 cfs Pumps

A = 65 cfs / 10 fps = 6.5 sf
D = 2.88 ft < 3.0 ft (36-in)

A = $(3.14*D^2)/4$ = 7.07 sf
V = 65 cfs / 7.07 sf = 9.19 fps
Velocity Head = $h_v = v^2/2g$ = 1.31 ft
Wetted Perimeter = P = 9.42 ft
Hydraulic Radius = R = A/P = 7.1 sf / 9.4 ft = 0.75 ft
Entrance Loss = $0.5 * v^2/2g$ = 0.66 ft
H_L= 0.76 ft
Check Valve = 0.55-ft
Flow Meter = 0.01-ft
Butterfly Valve = 0.50-ft
Exit Loss = $1.0 * v^2/2g$ = 1.31 ft

Total Estimated Headloss = 3.79-ft

60 cfs Pumps

A = 60 cfs / 10 fps = 6.0 sf
D = 2.76 ft < 3.0 ft (36-in)

A = $(3.14*D^2)/4$ = 7.07 sf
V = 60 cfs / 7.07 sf = 8.49 fps
Velocity Head = $h_v = v^2/2g$ = 1.12 ft
Wetted Perimeter = P = 9.42 ft
Hydraulic Radius = R = A/P = 7.1 sf / 9.4 ft = 0.75 ft
Entrance Loss = $0.5 * v^2/2g$ = 0.56 ft
H_L= 0.66 ft
Check Valve = 0.45-ft
Flow Meter = 0.01-ft
Butterfly Valve = 0.45-ft
Exit Loss = $1.0 * v^2/2g$ = 1.12 ft

Total Estimated Headloss = 3.25-ft

50 cfs Pumps

A = 50 cfs / 10 fps = 5.0 sf
D = 2.52 ft < 3.0 ft (36-in)

A = $(3.14*D^2)/4$ = 7.07 sf
V = 50 cfs / 7.07 sf = 7.07 fps
Velocity Head = $h_v = v^2/2g$ = 0.78 ft
Wetted Perimeter = P = 9.42 ft
Hydraulic Radius = R = A/P = 7.07 sf / 9.42 ft = 0.75 ft
Entrance Loss = $0.5 * v^2/2g$ = 0.39 ft
H_L= 0.57 ft
Check Valve = 0.32-ft
Flow Meter = 0.01-ft
Butterfly Valve = 0.26-ft
Exit Loss = $1.0 * v^2/2g$ = 0.78 ft

Total Estimated Headloss = 2.33-ft

40 cfs Pumps

A = 40 cfs / 10 fps = 4.00 sf
D = 2.26 ft < 2.5 ft (30-in)

A = $(3.14*D^2)/4$ = 4.91 sf

V = 40 cfs / 4.91 sf = 8.15 fps
Velocity Head = $h_v = v^2/2g$ = 1.03 ft
Wetted Perimeter = P = 7.85 ft
Hydraulic Radius = R = A/P = 4.91 sf / 7.85 ft = 0.63 ft
Entrance Loss = 0.5 * $v^2/2g$ = 0.52 ft
H_L= 0.76 ft
Check Valve = 0.45-ft
Flow Meter = 0.01-ft
Butterfly Valve = 0.45-ft
Exit Loss = 1.0 * $v^2/2g$ = 1.03 ft

Total Estimated Headloss = 3.22-ft

<u>30 cfs Pumps</u>
A = 30 cfs / 10 fps = 3.00 sf
D = 1.95 ft < 2.0 ft (24-in)

A = $(3.14*D^2)/4$ = 3.14 sf
V = 30 cfs / 3.14 sf = 9.55 fps
Velocity Head = $h_v = v^2/2g$ = 1.42 ft
Wetted Perimeter = P = 6.28 ft
Hydraulic Radius = R = A/P = 3.14 sf / 6.28 ft = 0.50 ft
Entrance Loss = 0.5 * $v^2/2g$ = 0.71 ft
H_L= 1.31 ft
Check Valve = 0.50-ft
Flow Meter = 0.01-ft
Butterfly Valve = 0.50-ft
Exit Loss = 1.0 * $v^2/2g$ = 1.42 ft

Total Estimated Headloss = 4.45 ft

<u>Table 18</u>

Pump Station Discharge Pipe Size Summary			
Pump Capacity (cfs)	Pipe Size (in)	Velocity (fps)	Estimated Headloss (ft)
125	48	9.92	3.99
100	48	7.94	2.69
90	42	9.38	3.66
80	42	8.33	2.91
65	36	9.19	3.79
60	36	8.49	3.25
50	36	7.07	2.33
40	30	8.15	3.22
30	24	9.55	4.45

1. Pump discharge piping does not take into consideration the pump column pipe size or valve/meter sizes at this time. Size recommendations solely based on pipe velocity.

b) Pipe Materials

The pump station discharge piping configuration is evaluated and discussed in the Technical Memorandum No. 4. The selected configuration will dictate what the flow capacities are for each discharge pipeline. However, generally speaking, Table 18 above, estimates the discharge pipe size for the given flows.

It is anticipated that the above ground discharge piping will be either fusion bonded epoxy lined and coated steel pipe or cement mortar lined and exterior painted steel pipe. Fusion bonded epoxy lined or cement mortar lined steel pipe is preferred in above ground installations where it is subject to inclement weather, UV exposure, seismic events, or nearby to traffic and vehicular access. The underground piping could be PVC pipe, HDPE pipe, FBE steel pipe, or CMLC steel pipe. The pipe class or pressure rating will depend on the pump selection and the associated shutoff head of each pump. However, for purposes of this evaluation a minimum pressure class of 50 psi has been estimated and is figured to be conservative.

c) Material Recommendations

The pump station discharge piping is estimated to be approximately 150-ft in length. The FBE lined steel pipe is estimated as the following costs per foot:

Table 19

Pump Station Discharge Piping Fusion Bonded Epoxy Lined Steel Pipe		
Nominal Diameter (in)	Material Pipe Cost ($/LF)	Material + Install Pipe Cost ($/LF)
24	$120.00	$210.00
30	$148.20	$238.50
36	$161.20	$287.83
42	$190.80	$321.00
48	$220.00	$356.38

The CML steel pipe is estimated as the following cost per foot:

Table 20

Pump Station Discharge Piping Cement Mortar Lined Steel Pipe		
Nominal Diameter (in)	Material Pipe Cost ($/LF)	Material + Install Pipe Cost ($/LF)
24	$100.00	$190.00
30	$123.50	$213.50
36	$171.00	$257.83
42	$194.00	$305.00
48	$220.00	$336.38

The underground piping may be plastic rather than FBE or CMLC steel pipe.

The SDR51 and DR51 PVC pipe is estimated as the following cost per foot:

Table 21

Pump Station Discharge Piping PVC Pipe (DR51 and SDR51)		
Nominal Diameter (in)	Material Pipe Cost ($/LF)	Material + Install Pipe Cost ($/LF)
24	$36.53	$95.53
27	$50.56	$111.56
30	$68.31	$132.31
36	$99.14	$187.14
42	$131.23	$223.73
48	$165.80	$263.80

The DR32.5 HDPE pipe is estimated as the following cost per foot:

Table 22

Pump Station Discharge Piping HDPE Pipe (DR32.5 and DR41)		
Nominal Diameter (in)	Material Pipe Cost ($/LF)	Material + Install Pipe Cost ($/LF)
24	$34.34	$96.34
30	$54.35	$142.35
36	$58.30	$184.30
42	$72.40	$210.40
48	$88.00	$240.00

F. Phase II Turnout

a) Sizing Criteria

The Phase II Turnout is currently illustrated with two turnouts – one on the north side of the conveyance canal and one on the south side of the conveyance canal. This results in a turnout capacity of 96 cfs each. However, this is subject to change based on the actual location of the Phase II Property and the canal alignment. In addition, it may be more cost efficient to install multiple turnouts such that there is a canal turnout to each recharge basin. This could result in four turnouts (2 each side) and reduce the capacity of the turnouts to approximately 48 cfs each.

The design flow per turnout for four turnouts to the Phase II Property is 48 cfs each.

- Flowrate = 48 cfs
- Maximum Velocity = 5 fps
- Pipe Diameter = Approximate 48-in (4.0-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$A = Q/V$

The headloss through the turnout piping was calculated using the velocity head of the pipe for minor entrance and exit losses and the Manning's Equation for the friction loss through the pipe.

Manning's Equation: $V = (1.49/n)*R^{2/3}*S^{1/2}$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
n = Material Coefficient (Used 0.012 for ADS HDPE pipe)
L = Pipe Length (Estimated as 150-ft)

Results:

A = 48 cfs / 5 fps = 9.6 sf
D = 3.49 ft < 4.0 ft (48-in)
D = 47.24" I.D.

$A = (3.14*D^2)/4 = 12.2$ sf
V = 48 cfs / 12.6 sf = 3.93 fps
Velocity Head = $h_v = v^2/2g = 0.24$ ft
Wetted Perimeter = P = 12.4 ft
Hydraulic Radius = R = A/P = 12.2 sf / 12.4 ft = 0.98 ft
Entrance Loss = $0.5 * v^2/2g = 0.12$ ft
H_L= 1.02 ft / 1,000 ft
Exit Loss = $1.0 * v^2/2g = 0.24$ ft

Total Estimated Headloss = 0.51-ft

Design the turnout piping so that the control water surface submerges the pipe at the headwall structure a minimum 1.78 times h_v plus 3-inches or approximately 8-inches.

b) Pipe Materials

The District desires to standardize the turnout piping to be 48-inch diameter. This will allow them to have uniform sizes for precast structures, slide gates, and stop log slots or weir boards.

The 48-inch diameter turnout piping is a size which falls within the availability of PVC, HDPE, CMLC, or RCP. The PVC pipe would be a pressure class 80 psi (DR51) pipe with a nominal interior diameter of 49.69-inches and an outside diameter of 50.80 inches. The HDPE pipe would be a pressure class of 50 psi (DR41) pipe with a nominal interior diameter of 45.52-inches and an outside diameter of 48.00-inches. The ADS N-12 corrugated HDPE pipe is also an alternative and has an O.D. of 54-inches and an I.D. of 47.24-inches. The cement

mortar lined and coated steel pipe would have a ¼-inch wall thickness, ½-inch thick lining, and ¾-inch thick coating. The wet cast and dry cast RCP pipe would be ASTM C361 pipe, C25 double gasketed pipe. The "C" designation signifies that the pipe is suitable for earth cover over the top of the pipe up to 15-ft. The "25" designation signifies that the pipe can handle hydrostatic heads up to 25-ft above the centerline of the pipe.

c) Material Recommendations

The turnout piping is estimated to be approximately 150-ft in length. The PVC pipe is estimated as $166 per lineal foot material cost and $264 per lineal foot material and installation. The HDPE pipe is estimated as $88 per lineal foot material cost and $240 per lineal foot for material and installation. The ADS N-12 pipe is estimated as $93 per lineal foot material cost and $161 per lineal foot material and installation. The CMLC steel pipe is estimated as $220 per lineal foot material cost and $336 per lineal foot for material and installation. The wet cast RCP is estimated as $486 per lineal foot material cost and $581 per lineal foot for material and installation while the dry cast RCP is estimated as $174 per lineal foot material cost and $268 per lineal foot for material and installation.

The ADS N-12 HDPE pipe is the most economical pipe material for the turnout piping and is a preferred material by the District. Therefore, it is recommended that ADS N-12 HDPE pipe be utilized at the Phase II turnouts.

G. West Basins Turnout

a) Sizing Criteria

Alternative 1: Reach 4 Open Channel Design

The West Basins Turnout is illustrated in the 30% Preliminary Design Report as one turnout with four barrels discharging water into the canal that supplies the easterly boundary of the West Basins. However, if Reach 4 is an open channel then a single turnout at the end of Reach 4 to the West Basins could be two barrels each 48" diameter in size.

The design flow for a two barrel design to the West Basins Property is 52.5 cfs per barrel.

- Flowrate = 52.5 cfs
- Maximum Velocity = 5 fps
- Pipe Diameter = Approximate 48-in (4.0-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$A = Q/V$

The headloss through the turnout piping was calculated using the velocity head of the pipe for minor entrance and exit losses and the Manning's Equation for the friction loss through the pipe.

Manning's Equation: $V = (1.49/n)*R^{2/3}*S^{1/2}$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
n = Material Coefficient (Used 0.012 for ADS HDPE pipe)
L = Pipe Length (Estimated as 200-ft)

Results:

A = 52.5 cfs / 5 fps = 10.5 sf
D = 3.65 ft < 4.0 ft (48-in)
D = 47.24" I.D.

$A = (3.14*D^2)/4 = 12.2$ sf
V = 52.5 cfs / 12.6 sf = 4.30 fps
Velocity Head = $h_v = v^2/2g = 0.29$ ft
Wetted Perimeter = P = 12.4 ft
Hydraulic Radius = R = A/P = 12.2 sf / 12.4 ft = 0.98 ft
Entrance Loss = $0.5 * v^2/2g = 0.15$ ft
H_L= 1.23 ft / 1,000 ft
Exit Loss = $1.0 * v^2/2g = 0.29$ ft

Total Estimated Headloss = 0.69-ft

Design the turnout piping so that the control water surface submerges the pipe at the headwall structure a minimum 1.78 times h_v plus 3-inches or approximately 10-inches.

Alternative 2: Reach 4 Closed Conduit Design

If multiple turnouts are constructed along a closed conduit design then it is anticipated that there may be four turnouts ranging in capacity from 18 cfs to 37.5 cfs.

The turnout piping is anticipated to be 36-inch diameter HDPE piping.

- Flowrate = 18 cfs
- Maximum Velocity = 5 fps
- Pipe Diameter = Approximate 36-in (3.0-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$A = Q/V$

The headloss through the turnout piping was calculated using the velocity head of the pipe for minor entrance and exit losses and the Manning's Equation for the friction loss through the pipe.

Manning's Equation: $V = (1.49/n)*R^{2/3}*S^{1/2}$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
n = Material Coefficient (Used 0.009 for HDPE pipe)
L = Pipe Length (Estimated as 200-ft)

Results:

A = 18 cfs / 5 fps = 3.6 sf
D = 2.14 ft < 3.0 ft (36-in)
D = 34.14" I.D.

$A = (3.14*D^2)/4 = 6.4$ sf
V = 18 cfs / 6.4 sf = 2.81 fps
Velocity Head = $h_v = v^2/2g = 0.12$ ft
Wetted Perimeter = P = 8.9 ft
Hydraulic Radius = R = A/P = 6.4 sf / 8.9 ft = 0.72 ft
Entrance Loss = $0.5 * v^2/2g = 0.06$ ft
H_L= 0.45 ft / 1,000 ft
Exit Loss = $1.0 * v^2/2g = 0.12$ ft

Total Estimated Headloss = 0.27-ft

Design the turnout piping so that the control water surface submerges the pipe at the headwall structure a minimum 1.78 times h_v plus 3-inches or approximately 6-inches.

- Flowrate = 37.5 cfs
- Maximum Velocity = 5 fps
- Pipe Diameter = Approximate 36-in (3.0-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

A = Q/V

The headloss through the turnout piping was calculated using the velocity head of the pipe for minor entrance and exit losses and the Manning's Equation for the friction loss through the pipe.

Manning's Equation: $V = (1.49/n)*R^{2/3}*S^{1/2}$

Where:

Q = Flow (cfs)
V = Velocity (fps)

D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
n = Material Coefficient (Used 0.009 for HDPE pipe)
L = Pipe Length (Estimated as 200-ft)

Results:

A = 37.5 cfs / 5 fps = 7.5 sf
D = 3.1 ft $\leq$ 3.0 ft (36-in)
D = 34.14" I.D.

$A = (3.14*D^2)/4 = 6.4$ sf
V = 37.5 cfs / 6.4 sf = 5.86 fps
Velocity Head = $h_v = v^2/2g = 0.53$ ft
Wetted Perimeter = P = 8.9 ft
Hydraulic Radius = R = A/P = 6.4 sf / 8.9 ft = 0.72 ft
Entrance Loss = $0.5 * v^2/2g = 0.27$ ft
H_L= 1.95 ft / 1,000 ft
Exit Loss = $1.0 * v^2/2g = 0.53$ ft

Total Estimated Headloss = 1.19-ft

Design the turnout piping so that the control water surface submerges the pipe at the headwall structure a minimum 1.78 times h_v plus 3-inches or approximately 15-inches.

b) Pipe Materials

The District desires to standardize the turnout piping to be 36-in or 48-inch diameter. This will allow them to have uniform sizes for precast structures, slide gates, and stop log slots or weir boards. A single turnout to the West Basins at the end of an open channel design in Reach 4 is anticipated to be two 48-inch barrels. If Reach 4 is a closed conduit design with four turnouts to the West Basins along the pipeline, then it is anticipated that each turnout will be a 36-inch diameter branch from the DR41 HDPE pipeline and controlled by a 36-inch diameter butterfly valve. The material recommendations below are for a single turnout to the West Basins at the end of an open channel design.

The 48-inch diameter turnout piping is a size which falls within the availability of PVC, HDPE, CMLC, or RCP. The PVC pipe would be a pressure class 80 psi (DR51) pipe with a nominal interior diameter of 49.69-inches and an outside diameter of 50.80 inches. The HDPE pipe would be a pressure class of 50 psi (DR41) pipe with a nominal interior diameter of 45.52-inches and an outside diameter of 48.00-inches. The ADS N-12 corrugated HDPE pipe is also an alternative and has an O.D. of 54-inches and an I.D. of 47.24-inches. The cement mortar lined and coated steel pipe would have a ¼-inch wall thickness, ½-inch thick lining, and ¾-inch thick coating. The wet cast and dry cast RCP pipe would be ASTM C361 pipe, C25 double gasketed pipe. The "C" designation signifies that the pipe is suitable for earth cover over the top of the pipe up to 15-ft. The "25" designation signifies that the pipe can handle hydrostatic heads up to 25-ft above the centerline of the pipe.

c) Material Recommendations

The turnout piping is estimated to be approximately 200-ft in length. The PVC pipe is estimated as $166 per lineal foot material cost and $264 per lineal foot material and installation. The HDPE pipe is estimated as $88 per lineal foot material cost and $240 per lineal foot for material and installation. The ADS N-12 pipe is estimated as $93 per lineal foot material cost and $161 per lineal foot material and installation. The CMLC steel pipe is estimated as $220 per lineal foot material cost and $336 per lineal foot for material and installation. The wet cast RCP is estimated as $486 per lineal foot material cost and $581 per lineal foot for material and installation while the dry cast RCP is estimated as $174 per lineal foot material cost and $268 per lineal foot for material and installation.

The ADS N-12 HDPE pipe is the most economical pipe material for the turnout piping and is a preferred material by the District. Therefore, it is recommended that ADS N-12 HDPE pipe be utilized at the West Basin turnouts. However, if a closed conduit system is utilized using DR41 HDPE then it is likely that the turnouts will also be DR41 HDPE pipe.

H. Phase I Turnout

a) Sizing Criteria

The Phase I Turnout is currently illustrated as one turnout with two barrels discharging into the Phase I property.

The design flow for a two barrel design to the Phase I Property is 52.5 cfs per barrel.

- Flowrate = 52.5 cfs
- Maximum Velocity = 5 fps
- Pipe Diameter = Approximate 48-in (4.0-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$$A = Q/V$$

The headloss through the turnout piping was calculated using the velocity head of the pipe for minor entrance and exit losses and the Manning's Equation for the friction loss through the pipe.

Manning's Equation: $V = (1.49/n)*R^{2/3}*S^{1/2}$

<u>Where</u>:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area

R = Hydraulic Radius
S = Slope
n = Material Coefficient (Used 0.012 for ADS HDPE pipe)
L = Pipe Length (Estimated as 200-ft)

Results:

A = 52.5 cfs / 5 fps = 10.5 sf
D = 3.65 ft < 4.0 ft (48-in)
D = 47.24" I.D.

$A = (3.14*D^2)/4 = 12.2$ sf
V = 52.5 cfs / 12.6 sf = 4.30 fps
Velocity Head = $h_v = v^2/2g = 0.29$ ft
Wetted Perimeter = P = 12.4 ft
Hydraulic Radius = R = A/P = 12.2 sf / 12.4 ft = 0.98 ft
Entrance Loss = $0.5 * v^2/2g = 0.15$ ft
H_L= 1.23 ft / 1,000 ft
Exit Loss = $1.0 * v^2/2g = 0.29$ ft

Total Estimated Headloss = 0.69-ft

Design the turnout piping so that the control water surface submerges the pipe at the headwall structure a minimum 1.78 times h_v plus 3-inches or approximately 10-inches.

b) Pipe Materials

The District desires to standardize the turnout piping to be 48-inch diameter. This will allow them to have uniform sizes for precast structures, slide gates, and stop log slots or weir boards. A single turnout to the Phase I Property at the end of an open channel design is anticipated to be two 48-inch barrels. If Reach 4 is a closed conduit design that continues all the way to the Phase I Property, then it is anticipated that the pipeline and the discharge to the Phase I property will be a 54-inch DR41 HDPE pipeline. The material recommendations below are for a single turnout to the Phase I Property at the end of an open channel design.

The 48-inch diameter turnout piping is a size which falls within the availability of PVC, HDPE, CMLC, or RCP. The PVC pipe would be a pressure class 80 psi (DR51) pipe with a nominal interior diameter of 49.69-inches and an outside diameter of 50.80 inches. The HDPE pipe would be a pressure class of 50 psi (DR41) pipe with a nominal interior diameter of 45.52-inches and an outside diameter of 48.00-inches. The ADS N-12 corrugated HDPE pipe is also an alternative and has an O.D. of 54-inches and an I.D. of 47.24-inches. The cement mortar lined and coated steel pipe would have a ¼-inch wall thickness, ½-inch thick lining, and ¾-inch thick coating. The wet cast and dry cast RCP pipe would be ASTM C361 pipe, C25 double gasketed pipe. The "C" designation signifies that the pipe is suitable for earth cover over the top of the pipe up to 15-ft. The "25" designation signifies that the pipe can handle hydrostatic heads up to 25-ft above the centerline of the pipe.

c) Material Recommendations

The turnout piping is estimated to be approximately 200-ft in length. The PVC pipe is estimated as $166 per lineal foot material cost and $264 per lineal foot

material and installation. The HDPE pipe is estimated as $88 per lineal foot material cost and $240 per lineal foot for material and installation. The ADS N-12 pipe is estimated as $93 per lineal foot material cost and $161 per lineal foot material and installation. The CMLC steel pipe is estimated as $220 per lineal foot material cost and $336 per lineal foot for material and installation. The wet cast RCP is estimated as $486 per lineal foot material cost and $581 per lineal foot for material and installation while the dry cast RCP is estimated as $174 per lineal foot material cost and $268 per lineal foot for material and installation.

The ADS N-12 HDPE pipe is the most economical pipe material for the turnout piping and is a preferred material by the District. Therefore, it is recommended that ADS N-12 HDPE pipe be utilized at the Phase I turnout. However, if a closed conduit system is utilized using DR41 HDPE then it is likely that the turnout will remain DR41 HDPE pipe.

I. Well Discharge Piping

a) Sizing Criteria

The Well Discharge Piping is the above ground piping and appurtenances from the well pump head to the transition below grade to the underground well conveyance piping.

The design flow for a well is 5 to 6 cfs.

- Flowrate = 6 cfs
- Maximum Velocity = 8 fps
- Pipe Diameter = Approximate 12-in (1-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$$A = Q/V$$

The headloss through the well discharge piping was calculated using the velocity head of the pipe for minor losses and the Hazen-Williams Equation for the friction loss through the pipe.

Hazen-Williams Equation: $h_f = (3.022 * V^{1.85} * L) / (C^{1.85} * D^{1.17})$

<u>Where</u>:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Roughness Coefficient (Used 145 for lined steel pipe)

L = Pipe Length (Estimated as 40-ft)

Results:

A = 6 cfs / 8 fps = 0.75 sf
D = 0.98 ft < 1.0 ft (12-in)

$A = (3.14*D^2)/4 = 0.78$ sf
V = 6 cfs / 0.78 sf = 7.64 fps
Velocity Head = $h_v = v^2/2g = 0.91$ ft
Wetted Perimeter = P = 3.1 ft
Hydraulic Radius = R = A/P = 0.78 sf / 3.1 ft = 0.25 ft
Entrance Loss = $0.5 * v^2/2g = 0.46$ ft
H_L= 0.52 ft
Check Valve = 2.7 ft
Flow Meter = 0.25 ft
Butterfly Valve = 0.40 ft
Minor Loss (90° Bend) = 0.18 ft
Exit Loss = $1.0 * v^2/2g = 0.91$ ft

Total Estimated Headloss = 5.42-ft

b) Pipe Materials

The well discharge piping will be fusion bonded epoxy lined and coated steel pipe. This is common for all the District wells. Fusion bonded epoxy steel pipe is preferred in above ground installations where it is subject to inclement weather, UV exposure, seismic events, or nearby to traffic and vehicular access.

c) Material Recommendations

The well discharge piping will be fusion bonded epoxy lined and coated steel pipe. The size is estimated as 12-inch diameter, however this is subject to change based on the actual well capacity at the time of design.

J. Well Conveyance Pipelines

a) Sizing Criteria

The Well Conveyance Piping is the below ground piping from the well discharge piping to the point of discharge typically at a canal. The pipeline lengths are subject to change, but have been estimated based on the feasibility study drawings for purposes of this analysis.

The design flow for the well conveyance piping from a single well is 6 cfs.

- Flowrate = 6 cfs
- Maximum Velocity = 5 fps
- Pipe Diameter = Approximate 15-in (1.25-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$A = Q/V$

The headloss through the well conveyance piping was calculated using the velocity head of the pipe for minor losses and the Hazen-Williams Equation for the friction loss through the pipe.

Hazen-Williams Equation: $h_f = (3.022 * V^{1.85} * L) / (C^{1.85} * D^{1.17})$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Roughness Coefficient (Used 150 for PVC pipe)
L = Pipe Length (Estimated as 1,830-ft)

Results:

A = 6 cfs / 5 fps = 1.2 sf
D = 1.22 ft < 1.25 ft (15-in)

$A = (3.14*D^2)/4 = 1.17$ sf
V = 6 cfs / 1.17 sf = 5.13 fps
Velocity Head = $h_v = v^2/2g = 0.41$ ft
Wetted Perimeter = P = 3.8 ft
Hydraulic Radius = R = A/P = 1.17 sf / 3.8 ft = 0.31 ft
Entrance Loss = $0.5 * v^2/2g = 0.22$ ft
H_L= 8.52 ft
Minor Losses (Bends) = 1.23 ft
Exit Loss = $1.0 * v^2/2g = 0.41$ ft

Total Estimated Headloss = 10.38-ft

The design flow for the well conveyance piping from two wells is 12 cfs.

- Flowrate = 12 cfs
- Maximum Velocity = 5 fps
- Pipe Diameter = Approximate 21-in (1.75-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$A = Q/V$

The headloss through the well conveyance piping was calculated using the velocity head of the pipe for minor losses and the Hazen-Williams Equation for the friction loss through the pipe.

Hazen-Williams Equation: $h_f = (3.022 * V^{1.85} * L) / (C^{1.85} * D^{1.17})$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Roughness Coefficient (Used 150 for PVC pipe)
L = Pipe Length (Estimated as 1,300-ft)

Results:

A = 12 cfs / 5 fps = 2.4 sf
D = 1.75 ft $\leq$ 1.75 ft (21-in)

$A = (3.14*D^2)/4 = 2.43$ sf
V = 12 cfs / 2.43 sf = 4.94 fps
Velocity Head = $h_v = v^2/2g = 0.38$ ft
Wetted Perimeter = P = 5.5 ft
Hydraulic Radius = R = A/P = 2.43 sf / 5.5 ft = 0.44 ft
Entrance Loss = $0.5 * v^2/2g = 0.19$ ft
H_L= 3.67 ft
Minor Losses (Bends) = 1.14 ft
Exit Loss = $1.0 * v^2/2g = 0.38$ ft

Total Estimated Headloss = 5.38-ft

The design flow for the well conveyance piping from three wells is 18 cfs.

- Flowrate = 18 cfs
- Maximum Velocity = 5 fps
- Pipe Diameter = Approximate 27-in (2.25-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$A = Q/V$

The headloss through the well conveyance piping was calculated using the velocity head of the pipe for minor losses and the Hazen-Williams Equation for the friction loss through the pipe.

Hazen-Williams Equation: $h_f = (3.022 * V^{1.85} * L) / (C^{1.85} * D^{1.17})$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Roughness Coefficient (Used 150 for PVC pipe)
L = Pipe Length (Estimated as 3,670-ft)

Results:

A = 18 cfs / 5 fps = 3.6 sf
D = 2.14 ft < 2.25 ft (27-in)

$A = (3.14*D^2)/4 = 3.97$ sf
V = 18 cfs / 3.97 sf = 4.53 fps
Velocity Head = $h_v = v^2/2g = 0.32$ ft
Wetted Perimeter = P = 7.1 ft
Hydraulic Radius = R = A/P = 3.97 sf / 7.1 ft = 0.56 ft
Entrance Loss = $0.5 * v^2/2g = 0.16$ ft
H_L= 6.62 ft
Minor Losses (Bends) = 0.96 ft
Exit Loss = $1.0 * v^2/2g = 0.32$ ft

Total Estimated Headloss = 8.06-ft

The design flow for the well conveyance piping from four wells is 24 cfs.

- Flowrate = 24 cfs
- Maximum Velocity = 5 fps
- Pipe Diameter = Approximate 30-in (2.5-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$A = Q/V$

The headloss through the well conveyance piping was calculated using the velocity head of the pipe for minor losses and the Hazen-Williams Equation for the friction loss through the pipe.

Hazen-Williams Equation: $h_f = (3.022 * V^{1.85} * L) / (C^{1.85} * D^{1.17})$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Roughness Coefficient (Used 150 for PVC pipe)
L = Pipe Length (Estimated as 1,500-ft)

Results:

A = 24 cfs / 5 fps = 4.8 sf
D = 2.47 ft < 2.5 ft (30-in)

$A = (3.14*D^2)/4 = 4.91$ sf
V = 24 cfs / 4.91 sf = 4.89 fps
Velocity Head = $h_v = v^2/2g = 0.37$ ft
Wetted Perimeter = P = 7.85 ft
Hydraulic Radius = R = A/P = 4.91 sf / 7.85 ft = 0.63 ft
Entrance Loss = $0.5 * v^2/2g = 0.19$ ft

H_L= 2.76 ft
Minor Losses (Bends) = 1.11 ft
Exit Loss = 1.0 * $v^2/2g$ = 0.37 ft

Total Estimated Headloss = 4.43-ft

The design flow for the well conveyance piping from six wells is 36 cfs.

- Flowrate = 36 cfs
- Maximum Velocity = 5 fps
- Pipe Diameter = Approximate 36-in (3.0-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$A = Q/V$

The headloss through the well conveyance piping was calculated using the velocity head of the pipe for minor losses and the Hazen-Williams Equation for the friction loss through the pipe.

Hazen-Williams Equation: $h_f = (3.022 * V^{1.85} * L) / (C^{1.85} * D^{1.17})$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
C = Roughness Coefficient (Used 150 for PVC pipe)
L = Pipe Length (Estimated as 1,500-ft)

Results:

A = 36 cfs / 5 fps = 7.2 sf
D = 3.03 ft $\leq$ 3.0 ft (36-in)

A = $(3.14*D^2)/4$ = 7.07 sf
V = 36 cfs / 7.1 sf = 5.07 fps
Velocity Head = $h_v = v^2/2g$ = 0.40 ft
Wetted Perimeter = P = 9.42 ft
Hydraulic Radius = R = A/P = 7.07 sf / 9.42 ft = 0.75 ft
Entrance Loss = 0.5 * $v^2/2g$ = 0.20 ft
H_L= 2.38 ft
Minor Losses (Bends) = 1.20 ft
Exit Loss = 1.0 * $v^2/2g$ = 0.40 ft

Total Estimated Headloss = 4.18-ft

Table 23

Well Conveyance Pipe Sizing Summary			
Turnout Capacity (cfs)	Number of Wells	Pipe Size (in)	Estimated Headloss (ft)
6	1	15	10.38
12	2	21	5.38
18	3	27	8.06
24	4	30	4.43
36	6	36	4.18

b) Pipe Materials

The 16-inch to 36-inch diameter well conveyance piping is a size which falls within the availability of PVC, HDPE, or CMLC, however plastic pipe would be the preferred material.

The ASTM D2241 PIP PVC pipe would be a pressure class 80 psi (SDR 51) pipe with the following nominal diameters:

- 15" 15.30" O.D. and 14.66" I.D.
- 18" 18.70" O.D. and 17.92" I.D.
- 21" 22.05" O.D. and 21.13" I.D.
- 24" 24.80" O.D. and 23.77" I.D.
- 27" 27.95" O.D. and 26.79" I.D.

The AWWA C905 PVC pipe would be a pressure class 80 psi (DR 51) with the following nominal pipe diameters:

- 30" 32.00" O.D. and 30.67" I.D.
- 36" 38.30" O.D. and 36.71" I.D.

The HDPE pipe would be a pressure class of 63 psi (DR32.5) and 50 psi (DR41) pipe with the following nominal pipe diameters:

- 16" 16.00" O.D. and 14.96" I.D.
- 24" 24.00" O.D. and 22.44" I.D.
- 30" 30.00" O.D. and 28.04" I.D.
- 36" 36.00" O.D. and 34.14" I.D.

c) Material Recommendations

The well conveyance piping is estimated to be approximately 1,300-ft to 3,600-ft in length for each pipe size. The ASTM D2241 SDR51 PIP PVC pipe is estimated as the following cost per foot:

Table 24

Well Conveyance Piping		
SDR51 PIP PVC Pipe		
Nominal Diameter (in)	Material Pipe Cost ($/LF)	Material + Install Pipe Cost ($/LF)
15	$18.17	$62.17
18	$19.98	$77.98
21	$28.76	$89.76
24	$36.53	$95.53
27	$50.56	$111.56

The AWWA C905 DR51 PVC pipe is estimated as the following cost per foot:

Table 25

Well Conveyance Piping		
C905 DR51 PVC Pipe		
Nominal Diameter (in)	Material Pipe Cost ($/LF)	Material + Install Pipe Cost ($/LF)
30	$68.31	$132.31
36	$99.14	$187.14

The DR32.5 and DR41 HDPE pipe is estimated as the following cost per foot:

Table 26

Well Conveyance Piping		
DR32.5 HDPE Pipe		
Nominal Diameter (in)	Material Pipe Cost ($/LF)	Material + Install Pipe Cost ($/LF)
16	$17.24	$67.24
24	$34.34	$96.34
30	$54.35	$142.35
36	$58.30	$184.30

Based on the costs above it is recommended that PVC pipe be installed for the well conveyance pipelines utilizing ASTM D2241 PIP PVC pipe in sizes 27-inches and smaller and AWWA C905 PVC pipe or HDPE pipe for sizes 30-inches and larger.

The size and pressure class of pipe are estimated, however this is subject to change based on the actual well capacity and conveyance pipeline configuration at the time of design. In addition, it is recommended that multiple pipe options such as PVC and HDPE be included in the bid to identify the most economical pipe between PVC and HDPE.

K. Interbasin Piping

a) Sizing Criteria

The Interbasin piping is the piping in between recharge basins that are used for the conveyance of water between basins. These are anticipated to be precast structures with weir boards for regulating flow and water level and the piping installed beneath the levee to a discharge point in the downstream basin. The District would like to standardize the size of the interbasin piping to be 36-inch or 48-inch diameter.

The design flow for a 36" single barrel design is 24 to 30 cfs.

- Flowrate = 30 cfs
- Maximum Velocity = 5 fps
- Pipe Diameter = Approximate 36-in (3.0-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$A = Q/V$

The headloss through the turnout piping was calculated using the velocity head of the pipe for minor entrance and exit losses and the Manning's Equation for the friction loss through the pipe.

Manning's Equation: $V = (1.49/n)*R^{2/3}*S^{1/2}$

<u>Where</u>:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
n = Material Coefficient (Used 0.012 for ADS HDPE pipe)
L = Pipe Length (Estimated as 60-ft)

<u>Results</u>:

A = 30 cfs / 5 fps = 6.0 sf
D = 2.76 ft < 3.0 ft (36-in)
D = 35.43" I.D.

$A = (3.14*D^2)/4 = 6.8$ sf
V = 30 cfs / 6.8 sf = 4.41 fps
Velocity Head = $h_v = v^2/2g = 0.30$ ft
Wetted Perimeter = P = 9.3 ft
Hydraulic Radius = R = A/P = 6.8 sf / 9.3 ft = 0.73 ft
Entrance Loss = $0.5 * v^2/2g = 0.15$ ft
H_L= 1.91 ft / 1,000 ft
Exit Loss = $1.0 * v^2/2g = 0.30$ ft

Total Estimated Headloss = 0.56-ft

Design the interbasin piping so that the control water surface submerges the pipe at the headwall structure a minimum 1.78 times h_v plus 3-inches or approximately 10-inches.

The design flow for a 48" single barrel design is 55 to 60 cfs.

- Flowrate = 60 cfs
- Maximum Velocity = 5 fps
- Pipe Diameter = Approximate 48-in (4.0-ft) Internal Diameter

The continuity equation was used to solve for the cross-sectional area of the pipe and the pipe diameter given the design flow and maximum velocity.

$A = Q/V$

The headloss through the turnout piping was calculated using the velocity head of the pipe for minor entrance and exit losses and the Manning's Equation for the friction loss through the pipe.

Manning's Equation: $V = (1.49/n)*R^{2/3}*S^{1/2}$

Where:

Q = Flow (cfs)
V = Velocity (fps)
D = Diameter (ft)
A = Pipe Internal Cross-Sectional Area
R = Hydraulic Radius
S = Slope
n = Material Coefficient (Used 0.012 for ADS HDPE pipe)
L = Pipe Length (Estimated as 60-ft)

Results:

A = 60 cfs / 5 fps = 12.0 sf
D = 3.91 ft < 4.0 ft (48-in)
D = 47.24" I.D.

$A = (3.14*D^2)/4 = 12.18$ sf
V = 60 cfs / 12.18 sf = 4.93 fps
Velocity Head = $h_v = v^2/2g = 0.38$ ft
Wetted Perimeter = P = 12.4 ft
Hydraulic Radius = R = A/P = 12.2 sf / 12.4 ft = 0.98 ft
Entrance Loss = $0.5 * v^2/2g = 0.19$ ft
H_L= 1.61 ft / 1,000 ft
Exit Loss = $1.0 * v^2/2g = 0.38$ ft

Total Estimated Headloss = 0.67-ft

Design the interbasin piping so that the control water surface submerges the pipe at the headwall structure a minimum 1.78 times h_v plus 3-inches or approximately 12-inches.

b) Pipe Materials

The District desires to standardize the interbasin piping to be 36-inch or 48-inch diameter piping. This will allow them to have uniform sizes for precast structures and stop log slots or weir boards.

The 36-inch and 48-inch diameter turnout piping is a size which falls within the availability of PVC, HDPE, CMLC, or RCP.

The AWWA C905 DR51 PVC pipe would be a pressure class 80 psi. The 36" PVC pipe has a 38.30" O.D. and a 36.71" I.D. The 48" PVC pipe has a 50.80" O.D. and a 49.69" I.D.

The HDPE pipe would be a pressure class 50 psi (DR 41). The 36" HDPE pipe has a 36.00" O.D. and a 34.14" I.D or the pipe could be a ADS Dual Wall HDPE Pipe, corrugated with a smooth interior wall and watertight joint. The ADS Dual Wall HDPE has an O.D. of 42.00" and an I.D. of 36.00". The 48" HDPE pipe has a 48.00" O.D. and a 45.52" I.D or the pipe could be a ADS Dual Wall HDPE Pipe, corrugated with a smooth interior wall and watertight joint. The ADS Dual Wall HDPE has an O.D. of 54.00" and an I.D. of 48.00".

The cement mortar lined and coated steel pipe would have a ¼-inch wall thickness, ½-inch thick lining, and ¾-inch thick coating. The 36" pipe has a 37.50" O.D. and a 34.50" I.D.

The ASTM C361 C25 double gasketed RCP would be suitable for hydrostatic heads up to 25-ft from the centerline of the pipe. The 36" RCP has a bell outside diameter of 50.25" O.D. and a 36" I.D.

c) Material Recommendations

The 36" interbasin piping is estimated to be approximately 60-ft in length. The PVC pipe is estimated as $99 per lineal foot material cost and $187 per lineal foot for material and installation. The HDPE pipe is estimated as $58 per lineal foot material cost and $184 per lineal foot for material and installation while the ADS pipe is estimated as $57 per lineal foot material cost and $117 per lineal foot for material and installation.

The 48" interbasin piping is estimated to be approximately 60-ft in length. The PVC pipe is estimated as $166 per lineal foot material cost and $264 per lineal foot for material and installation. The HDPE pipe is estimated as $88 per lineal foot material cost and $240 per lineal foot for material and installation while the ADS pipe is estimated as $93 per lineal foot material cost and $161 per lineal foot for material and installation.

<u>The ADS Dual-Wall HDPE pipe is the most economical pipe material for the interbasin piping. This pipe material is preferred for this application as it is corrosion resistant, has good strength, and the corrugations help extend the seepage path.</u>

V. Summary

The type and size of piping has been evaluated for each of the major project components. These are summarized below in Table 27.

Table 27

Project Facility	Nominal Pipe Size	Pipe Type
Aqueduct Turnout	108-inch	D50 Dry Cast RCP
Adohr Road Siphon	120-inch	C25 Dry Cast RCP
East Side Canal Siphon	120-inch	C25 Dry Cast RCP
Reach 2 Farm Road Siphon	120-inch	C25 Dry Cast RCP
Reach 3 Farm Road Siphon	120-inch	C25 Dry Cast RCP
Reach 4 Farm Road Siphon	90-inch	C25 Dry Cast RCP
Stockdale Hwy Cased Crossing Carrier Pipe	120-inch	D25 Dry Cast RCP
I-5 Fwy Cased Crossing Carrier Pipe	120-inch	D25 Dry Cast RCP
Reach 4 Conveyance Piping	63-inch and 54-inch	DR41 HDPE
Phase II Turnout	48-inch	ADS N12 WT HDPE
West Basins Turnout (Open Channel Design)	48-inch (2 Barrels)	ADS N12 WT HDPE
West Basins Turnout (Closed Conduit Design)	36-inch	DR41 HDPE
Phase I Turnout (Open Channel Design)	48-inch (2 Barrels)	ADS N12 WT HDPE
Phase I Turnout (Closed Conduit Design)	54-inch	DR41 HDPE
Well Conveyance Pipelines	15-inch to 27-inch	SDR51 PIP PVC
Well Conveyance Pipelines	30-inch to 36-inch	DR51 C900 PVC or DR41 HDPE
Interbasin Piping	36-inch and 48-inch	ADS N12 WT HDPE
In-Lieu Turnout Piping	24-inch	ADS N12 WT HDPE

1. *The "D" class of pipe is a conservative assumption at this stage in the design. The RCP pipe classification shall be re-evaluated during detailed design and be based on actual design elevations, earth cover, and operating conditions.*
2. *The project shall prepare for bid alternatives for pipe sizes and structures where more than one alternative is an option and close in pricing such as for the Reach 4 Conveyance Canal Piping, the Well Conveyance Pipelines, and Road Crossings and Bridges or Box Culverts.*

In addition, Table 28 summarizes the estimated material costs and installation costs (material + installation) for the various pipe sizes and capacities and highlights the most economical options.

Table 28

Kern Fan Project

Linear Pipeline Material and Cost Summary - Recommended

Pipe Capacity at 5-6 fps	SDR51 PIP PVC Pipe			DR41 & DR51 C900 PVC Pipe			DR32.5 & DR41 HDPE Pipe			ADS N-12 HDPE Pipe[1]			CMLC Pipe			FBEL&C Pipe			D50 Wet Cast RCP Pipe			D25 Dry Cast RCP Pipe		
	Pipe Size	Material Cost ($/LF)	Material + Install Cost ($/LF)	Pipe Size	Material Cost ($/LF)	Material + Install Cost ($/LF)	Pipe Size	Material Cost ($/LF)	Material + Install Cost ($/LF)	Pipe Size	Material Cost ($/LF)	Material + Install Cost ($/LF)	Pipe Size	Material Cost ($/LF)	Material + Install Cost ($/LF)	Pipe Size	Material Cost ($/LF)	Material + Install Cost ($/LF)	Pipe Size	Material Cost ($/LF)	Material + Install Cost ($/LF)	Pipe Size	Material Cost ($/LF)	Material + Install Cost ($/LF)
5 cfs	15	$18.17	$62.17	14	$19.42	$77.42	14	$14.58	$64.58															
10 cfs	18	$19.98	$77.98	18	$21.92	$79.92	20	$24.03	$82.03															
15 cfs	24	$36.53	$95.53	24	$49.68	$110.68	24	$34.34	$96.34															
20 cfs	27	$50.56	$111.56	24	$49.68	$110.68	28	$49.84	$127.84															
25 cfs				30	$68.31	$132.31	30	$54.35	$142.35															
30 cfs				30	$68.31	$132.31	34	$72.77	$178.77															
35 cfs				36	$99.14	$187.14	36	$58.30	$184.30	36	$56.50	$116.53	36	$171.00	$257.83	36	$161.00	$287.83	36	$300.00	$386.60	36	$111.78	$198.38
40 cfs				36	$99.14	$187.14	42	$72.40	$210.40	36	$56.50	$116.53	42	$194.00	$305.00	42	$190.00	$321.00	36	$300.00	$386.60	36	$111.78	$198.38
45 cfs				42	$131.23	$223.73	42	$72.40	$210.40	42	$70.18	$133.85	42	$194.00	$305.00	42	$190.00	$321.00	42	$390.00	$480.00	42	$142.83	$232.83
50 cfs				42	$131.23	$223.73	42	$72.40	$210.40	42	$70.18	$133.85	42	$194.00	$305.00	42	$190.00	$321.00	42	$390.00	$480.00	42	$142.83	$232.83
55 cfs				42	$131.23	$223.73	48	$88.00	$240.00	42	$70.18	$133.85	48	$220.00	$336.38	48	$220.00	$356.38	42	$390.00	$480.00	42	$142.83	$232.83
60 cfs				48	$165.80	$263.80	48	$88.00	$240.00	48	$93.15	$161.19	48	$220.00	$336.38	48	$220.00	$356.38	48	$486.18	$580.62	48	$173.88	$268.32
70 cfs				48	$165.80	$263.80	54	$104.20	$277.20	48	$93.15	$161.19	48	$220.00	$336.38	48	$220.00	$356.38	48	$486.18	$580.62	48	$173.88	$268.32
80 cfs				48	$165.80	$263.80	54	$104.20	$277.20	48	$93.15	$161.19	54	$255.00	$411.00	54	$255.00	$431.00	54	$617.90	$717.90	54	$204.93	$304.93
90 cfs				54	$266.35	$390.35	63	$128.37	$332.37	60	$130.41	$203.78	54	$255.00	$411.00	54	$255.00	$431.00	54	$617.90	$717.90	54	$204.93	$304.93
100 cfs				60	$316.45	$448.45	63	$128.37	$332.37	60	$130.41	$210.46	60	$340.00	$514.24	60	$330.00	$524.24	60	$749.61	$857.55	60	$235.98	$343.92
150 cfs													72	$550.00	$797.86	72	$500.00	$767.86	72	$1,043.22	$1,225.47	72	$298.08	$480.33
200 cfs													84	$650.00	$1,027.09	84	$600.00	$997.09	84	$1,327.25	$1,612.00	84	$360.18	$644.93
250 cfs													90	$700.00	$1,160.00	90	$650.00	$1,110.00	90	$1,470.36	$1,805.36	90	$391.23	$726.23
300 cfs													102	$936.00	$1,586.00	102	$750.00	$1,450.00	96	$1,608.89	$2,002.58	96	$422.28	$815.97
350 cfs													108	$1,070.00	$1,872.71	108	$810.00	$1,612.71	108	$2,009.00	$2,531.57	108	$484.38	$1,006.95
400 cfs													114	$1,152.00	$2,022.00	114	$1,007.37	$1,877.37	114	$2,231.16	$2,901.16	114	$515.43	$1,185.43
450 cfs													120	$1,205.00	$2,197.48	120	$1,205.00	$2,197.48	120	$2,453.32	$3,271.02	120	$546.48	$1,364.18
500 cfs													126	$1,320.00	$2,470.00	126	$1,320.00	$2,470.00	126	$2,565.69	$3,535.69	126	$577.53	$1,547.53

Represents most economical pipe material based upon costs estimates and information available in October 2020.

Represents secondary pipe material alternatives that may be more economical depending on actual design and project timing.

[1]The ADS N-12 HDPE pipe is not applicable to a linear, pressurized pipeline design, but is anticipated to be used at recharge facility turnouts, "in-lieu" turnouts, and interbasin structures.

VI. Related Work Specified Elsewhere

A. TM 2 – Conveyance Capacity
B. TM 4 – Pump Station Requirements
C. TM 5 – Geotechnical Requirements
D. TM 6 – Canal Liner and Turnout Requirements
E. TM 7 – Well Drilling and Equipping Requirements
F. TM 11- Engineer's Estimates

APPENDIX D

Technical Memorandum #4
Pump Station Requirements

DEE JASPAR & ASSOCIATES, INC.
CONSULTING CIVIL ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CA 93308
PHONE (661) 393-4796
FAX (661) 393-4799

KERN FAN GROUNDWATER STORAGE PROJECT

TECHNICAL MEMORANDUM NO. 4
(Pump Station Requirements)

PREPARED FOR: Groundwater Banking Joint Powers Authority (JPA)
PREPARED BY: Curtis Skaggs, P.E.
DATE: January 28, 2021

SUBJECT: ***Pump Station Requirements***

I. Executive Summary

There are currently five pump stations illustrated for the project:

1. Pump Station No. 1 at Stockdale Highway for the Conveyance Canal (Capacity = 443 cfs)

2. Pump Station No. 2 at the I-5 Freeway for the Conveyance Canal (Capacity = 435 cfs)

3. Pump Station No. 3 at the west end of the West Basins for the Conveyance Canal (Capacity = 240 cfs)

4. Return Water Pump Station to convey recovered water to the California Aqueduct (Capacity = 70 cfs)

5. Goose Lake Channel Pump Station to convey water from Cross Valley Canal or Kern River Water to the Phase I Property (Capacity = 240 cfs)

See Figure 1 below for the approximate location of each of the above referenced pump stations. The exact number of pump stations, locations of the pump stations, and pump station capacities are subject to change based upon the actual conveyance alignment, Phase I and Phase II property locations, and the design of the conveyance channel.

A Pump Station No. 4 may be necessary at the easterly end of the conveyance channel to lift 129 cfs to the Phase I Property, however this pump station has not been considered herein. This pump station is considered small enough that it may not require physical modeling provided it is designed as outlined herein.

The goal for sizing the pump station pumps and motors is to achieve the following:

- Design for a minimum flowrate of 30 cfs.
- Design for the full range of flow from 30 cfs to the maximum specified design rate in 5 cfs increments.
- Size pumps and pump bays to standardize on two stoplog slot dimensions.
- Size pumps to provide interchangeability between pump stations.

This memorandum serves to outline in general the minimum pump station design standards, evaluate alternatives for pump station configurations and the associated costs, discuss special considerations and other pertinent items such as physical modeling, electrical service, control building design, and the pump station control philosophy. The following outlines the memorandum sections:

Below is a summary of the recommended pump configurations for each pump station facility.

Pump Station Summary				
Pump Station Facility	Capacity	Pump Configuration	36-42 cfs Pumps	80-90 cfs Pumps
Pump Station No. 1	443 cfs	Six (6) Pumps	Two	Four
Pump Station No. 2	435 cfs	Six (6) Pumps	Two	Four
Pump Station No. 3	240 cfs	Four (4) Pumps	Two	Two
Pump Station No. 4	129 cfs	If Necessary		
Goose Lake Channel Pump Station	240 cfs	Four (4) Pumps	Two	Two
Return Water Pump Station	72 cfs	Three (3) Pumps	Three	

The pump station design shall be governed by the Hydraulic Institute Standards ANSI/HI 9.8-Most Recent Edition for Pump Intake Design and then the final design requirements determined by physical modeling as described herein. The physical modeling shall be performed prior to finalizing the design of the pump stations, however preliminary design will need to be completed prior to conducting any modeling.

Redundancy has been accounted for in the three conveyance canal pump stations and the Goose Lake Slough pump station. Redundant capacity is built-in by nature of the 1.5 filling factor from Technical Memorandum No. 2 “Conveyance

Capacity Requirements" that is being utilized for the short-term filling of recharge areas. This filling rate allows for the recharge basins to be filled in approximately three (3) to seven (7) days. It is believed that if a pump is out-of-service during the initial recharge filling period, that the pump stations will still be at 67% to 100% of their pumping capacity and that the filling rate can temporarily be reduced until the appropriate repairs are made. However, during the long-term recharge operations the pump stations will still be able to meet approximately 100% of the average maintenance rates for recharge with the largest pump out-of-service.

The Return Water Pump Station is recommended to be designed with a three pump configuration that will have one of the pumps solely for redundancy. Each pump would be sized for 36 cfs. The anticipated capacity of the pump station for returning water is approximately 72 cfs which leaves the third pump for redundancy or extreme conditions when the District may be returning more water than 72 cfs.

The pump and motor sizes utilized herein and the associated costs are preliminary and only for purposes of the preliminary engineering work. It is understood that the actual pump and motor sizes will be determined during the engineering design phase based on the actual hydraulic conditions of the conveyance facilities and that updated pricing will be evaluated.

The designer shall evaluate pumps from several reputable pump manufacturer's to determine the typical pump suction bell diameters for the design pump conditions. The pump suction bell diameters will be critical in the proper design of the pump station and pump bays.

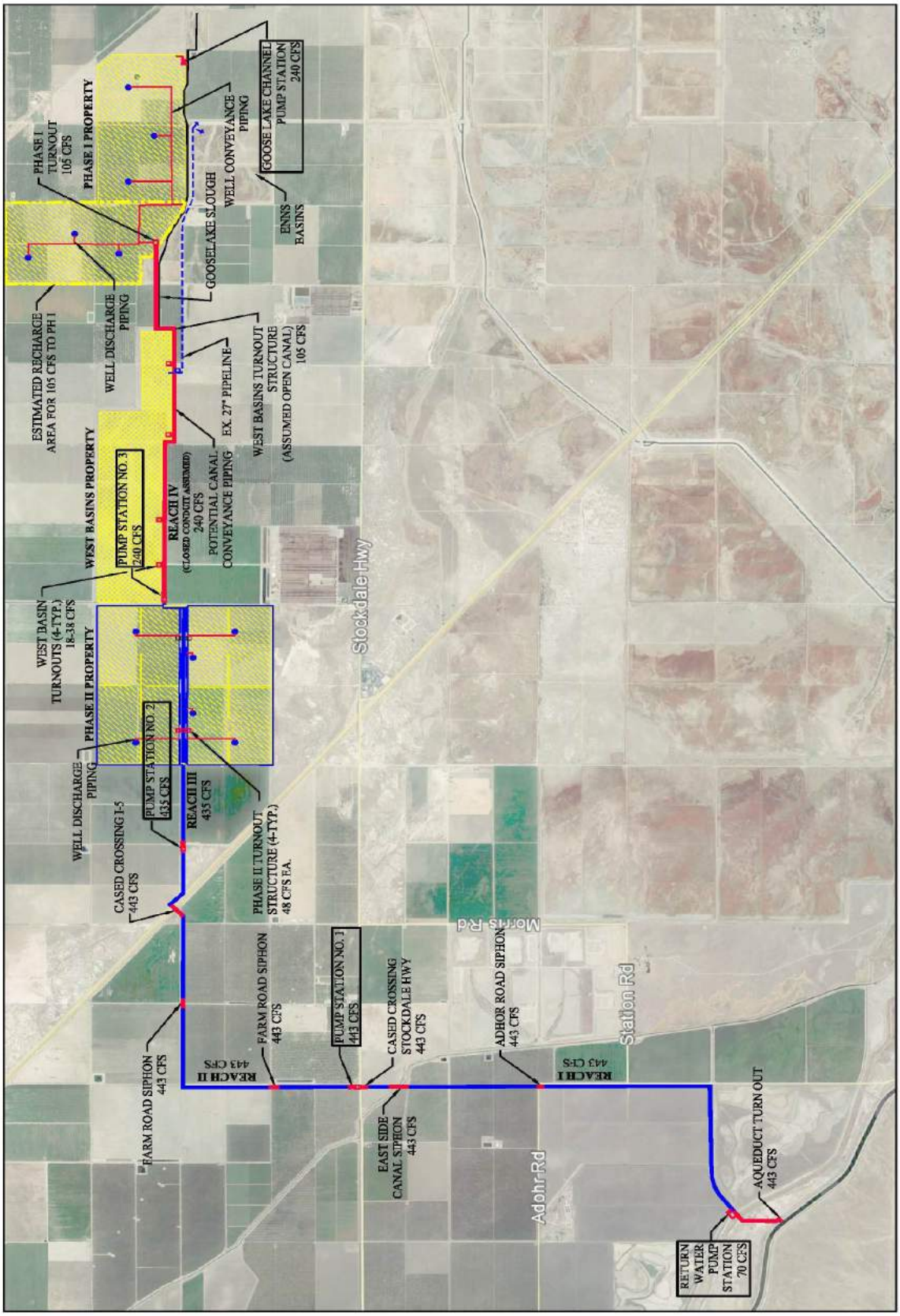


Figure 1: Pump Station Overview Map

II. Pump Station Design Standard

The pump station design shall be governed by the Hydraulic Institute Standards ANSI/HI 9.8-Most Recent Edition for Pump Intake Design.

The intake structure shall be designed to allow the pumps to achieve their optimum hydraulic performance for all operating conditions. The characteristics of the flow approaching an intake structure is one of the most critical considerations. The pump intake structure shall be designed in-line with the canal to provide a uniform approach to the pumps and the geometry of the intake structure should endeavor to limit the cross-flows that create asymmetrical flow patterns approaching any of the pumps.

The pump station shall be a rectangular intake design that is based on the design pump inlet bell diameter. The pump station shall be designed to mitigate or minimize adverse hydraulic performance resulting from the following:

- Submerged Vortices
- Free-Surface Vortices
- Excessive Pre-Swirl of Flow Entering the Pump
- Non-Uniform Spatial Distribution of Velocity at the Impeller Eye
- Excessive Variations in Velocity and Swirl with Time
- Entrained Air or Gas Bubbles

The conveyance canal pump station capacities will range from 240 cfs (107,712 gpm) to 443 cfs (198,818 gpm). These large flow capacities warrant hydraulic model testing. This is discussed further in Item VI below.

In addition, each conveyance canal pump station shall have a gravity return line for returning water to the California Aqueduct and have an approximate capacity of 70 cfs. This shall include a means of isolation via a slide gate or butterfly valve.

III. Pump Configuration

Pump stations shall be an open structure with reinforced concrete dividing walls between each of the pumps. The approach velocities to each pump shall be limited to a maximum of 1.5 ft per second within each pump bay per the Hydraulic Institute Standards. The pump bay width and depth shall be designed to limit the maximum pump approach velocities as well as providing a narrow and long channel flow toward each pump for uniformity and laminar flow.

Careful attention shall be paid to the minimum submergence of the pump bell or intake to reduce the possibility that unacceptable free-surface air core vortices occur. The minimum required submergence shall be determined using the ANSI Pump Intake Design manual, however if a submergence greater than that calculated is required by the pump manufacturer to provide the required NPSH, then the greater submergence shall govern.

A combination of reinforced concrete and heavy bar steel grating shall be designed and constructed for the pump deck that is suitable for a H20 loading. This will allow equipment to utilize the deck for the removal and installation of pumps and motors as well as for cleaning of trashracks while allowing for visibility down into each pump bay and convenient access to the pumps.

The pump stations shall include stop log slots for isolation of a pump bay while the remainder of the pump station is in operation, trashracks, ladder access, and safety grating and guardrailing. The District would prefer to have two sizes of steel stop logs that fit all the pump station bays. The location of stop logs within each pump bay shall take into consideration the need for future diffusing structures or other mitigation measures that could be implemented at the stop log slots.

Several combinations of pumps are evaluated below that consist of a six (6) pump and four (4) pump configuration. An eight (8) pump configuration was also considered during the preliminary engineering work, however the use of VFD's will allow the pumps to cover a wider range of flows and help in reducing the number of pumps needed. The conveyance canal pump stations shall be designed such that they can reach a minimum flow rate of 30 cfs, can cover the full range of flows from 30 cfs to the maximum specified design rate in 5 cfs increments, and minimize the number of pumps. The District would prefer to have consistency of pumps with respect to the size and capacity across all pump stations for ease of operations, maintenance, and pump interchangeability.

An example of this is outlined below with:

A. Pump Stations #1 and #2 with a Six (6) Pump Configuration and a Four (4) Pump Configuration

B. Pump Stations #3 with a Six (6) Pump, Four (4) Pump, and a Three (3) Pump Configuration

A. Pump Station No. 1 and No. 2 Pump Configurations

The Pump Stations No. 1 and No. 2 are essentially the same size at 435 cfs and 443 cfs. A four pump or six pump configuration could be utilized at these stations which would consist of high capacity, low lift pumps and motors. Below is a six pump configuration.

a) Six (6) Pump Configuration

The pump capacities are sized to endeavor to cover the majority of flow possibilities between 30 cfs to 443 cfs in 5 cfs increments.

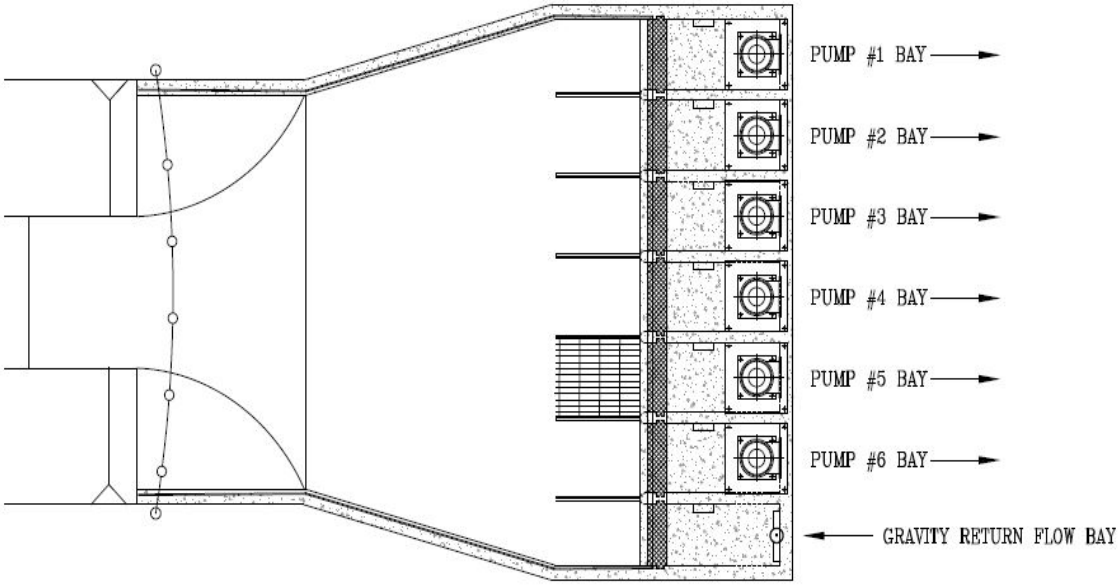


Figure 2: Pump Stations No. 1 and No. 2 Configuration with 6 Pumps

The pump station layout illustrated in Figure 2 above and in subsequent figures is conceptual to represent the number of pump bays and not intended to define the actual pump station design.

Pump Station No. 1 and No. 2 could have the following size pumps in a six pump configuration. Table 1 below illustrates the range of the pump station and its ability to meet the 5 cfs incremental criteria.

Pump Station No. 1

443 CFS Capacity
(2) 42 cfs Pumps
(4) 90 cfs Pumps

Pump Station No. 2

435 CFS Capacity
(2) 40 cfs Pumps
(4) 89 cfs Pumps

The two smaller pumps have an approximate 40 to 42 cfs capacity and the four larger pumps have an approximate 89-90 cfs capacity. It is estimated that the slower speed pumps will be able to reduce their capacity to approximately two-thirds with the use of a variable speed drive (VFD).

Table 1

Pump Station No. 1 and No. 2 with 6 Pump Configuration						
Pump Station Demand	40-42 cfs Pump[1]	40-42 cfs Pump[1]	89-90 cfs Pump[2]	89-90 cfs Pump[2]	89-90 cfs Pump[2]	89-90 cfs Pump[2]
30-45 cfs	x					
50-80 cfs	x	x				
85-90 cfs			x			
95-130 cfs	x		x			
135-170 cfs	x	x	x			
175-215 cfs	x		x	x		
220-260 cfs	x	x	x	x		
265-310 cfs	x		x	x	x	
315-350 cfs	x	x	x	x	x	
355-400 cfs	x		x	x	x	x
405-443 cfs	x	x	x	x	x	x

[1]Pump range with VFD estimated as 27 cfs to 42 cfs.

[2]Pump range with VFD estimated as 59 cfs to 90 cfs.

Table 2 below provides a cost estimate for the six (6) pump configuration.

Table 2

Kern Fan Project Pump Stations No. 1 and No. 2 - 6 Pump Configuration					
Item Description	Unit	Quantity		Unit Cost	Extended Cost
Earthwork & Site Ground Cover	1	LS	$	215,000.00	$ 215,000.00
Reinforced Concrete Structure	1	LS	$	920,000.00	$ 920,000.00
Miscellaneous Steel & Trashracks	1	LS	$	215,000.00	$ 215,000.00
Pumps and Motors	1	LS	$	2,222,000.00	$ 2,222,000.00
30" Discharge Piping & Appurtenances	2	EA	$	394,000.00	$ 788,000.00
42" Discharge Piping & Appurtenances	4	EA	$	485,000.00	$ 1,940,000.00
Variable Frequency Drives	1	LS	$	700,000.00	$ 700,000.00
Electrical and Controls	1	LS	$	995,000.00	$ 995,000.00
Electrical Control Building & Foundation	1	LS	$	380,000.00	$ 380,000.00
Cathodic Protection	1	LS	$	25,000.00	$ 25,000.00
Gravity Bypass Pipeline & Slide Gate	1	LS	$	205,000.00	$ 205,000.00
				Total 6 Pump Configuration Estimate:	**$ 8,605,000.00**

Footnote: Costs are for purposes of comparison between pump configurations and not intended to be inclusive of all pump station costs.

b) Four (4) Pump Configuration

The four pump configuration is illustrated below. The pump capacities are sized to endeavor to cover the majority of flow possibilities between 50 cfs to 443 cfs in 5 cfs increments. The limitation of this configuration is that the pump station minimum flow is not as low as the six pump configuration.

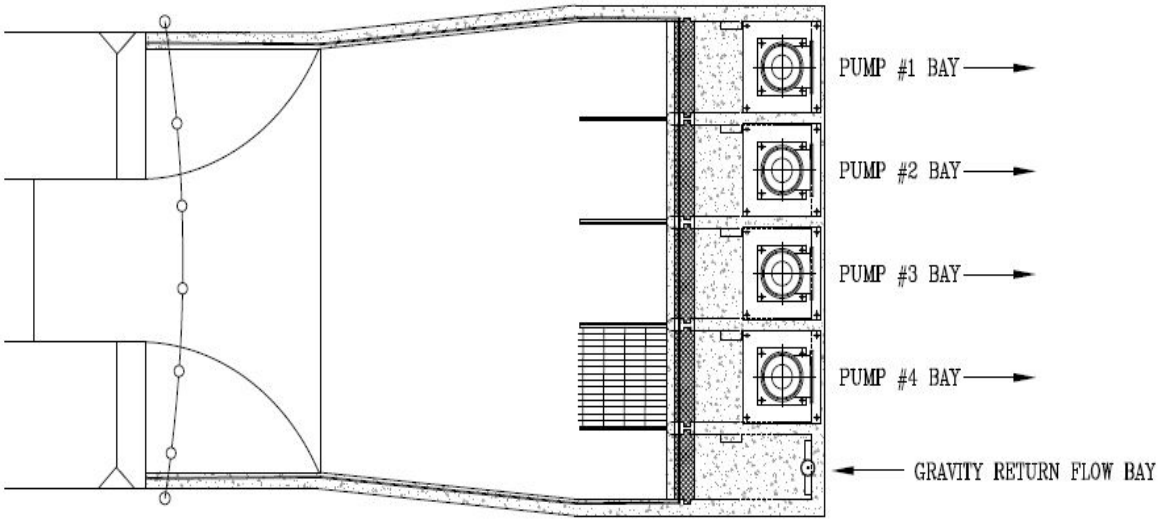


Figure 3: Pump Stations No. 1 and No. 2 Configuration with 4 Pumps

Pump Station No. 1 and No. 2 could have the following size pumps in a four pump configuration. Table 3 below illustrates the range of the pump station and its ability to meet the 5 cfs incremental criteria.

Pump Station No. 1

443 CFS Capacity
(2) 75 cfs Pumps
(2) 147 cfs Pumps

Pump Station No. 2

435 CFS Capacity
(2) 73 cfs Pumps
(2) 145 cfs Pumps

The two smaller pumps have an approximate 73 to 75 cfs capacity and the two larger pumps have an approximate 145-147 cfs capacity. It is estimated that the slower speed pumps will be able to reduce their capacity to approximately two-thirds with the use of a variable speed drive (VFD).

Table 3

Pump Station No. 1 and No. 2 with 4 Pump Configuration				
Pump Station Demand	73-75 cfs Pump[1]	73-75 cfs Pump[1]	145-147 cfs Pump[2]	145-147 cfs Pump[2]
30 cfs				
35 cfs				
40 cfs				
45 cfs				
50-80 cfs	x			
85 cfs				
90 cfs				
95-145 cfs			x	
150-220 cfs	x		x	
225-295 cfs	x	x	x	
300-365 cfs	x		x	x
370-443 cfs	x	x	x	x
[1]Pump range with VFD estimated as 48 cfs to 75 cfs.				
[2]Pump range with VFD estimated as 96 cfs to 145 cfs.				
Pumps may not be able to match these flow rates.				

Table 4 below provides a cost estimate for the four (4) pump configuration.

Table 4

Kern Fan Project				
Pump Stations No. 1 and No. 2 - 4 Pump Configuration				
Item Description	Unit	Quantity	Unit Cost	Extended Cost
Earthwork & Site Ground Cover	1	LS	$ 200,000.00	$ 200,000.00
Reinforced Concrete Structure	1	LS	$ 816,000.00	$ 816,000.00
Miscellaneous Steel & Trashracks	1	LS	$ 175,000.00	$ 175,000.00
Pumps and Motors	1	LS	$ 1,881,000.00	$ 1,881,000.00
42" Discharge Piping & Appurtenances	2	EA	$ 485,000.00	$ 970,000.00
54" Discharge Piping & Appurtenances	2	EA	$ 600,000.00	$ 1,200,000.00
Variable Frequency Drives	1	LS	$ 600,000.00	$ 600,000.00
Electrical and Controls	1	LS	$ 995,000.00	$ 995,000.00
Electrical Control Building & Foundation	1	LS	$ 380,000.00	$ 380,000.00
Cathodic Protection	1	LS	$ 25,000.00	$ 25,000.00
Gravity Bypass Pipeline & Slide Gate	1	LS	$ 205,000.00	$ 205,000.00
			Total 4 Pump Configuration Estimate:	**$ 7,447,000.00**

Footnote: Costs are for purposes of comparison between pump configurations and not intended to be inclusive of all pump station costs.

c) Pump Station No. 1 and 2 Recommendations

The six (6) pump configuration is better from the standpoint of being able to meet a minimum pump station capacity of 30 cfs and being able to match flows in 5 cfs increments from 30 cfs to 443 cfs. The four (4) pump configuration may have a difficult time matching flows below 50 cfs and even some flows between 80 to 95 cfs. However, the six pump configuration is estimated to be approximately $1,158,000 more in capital cost due to a little bigger structure and more pumps, motors, and electrical.

It is recommended that Pump Stations No. 1 and No. 2 have six pumps and motors each with two (2) 40 to 42 cfs pumps and four (4) 89 to 90 cfs pumps. This will allow pump bay widths to be similar for utilizing two standard stop log slot dimensions and also for providing interchangeability between pumps across all three conveyance canal pump stations.

Redundancy for theses two conveyance canal pump stations is built-in by nature of the 1.5 filling factor that is being utilized for the recharge areas. It is believed that if a pump is out-of-service during the initial recharge filling period at Pump Stations No. 1 and 2, that the pump stations will still be at 67% to 90% capacity and that recharge can temporarily be reduced until the appropriate repairs are made. However, during the long term maintenance rates or average recharge rates, Pump Stations No. 1 and No. 2 would be at 100% capacity with the largest pump out-of-service, i.e. 440 cfs – 90 cfs Pump = 350 cfs > 282 cfs average rate from Technical Memorandum No. 2 "Conveyance Capacity".

The pump and motor sizes utilized herein and the associated costs are preliminary and only for purposes of the preliminary engineering work. It is understood that the actual pump and motor sizes will be determined during the engineering design phase based on the actual hydraulic conditions of the conveyance facilities and that updated pricing will be evaluated.

B. Pump Station No. 3 Pump Configurations

The Pump Station No. 3 capacity is 240 cfs. A three pump, four pump, or six pump configuration would consist of high capacity, low lift pumps and motors. Below is a six pump configuration. The pump capacities are sized to endeavor to cover the majority of flow possibilities between 30 cfs to 443 cfs in 5 cfs increments.

Pump Station No. 3 supplies Reach 4 of the conveyance facilities. Reach 4 may be an open channel design or closed conduit design. Technical Memorandum No. 3 "Pipeline Requirements" considered Reach 4 as a closed conduit design. The pump configurations described herein would still be appropriate for this condition, however the pumps may pump at a higher head and not really be as interchangeable with the pumps from Pump Stations No. 1 and No. 2. As a closed conduit design, Reach 4

would convey approximately 105 cfs to the West Basins, approximately 129 cfs to the Phase I Property (105 cfs to Phase I & 24 cfs to Enns), and approximately 6 cfs to in-lieu lands.

In an open channel design it is anticipated that Reach 4 will convey water to the east end of the West Basins thus delivering 105 cfs to the West Basins and 6 cfs to in-lieu lands. However, a Pump Station No. 4 would then likely be required to convey 129 cfs to the Phase I Property. This could be achieved by conveying 105 cfs to the Phase I Property and 24 cfs to the Enns Basins through the existing WB Pipeline. This pump station has not been considered at this time, but is considered a small enough pump station that it will likely not require physical modeling, provided it is designed as outlined herein.

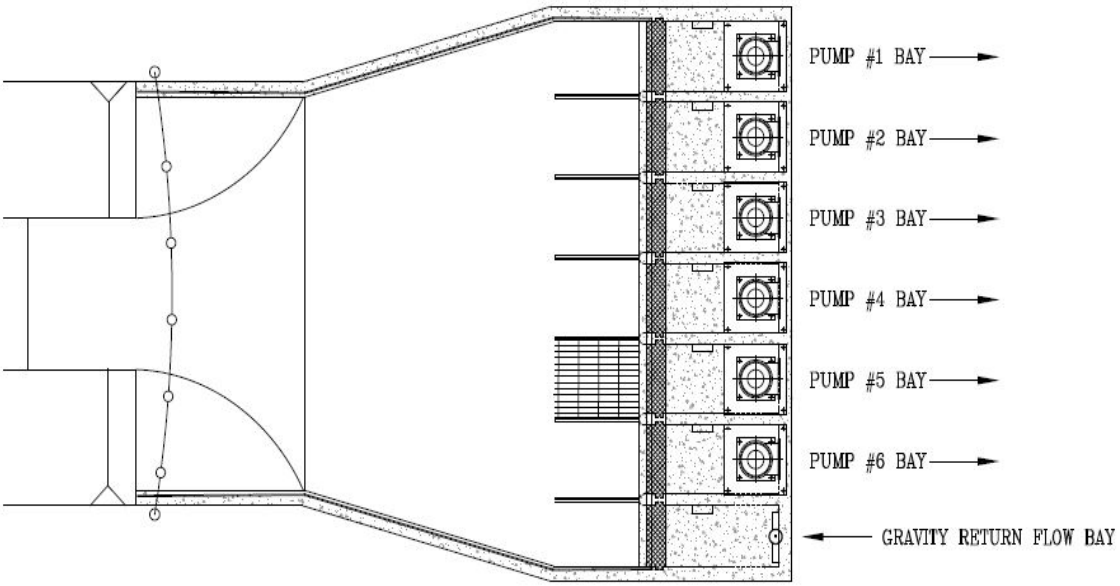


Figure 4: Pump Station No. 3 Configuration with 6 Pumps

a) Six (6) Pump Configuration

Pump Station No. 3 could have the following size pumps in a six pump configuration. Table 5 below illustrates the range of the pump station and its ability to meet the 5 cfs incremental criteria.

Pump Station No. 3

240 CFS Capacity
(6) 40 cfs Pumps

The pump configuration could also be two 25 cfs pumps and four 48 cfs pumps, for example, however the six 40 cfs pumps still allows the pump station to achieve the minimum flowrate of 30 cfs while utilizing pumps of

a similar size and capacity as those of the options for Pump Stations No. 1 and No. 2.

It is estimated that the range of a 40 cfs pump will be approximately 26 cfs to 40 cfs based on an estimate of the VFD being able to ramp down to approximately two-thirds of the pump design capacity.

Table 5

Pump Station No. 3 with 6 Pump Configuration						
Pump Station Demand	40 cfs Pump[1]	40 cfs Pump[1]	40 cfs Pump[1]	40 cfs Pump[1]	40 cfs Pump[1]	40 cfs Pump[1]
30-45 cfs	x					
50-80 cfs	x	x				
85-120 cfs	x	x	x			
125-160 cfs	x	x	x	x		
165-200 cfs	x	x	x	x	x	
205-240 cfs	x	x	x	x	x	x

[1]Pump range with VFD estimated as 26 cfs to 40 cfs.

Table 6 below provides a cost estimate for the six (6) pump configuration.

Table 6

Kern Fan Project Pump Station No. 3 - 6 Pump Configuration				
Item Description	Unit	Quantity	Unit Cost	Extended Cost
Earthwork & Site Ground Cover	1	LS	$ 200,000.00	$ 215,000.00
Reinforced Concrete Structure	1	LS	$ 900,000.00	$ 920,000.00
Miscellaneous Steel & Trashracks	1	LS	$ 200,000.00	$ 215,000.00
Pumps and Motors	1	LS	$ 1,584,000.00	$ 1,584,000.00
30" Discharge Piping & Appurtenances	6	EA	$ 394,000.00	$ 2,364,000.00
Variable Frequency Drives	1	LS	$ 540,000.00	$ 540,000.00
Electrical and Controls	1	LS	$ 880,000.00	$ 880,000.00
Electrical Control Building & Foundation	1	LS	$ 380,000.00	$ 380,000.00
Cathodic Protection	1	LS	$ 25,000.00	$ 25,000.00
Gravity Bypass Pipeline & Slide Gate	1	LS	$ 205,000.00	$ 205,000.00
	Total 6 Pump Configuration Estimate:			$ 7,328,000.00

Footnote: Costs are for purposes of comparison between pump configurations and not intended to be inclusive of all pump station costs.

b) Four (4) Pump Configuration

The four pump configuration would consist of four high capacity, low lift pumps and motors. The pump capacities are sized to endeavor to cover the majority of flow possibilities between 30 cfs to 240 cfs in 5 cfs increments. Table 7 below illustrates the range of the pump station and its ability to meet the 5 cfs incremental criteria.

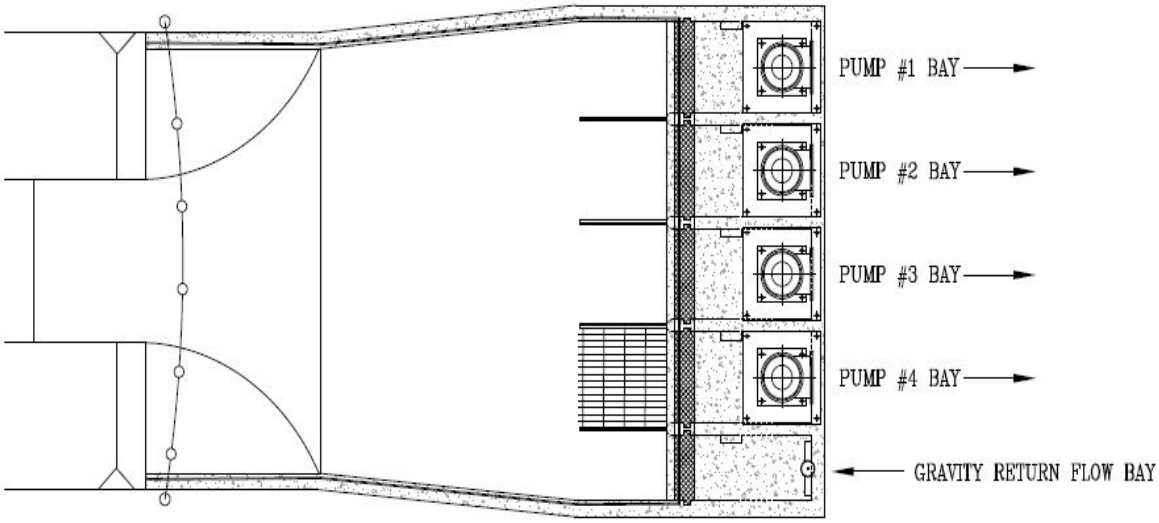


Figure 5: Pump Station No. 3 Configuration with 4 Pumps

Pump Station No. 3

240 CFS Capacity
(2) 40 cfs Pumps
(2) 80 cfs Pumps

The two smaller pumps have an approximate 40 cfs capacity and the two larger pumps have an approximate 80 cfs capacity. It is estimated that the slower speed pumps will be able to reduce their capacity to approximately two-thirds with the use of a variable speed drive (VFD).

Table 7

Pump Station No. 3 with 4 Pump Configuration				
Pump Station Demand	40 cfs Pump[1]	40 cfs Pump[1]	80 cfs Pump[2]	80 cfs Pump[2]
30-45 cfs	x			
50-80 cfs	x	x		
85-120 cfs	x		x	
125-160 cfs	x	x	x	
165-200 cfs	x		x	x
205-240 cfs	x	x	x	x
[1]Pump range with VFD estimated as 26 cfs to 40 cfs.				
[2]Pump range with VFD estimated as 53 cfs to 80 cfs.				

Table 8 below provides a cost estimate for the four (4) pump configuration.

Table 8

Kern Fan Project					
Pump Stations No. 3 - 4 Pump Configuration					
Item Description	Unit	Quantity		Unit Cost	Extended Cost
Earthwork & Site Ground Cover	1	LS	$	200,000.00	$ 200,000.00
Reinforced Concrete Structure	1	LS	$	800,000.00	$ 800,000.00
Miscellaneous Steel & Trashracks	1	LS	$	175,000.00	$ 175,000.00
Pumps and Motors	1	LS	$	1,287,000.00	$ 1,287,000.00
30" Discharge Piping & Appurtenances	2	EA	$	394,000.00	$ 788,000.00
42" Discharge Piping & Appurtenances	2	EA	$	485,000.00	$ 970,000.00
Variable Frequency Drives	1	LS	$	420,000.00	$ 420,000.00
Electrical and Controls	1	LS	$	900,000.00	$ 900,000.00
Electrical Control Building & Foundation	1	LS	$	380,000.00	$ 380,000.00
Cathodic Protection	1	LS	$	25,000.00	$ 25,000.00
Gravity Bypass Pipeline & Slide Gate	1	LS	$	205,000.00	$ 205,000.00
	Total 4 Pump Configuration Estimate:				$ 6,150,000.00

Footnote: Costs are for purposes of comparison between pump configurations and not intended to be inclusive of all pump station costs.

c) Three (3) Pump Configuration

The three pump configuration would consist of three high capacity, low lift pumps and motors. The pump capacities are sized to endeavor to cover the majority of flow possibilities between 50 cfs to 240 cfs in 5 cfs increments. Table 9 below illustrates the range of the pump station and its ability to meet the 5 cfs incremental criteria.

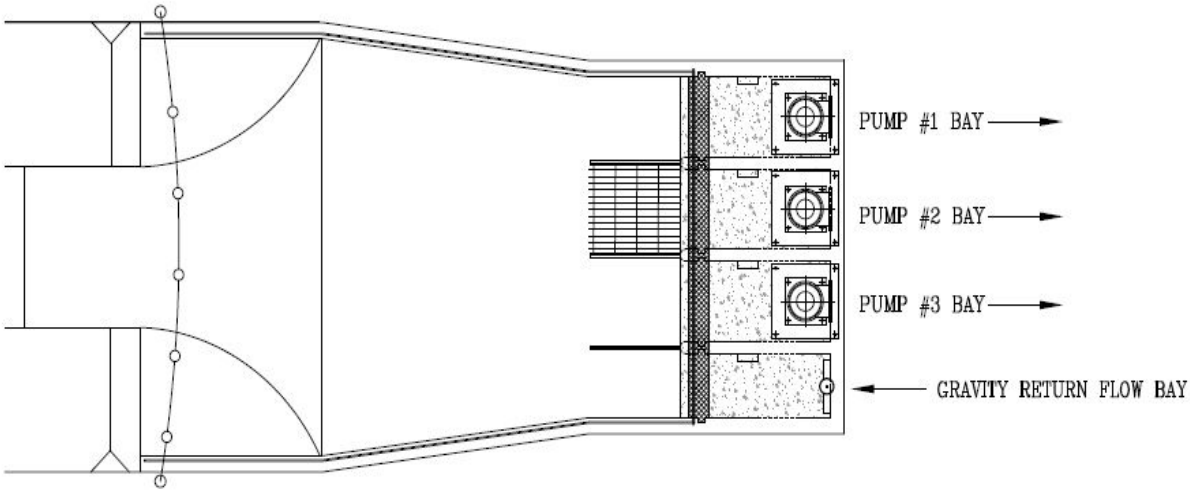


Figure 6: Pump Station No. 3 Configuration with 3 Pumps

Pump Station No. 3

240 CFS Capacity
(3) 80 cfs Pumps

It is estimated that the range of a 80 cfs pump will be approximately 53 cfs to 80 cfs based on an estimate of the VFD being able to ramp down to approximately two-thirds of the pump design capacity.

Table 9

Pump Station No. 3 with 3 Pump Configuration			
Pump Station Demand	80 cfs Pump[1]	80 cfs Pump[1]	80 cfs Pump[1]
30 cfs			
35 cfs			
40 cfs			
45 cfs			
50 cfs			
55-85 cfs	x		
90 cfs			
95 cfs			
100 cfs			
105-160 cfs	x	x	
165-240 cfs	x	x	x
[1]Pump range with VFD estimated as 53 cfs to 80 cfs.			
Pumps may not be able to match these flow rates.			

Table 10 below provides a cost estimate for the three (3) pump configuration.

Table 10

Kern Fan Project Pump Stations No. 3 - 3 Pump Configuration				
Item Description	Unit	Quantity	Unit Cost	Extended Cost
Earthwork & Site Ground Cover	1	LS	$ 185,000.00	$ 185,000.00
Reinforced Concrete Structure	1	LS	$ 700,000.00	$ 700,000.00
Miscellaneous Steel & Trashracks	1	LS	$ 150,000.00	$ 150,000.00
Pumps and Motors	1	LS	$ 1,138,500.00	$ 1,138,500.00
42" Discharge Piping & Appurtenances	3	EA	$ 485,000.00	$ 1,455,000.00
Variable Frequency Drives	1	LS	$ 360,000.00	$ 360,000.00
Electrical and Controls	1	LS	$ 700,000.00	$ 700,000.00
Electrical Control Building & Foundation	1	LS	$ 380,000.00	$ 380,000.00
Cathodic Protection	1	LS	$ 25,000.00	$ 25,000.00
Gravity Bypass Pipeline & Slide Gate	1	LS	$ 205,000.00	$ 205,000.00
			Total 3 Pump Configuration Estimate:	**$ 5,298,500.00**

Footnote: Costs are for purposes of comparison between pump configurations and not intended to be inclusive of all pump station costs.

d) Pump Station No. 3 Recommendations

The six (6) pump configuration is sufficient from the standpoint of being able to meet a minimum pump station capacity of 30 cfs and being able to match flows in 5 cfs increments from 30 cfs to 240 cfs. However, it is approximately $1,178,000.00 more in capital cost than a four (4) pump configuration. The four (4) pump configuration is also able to meet a minimum pump capacity of 30 cfs while matching flows in 5 cfs increments from 30 cfs to 240 cfs. The three (3) pump configuration is the least capital cost, however it will have difficulty meeting the minimum flow requirements and matching flow rates in 5 cfs increments particularly in the ranges of 30 cfs to 50 cfs and 90 cfs to 100 cfs.

Pump Station No. 3 is recommended to have four pumps and motors with two (2) 40 cfs pumps and two (2) 80 cfs pumps. This will allow pump bay widths to be similar for utilizing two standard stop log slot dimensions and also for providing interchangeability between pumps across all three conveyance canal pump stations.

Redundancy for this conveyance canal pump station is built-in by nature of the 1.5 filling factor that is being utilized for the recharge areas. It is believed that if a pump is out-of-service during the initial recharge filling period at Pump Station No. 3, that the pump station will still be at 67% to 90% capacity and that recharge can temporarily be reduced until the appropriate repairs are made. However, during the long term maintenance rates or average recharge rates, Pump Station No. 3 would be at 90-100% capacity with the largest pump out-of-service, i.e. 240 cfs – 80 cfs Pump = 160 cfs $\leq$ 170 cfs average rate from Technical Memorandum No. 2 "Conveyance Capacity".

The pump and motor sizes utilized herein and the associated costs are preliminary and only for purposes of the preliminary engineering work. It is understood that the actual pump and motor sizes will be determined during the engineering design phase based on the actual hydraulic conditions of the conveyance facilities and that updated pricing will be evaluated.

C. Goose Lake Channel Pump Station

The Goose Lake Channel Pump Station will be utilized to convey water to the proposed Phase I property via the Goose Lake Channel from the Cross Valley Canal (CVC) or the Kern River.

The initial fill rate of the Phase I property has been estimated as 240 cfs. In Technical Memorandum No. 2 (Conveyance Capacity), approximately 129 cfs of this demand will be exchanged with capacity from the east that has historically been delivered to the West Basins and the Enns Basins.

The remaining 111 cfs demand will consist of in-lieu water and water from the California Aqueduct (105 cfs) delivered to the Phase I property.

Given the above criteria, the Goose Lake Channel pump station would be designed for approximately 129 cfs, however it is recommended to design for the initial fill rate of 240 cfs in the event that quantity of water is available from the Goose Lake Channel.

Goose Lake Channel Pump Station Recommendation

A 240 cfs pump station was evaluated under Section B "Pump Station No. 3 Pump Configurations" for a three pump, four pump, and six pump configuration. It is recommended to utilize a four pump configuration with two 40 cfs pumps and two 80 cfs pumps in an effort to standardize the pump sizes.

Redundancy for the Goose Lake Channel Pump Station is built-in by nature of the 1.5 filling factor that is being utilized for the recharge areas. It is believed that if a pump is out-of-service during the initial recharge filling period at the Goose Lake Channel Pump Station, that the pump station will still be at 67% to 90% capacity and that recharge can temporarily be reduced until the appropriate repairs are made. However, during the long term maintenance rates or average recharge rates, the Goose Lake Channel Pump Station would still be at 100% capacity with the largest pump out-of-service, i.e. 240 cfs – 80 cfs Pump = 160 cfs = 160 cfs average rate from Technical Memorandum No. 2 "Conveyance Capacity".

D. Return Water Pump Station

The Return Water Pump Station will be utilized to convey recovered water from the Phase II Property, the West Basins, and the Phase I property as necessary up to the California Aqueduct. The project is anticipated to include up to twelve (12) recovery wells each with a capacity of 5 to 6 cfs for a total return flow capacity of 60 cfs to 72 cfs.

The criteria for the Return Water Pump Station includes:

- Minimum Flow Rate = 24 cfs (Approx. 4 wells)
- Capacity of 24 cfs to 72 cfs in 5 cfs increments
- Full Pump Redundancy if Largest Pump fails

A two pump and three pump configuration has been evaluated with and without pump redundancy:

a) Two Pump Configuration without redundancy

A two pump configuration without redundancy will consist of two pumps each with a capacity of approximately 36 cfs.

72 CFS Capacity
(2) 36 cfs Pumps

b) Two Pump Configuration with redundancy

A two pump configuration with redundancy will consist of two pumps each designed to convey the design flowrate of 72 cfs.

72 CFS Capacity
(2) 72 cfs Pumps

c) Three Pump Configuration without redundancy

A three pump configuration without redundancy will consist of three pumps each with a capacity of approximately 24 cfs.

72 CFS Capacity
(3) 24 cfs Pumps

d) Three Pump Configuration with redundancy

A three pump configuration with redundancy will consist of three pumps each designed to convey the design flowrate of 72 cfs between two pumps.

72 CFS Capacity
(3) 36 cfs Pumps

Return Water Pump Station Recommendation

A three pump configuration with redundancy, i.e. three (3) 36 cfs pumps is recommended. This design will:

- Allow for returning the maximum design flow to the California Aqueduct with one pump or motor out of service.
- Allow for the possibility of the three pumps to be an equivalent size to the 40 cfs pumps utilized at the Conveyance Canal Pump Stations and the Goose Lake Channel Pump Station.
- Achieve an approximate minimum flowrate of 24 cfs.
- Achieve 5 cfs increments from approximately 24 cfs to 72 cfs with the exception of the 40 cfs and 45 cfs increments. However, the canal will act as storage for minor variations in matching of flow rates.

The District will typically utilize the majority of the recovery wells when operating in a recovery mode. It appears unlikely that the District would operate less than four (4) wells when returning water to the California Aqueduct.

The mismatch in flows around the 40 cfs and 45 cfs increments is minor and can be accommodated by utilizing the available storage that is in the canal prism during recovery operations.

In the occasional event whereby there is shallow water at the commencement of recovery operations and the wells are over-performing, the third pump provided for redundancy could be utilized, i.e. 12 wells operating at 7.5 cfs instead of 6 cfs equals 90 cfs < 3 pumps at 36 cfs equating to 108 cfs.

IV. Discharge Pipe Sizing

The pump discharge piping sizes were evaluated in Technical Memorandum No. 3 (Pipeline Requirements). A summary of the sizes is listed below.

Capacity (cfs)	Discharge Pipe Size (in.)
125	48
100	48
90	42
80	42
75	42
65	36
60	36
50	36
40	30
30	24
20	20

The above ground pump discharge piping is anticipated to be fusion bonded epoxy lined and coated steel pipe. The principal advantages of steel pipe include high strength, the ability to deflect without breaking, ease of installation, shock resistance, availability of special configurations and modifications by welding.

It is anticipated that each pump discharge pipe will be independent and discharge directly to the downstream reach of the conveyance canal (pump station afterbay).

V. Special Considerations

A. Trashrack Style

Trashracks shall be utilized to prevent the passage of objectionably large floating and submerged objects or debris that could cause damage or operational problems for the pumps or downstream equipment.

The trashracks shall consist of rows of parallel vertical flat bars with a clear opening between flat bars that is as large as possible yet consistent with the features and equipment to be protected as well as the equipment that the District will use to clean the trashracks.

It is anticipated that the District will manually clean and rake the trashracks.

The trashracks shall be fabricated from structural steel and be hot-dip galvanized for corrosion protection. They shall be end bearing trashracks installed in the inclined position with the bars running from top to bottom and carrying the loads to the reinforced concrete structure. The trashracks shall be designed to provide a maximum approach velocity of 1 to 2 feet per second for the design flows. This slow approach velocity reduces the tendency to collect debris against the racks, minimizes the possibility of trashrack vibration, and makes them easier to clean.

Trashracks shall be installed a minimum of five pump bell diameters ahead of the pump intake.

B. Pump Station Deck

A combination of reinforced concrete and heavy bar steel grating shall be designed and constructed for the pump deck that is suitable for a H20 loading. This will allow equipment to utilize the deck for the removal and installation of pumps and motors as well as for cleaning of trashracks while allowing for visibility down into each pump bay and convenient access to the pumps. The minimum deck width for access shall be a clear width of 16'-0" from the largest pump discharge head and sole plate to the edge of the deck or handrailing.

Handrailing shall be installed around the pump station deck where adjacent to open pump bays or forebays for safety. Railings shall be installed in a manner that they are removable, if necessary, for access to stop log slots, trashracks, and for clean-out of the pump bays and forebay.

The pump station structure and pumps and motors shall be designed for State of California seismic requirements per the 2019 California Building Code (CBC) and ASCE 7-16.

Each pump shall be equipped with a pump mounting pad. The pumps will include a permanently anchored and grouted in place soleplate onto which the pump discharge head will be mounted. It is proposed that the reinforced concrete pump station structures will be constructed as part of the conveyance facility construction and that a separate contract will be issued to equip the pump stations with pumps, motors, discharge piping and appurtenances, and electrical and controls. The reinforced concrete pump station, miscellaneous steel embeds such as ladder rungs, stop log slots, grating, and handrailing, and steel trashracks will be installed as part of the Conveyance Facilities scope of work along with the conveyance canal earthwork and lining work. The "Pump Station Equipping" scope of work will include the pump sole plates, the pump assembly, pump discharge head, pump anchorage, motor, discharge piping, electrical, control building, site lighting, and site development.

C. Cathodic Protection

Cathodic protection shall be provided for buried steel structures and piping at the pump station as well as the submerged steel structures and pumps in order to prevent corrosion. The following items shall have cathodic protection, at a minimum:

- Underground steel pump discharge piping
- Submerged pump column piping
- Submerged steel trashracks

The cathodic protection system shall be designed by a company specializing in impressed current systems.

Anode assemblies shall be mounted in each pump bay within one pipe diameter of the pump column piping and within five-feet of the trashrack. The assembly shall be supported by anode supports for mounting on a concrete deck. The bottom of the anodes shall be one-foot (1') above the structure floor. The copper cables shall be routed to a pole mounted anode junction/resistance box. The anode junction box shall be connected to a wall mounted air-cooled rectifier (40V, 30 Amp) in the electrical/control building. As an alternative, a passive cathodic protection system can be installed utilizing zinc anode ribbons strapped to the pump column piping and trashrack structures or approved equal.

The underground steel pipelines shall be protected by an impressed current system. The soil anodes shall be constructed near the pipeline as directed by the Cathodic Protection specialist. A cathodic protection test station shall be installed as directed by the Cathodic Protection specialist.

D. Flow Meters

It is recommended to install individual flow meters at each pump discharge line so that the performance of the individual pumps and motors can be evaluated. The discharge pipe sizes vary but are expected to range between 30-inch and 54-inch diameter.

There are different types of meters available in these size ranges which are noted below. It is recommended that these meter options be evaluated further during the design phase of the pump stations to select the best meter for the application. The brands and models noted below are for reference, however other meters that are comparable may be considered.

1. Mag Meters (Full Body)

   Mag Meters are available up to 48-inch diameter and flows up to 420 cfs. These are flanged meters that do not have any moving parts and are easy to maintain. These are supplied by McCrometer out of Hemet, California.

2. Mag Meter (Insertion Probe)

An insertion electromagnetic flow sensor is available from Seametrics. The Model EX210 meter adjusts for pipe sizes from 10-inch to 48-inch diameter and flows up to 250 cfs.

3. Ultrasonic Meter

An ultrasonic flow transducer is available from Rittmeyer and has several different types that can be utilized, all of which are for pipes flowing full whether above ground or below ground. They provide clamp-on meters or transducers that can be installed through the pipe wall. They are suitable for a full range of pipe diameters, can be replaced with the pipelines in operation, and have a high accuracy. In addition, they make a flow controller / display that can monitor multiple pipes/meters at the same time which is ideal for a pump station facility.

4. Doppler Velocity Meter

Flow meters utilizing a doppler velocity sensor and depth sensor can provide flow measurement in large diameter pipes for full-pipe flow or partial pipe flow. These are supplied by SonTek, a xylem brand.

E. Valve and Appurtenances

1. Air Release Valve

An air release and vacuum relief valve is necessary to release air upon start-up or the slow build up of air and to prevent vacuum conditions in the pipeline from developing in the event of a power failure or pump shutdown. The valve shall be designed to allow large quantities of air to escape out of the orifice when filling the pipeline and to close watertight when the liquid enters the valve. The valve shall also permit large quantities of air to enter through the orifice when the pipeline is being drained to break the vacuum.

2. Check Valve

A check valve is utilized to prevent reverse flow and prevent runaway reverse pump speeds when the pump is shut off. It is common to use a slanting disc check valve in these applications. A slanting disc check valve contains a disc balanced on a pivot. Instead of being perpendicular to the longitudinal axis in conventional swing check valves, the seat is at an angle of 50 to 60 degrees from the valve longitudinal axis. The advantages of this type of valve include low headloss, top-mounted oil dashpots that can be used to control the opening and closing speeds, and the ability to adjust the valve controls in the field. The top-mounted oil dashpot system allows both the opening and closing speeds of the disc to be adjusted over the full range it travels.

3. Dresser Coupling

A sleeve coupling with AWWA M11 joint restraint harness shall be installed on the discharge piping near the pump discharge head. The coupling provides a flexible connection to the pump discharge head and pump station structure in the event of a seismic event and it is also serves as a convenience for breaking the pipe apart to remove the pump from the pump station, if necessary.

4. Butterfly Valve

A butterfly valve is recommended as the isolation valve to be installed on each pump discharge line. The isolation valve is either fully opened or fully closed. The valve can be used to isolate the pump discharge piping from the system in the event repairs or maintenance need to be performed.

F. Variable Frequency Drives

The pump station motors will each be equipped with variable speed drives (VFD's). The VFD drives shall be equipped with harmonic protection and include proper shielding and protections from PG&E power variations. These drives shall be the Yaskawa U1000 Industrial Matrix Drive, or approved equal, for ultra-low harmonics, full continuous regeneration, and high efficiency.

G. Site Development

Each of the pump station sites shall have all-weather surfacing installed around the pump station, control building, site lighting, electrical transformer, and site ingress and egress routes.

Site lighting (exterior) with electrical outlets shall be installed around the pump station facilities and control building in a manner that will ensure the entire pump station facility and appurtenances are adequately covered with light and auxiliary power. Type IV light distribution fixtures shall be utilized that cast light 2.75 times wider than their height but produce a more rounded distribution pattern that pushes the light outward. The site lighting shall be LED lighting, include an electrical outlet at the base of the pole, have a photocell for automatic operation, and a switch for manual off, manual on, and operation based on the photocell.

Site security shall consist of fencing around the pump station facilities as well as intrusion alarms at each of the control buildings at access doors. It is anticipated that barbed wire and field fencing will be installed around the conveyance canal. This fencing shall encompass the pump station facilities along the conveyance canal, i.e. Return Water Pump Station, Pump Stations No. 1 – No. 3, and a potential Pump Station No. 4. This fencing shall include multiple access points to the pump station facilities utilizing large drive gates for access with cranes and other large equipment and personnel gates that are 4-feet wide. Double-wide access gates shall be utilized with a minimum 24-ft wide overall opening. It is anticipated that 6-ft tall chainlink fencing with three strands of barbed wire will be installed around the Goose Lake Pump Station Facility and include large drive gates and personnel gates.

VI. Physical Hydraulic Modeling

Physical modeling of the conveyance canal pump station facilities shall be performed by reputable firms or laboratories such as the Utah Water Research Laboratory at Utah State University, the US Bureau of Reclamation Hydraulics Laboratory in Denver, the Clemson Engineering Hydraulics (CEH) in South Carolina, or Northwest Hydraulic Consultants (NHC) Laboratory in Canada or Seattle. Selection of the modeling laboratory should be based on qualifications, experience, costs, and availability and be subject to the approval of the JPA.

In addition to the physical modeling, numerical modeling using Computational Fluid Dynamics (CFD) shall be provided by the laboratory. The design firm shall be responsible for modeling of the entire canal network and structures utilizing HEC-RAS or equivalent to determine operating water levels and velocities for all flow conditions.

It is recommended that hydraulic modeling be performed for the three in-line pump stations along the conveyance canal. Hydraulic modeling may not be required for the Goose Lake Channel Pump Station, the Return Water Pump Station, or a fourth in-line Pump Station at the end of the conveyance channel (if necessary), however this will be at the discretion of the design firm and JPA. The fourth in-line Pump Station (if necessary) and the Return Water Pump Station are believed to be small enough that they do not warrant hydraulic modeling provided they are designed in accordance with the Hydraulic Institute Standards. The Goose Lake Channel Pump Station is equal in capacity to the Conveyance Canal Pump Station No. 3, but can be designed to utilize information from the Pump Station No. 3 modeling and will have a large pool to pump from given the Goose Lake Channel and a new weir structure. However, the necessity for modeling the Goose Lake Channel Pump Station will be at the discretion of the project design firm and the JPA.

The Pump Station facility shall be evaluated at an appropriate scale and be studied to ensure the pump stations:

- Meet the established design criteria
- Prevent accumulation of sediment and debris
- Avoid pump cavitation and vortices
- Optimize hydraulic performance and efficiency
- Reduce maintenance requirements

The hydraulic modeling shall provide recommendations for the overall pump station configuration, curtain walls, fillets, center splitters, and other mitigation measures,

Utah Water Research Laboratory (UWRL)

The UWRL has been building and testing physical scale models since its commissioning in 1965. They build geometrically scaled models and utilize

essential scaling parameters to accurately prototype flow conditions. They have the space to accommodate large model scales and thus reduce the potential for size scaling effects.

UWRL offers a composite model approach that couples physical modeling with numerical modeling that is highly effective in solving a wide array of difficult hydraulic problems. The numerical modeling is performed using Computational Fluid Dynamics (CFD).

US Bureau of Reclamation Hydraulics Laboratory

The US Bureau of Reclamation is capable of conducting large scale physical hydraulic models for conveyance channels and pump stations.

Clemson Engineering Hydraulics (CEH)

Clemson Engineering Hydraulics was first established as a research program at Clemson University in 2000 and then was launched as CEH in 2005 as a private commercial venture to fill the modeling needs of clients regionally, nationally, and worldwide.

The CEH physical modeling facility is a state of the art laboratory with 60,000 square feet of modeling space located near Anderson, South Carolina. The CEH team has extensive modeling experience with over 1,000 model studies of a wide range of hydraulic structures including pump intakes, siphon discharge systems, outfalls, and control structures.

Northwest Hydraulic Consultants (NHC)

NHC performs physical hydraulic modeling as well as numerical modeling using Computational Fluid Dynamics (CFD). These models are complex and sophisticated numerical tools used to investigate flow patterns and velocities in three dimensions and provide a detailed visual representation of the modelled system to address hydraulic issues or concerns. They have facilities in Vancouver, Edmonton, and Seattle.

A. Model Construction

A scale model of the proposed pump station shall be constructed in the selected laboratory. It is assumed at this time that the design of all three pump stations will be similar with the exception of the pump and motor sizes. If any special circumstances exist with one or more of the pump stations, then these special circumstances shall be captured in the model testing.

The layout of the physical modeling shall be based on the preliminary design drawings for the pump stations and the canal conveyance channel. All portions of the pump station that may affect the flow uniformity or the performance of the pumps shall be included in the physical model. The model

shall accurately reflect the orientation and configuration of the forebays and the afterbays at the pump station.

B. Model Testing

Model testing will begin with the proposed engineering design for the pump station, the canal approach, the forebay, and the afterbay and then the channel and forebay geometry will be modified in the physical model until the velocity profiles entering each pump bay are as uniform as possible. The proposed pumps and pump bell data should be known and provided so that the actual flow distribution, velocity profiles, vortices, velocity fluctuations, and general pump bay flow conditions can be measured at each respective pump and pump bay. The testing will need to include all possible scenarios of pump operation and at a minimum, shall include:

- Evaluation of discharge flow conditions to the afterbay specifically with regard to erosion and the need for energy dissipation.

- All pumping configurations shall be tested (i.e., three different flow rates (443 cfs, 435 cfs, and 240 cfs) at the possible pump combinations when pumps are on/off).

- A proposed test iteration is noted below:

Table 11

Test No.	Total Pump Flow Rate (cfs)[1]	Pumps Operating	WS Elev. at Pump (ft)[1]	Test Configuration
1	normal	All	normal	Pump Config. 1
2	low	All	high	Pump Config. 1
3	normal	All	low	Pump Config. 1
4	high	All	low	Pump Config. 1
5	high	All	normal	Pump Config. 1
6	high	All	high	Pump Config. 1
7	normal	One Pump Off	normal	Pump Config. 2
8	low	One Pump Off	high	Pump Config. 2
9	normal	One Pump Off	low	Pump Config. 2
10	high	One Pump Off	low	Pump Config. 2
11	high	One Pump Off	normal	Pump Config. 2
12	high	One Pump Off	high	Pump Config. 2

[1]Specific flow and water surface elevations corresponding to low, normal, and high will be provided during the model construction.

VII. Low Voltage versus Medium Voltage Service

The pump station electrical service may be low voltage or medium voltage depending on the total horsepower of the pump station.

Low voltage service is considered 480 volt service. Medium voltage service is considered 4,160 volt service. PG&E will typically not allow medium voltage service if the load is less than 600 hp.

Low voltage service is recommended under the following two circumstances:

1. Using solid-state reduced voltage starters (SSRV) and load is less than 600 hp.
2. Using variable speed drives (VFD) and the load is less than 2000 hp.

The benefits to low voltage service include the following:

1. Lower equipment cost
2. More familiar to maintenance personnel
3. Easier to obtain parts

The benefits to medium voltage service include the following:

1. Lower amperage
2. Lower energy losses

However, medium voltage service has a greater safety hazard.

At the larger horsepowers, an economic analysis shall be prepared that compares the starter costs, VFD costs, cable costs, etc. between the low voltage and the medium voltage services.

VIII. Utility Interface

PG&E will be the power service provider for the Pump Stations. It will be critical to involve them in the design process early. These will be large horsepower pump stations in the range of 800 hp to 1,600 hp and PG&E may need to make infrastructure upgrades to adequately support and serve these facilities.

It will be prudent to furnish PG&E with information and estimates of all the project loads and to provide an overall map that illustrates the locations of such loads.

Furthermore, the starting of these large motors at the Pump Stations may cause voltage drops or “flicker” and PG&E may require the installation of variable speed drives (VFD’s) for each pump and motor. The use of VFD’s at the Pump

Stations will also afford the JPA greater flexibility in matching flows and reducing the starting and stopping of pumps.

IX. Control Building Design

An electrical control building will be constructed at each Pump Station to house the electrical, control, and SCADA equipment. It is anticipated that the control building will be either a masonry building or a pre-cast concrete building.

The designer shall ensure the building is adequately sized to hold all the electrical and control equipment and provide adequate clearances for access and maintenance. The minimum ceiling height shall be 10-feet. Door openings shall be large enough for the removal of the largest piece of equipment or the roof shall be removable.

The building shall be climate controlled, the VFD units shall be vented to the building exterior and a means incorporated to minimize the AC loading in the building by utilizing outside (unconditioned) air for cooling the VFD units, and the roof shall be sloped appropriately with runoff away from the building ingress and egress. In addition, the building shall have intrusion alarms installed at all doors and access points for building security.

X. Pump Station Control Philosophy

The pump station control philosophy for each pump station facility will be developed during the detailed design of the conveyance canal and pump stations.

The pump stations will need to be capable of being controlled, monitored, and operated both locally and remote through SCADA. The operators shall have the flexibility to turn on pumps and turn off pumps as necessary. In addition, the SCADA system shall provide for water level monitoring in each pump forebay and afterbay as well as indicating the pump flow readings from the flow meters. The SCADA system shall communicate alarms at a minimum for power failure, motor failure, water level alarms, and high pressure alarms.

The Conveyance Canal Pump Station motors will be equipped with variable speed drives and will be able to modulate to maintain flow or level. The canal may be desired to be controlled based on flow or level. It may be advantageous to set the flow rate at each pump station and have the pumps modulate to maintain the flow set point while utilizing the water level as a secondary means of control in the event of high water levels or low water levels that could compromise the performance of the pump based on low submergence. Protective measures such as water level sensors shall be duplicated for redundancy.

The Goose Lake Channel Pump Station and Return Water Pump Station motors will be equipped with variable speed drives and will be able to modulate to maintain flow or level. It is anticipated that the Goose Lake Channel Pump Station and Return Water Pump Station will be operated for long periods of time or turned off for long periods of time. Override protective measures will be

designed such as a low water level cutoff in the event the pump submergence is compromised or a high pressure switch at the pump discharge in the event of a closed valve or blockage. Protective measures such as water level sensors shall be duplicated for redundancy.

XI. Summary

Each pump station shall be designed, at a minimum, in accordance with the Hydraulic Institute Standards ANSI/HI 9.8-Most Recent Edition for Pump Intake Design. Additionally, the conveyance canal pump stations shall have physical modeling and numerical modeling using CFD performed due to the large capacities of these pump stations.

It is recommended that Pump Stations No. 1 and No. 2 have six pumps and motors each with two (2) 40 to 42 cfs pumps and four (4) 89 to 90 cfs pumps. Pump Station No. 3 is recommended to have four pumps and motors with two (2) 40 cfs pumps and two (2) 80 cfs pumps.

In addition, the Goose Lake Channel Pump Station is recommended to have four pumps and motors with two (2) 40 cfs pumps and two (2) 80 cfs pumps and the Return Water Pump Station is recommended to have three (3) 36 cfs pumps. This will allow pump bay widths to be similar for utilizing two standard stop log slot dimensions and also for providing interchangeability between pumps across all pump stations.

A Pump Station No. 4 may be necessary at the easterly end of the conveyance channel to lift 129 cfs to the Phase I Property, however this pump station has not been considered herein. This pump station is considered small enough that it may not require physical modeling provided it is designed as outlined herein.

Table 12

Pump Station Summary				
Pump Station Facility	Capacity	Pump Configuration	36-42 cfs Pumps	80-90 cfs Pumps
Pump Station No. 1	443 cfs	Six (6) Pumps	Two	Four
Pump Station No. 2	435 cfs	Six (6) Pumps	Two	Four
Pump Station No. 3	240 cfs	Four (4) Pumps	Two	Two
Pump Station No. 4	129 cfs	If Necessary		
Goose Lake Channel Pump Station	240 cfs	Four (4) Pumps	Two	Two
Return Water Pump Station	72 cfs	Three (3) Pumps	Three	

The pump stations shall be equipped with galvanized steel trashracks, decks designed for H2O loadings to allow for cleaning of trashracks and removal of pumps/motors, cathodic protection, stilling wells for water level monitoring, and access to the pump forebay behind the trashracks and stoplog slots.

The pump motors will be equipped with variable speed drives. The pump discharge piping shall be equipped with air release valves, check valves, butterfly valves, dresser couplings, and flow meters as appropriate for the application.

The electrical service shall be coordinated early in the design process with PG&E and is anticipated to be a low voltage service (480V). The electrical equipment shall be designed in an electrical control building that is climate controlled to protect the equipment from the elements and vandalism.

XII. Related Work Specified Elsewhere

A. TM 2 – Conveyance Capacity Requirements
B. TM 3 – Pipeline Requirements
C. TM 5 – Geotechnical Investigation
D. TM 6 – Canal Liner and Turnout Requirements
E. TM 10 – Facility Operation and SCADA Requirements
F. TM 11- Engineer's Estimates

APPENDIX E

Technical Memorandum #5
Geotechnical Investigation

DEE JASPAR & ASSOCIATES, INC.
CONSULTING CIVIL ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CA 93308
PHONE (661) 393-4796
FAX (661) 393-4799

KERN FAN GROUNDWATER STORAGE PROJECT

TECHNICAL MEMORANDUM NO. 5
(Geotechnical Investigation)

PREPARED FOR: Groundwater Banking Joint Powers Authority (JPA)
PREPARED BY: Curtis Skaggs, P.E.
DATE: February 10, 2021

SUBJECT: ***Geotechnical Investigation***

I. Executive Summary

This memorandum serves to outline the general requirements for geotechnical investigation work and preparation of project soils reports. The requirements outlined herein should be considered recommendations and an estimate of the work that needs to be included, however the design firm shall ultimately be responsible for ensuring that adequate soils investigation is performed so that all facets of the project can be properly designed to minimize potential failures or problems.

Based on the Technical Memorandum No. 1 "Project Phasing and Design/Contractor Selection", it is envisioned that a Geotechnical Investigation and Soils Report will be necessary for each of the following phases:

- Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines Intertie; Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures
- Aqueduct Turnout Facility
- Conveyance Facilities including Turnouts & Pump Stations

A map overview of the project and the associated geotechnical portions is illustrated in Figure 1 below.

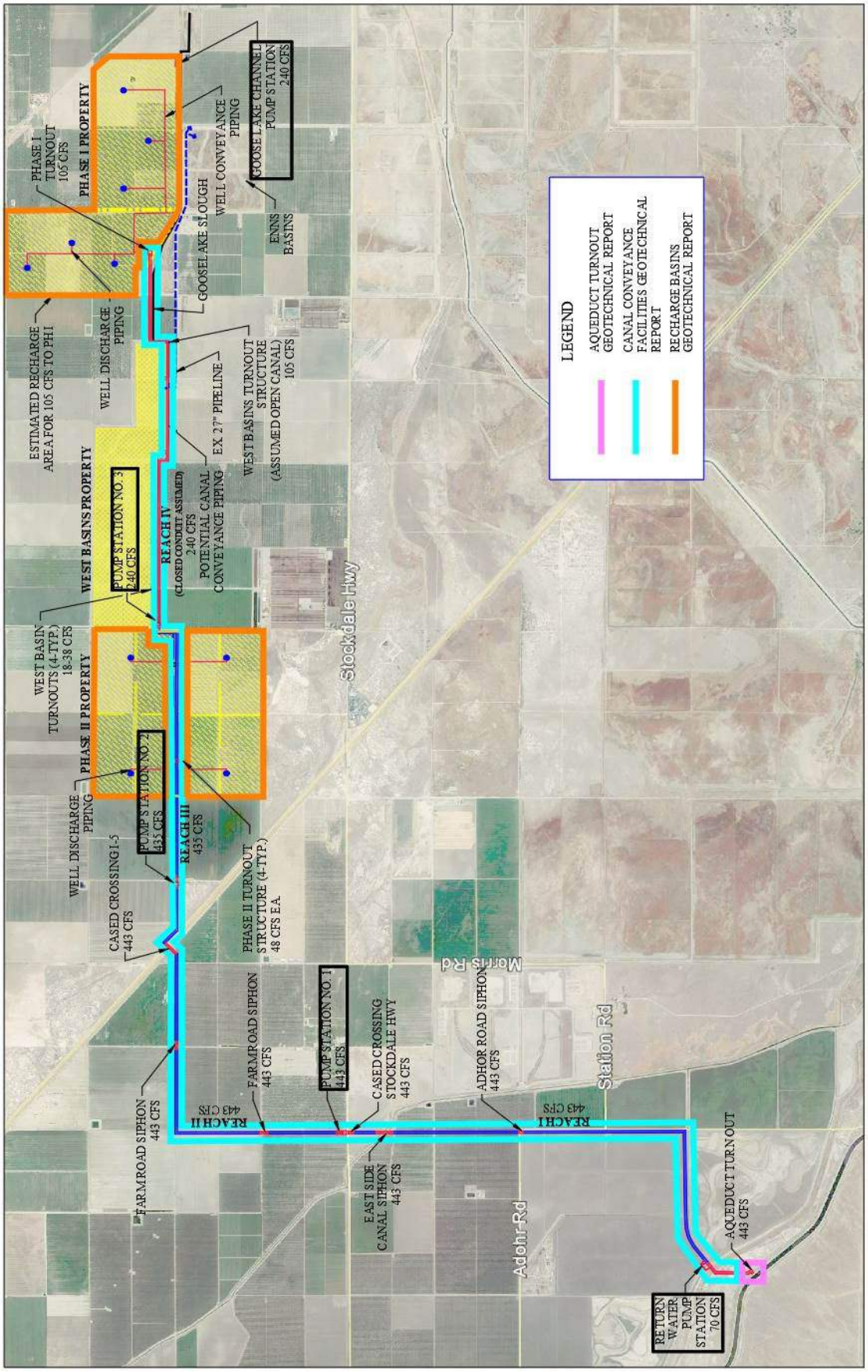


Figure 1: Project Geotechnical Overview

An outline of the memorandum is shown below:

II. Recharge Facility Soils Work Page 8

A. Review of Available Data
   a. Existing Borings
   b. Well Completion Reports
   c. Groundwater Data
   d. Aerial Photography
   e. Geologic Mapping
   f. Transient Electromagnetic (tTEM) Resistivity Correlations, etc.)

B. Field Exploration
   a. Test Pits
   b. Laboratory Testing

C. Site Conditions

D. Engineering Seismology
   a. Seismic Parameters for Engineering Design
      i. American Society of Civil Engineers (ASCE) 7-16
      ii. 2019 California Building Code (CBC)
   b. Liquefaction

E. Design Recommendations
   a. Structure Design
      i. Lateral Earth Pressures
      ii. Resistance to Lateral Loading,
      iii. Bearing Capacity
      iv. Settlement
   b. Levee Construction Earthwork
      i. Slope Stability
      ii. Areas of Concerns requiring Levee Keyways
      iii. Through seepage
      iv. Under seepage
   c. Permanent Slopes
      i. Static Stability
      ii. Seismic Stability
      iii. Maximum Inboard and Outboard Gradients
   d. Temporary Slopes
      i. Slope Stability and Maximum Slope Gradients
   e. Transfer Structures and Pipes
      i. Pipe Backfill Criteria
      ii. Cutoff Walls Backfill Criteria

E. Design Recommendations
   a. Structure Design
      i. Lateral Earth Pressures
      ii. Resistance to Lateral Loading
      iii. Bearing Capacity
      iv. Settlement
   b. Pipe Design
      i. Soil Properties
      ii. Vertical Loading
      iii. Soil Friction, E'
         1. Native
         2. Backfill
      iv. Compaction Criteria
         3. Pipe Zone
         4. Trench Zone
   c. Braced Cuts
      i. Bracing
      ii. Shoring
   d. Concrete Corrosion Potential
      i. Sulfate Reaction
      ii. Other Design Considerations
   e. Dewatering
      i. Temporary Piezometers

F. Earthwork
   a. Preparation of Subgrade
   b. Borrow Areas
      i. Suitability of Material
      ii. Gradations
   c. Compaction Criteria
      i. Relative Compaction and Compaction Moisture
      ii. Compaction Methods

IV. Conveyance Soils Work Page 11

A. Review of Available Data
   a. Existing Borings
   b. Well Completion Reports
   c. Groundwater Data
   d. Aerial Photography
   e. Geologic Mapping
   f. Transient Electromagnetic (TEM) Resistivity Correlations, etc.)

B. Field Exploration
   a. Soil Borings at Structures and Along Alignment
   b. Laboratory Testing
   c. In-situ Testing
   d. Temporary Piezometers

C. Site Conditions
   a. Turnouts
   b. Siphons
   c. Along Alignment

D. Engineering Seismology
   a. Seismic Parameters for Engineering Design
      i. American Society of Civil Engineers (ASCE) 7-16
      ii. 2019 California Building Code (CBC)
   b. Liquefaction

E. Design Recommendations
   a. Structure Design
      i. Lateral Earth Pressures
      ii. Resistance to Lateral Loading,
      iii. Bearing Capacity
      iv. Settlement
   b. Bridge Structures
      i. Vertical Capacity
      ii. Lateral Capacity
      iii. Seismic Design
      iv. Construction Considerations
   c. Pipe Design
      i. Soil Properties
      ii. Vertical Loading
      iii. Soil Friction, E'
         1. Native
         2. Backfill
      iv. Compaction Criteria
         3. Pipe Zone
         4. Trench Zone
   d. Jacking & Tunneling Design
      i. Anticipated Soil Stratigraphy
      ii. Tunnel Construction
      iii. Need for Soil Stabilization
   e. Canal Levee Construction
      i. Relative Compaction and Compaction Moisture
      ii. Compaction Methods
      iii. Slope stability
      iv. Permanent Piezometers
   f. Slope Stability
   g. Permanent Slopes
      i. Static Stability
      ii. Seismic Stability
      iii. Maximum Inboard and Outboard Gradients
   h. Temporary Slopes

i. Slope Stability and Maximum Slope Gradients

i. Braced Cuts

i. Bracing

ii. Shoring

j. Concrete Corrosion Potential

i. Sulfate Reaction

ii. Other Design Considerations

k. Dewatering

i. Temporary Piezometers

F. Earthwork

a. Preparation of Subgrade/Keyway

b. Borrow Areas

i. Suitability of Borrow Materials as Fill

1. Expansion Potential

2. Dispersiveness

ii. Gradations

c. Compaction Criteria

i. Relative Compaction and Compaction Moisture

ii. Compaction Methods

iii. Need for Blending of Levee Fill Materials

V. Summary Page 15

These soils reports will become the property of the JPA. As such, the JPA will be permitted to provide copies of the soils reports as necessary to other design firms, general contractors, and subcontractors as required for other phases of the project.

II. Recharge Facility Soils Work

A geotechnical investigation and report is necessary for the recharge facility projects listed in the design phase "Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines Intertie; Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures. The investigation work is considered the field work, sampling, and testing while the report is considered the final report summarizing the findings, conclusions, and recommendations.

This work will include a review of available data, field exploration, a description of site conditions, an outline of seismic parameters, and design and earthwork recommendations as outlined below.

This information will be necessary for the recharge facility earthwork, the design of earthen levees, the design of interbasin structures, the design of conveyance pipelines, and the design of other associated structures.

A. Review of Available Data

A review of available data in the area of the proposed recharge basins shall be performed. This shall include, but not be limited to, a review of existing borings, well completion reports, groundwater data, historic aerial photographs, geologic mapping, and transient electromagnetic (tTEM) surveys.

It is anticipated that the District will perform tTEM surveys on the Phase I and Phase II properties as part of the due diligence in purchasing the properties. The tTEM survey method measures the electrical resistivity of the earth and these resistivities are translated to soil lithology for a better understanding of the formations below the ground surface.

B. Field Exploration

The field exploration within the proposed recharge basin properties shall consist of test pits, borings, and laboratory testing.

It is anticipated that test pits shall be excavated across the properties of the Phase I and Phase II recharge areas to depths of approximately 5-feet to 10-feet. It is anticipated that up to 30 test pits, or approximately 1 test pit per 20 acres, could be excavated and that these would be performed in areas of geologic interest such as historic channels and seepage paths based upon the review of available data.

The actual depth and quantity of test pits, however, will be dependent on the property, the data review, and the discretion of the soils firm and design firm.

It may also be desirable to perform a few deep borings for correlation with the tTEM survey data.

Soil samples shall be collected from the test pits or borings and the following testing considered:

- Moisture Content (ASTM D2216)
- Unit Weight (ASTM D2937)
- Sieve Analysis (ASTM C136, D422, D1140)
- Dispersive Characteristics of Clay Soil by Double Hydrometer (ASTM D4221)
- Atterberg Limits (ASTM D4318)
- Standard Proctor (ASTM D698) or Modified Proctor (ASTM D1557) as appropriate
- Expansion Index (ASTM D4829)
- Soluble Sulfate & Soluble Chloride Contents (California Test Method No.'s 417 & 422)
- pH and Minimum Resistivity (California Test Method No. 643)
- Strength Testing – Direct Shear (ASTM D3080) or Unconfined Compressive Strength (ASTM D2166)
- Flexible Wall Permeability (ASTM D5084)
- Collapse Potential (ASTM D5333)

C. Site Conditions

The report shall outline the existing site conditions. This shall include background data on the properties and a description of subsurface conditions including obstructions and earth materials.

D. Seismic Design Parameters

The report shall outline the seismic design parameters for engineering design of structures and facilities within the project areas. The seismic parameters shall be in accordance with ASCE 7-16 and the 2019 California Building Code (CBC).

E. Design Recommendations

The report shall outline design recommendations for site earthwork, levee subgrade preparation, embankment construction, structure backfill, and structure design.

This shall include a recommendation of materials, compaction efforts, slope stability, permeability, bearing capacity, settlement, lateral earth pressures, lateral resistance, and pipe design parameters

such as E_b', backfill internal friction, active coefficient, and frictional coefficient.

III. Aqueduct Turnout Facility

A geotechnical investigation and report is necessary for the Aqueduct Turnout Facility. It is anticipated that the Department of Water Resources (DWR) and the Kern County Water Agency (KCWA) will provide information as to their standard geotechnical requirements once the turnout design commences.

The geotechnical work will include a review of available data, field exploration, a description of site conditions, an outline of seismic parameters, and design and earthwork recommendations as outlined below.

This information will be necessary for the turnout facility excavation, subgrade preparation, structure design, turnout piping design, and the structure and pipe backfill and compaction.

A. Review of Available Data

A review of available data in the area of the proposed Aqueduct Turnout shall be performed. This shall include, but not be limited to, a review of existing borings, well completion reports, groundwater data, historic aerial photographs, and geologic mapping.

B. Field Exploration

The field exploration at the Aqueduct Turnout shall consist of a minimum of one boring at the site and laboratory testing.

It is anticipated that the boring will extend to a minimum 10-feet below the planned invert of the turnout structure. It should also be considered to convert this boring into a piezometer for monitoring groundwater levels in the area of the turnout structure pre-construction, during construction, and post-construction of the turnout.

Soil samples shall be collected from the boring and the following testing considered:

- Moisture Content (ASTM D2216)
- Unit Weight (ASTM D2937)
- Sieve Analysis (ASTM C136, D422, D1140)
- Atterberg Limits (ASTM D4318)
- Modified Proctor (ASTM D1557)
- Soluble Sulfate & Soluble Chloride Contents (California Test Method No.'s 417 & 422)
- pH and Minimum Resistivity (California Test Method No. 643)

- Strength Testing – Direct Shear (ASTM D3080) or Unconfined Compressive Strength (ASTM D2166)
- Flexible Wall Permeability (ASTM D5084)

C. Site Conditions

The report shall outline the existing site conditions. This shall include background data on the turnout property and a description of subsurface conditions including obstructions and earth materials.

D. Seismic Design Parameters

The report shall outline the seismic design parameters for engineering design of the structure and appurtenances. The seismic parameters shall be in accordance with ASCE 7-16 and the 2019 California Building Code (CBC).

E. Design Recommendations

The report shall outline design recommendations for earthwork excavation, dewatering if necessary, turnout subgrade preparation, structure design, turnout piping design, and structure and pipe backfill and compaction.

This shall include a recommendation of materials, compaction efforts, dewatering, bearing capacity, seismic design, settlement, lateral earth pressures, lateral resistance, concrete corrosion potential, and pipe design parameters such as E_b', backfill internal friction, active coefficient, and frictional coefficient.

IV. Conveyance Facilities Soils Work

A geotechnical investigation and report is necessary for the Conveyance Facilities listed under the design phase "Conveyance Facilities including Turnouts & Pump Stations".

This work will include a review of available data, field exploration, a description of site conditions, an outline of seismic parameters, and design and earthwork recommendations as outlined below.

This information will be necessary for project earthwork, excavation, dewatering, subgrade preparation, levee embankment construction, structure design, bridge structures or culvert crossings, jacking and tunneling design, turnout design, pipeline design, and the associated backfill and compaction requirements.

A. Review of Available Data

A review of available data in the area of the proposed Conveyance Facility alignment and facilities shall be performed. This shall include, but not be limited to, a review of existing borings, well completion reports, groundwater data, historic aerial photographs, geologic mapping, and correlation with tTEM survey data.

B. Field Exploration

The field exploration for the Conveyance Facilities shall consist of approximately 48 to 50 borings along the conveyance alignment and at critical facilities as well as laboratory testing. It is estimated that borings would be performed at approximate quarter-mile increments along the conveyance canal unless coincident with a project structure. The actual depth and quantity of borings, however, will be dependent on the actual alignment, the data review, and the discretion of the soils firm and design firm.

It is anticipated that the borings will extend to a minimum 10-feet below the planned invert of structures such as the pump stations and the culvert or pipe crossings. It is anticipated that the borings will extend to a minimum of 5-feet below the invert for the conveyance canal as well as for borings at canal turnout structures. It should also be considered to convert some of the borings into piezometers for monitoring groundwater levels in the area of the canal or some structures that are adjacent to recharge facilities or locations with high ground water. Piezometers are estimated at the Return Water Pump Station and Reach 1 of the canal that are adjacent to the Buena Vista Water Storage District recharge area; Pump Station No. 1; the I-5 Cased Crossing; Pump Station No. 2; the portion of Reach 3 of the canal adjacent to the Phase II Recharge Property; Pump Station No. 3; and the portion of Reach 4 of the canal (if open channel) adjacent to the West Basins Property.

Soil samples shall be collected from the borings and the following testing considered:

- Moisture Content (ASTM D2216)
- Unit Weight (ASTM D2937)
- Sieve Analysis (ASTM C136, D422, D1140)
- Dispersive Characteristics of Clay Soil by Double Hydrometer (ASTM D4221)
- Atterberg Limits (ASTM D4318)
- Modified Proctor (ASTM D1557)
- Expansion Index (ASTM D4829)
- Soluble Sulfate & Soluble Chloride Contents (California Test Method No.'s 417 & 422)
- pH and Minimum Resistivity (California Test Method No. 643)

- Strength Testing – Direct Shear (ASTM D3080) or Unconfined Compressive Strength (ASTM D2166)
- Flexible Wall Permeability (ASTM D5084)
- Consolidation – Clayey Soil (ASTM D2435)
- Collapse Potential (ASTM D5333)

C. Site Conditions

The report shall outline the existing site conditions for the conveyance canal alignment, pump stations, turnouts, cased crossings and culvert or siphon crossings. This shall include background data on the project properties and a description of subsurface conditions including obstructions and earth materials.

D. Seismic Design Parameters

The report shall outline the seismic design parameters for engineering design of the structures and appurtenances. The seismic parameters shall be in accordance with ASCE 7-16 and the 2019 California Building Code (CBC).

E. Design Recommendations

The report shall outline design recommendations for earthwork excavation, dewatering if necessary, subgrade preparation, levee embankments, borrow areas, structure design, bridge structures, box culverts, jacking and tunneling design, pump stations, turnouts, pipeline design, and structure backfill and compaction.

Report considerations shall include:

a. Structure Design

The geotechnical report shall provide information for reinforced concrete structure design that includes recommendations for excavation work, dewatering (if necessary), liquefaction, subgrade preparation, backfill and compaction, slope stability for temporary and permanent slopes, braced cuts and shoring, seismic design, concrete corrosion potential, lateral earth pressures, resistance to lateral loading, bearing capacity, and estimated settlement.

b. Bridge Structures

The geotechnical report shall provide information for bridge structure design that includes recommendations for excavation work, dewatering (if necessary), liquefaction, subgrade preparation, backfill and compaction, slope stability for temporary and permanent slopes, braced cuts and shoring,

concrete corrosion potential, vertical capacity, lateral capacity, seismic design, and construction considerations.

c. Cased Crossings

The geotechnical report shall provide information for cased crossing design for jack and bore installation as well as the tunnel boring method. This shall include anticipated soil stratigraphy and recommendations for excavation work, dewatering (if necessary), backfill and compaction, slope stability for temporary and permanent slopes, braced cuts and shoring, concrete corrosion potential, tunnel construction, and the need for soil stabilization.

d. Culvert and Pipe Crossings

The geotechnical report shall provide information for culvert design, siphon design, and buried pipe design. This shall include soil properties and recommendations for excavation work, dewatering (if necessary), slope stability for temporary and permanent slopes, braced cuts and shoring, backfill and compaction, concrete corrosion potential, vertical loading, soil friction for native and backfill material, and pipe zone compaction efforts.

e. Conveyance Canal Design

The geotechnical report shall provide information for the conveyance canal earthwork. This shall include soil properties and recommendations for excavation work, dewatering (if necessary), subgrade preparation, suitability of borrow areas, levee embankment fill, compaction methods, relative compaction and compaction moisture, slope stability for temporary and permanent slopes, braced cuts and shoring, backfill and compaction, concrete corrosion potential, and piezometers for shallow groundwater areas.

Areas of potential borrow material for construction of the conveyance canal will need to be evaluated for their suitability with respect to soil characteristics, gradations, expansive potential, and dispersiveness.

V. Summary

This information herein serves to outline the general requirements for geotechnical investigation work and preparation of project soils reports. The requirements outlined herein should be considered recommendations and an estimate of the work that needs to be included, however the design firm shall ultimately be responsible for ensuring that adequate soils investigation is performed so that all facets of the project can be properly designed to minimize potential failures or problems.

Based on the Technical Memorandum No. 1 "Project Phasing and Design/Contractor Selection", it is envisioned that a Geotechnical Investigation and Soils Report will be necessary for each of the following phases:

- Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines Intertie; Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures

- Aqueduct Turnout Facility

- Conveyance Facilities including Turnouts & Pump Stations

These soils reports will become the property of the JPA. As such, the JPA will be permitted to provide copies of the soils reports as necessary to other design firms, general contractors, and subcontractors as required for other phases of the project.

A map of the proposed boring and test pit locations is illustrated in Figure 2 below. This is considered preliminary and subject to change based upon the actual Phase I and Phase II property locations, the actual conveyance canal alignment, and the needs and discretion of the design firm.

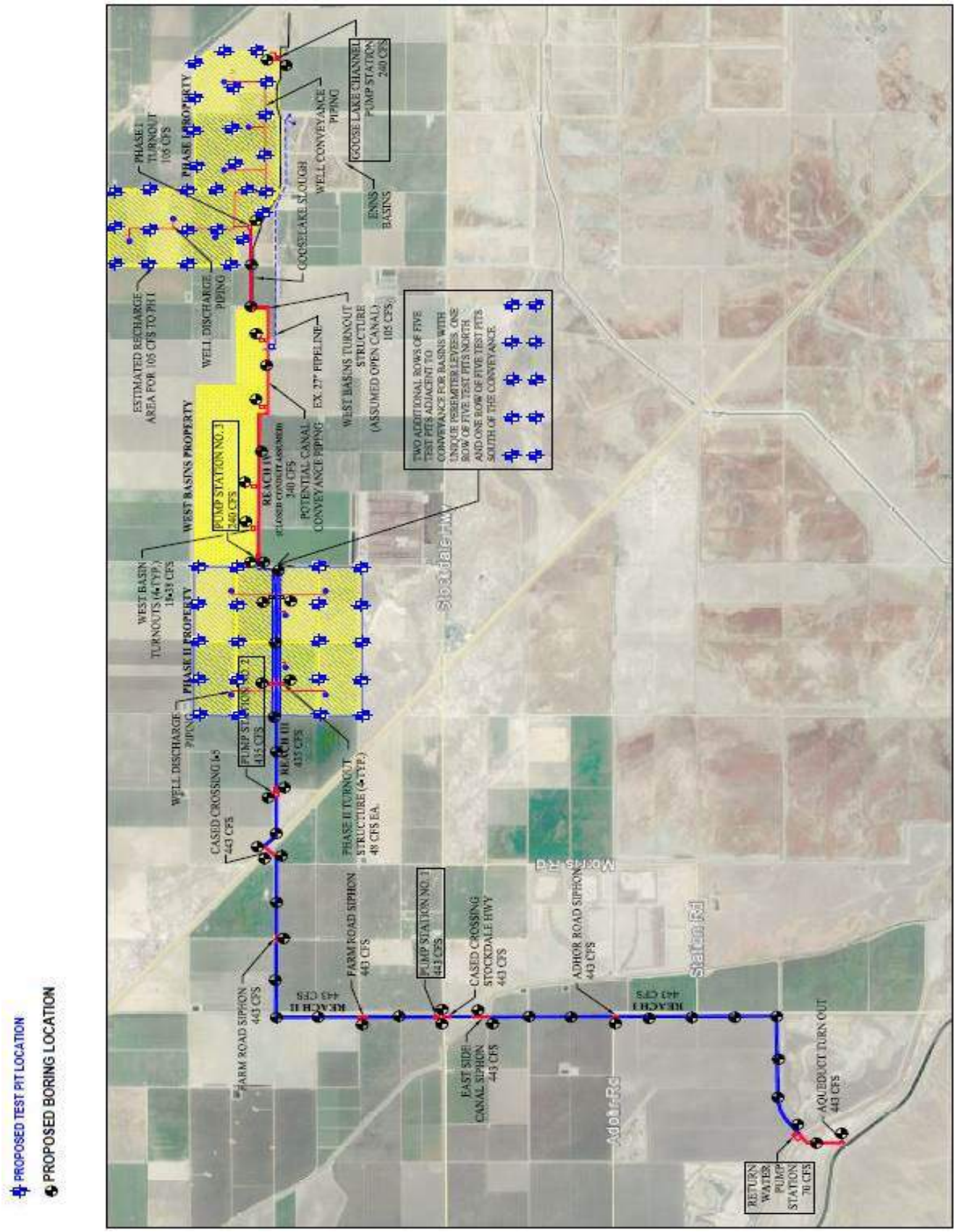


Figure 2: Preliminary Boring and Test Pit Location Map

In addition, below in Table 1 is a matrix table summarizing the proposed project components and the recommended laboratory testing. The actual type of laboratory tests and frequency shall be determined by the site conditions, the project needs, and the design firm.

Table 1

KERN FAN GROUNDWATER STORAGE PROJECT - GEOTECHNICAL INVESTIGATION OF PROJECT COMPONENTS AND LABORATORY TESTING

						Laboratory Testing[E]												
Reach	Structure Type	Structure Name	Approximate No. of Borings/Test Pits[A]	Comments on Minimum Depth of Exploration (ft)	Approximate No. of Temporary Piezometers[D]	Moisture Content (ASTM D2216)	Unit weight (ASTM D2937)	Sieve Analysis (ASTM C136), (ASTM D422), (ASTM D1140)	Dispersive Characteristics of Clay Soil by Double Hydrometer (ASTM D4221)	Atterberg Limits (ASTM D4318)	Modified Proctor (ASTM D1557)	Expansion Index (ASTM D4829)	Soluble Sulfate & Soluble Chloride Contents (California Test Method No's 417 & 422)	pH and Minimum Resistivity (California Test Method No. 643)	Strength Testing - Direct Shear (ASTM D3080) or Unconfined Compressive Strength (ASTM D2166)	Flexible Wall Permeability (ASTM D5084)	Consolidation (ASTM D2435) - Clayey Soil	Collapse Potential (ASTM D5333)
Reaches 1 - 3	Conveyance	Conveyance (Canal)	19[B]	5 feet below invert		X	X	X	X	X	X	X			X		X	X
Reach 1	Conveyance	Aqueduct Turnout	1	10 feet below invert of structure	1	X	X	X		X	X				X	X		
Reach 1	Pump Station	Return Water Pump Station	1	10 feet below invert of pumping bay	1	X	X	X		X	X				X			
Reach 1	Conveyance	Adhor Road Siphon	1	10 feet below invert of structure		X	X	X		X	X				X			
Reach 1	Conveyance	East Side Canal Siphon	2	10 feet below invert of structure		X	X	X		X	X				X			
Reaches 1/2	Conveyance	Stockdale Cased Crossing	2	10 feet below invert		X	X	X		X	X		X	X	X			
Reach 2	Conveyance	Pump Station No. 1	2	10 feet below invert of pumping bay	1	X	X	X		X	X				X		X	X
Reach 2	Conveyance	Farm Road Siphon	1	10 feet below invert of structure		X	X	X		X	X				X			
Reaches 2/3	Conveyance	Interstate 5 Cased Crossing	3	10 feet below invert	2	X	X	X		X	X		X	X	X	X		
Reach 3	Pump Station	Pump Station No. 2	2	10 feet below invert of pumping bay	1	X	X	X		X	X				X		X	X
Reach 3	Conveyance	Phase 2 Property - Turnout 1	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 3	Conveyance	Phase 2 Property - Turnout 2	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 3	Conveyance	Phase 2 Property - Turnout 3	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 3	Conveyance	Phase 2 Property - Turnout 4	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 3	Recharge Facility	Phase 2 Property	30[C]	5 to 10 feet		X	X	X	X	X	X	X	X	X	X	X		X
Reach 4	Conveyance	Conveyance (Pipeline)	4[B]	5 feet below invert		X	X	X	X	X	X				X			
Reach 4	Pump Station	Pump Station No. 3	2	10 feet below invert of pumping bay	1	X	X	X		X	X				X		X	X
Reach 4	Conveyance	West Basins Property - Turnout 1	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 4	Conveyance	West Basins Property - Turnout 2	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 4	Conveyance	West Basins Property - Turnout 3	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 4	Conveyance	West Basins Property - Turnout 4	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 4	Conveyance	Phase 1 Property - Turnout 1	1	5 feet below invert of structure		X	X	X		X	X		X	X	X	X		X
Reach 4	Recharge Facility	Phase 1 Property	28[C]	5 to 10 feet		X	X	X	X	X	X	X	X	X	X	X		X
Reach 4	Pump Station	Goose Lake Channel Pump Station	2	10 feet below invert of pumping bay		X	X	X		X	X				X			

[A]All explorations shall be measured horizontally and vertically by a licensed surveyor.

[B]Explorations advanced along the conveyance and earthen embankments shall be spaced approximately every ¼ mile, unless coincident with a project structure.

[C]Test pit explorations shall be advanced in areas of geologic interest, i.e. historic channels and seepage paths, based on a review of aerial photography, geologic mapping, Transient Electromagnetic (TEM) resistivity correlations, and readily available data.

[D]Piezometers to be installed where groundwater is encountered.

[E]Actual type of laboratory tests and frequency to be determine by site conditions and project needs.

VI. Related Work Specified Elsewhere

A. TM 1 – Project Phasing & Design/Contractor Selection
B. TM 2 – Conveyance Capacity Requirements
C. TM 3 – Pipeline Requirements
D. TM 4 – Pump Station Requirements
E. TM 6 – Canal Liner and Turnout Requirements
F. TM 9 – Recharge Basin Requirements
G. TM 11- Engineer's Estimates

APPENDIX F

Technical Memorandum #6
Conveyance and Turnout Requirements

DEE JASPAR & ASSOCIATES, INC.
CONSULTING CIVIL ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CA 93308
PHONE (661) 393-4796
FAX (661) 393-4799

KERN FAN GROUNDWATER STORAGE PROJECT

TECHNICAL MEMORANDUM NO. 6
(Conveyance and Turnout Requirements)

PREPARED FOR: Kern Fan Joint Powers Authority (JPA)
PREPARED BY: Curtis Skaggs, P.E.
DATE: March 25, 2021

SUBJECT: ***Conveyance and Turnout Requirements***

I. Executive Summary

This memorandum serves to consider the conveyance facility alternatives including potential canal lining alternatives, capital costs, and operations and maintenance costs over a fifty-year period. The canal lining alternatives considered herein include:

1. Earth Lined Canal (with mitigation options – see below)
2. High-Density Polyethylene (HDPE) Lined Canal
3. Reinforced Polyethylene (RPE) Lined Canal
4. Shotcrete Lined Canal
5. Concrete Lined Canal

In addition, a pipeline alternative (Alternative No. 6) has also been considered herein.

The outline of the memorandum includes the following:

The conveyance facility will cross recharge facilities, agricultural lands, private property, County roads, Stockdale Highway, and the I-5 Freeway. The conveyance facility is also planned to be utilized in the reverse

direction during recovery operations for returning water to the California Aqueduct.

In order to prepare an Engineer's Estimate for the proposed project, preliminary quantities needed to be estimated. Elevations along the canal alignment were estimated using Google Earth and a preliminary conveyance canal line and grade established. Canal cross-sections and earthwork quantity estimates were prepared for the canal conveyance alignment and are attached in Appendix A and B. The canal alignment, elevations, grades, slopes, and quantities are all estimates and are outlined herein for purposes of showing what the cost estimates are based upon. However, the quantities are merely for purposes of the cost estimate in Technical Memorandum No. 11 and no representations are made beyond that. The actual alignment, elevations, grades, slopes, and quantities may be very different once design information is obtained and layout completed.

Section II of this memorandum provides detail for the conveyance canal facility including the proposed preliminary alignment and canal profile. The conveyance canal is estimated as approximately 8.80 miles long or 46,400-ft. The canal cross-section for the lined canal options is estimated to be 8-ft deep with a 20-ft wide bottom and 1.5:1 side slopes. This section of the memorandum outlines the anticipated earthwork associated with the conveyance canal construction, the estimated earthwork volumes, the estimated right-of-way required, and the conveyance canal features. Tables 1 through 4 therein provide the capital cost estimate for the conveyance facilities while excluding any lining costs, pump station costs, or right-of-way acquisition. The earthwork cost estimate for the above described canal prism is $5,705,205 and the conveyance canal costs as outlined in Table 1 through 4 are estimated at $20,750,355.

Section III of this memorandum considers the earth lined canal and the sub-alternates that include mitigation efforts such as a return water pipeline or bentonite lining. The earth lined canal alternative is estimated to be a 20-ft wide bottom with 3:1 side slopes and an approximate 10-ft depth. This requires additional earthwork and increases the earthwork costs from $5,705,205 to approximately $7,148,566. This in turn increases the conveyance canal costs outlined in Tables 1 through 4 from $20,750,355 to approximately $22,193,716.

Sections IV through VI serve to evaluate the canal lining options such as poly linings, shotcrete lining, and conventional concrete canal lining. The construction methods are discussed therein, the hydraulic impacts are addressed, capital costs for each lining are developed, and the advantages and disadvantages are discussed. The lining capital costs are summarized below:

1.	Earth Lined Canal	$NA
1a.	Earth Lined Canal with Return Water Pipeline	$10,519,000
1b.	Earth Lined Canal with Bentonite Lining	$15,135,216
2/3.	Poly Lined Canal - High-Density Polyethylene (HDPE) Lined Canal or Reinforced Polyethylene (RPE) Lined Canal	$5,596,190

4. Shotcrete Lined Canal $14,818,490
5. Concrete Lined Canal $16,001,690

Section VII summarizes the canal lining alternatives and discusses the present worth analysis. Four canal lining alternatives and one pipeline alternative were evaluated:

1. Earth Lined Canal (see mitigation options below)
2/3. Poly Lined Canal - High-Density Polyethylene (HDPE) Lined Canal or Reinforced Polyethylene (RPE) Lined Canal
4. Shotcrete Lined Canal
5. Concrete Lined Canal
6. Conveyance Pipeline

In addition, two additional alternatives were considered as part of mitigation efforts with an earth lined canal:

1a. Earth Lined Canal with Parallel Return Water Pipeline
1b. Earth Lined Canal with Bentonite Lining

The capital costs were considered for each of the above alternatives including earthwork and conveyance facility costs, pump station costs, right-of-way costs, and canal lining costs.

The right-of-way costs are estimated as follows:

Canal with 1.5:1 Side Slopes – 180 ft Permanent R/W or approximately 200 acres at $25,000 per acre…….…..$5,000,000

Canal with 3:1 Side Slopes – 210 ft Permanent R/W or approximately 225 acres at $25,000 per acre……..$5,625,000

Closed Conduit – 140 ft Permanent R/W or approximately 150 acres at $25,000 per acre……...$3,750,000

The pump station costs for the conveyance canal alternatives include three pump stations along the alignment and a return water pump station. The costs from Technical Memorandum No. 4 "Pump Station Requirements" have been utilized for the pump stations. Pump Station No. 1 and No. 2 are estimated as $8,605,000 each, Pump Station No. 3 is estimated as $6,150,000 and the Return Water Pump Station is estimated as $2,081,000. The total pump station costs are approximately $28,945,000 which includes an approximate 15% contingency to account for unknowns and PG&E service costs.

The capital costs, including earthwork costs, conveyance facilities, pump stations, and right-of-way acquisition (not including lining or mitigation costs), are summarized below:

Earth Lined Alternatives (1, 1a, and 1b)	$56,763,716
Lined Alternatives (2, 3, 4, and 5)	$54,695,355

Section VIII evaluates a pipeline alternative for the conveyance facility. Alternative No. 6 is a conveyance pipeline, however due to the capacity and size of the pipeline, it is a much more significant capital cost. The capital cost for the pipeline, including the pump station, pipeline right-of-way, and road crossing work at Adohr Road, Stockdale Hwy, and the I-5 Fwy, is approximately $79,375,500.00.

In addition, a present worth analysis was performed that considered the well pumping costs during recovery periods, conveyance canal operational costs in an idle year, dry year, and wet year, and also the canal lining replacement costs and pump station replacement costs over a fifty-year (50) period. Below is a summary of the conveyance alternative costs and a ranking based upon a fifty (50) year present worth analysis.

Summary of Conveyance Alternatives

Ranking by Present Worth	Alternative No.	Alternative	Earthwork & Conveyance Facility Costs[2]	Pump Station Costs[3]	Right-of-Way Costs[4]	Lining Cost or Earth Canal Option Costs[5]	Total Conveyance Cost w/ Pump Stations[6]	Present Worth on 50 Yr Basis[7]
1	6	Pipeline	$62,242,300	$13,383,200	$3,750,000	NA	$79,375,500	$182,191,000
2	1a	Earth Lined w/Return Pipeline	$22,193,716	$28,945,000	$5,625,000	$10,519,000	$67,282,716	$188,594,201
3	2/3	HDPE/RPE Lined	$20,750,355	$28,945,000	$5,000,000	$5,596,190	$60,291,545	$190,764,330
4	4	Shotcrete Lined	$20,750,355	$28,945,000	$5,000,000	$14,818,490	$69,513,845	$191,170,614
5	5	Concrete Lined	$20,750,355	$28,945,000	$5,000,000	$16,001,690	$70,697,045	$191,481,030
6	1	Earth Lined[1]	$22,193,716	$28,945,000	$5,625,000	NA	$56,763,716	$197,012,451
7	1b	Earth Lined w/Bentonite Liner	$22,193,716	$28,945,000	$5,625,000	$15,135,216	$71,898,932	$202,678,919

[1]Earth Lined canal does not include a lining. There is additional earthwork and associated costs which are included under "Earthwork & Conveyance Facility Costs".

[2]Earthwork and conveyance costs based upon Tables 1 - 4 and include earthwork, facility relocations, fencing, spillways, and road crossings.

[3]Pump Station costs based on those developed in TM #4 plus a 15% contingency to account for unknowns and PG&E electrical service costs.

[4]Right-of-way costs estimated at $25,000 per acre.

[5]Costs from the liner alternatives evaluation in Sections III thru VI

[6]Total conveyance cost includes earthwork & conveyance facilities, pump stations, R/W, and linings.

[7]Present worth analysis based on 50 year period - see Exhibit C for spreadsheets.

Recommendations

Of the alternatives evaluated herein, the earth lined canal is not considered a good alternative due to concerns with rodent holes and piping failures, liability due to adjacent landowners, and overall increased canal maintenance with weed control, sedimentation, and rodent hole control. In addition, seepage losses are a concern when returning water to the California Aqueduct. In order to mitigate canal seepage when returning water to the Aqueduct, a return water pipeline or bentonite clay liner has been included in the cost. The earth lined canal alternative with a return water pipeline has the lowest present worth among the canal options, however it is not the recommended alternative for the reasons outlined above.

The poly lined and concrete lined alternatives are very similar in present worth over a fifty-year period and either alternative would be a good option for the conveyance canal. The HDPE or RPE canal lining has the best hydraulic properties and is easier to maintain than an earth lined canal. The drawback to the HDPE or RPE canal lining is the estimated useful life of 10 to 20 years for the San Joaquin Valley, however the present worth analysis demonstrates that this is a viable alternative over a fifty-year period. The concrete linings are also economical when evaluating the present worth over a fifty-year period and are more durable when performing canal cleaning and maintenance. Both of these lining systems are quality canal linings and result in a long useful life, however the shotcrete lining requires greater skill and quality control during application.

The pipeline alternative has the most expensive capital cost, however, it does allow for the elimination of a couple of pump stations and lower operations and maintenance expenses, therefore, over a fifty-year life cycle the closed conduit alternative actually becomes economical.

In addition, the pipeline alternative provides the added safety benefit of minimizing risks of levee breaches or flooding in Reach 1 or 2 as a result of the elevated head of the California Aqueduct above those reaches of an open channel. The pipeline alternative could place a single pump station on the east side of the I-5 Freeway which is at an elevation that would allow for it to float off the Aqueduct at the static or operating level of the California Aqueduct.

If the conveyance canal alternative is selected for design then the conventional concrete, shotcrete, and poly liners are all reasonable options as they are very similar in present worth based upon a fifty-year (50) period. In that event it is recommended that the "Conveyance Facilities including Turnouts & Pump Stations" bid package include bid alternates for the three types of canal linings. This will provide competitive pricing for each alternative, account for market fluctuations in material pricing, and allow the JPA to evaluate the lining costs in light of the total overall project costs.

However, the pipeline alternative is the most economical alternative when factoring in the operational, maintenance, and replacement costs over a fifty-year (50) period. In view of the operational and safety benefits, it is recommended that a pipeline alternative be considered in the design phase.

It is recommended that once the Phase I and Phase II properties are acquired, alignments fixed, and topographical survey completed, that the design firm perform updated value engineering work for the conveyance canal verses pipeline alternatives as well as considering hybrid approaches that utilize both reaches of conveyance canal and reaches of pipeline. At that time the JPA can evaluate the capital costs, the present worth, and the benefits of each alternative in making their final decision.

II. Open Channel Canal

A. Constructability/Methods

The primary purpose of this memorandum is to evaluate lining alternatives for the conveyance canal, however there are many other aspects of the project that will contribute to the overall costs of the canal. These include the earthwork, drainage systems (if necessary), transition structures, facility relocations, canal safety features, road surfacing, and fencing.

The conceptual conveyance alignment is shown in Figure 1. This alignment is subject to change as the JPA begins to acquire property and right-of-way.

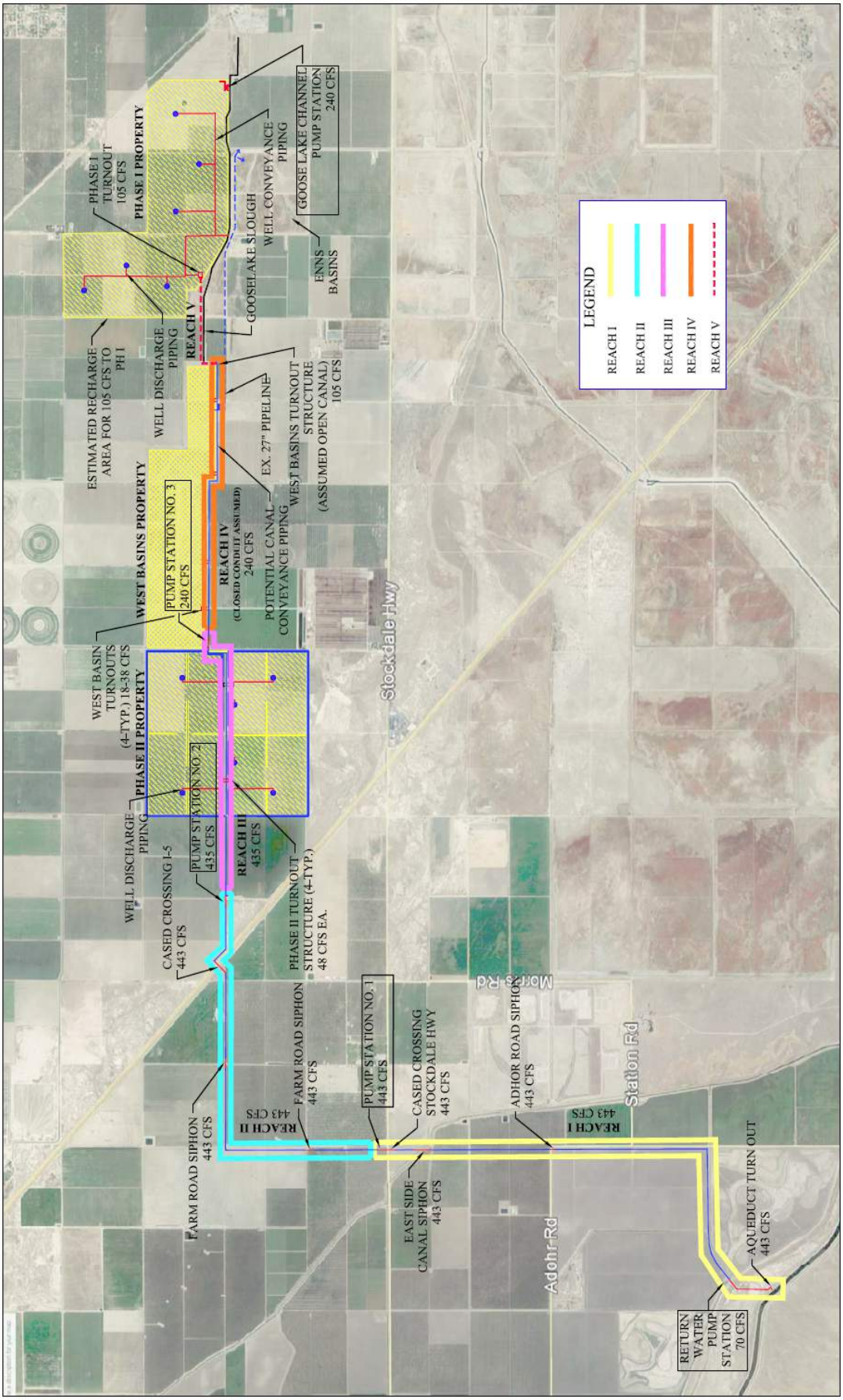


Figure 1: Preliminary Conveyance Alignment

The conceptual canal profile is shown in Figure 2. The elevations, slopes, and cross-sections of the canal are subject to change as well. The design firm will be responsible for value engineering the conveyance design.

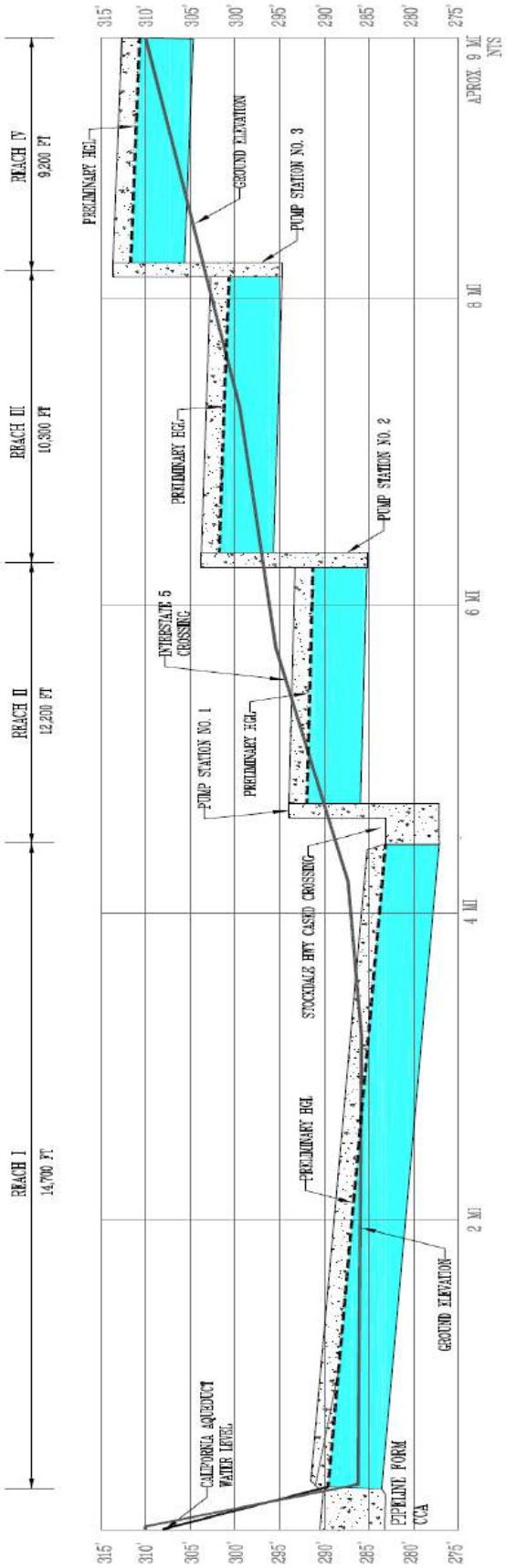


Figure 2: Preliminary Canal Profile

The elevations, slopes, and cross-sections identified herein are preliminary and for purposes of developing the preliminary Engineer's Estimates. These will be finalized during the design phase once the alignment is determined, detailed project surveying is performed, and detailed hydraulic analyses are completed.

Preliminary hydraulic modeling was performed utilizing Hec-Ras 5.0.7. The side slopes of a lined canal are anticipated to be 1.5:1 as originally outlined above. The canal cross-section is estimated as 8-ft deep with a 20-ft wide bottom. The pump stations along the conveyance canal have been estimated to have an approximate 15-ft to 20-ft total dynamic head at each station for the design capacities discussed in Technical Memorandum No. 4 "Pump Station Requirements". An earth-lined canal will have a different cross-section that has been estimated as 10-ft deep with a 20-ft wide bottom and 3:1 side slopes.

The earthwork of the canal will likely require borrow material of a suitable nature as determined by the soils firm and design firm. Potential borrow areas will be identified along the canal alignment and may include existing recharge areas of the Buena Vista Water Storage District, the West Kern Water Storage District, the Kern Water Bank Authority, as well as the Phase II property and the West Basins. The earthwork will involve clearing and grubbing of the right-of-way and the borrow areas. The subgrade will require excavation and re-compaction beneath the canal and the embankment levees. If a canal lining is constructed, the canal final grade must be flat and smooth, dry and free of rocks, rubble, roots, vegetation, debris, voids, protrusions, and any other objects. The earth material for the canal shall not be expansive or dispersive. The soils should have less than 15% finer than a 5 micron sieve so that there is not too much clay but also greater than 20% material finer than a 75 micron sieve so that there are fine sands and silts that provide good cohesion. The canal and levee material are estimated to be compacted to a minimum 90% relative compaction and graded to provide a smooth and uniform surface.

An approximate 180-ft wide permanent right-of-way has been estimated for the conveyance canal alignment and an approximate 260-ft wide temporary right-of-way. The conceptual canal cross-section includes an approximate 20-ft wide access road on each side of the canal for maintenance and operations. In addition, the right-of-way includes space for vehicular access along the outside toe of the exterior levee slopes for maintenance and weed abatement. See the canal cross-section below in Figure 3. This equates to an approximate land acquisition of 200 acres for canal right-of-way (with 1.5:1 side slopes), i.e. 180-ft by 46,400-ft = 8,352,000 sf or 192 acres. The land costs have been estimated at $25,000 per acre.

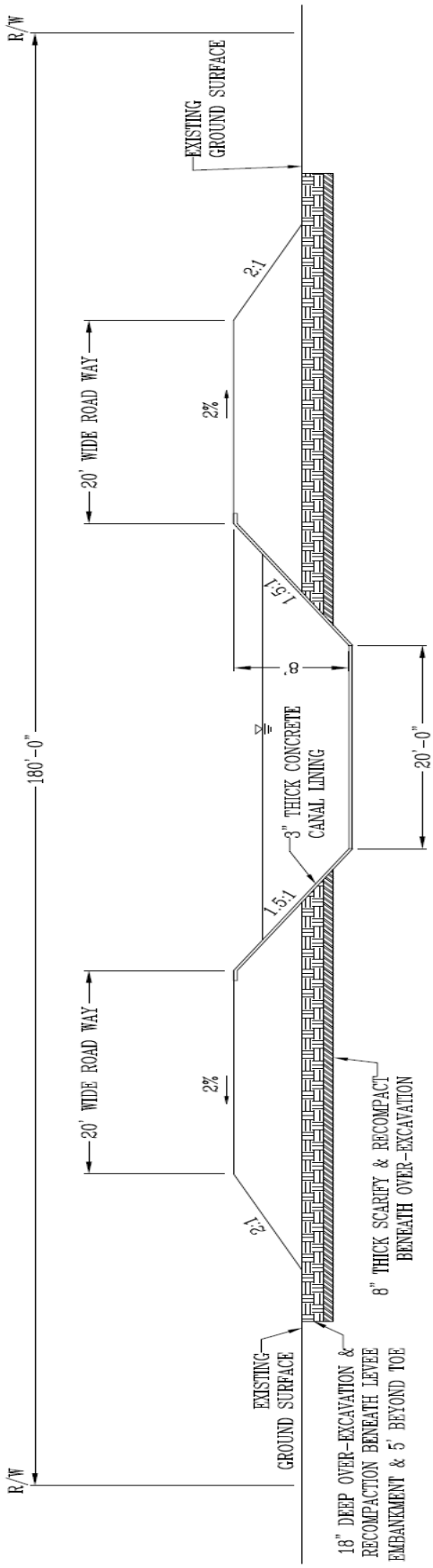


Figure 3: Preliminary Canal Cross-Section with 1.5:1 Side Slopes

Earthwork calculations were performed for the preliminary canal alignment for cost estimating purposes. Cross-sections were prepared for each reach of the lined canal options at approximate 1,000-ft intervals and illustrate the estimated "neat-line" cut and fill area for the conveyance canal and levee embankments/roads. The earthwork volume calculations utilizing the average end area method are attached in Appendix B. The calculations demonstrate the estimated cut and fill volumes for each reach of the canal resulting in a total of 244,227 cubic yards of cut and 716,381 cubic yards of fill for the entire conveyance canal. In addition, calculations for the subgrade preparation (over-excavation and re-compaction beneath the canal and embankments) have been prepared and estimate a "neat-line" volume of 226,189 cubic yards for the entire conveyance canal.

Where areas of the conveyance canal are in cut and adjacent to recharge operations, it may be necessary to install piezometers and a drainage system, add recharge basin setbacks or acquire additional conveyance right-of-way, put limits on recharge when groundwater levels are too shallow, or some combination thereof. The piezometers can be utilized to monitor the groundwater levels to ensure that water levels are maintained below the invert of the canal particularly if the canal is concrete lined. This is due to concerns with damaging concrete panels from a difference in hydrostatic pressure from the back side of the panel to the canal side. The drainage system can also provide mitigation in these situations as it collects water along the backside of the canal liner and allows for it to flow into the canal through a flapper valve if there is a difference in hydrostatic pressure.

It is also anticipated at this time that there will be canal safety features, all-weather road surfacing on the top of embankment levees, and canal fencing. The canal safety features include ladder rungs and safety buoys at the upstream and downstream side of siphon or culvert crossings and pump stations and ladder rungs at approximate quarter-mile distances in long stretches of the canal.

In addition, emergency spillways are recommended in reaches of the canal adjacent to recharge properties where water could be spilled over in the event of pump station problems or other issues. Reach 1 of the canal is well below the California Aqueduct elevation and if the turnout slide gate were to fail or not close it would be problematic. Therefore, it is recommended to provide an emergency spillway in Reach 1 of the canal that could discharge to the Buena Vista Water Storage District recharge basins, the West Kern Water District recharge basins, and/or the East Side Canal. Agreements with those agencies would be required. Emergency spillways could also be provided in Reach 3 that would discharge to the Phase II property and in Reach 4 that would discharge to the West Basins property.

The top of levee embankments are anticipated to provide for access along the canal and for canal maintenance. The levee embankment roads are estimated at 20-ft wide with a 16-ft wide all-weather road surfacing. The canal fencing is estimated to run parallel to the canal on each side and consist of barbed wire fencing with t-posts and chainlink access drive gates and personnel gates where appropriate.

The estimated capital costs for each reach of the canal are estimated in Tables 1 through 4 below. These costs are for the items discussed above and do not yet include costs for canal lining or right-of-way acquisition.

Table 1

Conveyance Canal				
Reach 1 - Approx. 14,700 LF				
Description	Quantity	Unit	Unit Cost	Extended Cost
Canal Clearing and Grubbing	90	AC	$1,200.00	$108,000.00
Subgrade Preparation	73,763	CY	$4.60	$339,309.80
Canal Earthwork-Cut	71,517	CY	$4.50	$321,826.50
Canal Earthwork-Fill	264,090	CY	$4.50	$1,188,405.00
Ladder Rungs	22	EA	$2,500.00	$55,000.00
Safety Buoys	8	EA	$10,000.00	$80,000.00
Facility Relocations	3	EA	$50,000.00	$150,000.00
Road Surfacing	4,400	CY	$50.00	$220,000.00
Barbed Wire Fencing	29,400	LF	$7.50	$220,500.00
Aqueduct Turnout Afterbay	1	LS	$283,000.00	$283,000.00
Emergency Spillway	1	LS	$168,750.00	$168,750.00
Adohr Road Crossing	1	LS	$954,400.00	$954,400.00
East Side Canal Crossing	1	LS	$1,429,000.00	$1,429,000.00
Stockdale Hwy Cased Crossing	1	LS	$1,529,000.00	$1,529,000.00
			Subtotal:	$7,047,191.30
			Cost per LF:	$479.40

*Earthwork quantities above are for the lined canal options with 1.5:1 side slopes.
**The costs do not include any lining options.

Table 2

Conveyance Canal				
Reach 2 - Approx. 12,200 LF				
Description	Quantity	Unit	Unit Cost	Extended Cost
Canal Clearing and Grubbing	75	AC	$1,200.00	$90,000.00
Subgrade Preparation	54,931	CY	$4.60	$252,682.60
Canal Earthwork-Cut	68,876	CY	$4.50	$309,942.00
Canal Earthwork-Fill	188,724	CY	$4.50	$849,258.00
Ladder Rungs	18	EA	$2,500.00	$45,000.00
Safety Buoys	8	EA	$10,000.00	$80,000.00
Facility Relocations	7	EA	$50,000.00	$350,000.00
Road Surfacing	3,650	CY	$50.00	$182,500.00
Barbed Wire Fencing	24,400	LF	$7.50	$183,000.00
Pump Station No. 1 Afterbay	1	LS	$427,000.00	$427,000.00
Farm Road Crossing No. 1	1	LS	$764,000.00	$764,000.00
Farm Road Crossing No. 2	1	LS	$764,000.00	$764,000.00
I-5 Fwy Cased Crossing	1	LS	$2,374,000.00	$2,374,000.00
			Subtotal:	$6,671,382.60
			Cost per LF:	$546.83

*Earthwork quantities above are for the lined canal options with 1.5:1 side slopes.
**The costs do not include any lining options.

Table 3

Conveyance Canal				
Reach 3 - Approx. 10,300 LF				
Description	Quantity	Unit	Unit Cost	Extended Cost
Canal Clearing and Grubbing	65	AC	$1,200.00	$78,000.00
Subgrade Preparation	60,331	CY	$4.60	$277,522.60
Canal Earthwork-Cut	68,073	CY	$4.50	$306,328.50
Canal Earthwork-Fill	149,708	CY	$4.50	$673,686.00
Ladder Rungs	16	EA	$2,500.00	$40,000.00
Safety Buoys	8	EA	$10,000.00	$80,000.00
Facility Relocations	5	EA	$50,000.00	$250,000.00
Road Surfacing	3100	CY	$50.00	$155,000.00
Barbed Wire Fencing	20600	LF	$7.50	$154,500.00
Emergency Spillway	1	LS	$168,750.00	$168,750.00
Pump Station No. 2 Afterbay	1	LS	$427,000.00	$427,000.00
Farm Road Crossing No. 3	1	LS	$764,000.00	$764,000.00
Farm Road Crossing No. 4	1	LS	$764,000.00	$764,000.00
			Subtotal:	$4,138,787.10
			Cost per LF:	$401.82

*Earthwork quantities above are for the lined canal options with 1.5:1 side slopes.
**The costs do not include any lining options.

Table 4

Conveyance Canal				
Reach 4 - Approx. 9,200 LF				
Description	Quantity	Unit	Unit Cost	Extended Cost
Canal Clearing and Grubbing	55	AC	$1,200.00	$66,000.00
Subgrade Preparation	37,164	CY	$4.60	$170,954.40
Canal Earthwork-Cut	35,761	CY	$4.50	$160,924.50
Canal Earthwork-Fill	113,859	CY	$4.50	$512,365.50
Ladder Rungs	14	EA	$2,500.00	$35,000.00
Safety Buoys	6	EA	$10,000.00	$60,000.00
Facility Relocations	5	EA	$50,000.00	$250,000.00
Road Surfacing	2,800	CY	$50.00	$140,000.00
Barbed Wire Fencing	18,400	LF	$7.50	$138,000.00
Pump Station No. 3 Afterbay	1	LS	$427,000.00	$427,000.00
Farm Road Crossing No. 5	1	LS	$764,000.00	$764,000.00
Emergency Spillway	1	LS	$168,750.00	$168,750.00
			Subtotal:	$2,892,994.40
			Cost per LF:	$314.46

*Earthwork quantities above are for the lined canal options with 1.5:1 side slopes.
**The costs do not include any lining options.

Table 5 summarizes the canal costs absent of any canal linings which will be discussed in detail below.

Table 5

Conveyance Canal		
Cost Summary (w/o Canal Linings)		
Reach No.	Earthwork Cost Estimate	Total Cost Estimate
Reach 1	$1,957,541	$7,047,191
Reach 2	$1,501,883	$6,671,383
Reach 3	$1,335,537	$4,138,787
Reach 4	$910,244	$2,892,994
Total (w/o Canal Linings):	$5,705,205	$20,750,355

*Earthwork quantities above are for the lined canal options with 1.5:1 side slopes.
**The costs do not include any lining options.

III. Earth Lined Canal

A. Constructability/Methods

i) Earth Lined Canal

The earth lined canal is estimated to be constructed to the lines and grades established during the design phase. The side slopes of an earth lined canal shall be revised to be 3:1 in order to alleviate erosion and provide for canal maintenance. The material for the canal shall not be expansive or dispersive. Expansive soils could result in swelling, drying, and shrinkage that results in cracking and problems with seepage or a levee breach. Dispersive soils can pose a threat as they move away from water and could result in piping or a levee breach. The soils should have less than 15% finer than a 5 micron sieve so that there is not too much clay but also greater than 20% material finer than a 75 micron sieve so that there are fine sands and silts that provide good cohesion. The canal and levee material are anticipated to be compacted to a minimum 90% relative compaction.

The quantities for an earth lined canal with 3:1 side slopes is approximately 472,615 cubic yards of cut and 783,801 cubic yards of fill for the entire conveyance canal. In addition, the quantity for the subgrade preparation of an earth lined canal is approximately 254,216 cubic yards for over-excavation and re-compaction, see Appendix B. The quantities noted herein are subject to change based on the final alignment, recharge locations, and final design. Borrow material is anticipated to be obtained from areas in close proximity to the canal including, but not limited to, the Buena Vista Water Storage District recharge basins, the West Kern Water District recharge basins, the Phase II recharge basins, and the West Basins. Costs associated with the borrow material have been included in the unit prices utilized for the earthwork cut, fill, and subgrade preparation.

An approximate 210-ft wide permanent right-of-way has been estimated for the conveyance canal alignment and an approximate 290-ft wide temporary right-of-way. The conceptual canal cross-section includes an approximate 20-ft wide access road on each side of the canal for maintenance and operations. In addition, the right-of-way includes space for vehicular access along the outside toe of the exterior levee slopes for maintenance and weed abatement. See the canal cross-section below in Figure 4. This equates to an approximate land acquisition of 225 acres for canal right-of-way (with 3:1 side slopes), i.e. 210-ft by 46,400-ft = 9,744,000 sf or 224 acres. The land costs have been estimated at $25,000 per acre.

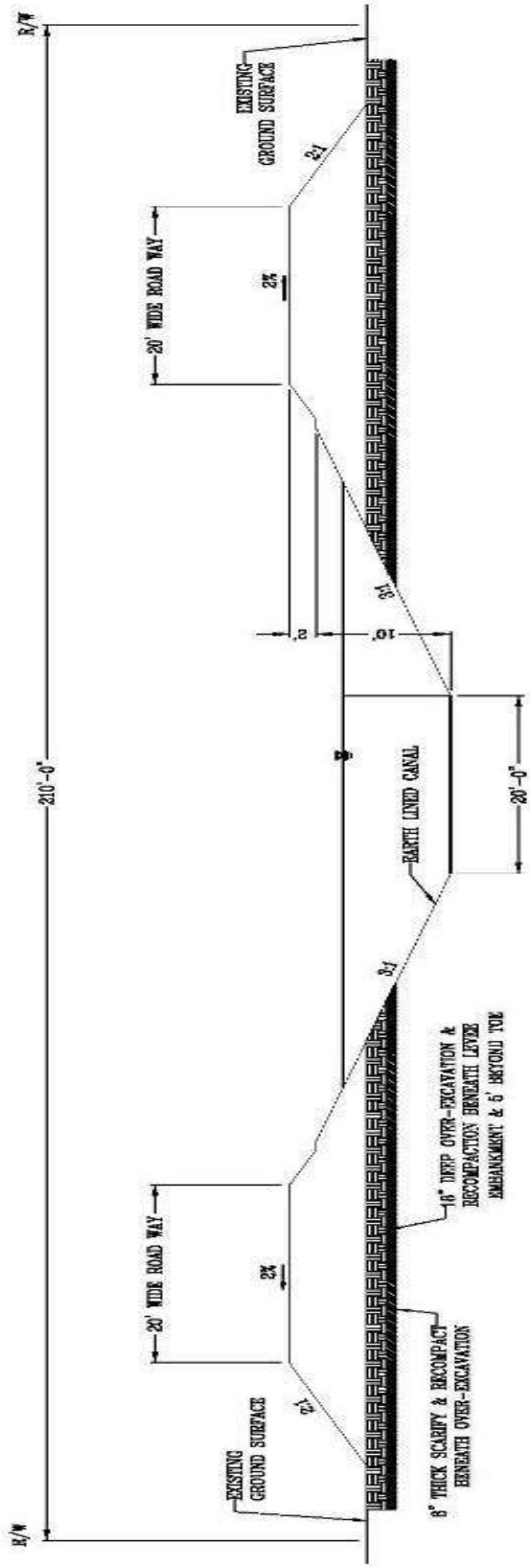


Figure 4: Preliminary Canal Cross-Section with 3:1 Side Slopes

For an earth lined canal there are concerns with rodent holes, piping, and levee breaches particularly in areas of levee embankment fill. In order to mitigate these concerns, a synthetic sheet piling could be utilized, or high risk areas of the canal could be lined, or increased maintenance could be implemented.

ii) Earth Lined Canal with Return Water Pipeline

Seepage losses are a concern with an earth lined canal. The seepage during recharge operations is not so much a concern as it can be counted as groundwater recharge, however it is a concern when operating the canal in the reverse direction for recovery of water and the return of water to the California Aqueduct. This could be mitigated with either a parallel return water pipeline or a special clay or bentonite liner.

In reverse flow operations, the Return Water Pump Station has been estimated to have an approximate 25-ft to 30-ft total dynamic head to return approximately 72 cfs to the California Aqueduct. If a parallel return water pipeline were utilized then this pump station could be eliminated and the water discharged directly to the California Aqueduct. The parallel return pipeline is estimated to be a 48" PVC or 54" HDPE pipeline for conveying 72 cfs based on Technical Memorandum No. 3 "Pipeline Requirements".

iii) Earth Lined Canal with Bentonite Liner

If a bentonite liner were utilized it is estimated that it would be a 1-ft thick liner in the earthen canal prism with a minimum clay content of 12% to 15%. Fill material that has a clay content less than this will require some form of soil amendment or importation of a soil with adequate clay content. Powdered bentonite could be used as a soil amendment. The percentage of bentonite added would be the difference between the natural site clay content and the required minimum clay content. The minimum pounds of bentonite per square foot of amended area will be the percentage bentonite times the compacted dry density of the site soil times the liner thickness. Bentonite shall be evenly spread by a computerized spreading truck which is directly fed by the bulk delivery truck. Spread rate shall be confirmed by a pan test. The amended area shall be uniformly mixed and moisture conditioned by a cross-shafted mixer directly connected to the water truck. This equipment is standard for a specialty soil stabilization contractor. Stabilization contractors typically only spread the amendment, moisture condition, and compact the amended soil. They do not move material to achieve rough grade or fine grade, therefore they generally subcontract to a general earthwork contractor. However, in some instances soil amendment can be performed in-place for a liner thickness up to 1.5 feet with the typical cross-shafted mixer and open-hub compactors and this may be an option.

B. Capital Cost Estimate

i) Earth Lined Canal

The earthwork for the conveyance canal has been considered separately and will be roughly the same for any of the above lining alternatives. The earth lined canal is planned to have 3:1 side slopes to reduce velocities and minimize erosion and sediment transport. Typically, seepage in the earth lined canal for this project would not be a concern since the seepage can be accounted for as groundwater recharge under the project. However, seepage is a concern when operating the canal in the reverse direction for recovery of water and the return of water to the Aqueduct. Therefore, a return pipeline would need to be constructed parallel to the canal or a special earth liner such as a clay liner or bentonite liner constructed. The capital cost estimates compare the costs of different lining materials. However, the earth lined canal will require a different canal cross-section in order to mitigate soil erosion and prevent seepage. Therefore, capital costs for the additional canal earthwork are also included.

The capital cost estimate for the canal earthwork with 3:1 side slopes is $7,148,566. This adds approximately $1,443,361 ($7,148,566 - $5,705,205) to the cost of the earthwork over and above the cost for the canal earthwork on the other lining alternatives because of the wider canal cross-section.

Additional Earthwork	$1,443,361

This alternative, as noted previously, would result in seepage losses. This is not a primary concern when recharging water as the JPA would account for the losses and include it with the overall recharge operations. However, during recovery operations the JPA would need to pump additional well water to overcome those losses. If the goal were to return 50,000 ac-ft in a dry year, and assuming 30% seepage losses, then it is estimated that 71,500 ac-ft would need to be pumped.

Monthly RRBWSD Operation & Maintenance Cost per well:	$1,333.00
Monthly PG&E Pumping Cost per well:	$24,150.00
Monthly Mission Unit O&M Cost per well:	$53.00
Subtotal Monthly Cost per well:	$25,536.00
Subtotal Annual Cost per well:	$306,432.00

It is estimated that it would require sixteen (16) recovery wells at 6 cfs each to return 71,500 ac-ft in one year. This is estimated to result in an annual O&M cost for sixteen wells of approximately $4,902,912.00. This is approximately $98.00 per ac-ft for returning 50,000 ac-ft.

ii) Earth Lined Canal with Return Water Pipeline

One of the recommended mitigation measures for the earth lined canal option is a parallel return water pipeline. The option to install a return water pipeline and not line the earthen canal involves installing approximately 45,000 feet of 48” to 54” pipe which at $280/lf equates to approximately $12,600,000. However, this does

eliminate the need for the Return Water Pump Station in turn saving approximately $2,081,000. This results in an additional cost of $10,519,000 or $12,600,000 - $2,081,000.

Return Water Pipeline	$10,519,000
Additional Earthwork	$1,443,361
Total Earth Lined Canal with Pipeline:	$11,962,361

This alternative would avoid seepage losses during recovery operations. The estimated O&M costs are listed below for returning 50,000 ac-ft in a dry year.

Monthly RRBWSD Operation & Maintenance Cost per well:	$1,333.00
Monthly PG&E Pumping Cost per well:	$24,150.00
Monthly Mission Unit O&M Cost per well:	$53.00
Subtotal Monthly Cost per well:	$25,536.00
Subtotal Annual Cost per well:	$306,432.00

It is estimated that it would require twelve (12) recovery wells at 6 cfs each to return 50,000 ac-ft in one year. This is estimated to result in an annual O&M cost for twelve wells of approximately $3,677,184.00. This is approximately $73.54 per ac-ft for returning 50,000 ac-ft.

iii) Earth Lined Canal with Bentonite Liner

Another potential mitigation measure is to line the earth canal with a bentonite liner approximately 1-ft thick. The soil amendment cost to treat/amend, mix, and compact the soil for a 1-ft thick liner is estimated at $3.93 per square foot. There are approximately 83 sf/lf x 46,400 lf or 3,851,200 square feet.

1-ft Thick Clay Liner at $3.93/sf	$15,135,216
Additional Earthwork	$1,443,361
Total Earth Lined Canal with Bentonite:	$16,578,577

This alternative would reduce the seepage losses, however it is estimated that there would still be some seepage. For purposes of this memorandum, an estimated seepage loss of 15% has been used. During recovery operations the JPA would need to pump additional well water to overcome those losses. If the goal were to return 50,000 ac-ft in a dry year, and assuming 15% seepage losses, then it is estimated that 58,850 ac-ft would need to be pumped.

Monthly RRBWSD Operation & Maintenance Cost per well:	$1,333.00
Monthly PG&E Pumping Cost per well:	$24,150.00
Monthly Mission Unit O&M Cost per well:	$53.00
Subtotal Monthly Cost per well:	$25,536.00
Subtotal Annual Cost per well:	$306,432.00

It is estimated that it would require fourteen (14) recovery wells at 6 cfs each to return 58,850 ac-ft in one year. This is estimated to result in an annual O&M cost for fourteen wells of approximately $4,290,048.00. This is approximately $85.80 per ac-ft for returning 50,000 ac-ft.

iv) Earth Lined Canal Summary

A summary of the costs for the earth lined canal options is provided in Table 6. A capital cost estimate is provided for the earth lined canal earthwork and then the additional capital costs are shown for adding a parallel pipeline or adding a bentonite liner. In addition, the operations and maintenance (O&M) costs are shown for each option and are based on the number of recovery wells necessary to return 50,000 ac-ft per year in a dry year while accounting for seepage losses. A present worth value is shown for the O&M costs as well as for the capital and O&M costs.

A present worth analysis was evaluated based on a capital recovery of 20 years and O&M costs for recovery operations anticipated to be approximately three years out of every ten years. The O&M costs were increased over a 20 year period at an inflation rate of 3% per year. The present worth values shown below are over a 20 year period.

Table 6

Conveyance Canal				
Cost Summary (w/o Canal Linings)				
Earth Lined Canal Options	Capital Cost Estimate	O&M Cost Estimate ($/yr)	Present Worth O&M Cost	Present Worth Capital & O&M Cost
Earth Lined Canal	$7,148,566	$4,902,912	$30.3 M	$37.5 M
Including Return Water Pipeline	$17,667,566	$3,677,184	$22.7 M	$40.4 M
Including Bentonite Liner	$22,283,782	$4,290,048	$26.5 M	$48.8 M

C. Hydraulic Impacts of Friction Losses

The earth lined canal has a 20-ft wide bottom with 3:1 side slopes. A Manning's coefficient of 0.022 to 0.040 was utilized which is a range for an earth lined canal that is maintained with short grass and few weeds to an unmaintained canal with a clean bottom and brush on the side slopes. The velocities of an earth lined canal are less than that of a lined canal and have been maintained in the range of 1.0 to 2.5 fps to minimize erosion and sediment transport. The water depth varies from approximately 6-ft to 8.22-ft. This increases the canal depth from 8-ft to approximately 10-ft as a result of the higher Manning's coefficient.

D. Advantages and Disadvantages

An earth lined canal is, generally speaking, the most economical conveyance canal since it does not require the additional cost associated with a canal lining. However, there are characteristics of the earth lined canal that are a concern. These include the following:

- There are portions of the canal that may be elevated above the natural ground surface. In addition, there may be long periods of time where this canal is not being utilized and is in a dry condition thus providing suitable habitat for rodents. The major concern is with rodent holes over time that could lead to piping and a levee breach and the potential for property damage to adjacent agricultural crops, homes, equipment, etc.
- Seepage losses particularly when recovering water for return to the California Aqueduct.
- Increased canal maintenance

In order to mitigate the above concerns with rodent holes, synthetic sheet piling could be considered, or concrete lining in high risk areas, or implementation of increased canal and levee maintenance to minimize rodent holes and seepage paths.

Seepage losses could be mitigated by constructing a 1-ft or 2-ft thick clay liner in the conveyance canal for the canal bottom and side slopes or a return water pipeline could be installed parallel to the canal for use during recovery operations.

In addition, an earth lined canal will require greater maintenance in general. The maintenance includes:

- Levee monitoring for rodent holes and areas of significant erosion that require earthwork maintenance
- Weed control on levee slopes and the canal bottom
- Removal of sediment and debris potentially at siphon crossings, turnouts, and pump station forebays

IV. Poly Lined Canal

A. Constructability/Methods

The poly lined canal will be constructed to the lines and grades established during the design phase. The side slopes of a poly lined canal are anticipated to be 1.5:1 as discussed above in Section II. The subgrade for the lining must be flat and smooth, dry and free of rocks, rubble, roots, vegetation, debris, voids, protrusions, and any other objects that can potentially puncture the liner over time. In some cases, a compacted bedding may be necessary. The subgrade material for the canal shall not be expansive or dispersive. The soils should have less than 15% finer than a 5 micron sieve so that there is not too much clay but also greater than 20% material finer than a 75 micron sieve so that there are fine sands and silts that provide good cohesion. The canal and levee material are estimated to be compacted to a minimum 90% relative compaction and graded to provide a smooth and uniform surface for the installation of the poly lining.

An anchor trench will need to be excavated parallel to the canal on each side of the conveyance canal, the poly liner installed in the trench, and the trench backfilled and compacted. In addition, the poly liner will need to be connected to the concrete at all structures, turnouts, and lift stations. See figures 5 and 6 for examples of typical installations.

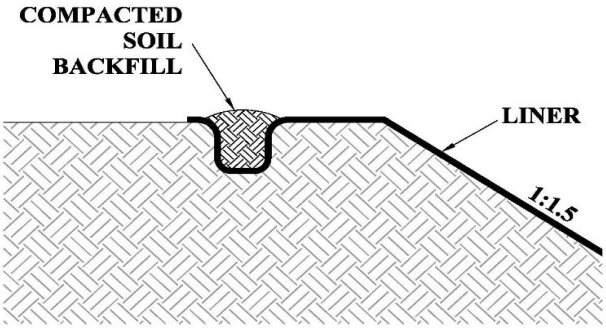


Figure 5: Typical Anchor Trench Detail

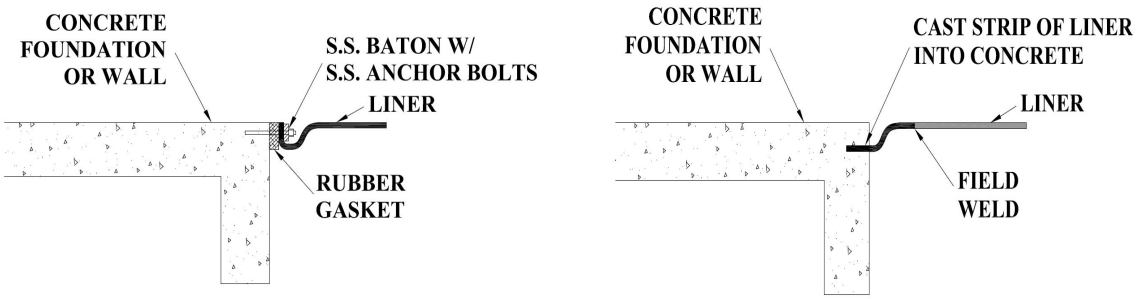


Figure 6: Typical HDPE Fastening to Concrete Structures Detail

B. Poly Liner Options

The two primary poly liners are a High Density Polyethylene (HDPE) lining and a Reinforced Polyethylene lining (RPE).

The high density polyethylene lining is a thick and durable liner that can be installed in exposed applications. HDPE liners should be installed by trained installers. The HDPE liner thickness of 40 mil and 60 mil can be utilized, however a 60 mil thickness is recommended for this application. The common HDPE properties are listed below:

- Nominal Thickness (ASTM D5199) 60 mil
- Density (ASTM D792) > 0.94 mg/l
- Tensile Strength (ASTM D6693) 126 lb/in
- Tear Resistance (ASTM D1004) 42 lbs
- Puncture Resistance (ASTM D4833) 108 lbs

The reinforced polyethylene is a combination of polyethylene reinforcement and co-extrusion in a special weave pattern which enhances thickness, flatness, tear properties, and UV resistance. The RPE lining comes in 30 mil thickness and 40 mil thickness. The 40 mil lining is the recommended thickness for canal lining installations. The common RPE properties are listed below:

- Nominal Thickness (ASTM D1777) 40 mil
- Weight 20.8 oz/yd^2
- Mullen Burst (ASTM D751) 800 psi
- Hydrostatic Resistance (ASTM D751) 769 psi
- Permeability (ASTM D4491) 2.06×10^{-12} cm/s
- Puncture Resistance (ASTM D4833) 243 lbs

C. Capital Cost Estimate

A 60 mil thick membrane HDPE lining or a 40 mil thick RPE lining is recommended for canal conveyance. The poly lining material will be approximately 2,830,400 sf based upon a canal length of 46,400 ft and a cross

sectional area of 61 sf/ft which includes an anchor trench on each side of the canal.

The capital cost estimates compare the costs of different lining materials. The poly lined canal is estimated to utilize approximately 2,830,400 sf of material. In addition, there will be locations where the lining must be connected to the concrete structures in the canal such as the transition structures, turnouts, and pump stations. This is estimated to be approximately 1,500 lineal feet. There will also be the need for underdrains where the canal is in cut adjacent to recharge basins.

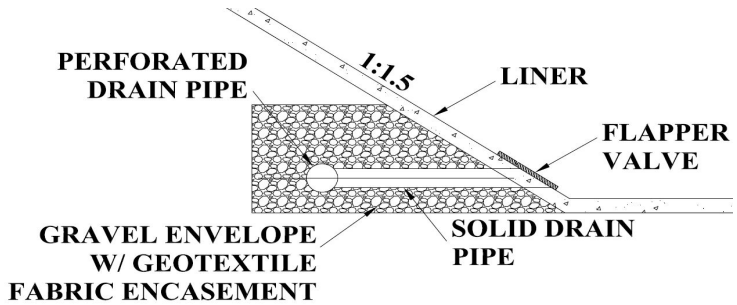


Figure 7: Typical Underdrain System

The capital cost estimate for the canal earthwork is approximately $5,705,205 and for the total canal without lining is $20,750,355. The cost of adding a Poly Lining adds $5,596,190 as presented below and summarized in Table 7 - Canal Lining Alternatives.

Poly Lining at $1/sf	$2,830,400
Poly Anchor Trench Installation	$928,000
Connection to Structures at $23/lf	$34,500
Underdrain System	$1,803,290
Total Poly Lining:	$5,596,190

D. Hydraulic Impacts of Friction Losses

The Manning's coefficient utilized for a poly lined canal is 0.010 and represents a well maintained canal. The velocities of the poly lined canal range from approximately 2.0 fps to 3.5 fps. The water depth varies from approximately 6-ft to 6.76-ft. This maintains a minimum of 1-ft of freeboard from the top of canal lining for an 8-ft deep canal cross-section.

E. Advantages and Disadvantages

A poly lined canal is an economical alternative and worth considering. It is less expensive than concrete lining and has other advantages as well as outlined below:

- Eliminates seepage losses
- Improved hydraulic properties with coefficient of friction of 0.10

- Ease of installation
- Less installation time

However, the poly lining can be prone to surface deterioration and tearing from UV damage and wind. The disadvantages are listed below:

- Subject to UV and wind damage
- Subject to damage by animals such as cattle or sheep
- More difficult to clean the canal of sediment and tumble weeds while not damaging lining
- Subject to rodent damage
- Petroleum product material cost volatility is greater than the concrete lining options

If the side slopes of the canal are 1.5:1 it is recommended that the lining be installed perpendicular to the canal conveyance direction. . Furthermore, the addition of future pipelines to the canal or well discharges would likely require concrete splash pads if discharging over the liner or a poly boot if penetrating the liner. The canal will have long periods of time when it is not in operation and is empty thus subject to sun exposure, wind, and damage. The anticipated useful life of a typical poly liner that is exposed to the elements in the San Joaquin Valley is 10 to 20 years. The Canal Lining Demonstration Project – Year 25 Durability Report by the Bureau of Reclamation estimated the useful life of an exposed geomembrane liner to be approximately 15 to 30 years.

V. Shotcrete Lined Canal

A. Constructability/Methods

The shotcrete lined canal is estimated to be constructed to the lines and grades established during the design phase. The side slopes of a shotcrete lined canal shall be 1.5:1 as discussed above in Section II. The subgrade material for the canal shall not be expansive or dispersive. The soils should have less than 15% finer than a 5 micron sieve so that there is not too much clay but also greater than 20% material finer than a 75 micron sieve so that there are fine sands and silts that provide good cohesion. The canal and levee material are estimated to be compacted to a minimum 90% relative compaction and graded to provide a smooth and uniform surface for the installation of the shotcrete lining.

The application of shotcrete is highly specialized and requires a certified nozzleman in order to ensure against rebound which results from a portion of the mortar bouncing away from the surface to which it is applied. It is recommended that the shotcrete lining have a smooth trowel surface in order to improve the hydraulic characteristics.

B. Capital Cost Estimate

Shotcrete is a pneumatically applied Portland cement mortar lining. The shotcrete lining is recommended to have a minimum 3" thickness. The shotcrete lining material would be approximately 2,366,400 sf based upon a canal length of 46,400 ft and a cross sectional area of 51 sf/ft. (Approximately 21,911 cubic yards).

The capital cost estimates compare the costs of different lining materials only. The shotcrete lined canal is estimated to utilize approximately 2,366,400 sf of material. There will also be the need for underdrains where the canal is in cut adjacent to recharge basins.

The capital cost estimate for the canal earthwork is $5,705,205 and for the total canal without lining is $20,750,355. The cost of adding a shotcrete lining adds $14,818,490 as presented below and summarized in Table 7 - Canal Lining Alternatives.

Shotcrete Lining at $5.50/sf	$13,015,200
Underdrain System	$1,803,290
Total Shotcrete Lining:	$14,818,490

C. Hydraulic Impacts of Friction Losses

The Manning's coefficient utilized for a shotcrete lined canal is between 0.025 to 0.030 per the Hydraulic Design Handbook. The Manning's coefficient assumes that the shotcrete surface will not be as smooth as conventional concrete placement and finishing. The velocities of the shotcrete lined canal range from approximately 2.0 fps to 3.0 fps. The water depth varies from approximately 6-ft to 7.33-ft. This would require the canal depth to be increased by approximately 0.5-ft to 1.0-ft in some locations to an 8.5-ft to 9.0-ft depth in order to maintain the minimum of 1-ft of freeboard to the top of canal lining.

D. Advantages and Disadvantages

A shotcrete lined canal is an economical alternative and worth considering. The shotcrete lining has the following advantages:

- High tensile strength
- Good durability
- Low permeability
- Long useful life

However, in general this type of lining is only slightly more economical than formed in place concrete when considering long, un-impacted stretches of canal. The disadvantages of shotcrete lining include:

- The shotcrete lining requires skilled operating personnel including a certified nozzleman
- Additional quality control measures to ensure against excessive rebound and to ensure application at the proper thickness and uniformity
- Less durable than conventional concrete lining
- Subject to damage from settlement, shrinkage, and hydrostatic pressure

If a concrete lined canal is the selected alternative, it is recommended that the concrete lining be allowed to be constructed by shotcrete application, slip-form placed, or formed in place.

VI. Conventional Concrete Lined Canal

A. Constructability/Methods

The concrete lined canal is estimated to be constructed to the lines and grades established during the design phase. The side slopes of a concrete lined canal are estimated to be 1.5:1 as discussed above in Section II. The subgrade material for the canal shall not be expansive or dispersive. The soils should have less than 15% finer than a 5 micron sieve so that there is not too much clay but also greater than 20% material finer than a 75 micron sieve so that there are fine sands and silts that provide good cohesion. The canal and levee material are estimated to be compacted to a minimum 90% relative compaction and graded to provide a smooth and uniform surface for the installation of the concrete lining.

B. Capital Cost Estimate

Concrete lining can be placed by slip-lining, using a rolling screed, or by cast in place methods. The concrete lining is recommended to have a minimum 3" thickness and crack control spacing at approximate 10'-0" spacing. The concrete lining material would be approximately 2,366,400 sf based upon a canal length of 46,400 ft and a cross sectional area of 51 sf/ft. (Approximately 21,911 cubic yards).

The capital cost estimates compare the costs of different lining materials only. The concrete lined canal is estimated to utilize approximately 2,366,400 sf of material. There will also be the need for underdrains where the canal is in cut adjacent to recharge basins.

The capital cost estimate for the canal earthwork is $5,705,205 and for the total canal without lining is $20,750,355. The cost of adding a concrete lining adds $16,001,690 as presented below and summarized in Table 7.

Concrete Lining at $6/sf	$14,198,400
Underdrain System	$1,803,290
Total Concrete Lining:	$16,001,690

C. Hydraulic Impacts of Friction Losses

Canal Hydraulics:

The Manning's coefficient utilized for the concrete lined canal is 0.012 to 0.016 per the Hydraulic Design Handbook. The velocities of the concrete lined canal range from approximately 2.0 fps to 3.2 fps. The water depth varies from approximately 6-ft to 7-ft. This maintains a minimum of 1-ft of freeboard from the top of canal lining and has better hydraulic characteristics than the shotcrete lining.

D. Advantages and Disadvantages

A concrete lined canal is an expensive alternative, but also is the most durable and has the longest useful life. The advantages include:

- High tensile strength
- Good durability for cleaning and maintenance
- Low permeability
- Long useful life

The disadvantages of concrete lining include:

- High capital cost
- Subject to damage from settlement, shrinkage, and hydrostatic pressure

Concrete lining has a typical useful life of beyond 60 years if well maintained and protected. The concrete lined canal will also require the smallest amount of maintenance for the canal lining alternatives and has better hydraulic characteristics than the shotcrete lining. Typical maintenance is the cleaning and removal of sediment and mud, if applicable, and then the replacement of cracked panels if it occurs.

VII. Canal Lining Summary/Present Worth Analysis

Six lining options (four canal lining options and two mitigation options for the earth lined canal) for the conveyance canal were evaluated. Below is a summary of the options:

Table 7
Canal Lining Alternatives

Conveyance Canal			
Lining Alternative	Estimated Liner Unit Cost per SF	Estimated Liner Unit Cost per LF	Estimated Liner or Earth Canal Total Cost
Earth Lined[1]	NA	NA	$1,443,361
HDPE/RPE Lined	$1.98	$121	$5,596,190
Earth Lined with Return Pipeline	NA	NA	$11,962,361
Shotcrete Lined	$6.26	$319	$14,818,490
Concrete Lined	$6.76	$345	$16,001,690
Earth Lined with Bentonite Liner	$4.30	$357	$16,578,577

[1]The earth lined alternative does not have a lining, however the cost shown is the estimate of additional earthwork necessary for 3:1 side slopes.

Table 8
Canal Lining Alternatives

Conveyance Canal			
Lining Alternative	Estimated Liner or Earth Canal Cost	Estimated Canal Unit Cost per LF	Estimated Canal Total Cost w/o Pump Stations
Earth Lined	$1,443,361	$478	$22,193,716
HDPE/RPE Lined	$5,596,190	$568	$26,346,545
Earth Lined with Return Pipeline	$11,962,361	$705	$32,712,716
Shotcrete Lined	$14,818,490	$767	$35,568,845
Concrete Lined	$16,001,690	$792	$36,752,045
Earth Lined with Bentonite Liner	$16,578,577	$805	$37,328,932

The estimated total canal cost above in Table 8 is the conveyance canal cost from Tables 1 through 4 in the amount of $20,750,355 plus the estimated liner cost or earth canal plus mitigation costs.

In addition, a present worth analysis was performed for each of the alternatives. The present worth analysis considered the project capital cost for each lining option. The capital cost included the conveyance canal costs from Tables 1 through 4, the estimated liner costs or mitigation costs, the right-of-way acquisition, and the estimated pump station costs for three pump stations and a return water pump station. The capital recovery for these costs was estimated at a 3% interest rate over a twenty (20) year period.

The cost of the conveyance canal including the three pump stations and the return water pump station as well as right-of-way procurement is as follows:

Conveyance Canal Cost Estimate (w/ 1.5:1 Slopes)	$20,750,355
Three Pumps Stations & Return Water Pump Station	$28,945,000
Right-of-Way Cost Estimate	$5,000,000
Conveyance Canal Estimate (w/ 1.5:1 Slopes)	$54,695,355

The estimated cost of the earthen conveyance canal with 3:1 side slopes including the three pump stations and the return water pump station as well as right-of-way procurement is as follows:

Conveyance Canal Cost Estimate (w/ 3:1 Slopes)	$22,193,716
Three Pumps Stations & Return Water Pump Station	$28,945,000
Right-of-Way Cost Estimate	$5,625,000
Conveyance Canal Estimate (w/ 3:1 Slopes)	$56,763,716

The pump station costs are based upon the cost estimates from Technical Memorandum No. 4 "Pump Station Requirements" which estimated $8,605,000 for Pump Station No. 1, $8,605,000 for Pump Station No. 2, and $6,150,000 for Pump Station No. 3. A cost estimate of $2,081,000 has been used for the Return Water Pump Station. Each of these pump station cost estimates have been increased by 15% to account for unknowns and PG&E service costs.

The operations and maintenance (O&M) costs were also included for each option and include the recovery well pumping costs, the canal operation costs for idle years, wet years, and dry years, and the liner replacement or repair costs. It has been estimated that there will be two wet years and three dry years out of every ten years and the remaining years will be idle years. The recovery well pumping costs in dry years are the same for the lined canal options whereby 72 cfs is being recovered from approximately twelve (12) wells. However, the earth lined canal alternative with bentonite liner estimates utilizing fourteen (14) wells to recover 84 cfs as a result of seepage losses while returning water to the California Aqueduct. Also the earth lined canal alternative estimates utilizing sixteen (16) wells to recover 96 cfs as a result of seepage losses while returning water to the California Aqueduct. The canal operations costs consist of RRBWSD operations and maintenance costs, electricity costs, mission unit costs, and DWR conveyance costs. These costs are similar for most of the options with the exception that the idle year costs for the earth lined canal options (1, 1a, and 1b) are more for the RRBWSD maintenance costs as they have to perform weed and rodent control along the conveyance canal. Pump station replacement costs have been included for items such as the pumps, the motors, the VFD's, electrical gear, and cathodic protection. It has been estimated that these items will be replaced every twenty-five (25) years and include an inflate rate of 3% per year. The liner replacement and repair costs are included for the poly lined canal, shotcrete lined canal, and the concrete lined canal. The poly lined canal estimates minor patches or repairs about every five years at a cost of $25,000 per year and

inflation at 3% per year. The shotcrete lined canal estimates panel replacements about every three years for approximately 1,200 lineal feet of side slope panels at a cost of $129,549 per year and inflation at 3% per year. The concrete lined canal estimates that it will be more durable than a shotcrete lined canal and panel replacements will not be necessary for the first 10 to 15 years. The concrete lined canal estimates panel replacement about every five years, beginning in year fifteen, for approximately 1,200 lineal feet of side slope panels at a cost of $150,000 per year and inflation at 3% per year. The present worth values are summarized in the table below.

Table 9

Summary of Conveyance Canal Alternatives					
Ranking by Present Worth	Alternative No.	Alternative	Lining Cost or Earth Canal Option Costs[2]	Total Conveyance Cost w/ Pump Stations[3]	Present Worth
1	1a	Earth Lined w/Return Pipeline	$11,962,361.00	$67,282,716	$188,594,201
2	2/3	HDPE/RPE Lined	$5,596,190.00	$60,291,545	$190,764,330
3	4	Shotcrete Lined	$14,818,490.00	$69,513,845	$191,170,614
4	5	Concrete Lined	$16,001,690.00	$70,697,045	$191,481,030
5	1	Earth Lined[1]	$1,443,361.00	$56,763,716	$197,012,451
6	1b	Earth Lined w/Bentonite Liner	$16,578,577.00	$71,898,932	$202,678,919

[1]Earth Lined lining cost is the increased cost related to earthwork for a larger canal cross section (3:1 side slopes).

[2]Costs from the liner alternatives evaluation in Sections III thru VI

[3]Total conveyance cost includes pump stations, road crossings, and return water pipelines.

The earth lined canal is not considered a good alternative due to concerns with rodent holes and piping failures, liability due to adjacent landowners, and overall increased canal maintenance with weed control, sedimentation, and rodent hole control. In addition, seepage losses are a concern when returning water to the California Aqueduct. In order to mitigate canal seepage when returning water to the Aqueduct, a return water pipeline or bentonite clay liner has been included in the cost. The earth lined canal alternative with a return water pipeline has the lowest present worth over a fifty-year (50) period, however it is not the recommended alternative for the reasons outlined above.

The HDPE or RPE canal lining is an economical alternative, has the best hydraulic properties, and is easier to maintain than an earth lined canal. The drawback to the HDPE or RPE canal lining is the estimated useful life of 10 to 20 years for the San Joaquin Valley. However, the present worth analysis still demonstrates it is a viable and economical alternative.

The cost difference between the shotcrete lining and the concrete lining is also not very significant. Both of these lining systems are quality canal linings and result in a long useful life, however the shotcrete lining requires greater skill and quality control during application. It is recommended that the conventional concrete lining be selected between these two options, however the contract documents could allow for

both application methods and the most economical alternative could be selected at bid time.

The conventional concrete, shotcrete, and poly liners are all very similar in present worth value over a fifty-year (50) period. If the conveyance canal alternative is selected, it is recommended that the "Conveyance Facilities including Turnouts & Pump Stations" bid package include bid alternates for the three types of canal linings. This will provide competitive pricing for each alternative, account for market fluctuations in material pricing, and allow the JPA to evaluate the lining costs in light of the total overall project costs.

VIII. Pipeline Option

A. Constructability/Methods

Technical Memorandum No. 3 "Pipeline Requirements" serves to evaluate the various pipe options and provides estimates of pipeline sizes and cost estimates.

The conveyance facility for the project could be a pipeline and if so, it is anticipated that it would be reinforced concrete pipe (RCP). For cost estimating purposes, the cost for dry cast RCP was utilized. The conveyance reach capacities are shown below in Table 10 along with the pipe size and type from Technical Memorandum No. 3.

Table 10

Conveyance Pipe Options				
Conveyance Reach	Reach Capacity	Pipe Size	Pipe Type	Material & Installation Cost
No. 1	443 cfs	120-in	RCP	$1,365/LF
No. 2	443 cfs	120-in	RCP	$1,365/LF
No. 3	435 cfs	120-in	RCP	$1,365/LF
No. 4	240 cfs	90-in	RCP	$727/LF
No. 5, if necessary	105 cfs	60-in	HDPE or PVC	$333/LF

Figure 8 is a conceptual illustration of the conveyance pipeline and includes a single pump station near the I-5 Freeway to pump the water to the Phase I, Phase II, and West Basin recharge properties. A pipeline bypass around the pump station could be constructed with valving such that the pressure from the well pumping could be maintained when returning water during recovery operations to the California Aqueduct.

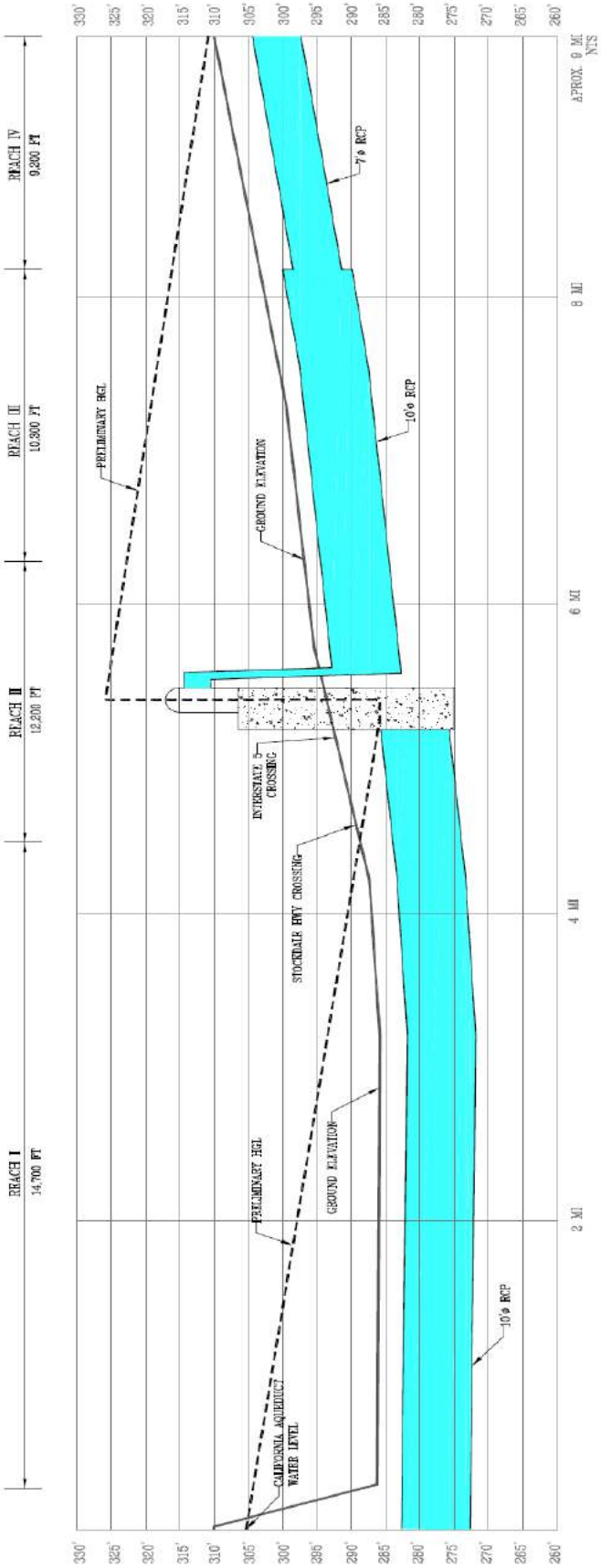


Figure 8: Preliminary Pipeline Profile

B. Capital Cost Estimate

The capital cost estimate for an underground pipeline is shown below in Table 11. The cost estimate is itemized for each reach of the conveyance and includes material and installation costs, however it does not take into account any special crossings, road crossings, or structures.

Table 11

Conveyance Pipe Options			
Conveyance Reach	Reach Length	Pipe Unit Cost	Pipeline Total Cost
No. 1	14,700-ft	$1,365/LF	$20,065,500
No. 2	12,200-ft	$1,365/LF	$16,653,000
No. 3	10,300-ft	$1,365/LF	$14,059,500
No. 4	9,200-ft	$727/LF	$6,688,400
No. 5, if necessary	4,500-ft	$333/LF	$1,498,500
		Total not including Reach 5:	$57,466,400
		Total including Reach 5:	$58,964,900

Table 12 compares the pipeline cost with the canal alternative costs for each reach of canal and the total cost as well. The pipeline alternative is much more expensive in the first three reaches of the canal. The pipe size and capacity reduces significantly in Reach No. 4 which brings the cost more in line with an open channel design, however it is still the most expensive alternative. In Reach 5, the pipe size and type are such that a pipeline is the most economical.

Table 12

Summary of Conveyance Alternative Capital Costs w/o Pump Stations						
Alternative	Reach No. 1	Reach No. 2	Reach No. 3	Reach No. 4	Reach No. 5, if necessary	Total Cost
Earth Lined	$7,504,463.00	$7,050,887	$4,459,188	$3,179,178	$1,498,500	$23,692,216
HDPE/RPE Lined	$8,820,122.00	$8,142,795	$5,381,045	$4,002,584	$1,498,500	$27,845,046
Earth Lined w/Return Pipeline	$10,836,991.00	$9,816,659	$6,794,225	$5,264,842	$1,498,500	$34,211,217
Shotcrete Lined	$11,741,842.00	$10,567,624	$1,428,236	$5,831,143	$1,498,500	$31,067,345
Earth Lined w/Bentonite Liner	$12,299,456.00	$11,030,405	$7,818,945	$6,180,126	$1,498,500	$38,827,432
Concrete Lined	$12,116,692.00	$10,878,724	$7,690,886	$6,065,743	$1,498,500	$38,250,545
Pipeline	$20,065,500.00	$16,653,000	$14,059,500	$6,688,400	$1,498,500	$58,964,900

There may be opportunities to design the conveyance facilities as a hybrid approach. For instance, Reach No. 1 and Reach No. 2 of the conveyance could be a pipeline due to the energy, O&M, and safety benefits, while Reach No. 3 could be open canal. Reach No. 4 and Reach No. 5, if necessary, could then be a pipeline. However, there are off-setting benefits. The savings by utilizing Reach No. 3 as a canal is approximately $7 to $9M, however it requires a second pump station installed instead of just one pump station for the pipeline alternative which minimizes the true capital cost savings. The design

firm should evaluate and consider a hybrid approach as part of the value engineering work.

The estimated overall capital cost for a pipeline, including the pump station, right-of-way, and road crossings, is as follows:

Conveyance Pipeline	$58,964,900
Adhor Road Earthwork	$216,000
Adhor Pavement Repair	$50,400
East Side Canal Earthwork	$216,000
Stockdale Cased Crossing	$975,000
I-5 Fwy Cased Crossing	$1,820,000
Pump Station & Bypass	$13,383,200
Right-of-Way Acquisition	$3,750,000
Total Pipeline Cost:	$79,375,500

C. O&M Impacts – Energy Costs related to Friction Losses

For purposes of this memorandum it has been estimated that a 120-inch diameter RCP pipeline would be installed from the California Aqueduct to the east side of the I-5 Freeway. A pump station would be constructed on the east side of the I-5 Freeway and pump approximately 435 cfs at a total dynamic head of approximately 50-ft. This is an approximate 3,800 hp pump station. It is estimated that the energy costs would be approximately $1,240,615 to convey approximately 112,500 ac-ft during a recharge year.

A present worth analysis was performed for the pipeline alternative. The present worth analysis considered the project capital cost of $79,375,500. The capital recovery for this cost was estimated at a 3% interest rate over a twenty (20) year period.

The operations and maintenance (O&M) costs were also included for this alternative and include the recovery well pumping costs and the pipeline operation costs in idle years, wet years, and dry years. It has been estimated that there will be two wet years and three dry years out of every ten years and the remaining years will be idle years. The recovery well pumping costs in dry years are the same for the lined canal options whereby 72 cfs is being recovered from approximately twelve (12) wells. The pipeline operations costs consist of RRBWSD operations and maintenance costs, electricity costs, mission unit costs, and DWR conveyance costs. A pipeline design is anticipated to include a single pump station with an approximate 50-ft TDH and also a smaller return water pump station. Pump station replacement costs have been included that account for replacing pumps, motors, VFD's, electrical gear, and cathodic protection every twenty-five (25) years. These costs have been inflated at 3% per year.

D. Advantages and Disadvantages

A pipeline alternative has been considered herein. The pipeline sizes and types have been based on the recommendations outlined in Technical Memorandum No. 3. The advantages to a pipeline for the conveyance facilities include:

- Smaller temporary and permanent right-of-way than an open channel design
- Less obtrusive to nearby properties and farming operations
- Less maintenance
- System operation simplified by one pumping station instead of three for conveyance canal
- Ability to float off static water level or operating water level of California Aqueduct from Aqueduct to Pump Station which eliminates risk of open canal design and flooding if slide gate fails or a levee embankment breaches.

The disadvantages of a pipeline include the following:

- Higher capital cost
- Higher energy cost due to friction head

IX. Turnout Requirements

A. Turnout Locations and Capacities

Technical Memorandum No. 3 "Pipeline Requirements" serves to evaluate the various turnout pipe options and provides estimates of the turnout pipeline sizes and cost estimates. These are summarized briefly below in Table 13.

Table 13

Turnout Locations and Capacities		
Turnout Location	Turnout Capacity	Turnout Size
Phase II Property	48 cfs	48"
West Basins Property	18 to 38 cfs	36"
Phase I Property	105 cfs	54"
In-Lieu Farmer Properties	5 to 20 cfs	24"

The turnout structures will be prefabricated structures that are the same size for uniformity and ease when replacing. The turnout structures will have 24" diameter pipes for the in-lieu farmer turnouts and 36" and 48" diameter pipes for the recharge basins. It is anticipated that the conveyance pipeline over to the Phase I property will be a 54" pipeline where it discharges to the Phase I property.

B. Turnout Pipe Materials

The proposed turnout pipeline materials are discussed in Technical Memorandum No. 3 "Pipeline Requirements". These are summarized briefly below in Table 14.

Table 14

Turnout Pipe Type		
Turnout Location	Turnout Capacity	Turnout Pipe Material
Phase II Property	48 cfs	ADS N12 WT HDPE
West Basins Property	18 to 38 cfs	DR41 HDPE
Phase I Property	105 cfs	DR41 HDPE
In-Lieu Farmer Properties	5 to 20 cfs	ADS N12 WT HDPE

C. Turnout Metering

It is recommended to install individual flow meters at each turnout facility so that the flow rates and recharge performance can be monitored. The turnout pipe sizes vary but are expected to range between 24-inch and 54-inch diameter.

There are different types of meters available in these size ranges which are noted below. It is recommended that these meter options be evaluated further during the design phase to select the best meter for the application. The brands and models noted below are for reference, however other meters that are comparable may be considered.

1. Ultrasonic Meter

   An ultrasonic flow transducer is available from Rittmeyer for measurement in a circular pipe under partially filled conditions. They are suitable for a full range of pipe diameters, can be replaced with the pipelines in operation, and have a high accuracy. The flow in closed pipes is able to be measured either with sensors mounted to the inside or outside of the pipe as well as non-invasive sensors installed on a mounting frame on the outside of the pipe. In addition, they make a flow controller / display that can monitor multiple pipes/meters at the same time which is ideal for a multiple barrel turnout facility.

2. Doppler Velocity Meter

   Flow meters utilizing a doppler velocity sensor and depth sensor can provide flow measurement in large diameter pipes for full-pipe flow or partial pipe flow. These are supplied by SonTek, a xylem brand.

X. Summary

The conveyance facility is estimated to be approximately 8.80 miles long or approximately 46,400-ft. This conveyance facility will cross recharge facilities, agricultural lands, private property, County roads, Stockdale Highway, and the I-5 Freeway. This facility is also planned to be utilized in the reverse direction during recovery operations for returning water to the California Aqueduct.

The cost of a conveyance canal is estimated to be approximately $20,750,355 for canal options with 1.5:1 side slopes to $22,193,716 for unlined earth canal options with 3:1 side slopes. This does not include any canal linings, however the cost does include earthwork, facility relocations, safety features, road surfacing, barbed wire perimeter fencing, and canal structures such as road crossings, see Tables 1 through 4. However, the cost estimate does not include the purchase of easements or rights-of-way.

The cost of the conveyance canal increases when including the three pump stations and the return water pump station as well as right-of-way procurement.

Conveyance Canal Cost Estimate (w/ 1.5:1 Slopes)	$20,750,355
Three Pumps Stations & Return Water Pump Station	$28,945,000
Right-of-Way Cost Estimate	$5,000,000
Conveyance Canal Estimate (w/ 1.5:1 Slopes)	$54,695,355

The estimated cost of the earthen conveyance canal with 3:1 side slopes increases when including the three pump stations and the return water pump station as well as right-of-way procurement.

Conveyance Canal Cost Estimate (w/ 3:1 Slopes)	$22,193,716
Three Pumps Stations & Return Water Pump Station	$28,945,000
Right-of-Way Cost Estimate	$5,625,000
Conveyance Canal Estimate (w/ 3:1 Slopes)	$56,763,716

Four canal lining alternatives were evaluated:

1. Earth Lined Canal
2/3. Poly Liners (HDPE or RPE)
4. Shotcrete Lined Canal
5. Concrete Lined Canal

In addition, two additional alternatives were considered as part of mitigation efforts with an earth lined canal:

1a. Earth Lined Canal with Parallel Return Water Pipeline
1b. Earth Lined Canal with Bentonite Lining

The capital costs, O&M costs, present worth values, and advantages/disadvantages were considered for each alternative and are shown in Table 15 below.

A sixth alternative was also considered which is a pipeline, however due to the capacity and size of the pipeline, it is a much more significant capital cost. The capital cost for the pipeline, including the pump station, pipeline right-of-way, and road crossing work at Adohr Road, Stockdale Hwy, and the I-5 Fwy is approximately $79,375,500. However, as a result of eliminating some pump stations and having a reduced O&M cost, the pipeline becomes more economical over a fifty (50) year life cycle.

The conveyance costs are estimated for each alternative in Table 15 below. This includes the lining cost as well as the total cost and includes the conveyance canal costs from Tables 1 through 4 in the amount of $20,750,355 plus the right-of-way costs, the pump station costs, and the estimated liner cost.

A present worth analysis was performed for each of the alternatives including the pipeline alternative. The present worth analysis considered the project capital cost for each alternative. The capital cost for the conveyance canal options includes the conveyance canal costs from Tables 1 through 4, the estimated liner costs, right-of-way acquisition, and the estimated pump station costs for three pump stations and a return water pump station.

The capital cost for the pipeline option includes the pipeline costs, road crossings, pump station costs for one pump station, right-of-way acquisition, and a return water pump station. The capital recovery for these costs was estimated at a 3% interest rate over a twenty (20) year period.

The operations and maintenance (O&M) costs were also included for each alternative and include the recovery well pumping costs, the canal operation costs for idle years, wet years, and dry years, and the liner replacement or repair costs. It has been estimated that there will be two wet years and three dry years out of every ten years and the remaining years will be idle years. The recovery well pumping costs in dry years are the same for the lined canal options and the closed conduit option whereby 72 cfs is being recovered from approximately twelve (12) wells. However, the earth lined canal alternative with bentonite liner estimates utilizing fourteen (14) wells to recover 84 cfs as a result of seepage losses while returning water to the California Aqueduct. Also the earth lined canal alternative estimates utilizing sixteen (16) wells to recover 96 cfs as a result of seepage losses while returning water to the California Aqueduct. The canal operations costs consist of RRBWSD operations and maintenance costs, electricity costs, mission unit costs, and DWR conveyance costs. These costs are similar for most of the options with the exception that the idle year costs for the earth lined canal options (1, 1a, and 1b) are more for the RRBWSD maintenance costs as they have to perform weed and rodent control along the entire conveyance canal. Also the idle year maintenance costs for the closed conduit option have been reduced as a result of the RRBWSD maintenance being minimized with a pipeline. Pump Station replacement costs have been included and account for pump,

motor, VFD, electrical gear, and cathodic protection replacement every twenty-five (25) years. The liner replacement and repair costs are included for the poly lined canal, shotcrete lined canal, and the concrete lined canal. The poly lined canal estimates minor patches or repairs about every five years at a cost of $25,000 per year and inflation at 3% per year. The shotcrete lined canal estimates panel replacements about every three years for approximately 1,200 lineal feet of side slope panels at a cost of $129,549 per year and inflation at 3% per year. The concrete lined canal estimates that it will be more durable than a shotcrete lined canal and panel replacements will not be necessary for the first 10 to 15 years. The concrete lined canal estimates panel replacement about every five years, beginning in year fifteen, for approximately 1,200 lineal feet of side slope panels at a cost of $150,000 per year and inflation at 3% per year. The present worth values are summarized in the table below.

Table 15

Summary of Conveyance Alternatives

Ranking by Present Worth	Alternative No.	Alternative	Earthwork & Conveyance Facility Costs[2]	Pump Station Costs[3]	Right-of-Way Costs[4]	Lining Cost or Earth Canal Option Costs[5]	Total Conveyance Cost w/ Pump Stations[6]	Present Worth on 50 Yr Basis[7]
1	6	Pipeline	$62,242,300	$13,383,200	$3,750,000	NA	$79,375,500	$182,191,000
2	1a	Earth Lined w/Return Pipeline	$22,193,716	$28,945,000	$5,625,000	$10,519,000	$67,282,716	$188,594,201
3	2/3	HDPE/RPE Lined	$20,750,355	$28,945,000	$5,000,000	$5,596,190	$60,291,545	$190,764,330
4	4	Shotcrete Lined	$20,750,355	$28,945,000	$5,000,000	$14,818,490	$69,513,845	$191,170,614
5	5	Concrete Lined	$20,750,355	$28,945,000	$5,000,000	$16,001,690	$70,697,045	$191,481,030
6	1	Earth Lined[1]	$22,193,716	$28,945,000	$5,625,000	NA	$56,763,716	$197,012,451
7	1b	Earth Lined w/Bentonite Liner	$22,193,716	$28,945,000	$5,625,000	$15,135,216	$71,898,932	$202,678,919

[1]Earth Lined canal does not include a lining. There is additional earthwork and associated costs which are included under "Earthwork & Conveyance Facility Costs".

[2]Earthwork and conveyance costs based upon Tables 1 - 4 and include earthwork, facility relocations, fencing, spillways, and road crossings.

[3]Pump Station costs based on those developed in TM #4 plus a 15% contingency to account for unknowns and PG&E electrical service costs.

[4]Right-of-way costs estimated at $25,000 per acre.

[5]Costs from the liner alternatives evaluation in Sections III thru VI

[6]Total conveyance cost includes earthwork & conveyance facilities, pump stations, R/W, and linings.

[7]Present worth analysis based on 50 year period - see Exhibit C for spreadsheets.

The earth lined canal is not considered a good alternative due to concerns with rodent holes and piping failures, liability due to adjacent landowners, and overall increased canal maintenance with weed control, sedimentation, and rodent hole control. In addition, seepage losses are a concern when returning water to the California Aqueduct. In order to mitigate canal seepage when returning water to the Aqueduct, a return water pipeline or bentonite clay liner has been included in the cost. The earth lined canal alternative with a return water pipeline has the lowest present worth among canal alternatives, however it is not the recommended alternative for the reasons outlined above.

The poly lined and concrete lined alternatives are very similar in present worth over a fifty-year period. The HDPE or RPE canal lining is an economical alternative, has the best hydraulic properties, and is easier to maintain than an earth lined canal. The drawback to the HDPE or RPE canal lining is the estimated useful life of 10 to 20 years for the San Joaquin Valley. However, the present worth analysis demonstrates that this is still a viable alternative.

The cost difference between the shotcrete lining and the concrete lining is also not very significant. Both of these lining systems are quality canal linings and result in a long useful life, however the shotcrete lining requires greater skill and quality control during application. The concrete lined canal alternative, however, is the most expensive lining alternative.

If the conveyance canal alternative is selected for design then the conventional concrete, shotcrete, and poly liners are all reasonable options as they are very similar in present worth based upon a fifty-year (50) period. In that event it is recommended that the "Conveyance Facilities including Turnouts & Pump Stations" bid package include bid alternates for the three types of canal linings. This will provide competitive pricing for each alternative, account for market fluctuations in material pricing, and allow the JPA to evaluate the lining costs in light of the total overall project costs.

However, the pipeline alternative appears to be the most economical over a 50 year period based upon the present worth analysis and therefore should be considered. There are significant benefits to the pipeline alternative that pertain to energy savings, operational and maintenance savings, reduced infrastructure, reduced right-of-way, and safety. The primary safety benefit is the pipeline alternative could place a single pump station on the east side of the I-5 Freeway which is at an elevation that would allow for it to float off the Aqueduct at the static or operating level of the California Aqueduct. This eliminates risks associated with canal levee breaches or overflows.

It is recommended that once the Phase I and Phase II properties are acquired, alignments fixed, and topographical survey completed, that the design firm perform updated value engineering work for the conveyance canal verses pipeline alternatives as well as considering hybrid approaches that utilize both reaches of conveyance canal and reaches of pipeline. At that time the JPA can evaluate the capital costs, the present worth, and the benefits of each alternative in making their final decision.

XI. Related Work Specified Elsewhere

A. TM 2- Conveyance Capacity Requirements
B. TM 3 – Pipeline Requirements
C. TM 4 – Pump Station Requirements
D. TM 5 – Geotechnical Investigation
E. TM 8 - ROW Acquisition
F. TM 10 – Facility Operation and SCADA Requirements
G. TM 11- Engineer's Estimates

Appendices

Appendix A – Canal Cross Sections
Appendix B – Quantity Calculations
Appendix C – Present Worth Analysis

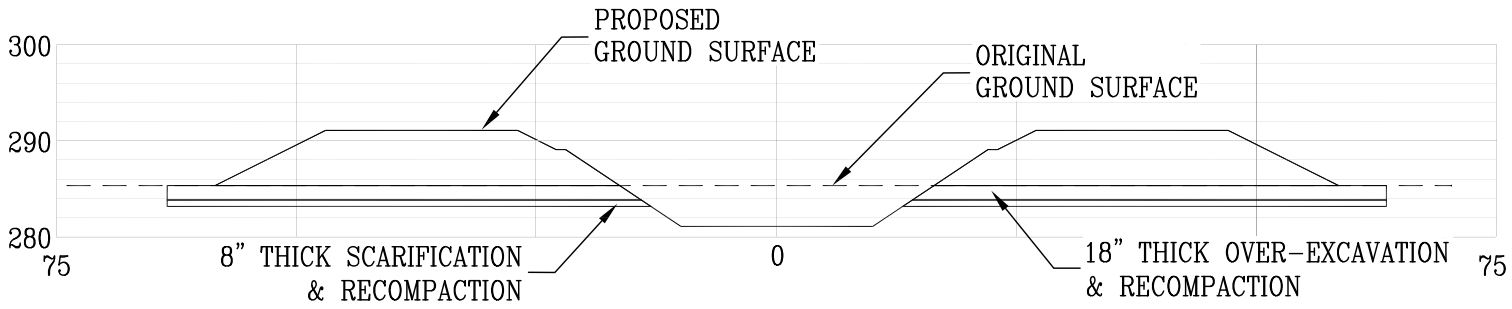
Appendix A
Canal Cross Sections

REACH 1

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

0' 20'
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
639 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
FAX 559 783-9275



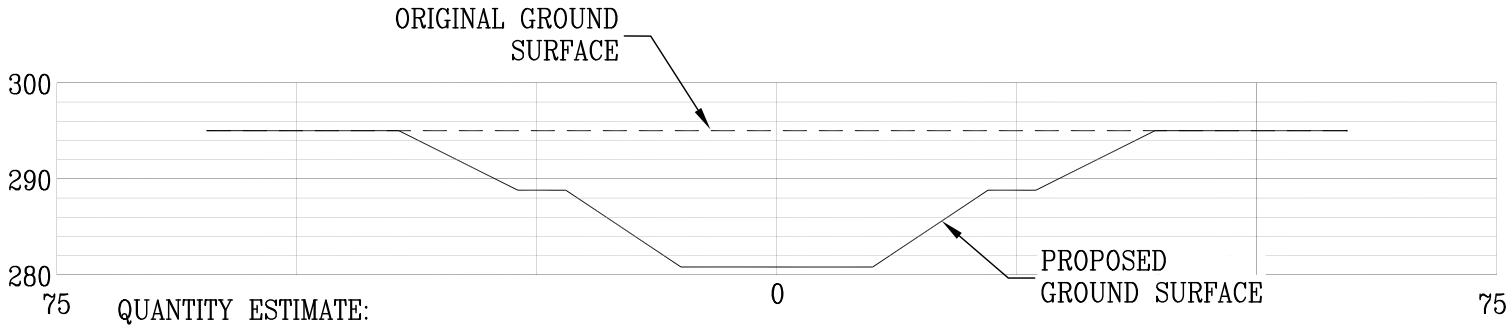
QUANTITY ESTIMATE:

"NEAT LINE" CUT AREA 112.1 CF/LF

"NEAT LINE" FILL AREA 362.7 CF/LF

OVER-EXCAVATION 144.8 CF/LF

STA 0+00



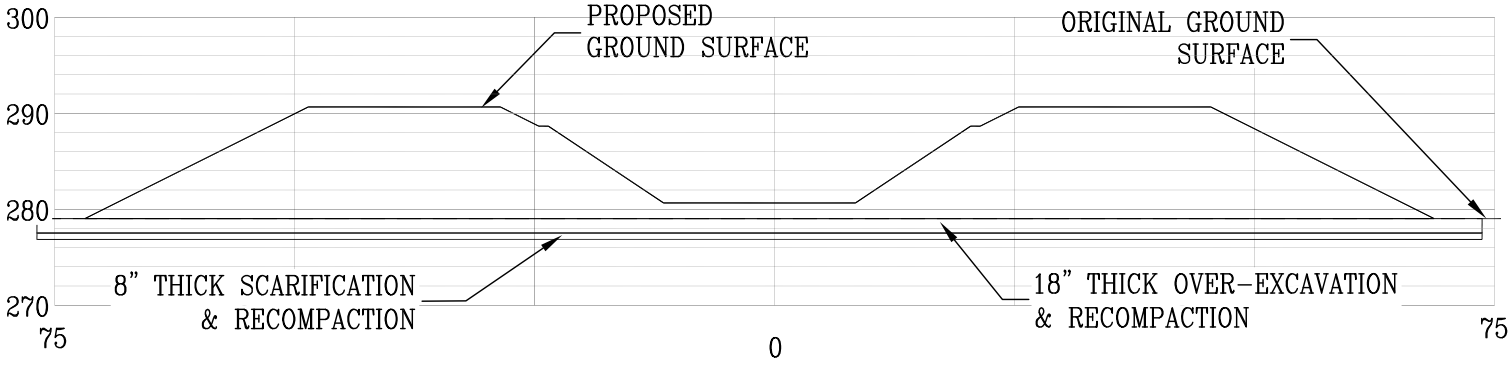
QUANTITY ESTIMATE:

"NEAT LINE" CUT AREA 667.7 CF/LF

"NEAT LINE" FILL AREA 0 CF/LF

OVER-EXCAVATION 0 CF/LF

STA 6+04



QUANTITY ESTIMATE:

"NEAT LINE" CUT AREA 0 CF/LF

"NEAT LINE" FILL AREA 1007.7 CF/LF

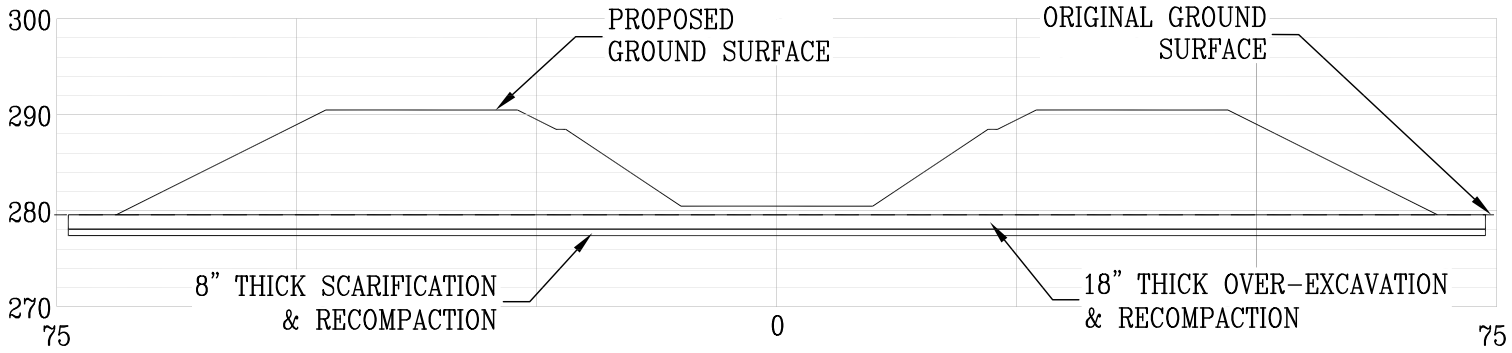
OVER-EXCAVATION 225.8 CF/LF

STA 12+04

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

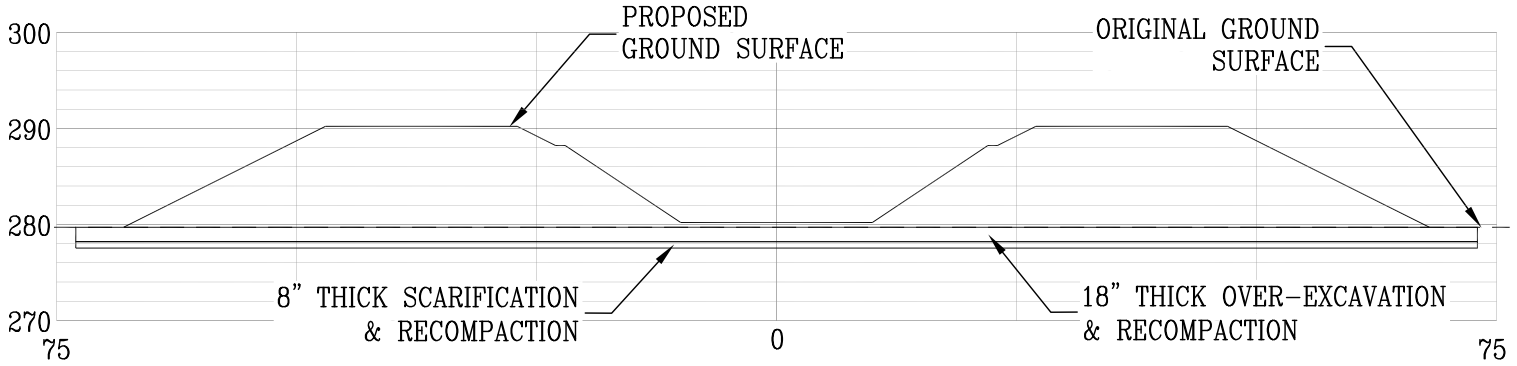
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
639 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
FAX 559 783-9275



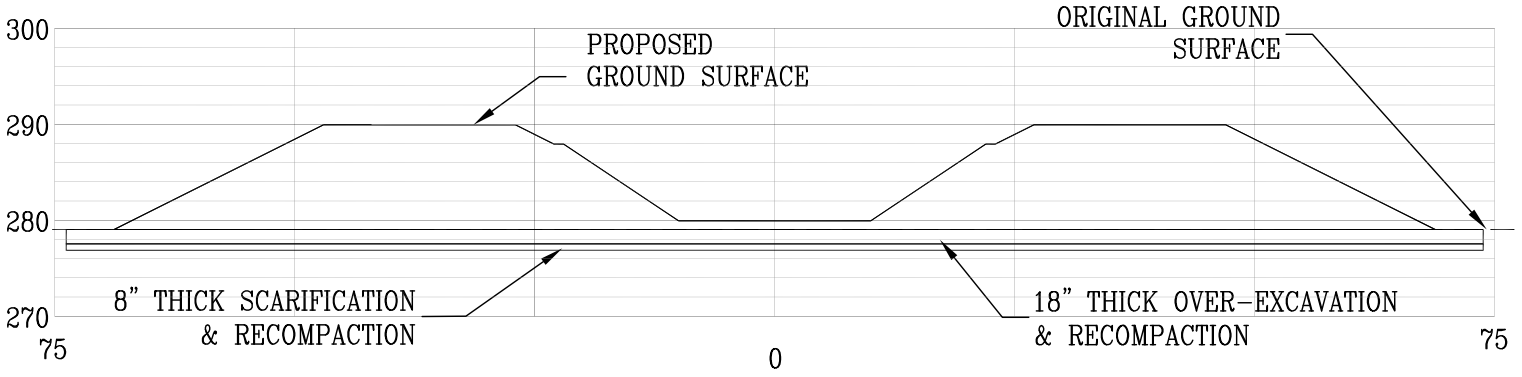
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 906.2 CF/LF
OVER-EXCAVATION 221.4 CF/LF

STA 18+04



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 851.5 CF/LF
OVER-EXCAVATION 219.0 CF/LF

STA 28+04



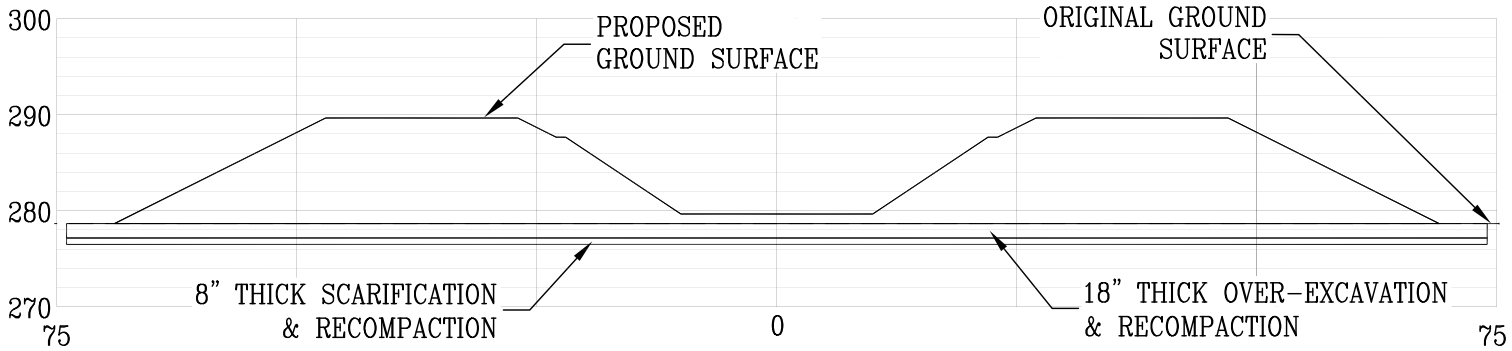
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 906.2 CF/LF
OVER-EXCAVATION 221.4 CF/LF

STA 38+04

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

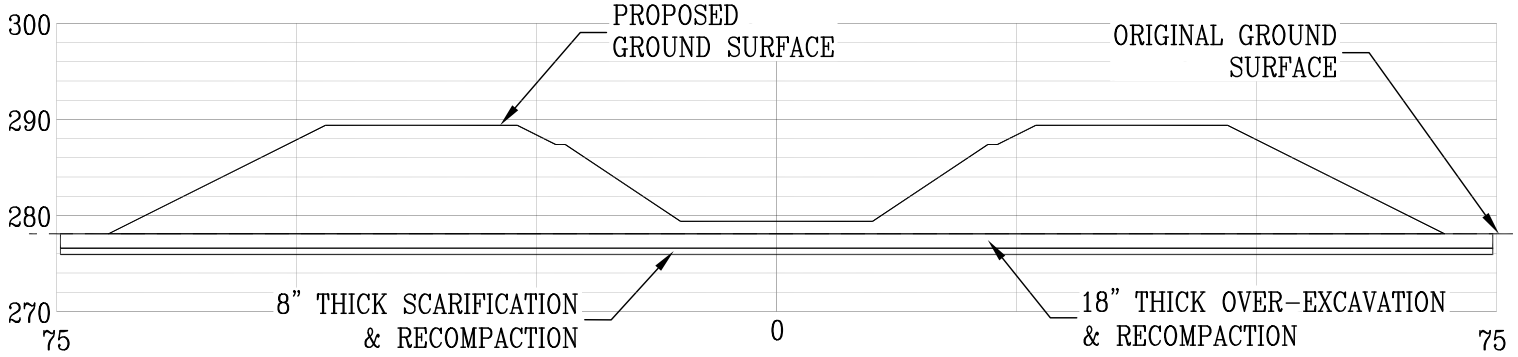
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
639 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
FAX 559 783-9275



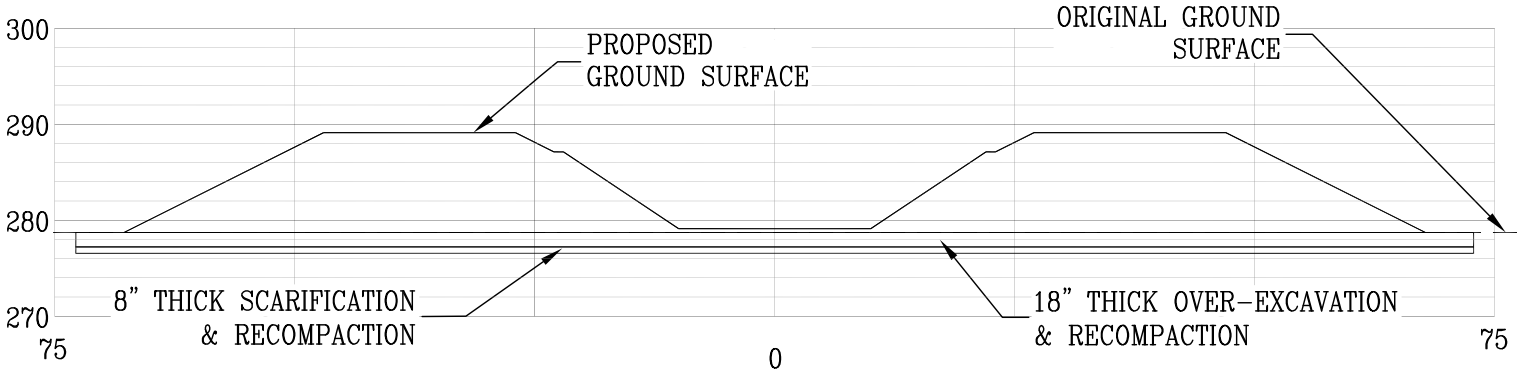
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 920.0 CF/LF
OVER-EXCAVATION 222.0 CF/LF

STA 48+04



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 961.6 CF/LF
OVER-EXCAVATION 223.8 CF/LF

STA 58+04



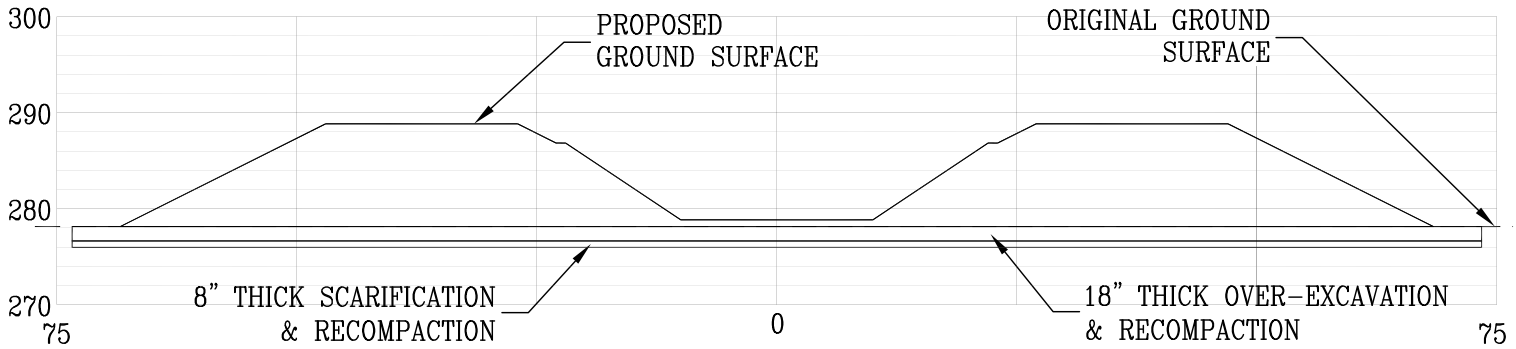
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 837.9 CF/LF
OVER-EXCAVATION 218.4 CF/LF

STA 68+04

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

SCALE: 1"= 20'

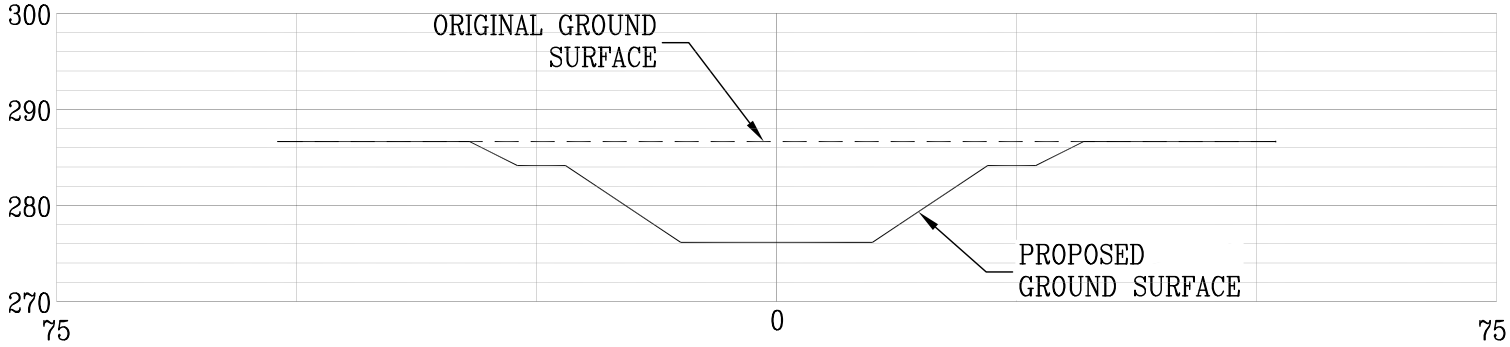
DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
639 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
FAX 559 783-9275



QUANTITY ESTIMATE:

"NEAT LINE" CUT AREA	0 CF/LF
"NEAT LINE" FILL AREA	878.8 CF/LF
OVER-EXCAVATION	220.2 CF/LF

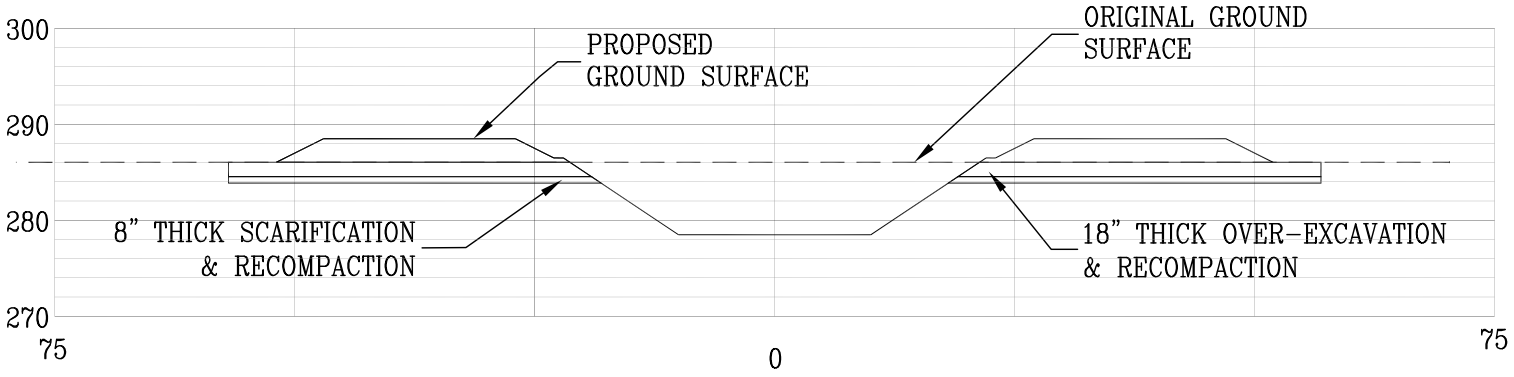
STA 78+04



QUANTITY ESTIMATE:

"NEAT LINE" CUT AREA	403.5 CF/LF
"NEAT LINE" FILL AREA	0 CF/LF
OVER-EXCAVATION	0 CF/LF

STA 85+80



QUANTITY ESTIMATE:

"NEAT LINE" CUT AREA	236.5 CF/LF
"NEAT LINE" FILL AREA	122.8 CF/LF
OVER-EXCAVATION	110.1 CF/LF

STA 89+00

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

0' 20'
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
639 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
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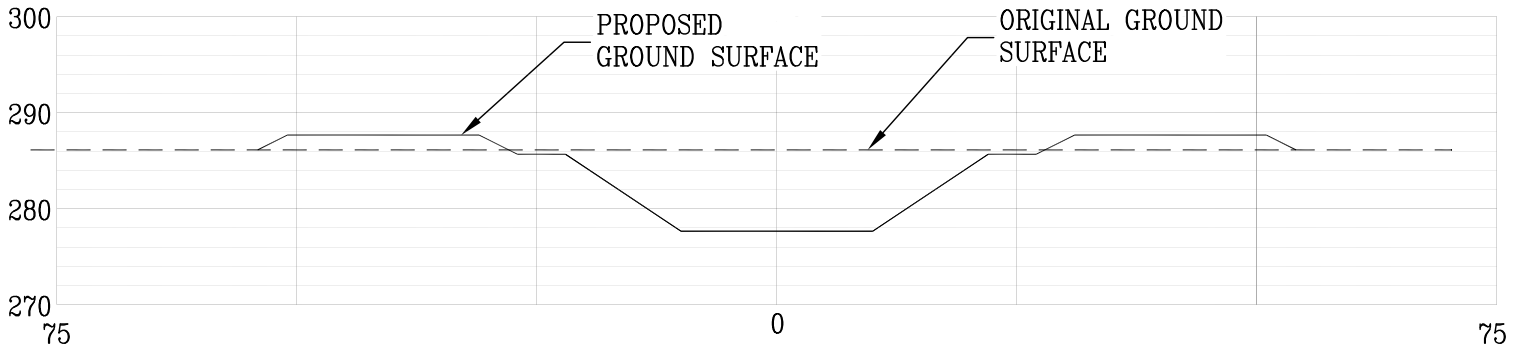
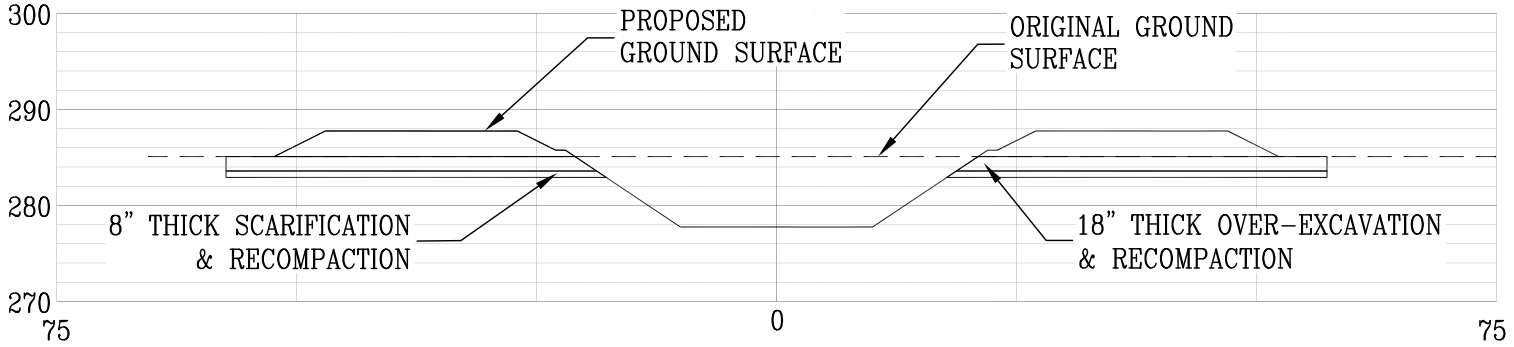


QUANTITY ESTIMATE:

"NEAT LINE" CUT AREA	281.3 CF/LF
"NEAT LINE" FILL AREA	71.0 CF/LF
OVER-EXCAVATION	0 CF/LF

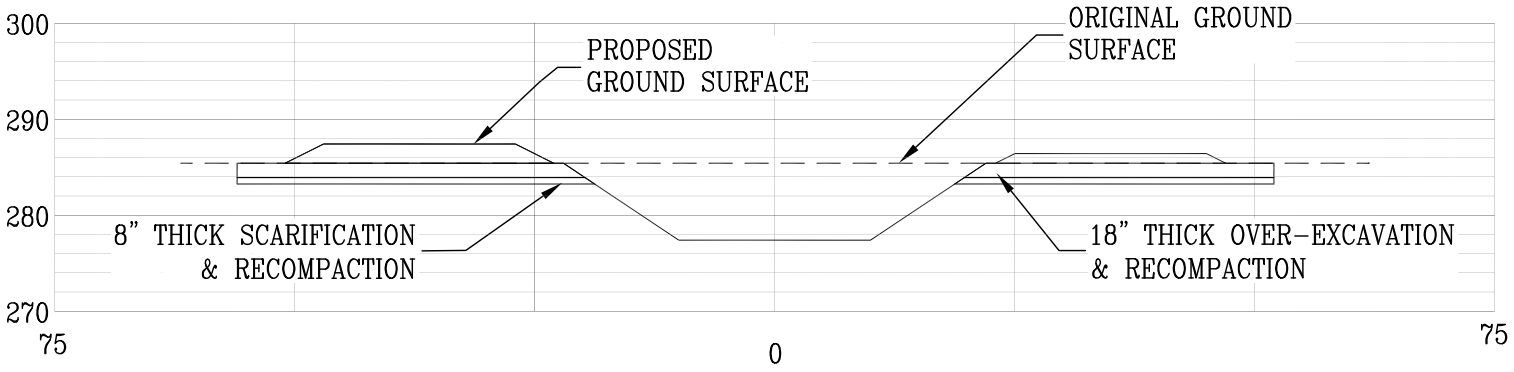
STA 99+55



QUANTITY ESTIMATE:

"NEAT LINE" CUT AREA	227.2 CF/LF
"NEAT LINE" FILL AREA	136.4 CF/LF
OVER-EXCAVATION	112.4 CF/LF

STA 109+75



QUANTITY ESTIMATE:

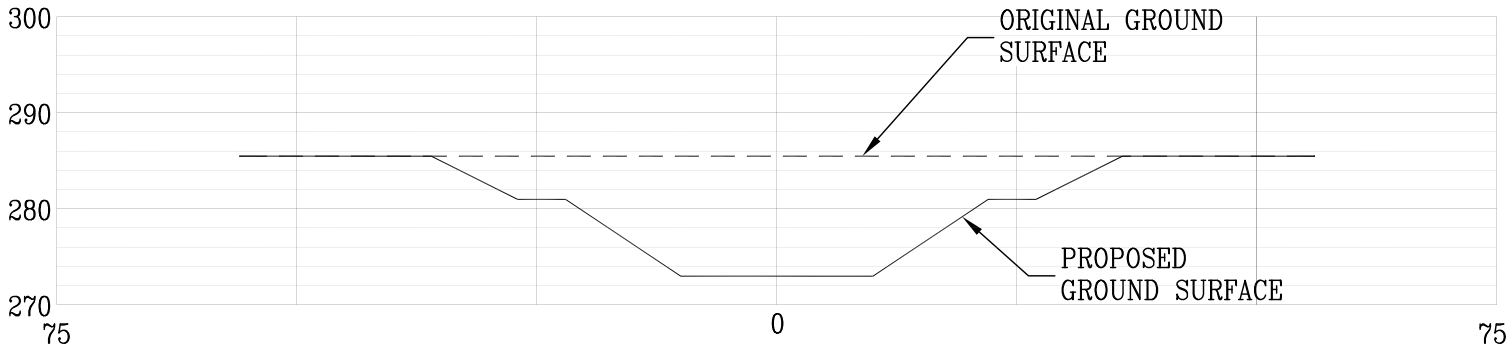
"NEAT LINE" CUT AREA	256.0 CF/LF
"NEAT LINE" FILL AREA	96.0 CF/LF
OVER-EXCAVATION	105.4 CF/LF

STA 119+75

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

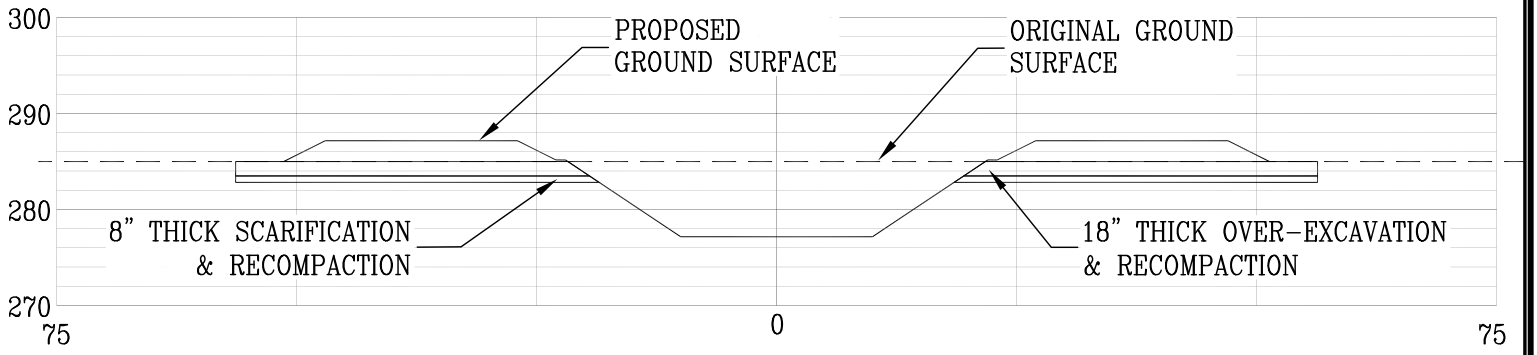
0' 20'
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
639 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
FAX 559 783-9275



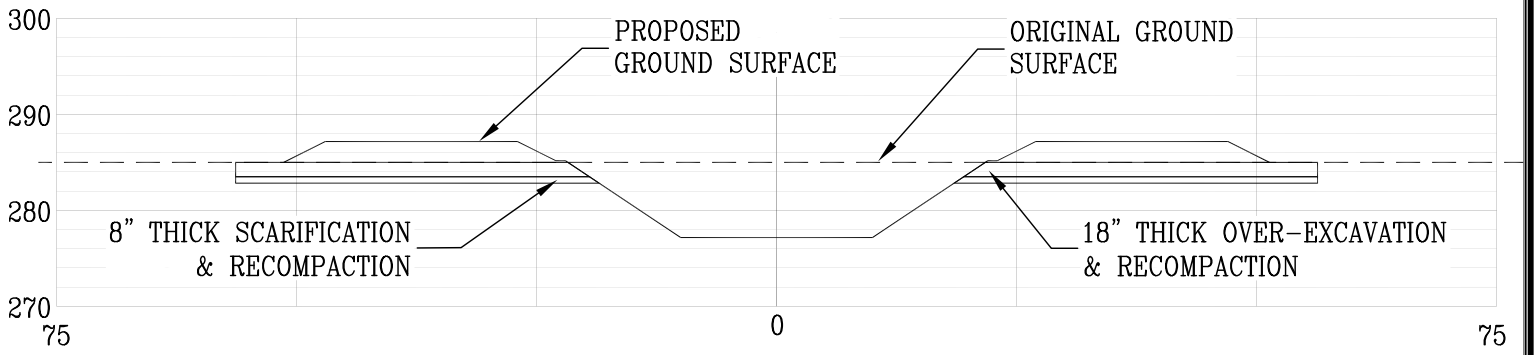
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 539.5 CF/LF
"NEAT LINE" FILL AREA 0 CF/LF
OVER-EXCAVATION 0 CF/LF

STA 130+10



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 248.6 CF/LF
"NEAT LINE" FILL AREA 106.0 CF/LF
OVER-EXCAVATION 107.2 CF/LF

STA 133+35



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 248.6 CF/LF
"NEAT LINE" FILL AREA 106.0 CF/LF
OVER-EXCAVATION 107.2 CF/LF

STA 138+60

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

SCALE: 1"= 20'

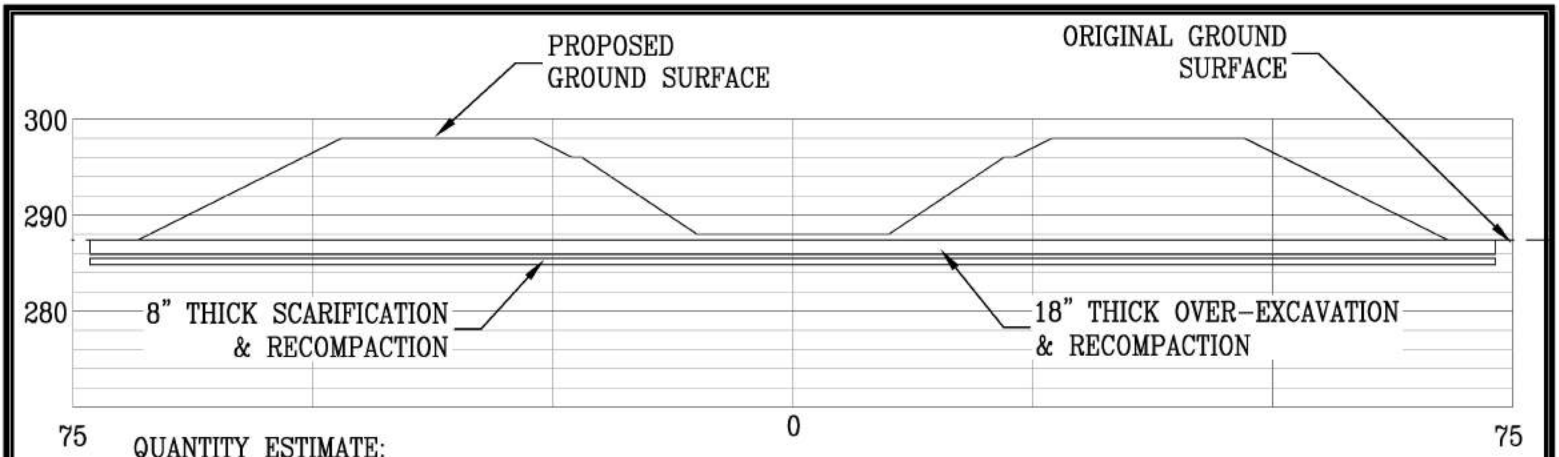
DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
639 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
FAX 559 783-9275

REACH 2

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

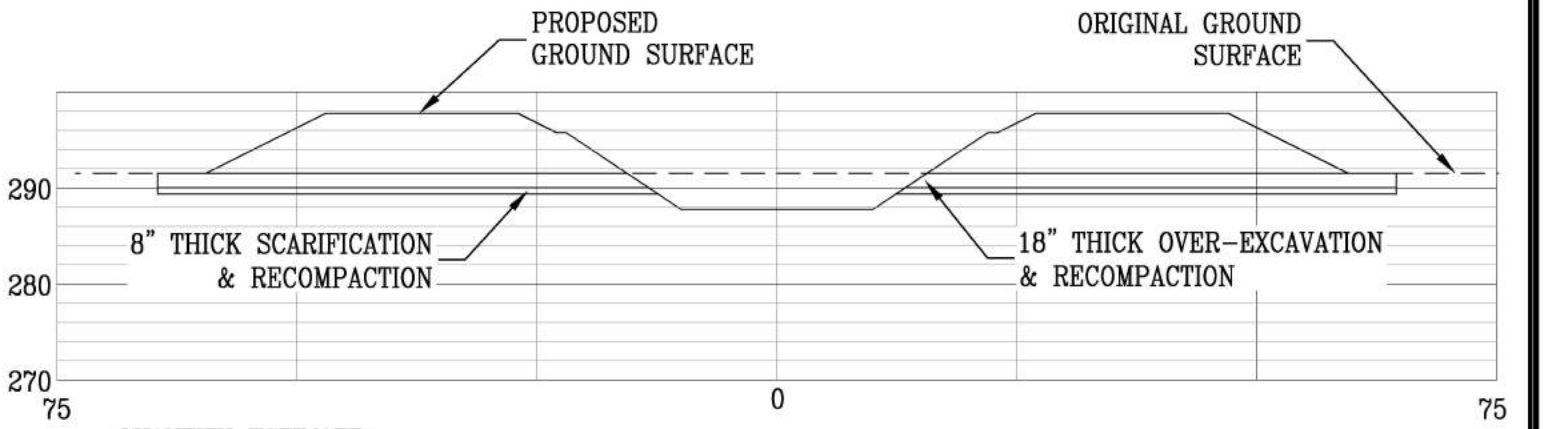
0' 20'
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
639 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
FAX 559 783-9275



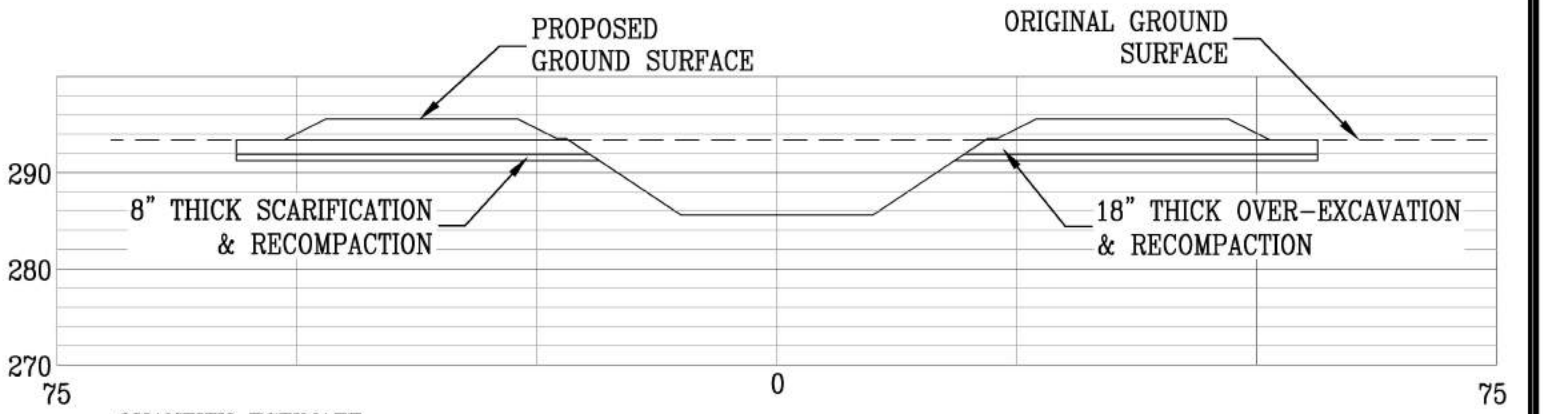
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 865.4 CF/LF
OVER-EXCAVATION 219.6 CF/LF

STA 143+40



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 96.1 CF/LF
"NEAT LINE" FILL AREA 405.7 CF/LF
OVER-EXCAVATION 150.0 CF/LF

STA 153+40



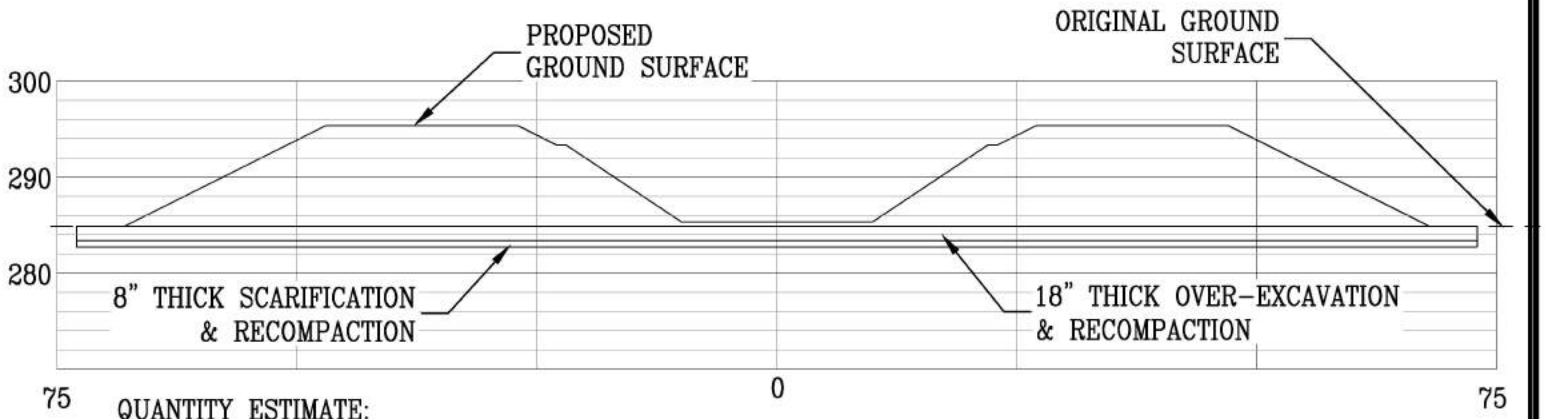
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 249.4 CF/LF
"NEAT LINE" FILL AREA 104.8 CF/LF
OVER-EXCAVATION 107.0 CF/LF

STA 163+40

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

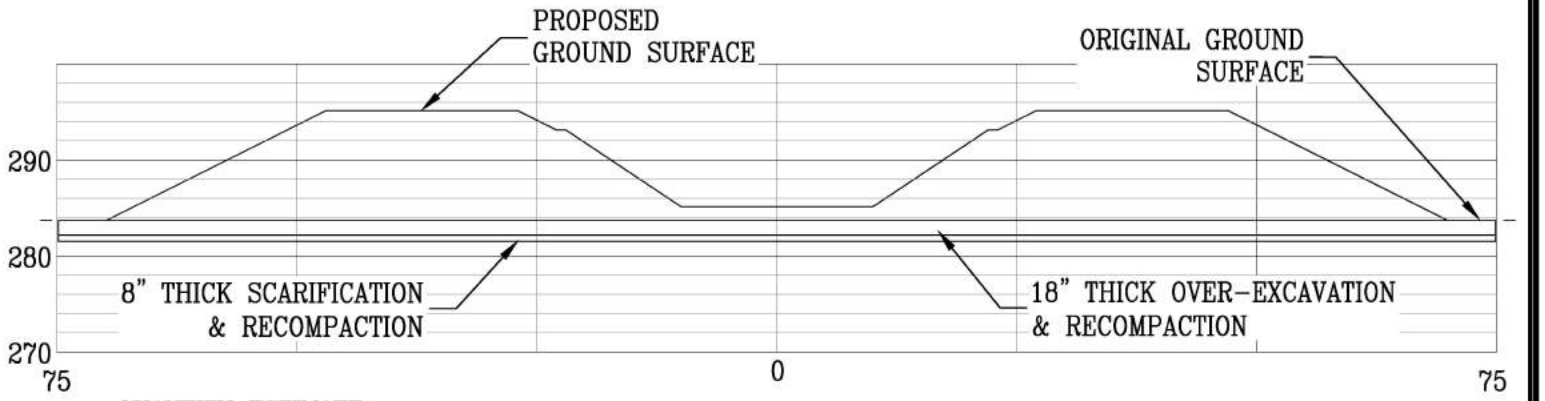
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
639 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
FAX 559 783-9275



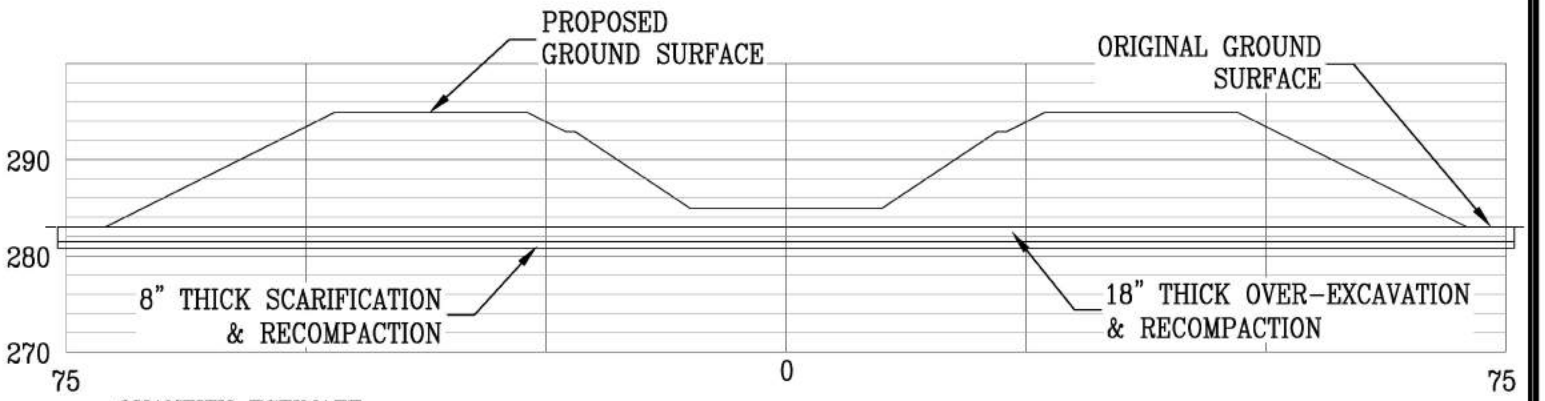
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 847.0 CF/LF
OVER-EXCAVATION 218.9 CF/LF

STA 173+40



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 979.9 CF/LF
OVER-EXCAVATION 224.6 CF/LF

STA 183+40



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 1,051.5 CF/LF
OVER-EXCAVATION 287.4 CF/LF

STA 193+40

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
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PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
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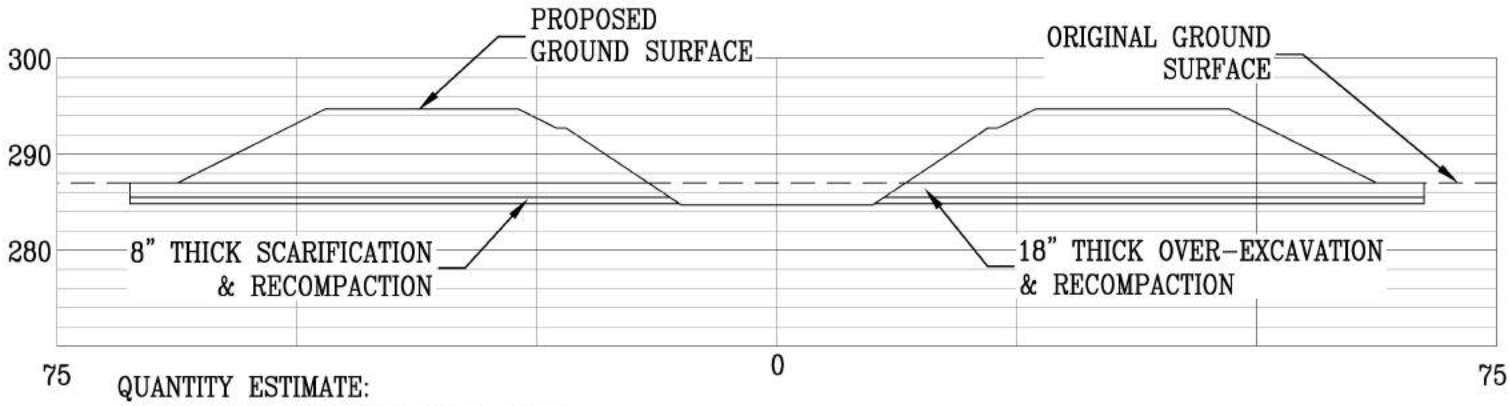
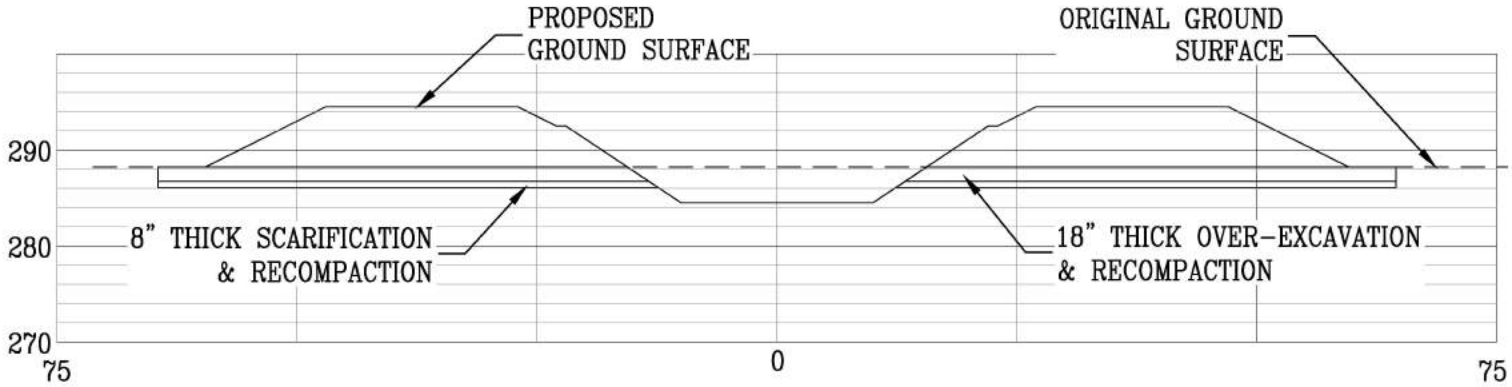


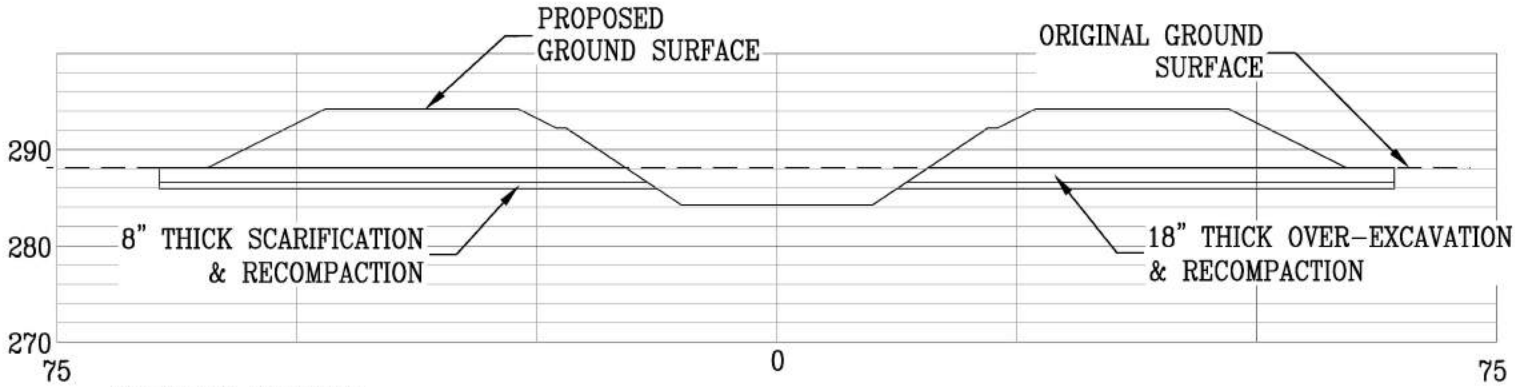
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 53.9 CF/LF
"NEAT LINE" FILL AREA 540.0 CF/LF
OVER-EXCAVATION 165.2 CF/LF

STA 203+40



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 96.1 CF/LF
"NEAT LINE" FILL AREA 405.7 CF/LF
OVER-EXCAVATION 150.0 CF/LF

STA 217+70



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 99.2 CF/LF
"NEAT LINE" FILL AREA 397.0 CF/LF
OVER-EXCAVATION 149.0 CF/LF

STA 221+90

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

0' 20'
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
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639 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
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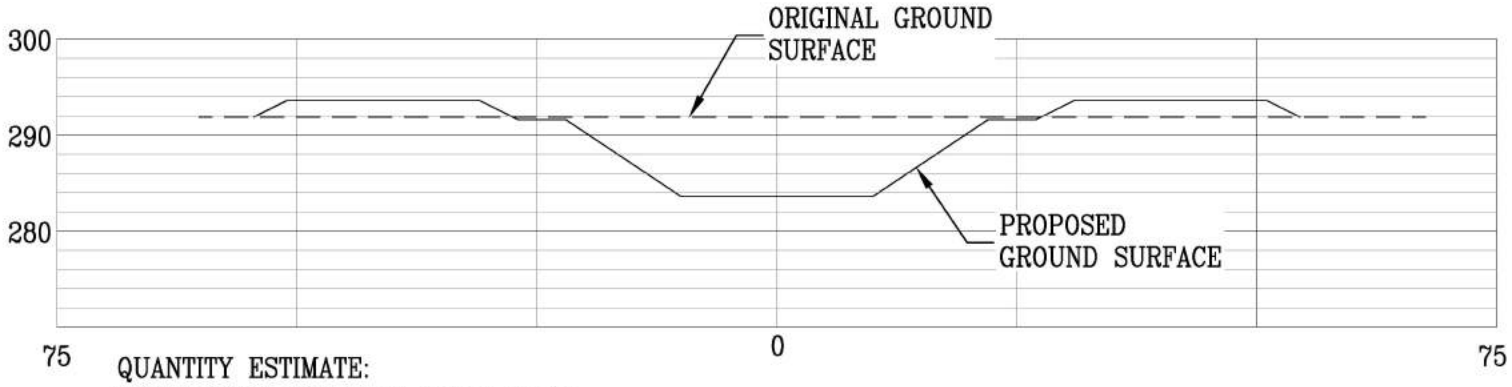
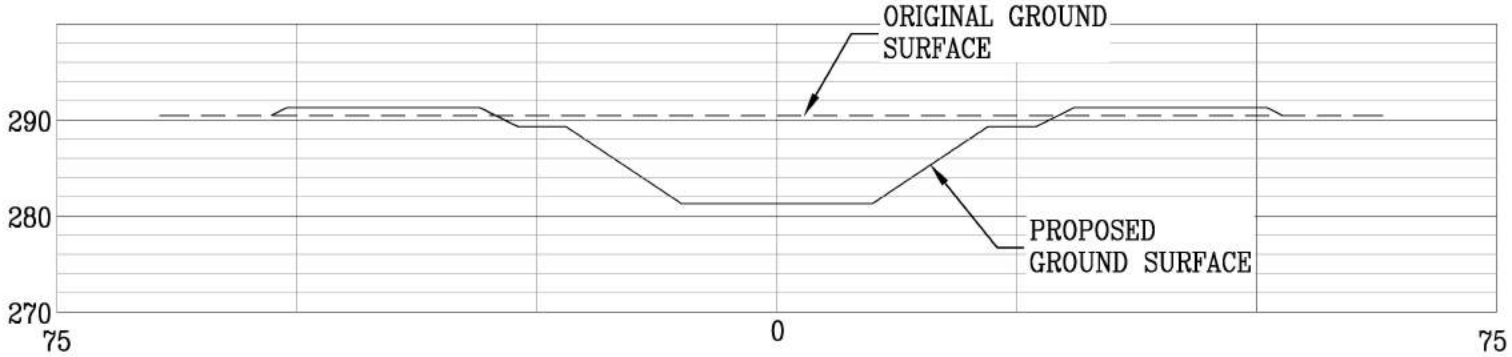


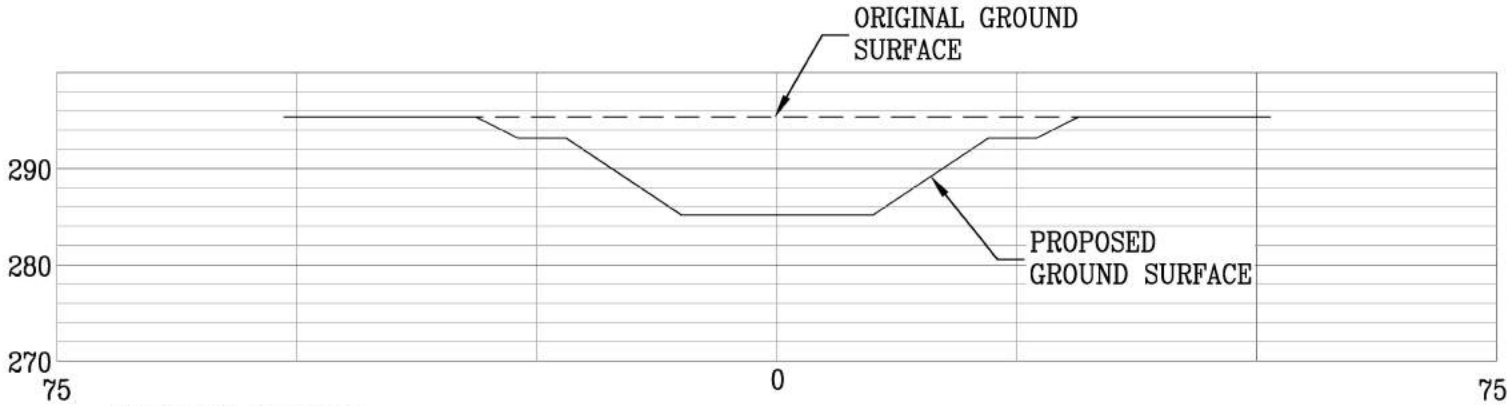
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 269.6 CF/LF
"NEAT LINE" FILL AREA 82.2 CF/LF
OVER-EXCAVATION 0 CF/LF

STA 232+30



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 320.7 CF/LF
"NEAT LINE" FILL AREA 36.9 CF/LF
OVER-EXCAVATION 0 CF/LF

STA 242+30



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 384.5 CF/LF
"NEAT LINE" FILL AREA 0 CF/LF
OVER-EXCAVATION 0 CF/LF

STA 252+70

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
639 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
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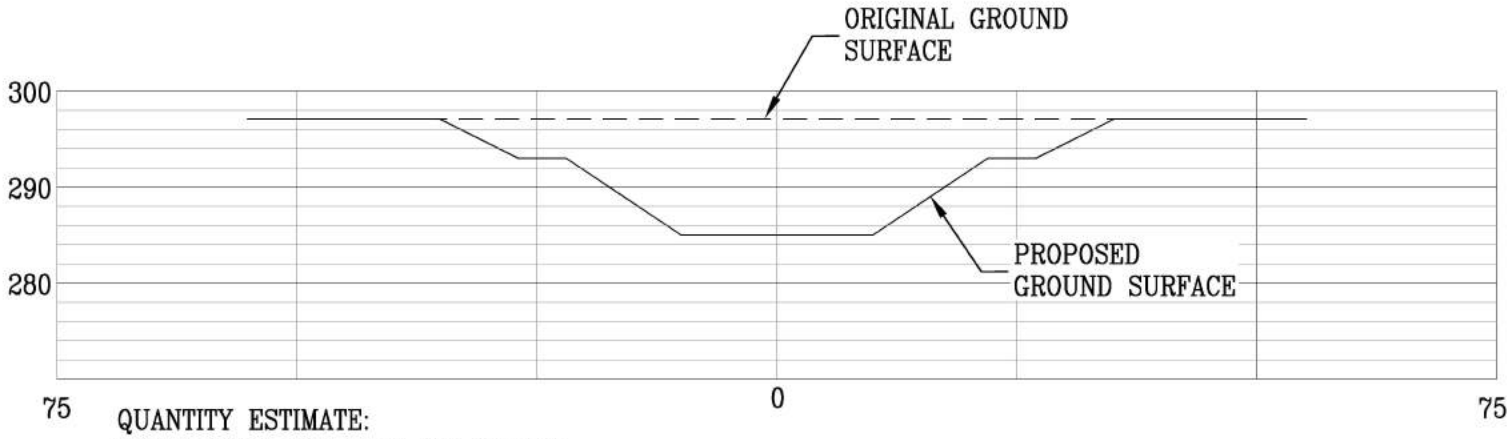
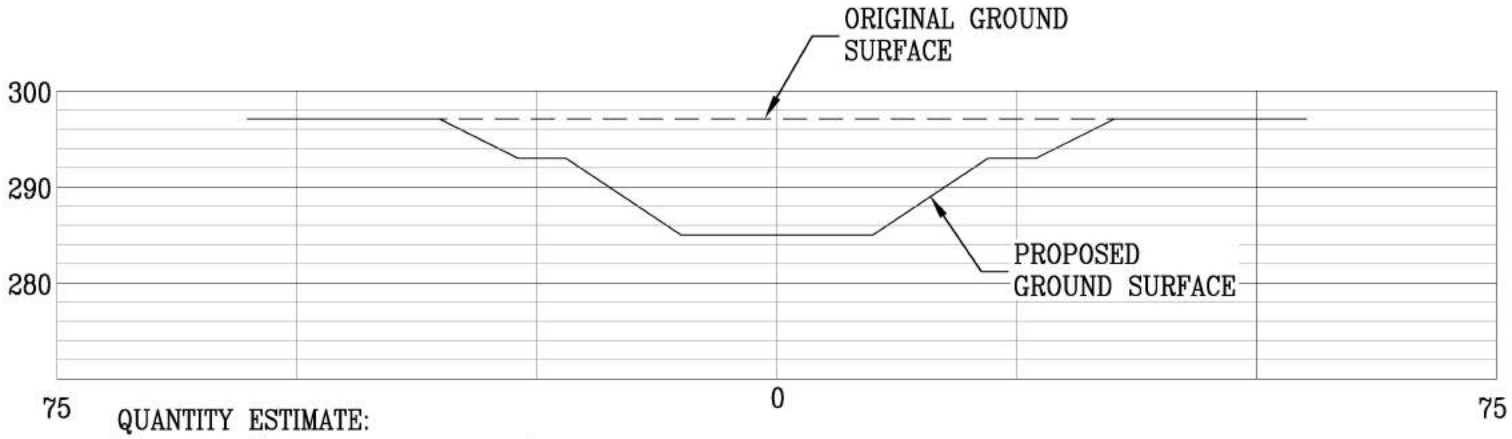


QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 511.0CF/LF
"NEAT LINE" FILL AREA 0 CF/LF
OVER-EXCAVATION 0 CF/LF

STA 256+90



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 511.0CF/LF
"NEAT LINE" FILL AREA 0 CF/LF
OVER-EXCAVATION 0 CF/LF

STA 267+20

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

0' 20'
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
639 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
FAX 559 783-9275

REACH 3

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

0' 20'
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
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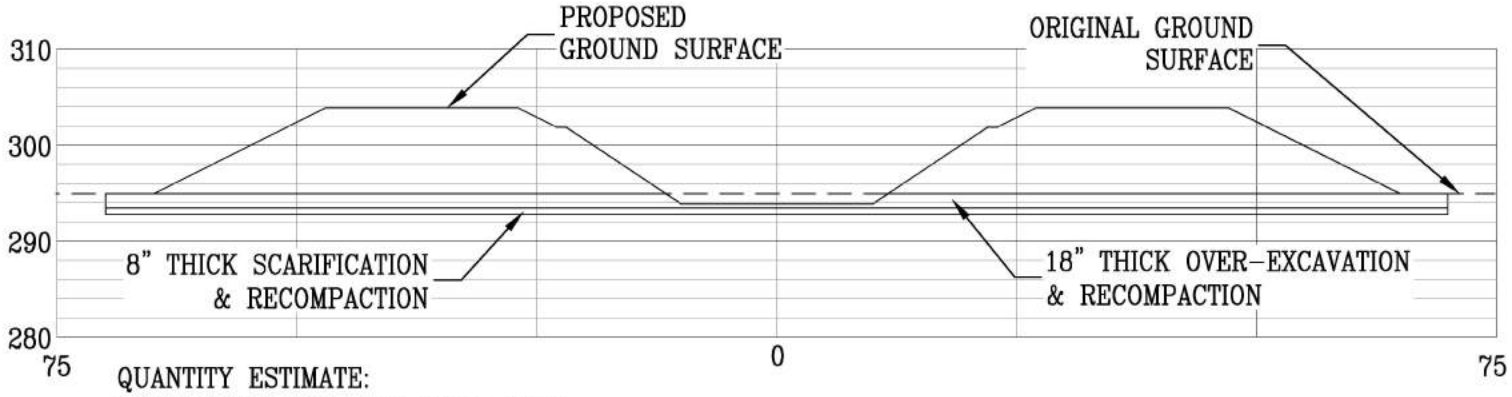
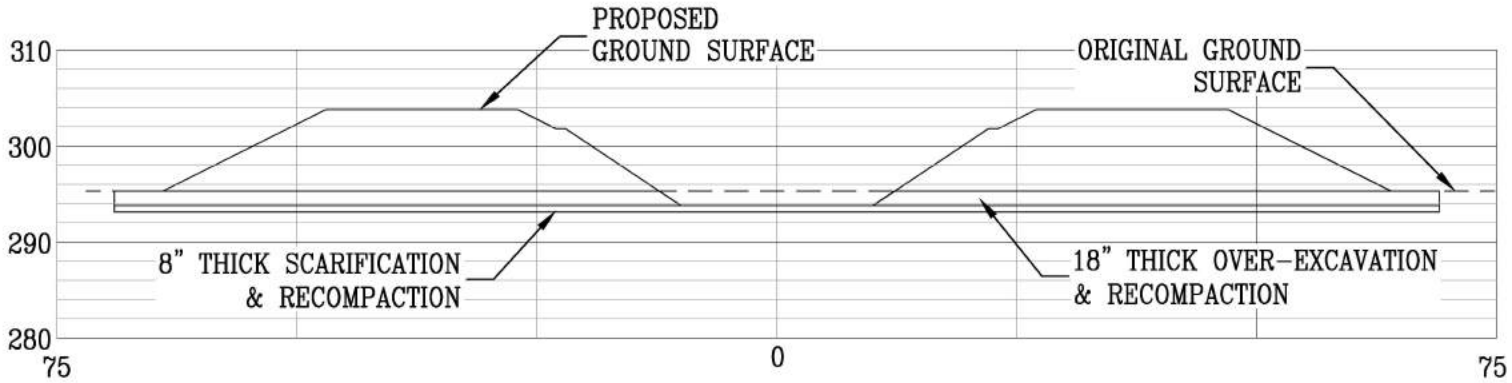
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
FAX 559 783-9275



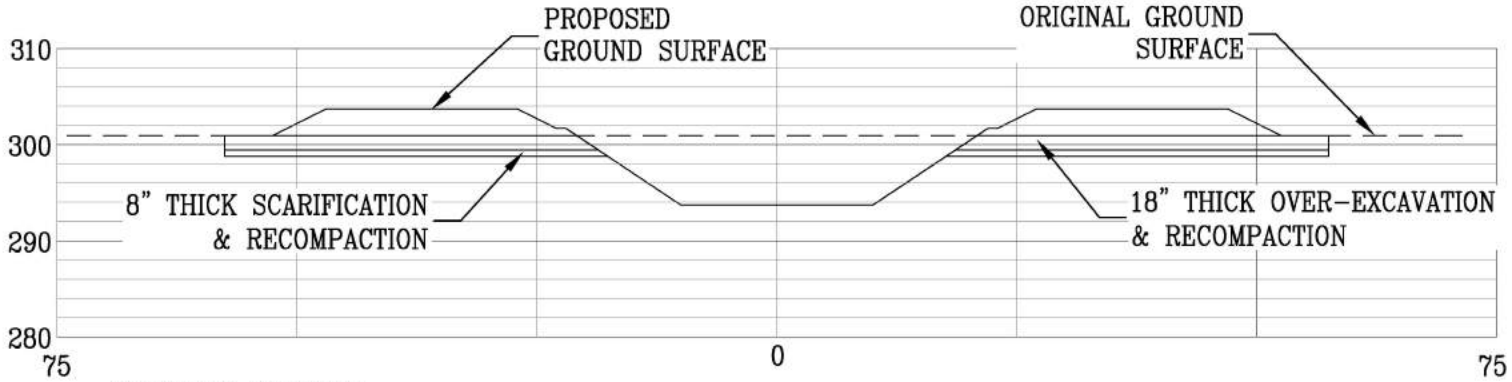
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 22.7 CF/LF
"NEAT LINE" FILL AREA 668.2 CF/LF
OVER-EXCAVATION 187.0 CF/LF

STA 267+20



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 33.4 CF/LF
"NEAT LINE" FILL AREA 620.8 CF/LF
OVER-EXCAVATION 173.8 CF/LF

STA 278+00



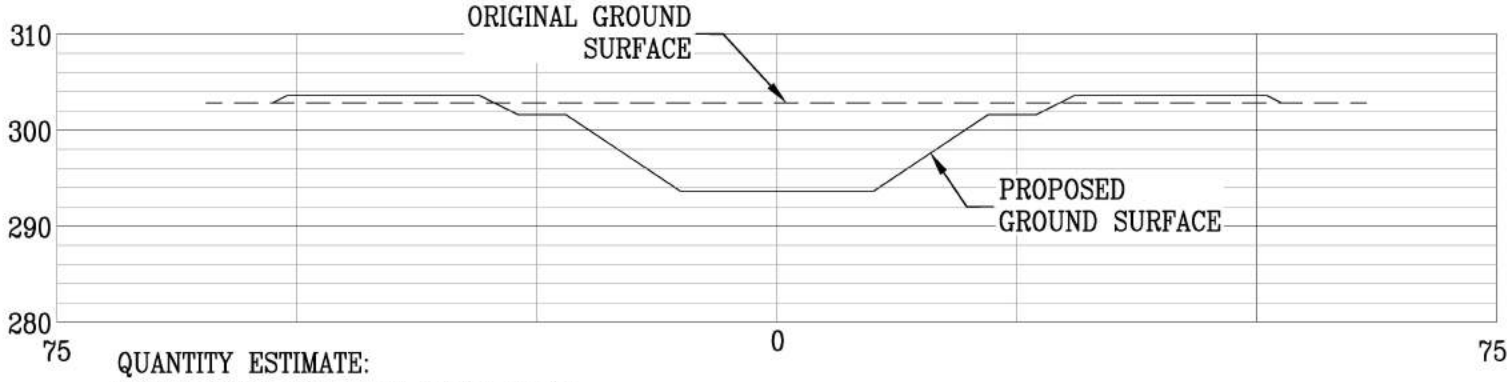
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 223.8 CF/LF
"NEAT LINE" FILL AREA 141.4 CF/LF
OVER-EXCAVATION 113.2 CF/LF

STA 288+00

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

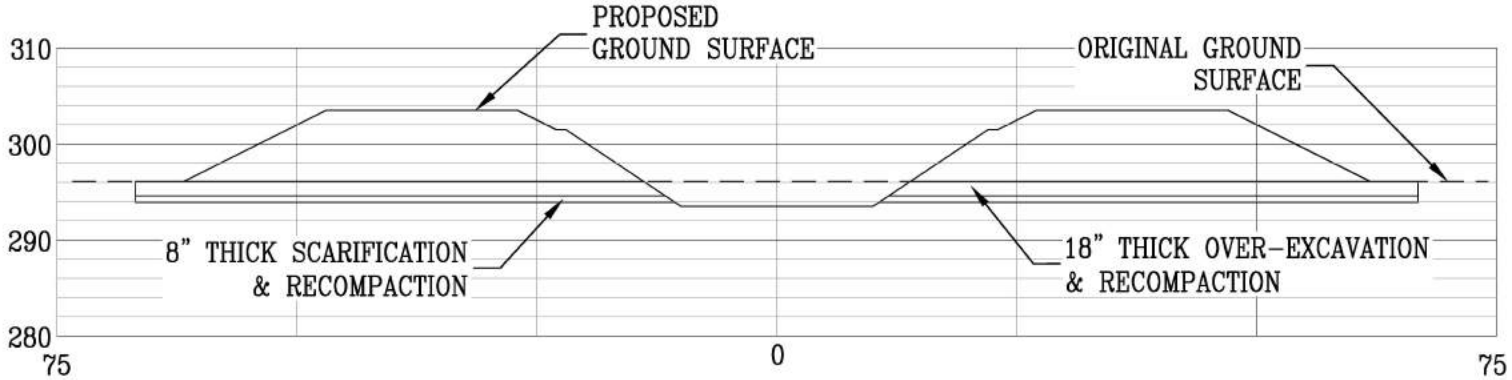
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
639 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
FAX 559 783-9275



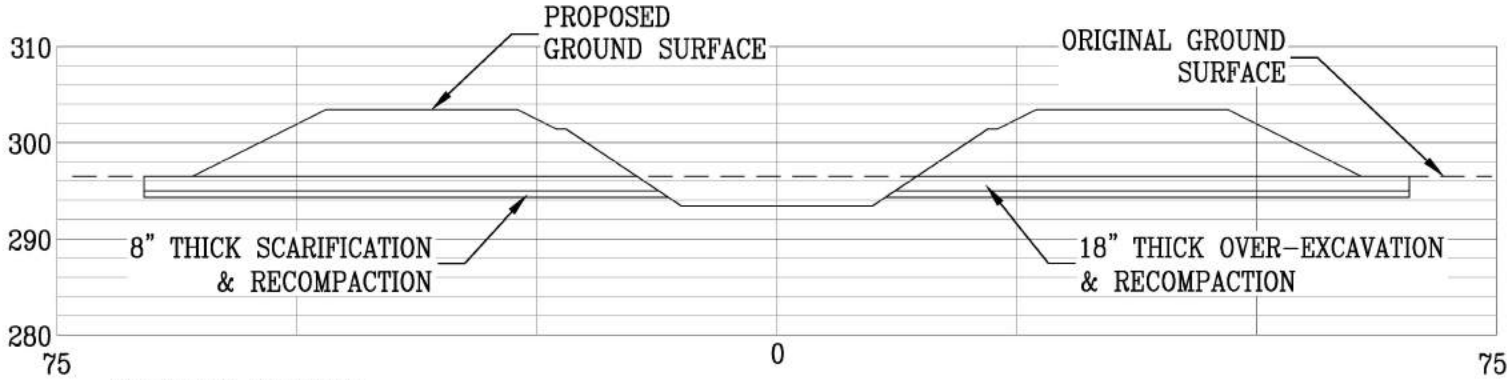
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 326.6 CF/LF
"NEAT LINE" FILL AREA 32.2 CF/LF
OVER-EXCAVATION 0 CF/LF

STA 298+00



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 62.1 CF/LF
"NEAT LINE" FILL AREA 511.2 CF/LF
OVER-EXCAVATION 162.0 CF/LF

STA 308+00



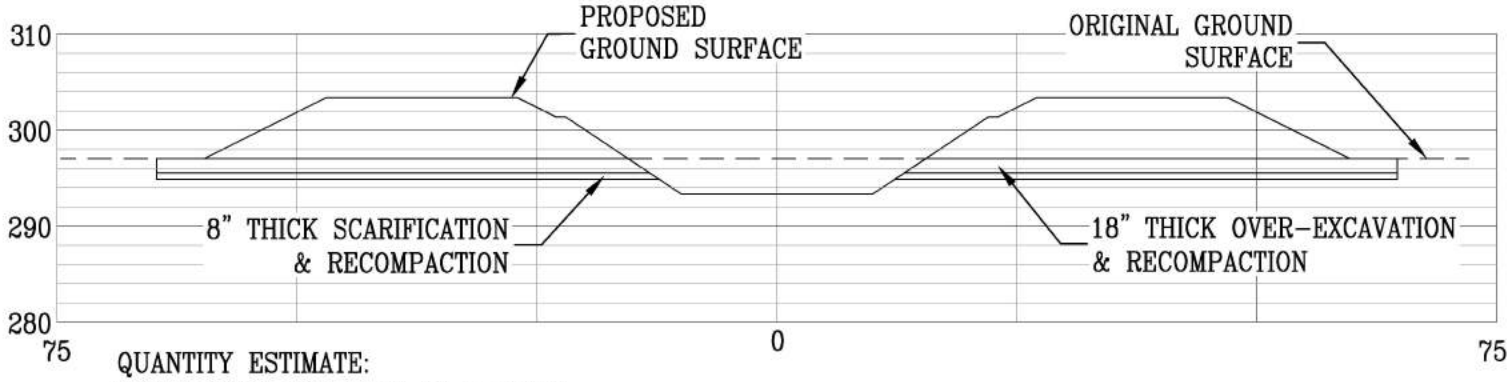
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 75.0 CF/LF
"NEAT LINE" FILL AREA 448.8 CF/LF
OVER-EXCAVATION 161.4 CF/LF

STA 318+00

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

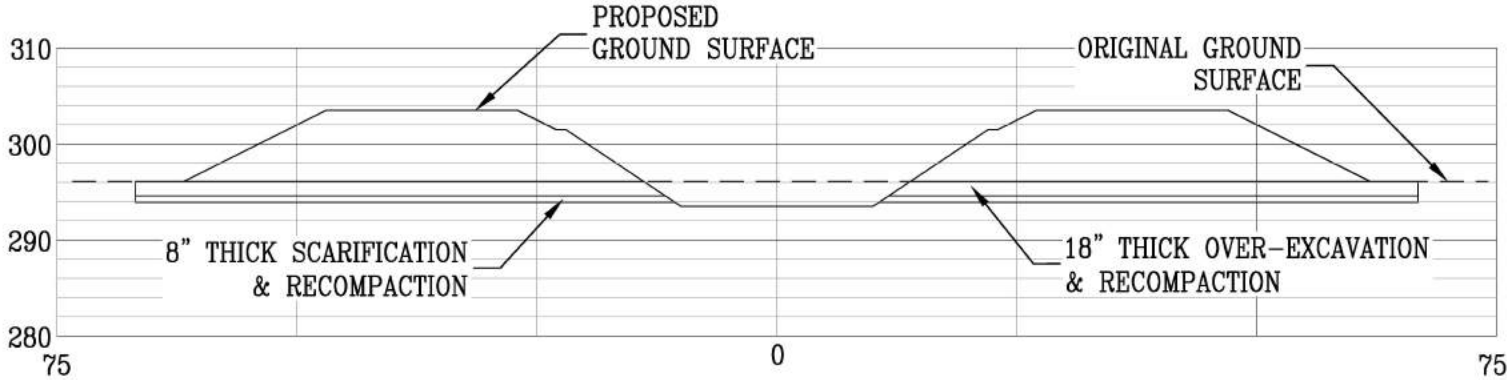
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
639 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
FAX 559 783-9275



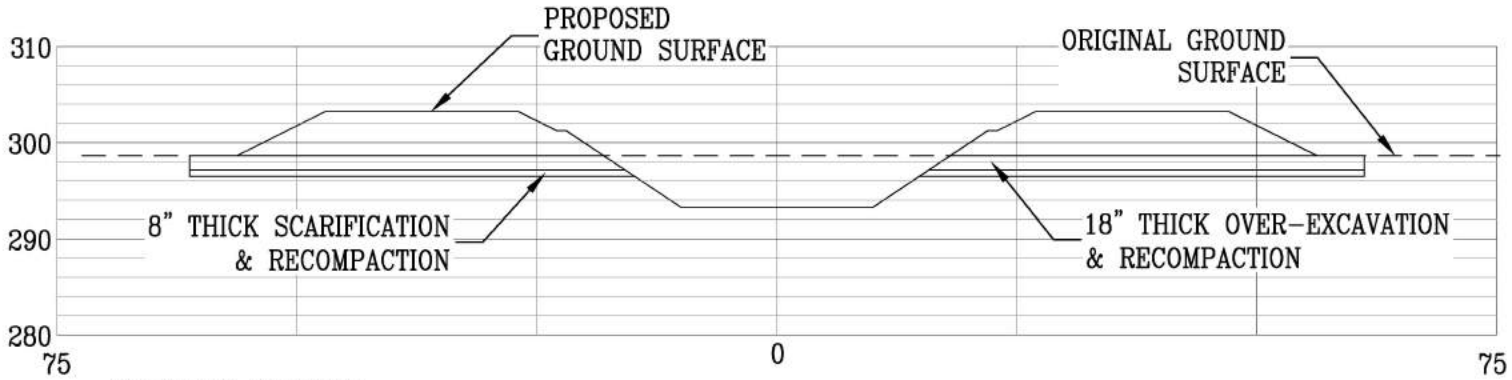
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 94.5 CF/LF
"NEAT LINE" FILL AREA 410.1 CF/LF
OVER-EXCAVATION 150.5 CF/LF

STA 328+00



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 91.4 CF/LF
"NEAT LINE" FILL AREA 419.0 CF/LF
OVER-EXCAVATION 151.6 CF/LF

STA 338+00



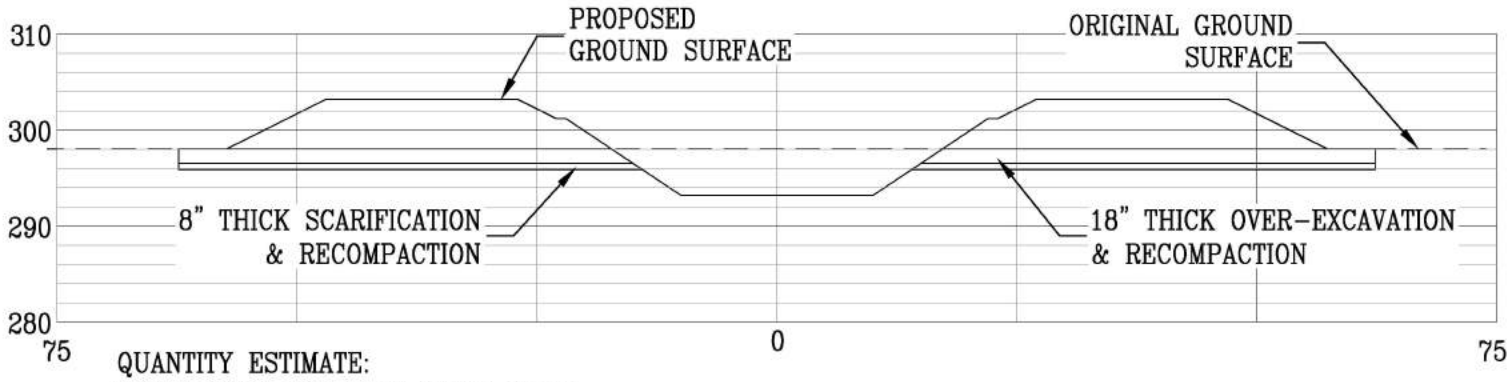
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 151.7 CF/LF
"NEAT LINE" FILL AREA 270.6 CF/LF
OVER-EXCAVATION 132.6 CF/LF

STA 348+00

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

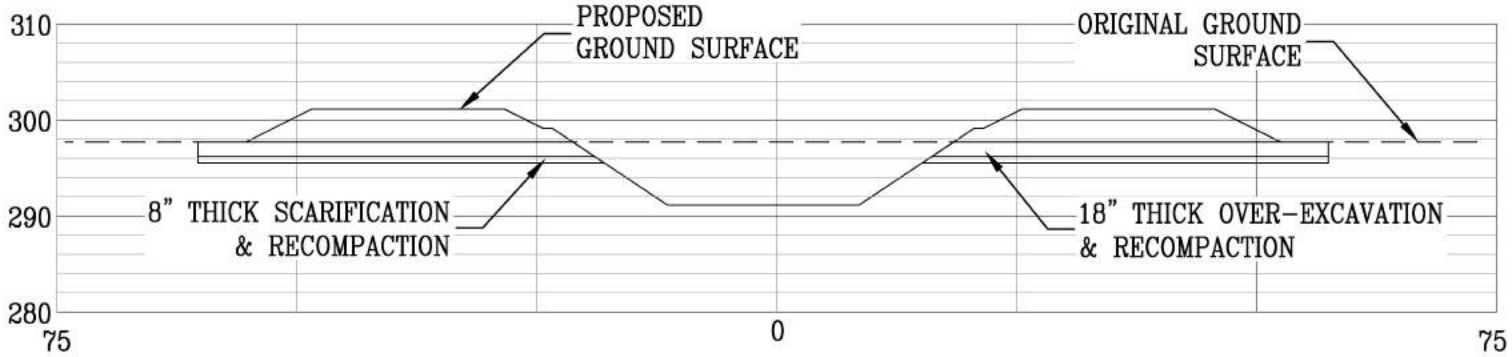
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
639 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
FAX 559 783-9275



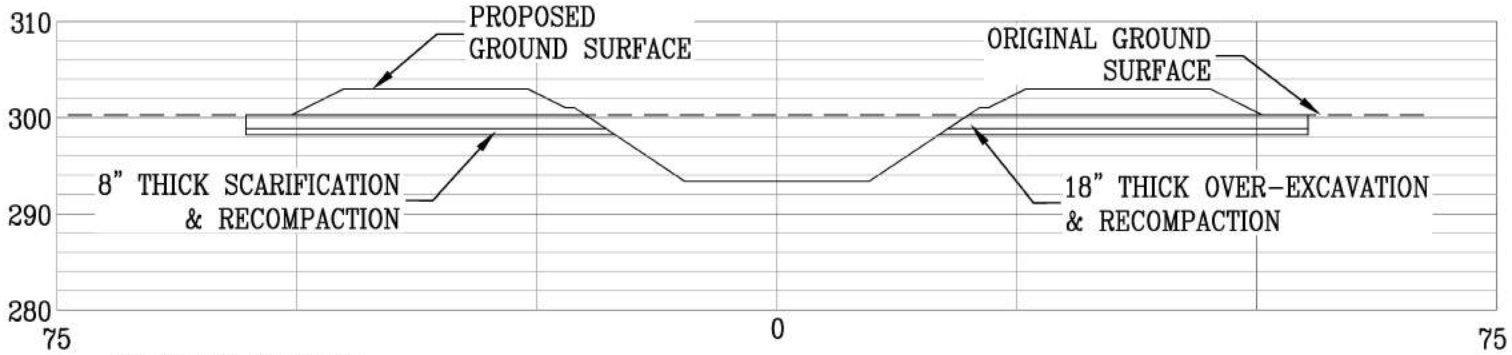
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 132.3 CF/LF
"NEAT LINE" FILL AREA 313.4 CF/LF
OVER-EXCAVATION 138.4 CF/LF

STA 358+00



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 195.4 CF/LF
"NEAT LINE" FILL AREA 187.4 CF/LF
OVER-EXCAVATION 120.6 CF/LF

STA 368+00



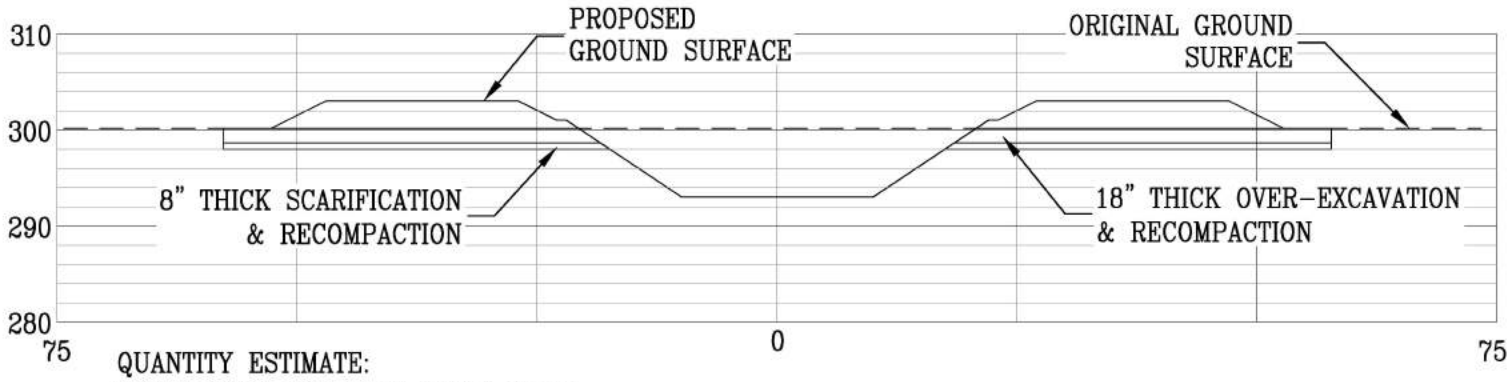
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 221.8 CF/LF
"NEAT LINE" FILL AREA 144.6 CF/LF
OVER-EXCAVATION 103.8 CF/LF

STA 378+00

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

0' 20'
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
639 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
FAX 559 783-9275



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 219.7 CF/LF
"NEAT LINE" FILL AREA 147.8 CF/LF
OVER-EXCAVATION 114.3 CF/LF

STA 392+80

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

0' 20'
SCALE: 1"= 20'

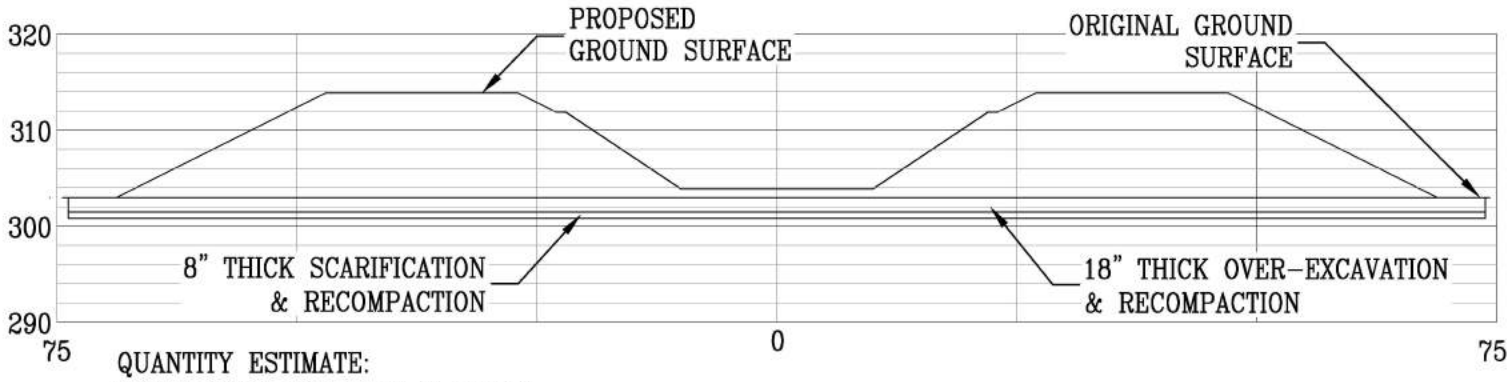
DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
639 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
FAX 559 783-9275

REACH 4

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

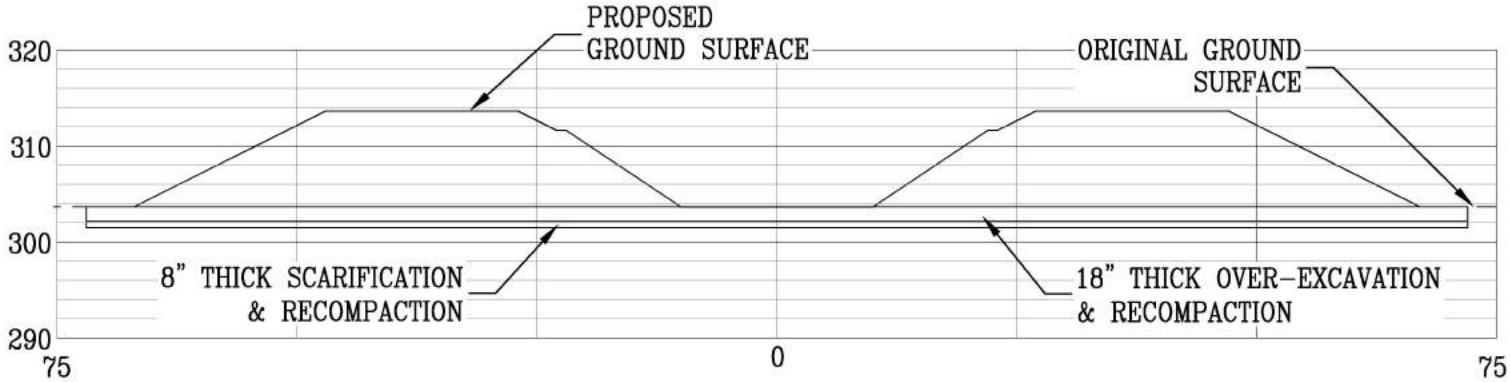
0' 20'
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
639 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
FAX 559 783-9275



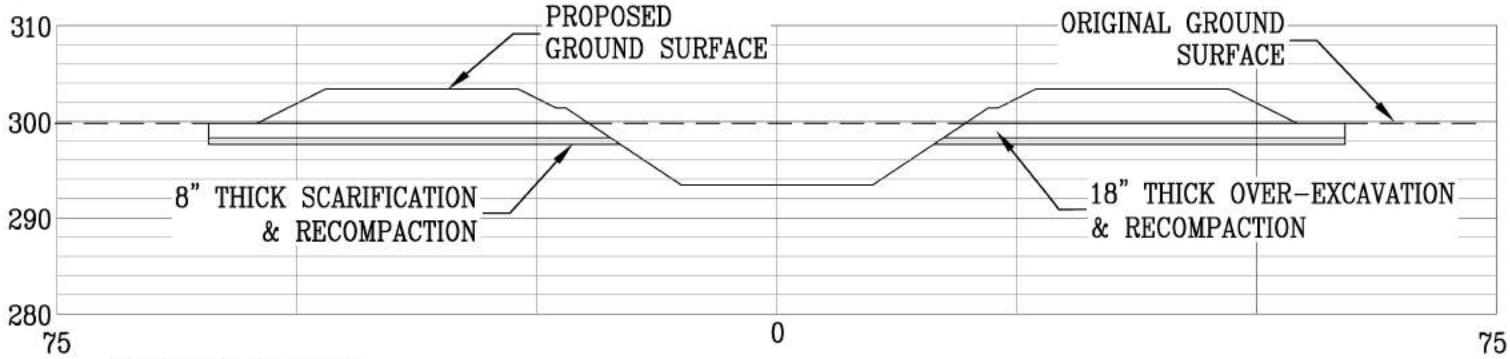
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 906.2 CF/LF
OVER-EXCAVATION 221.4 CF/LF

STA 393+60



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 781.7 CF/LF
OVER-EXCAVATION 215.9 CF/LF

STA 406+00



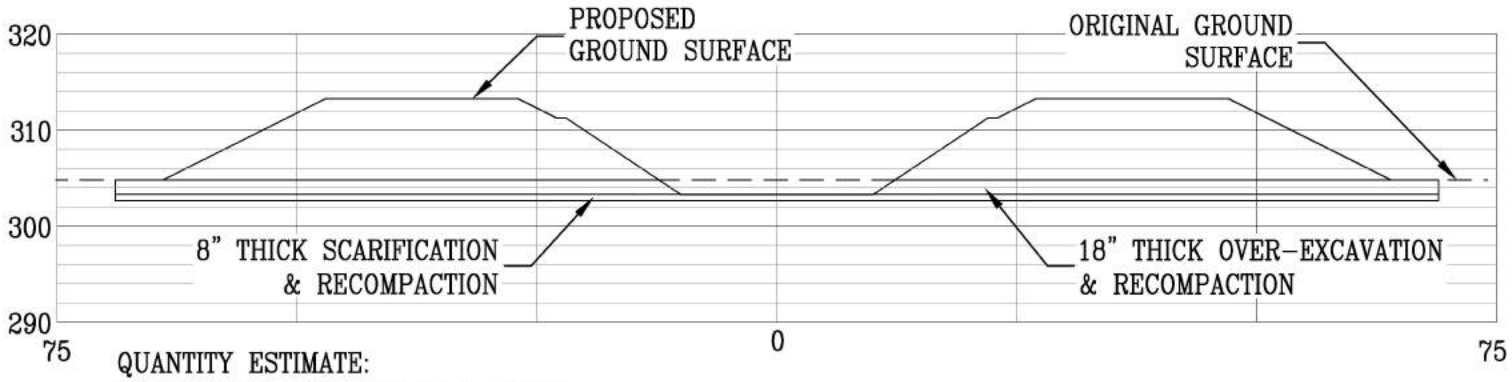
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 189.4 CF/LF
"NEAT LINE" FILL AREA 197.8 CF/LF
OVER-EXCAVATION 122.2 CF/LF

STA 416+00

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

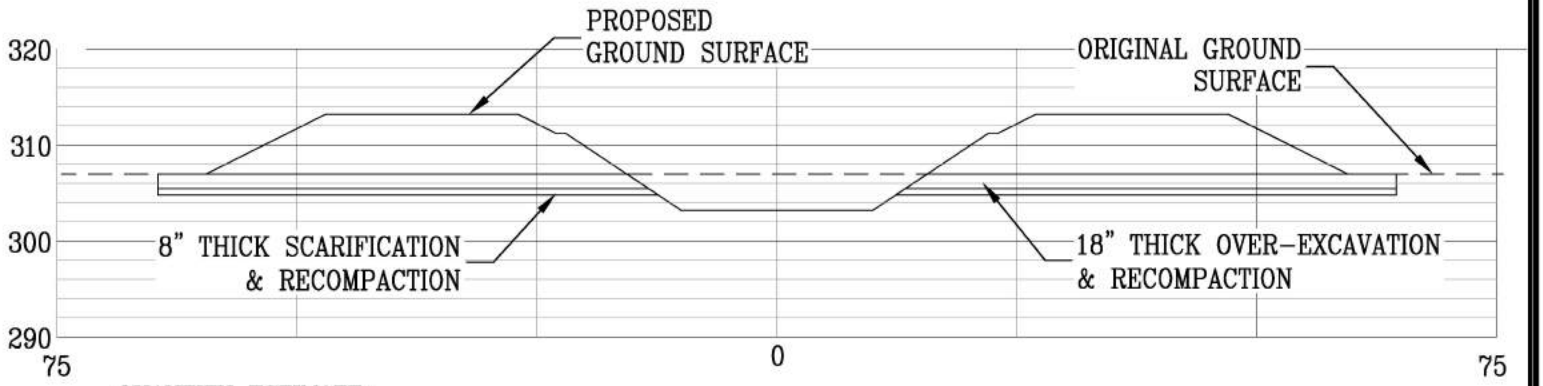
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
639 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
FAX 559 783-9275



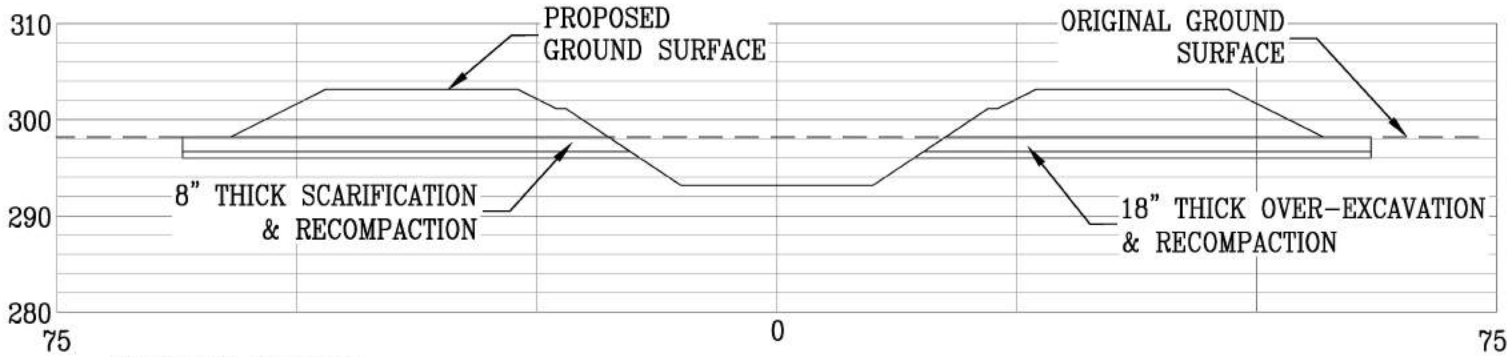
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 34.4 CF/LF
"NEAT LINE" FILL AREA 616.7 CF/LF
OVER-EXCAVATION 161.2 CF/LF

STA 426+00



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 96.1 CF/LF
"NEAT LINE" FILL AREA 405.7 CF/LF
OVER-EXCAVATION 150.0 CF/LF

STA 436+00



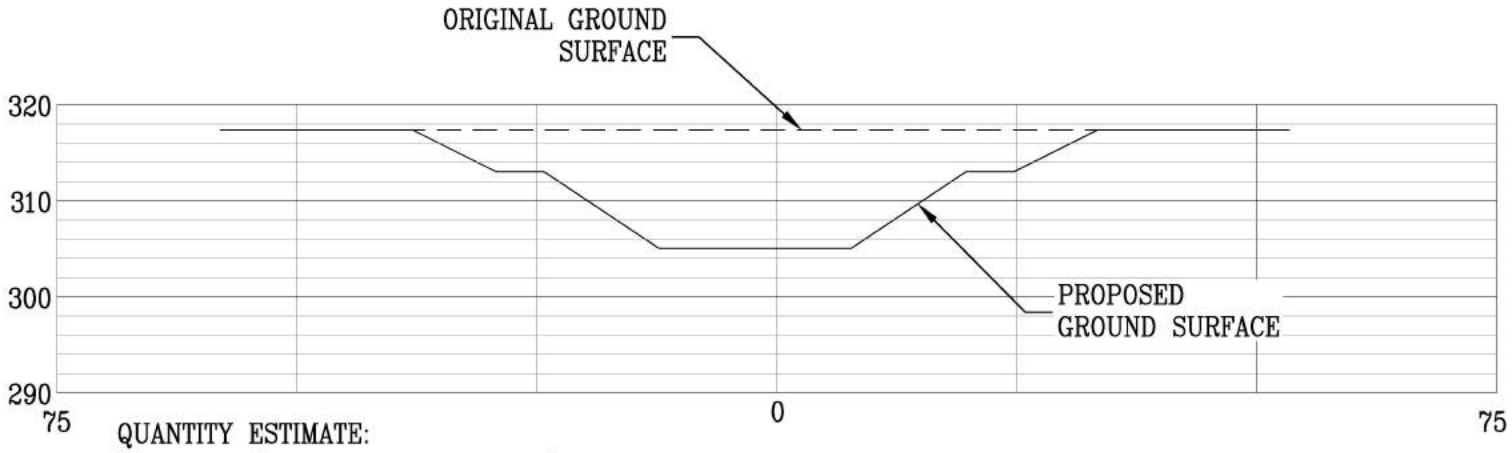
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 139.3 CF/LF
"NEAT LINE" FILL AREA 297.6 CF/LF
OVER-EXCAVATION 136.4 CF/LF

STA 446+00

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
639 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
FAX 559 783-9275



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 528.7 CF/LF
"NEAT LINE" FILL AREA 0 CF/LF
OVER-EXCAVATION 0 CF/LF

STA 464+00

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

0' 20'
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CALIFORNIA 93308
PHONE 661 393-4796
FAX 661 393-4799
639 N. MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
FAX 559 783-9275

Appendix B
Quantity Calculations

IRVINE RANCH / ROSEDALE RIO BRAVO WATER STORAGE DISTRICT

KERN FAN GROUNDWATER STORAGE PROJECT - CONVEYANCE CHANNEL (1.5:1 SLOPES)

EARTHWORK VOLUME CALCULATIONS

			END AREA		AVG END AREA		VOLUME	
STATION	**DESC**	**DIST**	**CUT (ft2)**	**FILL (ft2)**	**CUT (ft2)**	**FILL (ft2)**	**CUT (yd3)**	**FILL (yd3)**
-	BEGIN CANAL		112.1	362.7				
		604			389.9	181.4	8,722	4,057
604			667.7	-				
		600			333.9	503.9	7,419	11,197
1,204			-	1,007.7				
		600			-	957.0	-	21,266
1,804			-	906.2				
		1,000			-	878.9	-	32,550
2,804			-	851.5				
		1,000			-	878.9	-	32,550
3,804			-	906.2				
		1,000			-	913.1	-	33,819
4,804			-	920.0				
		1,000			-	940.8	-	34,844
5,804			-	961.6				
		1,000			-	899.8	-	33,324
6,804			-	837.9				
		1,000			-	858.4	-	31,791
7,804			-	878.8				
		776			201.8	439.4	5,798	12,629
8,580	BEGIN SIPHON		403.5	-				
8,900	END SIPHON		236.5	122.8				
		1,055			258.9	96.9	10,116	3,786
9,955			281.3	71.0				
		1,020			254.3	103.7	9,605	3,918
10,975			227.2	136.4				
		1,000			241.6	116.2	8,948	4,304
11,975			256.0	96.0				
		1,035			397.8	48.0	15,247	1,840
13,010	BEGIN SIPHON		539.5	-				
13,335	END SIPHON		248.6	106.0				
		525			248.6	106.0	4,834	2,061
13,860	BEGIN SIPHON		248.6	106.0				
14,185	END SIPHON		297.6	56.2				
		75			297.6	56.2	827	156
14,260	PP#1 FOREBAY		297.6	56.2				
					REACH 1 SUBTOTAL		71,517	264,090
14,340	PP#1 AFTERBAY		-	865.1				
		1,000			48.1	635.4	1,780	23,533
15,340			96.1	405.7				
		1,000			172.8	255.3	6,398	9,454
16,340			249.4	104.8				
		1,000			124.7	475.9	4,619	17,626
17,340			-	847.0				
		1,000			-	913.5	-	33,831
18,340			-	979.9				
		1,000			-	1,015.7	-	37,619
19,340			-	1,051.5				
		1,000			27.0	795.8	998	29,472
20,340			53.9	540.0				
		1,430			75.0	472.9	3,972	25,044
21,770	BEGIN SIPHON		96.1	405.7				

			END AREA		AVG END AREA		VOLUME	
STATION	**DESC**	**DIST**	**CUT (ft2)**	**FILL (ft2)**	**CUT (ft2)**	**FILL (ft2)**	**CUT (yd3)**	**FILL (yd3)**
22,190	END SIPHON		99.2	397.0				
		1,040			184.4	239.6	7,103	9,229
23,230			269.6	82.2				
		1,000			295.2	59.6	10,931	2,206
24,230			320.7	36.9				
		1,040			352.6	18.5	13,582	711
25,270	BEGIN SIPHON		384.5	-				
25,690	END SIPHON		511.0	-				
		1,030			511.0	-	19,494	-
26,720	PP#2 FOREBAY		511.0	-				
					REACH 2 SUBTOTAL		68,876	188,724
26,700	PP#2 AFTERBAY		22.7	668.2				
		1,100			28.1	644.5	1,143	26,257
27,800			33.4	620.8				
		1,000			128.6	381.1	4,763	14,115
28,800			223.8	141.4				
		1,000			275.2	86.8	10,193	3,215
29,800			326.6	32.2				
		1,000			194.4	271.7	7,198	10,063
30,800			62.1	511.2				
		1,000			68.6	480.0	2,539	17,778
31,800			75.0	448.8				
		1,000			84.8	429.5	3,139	15,906
32,800			94.5	410.1				
		1,000			93.0	414.6	3,443	15,354
33,800			91.4	419.0				
		1,000			121.6	344.8	4,502	12,770
34,800			151.7	270.6				
		1,000			142.0	292.0	5,259	10,815
35,800			132.3	313.4				
		1,000			163.9	250.4	6,069	9,274
36,800			195.4	187.4				
		1,000			208.6	166.0	7,726	6,148
37,800			221.8	144.6				
		1,480			220.8	146.2	12,100	8,014
39,280	PP#3 FOREBAY		219.7	147.8				
					REACH 3 SUBTOTAL		68,073	149,708
39,360	PP#3 AFTER BAY		-	906.2				
		1,240			-	844.0	-	38,759
40,600			-	781.7				
		1,000			94.7	489.8	3,507	18,139
41,600			189.4	197.8				
		1,000			111.9	407.3	4,144	15,083
42,600			34.4	616.7				
		1,000			65.3	511.2	2,417	18,933
43,600			96.1	405.7				
		1,000			117.7	351.7	4,359	13,024
44,600			139.3	297.6				
		1,800			320.0	148.8	21,333	9,920
46,400			528.7	-				
					REACH 4 SUBTOTAL		35,761	113,859
						TOTALS	244,227	716,381

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
3701 PEGASUS DRIVE, SUITE 121
BAKERSFIELD, CALIFORNIA 93308
PHONE 805 393-4796
FAX 805 393-4799

IRVINE RANCH / ROSEDALE RIO BRAVO WATER STORAGE DISTRICT

KERN FAN GROUNDWATER STORAGE PROJECT - SUBGRADE PREPARATION (1.5:1 SLOPE)

EARTHWORK VOLUME CALCULATIONS

			END AREA		AVG END AREA		VOLUME	
STATION	**DESC**	**DIST**	**CUT (ft2)**	**FILL (ft2)**	**CUT (ft2)**	**FILL (ft2)**	**CUT (yd3)**	**FILL (yd3)**
-	BEGIN CANAL		144.8	144.8				
		604			72.4	72.4	1,620	1,620
604			-	-				
		600			112.9	112.9	2,509	2,509
1,204			225.8	225.8				
		600			223.6	223.6	4,969	4,969
1,804			221.4	221.4				
		1,000			220.2	220.2	8,156	8,156
2,804			219.0	219.0				
		1,000			220.2	220.2	8,156	8,156
3,804			221.4	221.4				
		1,000			221.7	221.7	8,211	8,211
4,804			222.0	222.0				
		1,000			222.9	222.9	8,256	8,256
5,804			223.8	223.8				
		1,000			221.1	221.1	8,189	8,189
6,804			218.4	218.4				
		1,000			219.3	219.3	8,122	8,122
7,804			220.2	220.2				
		776			110.1	110.1	3,164	3,164
8,580	BEGIN SIPHON		-	-				
8,900	END SIPHON		110.1	110.1				
		1,055			55.1	55.1	2,151	2,151
9,955			-	-				
		1,020			56.2	56.2	2,123	2,123
10,975			112.4	112.4				
		1,000			108.9	108.9	4,033	4,033
11,975			105.4	105.4				
		1,035			52.7	52.7	2,020	2,020
13,010	BEGIN SIPHON		-	-				
13,335	END SIPHON		107.2	107.2				
		525			107.2	107.2	2,084	2,084
13,860	BEGIN SIPHON		107.2	107.2				
14,185	END SIPHON		-	-				
		75			-	-	-	-
14,260	PP#1 FOREBAY		-	-				
					REACH 1 SUBTOTAL		73,763	73,763
14,340	PP#1 AFTERBAY		219.6	219.6				
		1,000			184.8	184.8	6,844	6,844
15,340			150.0	150.0				
		1,000			128.5	128.5	4,759	4,759
16,340			107.0	107.0				
		1,000			163.0	163.0	6,035	6,035
17,340			218.9	218.9				
		1,000			221.8	221.8	8,213	8,213
18,340			224.6	224.6				
		1,000			226.0	226.0	8,370	8,370
19,340			227.4	227.4				
		1,000			196.3	196.3	7,270	7,270
20,340			165.2	165.2				
		1,430			157.6	157.6	8,347	8,347
21,770	BEGIN SIPHON		150.0	150.0				

			END AREA		AVG END AREA		VOLUME	
STATION	**DESC**	**DIST**	**CUT (ft2)**	**FILL (ft2)**	**CUT (ft2)**	**FILL (ft2)**	**CUT (yd3)**	**FILL (yd3)**
22,190	END SIPHON		149.0	149.0				
		1,040			74.5	74.5	2,870	2,870
23,230			-	-				
		1,000			-	-	-	-
24,230			-	-				
		1,040			-	-	-	-
25,270	BEGIN SIPHON		-	-				
25,690	END SIPHON		-	-				
		1,030			-	-	-	-
26,720	PP#2 FOREBAY		-	-				
					REACH 2 SUBTOTAL		52,709	52,709
26,700	PP#2 AFTERBAY		187.0	187.0				
		1,100			180.4	180.4	7,350	7,350
27,800			173.8	173.8				
		1,000			143.5	143.5	5,315	5,315
28,800			113.2	113.2				
		1,000			56.6	56.6	2,096	2,096
29,800			-	-				
		1,000			81.0	81.0	3,000	3,000
30,800			162.0	162.0				
		1,000			161.7	161.7	5,989	5,989
31,800			161.4	161.4				
		1,000			156.0	156.0	5,776	5,776
32,800			150.5	150.5				
		1,000			151.1	151.1	5,594	5,594
33,800			151.6	151.6				
		1,000			142.1	142.1	5,263	5,263
34,800			132.6	132.6				
		1,000			135.5	135.5	5,019	5,019
35,800			138.4	138.4				
		1,000			129.5	129.5	4,796	4,796
36,800			120.6	120.6				
		1,000			112.2	112.2	4,156	4,156
37,800			103.8	103.8				
		1,480			109.1	109.1	5,978	5,978
39,280	PP#3 FOREBAY		114.3	114.3				
					REACH 3 SUBTOTAL		60,331	60,331
39,360	PP#3 AFTER BAY		221.4	221.4				
		1,240			218.7	218.7	10,042	10,042
40,600			215.9	215.9				
		1,000			169.1	169.1	6,261	6,261
41,600			122.2	122.2				
		1,000			141.7	141.7	5,248	5,248
42,600			161.2	161.2				
		1,000			155.6	155.6	5,763	5,763
43,600			150.0	150.0				
		1,000			143.2	143.2	5,304	5,304
44,600			136.4	136.4				
		1,800			68.2	68.2	4,547	4,547
46,400			-	-				
					REACH 4 SUBTOTAL		37,164	37,164
						TOTALS	223,967	223,967

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
3701 PEGASUS DRIVE, SUITE 121
BAKERSFIELD, CALIFORNIA 93308
PHONE 805 393-4796
FAX 805 393-4799

IRVINE RANCH / ROSEDALE RIO BRAVO WATER STORAGE DISTRICT

KERN FAN GROUNDWATER STORAGE PROJECT - CONVEYANCE CANAL (EARTHLINED 3:1 SLOPES)

EARTHWORK VOLUME CALCULATIONS

			END AREA		AVG END AREA		VOLUME	
STATION	**DESC**	**DIST**	**CUT (ft2)**	**FILL (ft2)**	**CUT (ft2)**	**FILL (ft2)**	**CUT (yd3)**	**FILL (yd3)**
-	BEGIN CANAL		242.2	383.8				
		604			688.6	191.9	15,403	4,293
604			1,134.9	-				
		600			571.4	559.1	12,697	12,424
1,204			7.8	1,118.2				
		600			16.7	1,063.3	371	23,628
1,804			25.6	1,008.3				
		1,000			31.2	979.3	1,156	36,270
2,804			36.8	950.3				
		1,000			31.2	979.3	1,156	36,270
3,804			25.6	1,008.3				
		1,000			24.3	1,015.7	900	37,617
4,804			23.0	1,023.0				
		1,000			19.3	1,045.5	713	38,720
5,804			15.5	1,067.9				
		1,000			27.6	1,002.0	1,022	37,109
6,804			39.7	936.0				
		1,000			35.4	957.5	1,311	35,463
7,804			31.1	979.0				
		776			384.3	489.5	11,045	14,069
8,580	BEGIN SIPHON		737.5	-				
8,900	END SIPHON		464.6	123.1				
		1,055			503.2	97.1	19,662	3,792
9,955			541.8	71.0				
		1,020			494.8	104.1	18,691	3,931
10,975			447.7	137.1				
		1,000			473.9	116.6	17,550	4,317
11,975			500.0	96.0				
		1,035			722.8	48.0	27,705	1,840
13,010	BEGIN SIPHON		945.5	-				
13,335	END SIPHON		486.5	106.0				
		525			486.5	106.0	9,460	2,061
13,860	BEGIN SIPHON		486.5	106.0				
14,185	END SIPHON		568.6	56.2				
		75			568.7	56.2	1,580	156
14,260	PP#1 FOREBAY		568.8	56.2				
					REACH 1 SUBTOTAL		140,421	291,960
14,340	PP#1 AFTERBAY		33.9	964.6				
		1,000			124.1	698.7	4,594	25,878
15,340			214.2	432.8				
		1,000			351.2	268.8	13,006	9,956
16,340			488.1	104.8				
		1,000			262.8	525.7	9,733	19,470
17,340			37.5	946.6				
		1,000			25.0	1,017.1	924	37,670
18,340			12.4	1,087.6				
		1,000			6.2	1,127.1	230	41,743
19,340			-	1,166.5				
		1,000			70.8	877.8	2,620	32,511
20,340			141.5	589.1				
		1,430			177.9	511.0	9,419	27,061
21,770	BEGIN SIPHON		214.2	432.8				

			END AREA		AVG END AREA		VOLUME	
STATION	**DESC**	**DIST**	**CUT (ft2)**	**FILL (ft2)**	**CUT (ft2)**	**FILL (ft2)**	**CUT (yd3)**	**FILL (yd3)**
22,190	END SIPHON		219.8	422.8				
		1,040			371.2	252.5	14,298	9,726
23,230			522.6	82.2				
		1,000			564.4	59.3	20,902	2,196
24,230			606.1	36.4				
		1,040			656.9	18.2	25,303	701
25,270	BEGIN SIPHON		707.7	-				
25,690	END SIPHON		902.6	-				
		1,030			902.6	-	34,433	-
26,720	PP#2 FOREBAY		902.6	-				
					REACH 2 SUBTOTAL		135,462	206,912
26,700	PP#2 AFTERBAY		88.9	740.6				
		1,100			97.9	712.4	3,986	29,024
27,800			106.8	684.2				
		1,000			274.3	413.3	10,157	15,306
28,800			441.7	142.3				
		1,000			528.7	87.3	19,580	3,231
29,800			615.6	32.2				
		1,000			385.6	293.6	14,280	10,874
30,800			155.5	555.0				
		1,000			166.5	530.3	6,167	19,641
31,800			177.5	505.6				
		1,000			194.5	471.7	7,204	17,470
32,800			211.5	437.8				
		1,000			208.8	442.9	7,733	16,404
33,800			206.1	448.0				
		1,000			259.2	364.3	9,600	13,493
34,800			312.3	280.6				
		1,000			295.1	304.5	10,928	11,276
35,800			277.8	328.3				
		1,000			334.1	259.5	12,372	9,609
36,800			390.3	190.6				
		1,000			414.1	168.1	15,337	6,226
37,800			437.9	145.6				
		1,480			436.1	147.3	23,902	8,071
39,280	PP#3 FOREBAY		434.2	148.9				
					REACH 3 SUBTOTAL		141,246	160,625
39,360	PP#3 AFTER BAY		25.6	1,008.2				
		1,240			39.1	942.7	1,796	43,294
40,600			52.6	877.2				
		1,000			216.2	539.4	8,006	19,978
41,600			379.7	201.6				
		1,000			244.1	440.5	9,039	16,315
42,600			108.4	679.4				
		1,000			161.3	556.1	5,974	20,596
43,600			214.2	432.8				
		1,000			252.2	371.7	9,339	13,767
44,600			290.1	310.6				
		1,800			320.0	155.3	21,333	10,353
46,400			929.3	-				
					REACH 4 SUBTOTAL		55,486	124,303
						TOTALS	472,615	783,801

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
3701 PEGASUS DRIVE, SUITE 121
BAKERSFIELD, CALIFORNIA 93308
PHONE 805 393-4756
FAX 805 393-4799

IRVINE RANCH / ROSEDALE RIO BRAVO WATER STORAGE DISTRICT								
KERN FAN GROUNDWATER STORAGE PROJECT - SUBGRADE PREPARATION (3:1 SLOPE)								
EARTHWORK VOLUME CALCULATIONS								
			END AREA		AVG END AREA		VOLUME	
STATION	DESC	DIST	CUT (ft2)	FILL (ft2)	CUT (ft2)	FILL (ft2)	CUT (yd3)	FILL (yd3)
-	BEGIN CANAL		265.0	165.0				
		604			132.5	82.5	2,964	1,846
604			-	-				
		600			136.0	136.0	3,022	3,022
1,204			272.0	272.0				
		600			260.9	260.9	5,798	5,798
1,804			249.8	249.8				
		1,000			243.1	243.1	9,002	9,002
2,804			236.3	236.3				
		1,000			243.1	243.1	9,002	9,002
3,804			249.8	249.8				
		1,000			251.4	251.4	9,311	9,311
4,804			253.0	253.0				
		1,000			257.7	257.7	9,543	9,543
5,804			262.3	262.3				
		1,000			248.6	248.6	9,206	9,206
6,804			234.8	234.8				
		1,000			239.0	239.0	8,850	8,850
7,804			243.1	243.1				
		776			121.6	121.6	3,493	3,493
8,580	BEGIN SIPHON		-	-				
8,900	END SIPHON		115.5	115.5				
		1,055			57.8	57.8	2,257	2,257
9,955			-	-				
		1,020			59.4	59.4	2,244	2,244
10,975			118.8	118.8				
		1,000			113.8	113.8	4,215	4,215
11,975			108.8	108.8				
		1,035			54.4	54.4	2,085	2,085
13,010	BEGIN SIPHON		-	-				
13,335	END SIPHON		111.3	111.3				
		525			111.3	111.3	2,164	2,164
13,860	BEGIN SIPHON		111.3	111.3				
14,185	END SIPHON		-	-				
		75			-	-	-	-
14,260	PP#1 FOREBAY		-	-				
						REACH 1 SUBTOTAL	83,155	82,037
14,340	PP#1 AFTERBAY		239.7	239.7				
		1,000			206.1	206.1	7,633	7,633
15,340			172.5	172.5				
		1,000			141.8	141.8	5,250	5,250
16,340			111.0	111.0				
		1,000			173.4	173.4	6,422	6,422
17,340			235.8	235.8				
		1,000			251.0	251.0	9,294	9,294
18,340			266.1	266.1				
		1,000			273.3	273.3	10,120	10,120
19,340			280.4	280.4				
		1,000			237.4	237.4	8,791	8,791
20,340			194.3	194.3				
		1,430			183.4	183.4	9,713	9,713
21,770	BEGIN SIPHON		172.5	172.5				

			END AREA		AVG END AREA		VOLUME	
STATION	**DESC**	**DIST**	**CUT (ft2)**	**FILL (ft2)**	**CUT (ft2)**	**FILL (ft2)**	**CUT (yd3)**	**FILL (yd3)**
22,190	END SIPHON		171.0	171.0				
		1,040			85.5	85.5	3,293	3,293
23,230			-	-				
		1,000			-	-	-	-
24,230			-	-				
		1,040			-	-	-	-
25,270	BEGIN SIPHON		-	-				
25,690	END SIPHON		-	-				
		1,030			-	-	-	-
26,720	PP#2 FOREBAY		-	-				
					REACH 2 SUBTOTAL		60,518	60,518
26,700	PP#2 AFTERBAY		213.0	213.0				
		1,100			209.7	209.7	8,541	8,541
27,800			206.3	206.3				
		1,000			163.2	163.2	6,043	6,043
28,800			120.0	120.0				
		1,000			60.0	60.0	2,222	2,222
29,800			-	-				
		1,000			94.9	94.9	3,515	3,515
30,800			189.8	189.8				
		1,000			186.4	186.4	6,904	6,904
31,800			183.0	183.0				
		1,000			178.2	178.2	6,598	6,598
32,800			173.3	173.3				
		1,000			174.1	174.1	6,446	6,446
33,800			174.8	174.8				
		1,000			161.3	161.3	5,974	5,974
34,800			147.8	147.8				
		1,000			151.9	151.9	5,626	5,626
35,800			156.0	156.0				
		1,000			143.3	143.3	5,306	5,306
36,800			130.5	130.5				
		1,000			125.7	125.7	4,654	4,654
37,800			120.8	120.8				
		1,480			121.2	121.2	6,641	6,641
39,280	PP#3 FOREBAY		121.5	121.5				
					REACH 3 SUBTOTAL		68,469	68,469
39,360	PP#3 AFTER BAY		249.8	249.8				
		1,240			239.2	239.2	10,983	10,983
40,600			228.5	228.5				
		1,000			180.7	180.7	6,691	6,691
41,600			132.8	132.8				
		1,000			169.3	169.3	6,269	6,269
42,600			205.7	205.7				
		1,000			189.1	189.1	7,004	7,004
43,600			172.5	172.5				
		1,000			162.8	162.8	6,028	6,028
44,600			153.0	153.0				
		1,800			76.5	76.5	5,100	5,100
46,400			-	-				
					REACH 4 SUBTOTAL		42,074	42,074
						TOTALS	254,216	253,098

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
3701 PEGASUS DRIVE, SUITE 121 PHONE 805 393-4796
BAKERSFIELD, CALIFORNIA 93308 FAX 805 393-4799

Appendix C
Present Worth Analysis

Kern Fan Proje
Earth Lined Can

Alternative No. 1 - Earth Lined Canal (3:1 Side Slopes)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
CAPITAL COST	**$ 56,763,716**																					
O&M COSTS	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year
Recovery Well Pumping Costs [1]	$ -	$ -	$ -	$ -	$ 5,683,819	$ 5,854,333	$ 6,029,963	$ -	$ -	$ -	.	$ -	$ -	$ -	$ 7,638,577	$ 7,867,734	$ 8,103,766	$ -	$ -	$ -	$ -	$ -
Canal Operation Costs[2]	$ 138,200	$ 142,346	$ 3,382,929	$ 151,015	$ 419,019	$ 431,590	$ 444,537	$ 169,969	$ 4,039,394	$ 180,320	$ 185,729	$ 191,301	$ 4,546,374	$ 202,951	$ 563,127	$ 580,020	$ 597,421	$ 228,424	$ 5,428,608	$ 242,335	$ 249,605	$ 257,093
Pump Station No. 1 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 2 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 3 Replacement Costs [4]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Return Water Pump Station Replacement Costs [5]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Liner Replacement or Repairs[6]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Annual Operating Cost	$ 138,200	$ 142,346	$ 3,382,929	$ 151,015	$ 6,102,838	$ 6,285,923	$ 6,474,501	$ 169,969	$ 4,039,394	$ 180,320	$ 185,729	$ 191,301	$ 4,546,374	$ 202,951	$ 8,201,704	$ 8,447,755	$ 8,701,187	$ 228,424	$ 5,428,608	$ 242,335	$ 249,605	$ 257,093
Capital Recovery @ 3.0% / 20yrs.	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ -	$ -
Total Annual Costs	$ 3,953,613	$ 3,957,759	$ 7,198,342	$ 3,966,428	$ 9,918,251	$ 10,101,336	$ 10,289,914	$ 3,985,382	$ 7,854,807	$ 3,995,733	$ 4,001,143	$ 4,006,714	$ 8,361,787	$ 4,018,365	$ 12,017,117	$ 12,263,168	$ 12,516,601	$ 4,043,837	$ 9,244,021	$ 4,057,748	$ 249,605	$ 257,093
Average Monthly Cost	$ 329,468	$ 329,813	$ 599,862	$ 330,536	$ 826,521	$ 841,778	$ 857,493	$ 332,115	$ 654,567	$ 332,978	$ 333,429	$ 333,893	$ 696,816	$ 334,864	$ 1,001,426	$ 1,021,931	$ 1,043,050	$ 336,986	$ 770,335	$ 338,146	$ 20,800	$ 21,424
Equivilant Average Monthly Cost	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ -	$ -
Present Worth of Op. Costs @ 3%	$ 138,200	$ 138,200	$ 3,188,735	$ 138,200	$ 5,422,292	$ 5,422,292	$ 5,422,292	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200	$ 138,200	$ 3,188,735	$ 138,200	$ 5,422,292	$ 5,422,292	$ 5,422,292	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200	$ 138,200
Present Worth of Op. Costs	**$ 140,248,735**																					
Present Worth of Capital + Op. Costs	**$ 197,012,451**																					

[1]Recovery well pumping costs in dry year estimated as $4,902,912 per Section III. for 16 wells and increased for inflation at 3% per year.

[2]Canal operation costs based on 1) Idle Year = O&M Cost Estimate $69,100 per year x 2 due to increased canal maintenance for tumbleweeds and rodent holes; 2) Wet Year = O&M Cost Estimate based on $9,000 per month, $158.33 per month, and $404,296.88 per month for four months plus energy costs for three pump stations each with a 20-ft lift to move 112,500 ac-ft = $1,488,848 plus 8 idle months of $46,067; and 3) Dry Year = O&M Cost Estimate based on $8,000 per mo

[3]Pump Station replacement costs include pump and motor replacement at $2,222,000, VFD's at $700,000, electrical and control equipment at $900,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[4]Pump Station replacement costs include pump and motor replacement at $1,287,000, VFD's at $420,000, electrical and control equipment at $565,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[5]Pump Station replacement costs include pump and motor replacement at $540,000, VFD's at $150,000, electrical and control equipment at $565,000, and cathodic protection at $15,000. Costs increased for inflation at 3% per year.

[6]No liner replacement or repairs as part of the earth lined canal alternative.

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23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069
Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year
$ -	$ -	$ 10,265,609	$ 10,573,577	$ 10,890,785	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 13,796,120	$ 14,210,004	$ 14,636,304	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 18,540,832	$ 19,097,057	$ 19,669,968	$ -	$ -	$ -
$ 6,109,946	$ 272,750	$ 756,795	$ 779,499	$ 802,884	$ 306,982	$ 7,295,595	$ 325,677	$ 335,448	$ 345,511	$ 8,211,257	$ 366,553	$ 1,017,069	$ 1,047,581	$ 1,079,009	$ 412,558	$ 9,804,670	$ 437,683	$ 450,814	$ 464,338	$ 11,035,242	$ 492,616	$ 1,366,856	$ 1,407,862	$ 1,450,098	$ 554,444	$ 13,176,656	$ 588,210
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ 5,350,314	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,202,370
$ -	$ -	$ 2,581,649	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,405,399
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 6,109,946	$ 272,750	$ 34,980,915	$ 11,353,076	$ 11,693,668	$ 306,982	$ 7,295,595	$ 325,677	$ 335,448	$ 345,511	$ 8,211,257	$ 366,553	$ 14,813,189	$ 15,257,585	$ 15,715,312	$ 412,558	$ 9,804,670	$ 437,683	$ 450,814	$ 464,338	$ 11,035,242	$ 492,616	$ 19,907,688	$ 20,504,918	$ 21,120,066	$ 554,444	$ 13,176,656	$ 50,752,012
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 6,109,946	$ 272,750	$ 34,980,915	$ 11,353,076	$ 11,693,668	$ 306,982	$ 7,295,595	$ 325,677	$ 335,448	$ 345,511	$ 8,211,257	$ 366,553	$ 14,813,189	$ 15,257,585	$ 15,715,312	$ 412,558	$ 9,804,670	$ 437,683	$ 450,814	$ 464,338	$ 11,035,242	$ 492,616	$ 19,907,688	$ 20,504,918	$ 21,120,066	$ 554,444	$ 13,176,656	$ 50,752,012
$ 509,162	$ 22,729	$ 2,915,076	$ 946,090	$ 974,472	$ 25,582	$ 607,966	$ 27,140	$ 27,954	$ 28,793	$ 684,271	$ 30,546	$ 1,234,432	$ 1,271,465	$ 1,309,609	$ 34,380	$ 817,056	$ 36,474	$ 37,568	$ 38,695	$ 919,604	$ 41,051	$ 1,658,974	$ 1,708,743	$ 1,760,005	$ 46,204	$ 1,098,055	$ 4,229,334
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 3,188,735	$ 138,200	$ 17,208,292	$ 5,422,292	$ 5,422,292	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200	$ 138,200	$ 3,188,735	$ 138,200	$ 5,422,292	$ 5,422,292	$ 5,422,292	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200	$ 138,200	$ 3,188,735	$ 138,200	$ 5,422,292	$ 5,422,292	$ 5,422,292	$ 138,200	$ 3,188,735	$ 11,924,200

nth, $52.78 per month, and energy cost for Return Water Pump Station for 25-ft lift to move 50,000 ac-ft = $275,660.00. Costs increased for inflation at 3% per year.

Kern Fan Proje

Earth Lined Canal with Ret

Alternative No. 1a - Earth Lined Canal (3:1 Side Slopes) with Return Pipeline	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
CAPITAL COST	**$ 67,282,716**																					
O&M COSTS	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year
Recovery Well Pumping Costs [1]	$ -	$ -	$ -	$ -	$ 4,262,883	$ 4,390,769	$ 4,522,492	$ -	$ -	$ -	.	$ -	$ -	$ -	$ 5,728,958	$ 5,900,827	$ 6,077,851	$ -	$ -	$ -	$ -	$ -
Canal Operation Costs[2]	$ 138,200	$ 142,346	$ 3,382,929	$ 151,015	$ 419,019	$ 431,590	$ 444,537	$ 169,969	$ 4,039,394	$ 180,320	$ 185,729	$ 191,301	$ 4,546,374	$ 202,951	$ 563,127	$ 580,020	$ 597,421	$ 228,424	$ 5,428,608	$ 242,335	$ 249,605	$ 257,093
Pump Station No. 1 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 2 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 3 Replacement Costs [4]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Return Water Pump Station Replacement Costs [5]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Liner Replacement or Repairs[6]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Annual Operating Cost	$ 138,200	$ 142,346	$ 3,382,929	$ 151,015	$ 4,681,902	$ 4,822,359	$ 4,967,029	$ 169,969	$ 4,039,394	$ 180,320	$ 185,729	$ 191,301	$ 4,546,374	$ 202,951	$ 6,292,084	$ 6,480,847	$ 6,675,272	$ 228,424	$ 5,428,608	$ 242,335	$ 249,605	$ 257,093
Capital Recovery @ 3.0% / 20yrs.	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ -	$ -
Total Annual Costs	$ 4,660,655	$ 4,664,801	$ 7,905,384	$ 4,673,470	$ 9,204,357	$ 9,344,814	$ 9,489,485	$ 4,692,424	$ 8,561,849	$ 4,702,775	$ 4,708,185	$ 4,713,756	$ 9,068,829	$ 4,725,407	$ 10,814,540	$ 11,003,302	$ 11,197,728	$ 4,750,879	$ 9,951,063	$ 4,764,790	$ 249,605	$ 257,093
Average Monthly Cost	$ 388,388	$ 388,733	$ 658,782	$ 389,456	$ 767,030	$ 778,735	$ 790,790	$ 391,035	$ 713,487	$ 391,898	$ 392,349	$ 392,813	$ 755,736	$ 393,784	$ 901,212	$ 916,942	$ 933,144	$ 395,907	$ 829,255	$ 397,066	$ 20,800	$ 21,424
Equivilant Average Monthly Cost	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ -	$ -
Present Worth of Op. Costs @ 3%	$ 138,200	$ 138,200	$ 3,188,735	$ 138,200	$ 4,159,809	$ 4,159,809	$ 4,159,809	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200	$ 138,200	$ 3,188,735	$ 138,200	$ 4,159,809	$ 4,159,809	$ 4,159,809	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200	$ 138,200
Present Worth of Op. Costs	**$ 121,311,485**																					
Present Worth of Capital + Op. Costs	**$ 188,594,201**																					

[1]Recovery well pumping costs in dry year estimated as $3,677,184 per Section III. for 12 wells due to pipeline and increased for inflation at 3% per year.

[2]Canal operation costs based on 1) Idle Year = O&M Cost Estimate $69,100 per year x 2 due to increased canal maintenance for tumbleweeds and rodent holes; 2) Wet Year = O&M Cost Estimate based on $9,000 per month, $158.33 per month, and $404,296.88 per month for four months plus energy costs for three pump stations each with a 20-ft lift to move 112,500 ac-ft = $1,488,848 plus 8 idle months of $46,067; and 3) Dry Year = O&M Cost Estimate based on $8,000 per mo

[3]Pump Station replacement costs include pump and motor replacement at $2,222,000, VFD's at $700,000, electrical and control equipment at $900,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[4]Pump Station replacement costs include pump and motor replacement at $1,287,000, VFD's at $420,000, electrical and control equipment at $565,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[5]Pump Station replacement costs include pump and motor replacement at $540,000, VFD's at $150,000, electrical and control equipment at $565,000, and cathodic protection at $15,000. Costs increased for inflation at 3% per year.

[6]No liner replacement or repairs as part of the earth lined canal alternative.

ct

turn Pipeline

23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069
Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year
$ -	$ -	$ 7,699,240	$ 7,930,217	$ 8,168,124	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,347,135	$ 10,657,549	$ 10,977,276	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 13,905,684	$ 14,322,855	$ 14,752,540	$ -	$ -	$ -
$ 6,109,946	$ 272,750	$ 756,795	$ 779,499	$ 802,884	$ 306,982	$ 7,295,595	$ 325,677	$ 335,448	$ 345,511	$ 8,211,257	$ 366,553	$ 1,017,069	$ 1,047,581	$ 1,079,009	$ 412,558	$ 9,804,670	$ 437,683	$ 450,814	$ 464,338	$ 11,035,242	$ 492,616	$ 1,366,856	$ 1,407,862	$ 1,450,098	$ 554,444	$ 13,176,656	$ 588,210
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ 5,350,314	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,202,370
$ -	$ -	$ 2,581,649	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,405,399
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 6,109,946	$ 272,750	$ 32,414,547	$ 8,709,716	$ 8,971,008	$ 306,982	$ 7,295,595	$ 325,677	$ 335,448	$ 345,511	$ 8,211,257	$ 366,553	$ 11,364,204	$ 11,705,130	$ 12,056,284	$ 412,558	$ 9,804,670	$ 437,683	$ 450,814	$ 464,338	$ 11,035,242	$ 492,616	$ 15,272,540	$ 15,730,716	$ 16,202,638	$ 554,444	$ 13,176,656	$ 50,752,012
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 6,109,946	$ 272,750	$ 32,414,547	$ 8,709,716	$ 8,971,008	$ 306,982	$ 7,295,595	$ 325,677	$ 335,448	$ 345,511	$ 8,211,257	$ 366,553	$ 11,364,204	$ 11,705,130	$ 12,056,284	$ 412,558	$ 9,804,670	$ 437,683	$ 450,814	$ 464,338	$ 11,035,242	$ 492,616	$ 15,272,540	$ 15,730,716	$ 16,202,638	$ 554,444	$ 13,176,656	$ 50,752,012
$ 509,162	$ 22,729	$ 2,701,212	$ 725,810	$ 747,584	$ 25,582	$ 607,966	$ 27,140	$ 27,954	$ 28,793	$ 684,271	$ 30,546	$ 947,017	$ 975,428	$ 1,004,690	$ 34,380	$ 817,056	$ 36,474	$ 37,568	$ 38,695	$ 919,604	$ 41,051	$ 1,272,712	$ 1,310,893	$ 1,350,220	$ 46,204	$ 1,098,055	$ 4,229,334
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 3,188,735	$ 138,200	$ 15,945,809	$ 4,159,809	$ 4,159,809	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200	$ 138,200	$ 3,188,735	$ 138,200	$ 4,159,809	$ 4,159,809	$ 4,159,809	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200	$ 138,200	$ 3,188,735	$ 138,200	$ 4,159,809	$ 4,159,809	$ 4,159,809	$ 138,200	$ 3,188,735	$ 11,924,200

nth, $52.78 per month, and energy cost for Return Water Pump Station for 25-ft lift to move 50,000 ac-ft = $275,660.00. Costs increased for inflation at 3% per year.

Kern Fan Proje

Earth Lined Canal with Ber

Alternative No. 1b - Earth Lined Canal (3:1 Side Slopes) with Bentonite Liner	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
CAPITAL COST	**$ 71,898,932**																					
O&M COSTS	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year
Recovery Well Pumping Costs [1]	$ -	$ -	$ -	$ -	$ 4,973,341	$ 5,122,542	$ 5,276,218	$ -	$ -	$ -	.	$ -	$ -	$ -	$ 6,683,755	$ 6,884,268	$ 7,090,796	$ -	$ -	$ -	$ -	$ -
Canal Operation Costs[2]	$ 138,200	$ 142,346	$ 3,382,929	$ 151,015	$ 419,019	$ 431,590	$ 444,537	$ 169,969	$ 4,039,394	$ 180,320	$ 185,729	$ 191,301	$ 4,546,374	$ 202,951	$ 563,127	$ 580,020	$ 597,421	$ 228,424	$ 5,428,608	$ 242,335	$ 249,605	$ 257,093
Pump Station No. 1 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 2 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 3 Replacement Costs [4]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Return Water Pump Station Replacement Costs [5]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Liner Replacement or Repairs[6]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Annual Operating Cost	$ 138,200	$ 142,346	$ 3,382,929	$ 151,015	$ 5,392,360	$ 5,554,131	$ 5,720,755	$ 169,969	$ 4,039,394	$ 180,320	$ 185,729	$ 191,301	$ 4,546,374	$ 202,951	$ 7,246,882	$ 7,464,288	$ 7,688,217	$ 228,424	$ 5,428,608	$ 242,335	$ 249,605	$ 257,093
Capital Recovery @ 3.0% / 20yrs.	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ -	$ -
Total Annual Costs	$ 4,970,938	$ 4,975,084	$ 8,215,667	$ 4,983,752	$ 10,225,098	$ 10,386,869	$ 10,553,493	$ 5,002,706	$ 8,872,132	$ 5,013,057	$ 5,018,467	$ 5,024,039	$ 9,379,111	$ 5,035,689	$ 12,079,619	$ 12,297,026	$ 12,520,954	$ 5,061,161	$ 10,261,345	$ 5,075,072	$ 249,605	$ 257,093
Average Monthly Cost	$ 414,245	$ 414,590	$ 684,639	$ 415,313	$ 852,092	$ 865,572	$ 879,458	$ 416,892	$ 739,344	$ 417,755	$ 418,206	$ 418,670	$ 781,593	$ 419,641	$ 1,006,635	$ 1,024,752	$ 1,043,413	$ 421,763	$ 855,112	$ 422,923	$ 20,800	$ 21,424
Equivilant Average Monthly Cost	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ -	$ -
Present Worth of Op. Costs @ 3%	$ 138,200	$ 138,200	$ 3,188,735	$ 138,200	$ 4,791,042	$ 4,791,042	$ 4,791,042	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200	$ 138,200	$ 3,188,735	$ 138,200	$ 4,791,042	$ 4,791,042	$ 4,791,042	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200	$ 138,200
Present Worth of Op. Costs	**$ 130,779,987**																					
Present Worth of Capital + Op. Costs	**$ 202,678,919**																					

[1]Recovery well pumping costs in dry year estimated as $4,290,048 per Section III. for 14 wells and increased for inflation at 3% per year.

[2]Canal operation costs based on 1) Idle Year = O&M Cost Estimate $69,100 per year x 2 due to increased canal maintenance for tumbleweeds and rodent holes; 2) Wet Year = O&M Cost Estimate based on $9,000 per month, $158.33 per month, and $404,296.88 per month for four months plus energy costs for three pump stations each with a 20-ft lift to move 112,500 ac-ft = $1,488,848 plus 8 idle months of $46,067; and 3) Dry Year = O&M Cost Estimate based on $8,000 per mo

[3]Pump Station replacement costs include pump and motor replacement at $2,222,000, VFD's at $700,000, electrical and control equipment at $900,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[4]Pump Station replacement costs include pump and motor replacement at $1,287,000, VFD's at $420,000, electrical and control equipment at $565,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[5]Pump Station replacement costs include pump and motor replacement at $540,000, VFD's at $150,000, electrical and control equipment at $565,000, and cathodic protection at $15,000. Costs increased for inflation at 3% per year.

[6]No liner replacement or repairs as part of the earth lined canal alternative.

ct
ntonite Liner

23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069
Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year
$ -	$ -	$ 8,982,408	$ 9,251,880	$ 9,529,436	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 12,071,605	$ 12,433,753	$ 12,806,766	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,223,228	$ 16,709,925	$ 17,211,222	$ -	$ -	$ -
$ 6,109,946	$ 272,750	$ 756,795	$ 779,499	$ 802,884	$ 306,982	$ 7,295,595	$ 325,677	$ 335,448	$ 345,511	$ 8,211,257	$ 366,553	$ 1,017,069	$ 1,047,581	$ 1,079,009	$ 412,558	$ 9,804,670	$ 437,683	$ 450,814	$ 464,338	$ 11,035,242	$ 492,616	$ 1,366,856	$ 1,407,862	$ 1,450,098	$ 554,444	$ 13,176,656	$ 588,210
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ 5,350,314	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,202,370
$ -	$ -	$ 2,581,649	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,405,399
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 6,109,946	$ 272,750	$ 33,697,714	$ 10,031,379	$ 10,332,320	$ 306,982	$ 7,295,595	$ 325,677	$ 335,448	$ 345,511	$ 8,211,257	$ 366,553	$ 13,088,674	$ 13,481,334	$ 13,885,774	$ 412,558	$ 9,804,670	$ 437,683	$ 450,814	$ 464,338	$ 11,035,242	$ 492,616	$ 17,590,084	$ 18,117,786	$ 18,661,320	$ 554,444	$ 13,176,656	$ 50,752,012
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 6,109,946	$ 272,750	$ 33,697,714	$ 10,031,379	$ 10,332,320	$ 306,982	$ 7,295,595	$ 325,677	$ 335,448	$ 345,511	$ 8,211,257	$ 366,553	$ 13,088,674	$ 13,481,334	$ 13,885,774	$ 412,558	$ 9,804,670	$ 437,683	$ 450,814	$ 464,338	$ 11,035,242	$ 492,616	$ 17,590,084	$ 18,117,786	$ 18,661,320	$ 554,444	$ 13,176,656	$ 50,752,012
$ 509,162	$ 22,729	$ 2,808,143	$ 835,948	$ 861,027	$ 25,582	$ 607,966	$ 27,140	$ 27,954	$ 28,793	$ 684,271	$ 30,546	$ 1,090,723	$ 1,123,445	$ 1,157,148	$ 34,380	$ 817,056	$ 36,474	$ 37,568	$ 38,695	$ 919,604	$ 41,051	$ 1,465,840	$ 1,509,816	$ 1,555,110	$ 46,204	$ 1,098,055	$ 4,229,334
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 3,188,735	$ 138,200	$ 16,577,042	$ 4,791,042	$ 4,791,042	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200	$ 138,200	$ 3,188,735	$ 138,200	$ 4,791,042	$ 4,791,042	$ 4,791,042	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200	$ 138,200	$ 3,188,735	$ 138,200	$ 4,791,042	$ 4,791,042	$ 4,791,042	$ 138,200	$ 3,188,735	$ 11,924,200

nth, $52.78 per month, and energy cost for Return Water Pump Station for 25-ft lift to move 50,000 ac-ft = $275,660.00. Costs increased for inflation at 3% per year.

Kern Fan Proje
Poly Lined Can

Alternative No. 2/3 - HDPE Lined Canal or RPE Lined Canal	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
CAPITAL COST	**$ 60,291,545**																					
O&M COSTS	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year
Recovery Well Pumping Costs [1]	$ -	$ -	$ -	$ -	$ 4,262,883	$ 4,390,769	$ 4,522,492	$ -	$ -	$ -	.	$ -	$ -	$ -	$ 5,728,958	$ 5,900,827	$ 6,077,851	$ -	$ -	$ -	$ -	$ -
Canal Operation Costs[2]	$ 69,100	$ 71,173	$ 3,382,929	$ 75,507	$ 419,019	$ 431,590	$ 444,537	$ 84,984	$ 4,039,394	$ 90,160	$ 92,865	$ 95,651	$ 4,546,374	$ 101,476	$ 563,127	$ 580,020	$ 597,421	$ 114,212	$ 5,428,608	$ 121,167	$ 124,802	$ 128,546
Pump Station No. 1 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 2 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 3 Replacement Costs [4]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Return Water Pump Station Replacement Costs [5]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Liner Replacement or Repairs[6]	$ -	$ -	$ -	$ -	$ 28,982	$ -	$ -	$ -	$ -	$ 33,598	.	$ -	$ -	$ -	$ 38,949	$ -	$ -	$ -	$ -	$ -	$ 9,647,163	$ -
Total Annual Operating Cost	$ 69,100	$ 71,173	$ 3,382,929	$ 75,507	$ 4,710,884	$ 4,822,359	$ 4,967,029	$ 84,984	$ 4,039,394	$ 123,758	$ 92,865	$ 95,651	$ 4,546,374	$ 101,476	$ 6,331,034	$ 6,480,847	$ 6,675,272	$ 114,212	$ 5,428,608	$ 121,167	$ 9,771,965	$ 128,546
Capital Recovery @ 3.0% / 20yrs.	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ -	$ -
Total Annual Costs	$ 4,121,639	$ 4,123,712	$ 7,435,468	$ 4,128,046	$ 8,763,422	$ 8,874,898	$ 9,019,568	$ 4,137,523	$ 8,091,933	$ 4,176,297	$ 4,145,403	$ 4,148,189	$ 8,598,913	$ 4,154,015	$ 10,383,572	$ 10,533,386	$ 10,727,811	$ 4,166,751	$ 9,481,147	$ 4,173,706	$ 9,771,965	$ 128,546
Average Monthly Cost	$ 343,470	$ 343,643	$ 619,622	$ 344,004	$ 730,285	$ 739,575	$ 751,631	$ 344,794	$ 674,328	$ 348,025	$ 345,450	$ 345,682	$ 716,576	$ 346,168	$ 865,298	$ 877,782	$ 893,984	$ 347,229	$ 790,096	$ 347,809	$ 814,330	$ 10,712
Equivilant Average Monthly Cost	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ -	$ -
Present Worth of Op. Costs @ 3%	$ 69,100	$ 69,100	$ 3,188,735	$ 69,100	$ 4,185,559	$ 4,159,809	$ 4,159,809	$ 69,100	$ 3,188,735	$ 94,850	$ 69,100	$ 69,100	$ 3,188,735	$ 69,100	$ 4,185,559	$ 4,159,809	$ 4,159,809	$ 69,100	$ 3,188,735	$ 69,100	$ 5,410,500	$ 69,100
Present Worth of Op. Costs	**$ 130,472,785**																					
Present Worth of Capital + Op. Costs	**$ 190,764,330**																					

[1]Recovery well pumping costs in dry year estimated as $3,677,184 per Section III. for 12 wells and increased for inflation at 3% per year.
[2]Canal operation costs based on 1) Idle Year = O&M Cost Estimate $69,100 per year; 2) Wet Year = O&M Cost Estimate based on $9,000 per month, $158.33 per month, and $404,296.88 per month for four months plus energy costs for three pump stations each with a 20-ft lift to move 112,500 ac-ft = $1,488,848 plus 8 idle months of $46,067; and 3) Dry Year = O&M Cost Estimate based on $8,000 per month, $52.78 per month, and energy cost for Return Water Pump Station for 2
[3]Pump Station replacement costs include pump and motor replacement at $2,222,000, VFD's at $700,000, electrical and control equipment at $900,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.
[4]Pump Station replacement costs include pump and motor replacement at $1,287,000, VFD's at $420,000, electrical and control equipment at $565,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.
[5]Pump Station replacement costs include pump and motor replacement at $540,000, VFD's at $150,000, electrical and control equipment at $565,000, and cathodic protection at $15,000. Costs increased for inflation at 3% per year.
[6]Liner replacement or repairs estimated as minor patches at $25,000 every five years and complete liner replacement after 20 years at 40 years. Costs increased for inflation at 3% per year.

ct
al

23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069
Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year
$ -	$ -	$ 7,699,240	$ 7,930,217	$ 8,168,124	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,347,135	$ 10,657,549	$ 10,977,276	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 13,905,684	$ 14,322,855	$ 14,752,540	$ -	$ -	$ -
$ 6,109,946	$ 136,375	$ 756,795	$ 779,499	$ 802,884	$ 153,491	$ 7,295,595	$ 162,839	$ 167,724	$ 172,756	$ 8,211,257	$ 183,276	$ 1,017,069	$ 1,047,581	$ 1,079,009	$ 206,279	$ 9,804,670	$ 218,842	$ 225,407	$ 232,169	$ 11,035,242	$ 246,308	$ 1,366,856	$ 1,407,862	$ 1,450,098	$ 277,222	$ 13,176,656	$ 294,105
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ 5,350,314	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,202,370
$ -	$ -	$ 2,581,649	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,405,399
$ -	$ -	$ 52,344	$ -	$ -	$ -	$ -	$ 60,682	$ -	$ -	$ -	$ -	$ 70,347	$ -	$ -	$ -	$ -	$ -	$ 17,423,849	$ -	$ -	$ -	$ 94,540	$ -	$ -	$ -	$ -	$ 109,598
$ 6,109,946	$ 136,375	$ 32,466,891	$ 8,709,716	$ 8,971,008	$ 153,491	$ 7,295,595	$ 223,520	$ 167,724	$ 172,756	$ 8,211,257	$ 183,276	$ 11,434,551	$ 11,705,130	$ 12,056,284	$ 206,279	$ 9,804,670	$ 218,842	$ 17,649,255	$ 232,169	$ 11,035,242	$ 246,308	$ 15,367,080	$ 15,730,716	$ 16,202,638	$ 277,222	$ 13,176,656	$ 50,567,505
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 6,109,946	$ 136,375	$ 32,466,891	$ 8,709,716	$ 8,971,008	$ 153,491	$ 7,295,595	$ 223,520	$ 167,724	$ 172,756	$ 8,211,257	$ 183,276	$ 11,434,551	$ 11,705,130	$ 12,056,284	$ 206,279	$ 9,804,670	$ 218,842	$ 17,649,255	$ 232,169	$ 11,035,242	$ 246,308	$ 15,367,080	$ 15,730,716	$ 16,202,638	$ 277,222	$ 13,176,656	$ 50,567,505
$ 509,162	$ 11,365	$ 2,705,574	$ 725,810	$ 747,584	$ 12,791	$ 607,966	$ 18,627	$ 13,977	$ 14,396	$ 684,271	$ 15,273	$ 952,879	$ 975,428	$ 1,004,690	$ 17,190	$ 817,056	$ 18,237	$ 1,470,771	$ 19,347	$ 919,604	$ 20,526	$ 1,280,590	$ 1,310,893	$ 1,350,220	$ 23,102	$ 1,098,055	$ 4,213,959
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 3,188,735	$ 69,100	$ 15,971,559	$ 4,159,809	$ 4,159,809	$ 69,100	$ 3,188,735	$ 94,850	$ 69,100	$ 69,100	$ 3,188,735	$ 69,100	$ 4,185,559	$ 4,159,809	$ 4,159,809	$ 69,100	$ 3,188,735	$ 69,100	$ 5,410,500	$ 69,100	$ 3,188,735	$ 69,100	$ 4,185,559	$ 4,159,809	$ 4,159,809	$ 69,100	$ 3,188,735	$ 11,880,850

25-ft lift to move 50,000 ac-ft = $275,660.00. Costs increased for inflation at 3% per year.

Kern Fan Proje

Shotcrete Lined C

Alternative No. 4- Shotcrete Concrete Liner	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
CAPITAL COST	**$ 69,513,845**																					
O&M COSTS	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year
Recovery Well Pumping Costs [1]	$ -	$ -	$ -	$ -	$ 4,262,883	$ 4,390,769	$ 4,522,492	$ -	$ -	$ -	.	$ -	$ -	$ -	$ 5,728,958	$ 5,900,827	$ 6,077,851	$ -	$ -	$ -	$ -	$ -
Canal Operation Costs[2]	$ 69,100	$ 71,173	$ 3,382,929	$ 75,507	$ 419,019	$ 431,590	$ 444,537	$ 84,984	$ 4,039,394	$ 90,160	$ 92,865	$ 95,651	$ 4,546,374	$ 101,476	$ 563,127	$ 580,020	$ 597,421	$ 114,212	$ 5,428,608	$ 121,167	$ 124,802	$ 128,546
Pump Station No. 1 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 2 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 3 Replacement Costs [4]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Return Water Pump Station Replacement Costs [5]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Liner Replacement or Repairs[6]	$ -	$ -	$ 137,439	$ -	$ -	$ 150,183	$ -	$ -	$ 164,109	$ -	$ -	$ 179,326	$ -	$ -	$ 195,954	$ -	$ -	$ 214,125	$ -	$ -	$ 233,980	$ -
Total Annual Operating Cost	$ 69,100	$ 71,173	$ 3,520,367	$ 75,507	$ 4,681,902	$ 4,972,542	$ 4,967,029	$ 84,984	$ 4,203,503	$ 90,160	$ 92,865	$ 274,977	$ 4,546,374	$ 101,476	$ 6,488,039	$ 6,480,847	$ 6,675,272	$ 328,337	$ 5,428,608	$ 121,167	$ 358,782	$ 128,546
Capital Recovery @ 3% / 20yrs.	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ -	$ -
Total Annual Costs	$ 4,741,522	$ 4,743,595	$ 8,192,790	$ 4,747,930	$ 9,354,324	$ 9,644,964	$ 9,639,452	$ 4,757,407	$ 8,875,925	$ 4,762,582	$ 4,765,287	$ 4,947,399	$ 9,218,796	$ 4,773,898	$ 11,160,461	$ 11,153,269	$ 11,347,695	$ 5,000,759	$ 10,101,030	$ 4,793,590	$ 358,782	$ 128,546
Average Monthly Cost	$ 395,127	$ 395,300	$ 682,732	$ 395,661	$ 779,527	$ 803,747	$ 803,288	$ 396,451	$ 739,660	$ 396,882	$ 397,107	$ 412,283	$ 768,233	$ 397,825	$ 930,038	$ 929,439	$ 945,641	$ 416,730	$ 841,753	$ 399,466	$ 29,899	$ -
Equivilant Average Monthly Cost	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ -	$ -
Present Worth of Op. Costs @ 3%	$ 69,100	$ 69,100	$ 3,318,284	$ 69,100	$ 4,159,809	$ 4,289,358	$ 4,159,809	$ 69,100	$ 3,318,284	$ 69,100	$ 69,100	$ 198,649	$ 3,188,735	$ 69,100	$ 4,289,358	$ 4,159,809	$ 4,159,809	$ 198,649	$ 3,188,735	$ 69,100	$ 198,649	$ 69,100
Present Worth of Op. Costs	**$ 121,656,769**																					
Present Worth of Capital + Op. Costs	**$ 191,170,614**																					

[1]Recovery well pumping costs in dry year estimated as $3,677,184 per Section III. for 12 wells and increased for inflation at 3% per year.

[2]Canal operation costs based on 1) Idle Year = O&M Cost Estimate $69,100 per year; 2) Wet Year = O&M Cost Estimate based on $9,000 per month, $158.33 per month, and $404,296.88 per month for four months plus energy costs for three pump stations each with a 20-ft lift to move 112,500 ac-ft = $1,488,848 plus 8 idle months of $46,067; and 3) Dry Year = O&M Cost Estimate based on $8,000 per month, $52.78 per month, and energy cost for Return Water Pump Station for 2

[3]Pump Station replacement costs include pump and motor replacement at $2,222,000, VFD's at $700,000, electrical and control equipment at $900,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[4]Pump Station replacement costs include pump and motor replacement at $1,287,000, VFD's at $420,000, electrical and control equipment at $565,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[5]Pump Station replacement costs include pump and motor replacement at $540,000, VFD's at $150,000, electrical and control equipment at $565,000, and cathodic protection at $15,000. Costs increased for inflation at 3% per year.

[6]Liner replacement or repairs estimated as replacing 1,200-ft of lining at $129,549 every three years. Costs increased for inflation at 3% per year.

ct
ɜnal

23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069
Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year
$ -	$ -	$ 7,699,240	$ 7,930,217	$ 8,168,124	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,347,135	$ 10,657,549	$ 10,977,276	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 13,905,684	$ 14,322,855	$ 14,752,540	$ -	$ -	$ -
$ 6,109,946	$ 136,375	$ 756,795	$ 779,499	$ 802,884	$ 153,491	$ 7,295,595	$ 162,839	$ 167,724	$ 172,756	$ 8,211,257	$ 183,276	$ 1,017,069	$ 1,047,581	$ 1,079,009	$ 206,279	$ 9,804,670	$ 218,842	$ 225,407	$ 232,169	$ 11,035,242	$ 246,308	$ 1,366,856	$ 1,407,862	$ 1,450,098	$ 277,222	$ 13,176,656	$ 294,105
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ 5,350,314	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,202,370
$ -	$ -	$ 2,581,649	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,405,399
$ -	$ 255,676	$ -	$ -	$ 279,384	$ -	$ -	$ 305,291	$ -	$ -	$ 333,599	$ -	$ -	$ 364,533	$ -	$ -	$ 398,335	$ -	$ -	$ 435,272	$ -	$ -	$ 475,633	$ -	$ -	$ 519,737	$ -	$ -
$ 6,109,946	$ 392,051	$ 32,414,547	$ 8,709,716	$ 9,250,392	$ 153,491	$ 7,295,595	$ 468,129	$ 167,724	$ 172,756	$ 8,544,856	$ 183,276	$ 11,364,204	$ 12,069,663	$ 12,056,284	$ 206,279	$ 10,203,005	$ 218,842	$ 225,407	$ 667,441	$ 11,035,242	$ 246,308	$ 15,748,173	$ 15,730,716	$ 16,202,638	$ 796,959	$ 13,176,656	$ 50,457,907
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 6,109,946	$ 392,051	$ 32,414,547	$ 8,709,716	$ 9,250,392	$ 153,491	$ 7,295,595	$ 468,129	$ 167,724	$ 172,756	$ 8,544,856	$ 183,276	$ 11,364,204	$ 12,069,663	$ 12,056,284	$ 206,279	$ 10,203,005	$ 218,842	$ 225,407	$ 667,441	$ 11,035,242	$ 246,308	$ 15,748,173	$ 15,730,716	$ 16,202,638	$ 796,959	$ 13,176,656	$ 50,457,907
$ 509,162	$ 32,671	$ 2,701,212	$ 725,810	$ 770,866	$ 12,791	$ 607,966	$ 39,011	$ 13,977	$ 14,396	$ 712,071	$ 15,273	$ 947,017	$ 1,005,805	$ 1,004,690	$ 17,190	$ 850,250	$ 18,237	$ 18,784	$ 55,620	$ 919,604	$ 20,526	$ 1,312,348	$ 1,310,893	$ 1,350,220	$ 66,413	$ 1,098,055	$ 4,204,826
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 3,188,735	$ 198,649	$ 15,945,809	$ 4,159,809	$ 4,289,358	$ 69,100	$ 3,188,735	$ 198,649	$ 69,100	$ 69,100	$ 3,318,284	$ 69,100	$ 4,159,809	$ 4,289,358	$ 4,159,809	$ 69,100	$ 3,318,284	$ 69,100	$ 69,100	$ 198,649	$ 3,188,735	$ 69,100	$ 4,289,358	$ 4,159,809	$ 4,159,809	$ 198,649	$ 3,188,735	$ 11,855,100

ɜ5-ft lift to move 50,000 ac-ft = $275,660.00. Costs increased for inflation at 3% per year.

Kern Fan Proje
Concrete Lined Ca

Alternative No. 5- Conventional Concrete Liner	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
CAPITAL COST	**$ 70,697,045**																					
O&M COSTS	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year
Recovery Well Pumping Costs [1]	$ -	$ -	$ -	$ -	$ 4,262,883	$ 4,390,769	$ 4,522,492	$ -	$ -	$ -	.	$ -	$ -	$ -	$ 5,728,958	$ 5,900,827	$ 6,077,851	$ -	$ -	$ -	$ -	$ -
Canal Operation Costs[2]	$ 69,100	$ 71,173	$ 3,382,929	$ 75,507	$ 419,019	$ 431,590	$ 444,537	$ 84,984	$ 4,039,394	$ 90,160	$ 92,865	$ 95,651	$ 4,546,374	$ 101,476	$ 563,127	$ 580,020	$ 597,421	$ 114,212	$ 5,428,608	$ 121,167	$ 124,802	$ 128,546
Pump Station No. 1 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 2 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 3 Replacement Costs [4]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Return Water Pump Station Replacement Costs [5]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Liner Replacement or Repairs[6]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 226,888	$ -	$ -	$ -	$ -	$ 263,026	$ -	$ -
Total Annual Operating Cost	$ 69,100	$ 71,173	$ 3,382,929	$ 75,507	$ 4,681,902	$ 4,822,359	$ 4,967,029	$ 84,984	$ 4,039,394	$ 90,160	$ 92,865	$ 95,651	$ 4,546,374	$ 101,476	$ 6,518,973	$ 6,480,847	$ 6,675,272	$ 114,212	$ 5,428,608	$ 384,193	$ 124,802	$ 128,546
Capital Recovery @ 3% / 20yrs.	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ -	$ -
Total Annual Costs	$ 4,821,052	$ 4,823,125	$ 8,134,881	$ 4,827,459	$ 9,433,854	$ 9,574,311	$ 9,718,981	$ 4,836,936	$ 8,791,346	$ 4,842,112	$ 4,844,817	$ 4,847,602	$ 9,298,326	$ 4,853,428	$ 11,270,925	$ 11,232,799	$ 11,427,224	$ 4,866,164	$ 10,180,560	$ 5,136,145	$ 124,802	$ 128,546
Average Monthly Cost	$ 401,754.33	$ 401,927	$ 677,907	$ 402,288	$ 786,154	$ 797,859	$ 809,915	$ 403,078	$ 732,612	$ 403,509	$ 403,735	$ 403,967	$ 774,860	$ 404,452	$ 939,244	$ 936,067	$ 952,269	$ 405,514	$ 848,380	$ 428,012	$ 10,400	$ -
Equivilant Average Monthly Cost	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ -	$ -
Present Worth of Op. Costs @ 3%	$ 69,100	$ 69,100	$ 3,188,735	$ 69,100	$ 4,159,809	$ 4,159,809	$ 4,159,809	$ 69,100	$ 3,188,735	$ 69,100	$ 69,100	$ 69,100	$ 3,188,735	$ 69,100	$ 4,309,809	$ 4,159,809	$ 4,159,809	$ 69,100	$ 3,188,735	$ 219,100	$ 69,100	$ 69,100
Present Worth of Op. Costs	**$ 120,783,985**																					
Present Worth of Capital + Op. Costs	**$ 191,481,030**																					

[1]Recovery well pumping costs in dry year estimated as $3,677,184 per Section III. for 12 wells and increased for inflation at 3% per year.

[2]Canal operation costs based on 1) Idle Year = O&M Cost Estimate $69,100 per year; 2) Wet Year = O&M Cost Estimate based on $9,000 per month, $158.33 per month, and $404,296.88 per month for four months plus energy costs for three pump stations each with a 20-ft lift to move 112,500 ac-ft = $1,488,848 plus 8 idle months of $46,067; and 3) Dry Year = O&M Cost Estimate based on $8,000 per month, $52.78 per month, and energy cost for Return Water Pump Station for 2

[3]Pump Station replacement costs include pump and motor replacement at $2,222,000, VFD's at $700,000, electrical and control equipment at $900,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[4]Pump Station replacement costs include pump and motor replacement at $1,287,000, VFD's at $420,000, electrical and control equipment at $565,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[5]Pump Station replacement costs include pump and motor replacement at $540,000, VFD's at $150,000, electrical and control equipment at $565,000, and cathodic protection at $15,000. Costs increased for inflation at 3% per year.

[6]Liner replacement or repairs estimated as replacing 1,200-ft of lining at $150,000 every five years after the first 15 years. Costs increased for inflation at 3% per year.

ct
nal

23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069
Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year
$ -	$ -	$ 7,699,240	$ 7,930,217	$ 8,168,124	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,347,135	$ 10,657,549	$ 10,977,276	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 13,905,684	$ 14,322,855	$ 14,752,540	$ -	$ -	$ -
$ 6,109,946	$ 136,375	$ 756,795	$ 779,499	$ 802,884	$ 153,491	$ 7,295,595	$ 162,839	$ 167,724	$ 172,756	$ 8,211,257	$ 183,276	$ 1,017,069	$ 1,047,581	$ 1,079,009	$ 206,279	$ 9,804,670	$ 218,842	$ 225,407	$ 232,169	$ 11,035,242	$ 246,308	$ 1,366,856	$ 1,407,862	$ 1,450,098	$ 277,222	$ 13,176,656	$ 294,105
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ 5,350,314	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,202,370
$ -	$ -	$ 2,581,649	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,405,399
$ -	$ -	$ 304,919	$ -	$ -	$ -	$ -	$ 353,485	$ -	$ -	$ -	$ -	$ 409,786	$ -	$ -	$ -	$ -	$ 475,054	$ -	$ -	$ -	$ -	$ 550,718	$ -	$ -	$ -	$ -	$ 638,433
$ 6,109,946	$ 136,375	$ 32,719,466	$ 8,709,716	$ 8,971,008	$ 153,491	$ 7,295,595	$ 516,324	$ 167,724	$ 172,756	$ 8,211,257	$ 183,276	$ 11,773,990	$ 11,705,130	$ 12,056,284	$ 206,279	$ 9,804,670	$ 693,896	$ 225,407	$ 232,169	$ 11,035,242	$ 246,308	$ 15,823,258	$ 15,730,716	$ 16,202,638	$ 277,222	$ 13,176,656	$ 51,096,340
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 6,109,946	$ 136,375	$ 32,719,466	$ 8,709,716	$ 8,971,008	$ 153,491	$ 7,295,595	$ 516,324	$ 167,724	$ 172,756	$ 8,211,257	$ 183,276	$ 11,773,990	$ 11,705,130	$ 12,056,284	$ 206,279	$ 9,804,670	$ 693,896	$ 225,407	$ 232,169	$ 11,035,242	$ 246,308	$ 15,823,258	$ 15,730,716	$ 16,202,638	$ 277,222	$ 13,176,656	$ 51,096,340
$ 509,162	$ 11,365	$ 2,726,622	$ 725,810	$ 747,584	$ 12,791	$ 607,966	$ 43,027	$ 13,977	$ 14,396	$ 684,271	$ 15,273	$ 981,166	$ 975,428	$ 1,004,690	$ 17,190	$ 817,056	$ 57,825	$ 18,784	$ 19,347	$ 919,604	$ 20,526	$ 1,318,605	$ 1,310,893	$ 1,350,220	$ 23,102	$ 1,098,055	$ 4,258,028
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 3,188,735	$ 69,100	$ 16,095,809	$ 4,159,809	$ 4,159,809	$ 69,100	$ 3,188,735	$ 219,100	$ 69,100	$ 69,100	$ 3,188,735	$ 69,100	$ 4,309,809	$ 4,159,809	$ 4,159,809	$ 69,100	$ 3,188,735	$ 219,100	$ 69,100	$ 69,100	$ 3,188,735	$ 69,100	$ 4,309,809	$ 4,159,809	$ 4,159,809	$ 69,100	$ 3,188,735	$ 12,005,100

25-ft lift to move 50,000 ac-ft = $275,660.00. Costs increased for inflation at 3% per year.

Kern Fan Proje
Closed Conduit Pip

Alternative No. 6- Closed Conduit Pipeline	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
CAPITAL COST	**$ 79,375,500**																					
O&M COSTS	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year
Recovery Well Pumping Costs [1]	$ -	$ -	$ -	$ -	$ 4,262,883	$ 4,390,769	$ 4,522,492	$ -	$ -	$ -	.	$ -	$ -	$ -	$ 5,728,958	$ 5,900,827	$ 6,077,851	$ -	$ -	$ -	$ -	$ -
Pipeline Operation Costs [2]	$ 34,550	$ 35,587	$ 3,119,132	$ 37,754	$ 232,879	$ 239,865	$ 247,061	$ 42,492	$ 3,724,407	$ 45,080	$ 46,432	$ 47,825	$ 4,191,852	$ 50,738	$ 312,970	$ 322,359	$ 332,030	$ 57,106	$ 5,005,291	$ 121,167	$ 62,401	$ 64,273
Pump Station No. 1 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Return Water Pump Station Replacement Costs [4]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Liner Replacement or Repairs [5]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Annual Operating Cost	$ 34,550	$ 35,587	$ 3,119,132	$ 37,754	$ 4,495,762	$ 4,630,635	$ 4,769,554	$ 42,492	$ 3,724,407	$ 45,080	$ 46,432	$ 47,825	$ 4,191,852	$ 50,738	$ 6,041,928	$ 6,223,186	$ 6,409,881	$ 57,106	$ 5,005,291	$ 121,167	$ 62,401	$ 64,273
Capital Recovery @ 3% / 20yrs.	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ -	$ -
Total Annual Costs	$ 5,369,830	$ 5,370,867	$ 8,454,412	$ 5,373,034	$ 9,831,042	$ 9,965,915	$ 10,104,834	$ 5,377,773	$ 9,059,687	$ 5,380,360	$ 5,381,713	$ 5,383,106	$ 9,527,133	$ 5,386,018	$ 11,377,208	$ 11,558,466	$ 11,745,162	$ 5,392,386	$ 10,340,571	$ 5,456,448	$ 62,401	$ 64,273
Average Monthly Cost	$ 447,485.87	$ 447,572	$ 704,534	$ 447,753	$ 819,254	$ 830,493	$ 842,069	$ 448,148	$ 754,974	$ 448,363	$ 448,476	$ 448,592	$ 793,928	$ 448,835	$ 948,101	$ 963,205	$ 978,763	$ 449,366	$ 861,714	$ 454,704	$ 5,200	$ -
Equivilant Average Monthly Cost	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ -	$ -
Present Worth of Op. Costs @ 3%	$ 34,550	$ 34,550	$ 2,940,081	$ 34,550	$ 3,994,426	$ 3,994,426	$ 3,994,426	$ 34,550	$ 2,940,081	$ 34,550	$ 34,550	$ 34,550	$ 2,940,081	$ 34,550	$ 3,994,426	$ 3,994,426	$ 3,994,426	$ 34,550	$ 2,940,081	$ 69,100	$ 34,550	$ 34,550
Present Worth of Op. Costs	**$ 102,815,500**																					
Present Worth of Capital + Op. Costs	**$ 182,191,000**																					

[1]Recovery well pumping costs in dry year estimated as $3,677,184 per Section III. for 12 wells and increased for inflation at 3% per year.

[2]Pipeline operation costs based on 1) Idle Year = O&M Cost Estimate $69,100 per year divided by 2 because there will be less maintenance than a canal; 2) Wet Year = O&M Cost Estimate based on $9,000 per month, $52.78 per month, and $404,296.88 per month for four months plus energy costs for one pump station with a 50-ft lift to move 112,500 ac-ft = $1,240,615 plus 8 idle months of $46,067; and 3) Dry Year = O&M Cost Estimate based on $8,000 per month, $52.78 per n

[3]Pump Station replacement costs include pump and motor replacement at $2,800,000, VFD's at $840,000, electrical and control equipment at $1,500,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[4]Return Water Pump Station replacement costs include pump and motor replacement at $500,000, VFD's at $120,000, electrical and control equipment at $500,000, and cathodic protection at $15,000. Costs increased for inflation at 3% per year.

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23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069
Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year
$ -	$ -	$ 7,699,240	$ 7,930,217	$ 8,168,124	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,347,135	$ 10,657,549	$ 10,977,276	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 13,905,684	$ 14,322,855	$ 14,752,540	$ -	$ -	$ -
$ 5,633,499	$ 68,187	$ 420,605	$ 433,224	$ 446,220	$ 76,746	$ 6,726,693	$ 81,419	$ 83,862	$ 86,378	$ 7,570,952	$ 91,638	$ 565,259	$ 582,216	$ 599,683	$ 103,140	$ 9,040,112	$ 109,421	$ 112,703	$ 116,085	$ 10,174,726	$ 123,154	$ 759,660	$ 782,450	$ 805,923	$ 138,611	$ 12,149,155	$ 147,052
$ -	$ -	$ 10,499,382	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 21,983,373
$ -	$ -	$ 2,307,221	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,830,809
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 5,633,499	$ 68,187	$ 20,926,449	$ 8,363,441	$ 8,614,344	$ 76,746	$ 6,726,693	$ 81,419	$ 83,862	$ 86,378	$ 7,570,952	$ 91,638	$ 10,912,394	$ 11,239,765	$ 11,576,958	$ 103,140	$ 9,040,112	$ 109,421	$ 112,703	$ 116,085	$ 10,174,726	$ 123,154	$ 14,665,344	$ 15,105,305	$ 15,558,464	$ 138,611	$ 12,149,155	$ 26,961,235
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 5,633,499	$ 68,187	$ 20,926,449	$ 8,363,441	$ 8,614,344	$ 76,746	$ 6,726,693	$ 81,419	$ 83,862	$ 86,378	$ 7,570,952	$ 91,638	$ 10,912,394	$ 11,239,765	$ 11,576,958	$ 103,140	$ 9,040,112	$ 109,421	$ 112,703	$ 116,085	$ 10,174,726	$ 123,154	$ 14,665,344	$ 15,105,305	$ 15,558,464	$ 138,611	$ 12,149,155	$ 26,961,235
$ 469,458	$ 5,682	$ 1,743,871	$ 696,953	$ 717,862	$ 6,395	$ 560,558	$ 6,785	$ 6,988	$ 7,198	$ 630,913	$ 7,637	$ 909,366	$ 936,647	$ 964,747	$ 8,595	$ 753,343	$ 9,118	$ 9,392	$ 9,674	$ 847,894	$ 10,263	$ 1,222,112	$ 1,258,775	$ 1,296,539	$ 11,551	$ 1,012,430	$ 2,246,770
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 2,940,081	$ 34,550	$ 10,294,426	$ 3,994,426	$ 3,994,426	$ 34,550	$ 2,940,081	$ 34,550	$ 34,550	$ 34,550	$ 2,940,081	$ 34,550	$ 3,994,426	$ 3,994,426	$ 3,994,426	$ 34,550	$ 2,940,081	$ 34,550	$ 34,550	$ 34,550	$ 2,940,081	$ 34,550	$ 3,994,426	$ 3,994,426	$ 3,994,426	$ 34,550	$ 2,940,081	$ 6,334,550

nonth, and energy cost for Return Water Pump Station for 10-ft lift to move 50,000 ac-ft = $110,277.00. Costs increased for inflation at 3% per year.

APPENDIX G

Technical Memorandum #7
Well Drilling and Equipping Requirements

DEE JASPAR & ASSOCIATES, INC.
CONSULTING CIVIL ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CA 93308
PHONE (661) 393-4796
FAX (661) 393-4799

KERN FAN GROUNDWATER STORAGE PROJECT

TECHNICAL MEMORANDUM NO. 7
(Well Drilling and Equipping Requirements)

PREPARED FOR: Kern Fan Joint Powers Authority (JPA)
PREPARED BY: Curtis Skaggs, P.E.
DATE: April 16, 2021

SUBJECT: ***Well Drilling and Equipping Requirements***

I. Executive Summary

It is anticipated that there will be up to a total of twelve (12) recovery water wells constructed as part of this project with up to six (6) wells on the Phase I Property and up to six (6) wells on the Phase II Property. Each of these wells are anticipated to have an approximate capacity of 5 to 6 cfs.

The wells will be drilled using the fluid reverse-rotary drilling method. A surface conductor will be installed to a depth of 50-ft. For purposes of planning-level cost estimates, a pilot hole will be drilled to an approximate depth of 970-ft with formation samples every 10-ft and geophysical logging performed in the completed pilot hole. Water quality depth sampling will be performed in select wells. The wells will then be reamed to their final diameter and 20" I.D. HSLA steel casing installed along with a 3" gravel feed tube, a 3" sounding tube, gravel pack and a cement annular seal from ground surface to an approximate depth of 305-ft. Special testing requirements during the well drilling and development process are outlined in Section III.G.

The depths and diameters of the conductor casing, pilot holes and reamed holes; the lengths of casing, tubing, gravel pack, and cement seals; and the duration of well development methods are merely estimates based upon past experience and have been approximated for cost estimating purposes as part of Technical Memorandum No. 11 "Engineer's Estimate". The well design parameters and specifications will be prepared by the design engineer and project hydrogeologist. The plans and specifications will detail the well design based on the actual project location.

The actual field conditions encountered during the well drilling and development process will dictate the completed well design.

The wells are planned to be equipped with 12-inch column piping, 3 1/2-inch enclosing tubing, 2 3/16-inch lineshaft and a 500 hp motor with variable speed drive. The well will include 12-inch diameter fusion bonded epoxy lined and coated steel discharge piping with valves, fittings, supports, and instrumentation. The well will be protected with a pre-fabricated steel motor enclosure. The well site electrical gear will be free-standing and mounted to a concrete foundation with a galvanized steel shade structure and security locking gate beam across the front of the electrical equipment. Two flood lights will be mounted on the shade structure and one directed to face the electrical equipment and one directed to face the well pump and motor. Well site security and a SCADA system for remote monitoring will be included.

The project is not anticipated to negatively impact neighboring wells or recharge and recovery projects. Potential changes in groundwater levels predicted for project recovery scenarios were analyzed using a calibrated numerical groundwater flow model. The groundwater model used for the analysis was previously developed to evaluate groundwater level changes in the vicinity of banking projects along the Kern River west of Bakersfield, California. The results of this modeling are discussed in the Kern Fan Groundwater Storage Project EIR dated December 2020 and demonstrate that the regional pumping of wells for the project will not negatively impact neighboring wells or neighboring recharge and recovery projects. Anticipated static and pumping water levels for the region are discussed herein based on historical records and may be used for the design of the project pumps and motors.

If the actual well field configurations end up being moderately different from the configurations previously modeled, then the well impact analysis will be re-evaluated and updated as necessary.

In the event that groundwater levels are drawn near established minimum thresholds under SGMA, it is anticipated that groundwater recovery can be shifted to areas where groundwater levels are not near minimum thresholds. The District production wells cover an area of almost 18 square miles providing potential flexibility to shift pumping as needed.

This memorandum addresses the following:

II. Well Layout Requirements

The Phase I and Phase II Property locations have not been finalized yet, but property locations have been assumed as part of this preliminary engineering work. These property locations are shown in Figure 1 below.

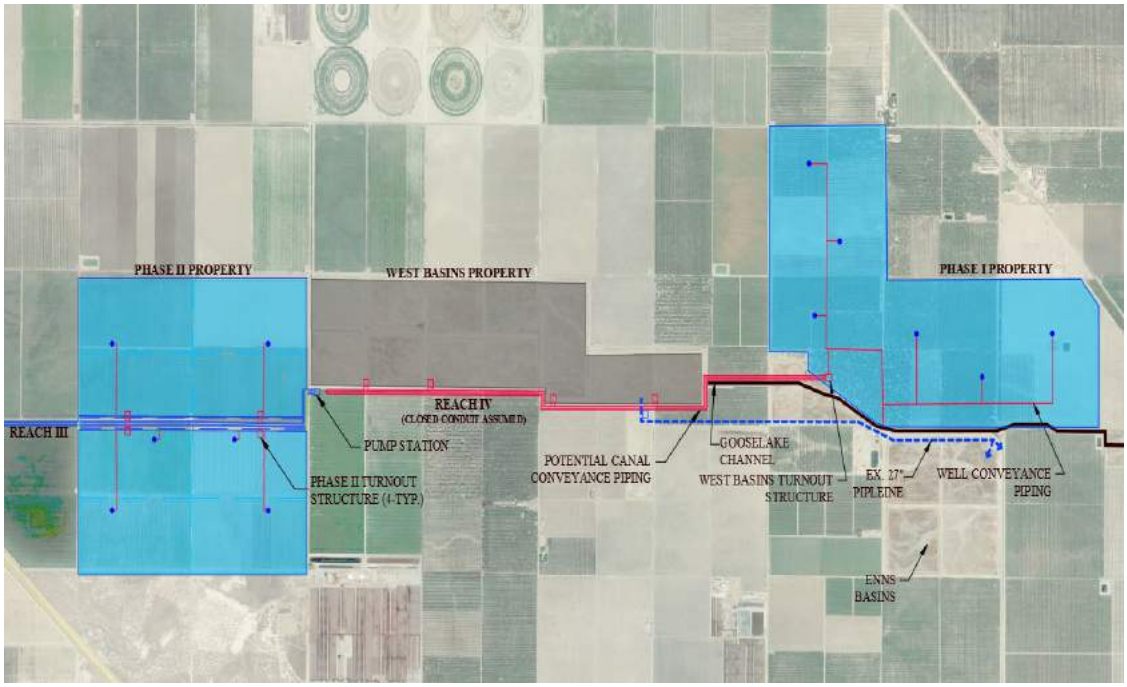

Figure 1: Phase I and Phase II Properties

A. Well Spacing and Setback Requirements

A preliminary layout has been estimated for approximately six (6) recovery water wells on each of the Phase I and Phase II Recharge Properties. The layout estimates a minimum 1,320-ft spacing in between recovery wells and from neighboring wells to minimize drawdown and interference. See Figure 2a and 2b below for a typical preliminary well layout.

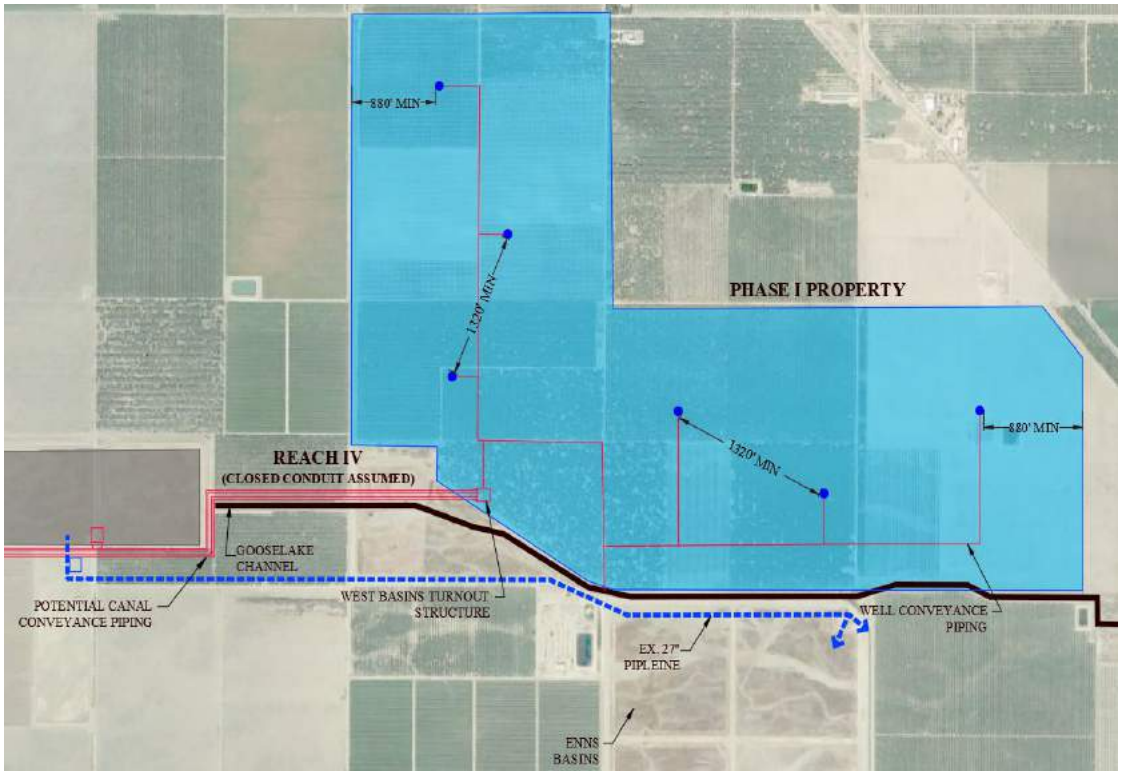

Figure 2a: Preliminary Well Layout for Phase I Property

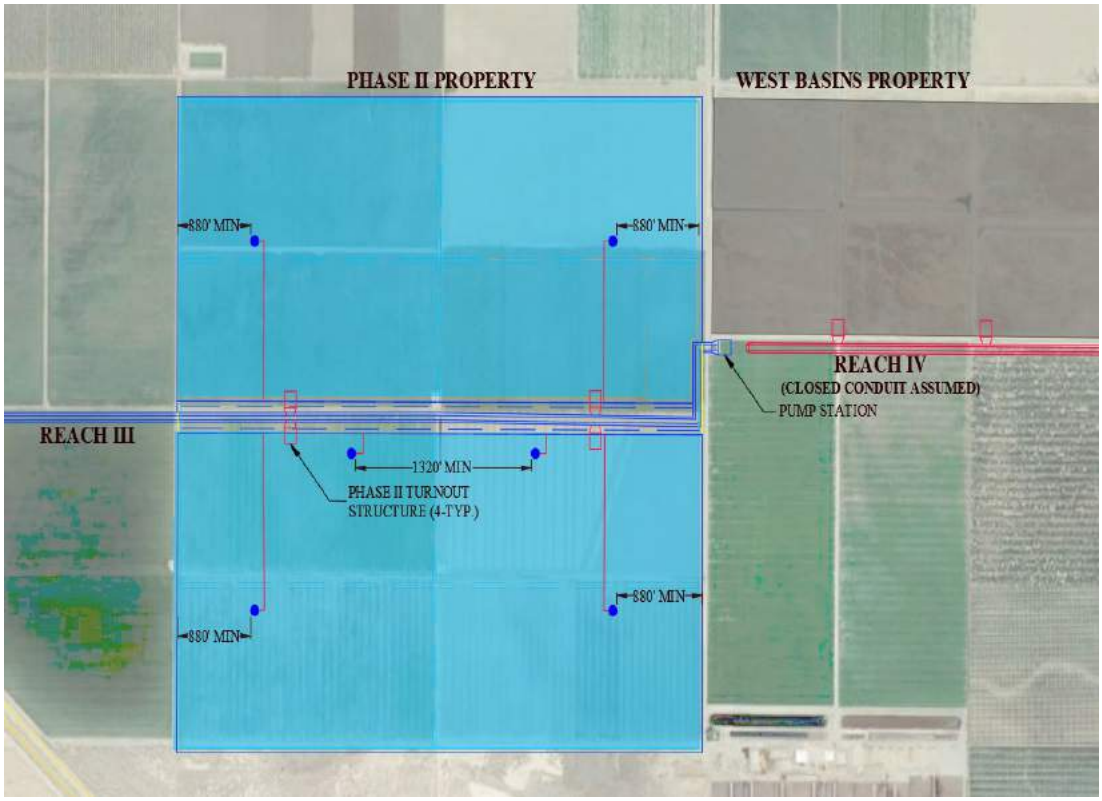

Figure 2b: Preliminary Well Layout for Phase II Property

B. Site Layout

A typical well site layout (an example from the RRBWSD Stockdale East Well Facilities) is illustrated in Figure 3 below. It is anticipated that earth well pads will be graded and prepared as part of the recharge facility earthwork project. The well pads will be approximately 100-ft by 100-ft. These well pads will be utilized for the drilling, construction, and development operations associated with the well construction.

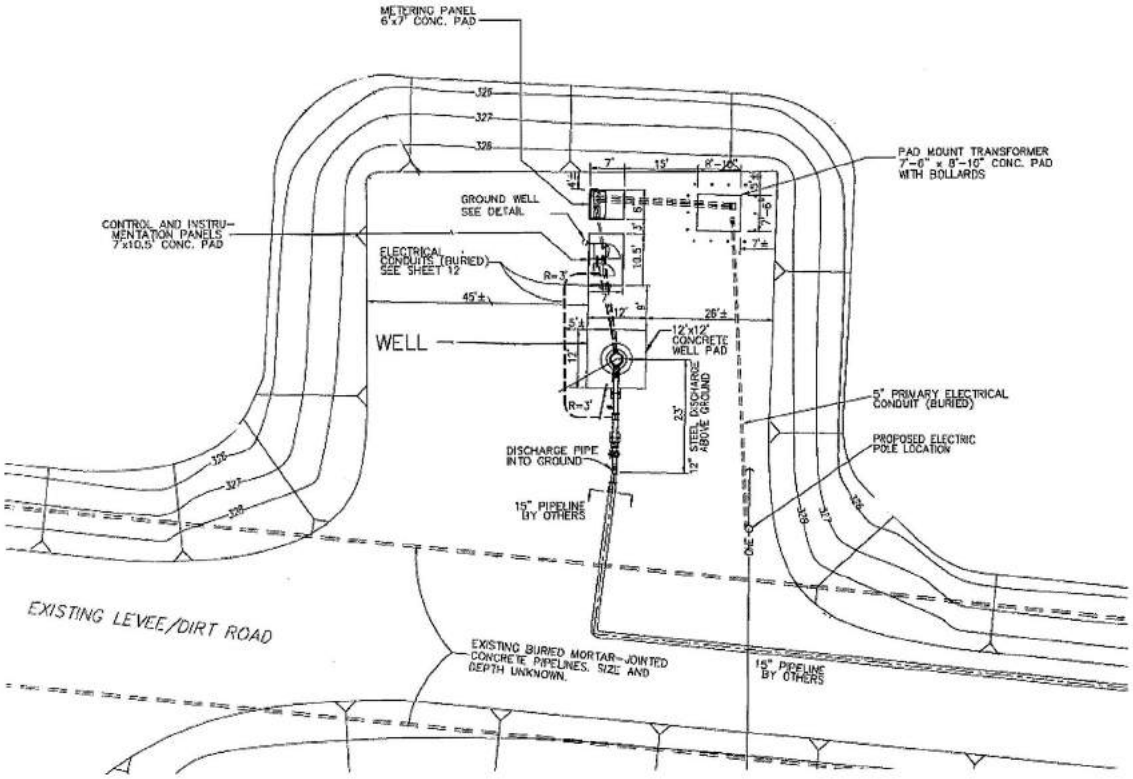

Figure 3: Well Site Layout

The well pad will accommodate the well drilling rig, pipe trailer, field office, mud pits, and settling tanks as well as all ancillary equipment and materials. A preliminary well construction layout is illustrated in Figure 4 below. Equipment may also be stored down in the recharge basin bottoms, however any use or disturbance to the basin bottoms shall be cleaned and ripped at the completion of the project.

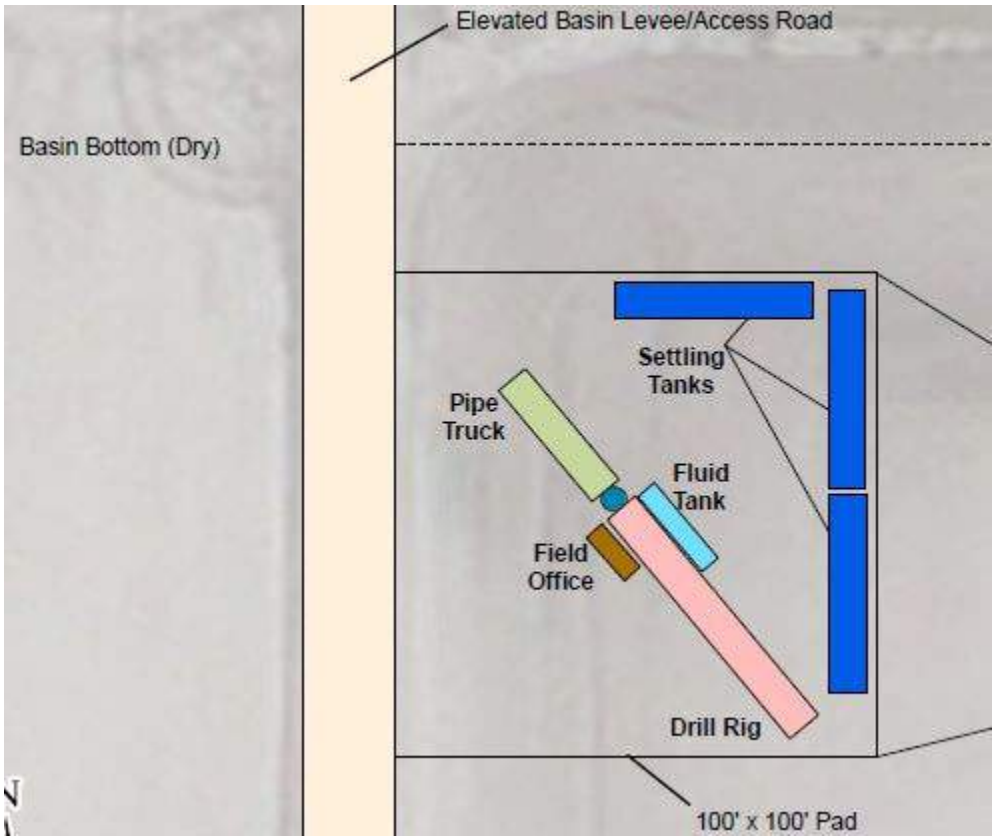

Figure 4: Well Construction Layout

C. Impact Analysis

a. Impact of Well Layout (Localized)

- Sound mitigation is not anticipated to be necessary given the remote location of the well sites relative to homes.

- Turbid groundwater generated during well development and testing will be clarified in a series of 20,000 gallon tanks prior to discharging to a nearby surface basin where it will be allowed to infiltrate into the subsurface. All discharge water will be carefully controlled to prevent runoff to adjacent properties, roads, etc.

- Water for use during the drilling operation will be supplied by the District within one-half (1/2) mile of the drilling location. Only groundwater of suitable quality, approved by the District, will be allowed for use during drilling operations.

- Drilling fluids and cuttings generated during drilling shall be contained on-site during construction. They shall be dried out and then they will be allowed to be

uniformly and evenly spread out on-site or on recharge pond levee slopes as directed by the District.

- All access roads and site areas will be sprayed with water regularly to prevent dust generation as a result of the drilling operation and for dust control.

- Upon completion of well construction, the site will be graded level and the top of well casing will be welded shut to prevent access until the permanent pump is installed.

b. Impact of Well Pumping (Regional)

Potential changes in groundwater levels predicted for project recovery scenarios were analyzed using a calibrated numerical groundwater flow model. The groundwater model used for the analysis was previously developed to evaluate groundwater level changes in the vicinity of banking projects along the Kern River west of Bakersfield, California. The model was developed using MODFLOW, a block centered, finite difference groundwater flow modeling code developed by the United States Geological Survey (USGS) for simulating groundwater flow (McDonald and Harbaugh, 1988).[1] MODFLOW is one of the most widely used and critically accepted model codes available (Anderson and Woessner, 2002).[2] The results of this modeling are discussed in the Kern Fan Groundwater Storage Project EIR dated December 2020 and demonstrate that the regional pumping of wells for the project will not negatively impact neighboring wells or neighboring recharge and recovery projects. Anticipated static and pumping water levels for the region are discussed herein based on historical records and may be used for the design of the project pumps and motors.

If the actual well field configurations end up being moderately different from the configurations previously modeled, then the well impact analysis will be re-evaluated and updated as necessary.

In the event that groundwater levels are drawn near established minimum thresholds under SGMA, it is anticipated that groundwater recovery can be shifted to areas where groundwater levels are not near minimum thresholds. The District production wells cover an area that includes several square miles providing potential flexibility to shift pumping as needed.

[1] McDonald, M.G., and Harbaugh, A.W., 1988. A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model: in Techniques of Water-Resources Investigations of the United States Geological Survey; Book 6 Modeling Techniques.

III. Well Design Requirements

The depths and diameters of the conductor casing, the pilot holes and reamed holes; the lengths of casing, tubing, gravel pack, and cement seals; and the duration of well development methods are merely estimates based upon past experience and have been approximated for cost estimating purposes as part of Technical Memorandum No. 11 "Engineer's Estimate". The well design parameters and specifications will be prepared by the design engineer and project hydrogeologist. The plans and specifications will detail the well design based on the actual project location. The actual field conditions encountered during the well drilling and development process will dictate the well design.

A. Borehole Drilling and Testing Procedures

Each well construction will include a minimum 50-ft deep steel conductor casing to serve as a near-surface sanitary seal and to provide borehole stability during drilling operations. The conductor casing will be set within a nominal 54-inch diameter borehole drilled using a bucket auger to a depth of 50-ft. For planning purposes, it is anticipated that the steel conductor will consist of a mild steel, 42-inch outside diameter casing with a 3/8-inch wall. The annular space between the steel conductor casing and the borehole wall will be filled with a 10.5-sack cement sand slurry to ground surface.

A pilot hole, approximately 17.5-inch diameter, will be drilled to the specified depths using the fluid reverse-rotary drilling method. For purposes of the planning-level cost estimates, each borehole will be drilled to a depth of 970-ft. Composite soil samples shall be collected throughout each 10-ft depth interval of drilling for visual description in the field. Drilling fluids and cuttings will be managed using an above-ground tank. Deviation surveys shall be performed at every 100-ft depth during drilling to verify a plumb pilot hole using an approved mechanical drift indicator. The maximum tolerance for the deviation surveys shall be ½-degree from vertical per 100-feet. At the completion of the pilot hole, geophysical logging shall be performed that includes:

- Gamma Ray
- Sonic Velocity Variable Density
- Spontaneous Potential
- Short Normal Resistivity
- Long Normal Resistivity
- Laterolog Resistivity
- Deviation Survey

The maximum allowable horizontal deviation (drift) from the vertical shall be 6-inches per 100-feet for the well deviation survey.

It is anticipated that isolated aquifer zone testing will be performed in boreholes at selected locations. It is not envisioned to conduct this testing at every well location given their relatively close proximity (approximately six wells per 640 acres). The design firm and hydrogeologist will select the drilling locations at which isolated aquifer zone testing will be conducted to provide the best representation of water quality in the recharge and recovery area. At each borehole selected for testing, the design firm and hydrogeologist will select the number and depth of isolated aquifer zones based on a review of the geophysical logs and log of soil cuttings.

Upon completion of the pilot hole and any aquifer zone testing, the design firm and hydrogeologist will prepare a final well design. The well design will specify the final casing diameter and material, perforation interval, slot size, filter pack gradation, filter pack interval, annular seal interval, sounding tube diameter and entry depth, and gravel feed tube diameter and depth. For planning purposes, the casing is anticipated to be 20-inches in diameter with a 5/16-inch wall thickness. The pilot hole will be enlarged to 36-inches in diameter to accommodate the casing, camera access/sounding tube, and gravel feed tube. The borehole diameter may be reduced to 32-inch diameter from the bottom of the gravel feed tube to the bottom of the borehole. At the completion of the reamed hole, a caliper log and deviation survey shall be performed.

B. Water Quality Testing Strategy

Groundwater quality testing will be conducted at selected well locations. For those locations where isolated aquifer zone testing is specified, the analytical testing suite will be focused on water quality constituents of concern.

Water quality concerns in the area include:

- 1,2,3-TCP (SRL 524M Low Level Test)
- Arsenic
- Nitrate

Nitrate is commonly detected in the shallow aquifer while the Arsenic concentration typically increases with depth. The perforated intervals for each well will be designed, based on the data collected, to avoid these constituents, if possible. It is estimated that three to five zone tests would be performed in select wells and that at least one of the initial wells would have zones in the deeper aquifer from 700-ft to 900-ft to verify the Arsenic concentrations.

Other water quality constituents to be included in the isolated aquifer zone testing suite will include:

- Total dissolved solids,
- pH

- General physical properties (color, odor, turbidity)
- General minerals (cations and anions)
- Ethylene dibromide (EDB)
- Dibromochloropropane (DBCP)
- Gross alpha

The design firm and/or hydrogeologist may select other constituents for analysis as needed.

Upon completion of development and testing of each well, groundwater samples will be collected for analysis of a full Title 22 water quality suite.

C. Casing Material and Size

The recovery well casing and screen is to be manufactured by Roscoe Moss Company of Los Angeles, California. For planning purposes, the casing is anticipated to be constructed of 20-inch I.D. high-strength, low-alloy (HSLA) steel with a 5/16-inch wall thickness. For cost estimating purposes, the blank casing length has been estimated as 420-ft.

The perforated interval lengths and depths as well as the slot size will be determined based upon the formation samples, geophysical logs, depth to water, and water quality data for each well. For cost estimating purposes, a perforated length of 510-ft has been estimated. The perforations are anticipated to be horizontal louvers in the "Ful-Flo" pattern.

D. Filter Pack and Annular Seals

The filter pack shall be designed based on sieve analysis for selected soil samples that are collected during the drilling of the pilot hole. The gravel material shall be composed of sound, durable, well rounded natural particles and be free of organic matter, clay balls, and other deleterious substances. The filter pack shall be placed by pumping into the annular space through a tremie pipe and shall not be allowed to free fall from more than 30-ft below the bottom of tremie pipe. For cost estimating purposes a filter pack length of 665-ft has been used.

The annular seal shall consist of a 10.5 sack cement sand slurry and shall be placed in the annular space from the top of the gravel pack and fine sand to the ground surface. The annular seal shall be placed by pumping into the annular space through a tremie pipe. For cost estimating purposes, a cement annular seal depth of 405-ft has been used.

E. Tubing Material and Sizes

The well installation shall include a gravel feed tube and a sounding tube or camera tube.

The gravel feed tube shall be a 3-inch Schedule 40, ASTM A53 Grade B steel tube. The depth of the feed tube shall be determined at the time of

the final casing design, however for cost estimating purposes a depth of 315-ft has been used.

The sounding tube or camera tube shall be a 3-inch Schedule 40, ASTM A53 Grade B steel tube. The sounding tube shall be installed outside of the casing in the annular space and terminate in a fabricated steel box welded to an opening in the well casing at the depth determined at the time of the final casing design. For cost estimating purposes a depth of 405-ft has been used.

A typical well cross-section is illustrated below in Figure 5 and illustrates the conductor casing, blank casing, perforated casing, tubing, gravel pack, and cement annular seal.

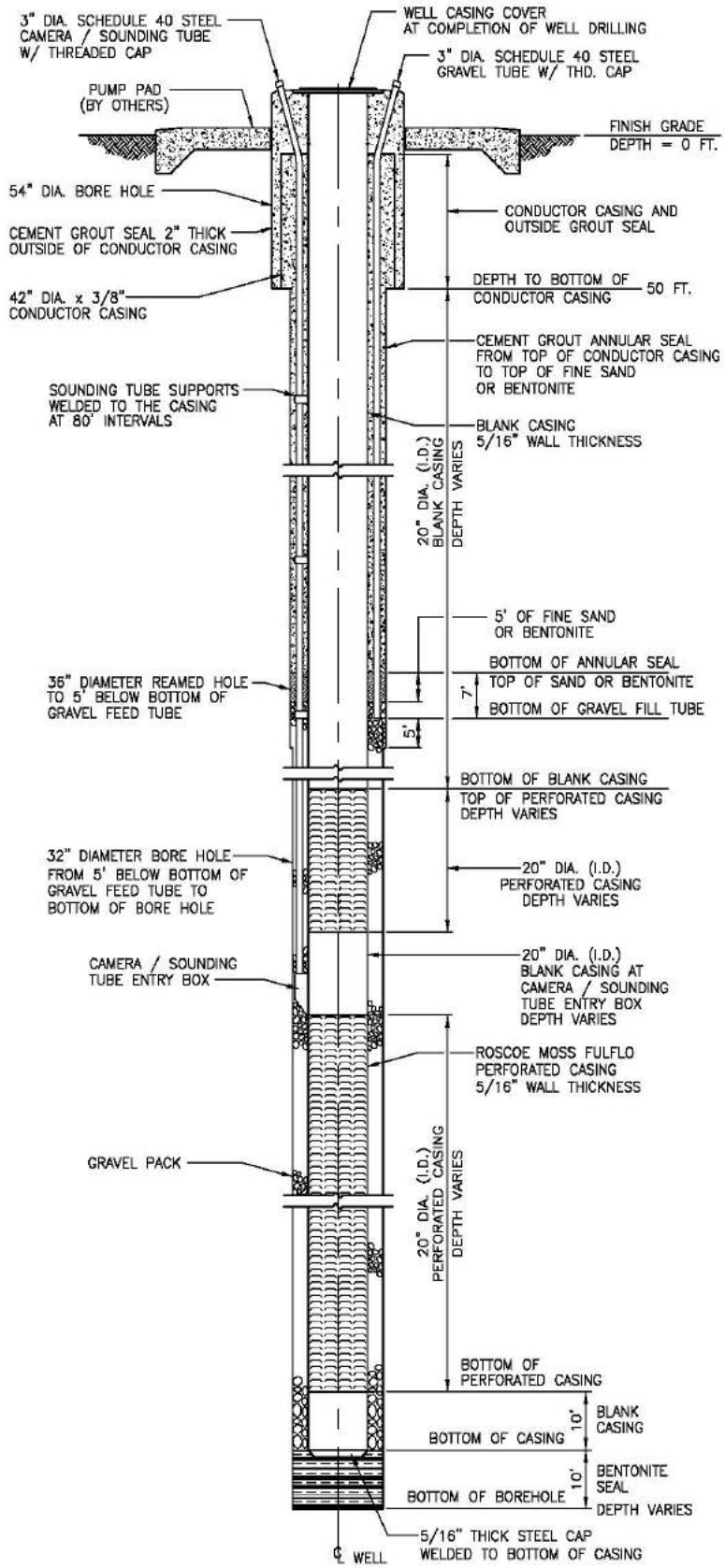

Figure 5: Typical Well Cross-Section

F. Well Development Procedures

Well development shall be performed in a two-stage process that includes initial development by airlifting and swabbing, followed by development by pumping and surging.

The initial development shall be performed using a dual swab tool that has swab flanges no more than 10-feet apart. The outside diameter of the swab rubber wipers shall be no more than one-half inch less than the inside diameter of the well screen. Initially, the well casing shall be airlifted with an open-ended single swab attached to the end of the drill pipe to remove sediment and materials from the bottom of the well. The screened interval of the well shall be swabbed in short screen intervals of no more than 20-feet. The swabbing and airlifting shall be performed to remove mud, sediment, and sand from the gravel pack and continue until the airlifted water is relatively clear.

If the Contractor uses a drilling mud additive at any time during the well construction, then chemical development shall be required in addition to the mechanical development. The chemicals to be utilized shall be a clay-dispersing agent approved by the hydrogeologist.

Pumping and surging development shall be conducted using a vertical turbine test pump. The pump capacity is anticipated to be approximately 4,000 gpm at a 600-ft TDH. The test pump shall be installed to the depth specified by the design firm and hydrogeologist. The quantity of water being pumped during development shall begin at a low volume and gradually increase as development continues. The well shall be thoroughly developed so that it will produce a maximum specific capacity based on the consideration of depth and nature of the water bearing formations and so that it will not produce an amount of fine sand in excess of the sand production limitations.

Chemical development shall be performed during development by pumping and surging using a clay-dispersing agent such as Mud-Nox.

In addition, final well development shall be performed as directed by the design firm and hydrogeologist and include a minimum of three flowrates (steps) for the step-drawdown test and a minimum 24-hr constant rate discharge test.

G. Special Testing Requirements

The minimum well testing requirements are outlined below:

- Deviation surveys (Mechanical Drift Indicator) every 100-ft depth of pilot hole
- Geophysical logs upon completion of pilot hole
  -Sonic Log
  -E-Log/Gamma Ray
  -Deviation Survey (Gyroscopic Survey)
- Isolated Aquifer Zone Test Water Quality Sampling (selected locations)
- Caliper log and Deviation survey (Gyroscopic Survey) upon completion of reamed hole
- Formation sieve analysis
- Gravel sieve analysis
- Well Development Specific Capacity, Turbidity and Sand Content
- Step-Drawdown Pumping Test (Minimum of three steps)
- Constant Rate Pumping Test (Minimum 24hr test)
- Dynamic Flowmeter (Spinner) Survey
- Gyroscopic Well Alignment Survey
- Well Video
- Title 22 Water Quality Analysis

IV. Well Equipping Requirements

A. Vertical Turbine Pump Design Range

a. Historic Water Levels

Water levels were reviewed from August 2013 through March 2021 in the area of the Kern Fan Groundwater Storage Project. Two wells were selected from the Strand Ranch Project, SREX-1 (north side of CVC) and SREX-7 (south side of CVC); two wells from the Stockdale West Project, SWEX-2 and SWEX-3; and three wells from the Drought Relief Project, SUP-1, SUP-5, and the Matuk Well.

The static water levels were low in 2013 through 2016 as a result of the drought. The lowest static water level observed in these wells was approximately 320-ft at SREX-7 around May of 2016. The static water levels then began to trend upwards as a result of groundwater recharge to their peak around January 2020. The shallowest static water level observed was approximately 87-ft at SWEX-3. See the graph of static water levels in Figure 6 below.

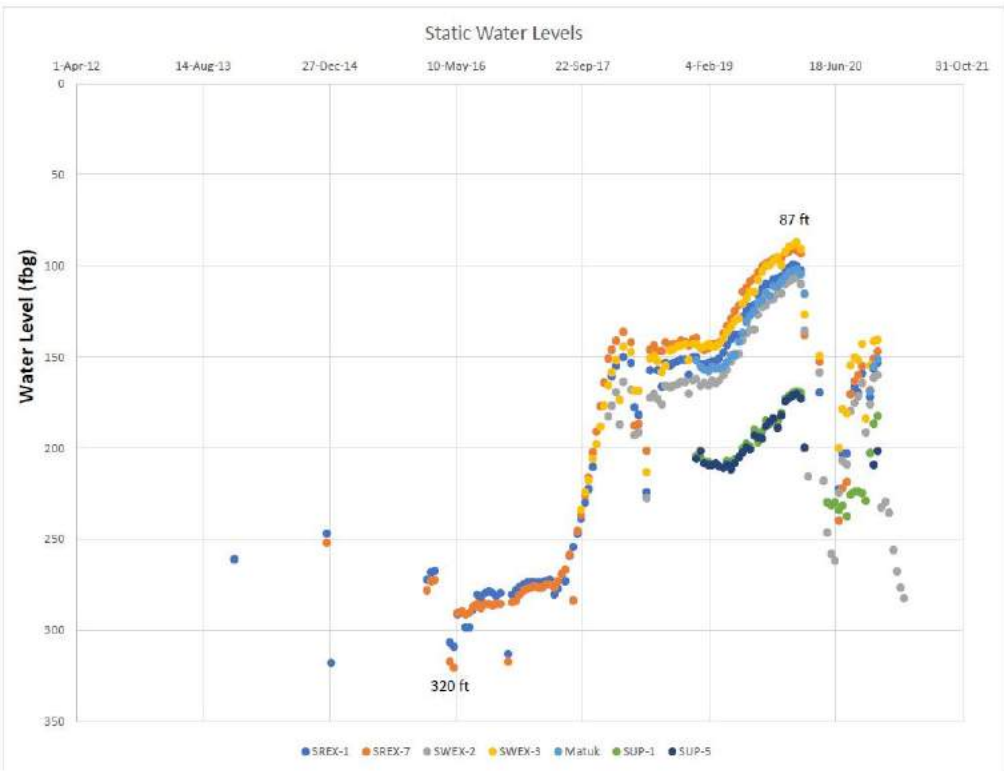

Figure 6: Historic Static Water Levels

The pumping water levels were also low in 2013 through 2016 as a result of the drought. The deepest pumping water level observed in these wells during the drought was approximately 440-ft at SREX-7 around April of 2016. The pumping water levels then began to trend upwards as a result

of groundwater recharge to their peak around February 2018. The shallowest pumping water level observed was approximately 277-ft at SREX-1. See the graph of pumping water levels in Figure 7 below.

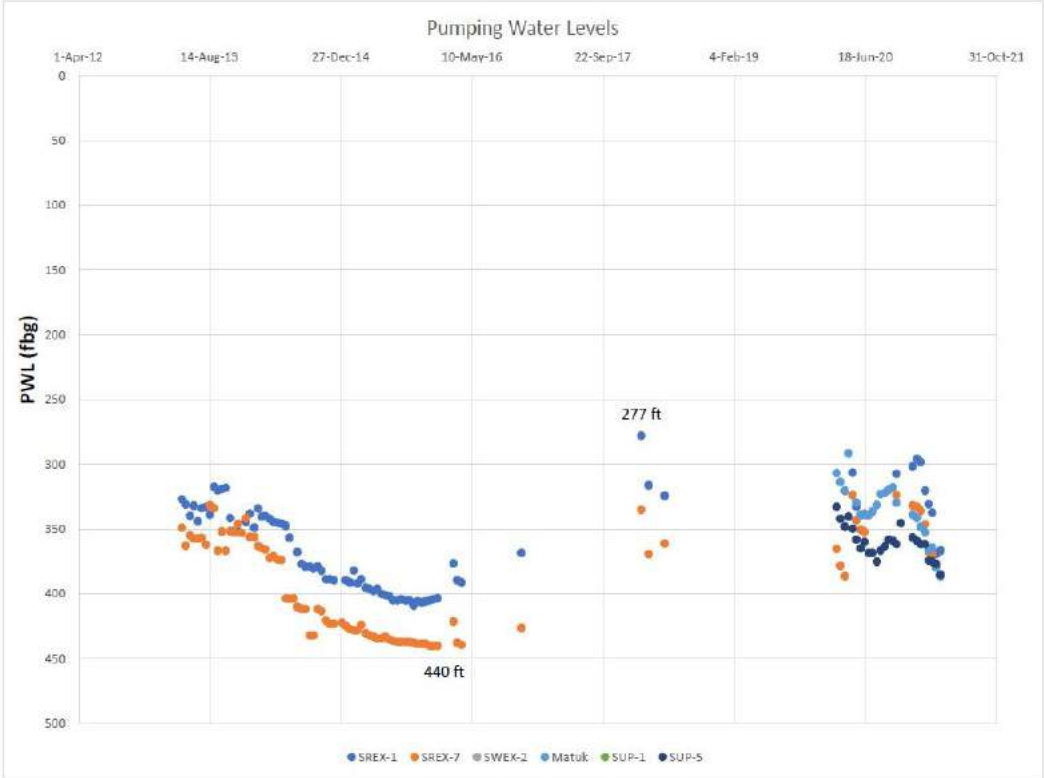

Figure 7: Historic Pumping Water Levels

b. Pump Design Criteria

The actual pump design point will be based upon the results of the well drilling and development, however the historical water level data in the area shall be used to provide a range of water levels for purposes of the pump design. It is recommended that the pump and motor be designed to provide the design flow rate at the deeper pumping water levels and then the VFD can be utilized to operate the pump at slower speeds, if necessary, when water levels are shallow.

The range observed for pumping water levels in the area is approximately 275-ft to 450-ft.

The design operating point for shallow pumping water levels (after recharge periods) would be approximately 4,000 gpm (9.0 cfs) at a pumping water level of 275-ft with a minimum bowl efficiency of 75%. In selecting the actual pump, the engineer will need to take into consideration column friction losses, discharge pipeline losses, and minor losses.

The design operating point for deeper pumping water levels (during sustained dry years) would be approximately 2,250 gpm (5 cfs) at a pumping water level of 450-ft with a minimum bowl efficiency of 68.0%.

In selecting the actual pump, the engineer will need to take into consideration column friction losses, discharge pipeline losses, and minor losses.

The preliminary design operating point for the pump is approximately 3,000 gpm (6.7 cfs) at an approximate pumping water level of 400-ft with a minimum bowl efficiency of 80.0%.

c. Pump Assembly

A vertical turbine pump shall be installed for each well. The size, capacity, and depth of pump setting will be determined based on the results of the final well development. The pump assembly will be oil-lubricated and include a 10 gallon oil reservoir with solenoid valve and manual bypass.

For cost estimating purposes, the pump has been estimated to include 12-inch column pipe, 3 1/2-inch enclosing tubing, and 2 3/16-inch lineshaft. The line shaft shall be Type 416 stainless steel with Type 316 stainless steel shaft couplings and bronze lineshaft bearings. The column piping shall also include a 5-ft section installed just above the pump and a 5-ft section installed just below the pump head. The pump assembly shall include a 5-ft long suction pipe with a stainless steel cone strainer. The depth of the pump setting will be dependent on the design of the well casing (install where adjacent to blank sections of casing), however it is anticipated to be set below a depth of 550-ft.

The pump discharge head shall sit on a reinforced concrete foundation. The camera tube, gravel feed tube, and casing shall be extended or trimmed as necessary to conform to the concrete foundation. In addition, a 3-inch casing vent shall be installed that is screened and extends 3-feet above the foundation.

B. Well Motor Type

The well motor shall be a vertical hollow shaft electric motor. The motor horsepower has been estimated as 400 to 500 hp.

C. Variable Speed Drives

A variable speed drive shall be installed at each well pump and motor. The variable speed drive is more energy efficient, reduces the motor starting voltages and flicker issues with the power supply grid, and provides more pumping flexibility with varying groundwater levels.

The variable speed drive is to be a Yaskawa U1000 Industrial Matrix Drive. This drive has ultra-low harmonics, full continuous regeneration, and high-efficiency.

D. Discharge Pipe Size and Appurtenances

The discharge piping is to be 12-inch fusion bonded epoxy lined and coated steel discharge piping as outlined in Technical Memorandum No. 3 "Pipeline Requirements".

The well discharge shall include the following at a minimum:

- a deep well air release and vacuum relief valve (Waterman AV-150 Air Vent with Vacuum Relief or approved equal)
- a sleeve coupling with joint harness (Dresser or approved equal)
- a high pressure switch (Mercoid or approved equal)
- pressure transmitter (Smar Technology or approved equal)
- sample port
- wafer check valve (Fresno Valve or approved equal)
- pressure gauge (Ashcroft or approved equal)
- magnetic flow meter (Seametrics or approved equal)
- combination air vent and vacuum relief valve assembly (Waterman CR101 or approved equal)
- butterfly valve (Grayline Valve or approved equal) and
- pipe supports

E. Electrical Service & Switchgear

The electrical service is anticipated to be provided by PG&E. A pad mounted transformer, as approved by PG&E, will be installed at each well site with bollards.

Each well site will have a main switchboard section with pull section, meter section, and main breaker. The motor control center will include security power, RTU panel, the well motor starter, 5 kVA transformer, a load panel (circuit breakers), a well level indicator screen, low well level alarm light and reset alarm button. The electrical equipment shall also be equipped with interior lighting and receptacles. The orientation of the electrical gear shall face north or east, as reasonable when designing the site layout, to minimize the direct sunlight on the face of the equipment.

The RTU unit is discussed in Technical Memorandum No. 10 (SCADA) and will be work performed by others. The motor control center (MCC) shall include a spare bucket or cabinet for installation of the RTU and I/O devices.

The electrical gear shall be enclosed in NEMA 3R equipment and shall be fully rated for continuous operation at 50° C ambient conditions within the electrical equipment for outdoor installation. Digital displays shall be installed between a height of 48-inches to 60-inches and be protected from direct sunlight.

F. Instrumentation & Controls

The instrumentation and controls will be utilized for well operation, safety features, and monitoring. The instrumentation and controls shall include the following devices:

- Well Level Transducer (4-20 ma) for monitoring groundwater levels (Endress + Hauser or approved equal). The estimated cost for the transducer is $1,500.00.
- Solenoid for oil drip to deep well pump.
- High Pressure Switch to protect piping from over-pressurizing (Mercoid or approved equal). The estimated cost for the high pressure switch is $1,200.00.
- Pressure Transmitter (4-20 ma) for monitoring discharge pressure (Smar Technology or approved equal). The estimated cost for the pressure transmitter is $1,000.00.
- Flow Meter signal (4 – 20 ma) for monitoring well flow (Seametrics Mag Meter with power supply – not battery)

G. Well Enclosures

The well motor enclosure consists of a 14-ft diameter welded steel hut. The enclosure shall have a cone roof and be tall enough to provide a minimum 24-inch clearance above the top of the well motor. The enclosure shall be made out of 2x2 square tubing, galvanized sheet metal, and 2x2 square welded wire fabric. The enclosure shall include a 31-inch wide by 84-inch tall access door and the enclosure shall be removable for times when the well, pump, and motor need to be serviced.

H. Equipment Security

Site security is important at these well sites to prevent theft and vandalism. Site security includes, site lighting, well motor enclosure, and electrical equipment locking gate beams.

I. Shade Structure

A pre-engineered electrical equipment canopy or shade structure shall be installed at each well site. The shade structure shall consist of steel square tubing for the frame and weather panel material for the roofing and siding. All material shall be hot-dip galvanized steel. The structure shall be anchored to the concrete foundation and designed for seismic and wind loading in accordance with ASCE 7-16 and the 2019 California Building Code (CBC).

The size and height of the shade structure shall be coordinated with the electrical gear dimensions and provide for a minimum 4-ft covered clear

space in front of the electrical gear and a minimum 2-ft clearance around the sides and back of the gear.

J. Control Philosophy and Monitoring

The wells are operated during recovery operations and are manually operated. They are turned on manually and turned off manually unless shutdown on a power failure, equipment failure, or high pressure switch. The operation, control, and monitoring of the well facilities is discussed further in Technical Memorandum No. 10 Facility Operation and SCADA Requirements.

The monitoring devices send information via 4-20 ma signals to the RTU panel or a Mission Unit. The RTU or Mission Unit is a remote monitoring device that displays the following:

- Well Status
- Groundwater Level
- Well Discharge Pressure
- Well Discharge Flow
- Any Alarms

V. Well Site Requirements

A. Site Fencing & Security

Site security is an important feature of these well sites as they are located in remote areas and are often not visible to the public and routine traffic.

Security will need to be provided for the electrical equipment and the well as the most vulnerable well site feature is the copper wiring to the motor.

The security for the electrical equipment shall include a locking cross bar that runs across the front of the electrical gear to prevent it from being opened. It includes steel posts, hinges, gate beams, support beams, and a lock box.

The well motor security consists of a 14-ft diameter welded steel enclosure hut. The enclosure shall have a cone roof and be tall enough to provide a minimum 24-inch clearance above the top of the well motor. The enclosure shall be made out of 2x2 square tubing, galvanized sheet metal, and 2x2 square welded wire fabric. The enclosure shall include a 31-inch wide by 84-inch tall access door and the enclosure shall be removable for times when the well, pump, and motor need to be serviced.

B. Site Lighting

Site lighting is another security feature due to the remote location of these well sites. It is helpful to have them well lit at night to deter trespassing and to aid in visibility for working at night, if necessary. It is estimated that a minimum of two flood lights will be installed at each well site on the shade structure with motion sensors and photo cells. The lighting will be directed to the motor control center and the well pump and motor.

C. Site Ground Surfacing

All-weather surfacing is a requirement for these sites to minimize maintenance for weeds and to provide good access to equipment. It is estimated that the all-weather surfacing will be 4-inch thick, ¾-inch Class II aggregate base.

VI. Related Work Specified Elsewhere

A. TM 1 – Project Phasing and Design/Contractor Selection
B. TM 3 – Pipeline Requirements
C. TM 5 – Geotechnical Investigation
D. TM 9 – Recharge Basin Requirements
E. TM 10 – Facility Operation and SCADA Requirements
F. TM 11- Engineer's Estimates

APPENDIX H

Technical Memorandum #8
Right-of-Way Acquisitions

DEE JASPAR & ASSOCIATES, INC.
CONSULTING CIVIL ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CA 93308
PHONE (661) 393-4796
FAX (661) 393-4799

KERN FAN GROUNDWATER STORAGE PROJECT

TECHNICAL MEMORANDUM NO. 8
(ROW Acquisitions)

PREPARED FOR: Groundwater Banking Joint Powers Authority (GBJPA)
PREPARED BY: Curtis Skaggs, P.E.
DATE: May 11, 2021

SUBJECT: ***Right of Way Acquisitions***

I. Executive Summary

This memorandum addresses the right-of-way acquisition work associated with the conveyance facility alignment and turnouts. The memorandum contents are outlined below:

The alignment illustrated herein is preliminary. The actual alignment of the conveyance facilities will be subject to the final locations of the Phase I and Phase II properties. In addition, the project design will dictate the final widths for the project right-of-way.

For purposes of this memorandum, the term "right-of-way" is used as a generic term for the conveyance facility land. The following terms should be understood to be defined as outlined below:

- "In-Fee" is understood to be permanent right-of-way owned in fee simple by the GBJPA.

- "Permanent Easement" is understood to be an easement to the GBJPA in perpetuity for the construction, operation, and maintenance of the conveyance facility.

- "Temporary Easement" is understood to be an easement to the GBJPA that is outside of the in-fee right-of-way or the permanent easement and is for construction purposes over a limited duration of time.

In the event the conveyance facility is an open canal, this memorandum has estimated a lined canal right-of-way width of 180-ft. This equates to approximately 201 acres of permanent right-of-way. This right-of-way is recommended to be purchased "in fee" for a lined canal. The estimated value of this right-of-way is between $4,385,280 to $4,691,956. In addition, an approximate width of 90-ft has been estimated for temporary construction easement which equates to approximately 101 acres. The estimated value for the temporary easement is $2,193,099 to $2,346,529.

In the event the conveyance facility is a pipeline, this memorandum has estimated a pipeline right-of-way width of 140-ft. This equates to approximately 158 acres of permanent right-of-way. This right-of-way could be purchased "in fee" or as a permanent easement. The estimated value of this right-of-way is between $3,411,488 to $3,650,156. In addition, an approximate width of 50-ft has been estimated for temporary construction easement which equates to approximately 56 acres. The estimated value for the temporary easement is $1,218,388 to $1,303,627.

The GBJPA will negotiate with landowners for right-of-way and easements. It is anticipated that as part of the negotiations the GBJPA will provide a farmer turnout to the property owners, free of charge, within the District service area. A landowner would receive a turnout per 160 acres of land that is adjacent to and impacted by the conveyance facility. In addition to relocating existing utilities or pipelines if impacted by the new facilities, the GBJPA will also provide one 12" diameter PVC pipe crossing for the width of the in-fee right-of-way or permanent easement per 160 acres of land that is adjacent to and impacted by the conveyance facility. This 12" PVC pipe crossing can be used by the landowner for a future utility crossing if needed. Any additional landowner crossings would be under an encroachment permit application process.

The GBJPA will prepare a package for each property owner. The package will describe the project, outline what will be crossing their property, illustrate the area of property impacted, provide the monetary offer, include an eminent domain pamphlet, and provide details for meet and confer negotiations, if necessary.

The GBJPA will:

- Obtain land and crop appraisals
- Obtain preliminary title reports
- Perform a Phase I Assessment, if determined necessary
- Submit draft plats and legal descriptions for property owners to review and provide input
- Prepare offer letters with final plats and legal descriptions
- Prepare offer letters
- Negotiate Fair Market Value
- Initiate Eminent Domain/Condemnation, if determined necessary

Eminent domain will only be utilized as a last resort. Eminent Domain allows the GBJPA to take private property for a public use with just compensation. Typically, the measure of just compensation is the fair market value of the property that is taken for public use. The alignment selected for the conveyance facility shall create the least public harm or least impact to the public and property values.

It is anticipated that the engineering design firm for the conveyance facilities will provide surveying and plats to illustrate the conveyance facility alignment across each property as well as providing legal descriptions and plats for the right-of-way or easement acquisition. These plats and right-of-way documents will be prepared and submitted to the GBJPA for review and comment prior to including in the land acquisition packages. This memorandum has been prepared based upon certain data now available and under certain items based upon information and belief and thus is subject to change or amendment upon the acquisition of additional data or the change in circumstances at a future unknown date.

II. ROW Requirements

A. Land Acquisition

The GBJPA is pursuing land acquisitions for the Phase I and Phase II properties. The actual alignment of the conveyance facilities will be subject to the locations of the Phase I and Phase II properties. The alignment utilized herein is preliminary.

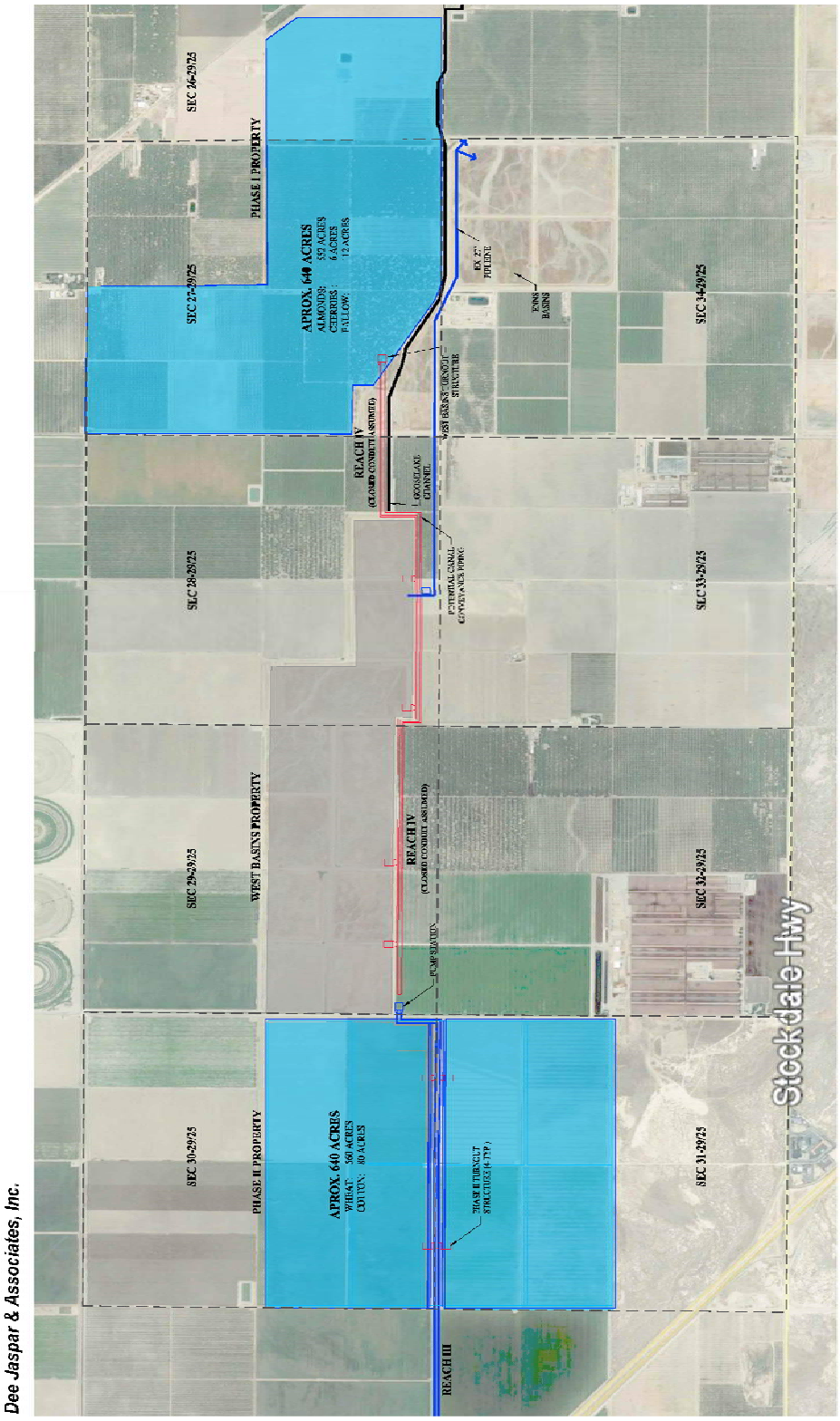

Figure 1: Preliminary Phase I and Phase II Locations

B. Conveyance Alignment

The conveyance alignment could be owned in fee or could be in the form of permanent easements. In the event the conveyance facilities are an open canal, it is recommended that the property ownership be in fee. The reason being that the landowner will not be able to use the land for anything in the area of the canal and the alignment will need to be fenced and secured with limited crossings and access for the property owners. Based upon the preliminary alignment, a canal with 1.5:1 side slopes, and a 180-ft right-of-way, it is estimated that the land acquisition required would be approximately 200 acres.

If the conveyance facilities consist of a pipeline, the right-of-way could be in fee or permanent easement. Permanent easement would allow the JPA to use the land for the underground pipeline and turnouts as well as access, while the landowner would retain ownership and limited use of the land. It is anticipated that the pipeline right-of-way would be maintained free and clear of crops, storage, or other structures that would preclude access along the right-of-way or make it difficult to initiate repairs to the pipeline.

The pipeline alignment would be parallel to and near property lines on the edge of crops and parcels and generally follow access roads where feasible. It is anticipated that landowners will remain responsible for maintaining existing farm roads.

This property acquisition will depend on the type of conveyance facilities constructed such as an open channel (canal) or closed conduit (pipeline) but is anticipated to range between 150 acres and 250 acres. The actual acreage will also depend on the final alignment of the facilities and the conveyance design which will dictate final right-of-way widths. Figure 2 illustrates the current preliminary alignment for the conveyance facility.

The property acquisition of the conveyance facilities will include the aqueduct turnout piping, the conveyance facilities, road crossings, pump stations, turnouts, and electrical facilities.

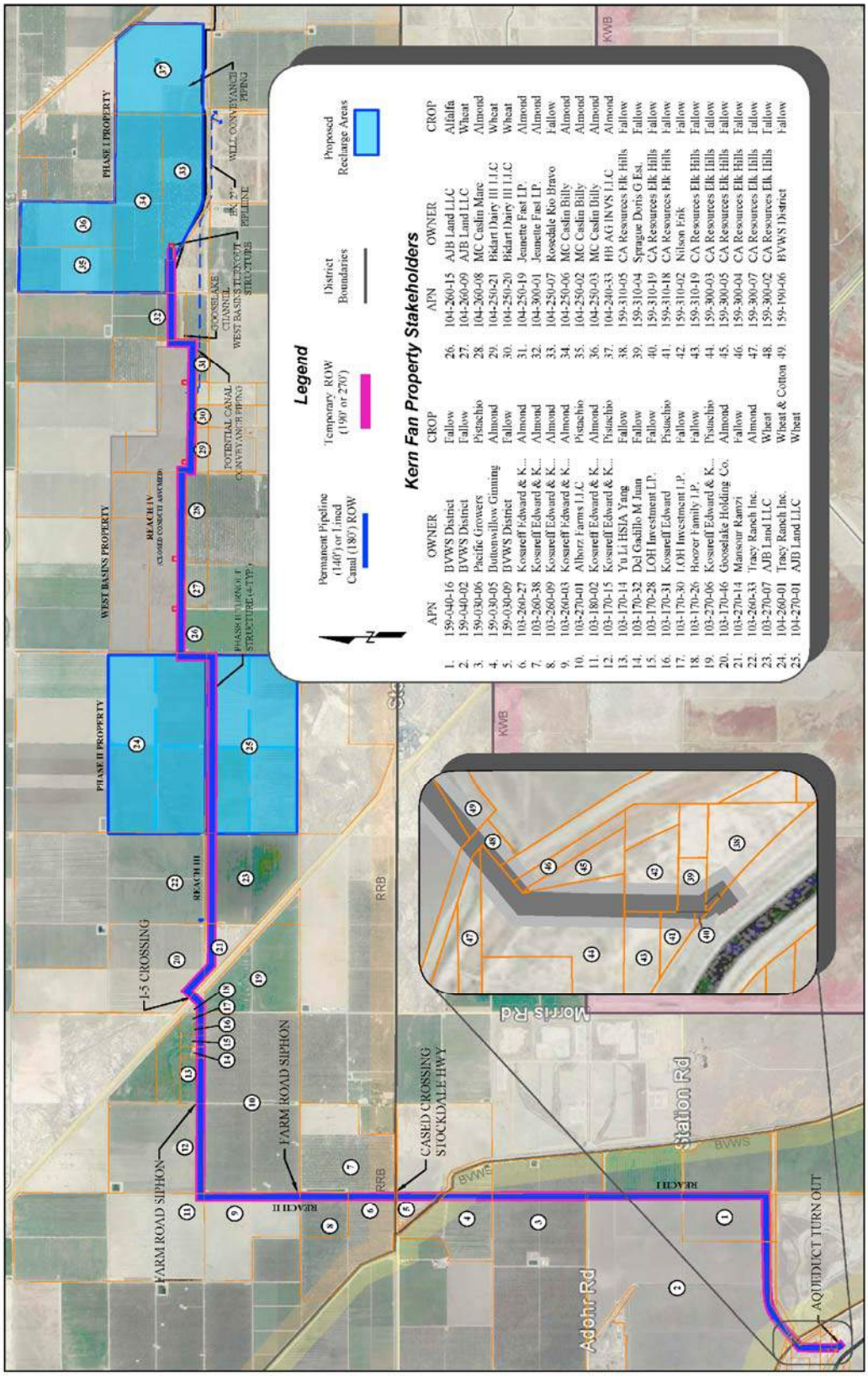

Figure 2: Preliminary Conveyance Alignment

C. Permanent Easements

As noted above, permanent easement is not recommended for the conveyance facility if it is an open canal.

The preliminary conveyance alignment is approximately 9.30 miles in length from the Aqueduct Turnout to the east end of the West Basins or approximately 49,080-ft. It is estimated that a permanent easement or in fee right-of-way of approximately 140-ft would be required to allow for repairs and maintenance of the pipeline. This equates to approximately 158 acres.

The permanent easement agreements will allow for the landowner to maintain limited use of the easement area, however it will not permit the following:

- There to be less than thirty-six (36") inches of earth cover or more than sixty (60") inches of earth cover measured vertically to the top of pipe.

- The grade of the existing ground surface above the pipeline to be changed by more than twelve (12") inches.

- Permanent crops anywhere within the easement area. The planting of crops within some of the easement area may be acceptable to the GBJPA through a subsequent encroachment permit process. However, the GBJPA would not be responsible for damage to crops or any related costs if the crop needed to be removed to maintain, repair, or replace the conveyance facilities.

The easement areas shall be kept open, clear, and free from buildings, structures, or permanent crops of any kind unless allowed for under an encroachment permit from the GBJPA. Monetary consideration will be provided for the permanent easement area and the GBJPA will compensate the landowner for the removal of any crop located within the permanent easement area.

All existing facilities impacted by the construction and installation of conveyance facilities will be restored or replaced in kind to the satisfaction of the GBJPA and the landowner.

A sample Water Pipeline Easement Agreement is attached in Appendix A.

D. Temporary Easements

Temporary easements are anticipated to be necessary for the conveyance alignment in all instances for purposes of construction.

In the event of a canal, it is estimated that an additional 90-ft temporary easement would be necessary for construction. This equates to approximately 101 acres.

In the event of a pipeline, it is estimated that an additional 50-ft temporary easement would be necessary for construction. This equates to approximately 56 acres.

The easement granted is a temporary right to enter upon the temporary easement area, to store and operate construction equipment and materials thereon, and to cross over the temporary easement area in connection with the performance of certain construction work. Monetary consideration will be provided for the temporary easement area and the GBJPA will compensate the landowner for the removal of any crop located within the temporary easement area.

Within fifteen (15) days following completion of the construction work, all construction equipment and materials will be removed from the temporary easement area and the temporary easement area restored to the condition it was in on the date and time of the execution of the agreement. The restoration work will specifically include the repair or replacement of any landscaping, structures, fences, driveways, or other improvements that were removed, damaged, or destroyed, however this does not include any crop for which consideration was previously made.

A sample Temporary Easement Agreement is attached in Appendix B.

III. Methodology

The GBJPA will negotiate with landowners for right-of-way and easements. It is anticipated that as part of the negotiations the GBJPA will provide a farmer turnout to the property owners, free of charge, within the District service area. A landowner would receive a turnout per 160 acres of land that is adjacent to and impacted by the conveyance facility. In addition to relocating existing utilities or pipelines if impacted by the new facilities, the GBJPA will also provide one 12" diameter PVC pipe crossing for the width of the in-fee right-of-way or permanent easement per 160 acres of land that is adjacent to and impacted by the conveyance facility. This 12" PVC pipe crossing can be used by the landowner for a future utility crossing if needed. Any additional landowner crossings would be under an encroachment permit application process.

The GBJPA will prepare a package for each property owner. The package will describe the project, outline what will be crossing their property, illustrate the area of property impacted, provide the monetary offer, include an eminent domain pamphlet, and provide details for meet and confer negotiations, if necessary.

The GBJPA will:

- Obtain land and crop appraisals
- Obtain preliminary title reports
- Perform a Phase I Assessment, if determined necessary
- Submit draft plats and legal descriptions for property owners to review and provide input
- Prepare offer letters with final plats and legal descriptions
- Prepare offer letters
- Negotiate Fair Market Value
- Initiate Eminent Domain/Condemnation, if determined necessary

Eminent domain will only be utilized as a last resort. Eminent Domain allows the GBJPA to take private property for a public use with just compensation. Typically, the measure of just compensation is the fair market value of the property that is taken for public use. An information pamphlet related to Eminent Domain is attached in Appendix C.

It is anticipated that the engineering design firm for the conveyance facilities will provide plats to illustrate the conveyance facility alignment across each property as well as providing legal descriptions and plats for the right-of-way or easement acquisition. These plats and right-of-way documents will be prepared and

submitted to the GBJPA for review and comment prior to including in the land acquisition packages.

It is anticipated that the engineering design firm will evaluate the specific conveyance alignment with considerations given to physical constraints, economics, and environmental issues. The engineering design firm shall refer to the Mitigation Monitoring and Reporting Program outlined in the Final Environmental Impact Report. The alignment selected for the conveyance facility shall seek to create the least public harm or least impact to the public and property values.

The GBJPA may also hire a third-party firm that specializes in land acquisitions. This firm would provide assistance in contacting property owners, negotiating with property owners, and finalizing the land acquisition paperwork.

IV. Land Valuations

Preliminary land valuation information was provided by Mike Ming with Alliance Ag Services, Inc. for cost estimating purposes.

A preliminary list of properties impacted by the conveyance alignment has been prepared and a crop valuation performed.

Acquisition of land within "white land" areas or lands without any specific proposal for District water are estimated to be $10,000 per acre.

Acquisition of property from the Buena Vista Water Storage District is estimated between $27,500 to $29,000 per acre.

Acquisition of land within District boundaries will be based upon the type of crop that is planted and being farmed.

- Fallow land is estimated between $15,000 to $16,000 per acre.
- Wheat and Cotton are estimated between $22,000 to $24,000 per acre.
- Almonds are estimated between $26,000 to $32,000 per acre.
- Pistachios are estimated between $48,000 to $55,000 per acre.

The total estimated land acquisition costs for a pipeline conveyance facility with a 140-ft right-of-way is $3,411,488 to $3,650,156. The cost for an additional 50-ft temporary easement is $1,218,388 to $1,303,627.

The total estimated land acquisition costs for a lined canal conveyance facility with a 180-ft right-of-way is $4,385,280 to $4,691,956. The cost for an additional 90-ft temporary easement is $2,193,099 to $2,346,529.

V. Crop Valuations

The crop valuations vary depending on the type of crop planted. Alliance Ag Services, Inc. utilizes a model to estimate the value of the crop on a per tree or per acre basis.

However, for purposes of this memorandum approximations of crop value have been estimated based on the right-of-way area and the average crop value per acre. These estimates are illustrated in Table 1 - Pipeline Conveyance and Table 2 – Lined Canal Conveyance.

Table 1

Pipeline Conveyance Crop Valuation

Groundwater Banking Joint Powers Authority

Kern Fan Groundwater Project

Preliminary Right-of-Way (ROW) Crop Take Estimates

Property Summary									AAS Crop Valuation				Permanent ROW		Temporary ROW	
No.	APN	Owner	Crop Type	Length (ft)	Permanent ROW Width (ft)	Potential Permanent ROW	Temporary ROW Width (ft)	Potential Temporary ROW	Crop Take $/Acre		WD	ASSUMPTION	LOW	HIGH	LOW	HIGH
38	159-310-05	CA Resources Elk Hills LLC	Fallow	100	140	0.3	50	0.1	$ 500	$ 600			$ 161	$ 193	$ 57	$ 69
40	159-310-17	CA Resources Elk Hills LLC	Fallow	200	140	0.6	50	0.2	$ 500	$ 600			$ 321	$ 386	$ 115	$ 138
41	159-310-18	CA Resources Elk Hills LLC	Fallow	200	140	0.6	50	0.2	$ 500	$ 600			$ 321	$ 386	$ 115	$ 138
43	159-310-19	CA Resources Elk Hills LLC	Fallow	200	140	0.6	50	0.2	$ 500	$ 600			$ 321	$ 386	$ 115	$ 138
44	159-300-03	CA Resources Elk Hills LLC	Fallow	1000	140	3.2	50	1.1	$ 500	$ 600			$ 1,607	$ 1,928	$ 574	$ 689
47	159-300-07	CA Resources Elk Hills LLC	Fallow	100	140	0.3	50	0.1	$ 500	$ 600			$ 161	$ 193	$ 57	$ 69
48	159-300-02	CA Resources Elk Hills LLC	Fallow	200	140	0.6	50	0.2	$ 500	$ 600			$ 321	$ 386	$ 115	$ 138
2	159-040-02	BVWS District	Fallow	3700	140	11.9	50	4.2	$ 27,500	$ 29,000	BV		$ 327,029	$ 344,858	$ 116,793	$ 123,163
1	159-040-16	BVWS District	Fallow	5500	140	17.7	50	6.3	$ 27,500	$ 29,000	BV		$ 486,111	$ 512,626	$ 173,611	$ 183,081
3	159-030-06	Pacific Growers	Pistachio	2600	140	8.4	50	3.0	$ 50,000	$ 55,000	BV	Median age,Prime Production	$ 417,815	$ 459,596	$ 149,219	$ 164,141
4	159-030-05	Buttonwillow Ginning	Almond	1400	140	4.5	50	1.6	$ 30,000	$ 32,000	BV	Median age,Prime Production	$ 134,986	$ 143,985	$ 48,209	$ 51,423
5	159-030-09	BVWS District	Fallow	1200	140	3.9	50	1.4	$ 27,500	$ 29,000	BV		$ 106,061	$ 111,846	$ 37,879	$ 39,945
6	103-260-27	Kosareff Edward & Katherine	Almond	1300	140	4.2	50	1.5	$ 26,000	$ 28,000	RRBWSD	Median age,Prime Production	$ 108,632	$ 116,988	$ 38,797	$ 41,781
8	103-260-09	Kosareff Edward & Katherine	Almond	1300	140	4.2	50	1.5	$ 26,000	$ 28,000	RRBWSD	Median age,Prime Production	$ 108,632	$ 116,988	$ 38,797	$ 41,781
9	103-260-03	Kosareff Edward & Katherine	Almond	2700	140	8.7	50	3.1	$ 26,000	$ 28,000	RRBWSD	Median age,Prime Production	$ 225,620	$ 242,975	$ 80,579	$ 86,777
11	103-180-02	Kosereff Edward & Katherine	Almond	200	140	0.6	50	0.2	$ 26,000	$ 28,000	RRBWSD	Median age,Prime Production	$ 16,713	$ 17,998	$ 5,969	$ 6,428
12	103-170-15	Kosareff Edward & Katherine	Pistachio	2700	140	8.7	50	3.1	$ 48,000	$ 50,000	RRBWSD	Median age,Prime Production	$ 416,529	$ 433,884	$ 148,760	$ 154,959
13	103-170-14	Yu Li HSIA Yang	Fallow	1300	140	4.2	50	1.5	$ 15,000	$ 16,000	RRBWSD		$ 62,672	$ 66,850	$ 22,383	$ 23,875
14	103-170-32	Del Gadillo M Juan	Fallow	300	140	1.0	50	0.3	$ 15,000	$ 16,000	RRBWSD		$ 14,463	$ 15,427	$ 5,165	$ 5,510
15	103-170-28	LOH Investment LP.	Fallow	300	140	1.0	50	0.3	$ 15,000	$ 16,000	RRBWSD		$ 14,463	$ 15,427	$ 5,165	$ 5,510
16	103-170-31	Kosareff Edward	Pistachio	300	140	1.0	50	0.3	$ 48,000	$ 50,000	RRBWSD	Median age,Prime Production	$ 46,281	$ 48,209	$ 16,529	$ 17,218
17	103-170-30	LOH Investment LP.	Fallow	300	140	1.0	50	0.3	$ 15,000	$ 16,000	RRBWSD		$ 14,463	$ 15,427	$ 5,165	$ 5,510
18	103-170-26	Boozer Family LP.	Fallow	400	140	1.3	50	0.5	$ 15,000	$ 16,000	RRBWSD		$ 19,284	$ 20,569	$ 6,887	$ 7,346
20	103-170-46	Gooslake Holding Co.	Almond	600	140	1.9	50	0.7	$ 30,000	$ 32,000	RRBWSD	Median age,Prime Production	$ 57,851	$ 61,708	$ 20,661	$ 22,039
21	103-270-14	Mansour Ramzi	Fallow	1700	140	5.5	50	2.0	$ 15,000	$ 16,000	RRBWSD	If no enviro issues	$ 81,956	$ 87,420	$ 29,270	$ 31,221
23	103-270-07	AJB Land LLC	Wheat	2700	140	8.7	50	3.1	$ 22,000	$ 24,000	RRBWSD	If no enviro issues	$ 190,909	$ 208,264	$ 68,182	$ 74,380
24	104-260-01	Tracy Ranch Inc.	Wheat & Cotton	700	140	2.2	50	0.8	$ 22,000	$ 24,000	RRBWSD		$ 49,495	$ 53,994	$ 17,677	$ 19,284
25	104-270-01	AJB Land LLC	Wheat	5280	140	17.0	50	6.1	$ 22,000	$ 24,000	RRBWSD		$ 373,333	$ 407,273	$ 133,333	$ 145,455
32	104-300-01	Jeanette Fast LP.	Almond	1400	140	4.5	50	1.6	$ 30,000	$ 32,000	RRBWSD	Median age,Prime Production	$ 134,986	$ 143,985	$ 48,209	$ 51,423
		RRBWSD West Basins	Recharge Basins	9200	140	29.6	50	10.6					$ -	$ -	$ -	$ -
		Total Length including Aqueduct Turnout Piping:		49080									$3,411,488	$3,650,156	$1,218,388	$1,303,627
		Total Length excluding Aqueduct Turnout Piping:		47080								Mean $/Acre	$ 21,627	$ 23,140	$ 21,627	$ 23,140
					Total ROW Acreage:	157.7		56.3								
					Total ROW Acreage excluding RRB Property:	128.2		45.8								

Table 2

Lined Canal Conveyance Crop Valuation

Groundwater Banking Joint Powers Authority

Kern Fan Groundwater Project

Preliminary Right-of-Way (ROW) Crop Take Estimates

Property Summary									AAS Crop Valuation				Permanent ROW		Temporary ROW	
No.	APN	Owner	Crop Type	Length (ft)	Permanent ROW Width (ft)	Potential Permanent ROW	Temporary ROW Width (ft)	Potential Temporary ROW	Crop Take $/Acre		WD	ASSUMPTION	LOW	HIGH	LOW	HIGH
38	159-310-05	CA Resources Elk Hills LLC	Fallow	100	140	0.3	90	0.2	$ 500	$ 600			$ 161	$ 193	$ 103	$ 124
40	159-310-17	CA Resources Elk Hills LLC	Fallow	200	140	0.6	90	0.4	$ 500	$ 600			$ 321	$ 386	$ 207	$ 248
41	159-310-18	CA Resources Elk Hills LLC	Fallow	200	140	0.6	90	0.4	$ 500	$ 600			$ 321	$ 386	$ 207	$ 248
43	159-310-19	CA Resources Elk Hills LLC	Fallow	200	140	0.6	90	0.4	$ 500	$ 600			$ 321	$ 386	$ 207	$ 248
44	159-300-03	CA Resources Elk Hills LLC	Fallow	1000	140	3.2	90	2.1	$ 500	$ 600			$ 1,607	$ 1,928	$ 1,033	$ 1,240
47	159-300-07	CA Resources Elk Hills LLC	Fallow	100	140	0.3	90	0.2	$ 500	$ 600			$ 161	$ 193	$ 103	$ 124
48	159-300-02	CA Resources Elk Hills LLC	Fallow	200	140	0.6	90	0.4	$ 500	$ 600			$ 321	$ 386	$ 207	$ 248
2	159-040-02	BVWS District	Fallow	3700	180	15.3	90	7.6	$ 27,500	$ 29,000	BV		$ 420,455	$ 443,388	$ 210,227	$ 221,694
1	159-040-16	BVWS District	Fallow	5500	180	22.7	90	11.4	$ 27,500	$ 29,000	BV		$ 625,000	$ 659,091	$ 312,500	$ 329,545
3	159-030-06	Pacific Growers	Pistachio	2600	180	10.7	90	5.4	$ 50,000	$ 55,000	BV	Median age,Prime Production	$ 537,190	$ 590,909	$ 268,595	$ 295,455
4	159-030-05	Buttonwillow Ginning	Almond	1400	180	5.8	90	2.9	$ 30,000	$ 32,000	BV	Median age,Prime Production	$ 173,554	$ 185,124	$ 86,777	$ 92,562
5	159-030-09	BVWS District	Fallow	1200	180	5.0	90	2.5	$ 27,500	$ 29,000	BV		$ 136,364	$ 143,802	$ 68,182	$ 71,901
6	103-260-27	Kosareff Edward & Katherine	Almond	1300	180	5.4	90	2.7	$ 26,000	$ 28,000	RRBWSD	Median age,Prime Production	$ 139,669	$ 150,413	$ 69,835	$ 75,207
8	103-260-09	Kosareff Edward & Katherine	Almond	1300	180	5.4	90	2.7	$ 26,000	$ 28,000	RRBWSD	Median age,Prime Production	$ 139,669	$ 150,413	$ 69,835	$ 75,207
9	103-260-03	Kosareff Edward & Katherine	Almond	2700	180	11.2	90	5.6	$ 26,000	$ 28,000	RRBWSD	Median age,Prime Production	$ 290,083	$ 312,397	$ 145,041	$ 156,198
11	103-180-02	Kosereff Edward & Katherine	Almond	200	180	0.8	90	0.4	$ 26,000	$ 28,000	RRBWSD	Median age,Prime Production	$ 21,488	$ 23,140	$ 10,744	$ 11,570
12	103-170-15	Kosareff Edward & Katherine	Pistachio	2700	180	11.2	90	5.6	$ 48,000	$ 50,000	RRBWSD	Median age,Prime Production	$ 535,537	$ 557,851	$ 267,769	$ 278,926
13	103-170-14	Yu Li HSIA Yang	Fallow	1300	180	5.4	90	2.7	$ 15,000	$ 16,000	RRBWSD		$ 80,579	$ 85,950	$ 40,289	$ 42,975
14	103-170-32	Del Gadillo M Juan	Fallow	300	180	1.2	90	0.6	$ 15,000	$ 16,000	RRBWSD		$ 18,595	$ 19,835	$ 9,298	$ 9,917
15	103-170-28	LOH Investment LP.	Fallow	300	180	1.2	90	0.6	$ 15,000	$ 16,000	RRBWSD		$ 18,595	$ 19,835	$ 9,298	$ 9,917
16	103-170-31	Kosareff Edward	Pistachio	300	180	1.2	90	0.6	$ 48,000	$ 50,000	RRBWSD	Median age,Prime Production	$ 59,504	$ 61,983	$ 29,752	$ 30,992
17	103-170-30	LOH Investment LP.	Fallow	300	180	1.2	90	0.6	$ 15,000	$ 16,000	RRBWSD		$ 18,595	$ 19,835	$ 9,298	$ 9,917
18	103-170-26	Boozer Family LP.	Fallow	400	180	1.7	90	0.8	$ 15,000	$ 16,000	RRBWSD		$ 24,793	$ 26,446	$ 12,397	$ 13,223
20	103-170-46	Gooslake Holding Co.	Almond	600	180	2.5	90	1.2	$ 30,000	$ 32,000	RRBWSD	Median age,Prime Production	$ 74,380	$ 79,339	$ 37,190	$ 39,669
21	103-270-14	Mansour Ramzi	Fallow	1700	180	7.0	90	3.5	$ 15,000	$ 16,000	RRBWSD	If no enviro issues	$ 105,372	$ 112,397	$ 52,686	$ 56,198
23	103-270-07	AJB Land LLC	Wheat	2700	180	11.2	90	5.6	$ 22,000	$ 24,000	RRBWSD	If no enviro issues	$ 245,455	$ 267,769	$ 122,727	$ 133,884
24	104-260-01	Tracy Ranch Inc.	Wheat & Cotton	700	180	2.9	90	1.4	$ 22,000	$ 24,000	RRBWSD		$ 63,636	$ 69,421	$ 31,818	$ 34,711
25	104-270-01	AJB Land LLC	Wheat	5280	180	21.8	90	10.9	$ 22,000	$ 24,000	RRBWSD		$ 480,000	$ 523,636	$ 240,000	$ 261,818
32	104-300-01	Jeanette Fast LP.	Almond	1400	180	5.8	90	2.9	$ 30,000	$ 32,000	RRBWSD	Median age,Prime Production	$ 173,554	$ 185,124	$ 86,777	$ 92,562
		RRBWSD West Basins	Recharge Basins	9200	180	38.0	90	19.0					$ -	$ -	$ -	$ -
		Total Length including Aqueduct Turnout Piping:		49080									$4,385,280	$4,691,956	$2,193,099	$2,346,529
		Total Length excluding Aqueduct Turnout Piping:		47080								Mean $/Acre	$ 21,820	$ 23,346	$ 21,527	$ 23,140
					Total ROW Acreage:	201.0		101.4								
					Total ROW Acreage excluding RRB Property:	163.0		82.4								

VI. Phase I Assessment

A Phase I Environmental Site Assessment or Phase I ESA shall be completed on property acquisitions at the discretion of the GBJPA. The Phase I ESA is completed to research the current and historical uses of a property as part of the due diligence work during the property transaction. The intent of the report is to assess if current or historical property uses have impacted the soil or groundwater beneath the property and could pose a threat to the proposed project and land uses.

If these issues are encountered then it could present a potential liability for the GBJPA. A Phase I ESA completed prior to the closure of a real estate transaction can be used to satisfy the requirements of CERCLA's (Comprehensive Environmental Response, Compensation, and Liability Act) innocent land owner defense under All Appropriate Inquiries (AAI).

The Phase I ESA report may be completed for all types of properties including vacant land, agricultural land, and residential/commercial/industrial lands. It shall comply with ASTM E1527-13.

VII. Title Work

Title work shall be completed for any land acquisition to ensure that the title is clean when it is passed from the Seller to the Buyer. A title company will be selected by the GBJPA that will perform this work. The title company researches the title to find out if there are any liens and encumbrances against the property, issues insurance policies, facilitates closings, and files and records paperwork.

The preliminary title report shall be reviewed closely and all legal descriptions, easements, rights-of-way, or other rights on the property shall be noted and mapped by a licensed surveyor in the State of California.

VIII. Land Surveying

Property surveying shall be performed for any land acquisition to confirm the property's boundary lines and legal description. The surveying work shall be performed by a registered, licensed surveyor in the State of California. An ALTA (American Land Title Association) survey shall be provided that maps any features, utility lines, oil wells, abandoned wells, roads, fences, or structures on the property and that determines any restrictions or easements included in the property.

Property legal descriptions and plats shall be prepared by a licensed surveyor in the State of California for the rights-of-way, permanent easements, and temporary easements that are required.

IX. Encroachments

The conveyance alignment will encroach into public rights-of-way and rights-of-way owned by the government that will require encroachment permits and/or agreements. These are estimated to include:

- Aqueduct Turnout Piping – DWR Agreement and Encroachment Permit
- Adohr Road Crossing – Kern County Encroachment Permit
- Stockdale Hwy Road Crossing – Caltrans Encroachment Permit
- I-5 Freeway Road Crossing – Caltrans Encroachment Permit
- Buena Vista Water Storage District – Encroachment Permit

The design firm shall provide detailed plans for these permit applications and assist the GBJPA with the permitting process as necessary.

The design firm shall evaluate the alignment with respect to the physical encroachments that may occur on facilities such as existing structures and/or existing utilities. Consideration shall be given to known utility crossings during the title work and survey work so that these can be included in the negotiations for land acquisition or planned for during the design phase to relocate the existing utility or to design the new conveyance facility around the existing utility.

The design firm shall also evaluate the alignment with respect to the environmental encroachments that may occur and include the appropriate mitigations in the bid documents for the conveyance facilities. The conveyance facility will cross known environmental habitat between the California Aqueduct and the Buena Vista Water Storage District property. This property may be subject to mitigation credits that may be obtained from the Kern Water Bank Authority. The Mitigation Monitoring and Reporting Program outlined in the Final Environmental Impact Report shall be adhered too. Additional biological surveys or cultural resource surveys may also be required.

X. Related Work Specified Elsewhere

A. TM 2 – Conveyance Capacity Requirements
B. TM 3 – Pipeline Requirements
C. TM 4 – Pump Station Requirements
D. TM 6 – Conveyance and Turnout Requirements
E. TM 7 – Well Drilling and Equipping Requirements
F. TM 9 – Recharge Basin Requirements
G. TM 11- Engineer's Estimates

Appendices

Appendix A – Water Pipeline Easement Agreement
Appendix B – Temporary Easement Agreement
Appendix C – Eminent Domain – Information Pamphlet

Appendix A

Water Pipeline Easement Agreement

RECORDING REQUESTED BY AND FOR
ROSEDALE –RIO BRAVO WATER
STORAGE DISTRICT

WHEN RECORDED MAIL TO:

ROSEDALE-RIO BRAVO WATER
STORAGE DISTRICT
P.O. Box 20820
Bakersfield, CA 93390

[Space above this line for Recorder's Use Only]

WATER PIPELINE EASEMENT AGREEMENT

FOR VALUABLE CONSIDERATION, the receipt of which is hereby acknowledged, _____, herein called "Grantor", hereby grants to ROSEDALE-RIO BRAVO WATER STORAGE DISTRICT, herein called "Grantee", a nonexclusive permanent easement and right of way ("Easement") to lay, construct, install, enlarge, operate, use, maintain, repair, reconstruct, improve, relocate, remove and replace a single pipeline for transporting water only, together with appurtenant and necessary structures, fittings and other equipment connected therewith or related thereto (hereinafter collectively referred to as the "District facilities") in, under, over, along, and across that parcel of real property (the "Easement Area") located in the unincorporated area of the County of Kern, State of California, which is more particularly described and depicted in Exhibits A and B to this Agreement.

Said Easement shall be subject to the following terms and conditions:

1. Grantee shall bury such pipeline laid by it so that the top of the pipe shall be at least 36 inches below the surface of the ground at all points. All trenches and other excavations made by the Grantee upon the premises at any time shall be backfilled as soon as practicable and the surface of the ground restored to a contour and condition satisfactory to Grantor. Grantee shall upon request, furnish Grantor with a map showing the location of its pipeline and all appurtenant valves, fittings or other equipment.

2. Grantee shall, at all times, maintain its pipeline in a safe and sound condition of repair.

3. Grantor reserves the right to use, and permit others to use, the Easement Area for any and all purposes which do not unreasonably interfere with the uses by Grantee that are granted herein. Without limiting the generality of the foregoing, Grantor shall neither take nor permit any of the following actions without Grantee's advance written consent: (1) cause the earth cover over Grantee's pipeline to be less than thirty-six (36) inches or more than sixty (60) inches, measured vertically from the top of the pipeline; (2) add to the earth cover more than twelve (12) inches over Grantee's pipeline; (3) remove more than twelve (12) inches of earth cover from above Grantee's pipeline; or (4) plant permanent crops anywhere within the Easement Area.

4. Except as otherwise specified herein, the Easement Area shall be kept open, clear and free from buildings, structures or permanent crops of any kind. The Grantee shall have the right to clear and keep clear said Easement Area from buildings, structures and permanent crops of all kinds, and other things interfering, or threatening to interfere, with the Grantees use of said Easement Area, and the Grantee shall have the permanent right of exclusive use and possession

within the Easement Area within a distance of one foot from the outside surface of the District facilities.

5. Grantor hereby grants to Grantee the right of ingress to and egress from the above-described lands, at any time, and from time to time, without prior notice by means of any existing roads and lanes or other routes as shall occasion the least inconvenience to Grantor.

6. Grantee shall indemnify, defend and hold harmless Grantor, its officers, agents and employees against any and all liability, claims, actions, causes of action of demands whatsoever against them, or any of them, before administrative or judicial tribunals of any kind whatsoever, arising out of, connected with, or caused by Grantee, Grantee's employees, agents, independent contractors, and provisions of this easement whether or not caused in part by a party indemnified hereunder, except of Grantor's sole active negligence or willful misconduct.

7. Grantor shall have the right to inspect, at Grantee's expense, any construction undertaken hereunder and Grantee shall respond to all requests by Grantor to conform construction to the plans and specifications approved by Grantor, if any.

8. Grantor shall, at its request, have the right to approve all plans and specifications for the construction called for hereunder and all construction shall conform to said plans and specifications unless deviations therefrom have been approved by Grantor in writing.

9. Should Grantee abandon the easement at any time for any reason, Grantee shall, at Grantee's sole cost, return the Easement Area to its previous condition after removal of all equipment, appliances, improvements, pipelines, and appurtenances of every kind and description.

10. This Agreement shall be binding on and shall inure to the benefit of the heirs, executors, administrators, successors, and assigns of Grantor and Grantee.

11. This Agreement and any other documents and instruments referred to in this Agreement will constitute the entire agreement between the parties with respect to the subject matter hereof and it correctly sets forth the obligations of the parties to each other as of the date of execution. Any and all prior agreements, oral or written, promises, representations or understandings, warranties or statements, by any party or any shareholder, director, officer, employee or agent of any party not expressly set forth herein or differ in any way from the terms and provisions of this Agreement, are hereby terminated and canceled in their entirety and are of no further force or effect whatsoever.

12. Any and all notices, demands or communications required, permitted or desired to be given hereunder, pursuant to this Agreement, by any party shall be in writing and shall be deemed duly delivered (i) when personally served on the party to whom the notice is directed, or (ii) two (2) days after the date when deposited in the United States mail, postage prepaid, registered or certified with return receipt requested and addressed to the party to whom they are directed, or delivered to a

nationally recognized overnight delivery service or carrier such as Federal Express.

13. The rights granted to the parties hereunder are of a special and unique kind and character, and if there is a breach by any party of any material provision of the Agreement, the other party would not have any adequate remedy at law. It is expressly agreed that the rights of the parties hereunder may be enforced by any action for specific performance and such other equitable relief as provided under the laws of the State of California.

14. No amendment, change, or modification to this Agreement shall be binding unless executed in writing by all of the parties. No waiver by any party of any of the provision of this Agreement shall be deemed a waiver of any other provision, whether or not similar, nor shall any waiver be construed as a continuing waiver. No waiver shall be binding unless executed in writing by the party making the waiver. Neither party shall be deemed to have waived any default by the other party, nor to have waived any other condition provided in this Agreement, unless such waiver is expressed in writing and signed by the waiving party

15. If any term, provision, covenant, condition, clause, paragraph, phrase, section or sentence of this Agreement is found or held by a court of competent jurisdiction to be invalid, null or void or unenforceable, the remainder of the Agreement shall nevertheless not be affected thereby and the parties will agree to negotiate an equitable adjustment of the affected provision with a view toward effecting the purpose of this Agreement. The remainder of this Agreement will continue to be in full force and effect and shall not in any way be affected, impaired or invalidated.

16. All parties participated in the drafting of this Agreement. Therefore, no greater or stricter construction should be applied to any party hereto.

17. Neither this Agreement nor any duties or obligations under this Agreement may be assigned by a party without the prior written consent of the other party; provided, however, that Grantee shall not be required to obtain the consent of Grantor to operate the pipeline for water management purposes, regardless of the source or ownership of the water being transported through the pipeline.

18. The parties hereby agree that time is of the essence with respect to this Agreement and to the performance by each party of each obligation, term and condition to be performed. The strict and timely performance of obligations by a party shall be a condition precedent to the enforcement by that party of the other party's obligations. The failure to timely perform any of the terms and conditions by any of the parties will constitute a breach and default under this Agreement by the party failing to perform.

19. This Agreement may be signed and signatures transmitted by facsimile or electronic mail, and any such facsimile or electronic mail copy shall be equivalent to a signed original for all purposes.

20. This Agreement may be executed in one or more counterparts and delivered via mail,

facsimile, or electronic mail, each of which will be deemed an original, but all of which together will constitute one and the same instrument which may be sufficient evidenced by one counterpart.

21. Venue for any action arising out of this Agreement brought by any party hereto will be the Superior Court in and for the County of Kern, California which is located in Bakersfield, California. This Agreement shall be interpreted, construed and enforced in accordance with the internal laws, and not the law of conflicts, of the State of California applicable to agreements made and to be performed in such state. The parties agree that all claims in respect of the action or proceeding will be heard and determined by such court, and agree not to bring any action or proceeding arising out of or relating to this Agreement in any other court.

22. Each individual executing and delivering this Agreement on behalf of a party hereby covenants, represents and warrants to the other party that such individual has been duly authorized and empowered to make such execution and delivery on its behalf.

IN WITNESS WHEREOF, the undersigned, by its duly authorized officers, has executed this Agreement this _____ day of _____, 2015.

GRANTOR	GRANTEE
	_____
Its:_____	Its:_____

CERTIFICATE OF ACCEPTANCE
(Government Code Section 27281)

THIS IS TO CERTIFY that the interest in real property conveyed by the Water Pipeline Easement Agreement, dated _____, 2015, from _____ to ROSEDALE-RIO BRAVO WATER STORAGE DISTRICT, a California Water Storage District formed pursuant to Division 13 of the California Water Code, is hereby accepted by the undersigned on behalf of Rosedale-Rio Bravo Water Storage District, pursuant to authority conferred by the Board of Directors of Rosedale-Rio Bravo Water Storage District, and the grantee consents to recordation thereof by its duly authorized agent or officer.

Dated:_____, 2015 By:_____
Rosedale-Rio Bravo Water Storage District

Appendix B

Temporary Easement Agreement

TEMPORARY EASEMENT AGREEMENT

Preamble

This Agreement is entered into on _____, 2015 by _____, herein called "Grantor," and ROSEDALE-RIO BRAVO WATER STORAGE DISTRICT, herein called "Grantee."

AGREEMENT

FOR VALUABLE CONSIDERATION, the receipt of which is hereby acknowledged, Grantor hereby grants to Grantee a temporary construction easement upon the terms set forth herein.

The purpose of said temporary construction easement is to allow Grantee and its' agents to lay and construct a single pipeline, together with appurtenant and necessary structures, fittings and other equipment in, under, over, along, and across a parcel of real property located in the unincorporated area of the County of Kern, State of California, which is more particularly described in a Water Pipeline Easement Agreement ("Permanent Easement Area") being executed by Grantor and Grantee concurrently with this Agreement.

The temporary construction easement shall be located over and upon a parcel of real property located in the unincorporated area of the County of Kern, State of California, which is more particularly described in Exhibit A hereto, and shown on Exhibit B hereto ("Temporary Easement Area").

Terms

1. Grant of Easement. In consideration of the sum of $_____, Grantor grants to Grantee and Grantee's agents and employees a temporary easement over and upon the Temporary Easement Area, on the terms and conditions set forth in this Agreement. In addition, Grantee shall pay to Grantor $____ as consideration for removal of XX almond trees within the Permanent Easement Area ($X.XX per tree); in the event additional almond trees located within the Permanent Easement Area or Temporary Easement Area are removed or lost as a result of the construction of the pipeline, Grantee shall pay to Grantor an amount of $X.XX per tree.

2. Character of Easement. The easement granted in this Agreement is an easement in gross.

3. Description of Easement. The easement granted in this Agreement is a temporary right to enter upon the Temporary Easement Area, to store and operate construction equipment and materials thereon, and to cross over the Temporary Easement Area in connection with the performance of certain construction work on the Permanent Easement Area.

4. Construction Work. The construction work referred to herein consists of the construction of a buried pipeline and related activities. Construction equipment and materials used will be typical to such construction.

5. Term. The temporary easement granted in this Agreement shall terminate on the earlier of completion of the construction work and satisfaction by Grantor of all requirements imposed by this Agreement or one year after Grantor commences construction. If the construction work is not completed within one year after Grantee commences construction, Grantee shall pay Grantor the sum of one-twelfth (1/12) of the consideration described in Paragraph 1 hereof for each month or portion of a month thereafter that this easement remains in effect.

6. Duty to Repair, Restore, or Replace. Within fifteen (15) days following completion of the construction work, Grantee shall (a) remove Grantee's construction equipment and materials from the Temporary Easement Area, and (b) restore the Temporary Easement Area to the condition it was in on the date and at the time of the execution of this Agreement. The restoration work shall specifically include the repair or replacement of any landscaping (which does not include trees for which consideration is paid pursuant to Paragraph 1 of this Agreement), structures, fences, driveways, or other improvements on the Temporary Easement Area that belong to Grantor and that are removed, damaged, or destroyed by Grantee or Grantee's agents or employees.

7. Nonexclusive Easement. The easement granted in this Agreement is nonexclusive. Grantor retains the right to make any use of the Temporary Easement Area, including the right to grant concurrent easements in said property to third parties that do not interfere unreasonably with Grantee's free use and enjoyment of the easement.

8. Agreement Nonassignable. This Agreement shall not be assigned. Any purported assignment of this Agreement or of any interest in this Agreement shall be void and of no effect.

9. Time of Essence. Time is of the essence in this Agreement.

10. Indemnification. Grantee shall indemnify, defend and hold harmless Grantor, its officers, agents and employees against any and all liability, claims, actions, causes of action of demands whatsoever against them, or any of them, before administrative or judicial tribunals of any kind whatsoever, arising out of, connected with, or caused by Grantee, Grantee's employees, agents, independent contractors, and provisions of this agreement whether or not caused in part by a party indemnified hereunder, except of Grantor's sole active negligence or willful misconduct.

11. Entire Agreement. This Agreement constitutes the entire agreement between Grantor and Grantee relating to the above easement. Any prior agreements, promises, negotiations, or representations not expressly set forth in this Agreement are of no force and effect. Any amendment to this Agreement shall be of no force and effect unless it is in writing and signed by Grantor and Grantee.

12. Binding Effect. This Agreement shall be binding on and shall inure to the benefit of the heirs, executors, administrators, successors, and assigns of Grantor and Grantee, except as otherwise provided in this Agreement.

IN WITNESS WHEREOF, the undersigned, by its duly authorized officers, has executed this Agreement this _____ day of _____, 2015.

GRANTOR	GRANTEE
_____	_____
Its:_____	Its:_____

Appendix C

Eminent Domain – Information Pamphlet

Rosedale-Rio Bravo Water Storage District ("District")

EMINENT DOMAIN – Information Pamphlet

I. Introduction

Eminent domain is the power of the government to purchase private property for a "public use" so long as the property owner is paid "just compensation." Whenever possible, the District tries to avoid use of the eminent domain power, exercising it only when it is necessary for a public project. The decision to acquire private property for a public project is made by the District only after a thorough review of the project, which often includes public hearings.

This pamphlet provides general information about the eminent domain process and the rights of the property owner in that process.[1]

- **What is a "public use"?**

  A "public use" is a use that confers public benefits, like the provision of public services or the promotion of public health, safety, and welfare. Public uses include a wide variety of projects such as street improvements, construction of water pipelines or storage facilities, construction of civic buildings, redevelopment of blighted areas, and levee improvements to increase flood protection. Some public uses are for private entities, such as universities, hospitals and public utilities, which serve the public.

- **What is "just compensation"?**

  Just compensation is the **fair market value** of the property being acquired by the government. The state law definition of fair market value is "the highest price on the date of valuation that would be agreed to by a seller, being willing to sell but under no particular or urgent necessity for so doing, nor obliged to sell, and a buyer, being ready, willing, and able to buy but under no particular necessity for so doing, each dealing with the other with full knowledge of all the uses and purposes for which the property is reasonably adaptable and available."

II. The Eminent Domain Process and the Property Owner's Rights

The eminent domain process begins with a public use project. When selecting a project location, the goal is to render the greatest public good and the least private injury or inconvenience. If it is determined that all or a portion of your property may be necessary for a public use project, the District will begin the appraisal process to determine the property's fair market value.

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[1] **The information in this pamphlet is not, nor should it be construed as, legal advice. You should consult with qualified legal counsel regarding your specific situation rather than relying on this pamphlet as legal advice.**

- **How is the fair market value of my property determined?**

The District will retain an independent, accredited appraiser familiar with local property values to appraise your property. The appraiser will invite you to accompany him or her during an inspection of your property. You may give the appraiser any information about improvements and any special features that you believe may affect the value of your property. It is in your best interest to provide the appraiser with all the useful information you can in order to ensure that nothing of value will be overlooked. If you are unable to meet with the appraiser, you may wish to have a person who is familiar with your property meet with the appraiser instead.

After the inspection, the appraiser will complete an appraisal that will include the appraiser's determination of your property's fair market value and the information upon which the fair market value is based. The appraiser will provide the District with the appraisal. The District will then make a written offer to purchase the property. The offer will also include a summary of the appraisal. The offer will be for no less than the amount of the appraisal.

- **What factors does the appraiser consider in determining fair market value?**

Each parcel of real property is different and, therefore, no single formula can be used to appraise all properties. Among the factors an appraiser typically considers in estimating fair market value are:

  - The location of the property;
  - The age and condition of improvements on the property;
  - How the property has been used;
  - Whether there are any lease agreements relating to the property;
  - Whether there are any environmental issues, such as contaminated soil;
  - Applicable current and potential future zoning and land use requirements;
  - How the property compares with similar properties in the area that have been sold recently;
  - How much it would cost to reproduce the buildings and other structures, less any depreciation; and
  - How much rental income the property produces, or could produce if put to its highest and best use.

- **Will I receive a copy of the appraisal?**

The District is required to provide you with its purchase offer, a summary of the appraiser's opinion, and the basis for the District's offer. Among other things, this summary must include:

  - A general statement of the District's proposed use for the property;
  - An accurate description of the property to be acquired;
  - A list of the improvements covered by the offer;
  - The amount of the offer; and

- The amount considered to be just compensation for each improvement which is owned by a tenant and the basis for determining that amount.

However, the District is only required to show you a copy of the full appraisal if your property is an owner-occupied residential property with four or fewer residential units. Otherwise, the District may, but is not required, to disclose its full appraisal during negotiations (though different disclosure requirements apply during the litigation process if the issue of fair market value goes to court).

- **Can I have my own appraisal done?**

Yes. You may decide to obtain your own appraisal of the property in negotiating the fair market value with the District. At the time of making its initial offer to you, the District must offer to reimburse you the reasonable costs, not to exceed $5,000, of an independent appraisal of your property. To be eligible for reimbursement, the independent appraisal must be conducted by an appraiser licensed by the State Office of Real Estate Appraisers.

- **What advantages are there in selling my property to the District?**

A real estate transaction with the District is typically handled in the same way as the sale of private property. However, there may be a financial advantage to selling to the District.

- You will not be required to pay for real estate commissions, title costs, preparation of documents, title policy or recording fees required in closing the sale. The District will pay all these costs.
- Although the District cannot give you tax advice or direction, you might also be eligible for certain property and income tax advantages. You should check with the Internal Revenue Service (IRS) for details or consult your personal tax advisor.

- **If only a portion of my property is taken, will I be paid for the loss to my remaining property?**

In general, when only a part of your property is needed, every reasonable effort is made to ensure you do not suffer a financial loss to the "remainder" property. The District will pay you the fair market value of the property being taken as well as compensation for any loss in value to your remaining property that is not offset by the benefits conferred by the project. The compensation for the loss in value to your remaining property is often referred to as "severance damages."

Also, if any remaining part is of such a size, shape, or condition as to be of little market value, the District will offer to acquire that remaining part (or remnant) from you, if you so desire.

- **Will I be compensated for loss of goodwill to my business?**

If you are the owner of a business that is conducted on the property being acquired, you may have a right to compensation for lost business goodwill if the loss is caused by the acquisition of the property. "Goodwill" consists of the benefits that accrue to a business as a result of its location, reputation for dependability, skill or quality, and any other circumstances resulting in probable retention of old or acquisition of new patronage.

- **What will happen to the loan on my property?**

Where the District is acquiring the entire property, generally the compensation payable to the owner is first used to satisfy outstanding loans or liens as in a typical real estate transaction. Where less than the entire property is being acquired, whether outstanding loans or liens are paid from the compensation will depend on the particular facts and circumstances.

- **Do I have to sell at the price offered?**

No. If you and the District are unable to reach an agreement on a mutually satisfactory price, you are not obligated to sign an offer to sell or enter into a purchase agreement.

- **If I agree to accept the District's offer, how soon will I be paid?**

If you reach a voluntary agreement to sell your property or an interest in the property to the District, payment will be made at a mutually acceptable time.
Generally, this should be possible within 30 to 60 days after a purchase/sale contract is signed by all parties.

- **What happens if we are unable to reach an agreement on the property's fair market value?**

The District, to the greatest extent practicable, will make every reasonable effort to acquire your property by negotiated purchase. If, however, the negotiations are unsuccessful, the District may either file an eminent domain action in a court located within the same county where your property is located or it may decide to abandon its intention to acquire the property. If the District abandons its intention to acquire, it will promptly notify you.

If the District proceeds with eminent domain, the first step is for the District staff to request authority from the [legislative body] to file a condemnation action. The approval from the [legislative body] is called a "Resolution of Necessity." In considering whether condemnation is necessary, the [legislative body] must determine whether the public interest and necessity require the project, whether the project is planned or located in the manner that will be most compatible with the greatest public good and the least private injury, and whether your property is necessary for the project. You will be given notice and an opportunity to appear before the [legislative body] when it considers whether to adopt the Resolution of Necessity. You may want to call an attorney or contact an attorney referral

service right away. You or your representatives can raise any objections to the Resolution of Necessity and the condemnation either orally before the [legislative body] or in writing to the [legislative body].

If the [legislative body] adopts the Resolution of Necessity, the District can file a complaint in court to acquire title to the property upon payment of the property's fair market value. The District is the plaintiff. Anyone with a legal interest in the property, generally determined from a title report on the property (including tenants or mortgage holders), are named as defendants. Often, the District will also deposit the amount the District believes is the "probable amount of compensation" with the State Treasurer where the complaint is filed. A deposit must be made if the District is seeking to acquire possession of the property before agreement is reached on the fair market value.

- **Can the District acquire possession of my property before the property's fair market value is determined in the eminent domain lawsuit?**

In some cases, the District may decide it needs possession of the property before the property's fair market value is finally determined. In such a case, the District must apply to the court for an "order for possession" to allow it to take possession and control of the property prior to resolution of the property's fair market value. The District is required to schedule a hearing with the court on the proposed order for possession and to give you notice of the hearing. Notice must generally be sent at least 90 days before the hearing date if the property is occupied and 60 days before the hearing date if the property is unoccupied. A judge will decide whether the order for possession should be granted. As noted above, the District must deposit with the State Treasurer the probable amount of just compensation in order to obtain possession of the property.

- **Can I oppose the motion for an order for possession?**

Yes. You may oppose the motion in writing by serving the District and the court with your written opposition within the period of time set forth in the notice from the District.

- **Can I rent the property from the District?**

If the District agrees to allow you or your tenants to remain on the property after the District acquires possession, you or the tenants will be required to pay a fair rent to the District. Generally, such rent will not be more than that charged as rent for the use of a property similar to yours in a similar area.

- **Can I withdraw the amount deposited with the State Treasurer before the eminent domain action is completed, even if I don't agree that the amount reflects the fair market value of my property?**

Yes. Subject to the rights of any other persons having a property interest (such as a lender, tenant, or co-owner), you may withdraw the amount deposited with the State Treasurer before the eminent domain action is completed. If you withdraw the amount on deposit, you

may still seek a higher fair market value during the eminent domain proceedings, but you may not contest the right of the District to acquire the property, meaning you cannot contest that the acquisition of your property is for a public purpose or is otherwise improper.

You also have the right to ask the court to require the District to increase the amount deposited with the State Treasurer if you believe the amount the District has deposited less than the "probable amount of compensation."

- **Can I contest the condemning agency's acquisition of the property?**

Yes. Provided you have not withdrawn the amount deposited, you can challenge in court the District's right to acquire or condemn the property.

- **What happens in an eminent domain trial?**

The main purpose of an eminent domain trial is to determine the fair market value of your property, including compensable interests such as lost business goodwill caused by the taking or severance damages. The trial is usually conducted before a judge and jury. You (and any others with interests in the property) and the District will have the opportunity to present evidence of value, and the jury will determine the property's fair market value. In cases where the parties choose not to have a jury, the judge will decide the property's fair market value. Generally, each party to the litigation must disclose its respective appraisals to the other parties prior to trial.

If you challenge the District's right to acquire the property, the eminent domain trial will also determine whether or not the District has the legal right to acquire the property. In such cases, the judge (not the jury) will make this determination before any evidence is presented concerning the property's fair market value.

At the end of the trial, the judge will enter a judgment requiring the District to pay fair market value. Once the District pays the amount listed in the judgment, the judge will enter a final order of condemnation. The District will record the final order with the County Recorder, and title to the property will then pass to the [condemning agency.]

- **Am I entitled to interest?**

Anyone receiving compensation in an eminent domain action is generally entitled to interest on that compensation from the date the condemning agency takes possession of the property until the person receiving the compensation has been fully paid. The rate and calculation of the interest is determined under formulas in State law.

- **Will the District pay my attorneys' fees and costs.**

In an eminent domain action, you are entitled to be reimbursed by the condemning agency for your court costs such as court filing fees. In some circumstances, you may also be entitled to be reimbursed by the condemning agency for your attorneys' fees in the lawsuit.

Whether you will be entitled to receive reimbursement for your attorneys' fees will depend on the particular facts and circumstances of the case and the offers and demand for compensation made in the action.

- **Will I receive assistance with relocation?**

Any person, business, or farm operation displaced as a result of the property acquisition is typically entitled to relocation advisory and financial assistance for eligible relocation expenses, such as moving expenses. The amount of relocation compensation is determined on a case-by-case basis in accordance with prescribed law. Relocation benefits are handled separate and apart from the determination of the property's fair market value and are not part of the eminent domain process.

III. Contact Information

We are available to answer your questions and to assist you in understanding the acquisition program and the eminent domain process. Should you desire further information, please contact Daniel N. Raytis at (661) 322-4417.

APPENDIX I

Technical Memorandum #9
Recharge Basin Requirements

DEE JASPAR & ASSOCIATES, INC.
CONSULTING CIVIL ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CA 93308
PHONE (661) 393-4796
FAX (661) 393-4799

KERN FAN GROUNDWATER STORAGE PROJECT

TECHNICAL MEMORANDUM NO. 9
(Recharge Basin Requirements)

PREPARED FOR: Groundwater Banking Joint Powers Authority (GBJPA)
PREPARED BY: Curtis Skaggs, P.E.
DATE: June 11, 2021

SUBJECT: ***Recharge Basin Requirements***

I. Executive Summary

The project is anticipated to provide a total storage capacity of approximately 100,000 acre-feet per year among approximately 1,280 gross acres of recharge property or approximately 1,040 net acres of wetted area. The recharge properties are referred to as a Phase I Property and a Phase II Property each of a size of approximately 640 gross acres. Potential locations for these recharge areas have been identified, however they are preliminary and subject to change based upon available properties and land negotiations.

The project will be supplied primarily by the State Water Project's (SWP) supplies that exceed the SWP Contractors allocation during a wet year (Article 21 supplies) and also by other wet-year water supplies as available, including Kern River water. In wet years, when it is declared available by the California Department of Water Resources (DWR), the GBJPA will take delivery of Article 21 supplies that might otherwise be lost to the ocean to store in the recharge areas. The GBJPA will benefit from the recharge water for water supply and groundwater benefits while twenty-five percent (25%) of the stored Article 21 water will be held as SWP system water that will be used for ecosystem benefits. The ecosystem benefits will be derived by exchanging water from the Kern Fan Groundwater Storage Project to the Oroville Reservoir where they will be released as needed for short term pulse flows.

In addition, since the recharge basins will be intermittently flooded with captured stream flows diverted into the California Aqueduct

and conveyed to the project area, the wetlands that will be incidentally formed by the constructed recharge basins will be intermittent wetlands. The recharge basins will include design features that will function as intermittent wetlands to support and benefit water birds and wetland-dependent upland birds and wildlife. The variable presence of water, soil, and vegetation, as well as bird habitat features, will be considered in the design and operation criteria for the recharge basins as discussed herein.

The memorandum herein discusses the recharge basin layout or orientation, levee embankments and design freeboard, general design considerations, habitat elements, interbasin structures, and site fencing.

II. Recharge Basin Layout/Orientation

Recharge basins are anticipated to be constructed on the entirety of the approximate 1,280 gross acres with the goal of recharging up to approximately 100,000 acre-ft per year in a wet year and for the recovery of up to approximately 50,000 acre-ft per year when necessary. It is estimated that the wetted acres or net acreage of the recharge basins is approximately 80% to 85% of the gross acres. The constructed recharge basins will be operated to allow water to infiltrate and recharge into the underlying aquifer for groundwater storage during wet years and then the groundwater may be pumped from the underlying aquifer during dry years when in a recovery mode.

It is currently anticipated that there will be a Phase I Recharge and Recovery area that encompasses approximately 640 gross acres and a Phase II Recharge and Recovery area that includes approximately 640 gross acres. The approximate locations of these properties are illustrated in Figure 1 and Figure 2 below, however the actual locations are subject to change based upon land negotiations and property acquisitions.

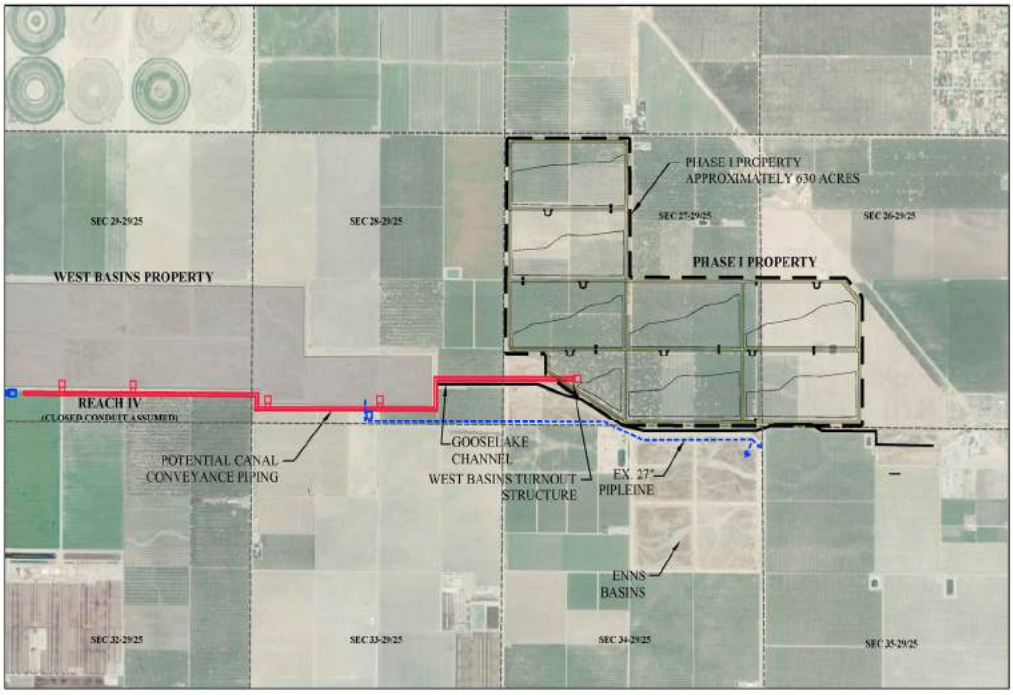


Figure 1: Preliminary Phase I Recharge Property

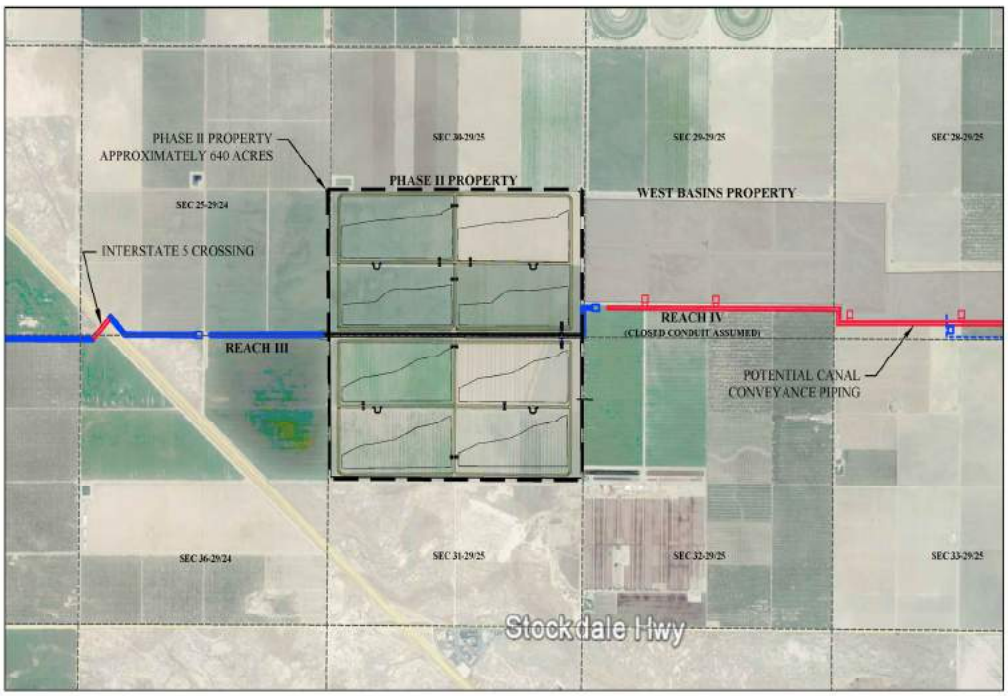


Figure 2: Preliminary Phase II Recharge Property

The recharge rates for the basins will be dependent on the actual Phase I and Phase II property locations and the associated soil types. Technical Memorandum No. 2 "Conveyance Capacity" evaluated the recharge rates of the Phase I and Phase II properties based on an assumed location. These recharge rates were based on soil survey maps, available tTEM geophysical survey information, and historical recharge rates for existing nearby recharge basins. The initial fill rates and the average recharge rates are discussed in that memorandum.

The recharge basin sizes may vary in size and shape (typically 20 acres to 80 acres in size) and will be constructed to minimize the amount of earthwork required while maximizing the amount of surface area covered by the recharge water. Recharge basins shall be oriented such that the long direction of the basins follow the predominant wind direction to minimize wave erosion. The recharge basins may need to be setback from property lines to allow room for levee slope maintenance and also setback from the conveyance canal alignment, if a canal is utilized, in order to allow for levee slope maintenance and to mitigate groundwater impacts on the canal lining.

The headworks structure conveying water to each recharge basin facility will be the conveyance canal or pipeline turnout facility. The recharge basin turnout facilities are discussed in Technical Memorandum No. 3 "Pipeline Requirements". These facilities will include flow meters for flow measurement.

III. Levee Embankments/Design Freeboard

The levee embankments will be designed and constructed to impound water when recharging water and to also provide roadways around the recharge basins for maintenance and general upkeep. It is anticipated that the levee embankments will consist of native material that is borrowed from the basin bottoms adjacent to the levee embankment alignments. The material will be compacted to the specified design relative compaction. The levee embankment will be 20-ft wide at the top of levee. The embankments will be between two feet to six feet in height with a 4:1 slope on the inboard slopes (water side) and 2:1 slopes on the outboard slopes (dry side). Recharge basins will be designed to provide a minimum 1.5-ft of freeboard with water depths in the recharge basin areas ranging from just a few inches to up to approximately 48-inches (4-feet). Figure 3 illustrates a typical levee embankment cross-section located in between basins.

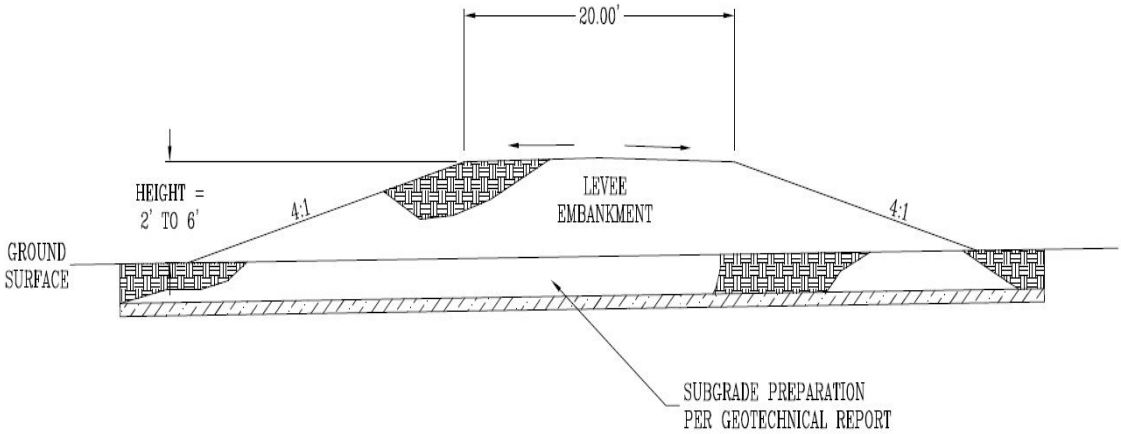


Figure 3: Levee Embankment Cross Section

The earthwork shall be performed as required by the geotechnical investigation and report, also refer to Technical Memorandum No. 5 "Geotechnical Investigation". The geotechnical report shall address recommendations for subgrade preparation beneath levee embankments including over-excavation depths and limits, scarification, moisture conditioning of soils, keyways, and compaction. The geotechnical report shall also provide a seepage

path analysis beneath the levee embankments to prevent nuisance seepage or a potential levee failure.

It is anticipated that suitable borrow material will be obtained from the adjacent basin bottoms and will be utilized in a manner to maintain the borrow areas in a level and uniform fashion. At the completion of the recharge basin construction, the basin bottoms shall be ripped to break up compacted areas and disturbed areas based on the recommendations of the geotechnical report.

The project area has a predominant land slope of two-feet per mile (2'/mile) which will remain across the basin bottoms after the recharge basin construction.

IV. Design Considerations

A. Existing Infrastructure

The design of the recharge basin facilities will need to take into account existing infrastructure, and access routes to said infrastructure, on the property such as existing roads, easements, power lines, underground and above ground utilities, irrigation systems, and water wells.

All existing infrastructure, easements, etc. shall be identified, accommodated, and shown on the design drawings. The existing infrastructure will need to be evaluated and decisions made by the GBJPA as to whether the facilities will be relocated, worked around, demolished, and/or removed as part of the work or if the recharge basins will be designed to accommodate and/or utilize the facilities.

If existing water wells are abandoned, these will be abandoned in accordance with Kern County standards for well destruction. The GBJPA may elect to keep existing water wells and utilize them as recovery wells or convert them into monitoring wells.

B. Well Sites

The well earth pads are estimated to be approximately 100-ft by 100-ft and will be constructed as part of the recharge basin levee embankments. They will be similar in height to the adjacent levee embankment and be sloped to drain towards the recharge basin. The well pad earthwork will be completed to the same design standards as the levee embankments.

C. Well Conveyance Pipelines

Well conveyance pipelines are planned to be installed below ground and extend from the well pads to the conveyance canal or pipeline. These pipelines are discussed in Technical Memorandum No. 3 "Pipeline Requirements".

The pipelines shall be installed in the levee embankments to the extent possible. When pipelines are installed underground beneath the basin bottoms, they shall be installed with a minimum cover of 5-feet to protect them from damage during pond maintenance, cleaning, or ripping.

D. Levee Access

The levee embankment width at the top shall be 20-ft wide for access and levee maintenance. The radius of turns at levee corners and intersections shall have a minimum radius of 50-ft.

All-weather surfacing may be required on the levee embankment access roads, however this will be dependent on the soil type and the recommendations of the geotechnical report.

E. Miscellaneous

The earthwork construction will require the preparation, filing, and adherence to a San Joaquin Valley Air Pollution Control District (SJVAPCD) Dust Control Permit and a Storm Water Pollution Prevention Plan (SWPPP). The design plans shall illustrate the best management practices (BMP's) that will need to be implemented and maintained.

V. Habitat Elements

The recharge basins are intended to serve as habitat as well. The recharge basins shall include design features that will function as intermittent wetlands to support and benefit water birds and wetland-dependent upland birds and wildlife. The variable presence of water, soil, and vegetation, as well as bird habitat features, shall be considered in the design and operation criteria for the recharge basins. The United States Fish and Wildlife Service maintains documents related to the classification of wetlands in the United States. Wetlands are classified as:

- Marine
- Estuarine
- Riverine
- Lacustrine
- Palustrine

A Riverine system has four subsystems:

- Tidal
- Lower Perennial
- Upper Perennial
- Intermittent

Since the recharge basins are intermittently flooded with captured stream flows, the recharge areas will most closely resemble a classification of Intermittent Flooded Riverine Wetlands with Unconsolidated Sandy Bottoms.

The recharge basins will be designed and constructed to meet the intermittent wetland requirements during recharge operations. During wet years when the project is recharging water, the basins will be inundated with water and will provide intermittent wetland habitat to support waterfowl, shorebirds, raptors, and other migratory birds. However, this water supply delivered for recharge may not be available for recharge year-round or during periods of drought and therefore are intermittent. The term "incidental" is also used to describe these intermittent wetlands because they are incidentally created as a result of water recharging in the recharge basins.

The 4:1 levee slopes and minimum 1.5-ft freeboard will result in a minimum 6-ft to 10-ft wide vegetative strip above the water line with vegetation extending into shallow water areas. Recharge basins will be designed to provide bird habitat in the intermittent wetlands that are created by these facilities. Recharge basins shall be constructed at multiple water depths to benefit both shorebirds and waterfowl as well as including periodic raptor boxes throughout the recharge area. The raptor boxes shall be installed every quarter-mile (1/4-mile) of levee embankment to provide perching structures for owls and hawks. These raptors serve to manage the burrowing rodents that can cause structural damage to earthen levee embankments. Shorebirds prefer mudflats to a depth of up to 6" with sparse vegetation (<40%) while waterfowl prefer depths of 6" to above 18" with a combination of open water and wetland cover. Dry land, levee embankments or islands, shall also be provided for resting areas with dense vegetation. Islands with similar gradual sloped banks and freeboard requirements will be constructed where reasonable and as recommended by the project biologist and design engineer.

In addition, the GBJPA will develop and maintain an adaptive management plan for the recharge areas. Land wildlife management is dynamic. As weather and climate patterns change, landscapes including intermittent wetlands, will react. Plants and wildlife will adapt to these changes on a variable basis therefore the recharge basin management will need to adapt as well to optimize wetland benefits. The adaptive management plan will include annual biota reports including adaptive management recommendations to be considered and implemented, as appropriate to optimize project water management and wildlife goals.

VI. Interbasin Structures

A. Interbasin Structures

The interbasin structure refers to the structure that is in the levee embankment of the recharge basins and is the inlet structure. The interbasin structure is on the upstream side of the conveyance of water between basins and is for the purpose of regulating flow and water level in the recharge basins.

It is anticipated that the interbasin structures will be precast concrete structures for uniformity in size and shape, see Figure 4. Each structure will include slots for weir boards and include a short stub-out of corrugated HDPE.

Water conveyance through the structure will be measured based on overflow weir measurements by District Staff. District Staff will be responsible for staff gauges or markings to ensure the maintaining of proper operating levels and measuring of flowrates.

Figure 4: Interbasin Precast Structure

Rock rip-rap shall be placed around the interbasin structures for a minimum width of ten-feet on the levee slopes on each side of the interbasin structure and out approximately ten-feet in front of the structure in the basin bottom to prevent erosion.

B. Interbasin Pipe Sizing

The interbasin piping is the piping in between the recharge basins that are used for the conveyance of water between basins. The District plans to standardize the size of the interbasin piping to be 36-inch or 48-inch diameter.

A single-barrel 36-inch pipe is anticipated to have a capacity of approximately 24 cfs to 30 cfs. A single-barrel 48-inch pipe is anticipated to have a capacity of approximately 55 cfs to 60 cfs.

C. Interbasin Pipe Type

The interbasin pipe is anticipated to be an ADS dual-wall corrugated HDPE pipe with smooth wall interior. This is an economical alternative that is corrosion resistant, has good strength properties, and the exterior corrugations help extend the seepage path.

D. Interbasin Backfill Requirements

The interbasin pipes are to be backfilled with native material and be compacted to the specified design relative compaction. There is often concern with the adequacy of compaction at the extreme haunch due to the difficulty of getting compaction equipment in this area. Therefore, it is recommended that the bottom of pipe to springline of pipe be backfilled with a two-sack cement slurry and that a concrete cutoff wall be added.

E. Discharge Structure

The corrugated HDPE pipe shall be an open discharge through the levee slope into the downstream recharge basin. The pipe invert may be below the basin bottom and discharge into a depressed area below the basin bottom to allow the water to bubble up and out into the basin bottom thus minimizing erosion and scour.

Rock rip-rap shall be placed around the pipe discharge for a minimum width of ten-feet on the levee slopes on each side of the pipe and throughout the depressed area below the basin bottom to prevent erosion.

VII. Site Fence Requirements

The recharge basin properties, Phase I and Phase II, may or may not be fenced. At locations where the recharge property is adjacent to paved County roadways it shall be fenced. If the recharge property is in rural or agricultural areas and is not adjacent to paved County roadways then it shall not be fenced. If the recharge areas are fenced they are typically done so with barbed 4-wire, field fence, t-posts, brace posts, and drive gates. A work area of 10-feet will be maintained between any fence line and levee toe.

Drive gates on County roads or State highways shall be set back so as to allow for safe ingress and egress when opening and closing gates. Fencing plans shall be included in the design but noted as "to be constructed by others" in the bid documents and bid packages.

VIII. Related Work Specified Elsewhere

A. TM 2 – Conveyance Capacity Requirements
B. TM 3 – Pipeline Requirements
C. TM 5 – Geotechnical Investigation
D. TM 11 - Engineer's Estimates

APPENDIX J

Technical Memorandum #10
Facility Operation and SCADA Requirements

DEE JASPAR & ASSOCIATES, INC.
CONSULTING CIVIL ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CA 93308
PHONE (661) 393-4796
FAX (661) 393-4799

KERN FAN GROUNDWATER STORAGE PROJECT

TECHNICAL MEMORANDUM NO. 10
(Facility Operation and SCADA Requirements)

PREPARED FOR: Kern Fan Joint Powers Authority (JPA)
PREPARED BY: Curtis Skaggs, P.E.
DATE: July 26, 2021

SUBJECT: ***Facility Operation and SCADA Requirements***

I. Executive Summary

A SCADA system combines software and hardware to create a control and monitoring system that is frequently referred to as automation technology. The system receives data from processes and related monitoring equipment – water levels, flowrates, pressures, run status, setpoints, and alarms – which supervisors and operators can utilize to control and optimize operations. The SCADA system described herein interfaces with but does not include the process and monitoring equipment to be designed and installed at each plant or facility.

The SCADA software is the computer program that helps monitor and control plant or facility operations as well as store data. The software processes data sent from microprocessors (PLC's or RTU's) that communicate with equipment such as valves, pumps, sensors, instruments, or HMI's. The SCADA software receives the data collected from the devices and facilities and processes the information and stores it in a database. The data is then displayed on screens and dashboards often in animated graphs, diagrams, and images so that operators know in real time what is happening in the system. The operators can analyze this data to determine whether operations are running optimally, whether adjustments are needed, or if there are urgent issues through the means of alarms.

The work will include developing a control philosophy, programming PLC devices, and furnishing and installing all SCADA equipment. The equipment includes, but is not limited to, hardware, software, and ancillary equipment for each remote facility (wells, pump stations, and turnouts) and central headquarters (RRBWSD District office) in order to have a fully functioning system as well as providing system redundancy. The SCADA system shall integrate with the existing facilities and the system integrator shall properly train all operators. The proposed new facilities are illustrated in Figure 1 for the alternative using a

pipeline for the conveyance facility from the California Aqueduct. Figure 2 illustrates the new facilities using a conveyance canal from the California Aqueduct.

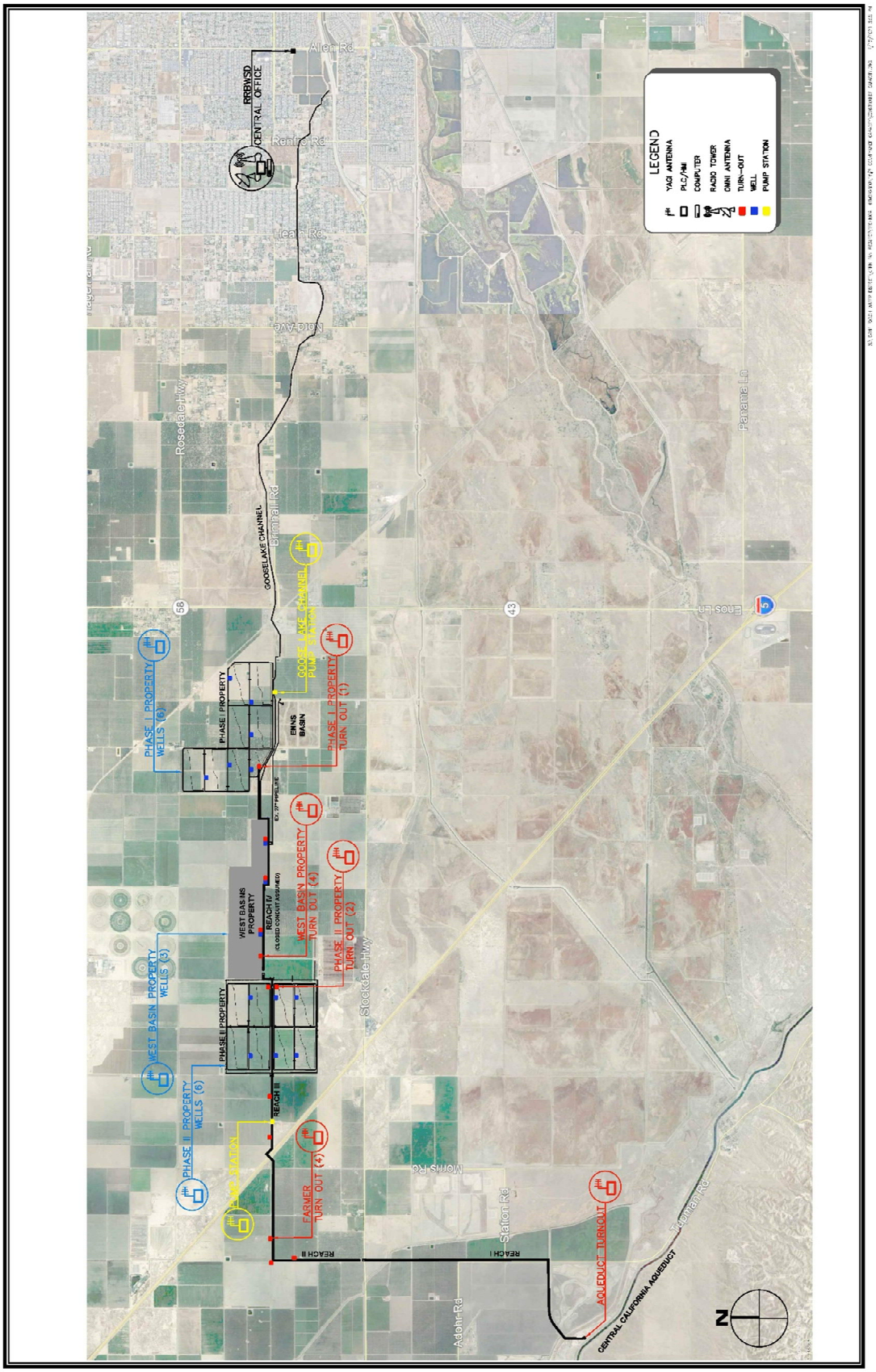


Figure 1: SCADA System Layout for Conveyance Pipeline

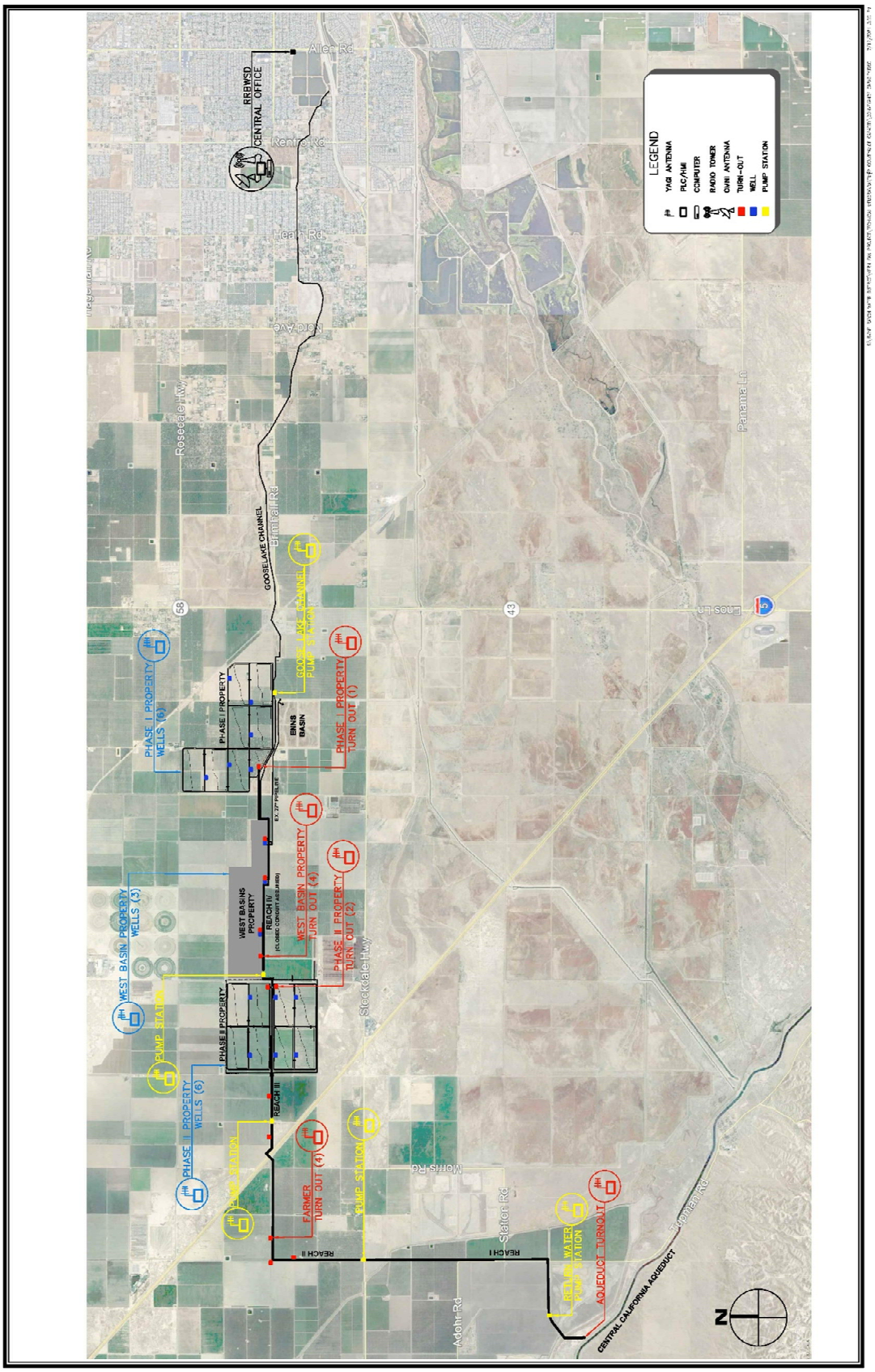


Figure 2: SCADA System Layout for Conveyance Canal

The District currently manages Mission units on some wells, SCADA with ControlLogix PLC at the DRP Pump Station, and monitoring on inflow points into the District. The implementation of SCADA for the Kern Fan Project will need to incorporate all existing water banking facilities including the DRP Pump Station, thirty-one (31) recovery wells, and the inflow monitoring points and turnouts. These existing facilities are illustrated in Figure 3.

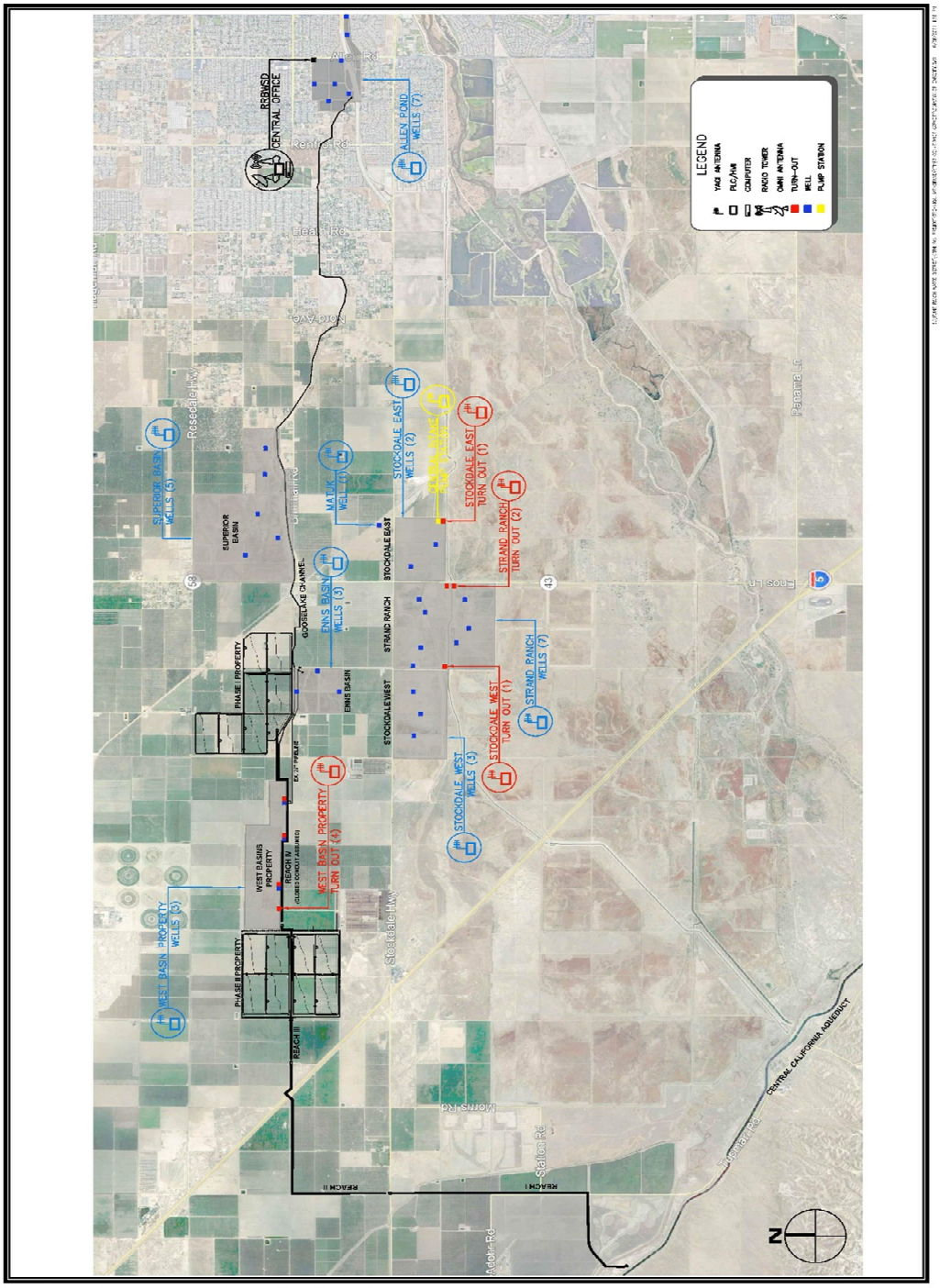


Figure 3: SCADA System Layout for Existing District Facilities

This work shall be coordinated with the design and construction efforts for the well sites, pump stations, and turnouts to ensure that the monitoring locations, PLC programming, and SCADA work is consistent with the monitoring equipment included in each facility design and its desired function.

It is anticipated that this work will be designed and constructed by a qualified firm that specializes in PLC programming and SCADA systems. The firm shall possess a State of California Class C-7 (Low Voltage Contractor) or C-10 (Electrical Contractor) Contractor's License.

The memorandum herein outlines preliminary engineering information for:

Definitions:

HMI	Human Machine Interface
I/O	Input/Output Modules
IP	Internet Protocol
PLC	Programmable Logic Controller
OIT	Operator Interface Terminal
OPC	Open Platform Communications
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SQL	Structured Query Language
TCP	Transmission Control Protocol

II. Conveyance Facility/Pump Station Control Philosophy

Canal Design Option (Open Channel)

The preliminary conveyance canal design option estimates three in-line pump station facilities along the conveyance canal. In addition, it estimates a return water pump station for returning water to the California Aqueduct during water recovery periods and also a Goose Lake Channel Pump Station facility for conveying water to the Phase I Recharge property. The pump station control philosophy for each pump station facility will be developed during the detailed design of the conveyance canal and pump stations.

The conveyance canal flows will be based on upstream control at the California Aqueduct turnout through the use of the slide gate and turnout flow meter. The Aqueduct Turnout and Pump Station slide gates shall have motor actuated controllers with position indicators and be capable of modulating positions.

The pump stations will need to be capable of being controlled, monitored, and operated both locally and remote through SCADA. The operators shall have the flexibility to turn on pumps and turn off pumps as necessary as well as being able to adjust set points and make changes to the operations. In addition, the SCADA system shall provide for water level monitoring in each pump forebay and afterbay as well as indicating the pump flow readings from the flow meters. The SCADA system shall provide:

- Pump Run Status
- Forebay Water Level
- Pump Bay Water Level
- Afterbay Water Level
- Emergency Spillway Water Level
- Pump Discharge Flow (Instantaneous Flow and Totalized Flow)
- Pump Discharge Pressure
- Pump Run Time
- Communicate alarm for power failure
- Communicate alarm for motor failure
- Communicate water level alarms
- Communicate high pressure alarms
- Communicate building intrusion alarms.

The Conveyance Canal pump station motors will be equipped with variable speed drives and will be able to modulate to maintain flow or level. The canal may be desired to be controlled based on flow and level. The pump station shall have the ability to set the flow rate at each pump station and have the pumps modulate to maintain the flow set point while utilizing the water level as a secondary means of control in the event of high water levels or low water levels that could

compromise the performance of the pump based on low submergence. Protective measures such as water level sensors shall be duplicated for redundancy.

The Goose Lake Channel Pump Station and Return Water Pump Station motors will be equipped with variable speed drives and will be able to modulate to maintain flow or level. It is anticipated that the Goose Lake Channel Pump Station and Return Water Pump Station will be operated for long periods of time or turned off for long periods of time. Override protective measures will be designed such as a low water level cutoff in the event the pump submergence is compromised or a high pressure switch at the pump discharge in the event of a closed valve or blockage. Protective measures such as water level sensors shall be duplicated for redundancy.

Pipeline Design Option (Closed Conduit)

The preliminary conveyance pipeline design option estimates one in-line pump station facility and also a Goose Lake Channel Pump Station facility for conveying water to the Phase I Recharge property. The pump station control philosophy for each pump station facility will be developed during the detailed design of the conveyance canal and pump stations.

The conveyance pipeline flows will be based on downstream control at the Pump Station facility. The California Aqueduct turnout can be opened and the pipeline and pump station can float off the Aqueduct. The Pump Station facility will then be set to a predetermined flowrate and the slide gate at the California Aqueduct can be modified to match the flow of the pump station, if necessary. The Aqueduct Turnout and Pump Station slide gates shall have motor actuated controllers with position indicators and be capable of modulating positions.

The pump stations will need to be capable of being controlled, monitored, and operated both locally and remote through SCADA. The operators shall have the flexibility to turn on pumps and turn off pumps as necessary as well as being able to adjust set points and make changes to the operations. In addition, the SCADA system shall provide for water level monitoring in each pump forebay, the pressure in the discharge pipeline, and also the pump flow readings from the flow meters. The SCADA system shall provide:

- Pump Run Status
- Forebay Water Level
- Pump Bay Water Level
- Pump Discharge Flow (Instantaneous Flow and Totalized Flow)
- Pump Discharge Pressure
- Pump Run Time
- Communicate alarm for power failure
- Communicate alarm for motor failure
- Communicate water level alarms
- Communicate high pressure alarms
- Communicate building intrusion alarms.

The Conveyance Pipe Pump Station motors will be equipped with variable speed drives and will be able to modulate to maintain flow or level. The pipeline may be desired to be controlled based on flow and level. The pump station shall have the ability to set the flow rate at the pump station and have the pumps modulate to maintain the flow set point while utilizing the water level as a secondary means of control in the event of high water levels or low water levels that could compromise the performance of the pump based on low submergence. Protective measures such as water level sensors shall be duplicated for redundancy.

The Goose Lake Channel Pump Station motors will be equipped with variable speed drives and will be able to modulate to maintain flow or level. It is anticipated that the Goose Lake Channel Pump Station will be operated for long periods of time or turned off for long periods of time. Override protective measures will be designed such as a low water level cutoff in the event the pump submergence is compromised or a high pressure switch at the pump discharge in the event of a closed valve or blockage. Protective measures such as water level sensors shall be duplicated for redundancy.

III. Conveyance/Pump Station Instrumentation

The instrumentation and controls for the pump stations will be utilized for pump and motor operation, safety features, and monitoring. The instrumentation and controls shall include the following devices:

- Water Level Transducer (4-20 ma) for monitoring pump station forebay levels and afterbay levels, if applicable (Ametek 575 or approved equal). Provide two transducers at each location for redundancy.
- High Level Float Switch for high level shutoff if forebay levels infringe into design freeboard level. Provide two high level float switches for redundancy.
- Low Level Float Switch for low level shutoff if forebay levels compromise minimum pump design submergence. Provide two low level float switches for redundancy.
- High Pressure Switch to protect piping from over-pressurizing (Mercoid or approved equal).
- Pressure Transmitter (4-20 ma) for monitoring discharge pressure (Smar Technology or approved equal).
- Flow Meter signal (4 – 20 ma) for monitoring pump flow (Seametrics Mag Meter with power supply – (not battery powered), Insertion Probe Meter, or Rittmeyer Meter)

IV. Conveyance Turnout Instrumentation

The conveyance turnouts consist of the Aqueduct Turnout, the Phase II Recharge Basin turnouts, the West Basin turnouts, the Phase I Recharge Basin turnout, and the in-lieu farmer turnouts. The instrumentation and controls for these turnouts will be utilized for slide gate operation, safety features, and monitoring.

California Aqueduct Turnout

The instrumentation and controls for the California Aqueduct Turnout shall include the following devices:

- Level Transducer (4-20 ma) for monitoring turnout forebay levels upstream of the trashrack as well as downstream of the trashrack (Endress + Hauser or approved equal).
- Flow Meter signal (4 – 20 ma) for monitoring turnout flow (Rittmeyer Meter)
- Slide gate position indicator

Conveyance Turnouts (Recharge Basin Turnouts and In-Lieu Farmer Turnouts)

The instrumentation and controls for the conveyance turnouts shall include the following devices:

- Flow Meter signal (4 – 20 ma) for monitoring turnout flow (SonTek IQ Meter)
- Stilling Well for level measurement
- Slide gate position indicator

V. Recovery Well Control Philosophy

The wells are operated during recovery operations and are manually operated. They are turned on manually and turned off manually unless shutdown on a power failure, equipment failure, or high pressure switch.

The monitoring devices send information via 4-20 ma signals to the RTU panel or a Mission Unit. The RTU or Mission Unit is a remote monitoring device that displays the following:

- Well Run Status
- Groundwater Level
- Well Discharge Pressure
- Well Discharge Flow
- Run Time
- Any Alarms

VI. Recovery Well Instrumentation

The instrumentation and controls for recovery wells will be utilized for well operation, safety features, and monitoring. The instrumentation and controls shall include the following devices:

- Well Level Transducer (4-20 ma) for monitoring groundwater levels (Endress + Hauser or approved equal).
- Solenoid for oil drip to deep well pump.
- High Pressure Switch to protect piping from over-pressurizing (Mercoid or approved equal).

- Pressure Transmitter (4-20 ma) for monitoring discharge pressure (Smar Technology or approved equal).
- Flow Meter signal (4 – 20 ma) for monitoring well flow (Seametrics Mag Meter with power supply – (not battery powered))

VII. SCADA Platforms

SCADA stands for Supervisory Control and Data Acquisition. SCADA is a tool with a very specific defined set of functions such as it can turn devices on and off, adjust setpoints, display real time operational data, provide equipment wide to system wide views of operation, trend data, and communicate alarms.

The platforms all connect and enable use of the Cloud, the internet, and mobile options. There are many platforms on the market including:

- AVEVA (formerly Wonderware)
- GE Intellution
- Iconics
- Ignition
- Mission Communications
- Rockwell FactoryTalk
- Siemens WinCC

These SCADA platforms are all viable alternatives, however this memorandum summarizes the three most popular software platforms, AVEVA (Wonderware), FactoryTalk, and Ignition, and has included additional detail for each of these in Appendix A, B, and C.

The PLC's installed throughout all facilities, including but not limited to, the Aqueduct Turnout, Conveyance Pump Station(s), Goose Lake Channel Pump Station, Turnouts, and Wells, shall be consistent and all of the same manufacturer. Acceptable PLC manufacturer's include ABB, Eaton, Honeywell, Rockwell Automation (Allen-Bradley), Schneider Electric, and Siemens.

The HMI's installed throughout all facilities at the discretion of the GBJPA, including but not limited to, the Aqueduct Turnout, Conveyance Pump Station(s), Goose Lake Channel Pump Station, Turnouts, and Wells, shall be consistent and all of the same manufacturer. Acceptable HMI manufacturer's include Eaton, Honeywell, Rockwell Automation (Allen-Bradley), Schneider Electric, and Siemens. The local HMI screens may display local facility information only or may display information for the entire system including wells, pump stations, and turnouts subject to the discretion of the GBJPA.

A. AVEVA System (formerly Wonderware)

The AVEVA platform is a highly scalable, flexible software that provides the tools for everything from advanced HMI/SCADA applications to small footprint embedded applications. The platform offers everything required to connect to almost any PLC or controller as well as create remote HMI applications.

However, it only works with the Windows operating system. It does also allow for remote monitoring and can add historian for data access and trending and a reporting option for dynamic reports.

The system would be recommended to include a primary server at the central headquarters and a redundant server installed at a remote location for redundancy. Each server location would include a desktop computer for access and monitoring. All mobile and remote device connections to the server are referred to as thin clients. These have access to the system using web based browser technology.

AVEVA Costs

AVEVA has what they call a perpetual system where there is the upfront cost of the system plus an annual fee that is some percentage of the original upfront cost.

AVEVA is beginning to push more for subscription arrangements which are based on a credit system. Products are valued in credits and you pay an annual fee only based on the products that you purchase.

Since the cost is directly tied to the size and features of the system, it is important that the system not be over-sized inappropriately. If additional needs become necessary or other facilities are added, the subscription system can be increased to include additional tags, clients, and plans as necessary.

A preliminary cost estimate for the AVEVA system includes the following:

Capital Cost:

• Two Custom Built Servers (Rack or Tower)	$20,000.00
• Two Custom Built Desktop PC's with Monitors	$6,000.00
• Firewall VPN	$2,000.00
• Voice Modules VoIP Modules	$1,000.00
• Radio Survey	$10,000.00
• Radio Tower at Central Headquarters	$40,000.00
• Radio Communication – Antenna, Radios, Cable, Switches, Grounding, and Enclosures for Aqueduct Turnout, Phase I Basins, Phase II Basins, and Pumping Station	$192,000.00
Total Capital Cost:	$271,000.00

Annual Costs:

• Subscription Model Estimate between $7,000 to $13,000 per year	$10,000 per yr

This equates to an approximate total cost (capital plus annual costs) over a ten (10) year period of $371,000.00.

B. FactoryTalk (Rockwell Automation)

FactoryTalk View Site Edition (SE) is the platform for Rockwell that allows for monitoring and controlling systems at all levels, from a single operator station up to multi-user applications. However, it only works with the Windows operating system. Rockwell utilizes "thin clients" to connect remotely to a server-based system that allows it to run apps, record data, and display content.Rockwell adds FactoryTalk View Point as a mobile-ready extension that provides a secure interface with the HMI applications through a web browser on any mobile device.

The system would be recommended to include a primary server at the central headquarters and a redundant server installed at a remote location for redundancy. Each server location would include a desktop computer for access and monitoring. All mobile and remote device connections to the server would be through FactoryTalk View Point. These devices have access to the system using web based browser technology.

FactoryTalk Costs

A preliminary cost estimate for the FactoryTalk system includes the following:

Capital Cost:

• Two Custom Built Servers	$20,000.00
• Two Custom Built Desktop PC's with Monitors	$6,000.00
• Two FactoryTalk View Site Edition Stations	$30,000.00
• Two FactoryTalk View Point Packages for Remote Access	$20,000.00
• Two Historian Packages	$10,000.00
• Two WIN-911 Software Packages	$10,000.00
• Firewall VPN	$2,000.00
• Voice Modules VoIP Modules	$1,000.00
• Radio Survey	$10,000.00
• Radio Tower at Central Headquarters	$40,000.00
• Radio Communication – Antenna, Radios, Cable, Switches, Grounding, and Enclosures for Aqueduct Turnout, Phase I Basins, Phase II Basins, and Pumping Station	$192,000.00
Total Capital Cost:	$341,000.00

Annual Costs:

• License Fees Estimate between $7,000 to $13,000 per year	$10,000 per yr

This equates to an approximate total cost (capital plus annual costs) over a ten (10) year period of $441,000.00.

C. Ignition (Inductive Automation)

The ignition platform is a modular platform with scalability and includes powerful features and core drivers to connect data and devices into one central hub. It has unlimited tags and powerful connectivity. It can connect to any major PLC and database with built-in SQL database connectivity and includes an OPC UA Server Module and core drivers such as Modbus, Allen-Bradley, and Siemens.

It is a modular platform that allows the client to select and choose the modules they desire and to combine options in the way that suites the project application the best. The software is compatible with Windows, Linux, and Mac among others. Ignition is a server software. In order to have redundancy two servers are required, however Ignition reduces the cost of the second server software 50% when being utilized in a redundant application.

The system would be recommended to include a primary server at the central headquarters and a redundant server installed at a remote location for redundancy. Each server location would include a desktop computer for access and monitoring. All mobile and remote device connections to the server are possible without any additional costs. These devices have access to the system using web based browser technology.

Ignition Costs

The ignition system is nice because the capital costs are a one-time cost and there are no annual licensing costs. If a redundant system is installed, then there are two licenses required with one for the primary and a second license at a 50% discount for the redundant application.

Capital Cost:

The cost is dependent on the modules that are selected. The software can easily be customized, however they do offer standard packages. There are three unlimited package systems that contain the basic components. These include (redundancy not included in costs):

- Basic Package $12,500.00
- Pro Package $19,600.00
- Ultimate Package $27,900.00

If redundancy is provided then the cost increases by fifty-percent:

- Basic Package $18,750.00
- Pro Package $29,400.00
- Ultimate Package $41,850.00

A preliminary cost estimate for the Ignition system includes the following:

• Pro Package Software w/Redundancy	$29,400.00
• Two Custom Built Servers (Rack or Tower)	$20,000.00
• Two Custom Built Desktop PC's with Monitors	$6,000.00
• Firewall VPN	$2,000.00
• Voice Modules VoIP Modules	$1,000.00
• Radio Survey	$10,000.00
• Radio Tower at Central Headquarters	$40,000.00
• Radio Communication – Antenna, Radios, Cable, Switches, Grounding, and Enclosures for Aqueduct Turnout, Phase I Basins, Phase II Basins, and Pumping Station	$192,000.00

When adding in the infrastructure for communication, the total estimated system cost is approximately $300,400.00.

There are no annual license fees. This equates to an approximate total cost (capital plus annual costs) over a ten (10) year period of $300,400.00 if the support care is not implemented.

Annual Costs

Ignition does provide three levels of support that results in an annual cost, however this support is not mandatory. The benefit to the support is that it covers the costs of any future software updates and upgrades as they are developed and provides support in the event of problems.

The drawback is if the support is not paid for on an annual basis, then when the client wants to purchase an update or software upgrade the cost of the update is 65% of the licensing cost. The care support options are:

D. Recommendations

FactoryTalk View has the advantage of being a Rockwell Automation product and is therefore well integrated with ControlLogix. The RSLinx Enterprise Tag Browser and Direct Referencing are the fastest and easiest way to get data from a ControlLogix PLC to an HMI. It also mixes fairly well with other Windows applications since it is a native Windows application.

However, Ignition has the simplest and fastest installation, the stability of the system is much better, and the vector graphics are nice. The SQL database integration in Ignition is also better than FactoryTalk and there is less need for conversions or exports with data. In addition, Ignition does not have any client licensing annual costs and it is a powerful tool as you can do just about anything with Ignition including trending and database access.

Ignition is fast becoming a very popular platform, is user friendly, powerful, and is the most cost effective solution for SCADA.

Cost Summary (Ten (10) Year Basis)

Ignition SCADA	$300,400.00
AVEVA SCADA	$371,000.00
FactoryTalk SCADA	$441,000.00

VIII. Radio Communication

A wireless I/O network is a radio system that communicates from the desktop to the RTU or PLC and then to the field instruments without wired connections, on one continuous radio network. Wireless communication is advantageous as it allows for increased transfer distance (geographic proximity) with the decreasing probability of failure, the high capacity and high speed of data transfer, and is economical. This can be accomplished using spread spectrum (unlicensed) radios or licensed radios.

Spread spectrum radio communication is likely the most common telemetry method. A spread spectrum system uses radio waves to transmit data between the RTU and the central headquarters. It uses a FCC-defined, but unregulated band of radio waves in the 900 MHz range to transmit the data. The radio equipment is economical and no subscription or licenses are required. There are no ongoing annual costs other than routine maintenance.

Radio communication is frequently used for SCADA systems and is an effective means of transmission, however it does have its drawbacks. It does require direct line of sight between the transmitter and receiver which means that the signal can be dramatically affected by physical interference like trees, buildings, and other facilities. There are geographic areas and times when signal issues can occur, there can be issues with excess traffic on a radio frequency, potential for lightning strikes, and radio equipment quickly becomes obsolete.

In any remote SCADA application utilizing facilities that communicate using wireless technology, it is imperative the radio paths are strong, have minimal or no interference, and react in this manner whether day or night. There are sometimes conditions that can be seen and sometimes conditions that cannot be seen that can inhibit RF modulation in some form or another. This communication could also be an issue across the Interstate 5 Freeway due to the amount of radio traffic. In order to avoid these types of issues it is recommended to conduct a detailed radio path study to determine the probability of strong communication links (greater than 99% reliability) by testing in various frequency bands (VHF, UHF, spread spectrum), and using the same equipment (radio, antennas, cables, and polyphasors) which would be used in a typical SCADA system. The firm performing the radio path study shall use software and GIS tools to obtain an initial idea of terrain and obstructions that might inhibit good RF signal transmission and then assess the actual field conditions as described above. The signal strengths shall be assessed at various antenna heights to obtain

a minimum threshold to ensure reliable transmissions with minimal data packet loss.

A final radio path survey report shall be submitted to the GBJPA that provides recommendations on the locations and heights of antennas, the type of radio equipment and frequencies to utilize, and a preliminary estimate of costs for infrastructure and equipment.

IX. Cellular Communication

Cellular communication uses a grid of towers to communicate data similar to cell phones. Cell companies have invested a massive amount of resources to constructing a strong infrastructure and keeping their networks active at all times.

The advantages to cellular communication is that you do not need large towers or lightning-prone antennas to ensure line of sight and strong signal strength. This communication simply requires a small antenna and cell service. This will likely be the best option of communication from the west side of the Interstate 5 Freeway to the east side of the freeway.

The disadvantages to cellular communication are the on-going costs and potential security issues. SCADA systems rarely use much data so the monthly costs typically are not that significant, but if there are many sites then it can add up and there will be continual monthly costs that are not associated with a radio system. Furthermore, standard cell data transmissions are online which means that there is the potential for hackers to attack the system which would require a private network or other protective measures at additional costs.

The security issues could be solved by using a Cellcom. This type of unit has a SIM card and can run off a 12V or 24V power connection. It receives the data from a PLC and communicates it through a cellular connection and can be viewed in a web browser on any device. This is a good alternative that allows for a back-up monitoring system to the SCADA platform and also allows for other Districts, Engineer's, and interested parties to view the system operation and data without risk of impacting set points, operations, or other real-time data. The cost is estimated as $240.00 to $360.00 per year for the cell phone data plan and $60.00 per month per site for the private system.

In addition, it may be that a combination of a radio system and a cellular system works best for this project. Due to the relative proximity of recovery wells within a recharge area or farmer turnouts, these locations could utilize radio communication between them to a central location. That central location could then utilize a cellular communication system to transmit data to the Central Headquarters. This would help maintain robust communication while minimizing the monthly costs associated with cellular data plans.

X. Related Work Specified Elsewhere

A. TM 2 – Conveyance Capacity
B. TM 3 – Pipeline Requirements
C. TM 4 – Pump Station Requirements
D. TM 7 - Well Requirements
E. TM 11- Project Engineer's Estimates

Appendices

Appendix A – AVEVA SCADA System
Appendix B – Ignition SCADA System
Appendix C – FactoryTalk SCADA System

Appendix A
AVEVA SCADA System

AVEVA System (formerly Wonderware)

AVEVA has three platforms that would potentially be suited for this system.

- Edge
- InTouch HMI
- System Platform

The Edge platform is a highly scalable, flexible software that provides the tools for everything from advanced HMI/SCADA applications to small footprint embedded applications. The platform offers everything required to connect to almost any PLC or controller as well as create remote HMI applications. However, it only works with the Windows operating system. It does also allow for remote monitoring and can add historian for data access and trending and a reporting option for dynamic reports.

The InTouch HMI platform provides the ability to visualize and control vital plant processes in real time. This is valuable where system operations require frequent adjustments and changes based on real-time process data. This system is around 1500 credits for unlimited everything (clients, tags, development tools, and Historian).

The System Platform allows for the secure visualization of enterprise-wide operations using an asset model to apply context to real-time processes, alarms, events, and archived historical data thus creating a single, common information stream that makes system design and maintenance more efficient, flexible, and provides operators with greater situational awareness for improved effectiveness. This system is around 2500 credits for unlimited everything.

These platforms do provide flat file logging, however this is not a relational database historian. It is recommended to add the Historian in order to provide data recall, low buffering, and access data for trending. Cloud options can be provided that allow for read only access.

The system would be recommended to include a primary server at the central headquarters and a redundant server installed at a remote location for redundancy. Each server location would include a desktop computer for access and monitoring. All mobile and remote device connections to the server are referred to as thin clients. These have access to the system using web based browser technology.

AVEVA Costs

AVEVA has what they call a perpetual system where there is the upfront cost of the system plus an annual fee that is some percentage of the original upfront cost. It is approximated that the perpetual cost would be on the order of $20,000 to $30,000 for the Edge Platform software with unlimited tags and an approximate annual cost of $1,500 to $2,500.

AVEVA is beginning to push more for subscription arrangements which are based on a credit system. Products are valued in credits and you pay an annual fee only based on the products that you purchase. The cost increases at varying credit thresholds. For instance:

• 1,500 Tags =	80 Credits
• 16,000 Tags =	150 Credits
• Unlimited Tags and One Thin Client =	700 Credits
• Historian =	500 Credits

It is estimated that a threshold of 700 credits equates to an annual subscription cost of approximately $7,000 per year. A threshold of 1,200 credits equates to an annual subscription cost of approximately $13,000 per year. A threshold of 1,700 credits equates to an annual subscription cost of approximately $20,000 per year.

Depending on the number of data points required, it might be a good option to go with 1,500 tags, unlimited clients, development, and Historian which would equate to approximately 700 credits and an annual cost of $7,000 per year.

Since the cost is directly tied to the size and features of the system, it is important that the system not be over-sized inappropriately. If additional needs become necessary or other facilities are added, the subscription system can be increased to include additional tags, clients, and plans as necessary.

A preliminary cost estimate for the AVEVA system includes the following:

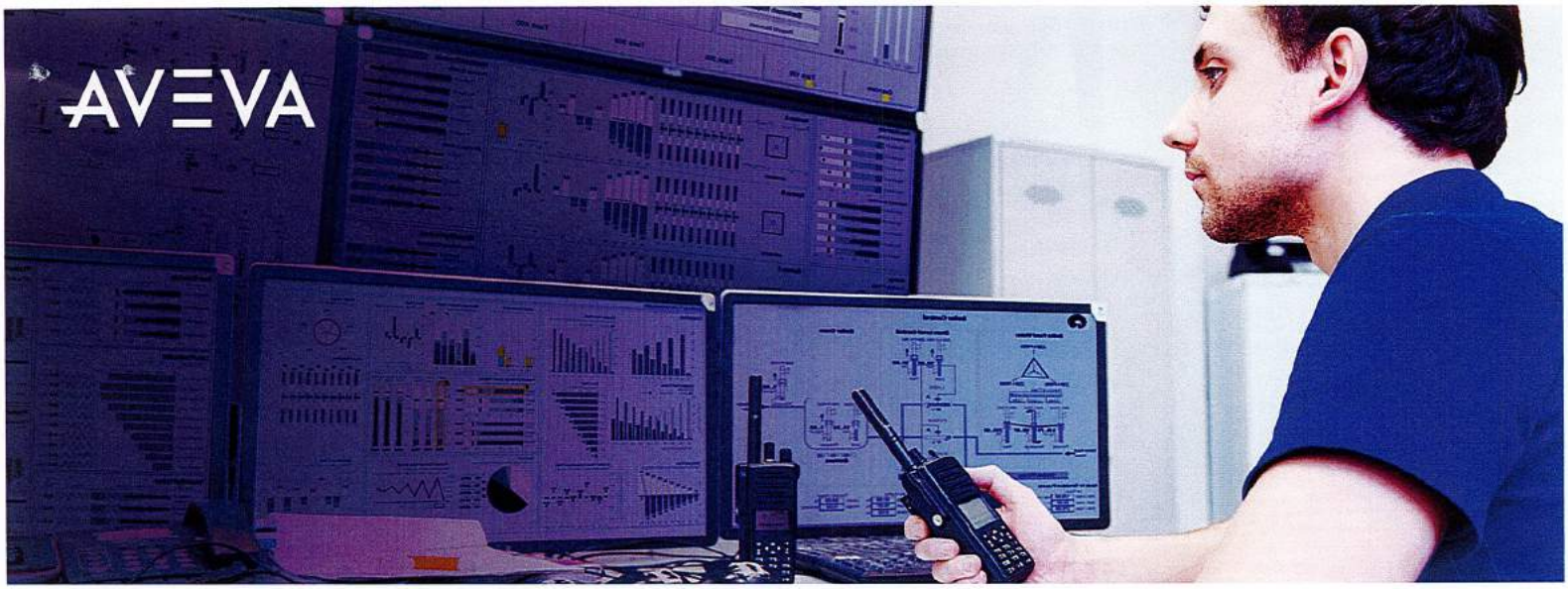
Capital Cost:

• Two Custom Built Servers (Rack or Tower)	$20,000.00
• Two Custom Built Desktop PC's with Monitors	$6,000.00
• Firewall VPN	$2,000.00
• Voice Modules VoIP Modules	$1,000.00
• Radio Survey	$10,000.00
• Radio Tower at Central Headquarters	$40,000.00
• Radio Communication – Antenna, Radios, Cable, Switches, Grounding, and Enclosures for Aqueduct Turnout, Phase I Basins, Phase II Basins, and Pumping Station	$192,000.00
Total Capital Cost:	$271,000.00

Annual Costs:

- Subscription Model
  Estimate between $7,000 to $13,000 per year $10,000 per yr

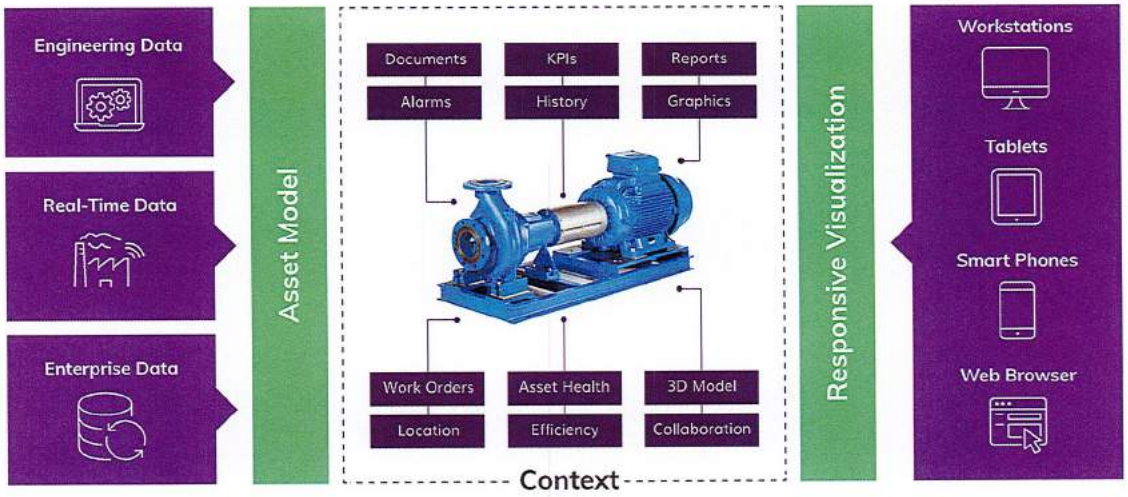
This equates to an approximate total cost (capital plus annual costs) over a ten (10) year period of $371,000.00.

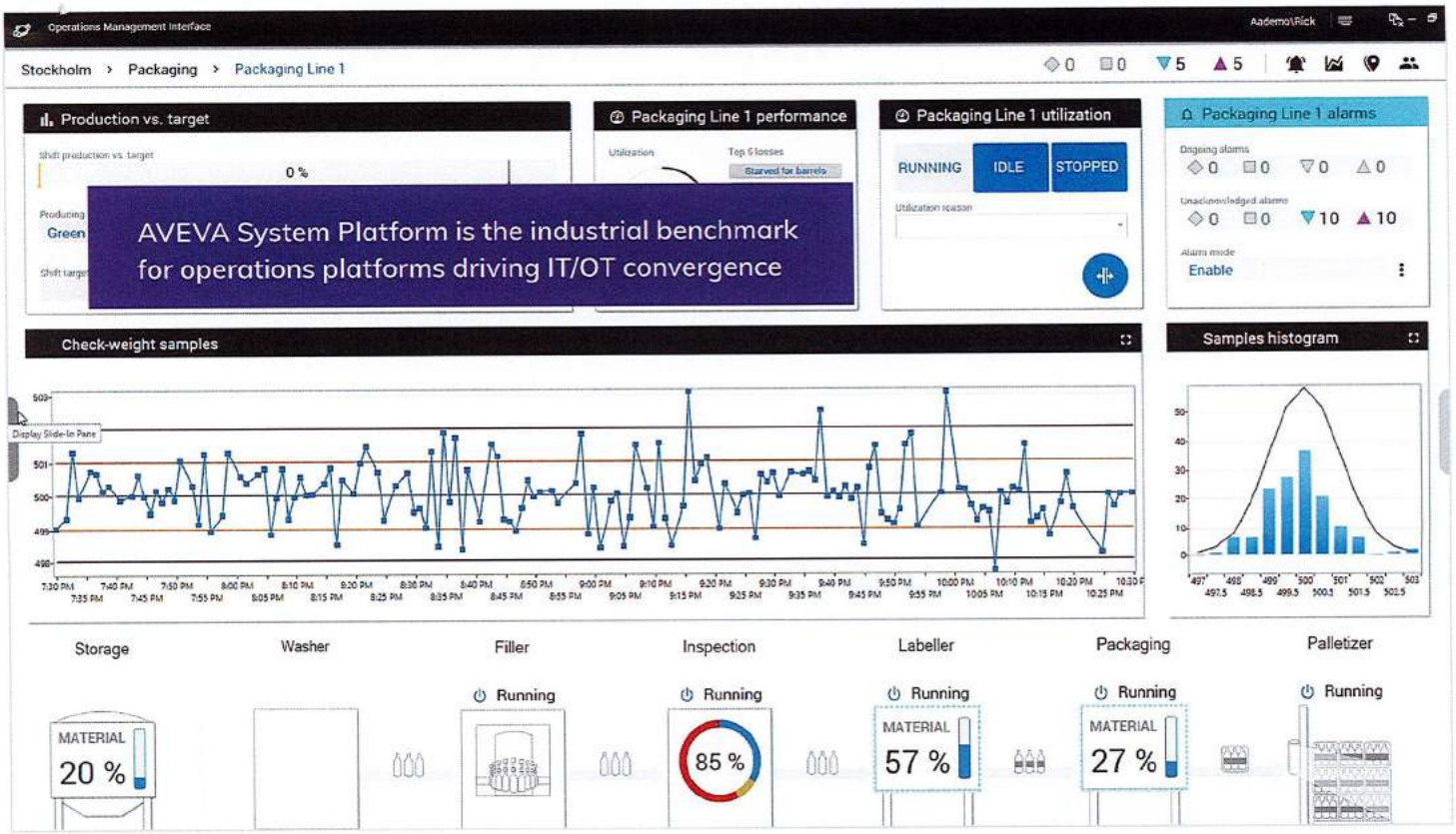


PRODUCT DATASHEET

AVEVA™ System Platform, formerly Wonderware

AVEVA System Platform with Operations Management Interface (OMI) is the world's only responsive, scalable solution for supervisory, Enterprise SCADA, MES, and IIoT applications that contextualizes operations processes across the organization. AVEVA System Platform provides a collaborative, standards-based foundation that unifies people, processes, and assets across all facilities for continuous operational improvement and real-time decision support.





Overview

AVEVA System Platform's Operations Management Interface (OMI) brings a responsive operations visualization framework to industrial organizations seeking an innovative new way to build rich, modern user experiences across all device formats through context-aware and re-usable content. Offering powerful experiences for both engineers and operators, AVEVA System Platform provides the foundation for a truly effective performance management system that reinforces positive outcomes. Achieve up to 80% reduction in engineering effort to create applications using templates, objects, and out-of-the-box content; and expand your operator situational awareness, increasing effectiveness up to 40%, by identifying and resolving abnormal situations 5 times faster than traditional HMIs.

At-a-glance

- Powerful context-aware UI/UX visualization framework
- Standards-based design techniques utilizing objects and templates
- Unique centralized deployment with native redundancy
- Comprehensive automation object and graphics library
- Extend your operations platform with additional AVEVA and 3rd Party software
- Hardware agnostic that works with any PLC, RTU or PAC
- Maximum device flexibility and eliminates the need for UI scripting
- Complete Scalability – unlimited IO, unlimited clients
- Most secure industrial platform with node-to-node TLS encryption

Industry-leading engineering experience

Responsive development has arrived

Easily create the optimal user experience across multiple form factor display devices from big screen monitors to smartphones.

Create applications that last

Standardize the use of templates and change propagation to build and maintain applications sustainably and maximize reusable engineering.

Dynamically build applications

By using new smart navigation capabilities and layout configurations, you can use your plant model to automatically link content.

Engineers can be wizards

Object wizards create versatile templates that adapt based on a device's configuration. Symbol wizards standardize custom configuration options like graphical elements, scripts or custom properties, and automatically assemble them into a single composite symbol.

Collaborative cloud-based development

Application design and testing can be done in the cloud or on-premise, to enable teams of engineers to work concurrently and remotely on the same application at the same time.

Most comprehensive out-of-the-box content

Leveraging pre-built application content, you can save time, reduce development costs, and reduce to time to value compared to custom configurations.

WYSIWYG

Use the device simulator and preview modes to build, test and optimize any monitor configuration or content to perform on every display screen, regardless of resolution. You can even test multi-monitor configurations without physical access to the monitors themselves.

Fluent communications for any device or system

Expand connectivity and increase the value of data by leveraging real benefits from the IIoT, big data and cloud technologies.

- Support for OPC-UA, MQTT, DNP3, Modbus and IEC 60870 protocols.
- Support for many PLC brands, including Schneider Electric, Allen-Bradley, GE, Siemens, Automation Direct, Bosch, Eaton, WAGO, Beckhoff, BACnet, Texas Instruments, Mitsubishi, Omron and Opto 22.
- Auto-Build capability expedites engineering efforts by reading the structure of a PLC program and automatically building templates and instances based on the PLC schema.
- Secure encrypted communications

Innovative user experience

Empower operators with situational awareness

- Deliver immersive control applications that weaves context throughout the visual design including situational awareness concepts for improved operator performance.
- Quickly navigate displays following intuitive and modern UI/UX design techniques, pop-out slide panels and multi-level window structures.
- Uncover new insights and training opportunities by reviewing historical activity through the historical playback capability – no scripting or configuration necessary. Just hit play.
- Apply geographical perspectives to decision-making with the Map OMI App enabling operators to become more aware of geographically distributed assets.
- Centralize access to non-traditional information sources such as work orders and team collaboration to bring greater context to process-centric views.
- Increase usability across devices with multi-touch and gesture controls such as panning, zooming, and declutter mechanisms.
- Automatically calculate statistical summary process data (i.e. maximum, minimum, average, etc.) in real-time without any coding.
- Capture the "best operator" in the system to reduce operator strain and expedite on-boarding for new operators.

Intelligent alarming supports productivity

Maximize the use of advanced alarm management capabilities like state-based alarming, alarm suppression, alarm shelving, alarm grouping and aggregation to identify and filter out nuisance and "bad actor" alarms based on severity to maintain focus on the most relevant process information, reducing operator distractions and fatigue.

Establish a system of record

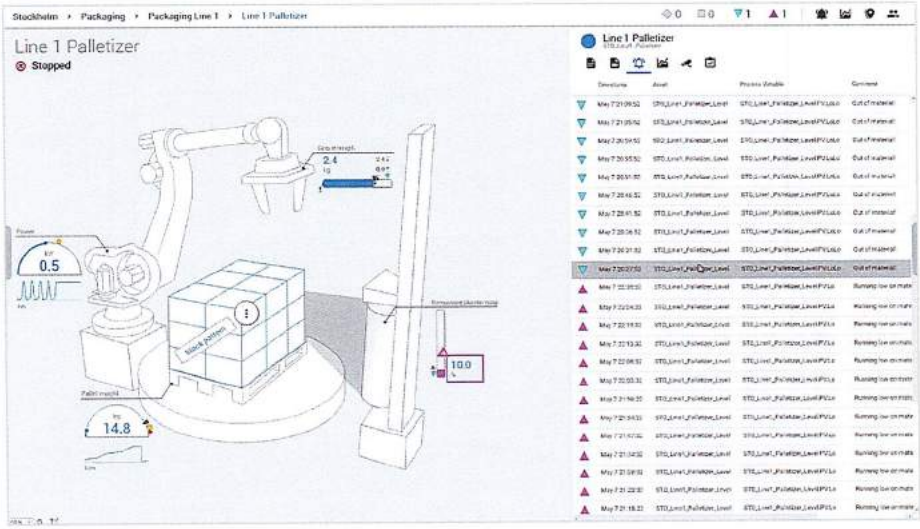
Unlike conventional relational databases, AVEVA Historian handles time-series data, as well as alarm and event data. Unique "block technology" captures plant data hundreds of times faster than a standard database system and utilizes a fraction of conventional storage space.

Capture everything on-time

Manage low bandwidth data communications, late coming information, and even data from systems with mismatched system clocks. Ensuring high resolution data is captured accurately every time.

Analyze complex trends

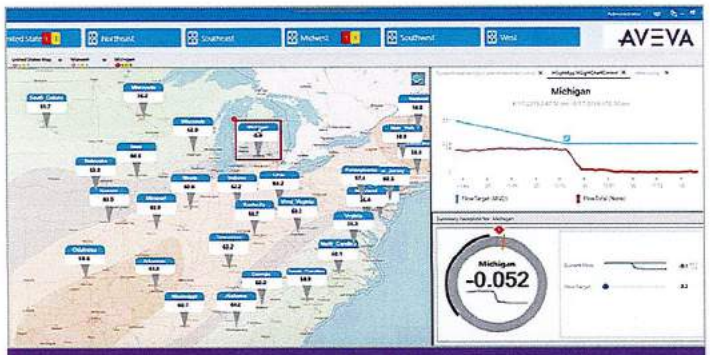
Process one year of historical data in less than a second to facilitate troubleshooting, identify inefficiencies, and eliminate the time-consuming activity of locating data, using AVEVA Historian Client's powerful trend, query and reporting tools.



Amplifying the operations platform

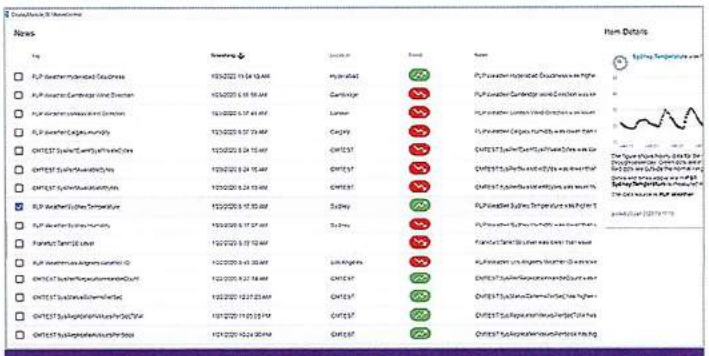
Visualize more with OMI Apps

OMI Apps are extensible add-on capability that can be incorporated into displays to provide enhanced functionality for specific use cases, our growing library of apps are available from both AVEVA and our partners.



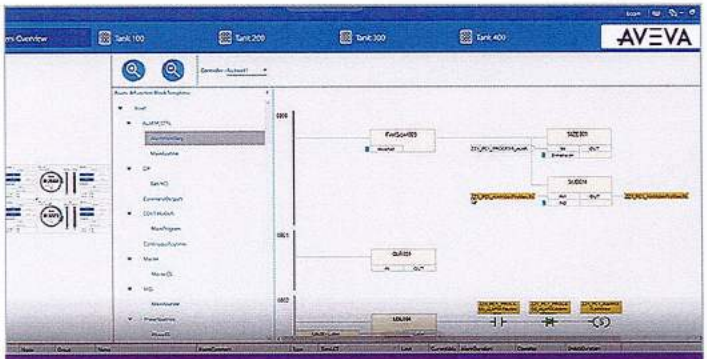
Map OMI App

Offers geographical contextual presentation which enhances the model-based navigation.



Insight OMI App

Builds artificial intelligence into the context of real-time decision making.

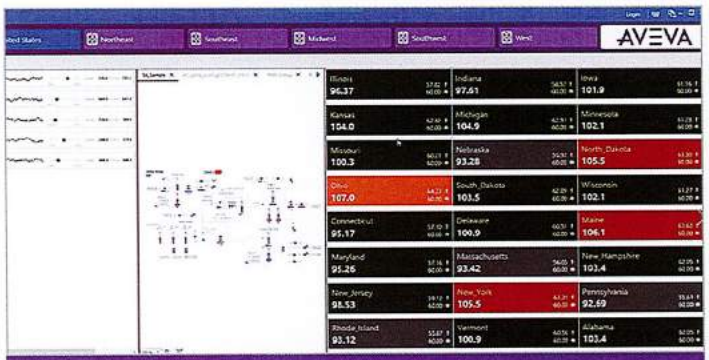


PLC Logic Viewer OMI App

Empowers operators to troubleshoot PLC logic and execution in real-time.

3D Viewer OMI App

Renders 3D models of assets contextually for alarms, alerts, and status changes.



Content Presenter OMI App

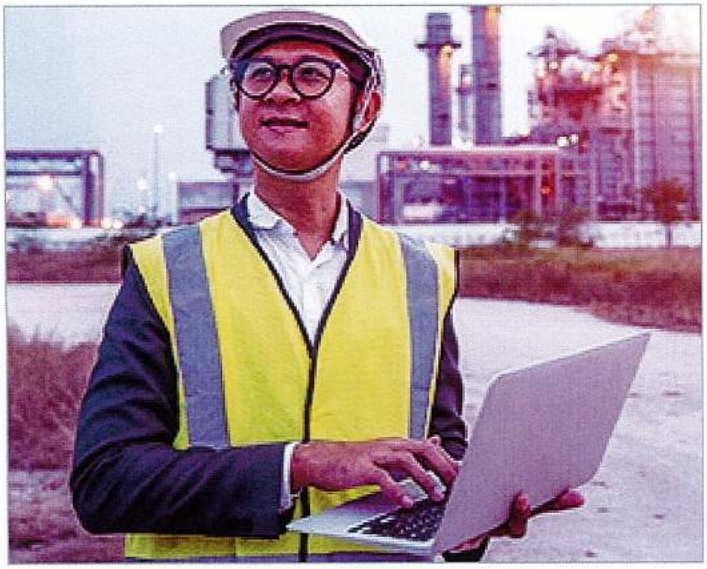
Dynamically create runtime dashboards with KPIs, symbols, or alarms status of area.

Graphic Repeater OMI App

Repeat any symbol to visually represent data that would typically be shown in a table.

Integrate with AVEVA & partner software

AVEVA System Platform is the ideal open standards-based foundation that interfaces to countless software systems and services.

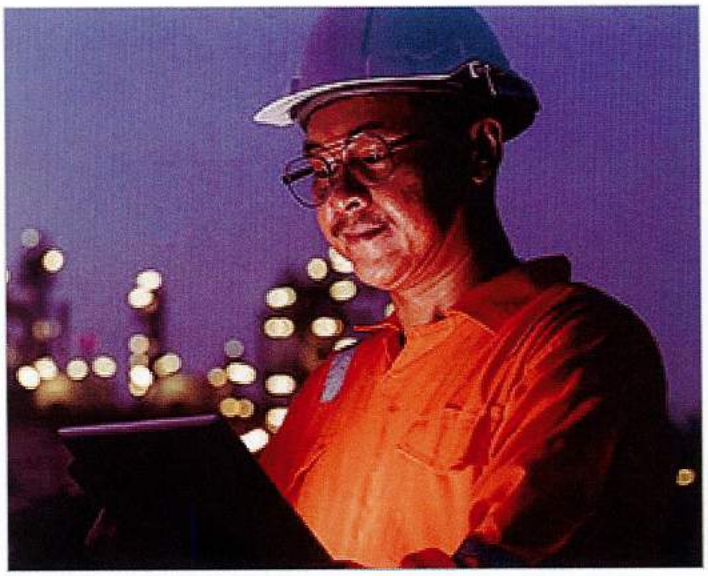


AVEVA Insight

Cloud based actionable information and Artificial Intelligence capabilities to help your teams improve asset reliability and operational performance.

AVEVA Work Tasks

Advanced management for the digital transformation of standard operating procedures and orchestration of work execution.



AVEVA Mobile Operator

Structured procedures provided on mobile devices to improve operations efficiency, streamline maintenance management, and increase regulatory compliance.

AVEVA MES

Digitally manages the production execution, quality and downtime activities using a model-driven approach for plant events in real-time.

Integrate with AVEVA & partner software

AVEVA System Platform is the ideal open standards-based foundation that interfaces to countless software systems and services.

AVEVA EAM

Comprehensive solution for providing maintenance management, spares, inventory management, and provides complete procurement capabilities.

AVEVA Teamwork

Performance support application in the cloud that empowers workers to learn, solve problems and share knowledge from their workstations.

AVEVA Batch Management

Manages multi-product and multi-stream batch operations to maximize plant throughput, increase flexibility and consistent quality to specification.

AVEVA Recipe Management

Simplifies management of product formulations, downloading of formula parameter values, and recipe execution to produce a specific product.

Future-proof investment

Architectural Flexibility

Easily scale as your operations grow, from a single box system, to client-server, to multi-tiered deployment without re-engineering the solution. AVEVA System Platform was designed to expand and change over time to accommodate shifting needs, including the ability to distribute the system across multiple servers for maximum uptime and redundancy.

The Best of All Worlds: On-Premise, Cloud, and Hybrid

AVEVA System Platform supports a mix of on-premise and cloud-based applications for the most pragmatic and flexible approach to real-time control and actionable insights that suits your needs.

Maintain A Healthy System

Enable continuous proactive monitoring of your system's health, performance, and availability. AVEVA System Platform greatly mitigates the risk of application downtime by making incremental changes on the fly and manages system patches centrally by downloading and pushing updates directly to networked machines.

Multi-device Experience

Configure applications once and deploy actionable content anywhere on any device.

For more information on AVEVA System Platform, please visit: aveva.com/en/products/system-platform/

For more information contact sales partner:

AVEVA

aveva.com

Appendix B
Ignition SCADA System

Ignition (Inductive Automation)

The ignition platform is a modular platform with scalability and includes powerful features and core drivers to connect data and devices into one central hub. It has unlimited tags and powerful connectivity. It can connect to any major PLC and database with built-in SQL database connectivity and includes an OPC UA Server Module and core drivers such as Modbus, Allen-Bradley, and Siemens.

It is a modular platform that allows the client to select and choose the modules they desire and to combine options in the way that suites the project application the best. It has many options that provide even greater tools and includes some of the following:

- Perspective Module Unlimited
  Allows for data to be deployed directly to a web browser, mobile device, or desktop computer.

- Reporting Module
  Allows for the creation of dynamic, database driven PDF reports.

- SQL Bridge Module
  Allows for the integration of PLC's and SQL databases in unlimited ways.

- Tag Historian Module
  Allows for a SQL database to become a high-performance tag historian.

- Alarm Notification Module
  Allows for the configuration and management of notification systems and email notifications. Can add additional modules for alarm notifications via phone, text, and twilio.

The software is compatible with Windows, Linux, and Mac among others. Ignition is a server software. In order to have redundancy two servers are required, however Ignition reduces the cost of the second server software 50% when being utilized in a redundant application.

The system would be recommended to include a primary server at the central headquarters and a redundant server installed at a remote location for redundancy. Each server location would include a desktop computer for access and monitoring. All mobile and remote device connections to the server are possible without any additional costs. These have access to the system using web based browser technology.

Ignition Costs

The ignition system is nice because the capital costs are a one-time cost and there are no annual licensing costs. If a redundant system is installed, then there are two licenses required with one for the primary and a second license at a 50% discount for the redundant application.

Capital Cost:

The cost is dependent on the modules that are selected. The software can easily be customized, however they do offer standard packages. There are three unlimited package systems that contain the basic components. These include (redundancy not included in costs):

- Basic Package $12,500.00

  -Unlimited Tags
  -Unlimited Clients
  -Unlimited SQL Database Connectivity
  -OPC UA Server and Client
  -Core Drivers Included
  -Tag Historian

- Pro Package $19,600.00

  -Unlimited Tags
  -Unlimited Clients
  -Unlimited SQL Database Connectivity
  -OPC UA Server and Client
  -Core Drivers Included
  -*Reporting Module**
  -Tag Historian
  -*SQL Bridge Module**
  -*Alarm Notification**

  **Modules that are part of Pro Package and not Basic Package*

- Ultimate Package $27,900.00

  -Unlimited Tags
  -Unlimited Clients
  -Unlimited SQL Database Connectivity
  -OPC UA Server and Client
  -Core Drivers Included
  -Reporting Module
  -Tag Historian
  -SQL Bridge Module
  -*Sequential Function Charts (SFC) Module**
  -*Web Development Module**

-Alarm Notification
*-Voice Notification Module**
*-SMS Notification Module**
*-Enterprise Administration Module**
*-OPC COM Module**

**Modules that are part of Ultimate Package and not Pro Package*

If redundancy is provided then the cost increases by fifty-percent:

- Basic Package $18,750.00
- Pro Package $29,400.00
- Ultimate Package $41,850.00

However, Ignition also allows for the customer to configure their own packaged system such that it only incorporates the modules that they actually need. For instance, a system could be provided with the following:

- Ignition Platform – Unlimited tags, clients, & connectivity $1,000
- Perspective Module Unlimited – Visualization on PC, phone, etc. $9,500
- Reporting Module – Create database driven PDF reports $3,300
- Tag Historian Module – Database trending $2,000
- Alarm Notification Module – Email notifications $1,900
- SMS Notification Module – Text notifications $800

The total estimated cost for the custom system is $18,500.00, however it increases to $27,750.00 for a redundant system.

A preliminary cost estimate for the Ignition system includes the following:

- Pro Package Software with Redundancy $29,400.00
- Two Custom Built Servers (Rack or Tower) $20,000.00
- Two Custom Built Desktop PC's with Monitors $6,000.00
- Firewall VPN $2,000.00
- Voice Modules VoIP Modules $1,000.00

- Radio Survey $10,000.00
- Radio Tower at Central Headquarters $40,000.00
- Radio Communication – Antenna, Radios, Cable, Switches, Grounding, and Enclosures for Aqueduct Turnout, Phase I Basins, Phase II Basins, and Pumping Station $192,000.00

When adding in the infrastructure for communication, the total estimated system cost is approximately $300,400.00.

There are no annual license fees. This equates to an approximate total cost (capital plus annual costs) over a ten (10) year period of $300,400.00 if the support care is not implemented.

Annual Costs

Ignition does provide three levels of support that results in an annual cost, however this support is not mandatory. The benefit to the support is that it covers the costs of any future software updates and upgrades as they are developed and provides support in the event of problems.

The drawback is if the support is not paid for on an annual basis, then when the client wants to purchase an update or software upgrade the cost of the update is 65% of the licensing cost. The care support options are:

- BasicCare 16% of License Cost Annually

  The BasicCare provides Upgrade Protection which includes unlimited free upgrades to purchased Ignition modules throughout the duration of the Support Plan and provides email and web support.

- TotalCare 20% of License Cost Annually

  The TotalCare provides Upgrade Protection which includes unlimited free upgrades to purchased Ignition modules throughout the duration of the Support Plan and provides phone, email, and web support.

- PriorityCare 24% of License Cost Annually

  The PriorityCare provides Upgrade Protection which includes unlimited free upgrades to purchased Ignition modules throughout the duration of the Support Plan and provides unlimited phone, email, and web support.

Ignition® 8.1
by inductive automation

Built For Everyone

The all new Long-Term Support (LTS) release introduces powerful new features to the Ignition Platform to help you develop and use projects more effectively.

"Ignition 8.1 is a milestone for Inductive Automation and for Ignition. It represents our full vision of what The New SCADA could be, and is the platform that all of our customers will want to leverage for their next generation solutions."

– Steve Hechtman
CEO & Founder, Inductive Automation

inductive automation®
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www.inductiveautomation.com

Ignition® by inductive automation

9-9-2020

For the Plant Floor

Ignition 8.1 adds amazing features to Ignition Perspective that help you see and control your plant-floor processes more effectively than ever before.

A New Perspective for the Plant Floor

With Perspective, you can create beautiful, mobile-responsive industrial applications that run natively on any mobile device and web browser. Now, with the new Perspective Workstation, you can instantly web-deploy native applications to any HMI, desktop, workstation, and multi-monitor configuration without the need for a third-party web browser.

Run in Full-Screen Kiosk Mode

Eliminate any distractions from the underlying OS with Perspective Workstation's Kiosk mode.

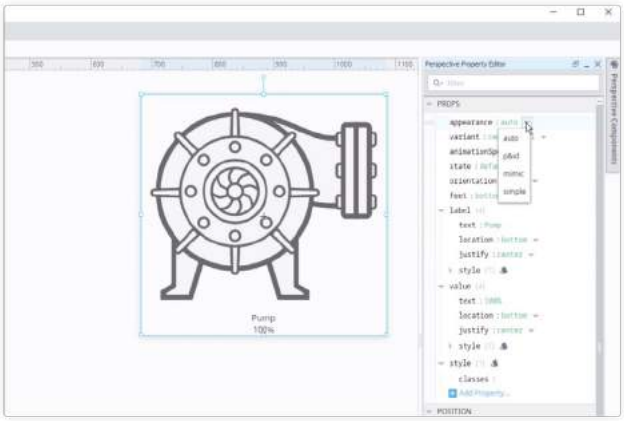
Screens courtesy of Corso Systems

Control the Plant Floor from Your Phone

Put the full control of your plant floor in the palm of your hand with the Perspective App for iOS & Android.

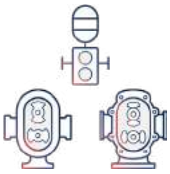
Design for Multiple Screen Sizes at the Same Time

Save development time by designing a single Perspective application that displays beautifully on screens of any size.



Powerful New Dynamic and Data-Driven Symbols

In 8.1, we're adding powerful dynamic symbols to the Perspective Module called Perspective Symbols. These symbols all have dynamic data models, so binding them to process values is a simple matter of drag-and-drop. They also have built-in animations so they will automatically change based on your data. With Perspective Symbols, creating beautiful HMIs is quicker and easier than ever.



Three Distinct Styles

Each Perspective Symbol comes with three different styles: Traditional P&ID, the realistic Mimic, and the optimized Simple style.

Customize Your Symbols

Visual options such as supporting text, animation, and device orientation can be defined to fit your project.

Get All the Basics & More

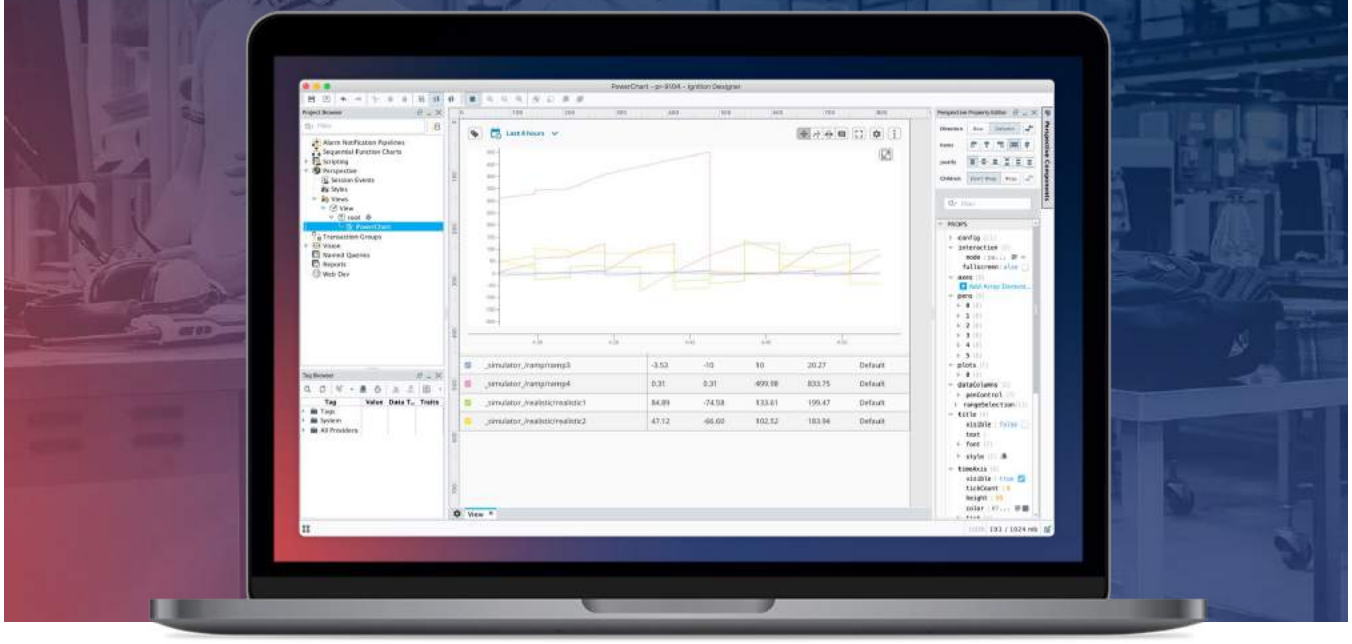
The initial release comes with the 2-way valve, motor, pump, vessel, and sensor, and many more symbols are coming soon.

"We were able to build a fresh, responsive display that would look amazing on any device, and that could scale massively."

– Sam Burns
Control Systems Engineer, ESM Australia

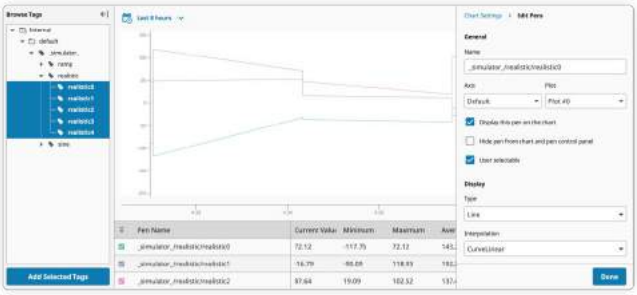
For Developers

With new super-tools like the Power Chart, refinements to the Ignition Designer, and support of Docker Hub deployments, Ignition 8.1 is making development faster and easier than ever before.



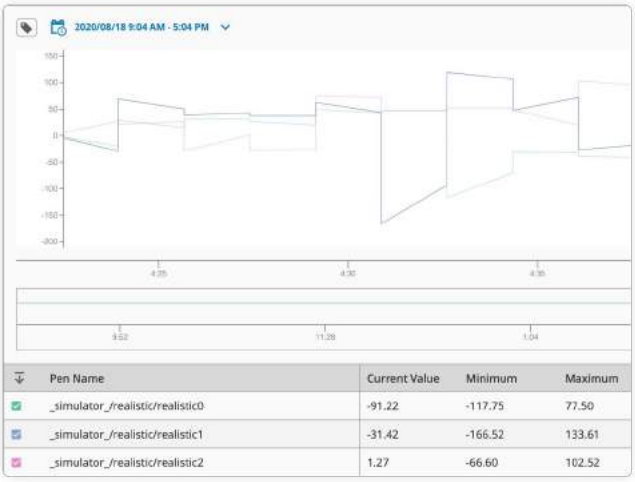
Add Powerful Ad Hoc Charts to Your Projects Instantly

The Power Chart component for Perspective allows you to quickly and easily create runtime-configurable time series charts from Tag Historian data. Now you can easily generate “ad hoc” charts within a Perspective session. Power Chart is also mobile-optimized so it adapts itself automatically for small screens.



Tag Browser Built Right In

You can easily access and analyze historical tag data right from the session window, no additional development necessary.



Data-Driven Table

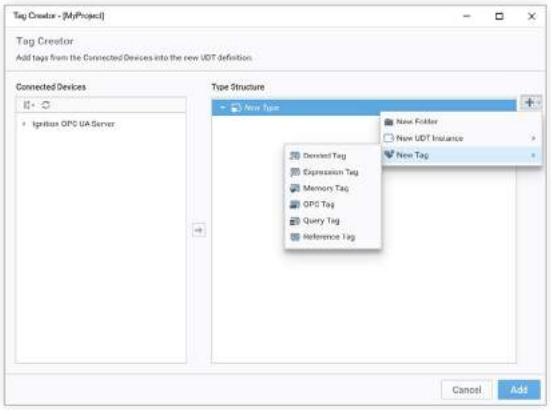
Easily view dynamic chart data in a table format for quick analysis, all within the session.

In-Session Chart Customization

You can easily and quickly customize charts by adjusting axes, chart pen parameters, and the chart's timeframe.

Develop Larger Systems Faster with Docker

Users who currently use Docker Hub will enjoy the ability to quickly develop on the Ignition platform. Quickly spin up multiple instances of Ignition and develop right away without the need for installation. You can also have multiple instances interact with each other to develop a multi-gateway architecture without the need to run multiple servers or be at multiple locations.

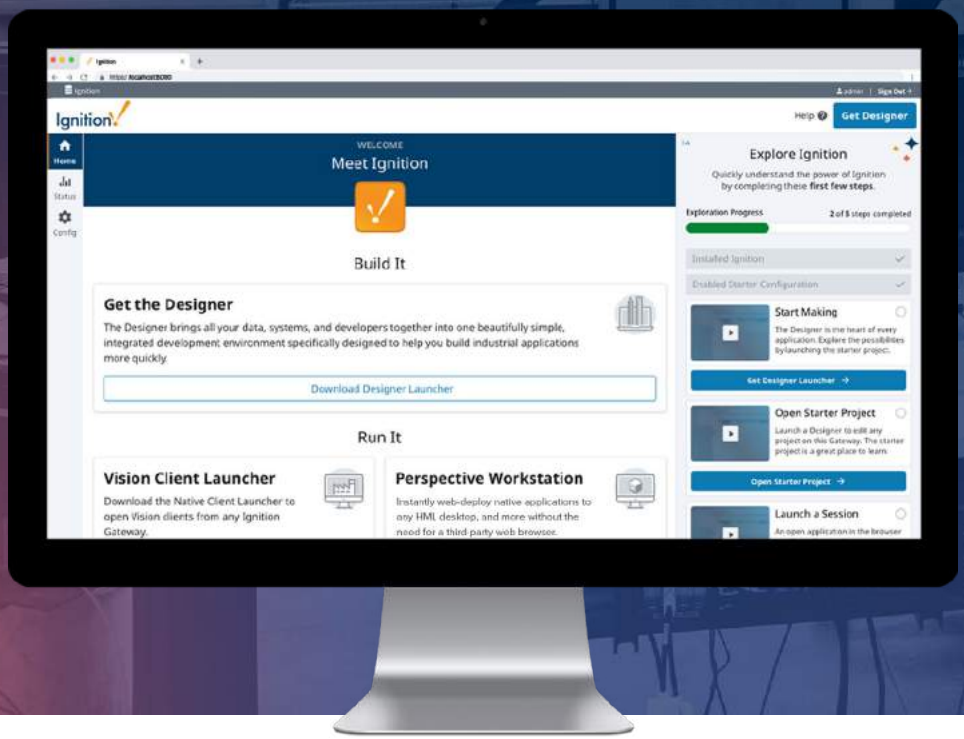


Browsing is a Breeze

In 8.1, we've refreshed the tag browser to make adding new tags to your project even easier and quicker than before. Tags are also easier to organize with new custom icons that identify tag types.

For New Users

Ignition 8.1 is packed with new features that make it easier than ever for new users to create powerful and dynamic applications from scratch.

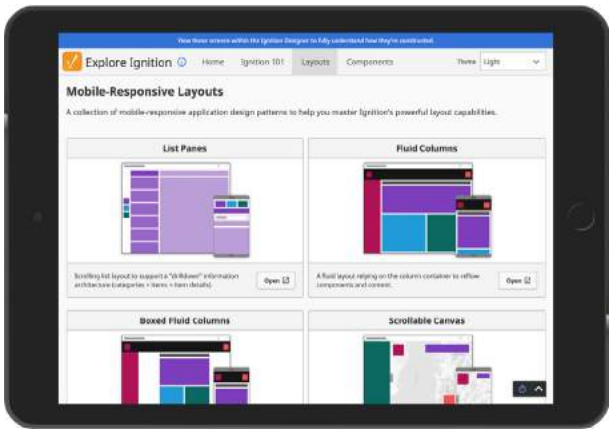


Hit the Ground Running with Quick Start

To help Ignition newcomers get up and running fast, we are introducing a feature called Ignition Quick Start. The Quick Start option provides simple tutorials and automatic configurations to set up things like security, connections to external devices, and databases faster than ever.

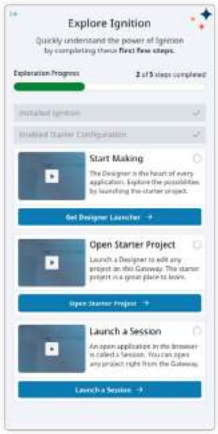
Learn by Deconstructing

Quick Start comes with a pre-configured sample project that includes core Ignition features for you to use, break apart, add to, and more to help you better understand and visualize Ignition.



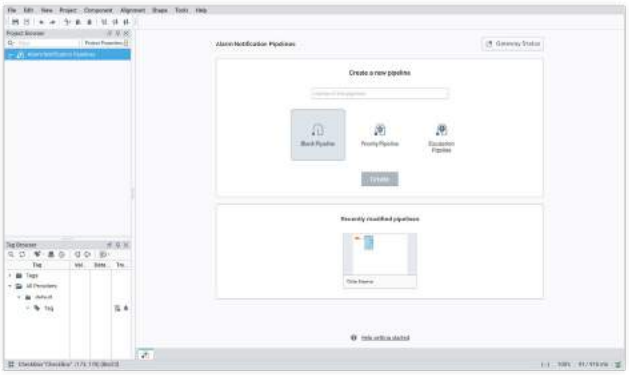
Explore Advanced Features

Learn about concepts like screen layout, components, and Python scripting.



Follow Tutorials in the Gateway

Save development time by designing a single Perspective application that displays beautifully on screens of any size.



Fast-Track Your Ignition Project Work

Developing projects is now even faster with the many shortcuts we've added across the Designer in Ignition 8.1. Instead of starting with a blank workspace when creating a new project resource, you'll now have access to clickable shortcuts for things like new Perspective resources, alarm pipelines, transaction groups, and more. Jump right in and start developing your project quickly!

Learn Ignition for Free at Your Own Pace

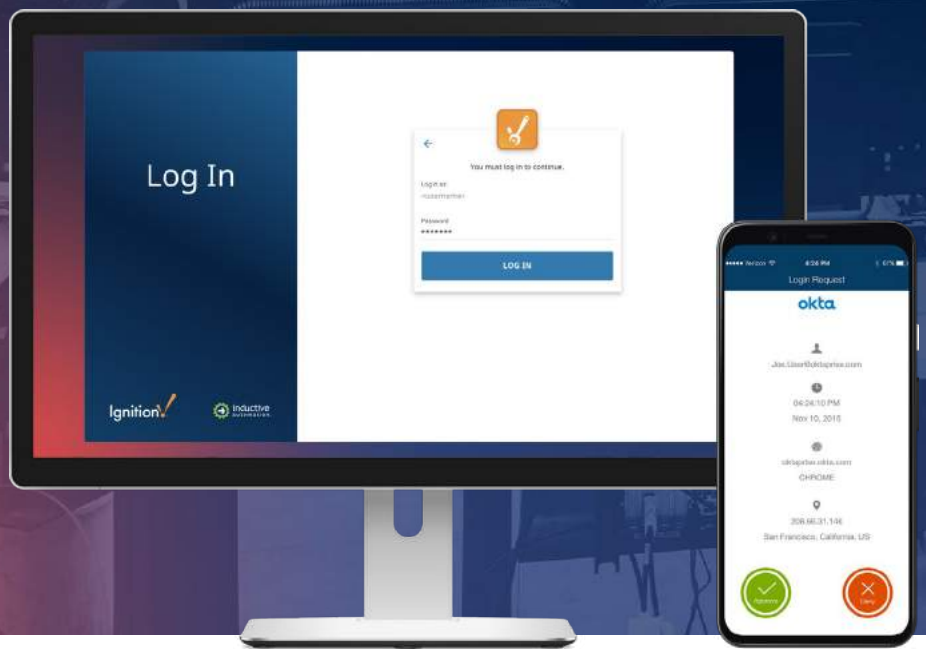
More videos are being added to Inductive University for 8.1, so anyone can learn how to use the newest version of Ignition on their own time. Inductive University is the industry's leading online-learning website for automation software. With more than 600 educational videos, you can learn how to use Ignition on-demand, all totally free!

"Using Ignition we were able to build a flexible, well-tested, highly resilient SCADA platform...meeting both the business requirements and IT requirements in terms of availability, security, and integrations..."

– Li Lu
IT Project Manager, Dublin Airport

For Enterprise

Ignition 8 introduced big updates for developing large-scale systems, including easy project management, and collaborative concurrent development. Ignition 8.1 builds on that with more great features to secure and expand large systems.

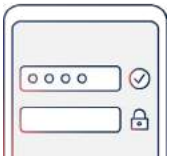


Add SSO and MFA Security to all Your Ignition Projects

Ignition 8.0 introduced support for federated identity with the Perspective Module. Now with Ignition 8.1, you can also take advantage of federated identity support for the Ignition Gateway, Designer, and the Vision Module, to add multi-factor (MFA) authentication and single sign-on (SSO) to all your Ignition projects across your enterprise.

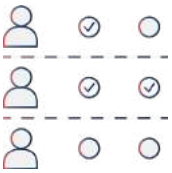
Integrate with Corporate Network Security

Ignition integrates with corporate network security using Microsoft Active Directory™.



Use Trusted Identity Management

Ignition integrates with trusted federated identity technologies such as SAML and OpenID Connect.



Control User Access

Easily control access to system areas for different users with the click of a button.

Built for Enterprise-Wide Systems of all Sizes

Ignition 8 is built to scale for any size implementation within your enterprise organization. With the ability to share project-inherited resources across multiple projects, a robust tag system that can handle huge amounts of data, and the ability to simultaneously launch hundreds of concurrent clients with ease, Ignition 8 was designed with enterprise deployment in mind.

Trusted by Manufacturing Companies Everywhere

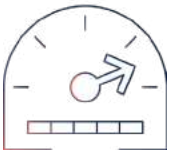
Ignition is trusted by some of the biggest industrial organizations in the world to run their mission-critical systems. With thousands of active Ignition deployments around the world, including installations with 54% of the Fortune 100 companies, Ignition is plant-floor proven and trusted by enterprises of all sizes to get the job done.

"Ignition 8.1 is all the innovation and power of the Ignition Platform, refined into a high-performing, secure, and reliable package ready for the future."

– *Carl Gould*
Director of Software Engineering, Inductive Automation

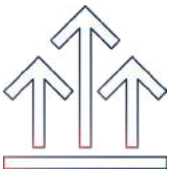
Confidence for the Long Haul

Ignition 8.1 is the first long-term supported (LTS) version of the Ignition 8 platform. As an LTS version, Ignition 8.1 will receive improvements and fixes for a full five years from the date of its release, so you can rely on 8.1 for the long haul.



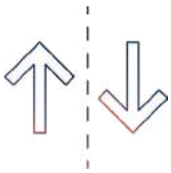
Focus on Performance

Upcoming improvements for 8.1 will focus on making its existing features even faster and more stable.



Regularly Updated

Inductive Automation will release regular updates for Ignition 8.1 for the next five years so you can always stay up-to-date.



Backward Compatibility

Ignition 8.1 is backwards-compatible, ensuring that your past projects will update safely from previous module versions.

Add Peace of Mind

There is no better way to protect your investment and future-proof your system than by adding a support contract to your Ignition purchase. That's because each support contract comes with Upgrade Protection, which includes unlimited free upgrades of purchased Ignition modules for the life of your contract, as well as access to Inductive Automation's industry-leading technical support team, so you can quickly get expert answers to your questions. Choose from three different support levels in our updated TotalCare program to fit your specific needs.

"By using Ignition we were able to develop a project that is reusable, tweakable, and we could implement feature requests rapidly...rolling out our customer's needs quicker."

–Raymond Stanford
Senior Engineer, Steritec Automation

PLATFORM FEATURES

Ignition 8.1 has everything you need to build reliable, reusable, and powerful projects for any industry at any size.

Unlimited Licensing Model

Add unlimited clients, screens, tags, connections & devices.

Server-Centric Web-Deployment

Easily deploy at one or more sites or in the cloud.

Modular Configurability

Use integrated modules to build the exact industrial application you need.

Cross-Platform Compatibility

Ignition works with any major operating system, even iOS and Android.

Run Web-Clients on Desktop or Mobile

Launch runtime clients in any web browser with no plugin required.

Based on Open Technology Standards

Built on HTML5, SQL, Python, MQTT & OPC UA.

Instant Installs and Updates

Install on a server in just 3 minutes, push updates to clients everywhere, instantly.

One Universal Platform

Build SCADA, MES, IIoT, alarming, reporting applications and more.

Mission-Critical

Add fault tolerance for mission-critical systems by adding redundant servers.

Platform Specs and Requirements

Supported Operating Systems

Windows Server 2016/2019

Windows 10

macOS (10.14+)

Linux (Support for popular distributions, tested with Ubuntu 18.04)

Supported Databases

Microsoft® SQL Server

Oracle

MySQL

MariaDB

PostgreSQL

Any database with a JDBC driver

Requirements

Dual-core processor

4 GB RAM

10 GB free HD space

(Requirements vary by usage.)

To learn more about Ignition 8.1, please contact an account representative at: **800.266.7798**

Appendix C
FactoryTalk SCADA System

FactoryTalk (Rockwell Automation)

FactoryTalk View Site Edition (SE) is the platform for Rockwell that allows for monitoring and controlling systems at all levels, from a single operator station up to multi-user applications. However, it only works with the Windows operating system.

Rockwell utilizes "thin clients" to connect remotely to a server-based system that allows it to run apps, record data, and display content.

Rockwell adds FactoryTalk View Point as a mobile-ready extension that provides a secure interface with the HMI applications through a web browser on any mobile device.

The system would be recommended to include a primary server at the central headquarters and a redundant server installed at a remote location for redundancy. Each server location would include a desktop computer for access and monitoring. All mobile and remote device connections to the server would be through FactoryTalk View Point. These devices have access to the system using web based browser technology.

FactoryTalk Costs

A preliminary cost estimate for the FactoryTalk system includes the following:

Capital Cost:

• Two Custom Built Servers	$20,000.00
• Two Custom Built Desktop PC's with Monitors	$6,000.00
• Two FactoryTalk View Site Edition Stations	$30,000.00
• Two FactoryTalk View Point Packages for Remote Access	$20,000.00
• Two Historian Packages	$10,000.00
• Two WIN-911 Software Packages	$10,000.00
• Firewall VPN	$2,000.00
• Voice Modules VoIP Modules	$1,000.00
• Radio Survey	$10,000.00
• Radio Tower at Central Headquarters	$40,000.00
• Radio Communication – Antenna, Radios, Cable, Switches, Grounding, and Enclosures for Aqueduct Turnout, Phase I Basins, Phase II Basins, and Pumping Station	$192,000.00
Total Capital Cost:	$341,000.00

Annual Costs:

- License Fees
  Estimate between $7,000 to $13,000 per year $10,000 per yr

This equates to an approximate total cost (capital plus annual costs) over a ten (10) year period of $441,000.00.

Practitioner's Guide To Planning and Deploying Industrial Internet of Things (IIoT) Solutions

Harbor Research

Sponsored by Rockwell Automation

SUMMARY

HOW TO DEVELOP AN IIOT VISION

"Leadership in many manufacturing companies is still observing or pondering how to initiate the transition to the high-stakes world of digital business..."

As network, software and digital technologies continue to invade the physical world of sensors, machines and manufacturing, leadership in many industrial organizations is rapidly recognizing the significant value created from extracting and leveraging the machine data and usage information from their equipment, systems and organizations.

The first movers embracing IIoT systems and solutions in manufacturing are on the road to locking down lasting dominant positions in their respective industries as a result of their early moves. Leadership in many manufacturing companies is still observing or pondering how to initiate the transition to the high-stakes world of digital business, and it is this transition, more than the technological shift, that will challenge many organizations.

Re-thinking operations and manufacturing systems to address new connected digital systems opportunities requires many changes in the way organizations think and act. These changes come in many areas.

- **Internal Leadership:** Organizations require strong leadership and support for planning and developing IIoT solutions. We have already seen—and expect to see more cases—where many members of an organization have a clear view of where the company needs to go, yet are unable to present the business case for change or ROI in a compelling enough manner to gain company-wide adoption.
- **Planning:** Companies may not know whom to invite to the planning table, let alone what to do when everybody is there. They may have planning processes in place that need to be re-designed to address the opportunities at hand. This might include inviting more, cross-discipline individuals to the table, as well as seeking third party insights.

- **Organization:** Companies risk overlooking the need to carefully assess what skills and relationships are required to successfully develop and deploy IIoT solutions. Understanding the required skills and new "digital" personas and roles that will plan, develop, design and enable new solutions is a critical element in adopting new technologies.

It's critical that the first step taken is to map out a vision and supporting goals for addressing IIoT solutions, including identifying the parts of the organization that will address IIoT first, developing and articulating a strategy for this transition and understanding clearly how the organization stands to benefit from this transformation.

"Understanding the required skills and new 'digital' personas and roles that will plan, develop, design and enable new solutions is a critical element in adopting new technologies."

HOW TO BUILD YOUR IIOT ROAD MAP AND IDENTIFY THE SUCCESS CRITERIA

Diverse organizations across the manufacturing landscape are getting into gear to plan on how to benefit from adopting IIoT technologies and systems. However, to actually reap those benefits, it's critical that you define your goals, assess your current capabilities, and determine what resources are required to put your plan in motion.

The planning and implementation of these technologies is not a one-size-fits-all, straightforward process. Businesses can face challenges and setbacks if they do not properly plan and execute their deployment. To get the most out of IIoT technologies, it is important to develop a road map with clear priorities, goals and performance measures.

Creating an IIoT implementation roadmap ensures that you address the diverse dimensions involved in planning for IIoT systems. Careful and focused planning for IIoT systems ensures that the final result and system capabilities match the business' needs and goals. A thorough planning process can clear up misunderstandings between members of the team and the organization they serve, eliminating the possibility of discrepancies between expectations and results. The organization should establish metrics and milestones to measure performance against.

The following are typical challenges shared by many organizations. These questions must be addressed in an IIoT solution implementation and deployment road map:

- How to initiate an industrial IoT project and get management support?
- What is the best process for deploying industrial IoT?
- How to deal with human factors?
- What are the typical roadblocks and how to deal with them?
- How to handle the mismatch between information technology (IT) and operational technology (OT)?
- What is the best way to deploy specific technologies such as machine learning?

HOW TO LAUNCH A PROOF OF CONCEPT AND/OR PILOT PROJECT

Rather than launch your initiative company-wide, consider starting out small and rolling out a pilot that addresses one or two business objectives at a time. The primary benefit of launching a small project initially is that you'll have an opportunity to launch rapidly and demonstrate success to the rest of the organization. This will help validate the investment to leadership while making a case for convergence to operations and IT teams who may not yet be united.

Identifying goals for an IIoT pilot proof of concept project is critical. Examples of projects include focusing on improving process efficiency, asset management or raising product quality. In a process efficiency pilot, proof of concept project illustrative goals could include:

- Optimized utilization of existing resources
- Lower error, failure or defect rates
- Faster throughput, lead time or turnaround
- Reduced costs and improved allocation of resources necessary
- Improved predictability

These goals and related project benefits motivate funding of pilot projects by clearly translating into financial metrics and ROI. The primary value of these goals is to release resources previously being sunk into inefficient processes, taxing valuable

resources such as energy, skills, time, equipment and material. This resource shortage represents an enormous opportunity cost.

IIoT system pilot deployments take time and should never be rushed. The entire process should consist of multiple rounds of implementations. The first stage should focus primarily on testing and validating technology, pilots, proof of concept and validating use cases. Business stakeholders and employees from various functions or departments should be included in this process.

Technical elements that need to be addressed in a pilot proof of concept project include:

- **Network Management:** Network Management is a key aspect of your IIoT implementation strategy as it enables real-time performance, security and connectivity monitoring. Your network should provide a complete view of every connected device, allowing you to control operations and troubleshoot issues as they emerge. Quick response is especially critical for those managing distributed assets.
- **Connectivity:** You'll have a few different options for achieving IIoT connectivity, including Wi-Fi, cellular, Bluetooth, Sigfox, Lora, etc. What you ultimately choose depends on bandwidth requirements, power consumption, the location of your environment, and several other factors.
- **Communications Protocols:** In a connected factory, devices from different manufacturers must work together. As such, you'll want to look for solutions such as advanced HMIs or protocol converters, that support multiple protocols, so devices can easily communicate with each other.
- **Automation:** IoT processes can be programmed to respond intelligently to events and improve system performance. Depending on your use case, you may want a solution that brings in sensor data and machine learning to make optimization decisions.

Meticulous, carefully planned implementation minimizes the risk of failure and ensures a working, effective IIoT system.

"Meticulous, carefully planned implementation minimizes the risk of failure and ensures a working, effective IIoT system."

YOUR INFRASTRUCTURE CONSIDERATIONS

An IIoT system cannot reach optimal performance without adequate infrastructure. Legacy IT equipment will not meet the IIoT's network and connectivity demands. You may need to modernize your technology and invest in infrastructure updates to ensure that your system is capable of handling a constant data flow. A secure, reliable infrastructure is essential if you want your system to be able to perform the analytics necessary for precise measurements and use case deployments.

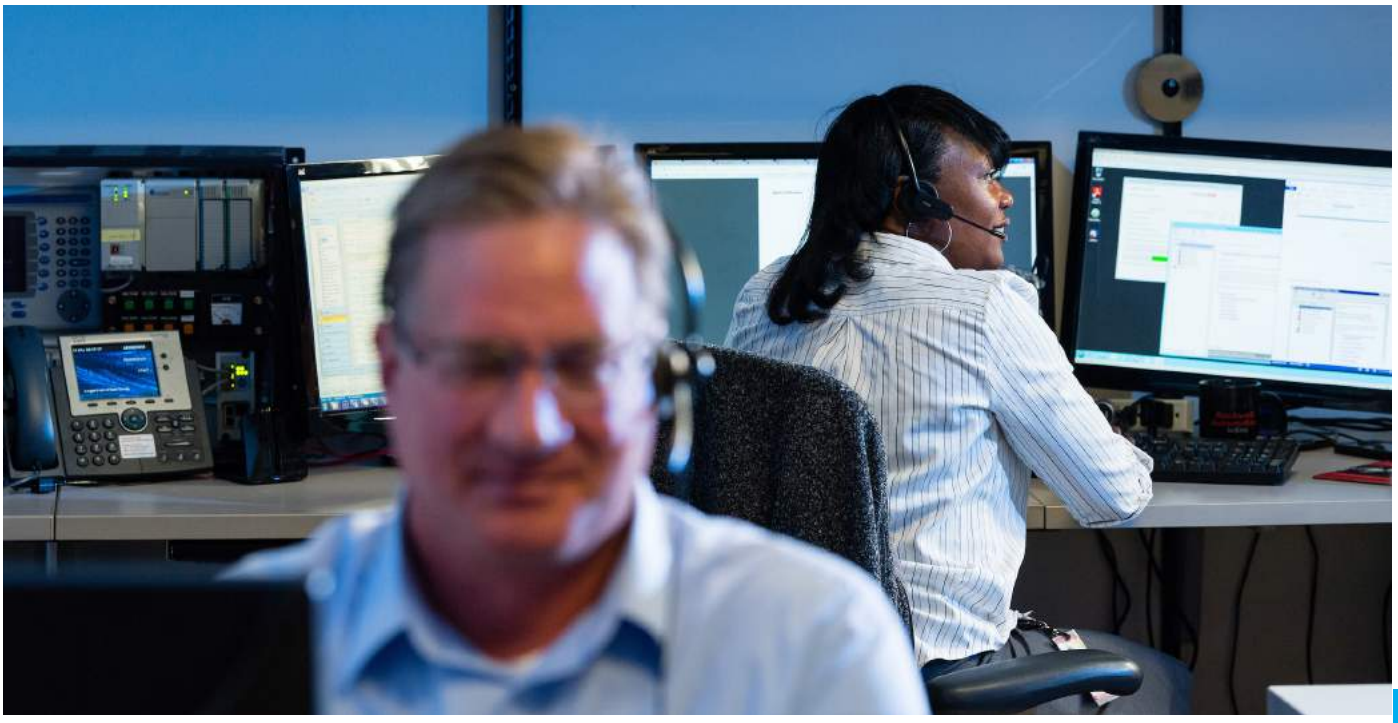
Essential capabilities to address include:

- **Edge computing:** Edge computing allows you to monitor data in real-time by bringing processing close to the data source. This is essential for IIoT applications that involve continuous uptime, like predictive maintenance or process monitoring. The quick processing time offered by the edge is also critical for detecting cyber threats that put OT equipment at risk.

- **Cloud Computing:** Where edge computing addresses time-sensitive data, you'll want to use the cloud for analyzing data, managing business tools, and long-term storage.

- **Data Management and Analytics:** One of the primary benefits of IIoT is the massive amount of data it generates, so you'll want to look for a solution that sorts, normalizes and analyzes data, extracts actionable insights, and performs actions based on its findings.

"A secure, reliable infrastructure is essential if you want your system to be able to perform the analytics necessary for precise measurements and use case deployments."



HOW TO SECURE IIOT SOLUTIONS

Security is vital, as these hyper-connected devices are vulnerable to hacking, malware and other potential security breaches. Security compromises can lead to financial and legal complications, and they will likely impact brand reputation and the customer experience.

The three standards of effective IoT security are:

- **Network Security:** Two-factor identification (2FA) and strong passwords that protect against brute force entry and guessing can thwart unauthorized access. Context-aware authentication provides another level of security by utilizing machine learning algorithms and contextual information to consistently measure risk and vulnerability.
- **Device Security:** Security capacity is a critical component of IoT devices. Always evaluate an IoT device's defenses before purchase and installation. The technology must be tamper-proof, with multiple layers of security to shield it from attacks.
- **Data Security:** Data should be protected at every point in the IoT system. From collection point to analysis to end storage, personal information and other sensitive data must be kept safe and secure.

An effective security system should be capable of automatically detecting new endpoints and verifying their legitimacy and permissions before allowing access to data. Sufficiently protected IIoT systems will be able to perform real-time risk analyses and stop potential security breaches before sensitive data is obtained.

YOUR KEY SUCCESS FACTORS

The outcomes from early IIoT pilot projects and deployments are primarily focused on the initial validation of IIoT technology choices, how to use the technology in an operational context, and an assessment of the changes required in your organization and its processes.

Key success factors for pilot projects and proof of concept programs include the following:

- Engaging multiple carefully selected partners to help you fill the gaps.
- Clarifying the requirements, constraints, risks and goals to have clear goal posts to prove ROI.
- Planning for the short-term milestones in the project, but never taking your eye off the longer horizon in order to have a plan to eventually scale.
- Understanding and planning for organizational relationships and interactions across functions and departments to have company-wide buy-in.
- Carefully defining milestones with the flexibility to iterate and refine objectives throughout the process.

- Creating time and budget for an early discovery and investigations phase to change course as needed.
- Consciously and deliberately planning reusability and scalability to ensure long-term success.

Launching an IIoT solution may at first appear daunting, but with proper planning, stakeholder input, technical considerations and partner participation, a successful pilot can be achieved.

To learn more, click here.

Harbor Research

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Rockwell Automation

APPENDIX K

Technical Memorandum #11
Engineer's Estimate

DEE JASPAR & ASSOCIATES, INC.
CONSULTING CIVIL ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CA 93308
PHONE (661) 393-4796
FAX (661) 393-4799

KERN FAN GROUNDWATER STORAGE PROJECT

TECHNICAL MEMORANDUM NO. 11
(Engineer's Estimates)

PREPARED FOR: Groundwater Banking Joint Powers Authority (GBJPA)
PREPARED BY: Curtis Skaggs, P.E.
DATE: July 31, 2021

SUBJECT: ***Engineer's Estimates***

I. Executive Summary

This memorandum serves to provide an updated Engineer's Estimate based on the previous technical memoranda that have been prepared.

The cost estimates provided herein are preliminary. They have been prepared in the absence of definitive property locations, a definitive conveyance alignment, survey work, and detailed design work. These estimates are to be considered a Class 3 estimate. Class 3 estimates are generally prepared to support full project funding requests and become the first of the proposed phase "control estimates" against which all actual costs and resources will be monitored for variations to budget. The Class 3 estimate is used as the project budget until replaced by more detailed estimates. Typically, the level of project definition is between 10% to 40%. The accuracy range for the cost estimates varies from -10% to -20% on the low side and +10% to +30% on the high side.

Two estimates have been prepared herein:

- Engineer's Estimate with Conveyance Facility as a Concrete Lined Canal
- Engineer's Estimate with Conveyance Facility as a Pipeline

Detailed cost estimates are provided for each of the alternatives above in Appendix A and Appendix B.

The cost estimates include the estimated capital cost, a mobilization and demobilization cost, a 2.5% design contingency for unknown items, a 20% construction contingency, land acquisition costs, right-of-way costs, HCP fees,

and non-contract costs such as project management, engineering design, environmental, electrical service, permitting, bid administration, and construction management and inspection. In addition, an escalation factor has been included at 2% per year for five years in an effort to account for the long project duration and rising costs.

The Engineer's Estimate for the project including contingencies, land and right-of-way acquisition costs, and soft costs is approximately $219,961,356 and is for the conveyance canal alternative.

The pipeline alternative increases the cost by approximately $10,000,000 with an Engineer's Estimate of approximately $229,449,874.

Including an escalation factor of 2.0% per year for the next five years as a result of inflation, increases the Engineer's Estimate range for the two alternatives between $238,200,000 to $248,873,783.

The costs outlined above have been separated and categorized into estimated amounts for each of the five proposed design packages and also separated and categorized into estimated amounts for each of the ten proposed construction packages. This is to aid in understanding the value and magnitude of each of the design packages as well as each of the construction packages. See the memorandum outline below:

II. Engineer's Construction Cost Estimate for each Design Package
III. Engineer's Construction Cost Estimate for each Construction Package
IV. Summary of Project Probable Costs

II. Engineer's Construction Cost Estimate for each Design Package

The design packages were planned to be in five packages per Technical Memorandum No. 1 "Project Phasing and Design/Contractor Selection". These five packages include:

- Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie; Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures
- Phase I Well Drilling and Equipping; Phase II Well Drilling and Equipping
- Aqueduct Turnout Facility
- Conveyance Facilities including Turnouts & Pump Stations
- SCADA and PLC Programming

The construction cost estimate for the project has been separated into the five categories above to provide an idea of the scale of each design package. In addition, a construction cost estimate has been prepared for the conveyance canal alternative as well as the conveyance pipeline alternative.

The cost estimates provided herein are preliminary. They have been prepared in the absence of definitive property locations, a definitive conveyance alignment, survey work, and detailed design work. These estimates are to be considered a Class 3 estimate. Class 3 estimates are generally prepared to support full project funding requests and become the first of the proposed phase "control estimates" against which all actual costs and resources will be monitored for variations to budget. The Class 3 estimate is used as the project budget until replaced by more detailed estimates. Typically, the level of project definition is between 10% to 40%. The accuracy range for the cost estimates varies from -10% to -20% on the low side and +10% to +30% on the high side.

A. Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie; Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures

Canal Alternative (Concrete Lined)

The design package noted above is anticipated to include the development of the Phase I and Phase II recharge areas including clearing and grubbing, subgrade preparation, levee construction, interbasin structures, site fencing, and recovery well pipelines. The cost estimate for Phase I and Phase II is illustrated in Tables 1 and 2 respectively.

Table 1

Recharge Basins & Infrastructure (Canal Alternative)	
Phase 1 - 640 ac Recharge Facility	
Item Description	Cost Estimate
Clearing & Grubbing	$384,000.00
Subgrade Preparation	$1,316,000.00
Embankment Fill	$1,323,000.00
Interbasin Structures	$1,377,500.00
Recovery Well Pipelines	$1,234,960.00
RRB Intake Canal Intertie	$106,600.00
Site Fencing & Gates	$158,400.00
Subtotal:	$5,900,460.00

Table 2

Recharge Basins & Infrastructure (Canal Alternative)	
Phase 2 - 640 ac Recharge Facility	
Item Description	Cost Estimate
Clearing & Grubbing	$384,000.00
Subgrade Preparation	$1,316,000.00
Embankment Fill	$1,470,000.00
Interbasin Structures	$1,102,000.00
Recovery Well Pipelines	$838,620.00
Site Fencing & Gates	$158,400.00
Subtotal:	$5,269,020.00

In addition, this design package may include a pump station to convey water from the Goose Lake Channel into the Phase I Recharge property along with a check structure to regulate water levels in the channel at the pump station. This work involves earthwork, a reinforced concrete pump station, pumps, motors, discharge piping and appurtenances, VFD's, electrical & controls, outlet piping and appurtenances, and a check structure. The cost estimate is illustrated in Table 3.

Table 3

Recharge Basins & Infrastructure (Canal Alternative)	
Goose Lake Channel Pump Station & Check Structure	
Item Description	Cost Estimate
Earthwork	$48,000.00
Concrete Pump Station	$455,000.00
Pumps & Motors	$1,300,000.00
Discharge Piping & Appurtenances	$1,638,000.00
Electrical & Controls	$400,000.00
Outlet Piping & Appurtenances	$457,500.00
Check Structure	$375,500.00
Subtotal:	$4,674,000.00

The total estimated capital cost for the "Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie; Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures" is $15,843,480.00.

Pipeline Alternative

The design package noted above for the pipeline alternative is anticipated to include the development of the Phase I and Phase II recharge areas including clearing and grubbing, subgrade preparation, levee construction, interbasin structures, site fencing, and recovery well pipelines. The cost estimate for Phase I and Phase II is illustrated in Tables 4 and 5 respectively.

Table 4

Recharge Basins & Infrastructure (Pipeline Alternative)	
Phase 1 - 640 ac Recharge Facility	
Item Description	Cost Estimate
Clearing & Grubbing	$384,000.00
Subgrade Preparation	$1,316,000.00
Embankment Fill	$1,323,000.00
Interbasin Structures	$1,377,500.00
Recovery Well Pipelines	$1,234,960.00
RRB Intake Canal Intertie	$106,600.00
Site Fencing & Gates	$158,400.00
Subtotal:	$5,900,460.00

Table 5

Recharge Basins & Infrastructure (Pipeline Alternative)	
Phase 2 - 640 ac Recharge Facility	
Item Description	Cost Estimate
Clearing & Grubbing	$384,000.00
Subgrade Preparation	$1,316,000.00
Embankment Fill	$1,470,000.00
Interbasin Structures	$1,102,000.00
Recovery Well Pipelines	$638,620.00
Site Fencing & Gates	$158,400.00
Subtotal:	$5,069,020.00

In addition, this design package may include a pump station to convey water from the Goose Lake Channel into the Phase I Recharge property along with a check structure to regulate water levels in the channel at the pump station. This work involves earthwork, a reinforced concrete pump station, pumps, motors, discharge piping and appurtenances, VFD's, electrical & controls, outlet piping and appurtenances, and a check structure. The cost estimate is illustrated in Table 6.

Table 6

Recharge Basins & Infrastructure (Pipeline Alternative)	
Goose Lake Channel Pump Station & Check Structure	
Item Description	Cost Estimate
Earthwork	$48,000.00
Concrete Pump Station	$455,000.00
Pumps & Motors	$1,300,000.00
Discharge Piping & Appurtenances	$1,638,000.00
Electrical & Controls	$400,000.00
Outlet Piping & Appurtenances	$457,500.00
Check Structure	$375,500.00
Subtotal:	$4,674,000.00

The total estimated capital cost for the "Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie; Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures" is $15,643,480.00.

B. Phase I Well Drilling & Equipping; Phase II Well Drilling & Equipping

Canal Alternative (Concrete Lined)

The design package noted above is anticipated to include the well drilling, construction, and development of up to six recovery wells within each of

the Phase I and Phase II recharge areas as well as include the equipping of these wells with pumps, motors, discharge piping, VFD's, electrical and controls, fencing, ground cover, and site painting. The cost estimate for Phase I and Phase II is illustrated in Tables 7 and 8 respectively.

Table 7

Recovery Wells (Canal Alternative)	
Phase 1 - Well Drilling and Equipping	
Item Description	Cost Estimate
Drilling Six Wells	$6,962,046.00
Equipping Six Wells	$7,773,000.00
Subtotal:	$14,735,046.00

Table 8

Recovery Wells (Canal Alternative)	
Phase 2 - Well Drilling and Equipping	
Item Description	Cost Estimate
Drilling Six Wells	$6,962,046.00
Equipping Six Wells	$7,773,000.00
Subtotal:	$14,735,046.00

The total estimated capital cost for the "Phase I Well Drilling and Equipping; Phase II Well Drilling and Equipping" is $29,470,092.00.

Pipeline Alternative

The design package noted above for the pipeline alternative is anticipated to include the well drilling, construction, and development of up to six recovery wells within each of the Phase I and Phase II recharge areas as well as include the equipping of these wells with pumps, motors, discharge piping, VFD's, electrical and controls, fencing, ground cover, and site painting. The cost estimate for Phase I and Phase II is illustrated in Tables 9 and 10 respectively.

Table 9

Recovery Wells (Pipeline Alternative)	
Phase 1 - Well Drilling and Equipping	
Item Description	Cost Estimate
Drilling Six Wells	$6,962,046.00
Equipping Six Wells	$7,773,000.00
Subtotal:	$14,735,046.00

Table 10

Recovery Wells (Pipeline Alternative)	
Phase 2 - Well Drilling and Equipping	
Item Description	Cost Estimate
Drilling Six Wells	$6,962,046.00
Equipping Six Wells	$7,773,000.00
Subtotal:	$14,735,046.00

The total estimated capital cost for the "Phase I Well Drilling and Equipping; Phase II Well Drilling and Equipping" is $29,470,092.00.

C. Aqueduct Turnout Facility

Canal Alternative (Concrete Lined)

The design package noted above is anticipated to include the installation and removal of a cofferdam in the Aqueduct, earthwork, reinforced concrete, miscellaneous steel, slide gate, turnout piping, metering, electrical and controls. The Aqueduct Turnout piping for the canal alternative is estimated as 9-ft diameter RCP. The cost estimate is illustrated in Table 11.

Table 11

Aqueduct Turnout (Canal Alternative)	
Aqueduct Turnout Facility	
Item Description	Cost Estimate
Cofferdam	$285,000.00
Earthwork	$129,000.00
Concrete Structure	$305,000.00
Turnout Piping & Appurtenances	$3,421,000.00
Electrical & Controls	$300,000.00
Aqueduct Restoration	$31,200.00
Subtotal:	$4,471,200.00

The total estimated capital cost for the "Aqueduct Turnout Facility" is $4,471,200.00.

Pipeline Alternative

The design package noted above for the pipeline alternative is anticipated to include the installation and removal of a cofferdam in the Aqueduct, earthwork, reinforced concrete, miscellaneous steel, slide gate, turnout piping, metering, electrical and controls. The Aqueduct Turnout piping for the pipeline alternative is estimated as 10-ft diameter RCP. The cost estimate is illustrated in Table 12.

Table 12

Aqueduct Turnout (Pipeline Alternative)	
Aqueduct Turnout Facility	
Item Description	Cost Estimate
Cofferdam	$285,000.00
Earthwork	$129,000.00
Concrete Structure	$305,000.00
Turnout Piping & Appurtenances	$4,186,500.00
Electrical & Controls	$300,000.00
Aqueduct Restoration	$31,200.00
Subtotal:	$5,236,700.00

The total estimated capital cost for the "Aqueduct Turnout Facility" is $5,236,700.00.

D. Conveyance Facilities including Turnouts & Pump Stations

Canal Alternative (Concrete Lined)

The design package noted above is anticipated to include the conveyance canal earthwork, canal lining, canal appurtenances, security fencing and gates, levee road surfacing, emergency spillways, afterbay structures, farm road crossings, the Adhor Rd crossing, the East Side Canal crossing, the Stockdale Hwy crossing, the I-5 Freeway crossing, three in-line pump stations, a return water pump station to the Aqueduct, and turnout facilities to the Phase I Recharge property, Phase II Recharge property, and the West Basin Recharge property. The cost estimate is illustrated in Table 13.

Table 13

Conveyance Facilities (Canal Alternative)	
Conveyance Facilities including Turnouts & Pump Stations	
Item Description	Cost Estimate
Canal Earthwork	$5,705,205.40
Canal Lining	$14,198,400.00
Canal Appurtenances	$2,973,500.00
Canal Fencing & Gates	$696,000.00
Canal Levee Surfacing	$697,500.00
Aqueduct Afterbay	$319,000.00
Emergency Spillways	$377,500.00
Adhor Road Crossing	$766,400.00
East Side Canal Crossing	$976,000.00
Stockdale Hwy Cased Crossing	$1,601,000.00
I-5 Fwy Cased Crossing	$2,446,000.00
Farm Road Crossings (4)	$2,880,000.00
Pump Station Afterbays (3)	$998,000.00
Pump Station No. 1	$8,724,000.00
Pump Station No. 2	$8,724,000.00
Pump Station No. 3	$6,616,000.00
Return Water Pump Station	$2,287,300.00
Reach 4 Pipeline & Appurtenances	$3,943,350.00
Phase I Turnout	$240,500.00
Phase II Turnouts (4)	$2,344,500.00
West Basin Turnouts (4)	$2,042,000.00
Subtotal:	$69,556,155.40

The total estimated capital cost for the "Conveyance Facilities including Turnouts & Pump Stations" is $69,556,155.40.

Pipeline Alternative

The design package noted above is anticipated to include the conveyance pipeline installation, the Adhor Rd crossing, the East Side Canal crossing, the Stockdale Hwy crossing, the I-5 Freeway crossing, one in-line pump station, and turnout facilities to the Phase I Recharge property, Phase II Recharge property, and the West Basin Recharge property. The cost estimate is illustrated in Table 14.

Table 14

Conveyance Facilities (Pipeline Alternative)	
Conveyance Facilities including Turnouts & Pump Stations	
Item Description	Cost Estimate
Right-of-Way Clearing & Grubbing	$204,000.00
Pipeline & Appurtenances	$58,659,500.00
Adhor Road Crossing	$54,000.00
East Side Canal Crossing	$170,000.00
Stockdale Hwy Cased Crossing	$975,000.00
I-5 Fwy Cased Crossing	$1,820,000.00
Pump Station No. 1	$13,383,000.00
Phase I Turnout	$220,050.00
Phase II Turnouts (4)	$1,406,000.00
West Basin Turnouts (4)	$1,484,000.00
Subtotal:	$78,375,550.00

The total estimated capital cost for the pipeline alternative of the "Conveyance Facilities including Turnouts & Pump Stations" is $78,375,550.00.

E. SCADA and PLC Programming

Canal Alternative (Concrete Lined)

The design package noted above is anticipated to include the installation of hardware and software for the SCADA system along with the PLC and SCADA programming to communicate between the new and existing banking facilities and the central headquarters. The cost estimate is illustrated in Table 15.

Table 15

SCADA (Canal Alternative)	
SCADA and PLC Programming	
Item Description	Cost Estimate
SCADA System Hardware	$271,000.00
SCADA System Software	$30,000.00
Programming & Screens	$150,000.00
Subtotal:	$451,000.00

The total estimated capital cost for the "SCADA and PLC Programming" is $451,000.00.

Pipeline Alternative

The design package noted above for the pipeline alternative is anticipated to include the installation of hardware and software for the SCADA system along with the PLC and SCADA programming to communicate between the new and existing banking facilities and the central headquarters. The cost estimate is illustrated in Table 16.

Table 16

SCADA (Pipeline Alternative)	
SCADA and PLC Programming	
Item Description	Cost Estimate
SCADA System Hardware	$271,000.00
SCADA System Software	$30,000.00
Programming & Screens	$150,000.00
Subtotal:	$451,000.00

The total estimated capital cost for the "SCADA and PLC Programming" is $451,000.00.

III. Engineer's Construction Cost Estimate for each Construction Package

The construction packages have been preliminarily planned to be in ten packages per Technical Memorandum No. 1 "Project Phasing and Design/Contractor Selection". These ten packages include:

- Phase I Recharge Basins
- Phase I Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie
- Phase I Well Drilling and Equipping
- Phase II Recharge Basins
- Phase II Well Drilling and Equipping
- Phase II Well Pipelines and Interbasin Structures
- Aqueduct Turnout Facility
- Conveyance Facilities including Turnouts & Pump Stations
- Pump Station Equipping
- SCADA and PLC Programming

The construction cost estimate for the project has been separated into the ten categories above to provide an idea of the scale of each construction package. In addition, a construction cost estimate has been prepared for the conveyance canal alternative as well as the conveyance pipeline alternative.

The cost estimates provided herein are preliminary. They have been prepared in the absence of definitive property locations, a definitive conveyance alignment, survey work, and detailed design work. These estimates are to be considered a Class 3 estimate. Class 3 estimates are generally prepared to support full project funding requests and become the first of the proposed phase "control estimates" against which all actual costs and resources will be monitored for variations to budget. The Class 3 estimate is used as the project budget until replaced by more detailed estimates. Typically the level of project definition is between 10% to 40%. The accuracy range for the cost estimates varies from -10% to -20% on the low side and +10% to +30% on the high side.

A. *Phase I Recharge Basins*

Canal Alternative (Concrete Lined) and Pipeline Alternative

The construction package noted above is anticipated to be for the recharge facility earthwork and include clearing and grubbing, subgrade preparation, levee construction, and site fencing. The cost estimate for the Phase I Recharge Basins is illustrated in Table 17. The estimated costs are the same regardless of the conveyance facility alternative.

Table 17

Recharge Basins & Infrastructure (Canal Alternative)	
Phase 1 - 640 ac Recharge Facility	
Item Description	Cost Estimate
Clearing & Grubbing	$384,000.00
Subgrade Preparation	$1,316,000.00
Embankment Fill	$1,323,000.00
Site Fencing & Gates	$158,400.00
Subtotal:	$3,181,400.00

The total estimated capital cost for the "Phase I Recharge Basins" is $3,181,400.00.

B. *Phase I Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie*

Canal Alternative (Concrete Lined) and Pipeline Alternative

The construction package noted above is anticipated to be for the pump station in the Goose Lake Channel to convey water into the Phase I Recharge property and includes a check structure for regulating water levels in the Goose Lake Channel as well as interbasin structures and well conveyance pipelines for the Phase I Recharge property. The work involves earthwork for the pump station, a reinforced concrete pump station structure, pumps and motors, discharge piping and appurtenances, electrical and controls, outlet piping and appurtenances, a check structure, interbasin structures, recovery well pipelines, and an intertie with the RRBWSD Intake Canal for returning water to the CVC. The cost estimate for the Phase I Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie is illustrated in Table 18. The estimated costs are the same regardless of the conveyance facility alternative.

Table 18

Recharge Basins & Infrastructure (Canal Alternative)	
Goose Lake Channel Pump Station & Check Structure	
Item Description	Cost Estimate
Earthwork	$48,000.00
Concrete Pump Station	$455,000.00
Pumps & Motors	$1,300,000.00
Discharge Piping & Appurtenances	$1,638,000.00
Electrical & Controls	$400,000.00
Outlet Piping & Appurtenances	$457,500.00
Check Structure	$375,500.00
Interbasin Structures	$1,377,500.00
Recovery Well Pipelines	$1,234,960.00
RRB Intake Canal Intertie	$106,600.00
Subtotal:	$7,393,060.00

The total estimated capital cost for the "Phase I Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines and Intertie" is $7,393,060.00.

C. *Phase I Well Drilling and Equipping*

Canal Alternative (Concrete Lined) and Pipeline Alternative

The construction package noted above is anticipated to be for the well drilling, construction, and development of up to six recovery wells within the Phase I Recharge property. This work also includes the equipping of each of these wells with pumps, motors, discharge piping and appurtenances, and electrical and controls. The cost estimate for the Phase I Well Drilling and Equipping is illustrated in Table 19. The estimated costs are the same regardless of the conveyance facility alternative.

Table 19

Recovery Wells (Canal Alternative)	
Phase 1 - Well Drilling and Equipping	
Item Description	Cost Estimate
Drilling Six Wells	$6,962,046.00
Equipping Six Wells	$7,773,000.00
Subtotal:	$14,735,046.00

The total estimated capital cost for the "Phase I Well Drilling and Equipping" is $14,735,046.00.

D. *Phase II Recharge Basins*

Canal Alternative (Concrete Lined) and Pipeline Alternative

The construction package noted above is anticipated to be for the recharge facility earthwork and include clearing and grubbing, subgrade preparation, levee construction, and site fencing. The cost estimate for the Phase II Recharge Basins is illustrated in Table 20. The estimated costs are the same regardless of the conveyance facility alternative.

Table 20

Recharge Basins & Infrastructure (Canal Alternative)	
Phase 2 - 640 ac Recharge Facility	
Item Description	Cost Estimate
Clearing & Grubbing	$384,000.00
Subgrade Preparation	$1,316,000.00
Embankment Fill	$1,470,000.00
Site Fencing & Gates	$158,400.00
Subtotal:	$3,328,400.00

The total estimated capital cost for the "Phase II Recharge Basins" is $3,328,400.00.

E. *Phase II Well Drilling and Equipping*

Canal Alternative (Concrete Lined) and Pipeline Alternative

The construction package noted above is anticipated to be for the well drilling, construction, and development of up to six recovery wells within the Phase II Recharge property. This work also includes the equipping of each of these wells with pumps, motors, discharge piping and appurtenances, and electrical and controls. The cost estimate for the Phase II Well Drilling and Equipping is illustrated in Table 21. The estimated costs are the same regardless of the conveyance facility alternative.

Table 21

Recovery Wells (Canal Alternative)	
Phase 2 - Well Drilling and Equipping	
Item Description	Cost Estimate
Drilling Six Wells	$6,962,046.00
Equipping Six Wells	$7,773,000.00
Subtotal:	$14,735,046.00

The total estimated capital cost for the "Phase II Well Drilling and Equipping" is $14,735,046.00.

F. *Phase II Well Pipelines and Interbasin Structures*

Canal Alternative (Concrete Lined)

The construction package noted above is anticipated to be for the interbasin structures and recovery well conveyance pipelines at the Phase II Recharge facility. The cost estimate for the Phase II Well Pipelines and Interbasin Structures is illustrated in Table 22.

Table 22

Recharge Basins & Infrastructure (Canal Alternative)	
Phase 2 - Well Pipelines and Interbasin Structures	
Item Description	Cost Estimate
Interbasin Structures	$1,102,000.00
Recovery Well Pipelines	$838,620.00
Subtotal:	$1,940,620.00

The total estimated capital cost for the "Phase II Well Pipelines and Interbasin Structures" is $1,940,620.00.

Pipeline Alternative

The construction package noted above for the pipeline alternative is anticipated to be for the interbasin structures and recovery well conveyance pipelines at the Phase II Recharge facility. The cost estimate for the Phase II Well Pipelines and Interbasin Structures is illustrated in Table 23.

Table 23

Recharge Basins & Infrastructure (Pipeline Alternative)	
Phase 2 - Well Pipelines and Interbasin Structures	
Item Description	Cost Estimate
Interbasin Structures	$1,102,000.00
Recovery Well Pipelines	$638,620.00
Subtotal:	$1,740,620.00

The total estimated capital cost for the "Phase II Well Pipelines and Interbasin Structures" is $1,740,620.00.

G. Aqueduct Turnout Facility

Canal Alternative (Concrete Lined)

The construction package noted above is anticipated to include the installation and removal of a cofferdam in the Aqueduct, earthwork, reinforced concrete, miscellaneous steel, slide gate, turnout piping, metering, electrical and controls. The Aqueduct Turnout piping for the canal alternative is estimated as 9-ft diameter RCP. The cost estimate is illustrated in Table 24.

Table 24

Aqueduct Turnout (Canal Alternative)	
Aqueduct Turnout Facility	
Item Description	Cost Estimate
Cofferdam	$285,000.00
Earthwork	$129,000.00
Concrete Structure	$305,000.00
Turnout Piping & Appurtenances	$3,421,000.00
Electrical & Controls	$300,000.00
Aqueduct Restoration	$31,200.00
Subtotal:	$4,471,200.00

The total estimated capital cost for the "Aqueduct Turnout Facility" is $4,471,200.00.

Pipeline Alternative

The construction package noted above for the pipeline alternative is anticipated to include the installation and removal of a cofferdam in the Aqueduct, earthwork, reinforced concrete, miscellaneous steel, slide gate, turnout piping, metering, electrical and controls. The Aqueduct Turnout piping for the pipeline alternative is estimated as 10-ft diameter RCP. The cost estimate is illustrated in Table 25.

Table 25

Aqueduct Turnout (Pipeline Alternative)	
Aqueduct Turnout Facility	
Item Description	Cost Estimate
Cofferdam	$285,000.00
Earthwork	$129,000.00
Concrete Structure	$305,000.00
Turnout Piping & Appurtenances	$4,186,500.00
Electrical & Controls	$300,000.00
Aqueduct Restoration	$31,200.00
Subtotal:	$5,236,700.00

The total estimated capital cost for the "Aqueduct Turnout Facility" is $5,236,700.00.

H. Conveyance Facilities including Turnouts & Pump Stations

Canal Alternative (Concrete Lined)

The construction package noted above is anticipated to include the conveyance canal earthwork, canal lining, canal appurtenances, security fencing and gates, levee road surfacing, emergency spillways, afterbay structures, farm road crossings, the Adhor Rd crossing, the East Side Canal crossing, the Stockdale Hwy crossing, the I-5 Freeway crossing, three in-line pump station concrete structures, a return water pump station concrete structure to the Aqueduct, and turnout facilities to the Phase I Recharge property, Phase II Recharge property, and the West Basin Recharge property. The cost estimate is illustrated in Table 26.

Table 26

Conveyance Facilities (Canal Alternative)	
Conveyance Facilities including Turnouts & Pump Stations	
Item Description	Cost Estimate
Canal Earthwork	$5,705,205.40
Canal Lining	$14,198,400.00
Canal Appurtenances	$2,973,500.00
Canal Fencing & Gates	$696,000.00
Canal Levee Surfacing	$697,500.00
Aqueduct Afterbay	$319,000.00
Emergency Spillways	$377,500.00
Adhor Road Crossing	$766,400.00
East Side Canal Crossing	$976,000.00
Stockdale Hwy Cased Crossing	$1,601,000.00
I-5 Fwy Cased Crossing	$2,446,000.00
Farm Road Crossings (4)	$2,880,000.00
Pump Station Afterbays (3)	$998,000.00
Pump Station No. 1	$1,810,000.00
Pump Station No. 2	$1,810,000.00
Pump Station No. 3	$1,750,000.00
Return Water Pump Station	$428,500.00
Reach 4 Pipeline & Appurtenances	$3,943,350.00
Phase I Turnout	$240,500.00
Phase II Turnouts (4)	$2,344,500.00
West Basin Turnouts (4)	$2,042,000.00
Subtotal:	$49,003,355.40

The total estimated capital cost for the "Conveyance Facilities including Turnouts & Pump Stations" is $49,003,355.40.

Pipeline Alternative

The construction package noted above is anticipated to include the conveyance pipeline installation, the Adhor Rd crossing, the East Side Canal crossing, the Stockdale Hwy crossing, the I-5 Freeway crossing, one in-line pump station concrete structure, and turnout facilities to the Phase I Recharge property, Phase II Recharge property, and the West Basin Recharge property. The cost estimate is illustrated in Table 27.

Table 27

Conveyance Facilities (Pipeline Alternative)	
Conveyance Facilities including Turnouts & Pump Stations	
Item Description	Cost Estimate
Right-of-Way Clearing & Grubbing	$204,000.00
Pipeline & Appurtenances	$58,659,500.00
Adhor Road Crossing	$54,000.00
East Side Canal Crossing	$170,000.00
Stockdale Hwy Cased Crossing	$975,000.00
I-5 Fwy Cased Crossing	$1,820,000.00
Pump Station No. 1	$2,290,000.00
Phase I Turnout	$220,050.00
Phase II Turnouts (4)	$1,406,000.00
West Basin Turnouts (4)	$1,484,000.00
Subtotal:	$67,282,550.00

The total estimated capital cost for the pipeline alternative of the "Conveyance Facilities including Turnouts & Pump Stations" is $67,282,550.00.

I. Pump Station Equipping

Canal Alternative (Concrete Lined)

The construction package noted above is anticipated to include the pump station equipping for three in-line pump stations and the return water pump station to the Aqueduct including pumps, motors, discharge piping and appurtenances, VFD's, electrical and controls, site ground cover, and bypass piping and appurtenances. The cost estimate is illustrated in Table 28.

Table 28

Conveyance Facilities (Canal Alternative)	
Pump Station Equipping	
Item Description	Cost Estimate
PS No. 1 Pumps and Motors	$2,140,000.00
PS No. 1 Discharge Piping and Appurtenances	$2,606,000.00
PS No. 1 VFD's	$640,000.00
PS No. 1 Electrical and Controls	$1,358,000.00
PS No. 1 Bypass Piping and Appurtenances	$125,000.00
PS No. 1 Site Ground Cover	$45,000.00
PS No. 2 Pumps and Motors	$2,140,000.00
PS No. 2 Discharge Piping and Appurtenances	$2,606,000.00
PS No. 2 VFD's	$640,000.00
PS No. 2 Electrical and Controls	$1,358,000.00
PS No. 2 Bypass Piping and Appurtenances	$125,000.00
PS No. 2 Site Ground Cover	$45,000.00
PS No. 3 Pumps and Motors	$1,300,000.00
PS No. 3 Discharge Piping and Appurtenances	$1,638,000.00
PS No. 3 VFD's	$400,000.00
PS No. 3 Electrical and Controls	$1,358,000.00
PS No. 3 Bypass Piping and Appurtenances	$125,000.00
PS No. 3 Site Ground Cover	$45,000.00
RWPS Pumps and Motors	$690,000.00
RWPS Discharge Piping and Appurtenances	$580,500.00
RWPS Electrical and Controls	$390,000.00
RWPS Bypass Piping and Appurtenances	$198,300.00
Subtotal:	$20,552,800.00

The total estimated capital cost for the "Pump Station Equipping" is $20,552,800.00.

Pipeline Alternative

The construction package noted above is anticipated to include the pump station equipping for one in-line pump station including pumps, motors, discharge piping and appurtenances, VFD's, electrical and controls, site ground cover, and bypass piping and appurtenances. The cost estimate is illustrated in Table 29.

Table 29

Conveyance Facilities (Pipeline Alternative)	
Pump Station Equipping	
Item Description	Cost Estimate
PS No. 1 Pumps and Motors	$3,280,000.00
PS No. 1 Discharge Piping and Appurtenance	$2,606,000.00
PS No. 1 VFD's	$1,900,000.00
PS No. 1 Electrical and Controls	$2,837,000.00
PS No. 1 Bypass Piping and Appurtenances	$425,000.00
PS No. 1 Site Ground Cover	$45,000.00
Subtotal:	$11,093,000.00

The total estimated capital cost for the pipeline alternative of the "Pump Station Equipping" is $11,093,000.00.

J. SCADA and PLC Programming

Canal Alternative (Concrete Lined) and Pipeline Alternative

The construction package noted above is anticipated to include the installation of hardware and software for the SCADA system along with the PLC and SCADA programming to communicate between the new and existing banking facilities and the central headquarters. The cost estimate is illustrated in Table 30. The estimated costs are the same regardless of the conveyance facility alternative

Table 30

SCADA (Canal Alternative)	
SCADA and PLC Programming	
Item Description	Cost Estimate
SCADA System Hardware	$271,000.00
SCADA System Software	$30,000.00
Programming & Screens	$150,000.00
Subtotal:	$451,000.00

The total estimated capital cost for the "SCADA and PLC Programming" is $451,000.00.

IV. Summary of Project Probable Costs

Engineer's Estimates were prepared for the Kern Fan Project with a conveyance canal alternative and also with a conveyance pipeline alternative. The detailed cost estimates are attached in Appendix A and Appendix B. These estimates are predicated on the work performed during the grant application process as well as each of the technical memoranda. Pipeline costs were estimated from Technical Memorandum No. 3 "Pipeline Requirements"; conveyance facilities and pump station costs were estimated based on Technical Memorandum No. 6 "Conveyance and Turnout Requirements"; right-of-way costs were estimated based on Technical Memorandum No. 8 "Right of Way Acquisitions"; and SCADA costs were estimated based on Technical Memorandum No. 10 "Facility Operation and SCADA Requirements".

The cost estimates provided herein are preliminary. They have been prepared in the absence of definitive property locations, a definitive conveyance alignment, survey work, and detailed design work. The previous technical memorandums have been utilized in developing these estimates. The estimates are to be considered a Class 3 estimate. Class 3 estimates are generally prepared to support full project funding requests and become the first of the proposed phase "control estimates" against which all actual costs and resources will be monitored for variations to budget. The Class 3 estimate is used as the project budget until replaced by more detailed estimates. Typically, the level of project definition is between 10% to 40%. The accuracy range for the cost estimates varies from -10% to -20% on the low side and +10% to +30% on the high side.

The cost estimates include the estimated capital cost, a mobilization and demobilization cost, a 2.5% design contingency for unknown items, a 20% construction contingency, land acquisition costs, right-of-way costs, HCP fees, and non-contract costs such as project management, engineering design, environmental, electrical service, permitting, bid administration, and construction management and inspection. In addition, an escalation factor has been included at 2% per year for five years in an effort to account for the long project duration and rising costs.

A summary of the costs are outlined below in Table 31 for the canal alternative:

Table 31

Preliminary Engineer's Estimate (Class 3)	
Conveyance Alignment - Canal Alternative	
Item Description	Cost Estimate
Aqueduct Turnout Facility	$4,471,200.00
Conveyance Facilities including Turnouts & Pump Stations	$69,556,155.40
Phase I Recharge Facility and Infrastructure	$5,900,460.00
Goose Lake Channel Pump Station & Check Structure	$4,674,000.00
Phase II Recharge Facility and Infrastructure	$5,269,020.00
Phase I Recovery Wells	$14,735,046.00
Phase II Recovery Wells	$14,735,046.00
SCADA and PLC Programming	$451,000.00
Mobilization and Demobilization	$1,820,000.00
Subtotal Construction Cost:	$121,611,927.40
Design Contingency - 2.5%:	$3,014,203.00
Subtotal Construction Cost with Design Contingency:	$124,626,130.40
Construction Contingency - 20%:	$24,925,226.08
Subtotal Construction Cost with Continency:	$149,551,356.48
Land Acquisition and Right-of-Way:	$40,960,000.00
Project Management, Design, Permitting, CM, & Fees:	$29,450,000.00
Engineer's Estimate at December 2020 Price Level:	$219,961,356.48
Escalation at 2.0% per year for 5 years (not including land acquisition and ROW):	$18,238,644.00
Engineer's Estimate with Escalation Factor through 2025:	$238,200,000.48

A summary of the costs are outlined below in Table 32 for the pipeline alternative:

Table 32

Preliminary Engineer's Estimate (Class 3)	
Conveyance Alignment - Pipeline Alternative	
Item Description	Cost Estimate
Aqueduct Turnout Facility	$5,236,700.00
Conveyance Facilities including Turnouts & Pump Stations	$78,375,550.00
Phase I Recharge Facility and Infrastructure	$5,900,460.00
Goose Lake Channel Pump Station & Check Structure	$4,674,000.00
Phase II Recharge Facility and Infrastructure	$5,069,020.00
Phase I Recovery Wells	$14,735,046.00
Phase II Recovery Wells	$14,735,046.00
SCADA and PLC Programming	$451,000.00
Mobilization and Demobilization	$1,820,000.00
Subtotal Construction Cost:	$130,996,822.00
Design Contingency - 2.5%:	$3,274,920.55
Subtotal Construction Cost with Design Contingency:	$134,271,742.55
Construction Contingency - 20%:	$26,854,348.51
Subtotal Construction Cost with Continency:	$161,126,091.06
Land Acquisition and Right-of-Way:	$38,873,783.00
Project Management, Design, Permitting, CM, & Fees:	$29,450,000.00
Engineer's Estimate at December 2020 Price Level:	$229,449,874.06
Escalation at 2.0% per year for 5 years (not including land acquisition and ROW):	$19,423,909.00
Engineer's Estimate with Escalation Factor through 2025:	$248,873,783.06

The Engineer's Estimate for the project including contingencies, land and right-of-way acquisition costs, and soft costs is approximately $219,961,356 and is for the conveyance canal alternative.

The pipeline alternative increases the cost by approximately $10,000,000 with an Engineer's Estimate of approximately $229,449,874.

Including an escalation factor of 2.0% per year for the next five years as a result of inflation, increases the Engineer's Estimate range for the two alternatives between $238,200,000 to $248,873,783.

V. Related Work Specified Elsewhere

A. TM 1 – Project Phasing and Design/Contractor Selection
B. TM 2 – Conveyance Capacity Requirements
C. TM 3 – Pipeline Requirements
D. TM 4 – Pump Station Requirements
E. TM 6 – Conveyance and Turnout Requirements
F. TM 7 – Well Drilling and Equipping Requirements
G. TM 8 – Right of Way Acquisitions
H. TM 9 – Recharge Basin Requirements
I. TM 10 – Facility Operation and SCADA Requirements

Appendices

Appendix A – Preliminary Engineer's Estimate: Canal Alignment

Appendix B – Preliminary Engineer's Estimate: Pipeline Alignment

Date: July 2021
Price Level: December 2020

Irvine Ranch Water District

Preliminary Engineer's Estimate (Class 3)

Canal Alignment - Concrete Lined Canal Alternative

Item No.	Item Description	Unit	Quantity	Unit Cost	Extended Cost	Section Subtotal
1	Aqueduct Cofferdam Assembly and Installation	EA	1	$ 185,000.00	$ 185,000.00	
2	Dewatering	EA	1	$ 35,000.00	$ 35,000.00	
3	Aqueduct Cofferdam Disassembly and Removal	EA	1	$ 65,000.00	$ 65,000.00	
4	Aqueduct Turnout Excavation	CY	2450	$ 30.00	$ 73,500.00	
5	Aqueduct Reinforced Concrete Structure - Floor	CY	45	$ 1,000.00	$ 45,000.00	
6	Aqueduct Reinforced Concrete Structure - Walls	CY	100	$ 1,500.00	$ 150,000.00	
7	Aqueduct Reinforced Concrete Structure - Deck/Beam	CY	5	$ 2,000.00	$ 10,000.00	
8	Aqueduct Backfill and Compaction	CY	1850	$ 30.00	$ 55,500.00	
9	Aqueduct Turnout Steel Embeds	EA	1	$ 10,000.00	$ 10,000.00	
10	Aqueduct Turnout Steel Grating	EA	1	$ 20,000.00	$ 20,000.00	
11	Aqueduct Turnout Steel Handrailing	EA	1	$ 20,000.00	$ 20,000.00	
12	Aqueduct Trashrack	EA	1	$ 50,000.00	$ 50,000.00	
13	Aqueduct Turnout Piping - 9' Diameter RCP	LF	2100	$ 1,010.00	$ 2,121,000.00	
14	Aqueduct Turnout Fittings	EA	6	$ 50,000.00	$ 300,000.00	
15	Outlet Canal Siphon Earthwork and Canal Restoration	CY	15000	$ 30.00	$ 450,000.00	
16	Aqueduct Metering	EA	1	$ 225,000.00	$ 225,000.00	
17	Aqueduct Meter Vault	EA	1	$ 250,000.00	$ 250,000.00	
18	Aqueduct Slide Gate & Actuator	EA	1	$ 75,000.00	$ 75,000.00	
19	Aqueduct Turnout Electrical Panels	EA	1	$ 170,000.00	$ 170,000.00	
20	Aqueduct Turnout Electrical Concrete Pad	EA	1	$ 15,000.00	$ 15,000.00	
21	Aqueduct Turnout Electrical Service	EA	1	$ 20,000.00	$ 20,000.00	
22	Aqueduct Turnout Light Standard	EA	1	$ 10,000.00	$ 10,000.00	
23	Aqueduct Turnout PLC Panel & Programming	EA	1	$ 20,000.00	$ 20,000.00	
24	Aqueduct Turnout Conduits, Wire, and Grounding	EA	1	$ 63,000.00	$ 63,000.00	
25	Electrical Equipment Bollards	EA	1	$ 2,000.00	$ 2,000.00	
26	Aqueduct Liner Repair Subgrade Earthwork	EA	1	$ 11,000.00	$ 11,000.00	
27	Aqueduct Liner Repair	SF	1500	$ 6.00	$ 9,000.00	
28	Levee Road Pavement Restoration	SF	1600	$ 7.00	$ 11,200.00	$ 4,471,200.00
29	Canal Clearing & Grubbing	AC	285	$ 1,200.00	$ 342,000.00	
30	Canal Earthwork-Cut	CY	244,227	$ 4.50	$ 1,099,021.50	
31	Canal Earthwork-Fill	CY	716,381	$ 4.50	$ 3,223,714.50	
32	Levee Subgrade Preparation	CY	226,189	$ 4.60	$ 1,040,469.40	
33	Concrete Canal Lining	SF	2,366,400	$ 6.00	$ 14,198,400.00	
34	Canal Drain System Excavation	CY	35150	$ 8.00	$ 281,200.00	
35	Canal Drain System Geotextile	SF	457000	$ 0.30	$ 137,100.00	
36	Canal Drain System Gravel Rock	CY	8880	$ 50.00	$ 444,000.00	
37	Canal Drain System Perforated Piping	LF	56300	$ 6.31	$ 355,000.00	
38	Canal Drain System Backfill and Compaction	CY	35150	$ 8.00	$ 281,200.00	
39	Canal Ladder Rungs	EA	70	$ 2,500.00	$ 175,000.00	
40	Canal Safety Buoy Chains	EA	30	$ 10,000.00	$ 300,000.00	
41	Canal Fencing	LF	92,800	$ 7.50	$ 696,000.00	
42	Levee Road Aggregate Base Ground Cover	CY	13,950	$ 50.00	$ 697,500.00	
43	Ex. Facility Relocations - Power Lines, Irrigation Lines, Ditches, Turnouts, etc.	EA	20	$ 50,000.00	$ 1,000,000.00	$ 24,270,605.40
44	Aqueduct Turnout Afterbay Structure Floor	CY	60	$ 1,000.00	$ 60,000.00	
45	Aqueduct Turnout Afterbay Structure Walls & Footings	CY	80	$ 1,500.00	$ 120,000.00	
46	Aqueduct Turnout Afterbay Earthwork	CY	3800	$ 30.00	$ 114,000.00	
47	Aqueduct Turnout Afterbay Steel Handrailing	EA	1	$ 25,000.00	$ 25,000.00	
48	Spillway Reinforced Concrete	CY	150	$ 800.00	$ 120,000.00	
49	Spillway Rip-Rap	CY	375	$ 130.00	$ 48,750.00	
50	Adohr Rd Forebay Structure Floor	CY	60	$ 1,000.00	$ 60,000.00	
51	Adohr Rd Forebay Structure Walls & Footings	CY	80	$ 1,500.00	$ 120,000.00	
52	Adohr Rd Siphon Pipe - 10' Diameter RCP	LF	100	$ 1,400.00	$ 140,000.00	
53	Adohr Rd Afterbay Structure Floor	CY	60	$ 1,000.00	$ 60,000.00	
54	Adohr Rd Afterbay Structure Walls & Foottings	CY	80	$ 1,500.00	$ 120,000.00	
55	Adohr Siphon Crossing Earthwork	CY	7200	$ 30.00	$ 216,000.00	
56	Adohr Siphon Pavement Repair	SF	7200	$ 7.00	$ 50,400.00	
57	Adohr Siphon Crossing Steel Handrailing	EA	2	$ 25,000.00	$ 50,000.00	
58	East Side Canal Forebay Structure Floor	CY	60	$ 1,000.00	$ 60,000.00	
59	East Side Canal Forebay Structure Walls & Footings	CY	80	$ 1,500.00	$ 120,000.00	
60	East Side Canal Siphon Pipe - 10' Diameter RCP	LF	250	$ 1,400.00	$ 350,000.00	
61	East Side Canal Afterbay Structure Floor	CY	60	$ 1,000.00	$ 60,000.00	
62	East Side Canal Afterbay Structure Walls & Footings	CY	80	$ 1,500.00	$ 120,000.00	
63	East Side Canal Siphon Crossing Earthwork	CY	7200	$ 30.00	$ 216,000.00	
64	East Side Canal Siphon Crossing Steel Handrailing	EA	2	$ 25,000.00	$ 50,000.00	
65	Stockdale Hwy Forebay Structure Floor	CY	60	$ 1,000.00	$ 60,000.00	
66	Stockdale Hwy Forebay Structure Walls & Footings	CY	80	$ 1,500.00	$ 120,000.00	
67	Stockdale Hwy Cased Crossing - 12' Diameter Casing with 10' Diameter CMLC	LF	150	$ 6,500.00	$ 975,000.00	
68	Stockdale Hwy Afterbay Structure Floor	CY	60	$ 1,000.00	$ 60,000.00	
69	Stockdale Hwy Afterbay Structure Walls & Footings	CY	80	$ 1,500.00	$ 120,000.00	
70	Stockdale Hwy Crossing Earthwork	CY	7200	$ 30.00	$ 216,000.00	
71	Stockdale Hwy Crossing Steel Handrailing	EA	2	$ 25,000.00	$ 50,000.00	$ 3,881,150.00

72	Lift Station Excavation	CY	11000	$	10.00	$	110,000.00		
73	Lift Station Reinforced Concrete Structure - Floor	CY	320	$	1,000.00	$	320,000.00		
74	Lift Station Reinforced Concrete Structure - Walls	CY	520	$	1,500.00	$	780,000.00		
75	Lift Station Reinforced Concrete Structure - Deck	CY	120	$	2,000.00	$	240,000.00		
76	Pump Fillets and Center Splitter	EA	6	$	10,000.00	$	60,000.00		
77	Lift Station Pumps - 40 cfs	EA	2	$	180,000.00	$	360,000.00		
78	Lift Station Pumps - 90 cfs	EA	4	$	300,000.00	$	1,200,000.00		
79	Lift Station Motors - 150 hp	EA	2	$	50,000.00	$	100,000.00		
80	Lift Station Motors - 300 hp	EA	4	$	120,000.00	$	480,000.00		
81	30" FBE Steel Discharge Piping	LF	300	$	700.00	$	210,000.00		
82	6" Air Release Valve	EA	2	$	7,500.00	$	15,000.00		
83	30" Dresser Coupling	EA	2	$	7,500.00	$	15,000.00		
84	30" Check Valve with Oil Dashpot	EA	2	$	100,000.00	$	200,000.00		
85	30" Butterfly Valve	EA	2	$	35,000.00	$	70,000.00		
86	Flow Meter	EA	2	$	35,000.00	$	70,000.00		
87	Pipe Supports	EA	8	$	2,500.00	$	20,000.00		
88	Pipe Excavation and Backfill	LF	200	$	300.00	$	60,000.00		
89	Painting System	EA	2	$	5,000.00	$	10,000.00		
90	42" FBE Steel Discharge Piping	LF	600	$	900.00	$	540,000.00		
91	8" Air Release Valve	EA	4	$	12,500.00	$	50,000.00		
92	42" Dresser Coupling	EA	4	$	12,500.00	$	50,000.00		
93	42" Check Valve with Oil Dashpot	EA	4	$	150,000.00	$	600,000.00		
94	42" Butterfly Valve	EA	4	$	55,000.00	$	220,000.00		
95	Flow Meter	EA	4	$	50,000.00	$	200,000.00		
96	Pipe Supports	EA	16	$	3,500.00	$	56,000.00		
97	Pipe Excavation and Backfill	LF	400	$	500.00	$	200,000.00		
98	Painting System	EA	4	$	5,000.00	$	20,000.00		
99	Lift Station 150 hp VFD's	EA	2	$	80,000.00	$	160,000.00		
100	Lift Station 300 hp VFD's	EA	4	$	120,000.00	$	480,000.00		
101	Lift Station Main Switchboard	EA	1	$	50,000.00	$	50,000.00		
102	Lift Station Motor Control Center	EA	1	$	175,000.00	$	175,000.00		
103	Lift Station PLC & Programming	EA	1	$	175,000.00	$	175,000.00		
104	Lift Station Transformer & Electrical Service	EA	1	$	30,000.00	$	30,000.00		
105	Lift Station Site Lighting	EA	4	$	20,000.00	$	80,000.00		
106	Lift Station Conduits, Wire, & Grounding	EA	1	$	500,000.00	$	500,000.00		
107	Lift Station Electrical Control Building Concrete Foundation	CY	40	$	1,200.00	$	48,000.00		
108	Lift Station Electrical Building & Appurtenances	EA	1	$	300,000.00	$	300,000.00		
109	Lift Station Backfill & Compaction	CY	6000	$	10.00	$	60,000.00		
110	Lift Station Slide Gates	EA	1	$	55,000.00	$	55,000.00		
111	Lift Station Trashracks	EA	6	$	20,000.00	$	120,000.00		
112	Lift Station Steel Embeds & Ladder Rungs	EA	1	$	20,000.00	$	20,000.00		
113	Lift Station Steel Grating	EA	1	$	50,000.00	$	50,000.00		
114	Lift Station Steel Handrailing	EA	1	$	25,000.00	$	25,000.00		
115	Lift Station Pump Column Pipe Cathodic Protection	EA	1	$	12,500.00	$	12,500.00		
116	Lift Station Underground Piping Cathodic Protection	EA	1	$	12,500.00	$	12,500.00		
117	Lift Station Bypass Pipeline	LF	200	$	350.00	$	70,000.00		
118	Lift Station Ground Cover	CY	900	$	50.00	$	45,000.00	$	8,724,000.00
119	Lift Station Afterbay Structure Floor	CY	120	$	1,000.00	$	120,000.00		
120	Lift Station Afterbay Structure Walls & Footings	CY	160	$	1,500.00	$	240,000.00		
121	Lift Station Afterbay Earthwork	CY	3800	$	30.00	$	114,000.00		
122	Lift Station Afterbay Steel Handrailing	EA	1	$	25,000.00	$	25,000.00		
123	(2) Farm Road Crossing Forebay Structure Floor	CY	120	$	1,000.00	$	120,000.00		
124	(2) Farm Road Crossing Forebay Structure Walls & Footings	CY	160	$	1,500.00	$	240,000.00		
125	(2) Farm Road Crossing Siphon Pipes - 10' Diameter RCP	LF	120	$	1,400.00	$	168,000.00		
126	(2) Farm Road Crossing Afterbay Structure Floor	CY	120	$	1,000.00	$	120,000.00		
127	(2) Farm Road Crossing Afterbay Structure Walls & Footings	CY	160	$	1,500.00	$	240,000.00		
128	(2) Farm Road Siphon Crossing Earthwork	CY	14400	$	30.00	$	432,000.00		
129	(2) Farm Road Siphon Crossing Steel Handrailing	EA	4	$	25,000.00	$	100,000.00		
130	I-5 Fwy Forebay Structure Floor	CY	60	$	1,000.00	$	60,000.00		
131	I-5 Fwy Forebay Structure Walls & Footings	CY	80	$	1,500.00	$	120,000.00		
132	I-5 Fwy Cased Crossing - 13' Diameter Casing with 10' Diameter RCP	LF	280	$	6,500.00	$	1,820,000.00		
133	I-5 Fwy Afterbay Structure Floor	CY	60	$	1,000.00	$	60,000.00		
134	I-5 Fwy Afterbay Structure Walls & Footings	CY	80	$	1,500.00	$	120,000.00		
135	I-5 Fwy Crossing Earthwork	CY	7200	$	30.00	$	216,000.00		
136	I-5 Fwy Crossing Steel Handrailing	EA	2	$	25,000.00	$	50,000.00	$	4,365,000.00

137	Lift Station Excavation	CY	11000	$	10.00	$	110,000.00		
138	Lift Station Reinforced Concrete Structure - Floor	CY	320	$	1,000.00	$	320,000.00		
139	Lift Station Reinforced Concrete Structure - Walls	CY	520	$	1,500.00	$	780,000.00		
140	Lift Station Reinforced Concrete Structure - Deck	CY	120	$	2,000.00	$	240,000.00		
141	Pump Fillets and Center Splitter	EA	6	$	10,000.00	$	60,000.00		
142	Lift Station Pumps - 40 cfs	EA	2	$	180,000.00	$	360,000.00		
143	Lift Station Pumps - 90 cfs	EA	4	$	300,000.00	$	1,200,000.00		
144	Lift Station Motors - 150 hp	EA	2	$	50,000.00	$	100,000.00		
145	Lift Station Motors - 300 hp	EA	4	$	120,000.00	$	480,000.00		
146	30" FBE Steel Discharge Piping	LF	300	$	700.00	$	210,000.00		
147	6" Air Release Valve	EA	2	$	7,500.00	$	15,000.00		
148	30" Dresser Coupling	EA	2	$	7,500.00	$	15,000.00		
149	30" Check Valve with Oil Dashpot	EA	2	$	100,000.00	$	200,000.00		
150	30" Butterfly Valve	EA	2	$	35,000.00	$	70,000.00		
151	Flow Meter	EA	2	$	35,000.00	$	70,000.00		
152	Pipe Supports	EA	8	$	2,500.00	$	20,000.00		
153	Pipe Excavation and Backfill	LF	200	$	300.00	$	60,000.00		
154	Painting System	EA	2	$	5,000.00	$	10,000.00		
155	42" FBE Steel Discharge Piping	LF	600	$	900.00	$	540,000.00		
156	8" Air Release Valve	EA	4	$	12,500.00	$	50,000.00		
157	42" Dresser Coupling	EA	4	$	12,500.00	$	50,000.00		
158	42" Check Valve with Oil Dashpot	EA	4	$	150,000.00	$	600,000.00		
159	42" Butterfly Valve	EA	4	$	55,000.00	$	220,000.00		
160	Flow Meter	EA	4	$	50,000.00	$	200,000.00		
161	Pipe Supports	EA	16	$	3,500.00	$	56,000.00		
162	Pipe Excavation and Backfill	LF	400	$	500.00	$	200,000.00		
163	Painting System	EA	4	$	5,000.00	$	20,000.00		
164	Lift Station 150 hp VFD's	EA	2	$	80,000.00	$	160,000.00		
165	Lift Station 300 hp VFD's	EA	4	$	120,000.00	$	480,000.00		
166	Lift Station Main Switchboard	EA	1	$	50,000.00	$	50,000.00		
167	Lift Station Motor Control Center	EA	1	$	175,000.00	$	175,000.00		
168	Lift Station PLC & Programming	EA	1	$	175,000.00	$	175,000.00		
169	Lift Station Transformer & Electrical Service	EA	1	$	30,000.00	$	30,000.00		
170	Lift Station Site Lighting	EA	4	$	20,000.00	$	80,000.00		
171	Lift Station Conduits, Wire, & Grounding	EA	1	$	500,000.00	$	500,000.00		
172	Lift Station Electrical Control Building Concrete Foundation	CY	40	$	1,200.00	$	48,000.00		
173	Lift Station Electrical Building & Appurtenances	EA	1	$	300,000.00	$	300,000.00		
174	Lift Station Backfill & Compaction	CY	6000	$	10.00	$	60,000.00		
175	Lift Station Slide Gates	EA	1	$	55,000.00	$	55,000.00		
176	Lift Station Trashracks	EA	6	$	20,000.00	$	120,000.00		
177	Lift Station Steel Embeds & Ladder Rungs	EA	1	$	20,000.00	$	20,000.00		
178	Lift Station Steel Grating	EA	1	$	50,000.00	$	50,000.00		
179	Lift Station Steel Handrailing	EA	1	$	25,000.00	$	25,000.00		
180	Lift Station Pump Column Pipe Cathodic Protection	EA	1	$	12,500.00	$	12,500.00		
181	Lift Station Underground Piping Cathodic Protection	EA	1	$	12,500.00	$	12,500.00		
182	Lift Station Bypass Pipeline	LF	200	$	350.00	$	70,000.00		
183	Lift Station Ground Cover	CY	900	$	50.00	$	45,000.00	$	8,724,000.00
184	Lift Station Afterbay Structure Floor	CY	120	$	1,000.00	$	120,000.00		
185	Lift Station Afterbay Structure Walls & Footings	CY	160	$	1,500.00	$	240,000.00		
186	Lift Station Afterbay Earthwork	CY	3800	$	30.00	$	114,000.00		
187	Lift Station Afterbay Steel Handrailing	EA	1	$	25,000.00	$	25,000.00		
188	Spillway Reinforced Concrete	CY	150	$	1,000.00	$	150,000.00		
189	Spillway Rip-Rap	CY	375	$	130.00	$	48,750.00		
190	(2) Farm Road Crossing Forebay Structure Floor	CY	120	$	1,000.00	$	120,000.00		
191	(2) Farm Road Crossing Forebay Structure Walls & Footings	CY	160	$	1,500.00	$	240,000.00		
192	(2) Farm Road Crossing Siphon Pipes - 10' Diameter RCP	LF	120	$	1,400.00	$	168,000.00		
193	(2) Farm Road Crossing Afterbay Structure Floor	CY	120	$	1,000.00	$	120,000.00		
194	(2) Farm Road Crossing Afterbay Structure Walls & Footings	CY	160	$	1,500.00	$	240,000.00		
195	(2) Farm Road Siphon Crossing Earthwork	CY	14400	$	30.00	$	432,000.00		
196	(2) Farm Road Siphon Crossing Steel Handrailing	EA	4	$	25,000.00	$	100,000.00	$	2,117,750.00
197	(4) Phase II 640 Acres Turnout Structure Excavation	CY	800	$	30.00	$	24,000.00		
198	(4) Phase II 640 Acres Turnout Reinforced Concrete Structure - Floor	CY	30	$	1,000.00	$	30,000.00		
199	(4) Phase II 640 Acres Turnout Reinforced Concrete Structure - Walls	CY	60	$	1,500.00	$	90,000.00		
200	(4) Phase II 640 Acres Turnout Reinforced Concrete Structure - Deck	CY	10	$	2,000.00	$	20,000.00		
201	(4) Phase II 640 Acres Structure Backfill & Compaction	CY	750	$	30.00	$	22,500.00		
202	(4) Phase II 640 Acres Turnout Reinforced Concrete Cutoff Wall	EA	4	$	20,000.00	$	80,000.00		
203	(4) Phase II 640 Acres Turnout Steel Embeds & Ladder Rungs	EA	4	$	10,000.00	$	40,000.00		
204	(4) Phase II 640 Acres Turnout Steel Grating	EA	4	$	10,000.00	$	40,000.00		
205	(4) Phase II 640 Acres Turnout Steel Handrailing	EA	4	$	5,000.00	$	20,000.00		
206	(4) Phase II 640 Acres Metering	EA	4	$	35,000.00	$	140,000.00		
207	(4) Phase II 640 Acres Meter Vault	EA	4	$	150,000.00	$	600,000.00		
208	(4) Phase II 640 Acres Piping	LF	600	$	170.00	$	102,000.00		
209	(4) Phase II 640 Acres Turnout Slide Gate	EA	4	$	55,000.00	$	220,000.00		
210	(4) Phase II 640 Acres Turnout Electrical Panels	EA	4	$	85,000.00	$	340,000.00		
211	(4) Phase II 640 Acres Turnout Electrical Concrete Pad	CY	16	$	1,000.00	$	16,000.00		
212	(4) Phase II 640 Acres Turnout Electrical Service	EA	4	$	20,000.00	$	80,000.00		
213	(4) Phase II 640 Acres Turnout Light Standard	EA	4	$	10,000.00	$	40,000.00		
214	(4) Phase II 640 Acres Turnout PLC Panel & Programming	EA	4	$	10,000.00	$	40,000.00		
215	(4) Phase II 640 Acres Turnout Conduits, Wire, and Grounding	EA	4	$	63,000.00	$	252,000.00		
216	(4) Phase II 640 Acres Turnout Electrical Equipment Bollards	EA	4	$	2,000.00	$	8,000.00		
217	(4) Phase II 640 Acres Outlet Structure - Excavation	CY	1200	$	30.00	$	36,000.00		
218	(4) Phase II 640 Acres Outlet Structure Rip-Rap	CY	800	$	130.00	$	104,000.00	$	2,344,500.00

219	Lift Station Excavation	CY	11000	$	10.00	$	110,000.00		
220	Lift Station Reinforced Concrete Structure - Floor	CY	320	$	1,000.00	$	320,000.00		
221	Lift Station Reinforced Concrete Structure - Walls	CY	520	$	1,500.00	$	780,000.00		
222	Lift Station Reinforced Concrete Structure - Deck	CY	120	$	2,000.00	$	240,000.00		
223	Pump Fillets and Center Splitter	EA	4	$	10,000.00	$	40,000.00		
224	Lift Station Pumps - 40 cfs	EA	2	$	180,000.00	$	360,000.00		
225	Lift Station Pumps - 80 cfs	EA	2	$	300,000.00	$	600,000.00		
226	Lift Station Motors - 150 hp	EA	2	$	50,000.00	$	100,000.00		
227	Lift Station Motors - 300 hp	EA	2	$	120,000.00	$	240,000.00		
228	30" FBE Steel Discharge Piping	LF	300	$	700.00	$	210,000.00		
229	6" Air Release Valve	EA	2	$	7,500.00	$	15,000.00		
230	30" Dresser Coupling	EA	2	$	7,500.00	$	15,000.00		
231	30" Check Valve with Oil Dashpot	EA	2	$	100,000.00	$	200,000.00		
232	30" Butterfly Valve	EA	2	$	35,000.00	$	70,000.00		
233	Flow Meter	EA	2	$	35,000.00	$	70,000.00		
234	Pipe Supports	EA	8	$	2,500.00	$	20,000.00		
235	Pipe Excavation and Backfill	LF	200	$	300.00	$	60,000.00		
236	Painting System	EA	2	$	5,000.00	$	10,000.00		
237	42" FBE Steel Discharge Piping	LF	300	$	900.00	$	270,000.00		
238	8" Air Release Valve	EA	2	$	12,500.00	$	25,000.00		
239	42" Dresser Coupling	EA	2	$	12,500.00	$	25,000.00		
240	42" Check Valve with Oil Dashpot	EA	2	$	150,000.00	$	300,000.00		
241	42" Butterfly Valve	EA	2	$	55,000.00	$	110,000.00		
242	Flow Meter	EA	2	$	50,000.00	$	100,000.00		
243	Pipe Supports	EA	8	$	3,500.00	$	28,000.00		
244	Pipe Excavation and Backfill	LF	200	$	500.00	$	100,000.00		
245	Painting System	EA	2	$	5,000.00	$	10,000.00		
246	Lift Station 150 hp VFD's	EA	2	$	80,000.00	$	160,000.00		
247	Lift Station 300 hp VFD's	EA	2	$	120,000.00	$	240,000.00		
248	Lift Station Main Switchboard	EA	1	$	50,000.00	$	50,000.00		
249	Lift Station Motor Control Center	EA	1	$	175,000.00	$	175,000.00		
250	Lift Station PLC & Programming	EA	1	$	175,000.00	$	175,000.00		
251	Lift Station Transformer & Electrical Service	EA	1	$	30,000.00	$	30,000.00		
252	Lift Station Site Lighting	EA	4	$	20,000.00	$	80,000.00		
253	Lift Station Conduits, Wire, & Grounding	EA	1	$	500,000.00	$	500,000.00		
254	Lift Station Electrical Control Building Concrete Foundation	CY	40	$	1,200.00	$	48,000.00		
255	Lift Station Electrical Building & Appurtenances	EA	1	$	300,000.00	$	300,000.00		
256	Lift Station Backfill & Compaction	CY	6000	$	10.00	$	60,000.00		
257	Lift Station Slide Gates	EA	1	$	55,000.00	$	55,000.00		
258	Lift Station Trashracks	EA	4	$	20,000.00	$	80,000.00		
259	Lift Station Steel Embeds & Ladder Rungs	EA	1	$	20,000.00	$	20,000.00		
260	Lift Station Steel Grating	EA	1	$	50,000.00	$	50,000.00		
261	Lift Station Steel Handrailing	EA	1	$	25,000.00	$	25,000.00		
262	Lift Station Pump Column Pipe Cathodic Protection	EA	1	$	12,500.00	$	12,500.00		
263	Lift Station Underground Piping Cathodic Protection	EA	1	$	12,500.00	$	12,500.00		
264	Lift Station Bypass Pipeline	LF	200	$	350.00	$	70,000.00		
265	Lift Station Ground Cover	CY	900	$	50.00	$	45,000.00	$	6,616,000.00
266	Reach Four 63" HDPE Pipeline	LF	8010	$	335.00	$	2,683,350.00		
267	Reach Four 54" HDPE Pipeline to Phase I	LF	4500	$	280.00	$	1,260,000.00		
268	West Basins Turnout Tee & Piping	EA	4	$	45,000.00	$	180,000.00		
269	West Basins Turnout Butterfly Valve	EA	4	$	45,000.00	$	180,000.00		
270	West Basins Metering	EA	4	$	35,000.00	$	140,000.00		
271	West Basins Metering Vault	EA	4	$	100,000.00	$	400,000.00		
272	West Basins Turnout Electrical Service to Flow Meter	EA	4	$	20,000.00	$	80,000.00		
273	West Basins Turnout PLC Panel & Programming	EA	4	$	10,000.00	$	40,000.00		
274	West Basins Turnout Conduits, Wire, and Grounding	EA	4	$	15,000.00	$	60,000.00		
275	West Basins Outlet Structure Excavation	CY	16000	$	30.00	$	480,000.00		
276	West Basins Outlet Structure Rip-Rap	CY	3400	$	130.00	$	442,000.00		
277	West Basins Outlet Structure Concrete Pad	SF	4	$	10,000.00	$	40,000.00		
278	Phase I Outlet Structure Excavation	CY	4000	$	30.00	$	120,000.00		
279	Phase I Outlet Structure Rip-Rap	CY	850	$	130.00	$	110,500.00		
280	Phase I Outlet Structure Concrete Pad	EA	1	$	10,000.00	$	10,000.00	$	6,225,850.00
281	Phase I 640 Acres Clearing & Grubbing	AC	320	$	1,200.00	$	384,000.00		
282	Phase I 640 Acres Levee Over-Excavation and Re-Compaction	CY	235000	$	4.60	$	1,081,000.00		
283	Phase I 640 Acres Levee Keyway	CY	50000	$	4.70	$	235,000.00		
284	Phase I 640 Acres Levee Embankment Fill	CY	315000	$	4.20	$	1,323,000.00		
285	Phase I 640 Acres Structure Headwalls	EA	10	$	30,000.00	$	300,000.00		
286	Phase I 640 Acres Structure Miscellaneous Steel & Weir Boards	EA	10	$	10,000.00	$	100,000.00		
287	Phase I 640 Acres Interbasin Structure Piping	LF	750	$	170.00	$	127,500.00		
288	Phase I 640 Acres Interbasin Structure Rip-Rap	EA	10	$	55,000.00	$	550,000.00		
289	Phase I 640 Acres Interbasin Structure Cutoff Walls	EA	20	$	15,000.00	$	300,000.00		
290	Phase I 640 Acres Site Fencing and Gates	LF	21120	$	7.50	$	158,400.00	$	4,558,900.00

291	Goose Lake Channel Turnout Structure Excavation	CY	1100	$	30.00	$	33,000.00		
292	Goose Lake Channel Turnout Reinforced Concrete Structure - Floor	CY	90	$	1,000.00	$	90,000.00		
293	Goose Lake Channel Turnout Reinforced Concrete Structure - Walls	CY	90	$	1,500.00	$	135,000.00		
294	Goose Lake Channel Turnout Reinforced Concrete Structure - Deck	CY	50	$	2,000.00	$	100,000.00		
295	Goose Lake Channel Turnout Backfill & Compaction	CY	500	$	30.00	$	15,000.00		
296	Goose Lake Channel Turnout Trashracks	EA	4	$	20,000.00	$	80,000.00		
297	Goose Lake Channel Turnout Steel Embeds & Ladder Rungs	EA	1	$	10,000.00	$	10,000.00		
298	Goose Lake Channel Turnout Steel Grating	EA	1	$	20,000.00	$	20,000.00		
299	Goose Lake Channel Turnout Steel Handrailing	EA	1	$	20,000.00	$	20,000.00		
300	Goose Lake Channel Lift Station Pumps - 80 cfs	EA	2	$	300,000.00	$	600,000.00		
301	Goose Lake Channel Lift Station Motors - 300 hp	EA	2	$	120,000.00	$	240,000.00		
302	Goose Lake Channel Lift Station Pumps - 40 cfs	EA	2	$	180,000.00	$	360,000.00		
303	Goose Lake Channel Lift Station Motors - 150 hp	EA	2	$	50,000.00	$	100,000.00		
304	Goose Lake Channel Lift Station 30" FBE Steel Discharge Piping	LF	300	$	700.00	$	210,000.00		
305	Goose Lake Channel Lift Station 6" Air Release Valve	EA	2	$	7,500.00	$	15,000.00		
306	Goose Lake Channel Lift Station 30" Dresser Coupling	EA	2	$	7,500.00	$	15,000.00		
307	Goose Lake Channel Lift Station 30" Check Valve with Oil Dashpot	EA	2	$	100,000.00	$	200,000.00		
308	Goose Lake Channel Lift Station 30" Butterfly Valve	EA	2	$	35,000.00	$	70,000.00		
309	Goose Lake Channel Lift Station Flow Meter	EA	2	$	35,000.00	$	70,000.00		
310	Goose Lake Channel Lift Station Pipe Supports	EA	8	$	2,500.00	$	20,000.00		
311	Goose Lake Channel Lift Station Pipe Excavation and Backfill	LF	200	$	300.00	$	60,000.00		
312	Goose Lake Channel Lift Station Painting System	EA	2	$	5,000.00	$	10,000.00		
313	Goose Lake Channel Lift Station 42" FBE Steel Discharge Piping	LF	300	$	900.00	$	270,000.00		
314	Goose Lake Channel Lift Station 8" Air Release Valve	EA	2	$	12,500.00	$	25,000.00		
315	Goose Lake Channel Lift Station 42" Dresser Coupling	EA	2	$	12,500.00	$	25,000.00		
316	Goose Lake Channel Lift Station 42" Check Valve with Oil Dashpot	EA	2	$	150,000.00	$	300,000.00		
317	Goose Lake Channel Lift Station 42" Butterfly Valve	EA	2	$	55,000.00	$	110,000.00		
318	Goose Lake Channel Lift Station Flow Meter	EA	2	$	50,000.00	$	100,000.00		
319	Goose Lake Channel Lift Station Pipe Supports	EA	8	$	3,500.00	$	28,000.00		
320	Goose Lake Channel Lift Station Pipe Excavation and Backfill	LF	200	$	500.00	$	100,000.00		
321	Goose Lake Channel Lift Station Painting System	EA	2	$	5,000.00	$	10,000.00		
322	Goose Lake Channel Turnout Slide Gate	EA	1	$	37,500.00	$	37,500.00		
323	Goose Lake Channel Turnout Main Switchboard	EA	1	$	40,000.00	$	40,000.00		
324	Goose Lake Channel Turnout Motor Control Center	EA	1	$	150,000.00	$	150,000.00		
325	Goose Lake Channel Turnout PLC & Programming	EA	1	$	25,000.00	$	25,000.00		
326	Goose Lake Channel Turnout Transformer & Electrical Service	EA	1	$	30,000.00	$	30,000.00		
327	Goose Lake Channel Turnout Site Lighting	EA	2	$	10,000.00	$	20,000.00		
328	Goose Lake Channel Turnout Conduits, Wire, & Grounding	EA	1	$	85,000.00	$	85,000.00		
329	Goose Lake Channel Turnout Electrical Concrete Foundation	EA	1	$	10,000.00	$	10,000.00		
330	Goose Lake Channel Electrical Shade Structure	EA	1	$	40,000.00	$	40,000.00		
331	Goose Lake Channel 96" Pipe Outlet	LF	200	$	820.00	$	164,000.00		
332	Goose Lake Channel Turnout Outlet Structure Excavation	CY	750	$	30.00	$	22,500.00		
333	Goose Lake Channel Turnout Outlet Structure Concrete Structure - Floor	CY	40	$	1,000.00	$	40,000.00		
334	Goose Lake Channel Turnout Outlet Structure Concrete Structure - Walls	CY	60	$	1,500.00	$	90,000.00		
335	Goose Lake Channel Turnout Outlet Structure Backfill & Compaction	CY	600	$	30.00	$	18,000.00		
336	Goose Lake Channel Turnout Outlet Structure Steel Grating	EA	1	$	10,000.00	$	10,000.00		
337	Goose Lake Channel Turnout Outlet Structure Steel Handrailing	EA	1	$	10,000.00	$	10,000.00		
338	Goose Lake Channel Turnout Pipe Cutoff Wall	EA	1	$	15,500.00	$	15,500.00		
339	Goose Lake Channel Outlet Rip-Rap	CY	1000	$	50.00	$	50,000.00		
340	Goose Lake Channel Check Structure - Earthwork	CY	200	$	30.00	$	6,000.00		
341	Goose Lake Channel Check Structure - Reinforced Concrete - Floor	CY	75	$	1,000.00	$	75,000.00		
342	Goose Lake Channel Check Structure - Reinforced Concrete - Walls	CY	21	$	1,500.00	$	31,500.00		
343	Goose Lake Channel Check Structure - Steel Embeds	EA	1	$	15,000.00	$	15,000.00		
344	Goose Lake Channel Check Structure - Steel Frame	EA	1	$	15,000.00	$	15,000.00		
345	Goose Lake Channel Check Structure - Steel Grating	EA	1	$	10,000.00	$	10,000.00		
346	Goose Lake Channel Check Structure - Steel Handrailing	EA	1	$	10,000.00	$	10,000.00		
347	Goose Lake Channel Concrete Lining	SF	2000	$	6.00	$	12,000.00		
348	Goose Lake Channel Check Structure - Rip-Rap	CY	1500	$	130.00	$	195,000.00		
349	Goose Lake Channel Check Structure - Weir Boards	EA	120	$	50.00	$	6,000.00	$	4,674,000.00
	Phase I 640 Acres Well Drilling, Construction, & Development	EA	6	$	1,160,341.00			$	6,962,046.00
350	Mobilization	EA	1	$	10,000.00	$	10,000.00		
351	Demobilization	EA	1	$	10,000.00	$	10,000.00		
352	Final Cleanup	EA	1	$	5,000.00	$	5,000.00		
353	Transport and dispose of drill cuttings offsite	EA	1	$	10,000.00	$	10,000.00		
354	Three 20,000-gallon temporary water storage tanks and discharge piping	EA	1	$	10,000.00	$	10,000.00		
355	Drill 54-inch minimum diameter surface casing/sanitary seal borehole	LF	50	$	620.00	$	31,000.00		
356	Drill 17.5-inch minimum diameter pilot borehole from 50 ft to 970 ft bgs	LF	920	$	110.00	$	101,200.00		
357	Drill 17.5-inch minimum diameter pilot borehole from 970 ft to 1,400 ft bgs	LF	430	$	110.00	$	47,300.00		
358	Conduct downhole geophysical surveys and alignment/deviation survey	EA	1	$	15,000.00	$	15,000.00		
359	Conduct isolated aquifer zone test	EA	3	$	25,000.00	$	75,000.00		
360	Conduct deep isolated aquifer zone test below 800 ft bgs	EA	3	$	35,000.00	$	105,000.00		
361	Enlarge pilot borehole to 36-inch diameter from 50 ft to 330 ft bgs	LF	280	$	110.00	$	30,800.00		
362	Enlarge pilot borehole to 32-inch diameter from 330 ft to 970 ft bgs	LF	660	$	110.00	$	72,600.00		
363	Conduct alignment/deviation tests in enlarged borehole	EA	1	$	5,500.00	$	5,500.00		
364	Conduct a caliper survey of enlarged borehole	EA	1	$	5,500.00	$	5,500.00		
365	Furnish and install 20-inch I.D. by 5/16-inch wall HSLA steel blank well casing	LF	424	$	220.00	$	93,280.00		
366	Furnish and install HSLA steel blank well casing with reinforced "Bull Nose"	EA	1	$	5,000.00	$	5,000.00		
367	Furnish and install 20-inch by 5/16-inch wall Ful Flo louvered, HSLA steel well screen	LF	510	$	320.00	$	163,200.00		
368	Furnish and install 3-inch I.D. schedule 40 mild steel sounding/camera access tube	LF	329	$	46.00	$	15,134.00		
369	Furnish and install 3-inch I.D. schedule 40 mild steel gravel feed tube	LF	319	$	38.00	$	12,122.00		
370	Furnish and install gravel pack in borehole annulus	LF	665	$	225.00	$	149,625.00		
371	Furnish and install 10.3-sack sand-cement grout upper annular seal	LF	305	$	170.00	$	51,850.00		
372	Perform initial well development	HRS	108	$	275.00	$	29,700.00		
373	Provide chlorine solution for chemical development of the well	GAL	255	$	26.00	$	6,630.00		
374	Provide polymer dispersant for chemical development of the well	GAL	40	$	110.00	$	4,400.00		
375	Mobilize, install, and demobilize test pumping equipment in newly completed wells	EA	1	$	25,000.00	$	25,000.00		
376	Conduct final development by pumping and surging	HRS	60	$	500.00	$	30,000.00		
377	Conduct step-drawdown pumping test in newly completed wells	HRS	8	$	500.00	$	4,000.00		
378	Conduct constant-rate pumping test in newly completed wells	HRS	28	$	500.00	$	14,000.00		
379	Conduct a dynamic flow meter survey	EA	1	$	10,000.00	$	10,000.00		
380	Conduct a color video camera survey	EA	1	$	2,500.00	$	2,500.00		
381	Conduct well alignment/deviation test in newly completed wells	EA	1	$	5,000.00	$	5,000.00		
382	Conduct final well disinfection in newly completed wells	EA	1	$	5,000.00	$	5,000.00		

	Phase I 640 Acre Well Equipping and Site Development	EA	6	$	1,295,500.00			$	7,773,000.00
383	Mobilization	EA	1	$	25,000.00	$	25,000.00		
384	Demobilization	EA	1	$	25,000.00	$	25,000.00		
385	Final Cleanup	EA	1	$	10,000.00	$	10,000.00		
386	Water Supply	EA	1	$	15,000.00	$	15,000.00		
387	Environmental Mitigation	EA	1	$	20,000.00	$	20,000.00		
388	Construct well site earthwork	CY	2400	$	10.00	$	24,000.00		
389	Furnish and install well concrete foundation	CY	20	$	1,200.00	$	24,000.00		
390	Furnish and install electrical concrete foundation	CY	15	$	1,200.00	$	18,000.00		
391	Furnish and install discharge pipe concrete pad	CY	5	$	1,200.00	$	6,000.00		
392	Furnish and install transformer pad	EA	1	$	10,000.00	$	10,000.00		
393	Furnish and install 12" FBE Steel Well Discharge Piping	LF	45	$	300.00	$	13,500.00		
394	Furnish and install Deep Well Air Release Valve	EA	1	$	3,500.00	$	3,500.00		
395	Furnish and install 12" Dresser Coupling	EA	1	$	2,000.00	$	2,000.00		
396	Furnish and install 12" Check Valve	EA	1	$	3,500.00	$	3,500.00		
397	Furnish and install 12" Flow Meter	EA	1	$	8,500.00	$	8,500.00		
398	Furnish and install 12" FBE Steel Tee	EA	1	$	2,500.00	$	2,500.00		
399	Furnish and install 12" Butterfly Valve	EA	1	$	3,500.00	$	3,500.00		
400	Furnish and install 2" Air Release Valve	EA	1	$	2,500.00	$	2,500.00		
401	Furnish and install Pressure Gauges	EA	2	$	500.00	$	1,000.00		
402	Furnish and install Pipe Supports	EA	3	$	1,000.00	$	3,000.00		
403	Furnish and install vertical turbine well pump assembly	EA	1	$	180,000.00	$	180,000.00		
404	Furnish and install vertical turbine well motor	EA	1	$	75,000.00	$	75,000.00		
405	Furnish and install well enclosures and appurtenances	EA	1	$	20,000.00	$	20,000.00		
406	Furnish and install electrical Main Switchboard	EA	1	$	50,000.00	$	50,000.00		
407	Furnish and install electrical Motor Control Center	EA	1	$	200,000.00	$	200,000.00		
408	Furnish and install Electrical Service and Transformer	EA	1	$	25,000.00	$	25,000.00		
409	Furnish and install Site Lighting	EA	2	$	10,000.00	$	20,000.00		
410	Furnish and install Multi-Lin	EA	1	$	10,000.00	$	10,000.00		
411	Furnish and install RTU and HMI	EA	1	$	10,000.00	$	10,000.00		
412	Furnish and install Electrical Instrumentation	EA	1	$	25,000.00	$	25,000.00		
413	Furnish and install Electrical Conduit, Wires, and Grounding	EA	1	$	150,000.00	$	150,000.00		
414	Furnish and install pre-fabricated metal canopy	EA	1	$	70,000.00	$	70,000.00		
415	Furnish and install site ground cover	CY	200	$	50.00	$	10,000.00		
416	Furnish and install site fencing	LF	400	$	50.00	$	20,000.00		
417	Furnish and install site painting	EA	1	$	10,000.00	$	10,000.00		
418	Furnish and install VFD's	EA	1	$	200,000.00	$	200,000.00		
419	Phase I 640 Acres Well Recovery Pipeline - 12" PVC	LF	4700	$	65.00	$	305,500.00		
420	Phase I 640 Acres Well Recovery Pipeline - 18" PVC	LF	2600	$	78.00	$	202,800.00		
421	Phase I 640 Acres Well Recovery Pipeline - 24" PVC	LF	4710	$	96.00	$	452,160.00		
422	Phase I 640 Acres Well Recovery Pipeline - 30" PVC	LF	1500	$	133.00	$	199,500.00		
423	Intertie Connection to Reach 4 Pipeline	LS	1	$	75,000.00	$	75,000.00	$	1,234,960.00
424	RRB Intake Canal Interconnection Excavation	CY	300	$	30.00	$	9,000.00		
425	RRB Intake Canal Interconnection Reinforced Concrete Structure - Floor	CY	5	$	1,000.00	$	5,000.00		
426	RRB Intake Canal Interconnection Reinforced Concrete Structure - Walls	CY	10	$	1,500.00	$	15,000.00		
427	RRB Intake Canal Interconnection Backfill & Compaction	CY	280	$	30.00	$	8,400.00		
428	RRB Intake Canal Interconnection Steel Handrailing	EA	1	$	10,000.00	$	10,000.00		
429	RRB Intake Canal Interconnection Butterfly Valve & Appurtenances	EA	1	$	50,000.00	$	50,000.00		
430	RRB Intake Canal Interconnection Concrete Lining	SF	700	$	6.00	$	4,200.00		
431	RRB Intake Canal Interconnection HDPE Liner Repair	EA	2	$	2,500.00	$	5,000.00	$	106,600.00
432	Phase II 640 Acres Clearing & Grubbing	AC	320	$	1,200.00	$	384,000.00		
433	Phase II 640 Acres Levee Over-Excavation and Re-Compaction	CY	235000	$	4.60	$	1,081,000.00		
434	Phase II 640 Acres Levee Keyway	CY	50000	$	4.70	$	235,000.00		
435	Phase II 640 Acres Levee Embankment Fill	CY	350000	$	4.20	$	1,470,000.00		
436	Phase II 640 Acres Structure Headwalls	EA	8	$	30,000.00	$	240,000.00		
437	Phase II 640 Acres Structure Miscellaneous Steel & Weir Boards	EA	8	$	10,000.00	$	80,000.00		
438	Phase II 640 Acres Interbasin Structure Piping	LF	600	$	170.00	$	102,000.00		
439	Phase II 640 Acres Interbasin Structure Rip-Rap	EA	8	$	55,000.00	$	440,000.00		
440	Phase II 640 Acres Interbasin Structure Cutoff Walls	EA	16	$	15,000.00	$	240,000.00		
441	Phase II 640 Acres Site Fencing and Gates	LF	21120	$	7.50	$	158,400.00	$	4,430,400.00
	Phase II 640 Acres Well Drilling, Construction, & Development	EA	6	$	1,160,341.00			$	6,962,046.00
442	Mobilization	EA	1	$	10,000.00	$	10,000.00		
443	Demobilization	EA	1	$	10,000.00	$	10,000.00		
444	Final Cleanup	EA	1	$	5,000.00	$	5,000.00		
445	Transport and dispose of drill cuttings offsite	EA	1	$	10,000.00	$	10,000.00		
446	Three 20,000-gallon temporary water storage tanks and discharge piping	EA	1	$	10,000.00	$	10,000.00		
447	Drill 54-inch minimum diameter surface casing/sanitary seal borehole	LF	50	$	620.00	$	31,000.00		
448	Drill 17.5-inch minimum diameter pilot borehole from 50 ft to 970 ft bgs	LF	920	$	110.00	$	101,200.00		
449	Drill 17.5-inch minimum diameter pilot borehole from 970 ft to 1,400 ft bgs	LF	430	$	110.00	$	47,300.00		
450	Conduct downhole geophysical surveys and alignment/deviation survey	EA	1	$	15,000.00	$	15,000.00		
451	Conduct isolated aquifer zone test	EA	3	$	25,000.00	$	75,000.00		
452	Conduct deep isolated aquifer zone test below 800 ft bgs	EA	3	$	35,000.00	$	105,000.00		
453	Enlarge pilot borehole to 36-inch diameter from 50 ft to 330 ft bgs	LF	280	$	110.00	$	30,800.00		
454	Enlarge pilot borehole to 32-inch diameter from 330 ft to 970 ft bgs	LF	660	$	110.00	$	72,600.00		
455	Conduct alignment/deviation tests in enlarged borehole	EA	1	$	5,500.00	$	5,500.00		
456	Conduct a caliper survey of enlarged borehole	EA	1	$	5,500.00	$	5,500.00		
457	Furnish and install 20-inch I.D. by 5/16-inch wall HSLA steel blank well casing	LF	424	$	220.00	$	93,280.00		
458	Furnish and install HSLA steel blank well casing with reinforced "Bull Nose"	EA	1	$	5,000.00	$	5,000.00		
459	Furnish and install 20-inch by 5/16-inch wall Ful Flo louvered, HSLA steel well screen	LF	510	$	320.00	$	163,200.00		
460	Furnish and install 3-inch I.D. schedule 40 mild steel sounding/camera access tube	LF	329	$	46.00	$	15,134.00		
461	Furnish and install 3-inch I.D. schedule 40 mild steel gravel feed tube	LF	319	$	38.00	$	12,122.00		
462	Furnish and install gravel pack in borehole annulus	LF	665	$	225.00	$	149,625.00		
463	Furnish and install 10.3-sack sand-cement grout upper annular seal	LF	305	$	170.00	$	51,850.00		
464	Perform initial well development	HRS	108	$	275.00	$	29,700.00		
465	Provide chlorine solution for chemical development of the well	GAL	255	$	26.00	$	6,630.00		
466	Provide polymer dispersant for chemical development of the well	GAL	40	$	110.00	$	4,400.00		
467	Mobilize, install, and demobilize test pumping equipment in newly completed wells	EA	1	$	25,000.00	$	25,000.00		
468	Conduct final development by pumping and surging	HRS	60	$	500.00	$	30,000.00		
469	Conduct step-drawdown pumping test in newly completed wells	HRS	8	$	500.00	$	4,000.00		
470	Conduct constant-rate pumping test in newly completed wells	HRS	28	$	500.00	$	14,000.00		
471	Conduct a dynamic flow meter survey	EA	1	$	10,000.00	$	10,000.00		
472	Conduct a color video camera survey	EA	1	$	2,500.00	$	2,500.00		
473	Conduct well alignment/deviation test in newly completed wells	EA	1	$	5,000.00	$	5,000.00		
474	Conduct final well disinfection in newly completed wells	EA	1	$	5,000.00	$	5,000.00		

Date: July 2021
Price Level: December 2020

	Phase II 640 Acres Well Equipping and Site Development	EA	6	$	1,295,500.00			$	7,773,000.00
475	Mobilization	EA	1	$	25,000.00	$	25,000.00		
476	Demobilization	EA	1	$	25,000.00	$	25,000.00		
477	Final Cleanup	EA	1	$	10,000.00	$	10,000.00		
478	Water Supply	EA	1	$	15,000.00	$	15,000.00		
479	Environmental Mitigation	EA	1	$	20,000.00	$	20,000.00		
480	Construct well site earthwork	CY	2400	$	10.00	$	24,000.00		
481	Furnish and install well concrete foundation	CY	20	$	1,200.00	$	24,000.00		
482	Furnish and install electrical concrete foundation	CY	15	$	1,200.00	$	18,000.00		
483	Furnish and install discharge pipe concrete pad	CY	5	$	1,200.00	$	6,000.00		
484	Furnish and install transformer pad	EA	1	$	10,000.00	$	10,000.00		
485	Furnish and install 12" FBE Steel Well Discharge Piping	LF	45	$	300.00	$	13,500.00		
486	Furnish and install Deep Well Air Release Valve	EA	1	$	3,500.00	$	3,500.00		
487	Furnish and install 12" Dresser Coupling	EA	1	$	2,000.00	$	2,000.00		
488	Furnish and install 12" Check Valve	EA	1	$	3,500.00	$	3,500.00		
489	Furnish and install 12" Flow Meter	EA	1	$	8,500.00	$	8,500.00		
490	Furnish and install 12" FBE Steel Tee	EA	1	$	2,500.00	$	2,500.00		
491	Furnish and install 12" Butterfly Valve	EA	1	$	3,500.00	$	3,500.00		
492	Furnish and install 2" Air Release Valve	EA	1	$	2,500.00	$	2,500.00		
493	Furnish and install Pressure Gauges	EA	2	$	500.00	$	1,000.00		
494	Furnish and install Pipe Supports	EA	3	$	1,000.00	$	3,000.00		
495	Furnish and install vertical turbine well pump assembly	EA	1	$	180,000.00	$	180,000.00		
496	Furnish and install vertical turbine well motor	EA	1	$	75,000.00	$	75,000.00		
497	Furnish and install well enclosures and appurtenances	EA	1	$	20,000.00	$	20,000.00		
498	Furnish and install electrical Main Switchboard	EA	1	$	50,000.00	$	50,000.00		
499	Furnish and install electrical Motor Control Center	EA	1	$	200,000.00	$	200,000.00		
500	Furnish and install Electrical Service and Transformer	EA	1	$	25,000.00	$	25,000.00		
501	Furnish and install Site Lighting	EA	2	$	10,000.00	$	20,000.00		
502	Furnish and install Multi-Lin	EA	1	$	10,000.00	$	10,000.00		
503	Furnish and install RTU and HMI	EA	1	$	10,000.00	$	10,000.00		
504	Furnish and install Electrical Instrumentation	EA	1	$	25,000.00	$	25,000.00		
505	Furnish and install Electrical Conduit, Wires, and Grounding	EA	1	$	150,000.00	$	150,000.00		
506	Furnish and install pre-fabricated metal canopy	EA	1	$	70,000.00	$	70,000.00		
507	Furnish and install site ground cover	CY	200	$	50.00	$	10,000.00		
508	Furnish and install site fencing	LF	400	$	50.00	$	20,000.00		
509	Furnish and install site painting	EA	1	$	10,000.00	$	10,000.00		
510	Furnish and install VFD's	EA	1	$	200,000.00	$	200,000.00		
511	Phase II 640 Acres Well Recovery Pipeline - 12" PVC	LF	6340	$	65.00	$	412,100.00		
512	Phase II 640 Acres Well Recovery Pipeline - 18" PVC	LF	340	$	78.00	$	26,520.00		
513	Phase II 640 Acres Canal Turn-In Facilities	EA	4	$	100,000.00	$	400,000.00	$	838,620.00
514	Aqueduct Lift Station Structure Excavation	CY	1750	$	30.00	$	52,500.00		
515	Aqueduct Lift Station Reinforced Concrete Structure - Floor	CY	45	$	1,000.00	$	45,000.00		
516	Aqueduct Lift Station Reinforced Concrete Structure - Walls	CY	90	$	1,500.00	$	135,000.00		
517	Aqueduct Lift Station Reinforced Concrete Structure - Deck	CY	25	$	2,000.00	$	50,000.00		
518	Aqueduct Lift Station Backfill & Compaction	CY	1200	$	30.00	$	36,000.00		
519	Aqueduct Lift Station Trashracks	EA	3	$	20,000.00	$	60,000.00		
520	Aqueduct Lift Station Steel Embeds & Ladder Rungs	EA	1	$	10,000.00	$	10,000.00		
521	Aqueduct Lift Station Steel Grating	EA	1	$	20,000.00	$	20,000.00		
522	Aqueduct Lift Station Steel Handrailing	EA	1	$	20,000.00	$	20,000.00		
523	Aqueduct Lift Station Pumps - 36 cfs	EA	3	$	180,000.00	$	540,000.00		
524	Aqueduct Lift Station Motors - 150 hp	EA	3	$	50,000.00	$	150,000.00		
525	Aqueduct Lift Station 30" FBE Lined and Coated Steel Pipe	LF	90	$	700.00	$	63,000.00		
526	Aqueduct Lift Station 36"x30" FBE Lined and Coated Steel Increaser	EA	3	$	7,500.00	$	22,500.00		
527	Aqueduct Lift Station 30" Dresser Coupling	EA	3	$	7,500.00	$	22,500.00		
528	Aqueduct Lift Station 30" Check Valve	EA	3	$	100,000.00	$	300,000.00		
529	Aqueduct Lift Station 30" Butterfly Valve	EA	3	$	35,000.00	$	105,000.00		
530	Aqueduct Lift Station Pipe Support	EA	9	$	2,500.00	$	22,500.00		
531	Aqueduct Lift Station 6" Air Release Valve	EA	6	$	7,500.00	$	45,000.00		
532	Aqueduct Turnout Afterbay Slide Gate	EA	1	$	75,000.00	$	75,000.00		
533	Aqueduct Lift Station Main Switchboard	EA	1	$	40,000.00	$	40,000.00		
534	Aqueduct Lift Station Motor Control Center	EA	1	$	150,000.00	$	150,000.00		
535	Aqueduct Lift Station PLC & Programming	EA	1	$	25,000.00	$	25,000.00		
536	Aqueduct Lift Station Transformer & Electrical Service	EA	1	$	30,000.00	$	30,000.00		
537	Aqueduct Lift Station Site Lighting	EA	1	$	10,000.00	$	10,000.00		
538	Aqueduct Lift Station Conduits, Wire, & Grounding	EA	1	$	85,000.00	$	85,000.00		
539	Aqueduct Lift Station Electrical Concrete Foundation	EA	1	$	10,000.00	$	10,000.00		
540	Aqueduct Lift Station Electrical Shade Structure	EA	1	$	40,000.00	$	40,000.00		
541	Aqueduct Lift Station 48" Pipe	LF	220	$	265.00	$	58,300.00		
542	Aqueduct Lift Station 48" Butterfly Valve	EA	1	$	65,000.00	$	65,000.00	$	2,287,300.00
543	SCADA System Hardware	EA	1	$	271,000.00	$	271,000.00		
544	SCADA System Software	EA	1	$	30,000.00	$	30,000.00		
545	SCADA System Programming and Screens	EA	1	$	150,000.00	$	150,000.00	$	451,000.00
	Subtotal:					**$**	**119,791,927.40**		
	Mobilization:	1.5%				$	1,820,000.00		
	Subtotal with Mobilization:					**$**	**121,611,927.40**		
	Contract Cost Allowances (Sum of):	2.5%				$	3,014,203.00		
	Design Contingencies, 2% (+/-)								
	APS (+/-). Type of Procurement: Request for Proposal, Competitive Bid								
	Contract Cost:					**$**	**124,626,130.40**		
	Construction Contingencies:	20.0%				$	24,925,226.08		
	Field Cost:					**$**	**149,551,356.48**		
	Project Management					$	6,500,000.00		
	Engineering & Design					$	6,900,000.00		
	Environmental					$	600,000.00		
	Permitting					$	600,000.00		
	Labor Compliance					$	500,000.00		
	PG&E Electrical Service					$	1,500,000.00		
	Bid Advertisement & Legal					$	250,000.00		
	Project Surveying					$	1,600,000.00		
	Construction Management & Inspection					$	7,800,000.00		
	HCP Fees					$	3,200,000.00		
	Land Acquisition and Rights of Way					$	40,960,000.00		
	Subtotal Non-Contract Costs excluding Land Acquisition and Rights of Way:					**$**	**29,450,000.00**		
	Subtotal Non-Contract Cost:					**$**	**70,410,000.00**		
	Construction Cost (Unit Price Level Dec 2018) excluding Land Acquisition and Rights of Way:					**$**	**179,001,356.48**		
	Construction Cost (Unit Price Level Dec 2018)					**$**	**219,961,356.48**		
	Escalation to end of Project Bidding Phases, from Unit Price Level (Dec 2018) to Bids (Dec 2023)					$	18,238,644.00		
	for Construction Cost exluding Land Acquisition and Rights of Way at	2.0%	per year for	5 years					
	Construction Cost (with Escalation to end of Bid Phases, Price Level Dec 2023)					**$**	**238,200,000.48**		

QUANTITIES		PRICES	
BY	**CHECKED**	**BY**	**CHECKED**
DATE PREPARED	**PEER REVIEW / DATE**	**DATE PREPARED**	**PEER REVIEW / DATE**

Date: July 2021
Price Level: December 2020

Groundwater Banking Joint Powers Authority

Preliminary Engineer's Estimate (Class 3)

Conveyance Alignment - Closed Conduit Pipeline Alternative

Item No.	Item Description	Unit	Quantity	Unit Cost	Extended Cost	Section Subtotal
1	Aqueduct Cofferdam Assembly and Installation	EA	1	$ 185,000.00	$ 185,000.00	
2	Dewatering	EA	1	$ 35,000.00	$ 35,000.00	
3	Aqueduct Cofferdam Disassembly and Removal	EA	1	$ 65,000.00	$ 65,000.00	
4	Aqueduct Turnout Excavation	CY	2450	$ 30.00	$ 73,500.00	
5	Aqueduct Reinforced Concrete Structure - Floor	CY	45	$ 1,000.00	$ 45,000.00	
6	Aqueduct Reinforced Concrete Structure - Walls	CY	100	$ 1,500.00	$ 150,000.00	
7	Aqueduct Reinforced Concrete Structure - Deck/Beam	CY	5	$ 2,000.00	$ 10,000.00	
8	Aqueduct Backfill and Compaction	CY	1850	$ 30.00	$ 55,500.00	
9	Aqueduct Turnout Steel Embeds	EA	1	$ 10,000.00	$ 10,000.00	
10	Aqueduct Turnout Steel Grating	EA	1	$ 20,000.00	$ 20,000.00	
11	Aqueduct Turnout Steel Handrailing	EA	1	$ 20,000.00	$ 20,000.00	
12	Aqueduct Trashrack	EA	1	$ 50,000.00	$ 50,000.00	
13	Aqueduct Turnout Piping - 10' Diameter RCP	LF	2100	$ 1,365.00	$ 2,866,500.00	
14	Aqueduct Turnout Fittings	EA	6	$ 50,000.00	$ 300,000.00	
15	Outlet Canal Siphon Earthwork and Canal Restoration	CY	15000	$ 30.00	$ 450,000.00	
16	Aqueduct Metering	EA	1	$ 225,000.00	$ 225,000.00	
17	Aqueduct Meter Vault	EA	1	$ 250,000.00	$ 250,000.00	
18	Aqueduct Slide Gate & Actuator	EA	1	$ 95,000.00	$ 95,000.00	
19	Aqueduct Turnout Electrical Panels	EA	1	$ 170,000.00	$ 170,000.00	
20	Aqueduct Turnout Electrical Concrete Pad	EA	1	$ 15,000.00	$ 15,000.00	
21	Aqueduct Turnout Electrical Service	EA	1	$ 20,000.00	$ 20,000.00	
22	Aqueduct Turnout Light Standard	EA	1	$ 10,000.00	$ 10,000.00	
23	Aqueduct Turnout PLC Panel & Programming	EA	1	$ 20,000.00	$ 20,000.00	
24	Aqueduct Turnout Conduits, Wire, and Grounding	EA	1	$ 63,000.00	$ 63,000.00	
25	Electrical Equipment Bollards	EA	1	$ 2,000.00	$ 2,000.00	
26	Aqueduct Liner Repair Subgrade Earthwork	EA	1	$ 11,000.00	$ 11,000.00	
27	Aqueduct Liner Repair	SF	1500	$ 6.00	$ 9,000.00	
28	Levee Road Pavement Restoration	SF	1600	$ 7.00	$ 11,200.00	$ 5,236,700.00
29	R/W Clearing & Grubbing	AC	100	$ 1,200.00	$ 120,000.00	
30	Conveyance Pipeline 10-ft Diameter Gravity	LF	30,000	$ 1,365.00	$ 40,950,000.00	
31	Pipeline Fittings	EA	10	$ 50,000.00	$ 500,000.00	
32	Outlet Canal Crossing Excavation	CY	2500	$ 20.00	$ 50,000.00	
33	Outlet Canal Backfill and Compaction	CY	2500	$ 20.00	$ 50,000.00	
34	Outlet Canal Dewatering	EA	1	$ 20,000.00	$ 20,000.00	
35	Outlet Canal Cutoff Walls	EA	2	$ 25,000.00	$ 50,000.00	
36	Adohr Rd Road Sawcut and Removal	LF	60	$ 100.00	$ 6,000.00	
37	Adohr Rd Road Pavement Repair	SF	6000	$ 8.00	$ 48,000.00	
38	East Side Canal Crossing Excavation	CY	2500	$ 20.00	$ 50,000.00	
39	East Side Canal Crossing Backfill and Compaction	CY	2500	$ 20.00	$ 50,000.00	
40	East Side Canal Dewatering	EA	1	$ 20,000.00	$ 20,000.00	
41	East Side Canal Cutoff Walls	EA	2	$ 25,000.00	$ 50,000.00	
42	Pipeline Fittings	EA	4	$ 50,000.00	$ 200,000.00	
43	Stockdale Hwy Crossing - 13' Diameter Casing with 10' Diameter RCP	LF	150	$ 6,500.00	$ 975,000.00	
44	I-5 Fwy Crossing - 13' Diameter Casing with 10' Diameter RCP	LF	280	$ 6,500.00	$ 1,820,000.00	$ 44,959,000.00
45	Lift Station Excavation	CY	11000	$ 10.00	$ 110,000.00	
46	Lift Station Reinforced Concrete Structure - Floor	CY	320	$ 1,000.00	$ 320,000.00	
47	Lift Station Reinforced Concrete Structure - Walls	CY	800	$ 1,500.00	$ 1,200,000.00	
48	Lift Station Reinforced Concrete Structure - Deck	CY	150	$ 2,000.00	$ 300,000.00	
49	Pump Fillets and Center Splitter	EA	6	$ 10,000.00	$ 60,000.00	
50	Lift Station Pumps - 40 cfs	EA	2	$ 200,000.00	$ 400,000.00	
51	Lift Station Pumps - 90 cfs	EA	4	$ 350,000.00	$ 1,400,000.00	
52	Lift Station Motors - 350 hp	EA	2	$ 140,000.00	$ 280,000.00	
53	Lift Station Motors - 800 hp	EA	4	$ 300,000.00	$ 1,200,000.00	
54	30" FBE Steel Discharge Piping	LF	300	$ 700.00	$ 210,000.00	
55	6" Air Release Valve	EA	2	$ 7,500.00	$ 15,000.00	
56	30" Dresser Coupling	EA	2	$ 7,500.00	$ 15,000.00	
57	30" Check Valve with Oil Dashpot	EA	2	$ 100,000.00	$ 200,000.00	
58	30" Butterfly Valve	EA	2	$ 35,000.00	$ 70,000.00	
59	Flow Meter	EA	2	$ 35,000.00	$ 70,000.00	
60	Pipe Supports	EA	8	$ 2,500.00	$ 20,000.00	
61	Pipe Excavation and Backfill	LF	200	$ 300.00	$ 60,000.00	
62	Painting System	EA	2	$ 5,000.00	$ 10,000.00	
63	42" FBE Steel Discharge Piping	LF	600	$ 900.00	$ 540,000.00	
64	8" Air Release Valve	EA	4	$ 12,500.00	$ 50,000.00	
65	42" Dresser Coupling	EA	4	$ 12,500.00	$ 50,000.00	
66	42" Check Valve with Oil Dashpot	EA	4	$ 150,000.00	$ 600,000.00	
67	42" Butterfly Valve	EA	4	$ 55,000.00	$ 220,000.00	
68	Flow Meter	EA	4	$ 50,000.00	$ 200,000.00	
69	Pipe Supports	EA	16	$ 3,500.00	$ 56,000.00	
70	Pipe Excavation and Backfill	LF	400	$ 500.00	$ 200,000.00	
71	Painting System	EA	4	$ 5,000.00	$ 20,000.00	
72	Lift Station 350 hp VFD's	EA	2	$ 150,000.00	$ 300,000.00	
73	Lift Station 800 hp VFD's	EA	4	$ 400,000.00	$ 1,600,000.00	
74	Lift Station Main Switchboard	EA	1	$ 100,000.00	$ 100,000.00	
75	Lift Station Motor Control Center	EA	1	$ 900,000.00	$ 900,000.00	
76	Lift Station PLC & Programming	EA	1	$ 175,000.00	$ 175,000.00	
77	Lift Station Transformer & Electrical Service	EA	1	$ 150,000.00	$ 150,000.00	
78	Lift Station Site Lighting	EA	4	$ 10,000.00	$ 40,000.00	
79	Lift Station Conduits, Wire, & Grounding	EA	1	$ 1,000,000.00	$ 1,000,000.00	
80	Lift Station Electrical Control Building Concrete Foundation	CY	60	$ 1,200.00	$ 72,000.00	
81	Lift Station Electrical Building & Appurtenances	EA	1	$ 400,000.00	$ 400,000.00	
82	Lift Station Backfill & Compaction	CY	6000	$ 10.00	$ 60,000.00	
83	Lift Station Slide Gates	EA	1	$ 55,000.00	$ 55,000.00	
84	Lift Station Trashracks	EA	6	$ 20,000.00	$ 120,000.00	
85	Lift Station Steel Embeds & Ladder Rungs	EA	1	$ 20,000.00	$ 20,000.00	
86	Lift Station Steel Grating	EA	1	$ 50,000.00	$ 50,000.00	
87	Lift Station Steel Handrailing	EA	1	$ 25,000.00	$ 25,000.00	
88	Lift Station Pump Column Pipe Cathodic Protection	EA	1	$ 12,500.00	$ 12,500.00	
89	Lift Station Underground Piping Cathodic Protection	EA	1	$ 12,500.00	$ 12,500.00	
90	Lift Station Bypass Pipeline	LF	200	$ 350.00	$ 70,000.00	
91	Lift Station Bypass Valving	LS	1	$ 300,000.00	$ 300,000.00	
92	Lift Station Ground Cover	CY	900	$ 50.00	$ 45,000.00	$ 13,383,000.00

93	R/W Clearing & Grubbing	AC	70	$	1,200.00	$	84,000.00		
94	Conveyance Pipeline 10-ft Diameter	LF	9,000	$	1,365.00	$	12,285,000.00		
95	Conveyance Pipeline 5-ft Diameter	LF	12700	$	335.00	$	4,254,500.00		
96	Pipeline Fittings	EA	6	$	50,000.00	$	300,000.00		
97	Turnout to Phase II 640 Acres	LF	600	$	240.00	$	144,000.00		
98	Turnout to West Basins	LF	600	$	240.00	$	144,000.00		
99	Turnout to Phase I 640 Acres	LF	100	$	240.00	$	24,000.00		
100	Turnout Fittings	EA	8	$	20,000.00	$	160,000.00		
101	36" Butterfly Valve	EA	9	$	45,000.00	$	405,000.00		
102	Phase II 640 Acres Outlet Structure Excavation	CY	16000	$	30.00	$	480,000.00		
103	Phase II 640 Acres Outlet Structure Cutoff Wall	EA	4	$	20,000.00	$	80,000.00		
104	Phase II 640 Acres Outlet Structure Rip-Rap	CY	3400	$	130.00	$	442,000.00		
105	West Basins Outlet Structure Excavation	CY	16000	$	30.00	$	480,000.00		
106	West Basins Outlet Structure Cutoff Wall	EA	4	$	20,000.00	$	80,000.00		
107	West Basins Outlet Structure Rip-Rap	CY	4000	$	130.00	$	520,000.00		
108	Phase I 640 Acres Outlet Structure Excavation	CY	4000	$	30.00	$	120,000.00		
109	Phase I 640 Acres Outlet Structure Cutoff Wall	EA	1	$	20,000.00	$	20,000.00		
110	Phase I 640 Acres Outlet Structure Rip-Rap	CY	85	$	130.00	$	11,050.00	$	20,033,550.00
111	Phase I 640 Acres Clearing & Grubbing	AC	320	$	1,200.00	$	384,000.00		
112	Phase I 640 Acres Levee Over-Excavation and Re-Compaction	CY	235000	$	4.60	$	1,081,000.00		
113	Phase I 640 Acres Levee Keyway	CY	50000	$	4.70	$	235,000.00		
114	Phase I 640 Acres Levee Embankment Fill	CY	315000	$	4.20	$	1,323,000.00		
115	Phase I 640 Acres Structure Headwalls	EA	10	$	30,000.00	$	300,000.00		
116	Phase I 640 Acres Structure Miscellaneous Steel & Weir Boards	EA	10	$	10,000.00	$	100,000.00		
117	Phase I 640 Acres Interbasin Structure Piping	LF	750	$	170.00	$	127,500.00		
118	Phase I 640 Acres Interbasin Structure Rip-Rap	EA	10	$	55,000.00	$	550,000.00		
119	Phase I 640 Acres Interbasin Structure Cutoff Walls	EA	20	$	15,000.00	$	300,000.00		
120	Phase I 640 Acres Site Fencing and Gates	LF	21120	$	7.50	$	158,400.00	$	4,558,900.00
121	Goose Lake Channel Turnout Structure Excavation	CY	1100	$	30.00	$	33,000.00		
122	Goose Lake Channel Turnout Reinforced Concrete Structure - Floor	CY	90	$	1,000.00	$	90,000.00		
123	Goose Lake Channel Turnout Reinforced Concrete Structure - Walls	CY	90	$	1,500.00	$	135,000.00		
124	Goose Lake Channel Turnout Reinforced Concrete Structure - Deck	CY	50	$	2,000.00	$	100,000.00		
125	Goose Lake Channel Turnout Backfill & Compaction	CY	500	$	30.00	$	15,000.00		
126	Goose Lake Channel Turnout Trashracks	EA	4	$	20,000.00	$	80,000.00		
127	Goose Lake Channel Turnout Steel Embeds & Ladder Rungs	EA	1	$	10,000.00	$	10,000.00		
128	Goose Lake Channel Turnout Steel Grating	EA	1	$	20,000.00	$	20,000.00		
129	Goose Lake Channel Turnout Steel Handrailing	EA	1	$	20,000.00	$	20,000.00		
130	Goose Lake Channel Lift Station Pumps - 80 cfs	EA	2	$	300,000.00	$	600,000.00		
131	Goose Lake Channel Lift Station Motors - 300 hp	EA	2	$	120,000.00	$	240,000.00		
132	Goose Lake Channel Lift Station Pumps - 40 cfs	EA	2	$	180,000.00	$	360,000.00		
133	Goose Lake Channel Lift Station Motors - 150 hp	EA	2	$	50,000.00	$	100,000.00		
134	Goose Lake Channel Lift Station 30" FBE Steel Discharge Piping	LF	300	$	700.00	$	210,000.00		
135	Goose Lake Channel Lift Station 6" Air Release Valve	EA	2	$	7,500.00	$	15,000.00		
136	Goose Lake Channel Lift Station 30" Dresser Coupling	EA	2	$	7,500.00	$	15,000.00		
137	Goose Lake Channel Lift Station 30" Check Valve with Oil Dashpot	EA	2	$	100,000.00	$	200,000.00		
138	Goose Lake Channel Lift Station 30" Butterfly Valve	EA	2	$	35,000.00	$	70,000.00		
139	Goose Lake Channel Lift Station Flow Meter	EA	2	$	35,000.00	$	70,000.00		
140	Goose Lake Channel Lift Station Pipe Supports	EA	8	$	2,500.00	$	20,000.00		
141	Goose Lake Channel Lift Station Pipe Excavation and Backfill	LF	200	$	300.00	$	60,000.00		
142	Goose Lake Channel Lift Station Painting System	EA	2	$	5,000.00	$	10,000.00		
143	Goose Lake Channel Lift Station 42" FBE Steel Discharge Piping	LF	300	$	900.00	$	270,000.00		
144	Goose Lake Channel Lift Station 8" Air Release Valve	EA	2	$	12,500.00	$	25,000.00		
145	Goose Lake Channel Lift Station 42" Dresser Coupling	EA	2	$	12,500.00	$	25,000.00		
146	Goose Lake Channel Lift Station 42" Check Valve with Oil Dashpot	EA	2	$	150,000.00	$	300,000.00		
147	Goose Lake Channel Lift Station 42" Butterfly Valve	EA	2	$	55,000.00	$	110,000.00		
148	Goose Lake Channel Lift Station Flow Meter	EA	2	$	50,000.00	$	100,000.00		
149	Goose Lake Channel Lift Station Pipe Supports	EA	8	$	3,500.00	$	28,000.00		
150	Goose Lake Channel Lift Station Pipe Excavation and Backfill	LF	200	$	500.00	$	100,000.00		
151	Goose Lake Channel Lift Station Painting System	EA	2	$	5,000.00	$	10,000.00		
152	Goose Lake Channel Turnout Slide Gate	EA	1	$	37,500.00	$	37,500.00		
153	Goose Lake Channel Turnout Main Switchboard	EA	1	$	40,000.00	$	40,000.00		
154	Goose Lake Channel Turnout Motor Control Center	EA	1	$	150,000.00	$	150,000.00		
155	Goose Lake Channel Turnout PLC & Programming	EA	1	$	25,000.00	$	25,000.00		
156	Goose Lake Channel Turnout Transformer & Electrical Service	EA	1	$	30,000.00	$	30,000.00		
157	Goose Lake Channel Turnout Site Lighting	EA	2	$	10,000.00	$	20,000.00		
158	Goose Lake Channel Turnout Conduits, Wire, & Grounding	EA	1	$	85,000.00	$	85,000.00		
159	Goose Lake Channel Turnout Electrical Concrete Foundation	EA	1	$	10,000.00	$	10,000.00		
160	Goose Lake Channel Electrical Shade Structure	EA	1	$	40,000.00	$	40,000.00		
161	Goose Lake Channel 96" Pipe Outlet	LF	200	$	820.00	$	164,000.00		
162	Goose Lake Channel Turnout Outlet Structure Excavation	CY	750	$	30.00	$	22,500.00		
163	Goose Lake Channel Turnout Outlet Structure Concrete Structure - Floor	CY	40	$	1,000.00	$	40,000.00		
164	Goose Lake Channel Turnout Outlet Structure Concrete Structure - Walls	CY	60	$	1,500.00	$	90,000.00		
165	Goose Lake Channel Turnout Outlet Structure Backfill & Compaction	CY	600	$	30.00	$	18,000.00		
166	Goose Lake Channel Turnout Outlet Structure Steel Grating	EA	1	$	10,000.00	$	10,000.00		
167	Goose Lake Channel Turnout Outlet Structure Steel Handrailing	EA	1	$	10,000.00	$	10,000.00		
168	Goose Lake Channel Turnout Pipe Cutoff Wall	EA	1	$	15,500.00	$	15,500.00		
169	Goose Lake Channel Outlet Rip-Rap	CY	1000	$	50.00	$	50,000.00		
170	Goose Lake Channel Check Structure - Earthwork	CY	200	$	30.00	$	6,000.00		
171	Goose Lake Channel Check Structure - Reinforced Concrete - Floor	CY	75	$	1,000.00	$	75,000.00		
172	Goose Lake Channel Check Structure - Reinforced Concrete - Walls	CY	21	$	1,500.00	$	31,500.00		
173	Goose Lake Channel Check Structure - Steel Embeds	EA	1	$	15,000.00	$	15,000.00		
174	Goose Lake Channel Check Structure - Steel Frame	EA	1	$	15,000.00	$	15,000.00		
175	Goose Lake Channel Check Structure - Steel Grating	EA	1	$	10,000.00	$	10,000.00		
176	Goose Lake Channel Check Structure - Steel Handrailing	EA	1	$	10,000.00	$	10,000.00		
177	Goose Lake Channel Concrete Lining	SF	2000	$	6.00	$	12,000.00		
178	Goose Lake Channel Check Structure - Rip-Rap	CY	1500	$	130.00	$	195,000.00		
179	Goose Lake Channel Check Structure - Weir Boards	EA	120	$	50.00	$	6,000.00	$	4,674,000.00

	Phase I 640 Acres Well Drilling, Construction, & Development	EA	6	$	1,160,341.00			$	6,962,046.00
180	Mobilization	EA	1	$	10,000.00	$	10,000.00		
181	Demobilization	EA	1	$	10,000.00	$	10,000.00		
182	Final Cleanup	EA	1	$	5,000.00	$	5,000.00		
183	Transport and dispose of drill cuttings offsite	EA	1	$	10,000.00	$	10,000.00		
184	Three 20,000-gallon temporary water storage tanks and discharge piping	EA	1	$	10,000.00	$	10,000.00		
185	Drill 54-inch minimum diameter surface casing/sanitary seal borehole	LF	50	$	620.00	$	31,000.00		
186	Drill 17.5-inch minimum diameter pilot borehole from 50 ft to 970 ft bgs	LF	920	$	110.00	$	101,200.00		
187	Drill 17.5-inch minimum diameter pilot borehole from 970 ft to 1,400 ft bgs	LF	430	$	110.00	$	47,300.00		
188	Conduct downhole geophysical surveys and alignment/deviation survey	EA	1	$	15,000.00	$	15,000.00		
189	Conduct isolated aquifer zone test	EA	3	$	25,000.00	$	75,000.00		
190	Conduct deep isolated aquifer zone test below 800 ft bgs	EA	3	$	35,000.00	$	105,000.00		
191	Enlarge pilot borehole to 36-inch diameter from 50 ft to 330 ft bgs	LF	280	$	110.00	$	30,800.00		
192	Enlarge pilot borehole to 32-inch diameter from 330 ft to 970 ft bgs	LF	660	$	110.00	$	72,600.00		
193	Conduct alignment/deviation tests in enlarged borehole	EA	1	$	5,500.00	$	5,500.00		
194	Conduct a caliper survey of enlarged borehole	EA	1	$	5,500.00	$	5,500.00		
195	Furnish and install 20-inch I.D. by 5/16-inch wall HSLA steel blank well casing	LF	424	$	220.00	$	93,280.00		
196	Furnish and install HSLA steel blank well casing with reinforced "Bull Nose"	EA	1	$	5,000.00	$	5,000.00		
197	Furnish and install 20-inch by 5/16-inch wall Ful Flo louvered, HSLA steel well screen	LF	510	$	320.00	$	163,200.00		
198	Furnish and install 3-inch I.D. schedule 40 mild steel sounding/camera access tube	LF	329	$	46.00	$	15,134.00		
199	Furnish and install 3-inch I.D. schedule 40 mild steel gravel feed tube	LF	319	$	38.00	$	12,122.00		
200	Furnish and install gravel pack in borehole annulus	LF	665	$	225.00	$	149,625.00		
201	Furnish and install 10.3-sack sand-cement grout upper annular seal	LF	305	$	170.00	$	51,850.00		
202	Perform initial well development	HRS	108	$	275.00	$	29,700.00		
203	Provide chlorine solution for chemical development of the well	GAL	255	$	26.00	$	6,630.00		
204	Provide polymer dispersant for chemical development of the well	GAL	40	$	110.00	$	4,400.00		
205	Mobilize, install, and demobilize test pumping equipment in newly completed wells	EA	1	$	25,000.00	$	25,000.00		
206	Conduct final development by pumping and surging	HRS	60	$	500.00	$	30,000.00		
207	Conduct step-drawdown pumping test in newly completed wells	HRS	8	$	500.00	$	4,000.00		
208	Conduct constant-rate pumping test in newly completed wells	HRS	28	$	500.00	$	14,000.00		
209	Conduct a dynamic flow meter survey	EA	1	$	10,000.00	$	10,000.00		
210	Conduct a color video camera survey	EA	1	$	2,500.00	$	2,500.00		
211	Conduct well alignment/deviation test in newly completed wells	EA	1	$	5,000.00	$	5,000.00		
212	Conduct final well disinfection in newly completed wells	EA	1	$	5,000.00	$	5,000.00		
	Phase I 640 Acre Well Equipping and Site Development	EA	6	$	1,295,500.00			$	7,773,000.00
213	Mobilization	EA	1	$	25,000.00	$	25,000.00		
214	Demobilization	EA	1	$	25,000.00	$	25,000.00		
215	Final Cleanup	EA	1	$	10,000.00	$	10,000.00		
216	Water Supply	EA	1	$	15,000.00	$	15,000.00		
217	Environmental Mitigation	EA	1	$	20,000.00	$	20,000.00		
218	Construct well site earthwork	CY	2400	$	10.00	$	24,000.00		
219	Furnish and install well concrete foundation	CY	20	$	1,200.00	$	24,000.00		
220	Furnish and install electrical concrete foundation	CY	15	$	1,200.00	$	18,000.00		
221	Furnish and install discharge pipe concrete pad	CY	5	$	1,200.00	$	6,000.00		
222	Furnish and install transformer pad	EA	1	$	10,000.00	$	10,000.00		
223	Furnish and install 12" FBE Steel Well Discharge Piping	LF	45	$	300.00	$	13,500.00		
224	Furnish and install Deep Well Air Release Valve	EA	1	$	3,500.00	$	3,500.00		
225	Furnish and install 12" Dresser Coupling	EA	1	$	2,000.00	$	2,000.00		
226	Furnish and install 12" Check Valve	EA	1	$	3,500.00	$	3,500.00		
227	Furnish and install 12" Flow Meter	EA	1	$	8,500.00	$	8,500.00		
228	Furnish and install 12" FBE Steel Tee	EA	1	$	2,500.00	$	2,500.00		
229	Furnish and install 12" Butterfly Valve	EA	1	$	3,500.00	$	3,500.00		
230	Furnish and install 2" Air Release Valve	EA	1	$	2,500.00	$	2,500.00		
231	Furnish and install Pressure Gauges	EA	2	$	500.00	$	1,000.00		
232	Furnish and install Pipe Supports	EA	3	$	1,000.00	$	3,000.00		
233	Furnish and install vertical turbine well pump assembly	EA	1	$	180,000.00	$	180,000.00		
234	Furnish and install vertical turbine well motor	EA	1	$	75,000.00	$	75,000.00		
235	Furnish and install well enclosures and appurtenances	EA	1	$	20,000.00	$	20,000.00		
236	Furnish and install electrical Main Switchboard	EA	1	$	50,000.00	$	50,000.00		
237	Furnish and install electrical Motor Control Center	EA	1	$	200,000.00	$	200,000.00		
238	Furnish and install Electrical Service and Transformer	EA	1	$	25,000.00	$	25,000.00		
239	Furnish and install Site Lighting	EA	2	$	10,000.00	$	20,000.00		
240	Furnish and install Multi-Lin	EA	1	$	10,000.00	$	10,000.00		
241	Furnish and install RTU and HMI	EA	1	$	10,000.00	$	10,000.00		
242	Furnish and install Electrical Instrumentation	EA	1	$	25,000.00	$	25,000.00		
243	Furnish and install Electrical Conduit, Wires, and Grounding	EA	1	$	150,000.00	$	150,000.00		
244	Furnish and install pre-fabricated metal canopy	EA	1	$	70,000.00	$	70,000.00		
245	Furnish and install site ground cover	CY	200	$	50.00	$	10,000.00		
246	Furnish and install site fencing	LF	400	$	50.00	$	20,000.00		
247	Furnish and install site painting	EA	1	$	10,000.00	$	10,000.00		
248	Furnish and install VFD's	EA	1	$	200,000.00	$	200,000.00		
249	Phase I 640 Acres Well Recovery Pipeline - 12" PVC	LF	4700	$	65.00	$	305,500.00		
250	Phase I 640 Acres Well Recovery Pipeline - 18" PVC	LF	2600	$	78.00	$	202,800.00		
251	Phase I 640 Acres Well Recovery Pipeline - 24" PVC	LF	4710	$	96.00	$	452,160.00		
252	Phase I 640 Acres Well Recovery Pipeline - 30" PVC	LF	1500	$	133.00	$	199,500.00		
253	Intertie Connection to Reach 4 Pipeline	LS	1	$	75,000.00	$	75,000.00	$	1,234,960.00
254	RRB Intake Canal Interconnection Excavation	CY	300	$	30.00	$	9,000.00		
255	RRB Intake Canal Interconnection Reinforced Concrete Structure - Floor	CY	5	$	1,000.00	$	5,000.00		
256	RRB Intake Canal Interconnection Reinforced Concrete Structure - Walls	CY	10	$	1,500.00	$	15,000.00		
257	RRB Intake Canal Interconnection Backfill & Compaction	CY	280	$	30.00	$	8,400.00		
258	RRB Intake Canal Interconnection Steel Handrailing	EA	1	$	10,000.00	$	10,000.00		
259	RRB Intake Canal Interconnection Butterfly Valve & Appurtenances	EA	1	$	50,000.00	$	50,000.00		
260	RRB Intake Canal Interconnection Concrete Lining	SF	700	$	6.00	$	4,200.00		
261	RRB Intake Canal Interconnection HDPE Liner Repair	EA	2	$	2,500.00	$	5,000.00	$	106,600.00
262	Phase II 640 Acres Clearing & Grubbing	AC	320	$	1,200.00	$	384,000.00		
263	Phase II 640 Acres Levee Over-Excavation and Re-Compaction	CY	235000	$	4.60	$	1,081,000.00		
264	Phase II 640 Acres Levee Keyway	CY	50000	$	4.70	$	235,000.00		
265	Phase II 640 Acres Levee Embankment Fill	CY	350000	$	4.20	$	1,470,000.00		
266	Phase II 640 Acres Structure Headwalls	EA	8	$	30,000.00	$	240,000.00		
267	Phase II 640 Acres Structure Miscellaneous Steel & Weir Boards	EA	8	$	10,000.00	$	80,000.00		
268	Phase II 640 Acres Interbasin Structure Piping	LF	600	$	170.00	$	102,000.00		
269	Phase II 640 Acres Interbasin Structure Rip-Rap	EA	8	$	55,000.00	$	440,000.00		
270	Phase II 640 Acres Interbasin Structure Cutoff Walls	EA	16	$	15,000.00	$	240,000.00		
271	Phase II 640 Acres Site Fencing and Gates	LF	21120	$	7.50	$	158,400.00	$	4,430,400.00

	Phase II 640 Acres Well Drilling, Construction, & Development	EA	6	$	1,160,341.00			$	6,962,046.00
272	Mobilization	EA	1	$	10,000.00	$	10,000.00		
273	Demobilization	EA	1	$	10,000.00	$	10,000.00		
274	Final Cleanup	EA	1	$	5,000.00	$	5,000.00		
275	Transport and dispose of drill cuttings offsite	EA	1	$	10,000.00	$	10,000.00		
276	Three 20,000-gallon temporary water storage tanks and discharge piping	EA	1	$	10,000.00	$	10,000.00		
277	Drill 54-inch minimum diameter surface casing/sanitary seal borehole	LF	50	$	620.00	$	31,000.00		
278	Drill 17.5-inch minimum diameter pilot borehole from 50 ft to 970 ft bgs	LF	920	$	110.00	$	101,200.00		
279	Drill 17.5-inch minimum diameter pilot borehole from 970 ft to 1,400 ft bgs	LF	430	$	110.00	$	47,300.00		
280	Conduct downhole geophysical surveys and alignment/deviation survey	EA	1	$	15,000.00	$	15,000.00		
281	Conduct isolated aquifer zone test	EA	3	$	25,000.00	$	75,000.00		
282	Conduct deep isolated aquifer zone test below 800 ft bgs	EA	3	$	35,000.00	$	105,000.00		
283	Enlarge pilot borehole to 36-inch diameter from 50 ft to 330 ft bgs	LF	280	$	110.00	$	30,800.00		
284	Enlarge pilot borehole to 32-inch diameter from 330 ft to 970 ft bgs	LF	660	$	110.00	$	72,600.00		
285	Conduct alignment/deviation tests in enlarged borehole	EA	1	$	5,500.00	$	5,500.00		
286	Conduct a caliper survey of enlarged borehole	EA	1	$	5,500.00	$	5,500.00		
287	Furnish and install 20-inch I.D. by 5/16-inch wall HSLA steel blank well casing	LF	424	$	220.00	$	93,280.00		
288	Furnish and install HSLA steel blank well casing with reinforced "Bull Nose"	EA	1	$	5,000.00	$	5,000.00		
289	Furnish and install 20-inch by 5/16-inch wall Ful Flo louvered, HSLA steel well screen	LF	510	$	320.00	$	163,200.00		
290	Furnish and install 3-inch I.D. schedule 40 mild steel sounding/camera access tube	LF	329	$	46.00	$	15,134.00		
291	Furnish and install 3-inch I.D. schedule 40 mild steel gravel feed tube	LF	319	$	38.00	$	12,122.00		
292	Furnish and install gravel pack in borehole annulus	LF	665	$	225.00	$	149,625.00		
293	Furnish and install 10.3-sack sand-cement grout upper annular seal	LF	305	$	170.00	$	51,850.00		
294	Perform initial well development	HRS	108	$	275.00	$	29,700.00		
295	Provide chlorine solution for chemical development of the well	GAL	255	$	26.00	$	6,630.00		
296	Provide polymer dispersant for chemical development of the well	GAL	40	$	110.00	$	4,400.00		
297	Mobilize, install, and demobilize test pumping equipment in newly completed wells	EA	1	$	25,000.00	$	25,000.00		
298	Conduct final development by pumping and surging	HRS	60	$	500.00	$	30,000.00		
299	Conduct step-drawdown pumping test in newly completed wells	HRS	8	$	500.00	$	4,000.00		
300	Conduct constant-rate pumping test in newly completed wells	HRS	28	$	500.00	$	14,000.00		
301	Conduct a dynamic flow meter survey	EA	1	$	10,000.00	$	10,000.00		
302	Conduct a color video camera survey	EA	1	$	2,500.00	$	2,500.00		
303	Conduct well alignment/deviation test in newly completed wells	EA	1	$	5,000.00	$	5,000.00		
304	Conduct final well disinfection in newly completed wells	EA	1	$	5,000.00	$	5,000.00		
	Phase II 640 Acres Well Equipping and Site Development	EA	6	$	1,295,500.00			$	7,773,000.00
305	Mobilization	EA	1	$	25,000.00	$	25,000.00		
306	Demobilization	EA	1	$	25,000.00	$	25,000.00		
307	Final Cleanup	EA	1	$	10,000.00	$	10,000.00		
308	Water Supply	EA	1	$	15,000.00	$	15,000.00		
309	Environmental Mitigation	EA	1	$	20,000.00	$	20,000.00		
310	Construct well site earthwork	CY	2400	$	10.00	$	24,000.00		
311	Furnish and install well concrete foundation	CY	20	$	1,200.00	$	24,000.00		
312	Furnish and install electrical concrete foundation	CY	15	$	1,200.00	$	18,000.00		
313	Furnish and install discharge pipe concrete pad	CY	5	$	1,200.00	$	6,000.00		
314	Furnish and install transformer pad	EA	1	$	10,000.00	$	10,000.00		
315	Furnish and install 12" FBE Steel Well Discharge Piping	LF	45	$	300.00	$	13,500.00		
316	Furnish and install Deep Well Air Release Valve	EA	1	$	3,500.00	$	3,500.00		
317	Furnish and install 12" Dresser Coupling	EA	1	$	2,000.00	$	2,000.00		
318	Furnish and install 12" Check Valve	EA	1	$	3,500.00	$	3,500.00		
319	Furnish and install 12" Flow Meter	EA	1	$	8,500.00	$	8,500.00		
320	Furnish and install 12" FBE Steel Tee	EA	1	$	2,500.00	$	2,500.00		
321	Furnish and install 12" Butterfly Valve	EA	1	$	3,500.00	$	3,500.00		
322	Furnish and install 2" Air Release Valve	EA	1	$	2,500.00	$	2,500.00		
323	Furnish and install Pressure Gauges	EA	2	$	500.00	$	1,000.00		
324	Furnish and install Pipe Supports	EA	3	$	1,000.00	$	3,000.00		
325	Furnish and install vertical turbine well pump assembly	EA	1	$	180,000.00	$	180,000.00		
326	Furnish and install vertical turbine well motor	EA	1	$	75,000.00	$	75,000.00		
327	Furnish and install well enclosures and appurtenances	EA	1	$	20,000.00	$	20,000.00		
328	Furnish and install electrical Main Switchboard	EA	1	$	50,000.00	$	50,000.00		
329	Furnish and install electrical Motor Control Center	EA	1	$	200,000.00	$	200,000.00		
330	Furnish and install Electrical Service and Transformer	EA	1	$	25,000.00	$	25,000.00		
331	Furnish and install Site Lighting	EA	2	$	10,000.00	$	20,000.00		
332	Furnish and install Multi-Lin	EA	1	$	10,000.00	$	10,000.00		
333	Furnish and install RTU and HMI	EA	1	$	10,000.00	$	10,000.00		
334	Furnish and install Electrical Instrumentation	EA	1	$	25,000.00	$	25,000.00		
335	Furnish and install Electrical Conduit, Wires, and Grounding	EA	1	$	150,000.00	$	150,000.00		
336	Furnish and install pre-fabricated metal canopy	EA	1	$	70,000.00	$	70,000.00		
337	Furnish and install site ground cover	CY	200	$	50.00	$	10,000.00		
338	Furnish and install site fencing	LF	400	$	50.00	$	20,000.00		
339	Furnish and install site painting	EA	1	$	10,000.00	$	10,000.00		
340	Furnish and install VFD's	EA	1	$	200,000.00	$	200,000.00		
341	Phase II 640 Acres Well Recovery Pipeline - 12" PVC	LF	6340	$	65.00	$	412,100.00		
342	Phase II 640 Acres Well Recovery Pipeline - 18" PVC	LF	340	$	78.00	$	26,520.00		
343	Phase II 640 Acres Well Recovery Pipeline - Connections to Conveyance Pipeline	EA	4	$	50,000.00	$	200,000.00	$	638,620.00
344	SCADA System Hardware	EA	1	$	271,000.00	$	271,000.00		
345	SCADA System Software	EA	1	$	30,000.00	$	30,000.00		
346	SCADA System Programming and Screens	EA	1	$	150,000.00	$	150,000.00	$	451,000.00
	Subtotal:					$	129,176,822.00		
	Mobilization:		1.4%			$	1,820,000.00		
	Subtotal with Mobilization:					**$**	**130,996,822.00**		
	Contract Cost Allowances (Sum of):		2.5%			$	3,274,920.55		
	Design Contingencies, 2% (+/-)								
	APS (+/-). Type of Procurement: Request for Proposal, Competitive Bid								
	Contract Cost:					**$**	**134,271,742.55**		
	Construction Contingencies:		20.0%			$	26,854,348.51		
	Field Cost:					**$**	**161,126,091.06**		
	Project Management					$	6,500,000.00		
	Engineering & Design					$	6,900,000.00		
	Environmental					$	600,000.00		
	Permitting					$	600,000.00		
	Labor Compliance					$	500,000.00		
	PG&E Electrical Service					$	1,500,000.00		
	Bid Advertisement & Legal					$	250,000.00		
	Project Surveying					$	1,600,000.00		
	Construction Management & Inspection					$	7,800,000.00		
	HCP Fees					$	3,200,000.00		
	Land Acquisition and Rights of Way					$	38,873,783.00		
	Subtotal Non-Contract Costs excluding Land Acquisition and Rights of Way:					**$**	**29,450,000.00**		
	Subtotal Non-Contract Cost:					**$**	**68,323,783.00**		
	Construction Cost (Unit Price Level Dec 2018) excluding Land Acquisition and Rights of Way:					**$**	**190,576,091.06**		
	Construction Cost (Unit Price Level Dec 2018)					**$**	**229,449,874.06**		
	Escalation to end of Project Bidding Phases, from Unit Price Level (Dec 2018) to Bids (Dec 2023)					$	19,423,909.00		
	for Construction Cost exluding Land Acquisition and Rights of Way at 2.0% per year for 5 years.								
	Construction Cost (with Escalation to end of Bid Phases, Price Level Dec 2023)					**$**	**248,873,783.06**		

QUANTITIES		PRICES	
BY	**CHECKED**	**BY**	**CHECKED**
DATE PREPARED	**PEER REVIEW / DATE**	**DATE PREPARED**	**PEER REVIEW / DATE**

APPENDIX L

Sample Agreement for Professional Services

AGREEMENT FOR PROFESSIONAL SERVICES BETWEEN
GROUNDWATER BANKING JOINT POWERS AUTHORITY
AND
CONSULTANT NAME, CAPITALIZED, BOLD

This AGREEMENT FOR PROFESSIONAL SERVICES (this "Agreement") is made and entered into this ____th day of _____ __, by and between GROUNDWATER BANKING JOINT POWERS AUTHORITY, a California joint powers authority organized under Article 1, Chapter 5, Division 7, Title 1 of the California Government Code, hereinafter referred to as "GBJPA," and **CONSULTANT NAME, CAPITALIZED** hereinafter referred to as "CONSULTANT."

W I T N E S S E T H

WHEREAS, GBJPA requires the following technical or professional services of a consultant: <**NAME OF SERVICES, i.e. engineering, architectural, consulting, technical>,** to be rendered on the

PROJECT NAME

as further described below; and,

WHEREAS, CONSULTANT represents that by virtue of its experience and training, it is qualified to perform the services required by GBJPA, and that it has available and will provide personnel and facilities necessary to accomplish the required services within the required time.

NOW, therefore, GBJPA and CONSULTANT agree as follows:

I. Definitions

A. "Scope of Work" means those services described in the scope of work which is attached hereto as Exhibit A and incorporated herein by this reference, as modified by any Variances, and, except to the extent modified by Exhibit A and any Variances, in the Request For Proposal.

B. "Project" means the Project identified in the first recital of this Agreement.

C. "Compensation Schedule" means the fee and cost schedule which is attached hereto as Exhibit B and incorporated herein by this reference, as modified by any Variance.

D. "Work" means all services to be provided by CONSULTANT pursuant to this Agreement.

E. "Notice to Proceed" is defined in Section II.

F. "Variance" means a Professional Services Variance executed and approved in the form of Exhibit C, which is attached hereto and incorporated herein by this reference, pursuant to Section VIII.

G. "Work Product" is defined in Section VI.

H. "Schedule" means the activity schedule set forth in the Request For Proposal, as modified by Exhibit A and any Variances.

I. "Request For Proposal" means the document, including any addenda and attachments thereto, used to solicit the proposal for the Work.

J. "Design Professional Services" means services related to the preparation of engineering or architectural drawings, construction documents and other design-related services required to be performed by or under the supervision of licensed professionals, as well as other services provided by or under the supervision of licensed professionals.

K. "Professional Services" means (1) services involving the provision of a report, study, plan, design, specification, document, program, advice, recommendation, analysis, review, opinion, inspection, investigation, audit, brokering or representation of GBJPA before or in dealings with another party, or (2) any other services which require a special skill or expertise of a professional, scientific or technical nature. Professional Services includes Design Professional Services.

II. CONSULTANT's Services; Authorization

CONSULTANT agrees to perform the services identified in the Scope of Work. CONSULTANT shall furnish all services, materials, equipment, subsistence, transportation and all other items necessary to perform the Work. GBJPA will pay applicable state or local fees necessary to obtain permits for the Project, unless otherwise provided in the Scope of Work.

Specific authorization to proceed with the Work shall be granted in writing by GBJPA. CONSULTANT shall not proceed with the Work unless it is authorized. If it is specified in the Scope of Work that the Work or a portion of the Work is to be performed in phases or tasks as authorized, CONSULTANT shall not proceed with any phase or task unless it is separately authorized. The authorization shall set forth the date of commencement of the Work, or phase or task of the Work ("Notice to Proceed"). CONSULTANT shall commence the Work, or phase or task of the Work, immediately upon receipt of the applicable written Notice to Proceed.

III. Compensation

In return for performing the services described in the Scope of Work, GBJPA agrees to pay, and CONSULTANT agrees to accept, compensation in accordance with the Compensation Schedule. Unless otherwise specified in the Compensation Schedule, compensation shall be made on a time and materials basis. Compensation shall not exceed the amount authorized in the Notice to Proceed, except as approved under Section VIII: Change in Scope of Work.

CONSULTANT shall submit an invoice to GBJPA, on a monthly basis or less frequently, for the Work performed pursuant to this Agreement. Each invoice shall itemize the services rendered by task as set forth in the Scope of Work and the amount due in

accordance with the Compensation Schedule. Within fifteen (15) calendar days of receipt of each invoice, GBJPA shall notify CONSULTANT in writing of any disputed amounts included on the invoice. Within thirty (30) calendar days of receipt of each invoice, GBJPA shall pay all undisputed amounts included on the invoice.

IV. Performance Standards

The standard of care for all Professional Services, including Design Professional Services, performed to execute the Work shall be the care and skill ordinarily used by members of the profession practicing under similar circumstances at the same time and locality of the Project. CONSULTANT makes no other warranty, either expressed or implied.

V. Integration; Amendment

This Agreement represents the entire understanding by and between GBJPA and CONSULTANT as to those matters contained herein. No prior oral or written understanding shall be of any force or effect with respect to those matters covered hereunder. This Agreement may not be modified or altered except in writing signed by both parties hereto.

VI. Documents

All original drawings, specifications, calculations, estimates, studies, reports, memoranda, records, reference material, data, charts, renderings, computations, compilations, submittals and any other documents developed or compiled for the Project, whether in the form of writing, figures, computer disks or other electronic format ("Work Product"), shall be and remain the property of GBJPA, without restriction upon their use or dissemination by GBJPA, with the exception of any intellectual property rights contained therein, owned or created by CONSULTANT prior to the effective date of this Agreement and/or created outside the scope of this Agreement. CONSULTANT may make and retain copies thereof for its records as desired, but no such items shall be the subject of a copyright application by CONSULTANT.

Reuse by GBJPA of Work Product for any project or purpose other than the Project shall be at GBJPA's sole risk. Nothing in this paragraph shall constitute or be construed to be any representation by the CONSULTANT that the Work Product is suitable in any way for any project other than the Project.

All data, documents, discussion and other information developed or received by CONSULTANT or provided for performance of this Agreement are deemed confidential and shall not be disclosed by CONSULTANT without GBJPA's prior written consent. GBJPA shall grant such consent if disclosure is legally required. Upon request, all GBJPA information shall be returned to GBJPA upon the termination or expiration of this Agreement. For this purpose, GBJPA confidential information shall not include (i) information that, at the time of disclosure by CONSULTANT, is publicly available or generally known or available to third parties, or information that later becomes publicly available or generally known or available to third parties through no act or omission by CONSULTANT; (ii) information that CONSULTANT can demonstrate was in its possession prior to receipt from GBJPA; (iii) information received by CONSULTANT from a third party who, to CONSULTANT's knowledge and reasonable belief, did not acquire

such information on a confidential basis either directly or indirectly from GBJPA; or (iv) information CONSULTANT can demonstrate was independently developed by it or a third party or for it or a third party and that was not obtained, in whole or in part, from GBJPA.

CONSULTANT acknowledges that GBJPA is a public agency subject to the Public Records Act. Information that CONSULTANT desires to retain as confidential should not be disclosed to GBJPA unless expressly requested by GBJPA. If GBJPA receives a request to disclose information that was provided to GBJPA by CONSULTANT in the course of performing this Agreement and was designated by CONSULTANT as "confidential information," GBJPA will notify CONSULTANT of such request. If CONSULTANT objects to the disclosure, CONSULTANT shall expeditiously, at its sole expense, seek a court protective order to prevent such disclosure, and absent the granting of such an order, GBJPA shall release the information as required by applicable law.

VII. Performance and Schedule

Time is of the essence in the performance of this Agreement. CONSULTANT agrees to coordinate the Work to ensure its timely completion and shall promptly notify GBJPA of any anticipated delays or causes or casualties beyond the CONSULTANT's control which may affect the Schedule. In the event the time for completing the Scope of Work is projected to be exceeded due to circumstances beyond the control of CONSULTANT, CONSULTANT shall have an additional amount of time to be agreed upon in writing between the parties pursuant to Section VIII, in which to complete the Work. CONSULTANT agrees to complete the Work in accordance with the Schedule.

The time provided to CONSULTANT to complete the Work required by this Agreement shall not affect GBJPA's right to terminate this Agreement.

VIII. Change in Scope of Work

GBJPA may request or CONSULTANT may recommend, that CONSULTANT perform services in addition to or different from that delineated in the original Scope of Work, and may delete services from the Scope of Work, and/or change the Schedule. Upon GBJPA's request or CONSULTANT's recommendation for additional or changed work, CONSULTANT shall provide a cost estimate and written description of the additional or changed work. Prior to any such addition, change, or deletion to the Work or any Schedule change, including a Schedule change pursuant to Section VII, GBJPA and CONSULTANT shall negotiate an adjustment of compensation and time for completion and shall execute a Variance. Upon execution of each Variance, (i) the Scope of Work and Compensation Schedule shall thereafter be as described in Exhibits A and B, respectively, as modified by the Variance and any previously executed Variance, and (ii) the time for completing the Work shall be as set forth in the Variance. Following execution of any Variance, all terms and provisions of the Agreement, except as expressly modified by such Variance, shall remain in full force and effect, including, but not limited to, "Performance Standards" and "Insurance and Indemnification." GBJPA will not be required to pay for any additional or changed work rendered in advance of the execution of a Variance covering the additional or changed work.

IX. Termination or Abandonment

GBJPA has a right to terminate or abandon any portion or all of the Work for any reason by giving ten (10) calendar days written notice. In the event of termination, GBJPA shall have the right to take possession immediately of all Work Product developed for that portion of the Work completed and/or being abandoned, and CONSULTANT shall deliver such Work Product to GBJPA. GBJPA shall pay CONSULTANT for services for any portion of the Work being terminated which were rendered prior to termination. If said termination occurs prior to completion of any task of the Work for which a payment request has not been received, the fee for services performed during such task shall be based on an amount mutually agreed to by GBJPA and CONSULTANT for the portion of such task completed but not paid prior to said termination. GBJPA shall not be liable for any costs other than the fees or portions thereof which are specified herein.

X. Insurance

During the term of the Agreement, CONSULTANT shall carry, maintain and keep in full force insurance against claims for injuries or death or damages to property that may arise from or in connection with CONSULTANT's performance of this Agreement. Such insurance shall be of the types and in the amounts set forth as follows:

Comprehensive general liability insurance with coverage limits of not less than One Million Dollars ($1,000,000) per occurrence and aggregate, including products and operations hazard, contractual insurance, broad form property damage, independent consultants, personal injury, underground hazard, and explosion and collapse hazard where applicable.

Business automobile liability insurance for vehicles used in connection with the performance of this Agreement with minimum limits of One Million Dollars ($1,000,000) per claimant and One Million Dollars ($1,000,000) per incident and aggregate.

Workers' compensation insurance as required by the laws of the State of California. This requirement may be waived by GBJPA upon certification by CONSULTANT that it has no employees or individuals who are defined as "employees" under the Labor Code.

If the Work includes design professional services, then in addition to the above-listed coverages, CONSULTANT shall carry, maintain and keep in full force professional liability insurance, with limits of not less than One Million Dollars ($1,000,000) per claim or occurrence and Two Million Dollars ($2,000,000) aggregate limits, throughout the term of this Agreement to cover claims caused by CONSULTANT's negligent acts, errors, or omissions of a professional nature.

Insurance coverages described above shall be afforded by insurance carriers that meet or exceed requirements for financial performance and security by having a Best's Key Guide rating of "A" or better; additionally, carriers shall have an assigned Financial Size Category of "VIII" or higher.

CONSULTANT shall provide evidence of insurance coverages on forms satisfactory to GBJPA, including endorsements providing that policies cannot be canceled or reduced except on thirty (30) calendar days written notice by the insurance carrier of cancellation or non-renewal (ten (10) calendar days notice for non-payment of premium). Industry standard forms for "certificate of insurance" from ACORD are accepted, provided that appropriate language regarding notice of non-renewal or cancellation is provided on the form. CONSULTANT shall provide proof that policies of insurance required herein expiring or terminated during the term of this Agreement have been renewed or replaced with other policies providing coverage meeting the requirements hereof. Such proof will be furnished at least fourteen (14) calendar days prior to the expiration or termination of the coverages. Any deductibles or self-insured retentions must be declared to and are subject to approval by GBJPA.

The general liability and automobile policies required by this Agreement shall contain an endorsement naming GBJPA and its directors, officers, agents, employees, volunteers, and other entities for which GBJPA directors are the governing body as additional insureds.

The general liability and automobile insurance provided by CONSULTANT shall be primary, and any insurance or self-insurance maintained by GBJPA shall be in excess of CONSULTANT's insurance and shall not contribute with it.

Insurance coverage required herein shall not prohibit CONSULTANT from waiving the right of subrogation prior to a loss. CONSULTANT hereby waives all rights of subrogation against GBJPA.

XI. Indemnification

Procurement of insurance by CONSULTANT shall not be construed as a limitation of CONSULTANT's liability or as full performance of CONSULTANT's duties to indemnify, hold harmless and defend under the following paragraph of this Agreement.

CONSULTANT shall indemnify, defend and hold GBJPA and its directors, officers, agents, employees, and other entities for which GBJPA's directors are the governing body harmless from all damages, costs, liability claims, losses, judgments, penalties and expenses, including reasonable attorney's fees as a result of third party claims, to the proportionate extent arising out of or pertaining or relating to the negligent acts, errors or omissions, or recklessness or willful misconduct of CONSULTANT, its officers, agents or employees, or out of CONSULTANT's breach of its obligations in performing this Agreement.

XII. Attorney's Fees and Costs

In the event an action is commenced by a party to this Agreement against any other party or parties hereto to enforce its rights or obligations arising from this Agreement, the prevailing party in such action, in addition to any other relief and recovery awarded by the court, shall be entitled to recover all statutory costs plus expert witness fees, and a reasonable amount of attorney's fees. If GBJPA is required to initiate or defend litigation with a third party because of the violation of any term or provision of this Agreement by CONSULTANT, then GBJPA shall be entitled to its expert fees, reasonable attorney's fees, and costs from CONSULTANT in that action.

XIII. Successors and Assigns

This agreement and all of the terms, conditions, and provisions hereof shall inure to the benefit of and be binding upon the parties hereto, and their respective successors and assigns; provided, however, that no assignment of this Agreement shall be made without written consent of the parties to this Agreement.

Any attempt by CONSULTANT to assign or otherwise transfer any interest in this Agreement without the prior written consent of GBJPA shall be void. Any notice or instrument required to be given or delivered by this Agreement may be given or delivered by depositing the same in any United States Post Office, registered or certified, postage prepaid, addressed to:

GBJPA:
c/o Rosedale Rio Bravo Water Storage District
849 Allen Road
Bakersfield, CA 93314
Attn: _____

CONSULTANT:
_____
_____
_____
Attn: _____

and shall be effective upon receipt thereof.

XIV. Project Organization

CONSULTANT proposes to assign _____as the Project Manager. The Project Manager shall not be removed from the Project or reassigned without prior approval of GBJPA.

Except as specifically identified in the Scope of Work, no subcontracting or subconsulting of any portion of the Scope of Work shall be made without prior approval of GBJPA, and any attempt to do so shall be void and have no effect.

In the performance of the Work, CONSULTANT shall assign only personnel, including its employees and its authorized subcontractors and subconsultants, who are qualified to perform the Work. If the quality of the Work of personnel assigned by CONSULTANT is unacceptable to GBJPA, CONSULTANT agrees to assign replacement personnel upon GBJPA's request.

CONSULTANT shall comply with all applicable federal, state and local laws and regulations, including the conflict of interest provisions of Sections 1090 et seq. and 81000 et seq. of the California Government Code.

CONSULTANT is an independent contractor and not an agent or employee of GBJPA, and CONSULTANT shall have no authority to act as an agent of GBJPA or to enter into

any agreement for or on behalf of GBJPA. In performing this Agreement, the parties are not the agents, employees, partners, joint venturers or associates of one another.

CONSULTANT shall determine the method, details and means of performing the services described in the Scope of Work.

XV. Miscellaneous

GBJPA shall have no obligation under this Agreement to any party other than CONSULTANT.

This Agreement shall be governed by the laws of the State of California. Any action regarding the interpretation or enforcement of this Agreement shall be filed in the County of Kern, California.

If the Work includes public work subject to the requirements of the California Labor Code, CONSULTANT shall comply with the requirements set forth in the attached addendum, which are incorporated herein by this reference, to the extent applicable to any of the Work.

XVI. Compliance with all Laws. CONSULTANT shall, at CONSULTANT's sole cost, comply with all of the requirements of Municipal, County, State, and Federal authorities now in force, or which may hereafter be in force, pertaining to this Agreement, and shall faithfully observe in all activities relating to or growing out of this Agreement all ordinances of the county and State and Federal statutes, rules or regulations, and permitting requirements now in force or which may hereafter be in force including, without limitation.

XVII. Authority. The person(s) executing this Agreement on behalf of the parties hereto warrant that (a) such party is duly organized and existing, (b) they are duly authorized to execute and deliver this Agreement on behalf of said party, (c) by so executing this Agreement, such party is formally bound to the provisions of this Agreement, and (d) the entering into this Agreement does not violate any provision of any other Agreement to which said party is bound.

XVIII. Unauthorized Use of GBJPA's Name. Except as required by law or with the prior written consent of GBJPA and its members (which consent may be withheld in its sole and absolute discretion), CONSULTANT shall not use GBJPA's name, seal or logo on marketing materials, nor shall CONSULTANT state, imply or in any way represent to any third party that GBJPA has endorsed or approved CONSULTANT or any of its work, services or products.

XIX. Execution.

Electronic Signatures. CONSULTANT and GBJPA may execute this Agreement using an "electronic signature," as that term is defined in California Civil Code Section 1633.2, or a "digital signature," as defined by California Government Code Section 16.5. An electronic or a digital signature will have full legal effect and enforceability unless otherwise prohibited by GBJPA or by ordinance, rule, or statute. Nothing in this Section

requires GBJPA to use or accept the submission of any subsequent or related document containing an electronic or digital signature.

CONSULTANT NAME

By:_____
CONSULTANT SIGNATORY NAME, TITLE

GROUNDWATER BANKING JOINT POWERS AUTHORITY

By:_____
GBJPA SIGNATORY NAME, TITLE