c. STAFF RECOMMENDATION

Staff believes these changes and additions to the DEID GSP and the Coordination Agreement represent a positive step towards meeting SGMA requirements and recommends the Board approves the changes outlined herein.

DELANO – EARLIMART IRRIGATION DISTRICT
GROUNDWATER SUSTAINABILITY AGENCY

APPENDIX L-3

Response to Comments Received By Tulare County

2024
2nd Amended Groundwater Sustainability Plan

Delano-Earlimart Irrigation District Groundwater Sustainability Agency

14181 Avenue 24 ◆ Delano, Ca 93215

January 23, 2020

Tulare County Board of Supervisors
2800 W. Burrel
Visalia, CA 93291
Attention: Denise England

Via email and U.S. mail

Dear Ms. England:

The Delano-Earlimart Irrigation District Groundwater Sustainability Agency (DEID GSA) received comments from the County of Tulare (County) on its Groundwater Sustainability Plan on December 16, 2019. The DEID GSA appreciates those comments and is providing the attached responses to those comments.

Final revisions to the GSP are currently being made to include comments received from the County and will be posted to the GSA page of e DEID website later this week. You may access the final draft GSP by going to deid.org/gsa/.

Sincerely,

for Eric Quinley, General Manager
Delano-Earlimart Irrigation District GSA

Delano-Earlimart Draft GSP - summary of County notes – responses to County notes

Draft Copy	County Notes	DEID Response to County Notes
Pg 1-6 Management Area 3. MOU between DEID GSA and Richgrove Community Service District designates DEID GSA as the principle agency with jurisdiction over RCSD Management Area for the purposes of SGMA and the implementation of this Plan (see **Appendix 1-C: MOU Between DEID GSA and Richgrove Community Service District**).	The County has land use authority in this service area. The MOU between DEID and the PUD should not impact the County's authorities over growth and well permitting. However, it is plausible that a groundwater availability restriction could be placed upon any development as a condition of service by the PUD. That would be a consideration on a case-by-case basis, based upon whether CEQA compliance is necessary (e.g. requiring any type of water supply sufficiency determination). Therefore, the County maintains land use authority in LAFCo designated PUD and CSD boundaries. Future development applications would rely on the PUD or CSD to provide a will serve letter. The County maintains and does not abdicate its authority regarding the application of land use and zoning regulations as feasible and appropriate through the administration of the County general plan, zoning ordinance, and ordinance code.	DEID recognizes the County's land use, zoning and well permitting authority in this Management Area as well as in other portions of the DEID GSA jurisdictional area. Please refer to Sections 1.4.4.1 and 1.4.4.6 (commencing on pp. 1-21 and 1-30) of the GSP.
Pg 1-6. Management Area 4 MOU between DEID GSA and Earlimart Public Utility District designates DEID GSA as the principle agency with jurisdiction over EPUD Management Area for the purposes of SGMA and the	See Pg 1-6 Management Area 3 comment above.	As stated above, DEID recognizes the County's land use, zoning and well permitting authority in this Management Area as well as in other portions of the DEID GSA jurisdictional area. Please refer to

implementation of this Plan (see **Appendix 1-D: MOU Between DEID GSA and Earlimart Public Utility District**).		Sections 1.4.4.1 and 1.4.4.6 (commencing on pp. 1-21 and 1-30) of the GSP.
Pg 1-8. Paragraph 1. The county governments each retains general land use planning authority and jurisdiction over its respective area.	See Pg 1-6 Management Area 3 comment above.	As stated above, DEID recognizes the County's land use, zoning and well permitting authority in this Management Area as well as in other portions of the DEID GSA jurisdictional area. Please refer to Sections 1.4.4.1 and 1.4.4.6 (commencing on pp. 1-21 and 1-30) of the GSP.
Pg 1-9. 1.4.1.3 Description of Plan Area	The existing land use designations described in this section are not general plan "Land Use Designations" they describe existing land uses on the ground. Incorporate at a minimum General Plan Figure 4-1 and reference the land use diagrams in the Communities, Hamlets, and Legacy Communities as applicable. The following adopted plans are located in the Delano-Earlimart GSA: Earlimart Community Plan Richgrove Community Plan Allensworth Hamlet Plan Teviston Hamlet Plan Jovista Legacy Plan Delano Area Community Plan (not completed as of yet)	Section 1.4.1.3 of the GSP has been amended to make that clarification. Please note that Tulare County land use designations are discussed in more detail in Section 1.4.4.1 (p. 1-21). Further, the only communities within the DEID GSA are Earlimart and Richgrove.
Pg 1-13 Table 1-2: Wells within DEID GSA by Well Type	This seems like a low count for all the likely rural domestic wells. Please note if the unknow category includes domestic wells. Please clarify.	As noted in section 1.4.1.4.1, the well density count within the DEID GSA was based on the DWR Well Completion Report Map Application tool. This tool only reports

		wells with well completion reports on file. A clarifying note will be added to this section recognizing that additional wells may be present that were not included in the DWR reporting tool.
Pg 1-14. 1.4.1.4.2.2 Groundwater Dependent Communities As previously described in Section 1.4.1.4 Identification of Water Use Sector & Water Source Type (see Figure 1-5), the Earlimart and Richgrove communities, which are part of the DEID GSA, rely exclusively on groundwater extractions to meet their municipal and industrial needs. Both of these communities are considered either Disadvantaged or Severely Disadvantaged Communities.	The County appreciates the GSA calling attention to the needs to protect these water sources for these disadvantaged communities.	Thank you.
Pg 1-21. Urban land use is more specifically managed in the Tulare County GP through the official adoption of Urban Development Boundaries (UDBs) and Urban Area Boundaries (UABs). UDBs establish a 20-year growth boundary that is consistent with the General Plan's time horizon and delineate an area around incorporated cities or unincorporated communities wherein urban development is allowed and services are likely to be extended. UABs are areas where land uses are presumed to have an impact upon the adjacent incorporated city. To coordinate land use	The Budget for the Tule Basin – and for the DE subset – stop any expansion of municipal pumping at 2040. Growth will continue to 2070 – the GSPs full sustainability period. But, the Budget at the end of this GSP has the "current" Muni Pumping at 2800 af/yr, and the future Muni pumping only at 3700 af/yr. While this is steady through the Sustainability period (unlike some of the other GSP's), it does accommodate some growth (e.g. 900 af of pumping – or about 3,000 to 4,000 people). This is consistent with the 1.3% growth from the (2030) Community Plans.	Thank you.

planning with cities, the County adopts City UABs and City UDBs wherein the city regulates land use within the City UDB and the city and the County coordinate on land use within the City UAB. Generally, the Planning Area of a city's General Plan is coterminous with the County Adopted City UAB. Within DEID GSA, there are two Community Plans that include UDBs and/or UABs that are addressed by this GSP. The most recent version of these plans, as well as the UDBs and/or UABs that they define, include: • Richgrove Community Plan Update (2017) • UDB for Richgrove • Earlimart Community Plan Update (2017) • UDB for Earlimart		
Pg 1-25. Paragraph 3. Tulare County's role in water management is broad and active, particularly through the implementation of its General Plan and its Zoning Ordinance (*Ordinance No. 352*), which translates GP policies into specific use regulations and development standards. The County also administers other ordinances that influence the use and management of water within the County, and it may adopt more in the future if deemed necessary. However, limited only to the implementation of its GP, Tulare County recognizes that its role in water management is	Good recognition of the cooperative nature necessary.	Thank you.

neither comprehensive, nor is it to be construed as such; rather, water management within the County is carried out by way of dynamic interactions between the many participants who each bear a variety of responsibilities:		
Page 1-27. 1.4.4.4 Effects of Land Use Plans within the Tule Subbasin The DEID GSA shall request the County of Tulare and the County of Kern that it be notified when land use plan changes are proposed within the DEID GSA. Any proposed land use plan changes will be reviewed for potential significant impacts to implementation of the DEID GSP. The DEID GSA will request that no land use changes be approved prior to said review and certification that that there will be no unmitigated impacts that would disrupt the sustainability goals of the GSA.	Agreed. The County maintains and does not abdicate its authority regarding the application of land use and zoning regulations as feasible and of the county general plan, zoning ordinance, and ordinance code. While the concept may argued to be consistent with the intent of the General Plan, the determination of "unmitigated" is not in the GSA's jurisdictional authority as it relates to land use choices but may be so as a responsible agency under CEQA.	Section 1.4.4.4 has been revised and no longer contains this language. Additional language has been added to further address the County's comment.
Page 1-27. 1.4.4.5 Water Supply Assumptions of Land Use Plans Water supply assumptions within the recently adopted General and Community Plans active within DEID GSA's jurisdiction generally provide global estimations of future water supplies and demands. Additionally, these plans provide Goals and Policies that recognize the need and, when implemented, provide for sustainable water management.	Please clarify that the plans active in DEIDGSA's jurisdiction should not be assumed to reflect a 2070 population. To be clear there may be unanticipated additional growth beyond what these land use plans assumed. The note on the 2017 Community Plans may not reflect a longer-term demand that may have been included in those Plans. However, as noted elsewhere, the DEID water budget (at the end of GSP's attachments) does reflect a higher Muni demand that "current" that may incorporate all the projected growth as anticipated in	As recognized by the County's comment, the water budget in the GSP reflects higher muni demand and may incorporate all of the projected growth for the communities within the DEID GSA. We will add clarification regarding not assuming 2070 population. Also, please note that the only communities within the DEID GSA are Earlimart and Richgrove.

	all the listed communities as well. The following adopted plans are located in the Delano-Earlimart GSA: Earlimart Community Plan (UDB) Richgrove Community Plan (UDB) Allensworth Hamlet Plan (HDB) Teviston Hamlet Plan (HDB) Jovista Legacy Plan (LDB) Delano Area Community Plan (UDB) The plans listed above utilize projections to 2030 and or 2040.	
Page 1-28. Paragraph 4. The projects and management actions proposed in this GSP provide a framework by which the opportunity to use lands according to existing land use designations as permitted by land use designations and zoning ordinances remains unaltered, subject to the sustainable use of groundwater within the DEID GSA's jurisdiction. However, the assumptions made by DEID GSA in this GSP anticipate a shift in water demand due to the implementation of certain projects and management actions that ultimately reduces the total volume of groundwater supply available for extraction on an annual basis and, therefore, current actual land uses reliant upon these groundwater supplies may change during the Plan's implementation horizon.	This includes the key word "unaltered" and seems to protect the County's planned growth from being restrained due to the GSP. It anticipated that there may be change to "actual land" uses reliant on groundwater under SGMA but the County anticipates that GSA will assist in any required mitigation to reduce the extent and impact of reduced groundwater pumping to existing uses.	As reflected in Section 5 of the GSP, the GSA will endeavor to reduce reliance on groundwater pumping by implementing projects and management actions aimed at improving the availability of supplemental and imported water sources as a substitute to pumping. However, changes in land uses may be necessary, particularly in light of the time it would take to implement those projects and in light of the reduced water delivery capacity of the FKC due to land subsidence resulting from excessive pumping in certain areas of the Tule Subbasin outside the DEID GSA jurisdiction.
Page 1-29. Paragraph 2. Each	The County will interact with the	Thank you.

county has its own policies and procedures to obtain a water well permit. The DEID GSA shall request notification of any proposed water wells within the DEID GSA and shall further request the opportunity to review said requests so that the potential for undesirable effects that a new well might have on implementation of the GSP and provide comments and/or approval prior to issuance of any well permit.	GSAs through review and input on well permitting. The County has modified its forms to integrate the role of GSAs in the process. GSA policies should be consistent with adopted County Environmental Health well permitting process. Specifically, see Water Code Section 10726.4(b).	
Page 1-29. 1.4.4.7 Effect of Land Use Plans Outside of the Tule Subbasin Given that GSPs implemented within adjacent Subbasins must (1) ensure no adverse impact to the GSPs implemented within the Tule Subbasin and must also (2) address any impact that the various land use plans active within their GSPs' respective Plan Areas may have on their successful implementation of their respective GSPs, DEID GSA does not anticipate any significant adverse impacts resulting from the implementation of land use plans adjacent to the Tule Subbasin.	This is important. But it is in the context of the water budget for DEIDGSA that shows some modest increase in future Muni groundwater pumping. Increases greater than those values could be claimed to be an impact (current conditions pumping 2800 af, future condition pumping 3700 af all the way to 2070A). The County has checked the Community Plans in this area and this growth rate appears consistent with these estimated budgets. If the budget is too low, it should be adjusted accordingly. Another avenue that could be considered is updating LAFCo MSR's as a first step regarding CSD and PUD pumping and water supply capabilities within the next 5 years (at the next update of the GSP).	Future Muni water budgets are believed to be reasonable estimations. Future estimates of water needs will be periodically reviewed with both EPUD and RCSD, at least every 5 years when GSP updates are done.
Page 2-1. Introduction The Basin Setting for the DEID GSA is derived from the Tule Subbasin Setting, which was developed for the Tule Subbasin by Thomas Harder	This document includes a budget for the entire Tule Subbasin, and separate sub-budgets for each GSA, included DEID GSA. The DEID GSA budget has current Muni pumping at 2800 af/yr, and future	Correct.

and Company, The Tule Subbasin Setting can be found as Attachment 2 to the Draft Tule Subbasin Coordination Agreement 1 (see Appendix A).	pumping at 3,700 af/yr.	
Page 2-13. Paragraph 1. However, when factoring subsurface inflows from outside of the subbasin and from other Tule Subbasin GSAs (1986/87-2016/17 average of 24,000 acre-feet) and subsurface outflows to others outside of the subbasin and other Tule Subbasin GSAs north and west of the DEID GSA (1986/87-2016/17 average of 52,000 acre-feet) the DEID GSP area is not in balance (***Table 2*** of ***Appendix C,*** *Tule Subbasin Setting)*. The primary source of this imbalance is an over-extraction of groundwater resources within GSAs that are located north and west of the DEID GSA.	Please clarify, this may be of concern, and given that the imbalance may not be reported in these surrounding GSA's please verify that the numbers are consistently being reported in the surrounding GSA's or at least report here the constituencies.	DEID GSA met with the other GSAs within the Tule Subbasin on numerous occasions to address this issue. It is the expectation of the DEID GSA that surrounding GSAs will implement projects and management actions to address this issue consistent with the Coordination Agreement and SGMA requirements.
Pag 2-14. 2.4.1.1.5 Municipal Deliveries from Wells For the period of 1986/87-2016/17, municipal pumping within DEID GSA on an average annual basis was estimated to be approximately 2,100 acre-feet/yr (see Table 1a of Appendix C, Tule Subbasin Setting).	Please clarify that the stated value of 2,100 is the "average" value for this period. Using an average value for Muni pumping should be noted that it increases with growth – unlike ag use, which varies greatly with crop trends and annual hydrology/rainfall. This should just show the range and indicate that current use is 2800 af/yr (see ch 2 of Tule Subbasin Setting Rpt, Appendix C, Table 1-a for DEID GSA)	Clarification made.
Page 2-16. 2.4.1.2.5.3 Deep Percolation of Applied Native Groundwater for Municipal Irrigation (Municipal Pumping) Deep percolation of applied groundwater for municipal	The value is an "average" and should be shown as a range, with the most recent value reflecting current population conditions.	Clarification made.

irrigation is described in ***Chapter 2.3.1.2.5***. For the period of 1986/87- 2016/17, deep percolation of applied groundwater for municipal irrigation within DEID GSA on an average annual basis was estimated to be approximately 1,400 acre-feet/yr (see ***Table 1b*** of ***Appendix C,*** *Tule Subbasin Setting*).		
Page 2-17. 2.4.1.2.9 Municipal Consumptive Use Municipal consumptive use is described in ***Chapter 2.3.1.2.6***. For the period of 1986/87-2016/17, the estimated municipal consumptive use from landscape irrigation within the DEID GSA on an average annual basis was estimated to be approximately 700 acre-feet/yr (see ***Table 1b*** of ***Appendix C,*** *Tule Subbasin Setting*).	The value is an "average" and should be shown as a range, with the most recent value reflecting current population conditions.	Clarification made.
Page 2-20. 2.4.4.1 Municipal Groundwater Pumping For the period of 1986/87-2016/17, municipal groundwater pumping within DEID GSA on an average annual basis was estimated to be approximately 2,100 acre-feet/yr (see ***Table 1b*** of ***Appendix C,*** *Tule Subbasin Setting*).	The value is an "average" and should be shown as a range, with the most recent value reflecting current population conditions.	Clarification made.
Page 2-26. 2.5 Management Areas • The Earlimart Public Utilities District- The Earlimart PUD serves the water and wastewater needs of the unincorporated community of Earlimart. With a service area of 773 acres, the EPUD has been	Will the GSA recognize any future expansion of these management areas as they may annex additional lands for growth? Or, are the boundaries as established fixed for the long-term future? If they are not consistent, they may need to become consistent (e.g. the GSA will need to match the County's land use Plans in the updated GSP	Any future annexation will need to be addressed at the time it is proposed; the proposed annexation's impact on water demand within the DEID GSA area will be an important factor in the GSA's position. The DEID GSA is not anticipating an expansion

historically dependent on groundwater. Because of its location and being a purveyor of domestic water as well as managing wastewater, the EPUD is its own management area. • The Richgrove Community Services District- The Richgrove CSD serves the water and wastewater needs of the unincorporated community of Richgrove. With a service area of 234 acres, the RCSD has been historically dependent on groundwater. Because of its location and being a purveyor of domestic water as well as managing wastewater, the RCSD is its own management area.	within the next 5 years.	through annexation in either the EPUD MA or the RCSD MA over the next 5 years.
Page 3-20. 3.5.2.5.3 Effects on Beneficial Uses **Well failures** (*e.g. collapsed casing due to excessive groundwater level decline or land subsidence*): Minimum Thresholds established for groundwater levels to minimize loss of existing wells.	Unclear if some domestic well impacts are expected, and, if so, how such impacts to these deminimus users would be mitigated. Also, it is not clear what objective or subjective criteria were used in relation to the term 'minimize'.	The projects and management actions contemplated in the GSP are intended to prevent water levels from dropping to a level that would impact wells, regardless of whether the wells are for domestic or irrigation/agricultural use. However, this may be negatively influenced by continued pumping in surrounding GSAs' beyond the Subbasin-wide minimum thresholds. Within the context of the proposed transitional pumping project (see Section 5.2.2), an analysis of potential impacts to the DEID MA has been evaluated through a study done by Thomas Harder

		and Associates using the groundwater model developed for the subbasin. The study is not the definitive analysis of the impacts of WMA pumping to the DEID MA, but it is indicative of an anticipated impact. Further study and analysis will be modeled to determine the impacts with actual groundwater elevations used to confirm those impacts. DEID intends to address potential negative well impacts through a mitigation program with other Tule Subbasin GSA in accordance with the Coordination Agreement. The intent is to mitigate the impacts of resulting lower groundwater levels on landowners within the DEID GSA area caused by other GSAs.
Page 5-1. 5.2 Projects and Management Actions Municipal Water Supply and Quality Projects	The County will have a role with these projects as it relates to supporting the Community Plans in this GSA boundary.	DEID GSA looks forward to working cooperatively with the County on these projects.
Page 5-3. 5.2.1.1 Action 1 – Continued Importation and Optimization of Imported Water Supplies	This action will help stabilize levels for rural domestic users within this management area. The County is supportive. While rural domestic use is not explicitly named, the maintenance of gw levels will benefit this use group.	Thank you.
Page 5-8. 5.2.1.2 Action 2 – Increase Importation of Imported Waters Action 2 of the DEID Management Area consist of increasing imported water quantities above historic operations to meet consumptive	Similar to Action 1, this action will help stabilize levels for rural domestic users within this management area. The County is supportive. While rural domestic use is not explicitly named, the maintenance of gw levels will benefit this user group.	Thank you.

use requirements, new water demands, and reduce reliance on groundwater pumping.		
Page 5-17. 5.2.1.4.1 Description This Action will build upon the historic direct water recharge projects described in Action 3 to enhance the water resources available to the DEID Management Area. Future direct water recharge projects will increase the amount of water in storage through utilization of unused CVP imported water supplies available to the DEID Management Area through its long-term CVP water contract with the U.S. Department of the Interior. Other non-CVP supplies will also be used when and if available.	This action has the potential to transport water quality constituents (e.g. nitrates or arsenic) into drinking water sources.	All projects and management actions will be implemented within the sustainable management criteria set forth in Section 3 of the GSP, including groundwater quality (please see Section 3.5.1.3)
Page 5-33. 5.2.2.2.4 Quantification of Water Budget Impact If all lands within the WMA were to use the maximum amount of water under Action 1, over-pumping would total approximately XXXX3 acre-feet between 2020-2035.	The extent of over-pumping will have an impact on any domestic wells in this area. The County would like some assurances that any domestic wells that go dry due to this planned management approach are mitigated by those continuing the excessive extraction. There are likely only a few wells in this area, so should be a nominal consideration.	Please see response above to comment regarding "Page 3-20. 3.5.2.5.3 Effects on Beneficial Uses Well failures"
Page 5-34. 5.2.2.2.7 Anticipated Benefits and Evaluation Action 1 will provide an orderly transition from current pumping levels to sustainable levels as required by SGMA over a 15-year time period. It is designed to avoid the economic	The avoidance of economic impacts is reasonable. For your consideration, impacts to domestic wells in the area due to ongoing lowering of groundwater levels may need to be mitigated at the GSA level.	Please see response above.

impact that would otherwise be felt in an "overnight" reduction in water supplies. While implementation of Action 1 will delay reaching sustainability before 2035, through responsible mitigation of impacts, the benefits of this Action can be realized while meeting the goal of sustainability by 2040.		
Page 5-57. 5.2.3.1.1 Introduction Projects and management actions for the RCSD MA are associated with the following general categories of actions: • Current Groundwater Supply Optimization • Development of Additional Groundwater Supplies • Existing and Future Managed Aquifer Recharge	These actions will be coordinated with the County's Community Plan for this management area. Recommend updating LAFCo MSR's as a first step regarding CSD and PUD water supply capabilities.	The DEID GSA looks forward to working cooperatively with the county on projects and management actions impacting the County's plans.
Page 5-69. 5.2.4.1.1 Introduction Projects and management actions for the EPUD MA are associated with the following general categories of actions: • Current groundwater supply optimization • Development of additional groundwater supplies • Existing and future managed aquifer recharge	These actions should be coordinated with the County's Community Plan for this management area.	The DEID GSA looks forward to working cooperatively with the county on projects and management actions impacting the County's plans.
Page 6-6. 6.5.2 DEID GSA Land-Based Assessment Fees As noted above, general expenses of the GSP are anticipated to be funded through a per-acre land-based assessment across all acreage in	The County requests that the GSA look towards a different assessment rate for deminimus users.	Any assessments imposed by the DEID GSA must be applied equitably and consistent with state law.

the DEID GSA. This is expected to be achieve through either a Proposition 218 election of a Proposition 26 fee assessment.		
Page 22 of TULE SUBBASIN COORDINATION AGREEMENT ATTACHMENT 2 2.3.1.1.5. Municipal Deliveries from Wells Groundwater pumping for municipal supply is conducted by the city of Porterville and small municipalities for the local communities in the Tule Subbasin. From water years 1986-87 to 2016/17, municipal pumping from wells was estimated to average approximately 20,000 acre-ft.yr.	As noted previously, values like this are an 'average'. Generally, urban use is going to continue to grow as population grows - though the use per person may be lower.	Agreed. The Basin Setting includes projections for future municipal water use for each GSA and the Subbasin.

DELANO – EARLIMART IRRIGATION DISTRICT
GROUNDWATER SUSTAINABILITY AGENCY

APPENDIX L-4

Comment Letters Received on Plan

2024
2nd Amended Groundwater Sustainability Plan

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Central Region
1234 East Shaw Avenue
Fresno, California 93710
(559) 243-4005
www.wildlife.ca.gov

GAVIN NEWSOM, Governor
CHARLTON H. BONHAM, Director

November 26, 2019

Via Mail and Electronic Mail

Dale Brogan, Special Projects Manager
Delano-Earlimart Irrigation District GSA
14181 Avenue 24
Delano, California 93215

Email: dbrogan@deid.org

Subject: Comments on the Delano-Earlimart Subbasin Groundwater Sustainability Plan

Dear Mr. Brogan:

The California Department of Fish and Wildlife (Department) Central Region is providing comments on the Delano-Earlimart Subbasin Draft Groundwater Sustainability Plan (GSP) prepared by Delano-Earlimart Irrigation District Groundwater Sustainability Agency (GSA) for its portion of the Tule Subbasin (subbasin), pursuant to the Sustainable Groundwater Management Act (SGMA). As trustee agency for the State's fish and wildlife resources, the Department has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and the habitat necessary for biologically sustainable populations of such species (Fish & Game Code §§ 711.7 and 1802).

Development and implementation of Groundwater Sustainability Plans under SGMA represents a new era of California groundwater management. The Department has an interest in the sustainable management of groundwater, as many sensitive ecosystems and species depend on groundwater and interconnected surface waters, including ecosystems on Department-owned and managed lands within SGMA regulated basins. SGMA and its implementing regulations afford ecosystems and species specific statutory and regulatory consideration, including the following as pertinent to Groundwater Sustainability Plans:

- Groundwater Sustainability Plans must identify and consider impacts to groundwater dependent ecosystems (GDE's) pursuant to 23 California Code of Regulations (CCR) § 354.16(g) and Water Code § 10727.4(l);
- Groundwater Sustainability Agencies must consider all beneficial uses and users of groundwater, including environmental users of groundwater pursuant to Water Code §10723.2 (e); and Groundwater Sustainability Plans should identify and consider potential effects on all beneficial uses and users of groundwater

pursuant to 23 CCR §§ 354.10(a), 354.26(b)(3), 354.28(b)(4), 354.34(b)(2), and 354.34(f)(3);

- Groundwater Sustainability Plans must establish sustainable management criteria that avoid undesirable results within 20 years of the applicable statutory deadline, including depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water pursuant to 23 CCR § 354.22 *et seq.* and Water Code §§ 10721(x)(6) and 10727.2(b) and describe monitoring networks that can identify adverse impacts to beneficial uses of interconnected surface waters pursuant to 23 CCR § 354.34(c)(6)(D); and

- Groundwater Sustainability Plans must account for groundwater extraction for all Water Use Sectors including managed wetlands, managed recharge, and native vegetation pursuant to 23 CCR §§ 351(al) and 354.18(b)(3).

Furthermore, the Public Trust Doctrine imposes a related but distinct obligation to consider how groundwater management affects public trust resources, including navigable surface waters and fisheries. Groundwater hydrologically connected to navigable surface waters and surface waters tributary to navigable surface waters are also subject to the Public Trust Doctrine to the extent that groundwater extractions or diversions affect or may affect public trust uses (*Environmental Law Foundation v. State Water Resources Control Board* (2018), 26 Cal. App. 5th 844). Accordingly, groundwater plans should consider potential impacts to and appropriate protections for navigable interconnected surface waters and their tributaries, and interconnected surface waters that support fisheries, including the level of groundwater contribution to those waters.

In the context of SGMA statutes and regulations and Public Trust Doctrine considerations, the Department values SGMA groundwater planning that carefully considers and protects groundwater dependent ecosystems and fish and wildlife beneficial uses and users of groundwater and interconnected surface waters.

COMMENT OVERVIEW

The Department supports ecosystem preservation in compliance with SGMA and its implementing regulations based on Department expertise and best available information and science.

The Department recommends the GSP provide additional information and analysis that considers all environmental beneficial uses and users of groundwater in its sustainability management criteria, and better characterize and consider surface water-groundwater connectivity. In addition, the Department is providing comments and recommendations below.

COMMENTS AND RECOMMENDATIONS

The Department comments are as follows:

1. **Comment #1 Groundwater-Dependent Ecosystems.** Attachment 2 Tule Subbasin Coordination Agreement Draft Tule Subbasin Setting. Chapter 2 Tule Subbasin Setting. Section 2.2 Groundwater Conditions, Subsection 2.2.7 Groundwater Dependent Ecosystems (page 19) and Figure 2-26. The GDE identification section, pursuant to 23 CCR § 354.16 (g), is based on limited information to thoroughly identify ecosystems that may depend on groundwater and risks the exclusion of potential GDEs.

    a. *Issue*: Methods applied to the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset to identify potential GDEs are not robust. Note Figure 2-26 does not present any GDEs on the map. The removal of areas with a depth to groundwater greater than 25 feet in January 2015 relies on a single-point-in-time baseline hydrology, specifically a point in time that is several years into a historic drought when groundwater levels were trending significantly lower due to reduced surface water availability. Exclusion of potential GDEs based on this singular groundwater elevation measurement is questionable because it does not consider representative climate conditions (i.e., seasons and a range of water type years) and it does not account for GDEs that can survive a finite period of time without groundwater access (Naumburg et al. 2005), but that rely on groundwater table recovery periods for long term survival.

    b. *Recommendations:* The Department recommends clarifying if the GSP identifies any likely GDEs and recommends the GSP consider the following for improved information gathering to better ground truth potential GDEs:

        i. <u>Depth to Groundwater</u>: If the GSP does indeed analyze GDEs based on a depth to groundwater analysis as suggested on Figure 2-26, the Department recommends the GSP develop a hydrologically robust baseline from which to identify GDEs that relies on multiple, climatically representative years of groundwater elevation, that accounts for the inter-seasonal and inter-annual variability of GDE water demand, and that is based on a clear understanding of shallow groundwater. A robust hydrologic baseline will help account for GDEs that can survive a finite period of time without groundwater access (Naumburg et al. 2005), but that rely on groundwater table recovery periods for long-term survival.

ii. Include Additional References for Evaluation: The Department recognizes that NCCAG (Klausmeyer et al. 2018) provided by California Department of Water Resources (CDWR) is a good starting reference for GDE's; however, the Department recommends the GSP include additional resources (including local knowledge) for evaluating GDE locations. The Department recommends consulting other references, including but not limited to the following tools and other resources: the California Department of Fish and Wildlife (CDFW) Vegetation Classification and Mapping Program (VegCAMP) (CDFW 2019A); the CDFW California Natural Diversity Database (CNDDB) (2019B); the California Native Plant Society (CNPS) Manual of California Vegetation (CNPS 2019A); the CNPS California Protected Areas Database (CNPS 2019B); the United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (2018); the USFWS online mapping tool for listed species critical habitat (2019); the United States Forest Service CALVEG ecological grouping classification and assessment system (2019); and other publications by Klausmeyer et al. (2019), Rohde et al. (2018), The Nature Conservancy (TNC) (2014, 2019), and Witham et al. (2014).

2. **Comment #2 Environmental Beneficial Users.** Section.5 Notice and Communications. Subsection 1.5.1 Beneficial Uses and Users (page 1-31). The GSP does not identify environmental beneficial uses and users of groundwater.

   a. *Issue*: The GSP does not specifically identify environmental uses and users of groundwater as beneficial uses in the subbasin (page 1-31).

   b. *Recommendation*: The Department recommends identifying environmental beneficial uses and users of groundwater and including a detailed description on how these users, such as GDEs and the species therein, may rely on groundwater and may be impacted by Sustainable Management Criteria pursuant to 23 CCR §§ 354.10(a), 354.26(b)(3), 354.28(b)(4), 354.34(b)(2), and 354.34(f)(3). The Critical Species Lookbook (TNC 2019) is a resource to help identify threatened and endangered species in any basin and subbasin subject to SGMA and to help understand species relationships to groundwater. The LookBook also offers narrative on species and habitat groundwater dependence that can be a model for describing environmental beneficial uses and users of groundwater in the GSP.

OTHER COMMENTS: Implementation of Future Project Actions Related to SGMA

SGMA exempts the preparation and adoption of GSPs from the California Environmental Quality Act (CEQA) (WC §10728.6); however, SGMA specifically states that implementation of project actions taken pursuant to SGMA are not exempt from CEQA (WC §10728.6). The Department is California's **Trustee Agency** for fish and wildlife resources and holds those resources in trust by statute for all the people of the State (Fish & G. Code, §§ 711.7, subd. (a) & 1802; Pub. Resources Code, § 21070; CEQA Guidelines § 15386, subd. (a)). The Department, in its trustee capacity, has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and habitat necessary for biologically sustainable populations of those species (*Id.*, § 1802). Similarly, for purposes of CEQA, the Department is charged by law to provide, as available, biological expertise during public agency environmental review efforts, focusing specifically on projects and related activities that have the potential to adversely affect fish and wildlife resources.

The Department is also a **Responsible Agency** under CEQA (Pub. Resources Code, § 21069; CEQA Guidelines, § 15381), and the Department expects that it may need to exercise regulatory authority as provided by the Fish and Game Code for implementation of projects related to the GSP that are also subject to CEQA. These projects may be subject to the Department's lake and streambed alteration regulatory authority (i.e., Fish & G. Code, § 1600 et seq.). Notification pursuant to Fish and Game Code § 1602 is warranted if a project will (a) substantially divert or obstruct the natural flow of any river, stream, or lake; (b) substantially change or use any material from the bed, bank, or channel of any river, stream, or lake (including the removal of riparian vegetation); and/or (c) deposit debris, waste or other materials that could pass into any river, stream, or lake. Likewise, to the extent that implementation of any project may result in "take" as defined by State law of any species protected under the California Endangered Species Act (CESA) (Fish & G. Code, § 2050 et seq.), related authorization as provided by the Fish and Game Code will be required. The Department is required to comply with CEQA in its issuance of a Lake or Streambed Alteration Agreement or an Incidental Take Permit.

Water Rights: The implementation of SGMA does not alter or determine surface or groundwater rights (WC §10720.5). It is the intent of SGMA to respect overlying and other proprietary rights to groundwater, consistent with section 1200 of the Water Code (Section 1(b)(4) of AB 1739). The capture of unallocated stream flows to artificially recharge groundwater aquifers are subject to appropriation and approval by the State Water Resources Control Board (SWRCB) pursuant to Water Code § 1200 et seq. The Department, as Trustee Agency, is consulted by SWRCB during the water rights process to provide terms and conditions designed to protect fish and wildlife prior to appropriation of the State's water resources. Certain fish and wildlife are reliant upon aquatic and riparian ecosystems, which in turn are reliant upon adequate flows of water. The Department therefore has a material interest in assuring that adequate water flows within streams for the protection, maintenance and proper stewardship of those resources. The Department provides, as available, biological expertise to review and comment on environmental documents and impacts arising from project activities.

CONCLUSION

In conclusion, the Delano-Earlimart Subbasin Draft GSP needs to address all SGMA statutes and regulations, and the Department recommends the GSP seriously consider fish and wildlife beneficial uses and interconnected surface waters. The Department recommends that the GSP consider the above comments before the GSP is submitted to the California Department of Water Resources. The Department appreciates the opportunity to provide comments on the Delano-Earlimart Subbasin Draft GSP. If you have any further questions, please contact Dr. Andrew Gordus, Staff Toxicologist, at Andy.Gordus@wildlife.ca.gov or (559) 243-4014, extension 239.

Sincerely,

for Julie A. Vance
Regional Manager, Central Region

Attachment (Literature Cited)

ec: See Page Seven

ec: **California Department of Fish and Wildlife**

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Literature Cited

California Department of Fish and Wildlife (CDFW). 2019A. Vegetation Classification and Mapping Program. Available from https://www.wildlife.ca.gov/Data/VegCAMP

California Department of Fish and Wildlife. 2019B. CNDDB (California Natural Diversity Database). Rarefind Version 5. Internet Application. CDFW, Sacramento, California. https://www.wildlife.ca.gov/Data/CNDDB/Maps-and-Data

California Department of Water Resources (CDWR) 2019. Critically Overdrafted Basins. https://water.ca.gov/Programs/Groundwater-Management/Bulletin-118/Critically-Overdrafted-Basins

California Department of Water Resources (CDWR). 1997. Tulare basin resources assessment - preliminary report. Memorandum report. State of California The Resources Agency, San Joaquin District. 58 pp.

California Native Plant Society (CNPS). 2019A. A Manual of California Vegetation, online edition. http://www.cnps.org/cnps/vegetation/

California Native Plant Society (CNPS). 2019B. California Protected Areas Database. (CPAD). Sacramento, California. https://www.calands.org/cpad/

Naumburg E, R. Mata-Gonzalez, R.G. Hunter, T. McLendon and D. Martin. 2005. Phreatophytic vegetation and groundwater fluctuations: a review of current research and application of ecosystem response modeling with an emphasis on great basin vegetation. *Environmental Management.* 35(6):726-40

Klausmeyer, K., J. Howard, T. Keeler-Wolf, K. Davis-Fadtke, R. Hull, and A. Lyons. 2018. Mapping indicators of groundwater dependent ecosystems in California. https://data.ca.gov/dataset/natural-communities-commonly-associated-groundwater

Klausmeyer, K. R., T. Biswas, M. M. Rohde, F. Schuetzenmeister, N. Rindlaub, and J. K. Howard. 2019. GDE pulse: taking the pulse of groundwater dependent ecosystems with satellite data. San Francisco, California. Available at https://gde.codefornature.org. (Same as:TNC. 2019. GDE pulse. Interactive map. Website. https://gde.codefornature.org/#/home

Rohde, M. M., S. Matsumoto, J. Howard, S. Liu, L. Riege, and E. J. Remson. 2018. Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act: Guidance for Preparing Groundwater Sustainability Plans. The Nature Conservancy, San Francisco, California.

The Nature Conservancy (TNC). 2014. Groundwater and stream interaction in California's Central Valley: insights for sustainable groundwater management. Prepared by RMC Water and Environment.

The Nature Conservancy (TNC). 2019. The Critical Species LookBook. Groundwater Resource Hub. https://groundwaterresourcehub.org/sgma-tools/the-critical-species-lookbook/

U.S. Forest Service. 2019. Landsat-based classification and assessment of visible ecological groupings, USDA Forest Service (March 2007). https://www.fs.fed.us/r5/rsl/projects/classification/system.shtml

U.S. Fish and Wildlife Service (USFWS). 2018. National Wetlands Inventory website. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. http://www.fws.gov/wetlands/

U.S. Fish and Wildlife Service (USFWS). 2019. Threatened & Endangered Species Active Critical Habitat Report: online mapping tool. https://fws.maps.arcgis.com/home/webmap/viewer.html?webmap=9d8de5e265ad4fe09893cf75b8dbfb77

Witham, C. W., R. F. Holland, and J. E. Vollmar. 2014. Changes in the Distribution of Great Valley Vernal Pool Habitats from 2005 to 2012. Prepared for CVPIA Habitat Restoration Program, U.S. Fish and Wildlife Service, Sacramento, CA. USFWS Grant Agreement No. F11AP00169 with Vollmar Natural Lands Consulting. October 14.

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December 16, 2019

Alpaugh GSA
Delano Earlimart Irrigation District GSA
Eastern Tule GSA
Lower Tule River Irrigation District GSA
Pixley Irrigation District GSA
Tri-County Water Authority GSA

Re: **Comments on Tule Subbasin Groundwater Sustainability Plans**

To: The Directors and Staff of the Referenced Groundwater Sustainability Agencies

The Friant Water Authority (FWA), which operates the 152-mile long Friant-Kern Canal (FKC or Canal) on behalf of the United States Department of Interior's Bureau of Reclamation (Reclamation) and which Canal conveys contract water to 34 water agencies and municipalities that in turn serve tens of thousands of residential customers and over 1 million acres of farmland, respectfully submits this comment letter on the Groundwater Sustainability Plans (GSPs) that have been drafted by each of the Groundwater Sustainability Agencies (GSAs) addressed in this letter pursuant to the Sustainable Groundwater Management Act (SGMA).[1]

As a preliminary matter, we commend the various boards, staff members and technical consultants for the efforts that have gone into the preparation of the draft GSPs and for the transparent and collaborative manner in which the GSAs have engaged with stakeholders such as FWA. We are in this together, and your leadership to date, as evidenced by the outreach to our agency, has been exemplary. With the exception of the issues noted below, FWA fully supports the adoption and implementation of the GSPs. To that end, FWA looks forward to continuing our collaboration in order to achieve the "Sustainability Goal" of the Tule Subbasin, which, as defined in the Tule Subbasin Coordination Agreement (Coordination Agreement), is "the absence of significant and unreasonable undesirable results associated with groundwater pumping."[2]

In our initial comment letter of May 28, 2019, we notified each GSA that FWA would be carefully reviewing the draft GSPs in terms of the description and definition of undesirable results with respect to subsidence impacts to the Canal, and noted that while SGMA established a 20-year planning period to bring the Tule Subbasin into sustainability, the continuation of unmitigated land subsidence impacts to the Canal would be unacceptable and that feasible solutions must be identified. With that

[1] Water Code § 10720 and following.
[2] Coordination Agreement, § 4.2.

outcome in mind, we provide our specific comments on the draft GSPs, particularly the GSP of the Eastern Tule GSA (ETGSA).

We support the stated intent in the Coordination Agreement as to the purpose of avoiding undesirable results in the context of land subsidence: "the avoidance of an undesirable result of land subsidence is to protect critical infrastructure for the beneficial uses within the Tule Subbasin, including excessive costs to fix, repair, or otherwise retrofit such infrastructure and may also result in an interim loss of benefits to the users of such infrastructure."[3] It cannot be disputed that the FKC is one of if not THE most critical infrastructure facility in the Tule Subbasin with respect to the conveyance of water for beneficial use. It also cannot be disputed, as documented in the GSPs, that groundwater pumping in the vicinity of the Canal has resulted in upwards of 9 feet of land subsidence in recent decades - several feet of which has occurred in recent years even after the adoption of SGMA.[4] Because the Canal's conveyance system relies on a "gravity" design, this subsidence has reduced the conveyance capacity of the Canal to 40% of its original capacity (from 4,000 to 1,650 cubic-feet per second (cfs)) in these subsided areas. The resulting constriction in the Canal is precluding the delivery of significant amounts of water to Friant Division Contractors (Friant Districts) below the subsided areas and also affects the ability to Friant Districts above the constricted area to engage in exchanges or transfers of water.

As a result of the persistent overdraft conditions in the Tule Subbasin, FWA, at considerable expense, is developing plans, undertaking environmental review, and pursuing permitting to address these existing subsidence impacts by restoring capacity through a project referred to as the "Friant-Kern Canal Middle Reach Capacity Correction Project" (Project). The current engineering estimates place the cost of the Project in excess of $500 million.

With this well-documented and undisputed background in mind, including the extensive information, analysis and modeling in the GSPs and their supporting technical appendices, FWA must express its dissatisfaction with both the proposed "minimum thresholds" for subsidence and the criteria used to define "undesirable results" with respect to future subsidence as applied to the FKC. Specifically, the draft GSPs provide for **up to three feet of additional subsidence along the Canal** caused by transitional pumping/use **BEFORE** the identified ***minimum thresholds*** are exceeded. This impact will be compounded by the reliance of the GSPs on the definition of undesirable results in the Coordination Agreement, which provides as follows:

> <u>§ 4.3.4.2 Criteria to Define Undesirable Results</u>: "*the criteria for an undesirable result for land subsidence is defined as the unreasonable subsidence below minimum thresholds at* ***greater than 50% of GSA Management Area RMS*** *resulting in significant impacts to critical infrastructure*." (Emphasis added.)

Figure 5-1 of the GSP for the ETGSA identifies seven Representative Monitoring Sites (RMS) along the most severely subsided portion of the FKC covering a distance of approximately 12 miles measured from the Tule River at Avenue 152 to Avenue 80. Using the proposed criteria for defining an undesirable result, the "transitional" overdraft pumping will be permitted to potentially cause 3 additional feet of

[3] Coordination Agreement, § 4.3.4.3.

[4] ETGSA GSP, § 4.3.5; see also FWA's Friant-Kern Canal Fact Sheet (attached).

subsidence over at least a 4-6 mile area (the distance of 4 of 7 RMS (i.e., more than 50% of the Representative Monitoring Sites)) BEFORE being deemed an undesirable result.[5] This is not acceptable to FWA unless there is concurrent and corresponding mitigation in the form of compensation to FWA and the Friant Districts to pay for the damages resulting from such pumping as discussed further below.[6] If the GSAs agree to incorporate the prompt adoption of management actions that would provide reasonable compensation to address "interim" subsidence (i.e., the continuation of subsidence until the proposed "minimum thresholds" are reached), then FWA would not object to the GSPs maintaining these objectives, not as minimum thresholds that must be exceeded before management action is taken, but rather, as a basis for ***additional*** management actions, including greater compensation for damages to the Canal and Friant Districts and potential additional reductions in groundwater pumping to achieve sustainability sooner and avoid further impacts to the Canal if these so-called minimum thresholds are exceeded.

In addition to establishing a uniform zero-tolerance for additional subsidence impacts to the Canal absent appropriate compensation/mitigation, the criteria for monitoring any continued undesirable results for land subsidence as pertaining to the Canal need to be site specific and should be based on <u>any additional subsidence detected at a</u> <u>single RMS location</u>. Furthermore, because the FKC is critical infrastructure, FWA recommends that the Tule Subbasin GSPs incorporate additional RMS along the FKC for the entire length of the Tule Subbasin and that such RMS locations be spaced not more than one mile apart. Some of the Friant Districts are adding such monitoring sites for their own water banking/recharge projects near the FKC, and we would encourage the GSAs to incorporate these facilities as part of their subsidence monitoring management actions with respect to the FKC.

While the GSPs do not calculate the amount of capacity loss to the Canal from the contemplated 3 additional feet of subsidence that is predicted over the first 15 years of the GSPs, FWA estimates this capacity reduction to be on order of 460 cubic feet per second (cfs), which would result in a conveyance capacity of 1,140 cfs (based on current deficient conditions) and put the Canal capacity at 2,860 cfs below the original design capacity of 4,000 cfs. FWA further estimates that the 3 additional feet of subsidence contemplated under the GSPs will result in further reduced water deliveries to Friant Districts below the impacted area on the order of at least 30,000 to 40,000 acre feet (AF) per year, in addition to the already significant inability to convey water during wet years such as 2017 and 2019 where FWA estimates that upwards of 300,000 AF could have been delivered to Friant Districts <u>but for</u> the capacity restrictions caused by subsidence due to overdraft groundwater pumping in the Tule Subbasin. Under such conditions, Friant Districts' imported surface water supplies through the FKC will be even further restricted, which in turn will diminish their ability to contribute to the sustainable management of their own respective subbasins in the future.

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[5] See ETGSA GSP, § 5.8.3.1.2 (Quantified Minimum Thresholds).

[6] See Civil Code section 3479: "**Anything which is injurious to** health, including, but not limited to … an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life or property, or unlawfully obstructs **the free passage or use**, in the customary manner, **of any** …**canal** … **is a nuisance**." (Emphasis added.) It is FWA's position that any pumping activity causing further subsidence to the Canal constitutes a nuisance unless appropriate compensation/mitigation is provided.

FWA is encouraged that the GSP for ETGSA establishes a "Friant-Kern Canal Subsidence Management Area." However, neither that Plan nor any of the other GSPs establish specific management actions or mitigation to address the continued subsidence impacts to the Canal despite the fact that the GSPs contemplate continued overdraft conditions (aka "transitional pumping/use") through the implementation period of 2040.[7]

For the above reasons, **<u>all</u>** further subsidence along the Canal as contemplated in the GSPs should be considered significant and unreasonable and deemed to substantially interfere with surface land uses <u>unless</u> appropriate mitigation is provided to fairly compensate FWA and the Friant Districts for such interference.[8] Accordingly, the GSPs should be revised to mandate the prompt adoption of management actions (following adoption of the GSP) that provide for such equitable compensation as a condition of the transitional groundwater pumping permitted under each GSP in areas where such pumping can reasonably be demonstrated to cause continued subsidence impacts to the Canal.

Given the acknowledged effects of continued subsidence proximate to the FKC, these immediate management actions to mitigate such impacts are required. To this end, concurrent with the adoption of the final GSPs, as amended to address the comments provided herein, FWA respectfully request that the Board of each GSA direct staff to continue to work with FWA and Friant Districts to promptly develop and bring back for adoption management actions that would establish mechanisms to mitigate future subsidence impacts in the form of compensation to FWA and Friant Districts to pay for the costs of repairs to the FKC resulting from the transitional pumping/use permitted under the GSPs as well as the reduced water deliveries to Friant Districts until such repairs are completed. This mitigation could come in the form of fees or charges imposed on groundwater pumping and/or assessments or charges spread over the lands benefitting from groundwater pumping permitted under the GSPs that have caused, and can reasonably be demonstrated will continue to cause, undesirable results to the Friant-Kern Canal.

On behalf of FWA, I appreciate your consideration of these comments. FWA staff looks forward to continued collaboration on prompt and appropriate actions that will help us move forward with our mandate to restore critically needed capacity to the Friant-Kern Canal.

Sincerely,

Jason Phillips, CEO

Attachment: FWA Subsidence Fact Sheet

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[7] We acknowledge that the Delano-Earlimart GSP does contain management actions that assert it will achieve sustainability, but because the plan still anticipates that future subsidence will occur, more attention to address FWA's concerns regarding compensation for continuing subsidence impacts to the FKC is still warranted.

[8] See Water Code § 10721(x)(5).

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January 27, 2020

Via Email (equinley@deid.org)
Board of Directors
Delano-Earlimart Irrigation District GSA
14181 Avenue 24
Delano, California 93215

RE: Support of Final DEID GSA Groundwater Sustainability Plan

Dear Members of the Board of Directors and GSA Staff:

Friant Water Authority (FWA) staff has reviewed the DEID GSA Groundwater Sustainability Plan (GSP) dated January 2020 (Final Redline) (Final GSP) that is proposed for adoption at your meeting today, and for the reasons set forth below, we encourage adoption of the Final GSP. [1]

As you are aware, FWA submitted a comment letter dated December 16, 2019, to each Groundwater Sustainability Agency (GSA) within the Tule Subbasin regarding the GSPs that were being developed. As the operating non-federal entity of the Friant-Kern Canal (FKC), FWA outlined in its comment letter generalized concerns with how the GSAs were intending to define and monitor "undesirable results" under SGMA with respect to future subsidence impacts to the FKC caused by transitional overdraft pumping included within any GSP. In addition, FWA requested that GSAs either include a management action in the GSP or provide assurance that such action would be promptly taken following adoption of a GSP, which action would provide a mechanism to compensate FWA and the Friant Districts that pay for the operations, maintenance and replacement of the FKC to the extent such transitional pumping resulted in additional subsidence impacts to the FKC.

In the ensuing weeks, FWA staff has met on multiple occasions with General Manager Eric Quinley and Special Projects Manager Dale Brogan to discuss FWA's concerns and how they were being addressed in the Final GSP. We commend them both on their efforts and outreach, which has greatly assisted us in coming to this position of support for the Final GSP.

As an initial matter, and as reflected in the Final GSP, FWA is cognizant of the distinction between the existing conditions and historic groundwater management within the lands under the jurisdiction of the Delano-Earlimart Irrigation District (a

[1] Because the Final GSP was not released until after the January FWA Board of Directors meeting, FWA staff was not able to present to Plan to the Board for consideration and a request for a letter of support. We plan to do so at the February Board meeting.

net depositor of groundwater to the subbasin) and the lands within the GSA, which when viewed separate from DEID, contribute to overdraft conditions. To that end, we support the establishment of the "Western Management Area" (WMA), which consists of approximately 7,555 acres of actively farmed land adjacent to DEID, but without any readily available access to surface water (i.e., a "white area") as set forth in Section 5.2.2 of the Final GSP.

Section 5.2.2.2.2 (Circumstantial Considerations) appropriately documents the historic subsidence impacts to the FKC resulting from overdraft pumping in the Tule Subbasin, as well as the continued impacts to the FKC anticipated to be caused by transitional pumping within the Subbasin, including the WMA, as identified in analyses prepared by Thomas Harder and Associates.

Most importantly, Section 5.2.2.2.10 (Cost & Funding) outlines the potential establishment of "an assessment on WMA lands employing transitional pumping to fund FKC subsidence mitigation caused by pumping on those lands. The transitional pumping price paid by WMA landowners will include a per acre-foot FKC mitigation fee that may be subject to retroactive and future adjustment based on an assignment of relative responsibility of FKC subsidence that is the result of continued over-pumping through the WMA transitional pumping project." This is precisely the type of management action that FWA requested be included in any GSP that permitted overdraft pumping in the vicinity of the FKC that could cause further impacts to the FKC, particularly with respect to reduced conveyance capacity.

Finally, we also want to acknowledge the efforts of your staff in pressing for changes to the final Tule Subbasin Coordination Agreement that incorporate FWA's request that the criteria to define undesirable results in Section 4.3.4.2 be revised to allow GSAs to adopt a more stringent criteria (e.g., subsidence at a single Representative Monitoring Site (RMS)) where land subsidence may cause unreasonable adverse effects on the functionality of the FKC. The final Coordination Agreement includes this revision.

In closing, based on the content outlined above, FWA staff supports the Board's adoption of the Final GSP with respect to the vital matter of future land subsidence and mitigating potential impacts to the Friant-Kern Canal.

Sincerely,

Jason Phillips, CEO

cc: Tule Subbasin GSAs

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Eastern Tule GSA
Lower Tule River Irrigation District GSA
Pixley Irrigation District GSA
Delano-Earlimart Irrigation District GSA
Tri-County Water Authority GSA
Alpaugh GSA

RE: Public Comments to Tule Basin Groundwater Sustainability Plans (GSP)

To: Directors and Staff of the Referenced Groundwater Sustainability Agencies

Lindsay Strathmore Irrigation District supports the comment letter dated December 16, 2019, submitted on behalf of Friant Water Authority concerning your Groundwater Sustainability Plans (GSP) for the Tule Subbasin. By and through this letter, the District adopts each comment and objection in that letter as its own, along with any exhibits or attachments to that letter, and incorporates herein by this reference all such comments, objections, and documents.

The District specifically wants to emphasize the importance of addressing and resolving the ongoing subsidence issues with the Friant-Kern Canal that are caused or exacerbated by groundwater pumping in the Tule Subbasin. Allowing for three (3) additional feet of subsidence along the Friant-Kern Canal is unacceptable without adequate mitigation. Nor is it acceptable to further handicap this issue by requiring more than 50% of the seven (7) monitoring sites to show three (3) feet of subsidence before considering this matter an undesirable result. To prevent further water supply loss and economic injury to the Friant Contractors, the District urges you to meaningfully address and resolve the issue of subsidence in your GSPs, including undertaking the actions suggested by Friant Water Authority.

Sincerely,

Craig N. Wallace
General Manager
Lindsay-Strathmore Irrigation District

cc. LSID Board of Directors
Friant Water Authority
District Legal Counsel

December 17, 2019 (**Revised GSI 4-page Memo)**

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RE: Public Comments to Tule Basin Groundwater Sustainability Plans (GSP)

To Whom It May Concern,

The letter concerns the Groundwater Sustainability Plans (GSPs) that have been drafted by each of the agencies addressed in this letter pursuant to the Sustainable

Groundwater Management Act (Water Code § 10720 *et seq*.) ("SGMA"). The GSPs are referred to herein collectively as the "Tule Subbasin GSPs".

SGMA regulations are set forth in Title 23 of the California Code of Regulations. 23 CCR § 350.4(f) (General Principles) state a GSP "will be evaluated, and its implementation assessed, consistent with the objective that a basin be sustainably managed within 20 years of Plan implementation *without adversely affecting the ability of an adjacent basin to implement its Plan or achieve and maintain its sustainability goal over the planning and implementation horizon.*" (Emphasis added.) Furthermore, 23 CCR § 354.28 (Minimum Thresholds) states a GSP must describe "how minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals." There are other sections that speak to similar requirements regarding adjacent basins (e.g., §§ 354.34, 354.38, 355.4).

As you are well aware, there are at least two (2) Kern County water districts, Arvin-Edison Water Storage District and Shafter-Wasco Irrigation District (collectively referred to as "Friant Districts"), that have contracts for 441,275 acre-feet of water service with the United States Department of Interior's Bureau of Reclamation (Reclamation) from Millerton Lake located in Fresno/Madera County that is subsequently conveyed through the Friant-Kern Canal (FKC).

The Friant Districts encompass over 170,000 acres within the Kern Subbasin, which is adjacent to and just south of the Tule Subbasin**. The Friant Districts are concerned that the minimum thresholds in the Tule Subbasin GSPs as currently drafted are not protective of the beneficial water users downstream of the Tule Subbasin and will negatively impact the Friant Districts by limiting their ability to receive significant quantities of their contracted surface water imports due to past and ongoing subsidence within the Tule Subbasin**. Historically, the surface water imports into Kern County from the FKC have enabled the Friant Districts to achieve sustainable groundwater conditions. Unlike declines in groundwater levels, subsidence is a largely irreversible process and therefore once they occur impacts to the FKC from subsidence cannot be reversed, only mitigated through costly infrastructure repairs.

While the Tule Subbasin GSPs did not report loss of water supply from continued subsidence, the Friant Water Authority (FWA) in coordination with others, has completed a draft feasibility study and performed engineering estimates that are detailed in the attached "Friant-Kern Canal Middle Reach Capacity Correction Project Draft Recommended Plan Report" (Report), with current FKC repairs being in excess of $500 million. The Report estimated a projected average annual loss of up to 145,000 acre-feet per year of surface supply caused by continued land subsidence and the corresponding reduction in the conveyance capacity of the FKC (Report Table 5-4). However, during wet years, similar to 2017 and 2019, FWA has estimated the water supply losses to be nearly 300,000 acre-feet in both wet years, which figure would be significantly higher with an additional 3 feet of subsidence. Under such conditions of continued subsidence, the Friant Districts' imported surface water supplies through the FKC will be restricted such that the Friant Districts' ability to contribute to the sustainable management of the Kern Subbasin will be greatly compromised. The continued subsidence negatively impacts the Friant Districts and does not comport with the SGMA regulations, which therefore violates the following, including without limitation: 23 CCR §§ 350.4(f), 354.28, and 355.4(b)(7).

Friant Districts take great exception to the Tule Subbasin GSPs that assume up to a **maximum of 3 feet** of additional subsidence along the FKC (as well as up to nearly 9 additional feet of subsidence in other areas in the Tule Subbasin). While the GSPs did not calculate the amount of FKC capacity loss from such 3 feet drop in elevation, the FWA estimated the capacity reduction to be 1,140 cfs (or 460 cfs drop from current conditions and 2,860 cfs from original design of 4,000 cfs) (Report Figure 5-2). Given current conditions that already restrict FKC deliveries, any further subsidence would be significant and unreasonable and substantially interfere with surface land uses. (See Water Code § 10721(x)(5)). **Consequently, the Friant Districts recommend the Tule Subbasin GSPs include immediate management actions that provide for no additional subsidence (0 feet) beyond that "legacy" subsidence[1] which would occur if pumping were to cease immediately.** No analysis was undertaken to demonstrate how minimum thresholds for subsidence would impact the FKC and affected interests of beneficial users of groundwater or land uses and property interests. Furthermore, the analysis conducted to establish minimum thresholds in the Tule Subbasin GSPs relies on modeling for which sufficient uncertainty and sensitivity analysis have not been completed, or at the very least are not presented. Given the inherent uncertainty in the subsidence model, use of a safety factor in establishing minimum thresholds is warranted.

The Friant Districts' note that in addition to negative impacts to the Friant Districts' water supply, other FKC contractors that are located upstream of the Tule Subbasin will also experience negative financial impacts as a result of the FWA's FKC Operations & Maintenance (O&M) cost recovery methodology, which methodology is essentially based on *actual deliveries*. With continued subsidence in the Tule Subbasin, the Friant Districts' deliveries will be reduced and therefore northern FKC contractors' prorata share of the FKC O&M will increase.

In addition to the continued 3-foot subsidence allowance, the Tule Subbasin GSPs define an Undesirable Result for subsidence to occur when subsidence minimum thresholds are exceeded at greater than 50% of Representative Monitoring Sites (RMS) on a Management Area basis. This definition would allow exceedances of minimum thresholds at multiple RMS (e.g., 3 out of 7 RMS along the FKC in the Eastern Tule GSA area) without it being deemed an Undesirable Result. Friant Districts' recommend an Undesirable Result at just 1 RMS. In addition to changing the threshold, provided that the FKC is critical infrastructure, Friant Districts recommend that the Tule Subbasin GSPs incorporate additional RMS, located at one-mile intervals or less, along the FKC that spans the entire length of the Tule Subbasin. **However,**

[1] "Legacy" subsidence here refers to subsidence resulting from ongoing depressurization and compaction of compressible subsurface units due to historical groundwater pumping and groundwater level declines. Based on the physical characteristics of the compressible subsurface units in the Tule Subbasin, such "legacy" subsidence would be expected to continue for a period of up to approximately two years if groundwater pumping were to cease immediately (see attached letter from Dr. Chin Man Mok, GSI Environmental Inc.).

the GSPs do not clarify the projects or management actions that would be taken to avoid such Undesirable Results.

The GSPs contemplate the continued overdraft conditions (aka “transitional pumping”) through the implementation period of 2040, which has been modelled by the Tule Subbasin to cause subsidence. <u>However, the Tule Subbasin GSPs (except one) do not propose any form of mitigation.</u> (See CCR 23 § 354.44) In that regard, the Friant Districts’ appreciate the Delano-Earlimart Irrigation District’s (DEID) Policy Point #8 (Transitional Pumping), which states unmitigated transitional pumping within the Tule Subbasin would not be supported by DEID, and DEID’s treatment of the Western Management Area covering non-districted or “white lands”, which states transitional pumping would be subject to mitigation fees.

It shall be noted that the Tule Subbasin Coordination Agreement states the following regarding FKC subsidence:

- “…may result in an interim loss of benefit to the users of such infrastructure…”
- “…exceedance of minimum thresholds…could likely induce financial hardship on land and property interest…”

Given the acknowledged effects of continued subsidence proximate to the FKC, management actions expressly required to avoid and mitigate such impacts are promptly required. (See CCR 23, § 355.4 and Water Code § 10720.1(e).)
Additional observations about the GSP, including review of subsidence information from local experts, is detailed in the attached is EKI Environment and Water and GSI Environmental Technical memorandums.

Sincerely,

Edwin Camp
AEWSD President

Craig Fulwyler
SWID President

cc. California Department of Water Resources
Friant Water Authority
Kern Groundwater Authority
AEWSD Board of Directors
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16 December 2019

To: Jeevan Muhar, Arvin-Edison Water Storage District (AEWSD)
Dana Munn, Shafter-Wasco Irrigation District (SWID)

From: Anona Dutton, P.G., C.Hg., EKI Environment & Water, Inc. (EKI)
Christopher Heppner, Ph.D., P.G., EKI

Subject: Review and Comment on Treatment of Subsidence in Draft Tule Subbasin Groundwater Sustainability Plans, Particularly in the Vicinity of the Friant-Kern Canal
(EKI B60064.03)

Dear Messrs. Muhar and Munn,

EKI Environment & Water, Inc. (EKI) has conducted a review of selected draft Tule Subbasin Groundwater Sustainability Plans (GSPs) with respect to their treatment of subsidence, particularly in the vicinity of the Friant-Kern Canal (FKC). This review was conducted on behalf of the Arvin-Edison Water Storage District (AEWSD) and the Shafter-Wasco Irrigation District (SWID), collectively referred to herein as "Friant Districts". Our review encompassed the following documents, collectively referred to herein as the "Tule Subbasin GSPs":

1. Eastern Tule Groundwater Sustainability Agency, Tule Subbasin, *Sustainable Groundwater Management Act Groundwater Sustainability Plan*, September 2019.[1]
2. Delano-Earlimart Irrigation District Groundwater Sustainability Agency, Tule Subbasin, *Sustainable Groundwater Management Act Groundwater Sustainability Plan*, November 15, 2019, 1st Revision.[2]
3. Alpaugh Groundwater Sustainability Agency, *Groundwater Sustainability Plan*, DRAFT, October 2019.[3]
4. Lower Tule River Irrigation District Groundwater Sustainability Agency, Tule Subbasin, *Sustainable Groundwater Management Act Groundwater Sustainability Plan*, September 2019.[4]

[1] "ETGSA Draft GSP_19.10.2.pdf" obtained from https://easterntulegsa.com/gsp/ on 10/22/2019.
[2] "0.1-DEIDGSA Draft GSP (Full Document)_11.15.19_Rev1.pdf" obtained from https://deid.org/gsa/ on 12/11/2019.
[3] "Alpaugh_GSP_2019 DRAFT with appendices.pdf" obtained from https://alpaughgsa.com/ on 11/11/2019.
[4] "LTRID GSA Draft GSP_10.2.19.pdf" obtained from http://www.ltrid.org/sgma/#gsp on 11/7/2019.

5. Pixley Irrigation District Groundwater Sustainability Agency, Tule Subbasin, *Sustainable Groundwater Management Act Groundwater Sustainability Plan*, September 2019.[5]
6. Tri-County Water Authority, *Groundwater Sustainability Plan*, December 2019.[6]
    a. Addendum No. 1 to Tri-County Water Authority, *Groundwater Sustainability Plan*, dated September 25, 2019.[7]

This letter is structured as follows: First, relevant background information is presented regarding the Tule Subbasin Groundwater Sustainability Agencies (GSAs), the coordination amongst the GSAs, and the FKC. Next, we provide a set of specific comments on the reviewed documents related to the topic of subsidence. Comments are organized by topic and are prefaced by specific background information relevant to that topic. In some cases, comments are further refined to address issues identified in those three GSPs that cover lands that are "adjacent" to the FKC as well as issues identified in the other GSPs that cover lands that are "non-adjacent" to the FKC but still have the potential to impact the FKC (i.e., critical infrastructure).[8] The FKC should reasonably be considered as one of the "land uses and property interests that have been affected or are likely to be affected by land subsidence in the basin" per 23 CCR § 354.28(c)(5)(A).

GENERAL BACKGROUND INFORMATION

Tule Subbasin GSAs

There are seven GSAs within the Tule Subbasin:

- "Adjacent" GSAs
    - Delano-Earlimart GSA (DEIDGSA)
    - Eastern Tule GSA (ETGSA)
    - Lower Tule River Irrigation District GSA (LTRIDGSA)
- "Non-adjacent" GSAs
    - Alpaugh GSA (AGSA)
    - Pixley Irrigation District GSA (PIDGSA)

[5] "Draft PixID GSA GSP_10.27.19.pdf" obtained from http://www.ltrid.org/sgma/#gsp on 11/7/2019.
[6] "GSP PUBLIC DRAFT MASTER B-3 REVISIONS_FINAL_120419.pdf" obtained from https://tcwater.org/ on 12/11/2019.
[7] "TCWA-GSP-Addendum-No.-1.pdf" obtained from https://tcwater.org/ on 11/7/2019.
[8] The DWR DRAFT Sustainable Management Criteria Best Management Practices (BMP) document (https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-6-Sustainable-Management-Criteria-DRAFT_ay_19.pdf) states that "A GSA may decide, for example, that localized inelastic land subsidence near critical infrastructure (e.g., a canal) and basinwide loss of domestic well pumping capacity due to lowering of groundwater levels are both significant and unreasonable conditions."

- Tri-County Water Authority GSA (TCWAGSA)
- Tulare County GSA

The map figure below shows the jurisdictional boundaries of the seven GSAs in the Tule Subbasin, as well as the location of the FKC. The DEIDGSA, the ETGSA, and the LTRIDGSA cover lands that underlie portions of the FKC, and for the purposes of this comment letter are classified as "adjacent" GSAs. The remaining four GSAs cover lands that do not underlie the FKC and are thus considered "non-adjacent", but still have the potential to impact the FKC indirectly through management actions related to groundwater supply, demand, and level management.

Figure 3-2 from the ETGSA GSP

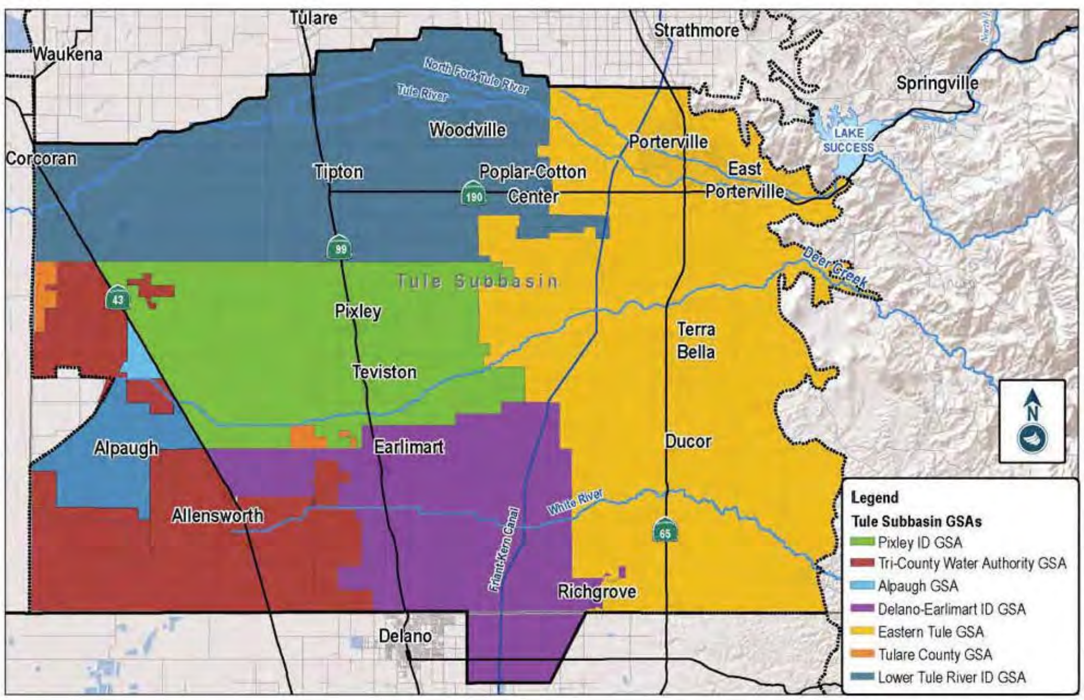

Figure 3-2: Tule Subbasin GSAs and GSP Plan Areas

Tule Subbasin Coordination Agreement

The seven Tule Subbasin GSAs have developed six coordinated GSPs[9], with certain key elements contained in a draft Tule Subbasin Coordination Agreement (TSCA). The version of the TSCA available at the time of this review is dated 9/16/2019. The key elements in the TSCA include:

[9] According to the Tule Subbasin Coordination Agreement (Section 1.2), the Tulare County GSA has entered into Memoranda of Understanding concerning coverage of territories under adjacent GSPs, and is therefore not preparing its own GSP.

- Coordinated Data and Methodologies for groundwater elevation and extraction, surface water supply, total water use, change in groundwater storage, and water budgets;
- Sustainable Management Criteria, including Undesirable Results (but not Minimum Thresholds, Measurable Objectives, and Interim Milestones);
- Monitoring Protocols, Networks, and Identification of Data Gaps; and,
- Implementation of GSPs.

The TSCA includes the following two attachments:

- Attachment 1: Tule Subbasin Monitoring Plan
- Attachment 2: Tule Subbasin Setting

Comments herein that pertain to topics covered in the TSCA are generally applicable to all Tule Subbasin GSAs, including the adjacent and non-adjacent GSAs, unless otherwise noted.

Friant-Kern Canal (FKC)

The FKC is a 152-mile long canal that forms the backbone of the United States Bureau of Reclamation (USBR) Central Valley Project's (CVP) Friant Division. The FKC conveys CVP Friant Division water from the Division's primary storage reservoir, Millerton Lake (formed by Friant Dam on the San Joaquin River), southwards to CVP Friant Division contractors within the Fresno, Kings, Kaweah, Tule and Kern County Subbasins, including to the Friant Districts. The Friant Districts collectively hold CVP contracts totaling 90,000 acre-feet (AF) of Class 1 Friant water (11.25% of the total Class 1) and 351,275 AF of Class 2 Friant water (25.0647% of the total Class 2 amount) (Friant Water Authority, 2019)[10]. As such, the Friant water supplies delivered through the FKC are critical to the ability of the Friant Districts to maintain and/or achieve sustainability within their service areas.

To date, subsidence along the FKC has impacted its conveyance capacity by 60 percent (Friant Water Authority, 2019).[11] As such, the Friant Districts have already lost access to a significant volume of their surface water supply, which has exacerbated groundwater issues in the Kern County Subbasin. Any further reduction in this critical surface water supply due to conveyance restrictions will impact the ability of the Friant Districts to support sustainable groundwater management locally and will impact the Kern County Subbasin's ability to implement its Plan and achieve and maintain its sustainability goal over the planning and implementation horizon.

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[10] Future Friant Division Supplies Tech Memo, https://friantwater.org/s/Future-Friant-Supplies-TM_20181228.pdf. Friant District contract amounts: Class 1 contracts: AEWSD: 40,000 AFY (5% of total Class 1), SWID: 50,000 AFY (6.25% of total Class 1). Class 2 contracts: AEWSD: 311,675 (22.2391% of total Class 2), SWID: 39,600 AFY (2.8256% of total Class 2).

[11] Friant Kern Canal Subsidence Fact Sheet, https://friantwater.org/s/Friant_Subsience_Impacts_Brochure.pdf

As shown in the figure above, the FKC passes through the eastern portion of the Tule Subbasin, primarily through the areas of the ETGSA and the DEIDGSA (with a small segment passing through the LTRIDGSA area). For this reason, some of the comments herein focus specifically on the treatment of subsidence in the DEIDGSA GSP, the ETGSA GSP and the LTRIDGSA GSP (i.e., the "adjacent" GSPs). However, given the critical importance of the FKC to the region's water supply, the comments pertain as well to the other GSPs prepared by the other Tule Subbasin GSAs (i.e., the "non-adjacent" GSPs) as they also have potential ability to impact the canal.

SELECTED COMMENTS

Based upon our review, we have the following comments, organized by topic.

1. **Regarding Tule Subbasin Sustainability Goal**

Background

Section 4.2 of the TSCA presents the Sustainability Goal for the Tule Subbasin, as follows:

> "Pursuant to 23 Cal. Code Regs. §357.24, the Sustainability Goal of the Tule Subbasin is defined as the absence of significant and unreasonable undesirable results associated with groundwater pumping, accomplished by 2040 and achieved through a collaborative, Subbasin-wide program of sustainable groundwater management by the various Tule Subbasin GSAs.
>
> Achievement of this goal will be accomplished through the coordinated effort of the Tule Subbasin GSAs in cooperation with their many stakeholders. It is further the goal of the Tule Subbasin GSAs that coordinated implementation of their respective Groundwater Sustainability Plans will achieve sustainability in a manner that facilitates the highest degree of collective economic, societal, environmental, cultural, and communal welfare and provides all beneficial uses and users the ability to manage the groundwater resource at least cost. Moreover, this coordinated implementation is anticipated to ensure that the sustainability goal, once achieved, is also maintained through the remainder of the 50-year planning and implementation horizon, and well thereafter.
>
> In achieving the Sustainability Goal, these Plans will inherently balance average annual inflows and outflows of water so that negative change in storage does not occur over time. The stabilization in change in storage should also drive stable groundwater elevations, which, in turn, works to inhibit water quality degradation and arrest land subsidence."

Comment: The Sustainability Goal in the TSCA and the Tule Subbasin GSPs is not fully consistent with the General Principles laid forth in the GSP Regulations.

This comment pertains to all of the Tule Subbasin GSPs (i.e., both the adjacent and the non-adjacent GSPs), as they all employ the same basin-wide definition of the Sustainability Goal found in the TSCA.

Under the GSP Emergency Regulations (Title 23 of the California Code of Regulations; 23 CCR) § 350.4(f), "a Plan will be evaluated, and its implementation assessed, consistent with the objective that a basin be sustainably managed within 20 years of Plan implementation without adversely affecting the ability of an adjacent basin to implement its Plan or achieve and maintain its sustainability goal over the planning and implementation horizon." The Sustainability Goal for the Tule Subbasin (Section 4.2 of the TSCA) does not mention ensuring that the GSPs prepared by GSAs within and for the Tule Subbasin will not adversely affect the ability of an adjacent basin to implement its Plan or achieve and maintain its sustainability goal over the planning and implementation horizon. Therefore, the Sustainability Goal does not reflect the General Principles of the GSP Emergency Regulations.

2. Regarding Undesirable Results Definitions

Background

This comment pertains to all of the Tule Subbasin GSPs (i.e., both the adjacent and the non-adjacent GSPs), as they all employ the same basin-wide definition of Undesirable Results found in the TSCA.

Section 4.3 of the TSCA asserts that four of the six Sustainability Indicators are relevant to the Tule Subbasin: (1) Chronic Lowering of Groundwater Levels, (2) Reduction of Groundwater Storage, (3) Degraded Water Quality, and (4) Land Subsidence. Section 4.3.4 of the TSCA provides the basin-wide definition of Undesirable Results for Land Subsidence.

Section 4.3.4.1 of the TSCA states:

> "Land subsidence shall be considered significant and unreasonable if there is a loss of a functionality of a structure or a facility to the point that, due to subsidence, the structure or facility cannot reasonably operate without either significant repair or replacement."

Section 4.3.4.2 of the TSCA further states:

> "the criteria for an undesirable result for land subsidence is defined as the unreasonable subsidence below minimum thresholds at greater than 50% of GSA Management Area [Representative Monitoring Sites] RMS resulting in significant impacts to critical infrastructure."

Section 4.3.4.3 of the TSCA further states:

> "the avoidance of an undesirable result of land subsidence is to protect critical infrastructure for the beneficial uses within the Tule Subbasin, including excessive costs to fix, repair, or otherwise retrofit such infrastructure and may also result in an interim loss of benefits to the users of such infrastructure."

Comment: The definition of Undesirable Results in the TSCA and the Tule Subbasin GSPs is not compliant with the GSP Regulations.

This comment pertains to all of the Tule Subbasin GSPs (i.e., both the adjacent and the non-adjacent GSPs), as they all employ the same basin-wide definition of Undesirable Results found in the TSCA.

Currently portions of the FKC have already experienced a 60 percent reduction of capacity due to subsidence (see Section 3.2 of the ETGSA Joint Powers Authority [JPA] Communication and Engagement Plan; Section III.B.3 of the DEIDGSA Communication & Engagement Plan). The Undesirable Results definition for Land Subsidence (Section 4.3.4.1 of the TSCA) does not provide a clear statement regarding whether the loss of FKC capacity to date is considered "significant and unreasonable". The TSCA also does not quantify how much additional capacity loss would be allowed by the GSAs before they would determine that the FKC "cannot reasonably operate without either significant repair or replacement". The Friant Districts maintain that the current 60 percent loss in FKC capacity is significant and unreasonable and that already the FKC is not able to reasonably operate without either significant repair or replacement. As such, the current condition meets the definition of an "Undesirable Result" and must be addressed.

As discussed further below under Comment #5, the Minimum Thresholds (MTs) for subsidence in the ETGSA GSP and DEIDGSA GSP allow for between 1.3 and 3.0 feet of additional subsidence at the eight Representative Monitoring Sites (RMS) along the FKC. The MT established in the LTRIDGSA GSP for the RMS closest to the FKC (RMS location W) would allow for up to 2.55 feet of additional subsidence. Any additional subsidence and subsequent loss of FKC capacity (and surface water supply) will adversely affect the ability of the Kern County Subbasin (which includes the Friant Districts) to implement its Plan or achieve and maintain its sustainability goal over the planning and implementation horizon. As such the MT definitions in the adjacent GSPs are inconsistent with GSP Regulations 23 CCR § 350.4(f) and § 354.28(b)(3). Furthermore, as discussed below, potential impacts to adjacent basins are required to be considered in the development of GSP monitoring networks, per GSP Regulations 23 CCR § 354.34(f)(3) and § 354.38(e)(4), and in the evaluation of Plans by the Department of Water Resources (DWR) per GSP Regulations 23 CCR § 355.4(b)(7).

The Undesirable Results definition for Land Subsidence (Section 4.3.4.2 of the TSCA) allows for up to 50 percent of the RMS to exceed their MTs. Given the sensitivity of the FKC capacity to changes in land surface elevation, and the documented loss of FKC capacity under historical subsidence conditions (mentioned in Sections 1.6 and 3.2 of the ETGSA JPA Communication and Engagement Plan; Sections III.A.1 and III.B.3 of the DEIDGSA Communication & Engagement Plan; Sections 5.2.1.2.1 and 5.2.2.2.2 of the DEIDGSA GSP; Section 2.5 of the Tule Subbasin Monitoring

Plan [Attachment 1 of the TSCA]; and Section 2.3.4 of the Tule Subbasin Setting [Attachment 2 to the TSCA]), allowing further subsidence to exceed MTs in up to 50% of RMS is not protective of this critical infrastructure. This Undesirable Results definition has the potential to significantly and unreasonably affect not only the Tule Subbasin but the Friant Districts and adversely affect the ability of the Kern County Subbasin (which includes the Friant Districts) to implement its Plan or achieve and maintain its sustainability goal over the planning and implementation horizon, which would be inconsistent with GSP Regulations 23 CCR § 350.4. and § 354.28(b)(3).

The Undesirable Results definition for Land Subsidence (Section 4.3.4.3 of the TSCA) only recognizes the beneficial uses within the Tule Subbasin, neglecting to recognize those downstream beneficial uses and users of critical infrastructure (i.e., the Friant Districts). This limited consideration of only in-basin beneficial uses and users in inconsistent with the GSP Emergency Regulations 23 CCR § 354.26(b)(3) which makes no such distinction between in-basin and out-of-basin beneficial uses and users, and § 350.4(f) which describes the evaluation of a Plan "consistent with the objective that a basin be sustainably managed within 20 years of Plan implementation without adversely affecting the ability of an adjacent basin to implement its Plan or achieve and maintain its sustainability goal over the planning and implementation horizon."

3. Regarding the Basin Setting

Background

A Tule Subbasin-wide summary of the Basin Setting element of GSPs is contained within the TSCA (Section II and Attachment 2) and includes a discussion of subsidence (Section 2.2.5 of Attachment 2 of the TSCA). With respect to subsidence along the FKC, the subsidence section in the TSCA Tule Subbasin Setting includes a single sentence providing a range of cumulative subsidence values for the 58-year period from 1959 – 2017 from benchmarks monitored by the Friant Water Authority:

> "Based on benchmarks located along the Friant-Kern Canal and monitored by the Friant Water Authority, cumulative land subsidence along the canal between 1959 and 2017 has ranged from approximately 1.7 ft in the Porterville area to 9 feet in the vicinity of Deer Creek (see Figure 2-24)".

A number of other subsidence rates for different time periods and different parts of the Tule Subbasin are mentioned and two subsidence map figures (one for the period 2015-2018 and the other for 2007-2011 which does not cover the FKC area) are included in the TSCA. However, despite the statement that "land surface subsidence in the Tule Subbasin as a result of lowering the groundwater level from groundwater production has been well documented" (TSCA, Attachment 2, Section 2.2.5), no supporting information is provided on groundwater level changes or groundwater production as it relates to observed subsidence rates. Additional and readily available information available through the SGMA Data Viewer is not used. As such, the Basin Setting portion of the TSCA and the GSPs is inconsistent with the standard that the "best available information" be used (23 CCR § 354.16).

The water budget section of the Tule Subbasin Setting (TSCA Attachment 2, Section 2.3.5) mentions impacts to the FKC due to subsidence:

> "The primary surface water supply issue affecting the ability of agencies to operate within the Sustainable Yield of the subbasin is reduced delivery capacity in the Friant-Kern Canal due to land subsidence. Land subsidence has lowered the canal elevation in certain areas resulting in a reduction in downstream canal delivery capacity".

The above statement does not include any quantitative descriptions of impacts to the FKC from subsidence, although such description is mentioned elsewhere in the document (i.e., in the Communication and Engagement Plans of the ETGSA and DEIDGSA).

Each individual GSP also contains a brief discussion of the Basin Setting elements, including subsidence, but the discussion refers to the TSCA Tule Subbasin Setting and does not provide any additional information.

Comment: The Basin Setting information lacks sufficient discussion of the serious issue of subsidence.

Adjacent GSPs: The Basin Setting sections of the adjacent GSPs do not provide detailed information about subsidence, particularly as it pertains to the impacts on the FKC. For example, the cumulative subsidence data provided at several points along the FKC are values over a very long time period (58 years), with no attempt made to correlate such values either in time or in space with changes in groundwater elevation. The InSAR data shown on one map figure (Figure 2-25 of the Tule Subbasin Setting) only cover four years. These exhibits are therefore of limited value in understanding the scale of the subsidence issue in the Tule Subbasin and its relation to declining groundwater levels which are the key factor over which GSAs are likely to have direct control (i.e., through management of water supplies and demands). By providing such a limited presentation of data and discussion, the GSPs are not in compliance with 23 CCR § 354.16(e), which states that a GSP must include information on "the extent, cumulative total, and annual rate of land subsidence, including maps depicting total subsidence, utilizing data available from the Department… or the best available information". Additional datasets available through the SGMA Data Viewer (i.e., data from USGS and DWR extensometers and InSAR data from the TRE Altamira and NASA JPL) should be examined and presented in the GSPs to the greatest extent possible and applicable, along with data on changes in groundwater levels.

While the 60 percent reduction in FKC delivery capacity as a result of subsidence in the Tule Subbasin is mentioned in the ETGSA JPA Communication and Engagement Plan and in the DEIDGSA Communication & Engagement Plan, it is not discussed elsewhere in either of these two GSP documents, nor in the LTRIDGSA GSP. This important fact should be mentioned in the "Potential Effects on Beneficial Uses and Users" sections of the GSPs and/or the Land Subsidence section (Section 2.2.5) of the Tule Subbasin Setting document (Attachment 2 to the TSCA). Additional information related to impacts to the FKC conveyance capacity should be included and appropriately cited.

Non-Adjacent GSPs: The non-adjacent GSPs similarly contain only limited information and discussions about subsidence in their Basin Setting sections. No correlations between subsidence, groundwater level declines and/or groundwater production area provided. Given the significance of the subsidence issue in the Tule Subbasin, and the relatively large subsidence rates observed over time and recently, more detailed information should be provided (for example, the additional datasets that have been made readily available through the DWR SGMA Data Viewer website; see list above). By providing such a limited presentation of data and discussion, the GSPs are not in compliance with 23 CCR § 354.16(e), which states that a GSP must include information on "the extent, cumulative total, and annual rate of land subsidence, including maps depicting total subsidence, utilizing data available from the Department… or the best available information".

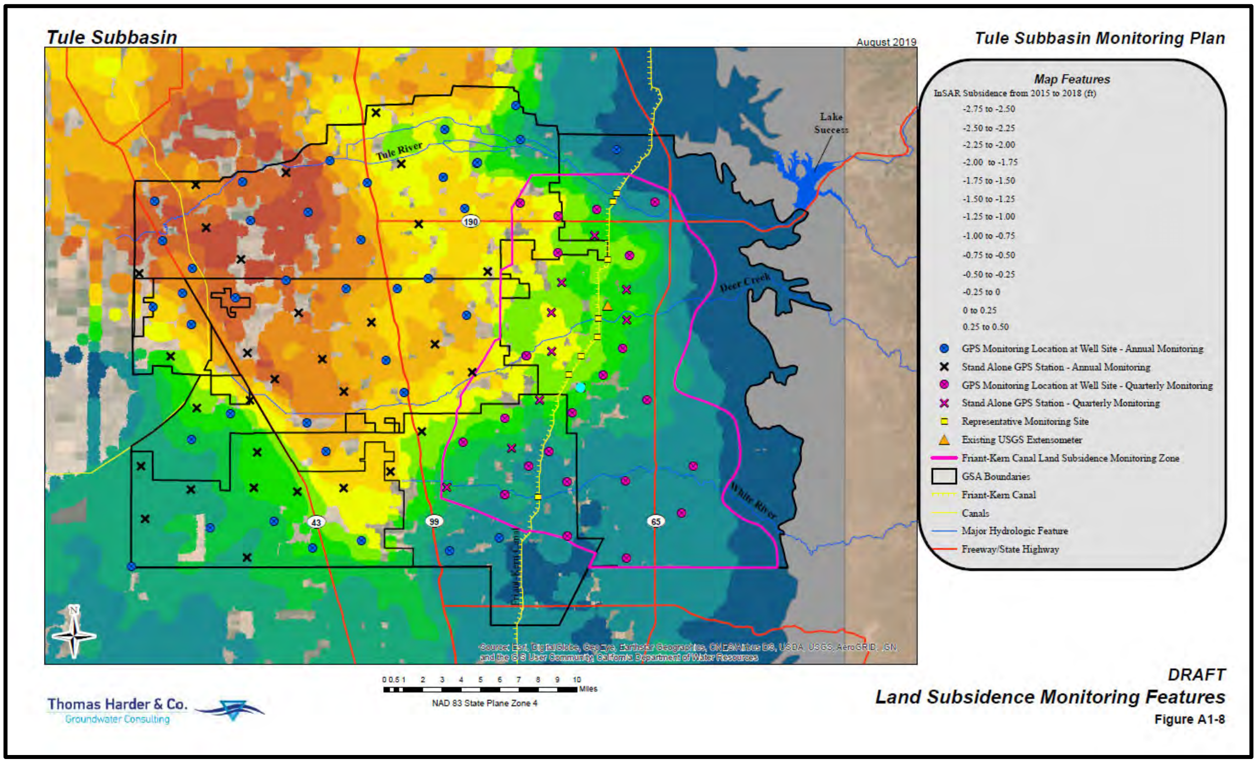
4. Regarding Monitoring Networks and Management Areas for Subsidence

Background

The Tule Subbasin contains a "land subsidence monitoring area" that is approximately centered around the FKC and extends west four miles and eastward to the 1-ft cumulative subsidence 1986-2017 contour. This area is shown by the solid pink line in Figure A1-8 of Attachment 1 of the TSCA (see figure below). This map figure also shows the cumulative subsidence between 2015 and 2018 based on InSAR data. Based on this data, the subsidence along the FKC during this period was up to 1.25 ft.

The ETGSA contains a "Friant-Kern Canal Subsidence Management Area" which appears to be the same as the "land subsidence monitoring area" mentioned in the TSCA Monitoring Plan.

Figure A1-8 from the Tule Subbasin Monitoring Plan (Attachment 1 of the TSCA)



The Tule Subbasin Monitoring Plan (Attachment 1 to the TSCA) describes the network and protocols for land subsidence (and other indicators). It consists of:

- GPS stations (existing ones operated by USBR along the FKC, and new ones including 63 at monitoring well locations and 39 standalone GPS stations); annual frequency for all sites, except quarterly for sites within the "FKC Monitoring Zone" (which is presumably the same as the "land subsidence monitoring area" mentioned in the TSCA);
- Extensometers (one operated by USGS along the FKC one mile north of Deer Creek crossing); continuous data collection with periodic uploads by USGS; and
- Satellite data (InSAR), obtained from JPL, USGS, or ESA and analyzed/interpreted by 3rd party to develop maps, for six periods over the first year of monitoring and then less frequent after that.

The Tule Subbasin Monitoring Plan also recommends the installation of a new extensometer in the northwestern portion of basin (not near the FKC).

There are a total of eight GPS monitoring locations along the FKC that are used as RMS in the three adjacent GSPs (seven RMS in the ETGSA GSP and one RMS in the DEIDGSA GSP). These locations are labeled B through I and shown in the two figures below.

Figure 6-3 from the ETGSA GSP

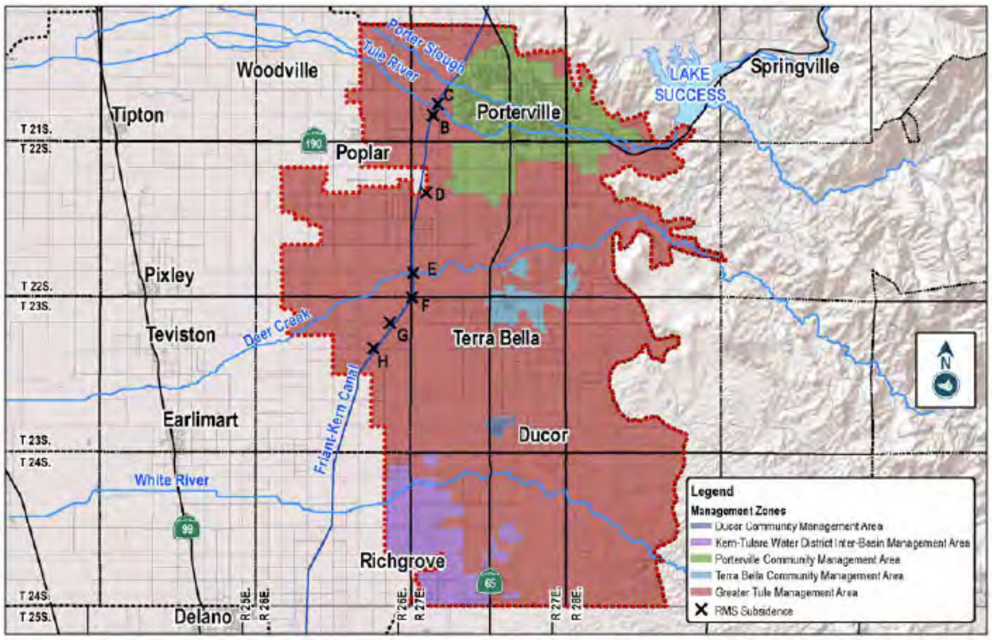


Figure 6-3: RMS for Monitoring Land Subsidence

Figure 4-3 from the DEIDGSA GSP

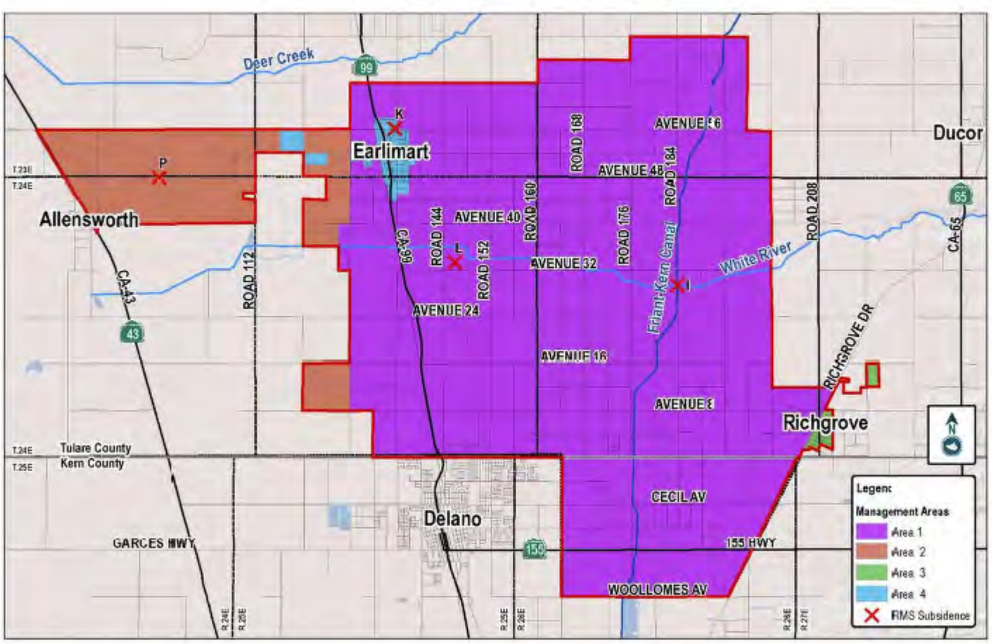


Figure 4-3: RMS for Monitoring Land Subsidence

Comment: The Monitoring Network for subsidence in the vicinity of the FKC is inadequate.

Adjacent GSPs: The DEIDGSA GSP monitoring network (Section 4.2.3.5) only contains a single RMS along the FKC, which provides inadequate spatial resolution to capture the details of subsidence in the DEIDGSA area. The GSP Regulations 23 CCR § 354.34(f) requires that the Agency "determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors … (3) Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal." Given that the DEIDGSA GSP monitoring network only contains a single subsidence RMS along the FKC, the network will not allow for sufficient characterization of impacts to overlying land uses (i.e., including critical infrastructure such as the FKC) and impacts to adjacent basins. As such, the subsidence monitoring network does not appear to satisfy the requirements of GSP Regulations 23 CCR § 354.34(f).

5. Regarding Sustainable Management Criteria for Subsidence in Adjacent GSPs

Background

Sustainable Management Criteria (SMCs) include Measurable Objectives (MOs), Interim Milestones (IMs), and Minimum Thresholds (MTs). The IMs and MOs for subsidence are defined based on the projected depth of subsidence calculated by the Groundwater Flow Model[12] based on a model run that incorporates planned Projects & Management Actions (P/MAs).

The MTs for subsidence, in terms of change from baseline (2020) elevations, are defined in the ETGSA GSP (Section 5.8.3.1.1) as the lesser of 3 ft -OR- the amount of elevation change observed over the 2007-2016 period (a "recent drought") subtracted from the lowest interim milestone from 2020-2030). This value is then subtracted from the baseline elevation to determine the MT in terms of elevation at each RMS. In the DEIDGSA GSP, there is no 3-ft maximum included in the subsidence MT definition (Section 3.5.2.4.1). Similarly, in the LTRIDGSA GSP, there is no 3-ft maximum included in the subsidence MT definition (Section 3.5.2.4.1), meaning that the MT is not limited to 3 feet.

The SMCs for the eight subsidence monitoring locations along the FKC are shown in Table 1, below, compiled by EKI from information included separately in the ETGSA and DEIDGSA GSPs. As shown in Table 1, five of the eight RMS locations along the FKC have MTs for subsidence that are 3.0 feet below the Baseline elevation (i.e., they would allow an additional 3.0 feet of land subsidence directly adjacent to the FKC). SMCs for subsidence RMS locations that are not along the FKC are also shown in Table 1. These MTs allow for subsidence of up to approximately 9.0 feet at some RMS locations.

[12] The numerical Groundwater Flow Model is based on the hydrogeologic conceptual model (see TSCA Section 2.2). Thomas Harder & Co., 2019. Groundwater Flow Model of the Tule Subbasin (DRAFT in Progress).

Table 1
SMCs for Land Subsidence in the Tule Subbasin GSPs

GSA	RMS ID	Baseline 2020 ft msl	Interim Milestones 2025 ft msl	Interim Milestones 2030 ft msl	Interim Milestones 2035 ft msl	Measurable Objective 2040 ft msl	Minimum Threshold ft msl	Difference between Baseline and MT ft
RMS Locations Along the Friant-Kern Canal								
ETGSA	B	406.46	406.12	405.90	405.84	405.85	404.80	1.66
ETGSA	C	404.30	404.03	403.83	403.78	403.77	403.00	1.30
ETGSA	D	403.99	403.50	403.25	403.25	403.25	400.99	3.00
ETGSA	E	396.86	396.54	396.38	396.39	396.39	393.86	3.00
ETGSA	F (1)	406.46	406.12	405.90	405.84	405.85	403.46	3.00
ETGSA	G	391.70	390.59	389.98	389.92	389.85	388.70	3.00
ETGSA	H	394.13	392.57	391.62	391.49	391.36	391.13	3.00
DEID GSA	I	396.24	396.00	395.77	395.65	395.62	394.77	1.47
RMS Locations Not Along the Friant-Kern Canal								
PIDGSA	A	201.95	201.2	200.39	199.83	199.66	194.6	7.35
PIDGSA	J	261.59	260.77	259.96	259.23	258.80	256.51	5.08
PIDGSA	Q	258.93	258.90	257.31	256.74	256.43	252.84	6.09
PIDGSA	R	232.34	231.07	230.22	229.70	229.37	225.94	6.40
PIDGSA	T	193.10	190.99	188.95	187.04	185.44	184.38	8.72
LTRIDGSA	U	202.19	200.80	199.35	197.94	194.91	194.91	7.28
LTRIDGSA	W	350.25	349.71	349.10	348.60	348.28	347.70	2.55
LTRIDGSA	X	259.71	257.98	256.14	254.48	253.24	250.73	8.98
LTRIDGSA	Y	255.53	254.39	253.25	252.10	251.18	249.64	5.89
LTRIDGSA	Z	228.86	227.34	225.84	224.51	223.60	220.25	8.61
TCWAGSA	No subsidence SMCs established	-	-	-	-	-	-	-
AGSA		-	-	-	-	-	-	-

Abbreviations

AGSA = Alpaugh Groundwater Sustainability Agency
DEID = Delano-Earlimart Irrigation District
ET = Eastern Tule
ft = feet
ft msl = feet above mean sea level
GSA = Groundwater Sustainability Agency
GSP = Groundwater Sustainability Plan
LTR = Lower Tule River
MT = Minimum Threshold
PID = Pixly Irrigation District
RMS = Representative Monitoring Site
SMC = Sustainable Management Criteria
TCWA = Tri-County Water Authority

Note:

(1) The Baseline, Interim Milestones, and Measurable Objective for RMS location F appears to be duplicative of RMS location B, and therefore may be incorrect.

The ETGSA GSP contains a subsidence discussion of "Minimum Thresholds in Relation to Adjacent Basins" (Section 5.8.3.3), as follows:

> "Per criteria described for define minimum thresholds for groundwater levels in Section 5.8.3.1 Criteria to Define Minimum Thresholds, the GFM projects groundwater elevations based the Tule Subbasin reaching sustainability by 2040, with built in operational flexibility of a 10-year drought occurring during the 20-year implementation horizon of this plan. Adjacent basins have been tasked with the same objective to reach sustainability 2040, therefore, based on the criteria previously described, if minimum thresholds were experienced at groundwater level RMS, adjacent basins would experience similar groundwater conditions not as a direct result of minimum thresholds set by the Agency."

The DEIDGSA GSP contains a section called "Effects on Adjacent Basins" that simply concludes that:

> "as groundwater elevations are stabilized to natural conditions during the Plan Implementation period, adjacent basins should not be affected by the GSA".

The DEIDGSA GSP also includes a section called "Effects on Beneficial Uses" that has a bullet on subsidence that mentions impacts to existing critical infrastructure "including the District canal system" but does not mention the FKC.

Comment: The proposed Sustainable Management Criteria for subsidence are insufficient in their consideration of impacts on adjacent basins.

<u>Adjacent GSPs</u>: The definitions of MTs for subsidence in the ETGSA GSP and the DEIDGSA GSP allows for large amounts of additional subsidence at the eight RMS locations along the FKC relative to present "Baseline" elevations. The MTs for subsidence at these eight RMS locations range from 1.3 feet to 3.0 feet, with five RMS locations with MTs of 3.0 feet. The MT established in the LTRIDGSA GSP for the RMS closest to the FKC (RMS location W) would allow for up to 2.55 feet of additional subsidence. These amounts of additional subsidence in close proximity to the FKC could have significant and unreasonable impacts on the FKC's ability to convey water to all downstream users and adversely affect the ability of the Kern County Subbasin (and Friant Districts) to implement its Plan or achieve and maintain its sustainability goal over the planning and implementation horizon. The MTs are therefore not protective of those beneficial users of the FKC both within the Tule Subbasin and in the adjacent Kern County Subbasin.

No analysis is provided in the ETGSA, DEIDGSA, and LTRIDGSA GSPs or in the TSCA as to specifically how the MTs for subsidence would impact the FKC, a "land use" of critical regional importance. Therefore, the discussion does not satisfy the requirements of GSP Regulations 23 CCR § 354.28(b)(4) which states that the description of MTs shall include "How minimum thresholds affect the interests of beneficial uses and users of groundwater or land uses and property interests" and GSP Regulations 23 CCR § 354.28(c)(5), which states "The minimum thresholds for land subsidence shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results."

The reference to Section 4.3.4.3 of the TSCA is insufficient in this regard, as that section (which pertains to Undesirable Results for Land Subsidence) only mentions "financial hardship on land and property interests, such as the redesign of previously planned construction projects and the fixing and retrofitting of existing infrastructure"; it does not contemplate the reduction in FKC capacity and subsequent reduced availability of FKC supplies to downstream users which will directly impact those users' and basin's ability to achieve and maintain sustainability throughout the planning and implementation horizon. Nor does it contemplate the significant financial impacts related to addressing the subsidence impacts to the FKC.

The ETGSA GSP discussion of "Minimum Thresholds in Relation to Adjacent Basins" (Section 5.8.3.3) is not specific to or relevant to the subsidence sustainability indicator (i.e., the same text is used for subsidence as for the chronic lowering of groundwater levels sustainability indicator). The discussion furthermore dismisses the possibility that actions or inactions within the Tule Subbasin could negatively affect adjacent basins, rather stating that "adjacent basins would experience similar groundwater conditions not as a direct result of minimum thresholds set by the Agency". This assertion is not supported by facts or consistent with the reality that the MTs for subsidence set by the Agency (i.e., the ETGSA) will affect FKC conveyance capacity and therefore adversely affect the Friant Districts and impact the Kern County Subbasin's ability to achieve groundwater sustainability.

The DEIDGSA GSP contains a section "Effects on Adjacent Basins" (Section 3.5.2.5.2) that simply concludes that "as groundwater elevations are stabilized to natural conditions during the Plan Implementation period, adjacent basins should not be affected by the GSA." This assertion is not supported by facts or consistent with the reality that the MTS for subsidence set by the Agency (i.e., the DIEDGSA) will very likely impact FKC conveyance capacity and therefore adversely affect the Friant Districts and impact the Kern County Subbasin's ability to achieve groundwater sustainability.

None of the adjacent GSA GSPs contains a discussion of how the out-of-basin interests were considered during the Minimum Threshold development process. The definitions of MTs in the ETGSA GSP and the DEIDGSA GSP, therefore, do not satisfy the requirements of GSP Regulations 23 CCR § 354.28(b)(3), which states that the description of MTs shall include "how minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals".

<u>Non-Adjacent GSPs</u>: The establishment of SMCs for subsidence in the non-adjacent Tule Subbasin GSPs is also problematic, even though subsidence in those areas may not have a direct impact on the FKC. For the two non-adjacent GSPs that do establish SMCs for subsidence, the MTs are set so as to allow for significant further subsidence beyond baseline conditions (see Table 1). Specifically, the MTs for subsidence in the LTRGSA GSP for RMS locations other than location W (discussed above) allow for between 5.89 and 8.98 feet of subsidence relative to baseline

conditions, and the MTs for subsidence in the PIDGSA GSP allow for between 5.08 and 8.72 feet of subsidence relative to baseline conditions.

The other two non-adjacent GSPs do not even set SMCs for subsidence. The TCWAGSA GSP does not set SMCs for subsidence, citing a lack of ground-based measurements, even though the available satellite-based subsidence data suggest subsidence rates of approximately 0.7 to 2.0 feet over the 16-month period from May 7, 2015 to September 10, 2016. Likewise, the AGSA GSP does not define SMCs for subsidence, but rather states that five years of monitoring (i.e., from 2020 – 2024) will be used to establish baseline rates of subsidence and then to set site-specific SMCs.

6. Regarding Projects and Management Actions

Background

The DEIDGSA GSP mentions subsidence-related FKC capacity constraints in one P/MA (Action 2 – Increase Importation of Imported Waters; Section 5.2.1.2), but only as a reason to pursue the action, not as a problem to be addressed. Under another P/MA (Action 1 – Transitional Pumping [for White Areas]), the DEIDGSA GSP includes additional discussion of impacts to the FKC, and states that additional study and analysis will:

> "look at finding the relative cause of future predicted subsidence along the FKC … likely to lead to an assessment of costs of FKC subsidence mitigation to those lands employing transitional pumping … collection of mitigation fees would then be used to correct subsidence impacts on the FKC … would restore the carrying capacity of the FKC … would restore the ability of Friant contractors in the Tule Subbasin and those further south to receive their contractual imported water without capacity limitations."

The ETGSA mentions subsidence as being one of the sustainability indicators that will be "generally" affected by various P/MAs.

The planned P/MAs that are aimed at achieving sustainability through a balancing of the groundwater budget are described in Section 2.3.5 of the Tule Subbasin Setting (Attachment 2 of the TSCA). Details of "transitional pumping" schedules for each of the GSAs under the planned P/MAs are provided in Table 2-7 of the Tule Subbasin Setting (below). As shown in Table 2-7, the projected year for achieving sustainability ranges from 2035 to 2040 for all areas except for the DEIDGSA District Area which is described as already being sustainable (i.e., "No Change / Sustainable"). Until sustainable conditions are achieved (i.e., for at least 15 more years in all areas except the DEIDGSA District Area), the planned P/MAs will allow for continued over-pumping which will result in continued water level declines. For the DEID White Lands (i.e., the "Western Management Area" consisting of undistricted lands), the transitional pumping schedule calls for no reduction in pumping relative to existing crop consumptive use.

Table 2-7 of the Tule Subbasin Setting (Attachment 2 of the TSCA)

Tule Subbasin
Chapter 2 - Basin Setting

DRAFT
Table 2-7

Planned Transitional Pumping by GSA

	Eastern Tule GSA	LTRID GSA	Pixley ID GSA	DEID-District Area	DEID White Lands Area	Tri-Co GSA	Alpaugh GSA
	2	A	A		-	-	-
2020-2025	90% of over-pumping[1]	2.0 af/ac Over Cons. Use Target	Fallow 5,000 acres; Remaining no change	No Change/ Sustainable	100% of over-pumping	100% of over-pumping	Reduce cropped area by 880 acres; 80% of overpumping
2025-2030	80% of over-pumping	1.5 af/ac Over Cons. Use Target	Fallow 5,000 acres; Remaining 1.5 af/ac Over Cons. Use Target[2]		Linear Transitional Pumping	Reduce pumping 10,000 af/yr	
2030-2035	30% of over-pumping	1.0 af/ac Over Cons. Use Target	Fallow 5,000 acres; Remaining 1.0 af/ac Over Cons. Use Target				50% of overpumping
2035-2040	Sustainable	0.5 af/ac Over Cons. Use Target	Fallow 5,000 acres; Remaining 0.5 af/ac Over Cons. Use Target		Sustainable	Sustainable	20% of overpumping
2040+		Sustainable	Sustainable				Sustainable

Notes:
[1] Over-pumping means pumping in excess of the consumptive use target
[2] Over consumptive use target means over pumping

Comment: The proposed Projects and Management Actions do not adequately address and mitigate impacts from subsidence.

Adjacent GSPs: None of the adjacent GSA GSPs include projects whose specific anticipated benefits will be mitigation of subsidence related impacts. The DEIDGSA GSP, under Action 1 for the Western Management Area "White Lands" (Section 5.2.2.2), discusses impacts to the FKC, and says that a future study is "anticipated", but it is not specifically called for. The P/MAs section of the ETGSA GSP (Section 7) only mentions subsidence as being one of the sustainability indicators that will be "generally" affected by various P/MAs.

GSP Regulations 23 CCR § 354.44(b)(1) require that a GSP include a description of P/MAs that includes "A list of projects and management actions … that may be utilized to meet interim milestones, the exceedance of minimum thresholds, or where undesirable results have occurred or are imminent." Given that significant and unreasonable impacts for land subsidence may have already occurred or are imminent, and that the list of P/MAs in the ETGSA GSP and DEIDGSA GSP does not include actions to address these undesirable results (only mentioning an "anticipated" future study), the list of P/MAs does not meet the requirements of GSP Regulations 23 CCR § 354.44(b)(1).

Further, the transitional pumping schedule for the DEIDGSA Western Management Area "White Lands" calls for no reduction from existing crop consumptive use demands for the first five years. This five-year delay in commencement of transitional pumping will perpetuate the water budget deficits in the DEIDGSA Area which are estimated through groundwater modeling to be in excess of -30,000 acre-feet per year (AFY) initially in 2020, eventually ramping down to -15,000 AFY in 2030 and -4,000 AFY in 2040 (Appendix C of the Tule Subbasin Setting). This five-year delay in commencement of transitional pumping will also perpetuate the subsidence issues and impacts to the FKC. As such evaluation of this P/MA has not considered "the interests of the beneficial uses and users of groundwater in the basin, and the land uses and property interests potentially affected…" as is required per CCR 23 § 354.4(b)(4).

Non-Adjacent GSPs: The TCWAGSA GSP similarly delays commencement of transitional pumping for the first five years (i.e., until 2025) which is projected to results in continued groundwater deficits of -12,000 AFY in 2020, -8,000 AFY in 2030, -6,000 AFY in 2040, and -3,000 AFY in 2070. These continued water budget imbalances will likely result in continued groundwater declines, as is corroborated by the projected hydrographs from the groundwater model (included in Appendices A through F of the Tule Subbasin Setting [Attachment 2 to the TSCA]). Consequently, the declining groundwater levels will likely lead to further land subsidence, effects of which could negatively impact beneficial uses and users within the Tule Subbasin and the adjacent Kern County Subbasin. As such evaluation of potential P/MAs has not considered "the interests of the beneficial uses and users of groundwater in the basin, and the land uses and property interests potentially affected…" as is required per CCR 23 § 354.4(b)(4).

Please let us know if you have any questions regarding this matter.

Sincerely,

EKI Environment & Water, Inc.

Anona Dutton, P.G., C.Hg.	Christopher Heppner, Ph.D., P.G.
Vice President	Supervising Hydrogeologist

December 16, 2019
GSI Proposal No. 9000-910
GSI EKI MSA 20180103

Jeevan Muhar
Arvin-Edison Water Storage District (AEWSD)
and
Dana Munn
Shafter-Wasco Irrigation District (SWID)

Re: Subsidence-Focused Review of Tule Subbasin Groundwater Sustainability Plans For Friant Districts in Kern County

Dear Mr. Muhar and Mr. Munn:

Per the request by EKI Environment and Water, Inc. (EKI) on behalf of the Friant Districts (Arvin Edison Water Storage District and Shafter-Wasco Irrigation District), GSI Environmental Inc. (GSI) has performed a subsidence-focused review of the following six draft Groundwater Sustainability Plans (GSPs) individual released by six respective Groundwater Sustainability Agencies (GSAs) in the Tule Subbasin:

- Alpaugh (A) GSA GSP,
- Delano-Earlimart Irrigation District (DEID) GSA GSP,
- Lower Tule River Irrigation District (LTRID) GSA GSP,
- Pixley Irrigation District (PID) GSA GSP,
- Eastern Tule (ET) GSA GSP, and
- Tri-County Water Authority (TCWA) GSA GSP.

The review focused on assessing whether subsidence has been adequately addressed in the GSPs to avoid negative future impacts on the Friant-Kern Canal (FKC) to an extent that will adversely affect the Friant Districts plan to achieve the groundwater sustainability goals in compliance with the State of California's Sustainable Groundwater Management Act (SGMA). The version of each document reviewed was downloaded through the website (https://tulesgma.com/) on December 2, 2019.

BACKGROUND

The Friant Districts are developing a GSP. To achieve the groundwater sustainability goals, the Friant Districts relies on contracts with the United States Bureau of Reclamation (USBR) for 90,000 acre-feet per year (AFY) of Class 1 water and 351,275 AFY of Class 2 water from the Friant Division of the Central Valley Project (CVP), delivered through the FKC, as a component of the available water resources to meet the predicted agricultural water demands. The FKC transmit water from the north, through the DEID and ET GSP Management Area in the Tule Subbasin and then through the Kern-Tulare GSP Management Area, into Kern County Subbasin.

Groundwater extraction has caused ground subsidence along the FKC in the Tule Subbasin since its construction was completed. The rate of subsidence was accelerated between 2008 and 2016 due to extreme drought condition. The water flow through the FKC was primarily driven by gravity. It has been reported that the FKC has lost approximately 60 percent of its design delivery capacity because historical land subsidence has reduced the topographic slope along the FKC alignment. In addition to ground subsidence and topographic slope changes, groundwater extraction also induces horizontal and vertical curvatures along a line on the ground surface in the vicinity of the extraction well. Differential subsidence also causes stresses and strains in the subsurface soils. Excessive strains can generate fissures and compaction faults. If the induced curvatures and slopes along the FKC are excessive, or if fissures and compaction faults developed in the subsurface underlying the FKC, FKC structural damage and water leak might occur. Reduction of water conveyance capacity and water leak along the FKC in the Tule Subbasin would potentially jeopardize Friant District's ability to achieve the groundwater sustainability goal set in their GSP. According to the GSP Regulations under the SGMA, the Tule Subbasin GSPs should "avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals".

OVERVIEW OF THE GSP REVIEW

The six GSPs were developed primarily based on a similar document structure. The GSPs include sections that describe the plan area, basin setting, sustainable management criteria, monitoring network, and projects and management actions. The following two attachments to the Tule Subbasin Coordination Agreement (TSCA):

- Attachment 1 (A1) – Tule Subbasin Monitoring Plan
- Attachment 2 (A2) – Tule Subbasin Basin Setting

were presented as appendices attached to the GSPs and are the basis for developing the GSPs. The TSCA provides a platform for coordinating data sharing and GSP approach. In addition, the GSPs were developed using the results of a Tule Subbasin Groundwater Flow Model (TSGFM) which has not been released for this review. Therefore, our review focused on how the TSGFM results were utilized to establish sustainability metrics. The quantitative metrics should be reviewed when the TSGFM is finalized.

The FKC passes through the ET and DEID GSA Management Areas (MA). The TSCA defined an area centered around the FKC and extends west four miles and eastward to the 1986-2017 one-foot subsidence contour as "land subsidence monitoring area". The ETGSA GSP refers to this area as "Friant-Kern Canal Subsidence Management Area" (FKCSMA). The A GSA and TCWA GSA GSP Management Areas (MA) are over ten miles from the FKC. The subsidence in these two GSP MAs is not expected to induce significant topographic slope changes, curvatures, or strain along the FKC. Our review focused on the sections related to subsidence along the FKC in the ET and DEID GSA GSPs. The sections in the LTRID and PID GSA GSP related to subsidence within the FKCSMA were also reviewed.

REVIEW COMMENTS

The following comments are related to defining the performance metric in relation to the potential subsidence impacts on FKC:

- The "Undesirable Results for Land Subsidence" were not adequately defined regarding subsidence related impacts on the FKC

  The GSPs only consider conveyance capacity reduction as an undesirable result of the FKC. Other undesirable results, such as structural damage resulting from curvatures and ground strains induced by groundwater extraction from nearby wells, were not considered. Based on our past experience, a major groundwater production well in the Corcoran area can potentially induce a vertical curvature on the order of 5e-6 ft^{-1}. In addition, such well can induce a horizontal movement of up to approximately 1/4 of the vertical subsidence within 2000 ft from the well. The FKC was constructed almost seventy years ago. The GSPs do not address the current condition and the vulnerability of the FKC. A major groundwater production well in close proximity to the FKC can potentially affect the structural integrity of the FKC. Based on the historical subsidence data from the United States Geologic Survey (USGS) and Jet Propulsion Laboratory (JPL), subsidence in the Tule Subbasin has been shifting eastward in the past decades due to additional groundwater extraction. The GSPs do not preclude the possibility of groundwater production wells in close proximity to the FKC.

- Allowing less than 50% of the Representative Monitoring Sites (RMSs) to exceed the Minimum Thresholds (MT) criterion might not be protective of adequate conveyance capacity of the FKC.

Conveyance capacity is governed by topographic slope, which is dictated by the differential subsidence at two locations. Although only up to 50% of the Representative Monitoring Sites (RMSs) are allowed to exceed their MTs, it does not prohibit the differential subsidence between two neighboring RMSs to be large (e.g., no subsidence at one RMS while the next upgradient RMS has reached the maximum subsidence limit). Based on our past experience, a major groundwater production well in the Corcoran area can potentially induce a vertical slope on the order of 0.002. A major groundwater production well in close proximity to the FKC can potentially affect the conveyance capacity of the FKC. In addition, the 50% criterion is not location specific. In an extreme case, if 50% of the upgradient RMSs has reached the MT limits and the subsidence at the downgradient RMSs are minimal, it is unclear whether the FKC conveyance capacity can meet the target flow rate needed.

- The FKC Conveyance Capacity needed was not defined

  Although FKC conveyance capacity is a major groundwater sustainability consideration, the GSPs did not present the FKC conveyance capacity needed. It has been reported that the FKC has already lost 60% of its conveyance capacity due to historical subsidence. The GSPs did not discuss the current conveyance capacity can adequately meet the flow rate needed and how much additional conveyance capacity loss is acceptable. The subsidence related Sustainable Management Criteria should address the acceptable FKC conveyance capacity loss.

- The relationship between the FKC Conveyance Capacity and Measurable Objectives (MOs)

  The GSP subsidence metric was defined in terms of subsidence, but the FKC conveyance capacity is a major groundwater sustainability consideration. The relationship between the subsidence metric and the FKC conveyance capacity was not addressed. The subsidence related Sustainable Management Criteria should be established to represent the acceptable FKC conveyance capacity loss.

- The ET and DEID GSA GSPs did not consider the amount of FKC flow needed by the Kern-Tulare GSA and Friant Districts (among others downstream that have historically taken delivery of FKC water) to achieve their GSP.

  According to the GSP Regulations under the SGMA, the GSP should “avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals”. The Friant Districts and many water agencies south of the Tule Subbasin rely on the water delivered through the FKC to meet their groundwater sustainability goals. The GSPs should ensure that subsidence would not cause the FKC conveyance capacity to be lower than the flow rate needed for the impacted GSAs to meet their groundwater sustainability goals.

- The Interim Milestones (IMs) and MTs were defined based on a TSGFC that has not been completed at the time this review is performed. When TSGFC is completed, its accuracy and uncertainty shall be evaluated, especially regarding the simulation of elastic and inelastic subsidence as well as the delayed responses. Matching ground level change does not guarantee accurate representation of individual deformation components. It appears that the current versions of the GSPs do not consider model errors and uncertainty. If model errors/uncertainty are large, uncertainty/error margin or a safety factor should be considered in deciding the IMs and MTs.

The following comments are related to monitoring:

- Insufficient RMSs along the FKC in the DEID GSA MA

  Only one RMS is located in the DEID GSP MA. Although historical subsidence along the FKC in the DEID GSA MA has been small, future subsidence will increase if groundwater extraction increases in the vicinity of the FKC. The GSPs do not preclude the possibility of groundwater production wells in close proximity to the FKC. Without additional RMSs along the FKC in the DEID GSP MA, the FKC conveyance loss and structural impacts might not be noticeable.

- RMSs at river crossing might not be approximate

  A few RMSs are located at river crossing. The actual siting should be appropriately evaluated to avoid potential subsurface influence by the river flow condition.

- The is no RMSs to address the concern of FKC structural damages

  Groundwater extraction close to the FKC might induce curvatures and strain. Monitoring and/or precaution against this situation was not addressed in the GSPs.

- The FKCSMA does not include the portions of FKC in the ET and DEID GSA MA. Although historical subsidence along the FKC in the DEID GSA MA has been small, future subsidence will increase if groundwater extraction increases in the vicinity of the FKC.

Other Comments:

- Overdraft in the subbasin was defined based on averaged hydrology from the years 1990/91 through 2009/10. The average condition between 1990/91 and 2009/10 might not be representative of the long-term average condition.

- Subsidence and associated ground deformation are mostly irreversible

  When the subsurface is stressed by groundwater extraction from a well, the associated elastic deformation is relatively small in comparison to inelastic deformation. Due to the presence of compressible materials in the aquifer unit, compression and subsidence has a delayed response component. After pumping stops, subsidence might continue for one to two years. Even if groundwater level rises in the future, ground surface elevation rebound is typically on the order of 10% of the subsided amount. If subsidence MTs are reached, they are not recoverable.

- Under the current project and management actions, if there is no curtailment of groundwater extraction, especially in the area close to the FKC, subsidence will continue and MTs would likely be reached in the future.

If you have any questions regarding the review comments, please let us know.

Best regards,
GSI ENVIRONMENTAL INC.

Chin Man Mok

Chin Man W. Mok, PhD, PE, GE, D.WRE, D.GE
Vice President and Principal Engineer

Chin Man W. Mok

PhD, PE, GE, PG, D.WRE, D.GE, F.ASCE, F.EWRI

Biographical Summary

Dr. Mok is a water resources and geo- professional with 34 years of consulting experience. He has directed many projects supporting the analysis and design of infrastructures, such as buildings, bridges, highways, tunnels, railroads, locks, dams and levees, pipelines, and underground structures; water resources management, such as watershed/groundwater basin evaluation, sustainability planning and optimization, system reliability assessment, flood and drainage evaluation, recharge study, and environmental remediation. His has substantial technical experience in evaluating subsurface stability and deformation due to infrastructure loading, groundwater extraction, and natural hazards. He has recently completed a subsidence study for the California High-Speed Rail System from San Francisco to Los Angeles through the rapidly subsiding Corcoran, El Nido, and Antelope Valley areas. He has been appointed to serve as a hydro- and geo- specialist on review panels for several high-profile projects. In addition, he has experience providing technical support to litigation projects.

In addition to consulting, Dr. Mok has been active in teaching and research. He is an adjunct professor at the University of Waterloo and Rice University. He has been teaching undergraduate and graduate courses on groundwater, geotechnics, engineering risk, data sciences, ground improvement, and environmental remediation at several universities, including the University of California at Berkeley. He has been a Principal Instructor of short courses in California and overseas, including workshops sponsored by the California State Water Resources Control Board and internal training classes for the Thailand Department of Groundwater Resources on issues related to water resources management, land subsidence, and environmental remediation. He has been the Principal Investigator of many research projects funded by federal agencies on high-resolution subsurface characterization, groundwater optimization, and subsurface system reliability analysis. He has been a Chair of the Groundwater Management Committee and is currently a panel member of the KSTAT standard committee of the American Society of Civil Engineers developing guidance documents.

Professional Background

Consulting:

Vice President / Principal Engineer and Hydrogeologist, GSI Environmental Inc., Oakland, CA. 2013 to present

Principal Engineer and Hydrogeologist, AMEC Environment and Infrastructure (currently Wood PLC), Oakland, California. 2008 to 2013

Principal Engineer and Hydrogeologist, Geomatrix Consultants, Inc., (acquired by AMEC), Oakland, California. 1987 to 2008

Structural and Geotechnical Engineer, Maunsell Consultants Asia, (currently AECOM), Hong Kong. 1985 to 1986

Academic:

Adjunct Professor, Earth, Environmental and Planetary Sciences, Rice University, Houston. 2017 to present

Adjunct Professor, Earth and Environmental Sciences, University of Waterloo, Canada. 2008 to present

Lecturer, Civil and Environmental Engineering, University of California at Berkeley, California. 2014, 2016

Rudolf Diesel Industry Fellow and Affiliated Professor, Engineering Risk Analysis, Institute for Advanced Study, Technical University of Munich, Germany. 2011 to 2014

Visiting Associate Professor, Civil and Environmental Engineering, University of Hong Kong, 2010

Education

Ph.D., Department of Civil and Environmental Engineering, University of California at Berkeley, 1999.

M.S., Department of Civil and Environmental Engineering, University of California at Berkeley, 1987.

B.Sc. (Eng.), Department of Civil and Structural Engineering, University of Hong Kong, 1985.

Professional Registrations, Qualifications and Affiliations

Professional Civil Engineer, California 46755, Arizona 39042, Florida 75351, Texas 119446

Professional Geologist, Arizona 40746

Registered Geotechnical Engineer, California 2365

Founding Diplomate, Water Resources Engineer, American Academy of Water Resources Engineers

Diplomate, Geotechnical Engineer, Academy of Geo-professionals

Honors and Awards

Rudolf Diesel Industry Fellow, Institute for Advanced Study, Technical University of Munich

Fellow, American Society of Civil Engineers

Fellow, Environmental and Water Resources Institute

Jane Lewis Fellowship, University of California, Berkeley

Parker Trask Fellowship, University of California, Berkeley

Hui Yin Hing Fellowship, University of Hong Kong

S.L. Pao Education Foundation Scholarship, University of Hong Kong

Representative Projects

Ground Subsidence Study, California High-Speed Rail Authority (CAHSR). Principal-in-charge. Task Leader of the AMEC Foster Wheeler team. Directed three-dimensional coupled groundwater and geomechanical modeling to estimate the potential impacts of groundwater extraction on subsurface deformation and induced vertical/horizontal topographic curvatures for infrastructure analysis. Evaluated the accuracy and reliability of an USGS' Central Valley Hydrologic Model in regard to refinement and specific calibration for HSR use. Applied data fusion to integrate available LiDAR, InSAR, GPS/RTK, survey data collected in the different areas and periods to develop data-driven subsidence prediction model. Developed simulation models to predict future subsidence in the HSR alignment areas in the San Joaquin Valley and Antelope Valley. Performed flood modeling to delineate runoff pathways and evaluated the subsidence induced flood plain changes in the historical Tulare Lake area. Flood plain change will impact surface water recharge to groundwater.

Tai Hang Road Subsidence Investigation, Government Geotechnical Engineering Office, Hong Kong. Principal-in-charge. Tasked by the Geotechnical Engineering Office, Dr. Mok was engaged by Fugro (Hong Kong) Limited as a subject expert in a detailed study of the subsurface conditions below Tai Hang Road where land subsidence occurred. Notable signs of subsurface deformation, slope failure, and road damages were observed. He conducted field-testing at several locations to investigate the hydrogeologic condition in the area for evaluating the likelihood of groundwater being the major cause of failure.

Northern California Toll Bridges, San Francisco Bay Area, California. Project Manager. Provided geotechnical engineering support for the seismic retrofit and vulnerability studies of the San Mateo–Hayward Bridge, Benicia-Martinez Bridge, Carquinez Bridge, Richmond–San Rafael Bridge, and the cable-suspension section of the San Francisco–Oakland Bay Bridge. Static and dynamic stability analyses were performed for natural terrain and slopes during and after construction. Analysis also included settlement and subsurface deformation estimation. The foundation types of these bridges include spread footings, driven piles, cast-in-drilled-hole piles, cast-in-steel-shell piles, and large caissons. Some of these piles terminate in soil and some are anchored in rock. Difficult geotechnical conditions were encountered at many bridge locations, including liquefiable zones, soft surficial soils, and weak rocks.

Optimized Regional Water Supply Operation Management and Water Resources Planning, Tampa Bay Water, Florida. Principal-in-charge. The project team developed an optimization framework to identify the best plan for operating the Agency's interconnected water supply system and managing the integrated water resources. The goal is to reliably and sustainably meet the municipal and industrial water demands while minimizing the hydro-ecological impacts on wetlands and the potential of seawater intrusion in multiple counties. The optimization considers physical system capacity, water use regulations and other operational constraints, as well as the uncertainties associated with the forecasting of water demands, surface water availability, climatic condition, and groundwater-surface water interaction.

Effects of Climate Variations and Water Management Strategies on Eco-Hydrologic Condition, Tampa Bay Water, Florida. Principal-in-charge. The project team evaluated the eco-hydrologic effects of various water management and operational strategies while accounting for the uncertainty of future climate condition, including severe droughts. A Monte Carlo approach was used to generate time series realizations of future climatic events. These realizations were utilized to generate time histories of the resulting water supply operation under various water management strategies. The effects of these water supply operations on the environmental and hydrologic condition in the region were estimated using a calibrated Integrated Hydrologic Model. The results were used to evaluate the reliability associated with each water management strategy to address the issues associated with large groundwater production during droughts.

Cost-effective Characterization of Large Plume Arrival Front at Edwards AFB, Air Force Civil Engineering Center, United States Department of Defence. Principal Investigator. This project demonstrated and validated that integrating data from hydraulic tomography (HT); groundwater and mass flux measurements; geophysical tomography (GT); chemical and hydraulic monitoring data; and geologic data cost-effectively improves the prediction of groundwater flow regime and reduces the associated uncertainty at the EAFB. Downhole, cross-hole, and hole-to-surface electrical resistivity tomography was performed. Tracer-enhanced time-lapsed tomography was conducted. Flux measurements using single-hole tracer dilution test, point velocity probes, and passive mass fluxmeters were performed and compared.

Erodibility Assessment of Lyons Dam, Tiger Creek Dam, Spaulding Lake Dams, Balch Diversion and Afterbay Dams, Lake Tabeaud Dam, and Lower Bear River Dam (Multiple Projects), Pacific Gas and Electric Company, California. Directed analyses to address the erosion potential of the foundation and abutment materials due to the hydrodynamic impact forces caused by water overflowing over dam crests during the maximum flood event. Both the Erodibility Index Method as well as the Comprehensive Fracture Mechanics and Dynamic Impulsion Models are used. Rock quality were evaluated based on field investigation and inspection.

Groundwater Training Courses, Thailand Department of Groundwater Resources. Principal Instructor. Retained to provide a series of three five-day short courses to train the Agency's professional staff on groundwater modeling, focusing on applications to water resources management, environmental remediation, and land subsidence control.

Groundwater and Seepage, University of California at Berkeley. Taught a one-semester course on flow through porous media, numerical analysis, hydrogeology, aquifer testing, and contaminant transport, focusing on the practical applications to geotechnical, water resources, and environmental problems, such as dams, levees, slope stability, land subsidence, water supplies, landfills, waste disposal, and contamination control and remediation.

Groundwater, University of Hong Kong. Taught a one-semester graduate-level course on groundwater and geotechnics. The course covered saturated and unsaturated flow, seepage, infiltration, slope stability, land subsidence, and contaminant transport. The focuses were on applications to water infrastructures and geo-environmental issues.

RECLAMATION

Managing Water in the West

SAN JOAQUIN RIVER RESTORATION PROGRAM

Friant WATER AUTHORITY

Friant-Kern Canal Middle Reach Capacity Correction Project

Draft Recommended Plan Report

October 2019

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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Abbreviations and Acronyms

AF	acre-feet
APE	Area of Potential Effect
B-C	benefit cost
CalSim II	California Water Resources Simulation Model
CDFW	California Department of Fish and Wildlife
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CER	Canal Enlargement and Realignment
cfs	cubic feet per second
CVP	Central Valley Project
CWC	California Water Commission
DEC	Design Engineering and Cost
D&S	Directives and Standards
DWR	California Department of Water Resources
EA	Environmental Assessment
EIS/R	Environmental Impact Statement/Environmental Impact Report
ESA	Endangered Species Act
FAA	Financial Assistance Agreement
FKC	Friant-Kern Canal
FWA	Friant Water Authority
GSA	groundwater sustainability agency
GSP	groundwater sustainability plan
Guidelines	Guidelines for the Application of Criteria for Financial Assistance for Local Projects under Part III of Public Law 111-11
HGL	Hydraulic Grade Line
ID	Irrigation District
IDC	Interest During Construction
InSAR	interferometric synthetic aperture radar
IS	Initial Study
JPA	Joint Powers Authority
MP	Mile Post
MUD	Municipal Utility District
NED	National Economic Development
NEPA	National Environmental Policy Act
NOD	Notice of Determination
NOI	Notice of Intent
NOP	Notice of Preparation
NMFS	National Marine Fisheries Service
NRDC	Natural Resources Defense Council

O&M	operations and maintenance
OM&R	operations, maintenance, and replacement
OPCC	opinion of probable construction cost
PCA	Project Cooperation Agreement
P.L	Public Law
PR&G	Principles, Requirements, and Guidelines for Federal Investment in Water Resources
Project	Friant-Kern Canal Middle Reach Capacity Correction Project
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
Report	Draft Recommended Plan Report
ROD	Record of Decision
ROW	Right of way
RWA	Recovered Water Account
Settlement	Stipulation of Settlement of Natural Resource Defense Council (NRDC) et al. v. Kirk Rodgers et al.
Settlement Act	San Joaquin River Restoration Settlement (Title X, Subtitle A) Provisions of Public Law 111-11
SGMA	Sustainable Groundwater Management Act
SJRRP	San Joaquin River Restoration Program
State	State of California
Study	FKC Middle Reach Capacity Correction Project Feasibility Study
SWAP	State-Wide Agricultural Production
TAF	thousand acre-feet
TM	technical memorandum
URFs	Unreleased Restoration Flows
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
VERA	Voluntary Emission Reduction Agreement
WD	Water District
WEAT	worker environmental awareness training
WIIN Act	Water Infrastructure Improvements for the Nation Act (P.L. 114-322) of 2016.
WSD	Water Storage District

Chapter 1 Introduction

The Friant-Kern Canal (FKC) is a principal feature of the Central Valley Project (CVP) that extends approximately 152 miles from Millerton Lake to the Kern River in the eastern portion of the San Joaquin Valley in central California. The FKC delivers CVP water supplies to Friant Division long-term contractors. The Middle Reach of the FKC, an approximately 33-mile section located within Tulare and Kern Counties, has experienced significant capacity loss. The capacity loss is a result of both regional land subsidence that has occurred over the past decade and an original design deficiency that prevents the intended flow capacity to be actualized. The FKC Middle Reach Capacity Correction Project (Project) is being developed to provide improvements to restore its originally designed and constructed capacity through the Middle Reach of the FKC.

The FKC Middle Reach Capacity Correction Project Feasibility Study (Study) is being developed by the Friant Water Authority (FWA) in coordination with the U.S. Department of the Interior, Bureau of Reclamation (Reclamation). Progress and results of the Study are being documented in a series of interim reports that will culminate in a Final Feasibility Report and associated compliance documentation consistent with the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA), the *Principles, Requirements, and Guidelines for Federal Investment in Water Resources* (PR&G) (CEQ 2013), Reclamation Directives and Standards (D&S) CMP 09-02 for Water and Related Resources Feasibility Studies (2015), and applicable environmental laws.

In recognition of the urgent need to address the capacity problems in the FKC, the Study is being prepared on an expedited schedule. This Draft Recommended Plan Report (Report) is the second progressive document in the development of the Final Feasibility Report. This Report presents the formulation and evaluation of Initial Alternatives, selection and evaluation of Feasibility Alternatives, and identification of a Recommended Plan.

Reclamation is the lead Federal agency for reviewing and approving this Study. FWA is the non-Federal partner and will implement the Selected Plan that will be identified in the Final Feasibility Report. The following subsections describe Federal, State of California (State), and local authorization and legislation relevant to this Project.

Purpose

The reduced capacity of FKC Middle Reach has resulted in water delivery impacts on Friant Division long-term contractors, reduced ability of the FKC to convey flood waters during wet periods, and reduced ability to implement provisions of the Water Management Goal as described in Paragraph 16 of the San Joaquin River Restoration Settlement (Settlement). The reduced delivery of water via the Friant-Kern Canal under long-term Friant Division contracts, the Recovered Water Account (RWA), and Unreleased Restoration Flows (URFs) also reduces funding necessary to implement the Restoration Goal provisions of the Settlement as described in Paragraph 11.

The purpose of the Project is to restore the conveyance capacity of the FKC Middle Reach to such capacity as previously designed and constructed by Reclamation, as provided for in the San Joaquin River Restoration Settlement Act (Public Law 111-11, Title X, Part III(a)(1)). The purpose of this Study is to describe the formulation, evaluation, and comparison of alternatives that address Project planning objectives and identify a Recommended Plan consistent with Federal authorizations and requirements. Information developed through the Study will be used in preparation of required environmental compliance documentation.

Planning Objective

The planning objective is to restore the capacity of the FKC in the Middle Reach from Mile Post (MP) 88.2 to MP 121.5 to address the subsidence-induced and original design deficiency capacity reductions. The FKC was designed to convey water at a normal capacity for the delivery of water under CVP contracts, and maximum capacity for the short-term conveyance of flood flows.

Organization of this Report

This report is organized as follows:

- **Chapter 1** provides background information about the study and related studies, projects, and programs.
- **Chapter 2** provides an overview of the water and related resources, problems, opportunities, and constraints.
- **Chapter 3** describes the initial alternative formulation process.
- **Chapter 4** presents the No Action Alternative and the two Feasibility Alternatives in terms of major features, costs, and other defining characteristics.
- **Chapter 5** presents benefit cost analyses of the Feasibility Alternatives and identifies a Recommended Plan.
- **Chapter 6** describes the Recommended Plan.
- **Chapter 7** presents findings.

- **Chapter 8** presents recommendations.
- **Chapter 9** provides a list of sources consulted in preparation of this report.

This report is supported by several appendices, attachments, and exhibits that provide greater technical detail used in the evaluation of project feasibility. The organization hierarchy of the Draft Recommended Plan Report is shown in Figure 1-1.

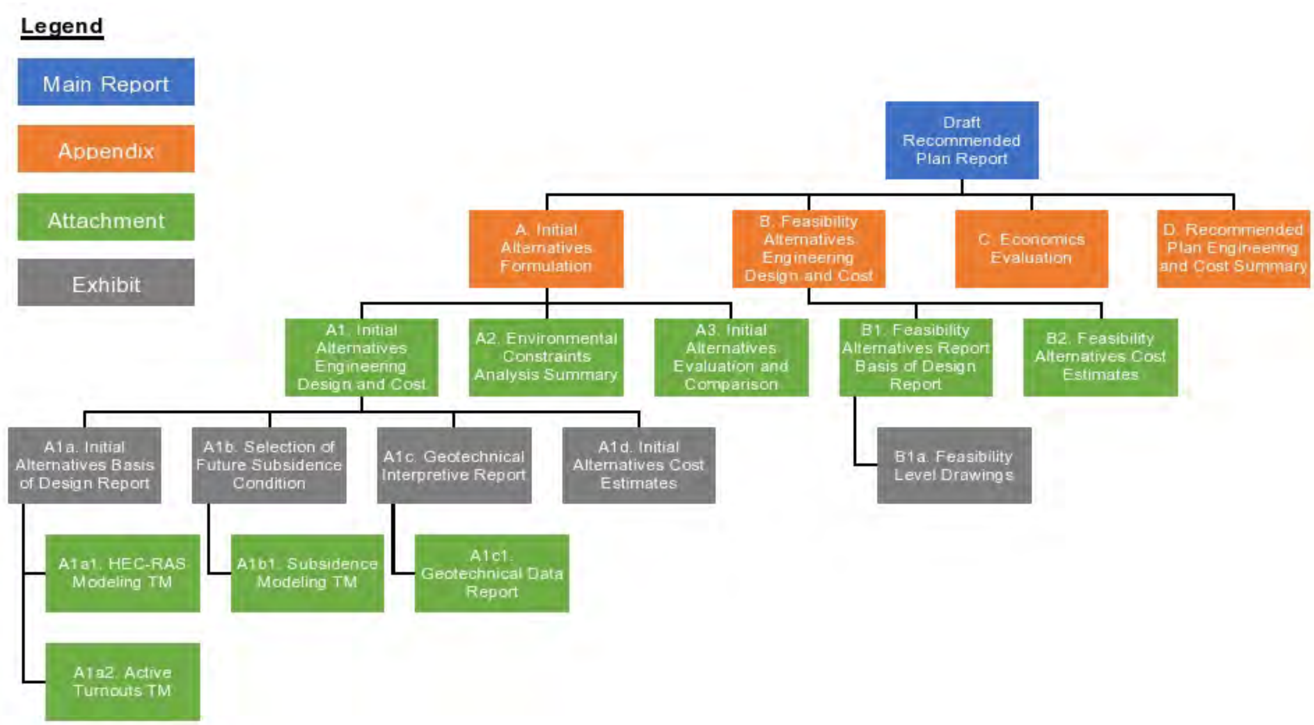

Figure 1-1. Draft Recommended Plan Report Document Hierarchy

Federal Authorities

The Study is being prepared to support feasibility determinations in accordance with the following Federal authorities:

- San Joaquin River Restoration Settlement (Title X, Subtitle A) provisions of Public Law [P.L.] 111-11 (Settlement Act), the Omnibus Public Land Management Act of 2009;
- Section 9603, Extraordinary Operation and Maintenance Work Performed by the Secretary, of P.L. 111-11; and
- The Water Infrastructure Improvements for the Nation Act (WIIN Act) (P.L. 114-322) of 2016.

P.L. 111-11

The Project and Study is authorized and funded in part by Sections 10201 and 10203(a) of the Settlement Act.

> *Section 10201:*
>
> *"(a) The Secretary of the Interior (hereafter referred to as the 'Secretary') is authorized and directed to conduct feasibility studies in coordination with appropriate Federal, State, regional, and local authorities on the following improvements and facilities in the Friant Division, Central Valley Project, California:*
>
> > *(1) Restoration of the capacity of the Friant-Kern and Madera Canal to such capacity as previously designed and constructed by the Bureau of Reclamation...*
>
> *(b) Upon completion of and consistent with the applicable feasibility studies, the Secretary is authorized to construct the improvements and facilities identified in subsection (a) in accordance with applicable Federal and State laws.*
>
> *(c) The costs of implementing this section shall be in accordance with Section 10203 and shall be a nonreimbursable Federal expenditure."*
>
> *Section 10203(a):*
>
> *"(a) The Secretary is authorized and directed to use monies from the fund established under section 10009 to carry out the provisions of section 10201(a)(1), in an amount not to exceed $35,000,000."*

Shortly following enactment of P.L. 111-11, Reclamation began evaluating the restoration of the capacity of the FKC and Madera Canal jointly. However, due to unique differences in the design and construction of these canals, Reclamation, in agreement with FWA and Madera-Chowchilla Water and Power Authority, separated the authorized funding as follows: $25 million for the FKC; and $10 million for the Madera Canal (Reclamation 2011). Of the $25 million for the FKC, approximately $6.1 million has been obligated and about $18.9 million remains available to study and implement projects that address FKC restored capacity, including the Project.

Project construction is also authorized under Section 9603, which addresses Extraordinary Operation and Maintenance Work Performed by the Secretary.

> *9603 (a) IN GENERAL.—The Secretary or the transferred works operating entity may carry out, in accordance with subsection (b) and consistent with existing transfer contracts, any extraordinary operation and maintenance work on a project facility that the Secretary determines to be reasonably required to preserve the structural safety of the project facility.*
>
> *(b) REIMBURSEMENT OF COSTS ARISING FROM EXTRAORDINARY OPERATION AND MAINTENANCE WORK.—*
>
> *(1) TREATMENT OF COSTS.—For reserved works, costs incurred by the Secretary in conducting extraordinary operation and maintenance work will be allocated to the authorized reimbursable purposes of the project and shall be repaid within 50 years, with interest, from the year in which work undertaken pursuant to this subtitle is substantially complete.*
>
> *(2) AUTHORITY OF SECRETARY.—For transferred works, the Secretary is authorized to advance the costs incurred by the transferred works operating entity in conducting extraordinary operation and maintenance work and negotiate appropriate 50-year repayment contracts with project beneficiaries providing for the return of reimbursable costs, with interest, under this subsection: Provided, however, That no contract entered into pursuant to this subtitle shall be deemed to be a new or amended contract for the purposes of section 203(a) of the Reclamation Reform Act of 1982 (43 U.S.C. 390cc(a)).*

WIIN Act

Authorization and funding for planning has been provided under authority of the WIIN Act. The WIIN Act addresses the needs of the nation's harbors, locks, dams, flood protection, and other water resources infrastructure critical to the economic growth, health, and competitiveness. The WIIN Act authorizes appropriations for Federal funding for the final design and construction of water storage projects and extends the authorization for Federal feasibility studies.

Unless directed otherwise by Congress, all costs for studies, report preparation, and review that falls under the WIIN Act authorization must be shared with a non-Federal cost-sharing partner. Costs will be accounted for and in-kind services valued in accordance with *Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards* (2 CFR 200). Cost-sharing must be in the form of in-kind services, cash payments, or a combination of the two. Unless authorizing legislation specifies a cost-share formula, the minimum non-Federal cost-share will be 50 percent of the total study costs.

The WIIN Act is applicable to non-reimbursable federal expenditures for authorized purposes. The Settlement Act authorizes non-reimbursable federal expenditures to restore the designed and constructed capacity of the FKC, thus, the WIIN Act is applicable for up to 50 percent federal non-reimbursable funding for the Project.

Local Authorities

The FWA is a Joint Powers Authority (JPA) public agency formed through its members under California law to operate and maintain the FKC and to represent its members in policy, political, and operational decisions that could affect the Friant Division of the CVP. FWA was formed in 2004 as the successor agency to the Friant Water Users Authority, which began FKC operations and maintenance (O&M) under agreement with Reclamation in 1986.

FWA maintains a professional staff with expertise in project operations, finance, and technical services that perform all on-going services related to the FKC O&M and represent their member entities. During the past 25 years, FWA has conducted several O&M actions along the FKC, including panel replacements, canal embankment seepage control, gate maintenance and repairs, automated monitoring, and control systems implementation.

As the responsible O&M entity for the FKC, FWA is leading the planning, permitting and design of the Project in coordination with Reclamation. FWA is the lead agency for environmental compliance pursuant to CEQA and will be responsible for the construction and O&M of the Project, if implemented.

Study Area

The study area, shown in Figure 1-2, encompasses the FKC from MP 88.2 (Fifth Avenue check) to MP 121.5 (Lake Woollomes check), the service areas of six[1] Friant Division long-term contractors that can experience water supply reductions as a result of capacity restrictions in this reach, and the areas that would be directly affected by construction-related activities.

[1] The six affected Friant Division long-term contractors include: Arvin-Edison Water Storage District, Delano-Earlimart Irrigation District, Kern-Tulare Water District, Saucelito Irrigation District, Shafter-Wasco Irrigation District, and Southern San Joaquin Municipal Utility District.

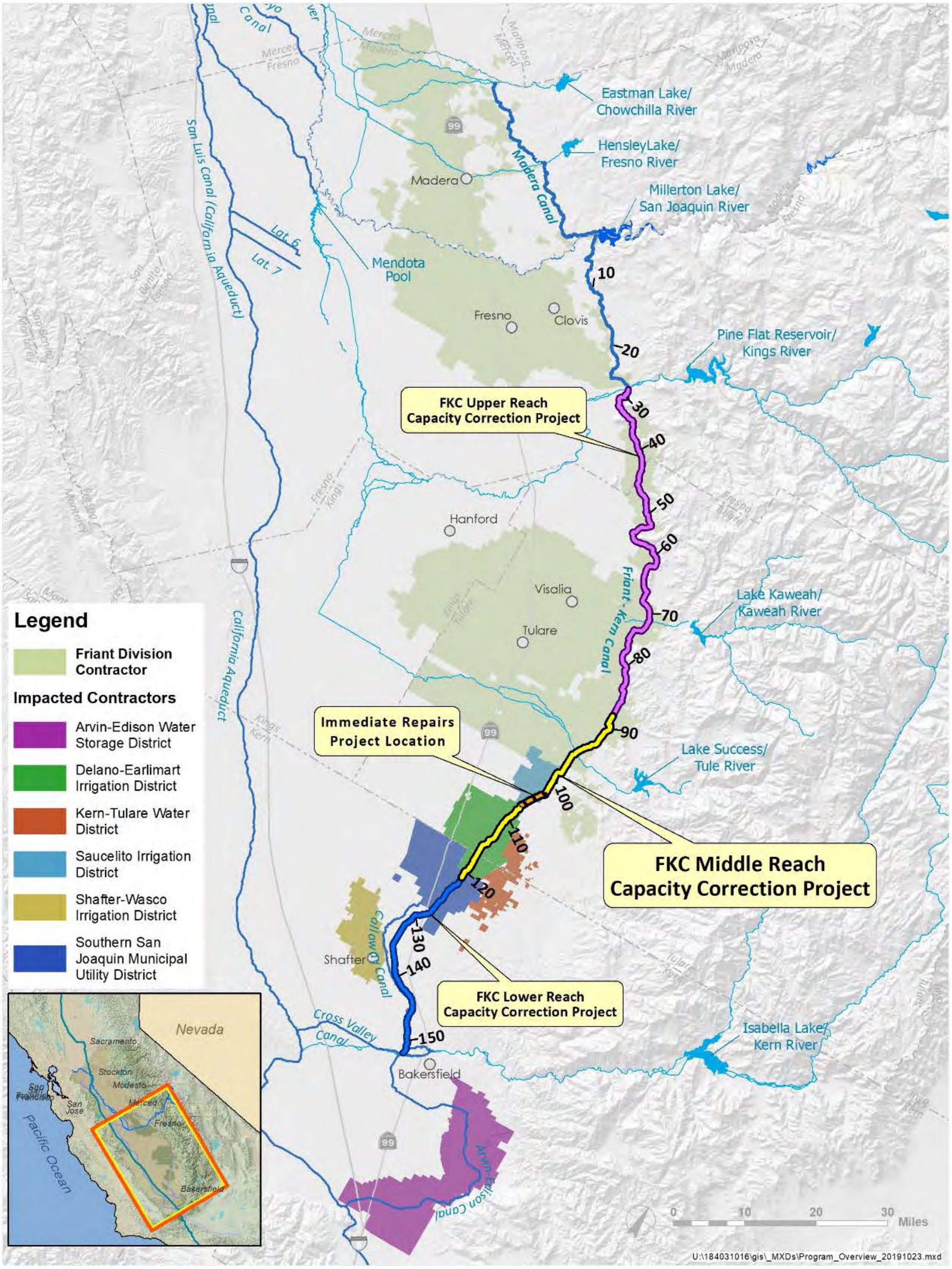

Figure 1-2. Study Area

Background

The FKC has a maximum design capacity of 5,300 cubic feet per second (cfs), gradually decreasing to 2,500 cfs to accommodate conveyance for downstream water demand. However, the maximum conveyance capacity has not been actualized due to several factors. Original design assumptions regarding the roughness or Manning's "n" value were found inaccurate shortly following construction completion. As a result, the FKC operating capacity is less than designed. Capacity has been further reduced by additional canal surface roughness with age, vegetation within canal sections, changes in water delivery patterns, localized seepage through embankments, and regional land subsidence.

In conjunction with the adjacent land, the canal has subsided. The FKC was designed with a relatively flat gradient, approximately 6 inches per mile, which makes it vulnerable to capacity reductions from subsidence. In particular, the section from MP 99 to MP 116 has subsided the most, with a significant localized depression between MP 103 and MP 107 that experienced subsidence greater than 10 feet since the FKC was constructed.

Over the decades, several efforts have been made to restore the canal capacity. In the late 1970s, Reclamation addressed subsidence-associated capacity reduction between MP 99 and MP 116 by raising the concrete lining on the canal. In the 1980s, Reclamation performed a subsequent lining raise between MP 0.0 and MP 28.5 that increased the canal capacity from 5,000 cfs to the design capacity of 5,300 cfs. While these efforts were successful, capacity restrictions continue to limit water deliveries throughout most of the canal.

The Settlement Act authorized the Secretary of the Interior to study, construct, and fund FKC capacity restoration to the original designed and constructed capacity. Under this authorization, Reclamation, identified four alternatives to restore the capacity of the entire FKC. However, the cost of all alternatives exceeded the available funding, which led to a focus on first restoring the Upper Reach from MP 29.14 to MP 88.2. Alternatives to restore capacity in the Upper Reach also exceeded the available funding. Reclamation presented the estimated costs to restore capacity of the Upper Reach to a group of Friant Division long-term contractors and FWA staff in September 2015. From that meeting, the contractors determined they would take the lead in identifying a path forward and report back to Reclamation.

In February 2017, FWA observed that a flow of 1,900 cfs was encroaching on the top of the liner and the lower chords of some bridges in the portions of the FKC Middle Reach (MP 88.2 to MP 121.5). In December 2017, FWA, on behalf of the Friant Division long-term contractors, provided their recommendations to Reclamation to complete appropriate feasibility, design, and compliance documents for the FKC Middle Reach and apply any remaining funds toward construction. To temporarily reduce capacity constraints in the Middle Reach of the FKC before the Project is constructed, FWA also implemented an Immediate Repairs Project which installed a temporarily liner between 103.85 to MP 106.32 in the winter of 2018-2019.

The Project is part of the FWA's approach to restore the design capacity of the entire FKC. The approach, with Reclamation's guidance and approval, will be implemented through projects located in three reaches of the FKC, based on the operational characteristics of the canal as well as the nature of the corrective actions to be accomplished. Reaches with the greatest capacity reduction will be prioritized, and all reaches will be designed to restore the original design capacity of the FKC:

- Upper Reach Capacity Correction Project – this project will address design capacity reduction in the FKC from approximately MP 29 (Downstream Kings River Siphon) to MP 88 (Fifth Avenue Check). As noted above, this project was previously evaluated by Reclamation and has an estimated cost of $140 million in 2014 dollars;

- Middle Reach Capacity Correction Project – this project, which is the subject of this Report, will address design and subsidence capacity reduction in the FKC from approximately MP 88 (Fifth Avenue Check) to MP 121 (Woollomes Check). The Project includes the Immediate Repairs Project (MP 103.6 to MP 107.3). If the Project includes modifications at the same location, the Immediate Repair improvements will be removed and replaced with Project actions. The Project will be coordinated with the FKC Pump-back Project, also authorized by the SJRRS Act, to the extent possible to identify infrastructure affected by both projects in the Middle Reach; and

- Lower Reach Capacity Correction Project – this project will address capacity reduction in the FKC from approximately MP 121 to the canal terminus at MP 152. The project will also coordinate with FKC Pump-back Project for affected infrastructure in the Lower Reach. The extent of work required in the Lower Reach has not been evaluated at this time and does not impact the Project.

As of December 2018, Reclamation and the FWA finalized a Financial Assistance Agreement (FAA) for the FKC Capacity Correction Project (R19AC00013). The FAA describes authorized federal funding sources including the Settlement Act and the WIIN Act.

Related Studies, Projects, and Programs

The following is a summary of pertinent previous studies and current activities that affect the Study.

1960s – Reclamation Technical Memorandum No. 661

In the 1940s and 1950s, Reclamation constructed several large concrete canals and subsequently found they were incapable of conveying the flows specified in the original designs. In response, Reclamation conducted a technical investigation of several canals, including the FKC, to determine the cause of conveyance limitations in canals and published its findings in Technical Memorandum No. 661 – Analyses and Descriptions of Capacity Tests in Large Concrete-Lined Canals (Reclamation 1964). A major conclusion from the Technical Memorandum No. 661 was that the basic hydraulic loss formulas used during the design of the large concrete canals required adjustment. Specifically, the original designs for the FKC used a Manning's "n-value" (or friction coefficient) of 0.014 for concrete-lined sections. Results from the Technical Memorandum No. 661 demonstrated that the friction coefficient for concrete-lined sections ranges from 0.015 to 0.019.

1970s – Reclamation Friant-Kern Canal Liner Raise

In the late 1970s, Reclamation addressed subsidence problems along the FKC between MP 99 to MP 116. In the 16.5-mile stretch, the concrete lining was raised between 1 foot and 4.5 feet above the top-of-canal lining. To accommodate the canal lining raise, Reclamation raised four concrete bridges approximately 3 feet (Ave. 112, Ave. 88, Ave. 80, and Road 192) and reconstructed and raised a farm bridge by 4.5 feet. When raising the bridges, Reclamation also modified attached utility pipe crossings. In conjunction with the liner raise and bridge work, Reclamation adjusted several turnouts, drain inlets, check structures, and culverts.

1980 – Reclamation Upper Reach Work

Between 1977 and 1980, Reclamation authorized, designed, and constructed a lining raise between the FKC headworks at MP 0.00 and the Kings River Check at MP 28.50. This work was necessitated by an increase in water demand and operational control. Thus, the initial maximum capacity of the FKC was increased from 5,000 cfs to 5,300 cfs and the design deficiency in this reach was corrected. The details for this construction can be found in Reclamation specification DC-7295.

2002 – FWA Liner Raise

In 2002, FWA installed an 18-inch concrete liner raise, from MP 75.77 (Spruce Bridge) to just downstream of MP 76.37 (Marinette Bridge). The purpose of this project was to both address subsidence and increase the flow capacity from 3,950 cfs to 4,300 cfs.

2018-2019 – Immediate Repairs

During the winter of 2018 to 2019, FWA undertook a series of repairs to increase the capacity of the Middle Reach to the extent possible while the Project is implemented. FWA installed a 0.045-inch-thick reinforced polypropylene liner between MP 103.85 and MP 106.32, coated five bridges with a protective sealant, repaired or reinforced utility supports spanning bridges, and mud-jacked as necessary to control seepage.

San Joaquin River Restoration Program

The Settlement Act, included in Public Law 111-11 and signed into law on March 30, 2009, authorizes and directs the Secretary of the Interior to implement the Stipulation of Settlement of Natural Resource Defense Council (NRDC) et al. v. Kirk Rodgers et al. (Settlement), which ended an 18-year legal dispute over the operation of Friant Dam and resolved longstanding legal claims brought by a coalition of conservation and fishing groups led by the NRDC. Reclamation is the Federal lead agency for the San Joaquin River Restoration Program (SJRRP). Along with Reclamation, the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), California Department of Water Resources (DWR), and California Department of Fish and Wildlife (CDFW) are implementing agencies.

The Settlement establishes two goals: (1) the Restoration Goal is to restore and maintain fish populations in good condition in the main stem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish, and (2) the Water Management Goal is to reduce or avoid adverse water supply impacts to all of the Friant Division long-term contractors that may result from the Interim Flows and Restoration Flows provided for in the Settlement.

To achieve the Water Management Goal, Paragraph 16 of the Settlement and Part III of the Settlement Act provide for actions to recapture Restoration Flows and increase access to water supply during wet hydrologic conditions, including restoration of the capacity of the FKC and Madera Canal. The reduced capacity of the FKC constrains Reclamation's ability to implement actions to achieve the Water Management Goal.

Interim Flows for experimental purposes began in 2009, and Restoration Flows began January 1, 2014. Current channel capacity constraints limit the ability to release full Restoration Flows. The flows will increase gradually over the next several years as channel capacity is increased through the implementation of SJRRP actions.

Friant-Kern Canal Capacity Restoration Feasibility Study

Part III of the Settlement Act authorizes Reclamation to conduct feasibility studies on restoration of the designed and constructed capacity of the FKC and Madera Canal. In 2011, Reclamation completed a Draft Feasibility Report for the FKC with the planning objective to improve the water deliveries and reliability within a funding constraint of $25,000,000. Estimated costs to restore the original designed and constructed capacity of the entire FKC exceeded the available funding. Therefore, the feasibility study alternative focused on raising the canal lining in the Upper Reach from the Kings River Siphon outlet (MP 29.14) to the 5th Avenue Check (MP 88.2). Based on the Draft Feasibility Report recommendations, Reclamation prepared a 60 percent design and cost estimate for the Upper Reach of the FKC, which found the project formulation was not feasible within the funding authorized in the Settlement Act.

Part III Financial Assistance for Local Projects

Part III of the Settlement Act authorizes Reclamation to provide financial assistance to local agencies within the Friant Division of the CVP for the planning, design, environmental compliance, and construction of local facilities to bank water underground or recharge groundwater. A project will be eligible if all or a portion of the project is designed to reduce, avoid, or offset the quantity of expected water supply impacts to Friant Division long-term contractors caused by Restoration Flows in the San Joaquin River released pursuant to the Settlement.

Reclamation completed Guidelines for the Application of Criteria for Financial Assistance for Local Projects under Part III of Public Law 111-11 (Guidelines) in consultation with Friant Division long-term contractors. The Guidelines provide a framework for obtaining Federal financial assistance for Friant Division groundwater recharge and/or banking projects as authorized by Part III. Consistent with statutory requirements of Part III of the Settlement Act, Office of Management and Budget cost principles and Reclamation policy, the Guidelines address the contents of a complete Planning Report and cost-share agreement.

Several Part III Projects have been constructed and are in operation in the Study Area and result in an increased ability to recharge groundwater. This increase in recharge capability can increase demand during wet hydrologic periods when FKC flows are typically highest. The reduced capacity of the FKC constrains the ability to deliver water to Part III projects.

Friant-Kern Canal Reverse Flow Pump-back Project

In September 2016, Reclamation and FWA entered into FAA Number R16AC00106 for the Friant-Kern Canal Reverse Flow Pump-back Project whereby FWA will perform the planning, environmental compliance documentation, and design and construction of Reverse Flow Pump-back Facilities. Reclamation initially studied permanent pump-back facilities along the southern portion of the FKC as part of the SJRRP. Reclamation evaluated permanently increasing pumping capacities to 200 cfs at the Shafter Check Structure and 75 cfs at the Lake Woollomes and Deer Creek Check structures. Building on the appraisal study, FWA is considering sizing the Reverse Flow Pump-back to improve water management during drought conditions. The MRCCP involves coordination with the Pump-Back Facilities Project.

Sustainable Groundwater Management Act

A three-bill package, known as the Sustainable Groundwater Management Act (SGMA), was passed by the California legislature and signed into law by Governor Edmund G. Brown in 2014. This legislation, amended in 2015, allows local agencies to customize groundwater sustainability plans to their regional economic and environmental needs, and creates a framework for sustainable, local groundwater management. The act defines sustainable groundwater management as the “management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results” such as land subsidence and water quality degradation.

The Study Area includes several high-priority basins under SGMA due to the severity of groundwater overdraft. As a result of this designation, the managing agencies or groundwater sustainability agencies (GSA) in the area are required to adopt groundwater sustainability plans (GSP) by January 31, 2020. The GSAs have twenty years to implement their GSPs and achieve their sustainability goal in the basin by 2040.

Chapter 2 Water Resources and Related Conditions

One of the most important elements of any water resources evaluation is defining existing conditions in the study area, the associated problems and opportunities, and how these conditions may change in the future. This chapter describes these critical topics which will provide guidance for the solutions presented in subsequent chapters.

Existing Conditions in Study Area

The existing and likely future conditions are used to establish the basis of comparing potential alternative plans, a process consistent with PR&G, NEPA, CEQA, and Reclamation D&S Standards. This section briefly discusses existing conditions in the study area.

Surface Water

The major surface water resources in the study area are the San Joaquin River and its tributaries. The San Joaquin River is the second longest river in California. It originates in the Sierra Nevada mountain range at an elevation of approximately 12,000 feet above mean sea level and carries snowmelt from mountain meadows to the valley floor before turning north and becoming the backbone of tributaries draining into the San Joaquin Valley. The San Joaquin River discharges to the Sacramento-San Joaquin Delta from the south and, ultimately, to the Pacific Ocean through San Francisco Bay.

Groundwater

The San Joaquin Valley Groundwater Basin, Figure 2-1, makes up the southern two-thirds of the 400-mile-long, northwest-trending, asymmetric trough of the Central Valley regional aquifer system (Page 1986). The study area overlies two main hydrologic regions within the San Joaquin Valley Groundwater Basin: The San Joaquin River Hydrologic Region and the Tulare Lake Hydrologic Region.

The San Joaquin River Hydrologic Region consists of surface-water basins that drain into the San Joaquin River system, from the Cosumnes River basin in the north through the southern boundary of the San Joaquin River watershed (DWR 1999). Aquifers in the San Joaquin Valley Groundwater Basin typically extend to depths of 800 feet. The San Joaquin River Hydrologic Region relies heavily on groundwater, accounting for approximately 30 percent of the region’s annual water supply for agricultural and urban uses (DWR 2003).

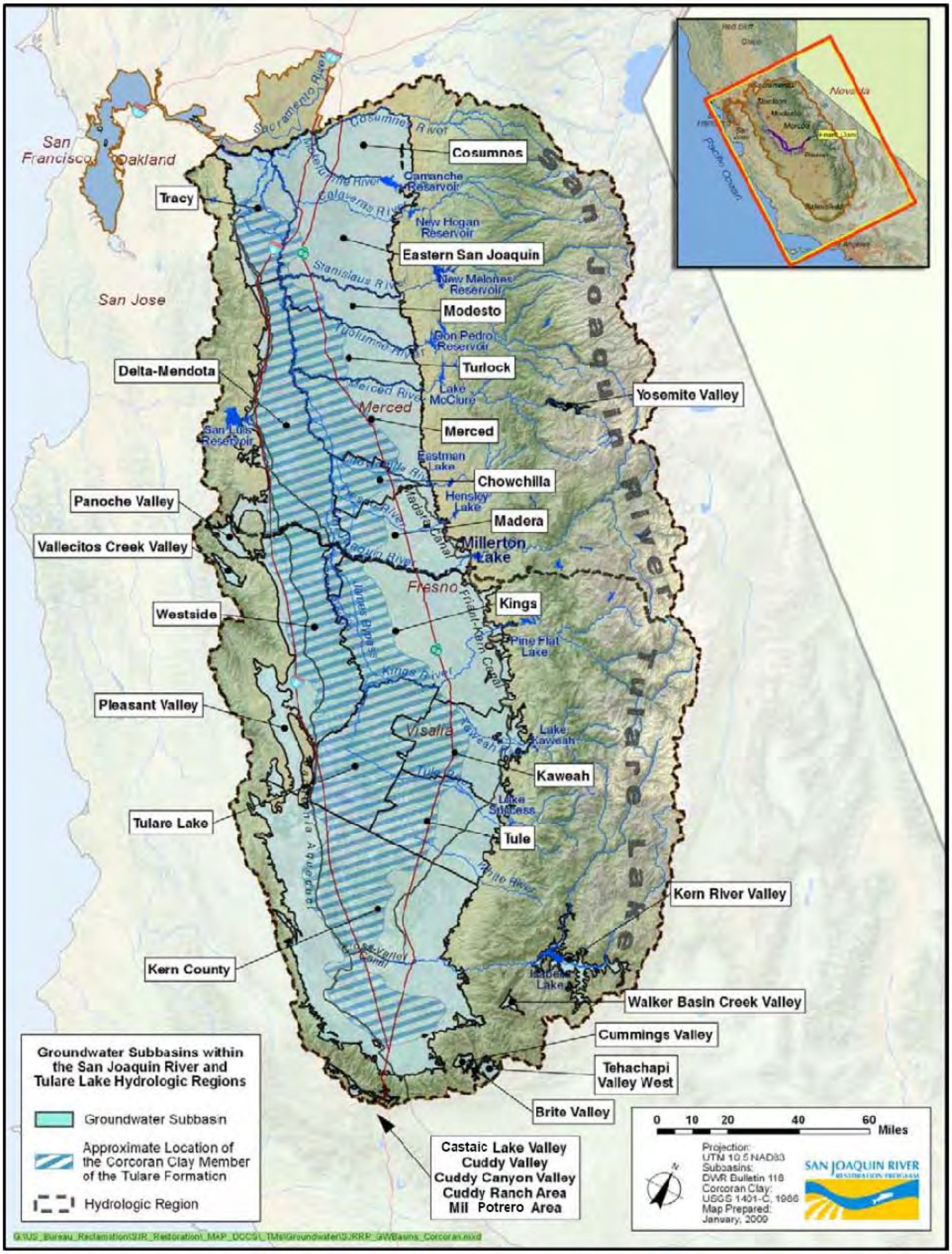

Figure 2-1. San Joaquin Valley Groundwater Basin and Sub-basins

The Tulare Lake Hydrologic Region is a closed drainage basin at the south end of the San Joaquin Valley, and encompasses the Kings, Westside, Pleasant Valley, Kaweah, Tulare Lake, Tule, and Kern County groundwater sub-basins. In the hydrologic region, the primary aquifer extends 1,000 feet below the surface (DWR 2003). The Tulare Lake Hydrologic Region also relies heavily on groundwater supplies; groundwater use has historically accounted for 41 percent of the total annual water supply within the region and for 35 percent of all groundwater use in California. Groundwater use in this hydrologic region represents approximately 10 percent of the state's total agricultural and urban water use (DWR 1998).

Friant Division of the Central Valley Project

The Friant Division of the CVP provides water to over one million acres of irrigated land on the east side of the southern San Joaquin Valley. Principal features of the Friant Division include Friant Dam and Millerton Lake, and the Madera and Friant-Kern canals.

Friant Dam and Millerton Lake

Friant Dam is a concrete gravity dam that impounds Millerton Lake on the San Joaquin River, located about 16 miles northeast of Fresno near the community of Friant. The dam, owned and operated by Reclamation, began releasing water from Millerton Lake in 1942. The lake has a capacity of 524 thousand acre-feet (TAF) which is typically filled during late spring and early summer from snowmelt. Prior to SJRRP implementation, annual water allocations draw down the reservoir storage to minimum levels by the end of September. Post-SJRRP implementation, the reservoir will reach minimum storage levels during late fall to early winter.

Friant Dam releases water deliveries to the Friant-Kern and Madera canal through outlet works. Outlets to the Madera Canal are located on the right side of the dam and outlets to the Friant-Kern Canal are located on the left. There is also a river outlet works located to the left of the spillway within the lower portion of the dam. The Friant Power Authority owns and operates powerhouses located on the FKC and Friant Dam river outlets that have a combined capacity of about 30 megawatts.

Madera Canal

The Madera Canal, operated and maintained by the Madera and Chowchilla Water and Power Authority, is a 36-mile-long canal that begins at Millerton Lake and terminates at the Chowchilla River. The canal was designed with an initial capacity of 1,000 cfs at the headworks, decreasing to 625 cfs at the Chowchilla River. In 1965, the canal lining was raised from the headworks to MP 2.09, increasing the capacity in that reach to 1,250 cfs.

Friant-Kern Canal

The FKC, operated and maintained by FWA, is a 152-mile, gravity canal that spans from Friant Dam south to the Kern River. The FKC has a maximum design capacity of 5,300 cfs, gradually decreasing to 2,500 cfs to accommodate conveyance for downstream water demand. However, maximum design capacity has not been actualized. Original design assumptions regarding the roughness or Manning's "n" value were found inaccurate shortly following completion of the canal, resulting in capacity reductions. The capacity has been further reduced because of increased canal surface roughness with age, vegetation within canal sections, changes in water delivery patterns, localized seepage through canal embankments, and land subsidence. As described in Chapter 1, the Project focuses on the Middle Reach of the FKC, from MP 88.2 to MP 121.5, which comprises four segments, as described below. The features and structures of the Middle Reach FKC are depicted in Figure 2-2A and 2-2B and summarized in Table 2-1. For more detail, refer to Appendix B Feasibility Alternatives Engineering Design and Cost.

Segment 1: 5th Ave. to Tule River The first (most upstream) segment of the Project is about 13 miles long and extends from the 5th Ave. Check (MP 88.2) to the Tule River (MP 95.6). It was designed for a normal flow of 3,500 cfs and a design maximum flow of 4,500 cfs. Sixteen state/county bridges cross the FKC in this segment and one bridge runs parallel to a siphon. In addition, this segment includes seven turnouts, three siphons, one wasteway, and one weir.

Segment 2: Tule River to Deer Creek The second segment is about seven miles long and extends from Tule River (MP 95.6) to Deer Creek (MP 102.7). It was designed for a normal flow of 3,000 cfs and a maximum flow of 4,000 cfs. Six state/county bridges one farm bridge, and one bridge parallel to a siphon cross the FKC in this segment. In addition, this segment includes ten turnouts and one siphon.

Segment 3: Deer Creek to White River The third segment is about 10 miles long and extends from Deer Creek (MP 102.7) to White River (MP 112.9). It was designed for a normal flow of 3,000 cfs and a maximum flow of 4,000 cfs.. Ten state/county bridges and two farm bridges cross the FKC in this segment. In addition, this segment includes, nine turnouts, one siphon, and one wasteway in this segment.

Segment 4: White River to Woollomes The fourth segment is about eight miles long and extends from White River (MP 112.9) to Lake Woollomes (MP 121.5). It was designed for a normal flow of 2,500 cfs and a design maximum flow of 3,000 cfs. Eight state or county bridges, two farm bridges, and one abandoned railroad bridge cross the FKC in this segment. In addition, this segment includes 12 turnouts, one siphon, and one reservoir structure (Lake Woollomes). The downstream limit of the Project is MP 121.5.

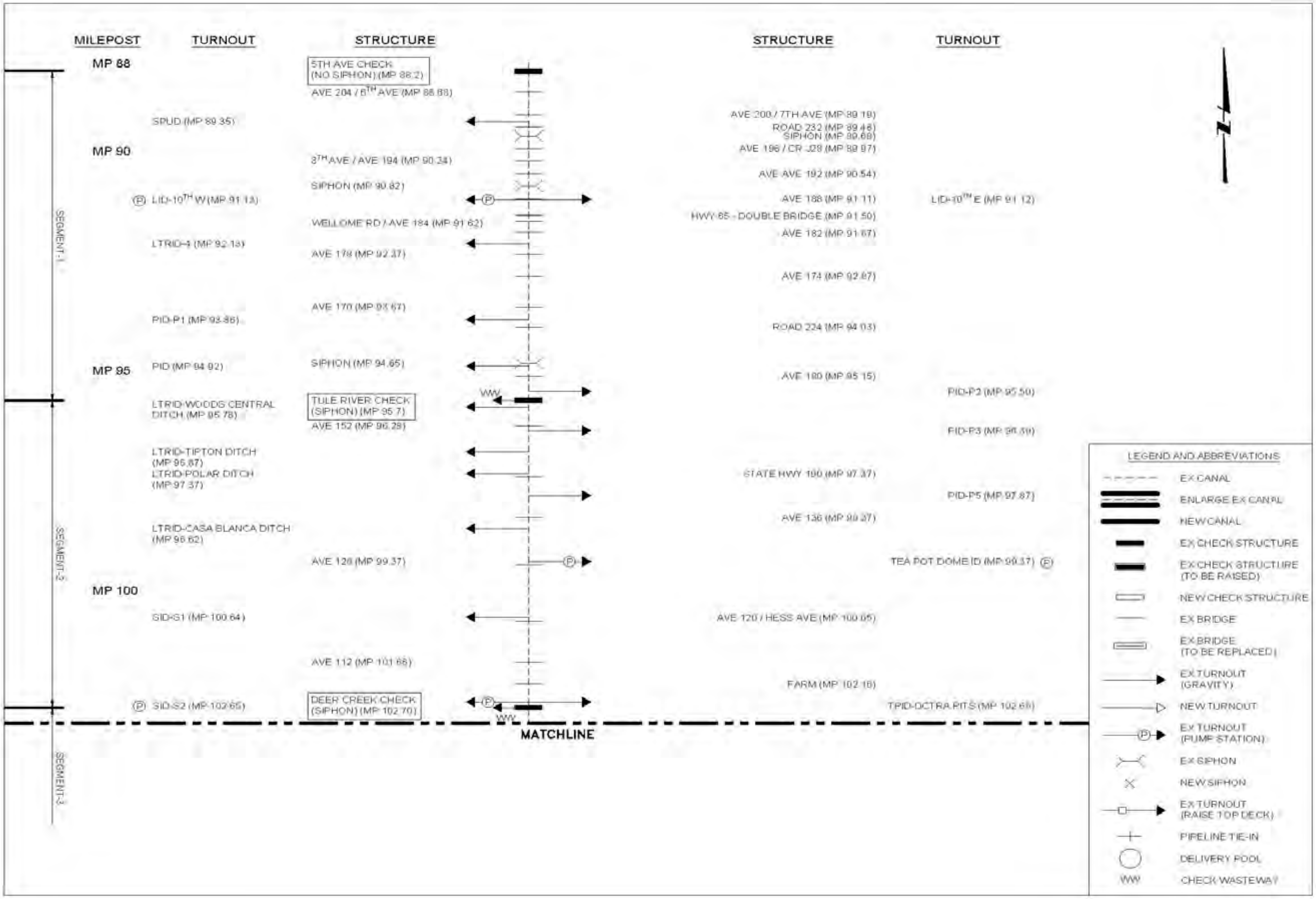

Figure 2-2A. Existing Canal Diagram Segments 1 and 2

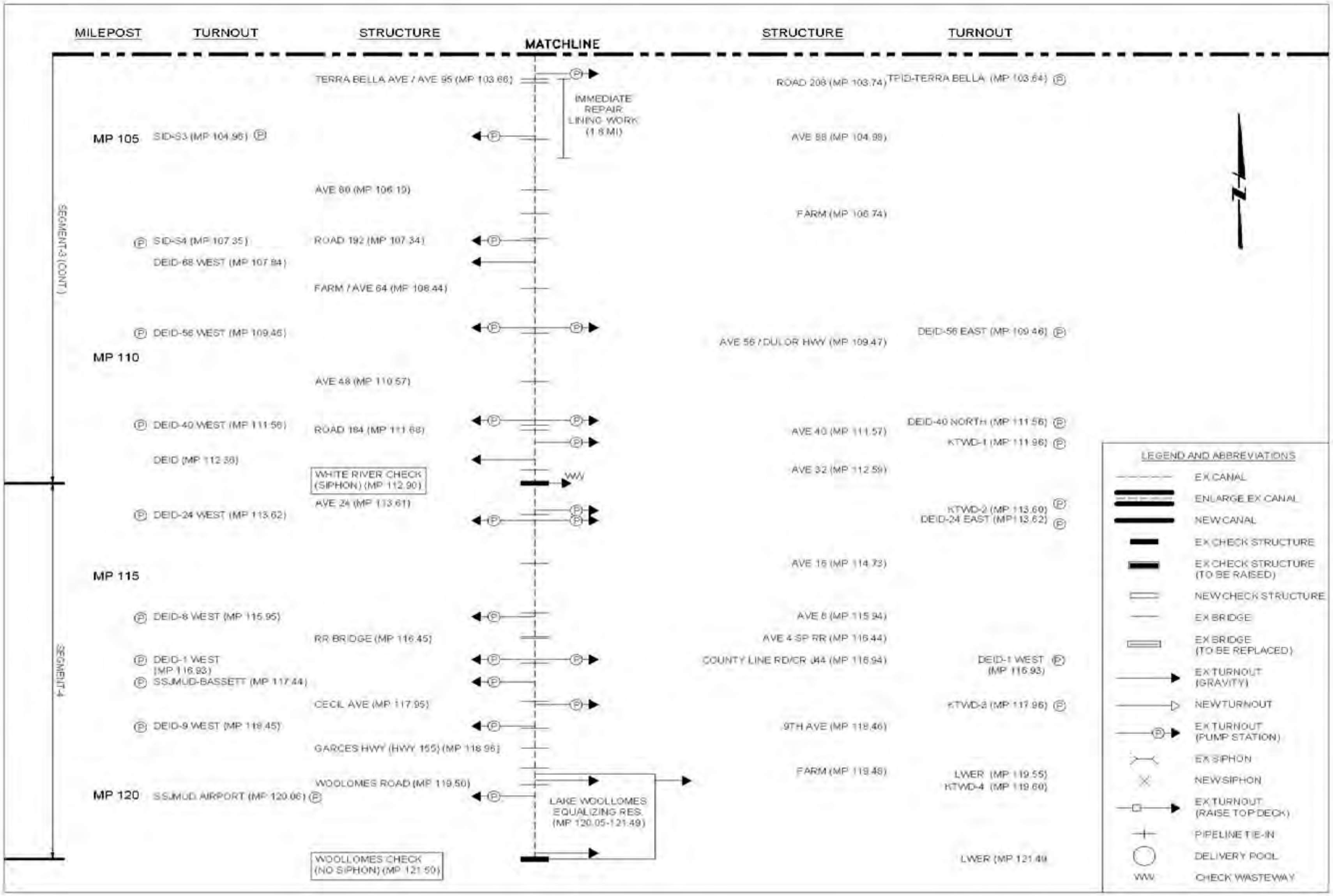

Figure 2-2B. Existing Canal Diagram Segments 3 and 4

Table 2-1. Friant-Kern Canal Structures by Segment

Structures	Segment 1 5th Ave. to Tule River (MP 88.2 – 95.6)	Segment 2 Tule River. to Deer Creek (MP 95.6 – 102.7)	Segment 3 Deer Creek to White River (MP 102.7 – 112.9)	Segment 4 White River. to Woollomes (MP 112.9 – 121.5)
Bridges, State/County	16	6	10	8
Bridges, Farm	0	1	2	2
Bridges, Other	1	1	0	1
Turnouts	7	10	9	12
Siphons	3	1	1	1
Other Structures	1 Wasteway, 1 Weir	0	1 Wasteway	1 Reservoir Structure

Note: Bridges, Other refers to the bridges parallel to siphons or the abandoned railroad bridge.

Friant Division Water Contracts

Reclamation holds most of the water rights on the San Joaquin River, allowing diversions at Friant Dam through purchase and exchange agreements with entities, or long-term contractors. Thirty-two Friant Division long-term contractors in Madera, Fresno, Kings, Tulare and Kern counties supply water to over 1.2 million acres of irrigated land, several small rural communities, and large urban areas.

Reclamation employs a two-class system of water contracts in the Friant Division. Class 1 contracts total 800 TAF and are dependable water supply and are generally assigned to agricultural and urban water users who have limited access to good quality groundwater. Class 2 contracts total approximately 1,401 TAF and, because of its uncertainty as to availability and timing, Class 2 contracts are considered undependable in nature and are applicable only when Reclamation makes available. Class 2 contracts support regional conjunctive use and are the basis to provide water supplies for groundwater replenishment during wetter years. Contract amounts for all Friant Division long-term contractors are listed in Table 2-2 and locations are shown in Figure 2-3.

Table 2-2. Friant Division Long-Term Contractors and Friant Water Authority Membership

Friant Division Long-Term Contractor[1]	FWA Membership: FKC O&M Membership	FWA Membership: Representation Membership	Class 1 Contract (AF)	Class 1 Contract (% of Total)	Class 2 Contract (AF)	Class 2 Contract (% of Total)	Total Contract (AF)	Total Contract (% of Total)
Chowchilla WD		X	55,000	6.9	160,000	11.4	215,000	9.8
Madera ID		X	85,000	10.6	186,000	13.3	271,000	12.3
Gravelly Ford WD			-	0.0	14,000	1.0	14,000	0.6
Madera County			200	0.0	-	0.0	200	0.0
Fresno County			150	0.0	-	0.0	150	0.0
Garfield WD	X		3,500	0.4	-	0.0	3,500	0.2
International WD	X		1,200	0.2	-	0.0	1,200	0.1
City of Fresno	X	X	60,000	7.5	-	0.0	60,000	2.7
Fresno ID	X	X	-	0.0	75,000	5.4	75,000	3.4
Tri-Valley WD	X		400	0.1	-	0.0	400	0.0
Hills Valley ID	X	X	1,250	0.2	-	0.0	1,250	0.1
City of Orange Cove	X		1,400	0.2	-	0.0	1,400	0.1
Orange Cove ID	X	X	39,200	4.9	-	0.0	39,200	1.8
Stone Corral ID	X		10,000	1.3	-	0.0	10,000	0.5
Ivanhoe ID	X		6,500	0.8	500	0.0	7,000	0.3
Kaweah Delta Water Conservation District	X	X	1,200	0.2	7,400	0.5	8,600	0.4
Tulare ID	X	X	30,000	3.8	141,000	10.1	171,000	7.8
Exeter ID	X		11,100	1.4	19,000	1.4	30,100	1.4
Lewis Creek WD	X		1,200	0.2	-	0.0	1,200	0.1
City of Lindsay	X		2,500	0.3	-	0.0	2,500	0.1
Lindsay-Strathmore ID	X	X	27,500	3.4	-	0.0	27,500	1.2
Lindmore ID	X	X	33,000	4.1	22,000	1.6	55,000	2.5
Lower Tule River ID	X		61,200	7.7	238,000	17.0	299,200	13.6
Porterville ID	X	X	15,000	1.9	30,000	2.1	45,000	2.0
Saucelito ID	X	X	21,500	2.7	32,800	2.3	54,300	2.5
Terra Bella ID	X	X	29,000	3.6	-	0.0	29,000	1.3
Tea Pot Dome WD	X		7,200	0.9	-	0.0	7,200	0.3
Delano-Earlimart ID	X		108,800	13.6	74,500	5.3	183,300	8.3
Kern-Tulare WD	X	X	-	0.0	5,000	0.4	5,000	0.2
Southern San Joaquin MUD	X		97,000	12.1	45,000	3.2	142,000	6.5
Shafter-Wasco ID	X		50,000	6.3	39,600	2.8	89,600	4.1
Arvin-Edison Water Storage District	X	X	40,000	5.0	311,675	22.2	351,675	16.0
Total Contract (AF)	**800,000**			**1,401,475**		**2,201,475**		

Note: [1]Contractors listed in a north to south orientation
Key:
AF = acre-feet
FKC = Friant-Kern Canal
FWA = Friant Water Authority
ID = irrigation district
MUD = municipal utility district
O&M = operations and maintenance
WD = water district

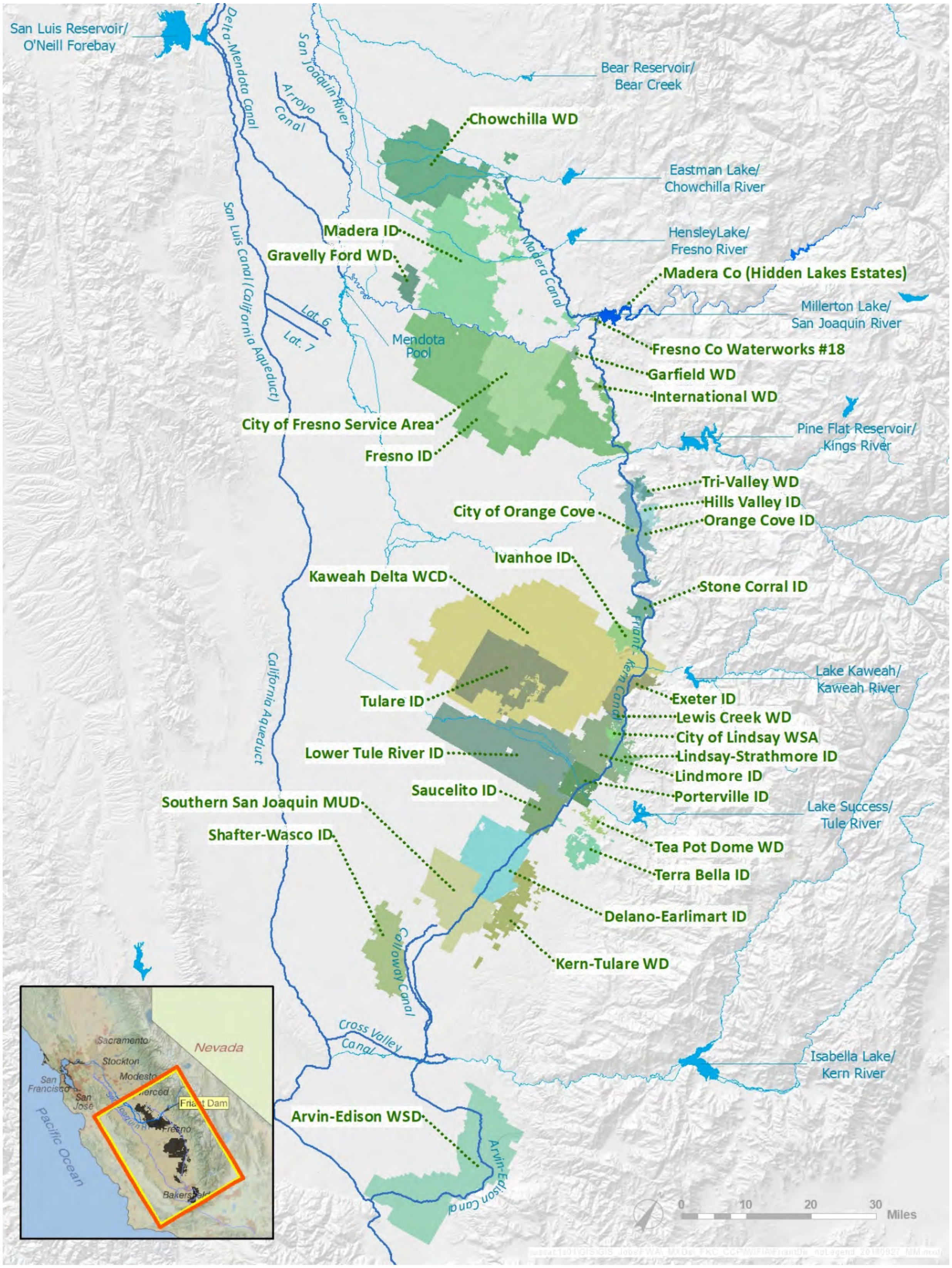

Figure 2-3. Friant Division Long-Term Contractors

In addition, Friant Division long-term contractors can obtain surface water in accordance with Section 215 of the Reclamation Reform Act of 1982 and under the provisions of Paragraph 16(b) of the Settlement. Section 215 authorizes Reclamation to deliver water that cannot be stored and otherwise would be released in accordance with flood management criteria or unmanaged flood flows. Delivery of Section 215 water has enabled the replenishment of San Joaquin Valley groundwater at higher levels than otherwise could be supported with Class 1 and Class 2 contract deliveries. Paragraph 16(b) provides for the delivery of water during wet hydrologic conditions at a cost of $10 per acre-foot, when water is not needed for Restoration Flows.

Friant Division long-term contractors schedule deliveries through daily water orders to Reclamation at Friant Dam. Due to long-standing irrigation practices, water delivery amounts vary by day of the week; water delivery demands are generally higher mid-week and lower on weekends. A review of historical releases at the FKC headworks from 2000 to 2017 demonstrates that daily demand can vary by week, month, and water year type. During a week, daily demand can vary by as much as 30 percent during July, at the peak of the irrigation season (Figure 2-4). The magnitude and timing of the variations fluctuate in accordance with the water year type; the largest variations occur during the peak irrigation months of dryer years and late irrigation months of wet years, as shown in Figure 2-5.

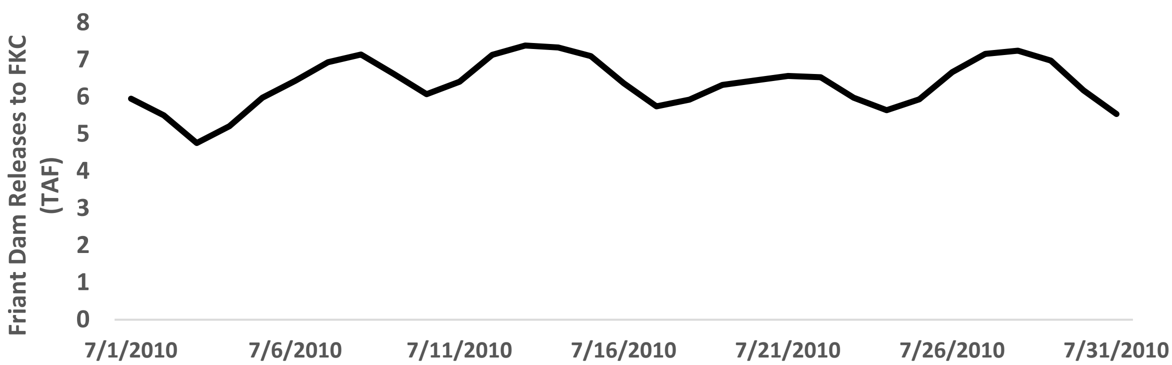

Figure 2-4. Variation of Daily Friant Dam Releases to Friant-Kern Canal During July 2010

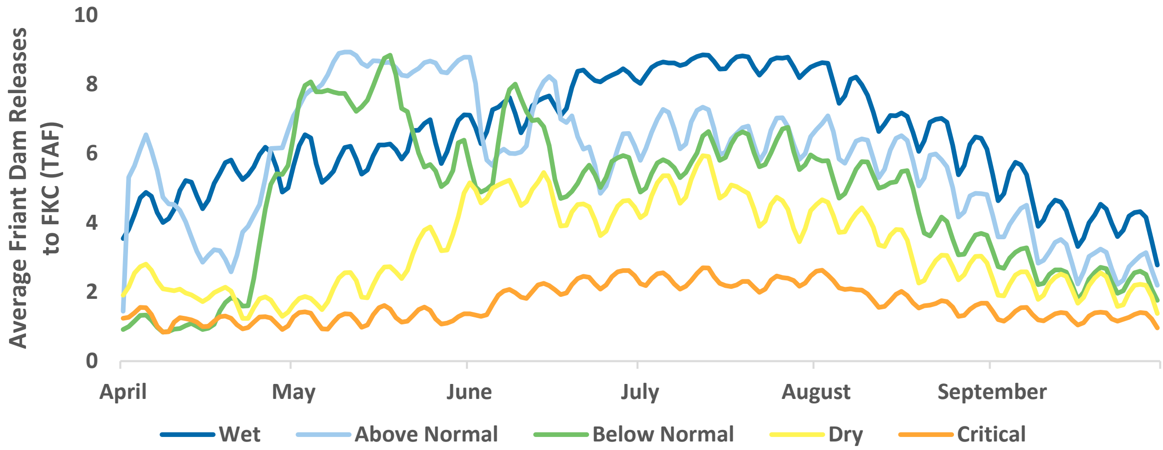

Figure 2-5. Average Daily Distribution Pattern by Water Year Type from 1921-2003

Land Use and Agricultural Resources

The Friant Division of the CVP contains some of the most productive lands in California, with the study area containing the top three agricultural producing counties in the nation (USDA 2007). The primary land uses in the study area are agriculture, urban, and open space; agriculture accounts for the majority of land use, with urban and open space accounting for only a small percentage. Table 2-3 shows the acreages of land use by the Friant Division long-term contractors that receive water deliveries from the FKC.

Table 2-3. Existing Land Uses in Friant Division Long-Term Contractors

Friant Division Long-Term Contractor	Land Use (acres)			
	Agricultural	Open Space	Urban	Total
Chowchilla ID	85,869	0	2,250	88,119
Madera ID	123,830	1	6,882	130,713
Gravelly Ford WD	8,431	0	0	8,431
*Madera County**	0	0	154	154
Fresno County WW No. 18	251	2	0	253
Garfield WD	1,813	0	0	1,813
International WD	724	0	0	724
City of Fresno	0	1,210	88,790	90,000
Fresno ID	187,489	64	60,336	247,889
*Tri Valley WD**	1,800	2,700	0	4,500
*Hills Valley ID**	3,500	800	0	4,300
City of Orange Cove	286	0	674	960
Orange Cove ID	29,163	0	116	29,279
Stone Corral ID	6,882	0	0	6,882
Ivanhoe ID	10,983	0	0	10,983
*Kaweah Delta Water Conservation District**	299,000	11,000	30,000	340,000
Tulare ID	69,293	0	4,220	73,513
Exeter ID	14,078	0	1,136	15,214
Lewis Creek WD	1,297	0	0	1,297
City of Lindsay	415	0	1,113	1,528
Lindsay-Strathmore ID	15,628	0	492	16,120
Lindmore ID	27,483	0	214	27,697
Lower Tule River ID	102,159	932	185	103,276
Porterville ID	15,842	0	1,194	17,036
Saucelito ID	19,826	0	0	19,826
Terra Bella ID	13,642	0	272	13,914
Tea Pot Dome WD	3,581	0	0	3,581
Delano-Earlimart ID	56,264	0	353	56,617
Kern-Tulare WD	17,433	2,639	0	20,082
Southern San Joaquin MUD	56,233	79	5,308	61,620
Shafter-Wasco ID	36,042	0	2,952	38,994
Arvin-Edison WSD	128,941	220	3,691	132,852
Total	**1,338,178**	**19,647**	**210,332**	**1,568,157**

Source: Draft SJRRP PEIS/R.
* *Friant Division Atlas*
Key:
ID = Irrigation District
MUD = Municipal Utility District
WD = Water District
WSD = Water Storage District

Problems, Needs, and Opportunities

Four predominant problems in the study area impact Friant Division water supply delivery and reliability: FKC design deficiency, groundwater overdraft, subsidence, and reduced canal capacity. These problems can be addressed through the Settlement Act, other provisions of P.L. 111-11, the WIIN Act, and the local implementation of SGMA.

Friant-Kern Canal Design Deficiency

The FKC was built prior to the development of Reclamation's current Design Standards No. 3, Release No. DS-3-5, dated 1967, and revised in 1994. As such, assumptions used in the original design led to an inability to achieve design conveyance capacity.

The design deficiency was recognized in the 1940s and 1950s when Reclamation observed that many large concrete canals were incapable of conveying flows specified in the original designs. This problem prompted a study on several canals in the 1950s, including the FKC. Reclamation documented the conclusions and results of this study in their early 1960s Technical Memorandum No. 661 – Analyses and Descriptions of Capacity Tests in Large Concrete-Lined Canals. Through Part III of the Settlement Act, Reclamation is authorized to restore the original design capacity.

Groundwater Overdraft

Groundwater overdraft is a regional problem that directly impacts FKC water deliveries. Overdraft occurs when use exceeds the recharge rate of an aquifer. Through an extensive evaluation process, the State classified which groundwater basins are subject to critical conditions of overdraft.[1] According to Bulletin 118 (DWR 2016), five subbasins in the Tulare Lake Hydrologic Region (Kings, Tulare Lake, Kern County, Kaweah, and Tule) and three subbasins in the San Joaquin River Hydrologic Region (Chowchilla, Eastern San Joaquin, and Madera) are subject to critical conditions of overdraft.

These eight subbasins are subject to critical conditions of overdraft as a result of limited access to surface water during dry hydrologic periods and widespread agricultural land use. The reduced FKC capacity, as a result of subsidence, affects Friant Division water deliveries to lands in some of these subbasins. As FKC capacity decreases, Friant Division contractors will likely meet their water needs with additional groundwater, causing groundwater levels to further decline. As groundwater levels decrease, the risk grows for impaired water quality, reduced water storage, and increased subsidence. To mitigate these risks, GSAs are developing GSPs under SGMA requirements. As the plans go into effect, it is likely that water users will adopt water management practices that include greater conservation of groundwater and surface water, yet their ability to implement these actions will be limited due to reduced capacity in the FKC.

Subsidence

Subsidence is a consequence associated with groundwater overdraft. When groundwater is extracted faster than the natural rate of replenishment, the water suspending fine-grained sediments are removed and the sediments compact, resulting in subsidence.

Subsidence is an ongoing regional issue, which was exacerbated during the 2012 to 2016 drought. Data from an interferometric synthetic aperture radar (InSAR) shows regional land

[1] Bulletin 118, Update 1980 defines a groundwater basin subject to critical conditions of overdraft "when continuation of present water management practices would probably result in significant adverse overdraft related environmental, social, or economic impacts."

subsidence from May 2015 to September 2016 lowered the land surface elevation by as much as 25 inches; within the FKC Middle Reach, the land subsided between 5 and 20 inches during this 16-month period (Figure 2-6).

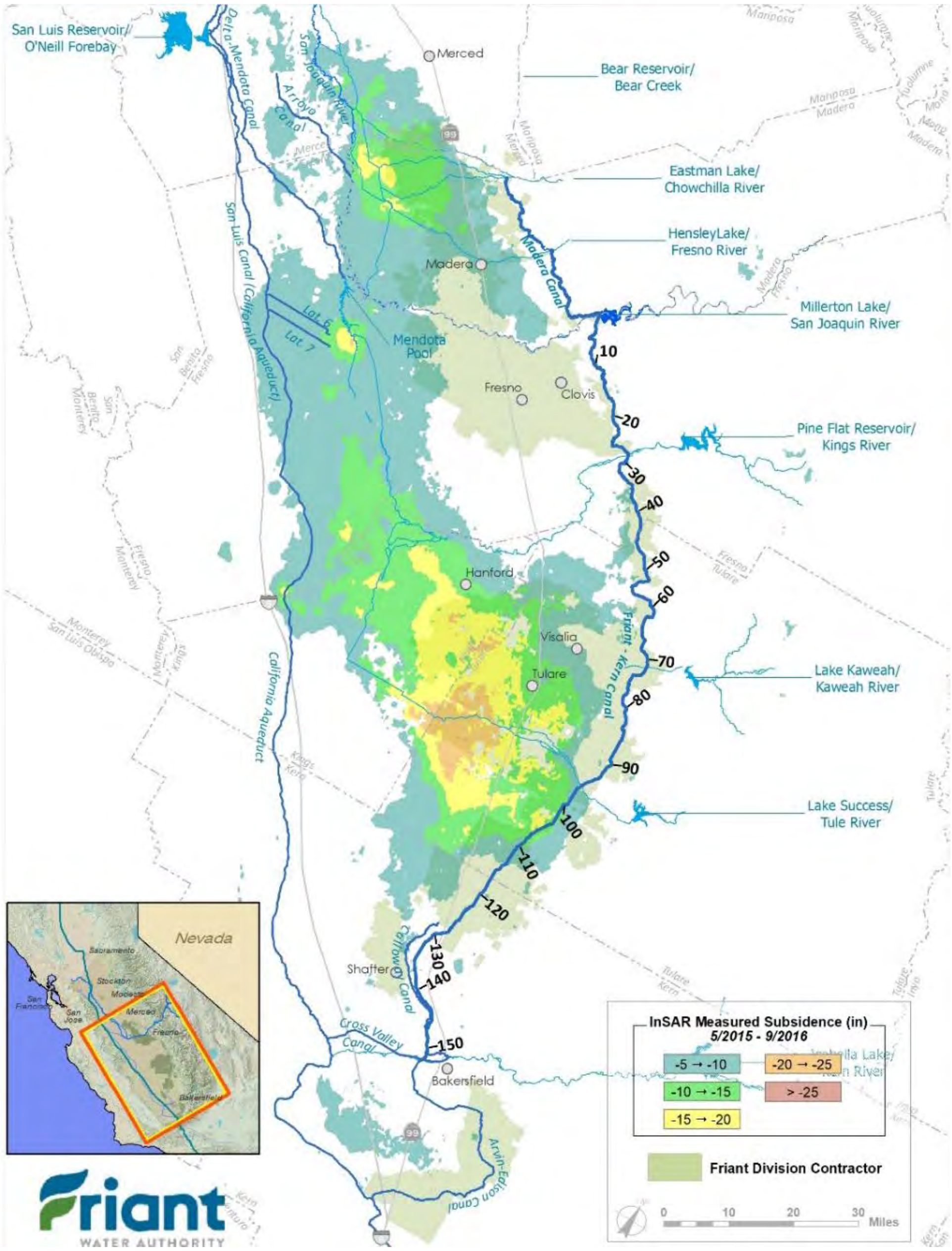

Figure 2-6. Recent Subsidence in the Friant Division

The FKC is located over the eastern portion of the regionally subsided area. As of July 2018, it is estimated that the FKC is approximately 12 feet below the original constructed elevation, creating a significant low point in the Middle Reach between MP 103 and MP 107 (Figure 2-7). Subsidence, and its consequences for the FKC, can be minimized through implementation of both SGMA and the Settlement Act. With the implementation of GSPs, it is expected that subsidence will lessen over time. While the GSPs address the root cause of subsidence, the Settlement Act provides the authority to restore the original design capacity of the FKC. To minimize the potential recurrence of this problem, design improvements should include features to accommodate future subsidence.

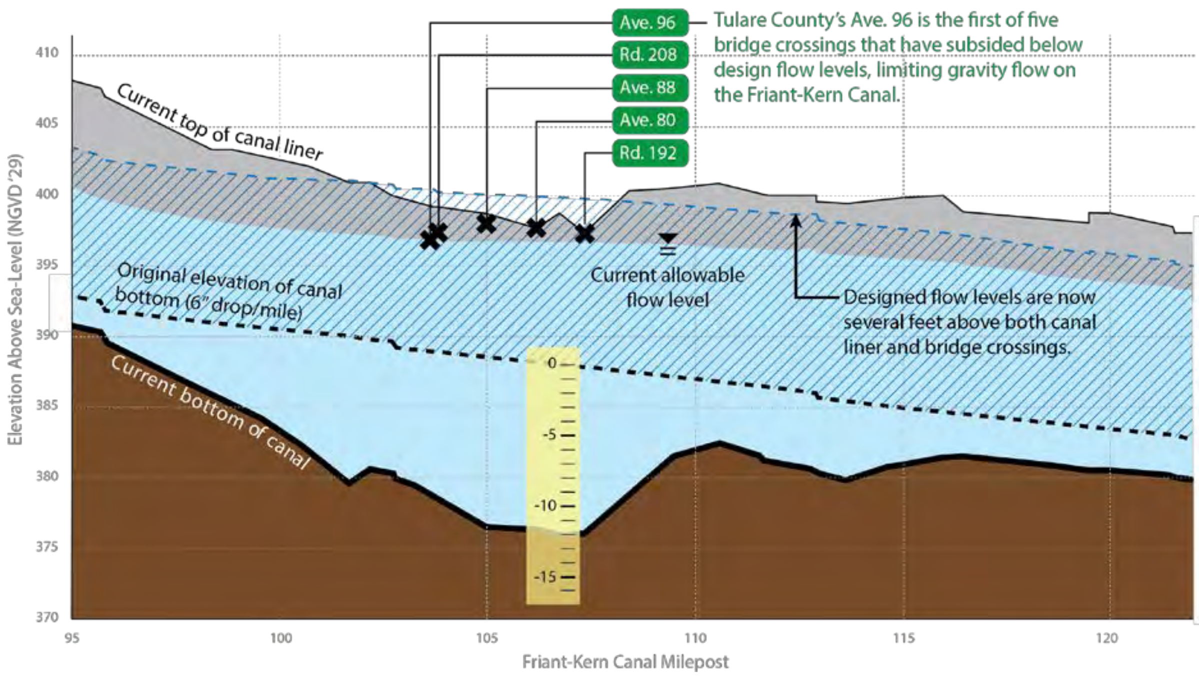

Figure 2-7. Schematic Illustration Along Friant-Kern Canal

Reduced Canal Capacity

As shown in Figure 2-8, the canal capacity is well below its designed maximum flow. The capacity reduction causes the water surface to encroach upon the operating freeboard and, at times, approach the top of the existing concrete liner. Operating canals at reduced freeboard increases seepage, which can damage the liner and increase risk of embankment failure. Higher water surface elevations can also adversely affect bridges, utilities, and other infrastructure.

During wet years, the reduced canal capacity limits the delivery of surface water supplies that would be used for groundwater replenishment, thereby creating an even greater reliance on groundwater supply. During dry years, contractors in the Friant Division conjunctive use area rely more on groundwater than surface water. The increased groundwater pumping reduces groundwater levels, which can further exacerbate subsidence and reduce the FKC capability to deliver surface water.

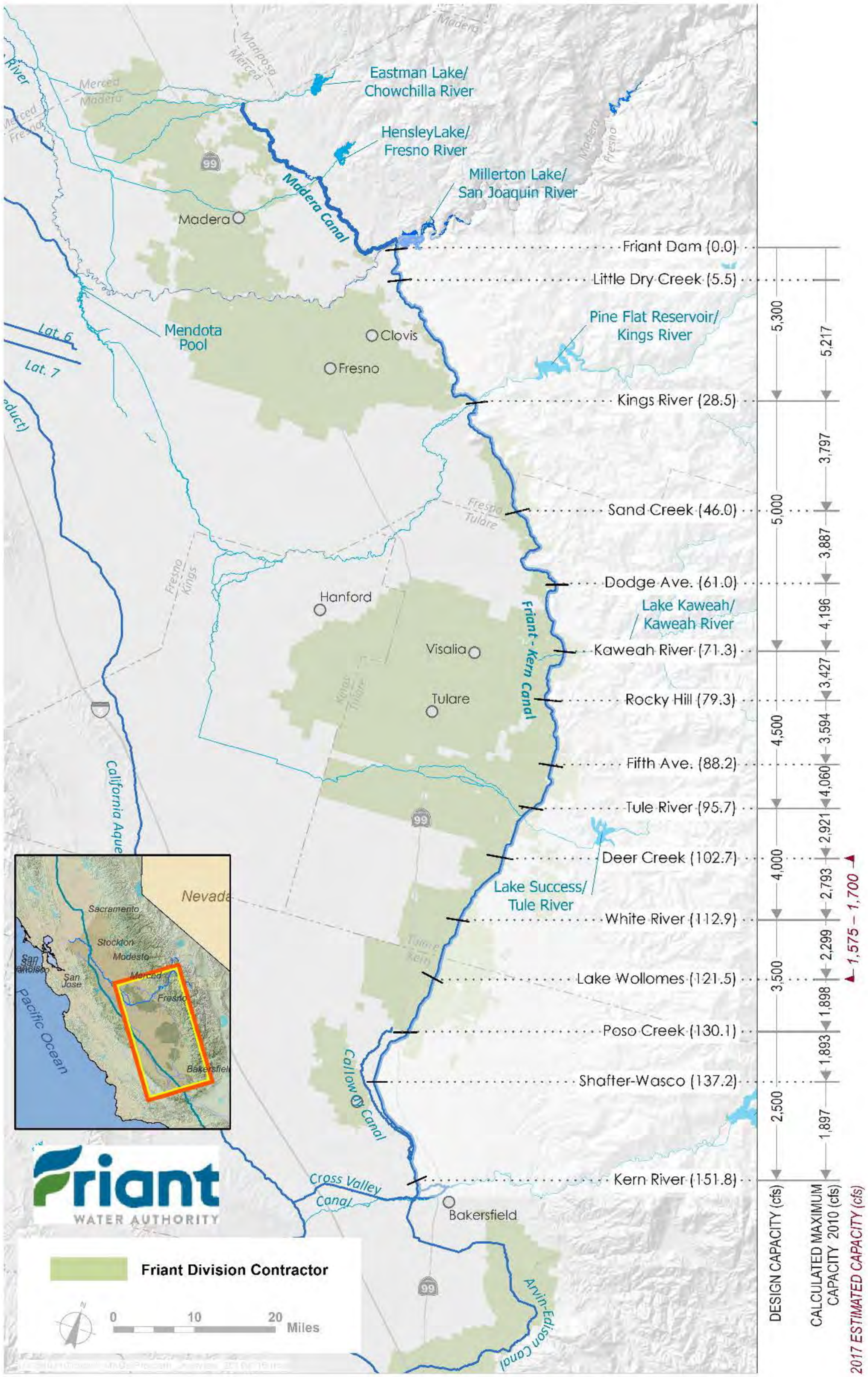

Figure 2-8. Friant-Kern Canal 2017 Capacity

Likely Future Without-Project Conditions Summary

The magnitude of potential water resources and related problems, needs, and opportunities is based not only on the existing conditions described above, but also on how these conditions may change in the future. Predicting future conditions is complicated by a variety of factors, including uncertainty regarding future regulatory requirements, ongoing programs and projects in the study area, future land subsidence, SGMA implementation, and future hydrologic conditions. The likely future without-project conditions represent the No Action Alternative, as discussed further in Chapter 4.

San Joaquin River Restoration Program Implementation

Physical changes to the San Joaquin River from Friant Dam to the Merced River are being implemented by the SJRRP and are assumed to be in place in the future without-project condition. These changes include levee modifications associated with incorporating new floodplain and related riparian habitat in the San Joaquin River, structure modifications to ensure fish passage, and channel capacity changes to accommodate Restoration Flows. The release of Restoration Flows will result in reductions to Friant Division water supplies.

Implementation of the SJRRP is progressing more slowly than planned due to unforeseen conditions and funding limitations. Currently, the release of full Restoration Flows is not possible due to downstream channel capacity constraints. As a result, URFs have been made available to Friant Contractors. The availability of URFs will decrease as channel improvements enable greater releases of Restoration Flows. Stage 1 SJRRP Implementation is scheduled to be completed by 2024 (SJRRP, 2018). The SJRRP anticipates project implementation would enable the release of full Restoration Flows no later than 2030. If that occurs, water deliveries to Friant Division contractors will decrease to levels anticipated by the SJRRP no later than the year 2030.

SGMA Implementation

Over the coming decades, SGMA will be implemented by GSAs. The eight high priority basins will have from 2020 until 2040 to come into compliance. Since the GSPs are still under development, the specific projects, programs, and anticipated timelines could not be included in this Study. Despite these unknowns, it is likely that SGMA implementation will include changes in agricultural practices and cropping patterns, reduction in irrigated acreage, and implementation of local and regional water management programs.

Future Subsidence

The performance of alternative designs should be evaluated relative to potential future conditions, particularly as it relates to subsidence. Subsidence projection studies relevant to the Middle Reach of the FKC are being developed in support of the Eastern Tule Basin GSA using the Tule Subbasins Groundwater Model.

To support evaluations presented in this Study, four potential groundwater pumping and hydrologic scenarios were evaluated to identify potential future subsidence along the alignment of the FKC. Results for each scenario are provided by decade (2030 – 2070), cumulating in a total of 20 potential subsidence profiles in the project area. Because it is not feasible to evaluate each design alternative over all subsidence projections, it is necessary to define a small number of potential conditions that represent a reasonable range of future outcomes. To achieve this, results were grouped into the following potential future subsidence conditions:

- Group 1. Minimal Mid-Term Subsidence Condition;
- Group 2. Moderate Mid-Term Subsidence Condition;
- Group 3. Severe Mid-Term Subsidence Condition; and
- Group 4. Severe Long-Term Subsidence Condition.

Each of the potential future subsidence conditions are based on achieving SGMA compliance by the year 2040, and residual subsidence continuing to the year 2070 and no subsidence thereafter. The subsidence conditions vary based on hydrologic assumptions and the timing of groundwater pumping reductions from current pumping levels to anticipated pumping levels that would achieve SGMA compliance.

Both Groups 1 and 2 represent conditions that are similar to today’s groundwater pumping and may come to fruition by the time the Project is constructed with little addition subsidence thereafter. Group 4 represents a worst-case scenario in terms of both hydrology and timeframe to achieve SGMA compliance and is thus unlikely. Therefore, the future subsidence condition described by Group 3, Severe Mid-Term Subsidence Condition, was selected as most representative for use in the evaluation of Project alternatives.

The results of Group 3 indicate that about 8.5 feet of additional subsidence could occur on the FKC by the year 2070 (see Figure 2-9). For a detailed explanation, please refer to Appendix B Engineering Design and Cost, Attachment 3 Selection of Future Subsidence Condition.

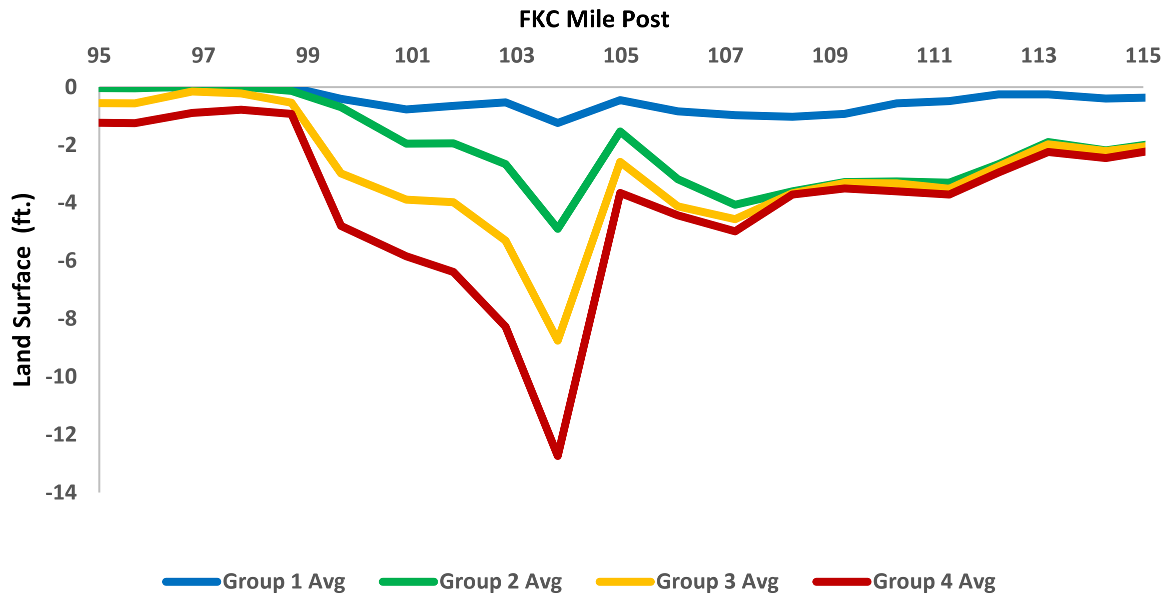

Figure 2-9. FKC Profiles Under Future Subsidence Scenarios

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Chapter 3 Initial Alternatives

The plan formulation process to the Study is based on the PR&G (CEQ 2013) and consists of the following deliberate and iterative steps:

1. Specify the water and related land resources problems and opportunities associated with the Federal objective and specific State and local concerns.
2. Inventory, forecast, and analyze existing and projected future resources conditions in the study area.
3. Formulate alternative plans.
4. Evaluate the potential effects of alternative plans.
5. Compare alternative plans.
6. Select a recommended plan to decision makers based on the comparison of alternatives.

Alternatives formulation was accomplished through a two-step approach: the Initial Alternative evaluation and Feasibility Alternative evaluation. This chapter describes the first step of the formulation, evaluation and comparison of Initial Alternatives and the selection of alternatives to be carried forward for evaluation as Feasibility Alternatives. Information in this chapter is supported with additional detail provided in Appendix A Initial Alternatives Formulation.

Project Planning Horizon

The Project is intended to be integrated into a long-term solution to restore capacity of the entire FKC, as part of the FWA's approach to restore the design capacity of the entire FKC. The planning horizon is 100 years, which is consistent with the expected service life of large civil engineering projects.

Planning and Resource Constraints

The primary constraints that affect the Project are funding availability and physical boundary conditions.

Funding Constraints

As described in Chapter 1, two Federal funding sources are currently available for the Project. These include SJRRP non-reimbursable funds of about $19 million and 2019 WIIN Act appropriations of about $2.2 million. WIIN Act appropriations are subject to a 50 percent cost share.

Boundary Conditions

When designing either a new canal or modifications to an existing canal, the first step is to identify the boundary conditions, or the required (design) water levels at each end of the system. Boundary conditions may be difficult to define, especially since they can change significantly with relatively minor changes to the Project. Although the upstream and downstream limits for this Project are the 5^{th} Avenue Check and the Lake Woollomes Check, hydraulics were analyzed from the 5^{th} Avenue Check through the canal terminus at the Kern River Check. The boundary condition was considered the Kern River Check because the Project needs to be compatible with any future modifications in the Lower Reach. From the analysis, it was determined that the hydraulic head varies about 25 feet between 5^{th} Avenue Check and the Kern River. Of this, approximately 20 feet is required for the canal gradient and the remaining 5 feet is required to accommodate for losses at canal structures, including bridges, turnouts, checks, and siphons.

The boundary conditions, along with the Project objectives, were used to establish a proposed hydraulic grade line (HGL). The proposed HGL was set as low as possible to minimize embankment raise requirements and the need to modify bridges. All management measures considered, and subsequent Project alternatives, are based on the proposed HGL. The proposed HGL is shown in Figure 3-1.

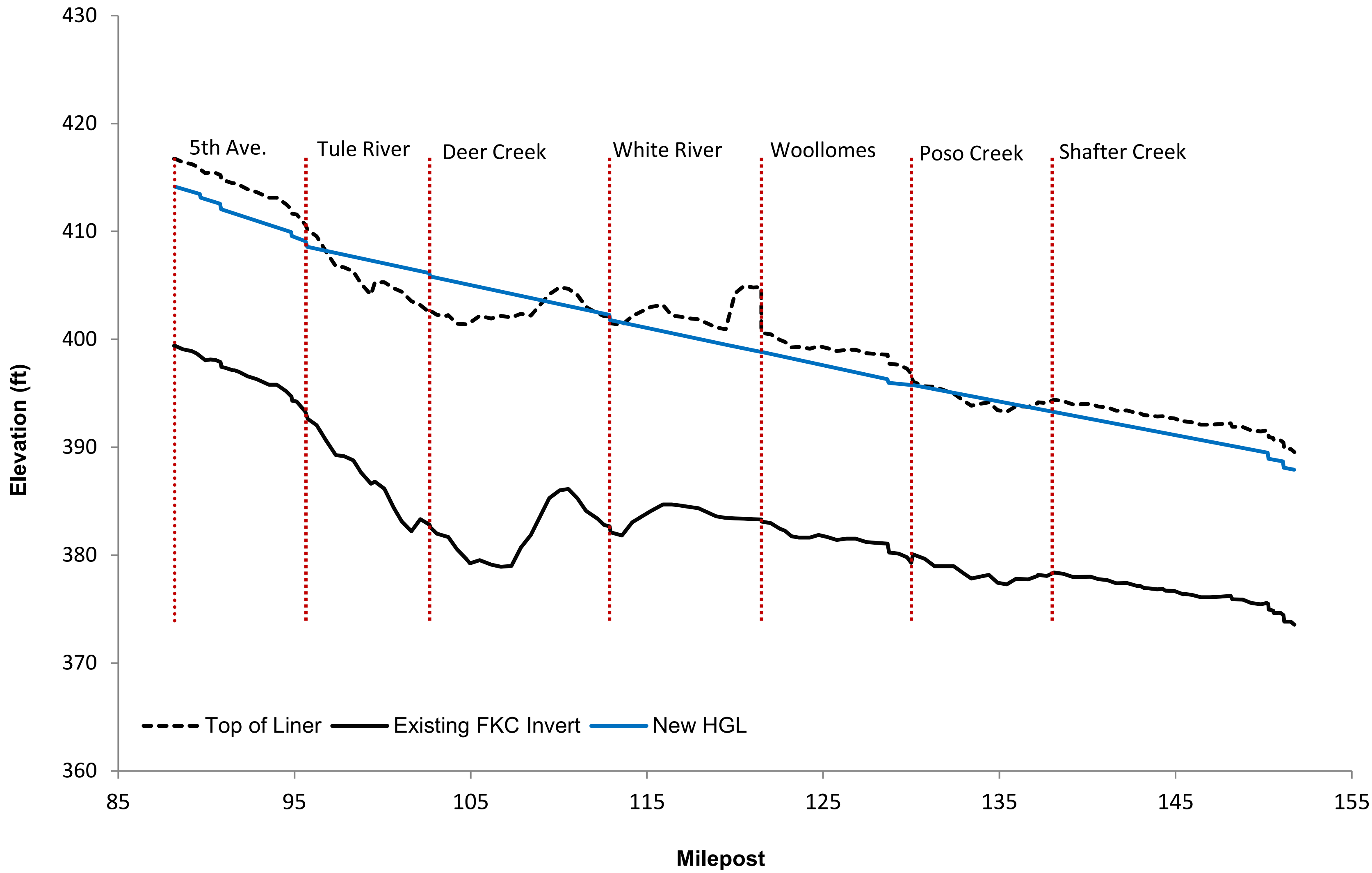

Figure 3-1. Canal Profile with Proposed Hydraulic Grade Line

Initial Alternatives Formulation

The Initial Alternatives Formulation describes the development, evaluation, and comparison of a set of seven Initial Alternatives. From the evaluation, two Initial Alternatives were selected for further development in this Study. For more detail, refer to Appendix A Initial Alternatives Formulation.

Measures Considered

In the formulation of Initial Alternatives, several structural measures were identified that could contribute to the Project objective of restoring the design FKC flow capacity. Nonstructural measures were not considered because the SJRRS Act requires the restoration of the originally designed and constructed capacity, which cannot be achieved through the implementation of nonstructural actions. Structural measures were organized into the following categories: canal enlargement, pumping plant, new canal, bridge modification, and other. Of the measures identified, several were selected for development into Initial Alternatives investigated in this Study (Table 3-1).

Table 3-1. Measures to Restore Friant-Kern Canal Capacity

Resource Management Measure	Status	Rationale
Canal Enlargement		
Raise Canal	Retained	Raising the canal would contribute to the Project objectives.
Raise and Widen Entire Cross Section	**Removed**	This measure is cost prohibitive and raises constructability concerns. Dropped from further consideration,
Raise and Widen Upper Portion of Cross Section	Retained	Enlarging the canal would contribute to Project objectives.
Pumping Plant		
Pumping Plant	Retained	The addition of a pumping plant would help restore capacity, thus contributing to Project objectives.
New Canal		
Bypass Canal	Retained	A bypass canal would restore capacity, though not in the original FKC.
Parallel Canal	Retained	A parallel canal would restore capacity, though not in the original FKC.
Bridge Modification		
Bridge Raise	Retained	A bridge raise does not sufficiently meet Project objectives but is an operational requirement.
Bridge Replacement	Retained	A bridge replacement does not sufficiently meet Project objectives but is an operational requirement to be included.
Other		
Pipeline	**Removed**	Initial hydraulic analysis revealed that headlosses would be greater than the available head, and project would require a pump station(s) to move water. This would be more costly than other available options.

Capacity Restoration Objectives for Initial Alternatives

As stated in Chapter 1, the objective of the Project is to restore the capacity of the FKC as previously design and constructed, consistent with SJRRS Act authority. This involves restoring the original design capacity of the FKC consistent with current Reclamation design standards for Normal and Design Maximum flow rates. The design of all Initial Alternatives was based on a canal capacity equal to the Design Maximum Flow Rate (Table 3-2). Canal lining depths were based on the normal depths at the Design Maximum Flow Rates plus the lined freeboard criteria for normal operations. The design flow rates were used to develop the HGL profiles for the Initial Alternatives. This approach is considered conservative and is inclusive of all potential flow and freeboard design requirements that may be considered in future evaluations.

Table 3-2. Design Flow Rates for Initial Alternatives

Canal Section No.	Canal Segment (MP to MP)	Description (Check to Check)	Normal Flow Rate (cfs)	Design Maximum Flow Rate (cfs)
4	88 to 95.67	5th Avenue to Tule	3,500	4,500
5	95.67 to 112.90	Tule to White River	3,000	4,000
6.1	112.90 to 128.69	White River to HWY 99	2,500	3,500
6.2	128.69 to 130.03	HWY 99 to Poso	2,500	3,000

Key:
cfs = cubic feet per second
HWY = highway
MP = mile post

Initial Alternatives

Seven Initial Alternatives were developed to meet the Project objective using the management measures. A brief overview of each alternative is provided below. A summary of features of each Initial Alternative is provided in Table 3-3.

Initial Alternative 1: Canal Enlargement

Initial Alternative 1 would increase the capacity of the FKC by either raising the embankments and the concrete liner or raising and widening the embankments and liner. To raise and widen the canal, a portion of the existing liner would be removed, a bench would be cut into the existing grade, the embankment would be widened, and liner would be extended on the bench and the raised embankment. This approach would minimize land acquisition requirements; however, 67 miles of embankment would be modified.

Initial Alternative 2: Pump Station at MP 109

Initial Alternative 2 would change the FKC from a gravity canal to a pumped canal. When flows are high and cannot be conveyed by gravity, water would be diverted from the original canal at MP 109, into a forebay, then pumped back into the original canal. The initial pump station design includes eight 250-cfs pumps. In the event of a power failure, water would be directed into a 400-acre emergency reservoir to prevent a surge.

Initial Alternative 3: Pump to Woollomes

In Initial Alternative 3, capacity restoration would be achieved by moving water from the original canal into an approximately 10-mile-long bypass canal and pumping it into Lake Woollomes. The existing canal would be used to maintain deliveries within the bypassed section.

Initial Alternative 4A: Bypass Canal-Tule River to White River

Alternative 4A is an offset bypass canal that would move water into a new canal at the Tule River and connect back into the existing canal at White River. The existing canal would be used solely to maintain deliveries between the two checks.

Initial Alternative 4B: Bypass Canal-Tule River to Woollomes

Initial Alternative 4B is the same as Initial Alternative 4A but extends to Lake Woollomes.

Initial Alternative 5A: Parallel Canal-Tule River to White River

Initial Alternative 5A is a combination of the canal enlargement and parallel canal measures. The parallel canal would run from Tule River to White River.

Initial Alternative 5B: Parallel Canal-Tule River to Woollomes

Initial Alternative 5B is the same as Initial Alternative 5A but extends to Lake Woollomes.

Table 3-3. Initial Alternative Features Summary

Alternative	Capital Cost (M)	Present Worth Additional OM&R (M)	Material Balance[1] (1,000 yd^3)	ROW Required (acres)[2]	Bridge Modification[3]	Stream Crossing	Embankment Modification (mi)
1: Canal Enlargement	$290	$0.3	-1,550	170	17	0	66
2: Pump Station at MP 109	$270	$3.1	+542	522	14	0	52
3: Pump to Woollomes	$380	$3.5	+945	622	23	1	27
4A: Bypass Canal—Tule River to White River	$300	$1	+1,750	508	18	1	32
4B: Bypass Canal—Tule River to Woollomes	$320	$1.4	+2,418	650	24	2	20
5A: Parallel Canal—Tule River to White River	$300	$0.9	Balanced	321	18	0	49
5B: Parallel Canal—Tule River to Woollomes	$300	$1.3	Balanced	390	24	0	43

Notes:
[1] Negative values indicate borrow and positive values indicate surplus.
[2] ROW required is the additional ROW needed outside the existing Reclamation ROW.
[3] Modifications can be a raise, replace, or new bridge. Farm bridge modifications are not included in this count.
Key:
M = million dollars
mi =miles
MP = mile post
OM&R = operations, maintenance, and replacement
yd^3 = cubic yard

Evaluation and Comparison of Initial Alternatives

The seven Initial Alternatives were evaluated and scored based on five criteria and several related sub-criteria, as listed in Table 3-4. The criteria addressed: (1) constructability, (2) operational requirements and flexibility, (3) cost, (4) schedule, and (5) environmental compliance and permitting. The evaluation and scoring considered both current (2018 survey) and projected future land surface elevations. Scoring results were evaluated as unweighted and weighted based on Project priorities of cost and schedule. A summary of the ranking results based on existing land surface is shown in Figure 3-2. The results from this analysis, as well as an analysis that considered potential future subsidence, revealed that Alternatives 1 and 5 consistently ranked highest. On the basis of these findings, Alternatives 1 and 5 were selected for further evaluation. Additional information on the Initial Alternatives evaluation can be found in Appendix A Initial Alternatives Formulation.

Table 3-4. Initial Alternatives Evaluation Criteria and Sub-Criteria

I. Constructability	II. Operational Requirements and Flexibility	III. Cost	IV. Schedule	V. Environmental Compliance and Permitting
CON-1. Complexity to Maintain Water Deliveries during Construction	OPS-1. Additional O&M Requirements and Expertise of FWA Staff	COST-1. Construction Cost*	SCH-1. Time to Start Construction	ENV-1. Complexity of Required Environmental Compliance
CON-2. Ability to O&M during Construction	OPS-2. Operations of District Turnouts	COST-2. Non-contract Cost*	SCH-2. Construction Duration	ENV-2. Number of Stream Crossings*
CON-3. Temporary Bypasses and Tie-Ins Needed to Construct the Project*	OPS-3. Ability to Accommodate Power Outages	COST-3. Present Worth Additional OM&R Costs*	SCH-3. Time Until Benefits Realized	ENV-3. Number of Bridges*
CON-4. Extent of Dewatering			SCH-4. Potential to Phase Construction	ENV- 4. Length of Modified Existing Embankment*
CON-5. Material Balance*			SCH-5. Land Acquisition*	
			SCH-6. Schedule Risk	

Note:
*Qualitative sub-criterion
Key:
O&M = operations and maintenance
OM&R = operations, maintenance, and replacement

UNWEIGHTED

Project Information			Average Scores					UNWEIGHTED	
ID	Alternative Name	Alternative Type	Constructability	Operational Requirments and Flexibility	Cost	Schedule	Environmental Compliance and Permitting	Composite Score	Alternative Ranking
			20%	20%	20%	20%	20%	UNWEIGHTED	
1	Canal Enlargement	G	1.8	5.0	4.7	4.8	2.6	3.8	1
2	Pump Station at MP 109	PS	2.7	2.3	3.4	2.8	2.9	2.8	5
3	Woollomes Pump Station	PS	2.8	2.0	1.0	1.9	1.7	1.9	7
4A	Bypass Canal: Tule River to White River	G	4.1	3.7	3.8	2.0	2.3	3.2	4
4B	Bypass Canal: Tule River to Woollomes	G	4.2	3.0	2.1	1.2	1.6	2.4	6
5A	Parallel Canal: Tule River to White River	G	4.2	4.3	3.9	3.0	2.4	3.6	2
5B	Parallel Canal: Tule River to Woollomes	G	4.5	3.7	3.4	2.4	2.0	3.2	3

COST

ID	Average Scores					COST	
	Constructability	Operational Requirments and Flexibility	Cost	Schedule	Environmental Compliance and Permitting	Composite Score	Alternative Ranking
	10%	15%	50%	10%	15%	COST	
1	1.8	5.0	4.7	4.8	2.6	4.1	1
2	2.7	2.3	3.4	2.8	2.9	3.0	5
3	2.8	2.0	1.0	1.9	1.7	1.5	7
4A	4.1	3.7	3.8	2.0	2.3	3.4	3
4B	4.2	3.0	2.1	1.2	1.6	2.3	6
5A	4.2	4.3	3.9	3.0	2.4	3.7	2
5B	4.5	3.7	3.4	2.4	2.0	3.2	4

SCHEDULE

ID	Average Scores					SCHEDULE	
	Constructability	Operational Requirments and Flexibility	Cost	Schedule	Environmental Compliance and Permitting	Composite Score	Alternative Ranking
	10%	15%	10%	50%	15%	SCHEDULE	
1	1.8	5.0	4.7	4.8	2.6	4.2	1
2	2.7	2.3	3.4	2.8	2.9	2.8	4
3	2.8	2.0	1.0	1.9	1.7	1.9	7
4A	4.1	3.7	3.8	2.0	2.3	2.7	5
4B	4.2	3.0	2.1	1.2	1.6	1.9	6
5A	4.2	4.3	3.9	3.0	2.4	3.3	2
5B	4.5	3.7	3.4	2.4	2.0	2.8	3

Figure 3-2. Evaluation and Comparison of Initial Alternatives

Selection of Alternatives for Feasibility-Level Evaluation

Alternatives 1 and 5 were further evaluated following the failure of California Proposition 3 in November 2018, a potential non-Federal funding source for the Project. The additional evaluation considered various design capacity and freeboard requirements for Initial Alternatives 1 and 5 with the objective of identifying challenges that may be associated with Project phasing.

Estimates of material quantities and costs were prepared for Initial Alternatives 1 and 5 under the following capacity and freeboard options:

- **Option 1 - Maximum Historical Flow with Flood Freeboard**. This option was defined based on a review of historical peak flows in each segment of the FKC. The existing flood freeboard was applied based on the assumption that historical peak flows were associated with the conveyance of flood flows. This condition occurs during the delivery of 215 water supplies and, in some instances, the delivery of Class 2 water supplies.

- **Option 2 - Design Normal Flow with Standard Freeboard**. This option was defined based on the original normal design flow using the current standard freeboard requirements.

- **Option 3 - Design Maximum Flow with Flood Freeboard**. This option was defined based on the original maximum design flow using the current flood freeboard requirements.

- **Option 4 - Design Maximum Flow with Standard Freeboard**. This option was defined based on the original maximum design flow using the current standard freeboard requirements. This assumption was applied in the assessment of all Initial Alternatives.

A summary of results of the additional analysis of Initial Alternatives is presented in Table 3-5. Based on this analysis, the following alternatives were selected for evaluation as Feasibility Alternatives:

- Initial Alternative 1 Option 1, hereafter referred to as Canal Enlargement, was selected for feasibility evaluation because it identifies modifications necessary to maintain continued operations of the FKC consistent with historical operations. While this capacity the original designed capacity, this information may be beneficial in evaluating cost allocation requirements.

- Initial Alternative 5 Option 3, hereafter referred to as Parallel Canal, was selected for feasibility evaluation. Option 3 would restore the canal to the original design capacity.

Table 3-5. Additional Analysis of Initial Alternatives for Selection of Feasibility Alternatives

Quantity	Alternative 1				Alternative 5			
	Option 1	**Option 2**	**Option 3**	**Option 4**	**Option 1**	**Option 2**	**Option 3**	**Option 4**
Length of Modified Canal (miles)	**17.10**	24	31	31	17.08	24	**31**	31
Length of Modified FKC Embankment (miles)	**34.20**	47.20	62.00	62.00	17.08	23.60	**38.40**	38.43
Permanent ROW required (acres)	**0**	0	154	170	218	299	**371**	386
Number of Parcels for Permanent ROW	**0**	16	131	165	70	87	**189**	182
Excavation of Existing Canal (1,000 cubic yards)	**190**	577	4,015	3,709	1,533	3,014	4,871	4,875
Embankment Material Required (1,000 cubic yards)	**1,883,537**	2,690,072	4,359,154	5,259,535	3,110,475	3,968,826	**3,552,038**	4,459,080
Material Balance (Borrow) or Waste (1,000 cubic yards)	**(1,694)**	(2,113)	(344)	(1,551)	(1,578)	(955)	**1,319**	416
Borrow / Waste Disposal ROW (acres)	**210**	326	469	488	195	403	**396**	448
Lining Required (thousand square yards)	**405**	488	1,612	1,686	968	1,327	**1,845**	1,946
Bridge Raise	**2**	2	3	3	0	0	**1**	1
Bridge Replacement/New Bridge	**16**	17	17	17	19	27	**27**	27
Total Project Cost ($M)	**$150**	$191	$298	$316	$192	$270	**$309**	$330
Low Cost Range (-25% on Field Costs; $M)	**$113**	$144	$228	$240	$147	$208	**$236**	$252
High Cost Range (+25% on Field Costs; $M)	**$185**	$235	$369	$391	$236	$334	**$381**	$405

Note: The ROW information presented in this table was calculated using two map layers. One layer called record ROW shows the right-of-way for the Friant-Kern Canal as described in the deed maps on record with the Bureau of Reclamation. Any misclosures or overlaps that occur reflect the problems contained within the legal description. The other layer called adjusted ROW shows the approximation of the right-of-way boundaries corrected and adjusted based upon minimal survey control. This information is not to be considered official or final and is only intended to show discrepancies and or problems between the deed and preliminary survey evidence recovered in the field.

Key:
$M = Million Dollars
FKC = Friant-Kern Canal
ROW = Right of Way

Chapter 4 Feasibility Alternatives

This chapter provides a description of the No Action Alternative and the two Feasibility Alternatives. The physical features of the Feasibility Alternatives, as well as the costs and anticipated permitting requirements, are summarized below and evaluated further in Chapter 5.

No Action Alternative

The No Action Alternative represents a projection of reasonably foreseeable future conditions that could occur if no action is taken to address current and projected future capacity reductions to the FKC (i.e., the future without the proposed Project). Reclamation recommends several criteria for including proposed future actions within the No Action Alternative: proposed actions should be (1) authorized; (2) approved through completion of NEPA, CEQA, Endangered Species Act (ESA), and other compliance processes; (3) funded; and (4) permitted. The No Action Alternative is considered the basis for comparison with the Recommended Plan, consistent with NEPA and the PR&G (CEQ 2013) guidelines. Therefore, if no proposed action is determined feasible, the No Action Alternative is the default option.

Under the No Action Alternative, Reclamation and FWA would not take additional actions towards restoring the capacity of the Middle Reach of the FKC. However, four foreseeable actions have been identified that affect future conditions: SJRRP implementation, continued subsidence, SGMA implementation, and CVP water delivery rescheduling in Millerton Lake.

SJRRP Implementation

Under the No Action Alternative, water supply availability to Friant Division long-term contractors will decrease as San Joaquin River channel improvements are implemented that allow for increased and ultimately full release of Restoration Flows. As shown in Figure 4-1, simulated long-term average annual Friant Division deliveries under the current level of SJRRP implementation is estimated at 1,119 TAF per year. As of October 2019, release of full Restoration Flows is not possible due to downstream channel capacity constraints. With full release of Restoration Flows to the San Joaquin River, anticipated by 2030, long-term annual average deliveries to the Friant Division would be reduced to about 1,052 TAF.

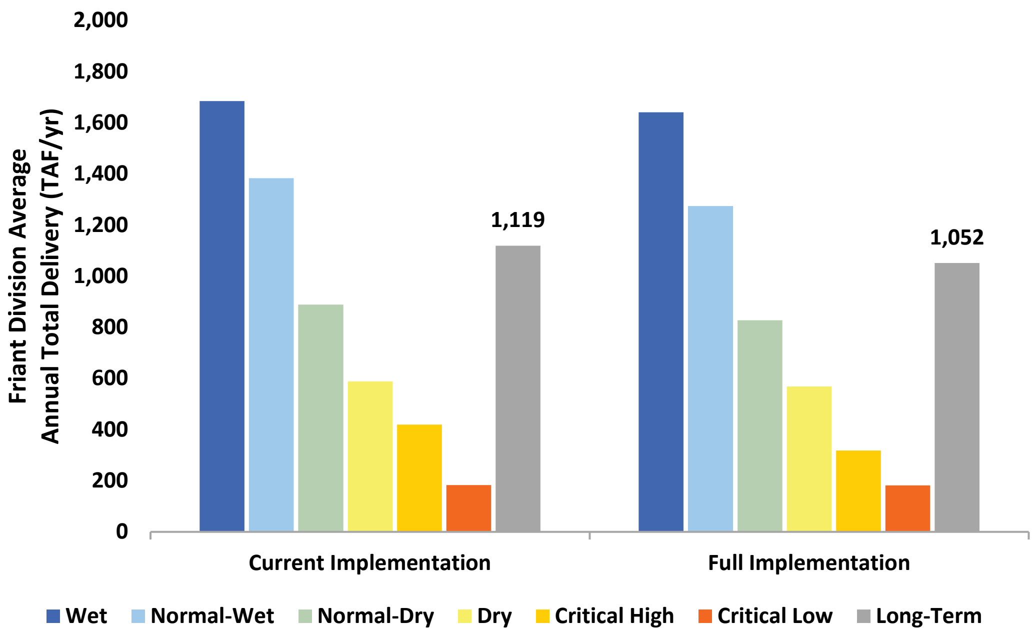

Figure 4-1. Simulated Friant Division Delivery Capability with SJRRP Implementation

Under the No Action Alternative, the current capacity-restricted condition of the FKC would continue to limit affected Friant Division long-term contractors' ability to receive water during periods of peak demand or peak flow. This could impact the ability of the contractors to take delivery of water under Paragraph 16 (b) of the Settlement "for the purpose of reducing or avoiding impacts to water deliveries to all of the Friant Division long-term contractors caused by the Interim and Restoration Flows," thus limiting the Secretary of the Interior's ability to achieve the Water Management Goal in the Settlement. As subsidence continues, water delivery impacts associated with decreased canal capacity would increase.

Future Subsidence

Under the No Action Alternative subsidence is expected to continue throughout the project area. As described in Chapter 2, a groundwater model of the Tule Subbasin was developed to simulate potential future groundwater and land subsidence conditions in support of planning for SGMA compliance. As described in Chapter 2 a condition of Severe Mid-Term Subsidence conditions was selected for use in Project evaluations, resulting in the maximum total subsidence displacement from the current condition of each year described in Table 4-1.

Table 4-1. Maximum Simulated Additional Subsidence in the Middle Reach of the FKC

Year	Displacement from Current Condition (ft)
2025	3.9
2030	6.7
2040	8.5
2070	9.5

Key:
ft = feet

SGMA Implementation

In response to reduced deliveries from Friant Dam as a result of SJRRP implementation and FKC capacity reduction, affected Friant Division long-term contractors would likely increase groundwater pumping. However, the duration of this response will be limited. SGMA implementation is expected to limit allowable groundwater pumping to amounts less than historical and current amounts. SGMA requires that actions to achieve sustainable groundwater management be in place no later than 2040. Therefore, it is assumed that any increased groundwater pumping in response to surface water reductions due to SJRRP Restoration Flow increases and FKC capacity limitations would be gradually reduced to zero by 2030.

Water Delivery Rescheduling

It is reasonable to expect the Friant Division long-term contractors would take some action to minimize water delivery shortages by rescheduling affected water deliveries in Millerton Lake. The potential for rescheduling affected water supplies is based on the following factors:

- Water demands for affected Friant Division contractors that would be served by non-Friant Division water supplies (local surface water, groundwater, or other supplies).
- Available storage capacity in Millerton Lake.
- Available capacity in the FKC to convey rescheduled water supplies.

The potential to reschedule affected Friant Division water deliveries in Millerton Lake was simulated by creating an account to track the storage of affected water supplies. Water in the rescheduled water account would be the first water subject to spill to assure that all existing obligations for the operation of Friant Dam would continue under existing priorities. Water would be diverted from the rescheduled water storage account to the FKC in months when demand that would be served by other supplies is available, as constrained by available conveyance capacity in the FKC.

Water would remain in the rescheduled storage account, including into successive years, until the account is evacuated, or flood releases are made from Friant Dam to the San Joaquin River. It is assumed that the rescheduled supplies would result in a shifting the timing of groundwater pumping and local surface water supply use to continue to meet demands in districts that would have a reduction in allocated CVP water supplies due to FKC capacity limitations. When capacity in the FKC is available to deliver rescheduled supplies, this would come at a time that would offset typical use of groundwater pumping or local surface water supplies.

Feasibility Alternative Plans

Based on the evaluation of Initial Alternatives, two alternatives were carried forward for an evaluation at a feasibility level. The Parallel Canal Alternative was developed based on refinements to Initial Alternative 5 Option 3, which includes construction of a new canal parallel to the FKC and modifying the FKC where possible to convey maximum design flow of the original authorized project. The Canal Enlargement Alternative was developed based on refinements to Initial Alternative 1 Option 1, which includes modifying the FKC to convey maximum capacity based on maximum historic flow. A summary of design capacity and freeboard requirements for the Feasibility Alternative Plans is provided in Table 4-2.

Table 4-2. Design Capacity and Freeboard Requirements in Feasibility Alternatives

	Canal Enlargement		Parallel Canal	
	Capacity (cfs)	**Freeboard (ft)**	**Capacity (cfs)**	**Freeboard (ft)**
Segment 1	4,008	1.12	4,500	1.12
Segment 2	3,497	1.08	4,000	1.08
Segment 3	2,888	1.08	4,000	1.08
Segment 4	2,490	1.03	3,500	1.03

Key:
cfs = cubic feet per second
ft = feet

In refining the retained Initial Alternatives, additional detail was developed regarding turnouts and canal crossings, consideration was given to minimizing ROW requirements, and modifications were made to minimize material hauling requirements. Descriptions of Feasibility Alternatives are provided below.

Parallel Canal Alternative

The Parallel Canal Alternative was refined after the Initial Alternatives Formulation in terms of alignment, water delivery strategy (turnouts), canal cross-section design, road crossings, check structures, utilities, and costs. A single-line schematic showing features included in the Parallel Canal Alternative is provided in Figure 4-2A and Figure 4-2B. As shown, the Parallel Canal Alternative includes a combination of modifications to the existing FKC and the construction of a new parallel canal immediately to the east of the FKC. The selection of canal modification or parallel canal was made based on the extent of modifications that would be required to the FKC. The parallel canal would be constructed in reaches where land subsidence has occurred to an extent that raising and widening the FKC to achieve the design capacity is considered less practical. Features of the Parallel Canal Alternative are described in the following sections.

Canal Alignment and Cross Sections

In comparison to Initial Alternative 5, significant refinements were incorporated in the Parallel Canal Alternative regarding the canal alignment and the cross sections. Initial Alternative 5 was based on a parallel canal from the 5th Avenue Check to either White River or Lake Woollomes, and the continued operation of the existing FKC for deliveries in the bypassed reaches.

Through the refinement process, the length of the parallel canal portion of this alternative was reduced. In some locations, it was found that modifying the FKC to achieve the objective conveyance capacity would be more practical than constructing a parallel canal. It was also found that retaining long segments of the existing FKC to provide deliveries in the bypassed segments would require modifications to several turnouts. In light of these refinements, the Parallel Canal Alternative was revised to a configuration that includes modifications to the FKC and the construction of a replacement parallel canal.

Where constructed, the parallel canal would be the exclusive water conveyance and delivery mechanism and most of the existing FKC would be demolished, filled in, and taken out of service. This approach was selected due to the numerous benefits it provides; it would reduce ROW acquisition requirements, reduce material hauling during canal earthwork, provide access to existing material, improve constructability, and would provide greater long-term durability.

The Parallel Canal Alternative would include modifications to the current FKC alignment from 5th Ave. Check (MP 88) to Ave. 152 (MP 96.3). Through this reach, the cross section of the existing FKC would be enlarged with a 24-foot bench on either side to increase canal capacity to meet the Design Maximum flow rate of 4,500 cfs in this segment, as shown in Figure 4-3. From 5th Ave. Check (MP 88) to Ave. 152 (MP 96.3) the existing bridges are estimated to be high enough to accommodate the new canal water surface level and the existing turnouts could continue to function without modification. To reduce cost, the enlarged canal would transition into the existing canal prism upstream and downstream from existing bridges and turnouts so that these structures may remain in place without modification.

At MP 96.3, the Parallel Canal Alternative alignment would head east, away from the existing canal centerline, and run on a parallel alignment until it reaches Garces Highway (MP 118.96). In this reach, the Parallel Canal would have a regular trapezoidal shape based on the configuration shown in Figure 4-4. At MP 118.96, the Parallel Canal Alternative would head west and reconnect with the existing alignment of the FKC, which would be enlarged between MP 118.96 to MP 121.5 as described above and shown in Figure 4-3.

The Parallel Canal Alternative, as described in this Report is based on canal embankments and liner that would achieve objective capacities if constructed at the current ground level. The alternative also includes design features to accommodate anticipated future subsidence. For example, the siphon-type road crossings are sized to accommodate future increases in HGL. In addition, canal embankments were configured such that they could be raised without interfering with the operation of the restored FKC and necessary right of way to accommodate the future raise is included, as identified as future concrete liner raise with embankment on Figure 4-4.

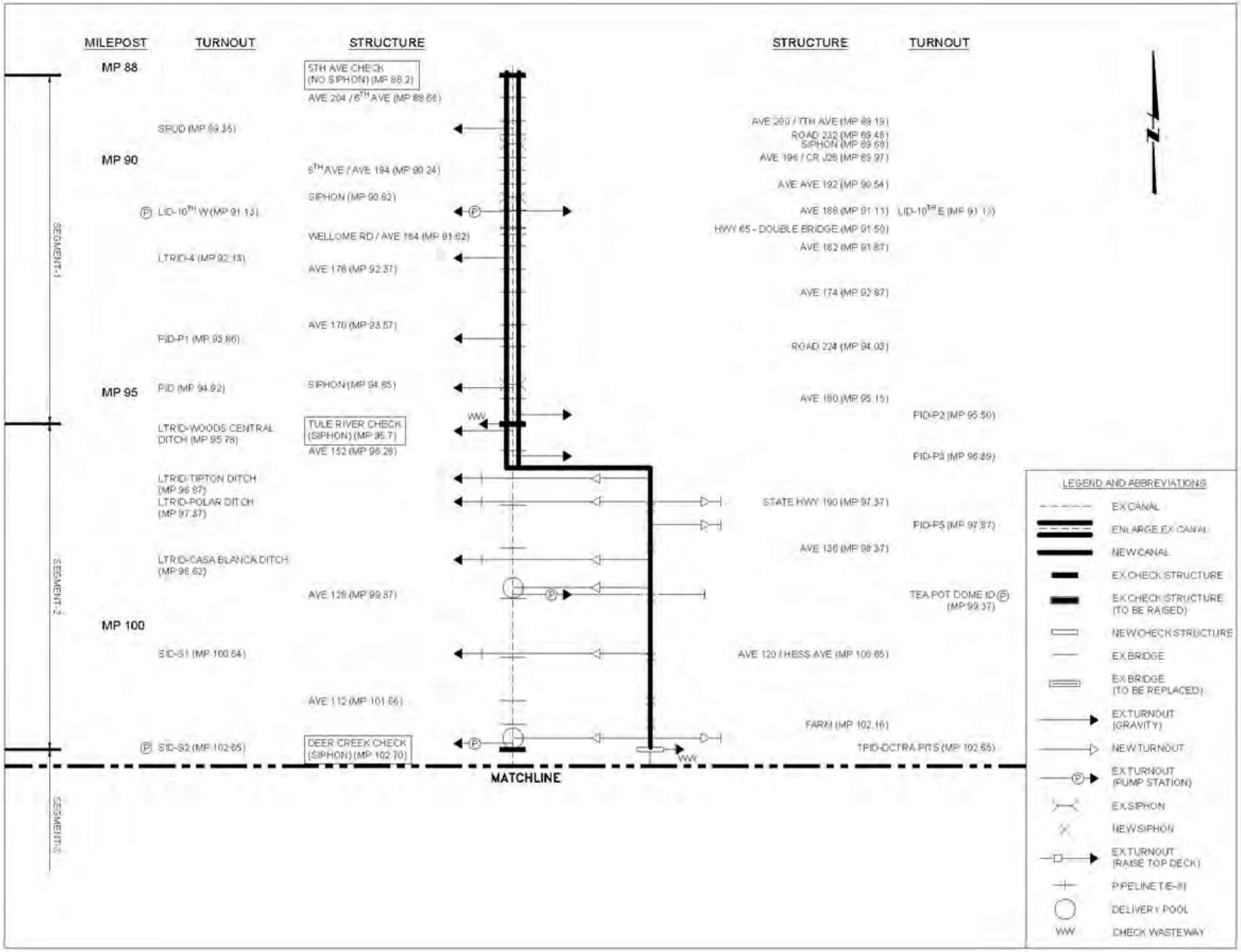

Figure 4-2A. Parallel Canal Alternative Single-Line Diagram of Canal Segments 1 and 2

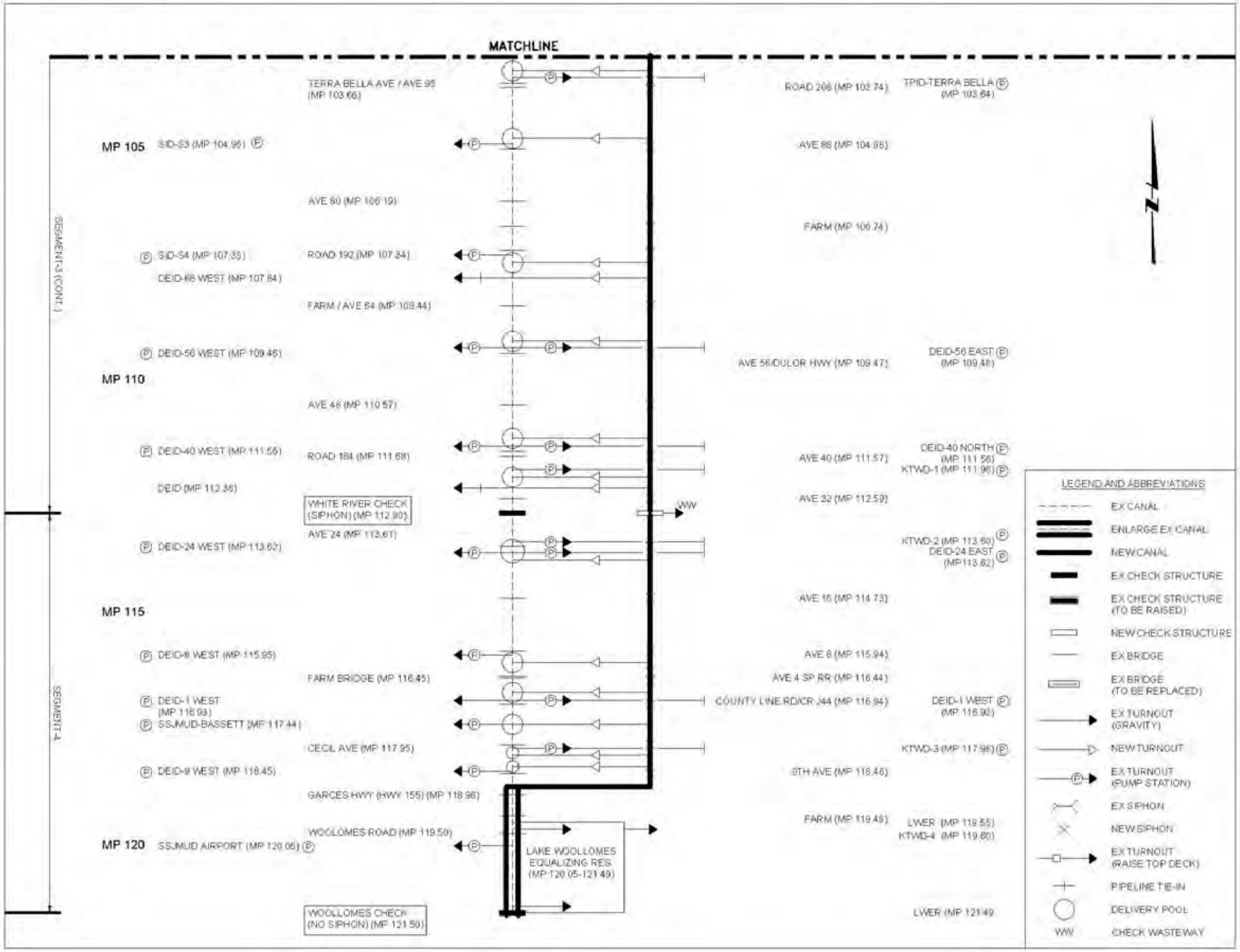

Figure 4-2B. Parallel Canal Alternative Single Line Diagram of Segments 3 and 4

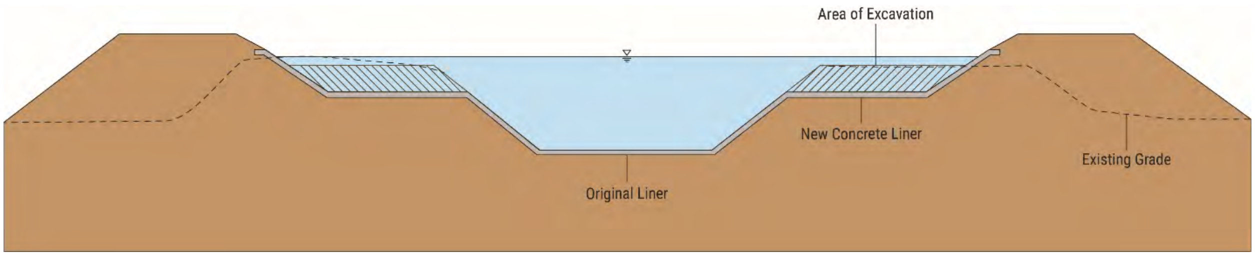

Figure 4-3. Compound Trapezoidal Cross Section in the Parallel Canal Alternative

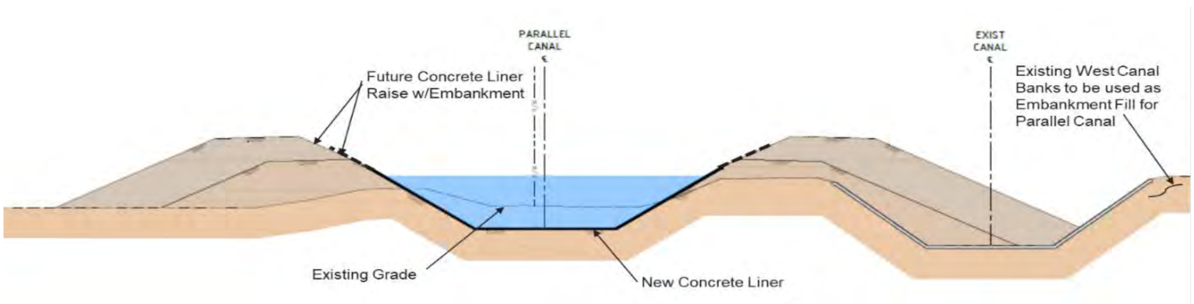

Figure 4-4. Trapezoidal Cross Section in the Parallel Canal Alternative

Construction Sequencing

The parallel canal portion of the Parallel Canal Alternative would be constructed as follows:

1. Partially build the right bank, from existing canal left bank material, while maintaining water deliveries in the existing canal.

2. Excavate the new cross section and use the excavated material to build the left bank. This work could be accomplished while the existing canal is in operation.

3. Put the Parallel Canal into operation and decommission the bypassed portion of the existing FKC.

4. Complete building the Parallel Canal right bank by using the decommissioned FKC right bank material.

For a detailed discussion on construction sequencing, refer to Appendix B Engineering Design and Cost.

Turnouts

The Parallel Canal Alternative includes features to address water delivery at existing turnouts, based, in part, on input provided by Friant Division long-term contractors. The Parallel Canal Alternative incorporates design concepts for pressurized and gravity systems to ensure compatibility between the canal and the contractors’ distribution systems, maintain water delivery capability during construction, control overflow, and enhance operational flexibility.

Pressurized Turnout Modifications In the Middle Reach, many of the 20 pressurized distribution systems have subsided at different rates than the land under the canal, causing varying differential head conditions from those used in the original system designs. All alternatives have been developed to achieve the proposed HGL, which is higher than the current water surface in the FKC. Increasing the HGL would increase head on the suction side of the pumping plants, which would increase the delivery head on district distribution systems. The removal and replacement of current pump stations at a location compatible with the current design was considered and dropped because of significant costs.

The water elevation in the parallel canal would often be above the elevation of the top decks of existing pump stations. If a pump station were to unexpectedly shutdown, the incoming flow from the adjacent canal could overflow the pump station and flood the facility and surrounding land, resulting in equipment and property damage. To avoid the potential risk associated with unexpected shutdowns, the Parallel Canal Alternative includes small delivery pools at each pump station turnout. As shown in Figure 4-5, the delivery pool would be created by preserving small portions of the existing FKC. Water would flow from the parallel canal through a new pipe to the delivery pool which would serve as a forebay for the existing turnout pump station. The parallel canal alignment would be modified at the location of each pump station turnout and be customized to meet the specific needs of each pressurized delivery system. A list of the modifications proposed to the pump station turnouts is provided in Table 4-3.

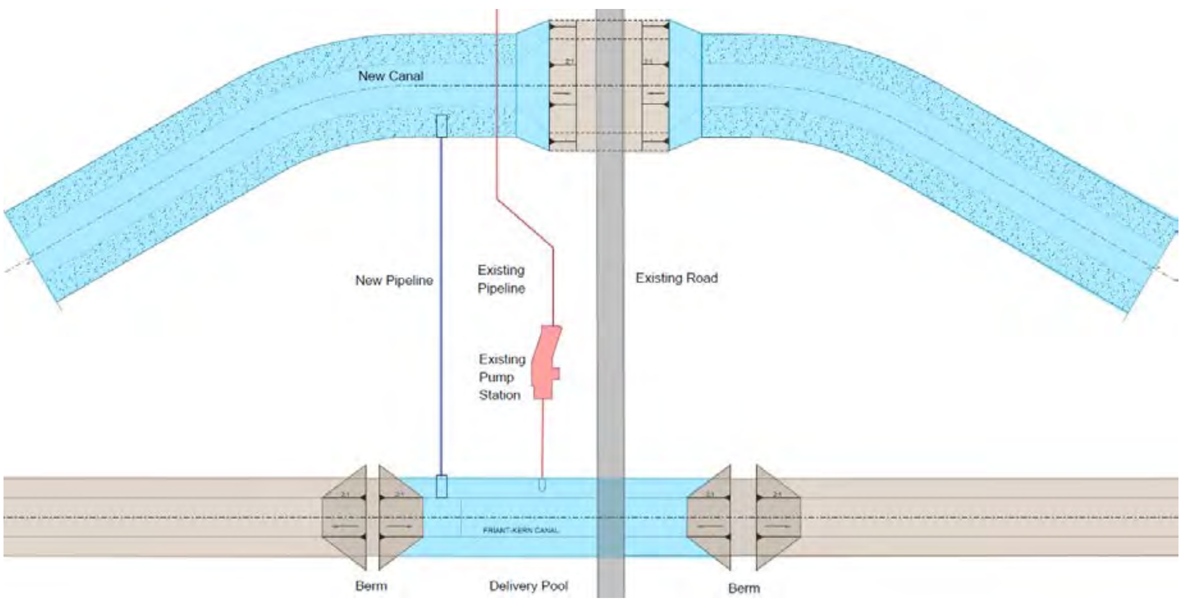

Figure 4-5. Example Pressurized System Turnout Design in the Parallel Canal Alternative

Table 4-3. Modifications at Pump Station Turnouts in the Parallel Canal Alternative

Pump Station Turnout	Canal Side	MP	Modification
LID-10th W	West	91.12	Unmodified
TPDWD-Teapot Dome	East	99.35	Remain Plus Delivery Pool
SID-S2	West	102.65	Remain Plus Delivery Pool
TBID-Terra Bella	East	103.64	Remain Plus Delivery Pool
SID-S3	West	104.96	Remain Plus Delivery Pool
SID-S4	West	107.35	Remain Plus Delivery Pool
DEID-56 EAST	East	109.46	Remain Plus Delivery Pool
DEID-56 West	West	109.46	Remain Plus Delivery Pool
DEID-40 North	East	111.56	Remain Plus Delivery Pool
DEID-40 West	West	111.56	Remain Plus Delivery Pool
KTWD-1	East	111.96	Remain Plus Delivery Pool
KTWD-2	East	113.6	Remain Plus Delivery Pool
DEID-24 East	East	113.62	Remain Plus Delivery Pool
DEID-24 West	West	113.62	Remain Plus Delivery Pool
DEID-8th West	West	115.95	Remain Plus Delivery Pool
DEID-#1 West	East	116.93	Remain Plus Delivery Pool
SSJMUD-Bassett	West	117.44	Remain Plus Delivery Pool
KTWD-3	East	117.96	Remain Plus Delivery Pool
DEID-9th West	West	118.45	Remain Plus Delivery Pool
SSJMUD-Airport	West	120.06	Unmodified

Gravity Turnout Modifications There are 18 gravity systems located in the Middle Reach, each of which were individually analyzed to determine an appropriate design approach. The analysis revealed that all existing gravity turnouts can either be preserved and reused or connected to new turnouts and pipelines on the parallel canal. A summary of actions for gravity turnouts under the Parallel Canal Alternative is provided in Table 4-4.

Table 4-4. Modifications at Gravity Turnouts Under the Parallel Canal Alternative

Gravity Turnout	Canal Side	MP	Modification
SPUD-STRATHMORE	West	89.35	Unmodified
LID-10th E	East	91.12	Unmodified
LTRID-4	West	92.13	Unmodified
PID-P1	West	93.86	Unmodified
PID-Porter Slough	West	94.92	Unmodified
PID-P2	East	95.50	Unmodified
LTRID-Tule River WW Gates	West	95.64	Unmodified
LTRID-Woods Central Ditch	West	95.78	Unmodified
PID-P3	East	96.39	Build Turnout on Parallel Canal
LTRID-Tipton Ditch	West	96.87	Build Turnout on Parallel Canal
LTRID-Poplar Ditch N&S	West & East	97.34	Build Turnout on Parallel Canal
PID-P5	East	97.86	Build Turnout on Parallel Canal
LTRID-Casa Blanca Ditch	West	98.62	Build Turnout on Parallel Canal
SID-S1	West	100.63	Build Turnout on Parallel Canal
TBID-DCTRA Pits	East	102.65	Build Turnout on Parallel Canal
DEID-68 West	West	107.84	Build Turnout on Parallel Canal
DEID	West	112.36	Build Turnout on Parallel Canal
LWER	East	119.55	Unmodified
LWER	East	121.49	Unmodified

Checks and Siphons

In the analysis of Initial Alternative 5, it was assumed that the parallel canal would tie-in to the FKC at the existing check and siphon structures at Deer Creek and White River, and that existing structures and gates would be raised to meet the new canal design objectives. It was expected that continued use of existing structures would reduce cost and environmental consequences. Upon further refinement, it was discovered that this approach would require significant structural modifications to the existing structures, would add two new road crossings (bridges) at the White River check, and ultimately increase the amount of bridge work and overall project cost. Thus, the Parallel Canal Alternative includes new checks and siphons at Deer Creek and White River.

Road Crossings

In the formulation of Initial Alternative 5, bridge modification options included either a raise of the existing bridge or replacement with a new bridge. However, after further analysis it has become apparent that raising or replacing bridges as part of the Parallel Canal Alternative would add complexity and cost.

Designs for raising or replacing existing bridges would require that each bridge design be assessed for current highway and seismic design standards. It is anticipated that significant bridge retrofits would be required should the existing bridge infrastructure remain. In addition, raising or replacing bridges would require approach roadway improvements. It is estimated that up to 1,800 feet of additional road work would be required per bridge, including significant amounts of earthwork to build up the approaches consistent with vertical curve requirements.

Through the refinement process, raised bridges and replacement bridges have been removed from further consideration in the Parallel Canal Alternative in favor of siphon- type crossings that divert canal flow below the existing roadway and allow the road to stay at existing grade. Two typical siphon-type road crossing designs were developed, based on the relative elevation of the existing roadway in comparison to the elevation of the parallel canal. Siphon A would be applied in conditions where the parallel canal water surface elevation would be higher than the existing road elevation at the crossing, as illustrated in Figure 4-6. Siphon B would be applied in conditions where the parallel canal water surface elevation would be lower than the existing road elevation at the crossing, as illustrated in Figure 4-7.

For either application, the existing bridge over the current FKC would be demolished and the abandoned portion of the FKC would be filled to road grade, with the new siphon placed under the new parallel canal. For bridges that fall outside of the parallel canal, no action would be taken. A list of anticipated modifications to bridges in the Parallel Canal Alternative is provided in Table 4-5.

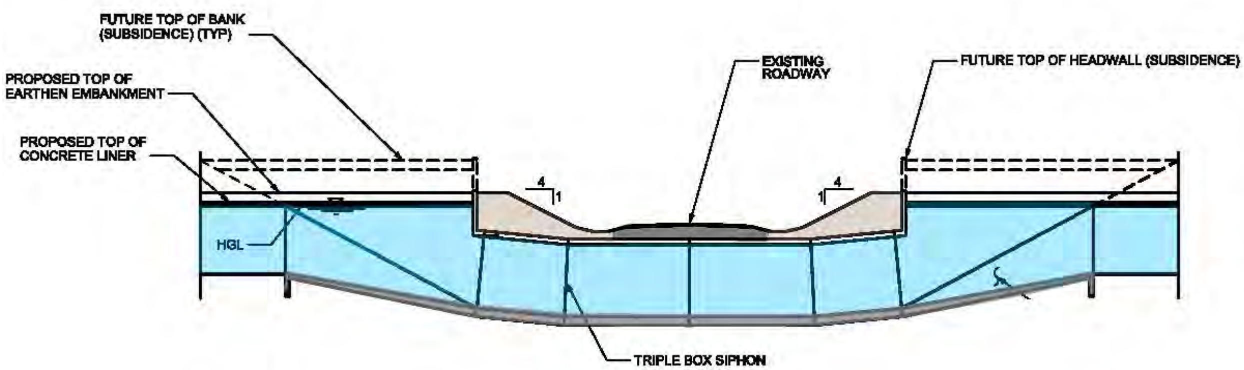

Figure 4-6. Typical Siphon A Road Crossing

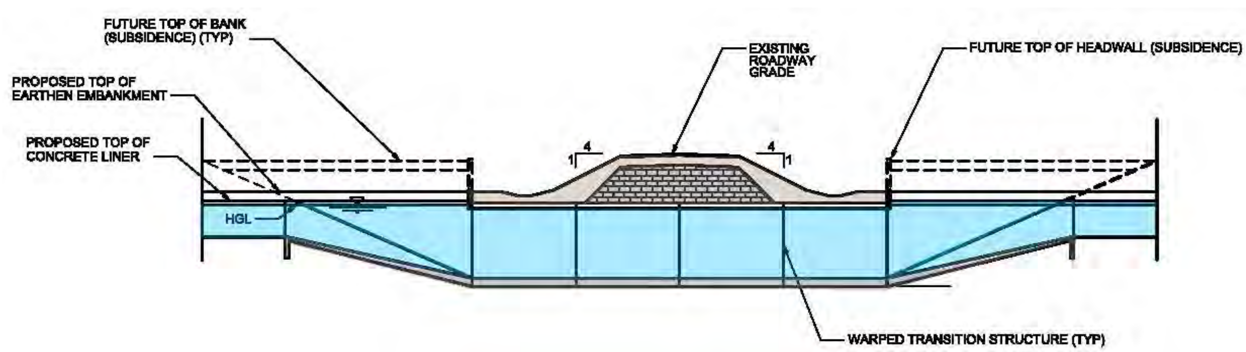

Figure 4-7. Typical Siphon B Road Crossing

Table 4-5. Road Crossing Actions in the Parallel Canal Alternative

Name	MP	Modification
6th Avenue Bridge	88.67	Unmodified
7th Avenue Bridge	89.17	Unmodified
Road 232 Bridge	89.45	Unmodified
Frazier Highway 196 Bridge	89.95	Unmodified
8th Avenue Bridge	89.95	Unmodified
Avenue 192 Bridge	90.23`	Unmodified
Avenue 188 Bridge	91.10	Unmodified
State Highway 65 Northbound Bridge (Double Bridge)	91.51	Unmodified
Welcome Avenue Bridge (Avenue 184)	91.60	Unmodified
Avenue 182 Bridge	91.85	Unmodified
Avenue 178 Bridge	92.35	Unmodified
W Linda Vista Avenue	92.85	Unmodified
W North Grand Avenue Bridge	93.55	Unmodified
N Westwood Street Bridge	94.01	Unmodified
W Henderson Avenue Bridge	95.12	Unmodified
Avenue 152 Bridge	96.26	Unmodified
Avenue 144 Bridge (Highway 190)	97.35	Demo- New Road Crossing/Siphon A
Avenue 136 Bridge	98.35	Demo- New Road Crossing/Siphon A
Avenue 128 Bridge	99.37	Demo- New Road Crossing/Siphon A
Hesse Avenue Bridge	100.64	Demo- New Road Crossing/Siphon A
Avenue 112 Bridge	101.64	Demo- New Road Crossing/Siphon A
Timber Farm Bridge	102.14	Demo- New Road Crossing/Siphon A
Road Terra Bella Avenue (J24)	103.65	Demo- New Road Crossing/Siphon A
Road 208 Bridge	103.72	Demo- New Road Crossing/Siphon A
Avenue 88 Bridge	104.95	Demo- New Road Crossing/Siphon A
Avenue 80 Bridge	106.72	Demo- New Road Crossing/Siphon A
Farm Bridge	106.75	Demo- New Road Crossing/Siphon A
Road 192 Bridge	107.32	Demo- New Road Crossing/Siphon A
Avenue 64 Bridge	108.42	Demo- New Road Crossing/Siphon A
Avenue 56 Bridge	109.45	Demo- New Road Crossing/Siphon A
Avenue 48 Bridge	110.55	Demo- New Road Crossing/Siphon A
Avenue 40 Bridge	111.55	Demo- New Road Crossing/Siphon A
Road 184 Bridge	111.66	Demo and Fill
Avenue 32 Bridge	112.57	Demo- New Road Crossing/Siphon A
Avenue 24 Bridge	113.59	Demo- New Road Crossing/Siphon A
Avenue 16 Bridge	114.71	Demo- New Road Crossing/Siphon B
Avenue 8 Bridge	115.91	Demo- New Road Crossing/Siphon B
Timber Farm (Avenue 4) Bridge (2 Bridges)	116.41	Demo- New Road Crossing/Siphon B
County Road Avenue 0 Bridge	116.91	Demo- New Road Crossing/Siphon B

Table 4-5. Road Crossing Actions in the Parallel Canal Alternative (contd.)

Name	MP	Modification
Timber Farm (Avenue 4) Bridge (2 Bridges)	116.41	Demo- New Road Crossing/Siphon B
County Road Avenue 0 Bridge	116.91	Demo- New Road Crossing/Siphon B
Cecil Avenue Bridge	117.92	Demo- New Road Crossing/Siphon B
9th Avenue Bridge	118.44	Demo- New Road Crossing/Siphon B
Garces Highway Bridge	118.94	Unmodified
Timber Farm Bridge	119.46	Unmodified
Woollomes Avenue Bridge	120.02	Unmodified

Utilities

Numerous utilities located in, along, and across the FKC would be affected by implementation of the Parallel Canal Alternative. The utilities include parallel irrigation canals, fly overs, overhead power lines, adjacent wells, drainage siphons and irrigation crossings under the existing canal, and utilities connected to bridges. Depending on the location and extent of canal modifications, the utilities will either be relocated or entirely replaced, as determined in the final design. A current estimate of potentially affected utilities, based on observations made during a site visit during February 2019, is provided in Table 4-6. It is expected that additional utilities that would be affected by the Parallel Canal Alternative will be identified as design progresses. More detailed information on utilities is provided in Appendix B Engineering Design and Cost.

Table 4-6. Preliminary Estimate of Modifications to Utilities for the Parallel Canal Alternative

Utility Modification	Quantity
Parallel Overhead Powerline Relocations	14 miles
Adjacent Groundwater Well Abandonments	23 wells
Culvert Extensions	13 extensions
Pipeline Overcrossing Replacements	7 replacements
Utility Crossing Replacements	14 crossings

Estimated Quantities and Cost

A list of items that will be included in the summary of quantities and costs is included in Table 4-7. A cost estimate is provided in Table 4-8.

Table 4-7. Parallel Canal Alternative Summary of Estimated Quantities

	-	Seg 1: 5th Ave. to Tule	Seg 2: Tule to Deer Creek	Seg 3: Deer Creek to White River	Seg 4: White River to Garces Highway	Seg 4: Garces Highway to Woollomes	-
Design Flow (Design Maximum) (cfs)	-	4,500	4,000	4,000	3,500	3,500	-
From MP to MP	-	88.2-96.67	95.67-102.7	102.7-112.9	112.9-118.96	118.96-121.5	-
Total Canal Miles	-	7.47	7.0	10.2	6.06	2.54	-
Description	**Unit**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Total**
NEW CANAL							
Clearing and grubbing	Acres	-	102	149	95	-	**346**
Pre-wetting	LS	-	-	-	-	-	-
Dewatering	LS	-	-	-	-	-	-
Excavation	CY	1,050,639	1,896,999	2,710,319	1,761,749	175,558	**7,595,264**
Compacted Canal Embankment construction	CY	530,741	1,939,674	2,748,399	401,363	43,436	**5,663,613**
Spoil Embankment		519,898	0	0	1,319,983	132,437	**1,972,318**
Trimming	SY	384,213	396,505	632,657	366,827	0	**1,780,202**
3-1/2" thick concrete lining	SY	384,213	396,505	632,657	366,827	0	**1,780,202**
Furnish and Place Transverse Canal Joints	LF	230,528	237,903	379,594	220,096	0	**1,068,121**
Furnish and Place Longitudinal Canal Joints	LF	313,720	265,534	423,682	263,499	0	**1,266,435**
Ladders	EA	105	99	144	92	0	**440**
Aggregate base O&M road surfacing	SY	105,011	98,653	149	92,245	28,701	**468,565**
CHECK STRUCTURES	**Unit**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Total**
New Check/Siphon Structure	-	0	1	1	0	0	**2**
Existing Check Structures Demolition and Disposal	-	0	1	1	0	0	**2**

Table 4-7. Parallel Canal Alternative Summary of Estimated Quantities (contd.)

		Seg 1: 5th Ave. to Tule River	Seg 2: Tule to Deer Creek	Seg 3: Deer Creek to White River	Seg 4: White River to Garces Highway	Seg 4: Garces Highway to Woollomes	
ROAD CROSSINGS – BRIDGES	**Unit**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Total**
Canal Transitions to Existing Bridges	EA	18	1	0	0	0	19
Bridge Replacement on Existing Canal – County or State Bridges	EA	0	0	0	0	0	0
Bridge Replacement on Existing Canal – Farm Bridges	EA	0	0	0	0	0	0
Existing Bridge Demolition	EA	0	6	12	8	0	26
ROAD CROSSINGS – SIPHONS	**Unit**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Total**
Siphon Construction on New Canal	EA	0	6	11	8	0	25
TURNOUTS	**Unit**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Total**
Canal Transitions on Existing Canal to Existing Turnouts	EA	7	2	0	0	3	12
Raise/Modify Existing Turnout Top Deck and Actuators	EA	0	0	0	0	0	0
Turnouts on New Canal	EA	0	9	8	6	0	23
Delivery Pools	EA	0	2	6	6	0	14
UTILITIES	**Unit**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Total**
Parallel Overhead Powerline Relocations	MI	4.5	3.5	3.0	2.5	0.5	14
Adjacent Groundwater Well Abandonments	EA	6	4	8	4	1	23
Culvert Extensions (Each End)	EA	4	5	4	0	0	13
Pipeline Overcrossing Replacements (8" to 12")	EA	0	1	2	4	0	7
Impacted Utility Crossings (Attached to Existing Bridge sizes range from 4" to 24")	EA	0	4	7	3	0	14
LAND ACQUISITION	**Unit**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Total**
Impacted Parcels	EA	69	17	25	20	8	139
Permanent Land Acquisition (ROW)	Acres	20	110	260	80	40	510

Key:
- = Not Applicable or zero
cfs = cubic feet per second
CY = cubic yard
EA = each
LF = linear feet
LS = lump sum
MI = mile
MP = milepost
O&M = operations and maintenance
ROW = Right of Way
SY = square yard

Table 4-8. Parallel Canal Alternative Cost Estimate

Item	Reference	Cost	Notes/ Inclusions
Segment 1 - 5th Ave to Tule	from estimate	$28,799,642	
Segment 2 - Tule to Deer Creek (New Bypass Canal)	from estimate	$56,507,656	
Segment 3 - Deer Creek to White River (New Bypass Canal)	from estimate	$91,356,060	
Segment 4 - White River to Garces Hwy (New Bypass Canal)	from estimate	$58,590,113	
Segment 5 - Garces Hwy to Woollomes (Widen Existing Canal)	from estimate	$1,943,335	
Construction Allowances, Mobilization, Startup, Commission, and Owner Training	from estimate	$4,001,997	
Subtotal		*$241,198,803*	
Contract Cost Allowance - Design Contingency	17%	$41,003,796	
Contract Cost		**$280,000,000**	Rounded
Construction Contingencies	20%	$56,000,000	
FIELD COST		**$340,000,000**	Rounded
Land Purchase - Construction Phase and ROW		$15,300,000	510 acres at $30,000/acre
Environmental Mitigation	5%	$17,000,000	Calculated as % of Field Cost
Engineering, Permitting, and Construction Management	10%	$34,000,000	Calculated as % of Field Cost
Legal and Administrative	2%	$6,800,000	Calculated as % of Field Cost
Non-Contract Costs		**$73,000,000**	Rounded
TOTAL CONSTRUCTION COST		**$410,000,000**	Rounded
Interest During Construction	3% Discount Rate	$22,091,214	2.5 year construction period
TOTAL CAPITAL COST		**$430,000,000**	Rounded
Annualized Capital Costs		$16,446,466	2.875% (FY19) over 50 years
Additional Annualized O&M Costs		$967,676	Excludes current O&M costs; 2.875% (FY19) over 50 years
TOTAL ANNUALIZED COST		**$17,500,000**	Rounded

Canal Enlargement Alternative

The Canal Enlargement Alternative closely follows the design evaluated as Initial Alternative 1. The design capacity was modified based on historical maximum flows. A single-line schematic showing features included in the Parallel Canal Alternative is provided in Figure 4-8A and Figure 4-8B.

In comparison to the Initial Alternative configuration, the concrete liner freeboard height in the Canal Enlargement Alternative was revised from the standard freeboard requirements applied to maximum design to the flood flow freeboard lining requirements applied to historical maximum flows. The application of revised freeboard criteria resulted in a concrete canal liner that is 1.03 to 1.18 feet lower than originally presented in the Initial Alternative 1. Other project refinements have been made to the canal cross section, turnouts, and road crossings.

Canal Alignment and Cross Section

The Canal Enlargement Alternative design was modified in comparison to the version included in Initial Alternative 1. The design of the canal cross section in Initial Alternative 1 used a 24-foot wide benched section to accommodate the maximum design flow and flood freeboard at the proposed HGL. The section was applied to the entire length of the Middle Reach.

The use of historical delivery capacity for the Canal Enlargement Alternative limited the need for a large bench and the extent of modifications. The Canal Enlargement Alternative design includes enlarging the FKC from the Tule River Check (MP 95.7) to Ave. 6 (MP 115.94). A 10-foot wide bench is included in the most subsided sections for the purpose of maintaining slope stability, as shown in Figure 4-9, not to provide additional cross section for conveyance capacity. Enlarging other portions of the canal would be accomplished by raising the lining at the current slope with no bench because the relatively small lining raise would not be expected to adversely affect slope stability.

The Canal Enlargement Alternative, as described in this Report, is based on canal embankments and liner that would achieve objective capacities if constructed at the current ground level. The alternative also includes design features to accommodate anticipated future subsidence. For example, the siphon-type road crossings are sized to accommodate future increases in HGL. In addition, canal embankments were configured such that they could be raised without interfering with the operation of the restored FKC and necessary right of way to accommodate the future raise is included, as indicated as the Stage 2 Raise in Figure 4-9.

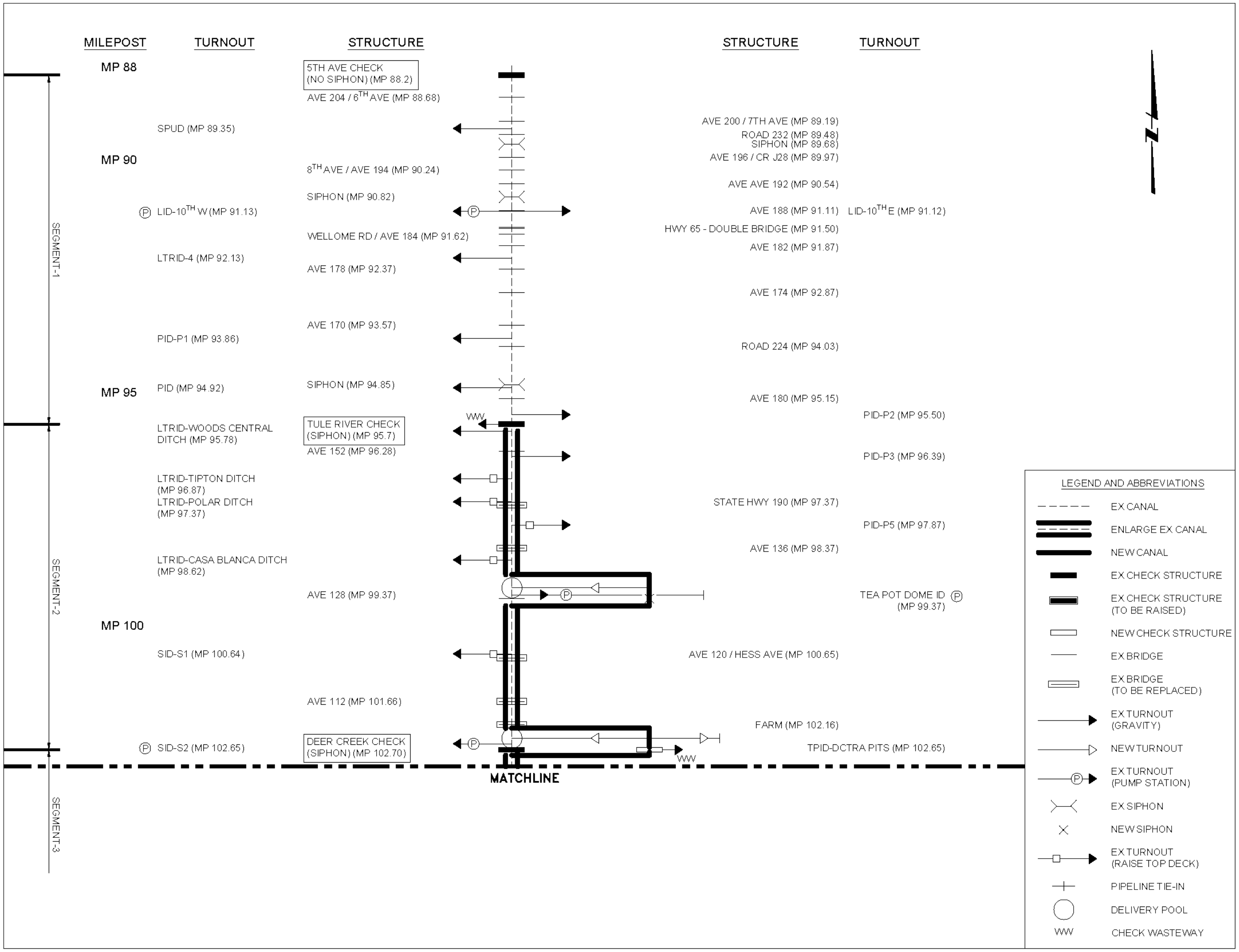

Figure 4-8A Canal Enlargement Alternative Single Line Diagram for Segments 1 and 2

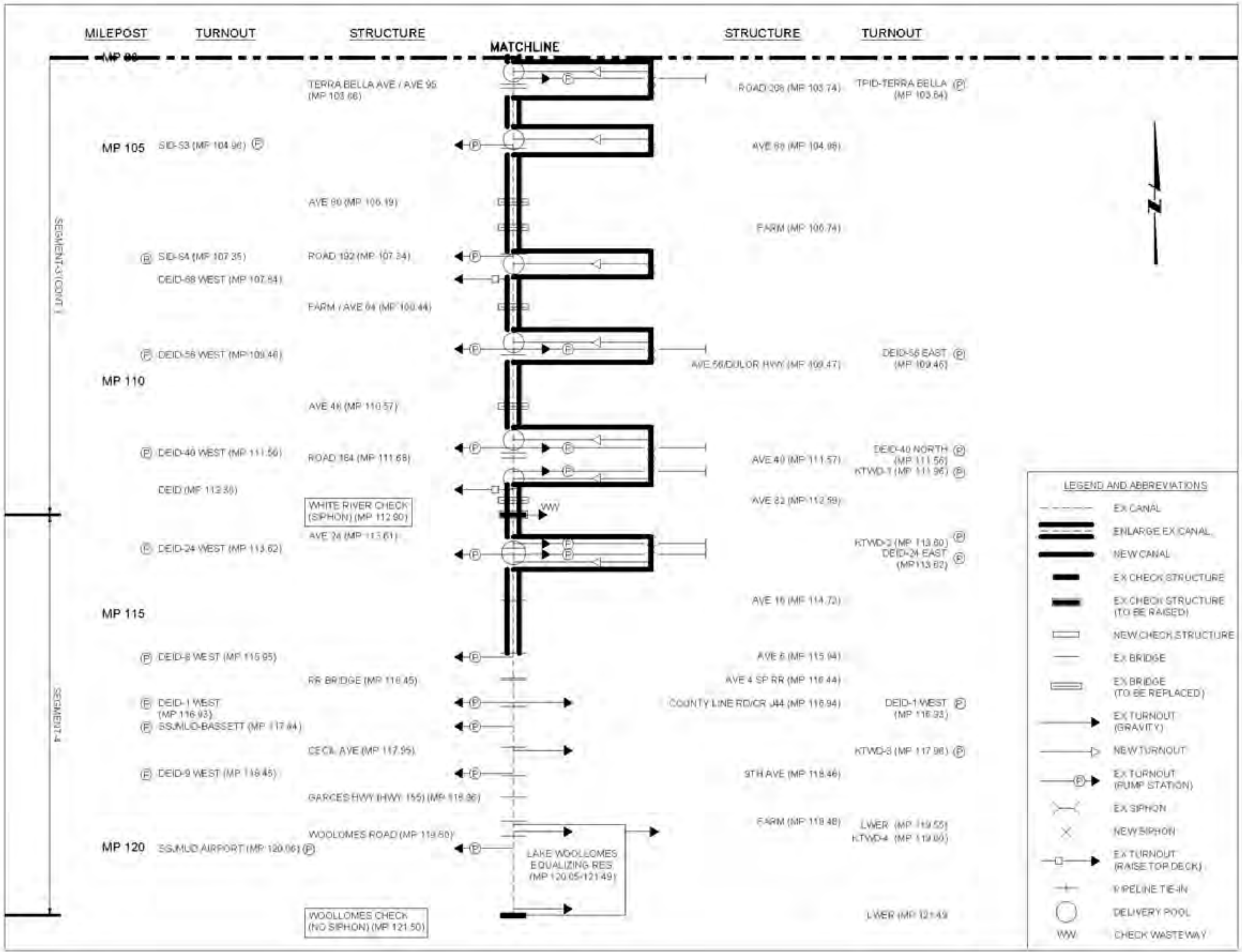

Figure 4-8B. Canal Enlargement Alternative Single Line Diagram for Segments 3 and 4

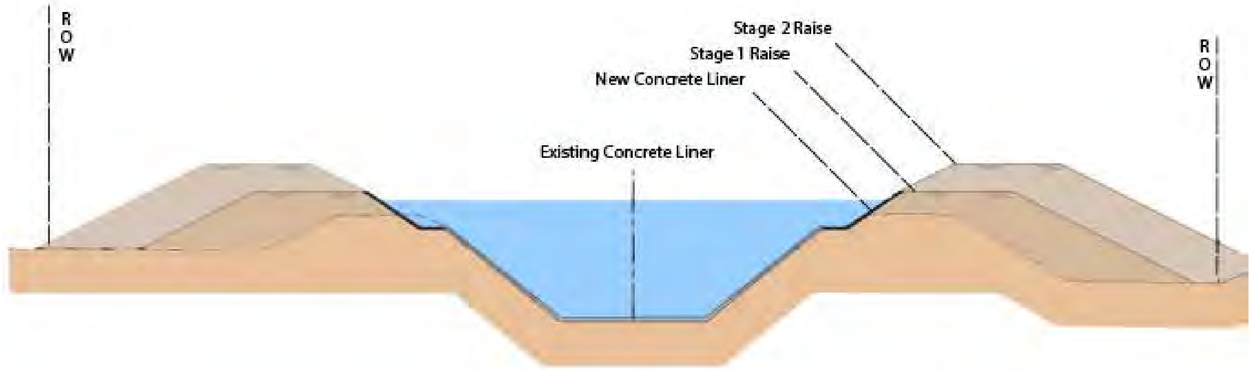

Figure 4-9. Typical Canal Enlargement Cross Section with 10-ft Slope Stability Bench

As shown in Figures 4-8A and 4-8B, the alignment of the Canal Enlargement Alternative would jog out to the east, away from the existing canal alignment, in the vicinity of each pumping plant turnout. Each jog out would include construction of a new trapezoidal canal similar to the trapezoidal cross section described for the Parallel Canal Alternative and shown in Figure 4-4.

Construction Sequencing

The enlargement of the existing canal would be constructed as follows:

1. During an annual two-month maximum canal shutdown period, the existing canal would be taken out of service and drained down to a level below the original grade at the toe of the existing canal banks. Existing bank material would be removed, processed, and recompacted with added material sourced offsite to construct the new, taller banks. During this step, the existing canal lining and supporting bank would be left in place for use during the following operational period.

2. The existing canal would be put back into service for use during the operational season. The existing canal would continue to operate at typical water surface elevations. "In-canal" work would cease until the next two-month canal shutdown period. Work outside of the existing canal prism, such as parallel canal sections and siphons, could continue during this period.

3. During the next shutdown period, the existing canal would be taken out of service and drained down to a level below the original grade at the toe of the existing canal banks. The portion of canal that had the bank earthwork completed in Step 1 above would have part of the existing lining removed, the slope stability bench constructed, and the new lining installed to the final elevations. This portion of canal would then be ready to operate at the new water surface elevations; however, this could not be done until an entire canal segment (check to check) had been completed and lined.

For a detailed discussion on construction sequencing and constraints, refer to Appendix B Engineering Design and Cost.

Turnouts

Similar to the Parallel Canal Alternative, the Canal Enlargement Alternative includes more detail for modifications at pressurized and gravity turnouts. Each turnout in the Middle Reach of the FKC was reviewed to determine modifications that would be required to maintain compatibility between the enlarged canal and district distribution systems, maintain water delivery capability during construction, control overflow, and enhance operational flexibility.

Pressurized Turnout Modifications The Canal Enlargement Alternative uses the same design for pressurized turnouts that is described under the Parallel Canal Alternative. The Canal Enlargement Alternative would modify a shorter portion of the Middle Reach and therefore fewer pressurized turnout modifications are required. It is estimated that this delivery pool concept would be applied at nine locations for the Canal Enlargement Alternative using the design approach shown in Figure 4-5. A summary of modifications to pressurized turnouts under the Canal Enlargement Alterative is provided in Table 4-9.

Table 4-9. Modifications to Actions for Pressurized Turnouts Systems Under the Canal Enlargement Alternative

Name	Side	MP	Modification
LID-10th West	West	91.12	Unmodified
TPDWD-Teapot Dome	East	99.35	Remain Plus Delivery Pool
SID-S2	West	102.65	Remain Plus Delivery Pool
TBID-Terra Bella	East	103.64	Remain Plus Delivery Pool
SID-S3	West	104.96	Remain Plus Delivery Pool
SID-S4	West	107.35	Remain Plus Delivery Pool
DEID-56 EAST	East	109.46	Remain Plus Delivery Pool
DEID-56 West	West	109.46	Remain Plus Delivery Pool
DEID-40 North	East	111.56	Remain Plus Delivery Pool
DEID-40 West	West	111.56	Remain Plus Delivery Pool
KTWD-1	East	111.96	Remain Plus Delivery Pool
KTWD-2	East	113.6	Remain Plus Delivery Pool
DEID-24 East	East	113.62	Remain Plus Delivery Pool
DEID-24 West	West	113.62	Remain Plus Delivery Pool
DEID-8th West	West	115.95	Unmodified
DEID-#1 West	East	116.93	Unmodified
SSJMUD-Bassett	West	117.44	Unmodified
KTWD-3	East	117.96	Unmodified
DEID-9th West	West	118.45	Unmodified
SSJMUD-Airport	West	120.06	Unmodified

Gravity Turnout Modifications In the portions of the Middle Reach where no modifications would be necessary to convey historical peak flows, existing gravity turnouts would not be modified. In the reach from MP 95.7 to MP 115.94, nearly all existing gravity turnouts would require raising the top deck by two to five feet. The extent of the raise at each turnout is dependent upon the lining raise at that location.

Raising the top deck of a gravity turnout generally consists of removing the existing top concrete deck, extending the turnout wall height to the new lining height, modifying the existing turnout gates to the new structure height, and rebuilding the top deck and site appurtenances such as retaining walls, railing, and fencing. A list of modifications to gravity turnouts in the Canal Enlargement Alternative is provided in Table 4-10 and shown in Figure 4-10. Additional detail is provided in Appendix B Engineering Design and Cost.

Table 4-10. Modifications to Gravity Turnouts Under the Canal Enlargement Alternative

Name	Side	MP	Modification
SPUD-STRATHMORE	West	89.35	Unmodified
LID-10th East	East	91.12	Unmodified
LTRID-4	West	92.13	Unmodified
PID-P1	West	93.86	Unmodified
PID-Porter Slough	West	94.92	Unmodified
PID-P2	East	95.5	Unmodified
LTRID-Tule River WW Gates	West	95.64	Unmodified
LTRID-Woods Central Ditch	West	95.78	Unmodified
PID-P3	East	96.39	Unmodified
LTRID-Tipton Ditch	West	96.87	1' Top Deck Raise
LTRID-Poplar Ditch N&S	West & East	97.34	2' Top Deck Raise
PID-P5	East	97.86	2' Top Deck Raise
LTRID-Casa Blanca Ditch	West	98.62	3' Top Deck Raise
SID-S1	West	100.63	4' Top Deck Raise
TBID-DCTRA Pits	East	102.65	Build New Turnout on New Canal
DEID-68 West	West	107.84	3' Top Deck Raise
DEID	West	112.36	2' Top Deck Raise
LWER	East	119.55	Unmodified
LWER	East	121.49	Unmodified

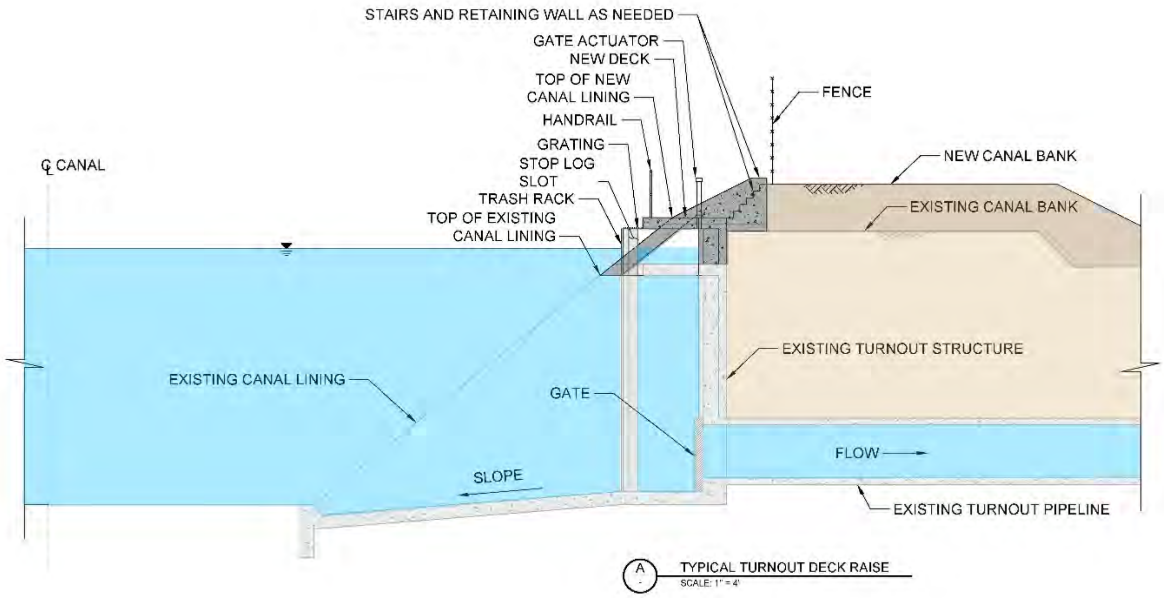

Figure 4-10. Typical Gravity Turnout Deck Raise

Checks and Siphons

The Canal Enlargement Alternative involves a new check and siphon at Deer Creek and modification of the existing check and siphon at White River. Modification of the White River check would generally consist of extending the height of the concrete canal warped transitions and the headwalls at upstream and downstream end of the existing siphon, plus raising the two existing radial gates and invert sill on the upstream end of the structure.

Road Crossings

Modifications at each road crossing would depend on the alignment and cross section modification at that location. In the segment from MP 88 to MP 95.7, where no modifications would be required, the road crossings would remain unchanged. In the modified portion, from MP 95.7 to MP 115.94, road crossings would either be replaced with a trapezoidal bridge along the existing FKC alignment or filled in and replaced with a siphon where the alignment jogs to the east to accommodate an existing pump station turnout. The Canal Enlargement Alternative includes installation of a trapezoidal bridge at 10 locations along the existing FKC alignment. A typical section for a trapezoidal bridge is shown in Figure 4-11. Siphons would be installed at nine road crossings affected by canal jogs to accommodate pump station turnouts, based on the design. Siphon A design is shown in Figure 4-6. A summary of road crossing modifications in the Canal Enlargement Alternative is provided in Table 4-11.

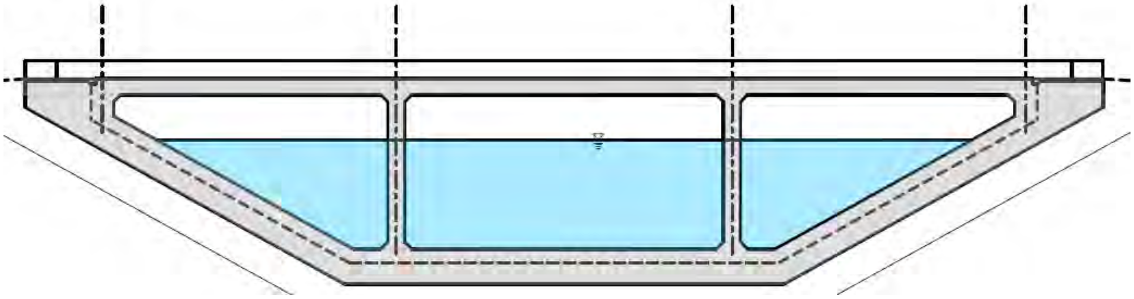

Figure 4-11. Trapezoidal Bridge Concept

Table 4-11. Road Crossing Modifications in the Canal Enlargement Alternative

Name	MP	Modification
6th Avenue Bridge	88.67	Unmodified
7th Avenue Bridge	89.17	Unmodified
Road 232 Bridge	89.45	Unmodified
Frazier Highway 196 Bridge	89.95	Unmodified
8th Avenue Bridge	89.95	Unmodified
Avenue 192 Bridge	90.23	Unmodified
Avenue 188 Bridge	91.10	Unmodified
State Highway 65 Northbound Bridge (Double Bridge)	91.51	Unmodified
Welcome Avenue Bridge (Avenue 184)	91.60	Unmodified
Avenue 182 Bridge	91.85	Unmodified
Avenue 178 Bridge	92.35	Unmodified
W Linda Vista Avenue	92.85	Unmodified
W North Grand Avenue Bridge	93.55	Unmodified
N Westwood Street Bridge	94.01	Unmodified
W Henderson Avenue Bridge	95.12	Unmodified
Avenue 152 Bridge	96.26	Unmodified
Avenue 144 Bridge (Highway 190)	97.35	New Trapezoidal Bridge
Avenue 136 Bridge	98.35	New Trapezoidal Bridge
Avenue 128 Bridge	99.37	Demo- New Road Crossing/Siphon A
Hesse Avenue Bridge	100.64	New Trapezoidal Bridge
Avenue 112 Bridge	101.64	New Trapezoidal Bridge
Timber Farm Bridge	102.14	New Trapezoidal Bridge
Road Terra Bella Avenue (J24)	103.65	Demo- New Road Crossing/Siphon A
Road 208 Bridge	103.72	Demo- New Road Crossing/Siphon A
Avenue 88 Bridge	104.95	Demo- New Road Crossing/Siphon A
Avenue 80 Bridge	106.72	New Trapezoidal Bridge
Farm Bridge	106.75	New Trapezoidal Bridge
Road 192 Bridge	107.32	Demo- New Road Crossing/Siphon A
Avenue 64 Bridge	108.42	New Trapezoidal Bridge

Table 4-11. Road Crossing Modifications in the Canal Enlargement Alternative (contd.)

Name	MP	Modification
Avenue 56 Bridge	109.45	Demo- New Road Crossing/Siphon A
Avenue 48 Bridge	110.55	New Trapezoidal Bridge
Avenue 40 Bridge	111.55	Demo- New Road Crossing/Siphon A
Road 184 Bridge	111.66	Demo- New Road Crossing/Siphon A
Avenue 32 Bridge	112.57	New Trapezoidal Bridge
Avenue 24 Bridge	113.59	Demo- New Road Crossing/Siphon A
Avenue 16 Bridge	114.71	Unmodified
Avenue 8 Bridge	115.91	Unmodified
Timber Farm (Avenue 4) Bridge (2 Bridges)	116.41	Unmodified
County Road Avenue 0 Bridge	116.91	Unmodified
Cecil Avenue Bridge	117.92	Unmodified
9th Avenue Bridge	118.44	Unmodified
Garces Highway Bridge	118.94	Unmodified
Timber Farm Bridge	119.46	Unmodified
Woollomes Avenue Bridge	120.02	Unmodified

Utilities

Numerous utilities located in, along, and across the FKC would be affected by implementation of the Canal Enlargement Alternative. The utilities include parallel irrigation canals, fly overs, overhead power lines, adjacent wells, drainage siphons and irrigation crossings under the existing canal, and utilities connected to bridges. Depending on the location and extent of canal modifications, the utilities will either be relocated or entirely replaced, as determined in the final design. A current estimate of potentially affected utilities, based on observations made during a February 2019 site visit, is provided in Table 4-12. It is expected that additional utilities that would be affected by the Parallel Canal Alternative will be identified as design progresses. More detailed information on utilities is provided in Appendix B Engineering Design and Cost.

Table 4-12. Preliminary Estimate of Modifications to Utilities for the Canal Enlargement Alternative

Utility Action	Quantity
Parallel Overhead Powerline Relocations	8 miles
Adjacent Groundwater Well Abandonments	12 wells
Culvert Extensions	9 extensions
Pipeline Overcrossing Replacements	5 replacements
Utility Crossing Replacements	12 crossings

Estimated Quantities and Cost A list of items that will be included in the summary of quantities is included in Table 4-13. The cost for the Canal Enlargement Alternative is presented in Table 4-14.

Table 4-13. Canal Enlargement Alternative Summary of Estimated Quantities

		Seg 1: 5th Ave. to Tule River	Seg 2: Tule to Deer Creek	Seg 3: Deer Creek to White River	Seg 4: White River to Ave. 8 Bridge	Total
Design Flow (Historical Maximum) (cfs)	-	4,008	3,497	2,888	2,490	-
From MP to MP	-	88.2-95.67	95.67-102.7	102.7-112.9	112.9-115.94	-
Total Canal Miles	-	7.47	7.0	10.2	3.04	-
Description	**Unit**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Total**
NEW CANAL						
Clearing and grubbing	Acres	-	34	50	14	**99**
Pre-wetting	LS	-	-	-	-	**-**
Dewatering	LS	-	-	-	-	**-**
Excavation	CY	-	152,649	430,113	122,032	**704,794**
Compacted Canal Embankment construction	CY	-	695,487	1,679,261	96,709	**2,471,457**
Spoil Embankment		-	146,123	307,553	69,142	**522,818**
Trimming	SY	-	146,123	307,553	69,142	**522,818**
3-1/2" thick concrete lining	SY	-	87,674	184,532	41,485	**313,691**
Furnish and Place Transverse Canal Joints	LF	-	121,681	230,482	64,923	**417,086**
Furnish and Place Longitudinal Canal Joints	LF	-	100	146	42	**287**
Ladders	EA	-	99,515	145,860	41,938	**287,313**
Aggregate base O&M road surfacing	SY	-	4,000	14,500	2,500	**21,000**
CHECK STRUCTURES	**Unit**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Total**
New Check/Siphon Structure		-	1	0	0	1
Existing Check Structures Demolition and Disposal		-	0	1	0	1

Table 4-13. Canal Enlargement Alternative Summary of Estimated Quantities (contd.)

		Seg 1: 5th Ave. to Tule	Seg 2: Tule to Deer Creek	Seg 3: Deer Creek to White River	Seg 4: White River to Ave. 8 Bridge	
ROAD CROSSINGS – BRIDGES	**Unit**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Total**
Canal Transitions to Existing Bridges	EA	-	1	0	2	**3**
Bridge Replacement on Existing Canal - County or State Bridges	EA	-	4	3	0	**7**
Bridge Replacement on Existing Canal - Farm Bridges	EA	-	1	2	0	**3**
Existing Bridge Demolition	EA	-	1	7	1	**9**
ROAD CROSSINGS - SIPHONS	**Unit**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Total**
Siphon Construction on New Canal	EA	-	1	7	7	**9**
TURNOUTS	**Unit**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Total**
Canal Transitions on Existing Canal to Existing Turnouts	EA	-	10	10	11	**31**
Raise/Modify Existing Turnout Top Deck and Actuators	EA	-	5	2	0	**7**
Turnouts on New Canal	EA	-	3	6	1	**10**
Delivery Pools	EA	-	2	6	1	**9**
UTILITIES	**Unit**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Total**
Parallel Overhead Powerline Relocations	MI	-	3.5	3.0	1	**8**
Adjacent Groundwater Well Abandonments	EA	-	4	8	0	**12**
Culvert Extensions (Each End)	EA	-	5	4	0	**9**
Pipeline Overcrossing Replacements (8" to 12")	EA	-	1	2	2	**5**
Impacted Utility Crossings (Attached to Existing Bridge sizes range from 4" to 24")	EA	-	4	7	1	**12**
LAND ACQUISITION	**Unit**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Total**
Impacted Parcels	EA	-	TBD	TBD	TBD	**TBD**
Permanent Land Acquisition (ROW)	Acres	-	20	70	10	**100**

Key:
- = Not Applicable or zero
cfs = cubic feet per second
CY = cubic yard
EA = each
LF = linear feet
LS = lump sum
MI = mile
MP = milepost
O&M = operations and maintenance
ROW = Right of Way
SY = square yard

Table 4-14. Parallel Canal Alternative Cost Estimate

Item	Reference	Cost	Notes/ Inclusions
Segment 1 - 5th Ave to Tule	from estimate	$0	
Segment 2 - Tule to Deer Creek (Enlarge Canal)	from estimate	$42,956,860	
Segment 3 - Deer Creek to White River (Enlarge Canal)	from estimate	$87,815,210	
Segment 4 - White River to Ave 8 Bridge (Enlarge Canal)	from estimate	$12,425,645	
Construction Allowances, Mobilization, Startup, Commission, and Owner Training	from estimate	$6,369,115	
Subtotal		*$149,566,830*	
Contract Cost Allowance - Design Contingency	17%	$25,426,361	
Contract Cost		**$175,000,000**	Rounded
Construction Contingencies	20%	$35,000,000	
FIELD COST		**$210,000,000**	Rounded
Land Purchase - Construction Phase and ROW		$3,000,000	100 acres at $30,000/acre
Environmental Mitigation	5%	$10,500,000	Calculated as % of Field Cost
Engineering, Permitting, and Construction Management	10%	$21,000,000	Calculated as % of Field Cost
Legal and Administrative	2%	$4,200,000	Calculated as % of Field Cost
Non-Contract Costs		**$39,000,000**	Rounded
TOTAL CONSTRUCTION COST		**$250,000,000**	Rounded
Interest During Construction	3% Discount Rate	$40,895,938	10-year construction period
TOTAL CAPITAL COST		**$290,000,000**	Rounded
Annualized Capital Costs		$10,989,353	2.875% (FY19) over 50 years
Additional Annualized O&M Costs		$284,611	Excludes current O&M costs; 2.875% (FY19) over 50 years
TOTAL ANNUALIZED COST		**$11,300,000**	Rounded

Chapter 5 Evaluation of Feasibility Alternatives

This chapter presents an evaluation and comparison of the No Action Alternative and the Feasibility Alternatives described in Chapter 4 based on an assessment of economic effects associated with changes in the delivery of water to Friant Division long-term contractors. Other potential benefit categories have not been evaluated for this Study. This chapter also presents a comparison of Feasibility Alternatives with respect to effectiveness, efficiency, completeness, and acceptability, the selection of a Recommended Plan, and the summary of refinements to the Recommended Plan.

Evaluation Approach to Quantify Water Supply Effects

Evaluating the benefits of the Feasibility Alternatives involves consideration of conditions that are expected to change over the 100-year planning horizon. Identified conditions that are expected to change and affect the Project include water supply availability at Friant Dam, the delivery capability of the FKC under the no action and all action alternatives in response to future subsidence, and changes in the value of water. The quantification of physical effects and calculation of monetary benefits of Feasibility Alternatives was accomplished through a multiple-step process, that included the following:

- Estimate water supply available at Friant Dam
- Determine the capacity of the existing FKC and the capacity of Feasibility Alternatives in response to future subsidence over the planning horizon
- Quantify water deliveries affected by reduced canal capacity
- Reschedule affected supplies in Millerton Lake to the extent possible
- Pump additional groundwater to offset reduced deliveries during the SGMA implementation period
- Quantify and value lost water supply based on current and future water values

A schematic of the evaluation approach is shown in Figure 5-1 and described in the following sections; additional detail is provided in the Appendix C Economics Evaluation.

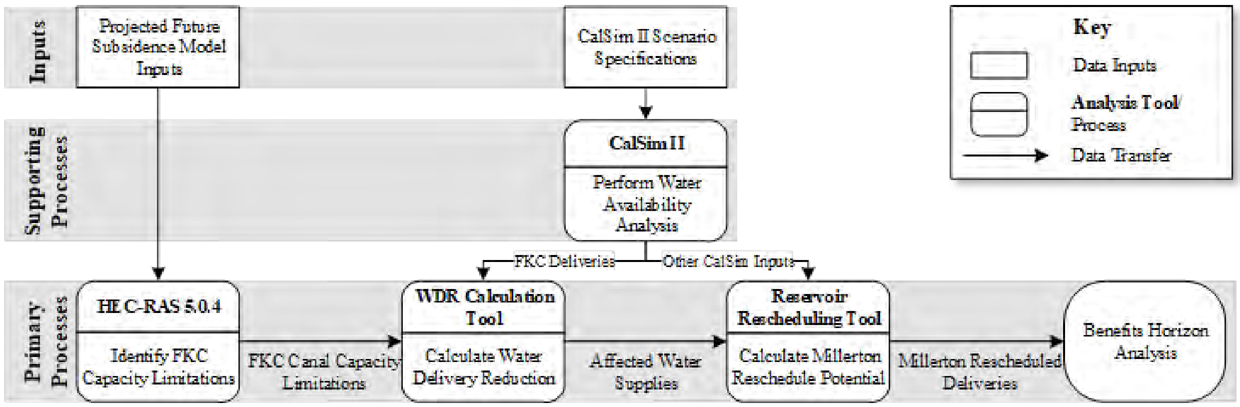

Figure 5-1. Modeling Process for Economics Evaluations

Water Supply Availability at Friant Dam

The California Water Resources Simulation Model (CalSim II) was used to estimate water deliveries from Friant Dam to Friant Division long-term contractors over an 82-year simulation period based on historical hydrologic data for water years 1922 through 2003. The CalSim II model simulates the operation of Millerton Lake to meet a variety of objectives, including the release of flows to the San Joaquin River for water rights and SJRRP Restoration Flows, diversion to the San Joaquin River and Friant-Kern and Madera canals for delivery of water under Friant Division Class 1 and Class 2 contracts and Section 215/other contracts and obligations, and flood operations. Simulated diversions to the Friant-Kern and Madera canals are based on CalSim-estimated water supply allocations under the various contract types, as applied to typical diversion patterns into the canals based on historical data. Only the capacity at the headworks of the canal is considered in the operation of the CalSim II model, meaning the diversions assume no conveyance capacity restrictions due to design deficiencies or subsidence.

For the benefits evaluation, the current implementation of the SJRRP Flow is used for the current water supply availability in the year 2019. This amount is projected to linearly decrease to delivery amounts under the full implementation of the SJRRP Flow in the year 2030. It is assumed that annual average Friant Division water supply availability would remain constant after 2030.

FKC Capacity

The capacity of the FKC will continue to decrease as land subsides in the future and the decreased capacity will reduce water delivery capability. The rate of land subsidence is assumed to be the same in the No Action Alternative and all action alternatives. Estimates of subsidence along the FKC for Group 3 conditions, as described in Chapter 2, for years 2030, 2040, and 2070 were used in a HEC-RAS model of the FKC, described in Appendix A1a1 HEC-RAS Modeling Technical Memorandum ™, to determine canal capacity at these dates. The groundwater model results indicate that the greatest amount of future land subsidence is projected occur between 2017 (first year of groundwater model simulation) and 2030, with additional subsidence occurring to 2040 when actions to achieve SGMA requirements would be fully implemented, and additional subsidence occurring to 2070 as a result of 'residual' subsidence of subsurface formations. As shown in Figure 5-2, additional land subsidence will reduce the capacity of the FKC. Similar computations were conducted to estimate the effect of land subsidence on the restored canal capacity at future points in time under the two Feasibility Alternatives.

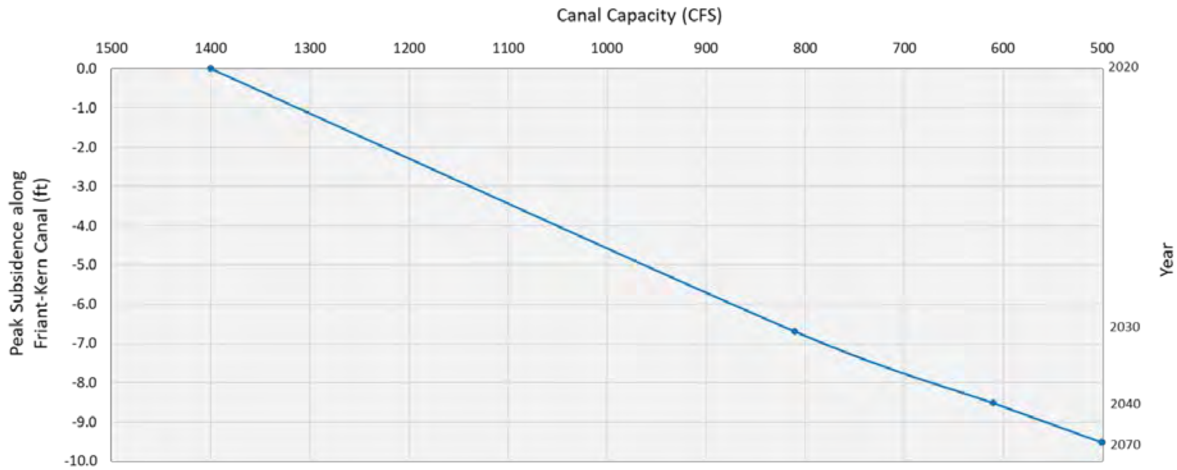

Figure 5-2. Friant-Kern Canal Capacity Under Future Peak Subsidence

Affected Water Deliveries

The modeled canal capacities from HEC-RAS simulations, combined with the variations of water availability, were used in the Water Delivery Reduction Tool to calculate the affected Class 1 and Class 2/other water supply for the Friant Division long-term contractors on the FKC downstream of the subsidence chokepoint. As described in the Economics Evaluation Appendix, the Water Delivery Reduction Tool applies historical patterns of daily diversions to the FKC to estimate water deliveries that would be affected as a result of reduced canal capacity. Evaluations were made for years corresponding to results for simulated ground subsidence during the project planning horizon and interpolated for intervening years. Table 5-1 presents the results of modeled flow capacity, from the HEC-RAS model and the total expected annual affected water deliveries, based on the Water Delivery Reduction Tool described in Appendix C.

Table 5-1. Modeled FKC Capacity and Average Annual Affected Water Supplies

Year	Estimated Minimum Capacity (cfs)	Average Annual Affected Water Supply (AF/yr)
2018	1,400	27,083
2030	810	102,651
2040	610	149,346
2070	500	179,746

Source: Information is from the Water Delivery Reduction Tool Calculation described in Appendix C-Economics Evaluation
Key:
cfs = cubic feet per second

The average annual affected water supply quantities listed in Table 5-1 apply to Class 1 and Class 2/Other water deliveries, based on information provided in the CalSim II model, which includes delivery of water under Paragraph 16(b) of the Settlement "for the purpose of reducing or avoiding impacts to water deliveries to all of the Friant Division long-term contractors caused by the Interim and Restoration Flows."

In the benefits evaluation over the planning horizon, the values of annual estimated capacity of the FKC and corresponding average annual affected water deliveries were linearly interpolated between the evaluation results listed in Table 5-1. It is assumed canal capacity and average annual affected water deliveries would remain constant after 2070.

Rescheduled Water Deliveries

As described in Chapter 4, the No Action Alternative and the Feasibility Alternatives assume that affected water supplies due to FKC capacity constraints would be rescheduled through Millerton Lake operations to the extent possible. While Millerton Lake is typically operated as an annual reservoir with no long-term carry-over storage objectives, the operation of Millerton Lake provides some opportunities to store water for use in successive periods. The approach used to evaluate rescheduled water deliveries for the Project assumes that all affected deliveries would be rescheduled using available conservation storage capacity in Millerton Lake. This approach is considered conservative because it represents the maximum opportunity for rescheduling and therefore results in a minimum estimate of additional groundwater pumping or lost water supplies. Actual opportunities for rescheduling are expected to be less than evaluated due to several factors, including supply and demand forecasting uncertainty, Millerton Lake operations, the ability of Friant Division long-term contractors to adjust local water uses, and CVP Friant Division contract term requirements. The economic analysis assumes that rescheduling of affected water deliveries could be accomplished at no additional cost.

Additional Groundwater Pumping

Under the No Action and Feasibility Alternatives, affected water supplies that could not be delivered through rescheduling in Millerton Lake would result in water supply reductions to Friant Division long-term contractors. In the near future, it is assumed that reduced deliveries would be replaced with additional groundwater pumping in the affected districts. However, this additional groundwater pumping to replace undeliverable supplies would exceed groundwater pumping conditions being used to develop long-term SGMA implementation plans. As a result, groundwater pumping to replace undeliverable water supplies was assumed to reduce from full replacement in 2020 to no groundwater pumping after 2030.

Reduced Deliveries to Friant Division Long-Term Contractors

Affected water supplies that could not be rescheduled in Millerton Lake or replaced with additional groundwater pumping would be lost as flood releases from Friant Dam to the San Joaquin River and represents a loss of water supply to affected Friant Division long-term contractors.

Water Valuation

The cost for pumping additional groundwater and value of water are both expected to change over the life of the project. Groundwater pumping cost is based on the cost of energy and the depth to groundwater, and capital costs associated with the construction or replacement of groundwater infrastructure. Costs for additional groundwater pumping in this analysis are limited to those associated with energy.

As reported by the California Energy Commission (CEC), electricity costs are projected to increase by about 1.7 percent annually between 2015 and 2024 (CEC 2014). The CEC does not provide estimated electricity costs after 2024.

The depth to groundwater in each affected Friant Division long-term contractor service area was estimated using 2018 available groundwater depth information. The weighted cost of groundwater pumping was calculated for years 2015, 2020, and 2024 using the groundwater depth, projected electricity prices, and the share of total subsidence water affected delivery for each affected contractor. Values were linearly interpolated between calculated years and assumed to remain constant after 2024. The calculated weighted average value of groundwater pumping is listed on Table 5-2.

Table 5-2. Weighted Average Value of Groundwater Pumping

Year	Groundwater Pumping Cost ($/AF)[1,2]
2015	$203
2020	$219
2024	$229

Notes:
1 Based on CEC electricity costs projections
2 2018 Price Level

In 2015, the California Water Commission (CWC) prepared estimates of water value in California under current operational requirements. The CWC classified current unit values of water as those for 2030 conditions. The values provided by the CWC in 2015, escalated to 2018 price levels using the U.S. Bureau of Economic Analysis GDP Deflator, are shown in Table 5-3.

Table 5-3. Estimated Water Values in the Eastern San Joaquin Valley

Water Year Type	2030 Condition Friant Service Area 2015 Price Value ($/AF of Consumptive Use)	2030 Condition Friant Service Area 2018 Price Value ($/AF of Consumptive Use)
Wet	$200	$211
Above Normal	$251	$265
Below-Normal	$261	$276
Dry	$278	$294
Critical	$324	$342
Weighted Average	$256	$271

Source: CWC WSIP Technical Reference Document

Monetary Benefits of Feasibility Alternatives

This Study anticipates that regional subsidence will continue and cause a decrease in the capacity of the FKC over the planning horizon, under the No Action Alternative and with the implementation of Feasibility Alternatives. To estimate the benefits of Feasibility Alternatives, the value of water delivery reductions was estimated for the No Action Alternative and Feasibility Alternatives. Benefits of the Feasibility Alternatives are based on differences in delivery reduction value in comparison to the No Action Alternative.

Table 5-4 through Table 5-6 show the planning horizon analysis for the No-Action and Feasibility Alternatives. Computations are made each year in the planning horizon. For ease of presentation, the tables report annual results for years 1 through 10 and then every decade following until year 100, the end of the planning horizon. The tables provide the net present value of reduced water deliveries over the planning horizon.

Feasibility Alternatives cost estimates are reported as an opinion of probable construction cost (OPCC) and cost ranges were provided based on plus or minus 25 percent variation in field costs. Feasibility Alternatives costs include Interest During Construction (IDC) over the construction duration, and life cycle costs over the planning horizon.

A summary of benefits associated with water deliveries and costs of Feasibility Alternatives is provided in Table 5-7.

Table 5-4. No-Action Horizon Analysis

Year	Average Annual Deliveries (TAF)	Average Annual No Action Affected Water Supply (TAF)	Reschedule in Millerton (TAF)	Percent Groundwater Pumping (%)	Assumed Groundwater Pumping (TAF)	Average Annual Reduction in Supply (TAF)	Value of Water Lost ($M)	Groundwater Pumping Cost ($M)	Annual Value of Water ($M)
1	410.2	41.3	15.6	90%	23.2	2.6	$271	$221	$5.8
2	408.2	46.1	17.3	80%	23.0	5.8	$271	$224	$6.7
3	406.2	50.9	19.0	70%	22.3	9.5	$271	$226	$7.6
4	404.2	55.6	20.8	60%	20.9	13.9	$271	$229	$8.6
5	402.2	60.4	22.5	50%	18.9	18.9	$271	$229	$9.5
6	400.2	68.8	24.7	40%	17.7	26.5	$271	$229	$11.2
7	398.2	77.3	26.8	30%	15.1	35.3	$271	$229	$13.0
8	396.2	85.7	29.0	20%	11.3	45.4	$271	$229	$14.9
9	394.2	94.2	31.2	10%	6.3	56.7	$271	$229	$16.8
10	392.2	102.7	33.3	0%	0.0	69.3	$271	$229	$18.8
20	392.2	149.3	36.4	0%	0.0	112.9	$271	$229	$30.6
30	392.2	159.5	35.7	0%	0.0	123.8	$271	$229	$33.5
40	392.2	169.6	34.9	0%	0.0	134.7	$271	$229	$36.5
50	392.2	179.7	34.1	0%	0.0	145.6	$271	$229	$39.4
60	392.2	179.7	34.1	0%	0.0	145.6	$271	$229	$39.4
70	392.2	179.7	34.1	0%	0.0	145.6	$271	$229	$39.4
80	392.2	179.7	34.1	0%	0.0	145.6	$271	$229	$39.4
90	392.2	179.7	34.1	0%	0.0	145.6	$271	$229	$39.4
100	392.2	179.7	34.1	0%	0.0	145.6	$271	$229	$39.4
								Net Present Value	$923

Table 5-5. Canal Enlargement Horizon Analysis

Year	Average Annual Deliveries (TAF)	Average Annual No Action Affected Water Supply (TAF)	Reschedule in Millerton (TAF)	Percent Groundwater Pumping (%)	Assumed Groundwater Pumping (TAF)	Average Annual Reduction in Supply (TAF)	Value of Water Lost ($M)	Groundwater Pumping Cost ($M)	Annual Value of Water ($M)
1	410.2	41.3	15.6	90%	23.2	2.6	$271	$221	$5.8
2	408.2	46.1	17.3	80%	23.0	5.8	$271	$224	$6.7
3	406.2	50.9	19.0	70%	22.3	9.5	$271	$226	$7.6
4	404.2	55.6	20.8	60%	20.9	13.9	$271	$229	$8.6
5	402.2	60.4	22.5	50%	18.9	18.9	$271	$229	$9.5
6	400.2	68.8	24.7	40%	17.7	26.5	$271	$229	$11.2
7	398.2	77.3	26.8	30%	15.1	35.3	$271	$229	$13.0
8	396.2	85.7	29.0	20%	11.3	45.4	$271	$229	$14.9
9	394.2	94.2	31.2	10%	6.3	46.7	$271	$229	$16.8
10	392.2	102.7	33.3	0%	0.0	69.3	$271	$229	$18.8
20	392.2	0.3	0.1	0%	0.0	0.2	$271	$229	$0.1
30	392.2	0.7	0.2	0%	0.0	0.4	$271	$229	$0.1
40	392.2	1.0	0.3	0%	0.0	0.7	$271	$229	$0.2
50	392.2	1.3	0.4	0%	0.0	0.9	$271	$229	$0.2
60	392.2	1.3	0.4	0%	0.0	0.9	$271	$229	$0.2
70	392.2	1.3	0.4	0%	0.0	0.9	$271	$229	$0.2
80	392.2	1.3	0.4	0%	0.0	0.9	$271	$229	$0.2
90	392.2	1.3	0.4	0%	0.0	0.9	$271	$229	$0.2
100	392.2	1.3	0.4	0%	0.0	0.9	$271	$229	$0.2
								Net Present Value	$100

Table 5-6. Parallel Canal Horizon Analysis

Year	Average Annual Deliveries (TAF)	Average Annual No Action Affected Water Supply (TAF)	Reschedule in Millerton (TAF)	Percent Groundwater Pumping (%)	Assumed Groundwater Pumping (TAF)	Average Annual Reduction in Supply (TAF)	Value of Water Lost ($M)	Groundwater Pumping Cost ($M)	Annual Value of Water ($M)
1	410.2	41.3	15.6	90%	23.2	2.6	$271	$221	$5.8
2	408.2	46.1	17.3	80%	23.0	5.8	$271	$224	$6.7
3	406.2	50.9	19.0	70%	22.3	9.5	$271	$226	$7.6
4	404.2	0.0	0.0	60%	0.0	0.0	$271	$229	$0.0
5	402.2	0.0	0.0	50%	0.0	0.0	$271	$229	$0.0
6	400.2	0.0	0.0	40%	0.0	0.0	$271	$229	$0.0
7	398.2	0.0	0.0	30%	0.0	0.0	$271	$229	$0.0
8	396.2	0.0	0.0	20%	0.0	0.0	$271	$229	$0.0
9	394.2	0.0	0.0	10%	0.0	0.0	$271	$229	$0.0
10	392.2	0.0	0.0	0%	0.0	0.0	$271	$229	$0.0
20	392.2	0.0	0.0	0%	0.0	0.0	$271	$229	$0.0
30	392.2	0.0	0.0	0%	0.0	0.0	$271	$229	$0.0
40	392.2	0.0	0.0	0%	0.0	0.0	$271	$229	$0.0
50	392.2	0.0	0.0	0%	0.0	0.0	$271	$229	$0.0
60	392.2	0.0	0.0	0%	0.0	0.0	$271	$229	$0.0
70	392.2	0.0	0.0	0%	0.0	0.0	$271	$229	$0.0
80	392.2	0.0	0.0	0%	0.0	0.0	$271	$229	$0.0
90	392.2	0.0	0.0	0%	0.0	0.0	$271	$229	$0.0
100	392.2	0.0	0.0	0%	0.0	0.0	$271	$229	$0.0
								Net Present Value	$20

Table 5-7. Benefit Cost Analysis of Feasibility Alternatives

Item	Canal Enlargement Alternative	Parallel Canal Alternative
Value of reduced water delivery in the No Action Alternative[1,2]	$923	$923
Value of reduce water delivery in the Project Alternative[1,2]	$100	$20
Net Benefit[1,2]	$823	$904
Net Present Value of Total Capital and Life Cycle Costs [1,3]	$267	$452
Cost Range of Net Present Value of Total Capital[1,4]	($220 - $360)	($320 - $540)

Notes:
[1] All costs are in millions of dollars
[2] Net Present Value based on 100-year project life
[3] Construction Cost of Initial Alternatives
[4] +/- 25% applied to field cost

Evaluation of Feasibility Alternatives using Federal Planning Criteria

The Federal planning process described in the PR&G includes four criteria for consideration in formulating and evaluating alternative plans: completeness, effectiveness, efficiency, and acceptability (CEQ 2013). A summary of the evaluation is provided in Table 5-8 and described in the following sections.

Table 5-8. Summary of Federal Planning Criteria Evaluation

	Canal Enlargement Alternative	Parallel Canal Alternative
Effectiveness	Medium-High	High
Efficiency	High	Medium-High
Completeness	Medium	High
Acceptability	Not yet determined	Not yet determined

Effectiveness

Effectiveness is the extent to which an alternative plan would alleviate problems and achieve the planning objectives for a project. Both Feasibility Alternatives would restore the capability to convey water supplies based on historical operations. However, the performance of the Feasibility Alternatives would not be the same if future operational objectives include deliveries that exceed historical peak flows.

Evaluations presented in this report are based on historical deliveries and do not include operational objectives in response to changing water supply conditions, particularly the implementation of SGMA. For example, many Friant Division long-term contractors have considered development of local water projects such as groundwater banking, canal enlargement or interties, and other actions that would improve water management in response to reduced water supply availability. If the implementation of such projects results in delivery of water from Friant Dam under existing CVP contracts at flows that exceed historical FKC flow rates, the performance of the Feasibility Alternatives would change.

Efficiency

This evaluation criterion is a measure of how an alternative plan alleviates the specified problems and realizes the specified opportunities at the least cost, or in a cost-effective manner. As noted in the discussion on Effectiveness, all analyses presented in this report are based on historical deliveries and do not include potential changes in future operations. Economic benefits for water supply based on this approach were compared to costs estimated for the Initial Alternatives (Alternative 1 Option 1 and Alternative 5 Option 3) as described in Chapter 3. Using this information, the benefit cost (B-C) ratios are 2.0 for the Parallel Canal Alternative and 3.0 for the Canal Enlargement Alternative. Both alternatives are efficient in achieving project objectives as evaluated. If future operational objectives include deliveries that exceed historical peak flows, the efficiency of the Feasibility Alternatives would change.

Completeness

Completeness is a determination of whether an alternative plan includes all elements necessary to realize planned effects, and the degree that intended benefits of the plan depend on the actions of others. Sub-criteria that are important in measuring completeness include (1) authorization, (2) planning objective(s), (3) reliability or durability, (4) physical implementability or constructability, and (5) effects on environmental resources. Each of these sub-criteria are described below.

Authorization

Authorization for Reclamation participation in this Project is provided by the Settlement Act (Public Law 111-11) and the WIIN Act.

Part III of the Settlement Act authorizes the restoration of the FKC to such capacity as previously designed and constructed by the Bureau of Reclamation. The Canal Enlargement Alternative, as evaluated in this Study, would restore the capacity of the FKC to less than the original capacity. The Parallel Canal Alternative, as evaluated in this Study, would restore the capacity of the FKC to the original maximum capacity with current freeboard Reclamation freeboard criteria. Both Feasibility Alternatives are consistent with the Settlement Act.

Reclamation is reviewing requirements of the WIIN Act as applicable to the FKC Middle Reach Subsidence and Capacity Correction Project. Additional benefit evaluations to support WIIN Act funding may be included in subsequent versions of this report.

Planning Objectives

The two Feasibility Alternatives evaluated in this Study would meet the planning objectives of increasing canal capacity and improving water supply reliability to Friant Division long-term contractors south of the FKC low point.

Reliability or Durability

The two Feasibility Alternatives would have different degrees of reliability in response to future land subsidence. The Canal Enlargement Alternative, which would be constructed to meet maximum historical deliveries, would be subject to reduced capacity in response to additional land subsidence early in the project life. As evaluated in this Study, the Parallel Canal Alternative, which would be constructed to the maximum design capacity, would not experience water delivery reductions during the planning horizon in response to additional land subsidence.

Physical Implementability or Constructability

Similar features have been included in both Feasibility Alternatives to address requirements for turnouts, road crossings, checks, siphons, and utilities. Both Feasibility Alternatives are constructible using accepted construction methods, however constraints associated with construction of canal modifications differ between the Feasibility Alternatives. Although detailed construction constraints and sequencing plans have not been developed, several challenges associated with their construction, particularly within the prism of an operating canal, have been identified.

- Borrow Material – The Parallel Canal Alternative could be constructed with either balanced material requirements for earthwork or a surplus that could be spoiled on project features. The Canal Enlargement Alternative would require significant borrow material, with borrow sources ideally located on each side of the FKC to limit hauling over the existing bridges, many of which have load restrictions. Depending on the location of borrow sources (which have not yet been identified), constraints on the larger equipment ideally suited to hauling large loads may be imposed.

- Potential Reduction in Water Deliveries During Construction – The water surface elevation in the FKC will need to be lowered in order to remove existing concrete lining to construct a new bench (setback) below the existing top of lining. This is required to reduce additional loading on the existing 1.25:1 canal side slopes. During this portion of the construction, the conveyance capacity of the canal will be reduced. Detailed analyses will need to be performed to define the actual bench elevation, with full consideration of geotechnical slope stability, and then estimate this impact to water supply deliveries. It is envisioned that scheduling of this construction will need to be coordinated with low delivery periods, which would extend the construction schedule so that water supply deliveries can be maintained as much as possible. Reduced water levels to accommodate in-prism construction would be more significant in the Canal Enlargement Alternative because the bench features would be constructed in the most subsided portion of the FKC, whereas bench features in the Parallel Canal Alternative would be located in the upper-most and lower-most portions of the Middle Reach.

- Safety Risk During Construction – The Canal Enlargement Alternative would have a greater safety risk to staff during construction than the Parallel Canal Alternative because more of the work would be completed within an active water delivery system.

- Tie-ins – Both Feasibility Alternatives include structures, such as check structures, wasteways, and siphons, that will require upstream and downstream tie-ins to the existing FKC. While achievable, tie-ins require appropriate advance planning, reliable concepts, and carry some risk that water deliveries could be interrupted during construction.

Environmental Resources

An analysis of potential environmental constraints was prepared and applied to the evaluation of Initial Alternatives. This evaluation contributed to the selection of the Feasibility Alternatives. Further environmental evaluations are being performed through the development of environmental compliance documents.

Acceptability

Acceptability is the viability and appropriateness of an alternative plan from the perspective of the Nation’s general public and consistency with existing Federal laws, authorities, and public policies. It does not include local or regional preference for particular solutions or political expediency. Acceptability among Friant Division long-term contractors will consider several factors that have not yet been evaluated, including the availability of Federal and State funding, the allocation of costs among Friant Division contractors, and the need for conveyance capacity to accommodate potential future operational requirements.

Identification of the Recommended Plan

The identification of the Recommended Plan is based on evaluation and comparisons of the net benefits and additional criteria to limit the impacts to Friant Division long-term contractors. As described below, the Parallel Canal Feasibility Alternative is identified as the Recommended Plan. The selection of the Parallel Canal Feasibility Alternative was also supported by the findings of a Value Planning Study performed by Reclamation which ranked the alternative highest compared to alternatives considered during the value planning process.

National Economic Development Plan

The objective of the National Economic Development (NED) analysis estimates the economic benefits of potential effects is necessary to establish the feasibility and identify a corresponding alternative plan that maximizes net benefits. As described above, the maximum net benefit is achieved by the Parallel Canal Feasibility Alternative, which supports the selection of this alternative as the Recommended Plan.

Constructability and Operational Considerations

Additional criteria considered in the selection of the Recommended Plan included potential to impact water deliveries during construction. The Parallel Canal Feasibility Alternative has a construction duration of two and half years compared to the Canal Enlargement Alternative could last up to ten years due to limitations time available for canal construction during lowered water levels. Water delivery impacts during construction of the Parallel Canal Feasibility Alternative would be minimal because most construction activities will be in the dry, using new materials and does not rely on the existing embankments for stability. The shorter construction duration, limited impact to contract deliveries during construction, and the more reliable construction methods are reasons support the selection of Parallel Canal Feasibility Alternative as the Recommended Plan.

Value Planning Study

In October of 2019 Reclamation performed a value planning study of the Friant-Kern Canal Capacity Correction Project. The goal of the value planning study is to achieve the most appropriate and highest value solution for an identified problem. The value planning study included an examination of the component features of the Project, or activity to define the critical functions, governing criteria, and associated costs. Alternative ideas and solutions were suggested to perform the functions, consistent with the identified criteria, at a lower cost or with an increase in long-term value.

The Value Planning review of the Initial and Feasibility Alternatives confirmed the Parallel Canal Feasibility Alternative as the superior alternative considered in this Study. The value planning study considers the Parallel Canal Feasibility Alternative as the Baseline Design in which alternative ideas are compared to, and additional design considerations are added to. The ideas were evaluated, analyzed, and prioritized, and a few of these were evaluated to a level suitable for comparison, decision-making, and adoption.

Reclamation produced the Draft Value Planning Report that summarizes the activities and ideas developed the value planning team. Table 5-9 shows the analysis matrix developed by the value planning team that ranked the developed ideas compared to the Baseline Design (Parallel Canal Feasibility Alternative). From the proposed ideas the Parallel Canal Feasibility Alternative was evaluated as the highest value project and confirms that selection of the Parallel Canal Alternative as the Recommended Plan.

Table 5-9. Analysis Matrix from Value Planning Study

Analysis Matrix

Criteria	A		B		C		D		E		F		Raw Score	Weighted Score	Ranking	Disposition
Weight	0.07		0.04		0.19		0.04		0.33		0.33					
Idea	Score	Weighted	Score	Weighted	Score	Weighted	Score	Weighted	Score	Weighted	Score	Weighted				
Baseline Design	4	0.27	5	0.22	5	0.93	5	0.22	4	1.31	5	1.64	28	4.6	**1**	
RCC Embakment	2	0.14	2	0.09	4	0.75	5	0.22	4	1.31	2	0.66	19	3.2	**4**	
MSE Wall	3	0.20	5	0.22	4	0.75	4	0.18	4	1.31	4	1.31	24	4	**3**	
Unlined Parallel Canal	4	0.27	5	0.22	5	0.93	3	0.13	3	0.99	5	1.64	25	4.2	**2**	
Recharge w/ Existing	5	0.34	5	0.22	5	0.93	5	0.22	2	0.66	5	1.64	27	4.01		

Score: Excellent = 5, Very Good = 4, Good = 3, Fair = 2, Poor = 1

Score 4-5
Score 3-4
Score 2-3

Summary of Refinements to the Parallel Canal Feasibility Alternative

As described above, the Parallel Canal Feasibility Alternative was selected as the Recommended Plan. Following that selection, several refinements were made to reduce material requirements and improve constructability and project resilience. Design refinements included reduction of the required length of canal realignment portion, refinement of the location of the center-line of the realigned segment, selection of canal cross-sections that provide greater resiliency under future subsidence conditions, identification of potential borrow sites, and other considerations. The results of these additional refinements reduced the cost of the Recommended Plan without reducing the estimated benefits in comparison to the Parallel Canal Feasibility Alternative described above. The refinements to the Parallel Canal Feasibility Alternative described below are reflected in the description of the Recommended Plan presented in Chapter 6. The Recommended Plan is also referred to as the Canal Enlargement and Realignment (CER) Alternative in environmental compliance documents.

Refinement of Length of Canal Realignment

The Parallel Canal Feasibility Alternative included a realigned canal segment from south of Ave. 152 near MP 96 to Garces Highway near MP 119. Through additional modeling and refinement, it was determined that the length of canal realignment segment could be shortened and achieve the maximum design capacity and HGL. The canal realignment in the Recommended Plan extends from MP 96 to Avenue 8 near MP 116. This refinement resulted in reducing the canal realignment by approximately 3 miles, reducing the among of required embankment material and reducing project costs.

Refinement of Canal Realignment Offset from Existing FKC

The realigned canal portion of Parallel Canal Feasibility Alternative, which was developed based on minimizing ROW requirements, required the placement of material within the existing FKC.

Upon consideration of material requirements, the centerline of the realigned canal was moved further east such that the west embankment of the realigned canal tied into the existing the eastern canal embankment. This refinement reduced the required embankment material by about 1 million cubic yards and enables a construction sequencing that provides for potential use of material in the existing canal embankments to construct parts of the realigned canal embankments.

Refinement of Raised and Widened Canal Segment Cross-Sections

The Parallel Canal Feasibility Alternative included canal enlargement in Segment 1 and a portion of Segment 4 through raising and widening the FKC. In these segments, the raised and widened section would include a 24-foot bench on either side of the canal. Through additional hydraulic modeling, it was determined that required capacity could be achieved by extending the existing prism by raising the embankment and extending the lining, thereby eliminating the need to widen the canal. Depending on location, the required lining raise varies from 15 inches to 24 inches. The elimination of the bench reduced the amount of embankment material and liner on the bench portion, and lowered cost. Table 5-10 shows the approximate lining raise required in Segment 1, a portion of Segment 2, and Segment 4B to achieve the maximum design flow.

Table 5-10. Lining Raise Requirements for the Recommend Plan

Segment	Maximum Design Flow (cfs)	Required Lined Freeboard	Canal Milepost (MP)	Canal Milepost (MP)	Approx. Canal Length	Lining Raise "H"
1	4,500 cfs	1.15' (13.80")	88.2 (5th Ave Check Outlet)	95.1 (Ave 180 Bridge)	6.9-miles	15"
			95.1 (Ave 180 Bridge)	95.7 (Tule Check Inlet)	0.6-miles	24"
2	4,000 cfs	1.11' (13.32")	95.7 (Tule Check Outlet)	96.3 (Ave 152 Bridge)	0.6-miles	24"
2/3/4A	*4,000 cfs 3,500 cfs*	*1.11' 1.08'*	*96.3 (Ave 152 Bridge)*	*115.9 (Ave 8 Bridge)*	*19.6-miles Parallel Canal*	
4B	3,500 cfs	1.08' (12.96")	115.9 (Ave 8 Bridge)	119.5 (Woollomes Rd Bridge)	3.6-miles	13"
4C	3,500 cfs	1.08' (12.96")	*119.5 (Woollomes Rd Bridge)*	*121.5 (Woollomes Check Inlet)*	*2.0-miles Existing Earth Canal (No Mods Necessary)*	

Key:
ave – avenue
cfs – cubic feet per second
mp – milepost
rd - road

Refinement of Realigned Canal Segment Cross-Sections

The cross-section geometry of the Parallel Canal Feasibility Alternative was based a 40-foot bottom width of the canal in all realigned segments. Further evaluation revealed that material balance could be improved and resiliency under future subsidence could be increased if the bottom width were narrowed. An analysis was performed to identify effect on canal capacity under future subsidence for a variety of bottom-width canal designs at the same design capacity Table 5-11 shows the reduction in capacity resulting from capacity on a variety of canal sections designed to convey 4,000 cfs. Under a future subsidence of 4 feet, the capacity of a 16-foot bottom width would be reduced by about 12 percent whereas the same subsidence would cause a 25 percent reduction of the capacity for a 40-foot bottom with canal.

On the basis of this analysis, the design for the Recommended Plan was revised to include varying widths from 16 to 24 feet. This change was made to minimize the canal capacity loss that would be experienced in the future from subsidence. This reduction in bottom width has the added advantage of reducing the amount of concrete lining required as part of the construction.

Table 5-11. Effect of Subsidence on Canal Capacity of Various 4,000 cfs Canal Designs

Future Subsidence	Canal Capacity Reduction Resulting from Subsidence			
	16-ft Bottom Width	24-ft Bottom Width	32-ft Bottom Width	40-ft Bottom Width
2-feet	5% (200 cfs)	7% (280 cfs)	10% (400 cfs)	12% (480 cfs)
4-feet	12% (480 cfs)	16% (640 cfs)	20% (800 cfs)	25% (1,000 cfs)
8.5-feet	32% (1,280 cfs)	41% (1,640 cfs)	49% (1,960 cfs)	56% (2,240 cfs)

Key:
cfs – cubic feet per second

Refinement to Identification of Borrow Sources

During the refinement of the Recommended Plan, as described above, additional potential borrow sites were identified through coordination with Friant Division long-term contractors. In response to SGMA requirements, some Friant Division long-term contractors are advancing plans to develop permanent groundwater recharge basins. To date, Friant Division long-term contractors have expressed interest in developing three sites in the general vicinity of the Project Area and have indicated their interest in making material from these sites available as borrow. In addition, at least one site, which is immediately adjacent to the FKC, is a candidate construction staging location. Preliminary designs, environmental compliance and permitting has been completed for some sites, whereas others have been evaluated at a conceptual or appraisal level. Geotechnical information is available at all sites and further evaluations will be included in the design development of the Recommended Plan.

Based the current design of the Recommended Plan and consideration of potential borrow from nearby and adjacent identified sites, the identified available borrow to construct exceeds the requirements for the Recommended Plan. Table 5-12 shows the borrow source and the amount of material identified as available from that source. As noted in Table 5-12 over 9 million cubic yards of potential borrow material has been identified, which significantly exceeds the estimated material requirements of approximately 5.7 million cubic yards.

Table 5-12. Borrow Sources and Estimated Volume Available

Borrow Source	General Location	Estimated Volume Available (CY)
Excavation of Realigned Canal	MP 96 to MP 116	2.1M
Existing FKC Bank Material[1]	Along 20 miles of existing canal (MP 96 to MP 116)	3.0M
SITE B - Terra Bella Irrigation District Site	East of canal at Milepost 102.2	1.5M
SITE A – Private Landowner Site	East of canal at Milepost 97.4	0.5M
SITE C - Delano-Earlimart Irrigation District Site	1 mile West of Canal near Milepost 114.0	2.0M
Total Potential Available Borrow		9.1M

Notes:
1 Material is not available until segments of old canal are out of operation.

Chapter 6 Recommended Plan

This chapter describes the Recommended Plan and project implementation requirements. It includes the demonstration of the feasibility of the Recommended Plan, identification of areas of potential risk and uncertainty, project implementation requirements, Federal and non-Federal responsibilities, and a project timeline.

Description of Recommended Plan Features

A single-line schematic showing features included in the Recommended Plan is provided in Figure 6-1A and Figure 6-1B. The Recommended Plan includes modification to enlarge the FKC where practical, and construction of a new canal realignment in locations where the land subsidence has occurred or is expected to occur to an extent that modifying the existing FKC to achieve the design capacity and HGL is considered less practical. Features of the Recommended Plan are described in the following sections.

Canal Alignment and Cross Sections

The Recommended Plan would include modifications to the current FKC alignment from 5th Ave. Check (MP 88) to Ave. 152 (MP 96.3). Through this reach, the cross section of the existing FKC would be enlarged with a canal embankment and lining raise to increase canal capacity to meet the Design Maximum flow rate and HGL in this segment, as shown in Figure 6-2. From 5th MP 88 to MP 96.3 existing bridge soffits are anticipated to be above the new maximum water surface elevation in the canal. Many of the existing turnouts in this segment of the canal will require raising the top deck by 0.5 to 2 feet. The extent of the raise at each turnout is dependent upon the lining raise at that location.

At MP 96.3, the new canal alignment would head east, away from the existing canal centerline, and run on a generally parallel alignment to the existing FKC until it reaches Ave. 8 (MP 115.94). In this reach, the new canal alignment would have a regular trapezoidal shape based on the configuration shown in Figure 6-3. At MP 115.94, the canal realignment would reconnect with the existing alignment of the FKC, which would be enlarged between MP 115.94 to Woollomes Ave. (MP 120) as described above and shown in Figure 6-2. From MP 120 to Reservoir Check Structure (MP 121.5) will remain as is with no modifications necessary to convey the Design Maximum flow.

The Recommended Plan is based on canal embankments and liner that would achieve objective capacities if constructed at the current (2018 survey) ground level and includes design features to accommodate anticipated future subsidence. For example, the siphon-type road crossings are sized to accommodate future increases in HGL. In addition, canal embankments were configured such that they could be raised without interfering with the operation of the restored FKC. The necessary ROW to accommodate such a future raise, as identified as future concrete liner raise with embankment on Figure 6-3.

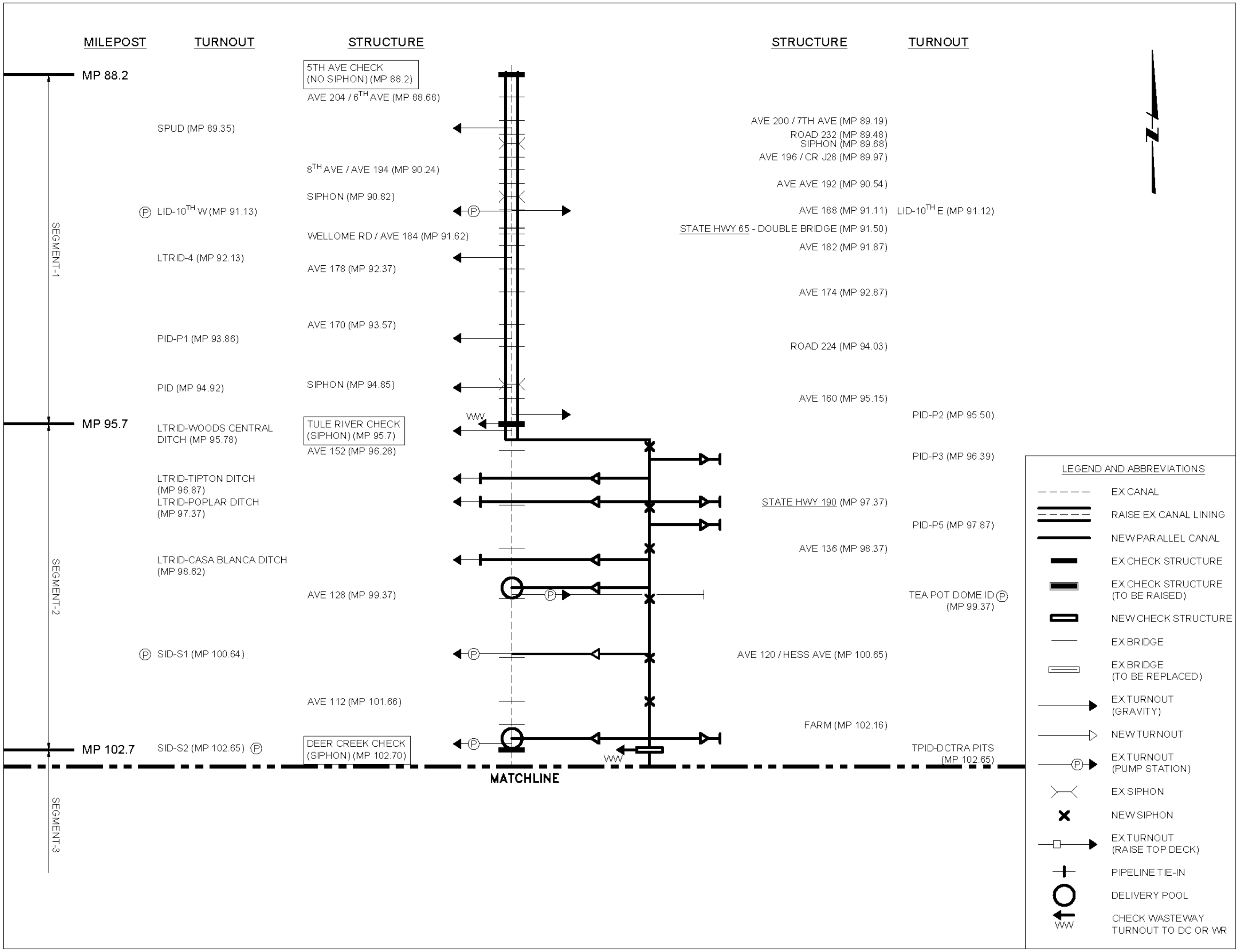

Figure 6-1A. Recommended Plan Single-Line Diagram of Canal Segments 1 and 2

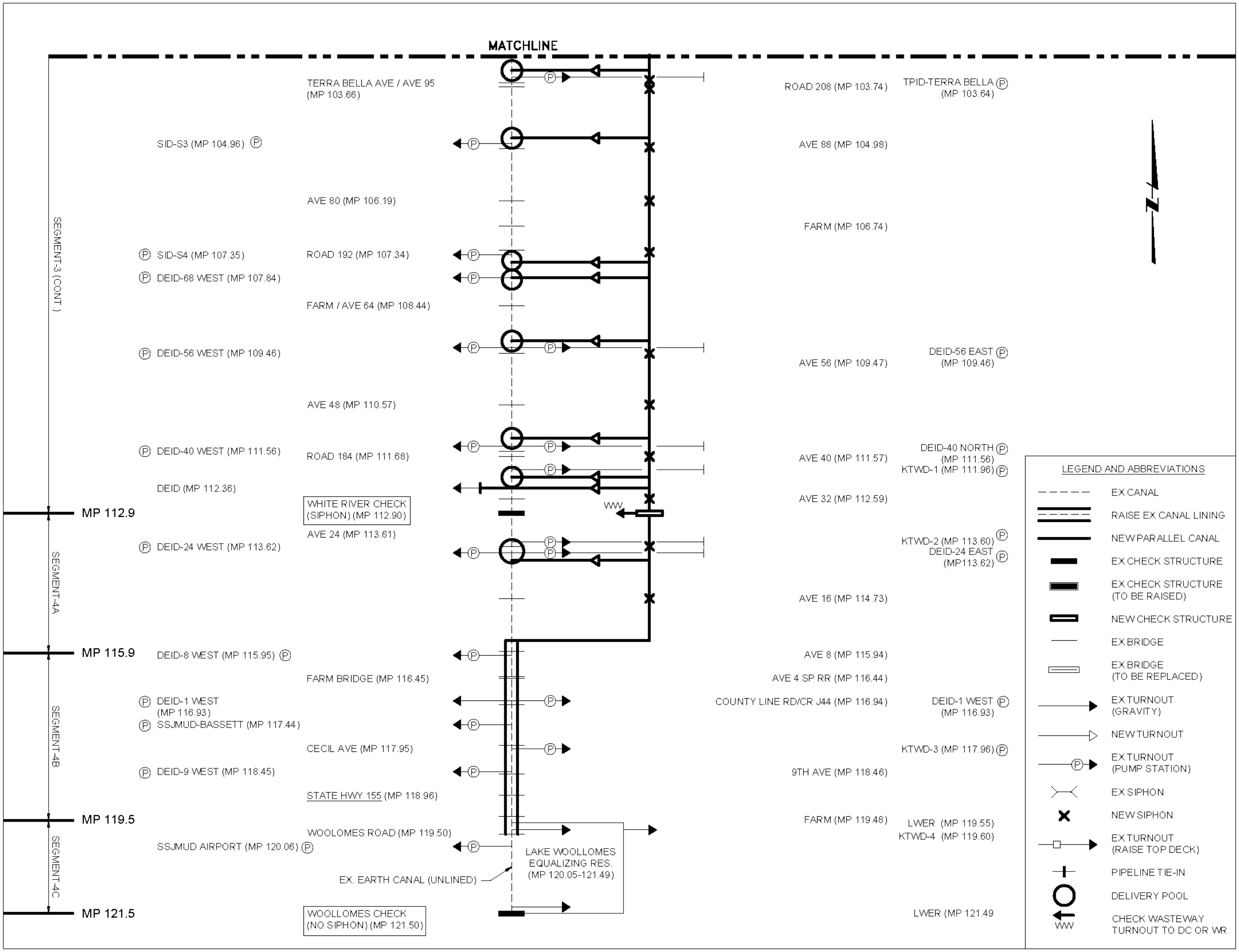

Figure 6-1B. Recommended Plan Single Line Diagram of Segments 3 and 4

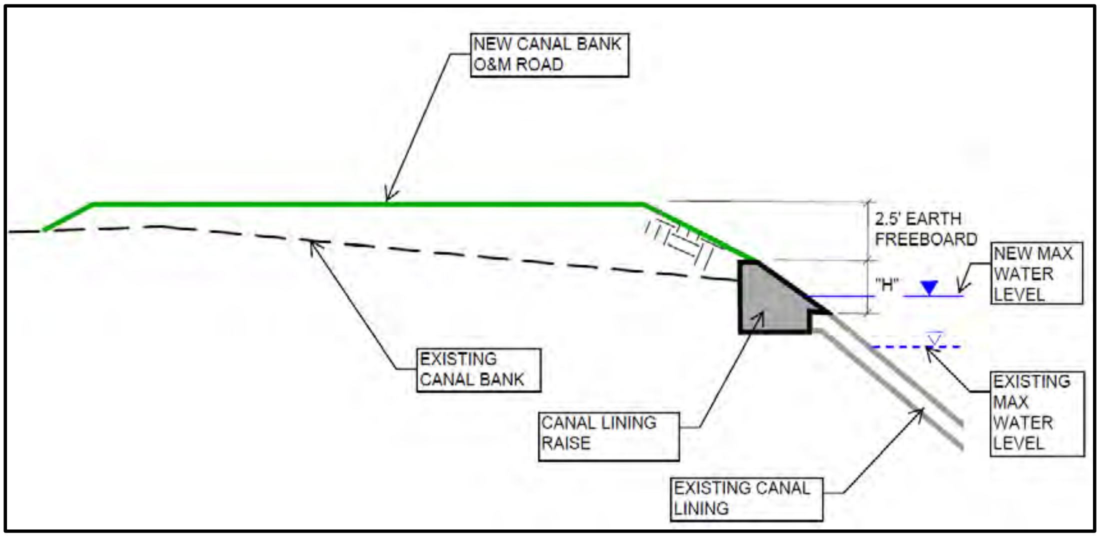

Figure 6-2. Canal Lining Raise in Segment 1 and Segment 4b of the Recommended Plan

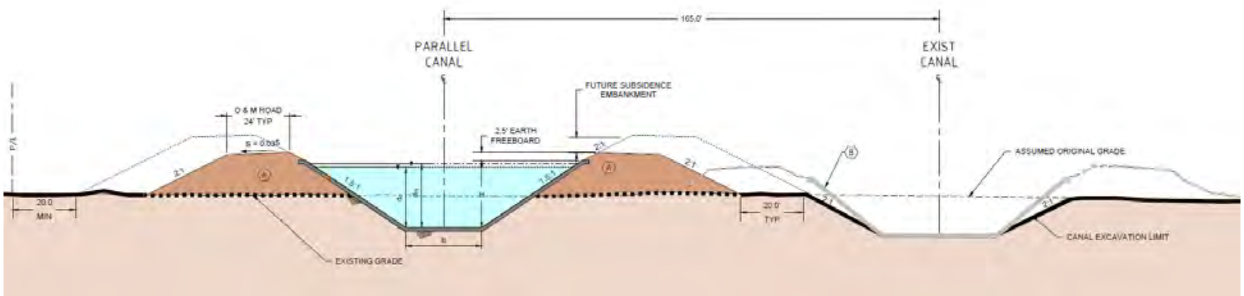

Figure 6-3. Trapezoidal Cross Section of Realigned Canal Segments in the Recommended Plan

Construction Sequencing

The canal realignment portion of the Recommended Plan would be constructed as follows:

1. Construct the new canal section from Ave. 56 (MP 109.47) to MP 115.94 with excavated prism material, construct the new White River Check Structure, and line the newly constructed canal.

2. The newly constructed canal from MP 109.47 to MP 115.94 put into operations with temporary tie in on the northern end.

3. Excavate material from the old FKC banks and haul material from MP 109.47 to White River Check (MP 112.9) north to construct canal realignment prism from Ave. 96 (MP 103.66) to MP 109.47.

4. Construct the new canal section from MP 103.66 to MP 109.47 with excavated prism material, and the hauled material from Step 3 or other potential borrow area near the Deer Creek Check. Line the canal section from MP 103.66 to MP 109.47.

5. The newly constructed canal from MP 103.66 to MP 109.47 put into operations with temporary tie on the northern end and connected to the canal section from MP 109.47 to MP 115.94.

6. Construct the canal section from MP 96.3 to Ave. 128 (MP 99.37) with excavated prism material, and line the newly constructed section.

7. The newly constructed canal from MP 96.3 to MP 99.37 put into operations with temporary tie in at the southern end.

8. Excavate material from the old FKC banks and haul material from MP 96.3 to MP 99.37 south to construct canal realignment prism from MP 99.37 to MP 103.66.

9. Construct the new canal section from MP 99.37 to MP 103.66 with excavated prism material, and the hauled material from Step 8. Line the canal section from MP 99.37 to MP 103.66. Construct the new Deer Creek Check Structure.

10. New Canal Realignment completed and in operation.

For a detailed discussion on construction sequencing, refer to Appendix D Recommended Plan Design and Cost Summary.

Turnouts

The Recommended Plan includes feature to address water delivery at existing turnouts, based in part, on input provided by Friant Division long-term contractors. The Recommended Plan incorporates design concepts for pressurized and gravity systems to ensure compatibility between the canal and the contractors' distribution systems, maintain water delivery capability during constructions, control overflow, and enhance operational flexibility.

Pressurized Turnout Modifications

In the Middle Reach, many of the 21 pressurized distribution systems have subsided at different rates than the land under the canal, causing varying differential head conditions from those used in the original system designs. All alternatives have been developed to achieve the proposed HGL, which is higher than the current water surface in the FKC. Increasing the HGL would increase head on the suction side of the pumping plants, which would increase the delivery head on district distribution systems. The removal and replacement of current pump stations at a location compatible with the current design was considered and dropped because of significant costs.

The water elevation in the new realigned canal would often be above the elevation of the top decks of existing pump stations. If a pump station were to unexpectedly shutdown, the incoming flow from the adjacent canal could overflow the pump station and flood the facility and surrounding land, resulting in equipment and property damage. To avoid the potential risk associated with unexpected shutdowns, the Recommended Plan includes small delivery pools at each pump station turnout in the canal realignment section. As shown in Figure 6-4, the delivery pool would be created by preserving small portions of the existing FKC to serve as a forebay for the existing turnout pump station. Water would flow from the new realigned canal through a new pipe to the delivery pool. The new canal realignment would be modified at the location of each pump station turnout and be customized to meet the specific needs of each pressurized delivery system. A list of the modifications proposed to the pump station turnouts is provided in Table 6-1.

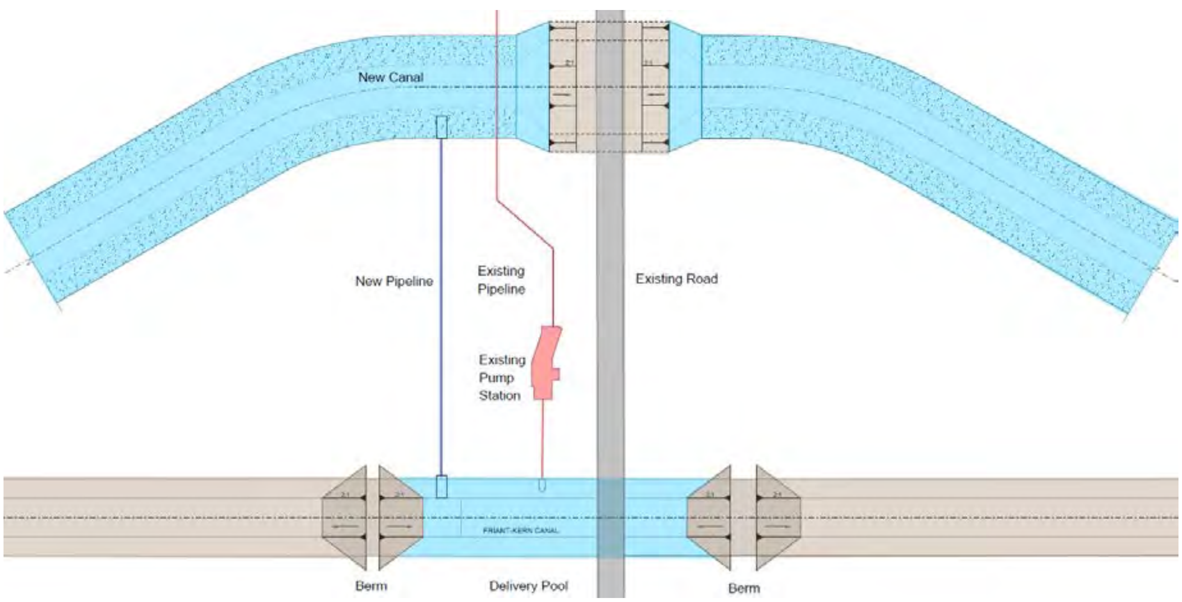

Figure 6-4. Example Pressurized System Turnout Design in the Recommended Plan

Table 6-1. Modifications at Pump Station Turnouts in the Recommended Plan

Pump Station Turnout	Canal Side	MP	Modification
LID-10th W	West	91.12	Raise Top Deck
TPDWD-Teapot Dome	East	99.35	New Delivery Pool Turnout
SID-S2	West	102.65	New Delivery Pool Turnout
TBID-Terra Bella	East	103.64	New Delivery Pool Turnout
SID-S3	West	104.96	New Delivery Pool Turnout
SID-S4	West	107.35	New Delivery Pool Turnout
DEID – 68 West	West	107.84	New Delivery Pool Turnout
DEID-56 EAST	East	109.46	New Delivery Pool Turnout (Shared)
DEID-56 West	West	109.46	New Delivery Pool Turnout (Shared)
DEID-40 North	East	111.56	New Delivery Pool Turnout (Shared)
DEID-40 West	West	111.56	New Delivery Pool Turnout (Shared)
KTWD-1	East	111.96	New Delivery Pool Turnout
KTWD-2	East	113.6	New Delivery Pool Turnout (Shared)
DEID-24 East	East	113.62	New Delivery Pool Turnout (Shared)
DEID-24 West	West	113.62	New Delivery Pool Turnout (Shared)
DEID-8th West	West	115.95	Raise Top Deck
DEID-#1 West	East	116.93	Raise Top Deck
SSJMUD-Bassett	West	117.44	Raise Top Deck
KTWD-3	East	117.96	Raise Top Deck
DEID-9th West	West	118.45	Raise Top Deck
SSJMUD-Airport	West	120.06	Unmodified

Gravity Turnout Modifications

There are 17 gravity systems located in the Middle Reach, each of which were individually analyzed to determine an appropriate design approach. The analysis revealed that all existing gravity turnouts can either be preserved and reused or connected to new turnouts and pipelines on the new canal realignment. A summary of actions for gravity turnouts under the Recommended Plan is provided in Table 6-2.

Table 6-2. Modifications at Gravity Turnouts Under the Recommended Plan

Gravity Turnout	Canal Side	MP	Modification
SPUD-STRATHMORE	West	89.35	Raise Top Deck
LID-10th E	East	91.12	Raise Top Deck
LTRID-4	West	92.13	Raise Top Deck
PID-P1	West	93.85	Raise Top Deck
PID-Porter Slough	West	94.92	Raise Top Deck
PID-P2	East	95.50	Raise Top Deck
LTRID-Woods Central Ditch	West	95.78	Raise Top Deck
PID-P3	East	96.39	New Gravity Turnout on Canal Realignment
LTRID-Tipton Ditch	West	96.87	New Gravity Turnout on Canal Realignment
LTRID-Poplar Ditch N&S	West & East	97.37	New Gravity Turnout on Canal Realignment
PID-P5	East	97.86	New Gravity Turnout on Canal Realignment
LTRID-Casa Blanca Ditch	West	98.62	New Gravity Turnout on Canal Realignment
SID-S1	West	100.64	New Gravity Turnout on Canal Realignment
TBID-DCTRA Pits	East	102.65	New Gravity Turnout on Canal Realignment
DEID	West	112.36	New Gravity Turnout on Canal Realignment
LWER	East	119.55	Unmodified
LWER	East	121.49	Unmodified

Checks and Siphons

The Recommended Plan project area includes five existing check structures located at 5th Avenue (MP 88.2), Tule River (MP 95.7), Deer Creek (MP 102.7), White River (MP 112.9), and Lake Woollomes (MP 121.5). Check Structures are essential to the operation of the FKC. These structures house radial gates that maintain the water level in the upstream canal segments to provide enough head to maintain submergence of turnouts. Table 6-3 provides a description of the existing check structures, and appurtenance facility, as well as the proposed modifications for each. The Recommended Plan would include new check structures at Deer Creek and White River. Additionally, there are 5 existing siphons, 3 in Segment 1 that will not require modification, and siphons at Deer Creek and White River that will require replacement.

Table 6-3. Modifications at Existing Check Structures Recommended Plan

Description	Gate Type	MP	Modification
Fifth Avenue Check	Radial Gates	88.22	No Modification
Tule River Wasteway	Radial Gates	95.64	No Modification
Tule River Check and Siphon	Radial Gates	95.66	No Modification
Deer Creek Wasteway	Radial Gates	102.69	Abandon Existing – Replace on New Realigned Canal
Deer Creek Check and Siphon	Radial Gates	102.69	Abandon Existing – Replace on New Realigned Canal
White River Wasteway	Radial Gates	112.9	Abandon Existing – Replace on New Realigned Canal
White River Check and Siphon	Radial Gates	112.9	Abandon Existing – Replace on New Realigned Canal
Lake Woollomes Check	Radial Gates	121.5	No Modification

Road Crossings

The Middle Reach of the FKC has approximately 45 existing bridge crossings, some of which will require replacement to accommodate the project. The majority of existing bridges are cast-in-place concrete type with a system of reinforced concrete "T" beams, or girders supporting a concrete roadway deck, and supported by a concrete pier wall in the center of the FKC and concrete abutments with monolithic wingwalls on either side of the canal. There are 2 proposed measures to accommodate all roadway crossings in the Middle Reach either leave in place or replace bridge with concrete box siphon.

The leave in place measure would generally consist of minimal to no modifications to the existing bridges. This is typically the case with existing bridges in the enlarged sections of the existing canal in Segments 1 and 4.

The concrete box siphon measure would be applied in the new realigned canal roadway crossings in Segments 2, 3, and part of 4. Along these segments County and State bridges would be removed and the crossings would be replaced with concrete box siphons. The concrete box siphons would generally consist of a buried cast-in-place concrete triple box siphon with each of the three boxes estimated to be 19 feet tall by 19 feet wide.

Canal lining transitions approximately 50 feet long would be provided at the siphon entrance and exit to transition from the trapezoidal open canal geometry to the square box geometry. The length of the siphons would vary by location but would range from 100 to 200 feet The concrete box siphons are designed to accommodate potential subsidence by considering future soil loading and extension of the concrete headwalls at the entrance and outlets. Figure 6-5 shows the concrete box siphon concept.

At each new siphon the adjacent existing bridge over the current FKC would be demolished and the abandoned portion of the FKC would be filled to road grade and the paved road surface reconstructed on earth fill. Table 6-4 provides a summary of the existing bridges and measures proposed for the roadway crossings in the Middle Reach.

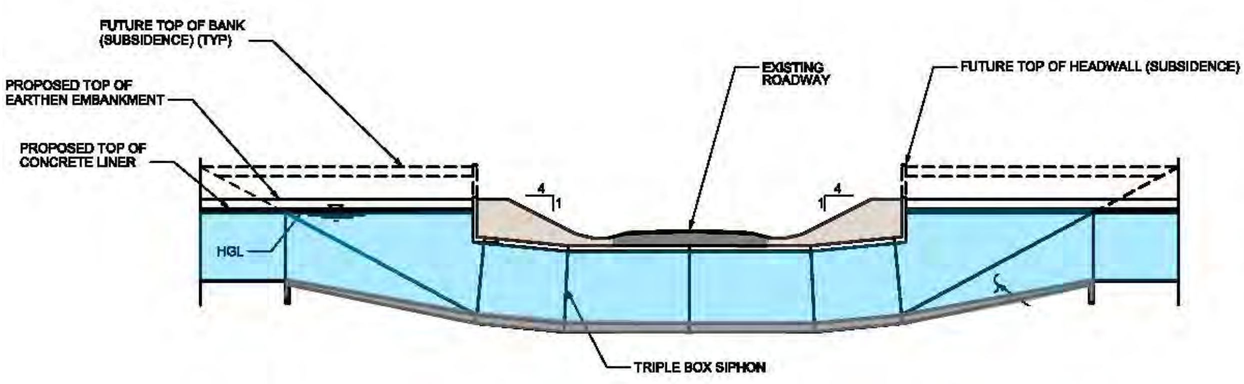

Figure 6-5. Typical Siphon Road Crossing

Table 6-4. Road Crossing Actions in the Recommended Plan

Name	MP	Modification
6th Avenue Bridge	88.67	No Modifications
7th Avenue Bridge	89.17	No Modifications
Road 232 Bridge	89.45	No Modifications
Frazier Highway/ Ave 196 Bridge	89.95	No Modifications
8th Avenue Bridge	89.95	No Modifications
Avenue 192 Bridge	90.23`	No Modifications
Avenue 188 Bridge	91.10	No Modifications
State Highway 65 Northbound Bridge (Double Bridge)	91.51	No Modifications
Welcome Avenue Bridge (Avenue 184)	91.60	No Modifications
Avenue 182 Bridge	91.85	No Modifications
Avenue 178 Bridge	92.35	No Modifications
W Linda Vista Avenue	92.85	No Modifications
W North Grand Avenue Bridge	93.55	No Modifications
N Westwood Street Bridge	94.01	No Modifications
W Henderson Avenue Bridge	95.12	No Modifications
Avenue 152 Bridge	96.26	Concrete Box Siphon

Table 6-4. Road Crossing Actions in the Recommended Plan (contd.)

Name	MP	Modification
Avenue 144 Bridge (Highway 190)	97.35	Concrete Box Siphon
Avenue 136 Bridge	98.35	Concrete Box Siphon
Avenue 128 Bridge	99.37	Concrete Box Siphon
Hesse Avenue Bridge	100.64	Concrete Box Siphon
Avenue 112 Bridge	101.64	Concrete Box Siphon
Timber Farm Bridge	102.14	None
Road Terra Bella Avenue (J24)	103.65	Concrete Box Siphon
Road 208 Bridge	103.72	Concrete Box Siphon
Avenue 88 Bridge	104.95	Concrete Box Siphon
Avenue 80 Bridge	106.72	Concrete Box Siphon
Farm Bridge	106.75	None
Road 192 Bridge	107.32	Concrete Box Siphon
Avenue 64 Bridge	108.42	None
Avenue 56 Bridge	109.45	Concrete Box Siphon
Avenue 48 Bridge	110.55	Concrete Box Siphon
Avenue 40 Bridge	111.55	Concrete Box Siphon (Shared)
Road 184 Bridge	111.66	Concrete Box Siphon (Shared)
Avenue 32 Bridge	112.57	Concrete Box Siphon
Avenue 24 Bridge	113.59	Concrete Box Siphon
Avenue 16 Bridge	114.71	Concrete Box Siphon
Avenue 8 Bridge	115.91	No Modifications
Timber Farm (Avenue 4) Bridge (2 Bridges)	116.41	No Modifications
County Road Avenue 0 Bridge	116.91	No Modifications
Cecil Avenue Bridge	117.92	No Modifications
9th Avenue Bridge	118.44	No Modifications
Garces Highway Bridge	118.94	No Modifications
Timber Farm Bridge	119.46	No Modifications
Woollomes Avenue Bridge	120.02	No Modifications

Utilities

Numerous utilities located in, along, and across the FKC would be affected by implementation of the Recommended Plan. The utilities include pipeline overcrossings, overhead power lines, adjacent wells, irrigation crossings under the existing canal, and utilities connected to bridges. Depending on the location and extent of canal modifications, the utilities will either be relocated or entirely replaced, as determined in the final design. Table 6-5 summarizes utility quantities that would require modification for the Recommended Plan. These quantities should be considered approximate until field locating confirms actual locations. Additional detailed information on utilities is provided in Appendix D.

Table 6-5. Preliminary Estimate of Modifications to Utilities for the Recommended Plan

Utility Modification	Quantity
Parallel Overhead Powerline Relocations	~1 mile
Overhead Electrical Crossing Modifications	20 crossings
Adjacent Groundwater Well Abandonments	10 wells
Drainage Culvert Conflicts	4 Conflicts
Pipeline Overcrossing Replacements	5 replacements
Pipeline Undercrossing Replacements	5 replacements
Utility Crossings at Bridges	20 crossings

Estimated Quantities and Cost

A list of items that will be included in the summary of quantities and costs is included in Table 6-6. A cost estimate is provided in Table 6-7.

Table 6-6. Recommended Plan Alternative Summary of Estimated Quantities

	-	**Seg 1: 5th Ave. to Tule**	**Seg 2: Tule to Deer Creek**	**Seg 3: Deer Creek to White River**	**Seg 4: White River to Ave. 8**	**Seg 4: Ave. 8 to Woollomes**	**-**
Design Flow (Design Maximum) (cfs)	-	4,500	4,000	4,000	3,500	3,500	-
From MP to MP	-	88.2-96.67	95.67-102.7	102.7-112.9	112.9-115.94	115.94-121.5	-
Total Canal Miles	-	7.47	7.0	10.2	3.04	5.56	-
Description	***Unit***	***Quantity***	***Quantity***	***Quantity***	***Quantity***	***Quantity***	***Total***
NEW CANAL							
Excavation	CY	125,000	1,813,350	2,558,850	330,750	75,000	**4,902,950**
Compacted Canal Embankment construction	CY	100,000	1,727,000	2,437,000	315,000	60,000	**4,639,000**
Concrete Lining	SY	4,200	396,905	632,657	184,000	2,800	**1,220,562**
Concrete for Structures	SY	-	19,976	30,682	6,501	-	**57,159**
Reinforcing Steel	lbs	-	3,822,812	5,945,669	117,035	-	**9,885,516**
Ladders	EA	105	99	144	46	-	**394**
Aggregate base O&M road surfacing	SY	104,221	98,653	105,011	47,000	77,067	**431,952**
CHECK STRUCTURES	**Unit**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Total**
New Check/Siphon Structure	-	-	1	1	-	-	**2**
Existing Check Structures Demolition and Disposal	-	-	1	1	-	-	**2**

Table 6-6. Recommended Plan Alternative Summary of Estimated Quantities (contd.)

		Seg 1: 5th Ave. to Tule	Seg 2: Tule to Deer Creek	Seg 3: Deer Creek to White River	Seg 4: White River to Ave. 8	Seg 4: Ave 8 to Woollomes	
ROAD CROSSINGS – BRIDGES	**Unit**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Total**
Bridge Replacement on Existing Canal – County or State Bridges	EA	-	-	-	-	-	-
Bridge Replacement on Existing Canal – Farm Bridges	EA	-	-	-	-	-	-
Existing Bridge Demolition	EA	-	7	12	2	-	21
ROAD CROSSINGS – SIPHONS	**Unit**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Total**
Siphon Construction on New Canal	EA	-	6	11	-	-	17
TURNOUTS	**Unit**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Total**
Raise/Modify Existing Turnout Top Deck and Actuators	EA	7	1	-	-	5	13
Turnouts on New Canal	EA	-	9	8	1	-	18
Delivery Pools	EA	-	2	7	1	-	10
UTILITIES	**Unit**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Total**
Parallel Overhead Powerline Relocations	Feet	-	800	4,400	-	-	5,200
Overhead Electrical Lines	EA	-	7	11	1	-	20
Adjacent Groundwater Well Abandonments	EA	-	4	6	-	-	10
Culvert Extensions (Each End)	EA	-	2	2	0	-	4
Pipeline Overcrossing Replacements (8" to 12")	EA	-	1	2	2	-	5
Impacted Utility Crossings (Attached to Existing Bridge sizes range from 4" to 24")	EA	-	5	11	4	-	20
LAND ACQUISITION	**Unit**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Quantity**	**Total**
Impacted Parcels	EA	69	17	25	20	8	139
Permanent Land Acquisition (ROW)	Acre	-	138	230	62	-	430

Key:
- = Not Applicable or zero
cfs = cubic feet per second
CY = cubic yard
EA = each
Lbs = pounds
LF = linear feet
LS = lump sum
MI = mile
MP = milepost
O&M = operations and maintenance
ROW = Right of Way
SY = square yard

Table 6-7. Recommended Plan Alternative Cost Estimate

Item	Reference	Cost	Notes/ Inclusions
Segment 1 - 5th Ave to Tule	from estimate	$7,434,215	
Segment 2 - Tule to Deer Creek (New Bypass Canal)	from estimate	$71,146,020	
Segment 3 - Deer Creek to White River (New Bypass Canal)	from estimate	$106,108,628	
Segment 4a - White River to Garces Hwy (New Bypass Canal)	from estimate	$18,320,084	
Segment 4b - Garces Hwy to Woollomes (Widen Existing Canal)	from estimate	$4,027,327	
Construction Allowances, Mobilization, Startup, Commission, and Owner Training	from estimate	$6,315,222	
Subtotal		$213,351,496	
Contract Cost Allowance - Design Contingency	17%	$36,239,754	
Contract Cost		**$250,000,000**	Rounded
Construction Contingencies	20%	$50,000,000	
FIELD COST		**$300,000,000**	Rounded
Land Purchase - Construction Phase and ROW		$20,000,000	Based on market research
Environmental Mitigation	5%	$29,000,000	From separate estimate
Engineering, Permitting, and Construction Management	20%	$60,000,000	Calculated as % of Field Cost
Legal and Administrative	2%	$6,800,000	Calculated as % of Field Cost
Non-Contract Costs		**$115,000,000**	Rounded
TOTAL CONSTRUCTION COST		**$415,000,000**	Rounded
Interest During Construction	3% Discount Rate	$25,562,071	4 year construction period
TOTAL CAPITAL COST		**$440,000,000**	Rounded
Annualized Capital Costs		$16,697,158	2.875% (FY19) over 50 years
Additional Annualized O&M Costs		$967,676	Excludes current O&M costs; 2.875% (FY19) over 50 years
TOTAL ANNUALIZED COST		**$17,500,000**	Rounded

Feasibility Determination for the Recommended Plan

A determination of feasibility is based on a review of four tests of feasibility: technical, environmental, economic and financial.

Technical Feasibility

Technical feasibility consists of engineering, operations, and constructability analyses verifying that it would be physically and technically possible to construct, operate, and maintain the Recommended Plan. The Recommended Plan is technically feasible, and includes features to address constructability and long-term operations, as demonstrated above. A Design, Engineering, and Cost (DEC) review will be performed on the Recommended Plan described in this chapter and Appendix D to identify additional information that is required to determine technical feasibility.

Environmental Feasibility

Environmental feasibility consists of analyses verifying that constructing or operating the project would not result in unacceptable environmental consequences or require costs that would adversely affect economic feasibility. Generally, environmental feasibility is based on the completion of NEPA compliance and environmental permitting processes. These processes are underway and are expected to be completed during 2020.

To date, several evaluations have been completed to inform environmental feasibility of the Project. An environmental constraints analysis was performed and applied to the evaluation of Initial Alternatives and selection of Feasibility Alternatives. An Environmental Assessment (EA)/Initial Study (IS) was prepared to evaluate potential environmental effects associated with the Canal Enlargement and Parallel Canal Feasibility Alternatives. The EA/IS identified the following resource areas may that have potentially significant impacts resulting from construction of the Feasibility Alternatives: agriculture/land use, air quality/Green House Gases, biological, cultural and tribal, hydrology, and water quality. Reclamation has determined that a joint Environmental Impact Statement/Environmental Impact Report (EIS/R) will be prepared because the Project could result in significant impacts, is a major undertaking and private land acquisition will be required.

Three cultural resources reports have been completed to support Section 106 compliance for geotechnical investigations of the Project. To date, the findings of two of these reports have been concurred on and the third is currently under review by the California Office of Historic Preservation. Additionally, a Section 106 technical memorandum was prepared in support of immediate repair activities from MP 103 to MP 107 and those findings have also been concurred on by the California Office of Historic Preservation.

Work is progressing on preparation of Section 106 reporting for the complete Project. Reclamation has established an Area of Potential Effect (APE) that accounts for potential direct and indirect effects of the Recommended Plan. Pedestrian surveys have been completed for all property within the Reclamation ROW, publicly accessible direct and direct APE have been completed, and a records search with a 1-mile search area of the entire project area from Mile Post 88 to 121 has been completed. The effects analysis is underway, the Section 106 report is in preparation, and a historic property treatment plan is in the early stages of development.

For biological resources, two Section 7 consultations have been completed for geotechnical investigations of the Project. The schedule for the Section 7 compliance consultation with the US Fish and Wildlife Services for the complete Project has been set. An aquatic resources delineation report for the Project is in preparation, and habitat characterization and assessment of potential biological in the Project area is in progress.

Environmental Mitigation Cost Estimates

The Feasibility Alternatives cost estimates presented in Chapter 5 included an allowance for environmental mitigation (which includes cultural resources mitigation) at 5 percent of the field cost. More detailed environmental mitigation cost estimates have been developed and incorporated into the cost estimate for the Recommended Plan.

The design and environmental analyses conducted to date for the project indicate that cost elements associated with environmental mitigation can be grouped into three main categories: 1) biological mitigation, 2) cultural mitigation, and 3) air quality mitigation. It is recognized that potential impacts of other project elements not yet defined, such as borrow pits, construction staging areas, and installation of construction access roads, could result in additional mitigation requirements. Details for each of these three main categories are summarized below.

- Biological Mitigation; general preconstruction surveys, San Joaquin Kit Fox pre-construction surveys, worker environmental awareness training (WEAT), environmental compliance monitoring during construction, fish salvage during canal tie-ins, and compensatory mitigation for San Joaquin Kit Fox.

- Cultural Mitigation; data recordation and mitigation for above-ground bridges and the FKC, WEAT, Construction monitoring for archeological and paleontological resources, and tribal monitoring in the vicinity of Deer Creek and White River.

- Air Quality Mitigation; preparation of a fugitive dust plan, and Voluntary Emission Reduction Agreement (VERA) with the San Joaquin Valley Air Pollution Control District.

Table 6-8 provides a budget estimate for each of the cost elements listed above, grouped into the three main categories. The following assumptions were used in developing these cost estimates:

- Construction monitoring for cultural resources, tribal resources, San Joaquin Kit Fox, and other biological resources for 3 years

- San Joaquin Kit Fox compensatory mitigation approach similar to the California High Speed Rail Project. Mitigation ratios of 2.0 to 1 for natural habitat; .and 0.1 to 1 for developed habitat.
- San Joaquin Kit Fox compensatory mitigation cost $15,000 per acre
- VERA approach similar to Reclamation's 2017 Reach 2B Mendota Pool Bypass Project

Table 6-8 Estimated Environmental Mitigation Cost

Item	Cost Estimate
Biological Mitigation	
General Pre-construction surveys	$133,000
San Joaquin Kit Fox pre-construction surveys	$1,464,000
WEAT	$20,000
During-construction compliance monitoring	$3,337,000
Fish Salvage	$279,000
Compensatory San Joaquin Kit Fox mitigation	$13,895,000
Subtotal, Biological Mitigation	**$19,128,000**
Cultural Mitigation	
Data recordation and mitigation for above-ground bridges and the FKC,	$150,000
WEAT	$20,000
Construction monitoring for archeological and paleontological resources	$2,246,000
Tribal monitoring in the vicinity of Deer Creek and White River	$1,123,000
Subtotal, Cultural Mitigation	**$3,539,000**
Air Quality Mitigation	
Fugitive dust plan	$100,000
VERA	$6,000,000
Subtotal, Air Quality Mitigation	**$6,100,000**
Total Estimated Mitigation Cost	**$28,767,000**

Economic Feasibility

As discussed in Chapter 5 the monetary benefits of the Feasibility Alternatives were determined using a 100-year planning horizon, that anticipates the regional subsidence will continue to cause a decrease in capacity of the FKC. The benefits of the Feasibility Alternatives presented in Chapter 5 are based on the differences in the delivery reduction in comparison to the No Action Alternative. The Recommended Plan is a design refinement of the Parallel Canal Feasibility Alternative that resulted in lower costs without reducing the estimated benefits. Table 6-9 shows the planning horizon analysis for the Recommended Plan. Computations are made for each year in the planning horizon. For ease of presentation, the tables report annual results for years 1 through 10 and then every decade following until year 100, the end of the planning horizon. The table provides the net present value of reduced water supply over the planning horizon.

A summary of benefits associated with water deliveries and costs of the Recommended Plan is provided in Table 6-10. As shown in Table 6-9, the calculated B-C ratio for the Recommended Plan is 2.0.

Table 6-9. Recommended Plan Horizon Analysis

Year	Average Annual Deliveries (TAF)	Average Annual No Action Affected Water Supply (TAF)	Reschedule in Millerton (TAF)	Percent Groundwater Pumping (%)	Assumed Groundwater Pumping (TAF)	Average Annual Reduction in Supply (TAF)	Value of Water Lost ($M)	Groundwater Pumping Cost ($M)	Annual Value of Water ($M)
1	410.2	41.3	15.6	90%	23.2	2.6	$271	$221	$5.8
2	408.2	46.1	17.3	80%	23.0	5.8	$271	$224	$6.7
3	406.2	50.9	19.0	70%	22.3	9.5	$271	$226	$7.6
4	404.2	55.6	20.8	60%	20.9	13.9	$271	$229	$8.6
5	402.2	0.0	0.0	50%	0.0	0.0	$271	$229	$0.0
6	400.2	0.0	0.0	40%	0.0	0.0	$271	$229	$0.0
7	398.2	0.0	0.0	30%	0.0	0.0	$271	$229	$0.0
8	396.2	0.0	0.0	20%	0.0	0.0	$271	$229	$0.0
9	394.2	0.0	0.0	10%	0.0	0.0	$271	$229	$0.0
10	392.2	0.0	0.0	0%	0.0	0.0	$271	$229	$0.0
20	392.2	0.0	0.0	0%	0.0	0.0	$271	$229	$0.0
30	392.2	0.0	0.0	0%	0.0	0.0	$271	$229	$0.0
40	392.2	0.0	0.0	0%	0.0	0.0	$271	$229	$0.0
50	392.2	0.0	0.0	0%	0.0	0.0	$271	$229	$0.0
60	392.2	0.0	0.0	0%	0.0	0.0	$271	$229	$0.0
70	392.2	0.0	0.0	0%	0.0	0.0	$271	$229	$0.0
80	392.2	0.0	0.0	0%	0.0	0.0	$271	$229	$0.0
90	392.2	0.0	0.0	0%	0.0	0.0	$271	$229	$0.0
100	392.2	0.0	0.0	0%	0.0	0.0	$271	$229	$0.0
								Net Present Value	$28

Table 6-10. Benefit Cost Analysis of Recommended Plan

Item	Recommended Plan
Value of reduced water delivery in the No Action Alternative[1,2]	$923
Value of reduce water delivery in the Project Alternative[1,2]	$28
Net Benefit[1,2]	$895
Net Present Value of Total Capital and Life Cycle Costs [1,3]	$451
Cost Range of Net Present Value of Total Capital [1,4]	($375 - $527)
B-C Ratio[5]	2.0

Notes:
[1] All costs are in millions of dollars
[2] Net Present Value based on 100-year project life
[3] Construction Cost of Initial Alternatives
[4] +/- 25% applied to field cost
[5] B-C Ratio based on Net Present Value of Total Capital and Life Cycle Costs (Total Construction Cost + IDC + OM&R)

Financial Feasibility

Financial feasibility consists of examining and evaluating project beneficiaries' ability to pay their allocated portion of the Recommended Plan, consistent with applicable law. Funding for the Project is expected to be derived from Federal and non-Federal sources. On the basis of WIIN Act authorizations, the Project is eligible for Federal funding of up to 50 percent of Project costs. FWA has been pursuing and evaluating multiple sources of funding to provide the non-Federal cost share, including potential funding from the State of California and financing through the FWA or member agencies. A summary of Federal and non-Federal funding under the SJRRS Act and the WIIN Act is shown in Table 6-11.

Table 6-11. Eligible Project Funding

Authorization	Federal Funds	Non-Federal Funds	Total
SJRSS Act	$18,900,000	$0	$18,900,000
WIIN Act	$198,050,000	$198,050000	$396,100,000
Total	$216,950,000	$198,050000	$415,000,000

Risk and Uncertainty

As described above, the Recommended Plan is economically feasible. However, as also described above and in Chapter 5, several assumptions have been made that can affect estimated project benefits and the resulting B-C ratio. In the economic analysis of the Recommended Plan, most assumptions regarding uncertainty were made that would result in conservative (i.e. lower benefit) estimates. This section describes how uncertainty regarding assumptions could affect estimated project benefits and the B-C ratios of the Recommended Plan. The evaluations presented below provide a reasonable range of expected outcomes under uncertainty.

Future Water Value

The economic analysis of the Recommended Plan is based on the estimated current value of agricultural water in the eastern San Joaquin Valley (representative of the Friant Division of the CVP). These values were developed by the CWC in 2015 through application of the State-Wide Agricultural Production (SWAP) model based on CALSIM II simulations of CVP and SWP operations that reflect water rights, contracts, and regulatory requirements, and the continued unrestricted availability of groundwater. The CWC classified the values of water estimated under projected 2030 land-use conditions as current values. The economic analyses of the Recommend Plan applied the 2030 (current) water values on a constant basis throughout the 100-year planning horizon. This analysis assumes that water values would not increase in response to reduced water supply availability due to SJRRS and SGMA implementation, changes in commodity values, changes in irrigation technology, or other factors.

The value of surface water in the eastern San Joaquin Valley has increased over the past several years as the percentage of land planted to permanent crops has increased, irrigation technology improvements have been implemented, more land has been brought into production, surface water supply reliability in the San Joaquin Valley have decreased, the reliance on groundwater has grown, and groundwater depth has increased. As described in Chapter 1, the State of California enacted SGMA in 2014, which requires the development and implementation of sustainable groundwater management practices. SGMA mandates that GSPs be developed by 2020 and groundwater sustainability be achieved by 2040 for “high priority basins”. The entire Friant Division of the CVP overlies groundwater basins that are designated as “high priority basins”, therefore it is expected that full SGMA compliance in the eastern San Joaquin Valley will be achieved by 2040. It is expected that water values in the eastern San Joaquin Valley will change over time in response to changes in water supply availability, particularly in response to SGMA implementation, because groundwater use will be limited to amounts that do not cause undesirable effects such as additional subsidence.

In 2015, the CWC also prepared estimates of future agricultural water value in California based on the same land uses, water rights, contracts and regulatory requirements as those included in the 2030 analysis, plus assumed groundwater availability limitations due to SGMA implementation. The resulting values are significantly greater than those based on 2030 conditions. While it is not certain that actual water values will result as projected, these estimates provide an indication of the potential future value of agricultural water supply in the eastern San Joaquin Valley once SGMA compliance is achieved. A comparison of 2030 (non-SGMA) and 2040 (with SGMA) values is provided in Table 6-12. For the economic analysis of the Recommend Plan, the 2030 values provided by the CWC in 2015 were escalated to a 2018 price level using once the U.S. Bureau of Economic Analysis GDP Deflator. The same escalation was applied to the 2040 values for use in this uncertainty analysis.

Table 6-12. Estimated Water Values in the Eastern San Joaquin Valley

Year	Estimated Consumptive Use Water Value ($/AF)	
	2015 Price Level	2018 Price Level
2030	$256	$271
2040	$511	$540

Source: CWC WSIP Technical Reference Document

If the value of agricultural water in the eastern San Joaquin Valley increases from the current value of $271/af to $540/af by the year 2040 in the planning horizon analysis and then remained constant at that value for the remaining of the planning horizon with all other variables unchanged, the net benefits of the Recommended Plan would increase by $808M and the B-C ratio would increase to 3.8.

Date Future Subsidence Stops

The economic analysis of the No Action Alternative and Recommended Plan is based on a projection of continued subsidence in response to gradually reduced groundwater pumping between 2018 and 2040 to levels that achieve SGMA requirements. The groundwater model simulations, which were based on a range of pumping reductions to achieve SGMA compliance by 2040, show that subsidence would continue at a generally consistent rate through 2030, then slow between 2030 and 2040 when actions to achieve SGMA requirements would be fully implemented. Groundwater model results also reveal that additional land subsidence would continue through 2070 as a result of residual consolidation of subsurface formations. As noted previously, GSAs in the region are in the process of developing their SGMA compliance plans and therefore is not precisely known how regional subsidence would occur.

If land subsidence occurs as projected from 2018 to 2040 and no additional subsidence occurs after 2040 and all other variables remain unchanged, the net benefits of the Recommended Plan would decrease by $104M and the B-C ratio would decrease to 1.8.

Design for Projected Future Subsidence

All analysis of the Recommended Plan is based on a 2018 topography and assumes the project will be built to the design capacity based on that ground surface. The analysis also included an evaluation of costs and required land acquisition of the Recommended Plan based on providing the design capacity at projected land conditions in the year 2040, based on land subsidence estimates developed using the groundwater analysis described above. The total increase in costs to accommodate future subsidence in the Recommended Plan is estimated at an additional $48M.

If the Recommended Plan includes features to provide the design capacity at the projected future land surface in 2040 and all other variables remain unchanged, the net benefits of the Recommended Plan would remain unchanged and, due to the increase in total construction cost, the B-C ratio would decrease to 1.8.

Millerton Reoperation

The economic analysis of the Recommended Plan assumes that affected water supplies could be rescheduled in Millerton Lake to subsequent months when the Friant Division contractor has sufficient water demand and capacity is available in the FKC. The only constraint applied to this operational assumption in the Recommended Plan was that the reoperation of affected water supply in Millerton Lake could not affect existing flood control requirements and operations. The analysis did not consider potential limitations to storing Class 2 water in Millerton Lake longer than the contractual maximum of 30 days. The analysis also assumes that water users could increase the use of non-CVP water supplies when canal capacity limits deliveries and would have perfect foresight of hydrologic conditions to predict when such changes would be required. Due to these assumptions, the analysis likely overestimates the amount of affected water supply that could be rescheduled, and therefore likely underestimates the water supply impact of the No Action Alternative. While it is not possible to precisely estimate the extent to which water users and Reclamation could optimize the use of Millerton Lake and the FKC to reschedule allocated water supplies, it is expected that no more than 70 percent of the affected water supply could be available for rescheduling in Millerton Lake and delivery in any given month.

If the amount of affected water supply that available be rescheduled in Millerton Lake is limited to 70 percent and all other variables remain unchanged, the net benefits of the Recommended Plan would increase by $121M and the B-C ratio would increase to 2.3.

Construction Duration Due to Funding Availability

The economic analysis of the Recommended Plan assumes a construction duration of four years, and the availability of funding to enable uninterrupted construction of all plan features. In the economic analysis, this assumption is reflected in the planning horizon analysis in the benefits provided by the project in the first three years and costs associated with construction and IDC. If the availability of funds is delayed, the rate of construction would be reduced, and the duration of construction would increase.

If availability of funding to implement the Recommended Plan required that the construction duration increase from three years to six years all other variables remain unchanged, the net benefits of the Recommended Plan would decrease by $19M and the B-C ratio would decrease to 1.95.

Reduced Deliveries in the Subsidence Section of the Canal

As described in Chapter 2, the reduced capacity of the FKC caused by subsidence limits flows can be conveyed for downstream deliveries, resulting in reduced water supplies to downstream Friant Division long-term contractors. The benefits of the Recommended Plan are based on avoiding reduced downstream deliveries that would occur in the No Action Alternative. In addition, subsidence in the Middle Reach of the FKC has decreased, and will further decrease, available head (water level) at water turnouts in the subsided reach and in some upstream portions of the FKC. The water diversion capacity of up to 6 gravity turnouts downstream from

Tule River Check Structure and the upstream from Deer Creek Check Structure is reduced and will further decline in the No Action Alternative as subsidence continues. It is likely that modifications would be required to some or all of these gravity turnouts to maintain continued delivery of allocated CVP contract supplies. While specific improvements have not been evaluated, or valued, it is expected that temporary permanent, pumps would be installed to assure access to contract water supplies. The timing of pump installation and use in the No Action Alternative would depend on site specific conditions for each contractor and CVP water supply availability. The Recommended Plan will return the HGL to restore the ability of these turnouts to deliver water at their designed capacity. If the reduced deliveries immediately upstream of the subsided section of the canal were valued, the quantified benefits of the Recommended Plan would be greater than those presented in this Report.

Summary of Risk and Uncertainty Findings

A summary of risk and uncertainty factors on project costs and benefits is provided in Table 6.13. Although the identified risk and uncertainty factors have the potential to increase or decrease project costs and benefits, none have been identified that could be expected to reduce the benefit cost ratio to less than one.

Table 6.13. Summary of Risk and Uncertainty Effect on Economic Feasibility of the Recommended Plan

Risk and Uncertainty Factor	Change in Net Benefits from Recommended Plan ($M)	Benefit-Cost Ratio Based on Risk and Uncertainty Factor
Recommended Plan	No change	2.0
Potentially Greater Future Water Value	808	3.8
Potential Less Future Subsidence	-104	1.8
Project Design for Projected Future Subsidence	No change	1.8
Ability to Operate Affected Water Supply in Millerton Lake	121	2.3
Potential Extended Construction Duration Due to Funding Availability	-19	2.0
Reduced Water Deliveries in the Subsided Portion of the FKC	Increase – not quantified	Increase – not quantified

Implementation Requirements

Implementation of the Recommended Plan would include major activities for design, environmental compliance and permitting, land acquisition, financing, and construction and O&M. It is anticipated that FWA would to lead all of these activities in close coordination with Reclamation. A schedule for implementation is shown in Figure 6-6, and brief descriptions of major activities is provided in the following sections.

Design Activities

FWA, in coordination with Reclamation, has begun to advance design of the Recommended Plan. This will include several the following key steps:

- DEC Review of the Recommended Plan
- Preparation of a 30 percent design report
- Geotechnical investigations to support final design
- Preparation of 60 percent, 90 percent, and 100 percent designs
- Establishing agreements with key project partners and stakeholders (e.g. Tulare County, SCE, So Cal Gas, Kern County) related to planning design, and construction activities.
- Preparing detailed plans, specifications, and bid packages.

Environmental Compliance and Permitting

Reclamation is initiating environmental compliance and permitting activities, in coordination with the FWA, to conduct and complete required NEPA and CEQA environmental compliance and all necessary permitting before implementation of the Project. Several key activities include the following:

- Required environmental compliance under NEPA and CEQA will involve preparation of a joint EIS/EIR document and issuance of a Record of Decision (ROD) and Notice of Determination (NOD), on the following schedule:
    - Notice of Intent/Notice of Preparation (NOI/NOP) - November, 2019
    - The Draft EIS/EIR release for public review - late January/early February, 2020
    - The Final EIS/EIR released to public - May, 2020
    - The Record of Decision (ROD) - October 2020

- Permitting requirements of Federal, state, and local laws, policies and environmental regulations.
- Implementation of mitigation measures may proceed before, or consistent with construction of project physical features.

Land Acquisition

Following completion of NEPA and CEQA compliance requirements, FWA would initiate activities in coordination with Reclamation to complete the acquisition of required lands, easements, and ROW.

Financing

Funding for the project would be obtained through Federal appropriations and non-Federal sources prior to the initiation of construction. If all project funds are not available at the time of construction initiation, the Project would be segmented into construction packages that could be accomplished with available funding to address the most urgent capacity correction portions of the Project.

Project Construction and Transfer to O&M Status

After the completion of environmental compliance and permitting, design, land acquisition, and financing, project implementation efforts would transition to the preparing and executing construction contracts, starting implementation of mitigation measures and/or construction activities, completing construction activities, commissioning new facilities, and finally, operating and maintenance responsibilities. FWA, in coordination with Reclamation, would solicit and award one or more construction contracts based that can be accomplished with available funds and right of way. As shown in Figure 6-6, construction is estimated to occur over a 3-year period, assuming all necessary funding and right of way is available.

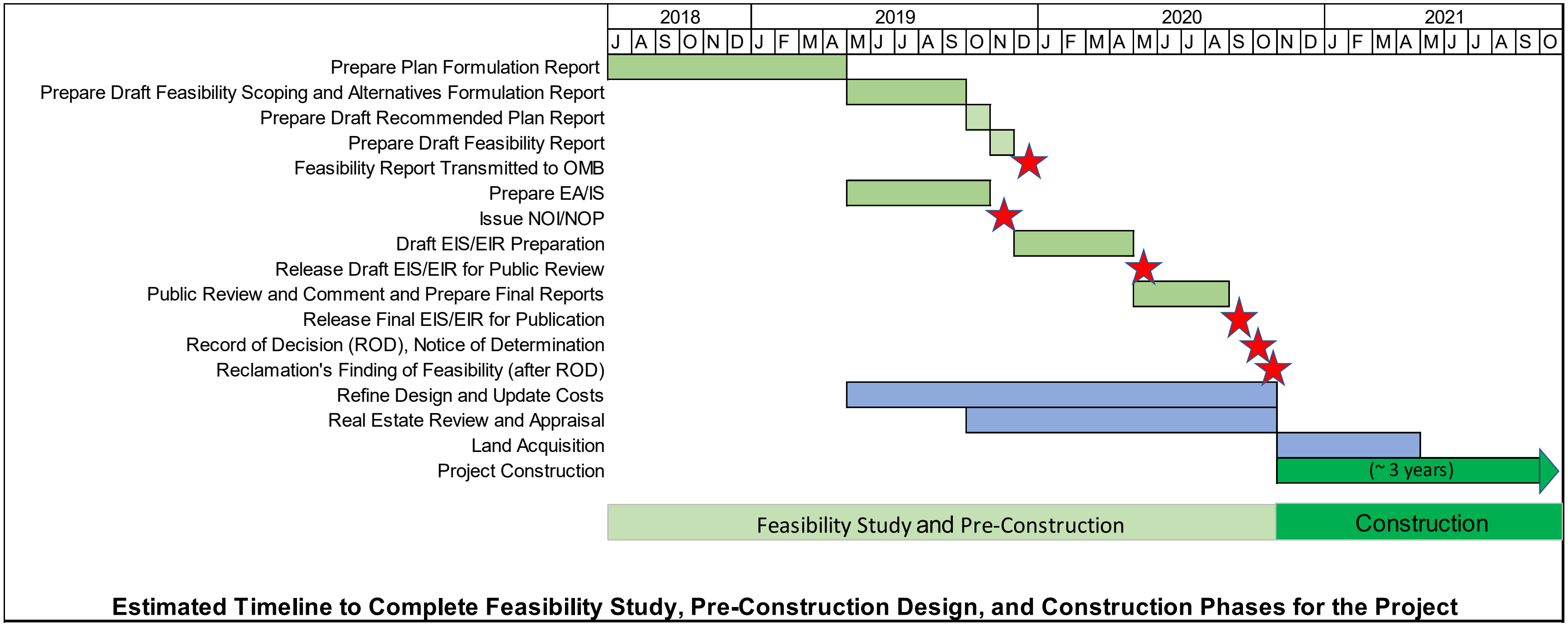

Figure 6-6. Friant-Kern Canal Middle Reach Capacity Correction Project Feasibility Study

Federal and Non-Federal Responsibilities

If a project is recommended for implementation, Federal and non-Federal obligations and requirements would be contained in a Project Cooperation Agreement (PCA).

Federal Responsibilities

If recommended for implementation, Reclamation would complete the required environmental analyses and documentation for NEPA. This includes other Federal laws, policies, and plans that may affect the implementation of any plan authorized for construction (e.g. Federal Endangered Species Act, National Historic Preservation Act Section 106). Reclamation would review and approve project designs, approve bid packages, approve the plan for Real Estate Acquisition, Administer Federal Funding, and monitor construction progress and closeout.

Non-Federal Responsibilities

Before implementation the FWA would perform items of local and state cooperation specific to the project. This would include the completion of environmental documentation for CEQA and acquiring relevant local and state permits. The FWA would also lead the completion of design of the project, acquire ROW, and obtain necessary non-Federal funding. In additional FWA would award construction contract(s), manage the construction of the project. Once completed FWA will continue with long-term O&M requirements as agreed upon with Reclamation.

Chapter 7 Findings

This Study includes development, evaluation, and comparison of alternatives consistent with the Federal PR&G (CEQ 2013). In coordination with this report, a Final EIS/R will be prepared consistent with NEPA and CEQA. This chapter summarizes major findings and conclusions of this Study.

Need for Project

The reduced capacity of FKC Middle Reach has resulted in water delivery impacts on Friant Division long-term contractors, reduced ability of the FKC to convey flood waters during wet periods, and reduced ability to implement provisions of the Water Management Goal as described in Paragraph 16 of the San Joaquin River Restoration Settlement (Settlement). The reduced delivery of water via the Friant-Kern Canal under long-term Friant Division contracts, the Recovered Water Account (RWA), and Unreleased Restoration Flows (URFs) also reduces funding necessary to implement the Restoration Goal provisions of the Settlement as described in Paragraph 11.

The purpose of the Project is to restore the conveyance capacity of the FKC Middle Reach to such capacity as previously designed and constructed by Reclamation, as provided for in the San Joaquin River Restoration Settlement Act (Public Law 111-11, Title X, Part III(a)(1)). The purpose of this Study is to describe the formulation, evaluation, and comparison of alternatives that address Project planning objectives and identify a Recommended Plan consistent with Federal authorizations and requirements. Information developed through the Study will be used in preparation of required environmental compliance documentation.

Recommended Plan

As required by the PR&G, the plan that produces the greatest net public benefit is identified as the Recommended Plan and is typically selected for recommendation to the Secretary of the Interior for consideration and approval (CEQ 2013). The identification of the Recommended Plan based upon the evaluation and comparisons described in Chapter 5. The Recommended Plan is described in detail in Chapter 6 and summarized below.

Recommended Plan Major Components

Major components of the Recommended Plan include:

- **Canal Enlargement** — The existing canal would be enlarged by raising the lining one to four feet from MP 88.2 to MP 95.7 and MP 119.0 to MP 121.5.
- **Canal Realignment** — A new realigned canal would be the exclusive water conveyance and delivery mechanism and most of the existing FKC would be demolished, filled in, and taken out of service. The realignment would stretch from MP 96.3 to MP 115.94.
- **Turnouts** — The approach to the turnouts varies by location and configuration. Turnouts in the canal enlargement portion would not be modified. In the canal realignment portion gravity turnouts would be replaced and new delivery pool turnouts would be constructed for pressurized turnouts along the canal realignment potion.
- **Checks and Siphons** — New or replacement check structures, wasteways and siphons would be required at the Deer Creek and White River crossings
- **Road Crossings** — Road crossings would either be left in place or replaced with a concrete box siphon, depending on the location.
- **Utilities** — Depending on the location and extent of canal modifications, the utilities like overhead power lines, adjacent wells, and elevated pipeline canal crossings would either be relocated or entirely replaced.

Costs and benefits

A summary of the B-C analysis is presented in Table 7-1 below.

Table 7-1. Benefit Cost Analysis of Recommended Plan

Item	Recommended Plan
Value of reduced water delivery in the No Action Alternative[1,2]	$923
Value of reduce water delivery in the Project Alternative[1,2]	$28
Net Benefit[1,2]	$895
Net Present Value of Total Capital and Life Cycle Costs [1,3]	$451
Cost Range of Net Present Value of Total Capital [1,4]	($375 - $527)
B-C Ratio[5]	2.0

Notes:
[1] All costs are in millions of dollars
[2] Net Present Value based on 100-year project life
[3] Construction Cost of Initial Alternatives
[4] +/- 25% applied to field cost
[5] B-C Ratio based on Net Present Value of Total Capital and Life Cycle Costs (Total Construction Cost + IDC + OM&R)

Feasibility of the Recommended Plan

Feasibility of the Recommended Plan is summarized below.

- The Recommended Plan was found to be technically feasible and constructible. The Recommended Plan could be implemented with a balance or surplus of material. Designs and cost estimates for the Recommended Plan have been developed to a feasibility-level and will be verified through the DEC Review process.

- The Recommended Plan was found to be economically feasible on the basis that monetized benefits for avoided water supply shortages exceed project costs. As evaluated in this report, Recommended Plan produces a B-C ratio of 2.0.

  - The B-C ratio was calculated using a planning horizon benefits analysis over the project service life of 100 years, and feasibility-level construction costs, IDC, and, life cycle costs.

  - Regional subsidence is expected to continue and cause a decrease in the capacity of the FKC in the No Action Alternative and the performance of the Recommended Plan. Benefits of the Recommended Plan are based on differences in delivery reduction value, or avoided water shortages, in comparison to the No Action Alternative.

- Environmental compliance and permitting processes are under way. An environmental constraints analysis and EA/IS were prepared and an EIS/R is in development. Cultural and biological resources analysis are ongoing and will be incorporated into the EIS/R. The Record of Decision for the EIS/R is anticipated for October 2020.

- More detailed environmental mitigation cost estimates for biological mitigation, cultural mitigation, and air quality mitigation have been developed and incorporated into the cost estimate for the Recommended Plan.

- Funding for the Project is expected to be derived from Federal and non-Federal sources, potentially including the WIIN Act and financing through FWA member agencies.

Risks and Uncertainty

- The design of features in the Recommended Plan is based on the surveyed land surface in 2018. Because additional subsidence is expected to occur in the region over the next several years while compliance with SGMA is achieved, the design for Recommended Plan was evaluated based on a projected land surface in 2040. The resulting design based on 2040 land surface would increase the cost of the Recommended Plan by approximately $48 million and reduce the B-C ratio to 1.8.

- The effect of uncertainty on net benefits and the B-C ratio resulting from several factors, such as future water value, the date subsidence would stop, reoperation of affected water deliveries in Millerton Lake, and lengthened construction duration was evaluated. The resulting B-C ratios would range from 1.95 to 3.8.

- The performance of the Recommended Plan was evaluated using historical operations and does not consider potential future water deliver requirements that could exceed historical peak flows in the FKC. The net benefits and B-C ratio of the Recommend Plan would increase if future operational objectives include deliveries that exceed historical peak flows.

Federal Interest

This Report demonstrates Federal interest in the Recommended Plan. The Recommended Plan was identified as the NED Plan among two Feasibility Alternatives and produces a B-C ratio of 2.0. Federal participation for design and construction is authorized in Part III of the Settlement Act, and the Project is eligible for Federal funding pursuant to the WIIN Act.

Environmental Compliance and Regulatory Requirements for Project Implementation

The Final EIS/R will satisfy NEPA and CEQA requirements by providing a meaningful analysis of all issues relevant to the physical, biological, cultural and human environments. Implementation of the Recommended Plan will also be subject to additional Federal, State, and local laws, policies, and environmental regulations. All Federal, State, and local agencies with permitting or approval authority over any aspect of project implementation will be expected to use the information that will be included in the Final EIS to meet most, if not all, of their information needs, to make decisions, and/or issue permits with respect to the authorized project.

Findings

The following findings are made based on the evaluation of Feasibility Alternatives:

- The Recommended Plan has been found to be technically and economically feasible, and appears to be environmental feasible based on evaluations completed to date in support of NEPA compliance and permitting. Financial feasibility will be determined as Federal and non-Federal financing is identified.

- Uncertainty evaluations have demonstrated that the B-C ratio would remain greater than one under a variety of potential conditions that could affect costs and benefits of the Recommended Plan.

- Implementation of the Recommended Plan would restore the ability of the FKC to convey flood waters during wet periods and implement provisions of the Water

Management Goal as described in Paragraph 16 of the San Joaquin River Restoration Settlement. The restored capacity of the FKC would avoid water shortages, and resulting reduced revenue, associated with delivery of water under long-term Friant Division contracts, the Recovered Water Account (RWA), Unreleased Restoration Flows (URFs) and other available water supplies.

- Restoring the capacity of the FKC would support greater conjunctive management of Friant Division resulting in increasing groundwater storage and improved management of Friant Division water supplies in Millerton Lake.

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Chapter 8
Recommendations

This section presents describes recommendations for action by the Secretary or through Congressional action in support of implementing the Recommended Plan and identifies Federal and Non-Federal roles for implementing the Recommended Plan.

Recommendations

As the Recommended Plan is being reviewed for Congressional recommendation and appropriations, the following items should be considered:

- Approve the Recommended Plan, as described in this Report.
- Allow Reclamation to increase the construction cost to allow for escalation from stated price levels (2018) to the notice to proceed for each contract or work package, based upon Reclamation's Construction Cost Trends publication, or similar source.
- Appropriate funds such that pre-construction activities are completed within 2 years and construction is completed within 3 years following construction initiation to avoid cost overruns and ensure timely completion.
- Allow the Federal Government to accept title to any non-Federal property within the Project boundaries.

Federal Role

Under the Recommended Plan, the Federal Government would have the following roles and responsibilities:

- Complete a Final EIS, all federal permitting, and prepare a ROD.
- Identify Federal funding requirements
- Review and approve Project designs, environmental compliance and permitting documentation, and land acquisition services proved by FWA
- Perform DEC review of the Recommended Plan
- Perform value engineering and constructability review of Project design documents

- Review and approval of construction bid packages and selection of a construction contractor.
- Provide administrative and technical support during planning, design, and construction.
- Accept transferred title of acquired lands and constructed Project.

Non-Federal Role

Under the Recommended Plan, the following roles apply to non-Federal entities:

- Complete investigation and design of all project facilities, including mitigation requirements.
- As the CEQA lead, FWA would complete a final EIS/R and all state permitting.
- Acquire lands necessary for implementation of the Recommended Plan.
- Construct all project facilities.
- Transfer acquired lands and constructed facilities to Reclamation.

Chapter 9 References

California Department of Water Resources (DWR). 1998. The California Water Plan Update 1998. Department of Water Resources Bulletin 160-98. Sacramento, California. November.2003.

———.1999. *California State Water Project Atlas*. Sacramento, CA.

———. 2003. California's Groundwater. *Bulletin 118-Update 2003*. October 2003

———. 2016. California's Groundwater. *Bulletin 118-Interim 216*. December 2016

California Energy Commission (CEC). 2014. California Energy Demand 2014-2024 Final Forecast Volume 1: Statewide Electricity Demand, End-User Natural Gas, Demand, and Energy Efficiency, Staff report. CEC-200-2013-004-V1-CMF. January. Available at: http://energy.ca.gov/2013publications/CEC-200-2013-004/CEC-200-2013-004-V1-CMF.PDF

Council on Environmental Quality (CEQ). 2013. Principles, Requirements and Guidelines for Water and Land Related Resources Implementation Studies.

California Water Commission (CWC). 2016. Water Storage Investment Program Technical Reference. Sacramento, California, November.

DWR. *See* California Department of Water Resources.

Page, R. W. 1986. Geology of the Fresh Groundwater Basin of the Central Valley, California with Texture maps and Sections. U.S. Geological Survey Professional Paper 1401-C.

San Joaquin River Restoration Program (SJRRP). 2018. Funding Constrained Framework for Implementation. May.

San Joaquin River Restoration Settlement Act (SJRRS). Public Law 111-11. 2006.

Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards (2 CFR 200)

U.S. Department of Agriculture. 2007. 2007 Census of Agriculture County Profile: Tulare County, California. Available: http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/County_Profiles/California/cp06107.pdf. Accessed June 29, 2010.

U.S. Department of the Interior, Bureau of Reclamation (Reclamation). 1964. Reclamation Technical Memorandum 661, *Analysis and Description of Capacity Tests in Large Concrete-Lined Canals*, April 1964.

———. 2011. Friant-Kern Canal Capacity Restoration Feasibility Study. Draft Feasibility Report. June

———. 2015. Water and Related Resources Feasibility Studies. Directives and Standards. CMP 09-02.

December 1, 2019

Sent via email to equinley@deid.org

Re: Comments on Draft Groundwater Sustainability Plan for Delano-Earlimart Groundwater Basin

To Whom It May Concern,

On behalf of the above-listed organizations, we would like to offer the attached comments on the draft Groundwater Sustainability Plan for the Delano-Earlimart Groundwater Basin. Our organizations are deeply engaged in and committed to the successful implementation of the Sustainable Groundwater Management Act (SGMA) because we understand that groundwater is a critical piece of a resilient California water portfolio, particularly in light of our changing climate. Because California's water and economy are interconnected, the sustainable management of each basin is of interest to both local communities and the state as a whole.

Our organizations have significant expertise in the environmental needs of groundwater and the needs of disadvantaged communities.

- The Nature Conservancy, in collaboration with state agencies, has developed several tools[1] for identifying groundwater dependent ecosystems in every SGMA groundwater basin and has made that tool available to each Groundwater Sustainability Agency.
- Local Government Commission supports leadership development, performs community engagement, and provides technical assistance dealing with groundwater management and other resilience-related topics at the local and regional scales; we provide guidance and resources for statewide applicability to the communities and GSAs we are working with directly in multiple groundwater basins.
- Audubon California is an expert in understanding wetlands and their role in groundwater recharge and applying conservation science to develop multiple-benefit solutions for sustainable groundwater management.
- Clean Water Action and Clean Water Fund are sister organizations that have deep expertise in the provision of safe drinking water, particularly in California's small disadvantaged communities, and co-authored a report on public and stakeholder engagement in SGMA[2].

[1] https://groundwaterresourcehub.org/

[2] https://www.cleanwater.org/publications/collaborating-success-stakeholder-engagement-sustainable-groundwater-management-act

Because of the number of draft plans being released and our interest in reviewing every plan, we have identified key plan elements that are necessary to ensure that each plan adequately addresses essential requirements of SGMA. A summary review of your plan using our evaluation framework is attached to this letter as Appendix A. Our hope is that you can use our feedback to improve your plan before it is submitted in January 2020.

This review does not look at data quality but instead looks at how data was presented and used to identify and address the needs of disadvantaged communities (DACs), drinking water and the environment. In addition to informing individual groundwater sustainability agencies of our analysis, we plan to aggregate the results of our reviews to identify trends in GSP development, compare plans and determine which basins may require greater attention from our organizations.

Key Indicators

Appendix A provides a list of the questions we posed, how the draft plan responds to those questions and an evaluation by element of major issues with the plan. Below is a summary by element of the questions used to evaluate the plan.

1. Identification of Beneficial Users. This element is meant to ascertain whether and how DACs and groundwater-dependent ecosystems (GDEs) were identified, what standards and guidance were used to determine groundwater quality conditions and establish minimum thresholds for groundwater quality, and how environmental beneficial users and stakeholders were engaged through the development of the draft plan.
2. Communications plan. This element looks at the sufficiency of the communications plan in identifying ongoing stakeholder engagement during plan implementation, explicit information about how DACs were engaged in the planning process and how stakeholder input was incorporated into the GSP process and decision-making.
3. Maps related to Key Beneficial Uses. This element looks for maps related to drinking water users, including the density, location and depths of public supply and domestic wells; maps of GDE and interconnected surface waters with gaining and losing reaches; and monitoring networks.
4. Water Budgets. This element looks at how climate change is explicitly incorporated into current and future water budgets; how demands from urban and domestic water users were incorporated; and whether the historic, current and future water demands of native vegetation and wetlands are included in the budget.
5. Management areas and Monitoring Network. This element looks at where, why and how management areas are established, as well what data gaps have been identified and how the plan addresses those gaps.
6. Measurable Objectives and Undesirable Results. This element evaluates whether the plan explicitly considers the impacts on DACs, GDEs and environmental beneficial users in the development of Undesirable Results and Measurable Objectives. In addition, it examines whether stakeholder input was solicited from these beneficial users during the development of those metrics.
7. Management Actions and Costs. This element looks at how identified management actions impact DACs, GDEs and interconnected surface water bodies; whether mitigation for impacts to DACs is discussed or funded; and what efforts will be made to fill identified data gaps in the first five years of the plan. Additionally, this element asks whether any changes to local ordinances or land use plans are included as management actions.

Conclusion

We know that SGMA plan development and implementation is a major undertaking, and we want every basin to be successful. We would be happy to meet with you to discuss our evaluation as you finalize your Plan for submittal to DWR. Feel free to contact Suzannah Sosman at suzannah@aginnovations.org for more information or to schedule a conversation.

Sincerely,

Jennifer Clary
Water Program Manager
Clean Water Action/Clean Water Fund

Samantha Arthur
Working Lands Program Director
Audubon California

Sandi Matsumoto
Associate Director, California Water Program
The Nature Conservancy

Danielle V. Dolan
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Local Government Commission

Appendix A
Review of Public Draft GSP

Groundwater Basin/Subbasin: Tule Subbasin (DWR 5-022.13)
GSA: Delano-Earlimart Irrigation District (DEID) GSA
GSP Date: November 15, 2019 Public Review Draft

1. Identification of Beneficial Users

Were key beneficial users identified and engaged?

Selected relevant requirements and guidance:
GSP Element 2.1.5, "Notice & Communication" (§354.10):
(a) A description of the beneficial uses and users of groundwater in the basin, including the land uses and property interests potentially affected by the use of groundwater in the basin, the types of parties representing those interests, and the nature of consultation with those parties.
GSP Element 2.2.2, "Groundwater Conditions" (§354.16):
(d) Groundwater quality issues that may affect the supply and beneficial uses of groundwater, including a description and map of the location of known groundwater contamination sites and plumes.
(f) Identification of interconnected surface water systems within the basin and an estimate of the quantity and timing of depletions of those systems, utilizing data available from the Department, as specified in Section 353.2, or the best available information.
(g) Identification of groundwater dependent ecosystems within the basin, utilizing data available from the Department, as specified in Section 353.2, or the best available information.
GSP Element 3.3, "Minimum Thresholds" (§354.28):
(4) How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.

Review Criteria		Yes	No	N/A	Relevant Info per GSP	Location (Section, Page[1])
1. Do beneficial users (BUs) identified within the GSP area include:	a. Disadvantaged Communities (DACs)	X			"the Earlimart and Richgrove communities, which are part of the DEID GSA, rely exclusively on groundwater extractions to meet their municipal and industrial needs. Both of these communities are considered either Disadvantaged or Severely Disadvantaged Communities." "Richgrove is a small, unincorporated severely disadvantaged community with a UBD of approximately 234 acres.[8] The community is located in the southeastern portion of Tulare County. The Richgrove CP provides an overview of the community's general conditions, states the Tulare County GP policies relevant to Richgrove, describes goals and policies specific to Richgrove, and designates land use and development boundaries." "Earlimart is a small, unincorporated severely disadvantaged community with a UBD of approximately 773 acres.[9] The community is located in the southeastern portion of Tulare County. The Earlimart CP provides an overview of the community's general conditions, states the Tulare County GP policies relevant to Earlimart, describes goals and policies specific to Earlimart, and designates land use and development boundaries."	1.4.1.4.2.2, page 22; 1.4.4.2, page 33; 1.4.4.3, page 34

[1] Page numbers refer to the page of the PDF.

	b. Tribes		X			
	c. Small community public water systems (<3,300 connections)		X			
2. What data were used to identify presence or absence of DACs?	a. DWR [DAC Mapping Tool](https://gis.water.ca.gov/app/dacs/)[2]		X		It is not clear what data source was used to identify DACs. "Combined, RCSD and EPUD cover the entirety of the unincorporated communities of Richgrove and Earlimart. Both the Richgrove and Earlimart communities are recognized by the State of California as severely disadvantaged communities."	1.4.1.2, page 16
	i. Census Places		X			
	ii. Census Block Groups		X			
	iii. Census Tracts		X			
	b. Other data source		X			
3. Groundwater Conditions section includes discussion of:	a. Drinking Water Quality	X			"While nitrate is not an issue for agricultural irrigation or dairy supply, elevated nitrate in groundwater from small domestic supply wells could limit the beneficial use of water where these wells are impacted."	Appendix A Attachment 2, page 652
	b. California Maximum Contaminant Levels (CA MCLs)[3] (or Public Health Goals where MCL does not exist, e.g. Chromium VI)	X			"Nitrate concentrations in excess of the Maximum Contaminant Level (MCL) of 45 mg/L have been detected in some wells, particularly in the northwest portion of the subbasin (see Figure 2-15)."	Appendix A Attachment 2, page 652
4. What local, state, and federal standards or plans were used to assess drinking water BUs in the development of Minimum Thresholds (MTs)?	a. Office of Environmental Health Hazard Assessment Public Health Goal (OEHHA PHGs)[4]		X			
	b. CA MCLs[3]	X			"any specific Title 22 MCL exceedance at baseline sampling event in Spring 2020" would be considered as a COC and set MTs for.	3.5.1.3.2, page 116
	c. Water Quality Objectives (WQOs) in Regional Water Quality Control Plans		X			
	d. Sustainable Communities Strategies/ Regional Transportation Plans[5]		X			
	e. County and/or City General Plans, Zoning Codes and Ordinances[6]		X			
5. Does the GSP identify how environmental BUs and environmental stakeholders were engaged throughout the development of the GSP?			X		"Section 2.2.7 of the Basin Setting notes that GDEs are unlikely to occur in the Tule Subbasin given that the average depth to groundwater relative to the root zone for groundwater dependent plants is well below those plants' roots systems." However, Section 2.2.7 Environmental users are not identified in the draft GSP Table II-2 All Beneficial Uses and Users of Groundwater with Interests in the DEID GSA.	1.4.1.4.2.1, page 22; Appendix D, page 1281

Summary/ Comments

The draft GSP identifies classes of beneficial users, but does not include a section specifically describing the beneficial users within the GSA area or how they were engaged

[2] DWR DAC Mapping Tool: https://gis.water.ca.gov/app/dacs/
[3] CA MCLs: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html
[4] OEHHA PHGs: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html
[5] CARB: https://ww2.arb.ca.gov/resources/documents/scs-evaluation-resources
[6] OPR General Plan Guidelines: http://www.opr.ca.gov/planning/general-plan/

throughout the development of the GSP, which is required under 23 CCR § 354.10.(a).

The GSP should discuss if any environmental groups were engaged during the GSP development process. The GSP should clearly identify whether or not the following beneficial uses and users of groundwater in the Subbasin are present: Protected Lands, including refuges, conservation areas, and recreational areas; and Public Trust Uses, including wildlife, aquatic habitat, fisheries, and recreation.

2. Communications Plan

How were key beneficial users engaged and how was their input incorporated into the GSP process and decisions?

Selected relevant requirements and guidance:
GSP Element 2.1.5, "Notice & Communication" (§354.10):
Each Plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:
(c) Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.
(d) A communication section of the Plan that includes the following:
(1) An explanation of the Agency's decision-making process.
(2) Identification of opportunities for public engagement and a discussion of how public input and response will be used.
(3) A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin.
(4) The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.

DWR Guidance Document for GSP Stakeholder Communication and Engagement[7]

Review Criteria	Yes	No	N/A	Relevant Info per GSP	Location (Section, Page)
1. Is a Stakeholder Communication and Engagement Plan (SCEP) included?	X			"APPENDIX D:DEID GSA'S COMMUNICATION & ENGAGEMENT PLAN" dated July 2018	Appendix D, page 1261
2. Does the SCEP or GSP identify that ongoing engagement will be conducted during GSP implementation?	X			"The Delano-Earlimart Irrigation District Groundwater Sustainability Agency's (DEID GSA) Communication & Engagement Plan addresses how stakeholders within the GSA's boundary are engaged through stakeholder education and opportunities for input and public review during the development and implementation of the GSP and will be updated throughout the phases. This plan provides an overview of the DEID GSA, its stakeholders, and decision-making process; identifies opportunities for public engagement and discussion of how public input and responses will be used; describes how the DEID GSA encourages the active involvement of diverse, social, cultural, and economic elements of the population within the GSA boundary; and the methods the GSA will use to inform the public stakeholders about the progress of GSP development, public review and implementation."	Appendix D, page 1269

[7] DWR Guidance Document for GSP Stakeholder Communication and Engagement
https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/Guidance-Document-for-Groundwater-Sustainability-Plan---Stakeholder-Communication-and-Engagement.pdf

3. Does the SCEP or GSP specifically identify how DAC beneficial users were engaged in the planning process?	**X**			"Communication and educational outreach efforts with disadvantaged communities (DAC) and severely disadvantaged communities (SDAC) are essential for the development and implementation of GSPs within the San Joaquin Valley Basin, and residents are generally dedicated to bettering their communities, particularly when it comes to their water supplies. Important information that will be essential to communicate and engage DACs will include an explanation of SGMA, education on water conservation, and soliciting feedback from community members on water quantity challenges their communities may face."	Appendix D, page 1272
4. Does the SCEP or GSP explicitly describe how stakeholder input was incorporated into the GSP process and decisions?	**X**			"A number of oral comments were received on plan elements as they were proposed and discussed during various stakeholder meetings as the GSP was being developed. Some written comments were also received during the development period which were considered as a part of stakeholder comments. Appendix E: Comments Received on Plan, which will contain public comments received by the GSA during the public comment period upon submittal of this Plan to DWR." "Regular meetings with active stakeholder groups have been and will continue to be held. Members of the public and partners from other local agencies are encouraged to attend Board of Directors and Stakeholder Committee meetings to voice their thoughts and concerns throughout the GSP development process, public review and implementation phases. Meeting notices and agendas are routinely distributed to the Interested Parties List and on the DEID GSA's page on the DEID website. Public input has been and will continue to be important in the development and implementation the GSP, as the GSP will affect all groundwater users within the DEID GSA jurisdiction, and the impact of the SGMA implementation is significant. With that in mind, the DEID GSA views all public input as key to a successful sustainability plan. Input received from the public will be used in all aspects on GSP development and implementation." "Stakeholder Committee – Advises the Board of Directors on matters dealing with GSA and GSP development, GSP implementation, and other GSA/GSP matters; open to all interested stakeholders who wish to participate. Committee meetings are generally split by the three management areas: DEID, EPUD, and DEID White Area Annex"	1.5.3, page 39; 1.5.3.2, page 40; I.A.3, page 1273

Summary/ Comments
It is important that stakeholder engagement be maintained through the development of future projects and management actions and other SGMA compliance and implementation steps.

3. Maps Related to Key Beneficial Uses

Were best available data sources used for information related to key beneficial users?

Selected relevant requirements and guidance:
GSP Element 2.1.4 "Additional GSP Elements" (§354.8):
Each Plan shall include a description of the geographic areas covered, including the following information:
(a) One or more maps of the basin that depict the following, as applicable:
(5) The density of wells per square mile, by dasymetric or similar mapping techniques, showing the general distribution of agricultural, industrial, and domestic water supply wells in the basin, including de minimis extractors, and the location and extent of communities dependent upon groundwater, utilizing data provided by the Department, as specified in Section 353.2, or the best available information.

GSP Element 3.5 Monitoring Network (§354.34)
(b) Each Plan shall include a description of the monitoring network objectives for the basin, including an explanation of how the network will be developed and implemented to monitor groundwater and related surface conditions, and the interconnection of surface water and groundwater, with sufficient temporal frequency and spatial density to evaluate the affects and effectiveness of Plan implementation. The monitoring network objectives shall be implemented to accomplish the following:
(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:
(1) Chronic Lowering of Groundwater Levels. Demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features by the following methods:
(A) A sufficient density of monitoring wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.
(4) Degraded Water Quality. Collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues.
(6) Depletions of Interconnected Surface Water. Monitor surface water and groundwater, where interconnected surface water conditions exist, to characterize the spatial and temporal exchanges between surface water and groundwater, and to calibrate and apply the tools and methods necessary to calculate depletions of surface water caused by groundwater extractions. The monitoring network shall be able to characterize the following:
(A) Flow conditions including surface water discharge, surface water head, and baseflow contribution.
(B) Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.
(C) Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.
(D) Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.
(f) The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:
(3) Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.

Review Criteria		Yes	No	N/A	Relevant Info per GSP	Location (Section, Page)
1. Does the GSP Include Maps Related to Drinking Water Users?	a. Well Density	X			"Figure 1-6: Well Density within DEID GSA reflects the density of wells in the DEID GSA per square mile based on DWR Well Completion Report Map Application tool and Table 1-2: Wells within DEID GSA by Well Type identifies the count of wells by type." Figure 1-6 lumps all well types together, and thus the reader cannot differentiate where high densities of domestic wells versus agricultural supply wells versus public supply wells lie in the GSA.	1.4.1.4.1, page 20
	b. Domestic and Public Supply Well Locations & Depths		X		Well locations by 1-sq mile are provided in Figure 1-6, but well types are not differentiated. No information on well depths is provided.	Figure 1-6, page 21

	i. Based on DWR Well Completion Report Map Application[8]?	X			"Figure 1-6: Well Density within DEID GSA reflects the density of wells in the DEID GSA per square mile based on DWR Well Completion Report Map Application tool"	1.4.1.4.1, page 20
	ii. Based on Other Source(s)?		X			
2. Does the GSP include maps related to Groundwater Dependent Ecosystem (GDE) locations?	a. Map of GDE Locations	X			"Figure 1-7: Potentially Groundwater Dependent Ecosystems within DEID GSA provides a map visualizing the extent of GDEs that may potentially occur within DEID GSA. The areas identified as potential DGE's [sic] on Figure 1-7 are undeveloped parcels with the presence of Iodine bush and shrubby seepweed as designated by the DWC NC Dataset Viewer Map application. Section 2.2.7 of the Basin Setting notes that GDEs are unlikely to occur in the Tule Subbasin given that the average depth to groundwater relative to the root zone for groundwater dependent plants is well below those plants' roots systems."	1.4.1.4.2.1, page 22
	b. Map of Interconnected Surface Waters (ISWs)		X		"Surface water features are addressed in Section 2.2.4 of this GSP, as well as in Chapter 2.1.5 and 2.2.6 of the Tule Subbasin Setting. As presently assessed, there is no indication of interconnected surface water systems within the Tule Subbasin per the definition provided in 23 CCR § 351(o)."	2.3.6, page 90
	i. Does it identify which reaches are gaining and which are losing?			X		
	ii. Depletions to ISWs are quantified by stream segments.			X		
	iii. Depletions to ISWs are quantified seasonally.			X		
3. Does the GSP include maps of monitoring networks?	a. Existing Monitoring Wells	X			"Within the DEID GSA, DEID has an established ongoing groundwater monitoring program that is included in its adopted Groundwater Management Plan (GWMP) for the DEID Management Area. The GWMP includes monitoring of groundwater levels, groundwater quality, imported water, and conjunctive use operations. Additional data are available from local, state, and federal agencies." Figure A1-2. Existing and Proposed Upper Aquifer Groundwater Level Monitoring Well Locations Figure A1-5. Existing and Proposed Lower Aquifer Groundwater Level Monitoring Well Locations	1.4.2, page 23; Appendix A – Attachment 1, page 370, 373
	b. Existing Monitoring Well Data sources: i. California Statewide Groundwater Elevation Monitoring (CASGEM)		X		"Since 2009, CASGEM Program has tracked seasonal and long-term groundwater elevation trends in groundwater basins statewide. The program's mission is to establish a permanent, locally managed program of regular and systematic monitoring in all of California's alluvial groundwater basins. This early attempt to monitor groundwater continues to exist as a tool to help achieve the goals set out under the SGMA." However, these wells are not clearly identified in a map in the GSP.	1.4.2.1, page 25
	ii. Water Board Regulated monitoring sites		X			
	iii. Department of Pesticide		X			

[8] DWR Well Completion Report Map Application: https://www.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37

	Regulation (DPR) monitoring wells					
	c. SGMA-Compliance Monitoring Network	X			"The locations of RMS sites in the subbasin are provided in Figure A1-2, Figure A1-5, Figure A1-7, Figure A1-8, and Figure A1-9, with additional details listed in Table A1-1, Table A1-2, Table A1-3, and Table A1-6 of the TSMP." Figure 4-1: RMS for Monitoring Groundwater Levels Figure 4-2: RMS for Monitoring Groundwater Quality	4.2.2.2, page 149; Figure 4-1, page 152; Figure 4-2, page 155
	i. SGMA Monitoring Network map includes identified DACs?		X			
	ii. SGMA Monitoring Network map includes identified GDEs?		X			

Summary/ Comments

The GSP should include detailed information about the location and depths of domestic wells. Providing maps of the monitoring network overlaid with location of DACs, domestic wells, community water systems, GDEs, and any other sensitive beneficial users will allow the reader to evaluate the adequacy of the network to monitor conditions near these beneficial users.

The GSP should present information on the historical and current groundwater conditions near the potential GDEs and the ecological conditions present to more thoroughly evaluate whether or not GDEs are present in the GSA area. The GSP should identify whether any endangered or threatened freshwater species of animals and plants, or areas with critical habitat, were found in or near any of the potential GDEs, since some organisms rely on uplands and wetlands during different stages of their lifecycle.

4. Water Budgets

How were climate change projections incorporated into projected/future water budget and how were key beneficial users addressed?

Selected relevant requirements and guidance: GSP Element 2.2.3 "Water Budget Information" (Reg. § 354.18) *Each Plan shall include a water budget for the basin that provides an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current and projected water budget conditions, and the change in the volume of water stored. Water budget information shall be reported in tabular and graphical form.* *Projected water budgets shall be used to estimate future baseline conditions of supply, **demand**, and aquifer response to Plan implementation, and to identify the uncertainties of these projected water budget components. The projected water budget shall utilize the following methodologies and assumptions to estimate future baseline conditions concerning hydrology, water demand and surface water supply availability or reliability over the planning and implementation horizon:* *(b) The water budget shall quantify the following, either through direct measurements or estimates based on data:* *(5) If overdraft conditions occur, as defined in Bulletin 118, the water budget shall include a quantification of overdraft over a period of years during which water year and water supply conditions approximate average conditions.* *(6) The water year type associated with the annual supply, demand, and change in groundwater stored.* *(c) Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:* *(1) Current water budget information shall quantify current inflows and outflows for the basin using the most recent hydrology, water supply, **water demand**, and land use information.* **DWR Water Budget BMP**[9] **DWR Guidance for Climate Change Data Use During GSP Development and Resource Guide**[10]

Review Criteria	Yes	No	N/A	Relevant Info per GSP	Location (Section, Page)
1. Are climate change projections explicitly incorporated in future/ projected water budget scenario(s)?	X			"The projected water budgets incorporated all planned projects and management actions of the Tule Subbasin GSAs as well as adjustments to hydrology and water deliveries from climate change guidelines provided by the CDWR (see Section 2.3.5). … The time period from 2040 to 2050 was selected because it occurs after all planned projects and management actions have been implemented but before the time when long-term climate change adjustments to hydrology and water deliveries are applied to the projected water budget (2050). The long-term climate change adjustments were not considered as reliable as the near-term adjustments."	Appendix A – Attachment 2 – 2.3.2.6, page 675

[9] DWR BMP for the Sustainable <management of Groundwater Water Budget: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-4-Water-Budget.pdf

[10] DWR Guidance Document for the Sustainable Management of Groundwater Guidance for Climate Change Data Use During GSP Development: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/Climate-Change-Guidance_Final.pdf

2. Is there a description of the methodology used to include climate change?		X			"Climate change adjustments to hydrology and surface water deliveries were applied over two time periods within the SGMA planning horizon, as defined by California Water Commission (2016)[2]: 1. A 2030 central tendency time period, which provides near-term projections of potential climate change impacts on hydrology, centered on the year 2030, and 2. A 2070 central tendency time period, which provides long-term projections of potential climate change impacts on hydrology, centered on the year 2070. For imported water supplies from the Friant-Kern Canal, TH&Co utilized projected delivery schedules from the Friant Water Authority (Friant Water Authority, 2018). The projected water deliveries include adjustments to supplies associated with the planned San Joaquin River Restoration Project (SJRRP). Adjustments to Friant-Kern Canal supplies to account for climate change and SJRRP were applied beginning in 2025. The adjustments were applied incrementally between 2025 and 2030 such that the full adjustments were in effect in 2030. TH&Co applied the 2070 central tendency time period climate-related adjustments to imported water deliveries in the Tule Subbasin model projection for the period from 2050 to 2070."	Appendix A – Attachment 2 –, 2.3.5, page 678
3. What is used as the basis for climate change assumptions?	a. DWR-Provided Climate Change Data and Guidance[11]	X			"Baseline Tule River flows, Friant-Kern Canal deliveries, and the State Water Project's California Aqueduct deliveries used in the future projection for the model were adjusted to account for projections of future climate change. Adjustments were applied based on output from the DWR's CalSim-II model, which provided adjusted historical hydrology for major drainages and imported supplies based on scenarios recommended by the DWR Climate Change Technical Advisory Group."	Appendix A – Attachment 2 –, 2.3.5, page 678
	b. Other		X			
4. Does the GSP use multiple climate scenarios?			X			
5. Does the GSP quantitatively incorporate climate change projections?		X			The draft GSP does not present the quantitative impacts on future water budget by climate change; but it states that climate change are incorporated and show the projected water budget in a table. "The model projection also incorporated adjustments to the hydrology and water deliveries to account for potential climate change. The final projected water budget is the one that produced the 50th percentile	Appendix A – Attachment 2 –, 2.3.5, page 678

[11] DWR Guidance Document for the Sustainable Management of Groundwater Guidance for Climate Change Data Use During GSP Development: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/Climate-Change-Guidance_Final.pdf
DWR Resource Guide DWR-Provided Climate Change Data and Guidance for Use During GSP Development: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/Resource-Guide-Climate-Change-Guidance_v8.pdf

						Sustainable Yield estimate (see Section 2.3.2.7 herein). The projected surface water and groundwater budgets are shown in Tables 2-8a, 2-8b, and 2-9. Projected water budgets for each of the six GSAs are provided in Appendices A through F."	
6. Does the GSP explicitly account for climate change in the following elements of the future/projected water budget?	a. Inflows:	i. Precipitation		X		"Baseline Tule River flows, Friant-Kern Canal deliveries, and the State Water Project's California Aqueduct deliveries used in the future projection for the model were adjusted to account for projections of future climate change."	Appendix A – Attachment 2 –, 2.3.5, page 678
		ii. Surface Water	X				
		iii. Imported Water	X				
		iv. Subsurface Inflow		X			
	b. Outflows:	i. Evapotranspiration		X			
		ii. Surface Water Outflows (incl. Exports)	X				
		iii. Groundwater Outflows (incl. Exports)		X			
7. Are demands by these sectors (drinking water users) explicitly included in the future/projected water budget?	a. Domestic Well users (<5 connections)			X		"It is noted that there are some households in the rural portions of the Tule Subbasin that rely on private wells to meet their domestic water supply needs. However, given the low population density of these areas, the volume of pumping from private domestic wells is considered negligible compared to the other pumping sources."	Appendix A – 3.7.2.1.5, page 289-289
	b. State Small Water systems (5-14 connections)			X		"Accounting of groundwater pumping for municipal supply will be provided on a monthly basis by the various cities/communities in the Tule Subbasin. These cities/communities include: 1. City of Porterville 2. Tipton Public Utility District 3. Pixley Public Utility District 4. Teviston Community Services District 5. Earlimart Community Services District 6. Terra Bella Irrigation District 7. Richgrove Community Services District 8. Poplar Community Services District 9. Woodville Community Services District 10. Allensworth Community Services District 11. Alpaugh Community Services District 12. Ducor Community Services District"	
	c. Small community water systems (<3,300 connections)		X				
	d. Medium and Large community water systems (> 3,300 connections)		X				
	e. Non-community water systems			X			
8. Are water uses for native vegetation and/or wetlands explicitly included in the current and historical water budgets?			X			"A detailed surface water and groundwater budget has been developed for the Tule Subbasin for the 31-year period from 1986/87 to 2016/17." "Evapotranspiration of precipitation from native vegetation and crops" is included in both surface water and groundwater budget. "Evapotranspiration (ET) is the loss of water to the atmosphere from free-water evaporation, soil-moisture evaporation, and transpiration by plants. Evapotranspiration of precipitation is assumed to be the difference	Appendix A, 274; Appendix A, 299

				between total precipitation (Section 3.7.1.1.1.1) and areal recharge from precipitation (Section 3.7.1.1.2.1). This value includes evapotranspiration of precipitation from crops as well as native vegetation."	
9. Are water uses for native vegetation and/or wetlands explicitly included in the projected/future water budget?	**X**			Table 2-8b Projected Future Tule Subbasin Surface Water Budget of Appendix A includes native vegetation along with agricultural.	Appendix A, 701

Summary/ Comments

Based on the data presented, it is not clear how climate change is expected to affect some specific elements of the water budget (i.e., precipitation and evapotranspiration), and multiple climate scenarios are not discussed in the projected water budget section of the GSP.

The description of the water budget in the draft GSP (and Coordination Agreement) is not fully transparent, and it is not clear how drinking water users will be protected when sustainable yield allocations are implemented. The GSP should include specific information on groundwater use by public water suppliers so that the public can determine if water use by all public water suppliers has been considered. The GSP should include information on the rural population estimates and density so that the public can assess whether it is a reasonable assumption to exclude rural residential demands from the water budget. It is also recommended that the GSP provide more detail on how the projected municipal pumping was determined so the public can assess the accuracy of the municipal pumping specified in the projected water budget.

The GSP should separate evapotranspiration by land-use type (for example: agricultural, municipal and domestic, and native and riparian).

5. Management Areas and Monitoring Network

How were key beneficial users considered in the selection and monitoring of Management Areas and was the monitoring network designed appropriately to identify impacts on DACs and GDEs?

Selected relevant requirements and guidance:
GSP Element 3.3, "Management Areas" (§354.20):

(b) A basin that includes one or more management areas shall describe the following in the Plan:
(2) The minimum thresholds and measurable objectives established for each management area, and an explanation of the rationale for selecting those values, if different from the basin at large.
(3) The level of monitoring and analysis appropriate for each management area.
(4) An explanation of how the management area can operate under different minimum thresholds and measurable objectives without causing undesirable results outside the management area, if applicable.
(c) If a Plan includes one or more management areas, the Plan shall include descriptions, maps, and other information required by this Subarticle sufficient to describe conditions in those areas.

CWC Guide to Protecting Drinking Water Quality under the SGMA[12]
TNC's Groundwater Dependent Ecosystems under the SGMA, Guidance for Preparing GSPs[13]

Review Criteria	Yes	No	N/A	Relevant Info per GSP	Location (Section, Page)
1. Does the GSP define one or more Management Area?	X			"The area covered by the DEID GSA has been divided into four (4) separate Management Areas corresponding to the jurisdictional status, principle land use, water use sector, and the water source type of those respective areas. The following sections describe the four Management Areas and the jurisdictional status of the areas within those areas. Figure 1-1: DEID GSA Management Areas shows the boundaries of the management areas within the DEID GSA"	1.4.1, page 13
2. Were the management areas defined specifically to manage GDEs?		X			
3. Were the management areas defined specifically to manage DACs?	X			The draft GSP does not specifically state that the management areas are defined to manage DACs, but "the Earlimart and Richgrove communities, which are part of the DEID GSA, rely exclusively on groundwater extractions to meet their municipal and industrial needs. Both of these communities are considered either Disadvantaged or Severely Disadvantaged Communities." "The DEID Management Area follows the original service area of the Delano-Earlimart Irrigation District and excludes the areas served by EPUD, RCSD, and the unincorporated area under the jurisdiction of the County. …	1.4.1.4.2.2, page 22; 1.4.1, page 14

[12] CWC Guide to Protecting Drinking Water Quality under the SGMA: https://d3n8a8pro7vhmx.cloudfront.net/communitywatercenter/pages/293/attachments/original/1559328858/Guide_to_Protecting_Drinking_Water_Quality_Under_the_Sustainable_Groundwater_Management_Act.pdf?1559328858
[13] TNC's Groundwater Dependent Ecosystems under the SGMA, Guidance for Preparing GSPs: https://www.scienceforconservation.org/assets/downloads/GDEsUnderSGMA.pdf

				The RCSD Management Area follows the service area of the Richgrove Community Service District. It is 234 acres in size. It serves the unincorporated townsite of Richgrove and is located in southeastern Tulare County. … The EPUD Management Area follows the service area of the Earlimart Public Utilities District. It is 773 acres in size. It serves the unincorporated townsite of Earlimart and is located in southern Tulare County."	
a. If yes, are the Measurable Objectives (MOs) and MTs for GDE/DAC management areas more restrictive than for the basin as a whole?		**X**			
b. If yes, are the proposed management actions for GDE/DAC management areas more restrictive/ aggressive than for the basin as a whole?		**X**			
4. Does the GSP include maps or descriptions indicating what DACs are located in each Management Area(s)?	**X**			"Figure 1-1: DEID GSA Management Areas shows the boundaries of the management areas within the DEID GSA"	1.4.1, page 13
5. Does the GSP include maps or descriptions indicating what GDEs are located in each Management Area(s)?		**X**			
6. Does the plan identify gaps in the monitoring network for DACs and/or GDEs?		**X**			
a. If yes, are plans included to address the identified deficiencies?		**X**			

Summary/ Comments

Care should be taken so that the management areas and the associated monitoring network are designed to adequately assess and protect against impacts to all beneficial users, including DACs. It is recommended that the GSP discusses what, if any, differential impacts would be anticipated as a result of the separate management of these areas.

Based on the potential for GDEs in the Subbasin, the GSP should include:

- Characterization of biological resources for each GDE unit, and when possible provide baseline conditions for assessment of trends and variability.
- A description of data gaps / insufficiencies.
- Plans to reconcile data gaps in the monitoring network.

6. Measurable Objectives, Minimum Thresholds, and Undesirable Results

How were DAC and GDE beneficial uses and users considered in the establishment of Sustainable Management Criteria?

Selected relevant requirements and guidance:
GSP Element 3.4 "Undesirable Results" (§ 354.26):
(b) The description of undesirable results shall include the following:
(3) Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results

GSP Element 3.2 "Measurable Objectives" (§ 354.30)
(a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin within 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.

Review Criteria	Yes	No	N/A	Relevant Info per GSP	Location (Section, Page)
1. Are DAC impacts considered in the development of Undesirable Results (URs), MOs, and MTs for groundwater levels and groundwater quality?		X		URs "Pursuant to 23 Cal. Code Regs. §354.26(b)(2), the criteria for an undesirable result for the chronic lowering of groundwater levels is defined as the unreasonable lowering of the groundwater elevation below the minimum threshold for two consecutive years at greater than 50% of GSA Management Area RMS Sites, which results in significant impacts to groundwater supply." "Pursuant to 23 Cal. Code Regs. §354.26(b)(2), the criteria for an undesirable result for the degradation of groundwater quality is defined as the unreasonable long-term changes of groundwater quality above the minimum thresholds at greater than 50% of GSA Management Area RMS wells caused by groundwater pumping and/or groundwater recharge." MOs "Step 1: Locate the RMS defined in the Tule Subbasin Monitoring Plan, identify which portion of the aquifer it represents, and prepare a hydrograph using available historical groundwater elevation data. Step 2: Incorporate into the RMS Well Hydrograph groundwater elevation data from the Groundwater Flow Model that includes historical and projected groundwater elevation data. Step 3: Adjust the GFM projected groundwater elevations at the RMS well to the most recent physically measured groundwater elevation. Each RMS site will further be adjusted to the groundwater elevation measured during February 2020 to establish the starting baseline conditions. Step 4: Utilize the adjusted GFM projected groundwater elevations for the period 2020 to 2040 to quantify numerically the interim milestones and the measurable objective value in 2040." "Step 1: Locate the RMS defined in the Tule Subbasin Monitoring Plan, identify which portion of the aquifer it represents, and the associated Constituents of Concern (COC) at the RMS based on groundwater suitability (Agriculture use, Domestic Use, Municipal Use). Step 2: Prepare a table summarizing available historical groundwater quality data for each COC at the RMS well. Step 3: Establish interim milestones and the measurable objective at each RMS well with calculating a change above the baseline groundwater quality to not exceed 10% of long term 10 year running average. Step 4: Each year, during the Plan Implementation Period, re-calculate the long term 10 year running average. Evaluate changes to groundwater quality based on reduction of groundwater elevation or from recharge efforts." MTs "Step 1: Utilize the Hydrograph created for each RMS well based on process	Attachment A – 4.3.1.2, page 308; Attachment A – 4.3.3.2, page 310 3.5.1.1.1, page 113; 3.5.1.3.1, page 116 3.5.2.1.1, page

				for establishing the interim milestones and measurable objective which assumes average hydrology. Step 2: Calculate the change in groundwater elevation during the most recent 10-year drought period (2007-2016) from historical groundwater data at the RMS well. Step 3: Deduct the calculated change in groundwater elevation during drought conditions from the lowest projected interim milestone during the initial 10-year plan implementation period (2020 - 2030). Step 4: Establish the minimum threshold for groundwater elevation for the entire plan implementation period as a single value below the interim milestones and measurable objective. The difference between the interim milestones and measurable objective is the operational flexibility established at each RMS well." "Step 1: Utilize the data and charts prepared to establish the interim milestones and measurable objectives outlined in this Plan, including COC identified. Step 2: Establish minimum threshold for COCs associated at each RMS well with calculating a change above the baseline groundwater quality to not exceed 15% of long term 10 year running average. Step 3: Each year, during the Plan Implementation Period, re-calculate the long term 10 year running average. Evaluate changes to groundwater quality based on reduction of groundwater elevation or from recharge efforts."	121; 3.5.2.3.1, page 123
2. Does the GSP explicitly discuss how stakeholder input from DAC community members was considered in the development of URs, MOs, and MTs?	X			"The Sustainable Management Criteria (hereafter "SMC") discussed and established in this Section were developed in consultation with the DEID GSA member agencies, local stakeholders, Tule Subbasin GSA counterparts, technical leads, regional partners, interbasin stakeholders, and other interested parties. … The general process leading up to the development and establishment of these Sustainable Management Criteria included: • Regular agenda items, material reviews, and presentations at DEID GSA Stakeholder meetings wherein information relevant pertinent to the development of Sustainable Management Criteria was discussed with recommendations provided; • Holding public outreach landowner meetings within DEID GSA and throughout the Tule Subbasin outlining the process for GSP development, discussing Sustainable Management Criteria, and providing data and context related to local groundwater-related issues;"	3.3, page 107
3. Does the GSP explicitly consider impacts to GDEs and environmental BUs of surface water in the development of MOs and MTs for groundwater levels and depletions of ISWs?		X			
4. Does the GSP explicitly consider impacts GDEs and environmental BUs of surface water and recreational lands in the discussion and development of Undesirable Results?		X			
5. Does the GSP include an analysis of the anticipated impacts of water level MOs and MTs on environmental uses and users?		X			

6. If yes:	a. On GDEs?			X		
	b. On endangered or threatened freshwater species?			X		
	c. On recreational land uses?			X		
	d. On privately and publicly protected conservation lands and open spaces?			X		
7. Does the GSP clearly identify and detail the anticipated degree of water level decline from current elevations to the water level MOs and MTs?			X		The draft GSP does not identify the anticipated degree of water level decline to the water level MOs and MTs.	
8. If yes, does it include:	b. Is this information presented in table(s)?			X		
	c. Is this information presented on map(s)?			X		
	d. Is this information presented relative to the locations of DACs and domestic well users?			X		
	e. Is this information presented relative to the locations of ISW and GDEs?			X		
2. Does the GSP include an analysis of the anticipated impacts of water level MOs and MTs on drinking water users?		X			"Each minimum threshold established for the various sustainability indicators considered the avoidance of unreasonable impacts to the beneficial users. The DEID GSA stakeholders developed projects and management actions to balance the economic impacts while achieving sustainability, specifically as follows: … • Degradation of water quality: With the lowering of groundwater levels, or the increased groundwater recharge, groundwater quality may be adversely affected. Within DEID GSA, there are no known groundwater plumes that could spread to groundwater beneficial users. The minimum thresholds for groundwater levels, groundwater storage, and groundwater quality were established to minimize impacts and extra costs to the groundwater users reliant on drinking water or agriculture pumping."	3.5.2.5.3, page 127
3. If yes:	a. On domestic well users?		X		The draft GSP does not include a detail discussion about the anticipated impacts on different drinking water users.	
	b. On small water system production wells?		X			
	c. Was an analysis conducted and clearly illustrated (with maps) to identify what wells would be expected to be partially and fully dewatered at the MOs?		X			
	d. Was an analysis conducted and clearly illustrated (with maps) to identify what wells would be expected to be partially and fully dewatered at the MTs?		X			
	e. Was an economic analysis performed to assess the		X		The draft GSP does not perform an economic analysis about the increased operation costs, but it states that "Increased operational costs for	3.5.2.5.3, page

increased operation costs associated with increased lift as a result of water level decline?				groundwater extraction: With the lowering of groundwater levels, the cost to pump groundwater will increase. The minimum thresholds for groundwater levels were established to minimize increase in pumping costs."	127
4. Does the sustainability goal explicitly include drinking water and nature?	**X**			"The Sustainability Goal of the Tule Subbasin is defined in the Coordination Agreement as the absence of significant and unreasonable undesirable results associated with groundwater pumping, accomplished by 2040 and achieved through an integrated program of sustainable groundwater management between the Tule Subbasin GSAs and their many stakeholders. It is further the goal of the Tule Subbasin GSAs that coordinated implementation of their respective Groundwater Sustainability Plans will achieve sustainability in a manner that facilitates the highest degree of collective economic, societal, environmental, cultural, and communal welfare and provides all beneficial uses and users the ability to manage the groundwater resource in the most cost efficient manner. Moreover, this coordinated implementation is anticipated to ensure that the sustainability goal, once achieved, is also maintained through the remainder of the 50-year planning and implementation horizon, and well thereafter.	Attachment A – 4.3.3.3, page 310;

Summary/ Comments

Based on the presented information, DAC members were not explicitly considered in the development of URs, MOs, and MTs for groundwater levels and water quality. More detail and specifics regarding DAC members, including those that rely on smaller community drinking water systems and domestic wells, is necessary to demonstrate that these beneficial users were adequately considered.

An impact analysis should be performed to evaluate the potential impacts to wells associated with the water level MOs/MTs and presented in the GSP. The locations of potentially impacted wells should be identified and presented in maps in the GSP so that the public and DWR may assess the well impacts specific to DACs and other sensitive users within the GSA area. Specifically, the basis for establishing undesirable results is assessed by Management Area and fails to take into account the influence of wells on an adjacent management area, which could cause undesirable results with much fewer than 50% of wells impacted. This is particularly true with the DEID, which surrounds and is significantly larger than the Richgrove Community Services District and the Earlimart Public Utilities District. The Plan should consider whether MOs and MTs in the DEID could trigger URs in these disadvantaged communities.

The GSP should clearly identify and detail the anticipated degree of water level decline from current elevations to the water level MOs and MTs. Given that the subbasin is in critical overdraft, the GSP should explain how the projected additional water level declines at MTs will result in sustainable conditions for beneficial users. The GSP should also consider and quantify both the potential dewatering of wells and the pumping costs associated with the increased lift at the projected lower water levels, in order to more fully and transparently consider the impacts to beneficial users.

It is also recommended that the impacts to groundwater gradients at the proposed MOs and MTs be analyzed and described in the GSP, in addition to the likely impacts to drinking water wells. The GSP and/or the Coordination Agreement should demonstrate how the proposed SMCs are achievable, analyze the changes to water level gradients, and clearly describe the impacts expected to result from the proposed SMCs within the GSA area, and particularly in areas with significant localized variability in anticipated water level changes.

GDEs, if present, should be included in the MO sections for Chronic Lowering of Water Levels and Water Quality, and the GSP should address whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment.

The GDE Pulse web application developed by TNC provides easy access to 35 years of satellite data to view trends of vegetation metrics, groundwater depth (where available), and precipitation data. This satellite imagery can be used to observe trends for NC dataset polygons within and near the GSA. Over the past 10 years (2009-2018), some NC dataset vegetation polygons have experienced adverse impacts to vegetation growth and moisture.

For each identified GDE unit with supporting hydrological datasets, include the following:

- Plot and provide hydrological datasets for each GDE.
- Define the baseline period in the hydrologic data.
- Classify GDE units as having high, moderate, or low susceptibility to changes in groundwater.
- Explore cause-and-effect relationships between groundwater changes and GDEs.

For each identifiable GDE unit without supporting hydrological datasets, describe data gaps and / or insufficiencies.
Compile and synthesize biological data for each GDE unit by:

- Characterizing biological resources for each GDE unit, and when possible provide baseline conditions for assessment of trends and variability.
- Describing data gaps / insufficiencies.

7. Management Actions and Costs

What does the GSP identify as specific actions to achieve the MOs, particularly those that affect the key BUs, including actions triggered by failure to meet MOs? What funding mechanisms and processes are identified that will ensure that the proposed projects and management actions are achievable and implementable?

Selected relevant requirements and guidance
GSP Element 4.0 Projects and Management Actions to Achieve Sustainability Goal (§ 354.44)
(a) Each Plan shall include a description of the projects and management actions the Agency has determined will achieve the sustainability goal for the basin, including projects and management actions to respond to changing conditions in the basin.
(b) Each Plan shall include a description of the projects and management actions that include the following:
(1) A list of projects and management actions proposed in the Plan with a description of the measurable objective that is expected to benefit from the project or management action.

Review Criteria			Yes	No	N/A	Relevant Info per GSP	Location (Section, Page)
1.	Does the GSP identify benefits or impacts to DACs as a result of identified management actions?			X			
2.	If yes:	a. Is a plan to mitigate impacts on DAC drinking water users included in the proposed Projects and Management Actions?		X			
		b. Does the GSP identify costs to fund a mitigation program?		X			
		c. Does the GSP include a funding mechanism to support the mitigation program?		X			
5.	Does the GSP identify any demand management measures in its projects and management actions?		X			See below	
6.	If yes, does it include:	a. Irrigation efficiency program	X			"•Crop change within the WMA - The WMA landowners may pursue a program of underwriting changes in cropping where revenues generated by the WMA would be used to contractually limit what can be grown with the intention of reducing water demands below current levels of water used within the WMA. Individual WMA landowners may also pursue crop changes within their own landholdings independently. • Conservation within the WMA - The WMA may pursue a program of water conservation where revenues generated by the WMA would be used to improve the application of water on lands currently farmed and in distribution systems delivering water with the intention of reducing nonrecoverable water losses."	5.2.2.8.1, page 217
		b. Ag land fallowing (voluntary or mandatory)	X			"• Land retirement within the WMA – The WMA landowners may pursue a program of voluntary land retirement where revenues generated by the WMA would be used to buy land currently farmed within the WMA with the intention of curtailing groundwater pumping on the acquired lands. Individual WMA landowners may also pursue land retirement within their own landholdings independently. …	5.2.2.8.1, page 217

					• <u>Wildlife habitat conversion</u> - The WMA may pursue a program of underwriting the conversion of currently farmed land to wildlife habitat where revenues generated by the WMA and revenues developed in conjunction with federal and state agencies and other non-governmental organizations (NGOS) would be used to purchase conservation easements within the WMA with the intention of curtailing its water use. Individual WMA landowners may also pursue wildlife habitat conversion within their own landholdings independently."	
	c. Pumping allocation/restriction	X			"This project proposes a transitional pumping schedule for the first 15 years of the SGMA implementation period. Annual groundwater extractions would be limited in the first five years (2020-2024) to existing crop consumptive use.[1] Following the initial 5 -year period, the transitional pumping portion of total groundwater extractions during the 2025-2034 time period would be reduced each year by 10 percent. Beginning in 2035, groundwater extractions would be limited to the sustainable yield plus precipitation accruals to groundwater and any supplemental groundwater credits developed from other projects. Transitional pumping allocations to individual landowners will be made annually with any unused amounts available to be carried over from year to year within the five-year period the allocation was made (2020-2024; 2025-2029; 2030-2034). Individual landowners may also carry over up to one-half of the total transitional pumping amounts allocated in one five-year period to the next five-year period, with all unused transitional pumping allocations terminating on December 31, 2034. Transitional pumping credits are not transferable between landowners but may be made available by landowners to their lessees for use on the property assigned such credits."	5.2.2.2.1, page 194
	d. Pumping fees/fines		X			
	e. Development of a water market/credit system	X			"<u>Intra-WMA groundwater credits program</u> - Because of its historic dependence on groundwater and to the extent it remains so to an appreciable degree during SGMA implementation, the DEID GSA anticipates a implementing a program establishing and providing for transfer of groundwater credits within the WMA. Groundwater credits will consist of the calculated sustainable yield and precipitation accruals to groundwater which would be allocated on an equal share, per acre basis. Credits may also be created through WMA projects and management actions which would results in supplemental water and would be allocated as determined by project proponents and administered by the DEID GSA under this Action. … <u>Inter-WMA groundwater acquisition credits program</u> - On behalf of the WMA, the DEID GSA will monitor the potential of meeting WMA water needs through participation in a groundwater credits acquisition program within the Tule Subbasin. Should such a program become available within the Tule Subbasin and a determination is first made by the DEID GSA that participation in the program will have of no unmitigated negative impact to others within the DEID GSA, WMA landowners will be given the option of participating in an inter-WMA groundwater credits acquisition program."	5.2.2.5.1, page 205
	f. Prohibition on new well construction		X			

	g. Limits on municipal pumping		X			
	h. Limits on domestic well pumping		X			
	i. Other	X			"Optimization of current groundwater supplies used within the RCSD MA will be maintained through current water conservation programs and future work to generate supplemental water conservation elements that will be incorporated into RCSD's adopted water ordinances. … Included within Action 1 is the completion of a project to implement full metering of RCSD water service connections and an associated volumetric rate structure. This will allow for the conservation procedures associated with a water meter rate structure to be employed, along with specific conservation enforcement procedures. Meters are installed on all service connections and are subject to technical review for accuracy, operation and potential replacement. Further, an appropriate volumetric rate structure is currently being evaluated. Rate structure implementation will be a function of successful passage of a Proposition 218 fee or assessment."	5.2.3.2.1, page 222
7. Does the GSP identify water supply augmentation projects in its projects and management actions?		X			See below	
8. If yes, does it include:	a. Increasing existing water supplies	X			"The DEID Management Area will continue its current practice of importing available water supplies from both CVP and non-CVP and optimizing those supplies for use within the DEID Management Area." "Action 2 of the DEID Management Area consist of increasing imported water quantities above historic operations to meet consumptive use requirements, new water demands, and reduce reliance on groundwater pumping."	5.2.1.1.1, page 167; 5.2.1.2, page 171
	b. Obtaining new water supplies	X			"WMA landowners propose to pursue purchases of surplus imported water that may be available from DEID and other Friant Division or Cross Valley contractors as well as other water acquisitions. These purchases may be either spot market or long-term purchase agreements and could include CVP Section 215 water, Recirculation Water, Unreleased Restoration Flows or other imported water supplies. Purchases of surplus imported water would be arms-length transactions and the purchase price would be at market rates or other mutually agreeable terms.."	5.2.2.3.1, page 199
	c. Increasing surface water storage		X			
	d. Groundwater recharge projects – District or Regional level	X			"Action 3 for the DEID Management Area consist of continued historic and current operations of existing in-district recharge/banking operations for future groundwater extraction needs." "Action 4 for the DEID Management Area consist of efforts to increase in-district recharge/banking operations for future groundwater extraction needs"	5.2.1.3, page 176; 5.2.1.4, page 180
	e. On-farm recharge		X			
	f. Conjunctive use of surface water		X			
	g. Developing/utilizing recycled water		X			
	h. Stormwater capture and reuse		X			
	i. Increasing operational flexibility (e.g., new interties	X			"• Interconnection with DEID's distribution system – DEID and WMA	5.2.2.7.1, page

and conveyance)				landowners will actively pursue and cooperatively assess opportunities to utilize DEID's existing distribution system for delivery of any imported water supplies WMA landowners may have available to them that originate from the FKC. These deliveries would be accomplished through new interconnections to existing DEID pipelines. • Use of White River – WMA landowners will pursue the use of White River to deliver water to WMA lands for irrigation and groundwater recharge. DEID and WMA will develop an allocation system to address any groundwater recharge credits that would be appropriately allocated to the WMA from seepage losses associated with WMA-introduced flows in White River. • Use of Deer Creek – The WMA will also pursue the use of Deer Creek to deliver water to lands in the WMA for irrigation and groundwater recharge. • Construction of new conveyance facilities - The WMA will assess the feasibility of a water distribution system for areas targeted for continuance of significant farming operations. Based on the finding of this feasibility assessment, pursuit of the design, development and construction of new conveyance facilities may follow."	213
j. Other	X			"As with the DEID Management Area's in-district water banking projects, the purpose of out-of-district (OOD) projects is to bank water in wet years that is surplus to the DEID MA's needs for later recovery in dry years. The DEID Management Area has been involved in banking water in OOD projects since 2006. DEID's OOD projects have a total banking capacity of 154,000 acre-feet. A total of 153,578 acre-feet have been banked over the life of the two OOD projects, with water recovered from those projects amounting to more than 56,000 acre-feet (2006-2017). Additional long-term OOD water exchanges have also been entered into for the benefit of the DEID Management Area. In 2017 and 2018 surplus CVP supplies were banked through long-term exchanges that will provide return water in the amount of 18,000 acre-feet in subsequent years."	5.2.1.5.1, page 185
9. Does the GSP identify specific management actions and funding mechanisms to meet the identified MOs for groundwater quality and groundwater levels?	X			Section 5 of the draft GSP presents management actions and corresponding funding sources, but it does not clarify the MOs targeted.	5, page 159
10. Does the GSP include plans to fill identified data gaps by the first five-year report?	X			"The Tule Subbasin TAC will periodically evaluate the monitoring network in Attachment 1 to determine if there are data gaps that could affect the ability of the subbasin to meet its sustainability goals. Current data gaps are identified in Attachment 1. Every five years, the Tule Subbasin TAC will provide an evaluation of data gaps in the five-year assessment, including steps to be taken to address data gaps before the next five-year assessment." 4.1 Data Gaps of the Tule Subbasin Monitoring Plan identifies data gaps and recommended monitoring features and testing to address data gaps.	Appendix A – 5.2, page 314; Appendix A – Attachment 1 – 4.1, page 354
11. Do proposed management actions include any changes to local ordinances or land use planning?	X			"Optimization of current groundwater supplies used within the EPUD MA will be maintained through current water conservation programs and future work to generate supplemental water conservation elements that will be incorporated into EPUD's adopted water ordinances. These provisions	5.2.4.2.1, page 234

				are/shall be constructed such that it will be required that each dwelling unit, commercial development or industrial enterprise be required to use plumbing fixtures meeting defined levels of conservation potential. These levels are to be achieved by the plumbing devices as a result of the incorporation of conservation principals into the design of the plumbing fixture. Current and future applicants for water service are required to agree to satisfy the specific provisions of the adopted ordinances as a condition of initial and continued service. Demonstrating compliance with a mandated level of conservation efficiency of water using fixtures and devices associated with any proposed development will be required. Conservation provisions of any adopted water ordinances will be revisited on a defined frequency and maintained current with respect to the incorporation of Best Available Technology. Conservation elements will be a permanent part of water supply procedures process used in EPUD."	
12. Does the GSP identify additional/contingent actions and funding mechanisms in the event that MOs are not met by the identified actions?		**X**			
13. Does the GSP provide a plan to study the interconnectedness of surface water bodies?		**X**		"Surface water features are addressed in Section 2.2.4 of this GSP, as well as in Chapter 2.1.5 and 2.2.6 of the Tule Subbasin Setting. As presently assessed, there is no indication of interconnected surface water systems within the Tule Subbasin per the definition provided in 23 CCR § 351(o)."	2.3.6, page 90
14. If yes: a. Does the GSP identify costs to study the interconnectedness of surface water bodies?		**X**			
b. Does the GSP include a funding mechanism to support the study of interconnectedness surface water bodies?		**X**			
15. Does the GSP explicitly evaluate potential impacts of projects and management actions on groundwater levels near surface water bodies?		**X**			

Summary/ Comments

The likely benefits and impacts to DAC members by the proposed projects and management actions are not clearly identified in the GSP.

The GSP should identify an assistance program for potentially impacted beneficial users, including DACs, small community water systems, and domestic well users, to mitigate adverse impacts that may be caused by the proposed MOs, MTs, and projects and management actions.

The GSP should identify the groundwater accounting plan or mechanism for each type of user that will be used to create individually tailored allocations, or, at a minimum identify key policies that will be incorporated into the groundwater accounting system that will ensure that DACs, small community water systems, and domestic well users will have access to safe, clean, affordable, and accessible drinking water.

Environmental resource protection needs should be considered in establishing project priorities. In addition, consistent with existing grant and funding guidelines for SGMA-related work, priority should be given to multi-benefit projects that can address water quantity as well as providing environmental benefits or benefits to disadvantaged communities. The GSP should include environmental benefits and multiple benefits as criteria for assessing project priorities.

Recharge basins, reservoirs and facilities for managed stormwater recharge projects can be designed as multi-benefit projects to include elements that act functionally as wetlands and provide a benefit for wildlife and aquatic species. In some cases, such multiple-benefit projects and facilities have been incorporated into local Habitat Conservation Plans (HCPs) and Natural Community Conservation Plans (NCCPs), more fully recognizing the value of the habitat that they provide and the species they support. For projects that construct recharge basins, the GSP should consider identifying if there is habitat value incorporated into the design and how the recharge basins will be managed to benefit environmental users. Grant and funding priorities for SGMA-related work may be given to multi-benefit projects that can address water quantity as well as provide environmental benefits. Therefore, the GSP include environmental benefits and multiple benefits as criteria for assessing project priorities. For examples of case studies on how to incorporate environmental benefits into groundwater projects, please visit: https://groundwaterresourcehub.org/case-studies/recharge-case-studies/

Delano-Earlimart Draft GSP - summary of County notes

Draft Copy	County Notes
Pg 1-6 Management Area 3. MOU between DEID GSA and Richgrove Community Service District designates DEID GSA as the principle agency with jurisdiction over RCSD Management Area for the purposes of SGMA and the implementation of this Plan (see **Appendix 1-C: MOU Between DEID GSA and Richgrove Community Service District**).	The County has land use authority in this service area. The MOU between DEID and the PUD should not impact the County's authorities over growth and well permitting. However, it is plausible that a groundwater availability restriction could be placed upon any development as a condition of service by the PUD. That would be a consideration on a case-by-case basis, based upon whether CEQA compliance is necessary (e.g. requiring any type of water supply sufficiency determination). Therefore, the County maintains land use authority in LAFCo designated PUD and CSD boundaries. Future development applications would rely on the PUD or CSD to provide a will serve letter. The County maintains and does not abdicate its authority regarding the application of land use and zoning regulations as feasible and appropriate through the administration of the County general plan, zoning ordinance, and ordinance code.
Pg 1-6. Management Area 4 MOU between DEID GSA and Earlimart Public Utility District designates DEID GSA as the principle agency with jurisdiction over EPUD Management Area for the purposes of SGMA and the implementation of this Plan (see **Appendix 1-D: MOU Between DEID GSA and Earlimart Public Utility District**).	See Pg 1-6 Management Area 3 comment above.
Pg 1-8. Paragraph 1. The county governments each retains general land use planning authority and jurisdiction over its respective area.	See Pg 1-6 Management Area 3 comment above.

Pg 1-9. 1.4.1.3 Description of Plan Area	The existing land use designations described in this section are not general plan "Land Use Designations" they describe existing land uses on the ground. Incorporate at a minimum General Plan Figure 4-1 and reference the land use diagrams in the Communities, Hamlets, and Legacy Communities as applicable. The following adopted plans are located in the Delano-Earlimart GSA: Earlimart Community Plan Richgrove Community Plan Allensworth Hamlet Plan Teviston Hamlet Plan Jovista Legacy Plan Delano Area Community Plan (not completed as of yet)
Pg 1-13 Table 1-2: Wells within DEID GSA by Well Type	This seems like a low count for all the likely rural domestic wells. Please note if the unknow category includes domestic wells. Please clarify.
Pg 1-14. 1.4.1.4.2.2 Groundwater Dependent Communities As previously described in Section 1.4.1.4 Identification of Water Use Sector & Water Source Type (see Figure 1-5), the Earlimart and Richgrove communities, which are part of the DEID GSA, rely exclusively on groundwater extractions to meet their municipal and industrial needs. Both of these communities are considered either Disadvantaged or Severely Disadvantaged Communities.	The County appreciates the GSA calling attention to the needs to protect these water sources for these disadvantaged communities.
Pg 1-21. Urban land use is more specifically managed in the Tulare County GP through the official adoption of Urban Development Boundaries (UDBs) and Urban Area Boundaries (UABs). UDBs establish a 20-year growth boundary that is consistent with the General Plan's time horizon and delineate an area	The Budget for the Tule Basin – an for the DE subset – stop any expansion of municipal pumping at 2040. Growth will continue to 2070 – the GSPs full sustainability period. But, the Budget at the end of this GSP has the "current" Muni Pumping at 2800 af/yr, and the future Muni pumping only at 3700 af/yr. While this is steady through the Sustainability period (unlike some of the other GSP's), it does accommodate

around incorporated cities or unincorporated communities wherein urban development is allowed and services are likely to be extended. UABs are areas where land uses are presumed to have an impact upon the adjacent incorporated city. To coordinate land use planning with cities, the County adopts City UABs and City UDBs wherein the city regulates land use within the City UDB and the city and the County coordinate on land use within the City UAB. Generally, the Planning Area of a city's General Plan is coterminous with the County Adopted City UAB. Within DEID GSA, there are two Community Plans that include UDBs and/or UABs that are addressed by this GSP. The most recent version of these plans, as well as the UDBs and/or UABs that they define, include: • Richgrove Community Plan Update (2017) • UDB for Richgrove • Earlimart Community Plan Update (2017) • UDB for Earlimart	some growth (e.g. 900 af of pumping – or about 3,000 to 4,000 people). This is consistent with the 1.3% growth from the (2030) Community Plans.
Pg 1-25. Paragraph 3. Tulare County's role in water management is broad and active, particularly through the implementation of its General Plan and its Zoning Ordinance (*Ordinance No. 352*), which translates GP policies into specific use regulations and development standards. The County also administers other ordinances that influence the use and management of water within the County, and it may adopt more in the future if deemed necessary. However, limited only to the implementation of its GP, Tulare	Good recognition of the cooperative nature necessary.

County recognizes that its role in water management is neither comprehensive, nor is it to be construed as such; rather, water management within the County is carried out by way of dynamic interactions between the many participants who each bear a variety of responsibilities:	
Page 1-27. 1.4.4.4 Effects of Land Use Plans within the Tule Subbasin The DEID GSA shall request the County of Tulare and the County of Kern that it be notified when land use plan changes are proposed within the DEID GSA. Any proposed land use plan changes will be reviewed for potential significant impacts to implementation of the DEID GSP. The DEID GSA will request that no land use changes be approved prior to said review and certification that that there will be no unmitigated impacts that would disrupt the sustainability goals of the GSA.	Agreed. The County maintains and does not abdicate its aughtoity regarding the application of land use and zoning regulations as feasible and of the county general plan, zoning ordinance, and ordinance code. While the concept may argued to be consistent with the intent of the General Plan, the determination of “unmitigated” is not in the GSA’s jurisdictional authority as it relates to land use choices but may be so as a responsible agency under CEQA.
Page 1-27. 1.4.4.5 Water Supply Assumptions of Land Use Plans Water supply assumptions within the recently adopted General and Community Plans active within DEID GSA’s jurisdiction generally provide global estimations of future water supplies and demands. Additionally, these plans provide Goals and Policies that recognize the need and, when implemented, provide for sustainable water management.	Please clarify that the plans active in DEIDGSA’s jurisdiction should not be assumed to reflect a 2070 population. To be clear there may be unanticipated additional growth beyond what these land use plans assumed. The note on the 2017 Community Plans may not reflect a longer-term demand that may have been included in those Plans. However, as noted elsewhere, the DEID water budget (at the end of GSP’s attachments) does reflect a higher Muni demand that “current” that may incorporate all the projected growth as anticipated in all the listed communities as well. The following adopted plans are located in the Delano-Earlimart GSA: Earlimart Community Plan (UDB) Richgrove Community Plan (UDB) Allensworth Hamlet Plan (HDB)

	Teviston Hamlet Plan (HDB) Jovista Legacy Plan (LDB) Delano Area Community Plan (UDB) The plans listed above utilize projections to 2030 and or 2040.
Page 1-28. Paragraph 4. The projects and management actions proposed in this GSP provide a framework by which the opportunity to use lands according to existing land use designations as permitted by land use designations and zoning ordinances remains unaltered, subject to the sustainable use of groundwater within the DEID GSA's jurisdiction. However, the assumptions made by DEID GSA in this GSP anticipate a shift in water demand due to the implementation of certain projects and management actions that ultimately reduces the total volume of groundwater supply available for extraction on an annual basis and, therefore, current actual land uses reliant upon these groundwater supplies may change during the Plan's implementation horizon.	This includes the key word "unaltered" and seems to protect the County's planned growth from being restrained due to the GSP. It anticipated that there maybe change to "actual land" uses reliant on groundwater under SGMA but the County anticipates that GSA will assist in any required mitigation to reduce the extent and impact of reduced groundwater pumping to existing uses.
Page 1-29. Paragraph 2. Each county has its own policies and procedures to obtain a water well permit. The DEID GSA shall request notification of any proposed water wells within the DEID GSA and shall further request the opportunity to review said requests so that the potential for undesirable effects that a new well might have on implementation of the GSP and provide comments and/or approval prior to issuance of any well permit.	The County will interact with the GSAs through review and input on well permitting. The County has modified its forms to integrate the role of GSAs in the process. GSA policies should be consistent with adopted County Environmental Health well permitting process. Specifically, see Water Code Section 10726.4(b).
Page 1-29. 1.4.4.7 Effect of Land Use Plans Outside of the Tule Subbasin	This is important. But it is in the context of the water budget for DEIDGSA that shows some modest increase in future Muni groundwater

Given that GSPs implemented within adjacent Subbasins must (1) ensure no adverse impact to the GSPs implemented within the Tule Subbasin and must also (2) address any impact that the various land use plans active within their GSPs' respective Plan Areas may have on their successful implementation of their respective GSPs, DEID GSA does not anticipate any significant adverse impacts resulting from the implementation of land use plans adjacent to the Tule Subbasin.	pumping. Increases greater than those values could be claimed to be an impact (current conditions pumping 2800 af, future condition pumping 3700 af all the way to 2070A). The County has checked the Community Plans in this area and this growth rate appears consistent with these estimated budgets. If the budget is too low, it should be adjusted accordingly. Another avenue that could be considered is updating LAFCo MSR's as a first step regarding CSD and PUD pumping and water supply capabilities within the next 5 years (at the next update of the GSP).
Page 2-1. Introduction The Basin Setting for the DEID GSA is derived from the Tule Subbasin Setting, which was developed for the Tule Subbasin by Thomas Harder and Company, The Tule Subbasin Setting can be found as Attachment 2 to the Draft Tule Subbasin Coordination Agreement1 (see Appendix A).	This document includes a budget for the entire Tule Subbasin, and separate sub-budgets for each GSA, included DEID GSA. The DEIR GSA budget has current Muni pumping at 2800 af/yr, and future pumping at 3,700 af/yr.
Page 2-13. Paragraph 1. However, when factoring subsurface inflows from outside of the subbasin and from other Tule Subbasin GSAs (1986/87-2016/17 average of 24,000 acre-feet) and subsurface outflows to others outside of the subbsasin and other Tule Subbasin GSAs north and west of the DEID GSA (1986/87-2016/17 average of 52,000 acre-feet) the DEID GSP area is not in balance (***Table 2*** of ***Appendix C,*** *Tule Subbasin Setting)*. The primary source of this imbalance is an over-extraction of groundwater resources within GSAs that are located north and west of the DEID GSA.	Please clarify, this may be of concern, and given that the imbalance may not be reported in these surrounding GSA's please verify that the numbers are consistently being reported in the surrounding GSA's or at least report here the constituencies.
Pag 2-14. 2.4.1.1.5 Municipal Deliveries from Wells	Please clarify that the stated value of 2,100 is the "average" value for this period. Using an average value for Muni pumping should be noted

For the period of 1986/87- 2016/17, municipal pumping within DEID GSA on an average annual basis was estimated to be approximately 2,100 acre-feet/yr (see Table 1a of Appendix C, Tule Subbasin Setting).	that it increases with growth – unlike ag use, which varies greatly with crop trends and annual hydrology/rainfall. This should just show the range and indicate that current use is 2800 af/yr (see ch2 of Tule Subbasin Setting Rpt, Appendix C, Table 1-a for DEID GSA)
Page 2-16. 2.4.1.2.5.3 Deep Percolation of Applied Native Groundwater for Municipal Irrigation (Municipal Pumping) Deep percolation of applied groundwater for municipal irrigation is described in ***Chapter 2.3.1.2.5***. For the period of 1986/87- 2016/17, deep percolation of applied groundwater for municipal irrigation within DEID GSA on an average annual basis was estimated to be approximately 1,400 acre-feet/yr (see ***Table 1b*** of ***Appendix C,*** *Tule Subbasin Setting*).	The value is an "average" and should be shown as a range, with the most recent value reflecting current population conditions.
Page 2-17. 2.4.1.2.9 Municipal Consumptive Use Municipal consumptive use is described in ***Chapter 2.3.1.2.6***. For the period of 1986/87-2016/17, the estimated municipal consumptive use from landscape irrigation within the DEID GSA on an average annual basis was estimated to be approximately 700 acre-feet/yr (see ***Table 1b*** of ***Appendix C,*** *Tule Subbasin Setting*).	The value is an "average" and should be shown as a range, with the most recent value reflecting current population conditions.
Page 2-20. 2.4.4.1 Municipal Groundwater Pumping For the period of 1986/87- 2016/17, municipal groundwater pumping within DEID GSA on an average annual basis was estimated to be approximately 2,100 acre-feet/yr (see ***Table 1b*** of ***Appendix C,*** *Tule Subbasin Setting*).	The value is an "average" and should be shown as a range, with the most recent value reflecting current population conditions.
Page 2-26. 2.5 Management Areas • The Earlimart Public Utilities District- The Earlimart PUD	Will the GSA recognize any future expansion of these management areas as they may annex additional lands for growth? Or, are the

serves the water and wastewater needs of the unincorporated community of Earlimart. With a service area of 773 acres, the EPUD has been historically dependent on groundwater. Because of its location and being a purveyor of domestic water as well as managing wastewater, the EPUD is its own management area. • The Richgrove Community Services District- The Richgrove CSD serves the water and wastewater needs of the unincorporated community of Richgrove. With a service area of 234 acres, the RCSD has been historically dependent on groundwater. Because of its location and being a purveyor of domestic water as well as managing wastewater, the RCSD is its own management area.	boundaries as established fixed for the long-term future? If they are not consistent, they may need to become consistent (e.g. the GSA will need to match the County's land use Plans in the updated GSP within the next 5 years.
Page 3-20. 3.5.2.5.3 Effects on Beneficial Uses **Well failures** (*e.g. collapsed casing due to excessive groundwater level decline or land subsidence*): Minimum Thresholds established for groundwater levels to minimize loss of existing wells.	Unclear if some domestic well impacts are expected, and, if so, how such impacts to these deminimus users would be mitigated. Also, it is not clear what objective or subjective criteria were used in relation to the term 'minimize'.
Page 5-1. 5.2 Projects and Management Actions Municipal Water Supply and Quality Projects	The County will have a role with these projects as it relates to supporting the Community Plans in this GSA boundary.
Page 5-3. 5.2.1.1 Action 1 – Continued Importation and Optimization of Imported Water Supplies	This action will help stabilize levels for rural domestic users within this management area. The County is supportive. While rural domestic use is not explicitly named, the maintenance of gw levels will benefit this use group.
Page 5-8. 5.2.1.2 Action 2 – Increase Importation of Imported Waters Action 2 of the DEID Management Area consist of increasing imported	Similar to Action 1, this action will help stabalize levels for rural domestic users within this management area. The County is supportive. While rural domestic use is not explicitly named,

water quantities above historic operations to meet consumptive use requirements, new water demands, and reduce reliance on groundwater pumping.	the maintenance of gw levels will benefit this user group.
Page 5-17. 5.2.1.4.1 Description This Action will build upon the historic direct water recharge projects described in Action 3 to enhance the water resources available to the DEID Management Area. Future direct water recharge projects will increase the amount of water in storage through utilization of unused CVP imported water supplies available to the DEID Management Area through its long-term CVP water contract with the U.S. Department of the Interior. Other non-CVP supplies will also be used when and if available.	This action has the potential to transport water quality constituents (e.g. nitrates or arsenic) into drinking water sources.
Page 5-33. 5.2.2.2.4 Quantification of Water Budget Impact If all lands within the WMA were to use the maximum amount of water under Action 1, over-pumping would total approximately XXXX3 acre-feet between 2020-2035.	The extent of over-pumping will have an impact on any domestic wells in this area. The County would like some assurances that any domestic wells that go dry due to this planned management approach are mitigated by those continuing the excessive extraction. There are likely only a few wells in this area, so should be a nominal consideration.
Page 5-34. 5.2.2.2.7 Anticipated Benefits and Evaluation Action 1 will provide an orderly transition from current pumping levels to sustainable levels as required by SGMA over a 15-year time period. It is designed to avoid the economic impact that would otherwise be felt in an “overnight” reduction in water supplies. While implementation of Action 1 will delay reaching sustainability before 2035, through responsible mitigation of impacts, the benefits of this Action	The avoidance of economic impacts is reasonable. For your consideration, impacts to domestic wells in the area due to ongoing lowering of groundwater levels may need to be mitigated at the GSA level.

can be realized while meeting the goal of sustainability by 2040.	
Page 5-57. 5.2.3.1.1 Introduction Projects and management actions for the RCSD MA are associated with the following general categories of actions: • Current Groundwater Supply Optimization • Development of Additional Groundwater Supplies • Existing and Future Managed Aquifer Recharge	These actions will be coordinated with the County's Community Plan for this management area. Recommend updating LAFCo MSR's as a first step regarding CSD and PUD water supply capabilities.
Page 5-69. 5.2.4.1.1 Introduction Projects and management actions for the EPUD MA are associated with the following general categories of actions: • Current groundwater supply optimization • Development of additional groundwater supplies • Existing and future managed aquifer recharge	These actions should be coordinated with the County's Community Plan for this management area.
Page 6-6. 6.5.2 DEID GSA Land-Based Assessment Fees As noted above, general expenses of the GSP are anticipated to be funded through a per-acre land-based assessment across all acreage in the DEID GSA. This is expected to be achieve through either a Proposition 218 election of a Proposition 26 fee assessment.	The County requests that the GSA look towards a different assessment rate for deminimus users.
Page 22 of TULE SUBBASIN COORDINATION AGREEMENT ATTACHMENT 2 2.3.1.1.5. Municipal Deliveries from Wells Groundwater pumping for municipal supply is conducted by the city of Porterville and small municipalities for the local communities in the Tule Subbasin. From water years 1986-87 to 2016/17, municipal pumping from	As noted previously, values like this are an 'average'. Generally, urban use is going to continue to grow as population grows - though the use per person may be lower.

wells was estimated to average approximately 20,000 acre-ft.yr.	

United States Department of the Interior

BUREAU OF RECLAMATION
Mid-Pacific Region
South-Central California Area Office
1243 N Street
Fresno, CA 93721-1813

IN REPLY REFER TO:
SCC-100
2.2.4.23

DEC 16 2019

VIA ELECTRONIC AND U.S. MAIL

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Subject: Comments on Tulare Subbasin Groundwater Sustainability Plans

Dear Tule Subbasin Groundwater Sustainability Agencies:

The United States Bureau of Reclamation (Reclamation) provides these comments on the draft groundwater sustainability plans submitted by the addressee Groundwater Sustainability Agencies (GSA) in the Tule Subbasin.

We commend and appreciate your efforts, time, and energy devoted to the very difficult task of developing groundwater sustainability plans (GSP) to comply with the Sustainable Groundwater Management Act of 2014.

The mission of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. In the Friant Division, one of the most critical features of infrastructure that allows us to meet our mission is the Friant-Kern Canal, which, has been operated and maintained by the Friant Water Users Authority and subsequently the Friant Water Authority (FWA) since 1986. The Friant-Kern Canal delivers water to numerous water and irrigation districts, as well as cities, and about 15,000 family farms, and the very existence and inspiration of the canal was to, among other things, combat issues such as subsidence by conveying surface water to incentivize farmers to pump less ground water. For decades, the Friant Division system has performed as intended and the farms and towns on the eastside of the San Joaquin Valley have flourished.

However, after the last prolonged drought that ended in 2017, it was discovered that about 60% of the Friant-Kern Canal delivery capacity had been lost due to severe land subsidence. The clearest explanation for this subsidence, is that it was caused largely by the over-pumping of groundwater on lands not currently served by surface water that lie within your respective GSAs. At the current detrimental rate of subsidence, FWA estimates that the Friant-Kern Canal will be operating at 30% capacity within three years. This is a trajectory that we ought naught allow to continue unchecked, and proactive measures need to be taken now to mitigate and prevent this cause and effect phenomenon.

For these and other reasons, as title holder and owner of the Friant-Kern Canal, we substantially concur with the comment letter submitted to the GSAs of the Tule Subbasin by the FWA on December 16, 2019 (attached) and look forward to the coordination and collaboration necessary to adopt appropriate management actions and plans to properly deal with staving off subsidence and its detrimental effects to the Friant-Kern Canal.

If you should have any questions on this matter, please contact me at (559) 262-0300 or by cellphone at (559) 260-8714, by electronic mail at mjackson@usbr.gov or for the hearing impaired at TTY (800) 877-8339.

Sincerely,

Michael P. Jackson

Michael P. Jackson, P.E.
Area Manager

Enclosure
Friant Water Authority Comment letter dated December 16, 2019

cc: Mr. Jason Phillips, CEO
Friant Water Authority
854 North Harvard Avenue
Lindsay, CA 93247
(w/enclosure)

WESTCHESTER
from nuveen

Westchester Group
Investment Management, Inc.
6715 N. Palm Avenue
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Fresno, CA 93704
WGIMglobal.com

November 27, 2019

Delano Earlimart Irrigation District GSP
Eric R. Quinley, General Manager
14181 Avenue 24
Delano, CA 93215

Re: DEID Groundwater Sustainability Plan

Dear Mr. Quinley,

Westchester Group Investment Management (WGIM) offers the following comments on the Draft Delano Earlimart Irrigation District (DEID) Groundwater Sustainability Plan (GSP):

Allocation of Native Yield

The GSP references native yield in terms of acre-feet per gross acre for water budget purposes. If referencing it this way is necessary, the GSP should clarify that these calculations are for initial water budget purposes ONLY, are non-precedent setting, and not a determination of individual landowner allocations or groundwater rights. Alternatively, native yield could be described only as a total volume of water and not associated with a given gross or net area. In the event that allocations are to be made at a landowner or property level, WGIM encourages DEID and other GSAs in the basin to initiate a stakeholder-driven process to develop a methodology for establishing landowner-level allocations that are coordinated across the basin. The allocation methodology should be consistent with various legal considerations drawn from applicable case law and attempt to be consistent with groundwater rights, recognizing that GSAs do not have statutory authority to make a final determination of water rights. An equal-per-gross acre approach to allocations is not likely to be consistent with established water rights doctrine, which must recognize many equitable considerations, in addition to acreage owned, to determine a legally defensible allocation. Further information regarding allocation methodology can be found in *Groundwater Pumping Allocations Under California's Sustainable Groundwater Management Act – EDF and NCWL, dated July, 2018.*

Pumping Restrictions

We understand that there are instances where it may be necessary to restrict pumping in order to achieve basin-wide sustainability and address local subsidence issues. If this becomes a necessity, the GSAs should implement pumping restrictions when supported by the best available data and appropriate analytical tools. Furthermore, if possible without creating undesirable

DELANO – EARLIMART IRRIGATION DISTRICT
GROUNDWATER SUSTAINABILITY AGENCY

APPENDIX M

DEID GSA Historical Surface Water and Groundwater Budget Tables

2024
2nd Amended Groundwater Sustainability Plan

Table 1: Delano-Earlimart Irrigation District GSA Historical Surface Water Budget

	Surface Water Inflow (acre-ft)						Surface Water Outflow (acre-ft)												
	A	B	C	D	E		F	G	H	I	J	K	L	M	N	O			
				Discharge from Wells						Deep Percolation of Applied Water			Evapotranspiration						
Water Year	Precipitation	Stream Inflow (White River)	Imported Water	Agricultural	Municipal	Total In	Areal Recharge of Precipitation	Streambed Infiltration (White River)	Recharge in Basins (Imported Water)	Imported Water	Agricultural Pumping	Municipal Pumping	Precipitation Crops/Native	Ag. Cons. Use (Imported Water)	Ag. Cons. Use (Pumped Water)	Municipal (Landscape ET)	Total Out	Change in Storage (acre-ft)	Cumulative Change in Storage (acre-ft)
1986-1987	23,951	0	114,782	40,679	1,600	181,012	0	0	0	27,100	7,555	1,100	23,951	87,600	33,324	600	181,230	-218	-218
1987-1988	34,596	0	110,345	41,679	1,600	188,220	0	0	0	23,200	7,655	1,100	34,596	87,100	33,324	600	187,575	645	427
1988-1989	28,386	0	105,980	45,679	1,700	181,745	0	0	0	22,400	8,555	1,100	28,386	83,600	37,324	600	181,965	-220	207
1989-1990	26,612	0	83,837	67,679	1,700	179,828	0	0	0	18,000	12,555	1,100	26,612	65,900	55,324	600	180,091	-263	-56
1990-1991	36,370	0	106,877	42,679	1,700	187,626	0	0	0	20,900	7,955	1,100	36,370	86,000	35,324	600	188,249	-623	-679
1991-1992	31,934	0	92,567	59,679	1,700	185,880	0	0	0	19,900	11,055	1,100	31,934	72,700	48,324	600	185,613	267	-412
1992-1993	51,450	0	133,359	22,679	1,700	209,188	3,997	0	5,600	25,400	4,155	1,100	47,015	102,400	18,324	600	208,591	597	185
1993-1994	31,934	0	92,394	61,679	1,800	187,807	0	0	700	21,400	11,455	1,100	31,934	70,300	50,324	600	187,813	-6	179
1994-1995	67,417	3,867	124,388	29,679	1,800	227,151	14,368	3,867	4,500	23,700	5,455	1,200	54,111	96,300	24,324	600	228,425	-1,274	-1,095
1995-1996	35,483	1,276	144,069	15,209	1,800	197,837	0	1,276	1,300	37,100	2,629	1,200	35,483	105,800	12,280	600	197,668	169	-926
1996-1997	49,676	6,659	153,967	13,293	1,800	225,394	4,000	6,659	5,300	42,100	2,294	1,200	46,128	106,500	10,599	600	225,379	15	-911
1997-1998	80,723	27,100	119,815	35,293	1,800	264,731	23,558	27,100	2,900	28,200	6,394	1,200	58,546	88,700	28,599	700	265,897	-1,166	-2,077
1998-1999	40,805	205	124,051	27,293	1,900	194,254	0	205	2,700	26,600	4,994	1,200	40,805	94,700	22,599	700	194,503	-249	-2,326
1999-2000	39,031	626	134,272	21,293	1,900	197,122	0	626	4,400	29,900	3,794	1,200	39,031	100,000	17,599	700	197,250	-128	-2,454
2000-2001	29,273	296	117,746	32,293	1,900	181,508	0	296	600	26,800	5,994	1,200	29,273	90,400	26,599	700	181,862	-354	-2,808
2001-2002	27,499	1,067	126,747	23,293	2,000	180,606	0	1,067	0	28,400	4,194	1,300	27,499	98,300	18,599	700	180,059	547	-2,261
2002-2003	27,499	646	121,277	23,386	2,000	174,808	0	646	0	23,800	3,288	1,300	27,499	97,500	19,599	700	174,331	477	-1,784
2003-2004	23,064	0	127,364	15,282	2,100	167,809	0	0	0	27,700	2,145	1,300	23,064	99,700	13,436	700	168,045	-236	-2,020
2004-2005	43,466	1,298	119,847	19,234	2,100	185,945	1,000	1,298	100	23,700	2,735	1,400	42,579	96,100	16,399	800	186,111	-166	-2,186
2005-2006	44,353	2,384	121,005	18,234	2,200	188,176	1,000	2,384	1,200	23,200	2,635	1,400	43,466	96,700	16,399	800	189,184	-1,008	-3,194
2006-2007	18,628	0	79,111	57,234	2,200	157,173	0	0	100	15,800	8,235	1,500	18,628	63,200	49,399	800	157,662	-489	-3,683
2007-2008	21,290	0	106,470	26,234	2,300	156,294	0	0	0	16,500	3,735	1,500	21,290	90,000	22,399	800	156,224	70	-3,613
2008-2009	22,177	0	111,556	27,234	2,400	163,367	0	0	2,500	19,500	3,735	1,500	22,177	89,600	23,399	800	163,211	156	-3,457
2009-2010	36,370	0	118,671	23,234	2,400	180,675	0	0	5,800	20,200	3,235	1,600	36,370	92,600	20,399	900	181,104	-429	-3,886
2010-2011	53,224	6,543	127,447	17,525	2,500	207,239	4,992	6,543	9,400	22,100	2,407	1,600	47,902	96,000	15,418	900	207,262	-23	-3,908
2011-2012	33,709	0	114,108	20,533	2,500	170,849	0	0	1,100	21,000	2,909	1,600	33,709	92,000	17,424	900	170,641	208	-3,700
2012-2013	15,080	0	87,302	45,533	2,600	150,515	0	0	0	16,300	6,509	1,700	15,080	71,000	39,424	900	150,913	-398	-4,098
2013-2014	10,645	0	38,106	92,533	2,600	143,884	0	0	0	7,100	13,209	1,700	10,645	31,000	79,424	900	143,978	-94	-4,192
2014-2015	15,967	0	18,591	110,533	2,700	147,791	0	0	0	2,700	15,809	1,700	15,967	15,900	94,424	1,000	147,500	291	-3,901
2015-2016	23,951	0	93,806	38,533	2,800	159,090	0	0	3,600	13,000	5,509	1,800	23,951	77,100	33,424	1,000	159,384	-294	-4,195
2016-2017	24,838	10,216	137,773	15,533	2,800	191,160	0	10,216	16,400	23,100	2,109	1,800	24,838	98,200	13,424	1,000	191,087	73	-4,122
86/87-16/17 Avg	**33,852**	**2,006**	**109,924**	**36,480**	**2,084**	**184,345**	**1,707**	**2,006**	**2,200**	**22,477**	**5,964**	**1,352**	**32,221**	**85,255**	**30,554**	**742**	**184,478**	**-133**	

Cumulative Change in Storage -4,122

Table 2: Delano-Earlimart Irrigation District GSA Historical Groundwater Budget

Water Year	Groundwater Inflows (acre-ft) A: Areal Recharge from Precipitation	B: Streambed Infiltration (White River)	C: Imported Water Deliveries – Recharge in Basins	D: Imported Water Deliveries – Return Flow	E: Agricultural Pumping Return Flow	F: Municipal Pumping Return Flow	G: Release of Water from Compression of Aquitards	H: Sub-surface Inflow – From Outside Subbasin	I: Sub-surface Inflow – From Other GSAs	Total In	Groundwater Outflows (acre-ft) J: Groundwater Pumping – Municipal	K: Groundwater Pumping – Agricultural	L: Groundwater Pumping – Groundwater Banking Extraction	M: Sub-surface Outflow – To Outside Subbasin	N: Sub-surface Outflow – To Other GSAs	Total Out	Change in Storage (acre-ft)	Cumulative Change in Storage (acre-ft)
1986-1987	0	0	0	27,100	7,555	1,100	8,066	3,651	7,639	55,111	1,600	40,679	0	19,571	43,809	105,659	-50,548	-50,548
1987-1988	0	0	0	23,200	7,655	1,100	8,182	3,332	7,050	50,520	1,600	41,679	0	17,483	47,154	107,916	-57,395	-107,943
1988-1989	0	0	0	22,400	8,555	1,100	7,804	3,718	7,232	50,810	1,700	45,679	0	16,385	46,438	110,201	-59,392	-167,335
1989-1990	0	0	0	18,000	12,555	1,100	15,586	4,916	10,224	62,381	1,700	67,679	0	18,523	42,145	130,047	-67,666	-235,001
1990-1991	0	0	0	20,900	7,955	1,100	4,264	4,526	9,363	48,109	1,700	42,679	0	20,456	47,285	112,119	-64,011	-299,011
1991-1992	0	0	0	19,900	11,055	1,100	7,816	5,368	10,439	55,679	1,700	59,679	0	14,640	42,821	118,840	-63,161	-362,172
1992-1993	3,997	0	5,600	25,400	4,155	1,100	530	4,365	7,648	52,796	1,700	22,679	0	15,682	44,747	84,808	-32,013	-394,185
1993-1994	0	0	700	21,400	11,455	1,100	7,380	6,216	10,898	59,149	1,800	61,679	0	12,275	38,072	113,826	-54,676	-448,861
1994-1995	14,368	3,900	4,500	23,700	5,455	1,200	566	4,859	8,653	67,201	1,800	29,679	0	13,123	44,538	89,140	-21,939	-470,800
1995-1996	0	1,300	1,300	37,100	2,629	1,200	623	4,946	7,726	56,824	1,800	15,209	0	12,601	44,618	74,228	-17,404	-488,204
1996-1997	4,000	6,700	5,300	42,100	2,294	1,200	911	4,828	7,303	74,636	1,800	13,293	0	14,795	45,411	75,299	-663	-488,867
1997-1998	23,558	27,100	2,900	28,200	6,394	1,200	1,321	5,636	9,350	105,658	1,800	35,293	0	13,937	42,876	93,906	11,752	-477,115
1998-1999	0	200	2,700	26,600	4,994	1,200	689	5,225	10,087	51,695	1,900	27,293	0	13,285	43,329	85,806	-34,111	-511,226
1999-2000	0	600	4,400	29,900	3,794	1,200	776	5,409	9,578	55,657	1,900	21,293	0	13,575	45,074	81,841	-26,185	-537,411
2000-2001	0	300	600	26,800	5,994	1,200	3,504	5,209	9,961	53,568	1,900	32,293	0	15,716	43,990	93,899	-40,331	-577,742
2001-2002	0	1,100	0	28,400	4,194	1,300	2,892	5,206	9,456	52,548	2,000	23,293	0	16,620	47,150	89,063	-36,515	-614,257
2002-2003	0	600	0	23,800	3,288	1,300	2,033	5,320	8,829	45,170	2,000	23,386	0	14,077	45,111	84,574	-39,405	-653,662
2003-2004	0	0	0	27,700	2,145	1,300	2,900	5,068	7,603	46,717	2,100	15,282	0	15,251	46,040	78,673	-31,956	-685,618
2004-2005	1,000	1,300	100	23,700	2,735	1,400	2,177	5,148	7,671	45,231	2,100	19,234	0	15,389	42,477	79,200	-33,969	-719,587
2005-2006	1,000	2,400	1,200	23,200	2,635	1,400	2,030	5,635	7,615	47,115	2,200	18,234	0	12,398	41,770	74,602	-27,487	-747,074
2006-2007	0	0	100	15,800	8,235	1,500	13,615	6,367	10,535	56,152	2,200	57,234	0	13,140	36,613	109,188	-53,036	-800,110
2007-2008	0	0	0	16,500	3,735	1,500	4,057	5,486	9,116	40,395	2,300	26,234	0	19,046	42,930	90,511	-50,116	-850,226
2008-2009	0	0	2,500	19,500	3,735	1,500	5,232	5,381	8,739	46,587	2,400	27,234	600	19,933	44,591	94,758	-48,170	-898,396
2009-2010	0	0	5,800	20,200	3,235	1,600	3,885	5,440	8,635	48,795	2,400	23,234	100	19,352	44,139	89,225	-40,430	-938,826
2010-2011	4,992	6,500	9,400	22,100	2,407	1,600	2,267	5,464	7,855	62,586	2,500	17,525	0	16,248	43,232	79,505	-16,918	-955,745
2011-2012	0	0	1,100	21,000	2,909	1,600	5,106	5,354	8,369	45,439	2,500	20,533	3,900	17,302	44,115	88,350	-42,911	-998,656
2012-2013	0	0	0	16,300	6,509	1,700	11,605	5,413	10,335	51,861	2,600	45,533	6,000	16,324	42,173	112,630	-60,769	-1,059,425
2013-2014	0	0	0	7,100	13,209	1,700	19,299	6,065	15,266	62,638	2,600	92,533	5,600	16,208	35,737	152,678	-90,040	-1,149,465
2014-2015	0	0	0	2,700	15,809	1,700	13,055	6,571	17,076	56,911	2,700	110,533	1,200	14,281	32,469	161,183	-104,272	-1,253,736
2015-2016	0	0	3,600	13,000	5,509	1,800	5,875	6,395	12,653	48,832	2,800	38,533	100	15,424	36,106	92,963	-44,131	-1,297,867
2016-2017	0	10,200	16,400	23,100	2,109	1,800	2,989	5,091	8,129	69,818	2,800	15,533	0	15,127	39,864	73,324	-3,506	-1,301,373
86/87-16/17 Avg	**1,707**	**2,006**	**2,200**	**22,477**	**5,964**	**1,352**	**5,388**	**5,213**	**9,388**	**55,696**	**2,084**	**36,480**	**565**	**15,747**	**42,801**	**97,676**	**-41,980**	

Cumulative Change in Storage -1,301,373

Table 3: Delano-Earlimart Irrigation District GSA Projected Surface Water Budget

	Surface Water Inflow (acre-ft)							Surface Water Outflow (acre-ft)												
	A	B	C	D	E	F		G	H	I	J	K	L	M	N	O	P			
				Discharge from Wells							Deep Percolation of Applied Water			Evapotranspiration						
Water Year	Precipitation	Stream Inflow (White River)	Imported Water	Agricultural	Municipal	Water Bank	Total In	Areal Recharge of Precipitation	Streambed Infiltration (White River)	Recharge in Basins (Imported Water)	Imported Water	Agricultural Pumping	Municipal Pumping	Precipitation Crops/Native	Ag. Cons. Use (Imported Water)	Ag. Cons. Use (Pumped Water)	Municipal (Landscape ET)	Total Out	Change in Storage (acre-ft)	Cumulative Change in Storage (acre-ft)
2017-2018	33,852	2,224	116,902	18,660	3,700	4,752	180,090	1,707	2,224	4,752	21,400	2,646	2,400	32,221	95,500	15,314	1,300	179,464	626	626
2018-2019	33,852	2,224	116,902	18,660	3,700	4,752	180,090	1,707	2,224	4,752	21,400	2,646	2,400	32,221	95,500	15,314	1,300	179,464	626	1,252
2019-2020	33,852	2,224	116,902	18,660	3,700	4,752	180,090	1,707	2,224	4,752	21,400	2,646	2,400	32,221	95,500	15,314	1,300	179,464	626	1,878
2020-2021	33,852	2,224	116,902	18,660	3,700	14,257	189,595	1,707	2,224	14,257	21,400	2,646	2,400	32,221	95,500	15,314	1,300	188,969	626	2,504
2021-2022	33,852	2,224	116,902	18,660	3,700	14,257	189,595	1,707	2,224	14,257	21,400	2,646	2,400	32,221	95,500	15,314	1,300	188,969	626	3,131
2022-2023	33,852	2,224	116,902	18,660	3,700	19,010	194,348	1,707	2,224	19,010	21,400	2,646	2,400	32,221	95,500	15,314	1,300	193,722	626	3,757
2023-2024	33,852	2,224	116,902	18,660	3,700	23,644	198,982	1,707	2,224	23,644	21,400	2,646	2,400	32,221	95,500	15,314	1,300	198,356	626	4,383
2024-2025	33,852	2,224	117,661	17,085	3,700	28,040	202,561	1,707	2,224	28,040	21,500	2,547	2,400	32,221	96,100	15,438	1,300	203,476	-915	3,468
2025-2026	33,852	2,224	118,420	16,509	3,700	28,040	202,745	1,707	2,224	28,040	21,600	2,447	2,400	32,221	96,800	14,563	1,300	203,301	-556	2,912
2026-2027	33,852	2,224	119,180	15,934	3,700	28,040	202,930	1,707	2,224	28,040	21,700	2,347	2,400	32,221	97,400	13,687	1,300	203,026	-96	2,816
2027-2028	33,852	2,224	119,939	15,359	3,700	28,040	203,114	1,707	2,224	28,040	21,800	2,247	2,400	32,221	98,100	12,812	1,300	202,850	263	3,079
2028-2029	33,852	2,224	120,698	14,784	3,700	28,040	203,297	1,707	2,224	28,040	22,000	2,047	2,400	32,221	98,700	11,936	1,300	202,575	722	3,801
2029-2030	33,852	2,224	121,457	14,208	3,700	28,040	203,481	1,707	2,224	28,040	22,100	1,948	2,400	32,221	99,400	12,061	1,300	203,400	81	3,883
2030-2031	33,852	2,224	121,457	13,633	3,700	28,040	202,906	1,707	2,224	28,040	22,100	1,948	2,400	32,221	99,400	12,185	1,300	203,525	-619	3,264
2031-2032	33,852	2,224	121,457	14,058	3,700	28,040	203,330	1,707	2,224	28,040	22,100	1,948	2,400	32,221	99,400	11,310	1,300	202,649	681	3,945
2032-2033	33,852	2,224	121,457	13,482	3,700	28,040	202,755	1,707	2,224	28,040	22,100	1,948	2,400	32,221	99,400	11,434	1,300	202,774	-19	3,926
2033-2034	33,852	2,224	121,457	13,907	3,700	28,040	203,180	1,707	2,224	28,040	22,100	1,948	2,400	32,221	99,400	11,559	1,300	202,899	281	4,207
2034-2035	33,852	2,224	121,457	13,610	3,700	28,040	202,883	1,707	2,224	28,040	22,100	2,007	2,400	32,221	99,400	11,903	1,300	203,302	-419	3,788
2035-2036	33,852	2,224	121,457	13,610	3,700	28,040	202,883	1,707	2,224	28,040	22,100	2,007	2,400	32,221	99,400	11,903	1,300	203,302	-419	3,369
2036-2037	33,852	2,224	121,457	13,610	3,700	28,040	202,883	1,707	2,224	28,040	22,100	2,007	2,400	32,221	99,400	11,903	1,300	203,302	-419	2,950
2037-2038	33,852	2,224	121,457	13,610	3,700	28,040	202,883	1,707	2,224	28,040	22,100	2,007	2,400	32,221	99,400	11,903	1,300	203,302	-419	2,532
2038-2039	33,852	2,224	121,457	13,610	3,700	28,040	202,883	1,707	2,224	28,040	22,100	2,007	2,400	32,221	99,400	11,903	1,300	203,302	-419	2,113
2039-2040	33,852	2,224	121,457	13,332	3,700	28,040	202,604	1,707	2,224	28,040	22,100	1,949	2,400	32,221	99,400	11,683	1,300	203,023	-419	1,694
2040-2041	33,852	2,224	121,457	13,332	3,700	28,040	202,604	1,707	2,224	28,040	22,100	1,949	2,400	32,221	99,400	11,683	1,300	203,023	-419	1,275
2041-2042	33,852	2,224	121,457	13,332	3,700	28,040	202,604	1,707	2,224	28,040	22,100	1,949	2,400	32,221	99,400	11,683	1,300	203,023	-419	856
2042-2043	33,852	2,224	121,457	13,332	3,700	28,040	202,604	1,707	2,224	28,040	22,100	1,949	2,400	32,221	99,400	11,683	1,300	203,023	-419	437
2043-2044	33,852	2,224	121,457	13,332	3,700	28,040	202,604	1,707	2,224	28,040	22,100	1,949	2,400	32,221	99,400	11,683	1,300	203,023	-419	18
2044-2045	33,852	2,224	121,457	13,332	3,700	28,040	202,604	1,707	2,224	28,040	22,100	1,949	2,400	32,221	99,400	11,683	1,300	203,023	-419	-401
2045-2046	33,852	2,224	121,457	13,332	3,700	28,040	202,604	1,707	2,224	28,040	22,100	1,949	2,400	32,221	99,400	11,683	1,300	203,023	-419	-820
2046-2047	33,852	2,224	121,457	13,332	3,700	28,040	202,604	1,707	2,224	28,040	22,100	1,949	2,400	32,221	99,400	11,683	1,300	203,023	-419	-1,238
2047-2048	33,852	2,224	121,457	13,332	3,700	28,040	202,604	1,707	2,224	28,040	22,100	1,949	2,400	32,221	99,400	11,683	1,300	203,023	-419	-1,657
2048-2049	33,852	2,224	121,457	13,332	3,700	28,040	202,604	1,707	2,224	28,040	22,100	1,949	2,400	32,221	99,400	11,683	1,300	203,023	-419	-2,076
2049-2050	33,852	2,224	121,457	13,332	3,700	28,040	202,604	1,707	2,224	28,040	22,100	1,949	2,400	32,221	99,400	11,683	1,300	203,023	-419	-2,495
2050-2051	33,852	2,152	112,046	23,332	3,700	28,040	203,121	1,707	2,152	28,040	20,700	3,349	2,400	32,221	91,300	19,683	1,300	202,851	270	-2,225
2051-2052	33,852	2,152	112,046	23,332	3,700	28,040	203,121	1,707	2,152	28,040	20,700	3,349	2,400	32,221	91,300	19,683	1,300	202,851	270	-1,955
2052-2053	33,852	2,152	112,046	23,332	3,700	28,040	203,121	1,707	2,152	28,040	20,700	3,349	2,400	32,221	91,300	19,683	1,300	202,851	270	-1,685
2053-2054	33,852	2,152	112,046	23,332	3,700	28,040	203,121	1,707	2,152	28,040	20,700	3,349	2,400	32,221	91,300	19,683	1,300	202,851	270	-1,415
2054-2055	33,852	2,152	112,046	23,332	3,700	28,040	203,121	1,707	2,152	28,040	20,700	3,349	2,400	32,221	91,300	19,683	1,300	202,851	270	-1,144
2055-2056	33,852	2,152	112,046	23,332	3,700	28,040	203,121	1,707	2,152	28,040	20,700	3,349	2,400	32,221	91,300	19,683	1,300	202,851	270	-874
2056-2057	33,852	2,152	112,046	23,332	3,700	28,040	203,121	1,707	2,152	28,040	20,700	3,349	2,400	32,221	91,300	19,683	1,300	202,851	270	-604
2057-2058	33,852	2,152	112,046	23,332	3,700	28,040	203,121	1,707	2,152	28,040	20,700	3,349	2,400	32,221	91,300	19,683	1,300	202,851	270	-334

2058-2059	33,852	2,152	112,046	23,332	3,700	28,040	203,121	1,707	2,152	28,040	20,700	3,349	2,400	32,221	91,300	19,683	1,300	202,851	270	-64
2059-2060	33,852	2,152	112,046	23,332	3,700	28,040	203,121	1,707	2,152	28,040	20,700	3,349	2,400	32,221	91,300	19,683	1,300	202,851	270	206
2060-2061	33,852	2,152	112,046	23,332	3,700	28,040	203,121	1,707	2,152	28,040	20,700	3,349	2,400	32,221	91,300	19,683	1,300	202,851	270	476
2061-2062	33,852	2,152	112,046	23,332	3,700	28,040	203,121	1,707	2,152	28,040	20,700	3,349	2,400	32,221	91,300	19,683	1,300	202,851	270	746
2062-2063	33,852	2,152	112,046	23,332	3,700	28,040	203,121	1,707	2,152	28,040	20,700	3,349	2,400	32,221	91,300	19,683	1,300	202,851	270	1,017
2063-2064	33,852	2,152	112,046	23,332	3,700	28,040	203,121	1,707	2,152	28,040	20,700	3,349	2,400	32,221	91,300	19,683	1,300	202,851	270	1,287
2064-2065	33,852	2,152	112,046	23,332	3,700	28,040	203,121	1,707	2,152	28,040	20,700	3,349	2,400	32,221	91,300	19,683	1,300	202,851	270	1,557
2065-2066	33,852	2,152	112,046	23,332	3,700	28,040	203,121	1,707	2,152	28,040	20,700	3,349	2,400	32,221	91,300	19,683	1,300	202,851	270	1,827
2066-2067	33,852	2,152	112,046	23,332	3,700	28,040	203,121	1,707	2,152	28,040	20,700	3,349	2,400	32,221	91,300	19,683	1,300	202,851	270	2,097
2067-2068	33,852	2,152	112,046	23,332	3,700	28,040	203,121	1,707	2,152	28,040	20,700	3,349	2,400	32,221	91,300	19,683	1,300	202,851	270	2,367
2068-2069	33,852	2,152	112,046	23,332	3,700	28,040	203,121	1,707	2,152	28,040	20,700	3,349	2,400	32,221	91,300	19,683	1,300	202,851	270	2,637
2069-2070	33,852	2,152	112,046	23,332	3,700	28,040	203,121	1,707	2,152	28,040	20,700	3,349	2,400	32,221	91,300	19,683	1,300	202,851	270	2,907
17/18-69/70 Avg	**33,852**	**2,197**	**117,089**	**18,131**	**3,700**	**25,948**	**200,917**	**1,707**	**2,197**	**25,948**	**21,443**	**2,610**	**2,400**	**32,221**	**95,642**	**15,394**	**1,300**	**200,862**	**55**	

Cumulative Change in Storage 2,907

Table 4: Delano-Earlimart Irrigation District GSA Projected Groundwater Budget

	Groundwater Inflows (acre-ft)										Groundwater Outflows (acre-ft)						
	A	B	C	D	E	F	G	H	I		J	K	L	M			
			Imported Water Deliveries					Sub-surface Inflow			Groundwater Pumping		Sub-surface Outflow				
Water Year	Areal Recharge from Precipitation	Streambed Infiltration (White River)	Recharge in Basins	Return Flow	Agricultural Pumping Return Flow	Municipal Pumping Return Flow	Release of Water from Compression of Aquitards	From Outside Subbasin	From Other GSAs	Total In	Municipal	Agricultural	To Outside Subbasin	To Other GSAs	Total Out	Change in Storage (acre-ft)	Cumulative Change in Storage (acre-ft)
2017-2018	1,707	2,200	4,752	21,400	2,646	2,400	3,885	4,741	7,841	51,573	3,700	18,660	18,652	40,151	81,163	-29,590	-29,590
2018-2019	1,707	2,200	4,752	21,400	2,646	2,400	4,267	4,725	7,847	51,944	3,700	18,660	18,826	39,655	80,841	-28,897	-58,487
2019-2020	1,707	2,200	4,752	21,400	2,646	2,400	4,368	4,714	8,042	52,229	3,700	18,660	18,918	38,428	79,706	-27,477	-85,964
2020-2021	1,707	2,200	14,257	21,400	2,646	2,400	4,600	4,691	8,175	62,076	3,700	18,660	18,509	37,673	78,542	-16,466	-102,430
2021-2022	1,707	2,200	14,257	21,400	2,646	2,400	4,819	4,673	8,084	62,187	3,700	18,660	18,114	37,308	77,782	-15,595	-118,025
2022-2023	1,707	2,200	19,010	21,400	2,646	2,400	4,968	4,665	7,934	66,930	3,700	18,660	17,769	36,740	76,869	-9,939	-127,964
2023-2024	1,707	2,200	23,644	21,400	2,646	2,400	5,159	4,696	7,705	71,557	3,700	18,660	17,369	36,737	76,467	-4,910	-132,874
2024-2025	1,707	2,200	28,040	21,500	2,547	2,400	4,571	4,644	7,422	75,030	3,700	17,085	16,591	34,500	71,876	3,155	-129,719
2025-2026	1,707	2,200	28,040	21,600	2,447	2,400	4,224	4,603	7,161	74,382	3,700	16,509	16,214	33,099	69,522	4,860	-124,859
2026-2027	1,707	2,200	28,040	21,700	2,347	2,400	4,011	4,585	6,841	73,831	3,700	15,934	15,858	32,161	67,654	6,177	-118,681
2027-2028	1,707	2,200	28,040	21,800	2,247	2,400	3,858	4,577	6,430	73,259	3,700	15,359	15,560	31,367	65,986	7,273	-111,408
2028-2029	1,707	2,200	28,040	22,000	2,047	2,400	3,717	4,551	6,038	72,700	3,700	14,784	15,188	30,651	64,322	8,378	-103,030
2029-2030	1,707	2,200	28,040	22,100	1,948	2,400	2,541	4,546	6,075	71,556	3,700	14,208	14,001	27,338	59,248	12,308	-90,722
2030-2031	1,707	2,200	28,040	22,100	1,948	2,400	2,423	4,526	6,152	71,495	3,700	13,633	13,793	26,521	57,648	13,848	-76,875
2031-2032	1,707	2,200	28,040	22,100	1,948	2,400	2,344	4,520	6,285	71,545	3,700	14,058	13,650	25,974	57,382	14,163	-62,712
2032-2033	1,707	2,200	28,040	22,100	1,948	2,400	2,263	4,497	6,342	71,497	3,700	13,482	13,450	25,397	56,030	15,467	-47,244
2033-2034	1,707	2,200	28,040	22,100	1,948	2,400	2,168	4,485	6,439	71,488	3,700	13,907	13,300	24,913	55,820	15,668	-31,577
2034-2035	1,707	2,200	28,040	22,100	2,007	2,400	1,617	4,652	7,074	71,796	3,700	13,610	12,939	22,356	52,605	19,191	-12,386
2035-2036	1,707	2,200	28,040	22,100	2,007	2,400	1,485	4,707	7,441	72,087	3,700	13,610	12,841	21,898	52,049	20,038	7,652
2036-2037	1,707	2,200	28,040	22,100	2,007	2,400	1,393	4,730	7,742	72,319	3,700	13,610	12,700	21,539	51,549	20,770	28,422
2037-2038	1,707	2,200	28,040	22,100	2,007	2,400	1,324	4,764	7,964	72,506	3,700	13,610	12,599	21,274	51,184	21,322	49,744
2038-2039	1,707	2,200	28,040	22,100	2,007	2,400	1,251	4,791	8,200	72,696	3,700	13,610	12,509	21,047	50,866	21,830	71,574
2039-2040	1,707	2,200	28,040	22,100	1,949	2,400	1,071	4,825	8,384	72,676	3,700	13,332	12,528	19,673	49,233	23,444	95,018
2040-2041	1,707	2,200	28,040	22,100	1,949	2,400	1,002	4,831	8,502	72,731	3,700	13,332	12,457	19,362	48,851	23,879	118,897
2041-2042	1,707	2,200	28,040	22,100	1,949	2,400	936	4,846	8,658	72,835	3,700	13,332	12,397	19,219	48,648	24,187	143,084
2042-2043	1,707	2,200	28,040	22,100	1,949	2,400	904	4,857	8,790	72,946	3,700	13,332	12,337	19,123	48,492	24,454	167,538
2043-2044	1,707	2,200	28,040	22,100	1,949	2,400	856	4,877	8,923	73,052	3,700	13,332	12,303	19,101	48,435	24,617	192,155
2044-2045	1,707	2,200	28,040	22,100	1,949	2,400	806	4,870	9,039	73,111	3,700	13,332	12,219	19,010	48,261	24,850	217,005
2045-2046	1,707	2,200	28,040	22,100	1,949	2,400	769	4,874	9,166	73,204	3,700	13,332	12,162	18,965	48,159	25,046	242,051
2046-2047	1,707	2,200	28,040	22,100	1,949	2,400	733	4,877	9,288	73,294	3,700	13,332	12,106	18,929	48,067	25,227	267,278
2047-2048	1,707	2,200	28,040	22,100	1,949	2,400	694	4,891	9,450	73,430	3,700	13,332	12,087	18,956	48,075	25,355	292,633
2048-2049	1,707	2,200	28,040	22,100	1,949	2,400	663	4,877	9,539	73,475	3,700	13,332	12,015	18,889	47,935	25,540	318,173
2049-2050	1,707	2,200	28,040	22,100	1,949	2,400	637	4,876	9,649	73,558	3,700	13,332	11,977	18,880	47,889	25,668	343,841
2050-2051	1,707	2,200	28,040	20,700	3,349	2,400	1,203	4,946	10,576	75,121	3,700	23,332	11,477	17,417	55,926	19,195	363,036
2051-2052	1,707	2,200	28,040	20,700	3,349	2,400	1,149	4,993	11,045	75,583	3,700	23,332	11,270	17,054	55,355	20,228	383,264
2052-2053	1,707	2,200	28,040	20,700	3,349	2,400	1,122	4,998	11,308	75,823	3,700	23,332	11,055	16,763	54,850	20,973	404,237
2053-2054	1,707	2,200	28,040	20,700	3,349	2,400	1,047	5,007	11,574	76,024	3,700	23,332	10,917	16,498	54,447	21,577	425,814
2054-2055	1,707	2,200	28,040	20,700	3,349	2,400	1,024	5,015	11,788	76,223	3,700	23,332	10,777	16,360	54,169	22,054	447,867
2055-2056	1,707	2,200	28,040	20,700	3,349	2,400	963	5,032	12,009	76,399	3,700	23,332	10,695	16,205	53,932	22,467	470,334
2056-2057	1,707	2,200	28,040	20,700	3,349	2,400	925	5,023	12,073	76,416	3,700	23,332	10,566	16,085	53,683	22,733	493,067
2057-2058	1,707	2,200	28,040	20,700	3,349	2,400	869	5,025	12,264	76,553	3,700	23,332	10,484	15,953	53,469	23,084	516,151
2058-2059	1,707	2,200	28,040	20,700	3,349	2,400	843	5,027	12,573	76,838	3,700	23,332	10,397	15,905	53,334	23,504	539,655

2059-2060	1,707	2,200	28,040	20,700	3,349	2,400	809	5,040	12,720	76,964	3,700	23,332	10,346	15,877	53,254	23,710	563,365
2060-2061	1,707	2,200	28,040	20,700	3,349	2,400	780	5,028	12,794	76,998	3,700	23,332	10,259	15,776	53,067	23,931	587,296
2061-2062	1,707	2,200	28,040	20,700	3,349	2,400	743	5,029	12,898	77,065	3,700	23,332	10,198	15,724	52,953	24,112	611,408
2062-2063	1,707	2,200	28,040	20,700	3,349	2,400	723	5,029	12,995	77,143	3,700	23,332	10,138	15,675	52,845	24,299	635,707
2063-2064	1,707	2,200	28,040	20,700	3,349	2,400	692	5,041	13,118	77,247	3,700	23,332	10,103	15,676	52,811	24,436	660,143
2064-2065	1,707	2,200	28,040	20,700	3,349	2,400	666	5,028	13,166	77,256	3,700	23,332	10,032	15,600	52,663	24,592	684,736
2065-2066	1,707	2,200	28,040	20,700	3,349	2,400	665	5,030	13,242	77,332	3,700	23,332	9,981	15,570	52,583	24,748	709,484
2066-2067	1,707	2,200	28,040	20,700	3,349	2,400	640	5,032	13,319	77,386	3,700	23,332	9,936	15,542	52,509	24,876	734,361
2067-2068	1,707	2,200	28,040	20,700	3,349	2,400	614	5,044	13,430	77,484	3,700	23,332	9,913	15,547	52,492	24,992	759,353
2068-2069	1,707	2,200	28,040	20,700	3,349	2,400	597	5,034	13,460	77,487	3,700	23,332	9,853	15,488	52,373	25,113	784,466
2069-2070	1,707	2,200	28,040	20,700	3,349	2,400	580	5,036	13,524	77,535	3,700	23,332	9,812	15,468	52,312	25,223	809,688
17/18-69/70 Avg	**1,707**	**2,200**	**25,948**	**21,443**	**2,610**	**2,400**	**1,830**	**4,831**	**9,594**	**72,564**	**3,700**	**18,131**	**12,871**	**22,585**	**57,286**	**15,277**	

Cumulative Change in Storage 889,737

DELANO – EARLIMART
IRRIGATION DISTRICT
GROUNDWATER SUSTAINABILITY AGENCY

APPENDIX N

Water Balance Analysis Technical Memorandum

2024
2nd Amended Groundwater Sustainability Plan

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TECHNICAL MEMORANDUM – TULE SUBBASIN GROUNDWATER BALANCE ANALYSIS

To:	Eric R. Quinley, Delano-Earlimart Irrigation District
From:	Steven Humphrey, PG; Nathan Hatch; David Jordan PE, D.WRE
Subject:	Tule Subbasin Groundwater Balance Analysis
Date:	June 20, 2024
cc:	David Wierenga, Delano-Earlimart Irrigation District

INTERA has prepared this technical memorandum (TM) on behalf of the Delano-Earlimart Irrigation District (DEID) regarding the quantification of the groundwater water balance for the Tule Subbasin (subbasin). This TM presents specific analyses of components of inflows and outflows for each Groundwater Sustainability Agency (GSA), derived primarily from the numerical groundwater flow model (GFM) and the Tule Subbasin Setting (Appendices A-2 and A-3 in the DEID Groundwater Sustainability Plan [GSP], 2022). This TM also provides an alternative approach to quantifying the groundwater balance for the DEID management area, which is primarily derived from estimates independent of the numerical model.

Executive Summary

The subbasin has been identified by the DWR as a critically overdrafted basin (i.e., the average annual amount of groundwater extraction [i.e., outflow] exceeds the long-term average annual supply [i.e., inflow]). This critical overdraft results in a negative change in storage for the aquifer system since outflow is greater than inflow, as described by the following simple water balance equation:

$$Inflow - Outflow = \Delta S$$

There are several components of inflows and outflows that are estimated based on collected data and simulated using the GFM, which are described in detail in this TM. The GFM is a useful tool for quantifying certain components of inflows and outflows throughout the subbasin and effectively demonstrates the status of the water balance for each GSA. Inflows consist of multiple components of return flows from water applied to the ground surface, managed and natural recharge, canal losses, and streambed infiltration. There are no groundwater discharges to the land surface due to the depth of groundwater, so outflows consist solely of groundwater extraction via pumping wells. Underflows to and from the subbasin and between GSAs are not included in the water balance equation for this analysis. In summary, the water balance analysis detailed in this TM demonstrates that every GSA is in overdraft conditions on average during a 30-year historical period (1987-2017), except for the DEID area (Figure 1). Figure 1 summarizes the water balance analysis described herein, showing the average historical (1986-2017) inflow and outflow amounts for each GSA. DEID is the only GSA with inflows exceeding outflows, which is due to DEID's conjunctive use operations (i.e., reliance on imported surface water) in addition to the management of recharge basins, which has resulted in a positive change in storage within DEID's boundary.

KTWD will be broken out of ETGSA in the final

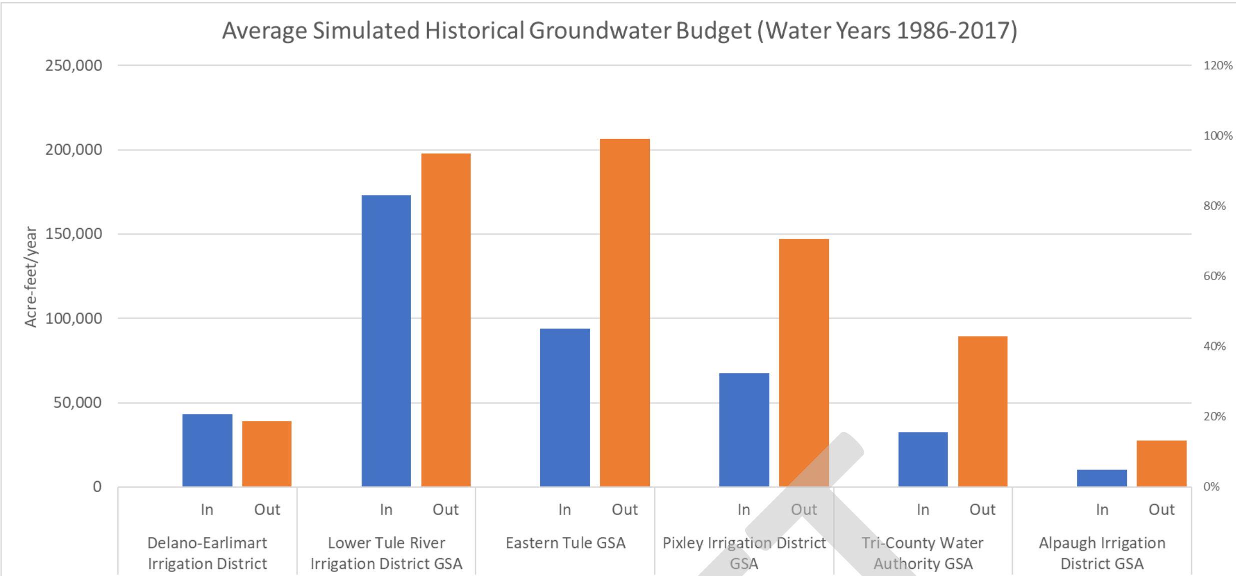

Figure 1: Water Balance Summary for Each GSA in the Tule Subbasin.

The details and calculation methods for each component of inflows and outflows are described in this TM, along with references for source data. The water balance components for the subbasin are summarized below:

INFLOWS:

- Return flows from applied water,
- Managed recharge,
- Unlined canal and streambed losses,
- Deep percolation of recharge from precipitation,
- Mountain block recharge

OUTFLOWS:

- Pumping wells

An additional method described in this memo calculates the water balance specific to the DEID area, and indicates inflows exceed outflows by an average of ~19,000 acre feet/year from 1987 to 2023. This amount is ~15,000 acre feet more than calculated using the GSP-derived method and provides further evidence of DEID's sustainable practices. In conclusion, the water balance analyses described herein provide a relative measure of overdraft conditions for each GSA within the subbasin.

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Water Balance Terms

Inflows to the subbasin consist of return flows from applied water, managed recharge, unlined canal/ditch losses, streambed infiltration, mountain block recharge, and recharge from precipitation. Outflows consist of pumping for agricultural, municipal, and industrial use, and groundwater banking extraction. Each water balance term is described in further detail below.

Return Flows from Applied Water

Water applied on lands within the subbasin comes from a variety of sources. Return flows from applied water are calculated for the GFM. The sources of water use associated with return flows are:

- Imported water use: primarily applied for agricultural use, this water is from the Central Valley Project. Water is imported into the subbasin (and GSAs) via the Friant Kern Canal (FKC) and is delivered to farmers via the Tule River and Deer Creek channels, unlined canals, and pipeline distribution systems of Pixley Irrigation District (PID), Lower Tule River Irrigation District (LTRID), Terra Bella Irrigation District, Teapot Dome Water District, DEID, and Saucelito Irrigation District. A small amount of imported water from the State Water Project and Kings River serves the Angiola Water District located in the westernmost areas of the subbasin within the Tri-County GSA.
- Native water use: primarily applied for agricultural use, this water is diverted from native surface water within the subbasin (e.g., Tule River and Deer Creek), delivered through a system of canals and ditches.
- Agricultural pumped water use: this water is sourced from local groundwater extraction wells typically located adjacent to agricultural land and applied for agricultural use.
- Recycled water use: this water is sourced from treated wastewater generated at the City of Porterville's Wastewater Treatment Facility and other treatment facilities within the subbasin. Most of the water from subbasin facilities is delivered to crops in the area. In the case of the City of Porterville, the balance is allowed to infiltrate into the subsurface in recharge ponds located in the old Deer Creek channel.
- Municipal/urban water use: this water is sourced from local pumping wells usually located adjacent to cities and urban areas within the subbasin, delivered primarily through pipeline systems. Water is applied to irrigate municipal and urban turf and landscaping.

Managed Recharge

Managed recharge is the practice of using water solely for the purpose of recharging the aquifer and involves the application of water in recharge basins meant for deep percolation to the groundwater table. Water used for managed recharge is sourced from imported or native surface water. Native surface water originates from the Tule River and Deer Creek and is delivered to recharge basins managed by Pioneer Water Company, Campbell and Moreland Ditch Company, Vandalia Water District, Deer Creek and Tule River Authority, PID, and LTRID. Imported water is sourced from the FKC and delivered to recharge basins managed by LTRID, Pixley Irrigation District, PID, Teapot Dome Water District and DEID.

Canal and Irrigation Ditch Losses

Diversions from the Tule River, Deer Creek, and imported water deliveries via unlined canals/ditches lose a portion of their flow as infiltration to the groundwater. Estimated streambed infiltration and evapotranspiration (ET) amounts are subtracted from the total losses reported in the annual water use summaries to calculate the losses to unlined canals/ditches. Imported water conveyed in channels and canals that infiltrates to the groundwater is estimated by subtracting infiltration losses attributed to native surface water from the total losses documented in LTRID and PID's respective annual water use summary reports.

Deep Percolation of Recharge from Precipitation

Historical precipitation for the subbasin was sourced from station data from the Western Regional Climate Center (WRCC) and California Irrigation Management Information System (CIMIS). Data collected from the sole precipitation station located within the subbasin (Porterville) and stations surrounding the subbasin were utilized to produce an isohyetal map to calculate the areal distribution of precipitation. Infiltration of precipitation within the subbasin was calculated using the "Williamson Method", which was based on a linear regression of precipitation data records from 1922-1971 and soil moisture storage (Williamson et. al., 1989; Faunt, 2009). The results indicated deep percolation of recharge from precipitation only occurs within the subbasin when average annual precipitation is greater than 9.69 inches.

<u>*Reapportioned precipitation*</u>: An additional step was taken in calculating the deep percolation of recharge from precipitation for each GSA. This step is based on the reasoning that if the sustainable yield is calculated for the entire subbasin (i.e., each GSA within the subbasin has the same sustainable yield), then water balance components used in the calculation of the sustainable yield that are dependent on natural processes (e.g., precipitation) should be reapportioned based on the area of the GSA to maintain consistency. Therefore, the deep percolation of recharge from precipitation term for the subbasin was multiplied by the percent area of each GSA.

Streambed Infiltration

Streambed infiltration refers to water flowing in native streams infiltrating through the streambed to recharge the groundwater. Streambed infiltration for the Tule River is calculated based on losses reported by the Tule River Authority and the LTRID. For areas where losses are not reported, a loss factor based on reported values is applied. Losses for the Deer Creek are estimated based on differences in streamflow measurements between stations and PID water use summaries, and ET is subtracted from streamflow losses to calculate the infiltration. For reaches of the Deer Creek where both native and imported flow occurs, PID's annual water use summaries are reviewed and several methodologies are applied, as documented in the Tule Subbasin Setting (Appendix A-2 in the DEID GSP, 2022). Streambed infiltration for the White River is assumed to be all surface water flows (after accounting for ET) measured at the White River gage.

<u>*Reapportioned streambed infiltration*</u>: Similar to the process described above, to maintain consistency with the Sustainable Yield, the streambed infiltration term for the subbasin was multiplied by the percent area of each GSA to calculate this water balance component for each GSA.

Mountain Block Recharge

The mountain block recharge term represents the groundwater inflow coming from the fractured rock aquifer system of the Sierra Nevada mountain block. This term was calibrated using the GFM and observed groundwater level data.

Reapportioned Mountain Block Recharge: Similar to the process described above, to maintain consistency with the Sustainable Yield, the mountain block recharge term for the subbasin was multiplied by the percent area of each GSA to calculate this water balance component for each GSA.

Groundwater Extraction (Pumping)

The pumping water balance term is the only outflow term for the subbasin and is estimated for municipal and agricultural water use. Municipal pumping supplies water to the City of Porterville and other small municipalities in the subbasin. Agricultural groundwater pumping is estimated as the total water used to grow crops within the subbasin. Pumping related to groundwater banking extraction is also an outflow term and refers to the groundwater that is extracted directly from banked water via the Turnipseed recharge basin managed by DEID GSA. An additional pumping term includes groundwater pumping for export, which Angiola Water District and the Boswell/Creighton Ranch have historically exported pumped groundwater out of the Tule Subbasin.

Results of Water Balance Calculation for Each GSA

The water balance components are calculated independently for each GSA based on the methods and definitions described above using data presented in the Tule Subbasin Setting and GFM documentation (DEID, 2022).

DEID GSA

The groundwater balance chart for DEID is shown on Figure 2. Inflows and outflows are presented as averages for the historical period (water years 1987-2017). The water balance components for DEID are summarized below:

INFLOWS:

- Imported Water Return Flows
- Agricultural Pumped Water Return Flows
- Municipal Pumped Water Return Flows
- Imported Water Recharge Basins
- Reapportioned Precipitation, Streambed Infiltration, and Mountain Block Recharge

OUTFLOWS:

- Municipal Pumping
- Agricultural Pumping
- Groundwater Banking Extraction

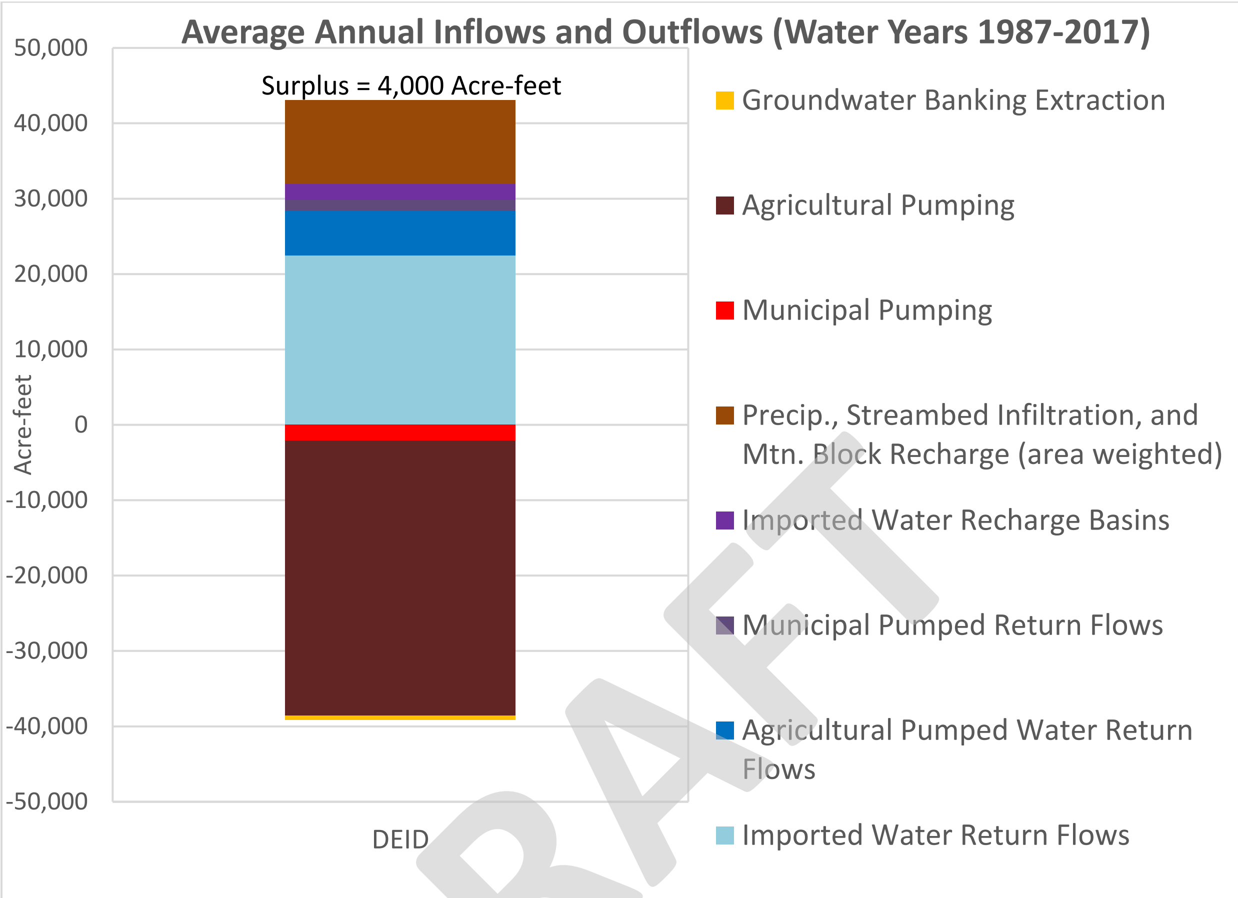

Figure 2: Water Balance Summary for DEID.

Most groundwater inflow is due to imported water return flows and most outflow is due to agricultural pumping. The overall groundwater balance results for DEID indicate a surplus of approximately 4,000 acre-feet per year (AFY).

LTRID GSA

The groundwater balance chart for LTRID GSA is shown on Figure 4. Inflows and outflows are presented as averages for the historical period (water years 1987-2017). The water balance components for LTRID GSA are summarized below:

INFLOWS:

- Imported Water Return Flows
- Native Water Return Flows
- Agricultural Pumped Water Return Flows
- Municipal Pumped Water Return Flows
- Imported Water Recharge Basins
- Native Water Recharge Basins

- Imported Water Canal Losses
- Native Water Canal Losses
- Reapportioned Precipitation, Streambed Infiltration, and Mountain Block Recharge

OUTFLOWS:

- Municipal Pumping
- Agricultural Pumping
- Groundwater Pumping Exports

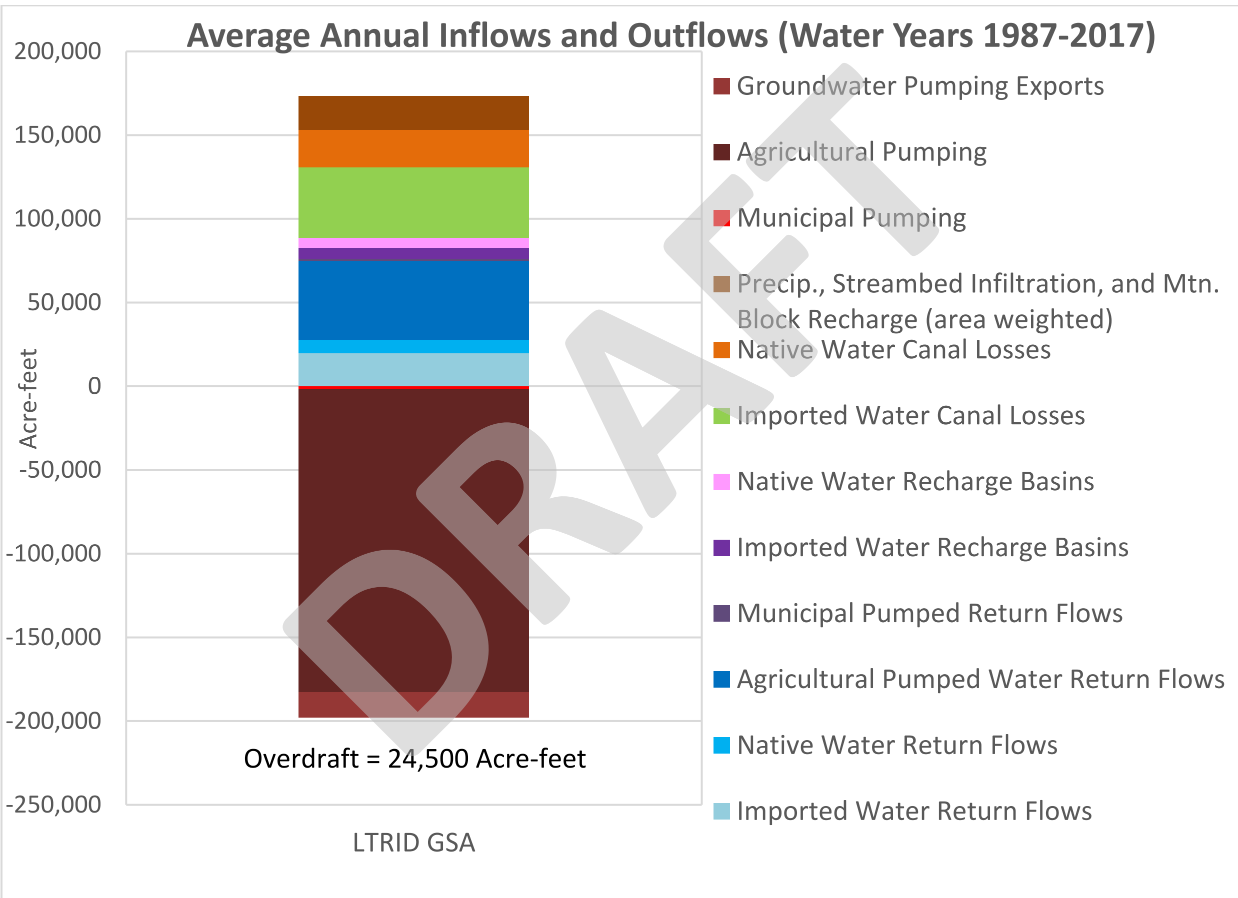

Figure 4: Water Balance Summary for LTRID GSA.

Most groundwater inflow is due to agricultural pumped water return flows and imported water canal losses, and most outflow is due to agricultural pumping. The overall groundwater balance results for LTRID indicate an overdraft of approximately 24,500 AFY.

ETGSA

The groundwater balance chart for ETGSA is shown on Figure 5. Inflows and outflows are presented as averages for the historical period (water years 1987-2017). The water balance components for ETGSA are summarized below:

INFLOWS:

- Imported Water Return Flows
- Native Water Return Flows
- Agricultural Pumped Water Return Flows
- Recycled Water Return Flows (Managed and Agricultural)
- Municipal Pumped Water Return Flows
- Native Water Recharge Basins
- Reapportioned Precipitation, Streambed Infiltration, and Mountain Block Recharge

OUTFLOWS:

- Municipal Pumping
- Agricultural Pumping

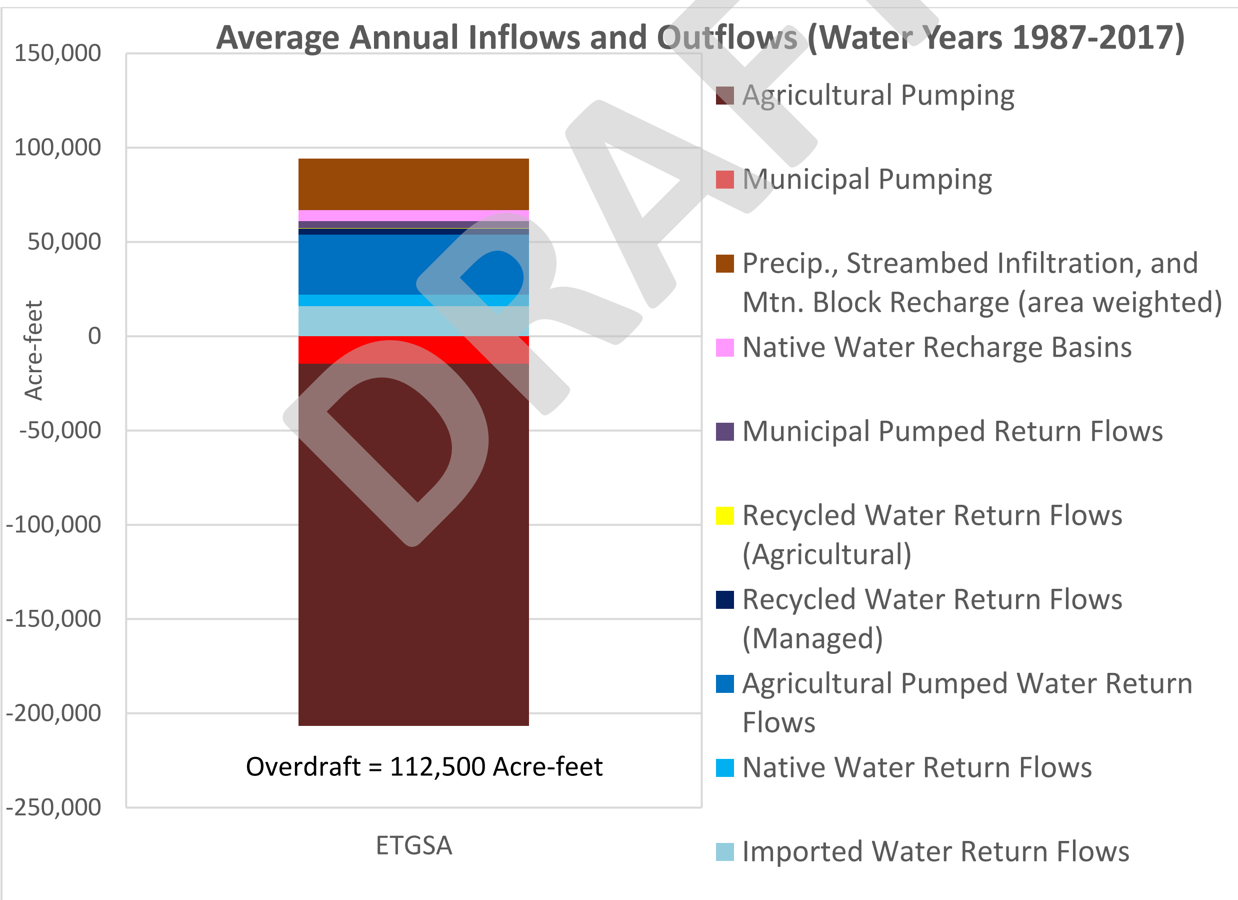

Figure 5: Water Balance Summary for ETGSA.

Most groundwater inflow is due to agricultural pumped water return flows and most outflow is due to agricultural pumping. The overall groundwater balance results for ETGSA indicate an overdraft of approximately 112,500 AFY.

PID GSA

The groundwater balance chart for PIDGSA is shown on Figure 6. Inflows and outflows are presented as averages for the historical period (water years 1987-2017). The water balance components for PID GSA are summarized below:

INFLOWS:

- Imported Water Return Flows
- Native Water Return Flows
- Agricultural Pumped Water Return Flows
- Recycled Water Return Flows (Managed and Agricultural)
- Municipal Pumped Water Return Flows
- Native Water Recharge Basins
- Reapportioned Precipitation, Streambed Infiltration, and Mountain Block Recharge

OUTFLOWS:

- Municipal Pumping
- Agricultural Pumping

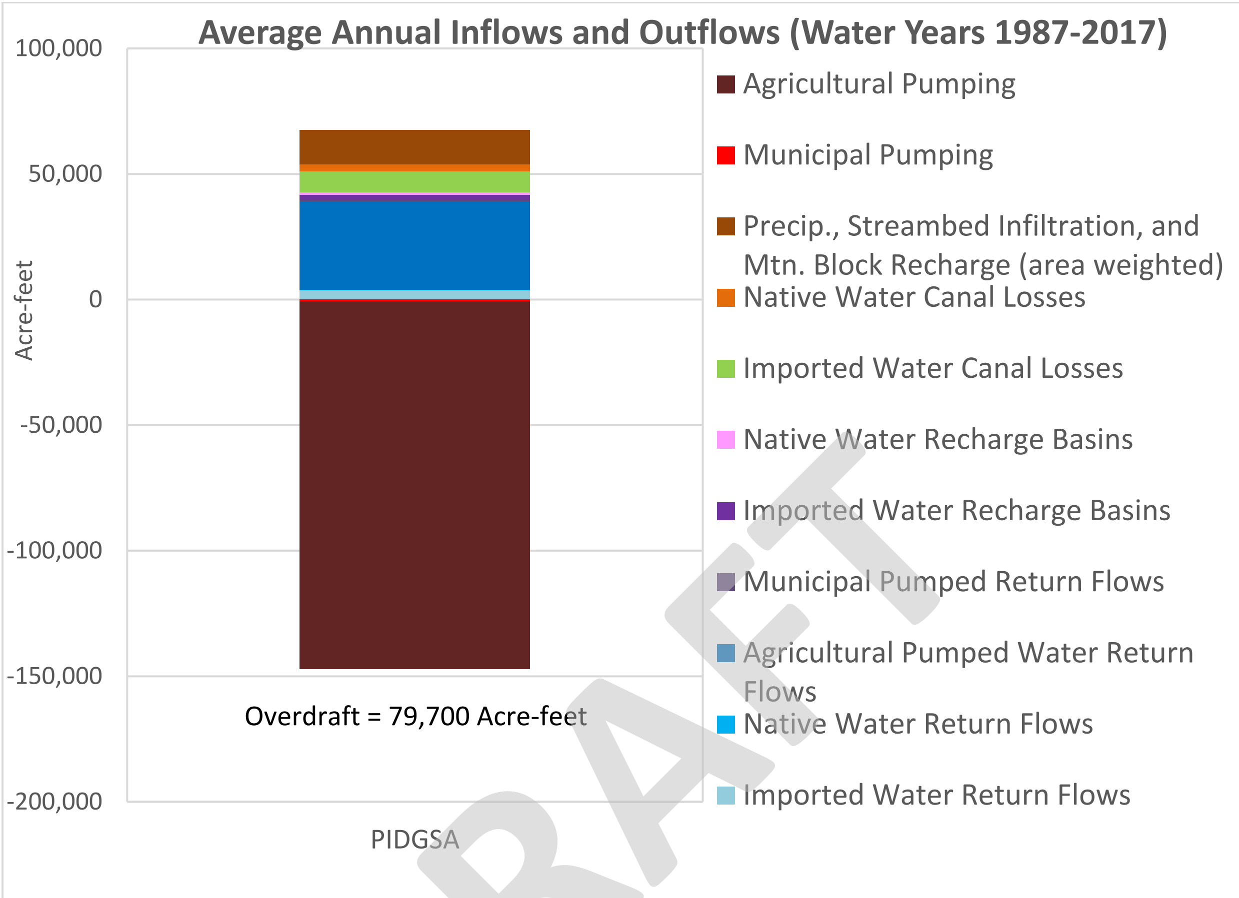

Figure 6: Water Balance Summary for PIDGSA.

Most groundwater inflow is due to agricultural pumped water return flows and most outflow is due to agricultural pumping. The overall groundwater balance results for PIDGSA indicate an overdraft of approximately 79,700 AFY.

TCWD GSA

The groundwater balance chart for TCWD GSA is shown on Figure 7. Inflows and outflows are presented as averages for the historical period (water years 1987-2017). The water balance components for TCWD GSA are summarized below:

INFLOWS:

- Imported Water Return Flows
- Agricultural Pumped Water Return Flows
- Reapportioned Precipitation, Streambed Infiltration, and Mountain Block Recharge

OUTFLOWS:

- Agricultural Pumping
- Groundwater Pumping Exports

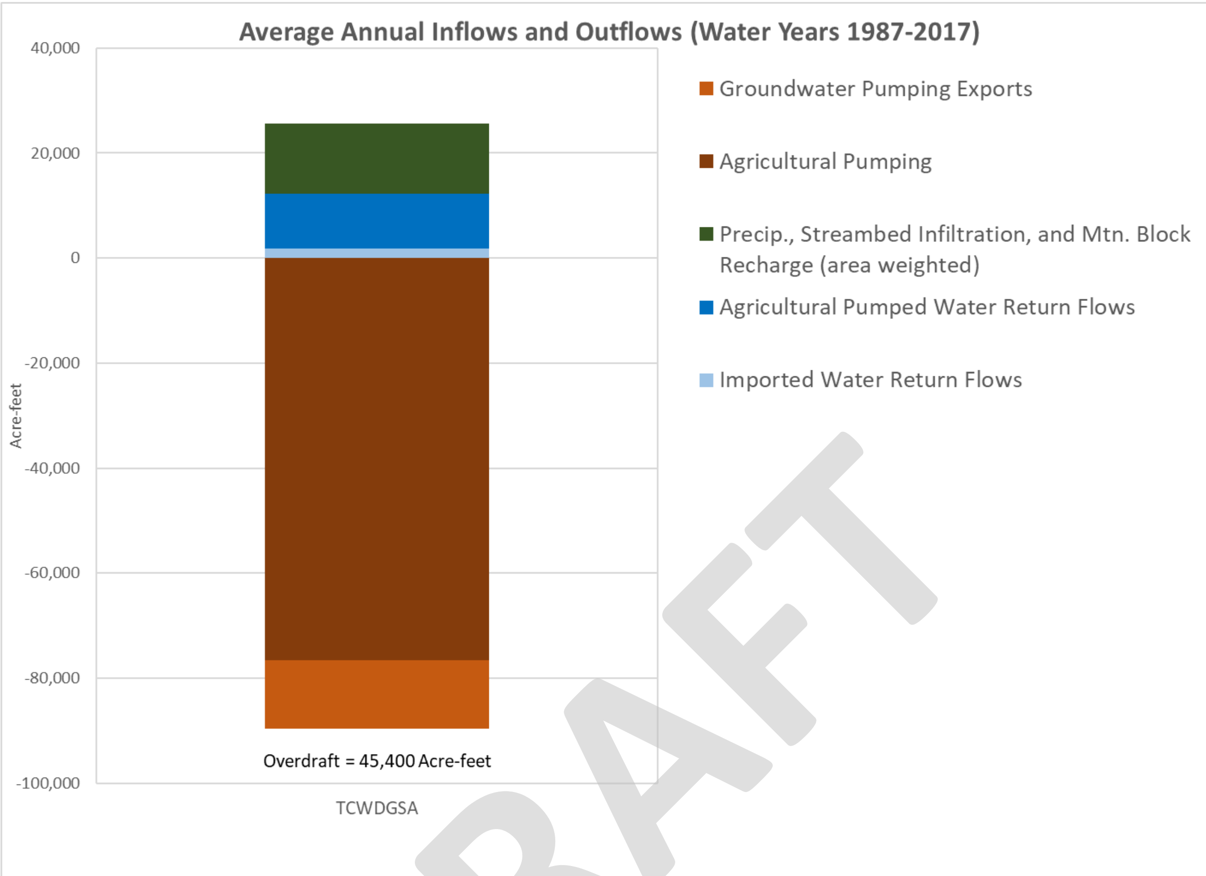

Figure 7: Water Balance Summary for TCWD GSA.

Most groundwater inflow is due to the reapportioned precipitation recharge, streambed infiltration, and mountain block recharge, and most outflow is due to agricultural pumping. The overall groundwater balance results for TCWD GSA indicate an overdraft of approximately 45,400 AFY.

Alpaugh GSA

The groundwater balance chart for Alpaugh GSA is shown on Figure 8. Inflows and outflows are presented as averages for the historical period (water years 1987-2017). The water balance components for Alpaugh GSA are summarized below:

INFLOWS:

- Imported Water Return Flows
- Agricultural Pumped Water Return Flows
- Municipal Pumping Water Return Flows
- Reapportioned Precipitation, Streambed Infiltration, and Mountain Block Recharge

OUTFLOWS:

- Municipal Pumping

- Agricultural Pumping

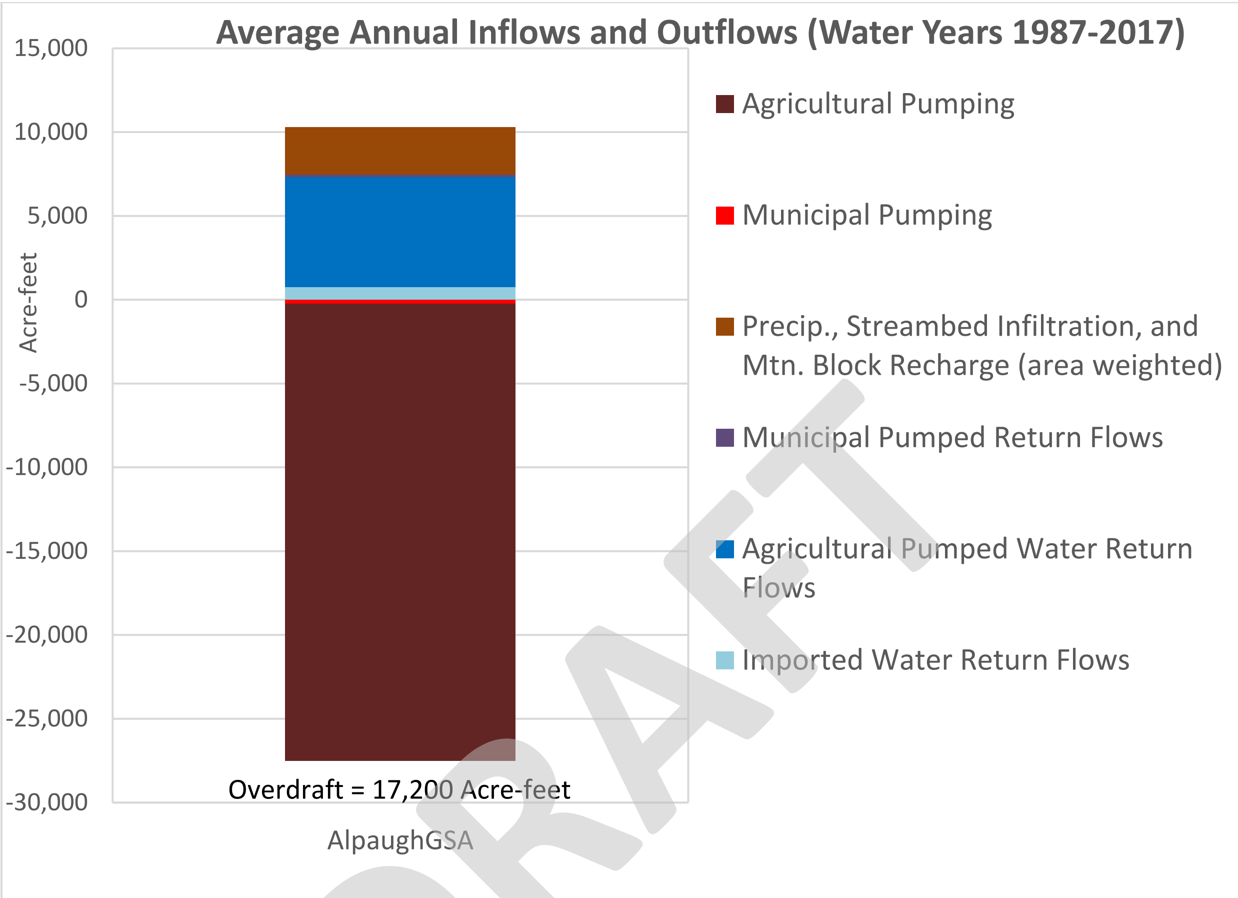

Figure 8: Water Balance Summary for Alpaugh GSA.

Most groundwater inflow is due to agricultural pumped water return flows and most outflow is due to agricultural pumping. The overall groundwater balance results for ETGSA indicate an overdraft of approximately 17,200 AFY.

Summary

The overall summary of water balance terms for each GSA is shown on Figure 9 and Table 1. The average annual water balance associated with each GSA (negative = surplus, positive = overdraft) is shown next to each bar on Figure 9 with numbers rounded to the nearest hundredth. Unrounded water balance terms are presented in Table 1. Table 1 also shows relative percentages of the total overdraft for each GSA within the subbasin, indicating ETGSA and PIDGSA account for most of the overdraft.

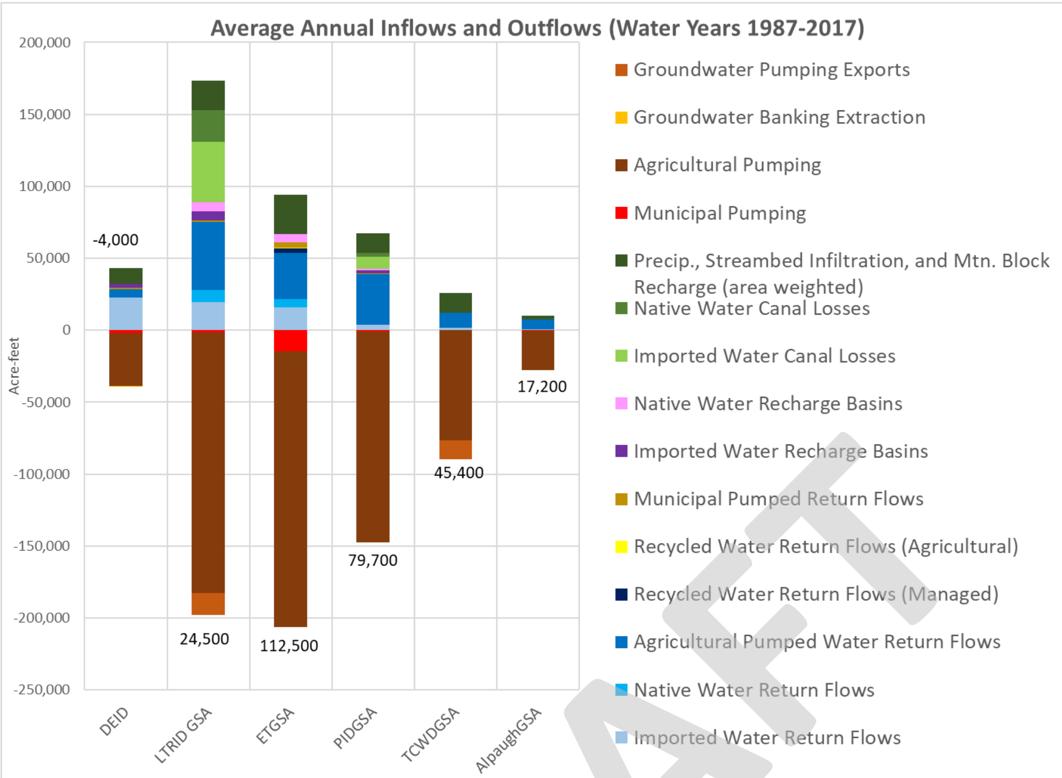

Figure 9: Water Balance Components for Each GSA with Overdraft Amounts Shown.

Table 1 - Summary of Average Annual Inflows and Outflows (in Acre-feet) for Each Water Balance Component

INFLOWS (annual average across water years 1987-2017)	DEID	LTRID GSA	ETGSA	PIDGSA	TCWDGSA	AlpaughGSA
Imported Water Return Flows	22,477	19,684	15,894	3,616	1,826	768
Native Water Return Flows	-	8,158	6,026	345	-	-
Agricultural Pumped Water Return Flows	5,964	47,294	32,029	35,139	10,487	6,574
Recycled Water Return Flows (Managed)	-	-	3,155	-	-	-
Recycled Water Return Flows (Agricultural)	-	-	377	-	-	-
Municipal Pumped Return Flows	1,352	1,023	3,665	552	-	148
Imported Water Recharge Basins	2,200	6,681	-	2,184	-	-
Native Water Recharge Basins	-	5,810	5,774	839	-	-
Imported Water Canal Losses	-	42,103	-	8,461	-	-
Native Water Canal Losses	-	22,258	-	2,600	-	-
Precip., Streambed Infiltration, and Mtn. Block Recharge (area weighted)	11,099	20,194	27,111	13,697	13,383	2,813
OUTFLOWS (annual average across water years 1987-2017)						
Municipal Pumping	(2,084)	(1,584)	(14,613)	(819)	-	(242)
Agricultural Pumping	(36,480)	(180,968)	(191,871)	(146,355)	(76,520)	(27,258)
Groundwater Banking Extraction	(565)	-	-	-	-	-
Groundwater Pumping Exports	-	(15,200)	-	-	(13,043)	-
BALANCE (INFLOWS - OUTFLOWS)	**3,964**	**(24,535)**	**(112,453)**	**(79,742)**	**(45,447)**	**(17,197)**
% of TOTAL OVERDRAFT	-	**9%**	**40%**	**29%**	**16%**	**6%**

Alternative Water Balance Calculation Method for DEID

An independent water balance calculation of the DEID service area was developed based on climate and satellite data, deliveries, water banking, and the sustainable yield for the subbasin. Water balance terms include data extended out to calendar year 2023. This DEID-specific method included the following water balance components:

INPUTS:

- Imported water
- Banked water
- Precipitation
- Sustainable Yield

OUTPUTS:

- Evapotranspiration (i.e., crop consumption)

Imported Water

Water imported into the DEID service area was quantified based on the record of annual in-district irrigation deliveries collected by DEID. The majority of imported water is delivered under Central Valley Project (CVP) contracts via the FKC. Additional sources of imported water are deliveries from flood/abandoned water, water banks, and water transfers.

Banked Water

Banked water is a term which refers to water that is stored in the subsurface for later use. DEID banks water using infiltration basins, and this water balance term reflects water that has been infiltrated through their operation of the Turnipseed Basin. This term is analogous to the "Imported Water Recharge Basins" term used in the subbasin water balance analysis; however, the DEID analysis includes recent years (post-2015), which have increased considerably compared to historical amounts as a result of the expansion of the Turnipseed Basin.

Precipitation

The precipitation water balance term is based on the same source of data used for the subbasin water balance analysis; however, DEID's analysis uses an area weighting method that weighs the total monthly precipitation by parcel area to calculate precipitation for each management area within the DEID GSA.

Sustainable Yield

The sustainable yield has been calculated for the subbasin for the GSP (DEID, 2022), which is based on the overall water balance, and is assumed to be the long-term average groundwater pumping rate that results in no net negative change in groundwater storage. Although the calculation of this term is indirectly related to the water balance components, the amount is considered water supply that is available for consumption within the subbasin. Hence, DEID has included the sustainable yield as an inflow term by multiplying the overall subbasin amount (0.14 acre-feet per acre) by the acreage of DEID's service area within the subbasin.

Evapotranspiration (ET)

The evapotranspiration water balance term represents the outflow for the DEID service area and is based on historical LandSAT and LandIQ data. The ET can also be referred to as the consumptive use and is weighted by parcel areas similar to the precipitation term above.

The overall annual water balance for the DEID service area is shown on Figure 10. From 1986 to 2023, DEID imported a total of 3.9 million acre-ft of water or on average 105,000 acre-ft/year. The average annual change to/from groundwater is calculated as a surplus of ~19,000 acre-feet per year. This amount is over four times the amount calculated for DEID using the subbasin approach (~4,000 acre-feet per year). The cumulative recharge to the groundwater from 1986-2023 was 708,600 (Figure 10). This independent DEID-specific water balance calculation method cannot be directly compared to the GSP method; however, it provides another line of evidence of DEID's sustainable practices.

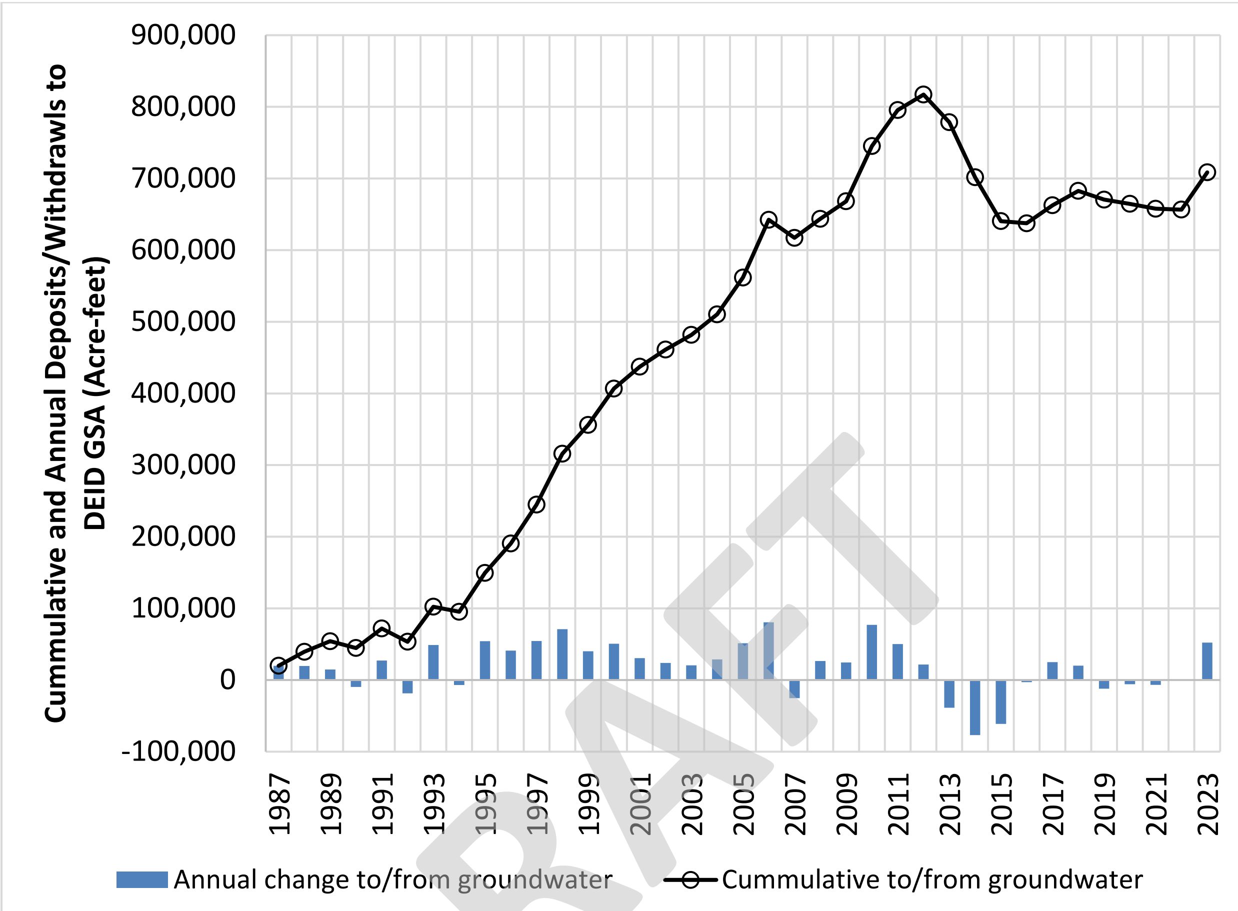

Figure 10: Annual Water Balance for the DEID Service Area.

References

Delano-Earlimart Irrigation District (DEID) Groundwater Sustainability Agency. 2022. Sustainable Groundwater Management Act, Groundwater Sustainability Plan, Updated July 2022.

DELANO – EARLIMART IRRIGATION DISTRICT
GROUNDWATER SUSTAINABILITY AGENCY

APPENDIX O

DEID Pipeline Analysis Technical Memorandum

Delano-Earlimart Irrigation District

Pipeline Subsidence Susceptibility and Risk

June 23, 2024

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Attachment A. Howes CV

Background

An analysis was conducted to examine how Delano-Earlimart Irrigation District's (DEID's) pipelines are impacted by the significant subsidence that has occurred since 1951 with a special emphasis on subsidence since 2015. In some locations the elevations have decreased by up to 16 feet in the northwest portion of the district since 1951. Since 2015 alone, there has been over 3.2 feet of subsidence in some parts of DEID. This subsidence has increased the amount of DEID pipe at risk as well as increasing the magnitude of risk on already at-risk pipelines.

The objective of the analysis in this report was to determine the susceptibility of water delivery pipelines in DEID to this subsidence and highlight potential risk with continued subsidence. The analysis was conducted assuming the pipelines were in the same condition as when they were installed. While there have been pipeline repairs since the system was constructed, the main lateral and sublaterals have not been replaced.

The analysis examines the original pipeline design compared to the current conditions with subsidence. The pipeline pressure classification (its rated pressure) is compared to the static pressure head to analyze potential risk areas where the pipe pressures are above the pressure classification.

All survey measurements were conducted by other consultants. Pipeline layouts were determined using a combination of GIS information prepared by Provost and Pritchard Engineering and as-built designs[1] provided by DEID. All elevations data in this memorandum are based on the NAVD 88 vertical datum.

The methodology used in this report is consistent with standard engineering practices. The analysis focused on comparing the pipe pressure ratings/classification to the current maximum working pressure in the pipeline. This is consistent with AWWA 2020[2] pipeline design methodology. The working pressure in the pipelines examined in this report is defined in AWWA as the static pressure since for gravity pipelines, this is higher than the hydraulic gradient. The analysis deviates from normal design when considering the subsidence in the region. However, the basic principle is a comparison of maximum pressure (static pressure head) to the pipeline pressure classification. For visual presentations, the pressures and pressure classifications were tied to the vertical datum and presented like a hydraulic grade line

[1] USBR. 1956. Central Valley Project – California. Friant kern Canal Distribution Systems. Delano-Earlimart Irrigation District – Unit 3. U. S. Bureau of Reclamation. As Built July 31 to August 1, 1956.
[2] AWWA. 2020. Design of Prestressed Concrete Cylinder Pipe. AWWA Standard C304-14 (R19). Effective Feb. 1. 2020

profile. This is the most common visual representation of pressures along a pipeline. It is not common to tie the pressure ratings to the datum, but it is technically sound and simplifies the discussion for non-engineers.

DEID Pipelines

DEID distribution system was designed with pressurized pipelines to deliver water to growers in its service area. Areas near and to the east of the Friant-Kern Canal (FKC) are supplied by pipelines pressurized with pumps. Areas to the west of the FKC are pressurized by gravity as the land slopes away from the FKC. Reinforced concrete pressure pipe (RCPP) was used throughout DEID with pressure classifications/ratings from 50 feet of head pressure (H50) up to 150 feet of head pressure (H150) in approximately 25-foot increments.

In the USBR specifications for DEID pipelines[3], the USBR specified that the pipelines had to be able to withstand 120% of the rated pressure of the pipe. This is the same as the internal field-test pressure requirements of 1.2 times the working pressure (static pressure in the case of DEID gravity supplied pipelines) for reinforced concrete pressure pipelines today (AWWA C304-14[4]). The 120% or 1.2 factor is considered the "factor of safety" within this document.

Static Analysis

The original DEID pipe classifications (i.e., pressure ratings) were selected in the original design to not exceed the maximum static head in the pipeline. In gravity fed pipelines, the maximum constant pressure occurs under a static condition (zero-flow condition) when the hydraulic grade line (HGL) is flat. The pressure is then dictated by the water source elevation on the gravity flow pipeline. For DEID gravity flow pipelines, the source water level elevation is from the Friant-Kern (FKC) Canal. It should be noted that the current water elevation in the FKC is lower than originally designed due to subsidence. Subsidence along the FKC has created a well-known capacity constraint that is being corrected in phases (Middle Reach Capacity Correction Project). The water elevations used for this analysis assume the final target water elevation in the FKC at each pipeline after the full capacity correction is completed.

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[3] USBR. 1953. Earthwork, pipe lines, and structures including pumping plants. Delano-Earlimart Irrigation District, Friant-Kern Canal Distribution System. Central Valley Project, CA. July 16, 1953. Specifications No. DC-3980.

[4] AWWA. 2020. Design of Prestressed Concrete Cylinder Pipe. AWWA Standard C304-14 (R19). Effective Feb. 1. 2020.

For public safety purposes, actual lateral names and locations will not be used in this memorandum. Alternative naming is being utilized. All figures are to scale but the length scale is not presented as to not identify exact locations of the at-risk pipelines.

Lateral A Static Analysis

Figure 1 and Figure 2 show the original design and current conditions on Lateral A. The figures show pipeline elevations, design flow and zero flow hydraulic grade lines (HGLs). Additionally, the pipe pressure rating plus pipe elevation is shown to compare with the HGLs. This provides a visual representation of pipe pressure rating versus the pipeline pressure relative to a consistent datum (NAVD88). The as-built conditions show how the original designers increased pipe pressure ratings as the pipe pressures increased due to the pipeline elevation change downhill from the FKC. In the original design, the pipe pressure class never drops below the maximum static pressure on the pipeline. However, under the current subsidence conditions, the pressure rating is below the static pressure at three locations (red circles). A closeup of these occurrences is shown in Figure 3, where the pipe pressure rating is over 5 feet below the static pressure condition near the end of the pipeline. Engineering design standards preclude such design conditions because sustained pressures above the pipe pressure rating increase the risk of pipeline failure. The furthest downstream point just meets the HGL. The closeup in Figure 2 shows the current pipe elevation plus pressure rating compared to the elevation due to subsidence by 2015 plus pressure rating. The amount of pipe that is at risk has significantly increased since 2015. Only the most downstream site had static pressure above the pressure rating by 2015. Since 2015, two additional locations have subsided to a point where the static pressure is above the pressure rating.

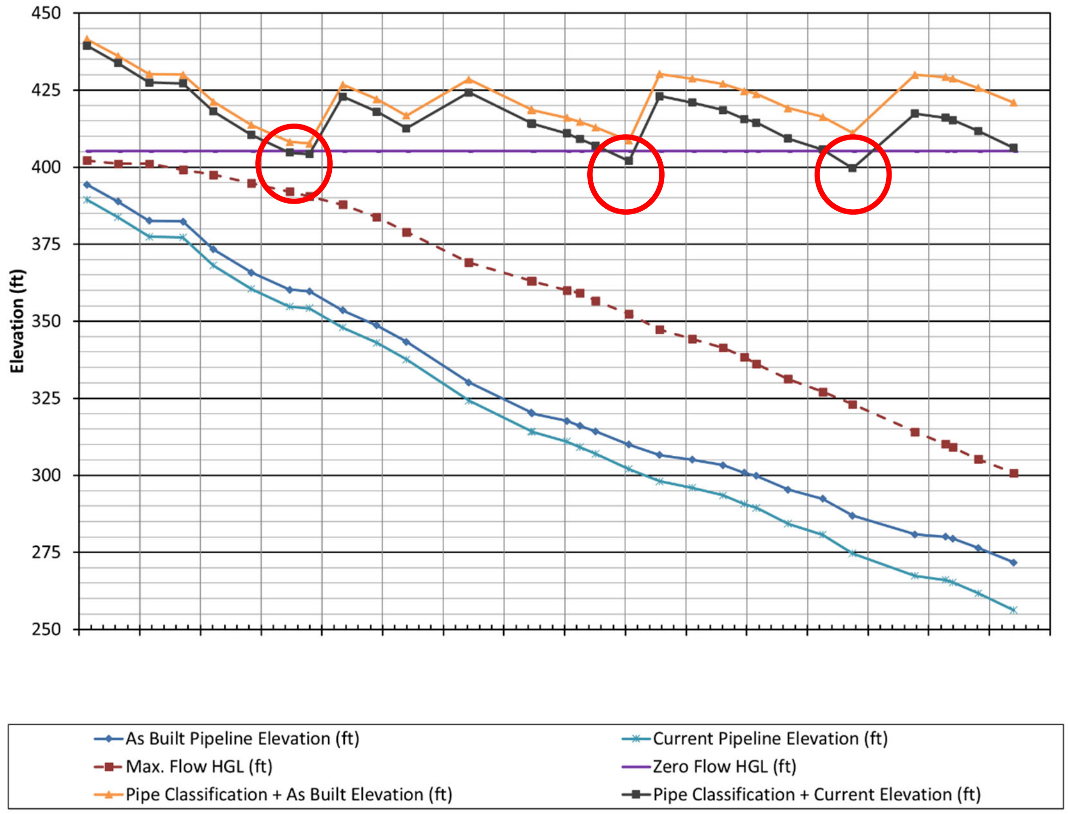

Figure 1. Lateral A Main pipeline elevation, HGLs and pipe pressure rating relative to elevations under current subsided conditions and in the original As Built.

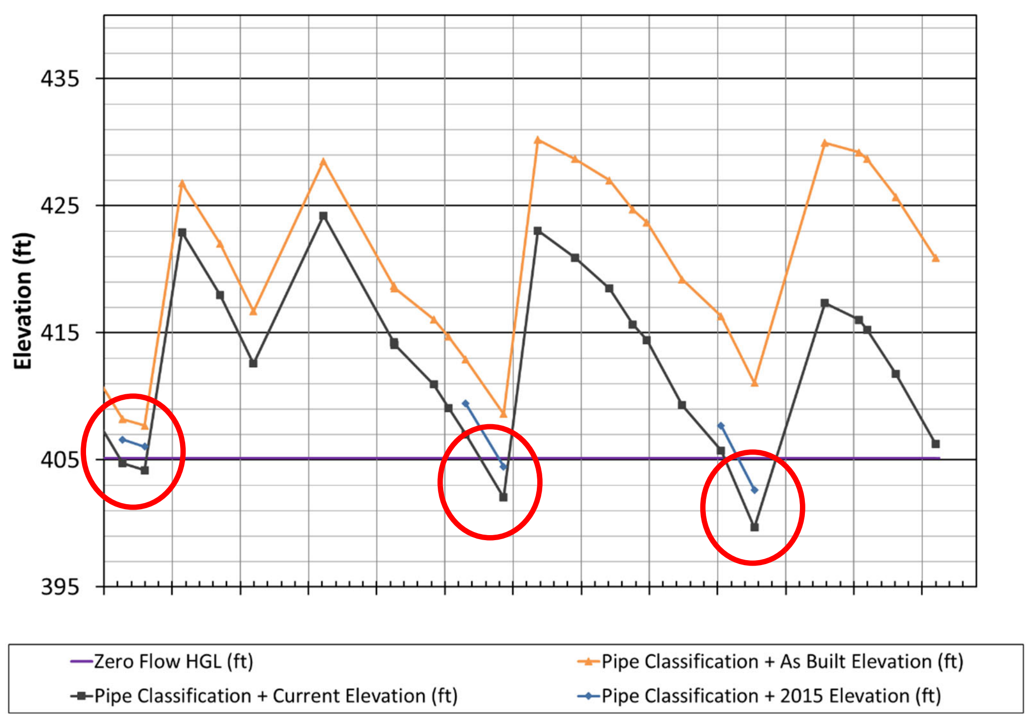

Figure 2. Current Lateral A Main pipeline elevations and pipe pressure rating plus pipe elevation HGLs at critical risk locations.

There are sublaterals that continue north and south from the mainline, whose pressure rating plus elevation drops near or below the static HGL. Figure 3 and Figure 4 are two laterals at the same location along Lateral A, one going north (AN) and the other south (AS). In both cases, the lateral pipeline pressures are above the pipe pressure classifications. By 2015, most of sublateral AN had its pressure rating below the static pressure on the lateral. But the subsidence since 2015 has increased the risk level on this sublateral since it has dropped further below the static pressure.

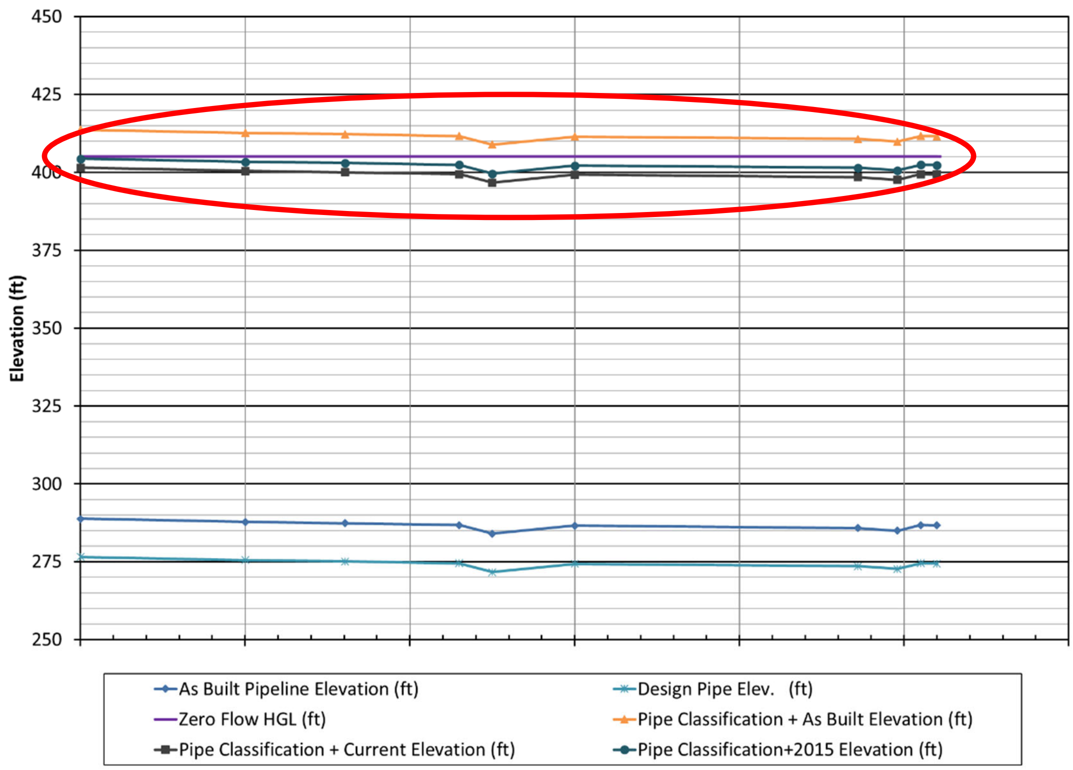

Figure 3. Sublateral AN of Lateral A showing the entire length has an actual pressure above the pipes pressure classification.

In Figure 4, the pressure rating was above the static pressure in most of sublateral AS in 2015. The upstream end of the lateral was the only location where the pressure rating was below the static pressure. Since 2015, the pressure rating has dropped below the static pressure for a majority of the sublateral AS.

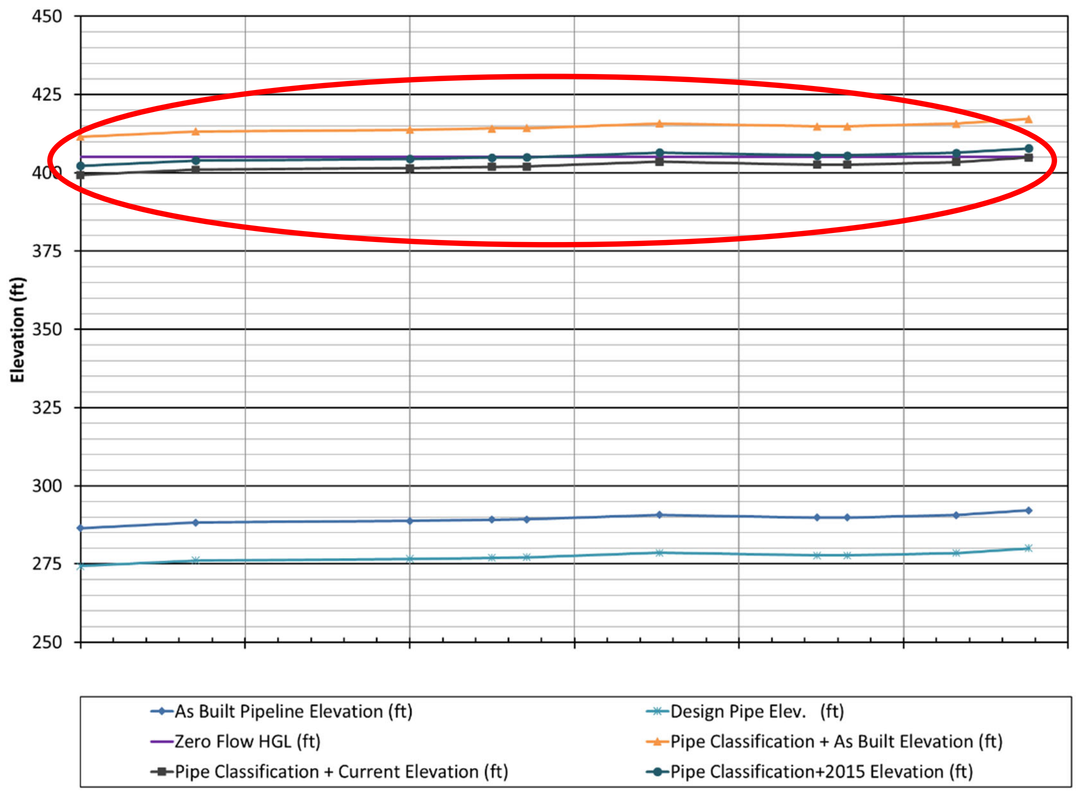

Figure 4. Sublateral AS of Lateral A showing the entire length, except for the very end, having an actual pressure above the pipes pressure classification.

Overall, subsidence of this lateral alone has weakened the pipe by approximately 10% compared to the original design. That is determined by comparing the pressure rating on the pipe to the level of subsidence. For example, the last segment of pipe is rated for 150 feet of head and the subsidence along this stretch of pipe is over 15 feet (over 10% of the pressure rating). Moving upstream, the level of subsidence is approximately 10% of the pressure rating. Given that the factor of safety is only 20% above the pressure rating, in some cases, the factor of safety has been halved, effectively weakening the pipe compared to how it was designed.

Laterals B through D Static Analysis

Like Lateral A, subsidence has impacted various locations along the other longer gravity laterals in DEID. Figure 5 through Figure 11 show the elevation profiles for Laterals B, C, and D lateral mainlines. Along each lateral there are cases where the pipe classification plus current pipe elevation drops lower than the static (zero flow) HGL. These at-risk sections have been highlighted on a smaller scale to visualize the amount of risk due to subsidence, and in particular subsidence that has occurred after 2015. Lateral C shows areas where the pipe rating is currently 8' below the HGL.

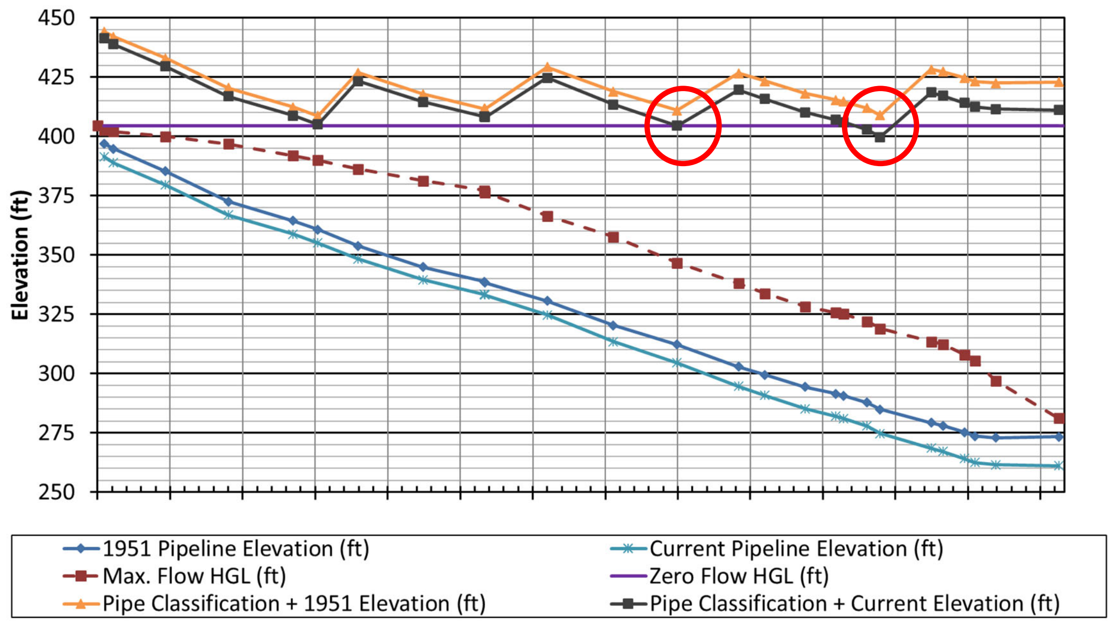

Figure 5. Elevation profiles for the Lateral B mainline

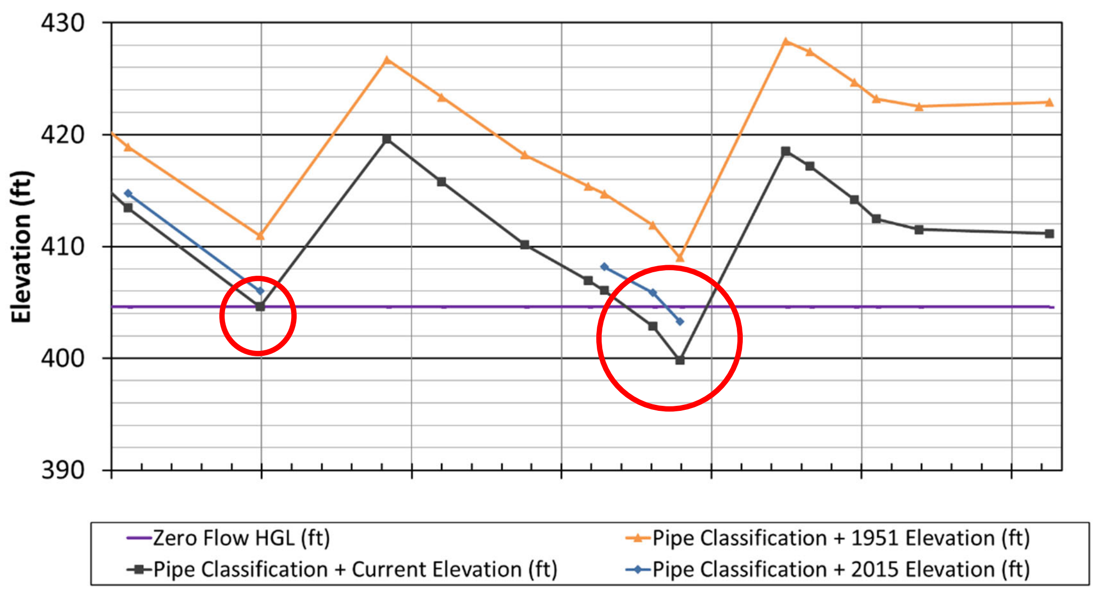

Figure 6. At risk sections of Lateral B mainline with current subsidence levels

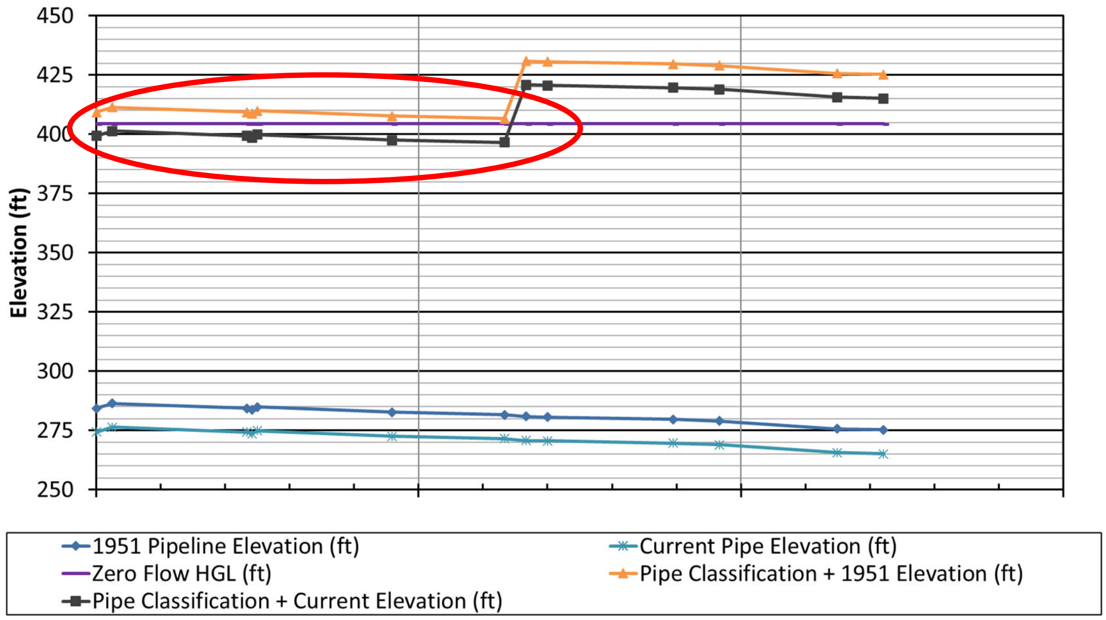

Figure 7. Sublateral on Lateral B where the static pressure is above the pipe pressure classification under current subsidence

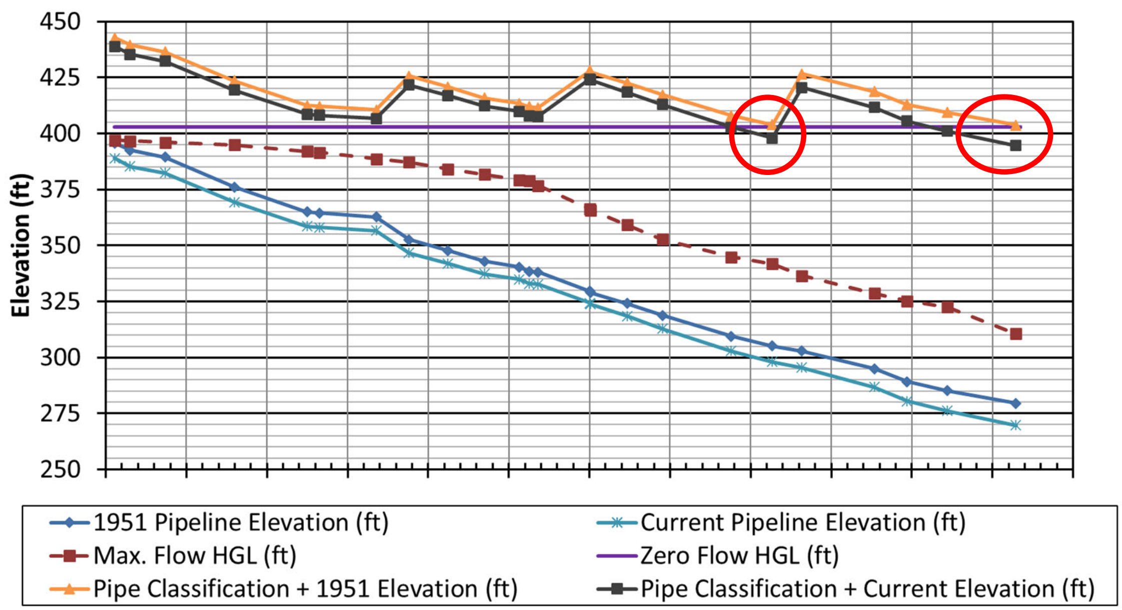

Figure 8. Elevation profiles for the Lateral C mainline

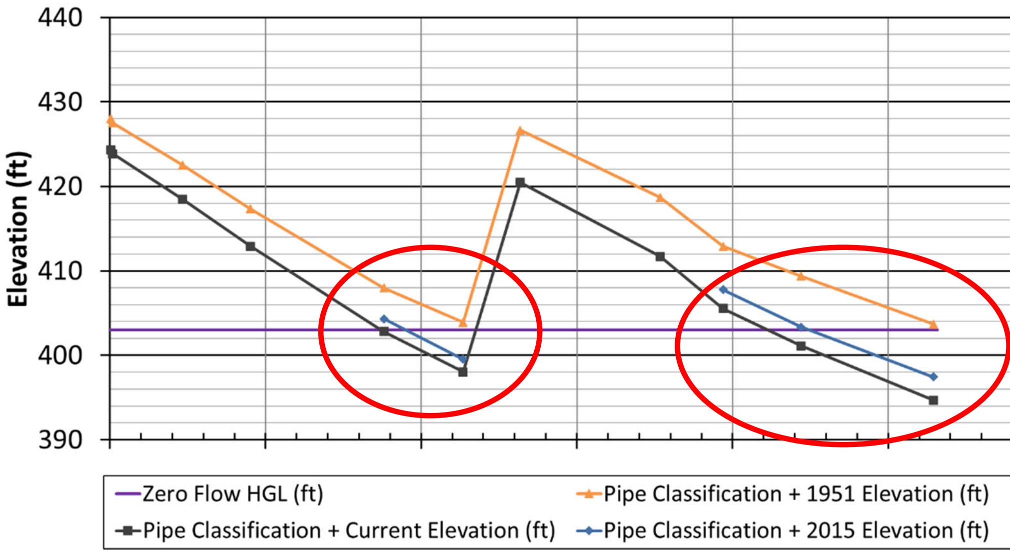

Figure 9. At risk sections of Lateral C mainline due to subsidence

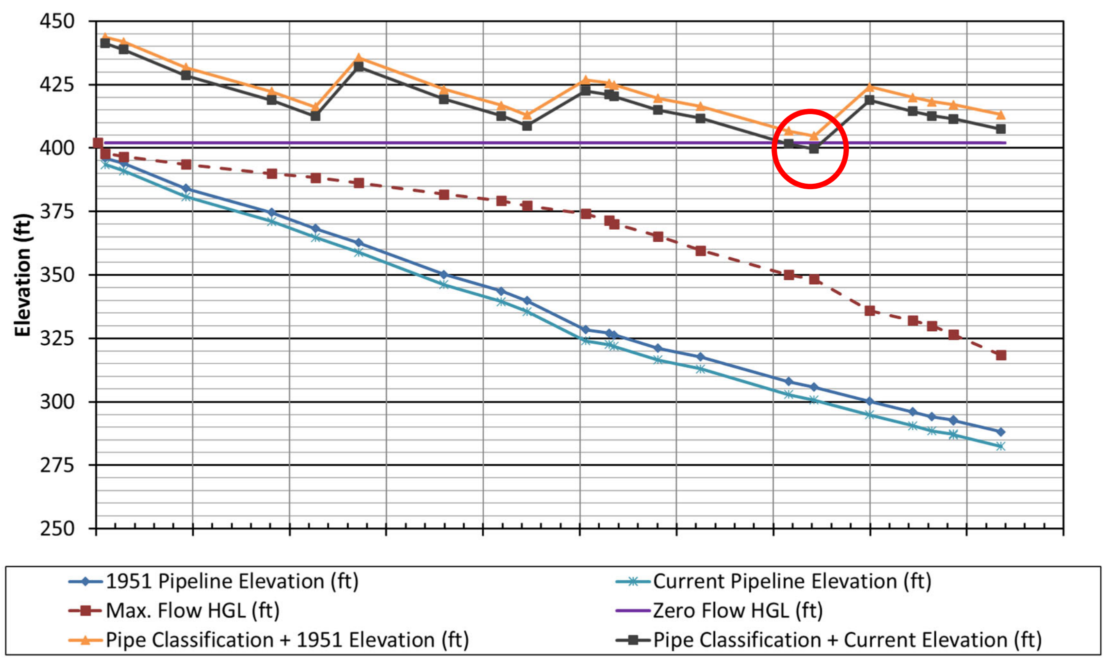

Figure 10. Elevation profiles for the Lateral D mainline

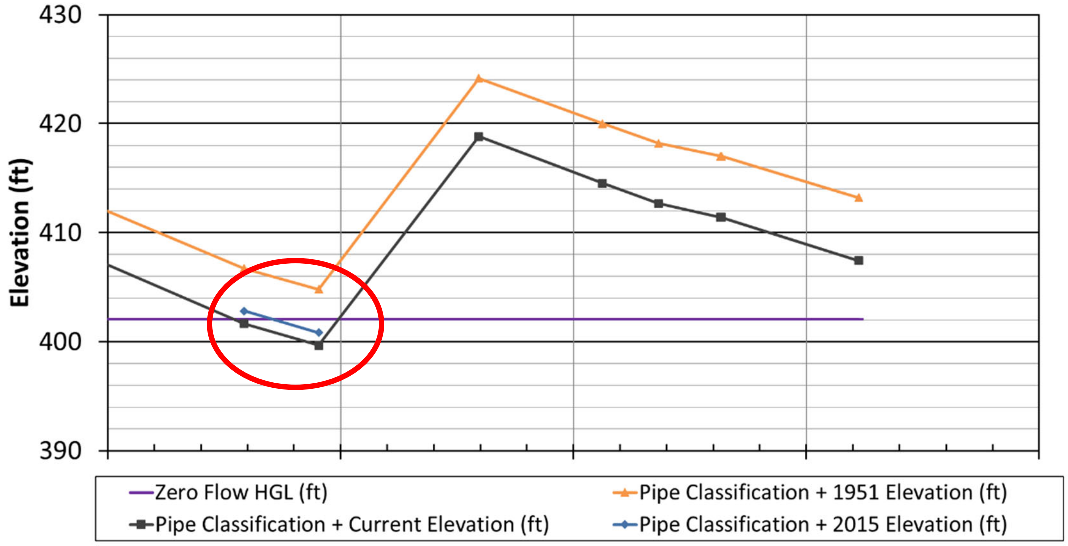

Figure 11. At risk section of Lateral D mainline due to subsidence

The static analysis shows that each of these laterals has pipelines at risk of failure due to subsidence. Additional subsidence not only increases the level of risk of the pipelines where the pressure is already above the pipeline pressure classification, but it will also increase the amount of the laterals and sublaterals at risk.

Summary and Conclusions

The data analysis in this memorandum indicates that subsidence has increased the risk of pipeline failure. The static analysis confirms that the static (zero flow) pressure on the pipelines now exceeds the pipe pressure rating by more than 8 feet in some locations. Up to 3 feet of additional subsidence has occurred since 2015. While the USBR pipeline specifications for DEID mandated that the manufacturer test the pipe to withstand 120% of the rated pressure, this “factor of safety” was never intended to be encroached upon under static or steady state flow condition. The factor of safety accounts for surge pressures that occur under normal dynamic operating conditions.

The risk due to pipe pressures exceeding the pipe pressure classification is pipeline failure. There are different types of failure that could occur in these conditions. The risk of gasket failure is increased at pipe joints due to both excessive pressure and pipe deflection due to the subsidence. The latter was not discussed in this memo since the overall deflection was within pipe installation tolerances. However, in combination with excessive pressure, the risk is increased. Not to mention the allowable deflection tolerance is intended for deflection at installation not subsidence. It is unknown what the actual deflection was in the pipelines at installation and any additional deflection could be problematic.

Another issue would be the failure of the steel reinforcement[5]. As continuous pipe pressure exceeds the pressure ratings, the reinforcing steel wire is likely to begin to fail individually until there is insufficient reinforcement to contain the pressure. At which point the pipeline will experience a blowout where the reinforcement is weakest. Transient forces due to surge pressure could exacerbate this failure mode.

It is evident that, even just since 2015, more pipelines have had their pressure rating exceeded and the magnitude of the at-risk pipe has increased. There are locations on Lateral C where the pipeline elevation plus pressure rating AND the factor of safety are inches away from being below the static pressure. The four laterals examined have at risk pipelines near major transportation routes, including railroads and major roads. In one case the at-risk pipeline is near a town and others have houses nearby. Catastrophic failure of these pipelines will not only impact DEID and its customers but may create regional public health and safety problems.

Based on the data and analysis in this memorandum, it is my opinion that any additional subsidence will further increase the risk of catastrophic pipe failure. Both the level of risk (pressure level above pressure rating) and the amount of pipeline at risk will increase with continued subsidence.

[5] Dong, X., T. Dou, B. Cheng, L. Zhao. 2021. Failure analysis of a prestressed concrete cylinder pipe under clustered broken wires by FEM. Structures. 33(2021): 3284-3297

Attachment A

Howes CV

Daniel J. Howes, Ph.D., P.E.

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dhowesphd@gmail.com

Dr. Howes is a Professor in the BioResource and Agricultural Engineering (BRAE) Department at California Polytechnic State University, San Luis Obispo and the Chairman of the Irrigation Training and Research Center. He has 29 years of experience working in the irrigation industry, on projects in the western U.S. and internationally. Dr. Howes' engineering experience includes irrigation project modernization, pipeline and open channel design, evaluation of basin and field level crop evapotranspiration, on-farm water management, nutrient and salinity management, remote sensing, flow measurement, and agricultural water energy use. He teaches irrigation courses at Cal Poly including irrigation water and salinity management, irrigation system design and management, pump and well design, and irrigation project design and modernization.

Education

2010 Ph.D. –Civil Engineering
University of California, Irvine

2001 M.S. – Engineering with a specialization in Water Engineering
California Polytechnic State University, San Luis Obispo, CA

1997 B.S. – Agricultural Systems and Environment
University of California, Davis, CA

Registration

Registered Professional Engineer, Civil (California Lic. No. 67719)

- Also licensed in Montana, Idaho, Arizona, and Washington. License numbers available upon request.

Areas of Expertise

Agricultural irrigation; canal modernization; evapotranspiration; remote sensing; hydraulics; on-farm irrigation; efficiency of water and energy; CFD modeling; GIS

Affiliations

American Society of Civil Engineers; EWRI; The Irrigation Association; United States Committee on Irrigation and Drainage (USCID)

Relevant Experience

Background and Research prior to 1999

Raised on a cotton, alfalfa, and corn farm near Hanford, California. Started working at the Kearney Research Center in Parlier while attending the University of California, Davis. After graduation continued as a Post Graduate Researcher. Duties included designing and installing research plots, as well as Irrigation related research and data collection on almonds, pistachios, citrus, peaches, grapes, and olives in field trials throughout the San Joaquin Valley.

<u>1999-Present: Irrigation Training and Research Center (ITRC), Cal Poly</u>
Currently the Chairman of the ITRC and project manager working on a variety of projects including the development of a remote sensing program to determine evapotranspiration from vegetation, net groundwater use using remote sensing and surface data, agricultural water energy requirements in California, irrigation district modernization throughout the western U.S., open channel flow measurement, large scale water balance investigations, short-course training, on-farm irrigation water management.

<u>2011-Present: BRAE, Cal Poly</u>
Currently a Full Professor of engineering classes on irrigation project design and modernization, evapotranspiration, irrigation scheduling, irrigation system design and management, pumps, and groundwater wells.

<u>2021-Present: Consultant and Expert Witness</u>
Providing confidential expertise related to water and waste management and design. Projects include analysis and conclusions related to water well design, installation, and maintenance, open channel design, open channel roughness and siphon loss assessment, pump station failure analysis, pipeline design, water balances, and flow measurement.

Select Projects: 2011 to Present

<u>Pipeline design analysis and pump station reconfiguration for energy savings.</u> Evaluated the existing pipeline designs and pump station configurations along 16 laterals in the Navajo Indian Irrigation Project. This evaluation included examining hydraulic grade lines and pipe ratings under existing designs and future designs with lower pressure requirements. Solutions to reduce energy needs included adding variable frequency drives to pumps within the pump stations, reducing applied volage by adding transformers and new motors, and physically lowering water tanks throughout the project. Designs for future blocks were also evaluated with new recommendations to reduce energy needs.

<u>Flow measurement and open channel hydraulics.</u> Designed and constructed a facility to test irrigation district turnout flow meters at the Cal Poly Water Resources Facility. This facility was used to test the uncertainty of canal meter gates in measuring flow rates to farm fields from canals. Designed a 2,200 CFS Replogle Flume (ramp flume) for the Gila Gravity Main Canal near Yuma, AZ (constructed in 2005) Designed a long-crested weir integrated with a Replogle flume in Rosedale-Rio Bravo WSD, near Bakersfield, CA (constructed in 2021).

Utilize three-dimensional open channel hydraulic modeling using finite difference/volume models to improve open channel flow measurement accuracy. An example is the development of a special contraction for improved flow meter accuracy using acoustic Doppler velocity meters. This has been published and installed in over a dozen sites in the western U.S. Testing innovative techniques to improve velocity profiles downstream of obstructions.

Utilize one-dimensional and two-dimensional fluid dynamics models for open channel design and flood/dam break evaluations, respectively. These models are run on larger scales to analyze issues related to control, capacity, or impacts of potential infrastructure improvements.

Pipeline hydraulic and transient analysis using commercial software packages.

<u>Water Conservation and Drought Planning, Irrigation Project Modernization, and On-site Training for Irrigation System Operators and Engineers.</u> Prepared over 20 Rapid Appraisals (overview of strategic plans for irrigation districts) throughout the western U.S. Prepared eight full modernization plans for irrigation water agencies in California and the western U.S. These plans integrate internal and external pressures with a wholistic analysis of infrastructure and operational constraints, to develop an overall strategic plan and detailed designs and recommendations to accomplish these plans. These designs improved check structures, turnouts, flow control structures, flow measurements structures for on-farm and major conveyances

Developed an irrigation safety plan for the Bureau of Indian Affairs irrigation projects. This includes risk analysis for a variety of water conveyance and irrigation project infrastructure. Conduct irrigation district operator training on-site and at Cal Poly. Worked on numerous water balances for irrigation district as well as water conservation plans and drought planning. Recent examples include a Comprehensive Water Conservation Plan and Drought Management Plan for Wapato Irrigation Project in Washington State.

<u>Remote Sensing of Evapotranspiration and Net Groundwater Use.</u> Developed the ITRC-METRIC methodology for computing vegetative evapotranspiration using remote sensing data. This technique allows greater spatial resolution of evapotranspiration within individual fields as well as between fields over a large basin compared to other evapotranspiration estimation methods. The interest has significantly increased in developing actual crop consumptive use (evapotranspiration) on a large scale. ITRC-METRIC.

I also developed the process to measure net groundwater use on a field/farm level called Net To/From Groundwater (NTFGW). This is being used to calibrate groundwater models and for regulating the field level groundwater use to meet the Sustainable Groundwater Management Act (SGMA) objectives. Agreements are already in place to provide this information monthly to the foreseeable future for multiple Groundwater Sustainability Agencies (GSAs).

Publications, Papers, Reports, and Proceedings

Papers and Conference Presentations – (** denotes peer-reviewed journal or conference paper*)

Howes, D.J. 2024. SGMA and Remote Sensing of Evapotranspiration. Presented to the Upper Valley Subbasin Implementation Committee. January 2024. Salinas, CA

Howes, D.J., M.P. McCullough, and D. Fisher. 2023. Analysis of Economic Sustainability in Irrigation Projects throughout the Western U.S. Presented at USCID 13th International Conference on Irrigation and Drainage. October 17-20, 2023. Fort Collins, CO

Howes, D.J. 2023. Sustainable Evapotranspiration for Groundwater Sustainability. Presented at USCID 13th International Conference on Irrigation and Drainage. October 17-20, 2023. Fort Collins, CO

Howes, D.J. 2022. SGMA Implementation Key Considerations. Presented at the Sustainable Ag Expo, Nov. 16, 2022. San Luis Obispo, CA

Howes, D.J. and C.M. Burt. (manuscript in preparation). Maximizing Almond and Pistachio Yield per Unit of Evapotranspiration. Expected submittal to journal summer 2019.

Howes, D. J. and J. Carlon. 2019. "Float Actuated Gate for Slow Dewatering of Remnant Flood Plain with Fish Bypass." Paper presented at USCID 12th International Conference on Irrigation and Drainage. November 4-8, 2019.

Howes, D., M. Whinery, E. Limas, and D. Vink. 2018. Using Net Groundwater Extractions for Farm Level Groundwater Sustainability Monitoring. Paper presented at USCID 11th International Conference on Irrigation and Drainage. Phoenix, Arizona. October 16-19, 2018.

*Howes, D. J., C. M. Burt, and J. Thorburn. 2017. "Supply Channel Velocity Influence on Farm Delivery Meter Gate Flow Measurement." *ASCE Journal of Irrigation and Drainage Engineering*. 143(7):06017003

*Howes, D. J. and C. M. Burt. 2016. "Accuracy of Round Meter Gates for On-Farm Deliveries." *ASCE Journal of Irrigation and Drainage Engineering.* 142(1): 04015032.

*Howes, D. J. and C. M. Burt. 2016. "Rating Rectangular Farm Delivery Meter Gates for Flow Measurement." *ASCE Journal of Irrigation and Drainage Engineering*, 142(1): 04015033.

Howes, D. J. and C. M. Burt. 2016. "Maximizing Almond and Pistachio Yield per Unit of Evapotranspiration." Presented at the USCID 9th International Conference on Irrigation and Drainage, Fort Collins, CO, October 2016

Howes, D.J. 2015. Influence of Drought on Actual Crop Evapotranspiration in California's Central Valley – 2011 Compared to 2014. Presented at the 2015 USCID Conference: Emerging Issues in Water Management Governance, Albuquerque, NM. November 17-20, 2015

Robinson, T. and D.J. Howes. 2015. Identification of agricultural land use in California through remote sensing: preliminary results. Paper will be presented at the 2015 USCID Conference: Emerging Issues in Water Management Governance, Albuquerque, NM. November 17-20, 2015.

*Fox, P., P.H. Hutton, D.J. Howes, A.J. Draper, and L. Sears. 2015. “Reconstructing the natural hydrology of the San Francisco Bay–Delta watershed.” *Hydrology and Earth Systems Sciences* (HESS), 19(10): 4257-4274

*Howes, D.J., P. Fox, P. Hutton. 2015. Evapotranspiration from Natural Vegetation in the Central Valley of California: Monthly Grass Reference Based Vegetation Coefficients and the Dual Crop Coefficient Approach. *ASCE Journal of Hydrologic Engineering*. 20(10), 04015004.

*Howes, D. J., S. Ellenson, L. Hoffman, and F. Gaudi. 2015. Center Pivot Sprinkler Distribution Uniformity Impacts on the Spatial Variability of Evapotranspiration. *ASCE Journal of Irrigation and Drainage Engineering*. 141(8): 04014085

Howes, D.J., C.M. Burt, and L. Hoffman. 2014. “Evaluating Net Groundwater Use from Remotely Sensed Evapotranspiration and Water Delivery Information.” Paper presented at the Irrigation Association 2014 Irrigation Show, November 17 and 18, 2014. Phoenix, AZ.

Howes, D.J. and E.W. Njuno. 2014. “Decision support - dynamic regional crop productivity indexing tool plus remote sensing of actual evapotranspiration”. Poster presented at the Water Resources and Policy Initiatives (WRPI) Poster Reception, March 25, 2014, Long Beach, CA. (Also presented at the Cal Poly Green and Gold Student Showcase May 2, 2014.)

Howes, D.J. 2014. “Calibrating Orifice Flow Turnout Gates for SBx7-7 Compliance.” California Irrigation Institute Conference on Building a Water and Energy Efficient California, January 23-24, 2014. Sacramento, CA.

Howes, D.J., P. Fox, and P. Hutton. 2014. “Evapotranspiration from Natural Vegetation in the Central Valley of California.” Presented at the CWEMG 2014 Annual Meeting, February 25, 2014. Folsom, CA.

Howes, D.J., and M. Pasquet. 2013. “Grass referenced based vegetation coefficients for estimating evapotranspiration for a variety of natural vegetation.” USCID Water Management Conference, Oct. 22-25, 2013. Denver, CO.

Howes, D.J., and S. Styles. 2013. “Integrating remote sensing of evapotranspiration with surface and groundwater information to target potential water conservation projects in watersheds.” Presented at Soil and Water Conservation Society Annual Conference July 21-24, 2013, Reno, NV.

*Howes, D. J., L. Hoffman and F. Gaudi. 2012. “Spatial variability in evapotranspiration related to irrigation system distribution uniformity." Paper presented at USCID Managing Irrigation Systems in Today's Environment Conference Nov. 13-16, 2012. Reno, NV.

*Howes, D. J., C.M. Burt and K. Feist. 2012. “Basin-wide remote sensing of actual evapotranspiration and its influence on regional water resources planning.” Paper presented at USCID Managing Irrigation Systems in Today's Environment Conference Nov. 13-16, 2012. Reno, NV.

Howes, D. J., L. Hoffman and F. Gaudi. 2012. “Comparison of field level and regional actual ETc values developed from remote sensing and dual crop coefficient procedure.” Paper presented at the Irrigation Association 2012 Irrigation Show Nov. 4-5, 2012. Orlando, FL.

Howes, D. J. 2012. “Evaluating regional evapotranspiration – Coupling high temporal resolution methods with high spatial resolution remote sensing information." Presented at the 2012 Land Grant and Sea Grant National Water Conference. May 20 – 24, 2012. Portland, OR.

*Howes, D. J. and B. F. Sanders 2011. “Velocity Contour Weighting Method I: Algorithm Development and Laboratory Testing." *Journal of Hydraulic Engineering*. 137(11): 1359-1367

*Howes, D. J. and B. F. Sanders 2011. “Velocity Contour Weighting Method II: Evaluation in Trapezoidal Channels and Roughness Sensitivity." *Journal of Hydraulic Engineering*. 137(11): 1368-1374

*Howes, D. J., C. M. Burt and B. F. Sanders. 2010. "Subcritical Contraction for Improved Open Channel Flow Measurement Accuracy with an Upward-Looking ADVM." *Journal of Irrigation and Drainage Engineering*, 136 (9): 617-626.

Howes, D. J. and B. F. Sanders. 2010. “Velocity Contour Weighting Method for Open Channel Discharge Measurement with Acoustic Doppler Velocity Meters." Presented at the Engineering Mechanics Institute 2010 Conference. August 8-11, 2010. Los Angeles, CA.

*Howes, D. J., C. M. Burt and B. F. Sanders 2009. “Flow Conditioner Design for Improving Open Channel Flow Measurement Accuracy from a SonTek Argonaut-SW." Paper presented at USCID Fifth International Conference on Irrigation and Drainage Nov. 3-6, 2009

Burt, C.M., F. Gaudi, and D.J. Howes. 2008. Improving Pump Performance. Paper presented at Irrigation Association 28th Annual International Irrigation Show. Anaheim, CA. November 2008.

Howes, D.J., F. Gaudi, and D. Ton. 2007. “Effluent Nitrogen Management for Agricultural Re-Use Applications.” Paper presented at the Irrigation Association Show. San Diego, CA. December 9, 2007.

*Mutziger, A.J, C.M. Burt, D.J. Howes and R.G. Allen. 2005. “Comparison of Measured and Modified FAO 56 Modeled Bare-Soil Evaporation.” *ASCE Journal Irrig. Drain. Engr*. 131(1):59-72.

*Howes, D.J., C.M. Burt, and S. Styles. 2003. “GIS Mapping for Irrigation District Rapid Appraisals.” Paper presented at the USCID 2nd International Conference on Irrigation and Drainage. Phoenix, AZ. May 12-15, 2003.

Burt, C.M., D.J. Howes, and A. Mutziger. 2001. “Evaporation Estimates for Irrigated Agriculture in California. Paper presented at the 2001 Irrigation Association Conference. San Antonio, TX. November 4-6, 2001.

List of other non-confidential reports and papers available upon request.

DELANO – EARLIMART IRRIGATION DISTRICT
GROUNDWATER SUSTAINABILITY AGENCY

APPENDIX P

Groundwater Dependent Ecosystem Review for DEID GSA

2024
2nd Amended Groundwater Sustainability Plan

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DRAFT MEMORANDUM

To: State Water Resources Control Board

From: Trey Driscoll, PG, CHG; Kait Palys; INTERA Incorporated

Date: July 10, 2024

RE: Review of Groundwater Dependent Ecosystems for Delano-Earlimart Irrigation District Groundwater Sustainability Agency

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This draft memorandum provides a response to comments to the Tule Subbasin Probationary Hearing Draft Staff Report, dated March 2024 (Draft Staff Report) specific to Groundwater Dependent Ecosystems (GDEs) for the Delano-Earlimart Irrigation District Groundwater Sustainability Agency (DEID GSA).

Draft Staff Report Figure 3-11, which depicts the State Board staff's evaluation of potenal GDEs within the DEID GSA sourced by the Natural Communities Commonly Associated with Groundwater (NCCAG) Dataset Viewer (Klausmeyer et al, 2018) and California Native Plant Society Manual (Sawyer et al, 2009) identified four potential GDEs Sites 1 through 4 in the DEID GSA (**Figure 1**).

DEID GSA used the following 3-step approach to evaluate whether mapped aquatic and vegetative GDEs are likely to occur.

(1) Aerial imagery during the historically wet 2023 conditions were reviewed to assess the presence of potential GDEs at sites identified as potential GDEs by the NCCAG dataset and California Native Plant Society Manual and reported by the State Water Resources Control Board (SWRCB). Each identified potential GDEs within DEID GSA shown in Figure 1 was assigned a site-identification (Sites No. 1 – No. 4) which correspond with the aerial imagery described below:

Findings: DEID GSA verified these four sites do not have potential GDEs or interconnected surface water present based on the upper aquifer groundwater levels exceeding possible rooting depths and review of the land use at these four sites, as summarized below:

- Site 1 (Earlimart) – This site is in the vicinity of agricultural lands and recharge and wastewater treatment facility retention ponds for the community of Earlimart. It is likely that these retention ponds were mischaracterized as potential GDEs. **Figure 2** is a snapshot of Google Earth in May 2023 of Site 1. The Earlimart Public Utilities District Wastewater Treatment Facility Waste Discharge Requirements (WDR) Order No. 98-140[1] and CEQA documentation for the facility[2] were reviewed to evaluate the potential for GDEs to occur. WDR Order No. indicates that, "Based on the information obtained from the 'Lines of Equal Elevation of Water in Wells in Unconfined Aquifer,' published by Department of Water

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[1] Water Boards (1998), available at https://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/tulare/98-140.pdf

[2] State of California (2024), CEQANet, available at https://ceqanet.opr.ca.gov/1996012045

Resources in Spring 1996, the depth of groundwater in the region is 100 feet below ground surface". As shown on **Figure 7**, the 2023 upper aquifer groundwater level elevation is 120 to 140 feet (ft) above mean sea level (amsl) or 120 to 140 ft below ground surface (bgs) near the retention ponds and not likely to support the minimum rooting depth of GDEs.

- Sites 2-4 (FKC North, Central, South) – These sites are located within and/or adjacent to the Friant-Kern Canal (FKC), which is a concrete lined system and disconnected from groundwater. It is likely that the NCCAG dataset and California Native Plant Society Manual sources mischaracterized these portions of the FKC as being aquatic ecosystems. Figure 3**,** Figure 4**,** and Figure 5 are snapshots from Google Earth in May 2023, in which groundwater levels were at or near their peak in the historic wet year[3].

(2) Compare surface conditions and potential GDE sites to upper aquifer groundwater level conditions in the most recent groundwater table high (Spring 2023)
   a. **Findings:** The depth to groundwater at each location exceeds the likely rooting depth of GDEs; which invalidates potential for interconnected surface water or GDEs

Site	Ground Surface Elev. (ft amsl)[a]	2023 Groundwater Elev (ft amsl)	2023 Depth to Groundwater (ft)
Site 1 – Earlimart PUD	~243	140 to 120	103 to 123
Site 2 – FKC (North)	~398	160 to 140	238 to 258
Site 3 – FKC (Central)	~398	160 to 140	238 to 258
Site 4 – FKC (South)	~396	160 to 140	236 to 256

Notes:
a. Elevation from 1-meter digital elevation model (USGS 2024).

(3) Review The Nature Conservancy's GDE Pulse 2.2 tool (TNC, 2024) The Nature Conservancy's GDE Pulse 2.2 tool is an advanced web application designed to monitor the health of Groundwater Dependent Ecosystems (GDEs). This tool provides a more accurate and updated version of the Natural Communities Dataset Viewer tool by displaying the NCCAG (Natural Communities Commonly Associated with Groundwater) dataset with enhanced precision
   a. **Findings**: **Figure 6** is a snapshot from the GDE Pulse 2.2 tool over the DEID GSA area. The nearest GDEs are outside of the GSA's jurisdiction. Thus, while State Board staff identified putative aquatic groundwater dependent ecosystems within DEID (Tule Basin Draft Staff Report, March 2024), DEID's analysis shows that these do not exist.

Based on review of historical and current depth to groundwater, review of aerial imagery and the potential rooting depts of vegetation that is groundwater-dependent, there are no GDEs within the DEID GSA.

[3] Aerial imagery was not available for February, March, or April 2024 via Google Earth; however, the groundwater levels in May 2023 are understood to be comparable to April 2023 conditions, with the surrounding wells not being used due to demand needs being met by precipitation and surface water access.

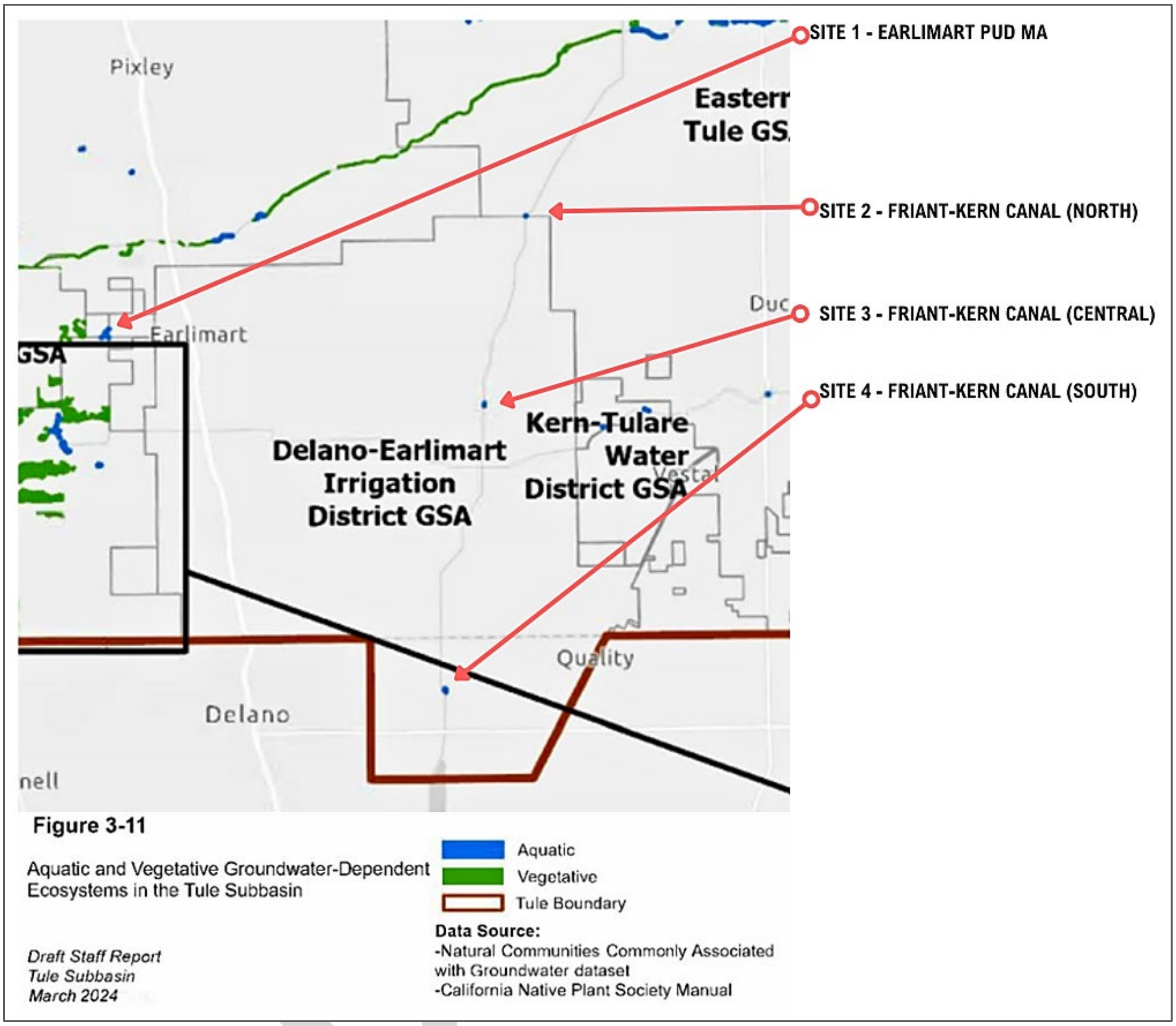


Figure 1. Potential GDEs identified in the State Board Staff Report and sites evaluated by DEID GSA

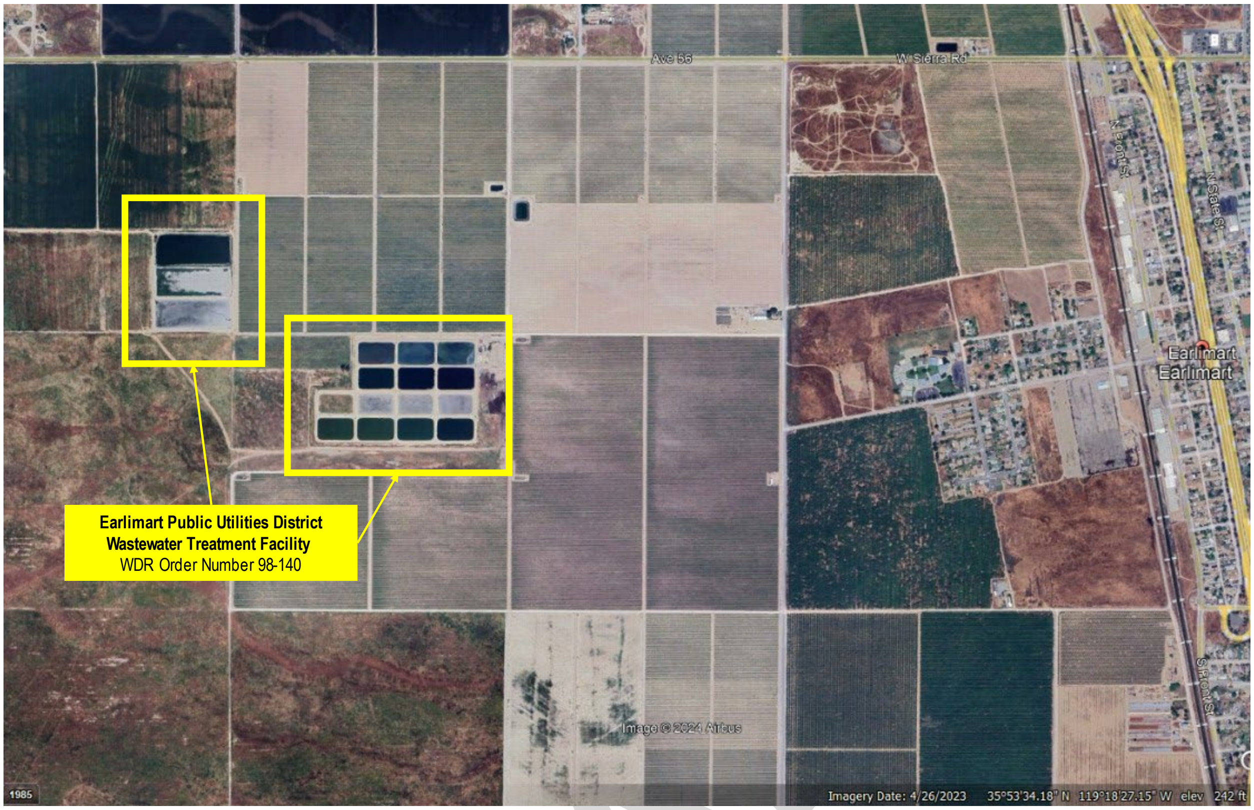


Figure 2. Site 1 (Earlimart) Source: Google Earth aerial photography from May 2023 (during historic wet year)[4,5]

[4] Water Boards (1958), available at https://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/tulare/98-140.pdf
[5] State of California (2024), CEQANet, available at https://ceqanet.opr.ca.gov/1996012045

Figure 3. Site 2 (FKC North) Source: Google Earth aerial photography from May 2023 (during historic wet year)

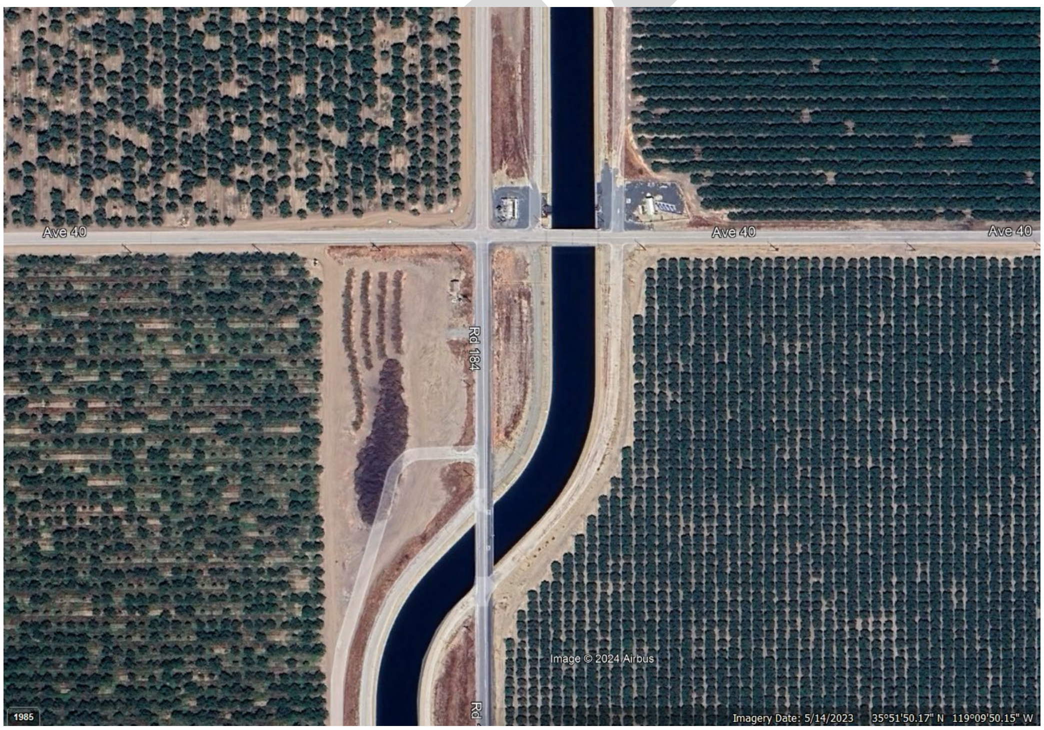


Figure 4. Site 3 (FKC Central) Source: Google Earth aerial photography from May 2023 (during historic wet year).

Figure 5. Site 4 (FKC South) Source: Google Earth aerial photography from May 2023 (during historic wet year).

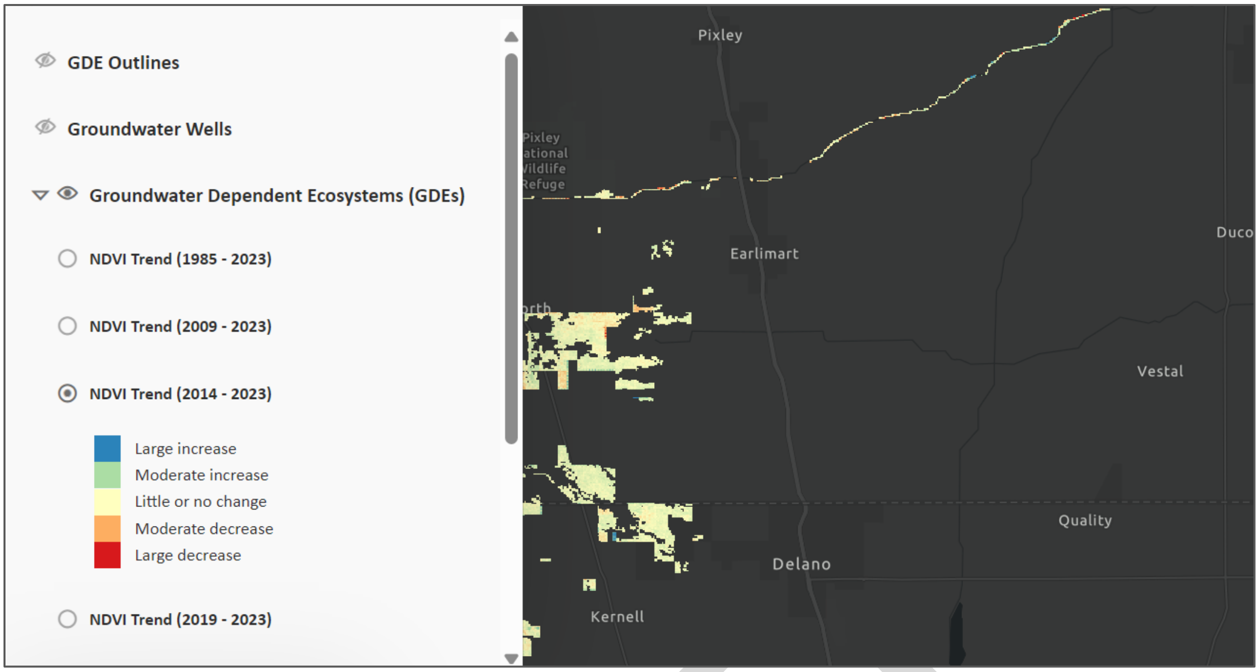


Figure 6. Snapshot from GDE Pulse 2.2 tool over DEID GSA plan area (2014 – 2023).

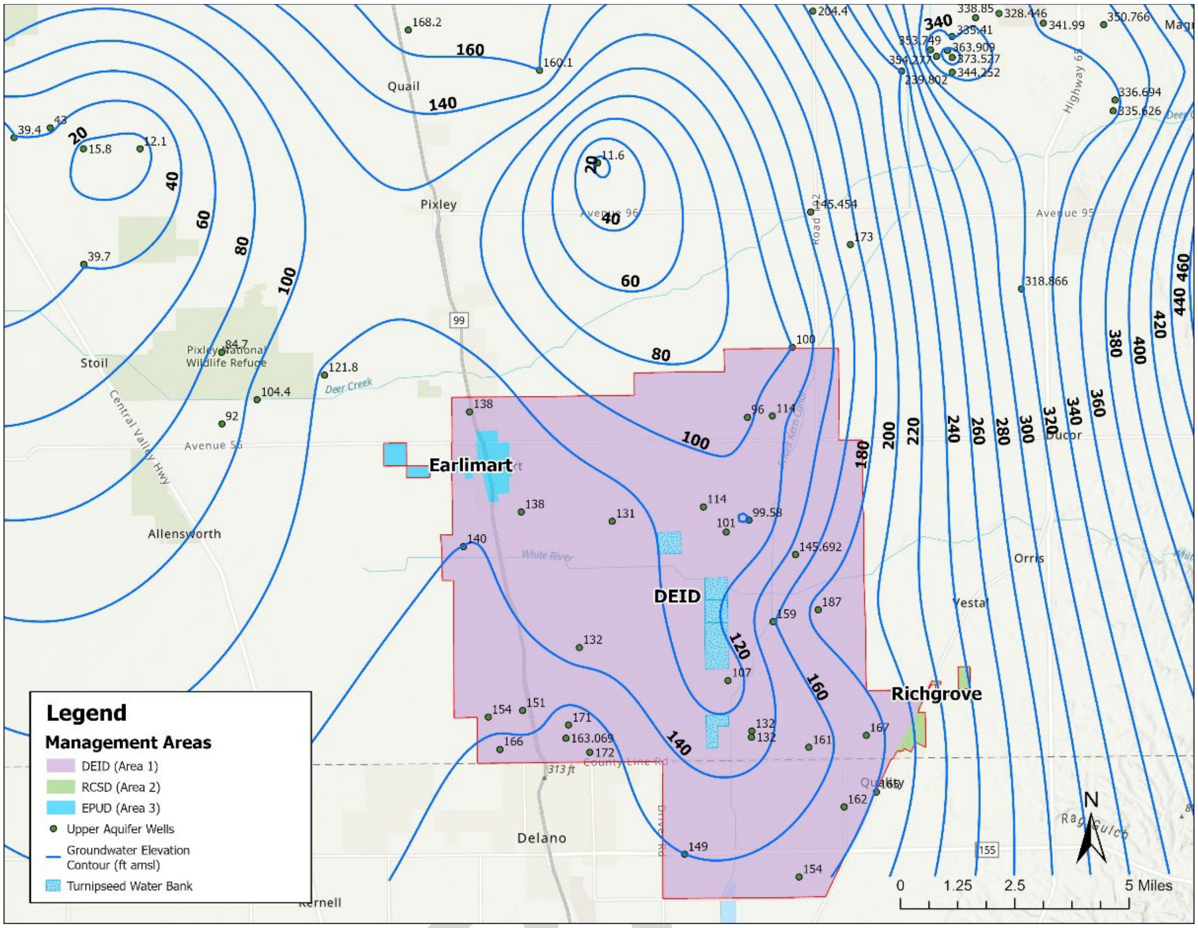


Figure 7. 2023 Water year seasonal high (spring 2023) upper aquifer groundwater level contours for the DEID GSA plan area

References

Klausmeyer, K., Howard J., Keeler-Wolf T., Davis-Fadtke K., Hull R., and Lyons A. (2018). Mapping Indicators of Groundwater dependent ecosystems in California.

Sawyer, J.O., T. Keeler-Wolf, and J.M. Evens. 2009. A Manual of California Vegetation, Second Edition. California Native Plant Society, Sacramento, CA. 1300 pp.

The Nature Conservancy, California. 2024. GDE Pulse v2.2.0. San Francisco, California. Site Accessed, July 2024. https://gde.codefornature.org.

USGS. 2024. One Meter Digital Elevation Model. TNM Download (v2.0). Site Accessed, July 2024. TNM Download v2 (nationalmap.gov).

DELANO – EARLIMART IRRIGATION DISTRICT
GROUNDWATER SUSTAINABILITY AGENCY

APPENDIX Q

Development of the Relationship Between Modeled Groundwater in Storage and Groundwater Elevations for the Delano-Earlimart Irrigation District Groundwater Sustainability Agency

2024
2nd Amended Groundwater Sustainability Plan

Appendix Q

Development of the Relationship Between Modeled Groundwater in Storage and Groundwater Elevations for the Delano-Earlimart Irrigation District Groundwater Sustainability Agency

This appendix presents data illustrating the relationship between modeled groundwater in storage and observed historic groundwater level elevations for the upper aquifer within the Delano-Earlimart Irrigation District Groundwater Sustainability Agency (DEID GSA). By developing this relationship, groundwater levels can be used to calculate annual volumes for groundwater in storage in the upper aquifer. The groundwater in storage volumes will be used to report annual change in storage required under the Sustainable Groundwater Management Act (SGMA).

Groundwater level measurements and model results from the month of March were selected for this analysis to represent spring-high groundwater conditions. Data from approximately 100 wells within the DEID boundary were selected for the relationship. Although sampling dates and frequencies varied greatly between wells, all available data was used to represent the elevations for the relationship. The arithmetic mean (average) was calculated using all available measurements made in March for 1988 through 2019.

Using the existing MODFLOW groundwater model developed by Thomas Harder and Company (TH&Co, 2020), groundwater in storage in the upper aquifer (model layer 1) was calculated based on the model grid properties. Only the modeled storage within the boundary of DEID was used for the relationship, and like the measured groundwater level elevations, only storage volumes calculated for the month of March were used.

Results of Correlation

A linear regression showing the relationship between the modeled groundwater in storage and average March measured groundwater level elevations for the upper aquifer within the DEID boundary is presented in Figure 1. The R^2 (the metric used for evaluating correlation) value of the regression was 0.88, showing that measured groundwater levels correlate with modeled groundwater in storage, and therefore can be used as a valid proxy for monitoring storage trends in the upper aquifer.

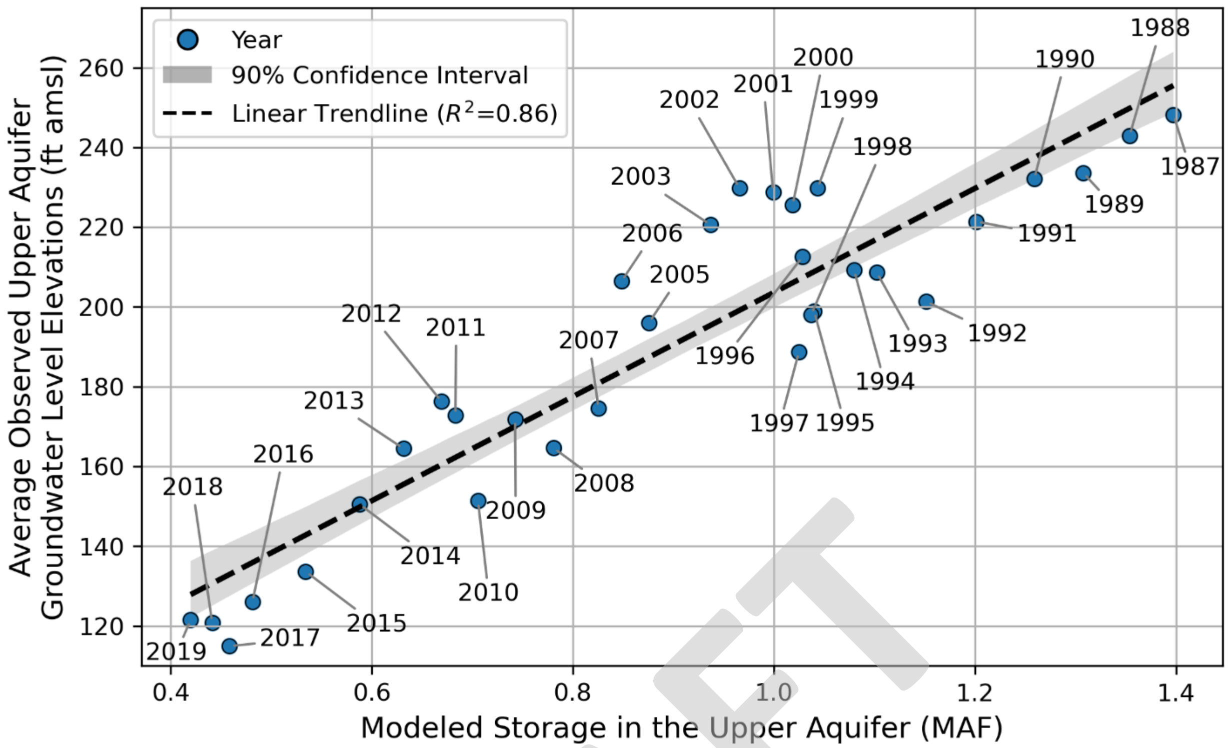
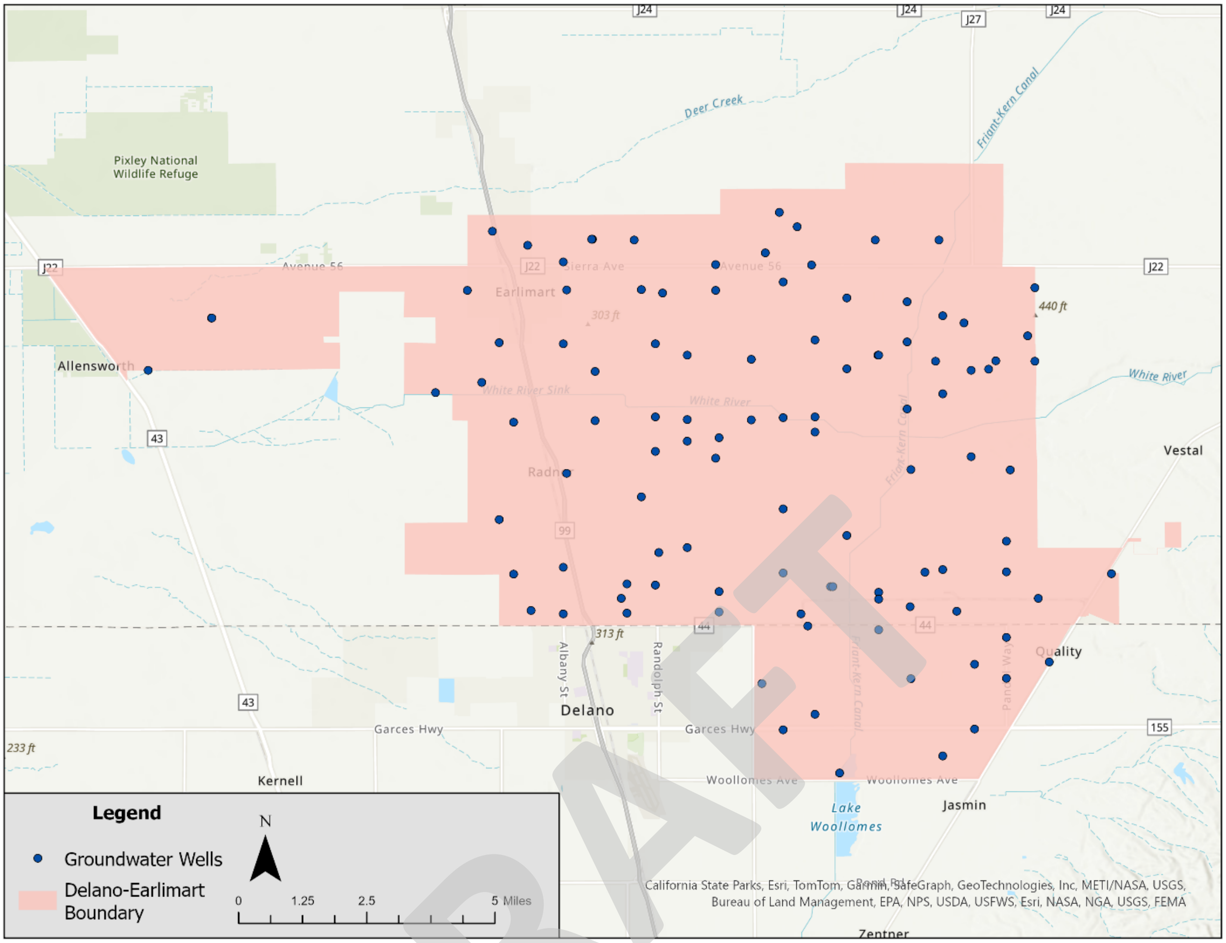


Figure 1: Linear regression between modeled groundwater in storage for the upper aquifer (model layer 1) and measured groundwater level elevations within DEID GSA. All measurements and model results were evaluated for only the month of March to represent spring-high conditions. A significant trend is present with an R^2 value of 0.86 and p-value less than $1x10^{-10}$.


Legend
Groundwater Wells
Delano-Earlimart Boundary
N
0
1.25
2.5
5 Miles
Pixley National Wildlife Refuge
Deer Creek
Friant-Kern Canal
Avenue 56
Sierra Ave
Earlimart
303 ft
440 ft
Allensworth
White River Sink
White River
Vestal
Radnor
Delano
Albany St
Randolph St
313 ft
Quality
Garces Hwy
Kernell
233 ft
Woollomes Ave
Lake Woollomes
Jasmin
Zentner
California State Parks, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS, Esri, NASA, NGA, USGS, FEMA