APPENDIX B1
Friant-Kern Canal Middle Reach Capacity Correction Project

Alternatives Description

Bureau of Reclamation
Interior Region 10 California-Great Basin
California*, Nevada*, Oregon*
***Partial**

September 2020

PROJECT ALTERNATIVES

This document provides further detail of the No Action/No Project Alternative (No Action Alternative) and the two Project alternatives developed for the Friant-Kern Canal Middle Reach Capacity Correction Project (Project).

No Action/No Project Alternative

The National Environmental Policy Act (NEPA) requires an analysis of an alternative in which the Project is not implemented, assuming the continuation of existing policies and management direction into the future. The No Action Alternative is used as the basis of comparison to determine the anticipated environmental effects of the action alternatives in the absence of the Project. Similarly, the California Environmental Quality Act (CEQA) requires an analysis of an alternative in which the Project is not implemented. CEQA calls this scenario the No Project Alternative. The No Action Alternative allows decision-makers to use the Environmental Impact Report to compare the impacts of approving the Project with the future conditions of not approving the Project.

The No Action Alternative represents a projection of reasonably foreseeable future conditions that could occur in the year 2070 if no action is taken to address current and projected future capacity reductions to the FKC (i.e., the future without the proposed Project). The year 2070 is used as the projected condition because the Action Alternatives are both designed to correct for anticipated future subsidence through 2070. Under the No Action Alternative, the Bureau of Reclamation (Reclamation) and the Friant Water Authority (FWA) would not take additional actions towards restoring the capacity of the FKC Middle Reach. However, four reasonably foreseeable activities have been identified that could affect future conditions: San Joaquin River Restoration Program (SJRRP) implementation, continued subsidence, Sustainable Groundwater Management Act (SGMA) implementation, and Central Valley Project (CVP) water delivery rescheduling in Millerton Lake.

SJRRP Implementation

Under the No Action Alternative, as the implementation of San Joaquin River channel improvements allows for increased and ultimately the complete release of the full Restoration Flow volume, water supply availability to Friant Division long-term contractors (Friant Contractors) will decrease. Simulated long-term average annual Friant Division deliveries under the current level of SJRRP implementation are 1,119 thousand acre-feet (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 Flow volume to the San Joaquin River anticipated by 2025, long-term annual average deliveries to the Friant Division would be reduced to about 1,052 TAF or 6 percent decrease.

Under the No Action Alternative, the current capacity-restricted condition of the FKC would continue to limit affected Friant Contractors' ability to receive water. This could impact the ability of the contractors to take delivery of water under Paragraph 16 (b) of the Stipulation of Settlement (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.

Future Subsidence

Under the No Action Alternative, subsidence is expected to continue throughout the Project area. A groundwater model of the Tule Subbasin was developed by Harder 2018 to simulate potential future groundwater and land subsidence conditions. The simulation, as shown in Figure 1-1, indicates that subsidence is projected to occur within the FKC Middle Reach through the year 2070 and would result in the canal sinking approximately 9.5 feet below current elevations at the most severe location.

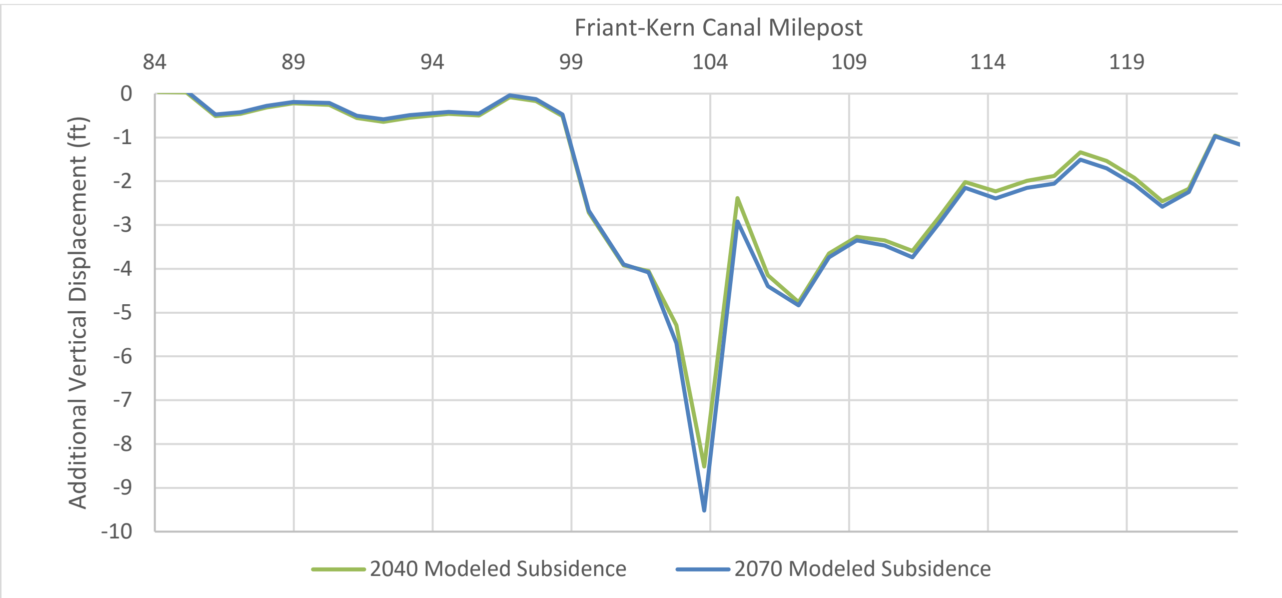


Figure 1-1. Projected Land Surface Elevation Change in 2040 and 2070 Along the Friant-Kern Canal

SGMA Implementation

SGMA, passed in 2014 and amended in 2015, creates a framework for sustainable, local groundwater management. The Project area includes two subbasins, Tule and Kern Subbasins, subject to SGMA. These basins were designated by the California Department of Water Resources as high-priority due to the severity of groundwater overdraft. As a result of this designation, the managing agencies or Groundwater Sustainability Agencies in the area are required to adopt Groundwater Sustainability Plans (GSPs) by January 31, 2020. The Groundwater Sustainability Agencies have 20 years to implement their GSPs and achieve their sustainability goal in the basin by 2040.

Adopted GSPs in the Tule Subbasin limit groundwater pumping to less-than-historical and current amounts. Adopted GSPs in the Kern Subbasin detail monitoring plans and other management actions that will be performed before groundwater pumping reductions are introduced. With full SGMA implementation, it is assumed that there would be no increase in groundwater pumping as a response to surface water reductions.

Rescheduling Affected Water Deliveries in Millerton Lake

Reduced water supply deliveries, resulting from capacity constraints, would limit water available for agricultural, municipal, and industrial uses. These CVP Friant Division water supplies, (Class 1[1], Class 2, and RWA/215) that cannot be delivered as scheduled due to canal capacity constraint are termed "affected water supplies". It is expected that Friant Contractors would respond by rescheduling affected water supplies in Millerton Lake conservation space to the extent possible. Rescheduling is dependent on available conservation space; limitations imposed by water rights, contracts, and Reclamation policy; the ability for contractors to shift to alternative water sources; and available canal conveyance capacity.

As shown in Figure 1-2, rescheduling affected water supplies would rely on a shift in the timing of groundwater pumping and the use of alternative local surface water supplies. Rescheduled affected water would be delivered to the FKC in months when demand exists that could be served by other supplies (local surface water, groundwater, or other supplies) and physical capacity is available to convey water through the FKC to the contractor.

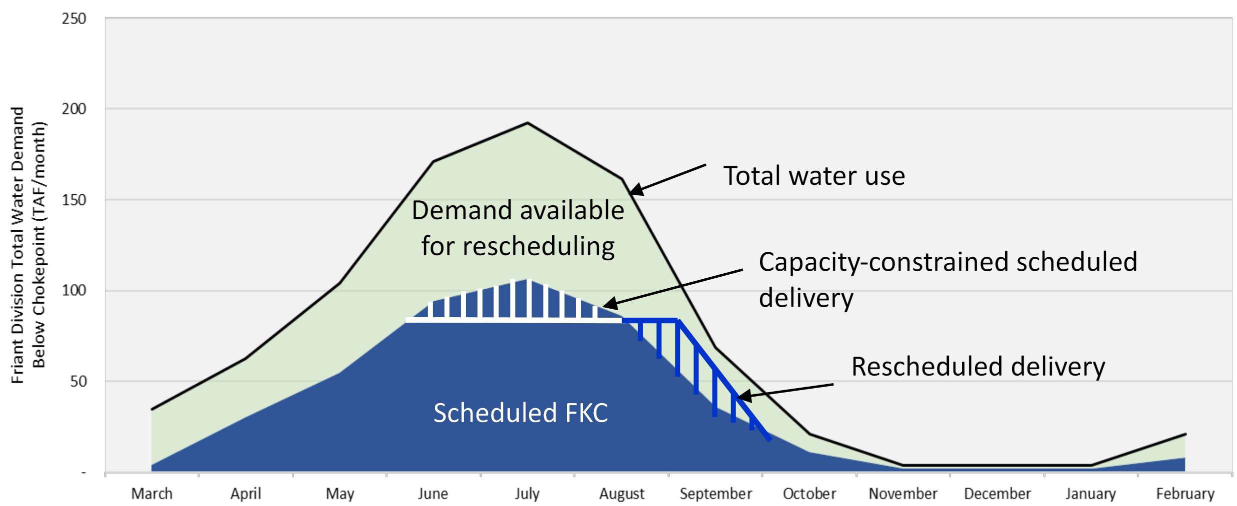


Figure 1-2. Rescheduling Availability

If rescheduled affected water supplies exceed the available conservation storage capacity of Millerton Lake and the reservoir reaches capacity or flood control space is encroached, then the water would be released from Friant Dam to the San Joaquin River as flood flows. Affected

[1] The water supply contract structure for the Friant Division implemented by Reclamation supports the conjunctive management of surface water and groundwater. Generally speaking up to the first 800 TAF of water supply developed that can be used by the Friant Division long-term contractors is called Class 1 and is assigned to agricultural and urban water users who have limited access to good quality groundwater. Class 2 water supply up to a total of approximately 1,401 TAF, and because of its uncertainty as to availability and timing, Class 2 water supply is considered undependable in nature and is available only when Reclamation's Contracting Officer makes available. Class 2 water supply supports regional conjunctive use and is the basis to provide water supplies for groundwater replenishment during wetter years.
Friant 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

water supplies released as flood flows would be managed in a similar manner to any other flood releases from Friant Dam, in consideration of storage capacity reduction rates, objective releases, San Joaquin River channel capacity, and other relevant factors that govern the management and release of flood flows from Friant Dam.

Project Alternatives

The two Project alternatives—the CER Alternative and the CE Alternative—would restore capacity in the FKC to 4,500 cubic feet per second (cfs) in the upstream segment of the Middle Reach and 3,500 cfs in the downstream segment. The two alternatives are corrective measures that would be implemented in each of the four segments of the FKC Middle Reach, as described below. Design of the Project alternatives includes additional future subsidence that is expected to occur within the Project area. An overview of the corrective measures of both action alternatives is shown in Figure 1-3, and Attachments A and B provide graphical representations of each of alternative.

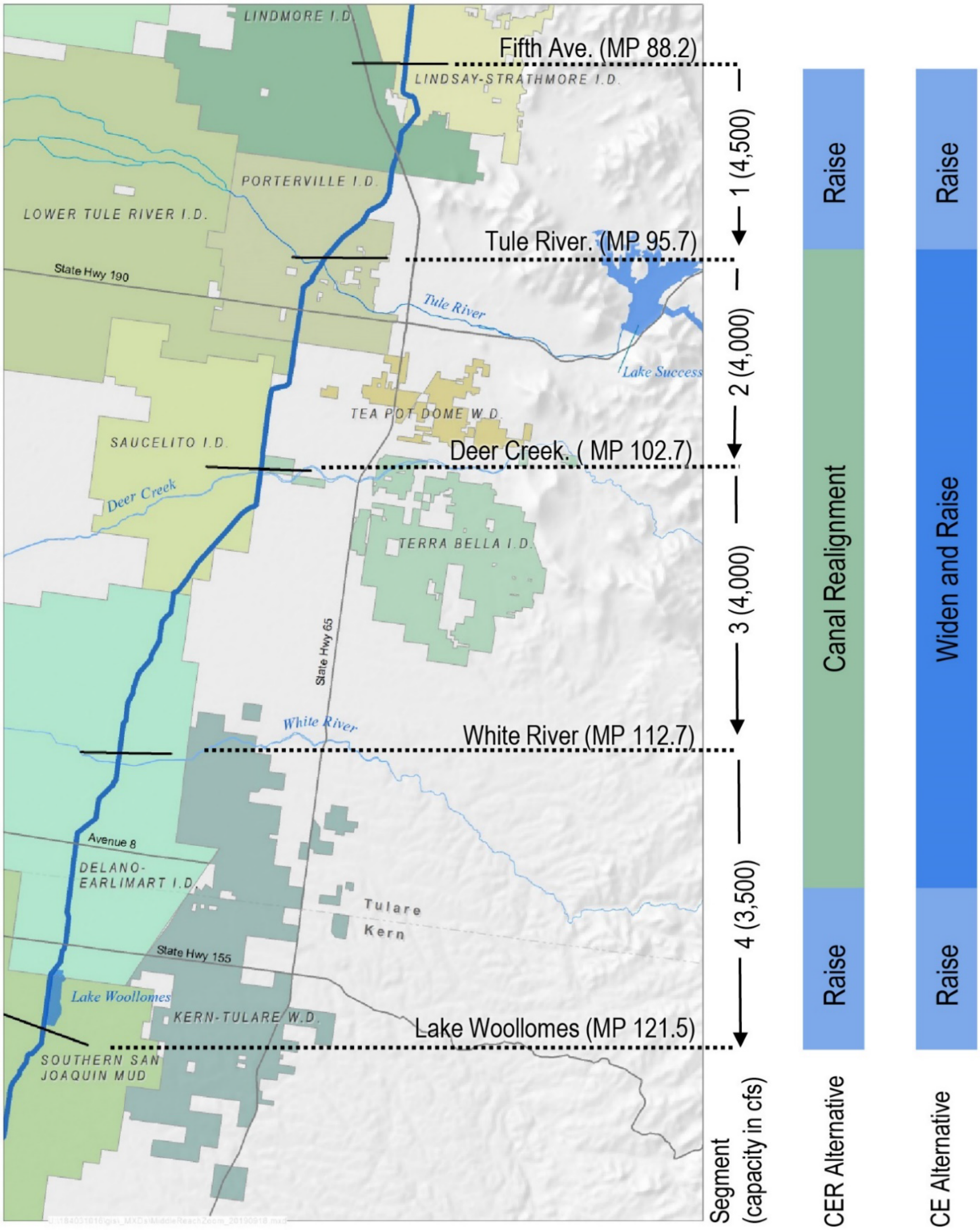


Figure 1-3. Project Alternatives Overview

Canal Enlargement and Realignment Alternative

The CER Alternative is identified as the proposed Project by FWA pursuant to CEQA. Reclamation has identified the CER Alternative as the Preferred Alternative pursuant to NEPA. The CER Alternative would restore the capacity of the 33-mile Middle Reach using two methods: (1) raising portions of the embankments in the existing FKC (see Figure 1-4) and (2) constructing a realigned canal east of the existing FKC (see Figure 1-5).

Raising the embankments would be accomplished by increasing the height of the earthen canal banks and extending the lining by adding a 1- to 4-foot-high concrete lining at a 1.5 to 1 slope above the existing lining. The canal would be raised in segment 1 from MP 88.2 (at Avenue 208) to MP 95.7 (immediately south of Tule River) and in segment 4 from MP 116 (at Avenue 8) to MP 121.5 (at the Lake Woollomes check).

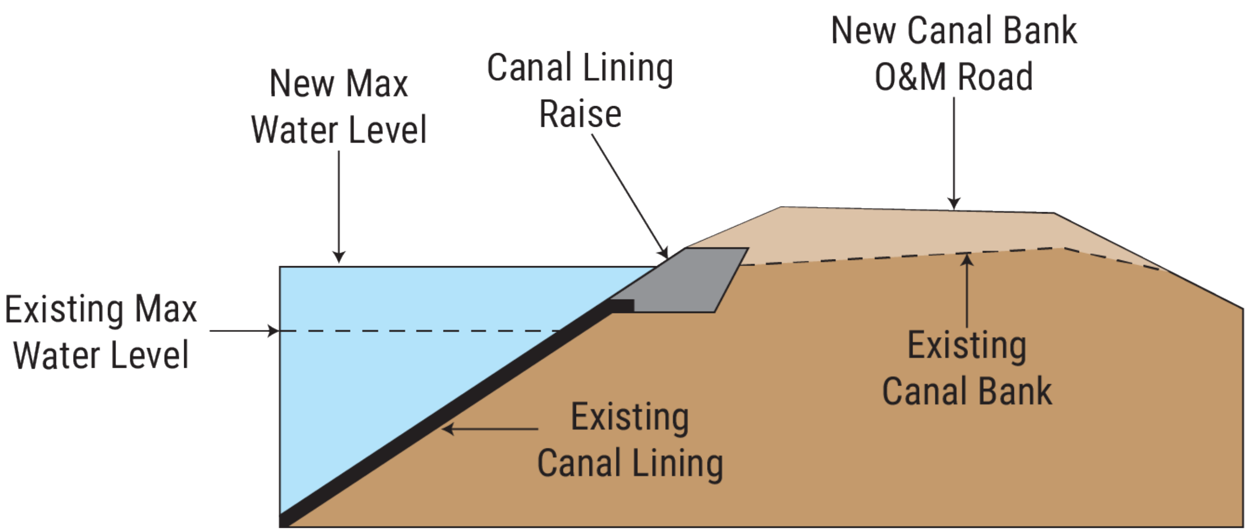


Figure 1-4. Typical Raise Cross-Section

The realigned canal would replace existing FKC segments 2 and 3 and a portion of segment 4. The realigned canal would be constructed east of the FKC beginning on the south side of the Tule River at MP 95.7 and extending 20 miles to MP 116. The centerline distance between the old segment and the realigned canal would vary but would average 127 feet.

The CER Alternative would ultimately result in taking about 20 miles of the 33-mile FKC Middle Reach out of service (Figure 1-4). Portions of the existing canal would be left in place, along with the concrete lining on the bottom of the canal. Out of service segments would be managed by FWA pursuant to their operations and maintenance (O&M) agreement and Reclamation regulations to minimize future threats to natural resources and public health and safety.

The FKC parallels County Road 192 near MP 10.3 for approximately 0.75 mile. There is insufficient room for the realigned canal between the existing FKC and County Road 192, so the realigned canal would be located approximately 155 feet east of the road (from centerline of the road to centerline of the canal). A similar situation occurs adjacent to County Road 184, beginning south of Avenue 40 at approximately MP 111.5 and continuing south for approximately two miles to MP 113.7 at Avenue 24.

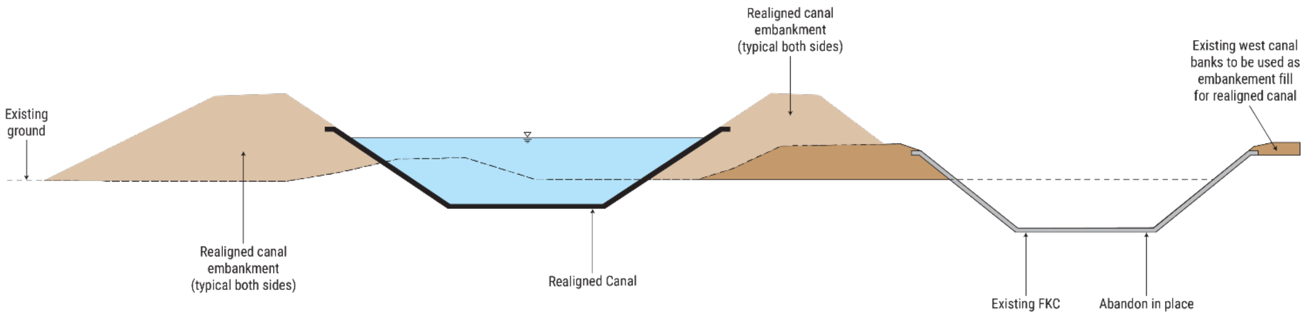


Figure 1-5. Typical Realigned Canal Section Finished Condition

Canal Enlargement Alternative

The CE Alternative would restore the capacity of the 33-mile Middle Reach using two methods: (1) raising portions of the embankments in the existing FKC (similar to what is described above under the CER Alternative) and (2) raising and widening the canal embankments and adding concrete lining. The canal would be raised in segment 1 from MP 88.2 (at Avenue 208) to MP 95.7 (immediately south of Tule River) and in segment 4 from MP 116 (at Avenue 8) to MP 121.5 (at the Lake Woollomes check) as described for the CER Alternative. The canal would be raised and widened in segments 2, 3, and part of 4 from MP 95.7 to MP 116.

Raising and widening the embankments would be accomplished by removing the uppermost extent of the existing concrete lining and, at the level of the demolished lining, excavating a horizontal bench (approximately 28 feet wide on each embankment for a total of 56 feet wide) into the existing grade and constructing new (i.e., wider) upper embankments, which would receive new concrete linings (Figure 1-6). This alternative would require short sections (between 0.25 and 2.2 miles) of bypass canal, totaling approximately four miles. The new bypass canal segments would be required around existing turnouts, changes to, or replacement of, existing turnouts, road crossings, check structures, utilities, and other facilities adjacent to the canal such as irrigation systems, private wells, and control buildings. Additionally, where the FKC parallels County Road 184, an approximate 2.2 mile bypass canal would be necessary to construct a replacement White River check structure east of the existing structure and adjacent to the . Descriptions of these changes are provided in the section describing Elements Common to Action Alternatives.

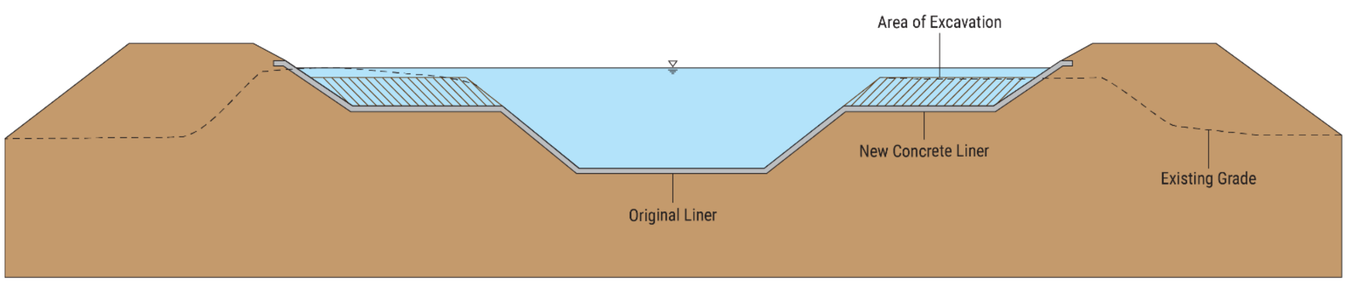


Figure 1-6. Typical Raising and Widening Cross-Section

Elements Common to Action Alternatives

Both alternatives include environmental commitments (ECs)/Mitigations Measures (MMs) to avoid or reduce impacts from implementation as described in Appendix B2. In addition, both alternatives have common Project elements as described below.

Turnouts

Both the CE Alternative and the CER Alternative must maintain water deliveries to irrigation districts through existing distribution systems via turnouts. The existing turnouts vary in size and configuration, and they supply water to both gravity-fed and pressurized systems. The pressurized systems depend on pump stations to draw water from the FKC and pump it into irrigation districts' systems.

Four potential measures to accommodate existing turnouts on the FKC are: (1) no modification, (2) new delivery pool turnout, (3) new turnout, and (4) deck raise. Table 1-1 shows the turnouts that would be used for each alternative and their location.

(1) No modification – No modification would typically be required for existing turnouts in the enlarged segments (i.e., raised, or raised and widened) of the FKC.

(2) New delivery pool turnout – This method would be applied at certain locations in segments 2, 3, and part of 4 to accommodate existing pressurized systems. Approximately 200-foot-long segments of the existing FKC would be converted to delivery pools. The delivery pools would help maintain existing water levels to accommodate existing turnouts. To create the delivery pools, two earthen berms would be placed upstream and downstream of the existing turnouts within the FKC. For the CE Alternative, a short segment of new canal—termed a bypass canal—would be constructed parallel to the delivery pool created by the two earthen berms. Within the delivery pool, the concrete lining and turnout structures feeding the existing pump stations would be unaltered. A cast-in-place concrete turnout structure would be constructed on the bypass canal segments (CE Alternative) or realigned canal (CER Alternative), and a new delivery pipeline from the new turnout structure to the delivery pool (Figure 1-7) would be constructed to convey water from the bypass canal or the realigned canal for delivery.

The CE Alternative would require up to 4 miles of newly constructed bypass canal segments next to the existing FKC turnouts to convey water around the newly constructed delivery pools. Both alternatives would require retention of up to 2 miles of the existing FKC for construction of the delivery pools.

3) New turnout – This method would be used at certain locations on the realigned canal in segments 2 and 3 for the CER Alternative. A new turnout would generally consist of a new cast-in-place concrete turnout structure on the realigned canal and a short segment of delivery piping that would connect to a district's existing system pipeline.

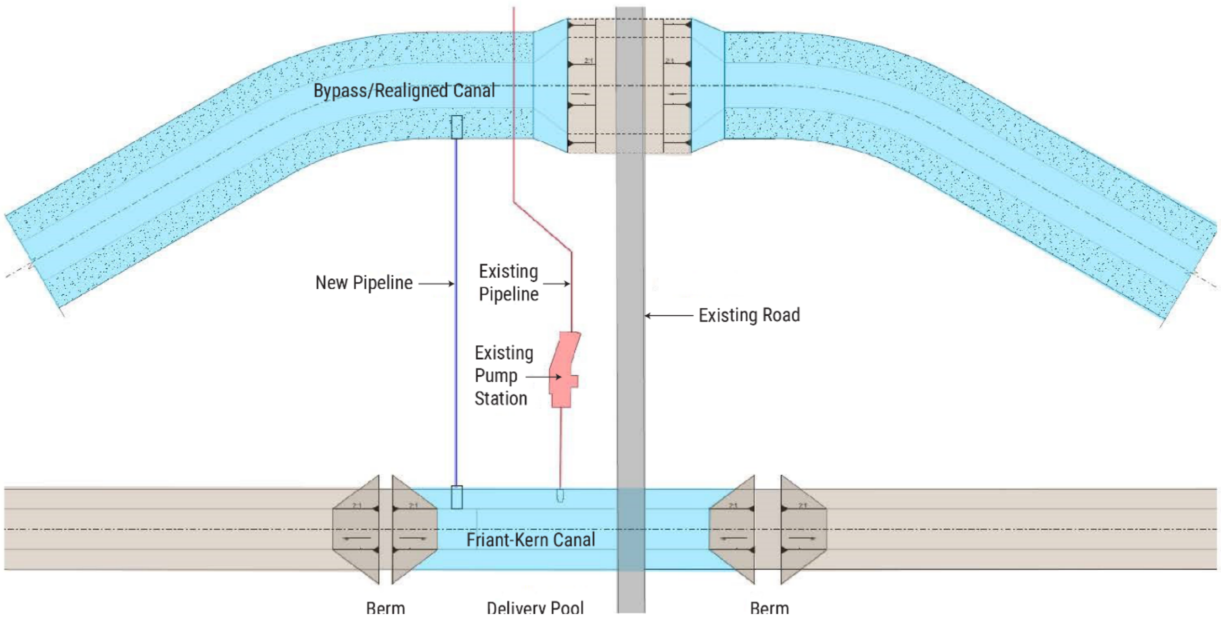


Figure 1-7. Typical Turnout Delivery Pool

4) Deck raise – This method would be used at certain locations in segments 1, 2, 3, and 4 for the CE Alternative and segment 1 and 4 for the CER Alternative. Raising the top deck of a gravity turnout generally consists of removing the 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. The deck height would be raised 1 to 4 feet, depending on the location. A typical deck raise is shown in Figure 1-8.

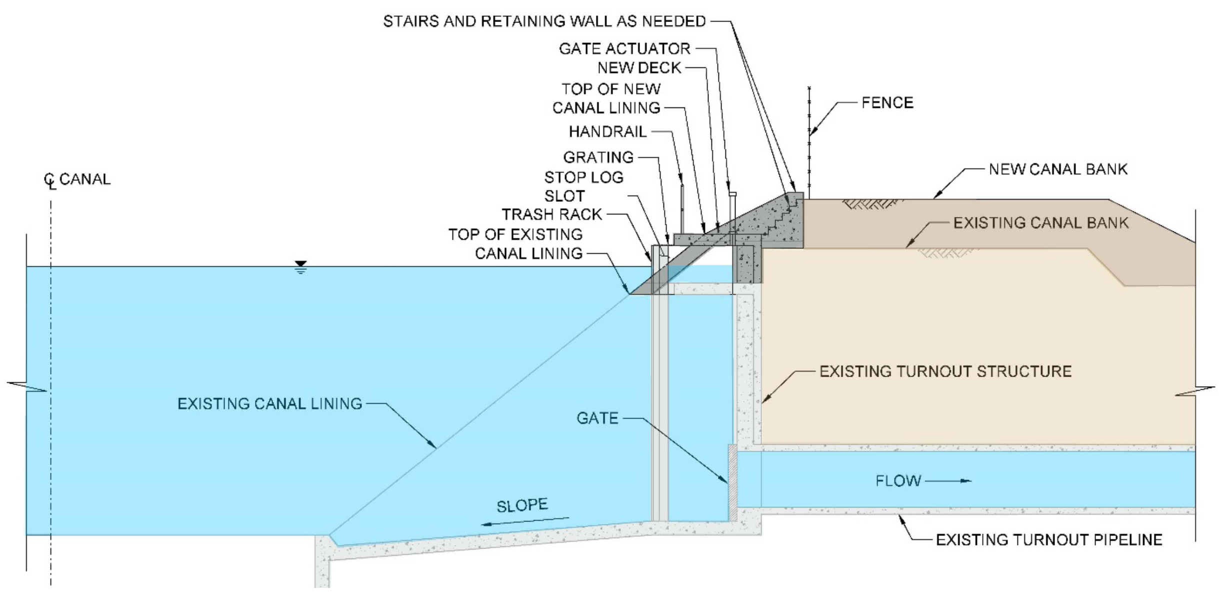


Figure 1-8. Typical Deck Raise

Table 1-1. Turnout Details

Segment	Mile Post	Canal Side	CER Alternative	CE Alternative
1	89.35	West	Deck Raise	Deck Raise
1	91.12	East	Deck Raise	Deck Raise
1	91.12	West	Deck Raise	Deck Raise
1	92.13	West	Deck Raise	Deck Raise
1	93.85	West	Deck Raise	Deck Raise
1	94.92	West	Deck Raise	Deck Raise
1	95.50	East	Deck Raise	Deck Raise
2	95.78	East	New Turnout	Deck Raise
2	96.39	East	New Turnout	Deck Raise
2	96.87	West	New Turnout	Deck Raise
2	97.37	West	New Turnout	Deck Raise
2	97.86	East	New Turnout	Deck Raise
2	98.62	West	New Turnout	Deck Raise
2	99.35	East	New Delivery Pool Turnout	Deck Raise
2	100.64	West	New Turnout	Deck Raise
2	102.65	East	New Turnout	Deck Raise
2	102.65	West	New Delivery Pool Turnout	Deck Raise
3	103.64	East	New Delivery Pool Turnout	New Delivery Pool Turnout
3	104.96	West	New Delivery Pool Turnout	Deck Raise
3	107.35	West	New Delivery Pool Turnout	Minor Modification to Pipe
3	107.84	West	New Turnout	New Delivery Pool Turnout
3	109.46	West	New Delivery Pool Turnout	New Delivery Pool Turnout
3	109.46	East	New Delivery Pool Turnout	New Delivery Pool Turnout
3	111.56	West	New Delivery Pool Turnout	New Delivery Pool Turnout
3	111.56	East	New Delivery Pool Turnout	New Delivery Pool Turnout
3	111.96	East	New Delivery Pool Turnout	New Delivery Pool Turnout
3	112.36	West	New Turnout	Deck Raise
4	113.60	East	New Delivery Pool Turnout	New Delivery Pool Turnout
4	113.62	West	New Delivery Pool Turnout	New Delivery Pool Turnout
4	113.62	East	New Delivery Pool Turnout	New Delivery Pool Turnout
4	115.95	West	Deck Raise	Deck Raise
4	116.93	East	Deck Raise	Deck Raise
4	117.44	West	Deck Raise	Deck Raise
4	117.96	East	Deck Raise	Deck Raise
4	118.45	West	Deck Raise	Deck Raise
4	119.55	East	Deck Raise	Deck Raise
4	120.06	West	Deck Raise	Deck Raise
4	121.49	East	Deck Raise	Deck Raise

Road Crossings

The Project area has approximately 45 bridges (referred interchangeably as road crossings), some of which would require alteration or replacement. Most of the bridges serve county roads, four serve state highways, and a few are considered farm bridges.

Road crossings would be accomplished by one of three methods: (1) leave in place, (2) replace with new trapezoidal bridge (applicable for the CE Alternative only), and (3) replace with concrete box siphon. Table 1-2 shows the road crossing methods for each alternative and the road crossing locations.

1) Leave in place with no modifications – This road crossing method would generally consist of leaving existing bridges in place with few to no modifications required to accommodate the Project. This would generally apply to bridges enlarged sections in segment 4 and State Route 65 in segment 1 for both alternatives.

2) Replace with trapezoidal bridge – This road crossing method would only be used for the CE Alternative. In segments 2, 3, and 4, some road crossings would be removed and replaced with trapezoidal bridges. The trapezoidal bridges would be cast-in-place concrete structures sized to match the trapezoidal cross section of the canal on the upstream and downstream side of the bridge. The bridges would be built to match the new, higher road elevations associated with raising the FKC (Figure 1-9). The corresponding bridge would be demolished, and demolition debris would be disposed of at a local landfill in accordance with federal, state, and local regulations.

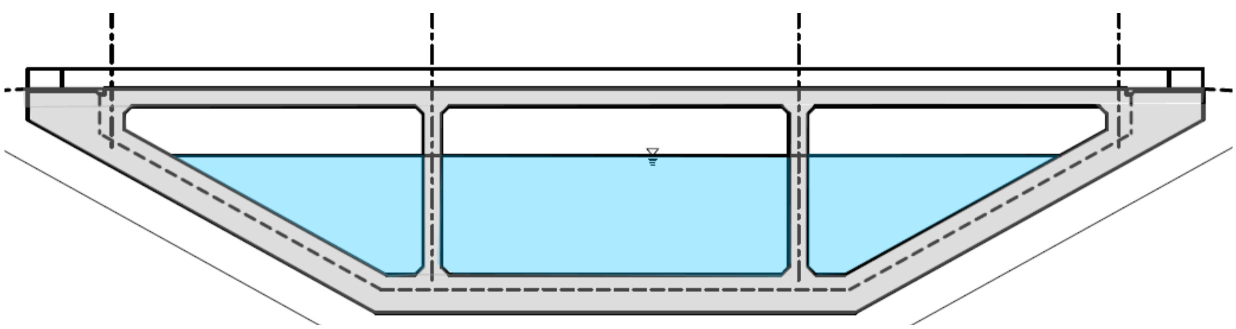


Figure 1-9. Typical Trapezoidal Bridge

3) Replace with concrete box siphon – This road crossing method would consist of replacing bridges with concrete box siphons along the realigned canal in segments 2, 3, and part of 4 for the CE Alternative and CER Alternative. The siphons would consist of buried cast-in-place concrete triple-box siphons, with each of the three boxes estimated to be 19 feet tall by 19 feet wide (Figure 1-10).

Approximately 50-foot-long canal lining transitions would be provided at the siphon entrances and exits to transition from the trapezoidal open canal geometry to the square box geometry. The length of the siphons would vary by location and would range from 100 to 200 feet. The siphons would accommodate any future subsidence by being designed for maximum future soil loading and by extending the height of the concrete headwalls at the entrance and outlet to match the maximum height of future subsidence banks.

At each siphon, the corresponding bridge over the existing FKC would be demolished, the unused segment of the FKC would be filled to road grade, and the paved road surface would be reconstructed on earth fill. Demolition debris that cannot be reused would be disposed of in accordance with federal, state, and local regulations at a local landfill.

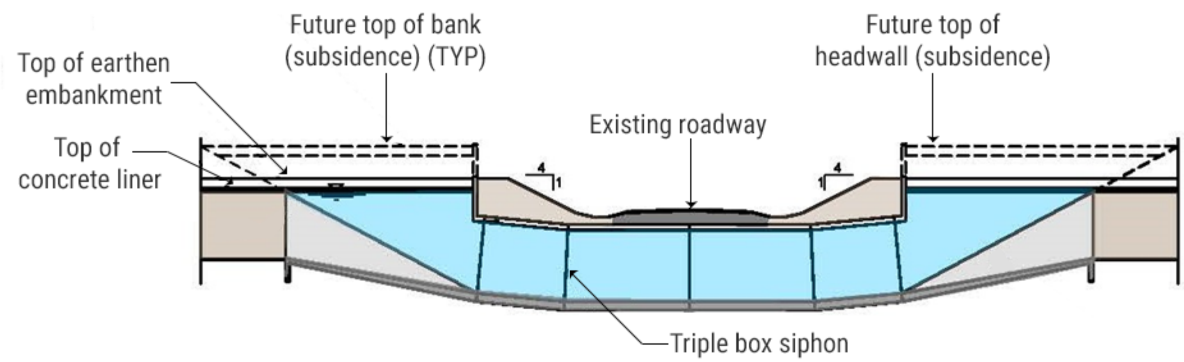


Figure 1-10. Typical Concrete Box Siphon Example

Table 1-2. Road Crossing Details

Segment	Mile Post	Bridge Description	Name	CER Alternative	CE Alternative
1	88.67	County	Ave 204/6th Ave	None	None
1	89.17	County	Ave 200/7th Ave	None	None
1	89.45	County	Road 232	None	None
1	89.95	County	Ave 196/CR J28/Frazier Hwy	None	None
1	89.95	County	Ave 194/8th Ave	None	None
1	90.23	County	Ave 192	None	None
1	91.10	County	Ave 188	None	None
1	91.47	State	State Hwy 65 (westbound)	None	None
1	91.50	State	State Hwy 65 (eastbound)	None	None
1	91.60	County	Ave 184/Welcome Rd	None	None
1	91.85	County	Ave 182	None	None
1	92.35	County	Ave 178/Mt View Ave	None	None
1	92.85	County	Ave 174/Linda Vista	None	None
1	93.55	County	Ave 170/W. North Grand Ave	None	None
1	94.01	County	Road 224/N. Westwood St	None	None
1	95.12	County	Ave 180/Henderson	None	None
2	96.26	County	Ave 152/Olive Ave	Concrete Box Siphon	Trapezoidal Bridge
2	97.35	State	State Hwy 190, Ave 144	Concrete Box Siphon	Trapezoidal Bridge
2	98.38	County	Ave 136	Concrete Box Siphon	Trapezoidal Bridge
2	99.37	County	Ave 128	Concrete Box Siphon	Concrete Box Siphon
2	100.64	County	Ave 120, Hesse Ave	Concrete Box Siphon	Trapezoidal Bridge

Segment	Mile Post	Bridge Description	Name	CER Alternative	CE Alternative
2	101.64	County	Ave 112	Concrete Box Siphon	Trapezoidal Bridge
2	102.14	Farm	Unnamed	Concrete Box Siphon	Trapezoidal Bridge
3	103.65	County	Ave 96, Terra Bella Ave	Concrete Box Siphon	Concrete Box Siphon
3	103.72	County	Road 208	Concrete Box Siphon	Concrete Box Siphon
3	104.95	County	Ave 88	Concrete Box Siphon	Trapezoidal Bridge
3	106.18	County	Ave 80	Concrete Box Siphon	Trapezoidal Bridge
3	106.75	Farm	Ave 74	Concrete Box Siphon	Trapezoidal Bridge
3	107.32	County	Road 192	Concrete Box Siphon	Concrete Box Siphon
3	108.42	Farm	Ave 64	Concrete Box Siphon	Trapezoidal Bridge
3	109.45	County	Ave 56/Ducor Hwy/Sierra Avenue	Concrete Box Siphon	Concrete Box Siphon
3	110.55	County	Ave 48	Concrete Box Siphon	Trapezoidal Bridge
3	111.55	County	Ave 40	Concrete Box Siphon	Concrete Box Siphon
3	111.66	County	Road 184	Concrete Box Siphon	Concrete Box Siphon
3	112.57	County	Ave 32	Concrete Box Siphon	Trapezoidal Bridge
4	113.59	County	Ave 24	Concrete Box Siphon	Concrete Box Siphon
4	114.71	County	Ave 16/SP RR	Concrete Box Siphon	Trapezoidal Bridge
4	115.91	County	Ave 8	None	None
4	116.41	Farm (2)	4th Ave/Old RR Crossing	None	None
4	116.91	County	County Line Rd /CR J44	None	None
4	117.92	County	Cecil Ave	None	None
4	118.44	County	9th Ave	None	None
4	118.94	State	Garces Hwy/State Hwy 155	None	None
4	119.46	Farm	H - 10	None	None
4	120.02	County	Woollomes Ave	None	None

Notes:
Ave = Avenue
CR = County Route
Hwy = Highway
RR = Railroad
SP = Southern Pacific
St = Street

Check Structures

The Middle Reach contains five check structures: 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) (Figure 1-3). The check structures at 5th Avenue, Tule River, and Lake Woollomes would not be altered. Under both alternatives, replacement check structures, wasteways, and siphons would be required at the Deer Creek and White River crossings.

The replacement check structures would be essentially the same for both the CE Alternative and the CER Alternative, both would be relocated to the east of the existing canal. The Deer Creek replacement structure would consist of four steel radial gates an estimated 20 feet tall that would be anchored to a cast-in-place concrete support. A concrete wasteway with three smaller radial gates would be constructed on the side of the canal immediately upstream of the check structure.

The new siphon immediately downstream of the new check structure would be similar to the buried cast-in-place structures for siphons described in the section describing Road Crossings, except that this siphon would be needed to divert canal flows below Deer Creek rather than beneath a road. The siphon would consist of a buried cast-in-place concrete quadruple-box siphon, with each of the four boxes being 14 feet tall by 14 feet wide, 170 feet long, and up to 20 feet below grade (Figure 1-11).

The new White River structure would be similar to but smaller than the Deer Creek structure due to the lower design flow capacities at its location. This structure would consist of two 20-foot-tall steel radial gates anchored to a cast-in-place concrete support. A fixed weir concrete wasteway structure would be constructed on the side of the canal immediately upstream of the check structure. Unlike the Deer Creek wasteway, the White River wasteway would serve only as an emergency canal overflow to White River; thus, no radial gates would be needed at this wasteway. The siphon at White River would consist of a buried cast-in-place concrete triple-box siphon, with each of the three boxes being 14 feet tall by 14 feet wide, 128 feet long, and up to 20 feet below grade (Figure 1-12).

Both of the replaced check structures would require control buildings and associated electrical, mechanical, and control equipment. Replacement control buildings would consist of approximately 500-square-foot concrete masonry block wall buildings with steel panel roofing supported by wood or steel trusses. The foundations of the buildings would be the reinforced concrete slab-on-grade type. In general, the buildings would be located adjacent to the radial gate check structure on the canal banks. Utility power would be extended from the power service point at the existing check structures immediately adjacent to the site. At the completion of construction, the existing siphons and check structures would be backfilled and buried in-place using a portion of the native material that was excavated from the work zone (see General Construction Practices – Other Project Facilities for Both Alternatives).

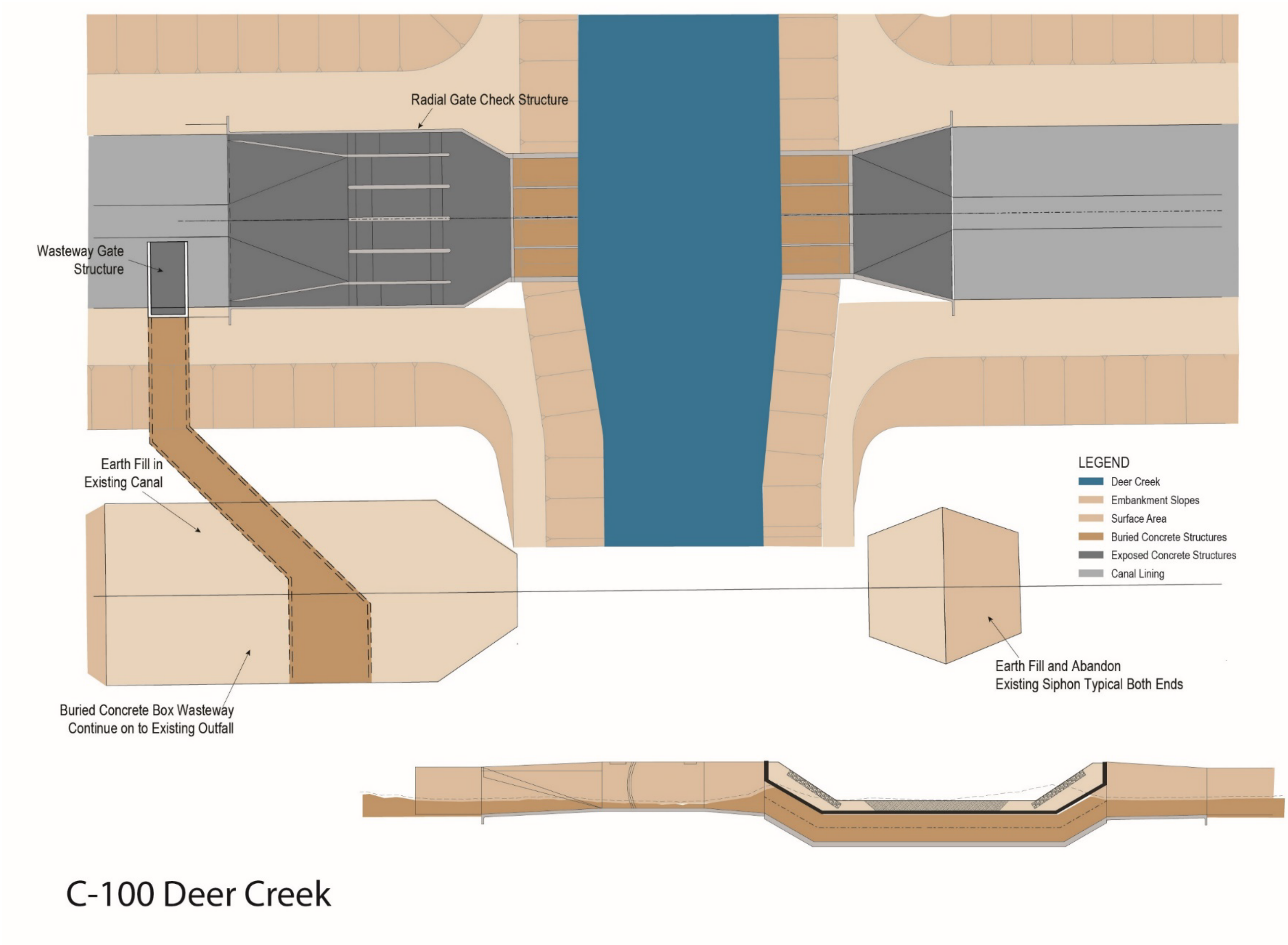


Figure 1-11. Deer Creek Check Structure Conceptual Plan for CER Alternative

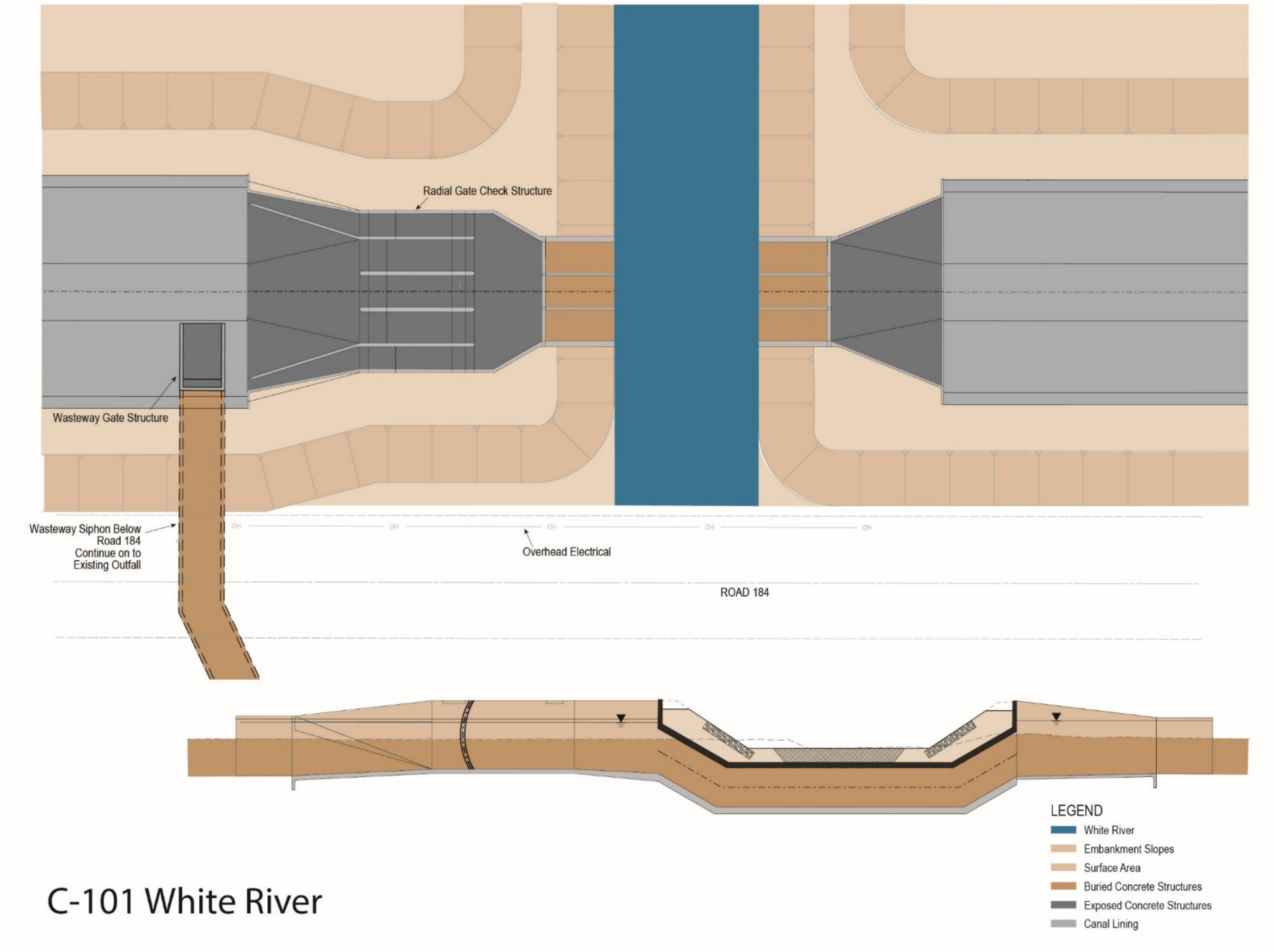


Figure 1-12. White River Check Structure Conceptual Plan for CER Alternative

Other Infrastructure

Other infrastructure in, along, and across the FKC would require modification or replacement. Infrastructure that would require modification or replacement includes parallel irrigation canals, elevated pipeline canal crossings, overhead power lines, adjacent wells, drainage siphons, and irrigation crossings that would go under the existing canal; they would also include utilities that are connected to bridges. Depending on the location and extent of canal modifications, this infrastructure could either be relocated or entirely replaced.

Electric Utilities

Overhead powerlines are generally owned and maintained by the local electrical utility provider, which is expected to be Southern California Edison for this Project. Relocation of overhead powerlines would be coordinated with the utility company during final design. Relocation of the poles and electrical lines would be performed by the utility owner prior to construction. Figure 1-13 shows a typical power line along the existing FKC.

Figure 1-13. Overhead Powerlines Adjacent to East Side of FKC

Wells

Well abandonment would include removal of pumps, motors, electrical equipment, and well casings; filling of the wells with cementitious grout; and demolition and clearing of any other site features such as paving, fencing, and piping. Figure 1-14 shows a typical groundwater well near the FKC.

Figure 1-14. Wells Adjacent to FKC

Culverts

Existing culverts convey surface drainage and runoff from adjacent lands across the FKC. Existing culverts in the portions of the canal that would be enlarged (the entire length of the CE Alternative and segments 1 and 4 of the CER Alternative) would be modified by leaving the existing culvert in place and extending the inlets and outlets out to the new canal banks with new precast concrete pipes. For the CER Alternative, culverts within the realigned canal sections in segments 2, 3, and 4 would be demolished and replaced with new culverts below the realigned canal. Figure 1-15 shows typical culvert modifications.

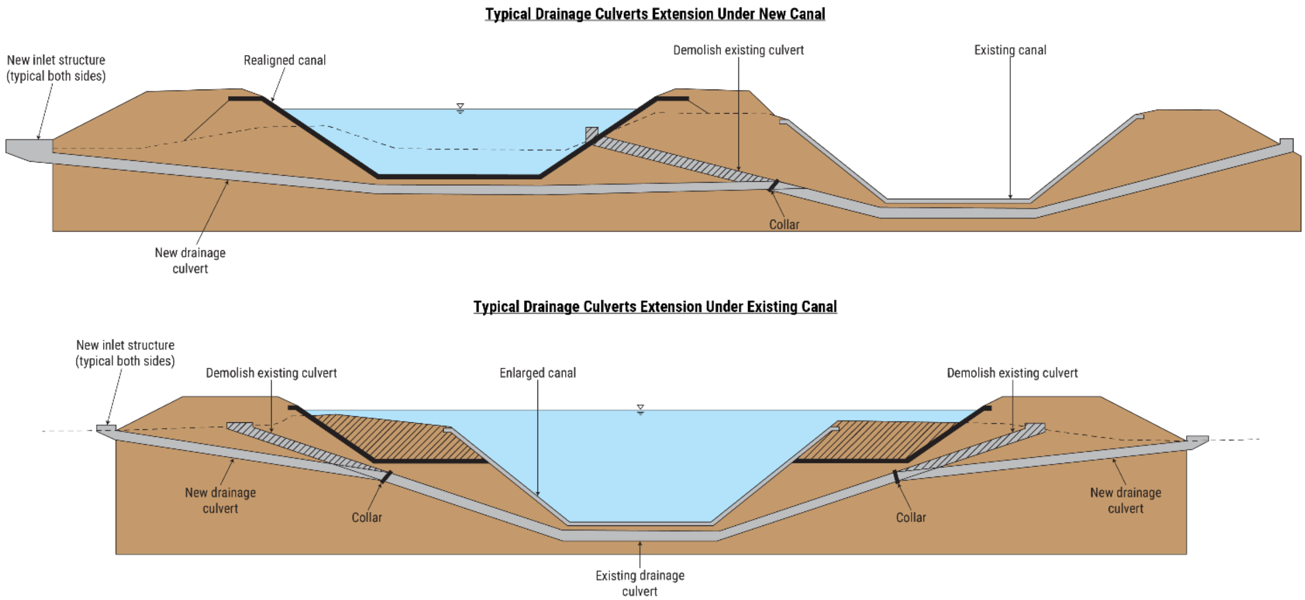


Figure 1-15. Typical Drainage Culvert Modifications

Overcrossings

For the CER Alternative and CE Alternative, up to six existing pipeline overcrossings on segments 2, 3, and 4 would be demolished and replaced with new pipeline overcrossings on the realigned canal. Pipeline overcrossings generally consist of concrete supports on each end of the crossing and a stiffened pipeline that crosses perpendicularly over the canal (Figure 1-16).

Figure 1-16. Pipeline Overcrossing on FKC

Table 1-3 shows the utility modifications that would be required for each alternative.

Table 1-3. Utility Modifications

Type of Utility	CER Alternative Modification	CER Alternative Estimated Quantity	CE Alternative Modification	CE Alternative Estimated Quantity
Overhead powerline	Relocation of parallel utility	4 miles	Relocation of parallel utility	7 miles
Groundwater Well	Abandonment	7 each	Abandonment	10 each
Culverts	Extension	10 each	Extension	10 each
Pipeline overcrossings	Relocation	6 each	Relocation	6 each

Operations and Maintenance

After construction, both alternatives would continue to be maintained by FWA Per Contract Number 8-07-20-X0356 (OM&R Agreement) or future contract agreement. This contract agreement states Reclamation agreed to transfer operation, maintenance and replacement (OM&R) responsibilities for the FKC and associated works to the FWA. The FWA agrees to perform OM&R activities for the FKC and associated facilities to maintain them in good and efficient condition. The operational activities are not expected to substantially change under implementation of either the Project alternative, as no changes in the number or type of facilities currently maintained will be constructed (e.g., no "new" facilities would be constructed beyond the replacement facilities). The maintenance activities for the alternatives are expected to be similar to existing activities that currently occur for the Middle Reach of the FKC. Additionally, improvements to the embankments, road crossings, and turnouts that would occur under both Project alternatives could reduce the amount of current maintenance.

Both alternatives would increase the amount Federal project lands within the Project area right-of-way (ROW) would be added to the FWA service area under both alternatives (see section describing Right-of Way and Work Area Limits). The FWA, as part of the OM&R Agreement, would administer the Federal project lands so that no unauthorized encroachment or use would occur on the lands and ROW. As part of ongoing daily maintenance activities, FWA would inspect the Federal project lands to identify and correct cases of trespass.

Construction Sequencing

Construction of both alternatives would require up to nine construction teams, with an average workforce of between 15 and 30 people per team working simultaneously. On any given day, up to 150 workers could be working onsite. Construction would occur Monday through Friday between 7 a.m. and 7 p.m.

Both on- and off-road equipment would be used for construction. On-road equipment would generally include worker vehicles (e.g., pickup trucks), flatbed haulers, and concrete/concrete pump trucks. Off-road equipment would include dump trucks, bulldozers, scrapers, water trucks, excavators, compactors, boom trucks, pavers, and forklifts.

Before beginning construction for either alternative, existing utilities surrounding the Project area (for example, powerlines and wells) would be relocated or replaced to the extent possible. Excavation for new road crossings, check structures, and turnouts would also occur before construction begins since they would not interfere with FKC operations. Preliminary construction sequencing plans are described below for each alternative.

General Construction Practices – Canal Enlargement and Realignment Alternative

Construction of the CER Alternative would occur in multiple phases but would not require the existing FKC to be shut down for extended periods. Construction would begin with mass excavation of the realigned canal and associated features (for example, road crossings and check structures). All work for the realigned canal would be near the existing FKC, and temporary shutdowns would be required only for tie ins of the realigned canal to the FKC.

The realigned canal would be excavated to the bottom of the canal prism, estimated to be a maximum of 18 feet below ground surface. The excavated material would be used to build the realigned canal embankments. Excavators would load the material into 10- to 20-cubic-yard off-road haul trucks, where the material would be hauled a maximum of 6 miles. The material would be dumped, spread by bulldozers in lifts, and compacted to final canal embankment grades. At the completion of the earthwork, a canal lining machine would travel down the new canal prism, lining the canal with the final cast-in-place concrete lining.

Once the lining of the canal is complete, flows would be diverted to the realigned canal, and operation of the FKC would continue using the realigned canal. The material from the west bank of the old canal would be used to complete the west bank of the realigned canal to finished grade. To complete this work, the existing canal lining would be stripped as necessary to access the bank material. Excavators would then remove the existing bank material and dump the material on the adjacent west bank of the realigned canal. Bulldozers would then spread the material so that it can be compacted in place to form the finished canal banks.

Excavated material from realigned canal would be used to build the new embankments of the realigned canal; however, up to 2.5 million cubic yards of borrow material would also be needed. The borrow material would be obtained from borrow sites at predetermined locations (see General Construction Practices, Canal Enlargement Alternative). Once completed, the borrow sites would be stabilized. Water trucks and other dust control measures would be used throughout the entire construction process to control fugitive dust.

Table 1-4 and Figure 1-17 provide information on construction sequencing for the CER Alternative.

Table 1-4. Realigned Canal Construction Sequencing

Step	Description of Activities	Status of Existing FKC
1	Excavate the realigned canal prism and use excavated material to build the realigned canal compacted embankments. Compaction of the of the excavated material is necessary to ensure that a firm foundation for the new lining is provided. Construct a portion of the new west turnouts within the realigned canal embankment.	Remains in operation
2	Trim the canal section to final grades and place concrete lining in new canal section. Construct new east side turnouts and connect piping to existing systems. Construct new concrete box siphons at roadway crossings and new Deer Creek and White River check structures/wasteways/siphons.	Remains in operation
3	Place new canal into operation while sequencing connection of new turnouts to existing system. Complete placement of new canal right and left embankments using existing FKC right embankment as borrow source. Decommission existing FKC within the right-of-way (ROW).	Removed from operation
4	(Future Subsidence). Construct subsidence embankments using material within the FKC ROW.	Removed from operation

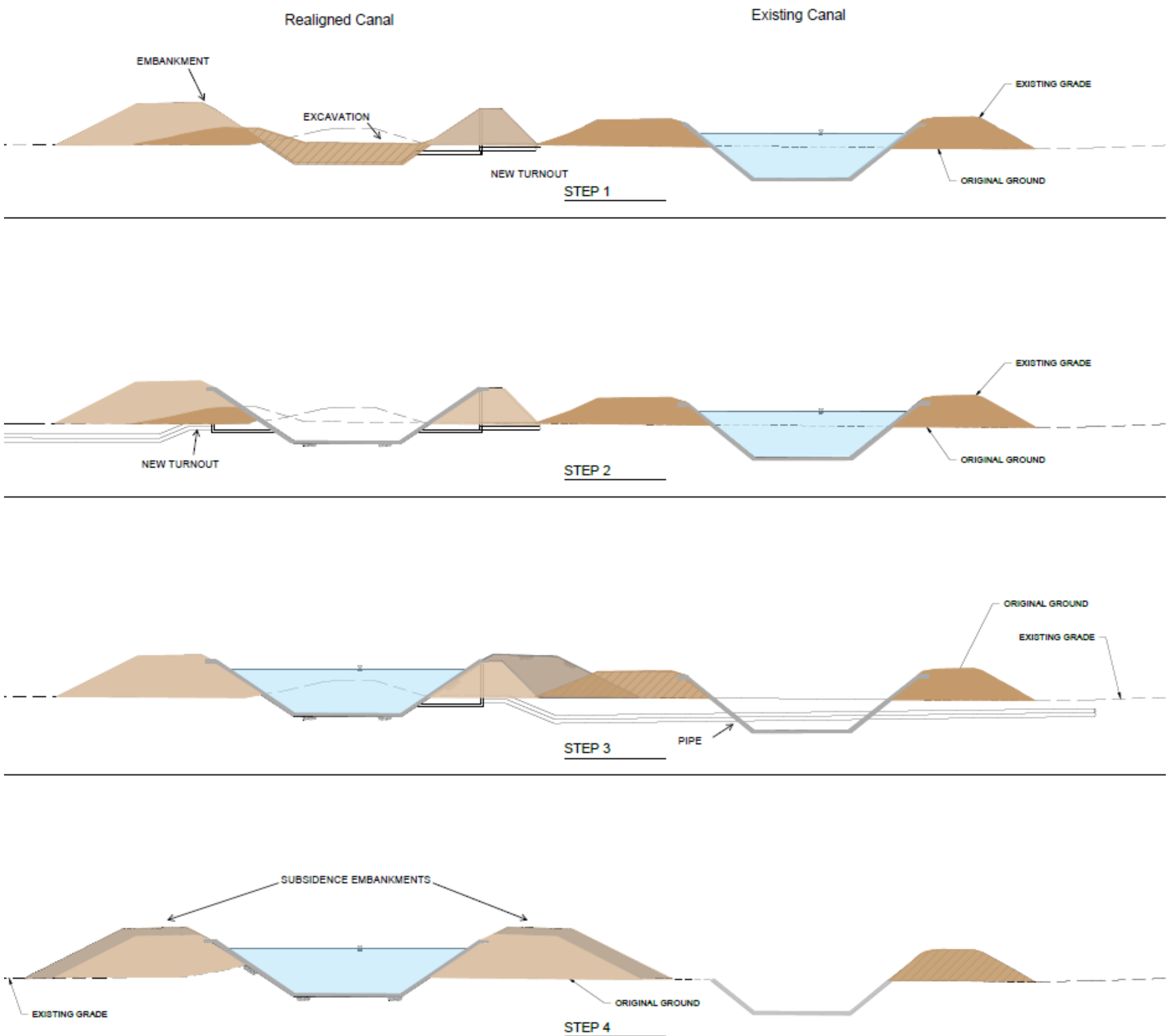


Figure 1-17. Realigned Canal Construction Sequencing Steps

General Construction Practices – Canal Enlargement Alternative

Construction of the CE Alternative would require shutting down the FKC multiple times for up to three months at a time and would be completed in two primary phases. The phasing is described below, summarized in Table 1-5 and depicted in Figure 1-18.

The first phase, broken down into two steps. Step 1 involves lowering the water level in the FKC to at least original ground level to provide a safe working environment; it is estimated that the operating capacity at this depth would be about 600 cfs or less. Thus, work would have to be scheduled around annual predetermined canal shutdowns in winter (November-February) to mitigate impacts to canal operations and water deliveries. Once the water level has been lowered, the existing FKC non-compacted embankments would be excavated and compacted to provide a firm foundation for the new lining. Construction of the new canal banks outside of the compacted banks would also occur at this time, using borrow material.

General construction methods would include earthwork operations such as mass excavation of the existing uncompacted canal banks followed by rebuilding the banks as engineered compacted banks. This work would be performed with excavators, bulldozers, hauling trucks, and compaction equipment.

The second step of phase one would involve bringing the water levels up to the existing surface water elevations and putting the existing canal back into operation. No construction activities would occur at this time.

The second phase of construction would begin in Step 3 and would consist of taking the canal out of operation for the three-month window by drawing down the water levels. With the lowered water levels, construction crews would then remove the top portion of the existing canal lining, excavate the new widened benches, and place new concrete lining on benches.

To accomplish this work, excavators would be staged on the top of the canal banks to excavate the bench section on either side of the canal. Once the banks are constructed, a canal lining machine would be mobilized to line the new bench sections on either side of the canal.

Once the new lining has been placed for an entire segment, the canal can be put back in operation at the new, higher water surface elevation. This is the final step (4) and does not involve any construction activities.

Table 1-5. Canal Enlargement Construction Sequencing

Phase	Step	Description of Activities	Status of FKC
1	1	Take FKC out of operation and draw down canal water levels. Excavate existing FKC embankments and recompact. Excavation and recompaction are needed to provide a firm foundation for the new lining. Construct the new canal banks outside of the recompacted material from borrow material.	Not in operation
1	2	Put FKC back into operation at typical existing water surface elevations. The existing lining and new banks from Step 1 would remain in place during this period.	Canal in operation
2	3	Take canal out of operation and draw down water levels during the next scheduled FKC shutdown period. Cut and remove top portion of the existing canal lining, excavate benches for canal widening, and trim and place new canal lining on excavated benches.	Not in operation
2	4	Put canal back into operation up to new water surface elevations. The canal cannot be put back into operation at new water surface elevations until an entire canal segment has been finished.	Canal in operation.

The CE Alternative would require about 7.6 million cubic yards of borrow material. Approximately 1.6 million cubic yards of material would be obtained from excavated material from the FKC embankments and the remaining (about 6 million cubic yards) would be obtained from borrow sites at predetermined locations (see General Construction Practices – Canal Enlargement Alternative). The borrow material would be loaded into large off-road (10- to 20-

cubic-yard) haul trucks where the material would be hauled a maximum of 10 miles. The material would be delivered via the existing canal alignment on temporary construction roads built within the existing canal ROW. The material would then be dumped and evenly spread by bulldozers to predetermined finished grades. Once completed, the borrow sites would be stabilized (for example, hydroseeded to establish vegetation and permanent ground cover). Water trucks and other dust control measures would be used throughout the entire construction process to control fugitive dust.

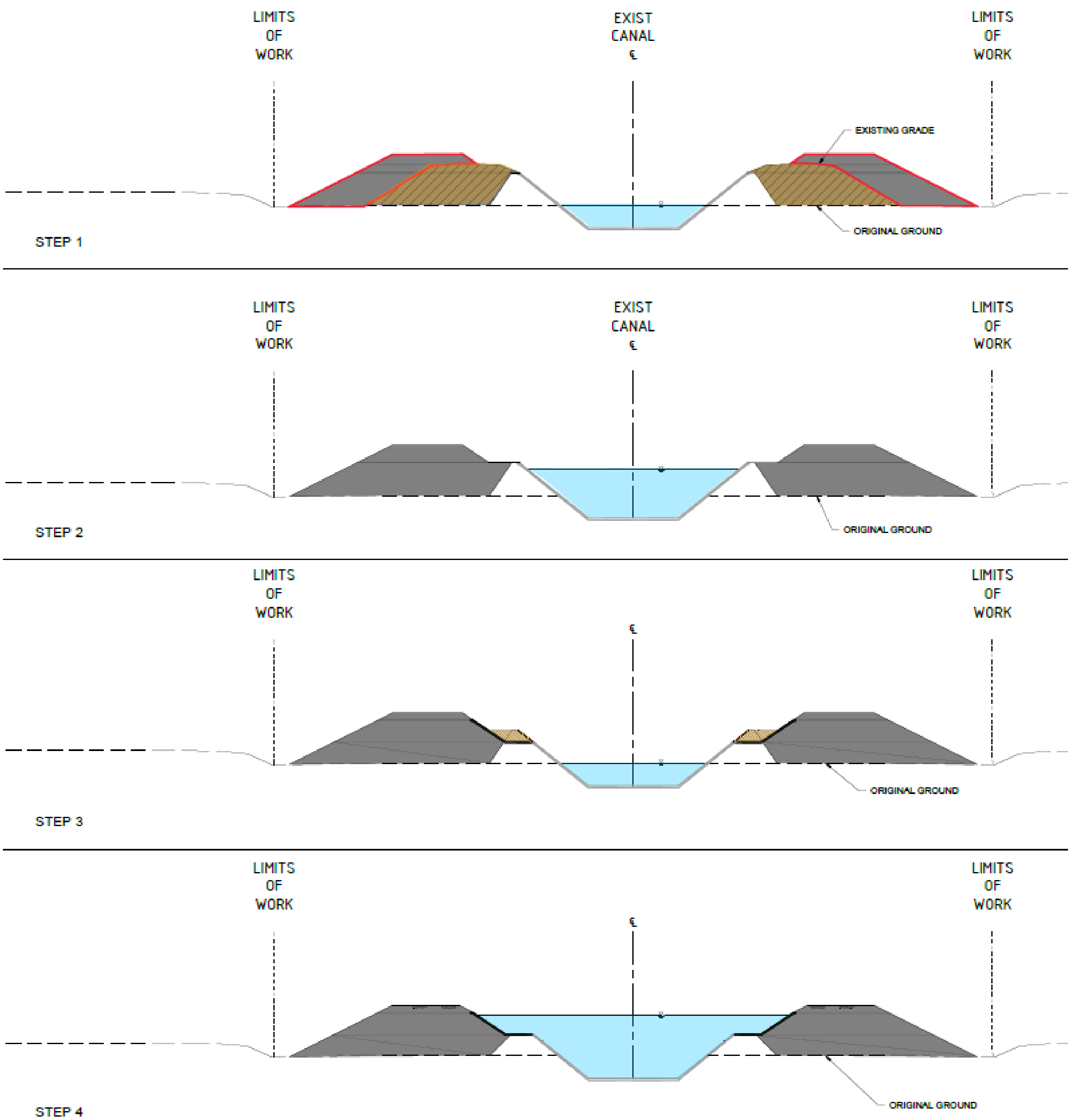


Figure 1-18. Canal Enlargement Construction Sequencing Steps

Borrow

Both alternatives would require large amounts of suitable soil for canal embankments. Borrow sources would be selected after soil samples have been obtained and evaluated during design and construction. Material hauled to the Project site would be transported using the access roads described under General Construction Practices. Potential borrow sources are as follows:

- Demolished canal embankments within the existing FKC (CER Alternative only) and excavated material for the new siphons and Deer Creek and White River replacement structures as described under General Construction Practices – Other Project Facilities for Both Alternatives.
- 164-acre parcel north of Deer Creek, west of the FKC (see Figure 1-19).
- 55-acre parcels located north of Avenue 128, west of the FKC (see Figure 1-20)
- 310-acre parcel west of the FKC south of White River adjacent to Avenue 24 (see Figure 1-21).

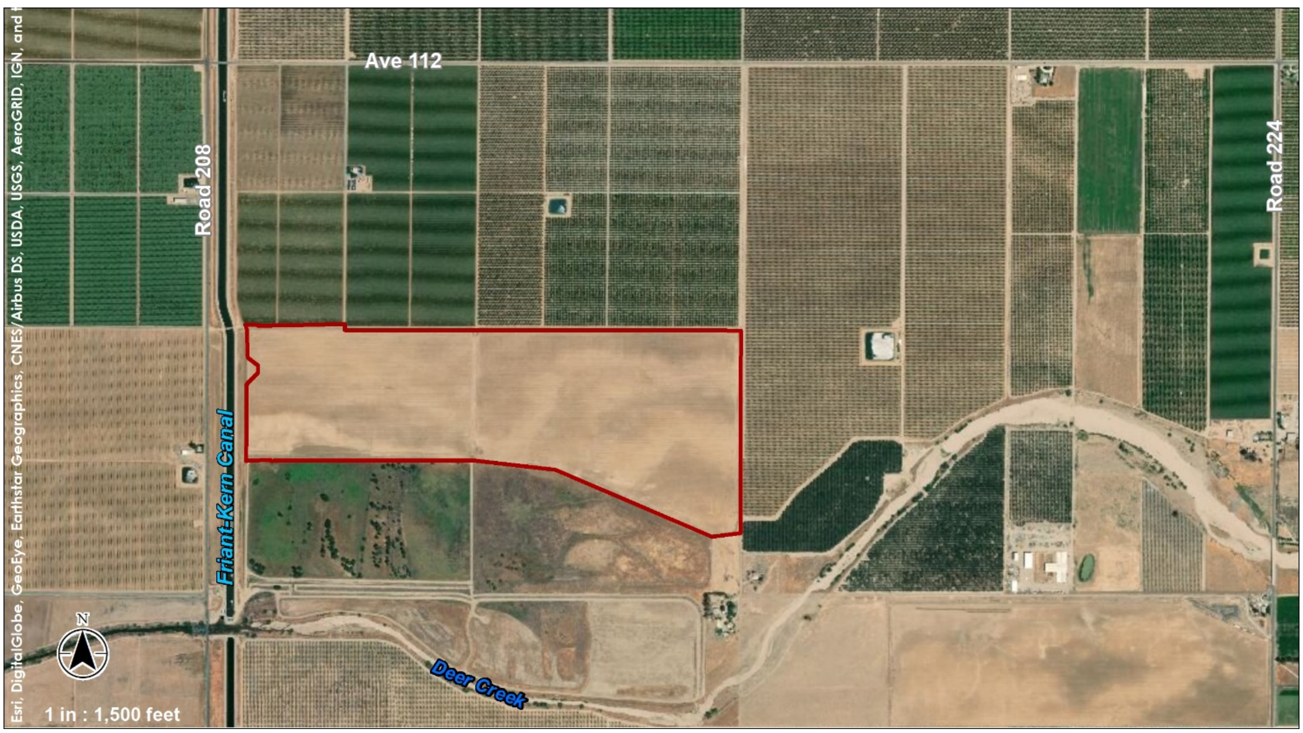


Figure 1-19. Proposed Borrow Sites Located North of Deer Creek

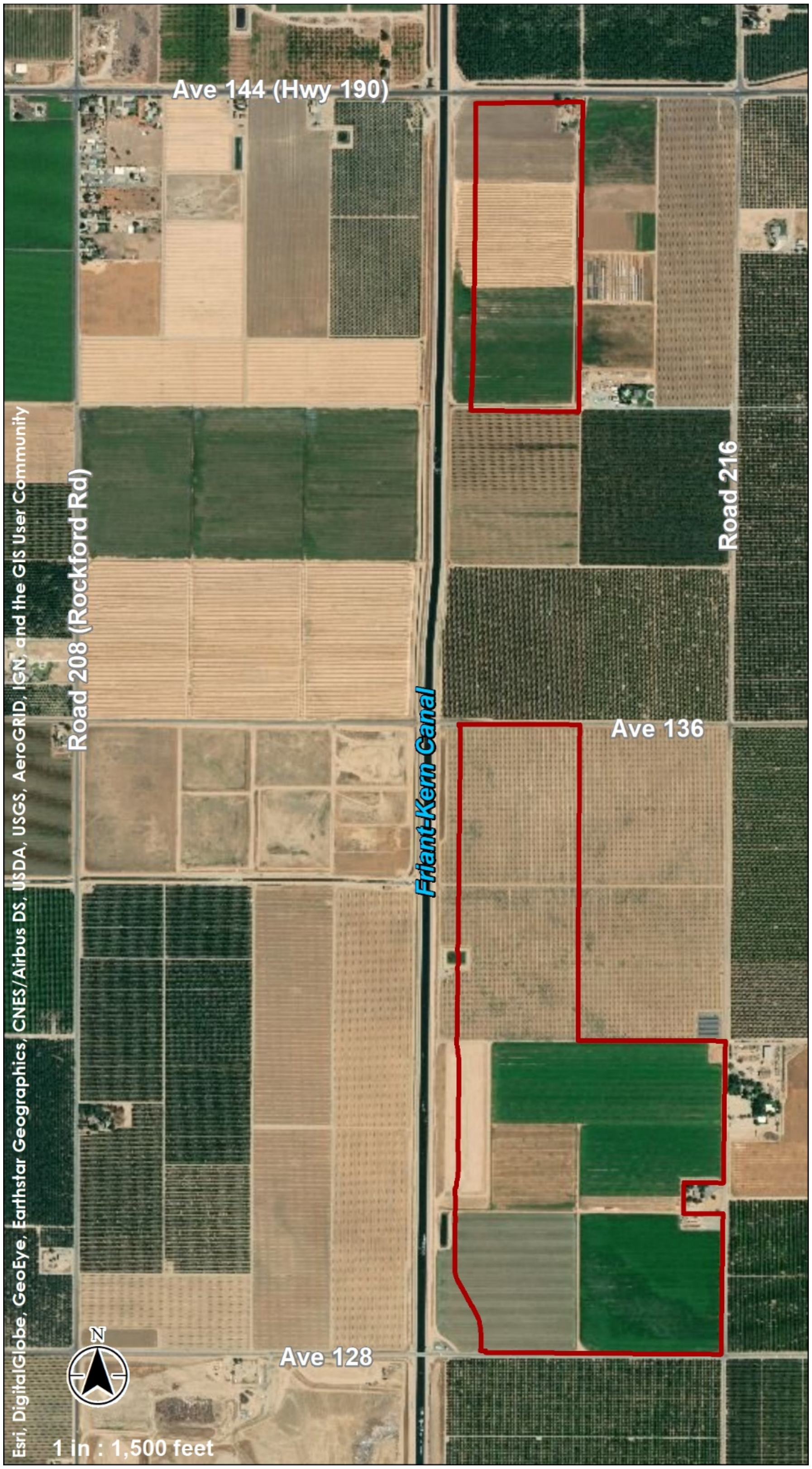


Figure 1-20. Proposed Borrow Sites Located north of Avenue 128

Figure 1-21. Proposed Borrow Site Located Near White River

General Construction Practices – Other Project Facilities for Both Alternatives

To prepare for installation of the new road crossings, the crossing area would first be excavated to the appropriate depth. Depending on soil conditions, the contractor may choose to slope back the excavations; however, if soil conditions are not adequate to provide a safe work zone at the base of the excavated slope, vertical shoring would be installed on the banks of the excavation. The maximum excavated area for a siphon would be 170 feet wide by 300 feet long and up to 35 feet below ground surface.

To accommodate traffic at the State Route 190 and Tulare County Road 192 crossing, temporary bypass roads would be constructed around the excavation sites. The bypass roads, likely with reduced speeds, would be in place for the duration of construction of these two siphons (about three months). Once the siphons are complete, the roads would be restored to their existing locations.

The area of disturbance for each road crossing would be approximately two acres. About 15,000 cubic yards of excess excavated material would be available for use on the canal banks. Once backfilled, the existing road would be replaced with a crushed rock base and asphaltic cement paving that matches the existing road. During construction of the road crossings, bypasses may be constructed around the worksite to accommodate traffic. Asphalt for roads would be obtained from regional commercial sources. Construction of a single crossing would take up to three months.

Construction of the replacement Deer Creek check structure would be very similar to that used for a typical road crossing. It is important to note the construction of the siphons would be constrained to the dry season as to keep the construction area dry and minimize impacts to the waterway. The excavated area would be up to 120 feet wide by 370 feet long and up to 20 feet below ground surface. Once the work zone has been excavated, the cast-in-place concrete structures would be built by placing concrete formwork, installing rebar, and then placing the concrete. At the completion of construction, the existing siphon and check structure at Deer Creek on the old FKC alignment would be backfilled and buried using a portion of the native material that was excavated from the work zone. Excess material from the excavation for the Deer Creek siphon would be used for construction of the new canal banks. About 8,000 cubic yards of excess soil would be available for use on the canal banks. Once the backfilling has been completed, the existing creek bed would be restored. This construction is expected to take up to seven months.

Construction of the replacement White River structure would be very similar to that for the Deer Creek structure. The excavated area would be up to 140 feet wide by 300 feet long and 25 feet below ground surface. Similar to the Deer Creek structure, the existing siphon and check structure would be backfilled and buried using a portion of the native material. The area of disturbance for the construction zone could be as large as two acres. Up to 7,000 cubic yards of excess soil would be available for use on the realigned canal banks. Once backfilling has been completed to finished grades, the existing riverbed would be restored. Construction is expected to take up to seven months.

Prior to the start of excavation, dewatering wells may be installed in some areas of deep excavation to reduce groundwater intrusion. The wells would lower the groundwater locally as the excavation proceeds. Dewatering water would be disposed of in accordance with state and federal requirements, and the wells would be removed once construction is completed.

A concrete batch plant would be built onsite for construction of canal linings for both alternatives. The batch plant would be located on a 30-acre parcel on Avenue 56 near the FKC in Tulare County (see Figure 1-22). The property would also be used for contractor staging, offices, and equipment and material storage.

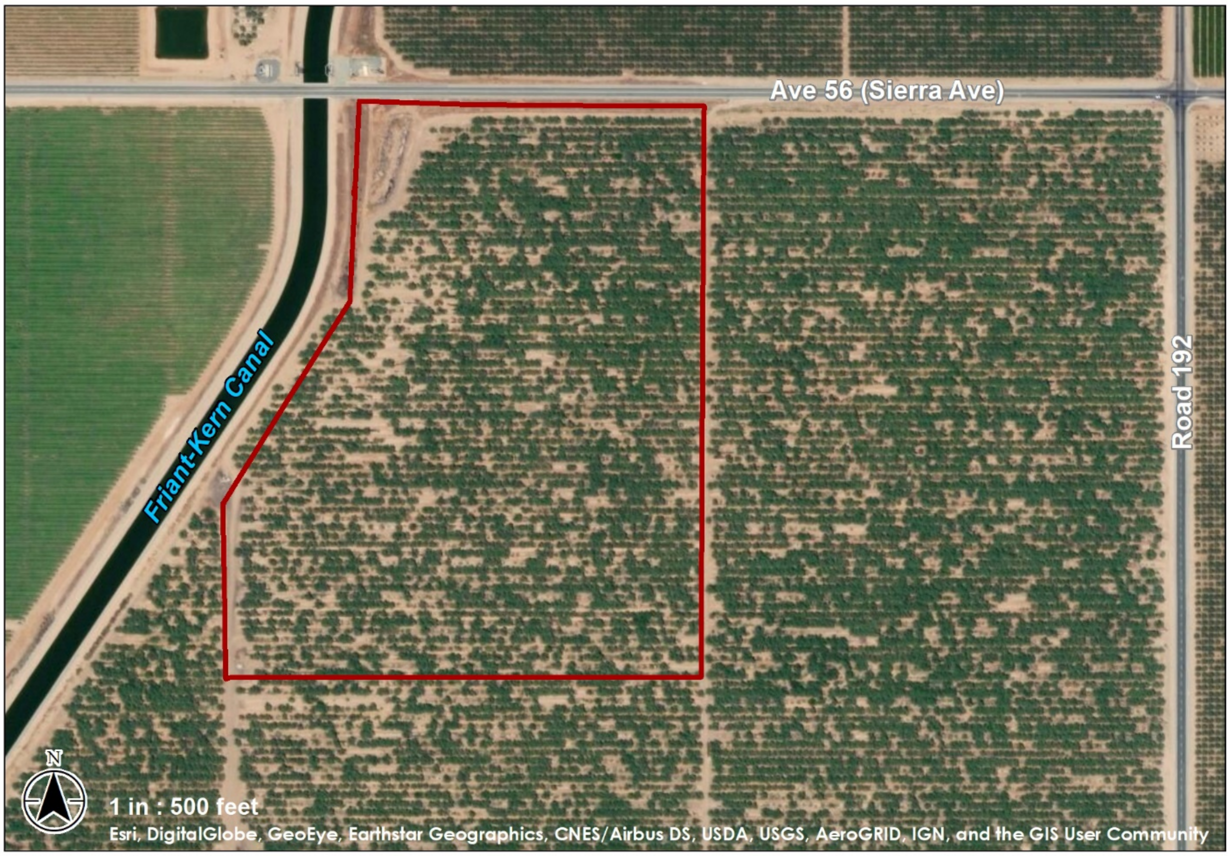


Figure 1-22. Batch Plant Location and Contractor Staging Area near Avenue 56

Construction Access and Staging

Except for the contractor staging areas identified at Avenue 56 and the potential borrow sites shown on Figures 1-18 through 1-20, construction traffic and equipment staging would be contained mostly within the new Project ROW. For both alternatives, new ROW limits would be 25 feet from the banks of the realigned canal. This additional ROW, which would be parallel to the canal alignment, would provide space for both temporary construction access roads and permanent operations and maintenance access roads parallel to and along the base of the final canal banks.

Thirty-seven Tulare County roads, three Kern County roads, and five state highways cross the Middle Reach of the FKC. Depending on which segment of the Project is under construction, each of these roadways may be used for construction access. Modification of county or state roads for construction access is not expected.

Multiple contractor staging areas and yards for Project offices, employee parking, and material and equipment storage would also be contained within the new ROW. Contractor staging areas would include but not be limited to the following:

<u>Segment 1:</u> Segment 1 would require approximately eight miles of canal modifications. An estimated 15 acres of temporary staging area could be required to support construction. Small areas of land believed to be within Reclamation's existing ROW along segment 1 could potentially be used for staging. The segment 1 potential staging areas (S1-PSA) are as follows:

- S1-PSA-01: Approximately three acres of open space on the west side of the FKC between Avenues 196 and 194 (MP 90.0 to 90.3). Access would be provided by Avenue 196 and Avenue 194.
- S1-PSA-02: Approximately two acres of open space on the west side of the FKC immediately south of Avenue 174 (MP 92.9 to 93.0). Access would be provided by Avenue 174.
- S1-PSA-02: Approximately 1.5 acres of open space on the west side of the FKC immediately south of Avenue 170 (MP 93.6 to 93.7). Access would be provided by Avenue 170.

<u>Segments 2 and 3:</u> Segments 2 and 3 would require approximately 17 miles of canal raising and widening for the CE Alternative or 17 miles of new canal construction for the CER Alternative. A project of this size and type may require between 20 and 50 acres of temporary staging area. Small areas of land believed to be within Reclamation's existing ROW along segments 2 and 3 could potentially be used for staging. The segment 2 and 3 potential staging areas (S2-PSA and S3-PSA) are as follows:

- S2-PSA-01: Approximately two acres of open space on the west side of the FKC immediately east of Rockford Road (MP 100.6 to 100.7). Access would be provided by Rockford Road.
- S3-PSA-01: Approximately 160 acres of farmland approximately one mile to east of the FKC south of Deer Creek, adjacent to the western side of Road 224 (MP 102.8). This is a large parcel approximately 5,000 feet by 1,200 feet. Access would be provided by Road 224.
- S3-PSA-02: Approximately ten acres of open space on the west side of the FKC beginning south of the Deer Creek check structure and ending at Terra Bella Avenue (MP 103.0 to 103.7). This is a long, narrow strip of land approximately 90 feet wide by 4,800 feet long. Access would be provided by Terra Bella Avenue.
- S3-PSA-03: Approximately 1.5 acres of open space on the west side of the FKC between Avenue 64 and Avenue 56 (MP 108.9). Access would be provided by Avenue 64 and Avenue 56.

- S3-PSA-04: Approximately 30 acres of farmland on the east side of the FKC south of Avenue 56 (MP 109.5). This parcel would also be used for the concrete batch plant as well as construction trailers, equipment and material staging, and parking. Access would be provided by Avenue 56.

Segment 4: Segment 4 would require 8.5 miles of construction, including up to 2.5 miles of new canal and six miles of raise to the existing canal for the CER Alternative and 2.5 miles of raise and widen of the existing canal and six miles of raise to the existing canal for the CE Alternative. A project of this size and type may require between 15 and 30 acres of temporary staging area. Small areas of land believed to be within Reclamation's existing ROW along segment 4 could potentially be used for staging. The segment 4 potential staging areas (S4-PSA) are as follows:

- S4-PSA-01: Approximately six acres of open space on the west side of the FKC between Avenue 4 and County Line Road (MP 116.5 to 116.9). Access would be provided by Avenue 4 and County Line Road.
- S4-PSA-02: Approximately six acres of open space on the east side of the FKC between Avenue 4 and County Line Road (MP 116.5 to 116.9). Access would be provided by Avenue 4 and County Line Road.
- S4-PSA-03: Approximately ten acres of open space on the east side of the FKC between County Line Road and Cecil Avenue (MP 117.0 to 117.7). Access would be provided by County Line Road and Cecil Avenue.

Construction Schedule

The CER Alternative would take approximately three years to construct. Construction would be year-round, with the existing canal remaining in operation during construction. It is expected that the CE Alternative would take approximately ten years to construct. In order to construct this alternative, the water level in the FKC would need to be lowered, which would require temporary pumping and diversions to water users along the canal. Because of the reduced capacity in the canal, water levels would be lowered only during the non-irrigation season (November through February). Incremental in-canal construction would, therefore, occur approximately three months per year.

Right-of-way and Work Area Limits

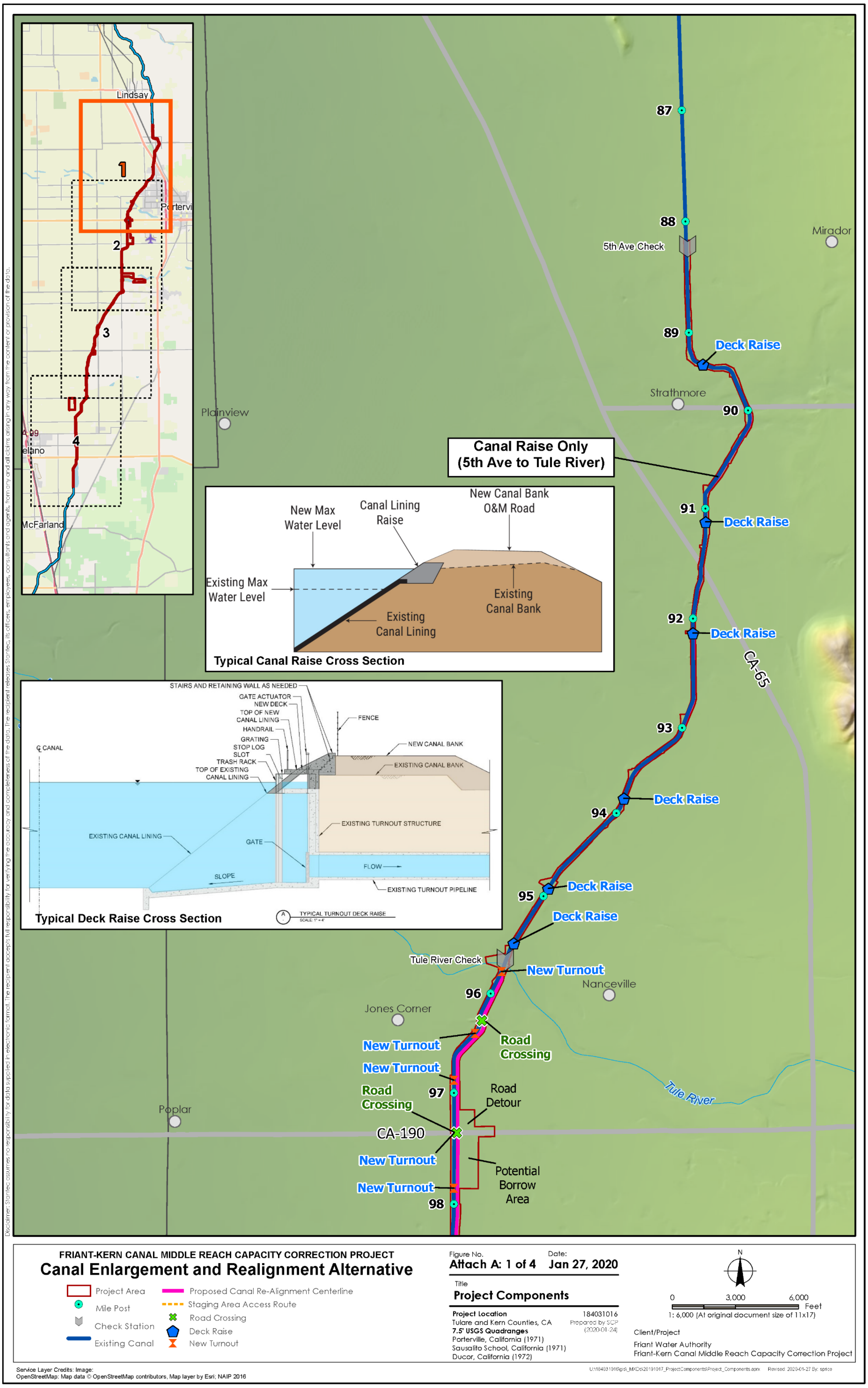
For the CER Alternative, 510 acres of additional ROW would be needed. The canal enlargement work in segments 1 and 4 would generally stay within the existing ROW, but approximately 60 acres of new ROW would be needed in areas where the outside canal bank toe extends outside the existing ROW. For the realigned canal in segments 2, 3, and part of 4, 450 acres of new ROW would be required.

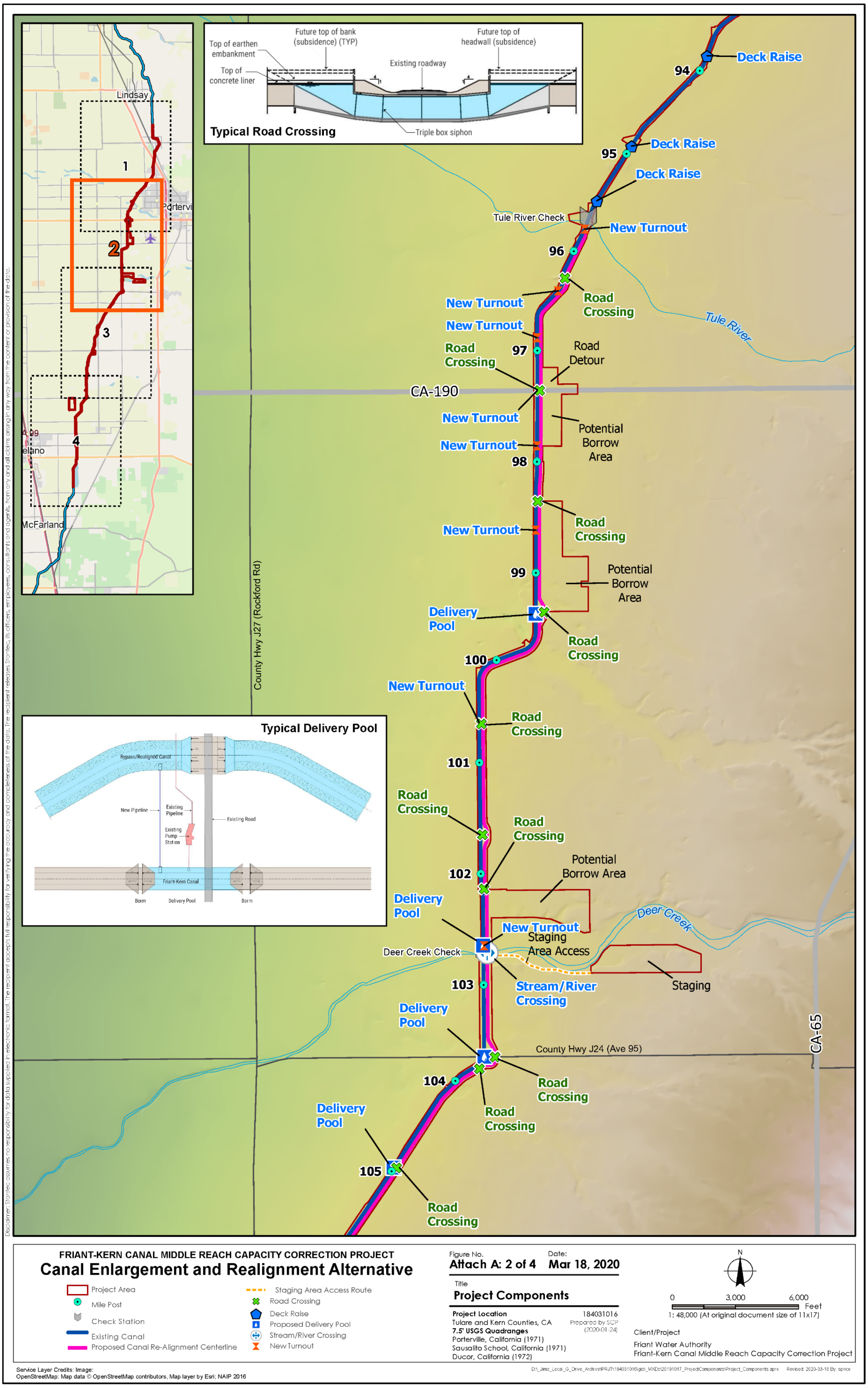
For the CE Alternative, a majority of the work would occur within the existing canal ROW, but a total of 170 acres of additional ROW would be needed in areas where the outside canal bank toe extends outside the existing ROW and where bypass canal segments would be constructed around delivery pools (see section describing Turnouts).

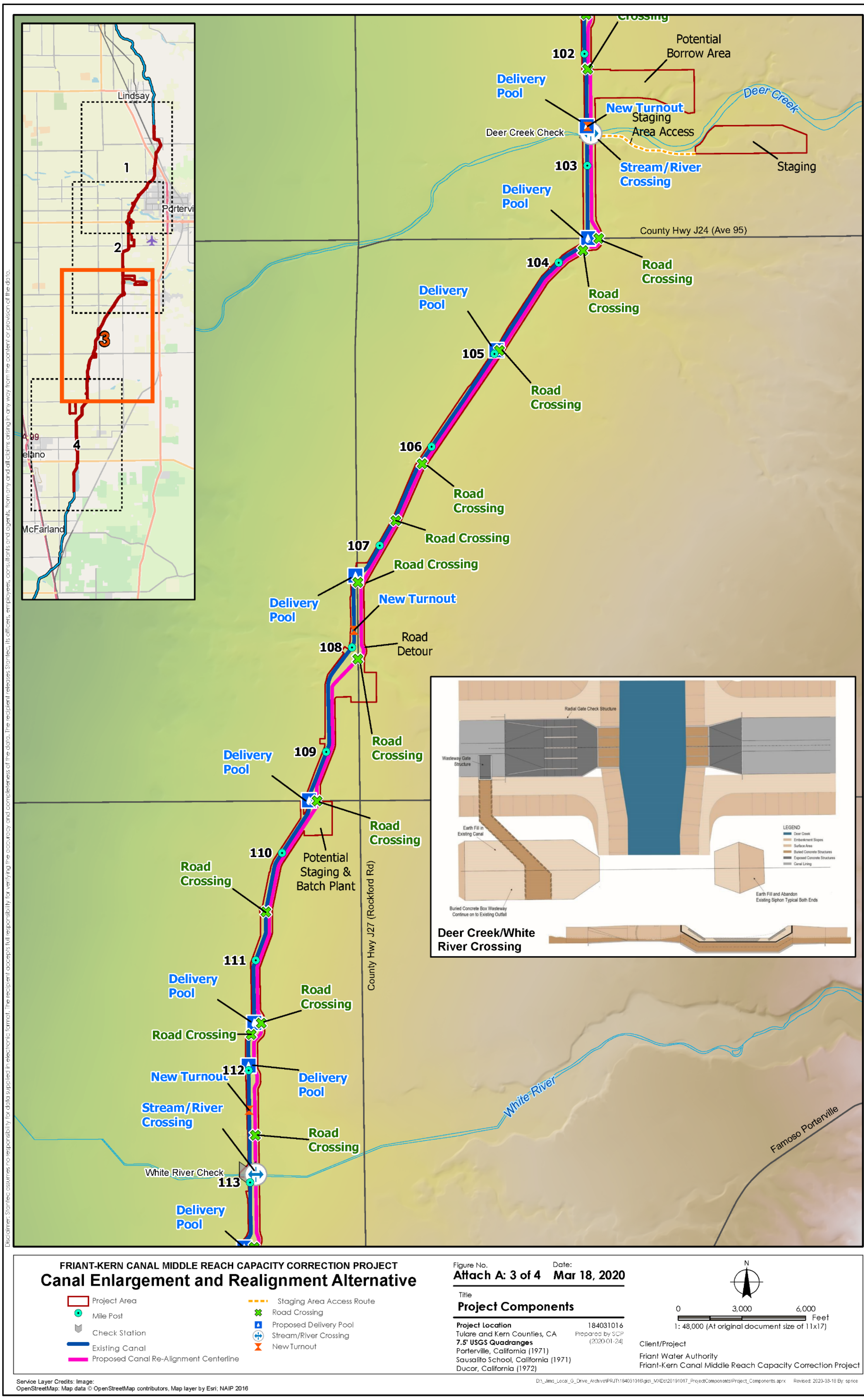
The anticipated construction areas as well as staging and borrow locations for the two action alternatives are shown in Attachments A and B.

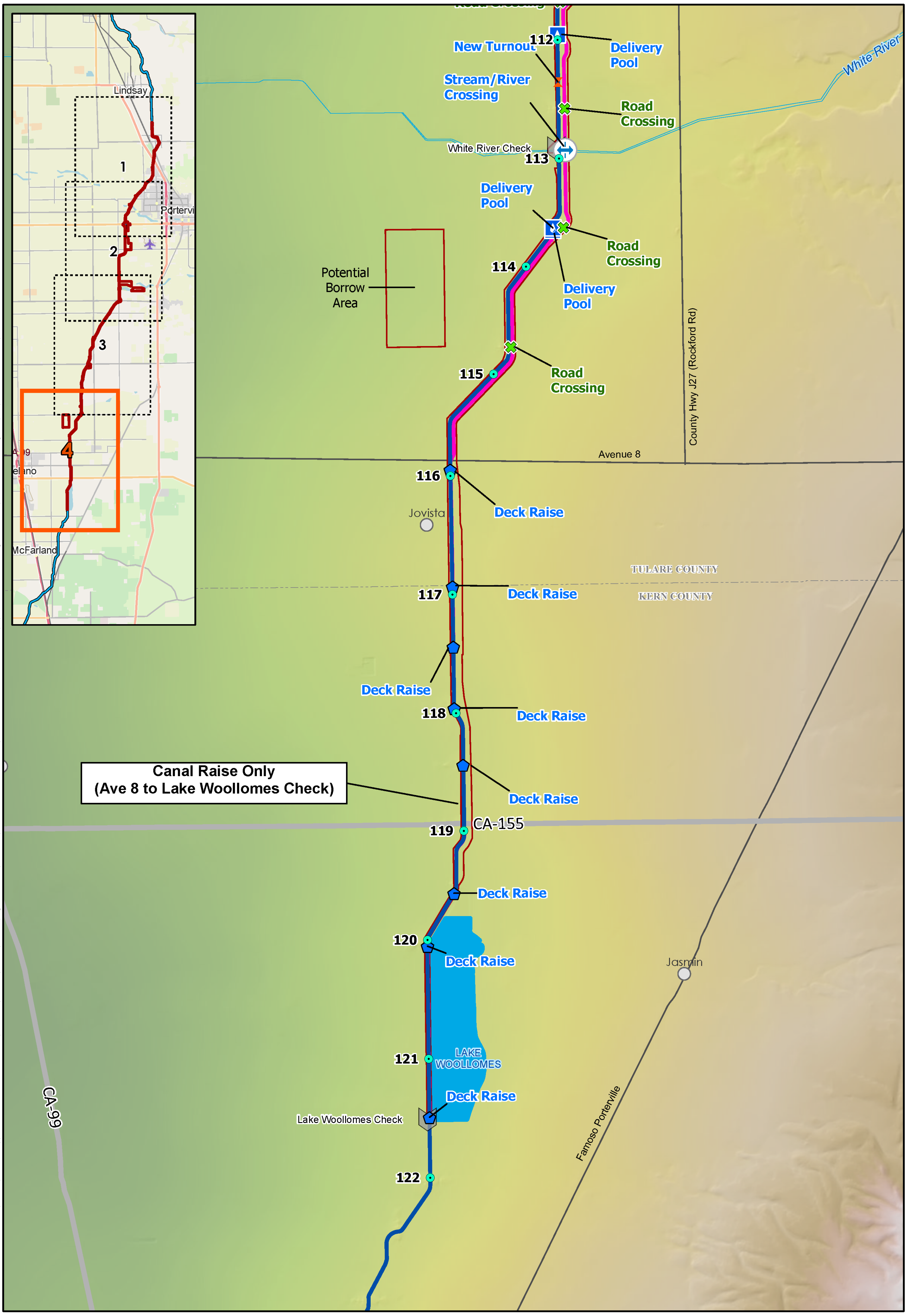
ATTACHMENT A

Project Description Details CER Alternative


Lindsay
Porterville
McFarland
Plainview
Mirador
Strathmore
5th Ave Check
87
88
89
90
91
92
93
94
95
96
97
98
Deck Raise
Canal Raise Only
(5th Ave to Tule River)
New Max Water Level
Canal Lining Raise
New Canal Bank O&M Road
Existing Max Water Level
Existing Canal Bank
Existing Canal Lining
Typical Canal Raise Cross Section
STAIRS AND RETAINING WALL AS NEEDED
GATE ACTUATOR
NEW DECK
TOP OF NEW CANAL LINING
HANDRAIL
GRATING
STOP LOG SLOT
TRASH RACK
TOP OF EXISTING CANAL LINING
FENCE
NEW CANAL BANK
EXISTING CANAL BANK
EXISTING TURNOUT STRUCTURE
EXISTING CANAL LINING
GATE
FLOW
SLOPE
EXISTING TURNOUT PIPELINE
TYPICAL TURNOUT DECK RAISE
Typical Deck Raise Cross Section
CA-65
Tule River Check
New Turnout
Nanceville
Jones Corner
Road Crossing
Road Detour
Tule River
Poplar
CA-190
Potential Borrow Area
FRIANT-KERN CANAL MIDDLE REACH CAPACITY CORRECTION PROJECT
Canal Enlargement and Realignment Alternative
Project Area
Mile Post
Check Station
Existing Canal
Proposed Canal Re-Alignment Centerline
Staging Area Access Route
Road Crossing
Deck Raise
New Turnout
Figure No.
Attach A: 1 of 4
Date:
Jan 27, 2020
Title
Project Components
Project Location
Tulare and Kern Counties, CA
7.5' USGS Quadrangles
Porterville, California (1971)
Sausalito School, California (1971)
Ducor, California (1972)
184031016
Prepared by SCP
N
0
3,000
6,000
Feet
1: 6,000 (At original document size of 11x17)
Client/Project
Friant Water Authority
Friant-Kern Canal Middle Reach Capacity Correction Project
Service Layer Credits: Image:
OpenStreetMap: Map data © OpenStreetMap contributors, Map layer by Esri; NAIP 2016


Typical Road Crossing
Future top of bank (subsidence) (TYP)
Future top of headwall (subsidence)
Top of earthen embankment
Top of concrete liner
Existing roadway
Triple box siphon
Lindsay
Porterville
McFarland
1
2
3
4
Typical Delivery Pool
Deck Raise
Deck Raise
Deck Raise
94
95
96
97
98
99
100
101
102
103
104
105
Tule River Check
New Turnout
Road Crossing
Tule River
New Turnout
New Turnout
Road Crossing
Road Detour
CA-190
New Turnout
New Turnout
Potential Borrow Area
Road Crossing
New Turnout
Potential Borrow Area
Delivery Pool
Road Crossing
County Hwy J27 (Rockford Rd)
New Turnout
Road Crossing
Road Crossing
Road Crossing
Potential Borrow Area
Delivery Pool
New Turnout
Staging Area Access
Deer Creek
Deer Creek Check
Staging
Stream/River Crossing
Delivery Pool
County Hwy J24 (Ave 95)
CA-65
Road Crossing
Road Crossing
Delivery Pool
Road Crossing
FRIANT-KERN CANAL MIDDLE REACH CAPACITY CORRECTION PROJECT
Canal Enlargement and Realignment Alternative
Project Area
Mile Post
Check Station
Existing Canal
Proposed Canal Re-Alignment Centerline
Staging Area Access Route
Road Crossing
Deck Raise
Proposed Delivery Pool
Stream/River Crossing
New Turnout
Figure No.
Attach A: 2 of 4
Date:
Mar 18, 2020
Title
Project Components
Project Location
184031016
Tulare and Kern Counties, CA
Prepared by SCP (2020-01-24)
7.5' USGS Quadrangles
Porterville, California (1971)
Sausalito School, California (1971)
Ducor, California (1972)
N
0 3,000 6,000 Feet
1: 48,000 (At original document size of 11x17)
Client/Project
Friant Water Authority
Friant-Kern Canal Middle Reach Capacity Correction Project
Service Layer Credits: Image:
OpenStreetMap: Map data © OpenStreetMap contributors, Map layer by Esri; NAIP 2016


Lindsay
Porterville
1
2
3
4
McFarland
Potential
Borrow Area
102
Delivery
Pool
New Turnout
Staging
Area Access
Deer Creek
Deer Creek Check
Staging
103
Stream/River
Crossing
Delivery
Pool
County Hwy J24 (Ave 95)
104
Road
Crossing
Road
Crossing
Delivery
Pool
105
Road
Crossing
106
Road
Crossing
Road Crossing
107
Road Crossing
Delivery
Pool
New Turnout
108
Road
Detour
Road
Crossing
Delivery
Pool
109
Road
Crossing
110
Potential
Staging &
Batch Plant
Road
Crossing
County Hwy J27 (Rockford Rd)
111
Delivery
Pool
Road
Crossing
Road Crossing
New Turnout
112
Delivery
Pool
Stream/River
Crossing
Road
Crossing
White River
White River Check
113
Delivery
Pool
Famoso Porterville
Deer Creek/White
River Crossing
FRIANT-KERN CANAL MIDDLE REACH CAPACITY CORRECTION PROJECT
Canal Enlargement and Realignment Alternative
Project Area
Mile Post
Check Station
Existing Canal
Proposed Canal Re-Alignment Centerline
Staging Area Access Route
Road Crossing
Proposed Delivery Pool
Stream/River Crossing
New Turnout
Figure No.
Attach A: 3 of 4
Date:
Mar 18, 2020
Title
Project Components
Project Location
184031016
Tulare and Kern Counties, CA
Prepared by SCP
(2020-01-24)
7.5' USGS Quadrangles
Porterville, California (1971)
Sausalito School, California (1971)
Ducor, California (1972)
N
0
3,000
6,000
Feet
1: 48,000 (At original document size of 11x17)
Client/Project
Friant Water Authority
Friant-Kern Canal Middle Reach Capacity Correction Project
Service Layer Credits: Image:
OpenStreetMap: Map data © OpenStreetMap contributors, Map layer by Esri; NAIP 2016
Revised: 2020-03-18 By: sprice



FRIANT-KERN CANAL MIDDLE REACH CAPACITY CORRECTION PROJECT

Canal Enlargement and Realignment Alternative

- Project Area
- Mile Post
- Check Station
- Existing Canal
- Proposed Canal Re-Alignment Centerline
- Staging Area Access Route
- Road Crossing
- Deck Raise
- Proposed Delivery Pool
- Stream/River Crossing
- New Turnout

Figure No. **Attach A: 4 of 4** Date: **Jan 27, 2020**

Title **Project Components**

Project Location 184031016
Tulare and Kern Counties, CA Prepared by SCP (2020-01-24)
7.5' USGS Quadranges
Porterville, California (1971)
Sausalito School, California (1971)
Ducor, California (1972)

N
0 3,000 6,000 Feet
1: 6,000 (At original document size of 11x17)

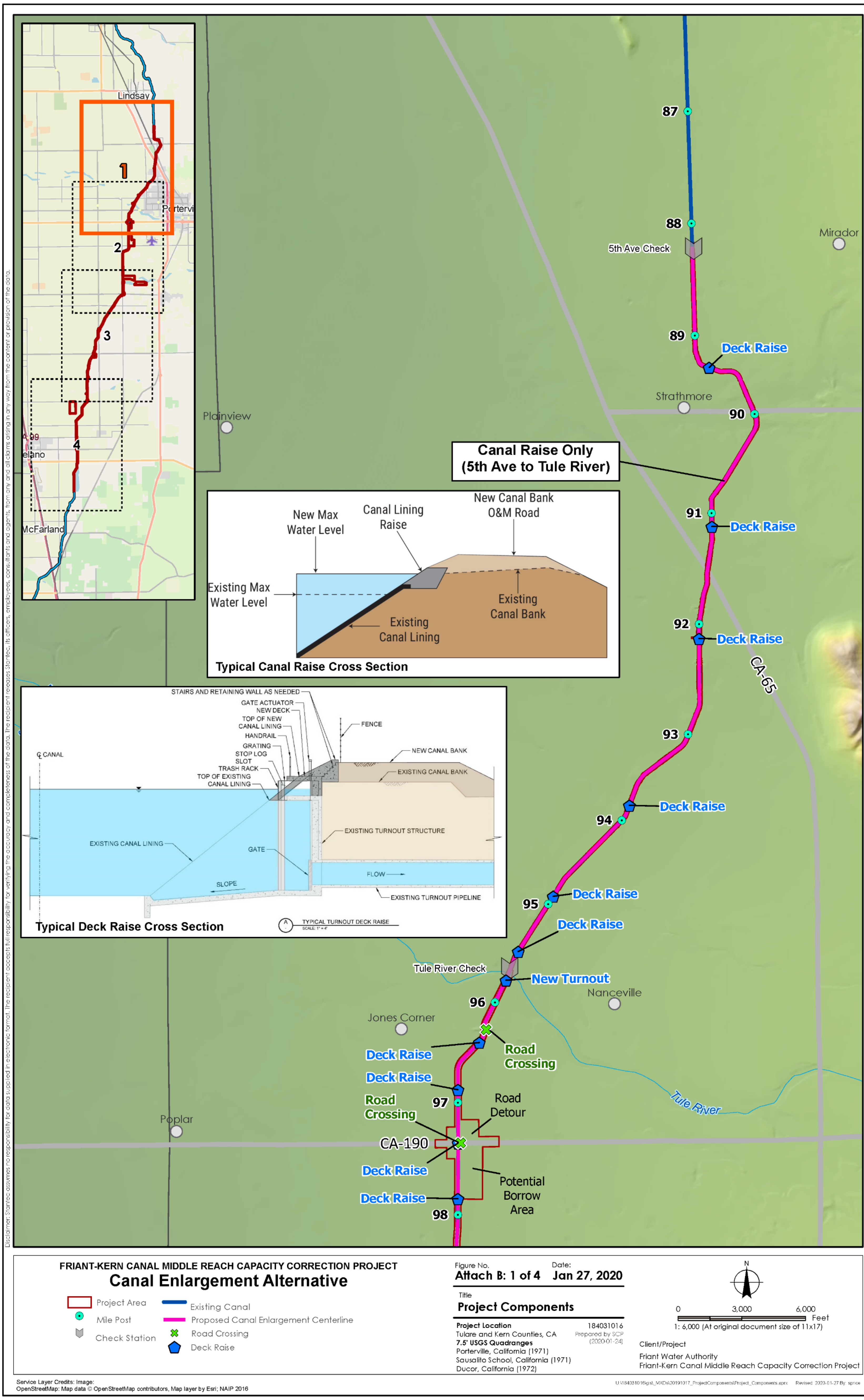
Client/Project
Friant Water Authority
Friant-Kern Canal Middle Reach Capacity Correction Project

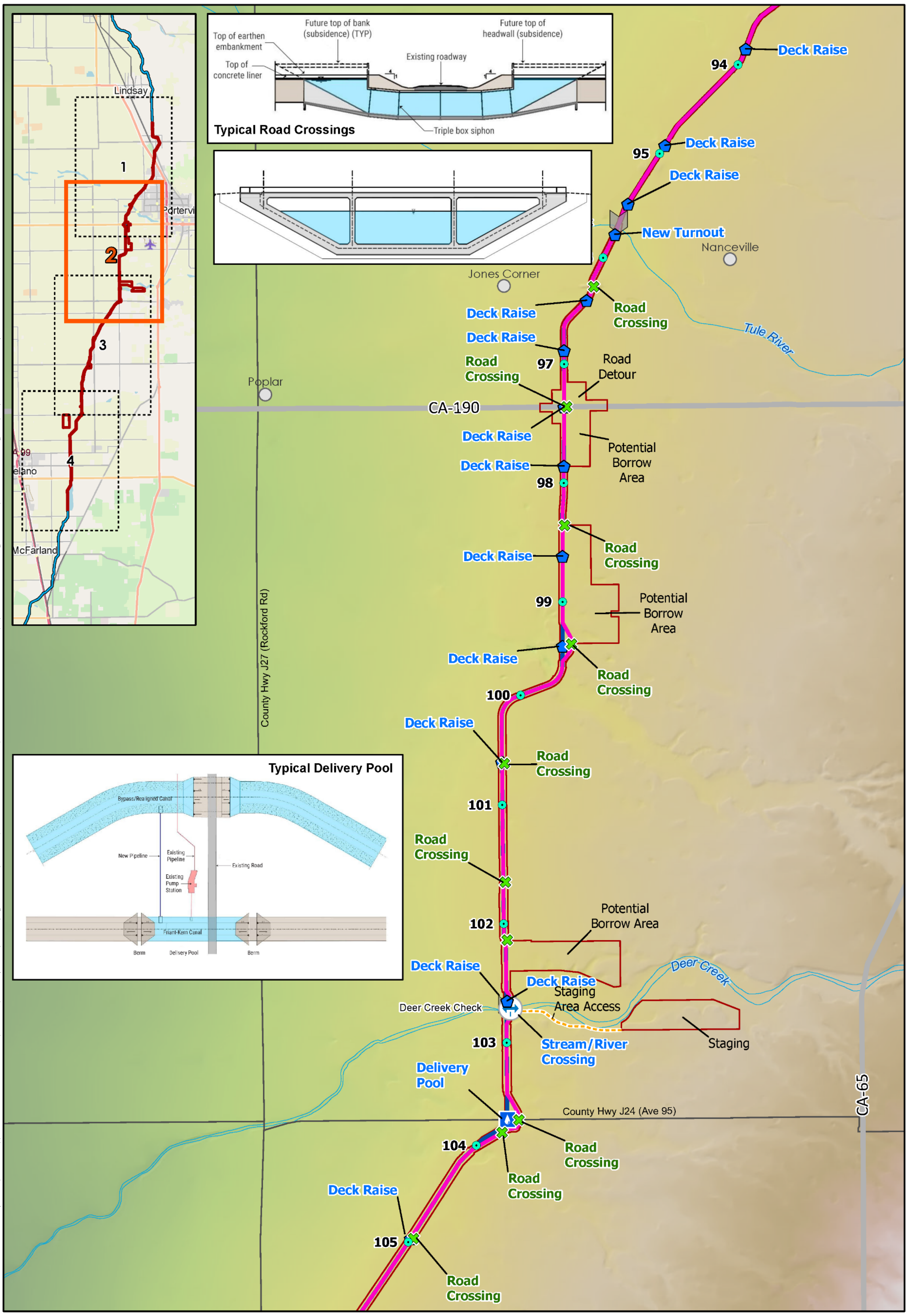
Service Layer Credits: Image:
OpenStreetMap: Map data © OpenStreetMap contributors, Map layer by Esri; NAIP 2016

U:\184031016\gis_MXDs\20191017_ProjectComponents\Project_Components.aprx Revised: 2020-01-27 By: sprice

ATTACHMENT B

Project Description Details CE Alternative


Lindsay
1
2
3
4
Porterville
Delano
McFarland
Plainview
Poplar
Jones Corner
Nanceville
Strathmore
Mirador
87
88
89
90
91
92
93
94
95
96
97
98
5th Ave Check
Tule River Check
Deck Raise
New Turnout
Road Crossing
Road Detour
CA-190
CA-65
Tule River
Potential Borrow Area
Canal Raise Only
(5th Ave to Tule River)
New Max Water Level
Canal Lining Raise
New Canal Bank O&M Road
Existing Max Water Level
Existing Canal Lining
Existing Canal Bank
Typical Canal Raise Cross Section
STAIRS AND RETAINING WALL AS NEEDED
GATE ACTUATOR
NEW DECK
TOP OF NEW CANAL LINING
HANDRAIL
GRATING
STOP LOG
SLOT
TRASH RACK
TOP OF EXISTING CANAL LINING
FENCE
NEW CANAL BANK
EXISTING CANAL BANK
EXISTING TURNOUT STRUCTURE
EXISTING CANAL LINING
GATE
FLOW
SLOPE
EXISTING TURNOUT PIPELINE
TYPICAL TURNOUT DECK RAISE
Typical Deck Raise Cross Section
FRIANT-KERN CANAL MIDDLE REACH CAPACITY CORRECTION PROJECT
Canal Enlargement Alternative
Project Area
Mile Post
Check Station
Existing Canal
Proposed Canal Enlargement Centerline
Road Crossing
Deck Raise
Figure No.
Attach B: 1 of 4
Date:
Jan 27, 2020
Title
Project Components
Project Location
Tulare and Kern Counties, CA
7.5' USGS Quadrangles
Porterville, California (1971)
Sausalito School, California (1971)
Ducor, California (1972)
184031016
Prepared by SCP
N
0
3,000
6,000
Feet
1: 6,000 (At original document size of 11x17)
Client/Project
Friant Water Authority
Friant-Kern Canal Middle Reach Capacity Correction Project
Service Layer Credits: Image:
OpenStreetMap: Map data © OpenStreetMap contributors, Map layer by Esri; NAIP 2016



FRIANT-KERN CANAL MIDDLE REACH CAPACITY CORRECTION PROJECT

Canal Enlargement Alternative

- Project Area
- Mile Post
- Check Station
- Existing Canal
- Proposed Canal Enlargement Centerline
- Staging Area Access Route
- Road Crossing
- Deck Raise
- Proposed Delivery Pool
- Stream/River Crossing

Figure No. **Attach B: 2 of 4** Date: **Jan 27, 2020**

Title **Project Components**

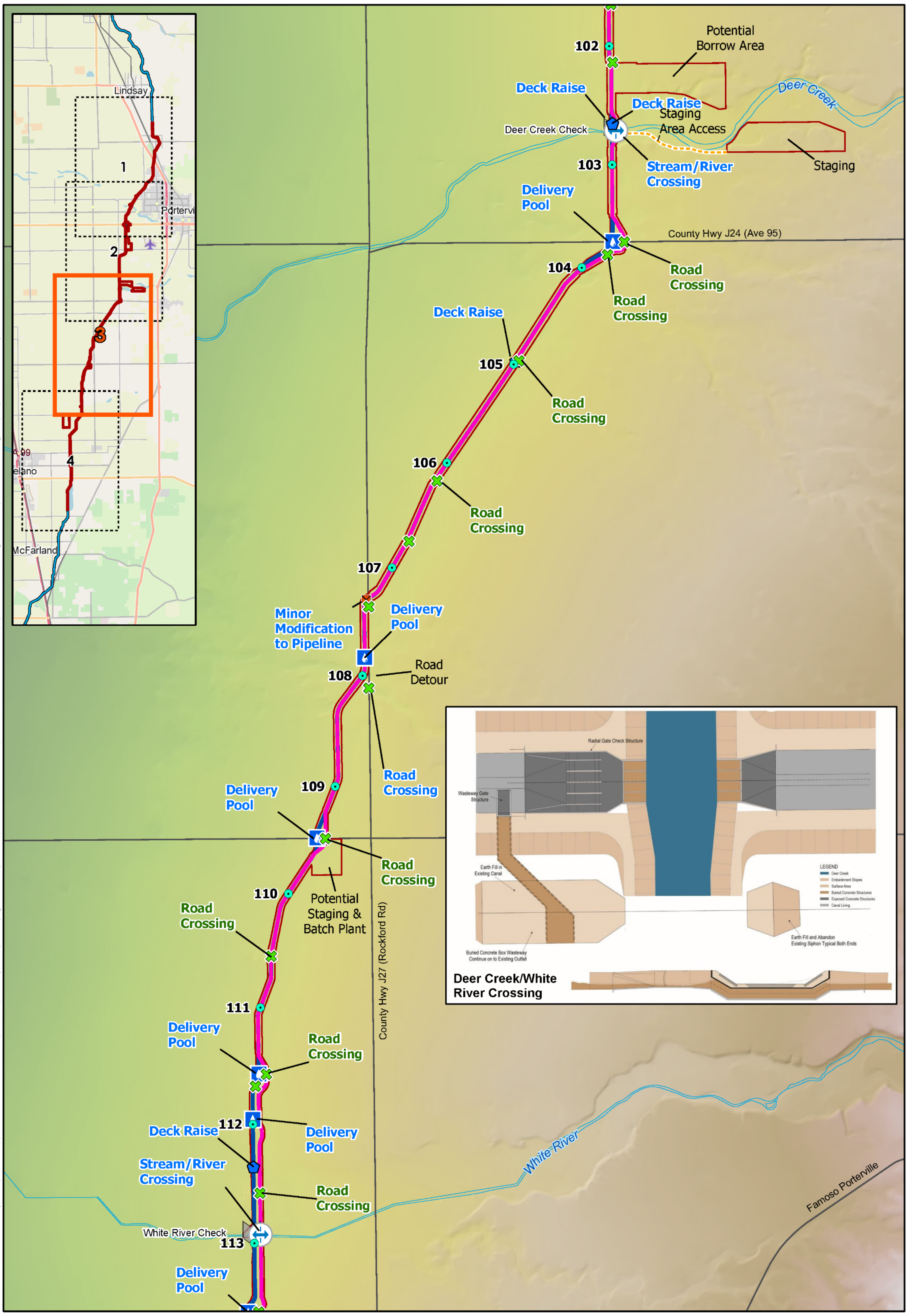
Project Location 184031016
Tulare and Kern Counties, CA
Prepared by SCP (2020-01-24)
7.5' USGS Quadranges
Porterville, California (1971)
Sausalito School, California (1971)
Ducor, California (1972)

N
0 3,000 6,000 Feet
1: 6,000 (At original document size of 11x17)

Client/Project
Friant Water Authority
Friant-Kern Canal Middle Reach Capacity Correction Project

Service Layer Credits: Image:
OpenStreetMap: Map data © OpenStreetMap contributors, Map layer by Esri; NAIP 2016

U:\184031016\gis_MXDs\20191017_ProjectComponents\Project_Components.aprx Revised: 2020-01-27 By: sprice



FRIANT-KERN CANAL MIDDLE REACH CAPACITY CORRECTION PROJECT

Canal Enlargement Alternative

- Project Area
- Mile Post
- Check Station
- Existing Canal
- Proposed Canal Enlargement Centerline
- Staging Area Access Route
- Road Crossing
- Deck Raise
- Proposed Delivery Pool
- Stream/River Crossing
- Pipe Modification

Figure No. **Attach B: 3 of 4** Date: **Jan 27, 2020**

Title **Project Components**

Project Location 184031016
Tulare and Kern Counties, CA
Prepared by SCP (2020-01-24)
7.5' USGS Quadranges
Porterville, California (1971)
Sausalito School, California (1971)
Ducor, California (1972)

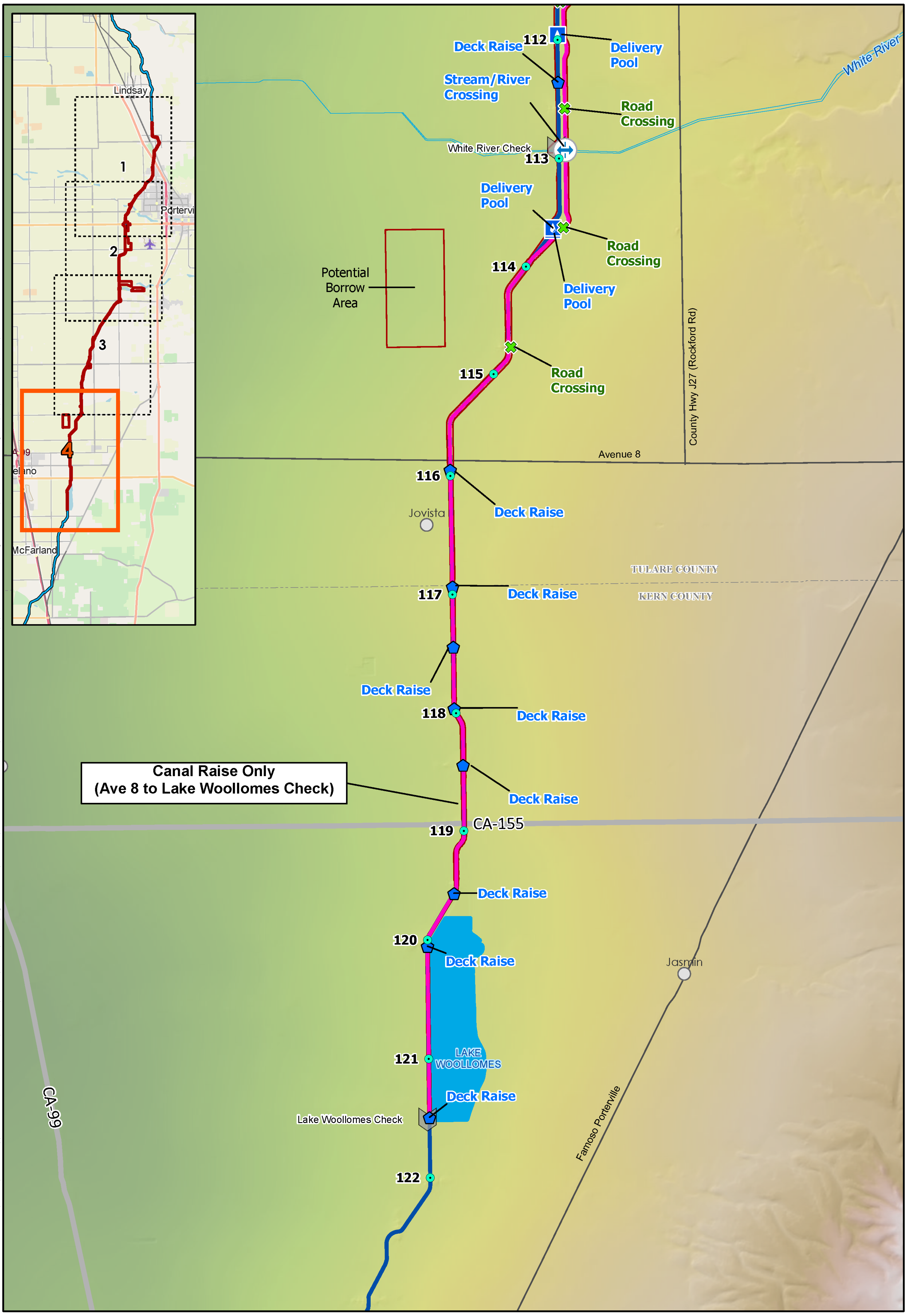
N

0 3,000 6,000 Feet
1: 6,000 (At original document size of 11x17)

Client/Project
Friant Water Authority
Friant-Kern Canal Middle Reach Capacity Correction Project

Service Layer Credits: Image:
OpenStreetMap: Map data © OpenStreetMap contributors, Map layer by Esri; NAIP 2016

U:\184031016\gis_MXDs\20191017_ProjectComponents\Project_Components.aprx Revised: 2020-01-27 By: sprice



FRIANT-KERN CANAL MIDDLE REACH CAPACITY CORRECTION PROJECT

Canal Enlargement Alternative

Project Area
Mile Post
Check Station
Existing Canal
Proposed Canal Enlargement Centerline
Road Crossing
Deck Raise
Proposed Delivery Pool
Stream/River Crossing

Figure No.
Attach B: 4 of 4

Date:
Jan 27, 2020

Title
Project Components

Project Location 184031016
Tulare and Kern Counties, CA
Prepared by SCP (2020-01-24)
7.5' USGS Quadranges
Porterville, California (1971)
Sausalito School, California (1971)
Ducor, California (1972)

N
0 3,000 6,000 Feet
1: 6,000 (At original document size of 11x17)

Client/Project
Friant Water Authority
Friant-Kern Canal Middle Reach Capacity Correction Project

Service Layer Credits: Image:
OpenStreetMap: Map data © OpenStreetMap contributors, Map layer by Esri; NAIP 2016

U:\184031016\gis_MXDs\20191017_ProjectComponents\Project_Components.aprx Revised: 2020-01-27 By: sprice

ATTACHMENT C

Selection of Future Subsidence Conditions

Friant
WATER AUTHORITY

Attachment C
Selection of Future Subsidence Conditions

Technical Memorandum – FINAL

Submitted to: Friant Water Authority

March 22, 2019

Stantec

Friant Water Authority
854 N Harvard Ave
Lindsay, CA 93247

Stantec Consulting Services Inc
3301 C Street, Suite 1900
Sacramento, CA 95816

Tel: 916-924-8844
Fax: 916-924-9102

To:	Doug DeFlitch
From:	Janet Atkinson
Authors:	William Swanson, David Rogers
Project:	Friant-Kern Canal Subsidence Correction Project
Subject	Selection of Future Subsidence Conditions Technical Memorandum
Date:	March 22, 2019
File	2019.01.25 FKSCP Subsidence TM revised final.docx

This page left blank intentionally

ABBREVIATIONS AND ACRONYMS

EPDM	Ethylene Propylene Diene Monomer
FKC	Friant-Kern Canal
FWA	Friant Water Authority
Harder	Thomas Harder & Company
HEC-RAS	Hydrologic Engineering Center River Analysis System
MP	Milepost
NAVD 88	North American Vertical Datum of 1988
PVC	Polyvinyl Chloride
RM	River Mile
TM	Technical Memorandum
TO	Turnout
WSEL	Water Surface Elevation

This page left blank intentionally

1.0 DESIGNING FOR FUTURE SUBSIDENCE

Stantec retained Thomas Harder & Company (Harder) to conduct a hydrogeological analysis of potential future subsidence specifically focused along the FKC using a calibrated numerical groundwater flow model of the Tule Subbasin and surrounding area. The results of the analysis are presented in a report titled *Analysis of Potential Subsidence Along the Friant-Kern Canal Using a Groundwater Flow Model* by Thomas Harder, 25-Sep-2018. This report is attached as **Appendix A**.

The following sections present a description of this technical issue as it relates to selecting potential future subsidence conditions for use as design criteria, conclusions reached, and supported reasons and considerations in reaching the conclusions.

2.0 DESCRIPTION OF TECHNICAL ISSUE

This technical memorandum (TM) addresses the selection of potential future subsidence conditions to be used in the evaluation and design of project alternatives. In order to provide adequate flow capacity into the future, the performance of alternative designs must be evaluated relative to potential future conditions after additional subsidence has occurred. Subsidence projection studies were developed using the Tule Subbasin Groundwater Model under four potential groundwater pumping and hydrologic scenarios. Results for each scenario are provided by decade (2030 – 2070), providing a total of 20 potential subsidence profiles in the project area. Because it is not feasible to evaluate each design alternative over such a large number of subsidence projections, it is necessary to define a small number of potential future subsidence conditions that represent a reasonable range of future outcomes. To achieve this, results of subsidence scenarios have been reviewed and grouped into a small number of potential future subsidence conditions that will be used in design development and evaluation.

3.0 RECOMMENDATIONS

Possible future subsidence along the canal alignment can be represented using four potential ground profiles, which show estimated subsidence resulting from the follow conditions:

- Condition 1 – Minimal near-term subsidence
- Condition 2 – Moderate mid-term subsidence
- Condition 3 – Severe mid-term subsidence
- Condition 4 – Severe long-term subsidence.

Recommendations for the use of these future conditions to evaluate design alternatives are as follows:

- Condition 1 (minimal near-term) represents the minimum subsidence condition. Because it does not differ enough from present conditions, Condition 1 should not be used for an additional specific analysis and comparison of alternatives; evaluation of the present conditions is sufficient to represent near-term conditions.
- Condition 4 (severe long-term) should be used as a worst-case condition to analyze and evaluate design alternatives.
- Conditions 2 and 3 (mid-term possibilities) could be used separately or could be combined to create a single mid-term average condition. In either case, mid-term conditions would allow further evaluation and comparison of design alternatives. Whether and how to use these projections of mid-term subsidence may depend on project funding or other variables that are not yet defined.
- Stantec recommends proceeding with alternative analysis using a severe mid-term subsidence condition that is a combination of Conditions 2 and 3. As described below, this subsidence projection is called *Group 3* and results in an 8-ft maximum subsidence point in the most affected area of the canal profile.

3.1 SUPPORTING REASONS

Potential future subsidence along Friant-Kern Canal has been predicted using model analysis. (Reference **Appendix A**: Technical Memorandum on *Analysis of Potential Subsidence Along the Friant-Kern Canal Using a Groundwater Flow Model, by Thomas Harder, 25-September-18*). Analysis considered four possible scenarios that include timing and magnitude of future groundwater pumping and various hydrologic conditions, as follows:

- **Scenario 1** - assumes that current rates of groundwater pumping in the Tule Subbasin will be reduced to sustainable levels (as determined from the sustainable yield of the subbasin) by the year 2025 (5-yr ramp down). This scenario incorporates an average hydrology, based on the historical period from 1986 to 2017, for the entire 50-yr future simulation.
- **Scenario 2** - assumes that current rates of groundwater pumping in the Tule Subbasin will be reduced to sustainable levels by 2040 on a gradual basis (20-yr ramp down). This scenario incorporates an average hydrology, based on the historical period from 1986 to 2017, for the entire 50-yr future simulation.
- **Scenario 3** - assumes that current rates of groundwater pumping in the Tule Subbasin will continue until 2030 before being reduced to sustainable levels by 2040 (10-yr ramp downs starting in 2030). This scenario assumes the following hydrology:
    - The hydrology for first 18 years of the planning horizon (2020 to 2038) is the average of the historical period from 1998/99 to 2015/16, which represents below average precipitation conditions

- The hydrology for years 2038 to 2050 of the planning horizon is the average of the historical period from 1986/87 to 1997/98, which represents above-average precipitation conditions;
- The hydrology for years 2050 to 2070 of the planning horizon is the average of the historical period from 1986/87 to 2016/17, which represents the long-term average.

- **Scenario 4** - assumes that current rates of groundwater pumping in the Tule Subbasin will be reduced to sustainable levels by 2030 (10-yr ramp down). This scenario applies the same hydrology described under Scenario 3.

The Harder study yielded different patterns and magnitudes of subsidence over the time period from 2030 to 2070. Fifteen different future land surface elevation maps were produced, resulting in 15 potential future canal invert profiles. Sometimes several of these profiles were quite similar, even though each was caused by a different combination of hydrology and groundwater pumping. A group of these similar profiles could then be averaged to produce a single profile assumption that is representative of several possible future conditions.

In order to compare alternative designs using a manageable number of design conditions, it makes sense to use just a few representative subsided canal profiles. Results from multiple subsidence scenarios that all produce a similar future ground profile can yield a single design condition.

Results of modeled scenarios have been grouped as shown in **Figure 1** and the subsequent subsidence profiles for each group are shown in **Figure 2**.

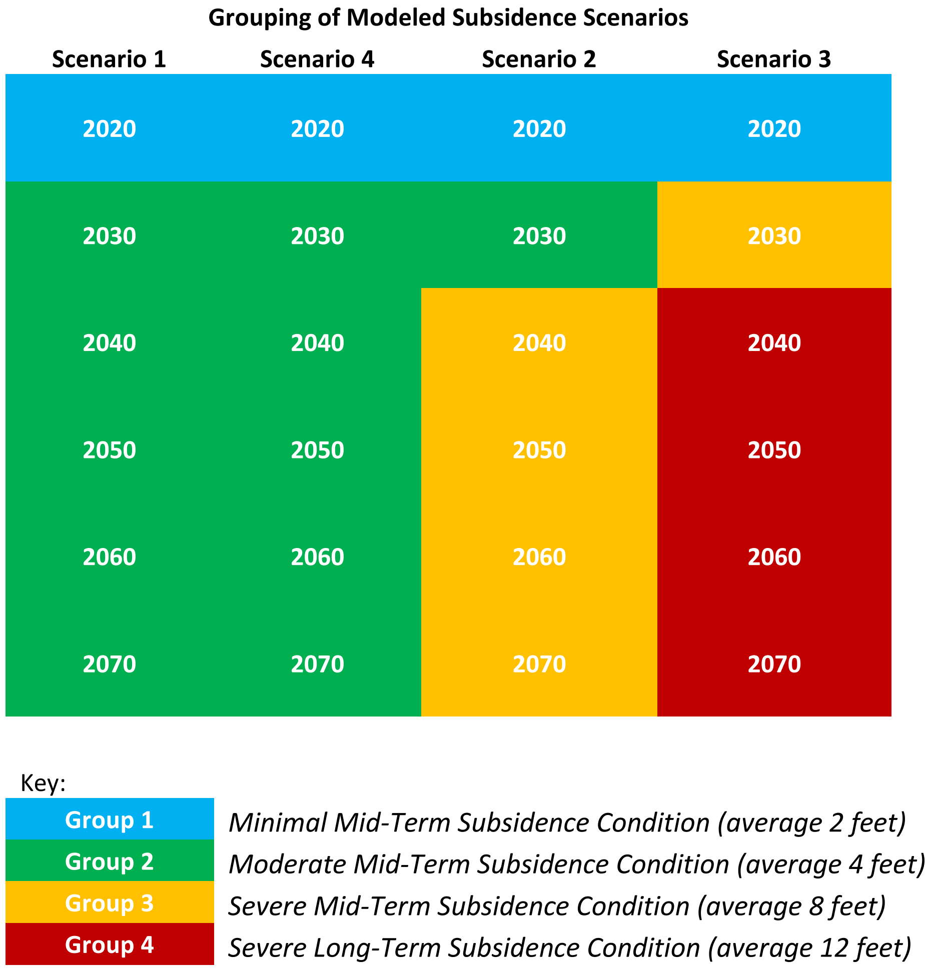


Figure 1. Future Groundwater Subsidence Conditions used for Project Design

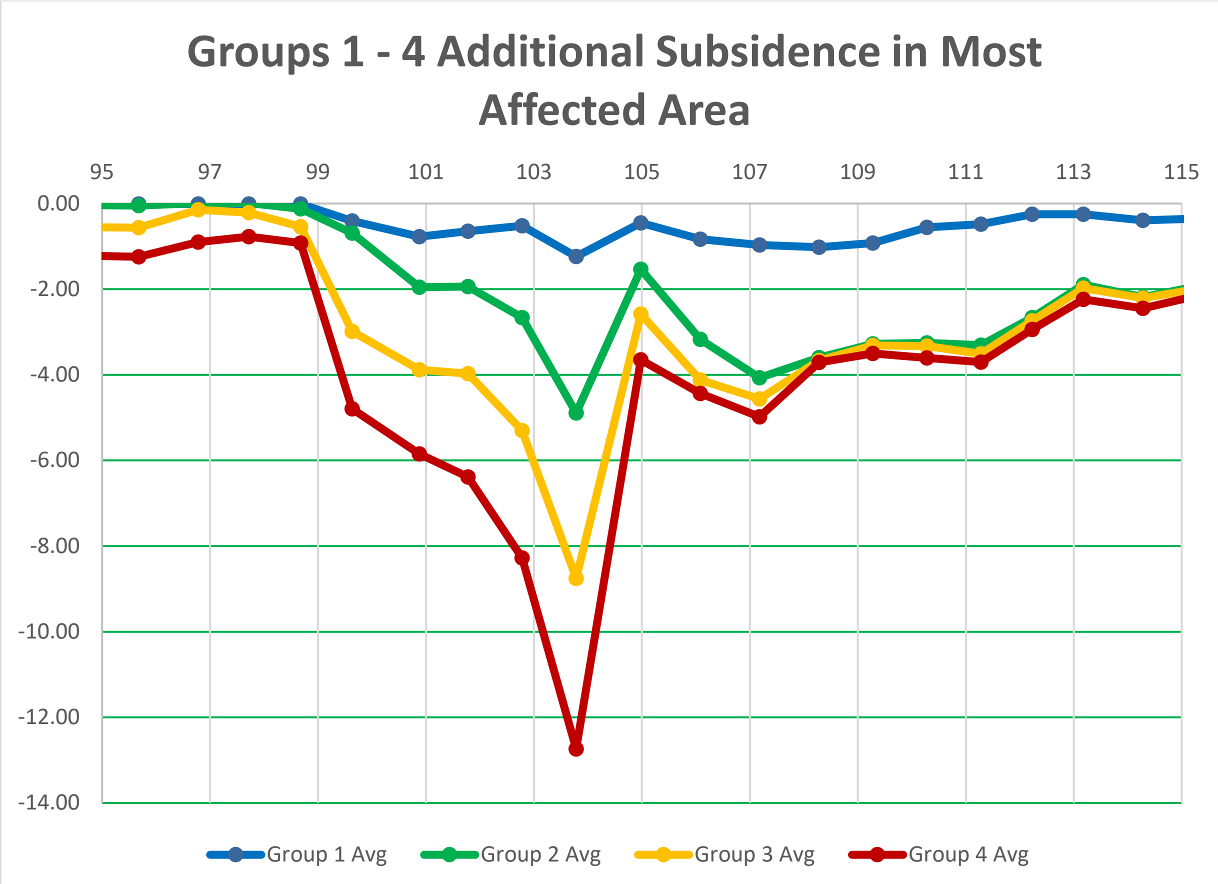


Figure 2. Future Subsidence Profiles

3.2 ADDITIONAL CONSIDERATIONS AND CONCLUSIONS

- Neither future groundwater pumping nor future hydrology can be predicted with certainty. Therefore, it is impossible to quantify exactly how and when subsidence will occur.
- It is more informative to frame and analyze subsidence possibilities without tying these possibilities to exact conditions that cause them or to dates when they will occur.
- Scenario 1 represents a minimal subsidence conditions. It is considered to be an overly optimistic prediction of reductions to groundwater pumping.
- For the purpose of evaluating design alternatives, four representative subsidence conditions can be framed:
    - Minimal Mid-term Subsidence Condition
    - Moderate Mid-term Subsidence Condition
    - Severe Mid-term subsidence Condition
    - Severe Long-term Subsidence Condition

- A minimal mid-term subsidence condition may occur in the next few years, and therefore may exist by the time the current correction project is constructed; a design based on this condition would not provide adequate protection against future subsidence.

- A moderate mid-term subsidence condition can result from either a slower rate of groundwater pumping over a longer period of time or a greater rate of groundwater pumping over a shorter time, resulting from dry hydrologic conditions. This condition would produce a mid-term design solution with a probable life-span of about ***10-20 years*** (2030-2040).

- A severe mid-term subsidence condition can result from a greater rate of groundwater pumping over a longer period of time under dry hydrologic conditions. This condition would produce a mid-term design solution, with a probable life-span of between ***20 and 40 years*** (2040-2060).

- A severe long-term subsidence condition would result from greater groundwater pumping, which could occur either at a fast rate for an intermediate time period or a moderate rate over a long time. This severe condition would produce a long-term design solution, with a probable life-span of between ***30 and 50 years*** (2050-2070).

- Scenario 1 provides a bookend to show the minimum subsidence condition. Eliminating the results from Scenario 1 assumptions allows results from Scenarios 2, 3 and 4 to be combined into three representative future subsidence conditions:
    - Group 2 – A Moderate Mid-term profile that represents Scenario 4 in the years 2030-2070 and Scenario 2 in the year 2030.
    - Group 3 – A Severe Mid-term profile that represents Scenario 2 in the years 2040-2070 and Scenario 3B in the year 2030.
    - Group 4 – A Severe Long-term profile that represents Scenario 3 in the years 2040-2070.

- Stantec recommends proceeding with alternative analysis using Group 3 subsidence projections that result in an 8-ft maximum subsidence point in the most affected area of the canal profile.

- This study of potential future subsidence conditions does not include evaluation of cost impacts, and recommendations are not based on cost comparisons.

- Conclusions and recommendations in this memorandum are intended to provide information to be used in subsequent analysis and comparison of design alternatives. Design criteria used in the development of these alternatives include embankment and lining heights based on subsidence projections. These details, along with technical and economic evaluation of design alternatives, are documented in the Plan Formulation Basis of Design Report.

- After producing the September 2018 report with subsidence predictions (see **Appendix A**), Thomas Harder has continued to calibrate and refine his model of subsidence in the Tule Basin. Recent simulations with a recalibrated model have produced results that support similar qualitative findings and groupings as presented in this Stantec TM. Due to ongoing refinements in calibration, future studies are likely to produce minor variations to subsidence predictions.