Appendix E

Kern Fan Banking Programs

Introduction

The Berrenda Mesa Spreading Grounds, Kern Water Bank, Pioneer Project, and West Kern Water District North Recharge and Recovery Project (Projects), located on the Kern River Alluvial Fan southwest of Bakersfield, have been operating under defined criteria to establish formal water banks for several decades (Figure 1). These Projects have been developed to help secure more reliable water supplies due to California's wet- and dry-year cycles. The Projects involve storing surface water in wet years for recovery in dry years for beneficial uses. The Projects comply with the SMCs developed in Sections 11-13 of this GSP.

Description of the Projects

These direct recharge[1] Projects all utilize the Kern River Alluvial Fan aquifer (Kern Fan) to temporarily store surface water underground for later recovery on behalf of specific project beneficiaries (participants)[2] for municipal and industrial (M&I) and agricultural beneficial uses.[3] These Projects are critical to the Kern County Subbasin's sustainability efforts – fully 73 percent by area of the Subbasin's water districts participate in one or more of these Projects. The Projects store participants available surface water from the State Water Project, the Kern River, and the Central Valley Project during wet years, and then recover the stored water in dry years to supplement the participants' beneficial needs. The Projects do not store water for entities that are outside the Kern, White Wolf, or Tulare Lake Subbasins. Instead, most of the recovered water is used within these Subbasins in the southern San Joaquin Valley, thereby reducing the participants' reliance on Subbasin groundwater. In addition, there are no domestic or other third-party beneficial groundwater users overlying the lands of any of the Projects, nor is irrigated farming conducted on any of the lands.[4]

Project Facilities

The Projects occupy approximately 24,000 acres southwest of Bakersfield. With the exception of minor oil production, the lands are used exclusively for water banking. Recharge basins are developed on approximately 10,500 acres of the lands, and stored water is recovered with 149 recovery wells (Figure 1). All of the recovery wells are metered.

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[1] See Section 5.52 for a description of water banking and the direct recharge process.

[2] The participants in one or more of the Projects include Belridge WSD, Berrenda Mesa WD, Buena Vista WSD, Dudley Ridge WD in the Tulare Lake Subbasin, Henry Miller WD, Improvement District 4, Kern Delta WSD, Lost Hills WD, Rosedale-Rio Bravo WSD, Semitropic WSD, Tejon-Castac WD in the White Wolf Subbasin, Westside Mutual Water Company, and Wheeler Ridge – Maricopa WSD in the Kern and White Wolf Subbasins.

[3] The M&I participants include Improvement District 4 which provides water to the City of Bakersfield and West Kern Water District which provides water to the disadvantaged community of Taft and other severely disadvantaged communities in the western portion of the Subbasin.

[4] Some of the lands are periodically grazed to control vegetation.

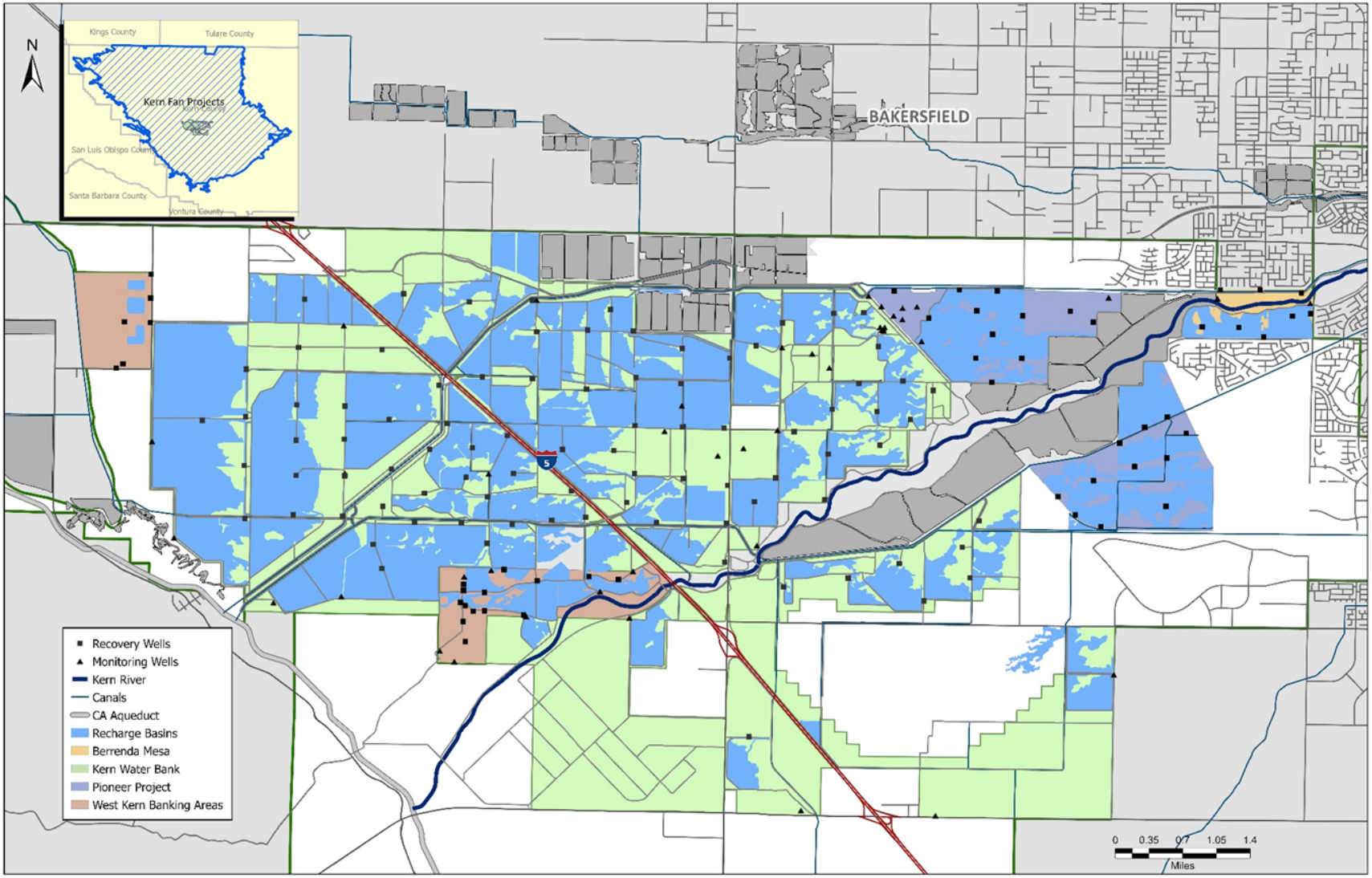

Figure 1. Kern Fan Projects' locations and facilities.

Project Monitoring

The Kern Fan area has been monitored extensively since the early 1990's when the California Department of Resources (DWR) installed a series of dedicated clustered monitoring wells throughout the area and an extensometer located in the center of the Kern Water Bank to evaluate the aquifer for water banking. The wells are used to monitor both water levels and groundwater quality. The extensometer, surveys of critical infrastructure, and remote sensing tools are used to track subsidence.

Groundwater levels are monitored monthly in 85 clustered monitoring wells at 31 locations (Figure 1). The wells are completed at various depth intervals so that piezometric information is available vertically within the aquifer. Groundwater quality is determined in both dedicated monitoring wells (49 wells at 18 locations) and all wells used to recover stored surface water. The monitoring well data is compiled and provided in operations reports available to Subbasin stakeholders and the public that include hydrographs, groundwater depth and elevation maps, and water quality graphs.[5] These reports also provide an accounting of all surface water stored and recovered both monthly and annually since project inception. The recovery well water quality data is provided to DWR and aqueduct stakeholders located downstream of the Projects (see below).

Project Operations

Storage – Project storage operations are directed by each of the Projects. Coordination between the Projects and surrounding agencies provides for water management benefits such as exchanges. The maximum annual volume of water recharged in any calendar year for the Projects is approximately 900 thousand acre-feet (TAF). An estimate of the upper limit of the Projects' storage capacity is approximately 3.0 million acre-feet MAF.[6]

Recovery – Recovered water is conveyed to the California Aqueduct and Cross Valley Canal (CVC) for direct delivery, exchange and/or reregulation to accomplish deliveries to participants in the Subbasins. Prior to initial recovery operations, and at three-year intervals, Pump-in Proposals are submitted to DWR and stakeholders downstream in the California Aqueduct. Once the proposals are approved, recovery operations are coordinated through the Kern County Water Agency (KCWA) and DWR. During recovery programs, Kern County submits a blending model daily to DWR and the stakeholders that documents the expected quality of water delivered to Improvement District 4 via the CVC and to the California Aqueduct at the CVC and Kern Water Bank Canal turnouts. Status meetings are scheduled between the parties as needed. West Kern Water District also recovers water to meet the demands of its M&I customers in the Disadvantaged Communities (DACs) it serves in western Kern County. The

[5] The latest Operations Report is available here: Footnote 5 – Kern Fan Operations Report
[6] This value is not fixed, but rather represents an estimate of the maximum amount of water that may accumulate given historic wet year-dry year storage and recovery cycles.

maximum annual volume of water recovered historically in any given year is just under 400 TAF. However, these rates decline significantly during extended droughts. For example, in 2015, the total volume of water recovered dropped 40 percent, to 240 TAF. Annual storage rates greatly exceed recovery rates, and each of the Projects can only recover previously stored surface water less losses and overdraft correction (ODC) volumes. Because each of the Projects can only recover previously stored surface water, by definition, each of the projects are net rechargers.

Losses and Overdraft Correction – The Projects all deduct 6 percent of all water metered onto the Projects to account for surface losses. In addition, adjoining districts can purchase 4 percent of the water stored for ODC purposes. Finally, certain districts can store water for ODC purposes in the Pioneer Project. Neither the 4 percent water nor the Pioneer ODC accounts are recovered by the Projects. Rather, this water is recovered within the adjoining districts for beneficial consumptive uses. The cumulative total of the 4 percent and ODC accounts through 2023 is approximately 628 TAF.

Accounting Methods and Current Account Status

The water delivered to the Projects and recovered from the Projects is measured with ultrasonic meters, propellor meters, rated gates, and weir structures. The volumes for the four Projects are reconciled with multiple public agencies, including DWR, the Kern County Water Agency (KCWA), Kern Water Bank, the City of Bakersfield, and Buena Vista WSD. Account records are maintained by KCWA for the Berrenda Mesa, Kern Water Bank, and Pioneer projects. West Kern Water District maintains their own records and provides that information to the Kern Fan Monitoring Committee (see below) for reporting purposes. Project records are also audited annually by independent auditing firms for the participants. The approximate volume of water stored in the projects at the end of 2023 exceeds 1.7 MAF. This volume does not include approximately 628 TAF of water provided for ODC purposes (Figure 2).

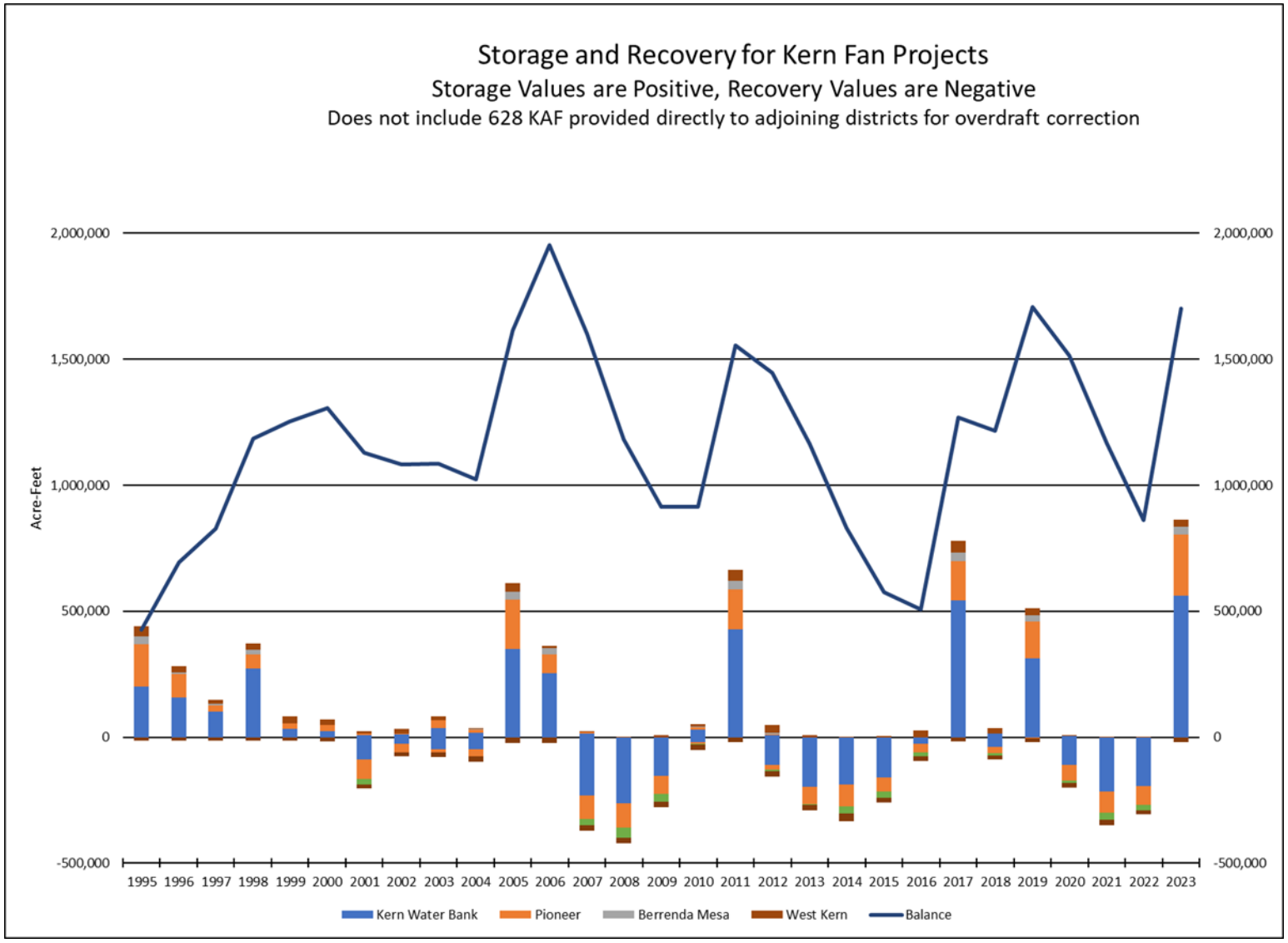

Figure 2. Operational history for the Projects. The stored water balance for the Projects has not been below a positive 500 TAF since 1995. The balance at the end of 2023 is 1.7 MAF.

Mitigation Measures

There are several documents that prescribe mitigation measures for the Projects. They include Memorandums of Understanding (MOUs), CEQA documents (including mitigation and monitoring plans), and a Joint Operations Plan.

The MOUs provide for the establishment of the Kern Fan Monitoring Committee with banking participants and adjoining stakeholders, reports documenting operations and monitoring, mitigation measures for potential water level and quality impacts, and the establishment of loss factors and ODC percentages.[7]

The mitigation measures developed in several CEQA documents reduce potential impacts to less-than-significant for operations, water quality, and subsidence, among others.[8] For example, the mitigation measures for the KWB include a Long-Term Operations Plan that mitigates potential impacts to domestic and irrigation wells in lands adjacent to the KWB.[9] Since 2017, the Pioneer and KWB recovery operations have been subject to the mitigation measures contained in the Joint Operations Plan described below (see P/MA KWBA-3 and RRB-12 in Section 14).

The Joint Operations Plan implements a well mitigation program for beneficial users.[10] It establishes a Joint Operations Committee (JOC) composed of representatives of multiple banking programs on the Kern Fan, establishes funding policies for mitigating short term/temporary water level impacts related to cumulative banking operations, and provides for public outreach. Potential short term/temporary water level impacts are analyzed with two MODFLOW models to determine “with” and “without” project groundwater levels. Mitigation is triggered when the “with” project levels are deeper than the “without” project levels by 15 feet for domestic and state small water system wells and 45 feet for agricultural wells.[11] Mitigation includes short-term water supplies and funds to lower a well pump, connect to an M&I provider, or replace the well with a deeper well. Since 2010, the JOC has assisted in funding 23 well replacements, 19 pump lowerings, and 6 connections to an M&I provider. Notably, the funds necessary to mitigate impacts since 2018 have been less than $6,000. This suggests that the relatively shallow domestic wells in the vicinity of the Projects that might be affected by banking operations during a drought cycle have for the most part already been mitigated (e.g., deepened) and are much less likely to need mitigation during future drought cycles. However, the Projects are committed to funding and implementing the Subbasin-wide well mitigation plan described in this GSP.

[7] The various MOUs to the Projects are available here: Footnote 7 – Project MOUs
[8] Pertinent CEQA documents for the Projects are available here: Footnote 8 – CEQA Documents
[9] The Long-Term Operations Plan is available here: Footnote 9 – Long-Term Operations Plan
[10] The Joint Operations Plan is available here: Footnote 10 – Joint Operations Plan
[11] Note that groundwater levels vary by 150 feet or more from other uses in these areas.

Sustainability Indicators

Chronic Lowering of Groundwater Levels and Reduction in Groundwater Storage - The Projects cannot cause a chronic lowering of groundwater levels or a reduction in groundwater storage because operating rules require that they only recover previously stored surface water from the aquifer after appropriate losses have been applied. If these supplies are exhausted, recovery operations will cease.[12] Importantly, the recovery of stored water in the projects provides much needed water supplies in times of drought to reduce pumping from overdrafted aquifers elsewhere in the Subbasin. The supplies also help Improvement District 4 and West Kern Water District meet their M&I needs for DACs. Nonetheless, the Projects utilize the SMC methodology developed by the Subbasin for these sustainability indicators (see Section 13.1 and 13.2 of the GSP).

Figure 3 shows a typical hydrograph reflecting historic Project operations. Before the start of most banking operations in 1995, groundwater was about 170 feet deep at this location. Since that time, there have been six wet cycles where significant volumes of water were stored (1995-1998, 2005-2006, 2011, 2017, 2019, and 2023) and five dry cycles where stored water was recovered. Each of the wet cycles resulted in water levels rising above that initial depth of 170 feet to near surface levels, demonstrating that through 30 years of operations there has never been a chronic lowering of water levels.

In fact, and contrary to a chronic lowering of groundwater levels, water levels on the Projects have been shallower for 22 of the 30 years the Projects have operated (Figure 3). With respect to groundwater levels in lands adjacent to the Projects, they have been higher for 23 of the 30 years the Projects have operated (Figures 4 and 5).

Project operations can cause a temporary lowering of groundwater levels in adjacent areas toward the end of extended drought cycles (Figure 5). However, as described above, the Projects have developed a well mitigation program that addresses any such impacts caused by those temporary conditions.

[12] If project supplies are exhausted, West Kern would rely on other banked surface water supplies to meet M&I demands for numerous DACs and SDACs in its service area. As such, the project will not contribute to Subbasin overdraft.

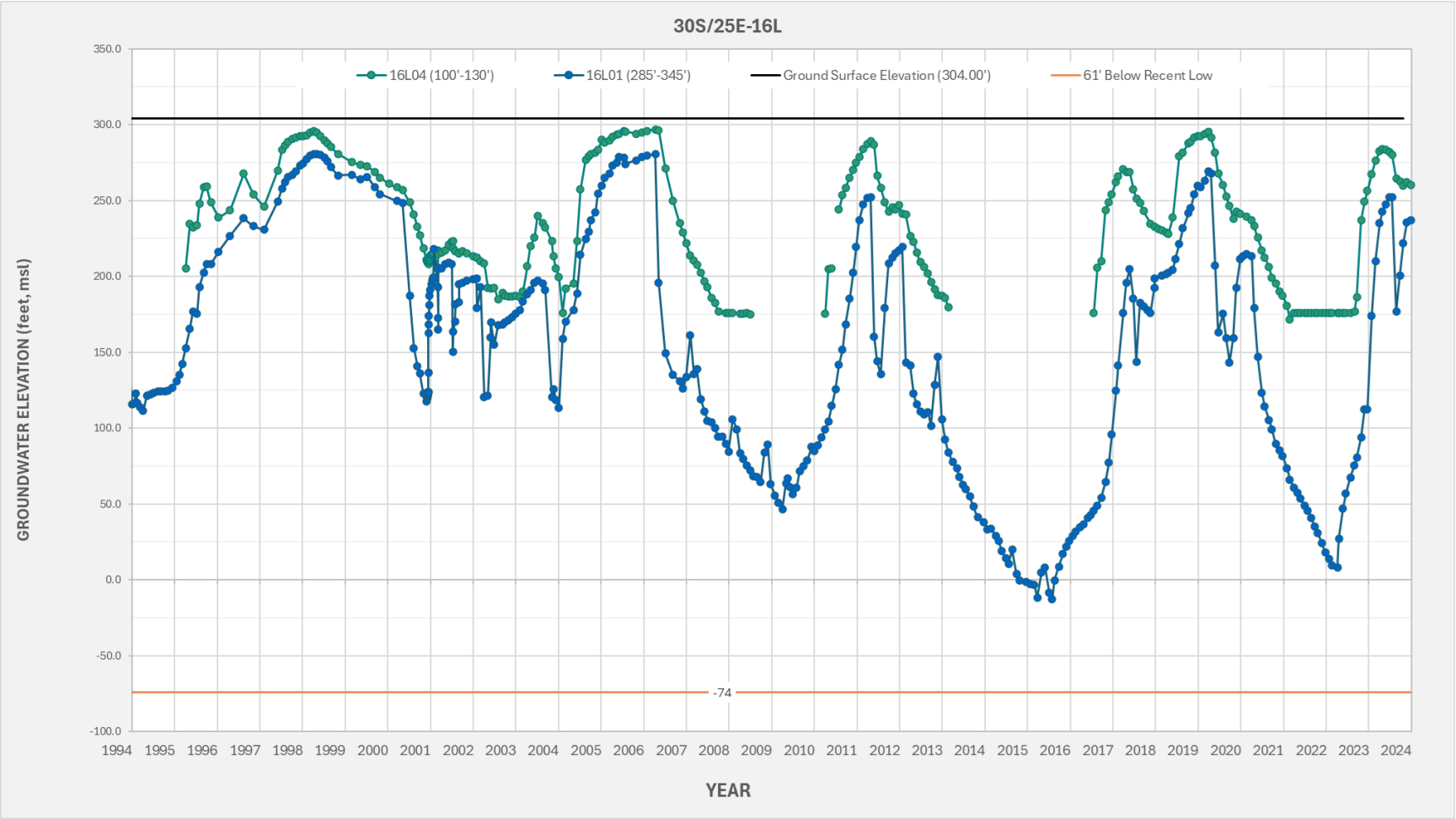

Figure 3. Hydrograph for well 30S/25E-16L. Water levels return to near surface during wet years, 170 feet above pre-project levels. Water levels are above the pre-project condition for 22 of 30 years of operations. A chronic lowering of water levels has not occurred. The MT at this location has been capped at 61 feet below the recent low (-74 msl).

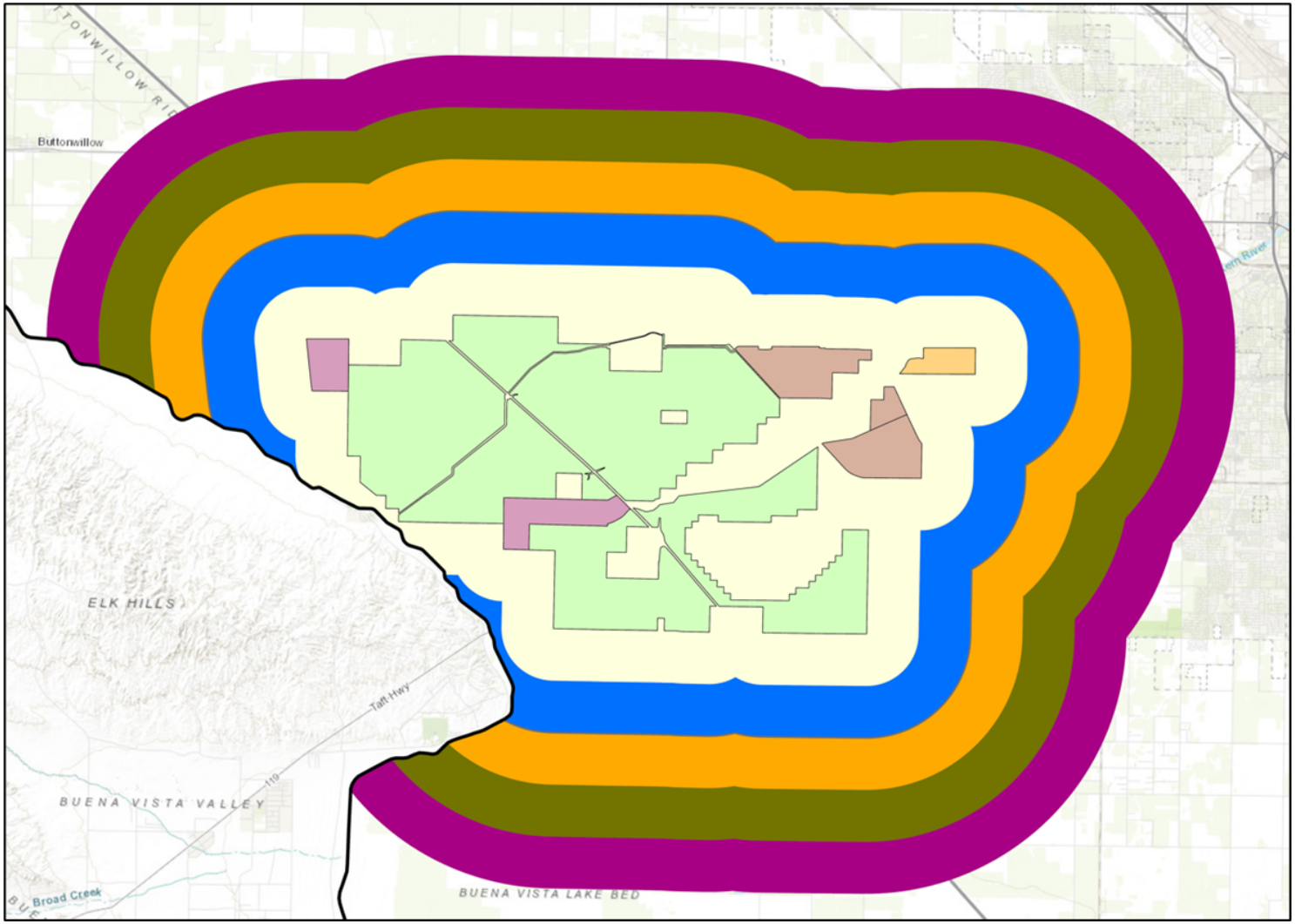

Figure 4. DWR modeled groundwater levels with KWB operations and without KWB operations through time in 1-mile-wide zones adjacent to the KWB (DWR, 2016). The same modelers and model was used to extended the analysis through 2023 and to include the four Projects. The five zones are shown in this figure. The results of the analysis are shown on Figure 5.

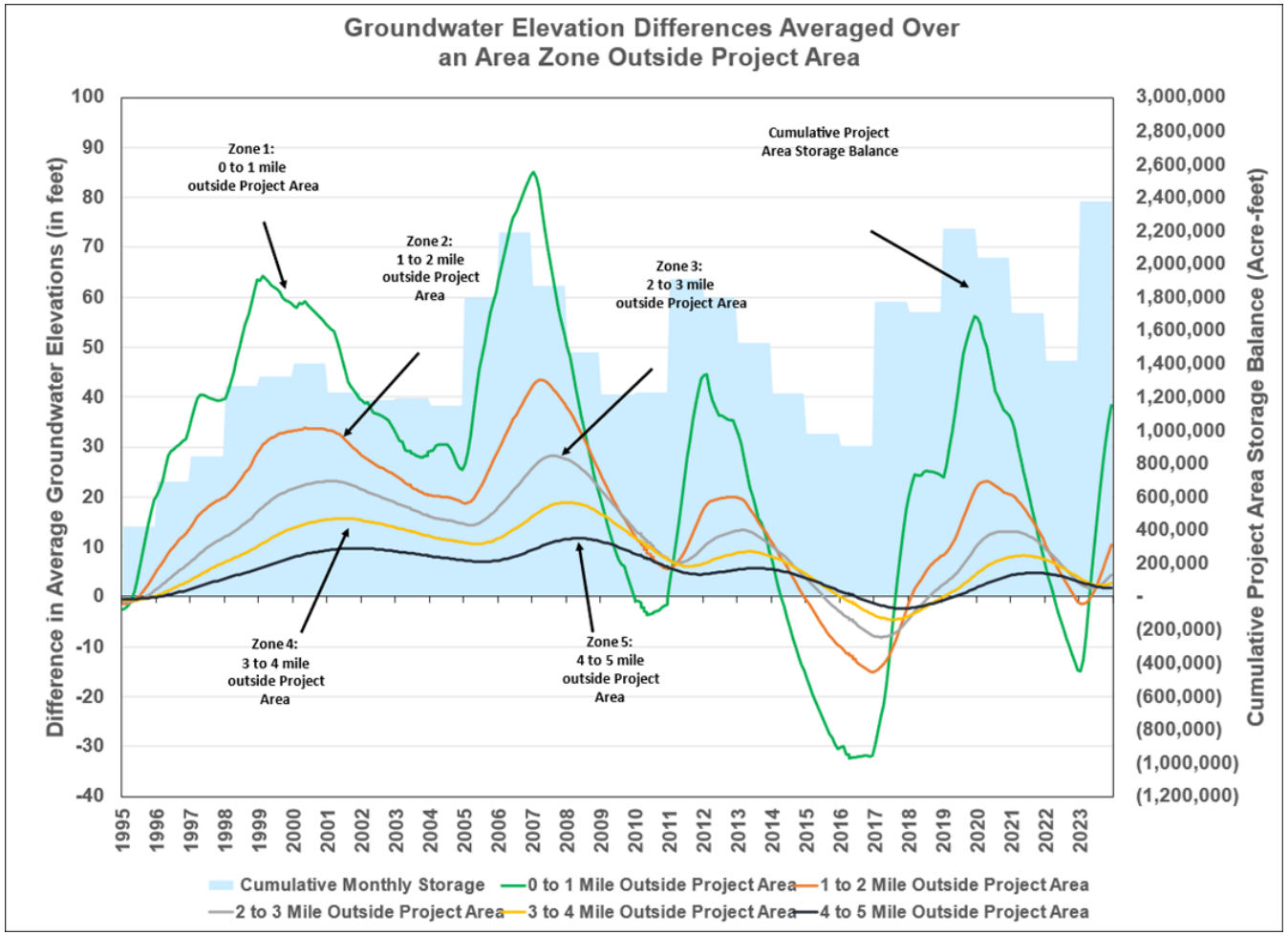

Figure 5. A summary of the influence of the Projects on adjoining areas. The curves show the changes in water levels in five 1-mile-wide zones as a result of the Projects' operations. The adjoining areas benefit significantly for 24 of the 30 years the projects have been operating. Should the Projects impact wells on adjoining lands during extended droughts, the Projects' Well Mitigation program corrects those impacts. Note the Projects' balance on this figure includes all ODC amounts.

Water Quality Degradation - The Kern Fan Monitoring Committee discussed above samples and regularly reviews the monitoring well groundwater quality data and has not identified any groundwater quality degradation concerns.[5&7] Water quality sampling in the future will align with Subbasin sampling referenced in the Plan. The water recovered and delivered to the California Aqueduct by the Projects meets the water quality requirements provided for in the Pump-in Policy administered by DWR and, as such, surface water degradation does not occur.[13] In fact, Project recovery typically improves water quality in the Aqueduct for many constituents, including some with Maximum Contaminant Levels (MCLs).[14] The water recovered by West Kern Water District for M&I uses only requires slight chlorination to meet water quality standards under its drinking water system permit.

The quality of surface water delivered to the Projects is monitored, as is the water recovered by the Projects and delivered to the Aqueduct and CVC. An analysis of this data indicates the ratio of exported salt to imported salt is 1.7:1. That is, 1.7 tons of salts are removed from the aquifer for every ton of salts imported in delivered surface water.[15] At the same time, total dissolved solids (TDS) concentrations in the Aqueduct are typically reduced.[14]

The SMC for Water Quality Degradation is described in Section 13.3 of the GSP.

Subsidence – Historic Project operations during six significant storage cycles and four significant recovery cycles where water levels have fluctuated over 250 feet have not caused any appreciable subsidence. An extensometer, maintained by DWR and located on the KWB, records only minor annual subsidence and rebound indicating elastic conditions exist on the Kern Fan (Figure 6). In fact, cumulative changes show ground elevations have risen since the inception of the Projects. InSar data for the 2015-2019 period shows 0 to 0.25 feet of rebound in a portion of the Project lands also demonstrating the elastic nature of elevation changes in the Kern Fan area.

[13] The current Pump-in Policy is available here: Footnote 13 – DWR Pump-In Policy
[14] e.,g., See: *DWR, 2017, Water Quality Assessment of non-Project Turn-ins to the California Aqueduct, 2016, page 108.* Linked here: Footnote 14 – DWR Water Quality Assessment of Non-Project Turn-ins
[15] See: Kern Fan Operations Report, 2021, pages 213, 215, 216, and 222. (Linked in footnote 5.)

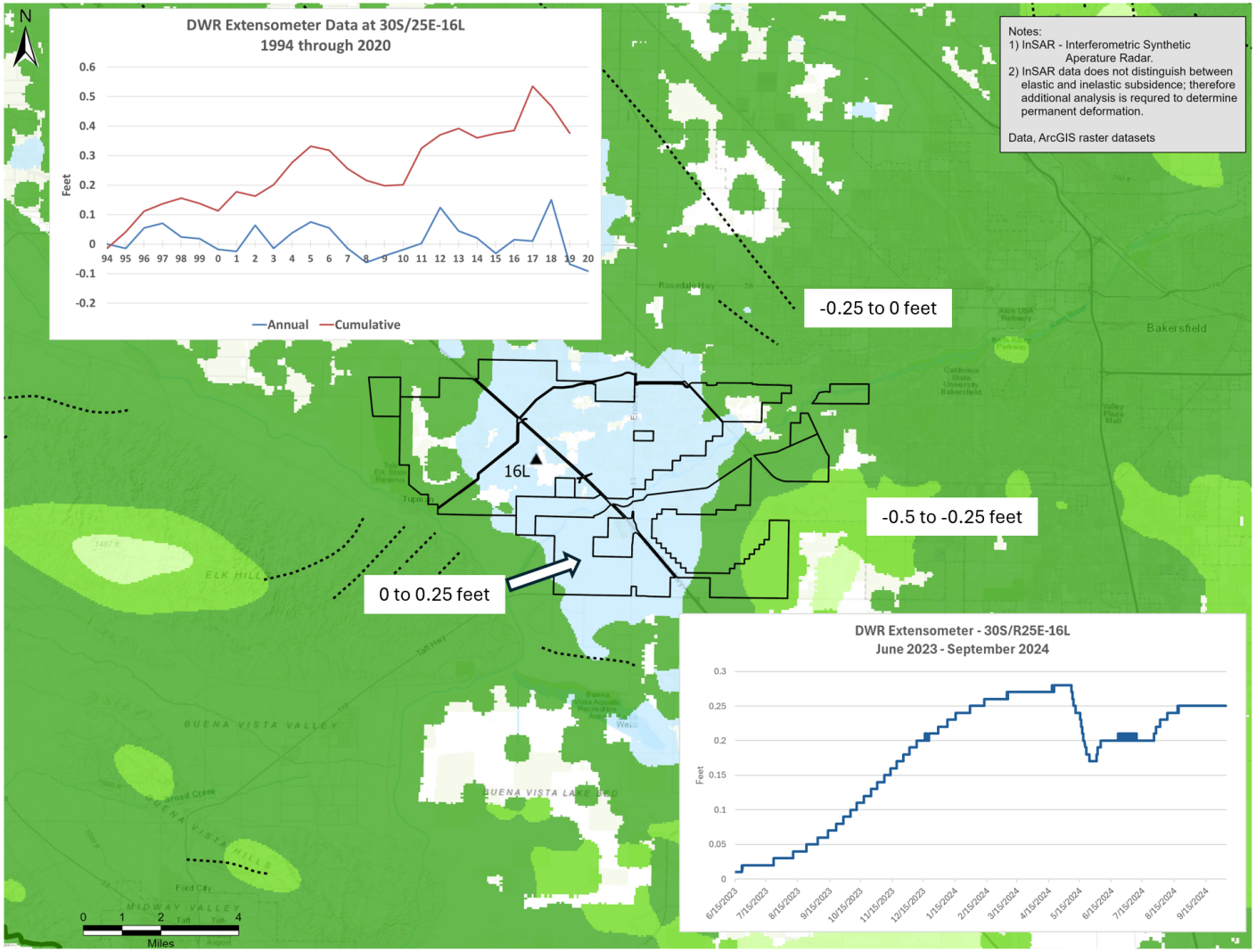

Figure 6. Subsidence monitoring data for the Kern Fan area. DWR Extensometer data indicates a cumulative rise of 0.4 feet in 2020 compared to the elevation in 1994. Recent data, after equipment refurbishment, also shows ground elevations rising. The background map is InSar data for the Kern Subbasin for the 2015-2019 period showing rebound in a portion of the Kern Fan area (from Figure 851 in Chapter 8 of the GSP).

The Kern Subbasin has determined the California Aqueduct is regional critical infrastructure. Short portions of Aqueduct pools 28 and 29 (*i.e.*, MP 236.5 to 239.5) are near the western end of some of the Projects. DWR data show that subsidence in this area over the last 48 years has been minimal.[16] Changes have ranged from 0.3 feet of uplift to 0.35 feet of subsidence and are indicative of elastic subsidence and rebound. Available Aqueduct freeboard for most of the area adjacent to the western portion of the Projects is essentially unchanged from as-built conditions (Figure 7). The Projects also coordinate with the operators of the CVC (Kern County Water Agency) and River Canal (City of Bakersfield) to monitor any impacts Project operations may cause to those facilities. None have been reported.

The SMC for Subsidence is described in Section 13.5 of the GSP.

Depletions of Interconnected Surface Water – With respect to interconnected surface-water depletions, the Kern River is a losing stream. Therefore, the Projects do not cause an impact related to this sustainability indicator. Figure 8 shows groundwater levels in a monitoring well adjacent to the Kern River from 1982 forward. During several extremely wet years where the average Kern River Index was 187 percent of average, groundwater levels were about 25 feet deep. During the ensuing dry years, groundwater levels dropped significantly to a depth of about 175 feet. Levels rebounded after a wet 1993 and then after the banking projects began storing water.[17]

The SMC for Depletions of Interconnected Surface Water is described in Section 13.6 of the GSP.

[16] *California Aqueduct Subsidence Study: Supplemental Report, Department of Water Resources, March 2019.* Linked here: Footnote 16 – California Aqueduct Subsidence Study

[17] Note that the ICONS ISW mapping shows “likely connected” conveyances in the vicinity of the Projects. These reflect the fact that the projects have raised water levels to near surface during recharge cycles (see Figure 3). They do not represent ISWs.

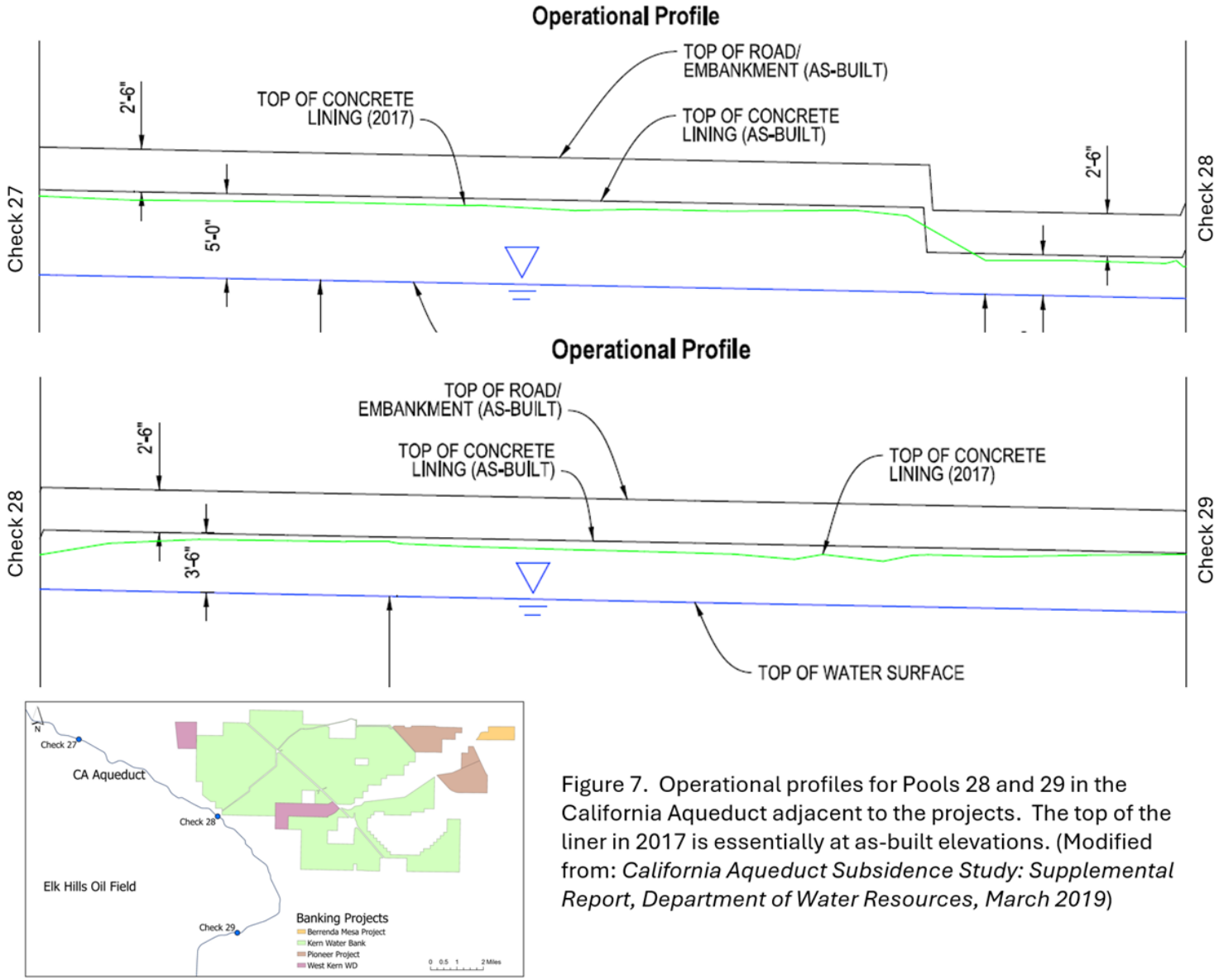

Figure 7. Operational profiles for Pools 28 and 29 in the California Aqueduct adjacent to the projects. The top of the liner in 2017 is essentially at as-built elevations. (Modified from: *California Aqueduct Subsidence Study: Supplemental Report, Department of Water Resources, March 2019*)

Figure 7. Operational profiles for Pools 28 and 29 in the California Aqueduct adjacent to the projects

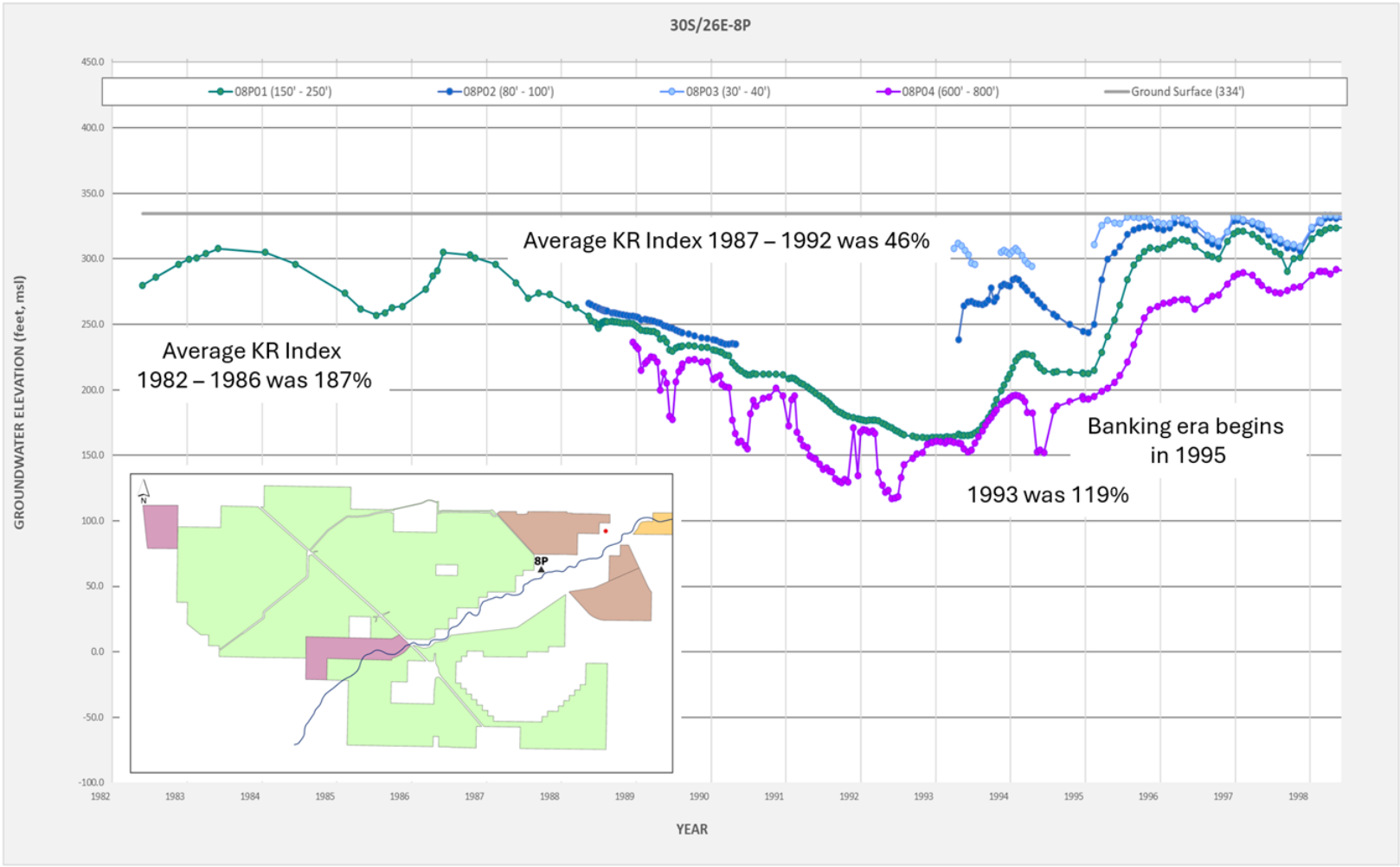

Figure 8. Hydrograph for monitoring well 30S/R26E-8P immediately adjacent to the Kern River. Inset map shows the four Projects. Groundwater levels have been below 25 feet even in the wettest years and below 50 feet for most years until surface water storage began in earnest in 1995. This indicates no interconnection between the Kern River and groundwater in the vicinity of the Projects.

Conclusions

With respect to water supplies and groundwater levels:

- The Projects have cumulatively stored 6 MAF of surface water in wet years and recovered 3.9 MAF of water for beneficial uses in the Kern, White Wolf, and Southern Tulare Lake Subbasins. These supplies raise overall Subbasin groundwater levels and contribute significantly to meeting sustainability goals.
- The Projects' storage of imported surface water raises groundwater levels in adjacent areas, except toward the end of extended droughts when there can be a temporary lowering of groundwater levels. Potential impacts from the temporary lowering of groundwater levels are not significant due to mitigation.

With respect to water quality:

- Extensive monitoring data reviewed by basin stakeholders has indicated no significant water quality issues.
- The Projects' deliveries to the CA Aqueduct meet pump-in guidelines and reduce Aqueduct background concentrations for many COCs.
- The Projects' storage and recovery results in a net removal of salts from the aquifer while reducing TDS in the CA Aqueduct.

With respect to subsidence and interconnected surface waters:

- No inelastic subsidence has occurred in the vicinity of the Projects – only minor subsidence and rebound.
- There are no interconnected surface waters in the vicinity of the Projects

The Projects have provided significant benefits to the Kern, White Wolf, and Tulare Lake Subbasins without contributing to undesirable results. The Draft Staff Report noted that: "Groundwater banking projects are an essential recharge component for groundwater sustainability in the Kern County Subbasin…" (July 2024 Draft Staff Report, page 57). The report also recognized that: "Surface water that is recharged or stored directly may continue to be extracted without being subject to reporting and fees." (ibid, page 58)