Joint Los Angeles Basin Replenishment and Extraction Master Plan

Final Report

August 2022

Water Replenishment District of Southern California and Los Angeles Department of Water and Power

in association with INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

in association with

Project No:	W9Y23900
Document Title:	Final Report
Document No.:	PPS0522201428LAC
Revision:	Final
Date:	August 2, 2022
Client Name:	Water Replenishment District of Southern California
Project Manager:	Vamsi Seeta, Jacobs

Jacobs Engineering Group Inc.

1000 Wilshire Boulevard, Suite 1140
Los Angeles, California 90017-2457
United States
T +1.213.538.1388
F +1.213.538.1399
www.jacobs.com

Contents

Appendixes

Tables

Figures

Acronyms and Abbreviations

AACE	Association for the Advancement of Cost Engineering
AF	acre-feet
AFY	acre-feet per year
ANSI/HI	American National Standards Institute/Hydraulic Institute
APA	Allowed Pumping Allocation
ARC	Albert Robles Center for Water Recycling and Environmental Learning
AWT	advanced water treatment
AWTF	Advanced Water Treatment Facility
AWTP	Advanced Water Treatment Plant
Basins	Central and West Coast Basins
bgs	below ground surface
CB	Central Basin
CBMWD	Central Basin Municipal Water District
cfs	cubic foot (feet) per second
City	City of Los Angeles
CPES	Conceptual and Parametric Engineering System (CPES)
DAF	dissolved air flotation
EPS	effluent pump station
ft	feet
GAMA	Groundwater Ambient Monitoring and Assessment
GDAP	Groundwater Development and Augmentation Plan
GPM	gallons per minute
HDPE	high-density polyethylene
Joint Master Plan	Joint Los Angeles Basin Replenishment and Extraction Master Plan
Joint Master Plan team	WRD, LADWP, and Jacobs
LACSD	Sanitation Districts of Los Angeles County
LACPGM	Los Angeles Coastal Plain Groundwater Model
LADWP	Los Angeles Department of Water and Power
LB	Long Beach
LBWD	Long Beach Water Department
LBWRP	Long Beach Water Reclamation Plant
LCWRP	Los Coyotes Water Reclamation Plant
LVL	Leo J. Vander Lans Advanced Water Treatment Facility
MAR	managed aquifer recharge
Metropolitan	Metropolitan Water District of Southern California
MF	microfiltration
MG	million gallons
MGD	million gallons per day

MPH	Material Physical Harm
Operation NEXT	Operation NEXT Water Supply Program
RBWRP	Regional Brackish Water Reclamation Program
RO	reverse osmosis
RRWP	Regional Recycled Water Project
SJC	San Jose Creek
SWRCB	State Water Resources Control Board
TM	Technical Memorandum
USGS	U.S. Geological Survey
UVAOP	ultraviolet advanced oxidation process
WB, WCB	West Coast Basin
WBMWD	West Basin Municipal Water District
WCB Barrier	West Coast Basin Barrier
WN	Whittier Narrows
WRD	Water Replenishment District of Southern California
WRP	Water Reclamation Plant
WSP	welded steel pipe

Executive Summary

1. Introduction/Background

The Water Replenishment District of Southern California (WRD) and the Los Angeles Department of Water and Power (LADWP) have initiated a partnership to identify solutions to maximize use of the Central and West Coast groundwater basins (Basins) through development of this Joint Los Angeles Basin Replenishment and Extraction Master Plan (Joint Master Plan). LADWP is developing the Operation NEXT Water Supply Program (Operation NEXT) that will create a significant amount of new local water supply by maximizing the use of recycled water purified from the City of Los Angeles' Hyperion Water Reclamation Plant (WRP). Groundwater recharge with Hyperion WRP advanced treated recycled water in the Basins managed by WRD provides an opportunity to enhance water supply sustainability for the Los Angeles region by more fully utilizing the available storage capacities and water rights in the Basins. This Joint Master Plan represents the initiation of the highly coordinated and collaborative effort required to identify optimum locations for replenishment and extraction of this recharge water, which is necessary to align LADWP's Operation NEXT goals with WRD's mission to "provide, protect and preserve safe and sustainable groundwater" through innovative, cost-effective, and environmentally sensitive basin management practices.

This Joint Master Plan builds on the broader, regional assessment of the groundwater storage in "available dewatered space" that was enabled by the 2013 and 2014 Judgment Amendments for the Basins (Superior Court of California 2013 and 2014). The potential for full utilization of these Basins was previously evaluated in the Groundwater Basins Master Plan (WRD 2016a) and its associated Environmental Impact Report (WRD 2016b). This Joint Master Plan further advances the examination of the use of the Basins for recharge and storage of local recycled water.

This Joint Master Plan Report consists of this Executive Summary and appendices containing eleven technical memoranda (TMs) that documented the findings of this planning effort. The numbering system for the TMs is tied to the respective task and subtask numbers of the corresponding Work Breakdown Structure for this study. There were no TMs associated with Task 5-Project Management, nor for Task 4-Additional Planning, the latter of which was eliminated and the work under Task 3-Project Development was, instead, expanded.

2. Project Opportunities and Concept Development

The development of the Joint Master Plan began with brainstorming a wide range of potential component projects that could, in various combinations, be implemented to achieve the Joint Master Plan goals. Through a series of workshops with WRD and LADWP, these components were considered as "building blocks" that were grouped to develop several Joint Master Plan Projects, which were evaluated and ranked to be carried forward for further evaluation.

2.1 Project Opportunity List Development

The Joint Master Plan applied a regional approach to identify a comprehensive list of existing and potential new replenishment water sources, treatment facilities, and replenishment and extraction locations, herein referred to as "system components" (Figure ES-1). These system components were then screened and used to develop implementable, complementary projects that can be further advanced toward implementation.

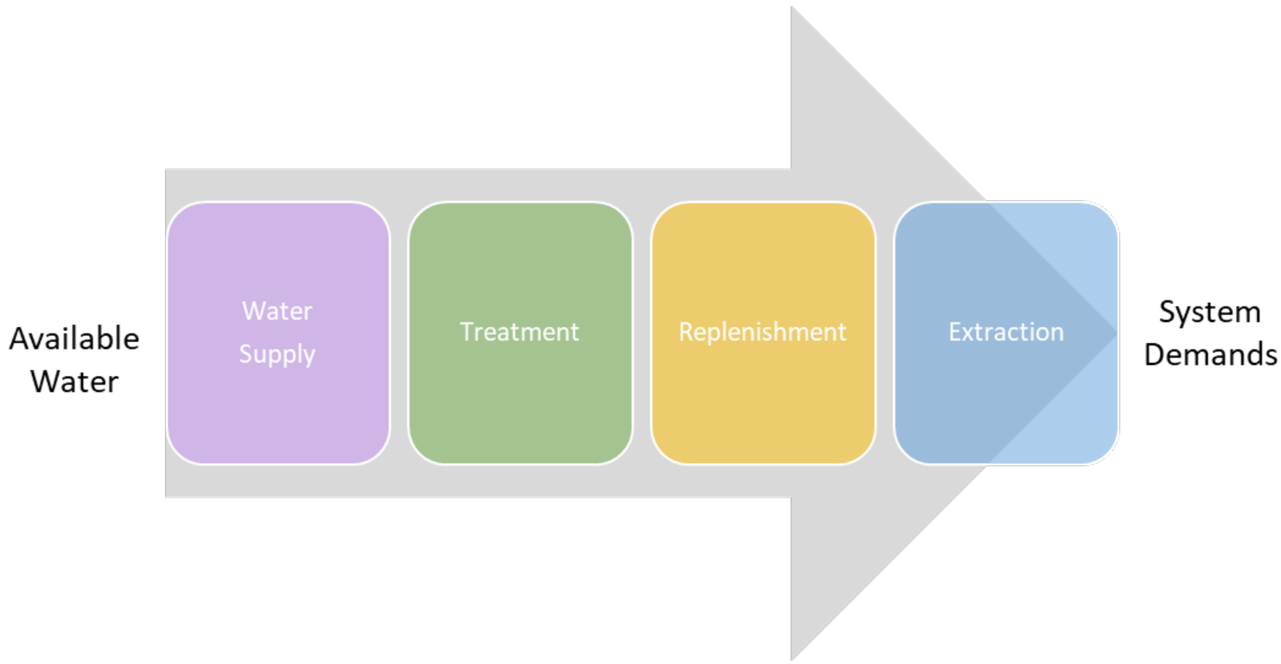


Figure ES-1. Four Project Component Groups Considered in the Joint Master Plan Goals

The goals of this Joint Master Plan for both WRD and LADWP were identified in TM 1, Identification of System Components (Appendix A). Individual agency goals and drivers were identified, and the Joint Master Plan's system boundaries and water demands were established. The primary purpose and objectives of the Joint Master Plan are to meet the WRD and City of Los Angeles (City) water supply goals by identifying project strategies that can:

- Reduce reliance on purchased imported water
- Maximize recycled water use from the Hyperion Water Reclamation Plant for beneficial reuse
- Increase replenishment of and extraction from the Basins
- Increase resiliency of the region by utilizing available groundwater storage space in the Basins

TM 1 listed potential system components that could help WRD and LADWP achieve their Joint Master Plan goals. It includes estimates of capacities for each component to inform an initial, high-level assessment of potential project capacity, where a project consists of a combination of applicable system components.

The potential system components were categorized into four groups:

- Water Supply: Existing water sources for potential groundwater replenishment and include wastewater, stormwater (dry and wet weather runoff), and imported water
- Treatment: Existing and proposed treatment facilities that provide levels of treatment beyond those facilities listed as existing Source Water Supplies
- Replenishment: Existing and proposed facilities for groundwater replenishment (injection or spreading) of treated water
- Extraction: Existing and proposed facilities for groundwater extraction of water to supply system demands

A comprehensive list of potential water supply sources, advanced treatment facilities, replenishment locations, and extraction locations was developed. Defined criteria such as the availability and water quality of replenishment source water flows, maximizing use of existing infrastructure, and ease of facility permitting were used to identify the most feasible components to carry forward as projects to consider in the Joint Master Plan. TM 1 concludes with a final list of project components to be considered, a list of project components that were not recommended, the screening criteria used to evaluate the feasibility of projects, and a matrix grouping the different individual projects from the supply, treatment, replenishment, and extraction project component groups into single projects for evaluation within the Joint Master Plan.

2.2 Project Concept Ranking and Selection

TM 2, Ranking of Project Concepts (Appendix B), describes the development of Project Concepts and the selection process used to identify projects for further analysis and refinement. The goal was to identify the most feasible concepts and further develop those through a more detailed analysis. The ultimate objective of the project selection process was to identify up to five implementable projects for further development. TM 2 then describes the logic involved in the screening of various alternatives.

A Project Concept consists of a combination of project system components from each of the four categories:

- Source of Water Supply
- Advanced Water Treatment (AWT) Facility
- Groundwater Replenishment Location
- Groundwater Extraction Location

Different terms were used to refer to the different combination of components. The term “project” could be referring to a project component, a Project Concept, or to an optional Project Concept. To establish a common nomenclature for this planning process, the following list defines the terms used in TM 2:

- **Project Concept**: A combination of system components that, when combined, form a complete project. The Project Concept must include components for water supply source, AWT (if needed for recharge), groundwater replenishment, and groundwater extraction.
- **Add-on (or Optional) Projects**: A combination of two or more system components that could be added to any other Project Concept for added benefit or to consider alternative water sources. During the meetings and workshops conducted during this phase of the Joint Master Plan process, these Add-on Projects were referred to as Optional Projects.
- **Project Variation:** An iteration to a Project Concept that addresses a limiting factor. For example, once the Project Concept was identified for Project 1 (see Figure ES-2) and the initial capacity of the components were considered (represented by the sizes of the color bars on Figure ES-2), the limitations of the project became evident. Project variations (P1a, P1b, and so on) were then created to address some of the limitations. In the example presented on Figure ES-2, the size of Project Concept 1 is limited by demand and treatment capacity. To address these constraints, Project Concept 1a is used as a variation to address the most limiting component: AWT. Therefore, new advanced treatment facilities or capacities would be needed for this Concept 1a variation.
- **Project or System Component**: A single existing or new facility identified as a location of supply, AWT, groundwater replenishment, or groundwater extraction. A single component on its own does not constitute a complete Project Concept, only part of a concept. Thinking in terms of “connecting the dots,” Project Components are the “dots.” Project Components were referred to as System Components in TM 1 (Appendix A).

Figure ES-2 illustrates the methodology used to develop project concept variations that are later compared using decision science. The figure illustrates how a project concept variation would derive from Project Concepts and Project Variations, and how Add-on Projects could be attached to any concept.

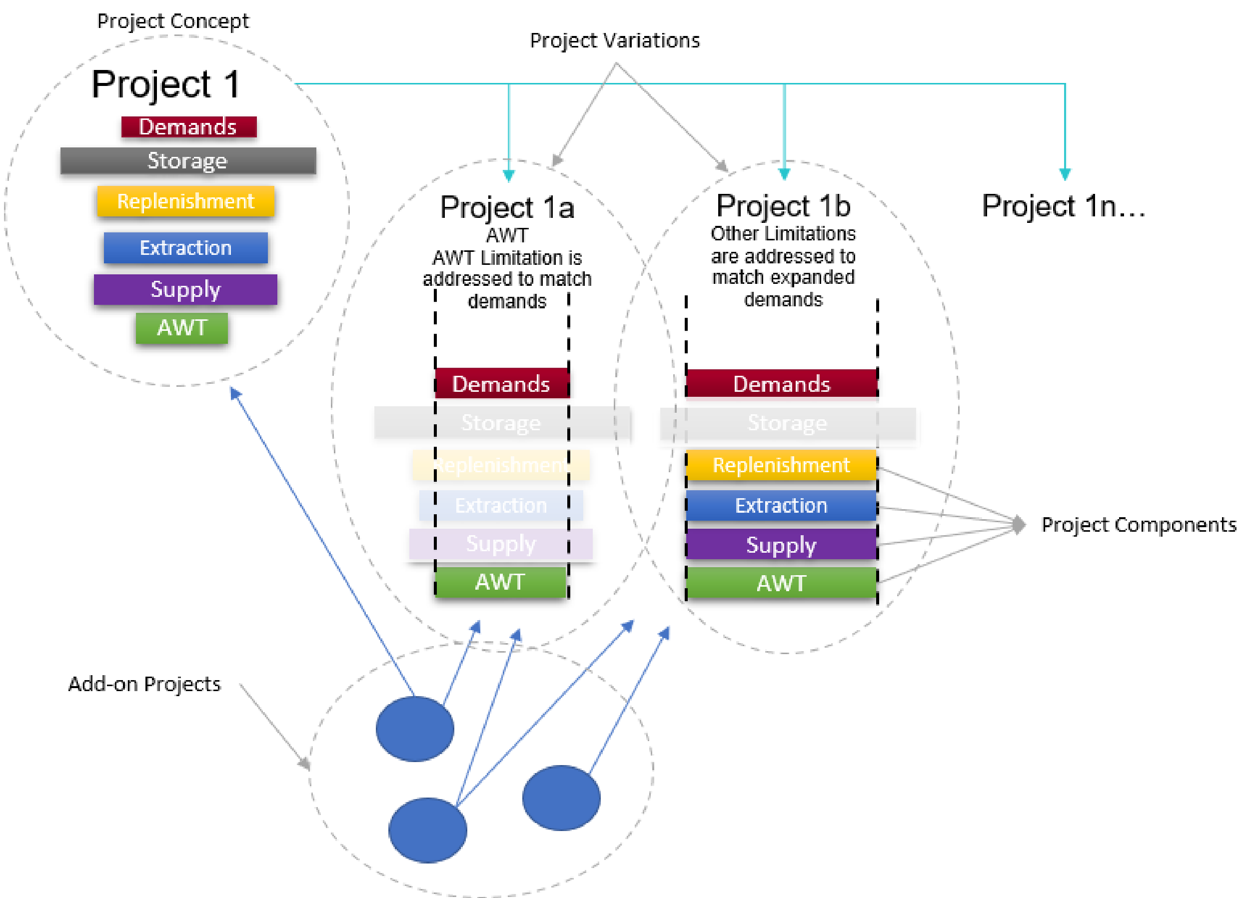


Figure ES-2. Methodology Used to Determine Project Concept Variations

To develop cost estimates for the Project Concepts, Jacobs used its Conceptual and Parametric Engineering System (CPES) tool. This planning and design tool is based on successful design and construction projects collated over the past 20 years into a single design platform. CPES leverages these past project designs to develop quantity estimates from the bottom-up, resulting in a more thorough cost estimate.

The accuracy for these cost estimates is considered Class 5 as defined by the Association for the Advancement of Cost Engineering (AACE), suitable for a concept screening purpose. The expected cost range is -20 to -50 percent at the low end of the spectrum and +50 to +100 percent at the high end. Lifecycle costs were calculated for a duration of 30 years based on the treatment facility and pump station design lifespans.

The system components identified in TM 1 were used to develop 30 Project Concepts and Add-on Projects. These Project Concepts were initially screened based on overall feasibility and workshop discussions between WRD, LADWP, and Jacobs (the Joint Master Plan team).

After screening, 17 Project Concepts were selected, having been scored using weighted screening criteria, and then ranked, using an iterative process to collaboratively determine which projects should be selected for further project development and serve as the overall recommended projects in the Joint Master Plan. A decision science methodology was used to guide the selection process. Decision science is a methodical approach to inform decision-making using the best, currently available information, providing transparency and a structured and defensible decision-making process.

A workshop was held to present the initial Project Concept ranking and discuss refinements with the Joint Master Plan team. After refinements to the benefit scores, nine Project Concept Variations were combined into two distinct Projects, titled based on their source waters:

1) **Hyperion WRP Project:** Five selected Project Concept Variations were combined into a single project, with a focus of maximizing the use of Hyperion WRP flows through injection and extraction in the Central Basin, spreading at the Montebello Forebay and siting of new spreading facilities, and potentially connecting excess flows to the Metropolitan Water District of Southern California's (Metropolitan's) Regional Recycled Water Program's (RRWP) advanced treated recycled water backbone conveyance system. Maintaining existing flows to the West Basin Municipal Water District's (WBMWD's) Edward C. Little Water Recycling Facility for injection at the West Coast Basin Barrier (WCB Barrier) is assumed.
2) **Leo J. Vander Lans (LVL)/Los Coyotes WRP Project:** Four selected Project Concept Variations were combined into a single project, with a focus on finding the best use of available flows from Sanitation Districts of Los Angeles County's (LACSD's) Los Coyotes WRP. The project was intended to evaluate whether Los Coyotes WRP flows should be sent north to the Montebello Forebay for replenishment of the Central Basin, or south for AWT at WRD's LVL Advanced Water Treatment Facility (AWTF) for injection at the Alamitos Seawater Intrusion Barrier or at new injection and extraction facilities in the Long Beach area. If the flows were to be found to be best used by sending them south toward Long Beach, then a connection of the WBMWD and Central Basin Municipal Water District (CBMWD) recycled water conveyance systems would be considered to convey flows using existing conveyance infrastructure.

TM 2 concluded with the identification of potential next steps in the project development process that were then considered by WRD and LADWP for advancement.

3. Initial Project Development

To advance the study of the Hyperion WRP and LVL/Los Coyotes WRP Project concepts, it is critical to identify potential impacts of the associated replenishment and extraction scenarios on the groundwater basins. Two Water Balance Models for the Central Basin were developed to establish a range of scenarios for both the Hyperion and Los Coyotes Projects. The resulting injection and extraction flows served as the basis for subsequent groundwater modeling scenarios.

It is also important to identify the location of the backbone advanced treated water delivery system from the Hyperion WRP, because minimizing the distance from the backbone to the injection wells is desirable to minimize project impacts, both physically and economically. Thus, a routing study was conducted to identify three alternative conveyance routes from Hyperion WRP to potential injection wellfields in the Central Basin, terminating at a potential connection with Metropolitan's RRWP backbone pipeline near the San Gabriel River.

A key component of the LVL/Los Coyotes WRP Project to enable application of available plant effluent for groundwater replenishment is the conveyance of the tertiary flow to the advanced treatment facility. Building on previous work, a preliminary design that had been completed by others for a pipeline to deliver flow from Los Coyotes to a potential expansion location at the LVL AWTF was reviewed and the associated cost estimate was updated. An evaluation of flow equalization storage volumes to optimize the utilization of the Los Coyotes effluent was also conducted.

Before launching these studies, a TM documenting the foundational data and assumptions was prepared for concurrence by WRD and LADWP.

3.1 Project Development Assumptions

TM 3.1, Basis of Project Development TM (Appendix C), established key assumptions used in the subsequent development of the Hyperion WRP Project and the LVL/Los Coyotes WRP Project that were selected after the screening process described in TM 2.

3.1.1 Project Development Focus

At this stage in the Joint Master Plan study, the Hyperion WRP Project defined during the screening process described in Section 2.2 was advanced by identifying the modeling basis for groundwater basin impact analysis. To help identify appropriate injection and extraction locations for the advanced treated water from Hyperion WRP, a routing study of the backbone delivery system for conveyance was conducted.

Evaluation of the LVL/Los Coyotes WRP Project was initiated with a peer review of preliminary design documents previously prepared for the pipeline and pump station between the Los Coyotes WRP and the LVL AWTF. This review also included updating estimated costs, identifying fatal flaws, and evaluating storage needs, discussed in Sections 3.4 and 4.2.1.

Conceptual overviews of the Hyperion WRP Project and LVL/Los Coyotes WRP Project as defined for further project development under the Joint Master Plan are shown in Figures ES-3 and ES-4, respectively.

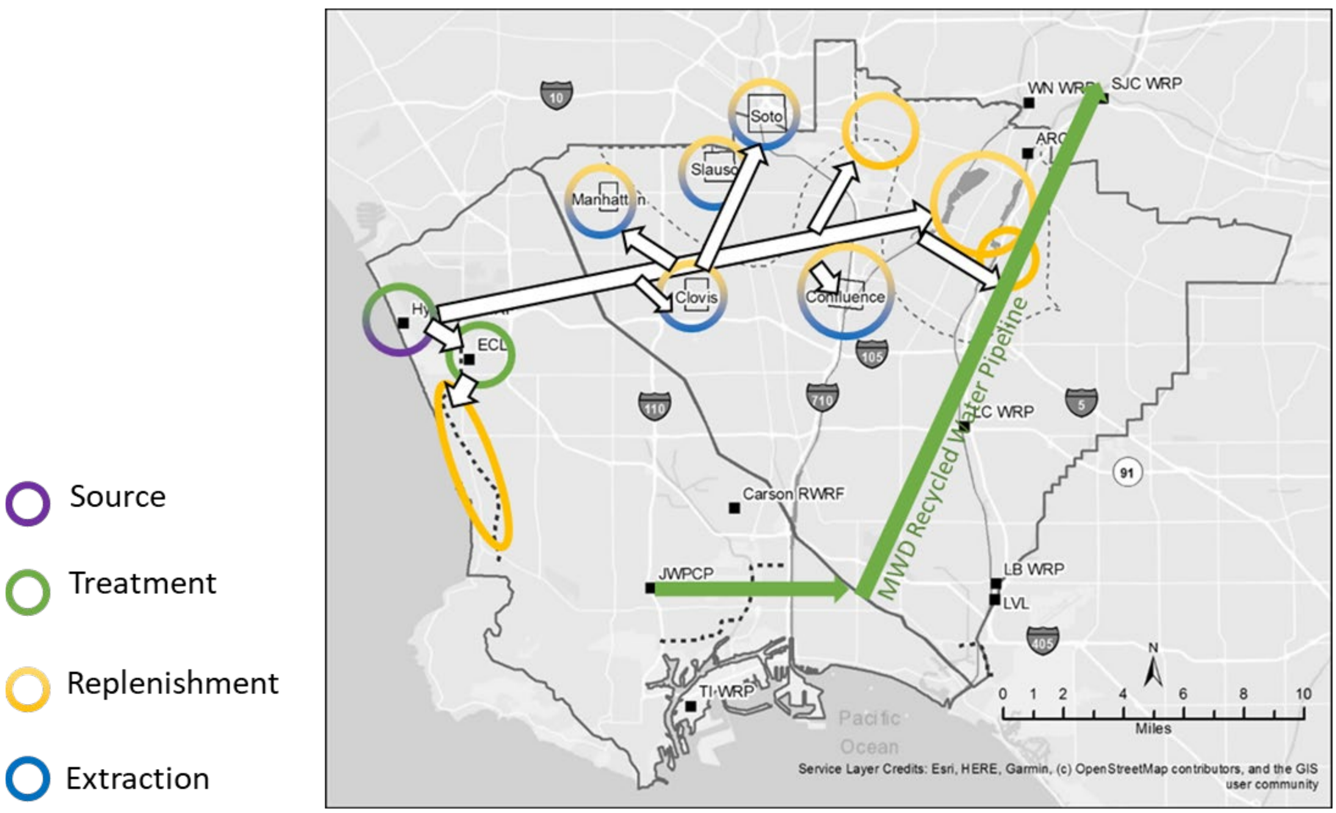


Figure ES-3. Hyperion WRP Project

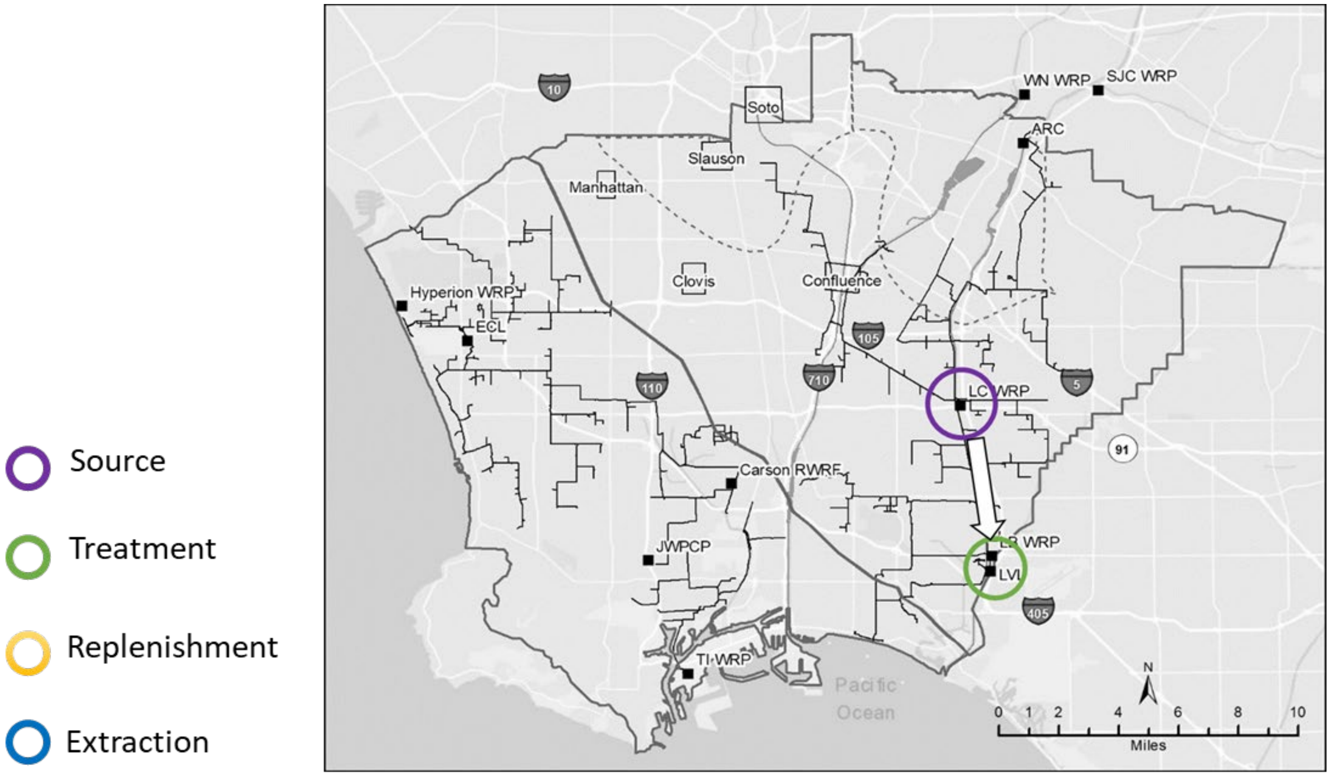


Figure ES-4. Los Coyotes WRP Project

3.1.2 Hyperion WRP Project Development Approach

Initial development of the Hyperion WRP Project consisted of identification of potential backbone delivery pipelines of the advanced treated water from Hyperion WRP, volumes of water delivered from Hyperion WRP to the Central Basin, injection and extraction volumes and preliminary wellfield locations for groundwater modeling analysis.

3.1.2.1 Hyperion WRP Project Modeling

To help understand the relationships of the complex system components and operational limitations of the Hyperion WRP Project, three types of models were applied in the development of this Joint Master Plan to simulate operational scenarios and identify physical groundwater basin limitations:

- **Resource Allocation Model:** This spreadsheet model was previously developed by LADWP to evaluate Los Angeles' water demands, supplies and resulting extraction limitations (LADWP 2019). The 30-year demand pattern provided by this model served as input to the Water Balance Model.
- **Water Balance Model:** This systems model of the Central Basin was developed for the Joint Master Plan to simulate recharge, storage, and extraction based on historical and predictive management scenarios, reflecting the constraints of the Basin Judgment requirements. This model provided time series with extraction and recharge as an input to the Groundwater Model.
- **Groundwater Model:** WRD's groundwater flow model, developed by the U.S. Geological Survey (USGS), was used to verify physical limitations of injection, storage, and extraction within the groundwater basins. The groundwater model used for this study is the Los Angeles Coastal Plain Groundwater Model (LACPGM), recently developed by USGS (Paulinski et al. 2020). The initial Hyperion WRP Project groundwater modeling is discussed in Section 3.2.

Results from the modeling efforts provided the basis for subsequent project planning under the Joint Master Plan.

The Hyperion WRP Project Water Balance Model was developed for the Joint Master Plan to simulate multiple scenarios that required varied basin operations. The model components are depicted in Figure ES-5 and specific input assumptions are described in TM 2 (Appendix B).

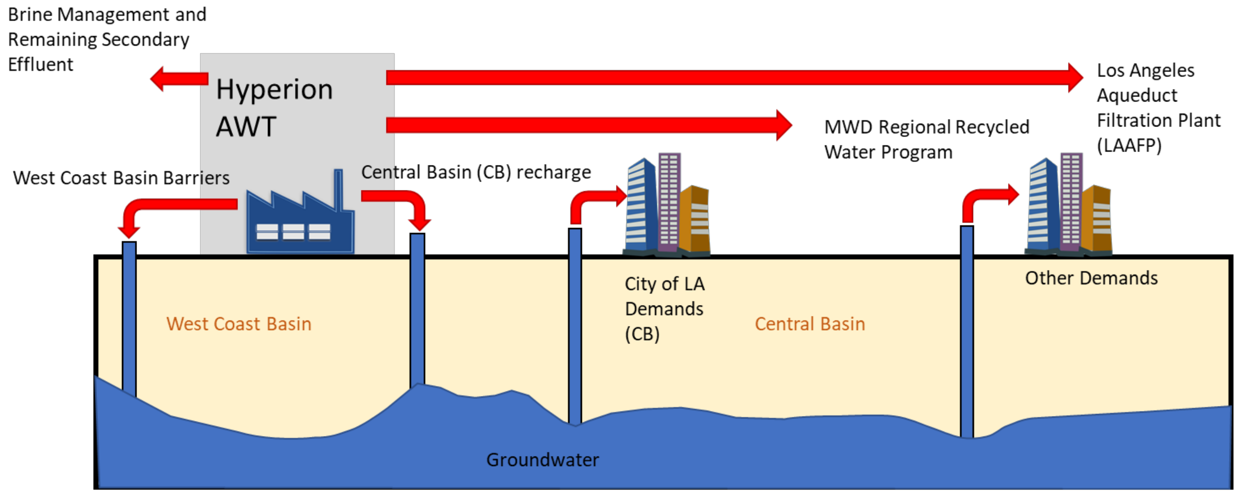


Figure ES-5. Water Balance Model System Components

The Water Balance Model scenarios were created in conjunction with WRD and LADWP. Attachment 1 of TM 2 (Appendix B) provides the details of these scenarios. The variables that change across scenarios are related to water rights for extraction, extraction capacity and timing, recharge, and water augmentation. The scenarios can be summarized as follows:

- Scenario 1: Baseline scenario with historical extractions and historical recharge, and additional WRD Regional Brackish Water Reclamation Program (RBWRP) operation (20,000 acre-feet per year [AFY] of extraction and replenishment).
- Scenario 2: Same assumptions as Scenario 1, with increase of LADWP water rights. Change (increase) in LADWP water demands in the Central Basin. Additional recharge available from WRD's Albert Robles Center for Water Recycling and Environmental Learning (ARC) Facility and Los Coyotes WRP.
- Scenario 3: Same as Scenario 2, with increase of LADWP water rights and correspondent increase of recharge of available advanced treated recycled water from the Hyperion WRP and LADWP extraction.
- Scenario 3a: Same as Scenario 3, with changes to the extraction pattern and limits for LADWP.
- Scenario 4: Same as Scenario 3, with expansion of Central Basin extractions by all pumpers to full Allowed Pumping Allocation rights and correspondent increase of recharge.
- Scenario 5: Same assumptions as Scenario 4, with an increase of West Coast Basin extraction by all pumpers to full water rights and correspondent increase in recharge.
- Scenario 6: Same assumptions as Scenario 5, with changes to the LADWP extraction pattern and capacity as well as addition of a water augmentation program.
- Scenario 7: Same as Scenario 6, with changes to the LADWP's extraction pattern and capacity.

Results from the Water Balance Model simulation of these operational scenarios were then used as inputs to the basin groundwater model to assess whether these operational strategies would have adverse impacts on the Basins.

The Water Balance Model processes the different scenario data into a time series of volumes associated with each of the different replenishment, injection, extraction, and water transfer components, subject to the respective adjudication and storage rules in the Central Basin. The groundwater model includes both the Central and West Coast Basins and was used to evaluate the physical limitations of each scenario's proposed replenishment, injection, and extraction locations and volumes. The physical or hydrogeologic limitations of a scenario was assessed by computing a groundwater model simulated head for the respective scenario and comparing that against threshold water levels. Depending on the component that exceeds the threshold, the groundwater model provided an upper or lower bound that can then be subsequently adjusted in the Water Balance Model. The adjusted Water Balance Model output was then used to revise the groundwater model and check other physical limitations in an iterative manner.

3.1.2.2 Hyperion WRP Project Backbone Alternative Route Development Basis

The purpose of the Hyperion WRP Project Backbone Alternative Route Development study was to develop three alternative routes to deliver advanced treated flows from the Hyperion WRP to replenishment facilities and, potentially, to the Metropolitan RRWP backbone pipeline. The criteria and general assumptions were described in TM 3.1 (Appendix C) and were used as the basis for the initial pipe segment development prior to the route screening process. Criteria development and route screening were documented in a TM and are discussed in Section 3.3.

3.1.3 LVL/Los Coyotes WRP Project Development Approach

Advancing the development of the LVL/Los Coyotes WRP Project included developing a Water Balance Model, exploring the feasibility of providing advanced treatment of Los Coyotes WRP effluent at two locations, conducting preliminary groundwater modeling, and reviewing the preliminary design and cost estimate for a conveyance pipeline from Los Coyotes to LVL AWTF.

3.1.3.1 LVL/Los Coyotes WRP Project Modeling

A separate Water Balance Model was developed for the LVL/Los Coyotes WRP Project so that many different scenarios could be analyzed for the two projects.

With a similar approach to that used for the Hyperion WRP Project, results from different scenarios were exported from the LVL/Los Coyotes WRP Water Balance Model and provided as inputs to the basin groundwater model. The goal was to check if the recharge and extraction values resulting from the above surface operations from different scenarios would have adverse impact in the groundwater basin and trying to identify optimal location of future wells. The scenarios modeled for the LVL/Los Coyotes WRP Project are summarized in Table ES-1.

Table ES-1. Model Runs with Variations of Treatment Location, Use of Long Beach WRP Flows, and Los Coyotes WRP Demand Variations

Alternatives	Expansion at Long Beach WRP*	Expansion at Los Coyotes WRP
Long Beach WRP excess backfills LVL AWTF	2a – Los Coyotes WRP allocation based on historical deliveries	3a – Los Coyotes WRP allocation based on historical deliveries
	2b – Los Coyotes WRP allocations to others maximized	3b – Los Coyotes WRP allocations to others maximized

Table ES-1. Model Runs with Variations of Treatment Location, Use of Long Beach WRP Flows, and Los Coyotes WRP Demand Variations

Alternatives	Expansion at Long Beach WRP*	Expansion at Los Coyotes WRP
Only minimum Long Beach WRP flows are used to backfill LVL AWTF	2a – Los Coyotes WRP allocation based on historical deliveries	3a – Los Coyotes WRP allocation based on historical deliveries
	2b – Los Coyotes WRP allocations to others maximized	3b – Los Coyotes WRP allocations to others maximized

Note:

Long Beach WRP priority will use water provided by the Long Beach WRP in excess of the contract amount (~ 6.5 MGD). Approximate due to the 1 month that Long Beach WRP could provide less than 6.5 MGD.

3.1.3.2 Advanced Water Treatment of Los Coyotes WRP Effluent

The Los Coyotes WRP has been considered as supplemental source of recycled water supply for the LVL AWTF and the Montebello Forebay Spreading Grounds. Expansion of up to an additional 8 million gallons per day (MGD) is now being considered and would include the same advanced treatment processes that are currently used at the LVL AWTF, microfiltration (MF), reverse osmosis (RO), and ultraviolet advanced oxidation process (UVAOP).

The feasibility of providing advanced treatment of Los Coyotes WRP effluent either at the plant or at the LVL AWTF was evaluated as part of the Detailed Project Development phase of the Joint Master Plan. A flow model was also built within the LVL/Los Coyotes WRP Water Balance Model to evaluate the need for storage and potential storage scenarios at both sites. These assessments are discussed in Section 4.2.2.

3.1.3.3 Los Coyotes WRP Conveyance Design Review

A review of a preliminary design prepared in 2012 of a pipeline and pump station to convey Los Coyotes WRP effluent to the LVL AWTF was conducted to identify modifications or updates needed to the previous design and provide an updated cost estimate. This review is discussed in Section 3.4.

3.2 Initial Groundwater Modeling

Groundwater modeling for the Joint Master Plan was conducted in two phases. The primary objective of Phase 1 groundwater modeling was to evaluate hydrogeologic feasibility of preliminary areas for injection and extraction facilities, including those identified in LADWP's Groundwater Development and Augmentation Plan (GDAP) (LADWP 2019). The Phase 1 groundwater modeling approach, results, and recommendations for the next phase are presented in TM 3.2.1, Phase 1 Groundwater Modeling (Appendix D).

Groundwater modeling performed during Phase 1 utilized inputs from a Water Balance Model developed specifically to identify and evaluate the different Hyperion WRP Project Components and scenarios. The Water Balance Model analyzed Hyperion WRP water demands and supplies, as well as LADWP's demands and conveyance constraints. The model was used to predict the timing and magnitude of advanced treated water available for existing recharge and new injection facilities, as well as the magnitude and timing of groundwater needed to meet LADWP demands from existing and new extraction facilities. Seven scenarios were developed with the Water Balance Model and include a Baseline scenario corresponding to historical conditions. The groundwater model used for this study was the LACPGM, which comprises both Basins. Inputs from the Water Balance Model scenarios were simulated using the LACPGM 30-year simulation period of 1986 to 2015 as the baseline hydrology. All the scenarios included WRD's RBWRP in the West Coast Basin. All scenarios except the Baseline scenario included injection by WRD near the LVL AWTF.

Three locations from the GDAP were evaluated for injection and extraction by LADWP. The new LADWP injection wells were simulated at Slauson and Soto locations. Extraction by LADWP was simulated at the new Confluence location, and existing Manhattan and 99th Street Wellfield locations. The RBWRP was simulated using 10 extraction wells pumping a total of 20,000 AFY in the West Coast Basin and reinjection of 20,000 AFY at the WCB Barrier wells. For injection near the LVL AWTF, three wells were used to simulate injection of 4,000 AFY.

Hydrogeologic feasibility of the injection and extraction well locations was assessed using water level thresholds based on the modeled well screen depths and model layer elevations at the respective locations. Injection was constrained by an upper water level threshold at 50 feet below the topmost layer. Exceedance of this threshold was seen to indicate potential for excessive mounding. Extraction was constrained by a lower water level threshold representing the top of the screened interval. Exceedance of this threshold was seen to indicate potential for dewatering of the aquifer and air entrainment. The feasibility evaluation did not include potential for subsidence at extraction wells and this was included in a subsequent phase of modeling.

Modifications to groundwater model injection and extraction inputs were made following results from a preliminary round of simulations. Following input from LADWP, pumping at the Confluence, Manhattan, and 99th Street locations was apportioned as 56%, 33%, and 11% of the specified pumping, respectively. The Soto injection location was deemed hydrogeologically infeasible because of exceedance of the high water-level threshold, and it was subsequently removed from consideration. Water level thresholds at all other simulated well locations were not exceeded. For the Slauson injection location, a further refined calculation of the potential drawup was performed using model input data. The analysis indicated that the maximum drawup for injection wells spaced 100 feet is approximately 92 feet and within the range of values for injection wells. The RBWRP's additional injection was restricted to well locations in the southern portion of the WCB Barrier closer to the extraction wells to mitigate high water levels in the northern portion.

All the project scenarios indicated that injection near the LVL AWTF exceeds thresholds, potentially because of high regional water levels in the area and low volumes of simulated extraction at nearby wells. Data collected through future expansion at the LVL AWTF will provide new information on prevailing hydrogeological conditions. These data will be incorporated into future modeling. Injection of additional volume at the WCB Barrier wells in the southern portion indicated no exceedances of thresholds. This assumption will need to be evaluated for any additional operational constraints or the WCB Barrier capacity.

A preliminary water quality data evaluation was conducted using data from the California Groundwater Ambient Monitoring and Assessment (GAMA) database and WRD's Regional Groundwater Monitoring Reports and Groundwater Contamination Prevention Program (California Water Boards 2022; WRD 2019, 2022). The GAMA data showed that there are several sites without depth information. At sites with depth information, most of the contamination is at depths less than 100 feet. Near the Confluence extraction location, contamination is at depths greater than 500 feet. This depth range is within the modeled extraction screen interval at the Confluence location, indicating a need for a further detailed evaluation at this location.

3.3 Hyperion Backbone Pipeline Alignment Alternatives

The Hyperion Backbone is a planned approximately 20-mile-long pipeline potentially ranging in diameter from 48- to 96-inches and will deliver advanced treated water from the Hyperion WRP to various turnouts and injection well sites spanning Los Angeles County between the plant and Interstate 605 near the San Gabriel River as part of LADWP's Operation NEXT and WRD's Los Angeles Basin Replenishment Project as shown on Figure ES-6.

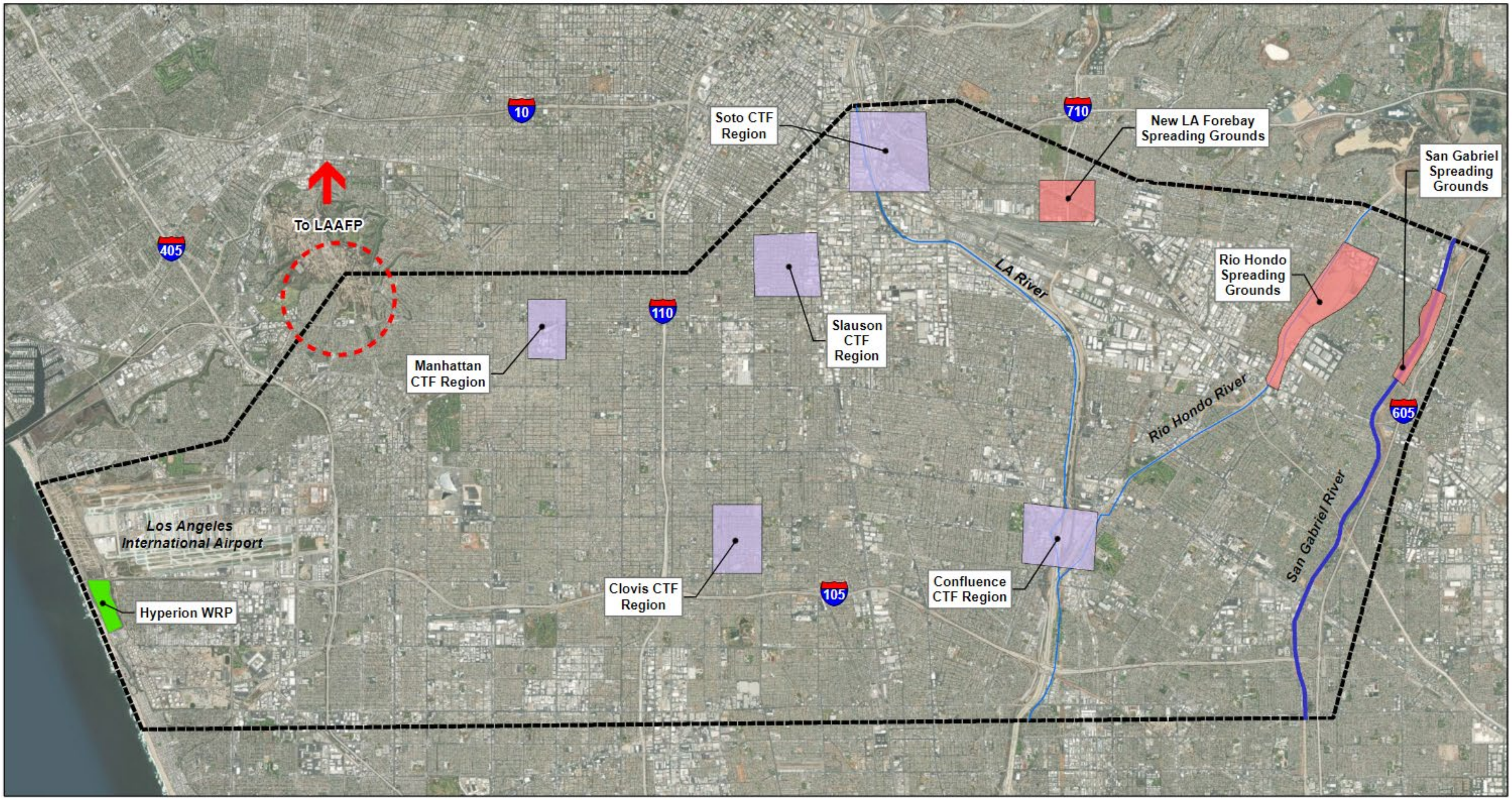


Figure ES-6. Hyperion Backbone Route Development Future Connections

As part of the Joint Master Plan, the first phase of an alternative route development, evaluation, and selection process for the Hyperion Backbone was conducted. The work included an alternative route study, which identified and developed recommendations for three routes alternatives for the Hyperion Backbone documented in TM 3.2.2, Hyperion Backbone Alternative Route Development TM (Appendix E). These alternatives will be further detailed and evaluated in a future phase of the project to determine the preferred alternative to be carried forward for consideration for regulatory permitting purposes and advancement of project definition.

The route development process involved coordination efforts among the Joint Master Plan team members through several workshops and stakeholder meetings, and solicited input from all parties to identify priorities, preferences, and potential route challenges. The resulting study included the finalization of overall project goals, a project area definition covering more than 150 square miles through the City of Los Angeles and Los Angeles County, development of potential routes delivering flow to injection well sites and project defined connection points, collection of existing utility information in the project area via coordination with more than 25 municipalities and utility agencies, screening of undesirable or less beneficial pipe segments, and development of three potential preferred alignments taking into consideration factors such as constructability, public impact, utility impacts, reaches requiring tunneling, environmentally sensitive or hazardous areas, and geotechnical and geologic conditions.

Three potential preferred alternatives taking routes along the following major roadways were identified for consideration in the next phase of the project (Figure ES-7). The alignments are:

- **Alternative 1:** Pershing – La Tijera – Slauson
- **Alternative 2:** Pershing – Manchester – Florence
- **Alternative 3**: El Segundo – Hawthorne – Manchester – Florence

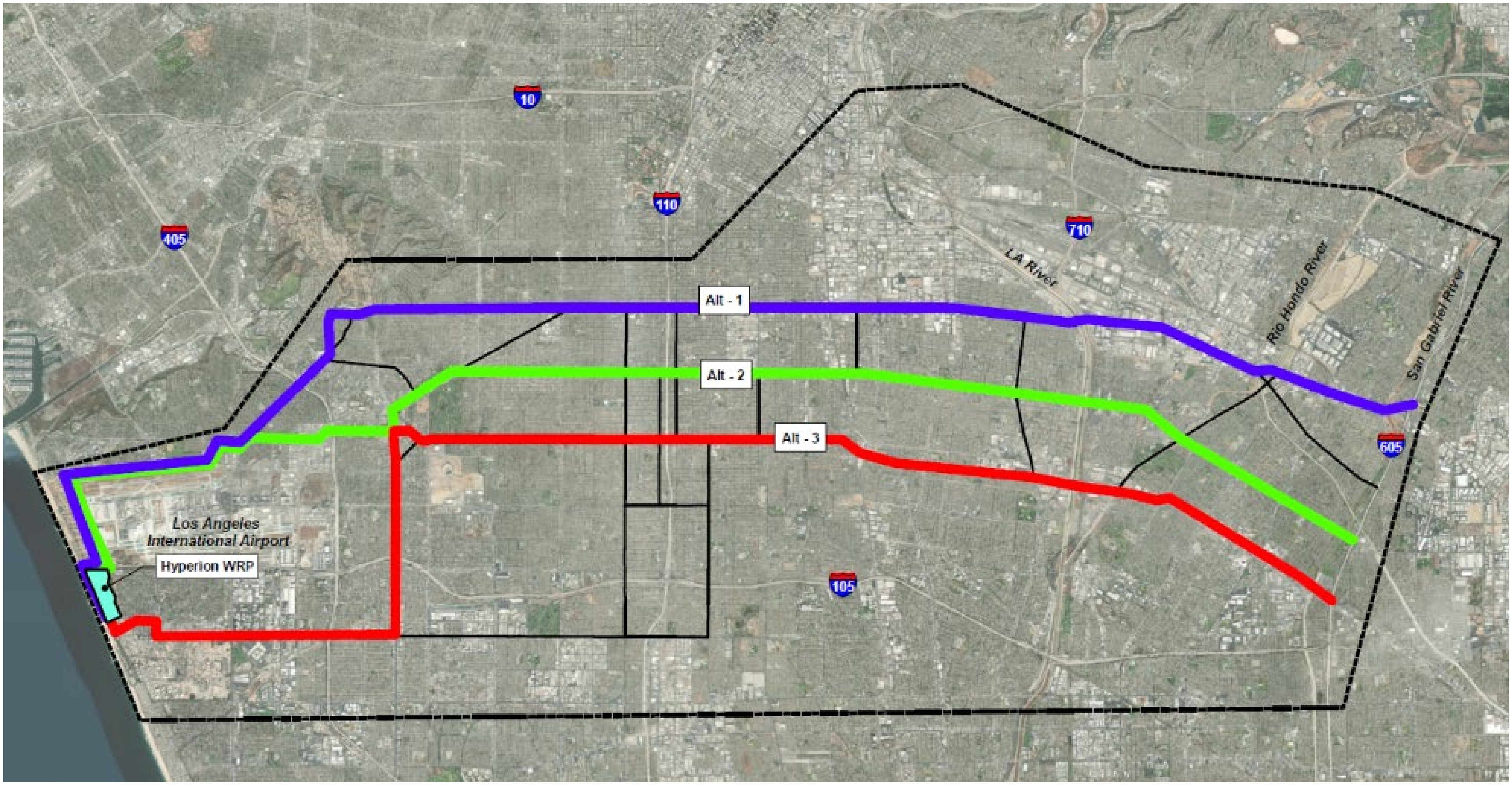


Figure ES-7. Potential Hyperion Backbone Alignments

These potential alignments were considered during the identification of additional injection wellfield locations for Phase 2 groundwater modeling. Proximity of the wellfields to the Backbone system reduces conveyance costs.

3.4 Review of Conveyance of Los Coyotes WRP Flows to LVL AWTF

TM 3.2.4, Los Coyotes Water Reclamation Plant to Leo J. Vander Lans Advanced Water Treatment Facility Review (Appendix F) was a more detailed evaluation of the LVL/Los Coyotes WRP Project**.** The focus of the project was to find the best use of available Los Coyotes WRP flows for groundwater replenishment. Based on discussion with WRD, the focus of the project shifted to a peer review of preliminary design documents for the pipeline and pump station between the Los Coyotes WRP and the LVL AWTF. The review also includes updating estimated costs, identifying fatal flaws, and evaluating above ground storage needs. TM 3.2.4 documents the LVL AWTF effluent flow analysis, preliminary design document review, and cost estimate for the LVL/Los Coyotes WRP Project.

3.4.1 Los Coyotes Effluent

The effluent flow analysis was based on the last 5 years of flow data from the Los Coyotes WRP, and suggests that LVL AWTF could be supplied with 8.7 MGD from the Los Coyotes WRP 76% of the time. Assuming LVL AWTF could adjust the production rate, use the current 0.18 MG of available storage, and be turned on and off multiple times during the day (which is recognizably not a realistic operating plan), the plant average annual inflow could reach 8,800 AFY (that is, 90% of plant capacity).

An 8.7-MGD plant and the current 0.18 MG of equalization storage could provide an average of 6,100 AFY of LVL AWTF inflows; however, that assumes the plant will be able to quickly adjust production rate to match plant inflows. This analysis should be refined based on actual plant flow adjustment capabilities.

Equalization storage could improve the plant production. The addition of system storage between 1 and 2 MG could increase average LVL AWTF inflows to between 8,400 to 9,200 AFY. Storage volumes greater than 1 to 2 MG (depending on the scenario) will have less of an impact on the additional average LVL AWTF inflow to the plant and will be used less than 20% of the time. A cost analysis and assessment of site availability to build storage should be conducted to determine the optimal size of storage.

It is not clear how flexible the LVL AWTF can be regarding flow and daily plant operations. A better understanding of its limitations could help identify the storage size needed.

3.4.2 Pump Station

TM 3.2.4 reported a review of the Pump Station Preliminary Design Report (PDR) for the Final Design for the Expansion of the Leo J. Vander Lans Water Treatment Facility (CDM Smith 2012). This Pump Station PDR was for a new Los Coyotes effluent pump station (EPS) located at the Los Coyotes WRP. This pump station was part of a conveyance system to provide tertiary effluent from the Los Coyotes WRP to the LVL AWTF. The Pump Station PDR considered the Los Coyotes EPS design flows of 4, 6, and 10 MGD. The Pump Station PDR evaluated three pump station alternatives and recommended one. The TM only discusses the technical review pertaining to Alternative 3 (selected by CDM Smith), which includes three vertical turbine pumps located in a new wet well that is connected to the dechlorination channel downstream from the effluent channel. In the Pump Station PDR, two duty pumps and one standby pump were selected based on the maximum design flow of 10 MGD.

TM 3.2.4 lists all recommendations after the review of the PDR, including that the pump wet well be redesigned to comply with Hydraulic Institute (HI) Standards recommendations, a trench style intake compliant with American National Standards Institute (ANSI)/HI, and further evaluation of pumps for possibly better hydraulic performance, equipment longevity, and energy savings. It also recommends the use of variable frequency drives for this project and a further investigation of the type and size of the new and existing control valves for all hydraulic conditions during final design. The TM also recommends that a surge analysis should be performed using the proposed pump selection.

For the pump cost, Jacobs reviewed the Opinion of Probable Construction Cost Estimate (CDM Smith 2012). The cost of each line item is verified against the quantities shown on the cost estimate. The cost for I&C appeared to be low based on Jacobs' historical averages. The quantities shown on the cost estimate are not compared with the quantities shown on the drawings. The I&C cost was adjusted to reflect current historical averages and then the overall proposed cost estimate was escalated from April 13, 2012, to May 12, 2020, including the construction duration of 54 months. The Class 4 cost estimate was escalated from $2,641,891 to $3,405,000, with low and high ranges of -30 to +50%.

3.4.3 Pipeline

The TM conclusions and recommendations from the Pipeline PDR technical review connecting Los Coyotes to LVL AWTF are that a nominal pipeline diameter of 24 inches is appropriate for the Los Coyotes WRP pipeline. Coordination with Los Angeles County Flood Control District, U.S. Army Corps of Engineers, California Department of Transportation, and the Los Angeles County Metropolitan Transportation Authority will be required for feasibility, permits and technical requirements.

The opinion of probable construction cost for the conceptual design of Alignment 1 of the Los Coyotes WRP pipeline, assuming high-density polyethylene (HDPE) pipe is used, is $20 million. If welded steel pipe (WSP) is used instead of HDPE pipe, the construction cost is anticipated to increase by 76%. This is expected because WSP typically provides more value with larger pipe sizes as opposed to a 24-inch diameter pipe. As a Class 4 estimate, this cost is generally prepared based on limited information and subsequently has a wide accuracy range.

3.4.4 Storage

Preliminary analysis presented in TM 3.1 (Appendix C) pointed the advantage of having equalization storage at LVL AWTF. The typical preliminary level unit cost assumption used to price aboveground prestressed concrete circular tanks is $1 per gallon. Constructions costs for buried cast-in-place concrete installations usually range 20 to 40% higher. Facility siting, available space, and comparison of aboveground versus buried tanks will need to be determined to fine-tune cost assumptions moving forward.

3.4.5 Permits

The estimated permits and environmental needs are listed in the TM. An encroachment permit from Los Angeles County Flood Control District would be required for work within its easement. This is expected to trigger Section 408 Review, which would require 1 to 2 years to process, including National Environmental Policy Act review and agency consultation. Other permits that might be triggered are listed in the TM; however, the time window for those need to be estimated.

4. Detailed Project Development

The next phase of the Joint Master Plan built on and advanced the analyses conducted during the Initial Project Development phase.

A replenishment/extraction siting study for the Hyperion WRP Project consisted of additional, more refined groundwater impact analysis coupled with a parcel investigation for identifying potential specific locations for injection and extraction wells. Additionally, a work plan for pilot injection wells and aquifer testing was prepared.

Increasing recharge for greater utilization of groundwater to meet water demands in the Long Beach area was explored with an augmentation program evaluation focused on utilization of the LVL/Los Coyotes WRP Project advanced treated water and potential additional flows from the Long Beach WRP. Groundwater modeling was conducted on select scenarios from LVL/Los Coyotes WRP water balance modeling, along with an evaluation of treatment facilities at LVL AWTF and the Los Coyotes WRP.

4.1 Hyperion WRP Replenishment/Extraction Siting Study

A critical element of the Hyperion WRP Project is the identification of preferred locations for the advanced treated water injection wells and the extraction wells for use of the replenished or stored water. An iterative well siting study process was conducted that included additional (Phase 2) groundwater modeling to identify hydrogeologic impacts, along with an assessment of the potential for the Project to pose Material Physical Harm (MPH) to the basin, as required by the Central Basin Judgment. The criteria considered for the MPH analysis were:

- Degradation of water quality
- Liquefaction
- Land subsidence

Because some of the injection wells would be located in the Los Angeles Forebay area of the Central Basin, where no injection wells currently exist, a plan was prepared for installation and monitoring of a test well to explore the hydraulic and geochemical feasibility of implementing injection in this area.

4.1.1 Refined (Phase 2) Groundwater Modeling

Groundwater modeling for the Joint Master Plan was conducted in two phases to identify and evaluate the feasibility of injection and extraction locations. A preliminary evaluation focused on hydrogeologic feasibility was conducted in Phase 1. In Phase 2, preliminary wellfield locations evaluated during Phase 1 were combined with new locations and evaluated for hydrogeologic feasibility and additional regulatory, permitting, and basin-management criteria. Feasible wellfield locations were used to identify and evaluate underutilized land parcels for siting of injection and extraction wells. The Phase 2 groundwater modeling approach, results, and recommendations are presented in TM 6.1.1 (Appendix G).

Groundwater modeling input for total pumping, replenishment and augmentation volumes were based on scenarios in the Hyperion WRP Water Balance Model. Scenario 7 has the highest volume of pumping by LADWP (average of 41,600 AFY) and other pumpers (average of 224,600 AFY) in the Basins, and the highest volume of injection by LADWP (average of 23,300 AFY). This scenario was used for evaluation of wellfield locations in Phase 2.

New wellfield locations were initially identified based on transmissivity values obtained from the groundwater model and input from LADWP. The Slauson injection location evaluated in Phase 1 was initially retained for Phase 2 evaluation and combined with the new wellfield locations. All the modeling evaluations included increased extractions from LADWP’s existing Manhattan and 99th Street Wellfields from an average of approximately 11,700 AFY to 18,300 AFY. Three sets of configurations were used to group the locations for simulating injection and extraction:

1) Centralized injection wellfield at the Slauson location (average of 23,300 AFY) and extraction from a single centralized wellfield (average of 23,200 AFY)
2) Centralized injection wellfield at the Slauson location (average of 23,300 AFY) and distributed extractions from several new wellfields (average of 7,700 AFY per wellfield for three wellfields)
3) Distributed injection (average of 11,600 AFY for two wellfields) and extractions (average of 7,700 AFY per wellfield for three wellfields) from several new wellfields

Distributed injection at Wellfield 2 and LADWP's Figueroa Pump Station, and extraction across DS 41, Parcel 1, and Wellfield 7 locations was deemed feasible and utilized for identification of underutilized parcels by Epic and INTERA. Parcels were grouped in to three tiers based on access, well spacing and likelihood of onsite or adjacent contamination. Tier 1 parcels with the most favorable criteria were used to calculate number of injection/extraction wells per parcel and subsequently simulated using the groundwater model. The Tier 1 injection locations satisfied hydrogeologic criteria while extraction locations intermittently exceeded the water level thresholds. All locations satisfied Title 22 requirements.

A detailed MPH evaluation was subsequently conducted. Contaminant site data from the state databases and additional input from the California Department of Toxic Substances Control (DTSC) and EPA was used to identify potential locations and depths of contaminants. Groundwater particle tracking was conducted to evaluate the potential impact of project. Modeling results indicate potential impact on contamination sites near injection wells in the model layers where injection and extraction are simulated, and no impact on contamination sites in the shallow layers.

4.1.2 Injection Test Well Work Plan

TM 6.1.2, Injection Test Well Work Plan (Appendix H) was developed to support installation of injection test well(s) and associated monitoring well(s) to verify the feasibility of injecting advanced treated water in the Los Angeles Forebay for the Hyperion WRP Project. The work plan includes the following:

- Recommendations for the injection test well location, including receiving aquifers and injection test well and monitoring well preliminary designs
- A well installation and testing plan that outlines the injection test well field program
- An approach to analyzing the results of the field program, including the required data, collection methods, and processes to evaluate local hydrogeologic conditions and to conduct a geochemical compatibility evaluation to assess the viability of full-scale managed aquifer recharge (MAR) operations
- The anticipated permits and approvals required to complete the injection test well installation and testing
- A baseline schedule for implementing the injection test well program

The results of Phase 2 of the Hyperion WRP groundwater modeling identified an area in the Los Angeles Forebay near the intersection of Slauson Avenue and State Route 110 (referred to as Figueroa Pump Station) where a geographically dispersed injection wellfield injecting into three chronostratigraphic sequences (Pacific A, Pacific, and Harbor), defined by the USGS, should satisfy the hydraulic, MPH, and Title 22 requirements of the project. LADWP's Manhattan Wellfield, which is approximately 2 miles west of Figueroa Pump Station, may extract from up to three deeper sequences (Bent Spring, Upper Wilmington A, and Upper Wilmington B). The work plan provides preliminary designs and associated recommended field investigations to install nested monitoring wells and an injection test in the Figueroa Pump Station area to depths of approximately 2,200 feet, which correspond to all six sequences above.

The work plan outlines field investigative techniques for drilling, soil and groundwater sampling and analysis, well construction, well development, aquifer testing, well disinfection, securing the wells, and well or borehole destruction, if needed. The preliminary design and field activities outlined in the work plan for the injection test well and nested monitoring wells will serve as a basis to develop detailed technical specifications and plans and solicit bids to complete the work.

As an important consideration to the work plan, Hyperion WRP will not produce advanced treated water for recharge in the Los Angeles Forebay for approximately 15 to 20 years. The long-term performance and potential environmental implications of injecting advanced treated water, such as well clogging and mobilization of metals in the receiving aquifer, respectively, are highly contingent on physical characteristics of the recharge along with geochemical reactions between the recharge water and native groundwater chemistries. Potable water from the distribution system will display different chemical characteristics than advanced treated water produced by Hyperion WRP and could display chemical characteristics that are geochemically incompatible with the native groundwater chemistry. Hence, the work plan does not recommend using potable water from the distribution system to perform injection testing; rather, it focuses on performing pumping tests to evaluate the hydraulic feasibility of injecting into different aquifer units and conducting water quality and soil analyses to characterize the geochemistry of the native groundwater and minerology of the different aquifers.

The work plan provides an approach to evaluate data collected during the injection test well field program to refine the understanding of the local geology, hydrogeology, and water quality; assess the geochemical compatibility of Hyperion WRP advanced treated water, native groundwater, and the receiving aquifer; and make recommendations for future pilot injection equipment. The current raw water chemistry at Hyperion WRP may be used to simulate the future advanced treated water chemistry by applying the expected treatment processes anticipated at the treatment plant. The simulated advanced treated water from Hyperion WRP may be used to determine the geochemical compatibility of the future Hyperion WRP water, native groundwater, and minerology of the receiving aquifer.

Permitting for the field program may include well permits, local permits (for example, for encroachment and excavation), discharge permits for disposal of test water to the sewer or stormwater collection systems, and noise variances for nighttime construction work. The work plan outlines potential future permits for injection of Hyperion WRP advanced treated water, pending any advancement of regulations for direct potable reuse.

A preliminary schedule for the drilling, installation, development, and testing of the injection test well and associated monitoring wells, and the associated data evaluations, requires approximately 3 years to complete.

4.2 LVL/Los Coyotes WRP Project Augmentation Program Evaluation

The LVL/Los Coyotes WRP Project has the potential to provide additional advanced treated water for the Central Basin for replenishment; that is, to support the extraction of groundwater within the water rights of parties to the Central Basin Judgment, or as augmentation projects wherein water is stored and extracted by parties within a given year. This portion of the Joint Master Plan explored the potential for providing additional groundwater recharge with advanced treated water to satisfy demands in the Long Beach area that are currently met by imported water.

The advanced treatment of tertiary effluent from the Los Coyotes WRP can be provided either by expanding the existing LVL AWTF or with a new AWTF near the Los Coyotes WRP. The Long Beach WRP is currently the only source water for LVL AWTF. To fully utilize the existing capacity of LVL, the LVL/Los Coyotes WRP Project analysis also included the potential for the treatment of additional flows from the Long Beach WRP at LVL AWTF.

The approach to this LVL/Los Coyotes WRP Project augmentation program evaluation included developing injection and extraction water balance scenarios; associated groundwater modeling of select scenarios; and the evaluation of two site locations, at LVL AWTF and at the Los Coyotes WRP, to provide additional advanced treated water for basin recharge.

4.2.1 LVL/Los Coyotes WRP Water Balance Model

The LVL/Los Coyotes WRP Water Balance Model, previously developed to estimate above ground equalization storage at the LVL AWTF (discussed in TM 3.2.4, Appendix F) was further developed to evaluate scenarios that more fully utilized or expanded the LVL AWTF with influent flows from either the Long Beach WRP or the Los Coyotes WRP. The components of the LVL/Los Coyotes WRP Project represented in the Water Balance Model are depicted in Figure ES-8. TM 6.2.1, Leo J. Vander Lans Water Balance Model (Appendix I) documents the assumptions and results related to several scenarios simulations for the LVL/Los Coyotes WRP Project.

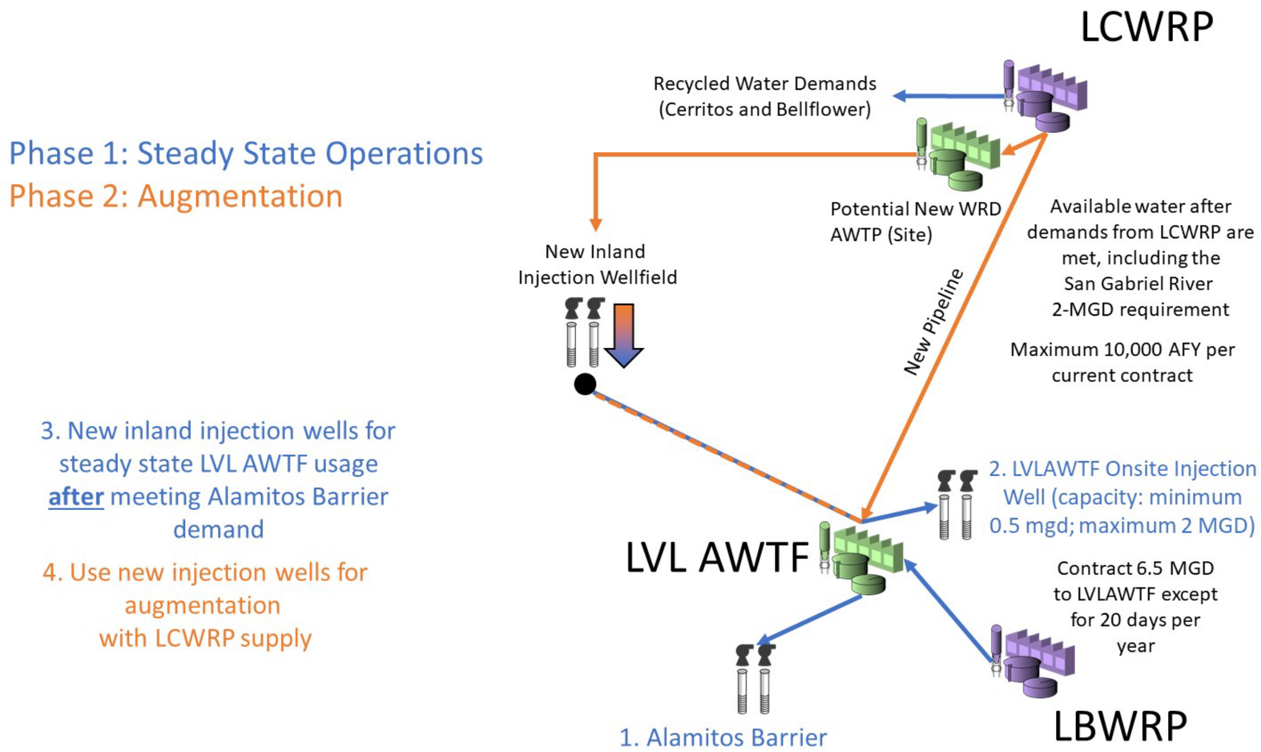


Figure ES-8. System Schematic Showing Main Project Components by Phase

Notes:

LBWRP = Long Beach Water Reclamation Plant

LCWRP = Los Coyotes Water Reclamation Plant

The estimated groundwater injection flows and extractions results from the Los Coyotes WRP Water Balance Model scenarios were used as inputs to the basin groundwater model discussed in Section 4.2.3. The intent was to determine the impact of future operations in the groundwater basin under these scenarios.

The model runs considered the following input variations:

- Location of the expansion: On the Los Coyotes WRP property or adjacent to the Long Beach WRP
- Size of the expansion: The initial estimate doubled the current LVL AWTF capacity of 8-MGD product water; other plant sizes were also tested
- Equalization storage volume: Between 0.1 and 6 million gallons (MG)

The LVL/Los Coyotes WRP Water Balance Model also considered Los Coyotes WRP effluent availability under different tertiary water demands and demands for Alamitos Barrier injection water to be provided by the LVL AWTF.

Optimization model runs resulted in eight different model scenarios with combinations of treatment and equalization storage that would minimize the unit costs of new advanced treated water and use the available 10,000 AFY of supply from the Los Coyotes WRP. Combinations of treatment capacity and equalization storage were determined for each of the scenarios so that the unit cost for the advanced treated water would be minimum, and the WRD allocation of Los Coyotes WRP tertiary effluent would be used in its entirety.

The eight different model simulations that were carried over for final analysis are presented above in Table ES-1. The scenarios considered variations in the location of the expansion and availability of influent flows to the AWT plants from Long Beach WRP and Los Coyotes WRP.

Table ES-2 shows model results for all eight scenarios, the unit cost for the new advanced treated water, the required AWT production capacity, the required size of equalization storage, and the additional flow from the LBWRP that has been used above the minimum flows determined by the contract.

The lowest unit cost project size suggests the following:

- Advanced treated water expansion at current Long Beach WRP/LVL AWTF location might be more cost efficient than a new AWT plant at the Los Coyotes WRP.
- AWT expansion of 8.1 MGD with 3.8 million gallons of equalization storage could better accommodate uncertainties related to future Los Coyotes WRP demands and uncertainties about additional water that could be provided by the Long Beach WRP.

Table ES-2. Summary of Model Results Related to Facilities Size and Unit Cost of Water

Alternatives where Long Beach WRP Excess Backfills LVL (Alt 1)	**Units**	**Long Beach WRP Location**		**Los Coyotes WRP Location**	
		2a	**2b**	**3a**	**3b**
New Water Cost ($/AF)	$/AF	$1,271.00	$1,327.00	$1,482.00	$1,550.00
Production Capacity (NEW treatment)	MGD	**7.3**	**8.1**	**8.8**	**8.2**
EQ Storage	MG	0.87	3.83	0	3.27
Additional Long Beach water used (beyond 6.5 MGD)	AFY	1,457	1,457	1,233	1,233
	MGD	1.3	1.3	1.1	1.1
Alternatives where No Long Beach WRP Excess Used (Alt2)	**Units**	**Long Beach WRP Location**		**Los Coyotes WRP Location**	
		2a	**2b**	**3a**	**3b**
New Water Cost ($/AF)	$/AF	$1,408.00	$1,455.00	$1,485.00	$1,553.00
Production Capacity (NEW treatment)	MGD	**5.6**	**6.5**	**8.8**	**8.2**
EQ Storage	MG	1.24	3.11	0	3.27
Additional Long Beach water used (beyond 6.5 MGD)	AFY	-	-	-	-
	MGD				

Note:

All scenarios assume capacity of treatment and equalization (Eq) storage to use 10,000 AFY of Los Coyotes effluent.

AF = acre-foot (feet)

The following is a summary of the lowest unit costs achieved by the scenario runs presented.

Expansion Located at the Current Long Beach WRP/LVL AWTF Site

Optimization results from the model indicate slightly different treatment capacities and equalization tank sizes for the two scenarios presented in Table ES-2:

- Scenario a: The optimization results returned an expansion of 7.3 MGD (of product water, in addition to the current 8-MGD LVL AWTF capacity) with an equalization tank of 0.87-MG capacity. The total unit was $1,271 per AF.

- Scenario b: The optimization results returned an expansion of 8.1 MGD (of product water, in addition to the current 8-MGD LVL AWTF capacity) with an equalization tank of 3.83-MG capacity. The total unit cost was $1,327 per AF.

The scenarios where additional Long Beach WRP flows (above contractual minimums) were not considered had greater costs than the alternatives where the additional, available flow was used to produce advanced treated water.

Expansion Located at the Los Coyotes WRP

Optimization results from the model indicate slightly different treatment capacities and equalization tank sizes for the two scenarios presented in Table ES-2:

- Scenario a: The optimization results returned a new Advanced Water Treatment Plant (AWTP) of 8.8 MGD (of product water) located at the Los Coyotes WRP with no equalization tank. The total unit cost was $1,482 per AF.
- Scenario b: The optimization results returned a new AWTP of 8.2 MGD (of product water) located at the Los Coyotes WRP with an equalization tank of 3.27-MG capacity. The total unit cost was $1,550 per AF.

The scenarios where additional Long Beach WRP flows were not considered (above contractual minimums) had slightly greater costs than the alternatives where the additional, available flow was used to produce advanced treated water.

4.2.2 Leo J. Vander Lans AWTF Expansion Feasibility Evaluation

The LVL AWTF is owned and operated by the WRD. The facility provides advanced treatment to water supplied from the adjacent Long Beach LBWRP prior to groundwater injection into the Alamitos Seawater Barrier. It can produce up to 8 MGD of water through treatment by MF, RO, and UVAOP. Future plans are in place for the facility to receive additional water from the Long Beach WRP and, potentially, new water from the Los Coyotes WRP, located about 6 miles north, as a supplemental source. As more water is provided from the Long Beach WRP and Los Coyotes WRP, the treatment capacity of the LVL AWTF must be expanded to support the additional injection. TM 6.2.2, LVL AWTF Expansion Feasibility (Appendix J) evaluates the feasibility of providing an additional 8 MGD of advanced water treatment at two locations: (1) the Long Beach WRP site that is adjacent to the existing LVL AWTF site, and (2) the Los Coyotes WRP site.

A conceptual design and layout were developed for each site, as shown in Figures ES-9 and ES-10, and are based on the following assumptions:

- An expansion capacity of 8 MGD was assumed based on the results of the Water Balance Model, which suggest that the new AWTF could range in capacity from 5.6 to 8.8 MGD.
- The new facility matches the current treatment process used at LVL AWTF and the overall plant recovery (92%). Area requirements for treatment units were sized using existing footprints at the LVL AWTF. Treatment of MF backwash waste with dissolved air flotation (DAF) was omitted from the new facility because WRD currently bypasses DAF and performance is acceptable.
- To minimize site area requirements, the main treatment processes (that is, MF, RO, and UVAOP) were collocated in a single, two-story building located above a below-grade equalization tank. The configuration of ancillary facilities (for example, a chemical building) and some treatment processes (for example, decarbonation and water stabilization) were adjusted to best fit individual site constraints.

An estimated 2.7 acres of land is available at the Long Beach WRP site immediately south of the existing LVL AWTF, compared to only 1.5 acres of available land at the southern end of the Los Coyotes WRP site. The proposed layouts show that both sites can accommodate an 8-MGD AWTF, but implementation challenges are present at both. Key considerations at the Long Beach WRP site include the significant fill requirement because of the 16-foot grade difference between the existing LVL AWTF grade and the proposed site, and the existing sewer discharge limitation that would require significant sewer system improvements to accommodate the increased waste discharge flow. Although there are no sewer limitations at the Los Coyotes WRP site, the limited space available at the southern end of the site and the underground utilities and yard piping nearby would present challenges during construction. Additionally, odor from the aeration tanks at the south end of Los Coyotes WRP and the potential impact on Los Coyotes WRP operations from chemical deliveries to the AWTP would also have to be considered.

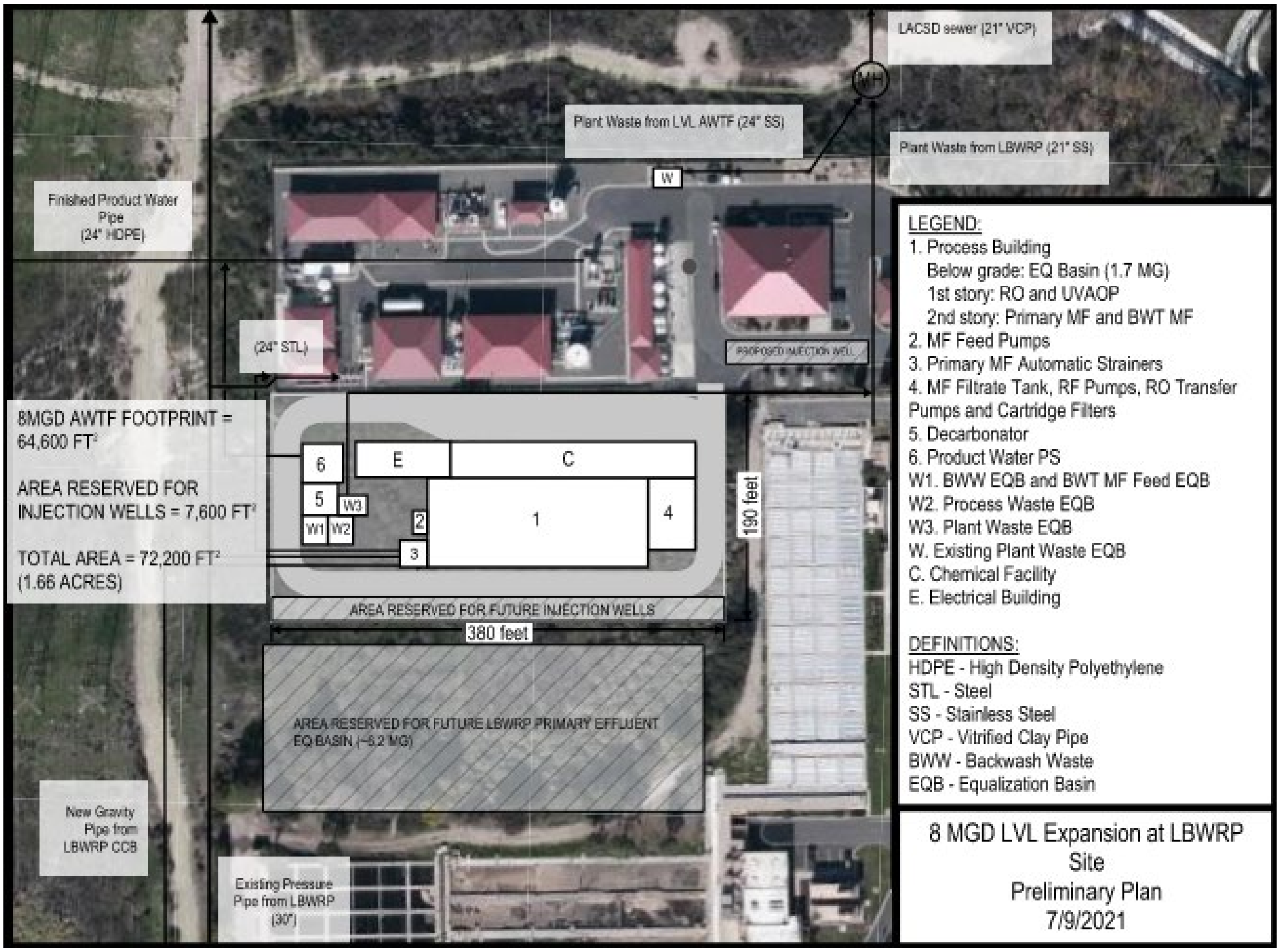


Figure ES-9. Expansion Advanced Water Treatment Plant Layout at the Long Beach Water Reclamation Plant Site

Source: Americas Imagery Catalog (Jacobs.com)

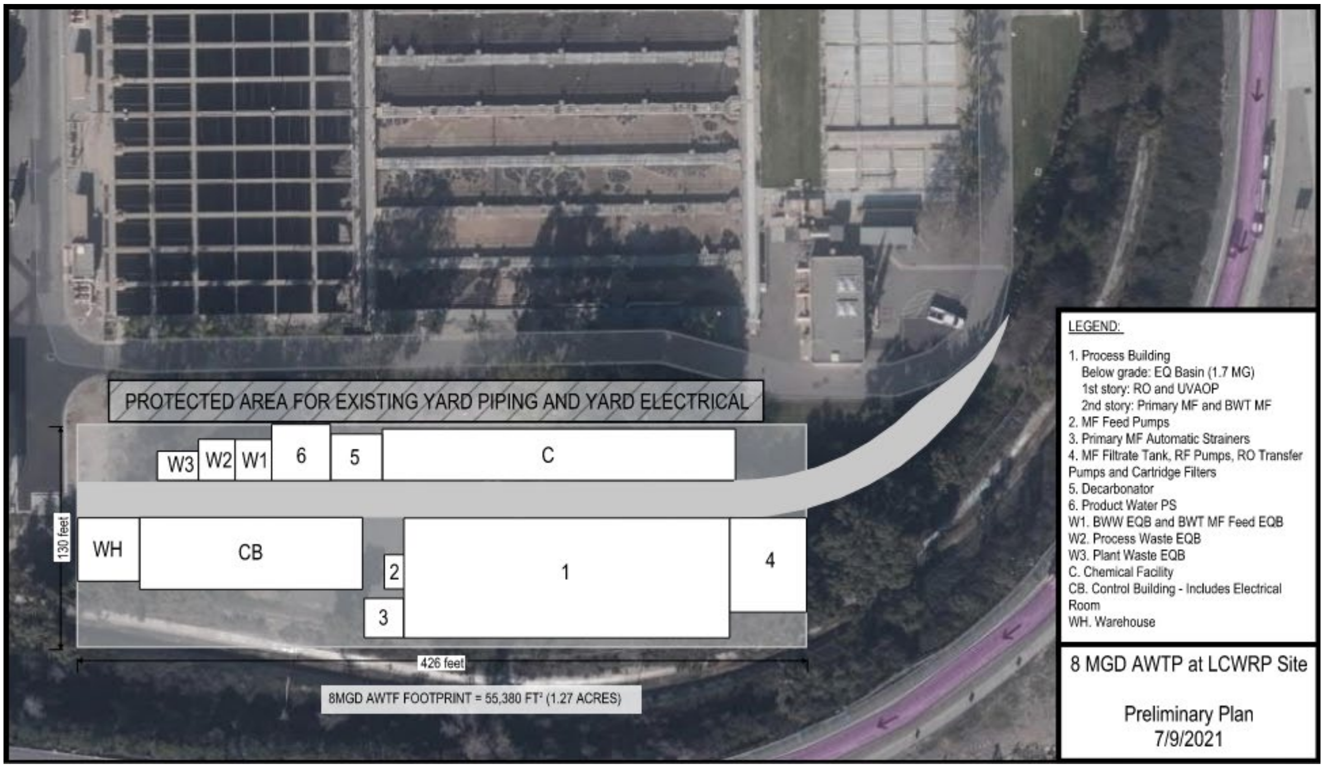


Figure ES-10. New Advanced Water Treatment Plant at the Los Coyotes Water Reclamation Plant Site
Source: Americas Imagery Catalog (Jacobs.com)

4.2.3 LVL AWTF Groundwater Modeling

Groundwater modeling was conducted to evaluate replenishment and augmentation Project Concepts near the LVL AWTF and Los Coyotes treatment facilities. Phase 1 groundwater modeling included a hydrogeologic evaluation of replenishment/augmentation near the LVL AWTF. The objective of Phase 2 groundwater modeling for the LVL AWTF and Los Coyotes components was to evaluate the hydrogeologic feasibility of replenishment and augmentation at the LVL and Los Coyotes facilities. Phase 2 groundwater modeling approach, results and recommendations are presented in TM 6.2.4 (Appendix K).

Phase 2 modeling incorporated scenarios from a new LVL/Los Coyotes WRP Water Balance Model and data and plans from the Long Beach Water Department (LBWD). Scenario 7 from the Hyperion WRP Water Balance Model was modified to maximize LBWD's extractions at existing wells and incorporate information from LBWD's Water Resources Plan (LBWD 2019). Two scenarios from the LVL/Los Coyotes Water Balance Model were identified for evaluation using the groundwater model, as they represented the maximum amount of advanced treated recycled water available for recharge near the LVL AWTF and Los Coyotes facilities, respectively:

1) Alternative 1, 2a: Expansion at LVL AWTF
2) Alternative 1, 3a: Expansion at Los Coyotes WRP

Alternative 1 corresponds to availability of excess water from the Long Beach WRP, above 6.5 MGD to backfill the LVL AWTF to fully utilize available treatment capacity. The variants 2a and 3a correspond to Los Coyotes WRP allocation based on historical data. The modified Hyperion WRP Scenario 7 was combined with the two LVL/Los Coyotes WRP Water Balance Model scenarios for hydrogeologic feasibility assessment. The assessment focused on the new injection locations, including the new 2-MGD well at LVL AWTF, and evaluating whether full replenishment was feasible or whether augmentation would be required to mitigate high water levels. The locations of injection wells were identified based on model transmissivity, proximity to existing extraction locations, site feasibility, and proximity to Metropolitan's recycled water backbone conveyance system or to the LVL AWTF. Modeling results indicated:

- Replenishment near the LVL AWTF is constrained by high water levels in the injected (confined) sequences.
- Augmentation near the LVL AWTF lowers water levels at the LVL AWTF injection wells by approximately 10 feet compared to the Replenishment Scenario. However, water levels still rise above the threshold at the injection locations.
- Replenishment near the Los Coyotes Facility is more feasible compared to replenishment near the LVL AWTF, with intermittent exceedances of the threshold at wells closer to the LVL AWTF.
- Augmentation in the Los Coyotes area decreases water levels at the Los Coyotes injection wells by an average of approximately 10 feet. Three locations intermittently exceed the high water level threshold in the Los Coyotes area.

For all the injection locations, particle-tracking results indicated that the Title 22 minimum residence time requirement of 6 months is satisfied. Water quality data were compiled from state databases for a preliminary evaluation of contaminated sites and depths near the injection and extraction wellfield locations. Preliminary water quality data compilation and evaluation indicated that (based on the data reviewed) areas close to the LVL AWTF and Los Coyotes facilities have few locations with contamination deeper than 500 feet. However, the absence of data does not necessarily imply the absence of contamination; therefore, future work should include a more comprehensive water quality evaluation with site-specific field data collection in and around proposed injection and extraction facilities.

The Phase 2 evaluation was limited to hydrogeologic feasibility of replenishment and augmentation scenario. The subsequent phase of modeling will need to include assessment of potential MPH (including a more comprehensive water quality evaluation) in addition to any LBWD and Metropolitan future plans. Field data from WRD's 2-MGD well installation program at LVL AWTF should be used to validate the LACPGM model and high water levels. The Phase 2 results will need to be evaluated in a future phase based on pumpers rights, future demands, and interest in augmenting their pumping rights through additional extractions.

5. Conclusions and Next Steps

Two distinct projects were identified in this Joint Master Plan through a project development and screening process conducted with WRD and LADWP: the Hyperion WRP Project and the LVL/Los Coyotes WRP Project. Through the use of the Water Balance Models developed for each project, in conjunction with hydrogeologic, MPH, and real estate considerations, groundwater modeling of potential replenishment and extraction well locations in the Central Basin was conducted. Several feasible locations were identified that can be carried forward into future phases of study.

Additionally, for the Hyperion WRP Project, a routing study of three potential backbone conveyance options was conducted that informed the selection of potential replenishment and extraction well locations. These alignments can be advanced for further evaluation under LADWP's Operation NEXT. An injection test well work plan was also prepared for implementation in coordination with WRD and LADWP to verify the feasibility of injection of advanced treated water in the Los Angeles Forebay.

For the LVL/Los Coyotes WRP Project, no fatal flaws were identified for the two locations evaluated for providing advanced treatment of Los Coyotes WRP effluent (that is, at the Los Coyotes WRP and as an expansion to LVL AWTF). As such, both sites were found to be worthy of further consideration. Although the scope of this evaluation for expanded advanced treatment at LVL AWTF assumed the implementation of a new conveyance system from Los Coyotes WRP to LVL AWTF, a suggestion to explore the use of the San Gabriel River to convey the tertiary effluent from Los Coyotes WRP was made by one of the stakeholders. Although potentially challenging to permit and implement, this suggestion may be worthy of further consideration.

An injection test well with a capacity of 2 MGD is being constructed by WRD at the LVL AWTF. Once operation commences and data are collected on well capacity and water quality, refinements to the assumptions in the water balance and groundwater modeling analyses for the Los Coyotes WRP Project may be considered. Additionally, the analyses for this Joint Master Plan were being conducted just as the LBWD was initiating its Water Supply Optimization and Supply Management Study, which is intended to shift its water resource strategy to prioritize the use of local water supplies. Plans resulting from that study that identify the development of injection and extraction facilities in the Basins in coordination with WRD can be incorporated into updated evaluations and revisions to this Joint Master Plan.

6. Acknowledgements

The Jacobs team would like to express our sincere gratitude and appreciation for all of the stakeholders engaged in developing this Joint Master Plan. This collaboration was instrumental to staying focused on the task at hand, while balancing respective priorities and objectives. The following stakeholders contributed to the success of this Joint Master Plan project:

Long Beach Water Department – The team would like to thank the LBWD for providing demand and supply projections, GIS datasets, information on its Adaptive Management Plan, and additional input on representative scenarios for inclusion into groundwater modeling. We anticipate continued collaboration as LBWD further develops its plans for injection and extraction facilities.

California Department of Toxic Substances Control (DTSC) – The team would like to thank DTSC staff for working with WRD and INTERA and providing additional information on the status and depth of contamination at environmental sites in the Central Basin near the proposed project areas.

Environmental Protection Agency (EPA) - The team would like to thank EPA staff for working with WRD and providing information on the known major areas of contamination in the Central Basin near the proposed project areas.

LACSD – We thank LACSD for its cooperation and invaluable feedback provided in the alternatives AWT site analysis for the LVL/Los Coyotes WRP Project, particularly for the Los Coyotes WRP location.

The team gratefully acknowledges all those who provided technical and consulting input to make this Joint Master Plan a success.

The team would also like to formally thank **WRD** for leading the groundwater replenishment goals and strategy as well as **LADWP** for leading the efforts on how best to recharge groundwater for future drinking water use. WRD and LADWP worked together graciously to lead the Joint Master Plan efforts effectively.

The team also would like to pay tribute to our **Blue Ribbon Panel** made up of industry leading experts providing strategic advice that created a strong foundation for the Joint Master Plan, including **Jim Stahl**, former General Manager of LACSD; **Ken Weinberg**, former Director of Water Resources for the San Diego County Water Authority; **Ron Gastelum**, former General Manager of Metropolitan; and **Bob Harding**, former Program Manager of the Metropolitan/LACSD Regional Recycled Water Program.

The team's subconsultants provided paramount technical services which fundamentally supported this Joint Master Plan. The team formally thanks **INTERA Incorporated** for its groundwater modeling and contamination assessments and **Epic Land Solutions** for providing entitlement and property acquisition services.

7. References

California Water Boards. 2022. *GAMA Groundwater Information System*. Accessed April 23, 2021. https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/.

CDM Smith Inc. 2012. Final Design for the Leo J. Vander Lans Water Treatment Facility for the Water Replenishment District of Southern California: Pump Station Preliminary Design Report. June 28.

Long Beach Water District. 2019. Water Resources Plan. Prepared by CDM Smith. December. https://lbwater.org/wp-content/uploads/2020/04/LBWD-WRP-1.pdf.

Los Angeles Department of Water and Power (LADWP). 2019. Draft Groundwater Development and Augmentation Plan, Phase 1 Report, Central Basin, Los Angeles. Review Draft. March 14.

Paulinski, S., ed. 2021. Development of a groundwater-simulation model in the Los Angeles Coastal Plain, Los Angeles County, California: U.S. Geological Survey Scientific Investigations Report 2021-5088, 489 p. https://doi.org/10.3133/sir20215088.

Superior Court of California. 2013. Central and West Basin Water Replenishment District v. Charles E. Adams. 2013. Third Amended Judgment. https://rights.wrd.org/docs/CB_Third_Amended_Judgement.pdf.

Superior Court of California. 2014. California Water Service Company et al. v. City of Compton et al. Amended Judgment. https://rights.wrd.org/docs/WCB_Amended_Judgement.pdf.

Water Replenishment District of Southern California (WRD). 2016a. *Groundwater Basins Master Plan*. Final Report. September 2016. Accessed at: https://www.wrd.org/content/groundwater-basins-master-plan.

Water Replenishment District of Southern California (WRD). 2016b. *Groundwater Basins Master Plan*. Final Program Environmental Impact Report. September. Accessed at: https://www.wrd.org/sites/pr/files/WRD%20Groundwater%20Basins%20MP%20FPEIR.pdf.

Water Replenishment District of Southern California (WRD). 2019. Regional Groundwater Monitoring Report Water Year 2017-2018. March.

Water Replenishment District of Southern California (WRD). 2022. Groundwater Contamination Prevention Program. https://www.wrd.org/GCPP.

Appendix A
TM 1-Identification of System Components

Jacobs

Memorandum

1000 Wilshire Boulevard, Suite 1140
Los Angeles, California 90017
United States
T +1.213.538.1388
F +1.230.538.1399
www.jacobs.com

Subject	**Technical Memorandum 1 – Identification of System Components – Final**
Project Name	WRD and LADWP Joint Los Angeles Basin Replenishment and Extraction Master Plan
Date	May 20, 2019 (Revised)

1. Introduction

The Water Replenishment District of Southern California (WRD) and the Los Angeles Department of Water and Power (LADWP) have initiated a partnership to identify solutions to maximize use of the Central and West Coast groundwater basins through development of the Joint Los Angeles Basin Replenishment and Extraction Master Plan (Joint Master Plan). The Joint Master Plan will use a regional approach to identify a comprehensive list of existing and potential new replenishment water sources, treatment facilities, and replenishment and extraction locations, herein referred to as "system components." These system components will then be screened and used to develop implementable, complementary projects that can be initiated upon completion of the plan.

A kickoff meeting with WRD, LADWP, and Los Angeles Sanitation and Environment (LASAN) was held on March 4, 2019, followed by a workshop on March 29, 2019, to identify and discuss Joint Master Plan goals, system components, and potential project configurations. This technical memorandum is the first deliverable of the Joint Master Plan. It describes the plan's setting and recommends system components to be used in project development. This technical memorandum is organized into the following sections:

- Section 1 – Introduction
- Section 2 – Joint Master Plan Goals
- Section 3 – System Background
- Section 4 – System Components
- Section 5 – System Component Selection Criteria
- Section 6 – Component Screening Recommendations
- Section 7 – Matrix of Previously Identified Projects and Components
- Section 8 – Initial Project Ranking Criteria
- Section 9 – Conclusions

2. Joint Master Plan Goals

This section presents a brief description of the two agencies responsible for the development of the Joint Master Plan, the individual agencies, and the overall Joint Master Plan goals.

2.1 Water Replenishment District of Southern California

The WRD is a State Special District that was established in 1959 to manage the groundwater resources within the Central Basin and West Coast Basin in southern Los Angeles County. WRD's mission is to provide, protect, and preserve high-quality groundwater through innovative, cost-effective, and environmentally sensitive basin management practices for the benefit of residents and businesses of these groundwater basins. The aquifers in the Central and West Coast Basins provide about 40% of the total water needs for the people and businesses in the 43 cities covering WRD's 420-square-mile service area.

To accomplish its mission, WRD conducts managed aquifer recharge using imported water, recycled water, and stormwater; prevents seawater intrusion through injection of imported water and recycled water into coastal barrier wells; protects and preserves groundwater quality through monitoring, testing, data analysis, and treatment; and ensures a future supply of reliable groundwater through planning, conjunctive use, and development of new projects. WRD coordinates basin replenishment with the Los Angeles County Department of Public Works, which owns and operates the spreading grounds and seawater intrusion barriers.

In 2003, WRD's Board of Directors began the Water Independence Now (WIN) program to protect the security of the region's groundwater supplies. WIN is a suite of projects aimed at maximizing local stormwater and recycled water sources to replenish, preserve, and protect two of the most used urban groundwater basins in the nation. Historically, a large percentage of imported water was used to replenish groundwater basins in the WRD service area. However, through the implementation of components of the WIN program to date and completion of the Albert Robles Center for Water Recycling and Environmental Learning (ARC), WRD has significantly reduced its dependence on imported water and became independent of imported water in 2019 (WRD 2019a).

2.2 Los Angeles Department of Water and Power

LADWP began in 1902 as a municipal water system and grew to become the largest municipally owned utility in the nation. LADWP's mission is to provide customers and the communities with safe, reliable, and cost-effective water and power in a customer-focused and environmentally responsible manner. As a department within the City of Los Angeles (also referred to as the City), LADWP primarily supplies water to the City of Los Angeles, serving a population of approximately 4 million people within 472 square miles. LADWP's water system is currently the nation's second largest municipal water utility and is responsible for supplying, treating, and distributing water to the City of Los Angeles. LADWP has identified three areas as its top priorities: safety of drinking water, reliability of water infrastructure, and sustainability of water supplies. LADWP's portfolio of water sources include water imported from the Owens Valley via the Los Angeles Aqueduct, imported water purchased from the Metropolitan Water District of Southern California (Metropolitan), groundwater, stormwater, and recycled water (LADWP 2018).

2.3 Agency and Interagency Goals

2.3.1 Water Replenishment District of Southern California Goals

With WRD's objective of 100% independence from imported water for groundwater replenishment being met by the WIN program, WRD's 2040 Plan, "WIN 4 ALL," sets forth the following new goals:

- Use of full pumping rights by pumpers
- Identification and development of new replenishment sources and locations available to WRD
- Maximization of the use of available groundwater storage
- Achievement of 100% reliance on groundwater within the service area by 2040

2.3.2 Los Angeles Department of Water and Power Goals

Sustainable City pLAn. In April 2015, Mayor Eric Garcetti issued the City's Sustainable City pLAn, which established targets for the City over the next 20 years to strengthen and promote sustainability. The City pLAn has been recently called the LA's Green New Deal. The pLAn set forth the following water resources targets (Garcetti 2019):

- Source 70% of Los Angeles' water locally and capture 150,000 acre-feet per year (AFY) of stormwater by 2035
- Recycle 100% of all wastewater for beneficial reuse by 2035
- Build at least 10 new multi-benefit stormwater capture projects by 2025; 100 by 2035; and 200 by 2050
- Reduce potable water use per capita by 22.5% by 2025; and 25% by 2035; and maintain or reduce 2035 per capita water use through 2050
- Install or refurbish hydration stations at 200 sites, prioritizing municipally owned buildings and public properties such as parks, by 2035

Senate Bill 332. On February 19, 2019, Senators Hertzberg and Wiener introduced a bill that would require each wastewater treatment facility that discharges through an ocean outfall to reduce the facility's annual flow by at least 50% by 2030 and at least 95% by 2040.

Los Angeles Reuse Goal. On February 21, 2019, Mayor Eric Garcetti announced that the City will recycle 100% of its wastewater from all four of its reclamation plants, for beneficial reuse, by 2035.

2.3.3 WRD-LADWP Partnership and Interagency Goals

WRD and LADWP entered into a Memorandum of Understanding (MOU) on September 19, 2018. The MOU initiated a 3-year partnership between the agencies to develop groundwater resources in the greater Los Angeles area. In evaluating each agency's goals, the following interagency goals have been identified to guide Joint Master Plan development:

- Reduce the purchase of imported water
- Increase replenishment of and extraction from the Central and West Coast Basins
- Increase resiliency of the region by utilizing available storage capacity in the basins

2.4 Joint Master Plan Need, Purpose, and Objective Statements

To guide development of the Joint Master Plan, it is important to develop a common understanding and achieve concurrence among WRD and LADWP on its fundamental rationale. The California Environmental Quality Act requires that an environmental impact report contain a statement of the objectives sought by a proposed project. This statement of objectives aids in development of a reasonable range of alternatives that will be evaluated in the environmental impact report. The National Environmental Policy Act requires that a project's Environmental Impact Statement include a statement of purpose and need to which the proposed project is responding. The Joint Master Plan Need, Purpose and Objectives provided in this technical memorandum will serve as standard language for future environmental documentation of the plan and resulting projects.

2.4.1 Joint Master Plan Need

The Central and West Coast Basins currently supply approximately 40% of the water demand of the overlying areas. Additional demand is primarily met through imported water from the Los Angeles Aqueduct or purchased from Metropolitan. Historically, the availability of low-priced potable water from Metropolitan has caused pumping within the WRD service area to be below the adjudicated levels, indicating underutilization of the groundwater basins and reliance on purchased imported water, which is subject to supply availability, energy costs, natural disasters, and climate variability. Efforts to reduce reliance on imported water have already been initiated by WRD and LADWP throughout their respective jurisdictions.

To further offset the need for purchased imported water, recycled water is identified as a key local water supply source through groundwater replenishment. The City of Los Angeles' Hyperion Water Reclamation Plant (WRP) and the Sanitation Districts of Los Angeles County (LACSD) Joint Water Pollution Control Plant (JWPCP) are the two largest wastewater treatment facilities in the Joint Master Plan area. Their current combined discharge averages more than 450,000 AFY (400 million gallons per day [MGD]) through ocean outfalls. In response to recent state regulations and local goals, ocean discharges will be greatly reduced in coming years, driving a need for beneficial use of the effluent flows. With a combined available storage capacity of approximately 450,000 acre-feet (146,663 million gallons), the Central and West Coast Basins can be instrumental in storing water available from the Hyperion WRP and additional recycled water from other WRPs in the region.

To fully use the regional resources available and guide this sustainable groundwater strategy, the Joint Master Plan will identify a series of projects to enhance groundwater replenishment and extraction in the Central and West Coast Basins.

2.4.2 Joint Master Plan Purpose and Objectives

The primary purpose and objectives of the Joint Master Plan are to meet the WRD and City of Los Angeles goals described in Section 2.3 by identifying project strategies that can:

- Reduce reliance on purchased imported water
- Recycle 100% of the City's wastewater
- Increase replenishment of and extraction from the Central and West Coast Basins
- Increase resiliency of the region by utilizing available storage space in the basins

3. System Background

The objective of Task 1 of the Joint Master Plan is to develop a list of system components, which can be combined into projects to support WRD's and LADWP's Joint Master Plan goals. These potential projects will be further evaluated as part of Task 2 of the Joint Master Plan effort.

Several past studies have already analyzed different aspects of developing more local water sources for the Los Angeles area. Information from published reports, presented in Section 3.1, provides background on the overall system and its components.

3.1 System Boundaries

The Joint Master Plan study area intersects three major watersheds in the California South Coast Hydrologic region (Figure 1):

- Los Angeles River: an 834-square-mile watershed that drains to the Los Angeles River. More than 90% of the Los Angeles River is concrete lined for flood control purposes. The watershed contains 22 lakes and flood control reservoirs and several spreading grounds (basins that capture stormwater for groundwater recharge), mostly located at the foot of the San Gabriel Mountains. The Los Angeles River discharges to the Pacific Ocean at the city of Long Beach.

- San Gabriel River: a 640-square-mile watershed that drains to the San Gabriel River. Upper areas of the watershed are undeveloped. Several spreading grounds are located at the foot of the San Gabriel Mountains. The river discharges to the Pacific Ocean at the city of Long Beach.

- Santa Monica Bay: a 673-square-mile coastal watershed that extends from Ventura County to Long Beach. Main tributaries in this watershed include Ballona, Topanga, and Malibu creeks.

Figure 1. Major Watersheds Overlying the Joint Master Plan Area

Figure 2 shows WRD and City of Los Angeles service areas, along with the Central Basin and West Coast Basin boundaries. The WRD service area encompasses the Central and West Coast Basins. The LADWP service area includes the City of Los Angeles. Although WRD and LADWP have similar overall service area sizes of approximately 450 square miles, they only share approximately 94 square miles of jurisdictional area. Limiting the Joint Master Plan, system components, and potential projects to those in the overlapped area would also limit the benefit to groundwater and potential project partners that could benefit from future project implementation. Therefore, the boundaries of the Joint Master Plan are not limited to the WRD or the LADWP service areas but extend to the three watersheds overlying the City's and WRD's jurisdictional boundaries, as shown on Figure 2.

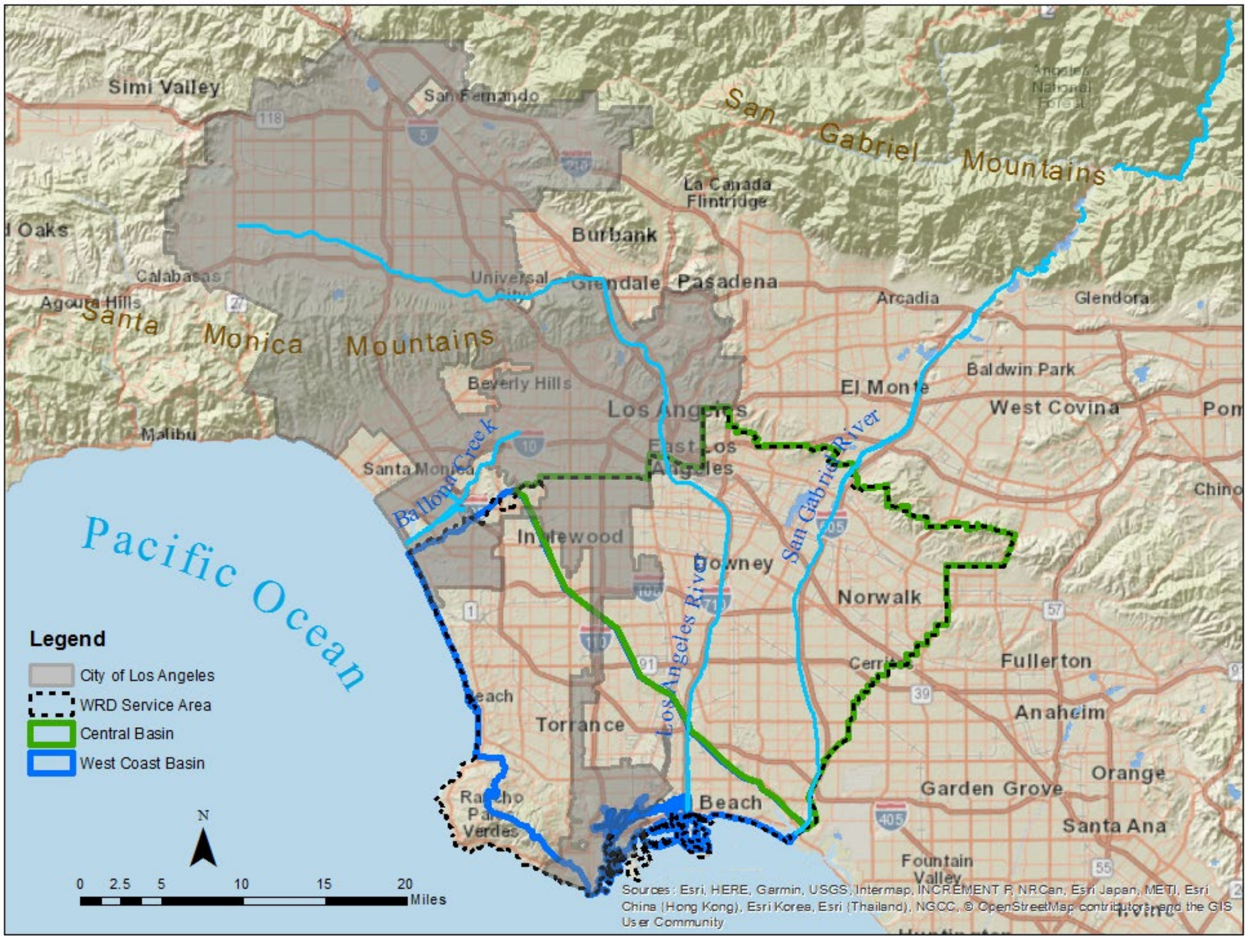


Figure 2. WRD and City of Los Angeles Service Areas, along with Central Basin and West Coast Basin Boundaries

3.2 System Supplies and Demands

The Joint Master Plan study area receives imported water from the Los Angeles Aqueduct and from Metropolitan's system (State Water Project and Colorado River Aqueduct). The goal to reduce imported water described in Section 2.3.1 is related to water that is purchased from Metropolitan.

The Joint Master Plan is mainly focused on system demands within the WRD and the City of Los Angeles service areas. The potable water demand for the City of Los Angeles has dropped from 700,000 to 500,000 AFY since 1987 (LADWP 2016). Of the total system potable water demand, it is estimated that an average of 86% is imported water (LADWP 2016) that includes the Los Angeles Aqueduct deliveries (29%) and water purchased from Metropolitan (57%).

A summary of imported water purchased from Metropolitan for delivery to the LADWP and WRD service areas follows:

- **City of Los Angeles Service Area:** Average total purchased imported water demand of 187,000 AFY (1969 to 2018) (LADWP 2016). The amount of purchased imported water has varied from 166,000 to 442,000 AFY since 2000. The range is highly variable depending on hydrological conditions that determine flows in the Los Angeles Aqueduct (preferred source of City-owned imported water). The last 6-year average (2013 to 2018) imported water system demand for the City of Los Angeles within the WRD service area was 58,600 AFY (28,300 AFY in the Central Basin and 30,300 AFY in the West Coast Basin).

- **WRD Service Area:** Average total imported water demand of 217,000 AFY for the last 6 years (2013 to 2018) for cities in the WRD service area, except the City of Los Angeles. Of the 217,000 AFY total, 93,000 AFY is used within the area overlying the Central Basin and 124,000 AFY is used within the area overlying the West Coast Basin. Imported water demands in the WRD service area (excluding City of Los Angeles) have been more consistent than the demands for the City of Los Angeles, varying from 183,000 to 255,000 AFY during the last 6 years.

The total imported water demand for the Joint Master Plan is estimated as the sum of the average imported water purchases: 187,000 AFY for the City of Los Angeles and 217,000 AFY for the WRD service areas for a total of 404,000 AFY. Demand is rounded to the nearest 1,000 AFY.

The objective of the Joint Master Plan is to identify projects that will provide for the replacement of purchased imported water by LADWP and by the water purveyors overlying the Central and West Coast Basins, as shown on Figure 3.

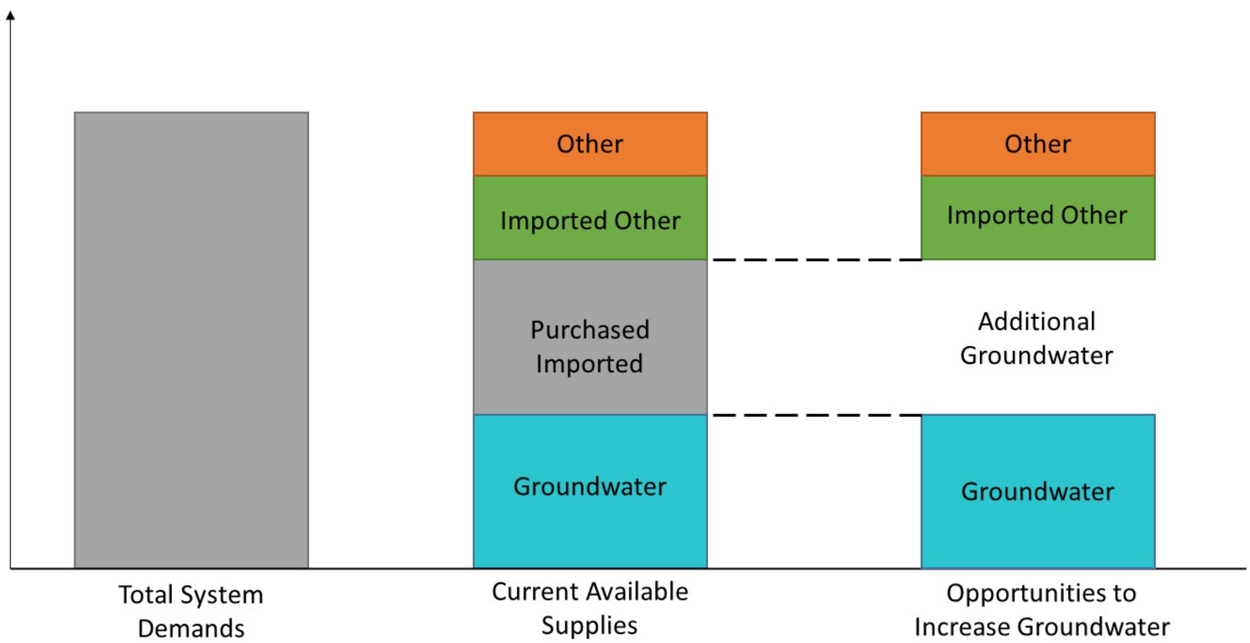


Figure 3. Replacement of Purchased Imported Water with Additional Groundwater Extraction

Figure 4 provides information about the top 10 imported water purveyors within the WRD service area, excluding the City of Los Angeles. The right-side bar chart of the figure shows the 6-year average of imported water use for the top water purveyors overlying the WRD service area. Most of the top 10 imported water purveyors are located within the West Coast Basin (approximately 111,000 AFY of demand).

Figure 4 also shows the well locations of these top imported water purveyors. Assuming future extraction facilities would be located near the purveyors' existing wells, this map can be used to indicate potential well locations in the basin that might offer existing and possibly significant opportunities to increase groundwater extraction as a means of offsetting purchased imported water demands.

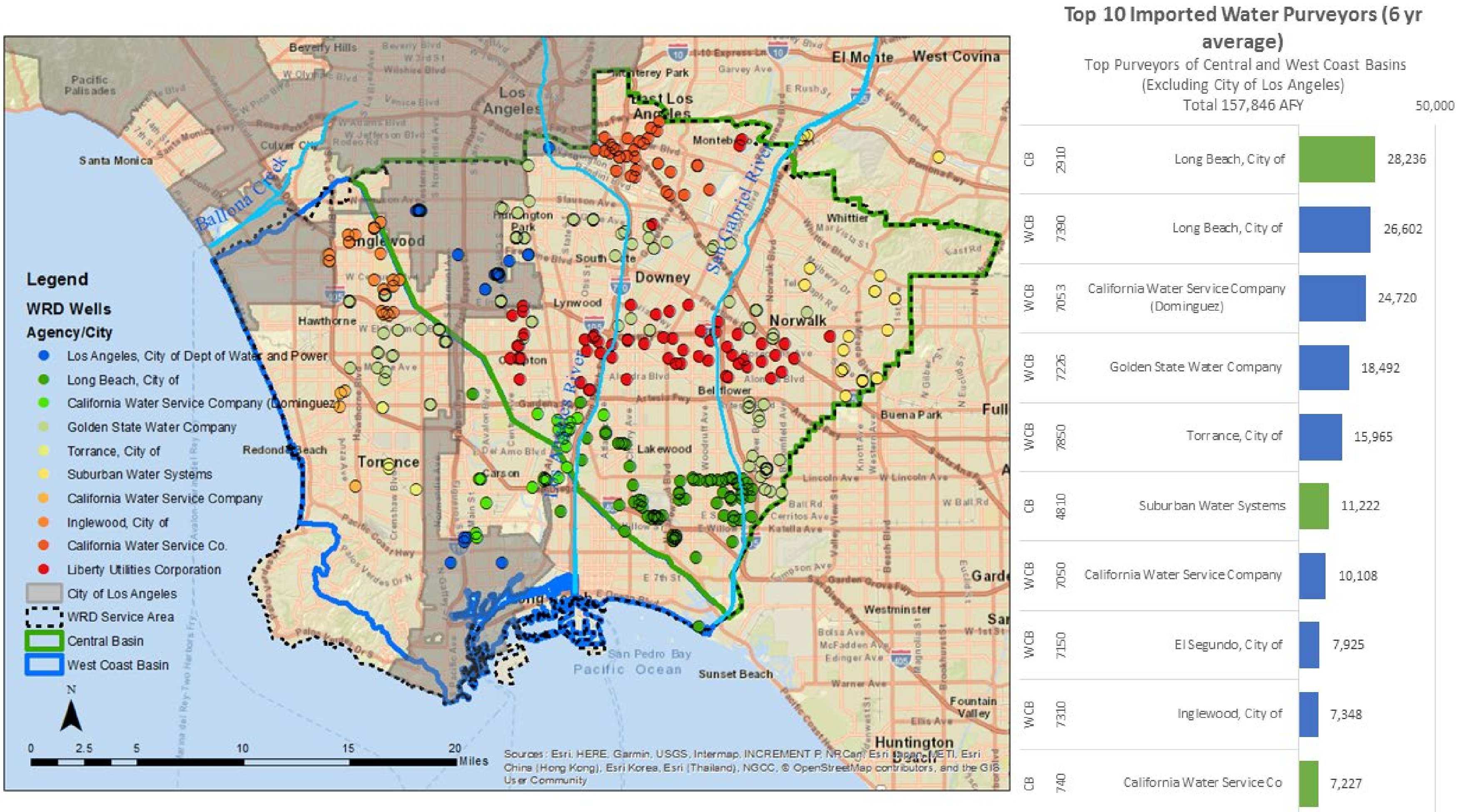


Figure 4. Top Imported Water Purveyors within WRD Service Area (excluding City of Los Angeles)

4. System Components

The figure in Attachment 1 illustrates locations of possible resources and facilities for source water supply, advanced treatment, replenishment, and extraction to achieve the Joint Master Plan goals. The figure in Attachment 1 shows the approximate location of the system components described in Sections 4.1 through 4.4 related to the Central and West Coast Basins. Sections 4.1 through 4.4 provide further discussion of each component.

4.1 Source Water Supply

Potential water sources for groundwater replenishment include wastewater, stormwater (dry and wet weather runoff), and imported water.

In the City of Los Angeles, recycled water is produced by LASAN at its four WRPs: the Donald C. Tillman WRP, Los Angeles-Glendale WRP, Hyperion WRP, and Terminal Island WRP. The wastewater treated by these facilities is collected from the City and 29 satellite agencies (21 agencies and 8 cities). The satellite agency flows constitute approximately 15% of the total treatment plant influent flows. Treatment process solids from Donald C. Tillman WRP and Los Angeles-Glendale WRP and wastewater flows that are not diverted to Donald C. Tillman WRP and Los Angeles-Glendale WRP are treated at the Hyperion WRP.

LACSD collects and treats wastewater from the southern areas of Los Angeles County. The wastewater is treated at 11 treatment plants, the largest of which is the JWPCP. It exceeds the nominal treatment capacity of the other 10 treatment plants combined. Five of these plants are in the Joint Master Plan study area: San Jose Creek WRP, Whittier Narrows WRP, Los Coyotes WRP, Long Beach WRP, and the JWPCP. The JWPCP is the terminal plant in the Joint Outfall System; all treatment process solids and wastewater flows that bypass the upstream plants are treated at the JWPCP.

Although there is currently a significant potential demand for recycled water in the region, on the order of 100,000 AFY based on the Twenty-Seventh Annual Status Report on Recycled Water Use (LACSD 2016), most of the effluent treated is discharged to the ocean via Hyperion WRP and the JWPCP.

Stormwater from the Los Angeles River and San Gabriel River watersheds is included as potential source water for the Joint Master Plan projects. This includes the Rio Hondo River, a tributary of the Los Angeles River watershed that is linked to the San Gabriel River.

Imported untreated and treated surface water from Metropolitan could be purchased for replenishment. During wet years, excess untreated surface water flows from the Los Angeles Aqueduct (City of Los Angeles-owned) may be available and will be considered as a potential replenishment source water supply. Also, during wet years, treated surface water may be purchased from Metropolitan and delivered to Los Angeles and other cities in the study area for potable use in lieu of groundwater extractions from the Central or West Coast Basins, this would save groundwater stored in the basin to be used under dry years.

Several potential sources for the supply of replenishment water have been identified for consideration. They include water reclamation facilities, advanced water treatment facilities (AWTFs), water imports, rivers, and aqueducts, as follows:

1) **Hyperion WRP – West Coast Basin** (S1 on Attachment 1) is a wastewater treatment plant located in Playa del Rey, bordering Dockweiler State Beach on Santa Monica Bay. The plant is the largest of its kind in the Los Angeles metropolitan area, rated at a capacity of 450 MGD (504,200 AFY). The recent average flow was 259 MGD (290,000 AFY) for the year 2018. The plant currently produces secondary

effluent that is discharged to the Santa Monica Bay through a 5-mile outfall. Of the recent average flow:

- Approximately 35 MGD are provided to the West Basin Municipal Water District (WBMWD) for additional treatment.
- Up to 1.5 MGD are committed for an advanced water purification facility for the Los Angeles International Airport.
- Potentially 25 MGD of influent sewage (East Valley sewer) will be diverted into the future to the Donald C. Tillman WRP. More recent flow data indicate this might be closer to 9-10 MGD.
- 36 MGD for in-plant use (25 MGD for once—through cooling and 11 MGD for consumptive use).
- The remaining secondary effluent flow of 161.5 MGD (181,000 AFY, based on the 2018 average flow) could be available for a groundwater augmentation project.

2) **JWPCP – West Coast Basin** (S2 on Attachment 1) is a wastewater treatment plant in the city of Carson. The JWPCP is the largest of LACSD's plants, rated at a capacity of 400 MGD (448,000 AFY), with a recent average flow for the year 2017 of 257 MGD (287,900 AFY). Secondary effluent flows of up to 190 MGD (213,000 AFY) are committed to the Metropolitan/LACSD Regional Recycled Water Project to produce 150 MGD of advanced treated water for groundwater recharge, with up to 14 MGD (14,000 AFY) designated for the Central Basin and up to 19 MGD (21,000 AFY) designated for the West Coast Basin. The potential available flow for additional augmentation projects is estimated to be the average production (257 MGD) minus the already committed flow (190 MGD), which equals 67 MGD (75,000 AFY). The potential exists for coordination with this project to maximize beneficial use of the groundwater storage for the region (Metropolitan 2019).

3) **Los Coyotes WRP – Central Basin** (S10 on Attachment 1) is a wastewater reclamation plant owned by LACSD and located in Cerritos. Its rated capacity is 37.5 MGD (42,000 AFY). It produced 21 MGD (23,000 AFY) in Fiscal Year 2015-2016. Of this, 26.9% is beneficially reused. Approximately 15 MGD (17,000 AFY) of recycled water could be available for groundwater augmentation projects (LACSD 2016).

4) **Long Beach WRP – Central Basin** (S11 on Attachment 1) is a wastewater reclamation plant owned by LACSD. It is located in Long Beach and has a rated capacity of 25 MGD (28,000 AFY). The quantity of recycled water in Fiscal Year 2015-2016 was 12 MGD (13,700 AFY). Of this annual total, 51.2% is beneficially reused; however, during the summer months, no recycled water is available for additional uses. This component is still considered because Long Beach is one of the top imported water purveyors in the basin (LACSD 2016).

5) **Los Angeles River – Central Basin** (S13 on Attachment 1) is an approximately 51-mile-long river spanning from the Simi Hills and the Santa Susana Mountains through Los Angeles County to Long Beach. The average current dry weather flow in the Los Angeles River is approximately 50,000 AFY but may be reduced to as little as 1,000 to 10,000 AFY in the future. This potential reduction may occur because of stormwater National Pollutant Discharge Elimination System permit requirements for water quality improvements, recycled water diversions for beneficial use, and Los Angeles River revitalization efforts. Although dry weather flow opportunities may be limited for augmentation projects, wet weather flows (estimated to range from 23,000 to 43,000 AFY) could be available for consideration under the Joint Master Plan (LADWP 2019).

6) **Los Angeles Aqueduct – Central Basin** (S17 on Attachment 1). Built and operated by LADWP, the aqueduct delivers water from the Owens River, located in the eastern Sierra Nevada, to Los Angeles. Flows from the Los Angeles Aqueduct are treated at the City's Los Angeles Aqueduct Filtration Plant in Sylmar. The current flow in the Los Angeles Aqueduct is approximately 248 MGD (278,000 AFY), and the projected future flow is estimated to be 266 MGD (298,000 AFY) because of completion of the Owens Lake Master Project (LADWP 2019). Any excess aqueduct water will likely go into the San

Fernando Basin, be stored in Antelope Valley, or be exchanged with Metropolitan or other agencies. However, during wet years, excess water flows from the Los Angeles Aqueduct could be considered as a potential source for groundwater augmentation projects.

7) **Metropolitan – Imported Water** is imported from outside the Los Angeles region from the Colorado River Aqueduct and State Water Project. Treated and untreated water is delivered by Metropolitan, and it can be purchased by its member agencies. In the Central and West Coast Basin areas, these member agencies include LADWP, WBMWD, Central Basin Municipal Water District, the City of Long Beach, the City of Compton, and the City of Torrance. Local water purveyors can purchase imported water through these member agencies (S12 on Attachment 1). One of the primary goals of the Joint Master Plan is to reduce or eliminate dependence on purchased imported water from Metropolitan. Purchased imported water, however, remains a viable backup when demand exceeds the local water supply. Although this imported water supply is currently targeted for reduction, it could potentially be a component of projects that will consider additional groundwater extraction in-lieu of Metropolitan-imported water delivered upstream of current delivery locations.

4.2 Advanced Treatment

The WRPs identified as source water supplies directly treat sewage from wastewater collection systems in the study area. Also, several treatment facilities in the study area provide advanced treatment to the effluent from these WRPs.

Existing AWTFs include the WBMWD Edward C. Little Water Recycling Facility (WRF) and Juanita Millender-McDonald Carson Regional WRP. Both provide multiple levels of advanced treatment for various end uses, including replenishment of the West Coast Basin, irrigation, and industrial uses. In addition, WRD has two advanced treatment facilities that provide replenishment in the Central Basin: the ARC and the Leo J. Vander Lans AWTF (LVL AWTF). The City of Los Angeles Terminal Island WRP also has an onsite AWTF that provides water for replenishment to the West Coast Basin.

New potential advanced treatment components that were identified in the background reports include advanced treatment at Hyperion WRP, either with full advanced treatment with reverse osmosis membranes and advanced oxidation, or with more limited tertiary treatment to provide nitrification/denitrification with membrane bioreactors. New AWTFs are also being considered for the San Jose Creek WRP, Los Coyotes WRP, JWPCP, or as a new satellite AWTF in the City's service area. The JWPCP AWTF is being addressed through the Metropolitan/LACSD Regional Recycled Water Program.

In addition, soil-aquifer treatment is included as an explicit advanced treatment component for projects that replenish via surface spreading.

Advanced treatment is required for direct injection into the groundwater basins. For the purposes of this study, advanced treatment is defined as treatment beyond the level provided with the source water supplies described in Section 4.1. Ten entities are possible components for providing advanced treatment for groundwater augmentation projects. These components are:

1) **Edward C. Little WRF – West Coast Basin** (T1 on Attachment 1) is owned by WBMWD and is located in El Segundo. In 2018, it treated 34 MGD (38,000 AFY) of secondary effluent from the Hyperion WRP, producing four different qualities of recycled water onsite and feeding other downstream treatment plants. One of the treatment streams is an AWTF that provides replenishment water for injection into the West Coast Basin Barrier Project. The 2016 Groundwater Basin Master Plan (WRD 2016) has estimated that the AWTF could be expanded onsite by 10 MGD (11,200 AFY) beyond its current capacity of 17 MGD (19,000 AFY). Expansion beyond 10 MGD could be accomplished in the vicinity of Edward C. Little WRF, but land would need to be acquired. Based on the information above, it is

estimated that 11,200 AFY (10 MGD) of capacity could be available for groundwater augmentation to meet Joint Master Plan goals.

2) **Juanita Millender-McDonald Carson Regional Water Reclamation Facility –West Coast Basin** (T2 on Attachment 1). Also owned and operated by WBMWD is the Juanita Millender-McDonald Carson Regional Water Reclamation Facility treats tertiary-treated water conveyed from the Edward C. Little WRF with nitrification and advanced treatment for industrial use. The existing site is constrained, and the current product water is fully committed to end users; thus, there is limited opportunity to expand or tap this plant for additional replenishment of the West Coast Basin. (WRD 2016)

3) **ARC – Central Basin** (T3 on Attachment 1) is a facility adjacent to the San Gabriel River in Pico Rivera. This component represents a potential expansion of the newly constructed ARC facility to provide additional replenishment water for the Central Basin. The basis of design report indicates a current design capacity of 13,000 AFY, with the potential to expand to 26,000 AFY. It is estimated that 13,000 AFY (12 MGD) of capacity could be available for groundwater augmentation to meet Joint Master Plan goals.

4) **LVL AWTF – Central Basin** (T4 on Attachment 1) is owned by WRD and is located in Long Beach. It produces advanced treated water for injection into the Alamitos Barrier Project to protect the Central Basin from seawater intrusion. The facility has recently been expanded to a capacity of 8 MGD (9,000 AFY). Approximately 1.8 MGD (2,000 AFY) could be available for groundwater augmentation to meet Joint Master Plan goals. Further expansion of this facility would require additional source water.

5) **New Hyperion WRP AWTF – West Coast Basin** (T5 on Attachment 1) is planned for conversion of the existing Hyperion WRP to produce advanced treated recycled water. A 1.5-MGD AWTF is expected to be completed in 2023 for product water use at Los Angeles International Airport. The results of this project and determination of available plant site capacity for flow equalization will inform the amount of flow available for groundwater augmentation (part of the Joint Master Plan goals), with ultimate flow estimated to be between 134 to 174 MGD (150,000 AFY to 195,000 AFY) of product water.

6) **New Hyperion WRP Nitrification/Denitrification Membrane Bioreactor – West Coast Basin** (T6 on Attachment 1) consists of the implementation of membrane bioreactor technology at Hyperion WRP to provide nitrification and denitrification. Depending on the results of pilot testing, 134 to 174 MGD (150,000 AFY to 195,000 AFY) of nitrification/denitrification secondary effluent could be available for Hyperion WRP for groundwater augmentation projects (part of the Joint Master Plan goals) (LADWP 2019).

7) **New JWPCP AWTF – West Coast Basin** (T7 on Attachment 1) represents the advanced treatment product water from the Metropolitan/LACSD Regional Recycled Water Program AWTF. Treated flows will range from 100 to 150 MGD (112,000 AFY to 168,000 AFY) (Metropolitan 2019).

8) **New Los Coyotes WRP AWTF – Central Basin** (T13 on Attachment 1) would provide up to 8.5 MGD (9,500 AFY) of advanced treated water for groundwater augmentation.

9) **New Soil Aquifer Treatment – Central Basin** (T9 on Attachment 1) provides recharge through infiltration of Los Angeles River stormwater along the power line easement between the Los Angeles River and Interstate 710 to recharge the Los Angeles Forebay. This component will provide approximately 5,000 AFY of flow for a groundwater augmentation project.

10) **Los Angeles Aqueduct Filtration Plant** was added for its ability to supply treated drinking water to the entire City of Los Angeles system. It is assumed that the capacity would be available for water extracted from the Central Basin as long as all of the Los Angeles Aqueduct flows are treated first.

4.3 Replenishment

Five groundwater basins are located in the Coastal Plain of Los Angeles, south of the Santa Monica mountains: West Coast, Central, North Central (unadjudicated part of Central Basin), Hollywood, and Santa Monica Basins. Of the five groundwater basins, only two are managed by WRD and are considered for the Joint Master Plan study:

- West Coast Basin, with approximately 120,000 acre-feet of available storage capacity
- Central Basin, with approximately 330,000 acre-feet of available storage capacity

These two groundwater basins are adjudicated, and the judgments set out maximum annual pumping rights for different parties. The North Central Basin is hydrogeologically connected to the Central Basin but is not adjudicated (LADWP 2019) and the Santa Monica Basin is hydrogeologically connected to the West Coast Basin. It is expected that adjacent groundwater basins would be considered in the Joint Master Plan if they impact Joint Master Plan goals. Recent amendments to the West Coast and Central Basin judgments allow for more flexible use of the available storage, thus providing an opportunity for additional basin recharge and extraction (Superior Court of California 2013; Superior Court of California 2014).

Artificial recharge (replenishment with recycled water or imported water) of the groundwater basins is provided primarily at spreading grounds and via injection wells. The existing spreading grounds are located in the Montebello Forebay area of the Central Basin. Current replenishment sources for spreading include local runoff, untreated imported water, and recycled water. The amount of recycled water that can be spread is limited by groundwater mounding, the permitted recycled water contribution (currently permitted for a maximum of 45% over a 10-year averaging period), and other factors. Total average annual replenishment through spreading over the past 20 years has been approximately 135,000 AFY.

The potential for additional spreading grounds in the Los Angeles Forebay area is considered for the Joint Master Plan. The Los Angeles Forebay was historically a recharge area for the Los Angeles River. However, the forebay's recharge function has been substantially reduced since the river channel was lined. Natural recharge is now limited to deep percolation of precipitation and subsurface inflow from the Montebello Forebay to the east, the Hollywood Basin, and relatively small amounts from the San Fernando Valley through the Los Angeles Narrows (WRD 2016).

Replenishment via injection is provided at the three existing seawater intrusion barriers:

- West Coast Basin Barrier Project (West Coast Basin)
- Dominguez Gap Barrier Project (West Coast Basin)
- Alamitos Barrier Project (Central Basin)

Recently, inland injection wells in the Montebello Forebay have been installed for replenishment of advanced treated water produced at the ARC facility. Expansion of the existing barrier well systems and the potential installation of new inland injection wellfields are considered for the Joint Master Plan.

Eighteen replenishment components are being considered for the Joint Master Plan. These components are described in order of current significance with respect to existing replenishment volumes provided. The components include spreading grounds (existing and potential), injection wells (existing and potential), and dry wells (potential). The replenishment components are as follows:

1) **Montebello Forebay (Rio Hondo and San Gabriel Spreading Grounds) – Central Basin** (R5 and R6 on Attachment 1) is the primary recharge facility for the Central Basin and is a hydrogeologically unconfined region downstream from the Whittier Narrows Dam that covers approximately 1,000 acres. Within the forebay, flows from the Rio Hondo and San Gabriel rivers are diverted into a

series of recharge basins for infiltration and percolation into the groundwater basin. The recharge basins have a total capacity of 362,000 AFY (500 cubic feet per second [cfs]); however, recharge is limited by operational constraints and groundwater mounding. An additional recharge of 17,000 AFY could be achieved but would depend on operational variables, including the location of additional extraction and availability of additional replenishment water (potentially to be supplied by ARC). The average recharge for the Montebello Forebay is 132,300 AFY (over the last 59 years).

Current imported water that is recharged at the forebay can be replaced by local supplies, averaging 17,000 AFY over the last 5 years. The recharge permit allows up to a 45% blend of recycled water to diluent water (imported water, stormwater, precipitation, and underflow) recharged over a 10-year period. Advanced treated water does not qualify as diluent water under current groundwater replenishment regulations but can be considered "null" water (that is, neither recycled water nor diluent water). Thus, a total of 34,000 AFY could be available to the project for new recharge opportunities (additional recharge of 17,000 AFY) and replacement of imported water (17,000 AFY).

2) **New Los Angeles Forebay Spreading Grounds – Central Basin** (R12 on Attachment 1) is a conceptual system component that would implement spreading grounds in the Los Angeles Forebay area. Currently, no information is available regarding the location of such facilities or the infiltration capacity of the spreading grounds. Infiltration capacity can be a function of various factors, including location and quality of the inflows. The Montebello Forebay was designed for approximately 0.5 MGD per acre of infiltration capacity receiving water from San Gabriel and Rio Hondo rivers. advanced treated water quality might significantly improve recharge rates. An estimate of 1 MGD per acre (1,121 AFY) will be assumed for the Joint Master Plan analysis, but this estimate will need to be evaluated in more detail during subsequent phases of this study.

3) **West Coast Barrier Injection Wells – West Coast Basin** (R1 on Attachment 1) are a series of injection wells along the western coast of the Los Angeles County coastal plain that prevents seawater intrusion with the injection of fresh water. The wells are within the WBMWD service area. The Los Angeles County Flood Control District (LACFCD) owns, operates, and maintains the barrier project, and WRD purchases all of the water that is injected into the barrier. A cursory analysis conducted for the Groundwater Basins Master Plan (WRD 2016) estimated an ultimate capacity of 38 MGD (43,000 AFY) for the 127 wells in use during the 2001-2002 study period. If the 35 wells that did not have data or were not being used were brought back into service, then a capacity of 47 MGD (53,000 AFY) could be available. During Water Year 2017-2018, barrier injections averaged 13 MGD (14,800 AFY) (WRD 2019b), indicating a potential available injection capacity of 15 MGD to 32 MGD (17,000 to 36,000 AFY) that could be considered for a groundwater augmentation project. Most of the barrier wells are decades old, with the first wells installed in 1953. Condition of the wells could limit the practicality or value of their use, so additional analysis would be needed to establish the additional flows they could accommodate.

4) **Dominguez Gap Barrier Injection Wells – West Coast Basin** (R2 on Attachment 1) are a series of injection wells along the south coast that prevents seawater intrusion with the injection of fresh water. The wells are along the Dominguez Channel in the cities of Wilmington and Carson. LACFCD owns, operates, and maintains the barrier project, and WRD purchases from Metropolitan all the imported water that is injected into the barrier. The barrier currently receives approximately 1,000 AFY of advanced treated recycled water from the Terminal Island WRP. The estimated, ultimate injection capacity of the barrier is 34 MGD (38,000 AFY). During Water Year 2017-2018 operations, 6 MGD (6,900 AFY) were injected (WRD 2019b). This amount indicates that approximately 28 MGD (31,400 AFY) of capacity could be available for additional injection at the barrier for a groundwater augmentation project. The barrier was originally constructed in 1969, so the condition of the barrier would need to be further considered to establish realistic available capacities.

5) **Alamitos Barrier Injection Wells – Central Basin** (R3 on Attachment 1) are a series of injection wells along the south coast that prevents seawater intrusion with the injection of fresh water. The wells are

near the Los Angeles-Orange County line, about 2 miles inland from the mouth of the San Gabriel River. LACFCD owns, operates, and maintains the barrier project. WRD purchases the water injected into the Los Angeles County side of the barrier, and the Orange County Water District purchases the water injected into the Orange County side of the barrier. Injected water is currently a blend of imported and recycled water. The imported water is purchased from a Metropolitan member agency, and the recycled water is purchased from the WRD LVL AWTF, operated by the Long Beach Water Department. The estimated, ultimate injection capacity of the barrier is 8 MGD (9,000 AFY). During Water Year 2017-2018 operations, 3.8 MGD (4,300 AFY) was injected into the barrier (WRD 2019b). This amount indicates that approximately 4.3 MGD (4,800 AFY) of capacity could be available for additional injection at the barrier for a groundwater augmentation project. The barrier was originally constructed in 1964, so the condition of the barrier would need to be further considered to establish realistic available capacities.

6) **New Montebello Forebay Injection Wells – Central Basin** (R4 on Attachment 1) refers to the installation of new injection wells located in the Montebello Forebay area. The option CB-P8a presented in the Groundwater Basins Master Plan (WRD 2016) suggests that four wells with a total capacity of 5,000 AFY could be supplied by advanced treated water from the Los Coyotes WRP. As a component of the Joint Master Plan, the Montebello Forebay Injection Wells are an option for injection from other sources, as well.

7) **ARC Injection Wells – Central Basin** (R8 on Attachment 1) is a conceptual component that represents additional injection associated with expansion of the newly constructed ARC treatment plant. The injection wells could be located near a plant or elsewhere in the Montebello Forebay area.

8) **New West Coast Basin Injection Wells (Inland) – West Coast Basin** (R9 on Attachment 1) refers to the installation of new injection wells located inland in the West Coast Basin. The option WCB-P2 presented in the Groundwater Basins Master Plan suggests 14 injection wells centrally located in the north of the JWPCP, with a total capacity of 13 MGD (15,000 AFY), supplied by advanced treated water from the JWPCP. This component can represent an option for injection of other sources, as well (other sources are listed under Section 4.1, not only JWPCP).

9) **New Central Basin Injection Wells – Central Basin** (R10 on Attachment 1) refers to the installation of new injection wells located inland in the Central Basin. A concept identified in Metropolitan's Regional Recycled Water Program (Metropolitan 2019) includes retrofitting existing wells located in the Long Beach area to inject 4 MGD (4,500 AFY) and installing new wells in the Rio Hondo area to inject 9 MGD (10,000 AFY). The source water assumed in this concept would be supplied by advanced treated water from the JWPCP; however, as a component of the Joint Master Plan, this can represent an option for injection from other sources, as well.

10) **New Los Angeles Forebay Injection Wells – Central Basin** (R11 on Attachment 1) refers to the installation of new injection wells located inland in the unadjudicated North Central Basin area of the Los Angeles Forebay. A concept identified in the Groundwater Development and Augmentation Plan (GDAP) includes six, 1-square-mile locations for production/recharge wells (five at 10,000 AFY and one at 15,000 AFY) for a total of 65,000 AFY (LADWP 2019).

11) **New Beverly Parcel Recharge Project – Central Basin** (R16 on Attachment 1) is a conceptual project that would capture and filter roughly 21.5 AFY of stormwater for aquifer recharge. Up to 13,000 acre-feet of ultra-pure recycled water could be piped in from WRD's nearby ARC facility and injected to replenish groundwater. The project location is a vacant 19-acre parcel in the city of Pico Rivera. The land available for the project is directly south of Beverly Boulevard, west of Interstate 605 and east of the San Gabriel River. The site selected for the Beverly Parcel Recharge Project, a vacant 19-acre parcel in the city of Pico Rivera, currently acts as a valuable stormwater infiltration buffer between the freeway and the river.

12) **LADWP Proposed New Injection Locations – Central Basin**

The new injection locations are contingent upon the ability to acquire properties that would make injection possible.

12a. LADWP New Injection Wells Manhattan (R17 on Attachment 1) would be located at Manhattan and 99th Street in the vicinity of the existing LADWP Manhattan Wellfield. A concept identified in the GDAP includes an estimated injection of 9 MGD (10,000 AFY), based on the production and recharge rates assumed in the groundwater modeling analysis. This concept is contingent upon LADWP's ability to acquire new properties.

12b. LADWP New Injection Wells Clovis (R18 on Attachment 1) would be located in the vicinity of Clovis Avenue, north of Imperial Highway and south of Century Boulevard along the Los Angeles Forebay. A concept identified in the GDAP includes an estimated injection of 18 MGD (20,000 AFY) based on the production and recharge rates assumed in the groundwater modeling analysis. This concept is contingent upon LADWP's ability to acquire new properties.

12c. LADWP New Injection Wells Slauson (R19 on Attachment 1) would be located near the former LADWP Slauson Wellfield. A concept identified in the GDAP includes an estimated injection of 9 MGD (10,000 AFY) based on the production and recharge rates assumed in the groundwater modeling analysis. This concept is contingent upon LADWP's ability to acquire new properties.

12d. LADWP New Injection Wells Soto (R20 on Attachment 1) would be located near the former LADWP Soto Wellfield. A concept identified in the GDAP includes an estimated injection of 13 MGD (15,000 AFY) based on the production and recharge rates assumed in the groundwater modeling analysis. This concept is contingent upon LADWP's ability to acquire new properties.

12e. LADWP New Injection Wells Confluence (R21 on Attachment 1) would be located near the confluence of the Rio Hondo and the Los Angeles rivers. A concept identified in the GDAP includes an estimated injection between 54 and 71 MGD (60,000 to 80,000 AFY corresponding to 1 and 4 square mile areas) based on the production and recharge rates assumed in the groundwater modeling analysis and the available land to locate the wells. This concept is contingent upon LADWP's ability to acquire new properties.

13) **New Injection Wells Inland of Alamitos Barrier** (R22 on Attachment 1) represents the installation of new injection wells located inland of the Alamitos Barrier Project to recharge the Central Basin.

14) **New Injection Wells Inland of Dominguez Barrier** (R23 on Attachment 1) represents the installation of new injection wells located inland of the Dominguez Barrier Project to recharge the West Coast Basin.

15) **New Injection Wells Regional Brackish Water Reclamation** Program (R24 on Attachment 1) assumes reinjection of desalinated product water from remediation of the West Coast Basin saline plume.

16) **New Injection Wells for Top Imported Water Users/Pumpers** (R25 on Attachment 1) represents the installation of new injection wells to replenish water extracted and delivered to the water users overlying the West Coast and Central Basins with the greatest imported water demand.

17) **New Injection Wells Los Angeles River Power Line Easement** (R26 on Attachment 1) represents the installation of new injection wells located within a power line easement along the Los Angeles River.

18) **New Los Angeles River Dry Wells** (R15 on Attachment 1) represents a series of dry wells along the Los Angeles River just east of the Metropolitan headquarters and north of Highway 101. Available flow is estimated to be 5 MGD (5,600 AFY).

4.4 Extraction

LADWP holds permanent pumping rights in the West Coast and Central Basins. The City's allowed pumping allocation in the Central Basin is 17,236 AFY out of the total of 217,367 AFY allocated to the parties to the judgment (LADWP 2019). In the West Coast Basin, the City's adjudicated water right is 1,503 AFY. The recent amended judgments also allow water rights holders to implement augmentation projects that provide for the use of basin storage outside the parties' water rights. The amendments also allow LADWP to transfer its unused water rights (up to 5,000 AFY) from the West Coast Basin to the Central Basin.

LADWP has not been pumping its groundwater rights in West Coast Basin. The City has two existing wellfields in the basins: the 99th Street and Manhattan wellfields in the Central Basin, and the inactive Lomita wellfield in the West Coast Basin. New extraction wells in both basins are included as potential components in the Joint Master Plan. LADWP's GDAP report (LADWP 2019) evaluated model scenarios where pumping capacity was available to extract all its stored water in 6 months if needed.

The following 10 extraction sites, consisting of existing and new wellfields, are being considered for the Joint Master Plan:

1) **LADWP Existing Extraction Locations**

   The GDAP report estimates that the existing wells (99^{th} Street and Manhattan Wellfields) have a total of 20,000 AFY of capacity (LADWP 2019). Numbers presented for the baseline GDAP scenario imply that the historical average wellfield usage is 8,100 AFY. Based on the GDAP information, it is estimated that the combined wellfield capacity for the 99^{th} Street and Manhattan Wellfields available to the meet Joint Master Plan goals is 12 MGD (13,450 AFY).

   LADWP 99th Street Wellfield (E2 on Attachment 1), also referred as 99^{th} Street pumping station complex, has an ongoing project to treat for iron and manganese located near Ted Watkins Memorial Park. The available capacity is estimated to be 6 MGD (6,700 AFY), based on the wellfield's existing pumping capacity.

   LADWP Manhattan Wellfield (E3 on Attachment 1) is located between the Newport-Inglewood Fault and the Los Angeles Forebay. The wellfield is treating iron and manganese, and trichloroethene treatment could be required in an intermediate aquifer. The GDAP report estimates that this wellfield has a current total capacity of 21,300 AFY (LADWP 2019). The extraction capacity available for Joint Master Plan goals is estimated to be 5.8 MGD (6,500 AFY), based on the wellfield's existing pumping.

2) **New West Coast Basin Wellfield** (E4 on Attachment 1) is a potential wellfield with location to be determined.

3) **New Central Basin Wellfield** (E5 on Attachment 1) is a component concept from the GWMP report (WRD 2016). The wells would be located in Inglewood, west of Interstate 110 and north of Manchester Avenue. Extraction of 25 MGD (28,000 AFY) is assumed.

4) **Los Angeles Forebay New Extraction Wellfield** (E6 on Attachment 1) is a component concept from the GDAP report. The wells would be located within the Los Angeles Forebay near Florence, east of Interstate 110 . Extraction of 58 MGD (65,000 AFY) from 21 wells is assumed.

5) **Existing Wells – West Coast Basin** (E8 on Attachment 1) is a component concept representing the combined, existing but unused capacities of the wells within the West Coast Basin. The extraction capacity of this potentially available component is not known at this time.

6) **Existing Wells – Central Basin** (E9 on Attachment 1) is a component concept representing the combined, existing but unused capacities of the wells within the Central Basin. The extraction capacity of this potentially available component is not known at this time.

7) **New Regional Brackish Groundwater Desalter** (E11 on Attachment 1) is a project that will remediate the West Coast Basin saline plume. A feasibility study for the desalter was recently completed, and further study is underway. The extraction wells for this project may be in the vicinity of the centralized desalter facility, currently planned to be located in the city of Torrance. Approximately 12,500 to 20,000 AFY of groundwater extraction is anticipated.

8) **LADWP Proposed New Extraction Locations**

Some of the locations present challenges related to either pumping, downstream capacity, or water quality. Assumed extraction values are rough estimates.

LADWP New Extraction Well Manhattan (E12 on Attachment 1) is a component concept from the GDAP report, located at Harvard Park and Recreation Center. Extraction of 9 MGD (10,000 AFY) is assumed.

LADWP New Extraction Well Clovis (E13 on Attachment 1) is a component concept from the GDAP report, located near Ted Watkins Memorial Park, east of Interstate 110 and north of Interstate 105. Extraction of 18 MGD (20,000 AFY) is assumed.

LADWP New Extraction Well Slauson (E14 on Attachment 1) is a component concept from the GDAP report, located near South Alameda Street and Slauson Avenue. Extraction of 9 MGD (10,000 AFY) is assumed.

LADWP New Extraction Well Soto (E15 on Attachment 1) is a component concept from the GDAP report, located near the former LADWP Soto Wellfield. Extraction of 13 MGD (15,000 AFY) is assumed.

LADWP New Extraction Wells Confluence (E16 on Attachment 1) is a component concept from the GDAP report, located near the intersection of Century Boulevard and South Alameda Street. Extraction of 54 MGD (60,000 AFY) to 71 MGD (80,000 AFY) is assumed.

9) **New Extraction Wells for Top Imported Water Users/Pumpers** (E17 on Attachment 1) is a component concept that represents the installation of new extraction wells for delivery to the water users overlying the West Coast and Central Basins.

10) **New Extraction Wells Outside of Los Angeles** (E18 on Attachment 1) is a component concept that represents the installation of new extraction wells for delivery to water users outside the City of Los Angeles to replace imported water demands.

5. System Component Selection Criteria

With a comprehensive list of potential replenishment sources, treatment locations, replenishment locations, and extraction locations identified, the following criteria were used to identify the most feasible components to carry forward as projects to consider in the Joint Master Plan:

- Replenishment source flows (recycled water or surface water) available and uncommitted
- Water quality appropriate for replenishment
- Infrastructure located within the City of Los Angeles or WRD jurisdiction
- Reliability of the component to meet the project goals
- Ability to maximize use of existing Infrastructure and opportunities to partner/collaborate
- Potential to expand existing facility
- Land availability for new facility
- Suitable hydrogeologic conditions for replenishment and extraction locations
- Ease of permitting for new facilities or changes to existing facilities

6. Component Screening Recommendations

Screening of the comprehensive list of project components was conducted during a workshop (Workshop No. 1) held with WRD and LADWP on March 29, 2019. Based on the application of the screening criteria identified in Section 5, the team selected existing and future facilities for further consideration in the Joint Master Plan projects. Table 1 presents the facilities that were selected. Table 2 presents the existing and future facilities that were eliminated from further consideration for inclusion in the Joint Master Plan projects, and the basis for their exclusion.

Table 1. System Components To Be Considered in the Joint Master Plan Project Formulation

ID	Facility Name
Source	
S1	Hyperion Water Reclamation Plant
S2	Joint Water Pollution Control Plant
S10	Los Coyotes Water Reclamation Plant
S11	Long Beach Water Reclamation Plant
S12	Metropolitan Imported Water
S13	Los Angeles River
S17	Los Angeles Aqueduct
Treatment	
T1	Edward C. Little Water Recycling Facility
T2	Carson Regional Water Recycling Facility
T3	Albert Robles Center for Water Recycling
T4	Leo J. Vander Lans Advanced Water Treatment Facility
T5	New Hyperion Water Reclamation Plant Advanced Water Treatment Facility
T6	New Hyperion Water Reclamation Plant Nitrification/Denitrification Membrane Bioreactor
T7	New Joint Water Pollution Control Plant Advanced Water Treatment Facility
T9	New Soil Aquifer Treatment
T13	New Los Coyotes Water Reclamation Plant Advanced Water Treatment Facility
T15	Los Angeles Filtration Plant
Replenishment	
R1	West Coast Barrier Injection Wells
R2	Dominguez Gap Injection Wells
R3	Alamitos Barrier Injection Wells
R4	Montebello Forebay Injection Wells
R5	Rio Hondo Spreading Grounds

Table 1. System Components To Be Considered in the Joint Master Plan Project Formulation

ID	Facility Name
R6	San Gabriel Spreading Grounds
R8	Albert Robles Center for Water Recycling Injection Wells
R9	New West Coast Basin Injection Wells (inland)
R10	New Central Basin Injection Wells
R11	New Los Angeles Forebay Injection Wells
R12	New Los Angeles Forebay Spreading Grounds
R15	New Los Angeles River Dry Wells
R16	New Beverly Parcel Recharge Project
R17	LADWP New Injection Manhattan
R18	LADWP New Injection Clovis
R19	LADWP New Injection Slauson
R20	LADWP New Injection Soto
R21	LADWP New Injection Confluence
R22	New Injection Wells Inland of Alamitos Barrier
R23	New Injection Wells Inland of Dominguez Barrier
R24	New Injection Wells Regional Brackish Water Reclamation Program
R25	New Injection Wells for Top Imported Water Users/Pumpers
R26	New Injection Wells Los Angeles River Power Line Easement
Extraction	
E2	LADWP 99th Street Wellfield
E3	LADWP Manhattan Wellfield
E4	New West Coast Basin Wellfield
E5	New Central Basin Wellfield
E6	Los Angeles Forebay New Extraction Wellfield
E8	Existing Wells West Coast Basin
E9	Existing Wells Central Basin
E11	New Regional Brackish Groundwater Desalter
E12	LADWP New Extraction Manhattan
E13	LADWP New Extraction Clovis
E14	LADWP New Extraction Slauson
E15	LADWP New Extraction Soto

Table 1. System Components To Be Considered in the Joint Master Plan Project Formulation

ID	Facility Name
E16	LADWP New Extraction Confluence
E17	New Extraction Wells for Top Imported Water Users/Pumpers
E18	LADWP New Extraction Wells Outside of Los Angeles

Table 2. System Components Eliminated from Consideration

ID	Facility Name	Reason
Replenishment Sources		
S3	Terminal Island Water Reclamation Plant	All flows are previously committed.
S4	Goldsworthy Desalter	Treated to potable water quality, thus not desirable for replenishment (expensive source).
S5	Brewer Desalter	Treated to potable water quality, thus not desirable for replenishment (expensive source).
S6	New Regional Brackish Groundwater Desalter	Treated to potable water quality, thus not desirable for replenishment (expensive source).
S7	New Ocean Desalination	Treated to potable water quality, thus not desirable for replenishment (expensive source).
S8	Whittier Narrows Water Reclamation Plant	All flows are previously committed.
S9	San Jose Creek Water Reclamation Plant	All flows are previously committed.
S14	San Gabriel River	Infeasible – Additional flows are not available.
S15	Rio Hondo River	Infeasible – Additional flows are not available.
S16	New – Sewer Scalping	Does not maximize use of existing facilities because implementation would reduce influent flows to existing WRPs.
Advanced Treatment		
T8	New Satellite Advanced Water Treatment Facility	Decentralized (satellite) treatment is undesirable. All advanced treatment will be assumed to be located near existing WRP or AWTF.
T10	New San Jose Creek Water Reclamation Plant Nanofiltration	All flows are previously committed.
T11	New San Jose Creek Water Reclamation Plant Ozone/BAC/GAC	All flows are previously committed.
T12	New San Jose Creek Water Reclamation Plant Advanced Water Treatment Facility AWTF	All flows are previously committed.
T14	Existing Terminal Island AWTF	All flows are previously committed.

Table 2. System Components Eliminated from Consideration

ID	Facility Name	Reason
Replenishment Locations		
R7	Dominguez Gap Spreading Grounds	Infeasible – confined aquifer area.
R13	Santa Fe Spreading Grounds	Outside of Joint Master Plan boundary (part of Metropolitan/LACSD Regional Program).
R14	Orange County Spreading Grounds	Outside of Joint Master Plan boundary (part of Metropolitan/LACSD Regional Program).
Extraction Locations		
E1	LADWP Lomita Wellfield (inactive)	Infeasible – inactive and potential water quality challenges.
E7	Santa Fe Spreading Grounds	Outside of Joint Master Plan boundary (part of Metropolitan/LACSD Regional Program).
E10	Existing Wells Orange County Basin	Outside of Joint Master Plan boundary (part of Metropolitan/LACSD Regional Program).

Notes:

BAC = biological activated carbon

GAC = granular activated carbon

7. Matrix of Previously Identified Projects and Components

With the elimination of the components identified in Table 2, the matrix shown in Attachment 2 summarizes the remaining components and identifies where these components have been described in other planning studies.

The use of the matrix shown in Attachment 2 is the first step toward organizing the system components into potential projects. The matrix is also a reference for system components. Some of the potential projects were listed under the corresponding report in which they were presented; for example, all projects presented in the WRD Groundwater Basins Master Plan are listed under identification numbers from 400 to 500.

Under Task 2 of the Joint Master Plan, additional projects with new combinations of system components will be added to the matrix presented in Attachment 2.

The figures that follow in this section (Figures 5 through 8) show the general locations of the project components that will be considered during Task 2. Some of the locations are general and some are not yet defined. Some of the components' capacities are yet to be defined under more rigorous analysis to be performed under Task 2; those are listed as to be determined (TBD) values. Some of the capacity values are variable and were described in Section 4, Figures 5 through 8 present the most likely value based on the current data available.

Figure 5 shows water supply locations and the availability of flows by system component. Most of the available supplies are from the two major wastewater treatment facilities and are located in the West Coast Basin. The value for the JWPCP is an estimate after flows are committed to Regional Recycled Water Program Conceptual Planning project (Metropolitan 2019).

Figure 6 shows advanced treatment locations and the availability of capacities by system component. The known available capacity of advanced water treatment facilities in the system is approximately 40,000 AFY. Many options for advanced treated water are being considered, and facility capacities have yet to be defined.

Figure 7 shows replenishment locations and the availability of replenishment capacity by system component. All system components related to replenishment are located in the Central Basin, with the exception of the sea water barriers (West Coast and Dominguez Gap barriers). The total replenishment capacity estimate without new projects is 115,000 AFY. New replenishment projects such as the ones described on the GDAP report (LADWP 2019) could add a significant amount of recharge capacity for the groundwater basin.

Figure 8 shows extraction locations and the availability of extraction capacity by system component. Most of the reported capacity is estimated for new projects. It is expected that the Central and West Coast Basins have extraction capacity available within the basins, but that available extraction capacity is unknown at this moment.

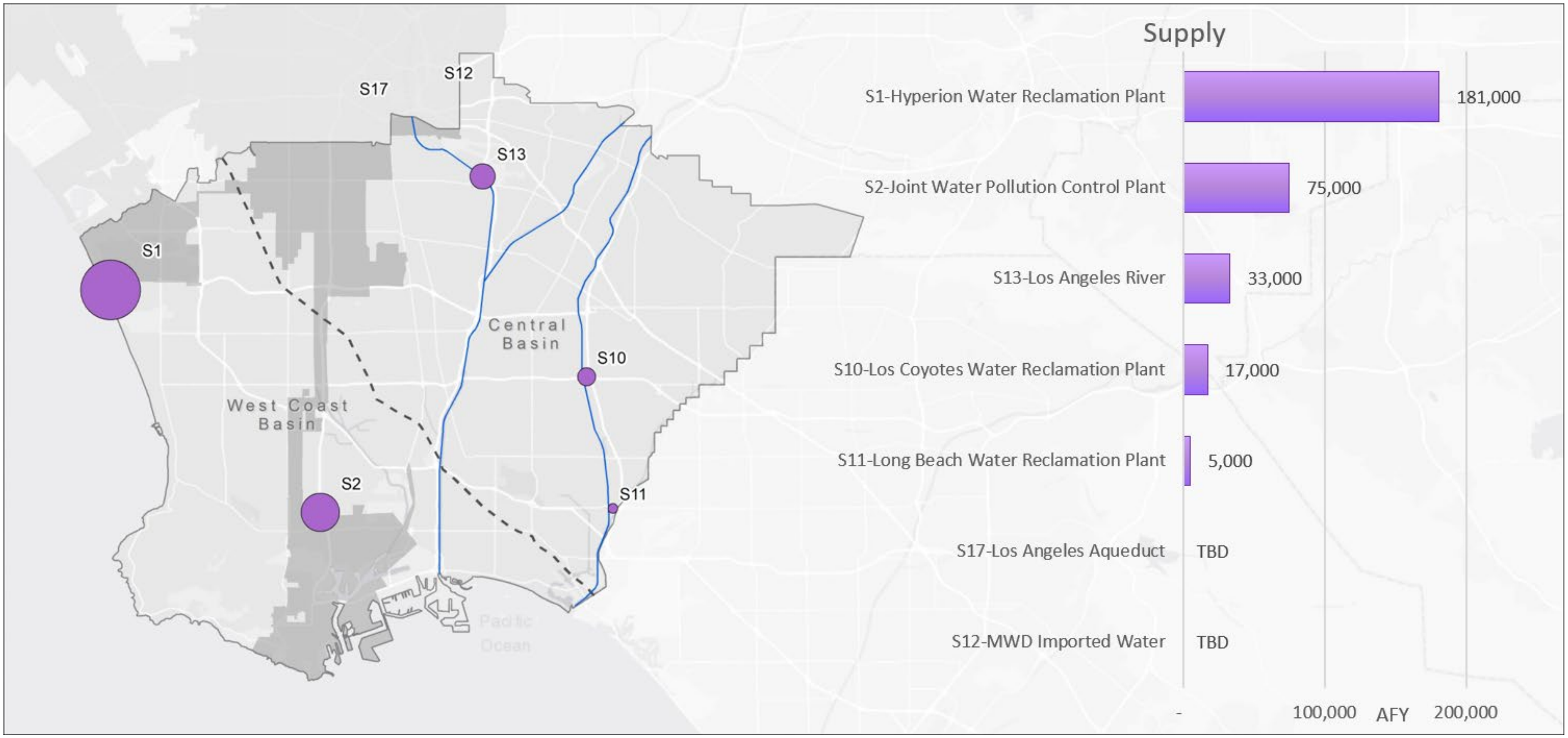


Figure 5. Water Supply Resources and Estimated Available Supply

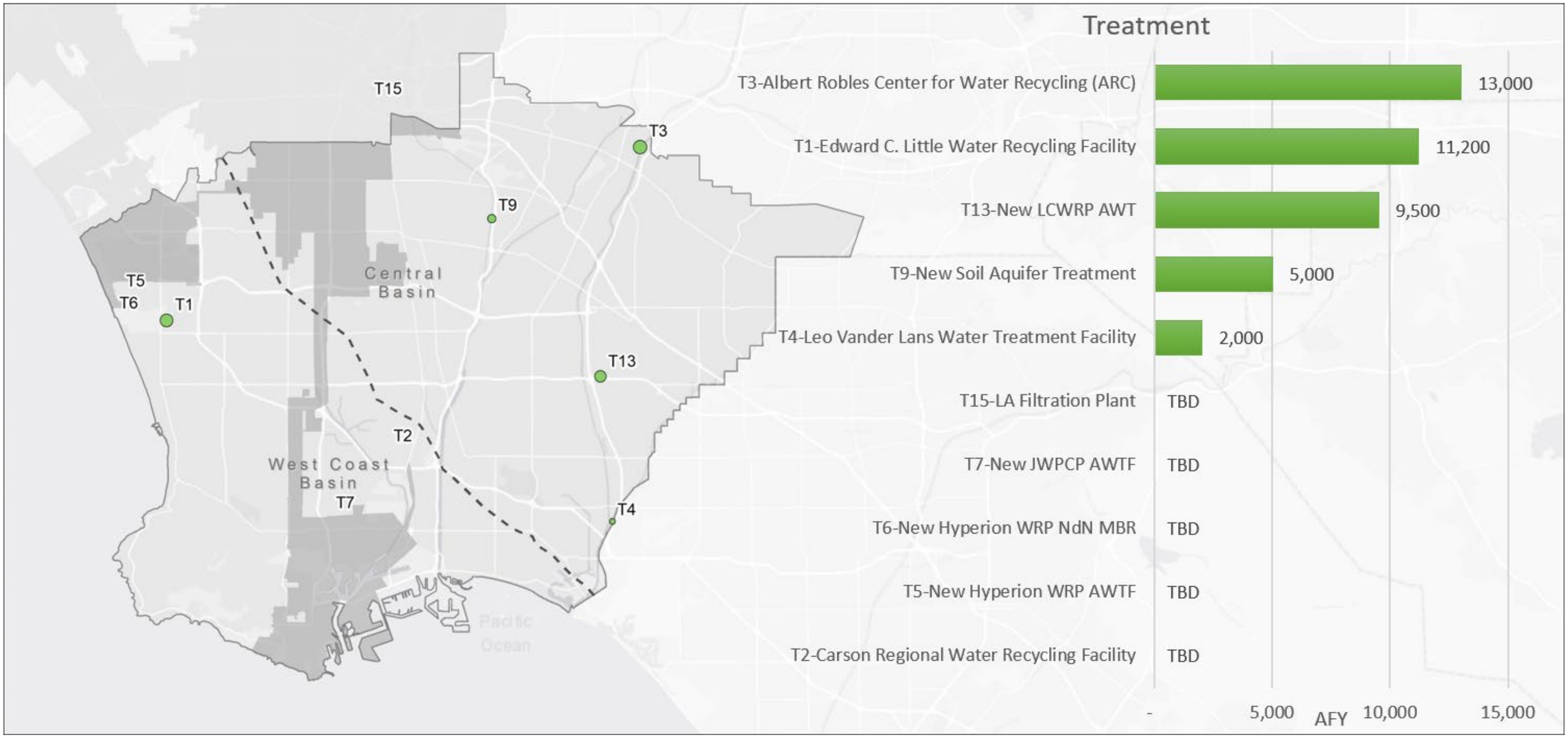


Figure 6. Treatment Resources and Estimated Available Treatment Capacity

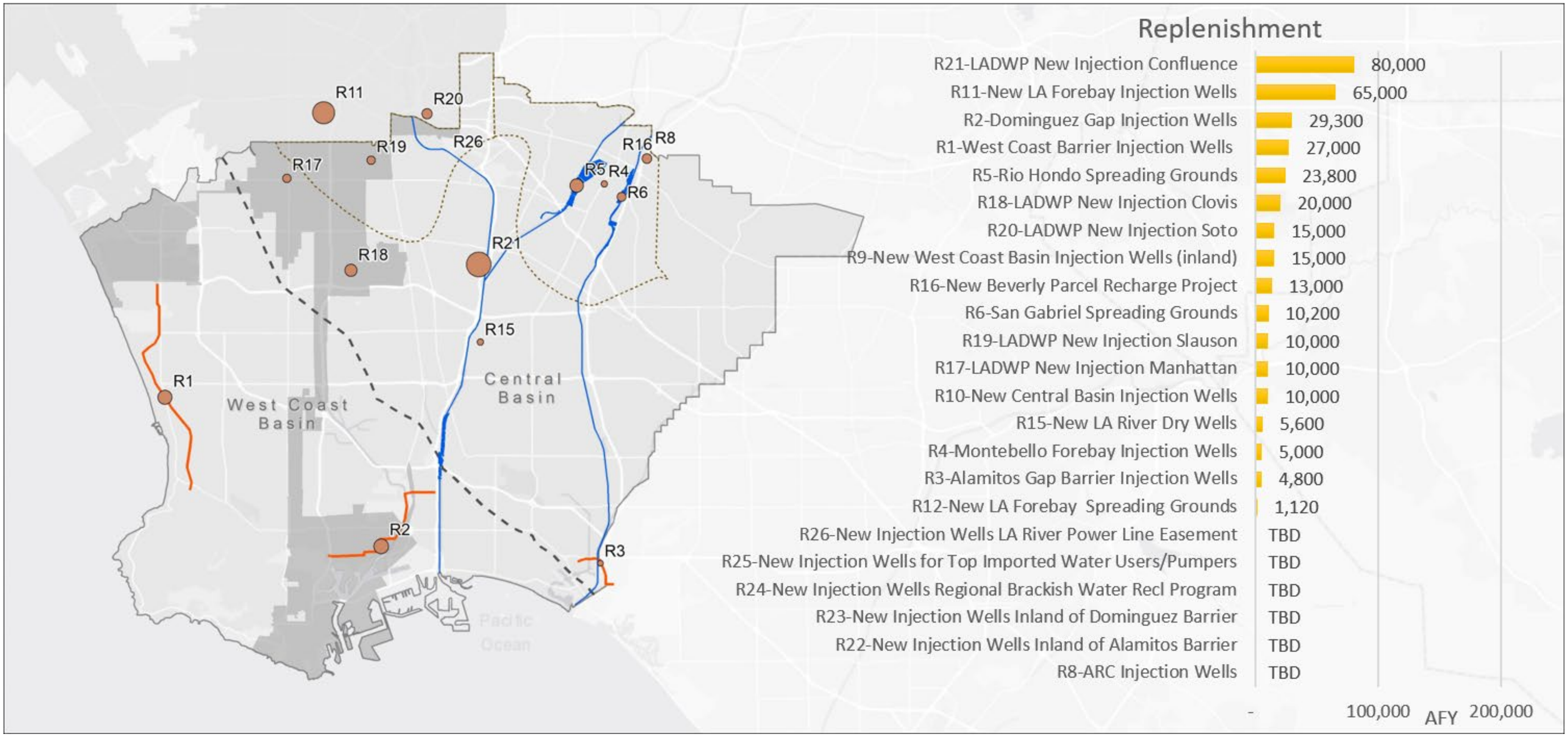


Figure 7. Replenishment Resources and Estimated Available Replenishment Capacity

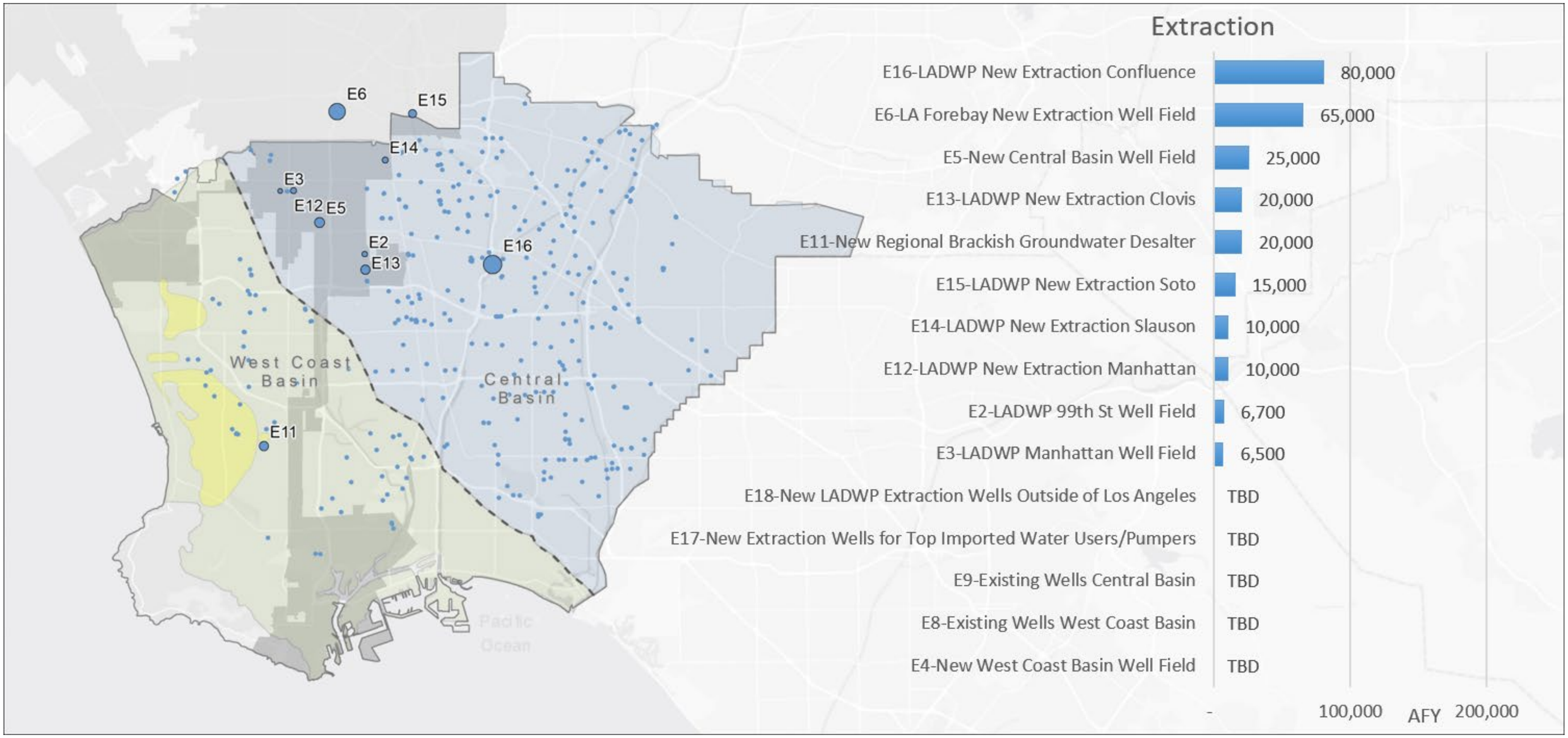


Figure 8. Extraction Resources and Estimated Available Extraction Capacity

8. Initial Project Ranking Criteria

The most feasible system components will be carried forward to develop complete Project Concepts. Based on the Joint Master Plan goals and objectives, it is recommended that the project ranking criteria presented in Table 3 be used to select the most economical projects that provide the greatest benefit.

Table 3. Project Evaluation Criteria

No.	Performance Measure	Measure	Range of Performance Spectrum	
			Minimum Score	**Maximum Score**
1	Ability to Meet the Joint Master Plan Need, Purpose, and Objectives	Scalable	Project does not meet the Project Need, Purpose, and Objectives	Project meets the Project Need, Purpose, and Objectives
2	Hyperion effluent usage	Ocean discharges	No effluent usage, high discharges to the ocean	100% of effluent usage, no discharges to the ocean
3	New volume of local supplies	AFY	0 AFY	TBD
4	Overall Cost (CAPEX/OPEX)	$/AF	Overall cost of the water used to replace imported water $$$	Overall cost of the water used to replace imported water $
5	WRD purveyors pumping cost	$/AF	$$$	$
6	Storage need	AF	Significant amount of carryover storage is needed	Minimal storage needed
7	Improved groundwater quality in the basin	Scalable	Amount of water (AFY) flushing contaminated plumes	Amount of water (AFY) flushing contaminated plumes
8	Permitting Difficulty	Scalable	Project has permitting hurdles that could lead to schedule delays	Project is permittable and the permitting process is not expected to cause delay
9	Regulatory Pathway	Scalable	Project implementation depends on future regulations	Project can operate within current regulatory framework
10	Institutional Arrangement	Scalable	Implementation of project would require coordination with several other agencies	Project can be implemented without engaging other agencies
11	Potential Project Phasing	Scalable	Project cannot be phased	Potential for project to be phased
12	Potential Adverse Impacts on Groundwater Quality	Scalable	Project diminishes groundwater quality	Project improves groundwater quality

Notes:

$ = reasonable

$$$ = expensive

AF = acre-foot

CAPEX = capital expenditure

OPEX = operational expenditure

9. Conclusions

The objective of Task 1 of the Joint Master Plan is to develop a list of system components that can be combined into projects that will support WRD and LADWP Joint Master Plan goals. These potential projects will be further evaluated as part of Task 2 of the Joint Master Plan effort. Therefore, Task 1 concludes with two project component lists:

- System components that have potential to be grouped into projects and achieve Joint Master Plan goals (Table 1)
- System components initially considered but later rejected, and the reason for rejection (Table 2)

Section 4 describes the system components that are relevant to the Joint Master Plan goals. Various options are available when considering existing and new projects. The capacities of most new components are yet to be determined, and the preference is to use current system idle capacity. Based on the information presented in Section 4, the current system is limited by replenishment capacity, advanced water treatment, and ability to extract and use all recharged Hyperion WRP effluent (the most significant available supply) within Los Angeles area.

Although there are clear jurisdictional boundaries for WRD and the City of Los Angeles, the Joint Master Plan will identify projects composed of system components that are beneficial for WRD, the City of Los Angeles, and for the Los Angeles region. This technical memorandum describes the efforts of the first step toward selecting the best projects for the region, which is simply the identification of available system components (supplies, advanced treatment, replenishment, and extraction).

The following top system components are most likely to be included in the project options:

- Hyperion WRP wastewater flows treated at a new AWTF
- New AWTF
- Use of current idle capacity at seawater intrusion barriers with AWTF flow
- Use of idle extraction capacity available at the Central and West Coast Basins
- New injection wells east of the Regional Brackish Desalter and in the vicinity of the Dominguez Gap Barrier Project and Alamitos Barrier Project

Although these system components are key to achieving the Joint Master Plan goals, existing injection and extraction well capacities that may be available will not be sufficient, and new components will be necessary. Many new components are suggested under Task 1; however, under Task 2, a more rigorous analysis will be conducted to understand what components could offer the most benefits when combined into projects.

The following system characteristics are relevant for system component selection to develop projects:

- Diurnal flow patterns that could limit wastewater effluent flow available for an AWTF without equalization storage
- Challenge of recharge and extraction in the Central and West Coast Basins at locations that are available for new projects and have favorable hydrogeologic conditions
- Diluent water availability and accounting to meet the recycled water contribution requirement in the water recycling permit
- Brine management considerations

Other system components (existing but highly uncertain with respect to the ability to meet Joint Master Plan goals) might add flexibility to the system operations and will also be considered under Task 2. The study team will remain flexible and open to reconsider removed components or other components that initially were not included in this evaluation but, due to further analysis and project considerations, could be relevant to the Joint Master Plan goals.

10. References

Garcetti, Eric, Mayor. 2019. *L.A.'s Green New Deal. Sustainable City pLAn*. City of Los Angeles. https://plan.lamayor.org/sites/default/files/pLAn_2019_final.pdf.

Los Angeles Department of Water and Power (LADWP). 2016. Urban Water Management Plan 2015. April 2016.

Los Angeles Department of Water and Power (LADWP). 2018. *Briefing Book 2017-2018*. https://s3-us-west-2.amazonaws.com/ladwp-jtti/wp-content/uploads/sites/3/2017/09/08143247/Briefing-Book-Rolling-PDF.pdf. Accessed March 2019.

Los Angeles Department of Water and Power (LADWP). 2019. *Groundwater Development and Augmentation Plan – Preliminary Hydraulic Assessment to Utilize Central Basin Groundwater Replenished Supply from Hyperion*.

Metropolitan Water District of Southern California (Metropolitan). 2019. *Regional Recycled Water Program Conceptual Planning Studies Report*. http://www.mwdh2o.com/DocSvcsPubs/rrwp/assets/1-rrwp_conceptual_planning_studies_report_02212019.pdf. Accessed March 2019.

Sanitation Districts of Los Angeles County (LACSD). 2016. *Twenty-Seventh Annual Status Report on Recycled Water Use*. https://www.lacsd.org/civicax/filebank/blobdload.aspx?blobid=14586. Accessed March 2019.

Superior Court of California. 2013. Central and West Basin Water Replenishment District v. Charles E. Adams. 2013. Third Amended Judgment. https://rights.wrd.org/docs/CB_Third_Amended_Judgement.pdf.

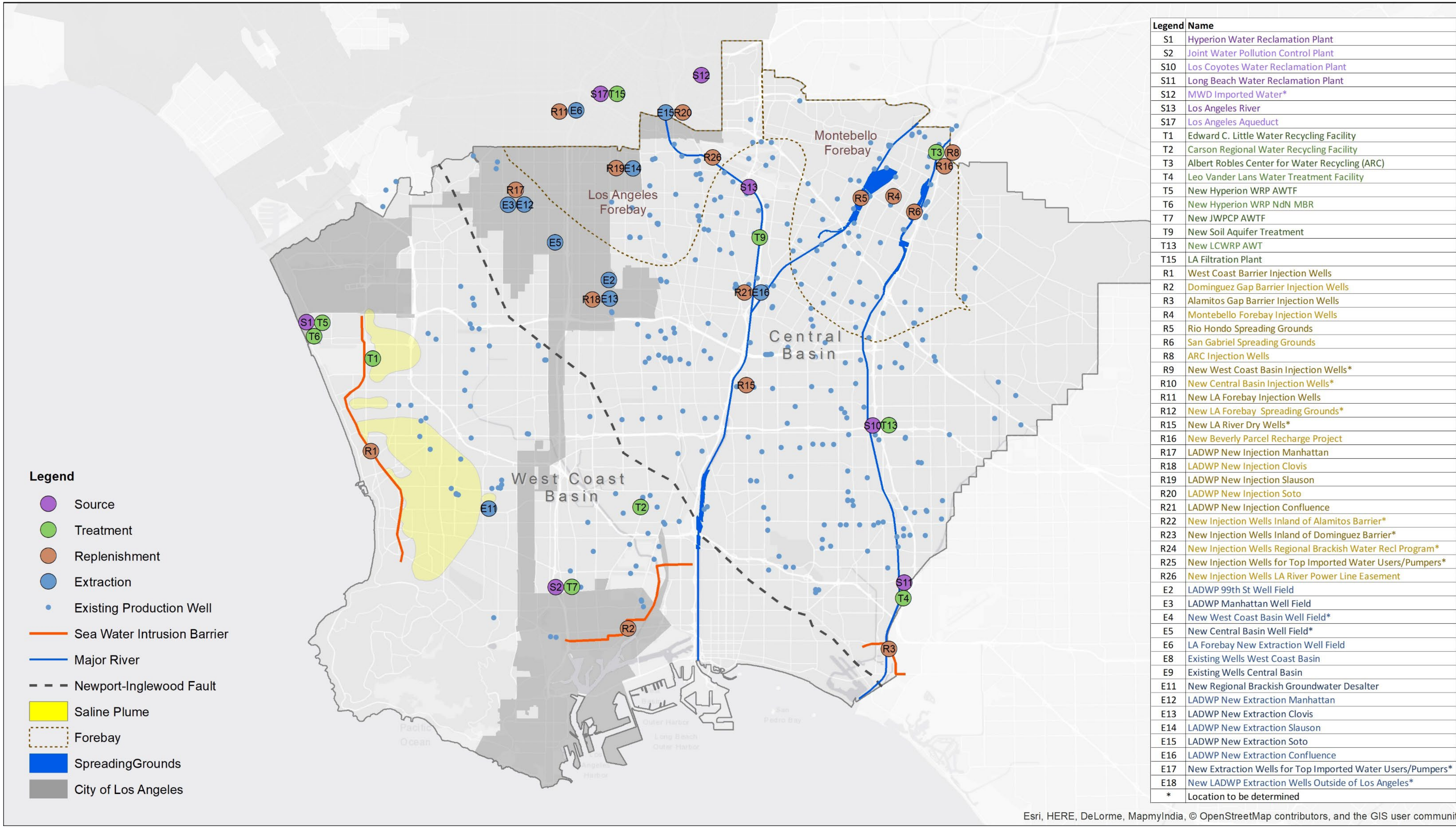
Superior Court of California. 2014. California Water Service Company et al. v. City of Compton et al. Amended Judgment. https://rights.wrd.org/docs/WCB_Amended_Judgement.pdf.

Water Replenishment District of Southern California (WRD). 2016. *Groundwater Basins Master Plan*. Final Report. September. https://www.wrd.org/sites/pr/files/GBMP_FinalReport_Text%20and%20Appendicies.pdf.

Water Replenishment District of Southern California (WRD). 2019a. What is WIN? https://www.wrd.org/content/what-win. Accessed March 2019.

Water Replenishment District of Southern California (WRD). 2019b. *Engineering Survey and Report*. March 6.

Attachment 1
Locations of Possible Resources and Facilities for Source Water Supply



Montebello Forebay
Los Angeles Forebay
Central Basin
West Coast Basin
Legend
Source
Treatment
Replenishment
Extraction
Existing Production Well
Sea Water Intrusion Barrier
Major River
Newport-Inglewood Fault
Saline Plume
Forebay
SpreadingGrounds
City of Los Angeles
Legend Name
S1 Hyperion Water Reclamation Plant
S2 Joint Water Pollution Control Plant
S10 Los Coyotes Water Reclamation Plant
S11 Long Beach Water Reclamation Plant
S12 MWD Imported Water*
S13 Los Angeles River
S17 Los Angeles Aqueduct
T1 Edward C. Little Water Recycling Facility
T2 Carson Regional Water Recycling Facility
T3 Albert Robles Center for Water Recycling (ARC)
T4 Leo Vander Lans Water Treatment Facility
T5 New Hyperion WRP AWTF
T6 New Hyperion WRP NdN MBR
T7 New JWPCP AWTF
T9 New Soil Aquifer Treatment
T13 New LCWRP AWT
T15 LA Filtration Plant
R1 West Coast Barrier Injection Wells
R2 Dominguez Gap Barrier Injection Wells
R3 Alamitos Gap Barrier Injection Wells
R4 Montebello Forebay Injection Wells
R5 Rio Hondo Spreading Grounds
R6 San Gabriel Spreading Grounds
R8 ARC Injection Wells
R9 New West Coast Basin Injection Wells*
R10 New Central Basin Injection Wells*
R11 New LA Forebay Injection Wells
R12 New LA Forebay Spreading Grounds*
R15 New LA River Dry Wells*
R16 New Beverly Parcel Recharge Project
R17 LADWP New Injection Manhattan
R18 LADWP New Injection Clovis
R19 LADWP New Injection Slauson
R20 LADWP New Injection Soto
R21 LADWP New Injection Confluence
R22 New Injection Wells Inland of Alamitos Barrier*
R23 New Injection Wells Inland of Dominguez Barrier*
R24 New Injection Wells Regional Brackish Water Recl Program*
R25 New Injection Wells for Top Imported Water Users/Pumpers*
R26 New Injection Wells LA River Power Line Easement
E2 LADWP 99th St Well Field
E3 LADWP Manhattan Well Field
E4 New West Coast Basin Well Field*
E5 New Central Basin Well Field*
E6 LA Forebay New Extraction Well Field
E8 Existing Wells West Coast Basin
E9 Existing Wells Central Basin
E11 New Regional Brackish Groundwater Desalter
E12 LADWP New Extraction Manhattan
E13 LADWP New Extraction Clovis
E14 LADWP New Extraction Slauson
E15 LADWP New Extraction Soto
E16 LADWP New Extraction Confluence
E17 New Extraction Wells for Top Imported Water Users/Pumpers*
E18 New LADWP Extraction Wells Outside of Los Angeles*
* Location to be determined
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

Attachment 2
Components of Previously Identified Projects and New Projects

ID	Previously Identified Potential Projects	S1 Hyperion Water Reclamation Plant	S2 Joint Water Pollution Control Plant	S10 Los Coyotes Water Reclamation Plant	S11 Long Beach Water Reclamation Plant	S12 MWD Imported Water	S13 Los Angeles River	S17 Los Angeles Aqueduct	T1 Edward C. Little Water Recycling Facility	T2 Carson Regional Water Recycling Facility	T3 Albert Robles Center for Water Recycling (ARC)	T4 Leo Vander Lans Water Treatment Facility	T5 New Hyperion WRP AWTF	T6 New Hyperion WRP NdN MBR	T7 New JWPCP AWTF	T9 New Soil Aquifer Treatment	T13 New LCWRP AWT	T15 LA Filtration Plant	R1 West Coast Barrier Injection Wells	R2 Dominguez Gap Injection Wells	R3 Alamitos Gap Barrier Injection Wells	R4 Montebello Forebay Injection Wells	R5 Rio Hondo Spreading Grounds	R6 San Gabriel Spreading Grounds	R8 ARC Injection Wells	R9 New West Coast Basin Injection Wells (Inland)	R10 New Central Basin Injection Wells	R11 New LA Forebay Injection Wells	R12 New LA Forebay Spreading Grounds	R15 New LA River Dry Wells	R16 New Beverly Parcel Recharge Project	R17 LADWP New Injection Manhattan	R18 LADWP New Injection Clovis	R19 LADWP New Injection Slauson	R20 LADWP New Injection Soto	R21 LADWP New Injection Confluence	R22 New Injection Wells Inland of Alamitos Barrier	R23 New Injection Wells Inland of Dominguez Barrier	R24 New Injection Wells Regional Brackish Water Recl Program	R25 New Injection Wells for Top Imported Water Users/Pumpers	R26 New Injection Wells LA River Power Line Easement	E2 LADWP 99th St Well Field	E3 LADWP Manhattan Well Field	E4 New West Coast Basin Well Field	E5 New Central Basin Well Field	E6 LA Forebay New Extraction Well Field	E8 Existing Wells West Coast Basin	E9 Existing Wells Central Basin	E11 New Regional Brackish Groundwater Desalter	E12 LADWP New Extraction Manhattan	E13 LADWP New Extraction Clovis	E14 LADWP New Extraction Slauson	E15 LADWP New Extraction Soto	E16 LADWP New Extraction Confluence	E17 New Extraction Wells for Top Imported Water Users/Pumpers	E18 New LADWP Extraction Wells Outside of Los Angeles	
		Source							Treatment										Replenishment																							Extraction															
100	**Replenishment Projects**																																																								
101	LA River Flow Capture Project (1)						X																						X																												
102	LA River Flow Capture Project (2)						X				X														X																																
103	LA River Flow Capture Project (3)						X																							X																											
104	Beverly Parcel Recharge Project						X																								X																										
105	Additional Central Basin Replenishment																										X																														
106	~~Additional West Basin Replenishment~~ (same as Regional Brackish Program)																																																								
200	**Extraction Projects**																																																								
201	Regional Brackish Water Reclamation Program	X	X						X										X							X																							X								
202	~~Manhattan Well Field Extraction Expansion~~ (Same as Manhattan GDAP Project)																																									X														
203	~~99th Street Well Field Extraction Expansion~~ (Same as Clovis GDAP Project)																																								X															
204	~~Additional Central Basin Extraction~~ (Same as GDAP Projects)																																											X												
205	Additional West Coast Basin Extraction																																										X													
300	**Combined Projects**																																																								
301	Hyperion - GRIP Expansion/Spreading Project (1)	X									X		X	X									X	X																																	
302	Hyperion - GRIP Expansion/Spreading Project (2)	X											X	X												X	X																														
303	Hyperion – Injection Project	X											X	X																																											
304	Joint Plant Product Water Flow Diversion		X									X									X						X																														
305	Cerritos Interconnect			X								X																																													
306	~~MWD/Joint Plant Regional Project~~ (same as MWD/LACSD Regional RW Program)																																																								
400	**WRD Groundwater Basins Master Plan**																																																								
401	WCB-P1a,b: Hyperion WRP to West Coast Basin Barrier via WBMWD	X							X										X																									X			X										
402	WCB-P2: JWPCP to Mid-basin injection wells		X												X											X																		X			X										
403	WCB-P3: JWPCP to Dominguez Gap Barrier		X												X																													X			X										
404	CB-P1a,b,c:SJCWRP – 100% Tertiary to MFSG																						X	X																								X									
405	CB-P2a,b,c: SJCWRP – 100% AWT to MFSG										X												X	X																								X									
406	CB-P3: SJCWRP – 50% AWT/50% Tertiary to MFSG										X												X	X																								X									
407	CB-P4: SJCWRP – 100% NF to MFSG																						X	X																								X									
408	CB-P5: SJCWRP – 50% NF/50% Tertiary to MFSG																						X	X																								X									
409	CB-P6: SJCWRP – Ozone/BAC/GAC/UV to MFSG																						X	X																								X									
410	CB-P7: LCWRP AWT to MFSG			X																			X	X																								X									
411	CB-P8: LCWRP full advanced treated to injection at Montebello Forebay			X																		X																										X									
412	CB-P9: Los Angeles River to ARRF at Los Angeles Forebay						X									X												X	X																		X											
413	CB-P10: San Gabriel River/Rio Hondo to MFSG																						X	X																						X												
414	CB-P11: SJCWRP – 100% AWT to injection at Montebello Forebay**																X					X																																			
415	CB-P12: New Satellite AWT (MBR/RO/AOP) to injection at LA Forebay**																											X																			X											

**Project may no longer be viable as the result of conservation (reduced sewer flows and MWD AWT).

ID	Previously Identified Potential Projects		Hyperion Water Reclamation Plant	Joint Water Pollution Control Plant	Los Coyotes Water Reclamation Plant	Long Beach Water Reclamation Plant	MWD Imported Water	Los Angeles River	Los Angeles Aqueduct	Edward C. Little Water Recycling Facility	Carson Regional Water Recycling Facility	Albert Robles Center for Water Recycling (ARC)	Leo Vander Lans Water Treatment Facility	New Hyperion WRP AWTF	New Hyperion WRP NdN MBR	New JWPCP AWTF	New Soil Aquifer Treatment	New LCWRP AWT	LA Filtration Plant
500	**One Water LA**	46																	
501	Concept Option # 10 Hyperion WRP to West Coast Basin Injection Wells	47	■											■					
502	Concept Option # 11 Hyperion WRP to Central Basin Injection Wells	48	■											■					
503	Concept Option # 12 Hyperion WRP to Central Basin with Spreading Basins	49	■											■					
504	Concept Option # 13 MBR at Hyperion WRP to Regional System	50	■												■				
505	**Projects outside of WRD jurisdiction:**	51																	
506	Concept Option # 7 Upper Los Angeles River to Tillman WRP	52																	
507	Concept Option # 9 Tillman WRP to San Fernando Basin Injection Wells	53																	
508	Concept Option # 14 Hyperion WRP to San Fernando Basin Injection Wells	54																	
509	Concept Option # 15 Tillman WRP to Los Angeles Aqueduct Filtration Plant	55																	
510	Concept Option # 16 Tillman WRP to LADWP Distribution System	56																	
511	Concept Option # 17 LAGWRP to Headworks Reservoir	57																	
512	Concept Option # 18 Hyperion WRP to LADWP Distribution System	58																	
513	Concept Option # 19 Hyperion WRP to Headworks Reservoir	59																	
514	Concept Option # 20 Hyperion WRP to Los Angeles Aqueduct Filtration Plant	60																	
515	Concept Option # 22 East-West Valley Interceptor Sewer	61																	
516	Concept Option # 23 Increase Recycled Water Demand beyond 2015 UWMP	62																	
517	Concept Option # 26 Japanese Garden & Sepulveda Basin Lakes Recirculation	63																	
		64																	
600	**Groundwater Development and Augmentation Plan**	65																	
601	Baseline	66	■											■					
602	Scenario 1,2, and 3	67	■											■					
603	Scenario 4	68	■											■					
604	Scenario 5	69	■											■					
		70																	
700	**MWD LACSD Regional Recycled Water Program**	71																	
701	Regional Recycled Water Facility	72		■												■			
		73																	
800	**Hyperion Reuse Feasibility Study**	74																	
801	Scenario1 Hyperion/TI/ECL	75	■							■				■					
802	Scenario2 Hyperion ECL	76	■							■				■					
803	Scenario3 Hyperion Carson	77	■												■				

ID	Previously Identified Potential Projects	West Coast Barrier Injection Wells	Dominguez Gap Injection Wells	Alamitos Gap Barrier Injection Wells	Montebello Forebay Injection Wells	Rio Hondo Spreading Grounds	San Gabriel Spreading Grounds	ARC Injection Wells	New West Coast Basin Injection Wells (Inland)	New Central Basin Injection Wells	New LA Forebay Injection Wells	New LA Forebay Spreading Grounds	New LA River Dry Wells	New Beverly Parcel Recharge Project	LADWP New Injection Manhattan	LADWP New Injection Clovis	LADWP New Injection Slauson	LADWP New Injection Soto	LADWP New Injection Confluence	New Injection Wells Inland of Alamitos Barrier	New Injection Wells Inland of Dominguez Barrier	New Injection Wells Regional Brackish Water Recl Program	New Injection Wells for Top Imported Water Users/Pumpers	New Injection Wells LA River Power Line Easement
500	**One Water LA**																							
501	Concept Option # 10 Hyperion WRP to West Coast Basin Injection Wells	■							■															
502	Concept Option # 11 Hyperion WRP to Central Basin Injection Wells									■	■													
503	Concept Option # 12 Hyperion WRP to Central Basin with Spreading Basins					■	■																	
504	Concept Option # 13 MBR at Hyperion WRP to Regional System																							
505	**Projects outside of WRD jurisdiction:**																							
506	Concept Option # 7 Upper Los Angeles River to Tillman WRP																							
507	Concept Option # 9 Tillman WRP to San Fernando Basin Injection Wells																							
508	Concept Option # 14 Hyperion WRP to San Fernando Basin Injection Wells																							
509	Concept Option # 15 Tillman WRP to Los Angeles Aqueduct Filtration Plant																							
510	Concept Option # 16 Tillman WRP to LADWP Distribution System																							
511	Concept Option # 17 LAGWRP to Headworks Reservoir																							
512	Concept Option # 18 Hyperion WRP to LADWP Distribution System																							
513	Concept Option # 19 Hyperion WRP to Headworks Reservoir																							
514	Concept Option # 20 Hyperion WRP to Los Angeles Aqueduct Filtration Plant																							
515	Concept Option # 22 East-West Valley Interceptor Sewer																							
516	Concept Option # 23 Increase Recycled Water Demand beyond 2015 UWMP																							
517	Concept Option # 26 Japanese Garden & Sepulveda Basin Lakes Recirculation																							
600	**Groundwater Development and Augmentation Plan**																							
601	Baseline																							
602	Scenario 1,2, and 3															■	■	■	■					
603	Scenario 4														■	■	■	■	■					
604	Scenario 5										■				■	■	■	■	■					
700	**MWD LACSD Regional Recycled Water Program**																							
701	Regional Recycled Water Facility				■	■			■															
800	**Hyperion Reuse Feasibility Study**																							
801	Scenario1 Hyperion/TI/ECL																							
802	Scenario2 Hyperion ECL																							
803	Scenario3 Hyperion Carson																							

ID	Previously Identified Potential Projects	LADWP 99th St Well Field	LADWP Manhattan Well Field	New West Coast Basin Well Field	New Central Basin Well Field	LA Forebay New Extraction Well Field	Existing Wells West Coast Basin	Existing Wells Central Basin	New Regional Brackish Groundwater Desalter	LADWP New Extraction Manhattan	LADWP New Extraction Clovis	LADWP New Extraction Slauson	LADWP New Extraction Soto	LADWP New Extraction Confluence	New Extraction Wells for Top Imported Water Users/Pumpers	New LADWP Extraction Wells Outside of Los Angeles	
500	**One Water LA**																
501	Concept Option # 10 Hyperion WRP to West Coast Basin Injection Wells			■			■										
502	Concept Option # 11 Hyperion WRP to Central Basin Injection Wells				■												
503	Concept Option # 12 Hyperion WRP to Central Basin with Spreading Basins				■												
504	Concept Option # 13 MBR at Hyperion WRP to Regional System						■	■									
505	**Projects outside of WRD jurisdiction:**																
506	Concept Option # 7 Upper Los Angeles River to Tillman WRP																
507	Concept Option # 9 Tillman WRP to San Fernando Basin Injection Wells																
508	Concept Option # 14 Hyperion WRP to San Fernando Basin Injection Wells																
509	Concept Option # 15 Tillman WRP to Los Angeles Aqueduct Filtration Plant																
510	Concept Option # 16 Tillman WRP to LADWP Distribution System																
511	Concept Option # 17 LAGWRP to Headworks Reservoir																
512	Concept Option # 18 Hyperion WRP to LADWP Distribution System																
513	Concept Option # 19 Hyperion WRP to Headworks Reservoir																
514	Concept Option # 20 Hyperion WRP to Los Angeles Aqueduct Filtration Plant																
515	Concept Option # 22 East-West Valley Interceptor Sewer																
516	Concept Option # 23 Increase Recycled Water Demand beyond 2015 UWMP																
517	Concept Option # 26 Japanese Garden & Sepulveda Basin Lakes Recirculation																
600	**Groundwater Development and Augmentation Plan**																
601	Baseline	■	■														
602	Scenario 1,2, and 3	■	■								■	■	■	■			
603	Scenario 4	■	■							■	■	■	■	■			
604	Scenario 5	■	■			■				■	■	■	■	■			
700	**MWD LACSD Regional Recycled Water Program**																
701	Regional Recycled Water Facility						■	■									
800	**Hyperion Reuse Feasibility Study**																
801	Scenario1 Hyperion/TI/ECL																
802	Scenario2 Hyperion ECL																
803	Scenario3 Hyperion Carson																

Table Notes:

Purple: Source Water Supplies

Green: Advanced Treatment

Yellow: Replenishment

Blue: Extraction

Appendix B
TM 2-Project Concept Development and Selection

Jacobs

Memorandum

1000 Wilshire Boulevard, Suite 1140
Los Angeles, California 90017
United States
T +1.213.538.1388
F +1.230.538.1399
www.jacobs.com

Subject	**Technical Memorandum 2 – Project Concepts – Final**
Project Name	WRD and LADWP Joint Los Angeles Basin Replenishment and Extraction Master Plan
Date	October 25, 2019 (Revised)

1. Introduction

The Water Replenishment District of Southern California (WRD) and the Los Angeles Department of Water and Power (LADWP) have initiated a partnership to identify solutions to maximize use of the Central Basin and West Coast Basin through development of the Joint Los Angeles Basin Replenishment and Extraction Master Plan (Joint Master Plan). The Joint Master Plan uses a regional approach to identify a comprehensive list of existing and potential new replenishment water sources, treatment facilities, and replenishment and extraction locations, referred to here as project components, as described in Technical Memorandum (TM) 1 (Appendix A).

TM 2 is the second deliverable of the Joint Master Plan study. It describes the development of Project Concepts and the selection process used to identify projects for further analysis and refinement. Specifically, this TM is organized as follows:

- Section 1 – Introduction
- Section 2 – Project Concept Development
- Section 3 – Potential Project Details
- Section 4 – Project Cost Estimates
- Section 5 – Project Selection and Decision Science
- Section 6 – Conclusions and Next Steps

1.1 Project Collaboration

WRD, LADWP, and Jacobs (the Joint Master Plan team) continually collaborated to develop and select the Project Concepts. The Joint Master Plan team held progress meetings every month, along with two additional concept brainstorming meetings to identify and incorporate project ideas into Project Concepts. The results of the project development and screening were presented and refined during Workshop 2 on August 8, 2019, as described in Section 5. The following list and Figure 1 summarize the meetings held to develop the work this TM presents:

- April 15, 2019, Monthly Progress Meeting: This meeting was held to review updates to the list of system components based on Workshop 1.
- May 13, 2019, Monthly Progress Meeting: This meeting was held to review previous groundwater modeling efforts LADWP led for proposed new and expanded well sites.
- June 5, 2019, Concept Meeting: This brainstorming session was held to generate project ideas, which were documented using a dry-erase map to draw Project Concepts.

- June 13, 2019, Monthly Progress Meeting: This meeting was held to review and confirm the Project Concepts developed during the June 5 meeting.
- July 3, 2019, Concept Meeting: This meeting was held to review the variations and potential limitations identified for each project.
- July 16, 2019, Monthly Progress Meeting: This meeting was held to review the final list of Project Concepts and discuss the screening process and criteria.
- August 8, 2019, Workshop 2: During this workshop, results of the project screening were presented, discussed, and refined.
- August 13, 2019, Workshop 2 Follow-up: This meeting was used to confirm the results of Workshop 2 and the projects selected for further development.

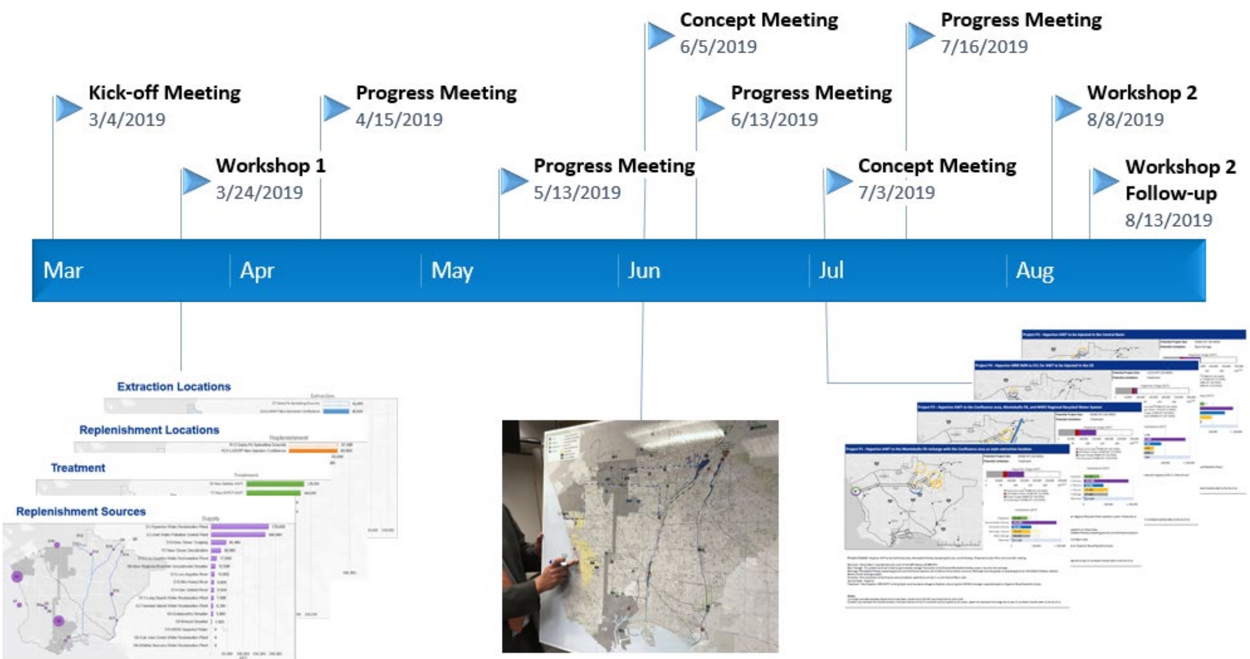


Figure 1. Project Collaboration Meeting Timeline

2. Project Concept Development

The primary goal of the Joint Master Plan is to identify implementable Project Concepts to use available effluent from the Hyperion Water Reclamation Plant (WRP), the Los Coyotes WRP, and other locally available recycled water or stormwater supplies for new replenishment and extraction projects within the Central and West Coast Basins. A Project Concept can have a combination of project system components from each of the following categories:

- Source of water supply
- Advanced water treatment (AWT) facility capacity
- Groundwater replenishment location
- Groundwater extraction location

Different terms were used to refer to the different combination of components. The term "project" could be referring to a project component, a Project Concept, or an optional Project Concept. To establish a common nomenclature for this planning process, the following list defines the terms used in this TM:

- **Project Concept**: A combination of project components that, when combined, form a complete project. The Project Concept must include components for water supply source, AWT (if needed for recharge), groundwater replenishment, and groundwater extraction.
- **Add-on Projects**: A combination of two or more project components that could be added to any other Project Concept for added benefit or to consider alternative water sources. (During the meetings and workshops previously described, these Add-on Projects were referred to as optional projects.)
- **Project Variation**: An iteration of a Project Concept that addresses a limiting factor. For example, once the Project Concept was identified for Project 1 (Figure 2) and the initial capacities of the components were considered (sizes of the color bars on Figure 2), the limitations of the project became evident. Project Variations (Project 1a, Project 1b, and so on) were then created to address some of the limitations. In the example presented on Figure 2, the size of Project 1 is limited by demand and treatment capacity. To address these constraints, Project 1a is used as a variation to address the most limiting component: AWT. Therefore, new advanced treatment facilities or capacities would be needed for this Project 1a Variation.
- **Project or system component**: A single existing or new facility identified as a location of supply, AWT, groundwater replenishment, or groundwater extraction. A single component on its own does not constitute a complete Project Concept, only part of a concept. Thinking in terms of "connecting the dots," project components would be the dots. TM 1 (Appendix A) identified the project components.

Figure 2 illustrates the methodology used to develop Project Concept Variations that are later compared using decision science. The figure illustrates how a Project Concept Variation would derive from Project Concepts and Project Variations, and how Add-on Projects could be attached to any concept.

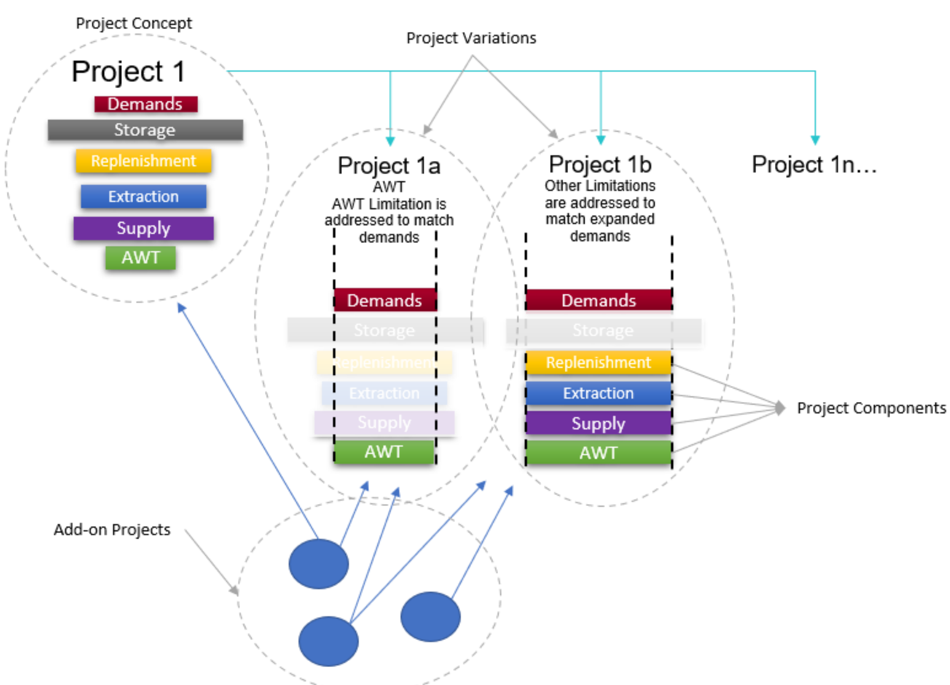


Figure 2. Methodology Used to Determine Project Concept Variations

Project Concepts, Variations, and Add-on Projects were developed based on Joint Master Plan team meetings with input from WRD and LADWP. Table 1 describes the 30 Project Concepts. During the monthly progress meeting on July 16, 2019, the list of 30 Project Concepts was reviewed to confirm which projects would be scored and ranked in a more formal screening process using multi-objective decision analysis (MODA). From the 30 Project Concepts and Add-on Projects identified, 17 Project Concepts were selected to be carried forward for MODA; these are designated by a "P" in the Project Concept name. Other projects, or "O" projects, were screened from further analysis because WRD and LADWP will evaluate them separately, or they were rejected based on overall feasibility in the context of this Joint Master Plan.

Table 1. Project Concepts and Add-on Projects

Project Concept Name	Description	Capacity AFY	Capacity MGD	Initial Screening
P1	Hyperion AWT with recharge at Montebello Forebay, new spreading grounds and Confluence area, and extraction at Confluence	65,000	58	Selected for further analysis
P2	Hyperion AWT with recharge at Montebello Forebay and Confluence area, excess advanced treated flows to Metropolitan's regional recycled water system, and extraction at the Confluence area	65,000	58	Selected for further analysis
P3	Hyperion AWT with recharge and extraction at Confluence, Clovis, Manhattan, Slauson, and Soto wellfields	54,500	49	Selected for further analysis
P4	Hyperion MBR NdN to ECL AWT with recharge and extraction at Clovis and Manhattan wellfields	11,200	10	Selected for further analysis
P5	Hyperion MBR NdN to ECL AWT with recharge at WCB Barrier	11,200	10	Selected for further analysis
P6	Hyperion AWT with recharge at WCB Barrier and DG Barrier, and injection and extraction along pipe route	65,000	58	Selected for further analysis
P7	Hyperion MBR NdN to Carson RWRF for AWT to be injected at DG Barrier and delivered to Harbor area recycled water demands	41,400	37	Selected for further analysis
P8	Hyperion MBR NdN and JWPCP secondary to Carson RWRF AWT with recharge at Montebello Forebay, new spreading grounds, and DG Barrier, and injection and extraction facilities throughout the West Coast and Central Basins	90,000	80	Selected for further analysis
P9	Los Coyotes WRP AWT with recharge at Alamitos Barrier, and injection and extraction in Long Beach and Central Basins	9,500	8	Selected for further analysis
P10	Recharge along pipe routes (general concept)	-	-	Selected for further analysis

Table 1. Project Concepts and Add-on Projects

Project Concept Name	Description	Capacity AFY	Capacity MGD	Initial Screening
P11	Hyperion AWT to Los Angeles Aqueduct Filtration Plant (raw water augmentation)	78,470	70	Selected for further analysis
P12	Connect WBMWD and CBMWD recycled water distribution systems	-	-	Selected for further analysis
P13a	Los Coyotes WRP tertiary to LVL AWTF with recharge at Alamitos Barrier	4,500	4	Selected for further analysis
P13b	Los Coyotes WRP tertiary with recharge at Montebello Forebay and new spreading grounds	17,000	15	Selected for further analysis
P13c	Los Coyotes WRP tertiary to ARC AWTF with recharge at Montebello Forebay	13,000	12	Selected for further analysis
P14a	Los Angeles River flows are advanced treated and injected into Central Basin	33,000	29	Selected for further analysis
P14b	Los Angeles River flows are Title 22 treated for distribution using CBMWD recycled water pipelines to ARC AWT for recharge at Montebello Forebay	22,500	20	Selected for further analysis
O2	Sewer collection intertie and treatment at TIWRP	-	-	Evaluated separately
O3	Decrease underflow from Santa Monica's Charnock Basin to West Coast Basin by sending Hyperion AWT water to Santa Monica	-	-	Rejected
O3a	Indirectly decrease underflow from Santa Monica's Charnock Basin to West Coast Basin by increasing recharge at the WCB Barrier	-	-	Rejected
O6	Connect LVL AWTF to and from TIWRP to provide operation flexibility	-	-	Evaluated separately
O9	JWPCP AWT or JWPCP MBR NdN to WBMWD Carson Facility for AWT to serve Long Beach	-	-	Evaluated separately
O10	JWPCP AWT to Long Beach Area, potential for augmentation at Long Beach Groundwater Treatment Plant	-	-	Evaluated separately
O11	JWPCP MBR NdN to TIWRP for AWT for injection at the DG Barrier or new injection wells in the West Coast Basin	-	-	Evaluated separately
O12	JWPCP MBR NdN to LVL AWTF for AWT for injection at the Alamitos Barrier or new injection wells in the Central Basin	-	-	Evaluated separately

Table 1. Project Concepts and Add-on Projects

Project Concept Name	Description	Capacity AFY	Capacity MGD	Initial Screening
O14	Dedicated AWT basins at spreading grounds	-	-	Evaluated separately
O15	JWPCP AWT or JWPCP MBR NdN to WBMWD Carson Facility for AWT to serve Long Beach	-	-	Rejected
O16	Recharge in West Coast Basin for Regional Brackish Water Reclamation Facility	-	-	Evaluated separately
O17	Hyperion MBR NdN to JWPCP for AWT	-	-	Rejected
O17a	Hyperion MBR NdN to JWPCP for AWT and connection to the Metropolitan Regional Recycled Water Backbone	-	-	Rejected

Notes:

- = not applicable

AFY = acre-foot (feet) per year

ARC = Albert Robles Center

CBMWD = Central Basin Municipal Water District

DG = Dominguez Gap

ECL = Edward C. Little

JWPCP = Joint Water Pollution Control Plant

LVL AWTF = Leo J. Vander Lans Advanced Water Treatment Facility

MBR = membrane bioreactor

MGD = million gallon(s) per day

MWD = Metropolitan Water District of Southern California

NdN = nitrification and denitrification

RWRF = Regional Water Reclamation Facility

TIWRP = Terminal Island Water Reclamation Plant

WBMWD = West Basin Municipal Water District

3. Potential Project Details

A project schematic was developed for each of the Project Concepts and Add-on Projects that were selected for further analysis (Table 1). Figure 3 is an example project schematic showing the general location of the following main project components that were included in this Project Concept:

- Source of water
- Advanced treatment
- Replenishment
- Extraction

The arrows indicate the general connectivity of the system. Summary sheets in Attachment 1 include all project schematic figures.

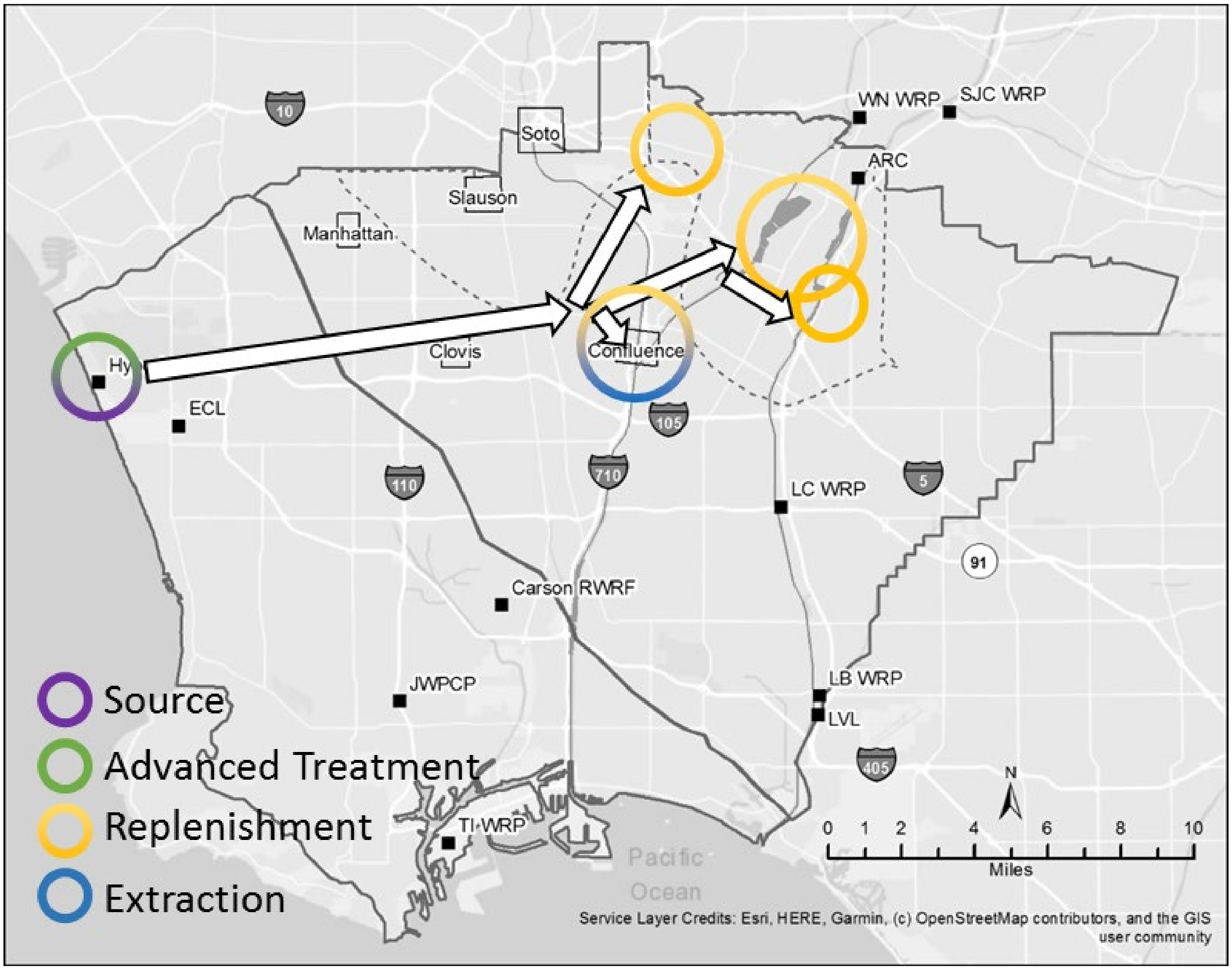


Figure 3. Example of Project Components and Overall Connectivity

WN	*Whittier Narrows*
SJC	*San Jose Creek*
LB	*Long Beach*

Project details were further refined for each Project Concept and Add-on Project based on the capacities of the project components evaluated in TM 1 (Appendix A). The project details indicate the capacity limitations and water supply use of each concept. The potential feasibility of the project was evaluated at a high level based on the following six characteristics:

1) Source water available: amount of supply available
2) Treatment capacity: AWT capacity available
3) Replenishment: groundwater recharge capacity
4) Extraction: groundwater extraction capacity
5) Basin storage: storage needed if no extractions occur for 1 year
6) Demands: water demands that the project could meet

The following two primary indicators were used to evaluate the project capacities and limitations:

1) Hyperion or Los Coyotes WRP effluent usage
2) Overall project limiting constraint based on each of the project components, as well as basin storage use and water demands met

Figure 4 shows an example of a Hyperion usage graph that was developed for projects using Hyperion effluent. The figure shows the following information:

- Total effluent already committed to other uses
- Estimated AWT reject (15% of the project usage)
- Effluent usage by the Project Concept
- Unused effluent up to the current average effluent production of 259 MGD (290,800 AFY)

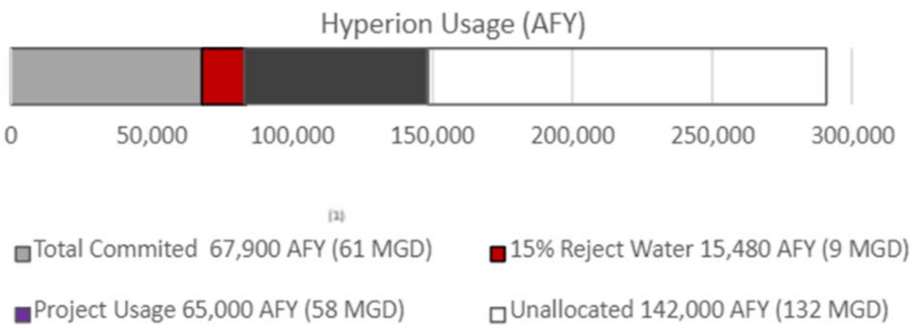


Figure 4. Example of Hyperion Effluent Use

Figure 5 shows an example of how the Project Concept capacity was evaluated. The figure presents project component capacities on a bar chart with two shades of color. The darker shading indicates a good estimate for potential for expansion (solid color shade) with some uncertainty (lighter color shade). The solid color indicates a more conservative capacity based on values TM 1 (Appendix A) established, and the lighter shade of color represent a potential but with a high degree of uncertainty.

The sizes of the Project Concepts were driven by the overall project limiting component. For example, a Project Concept could have enough recharge and extraction capacity, but the overall project could be limited by advanced treatment capacity. Therefore, treatment would be the limiting component of the project, and the potential capacity of recharge and extraction could be reduced to the treatment capacity. Because annual replenishment is assumed to be constant, and extraction can vary seasonally, extraction capacity was assumed to be double the recharge capacity to allow for more flexibility with use of the groundwater storage.

Adjusted project component capacities were used as the basis for estimating the cost of each Project Concept, as presented on Figure 6. If treatment was the limiting factor in a concept, the other facilities were scaled down from their maximums to values that would match, or be appropriate for, the limiting treatment capacity.

Attachment 1 presents project descriptions for each of the Project Concepts listed in Table 1, with the two graphs presented on Figure 4 and Figure 5.

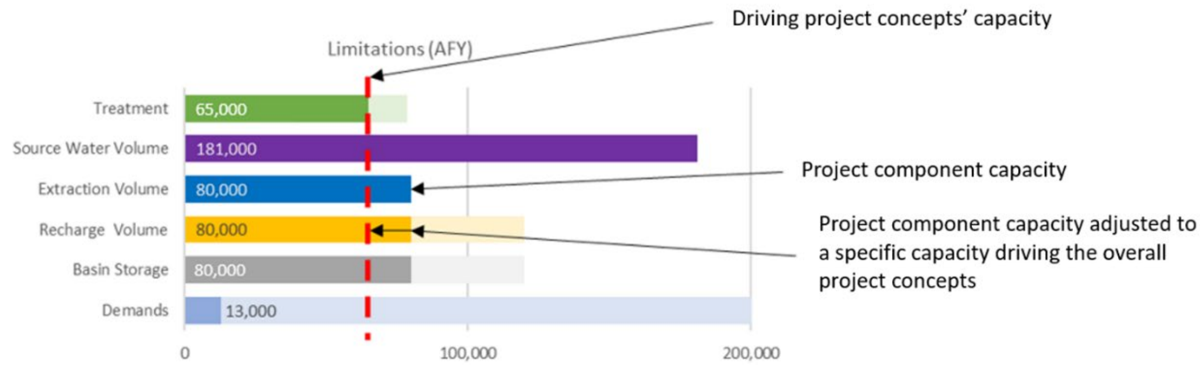


Figure 5. Example of Graph Indicating Potential Project Limitations and Capacities

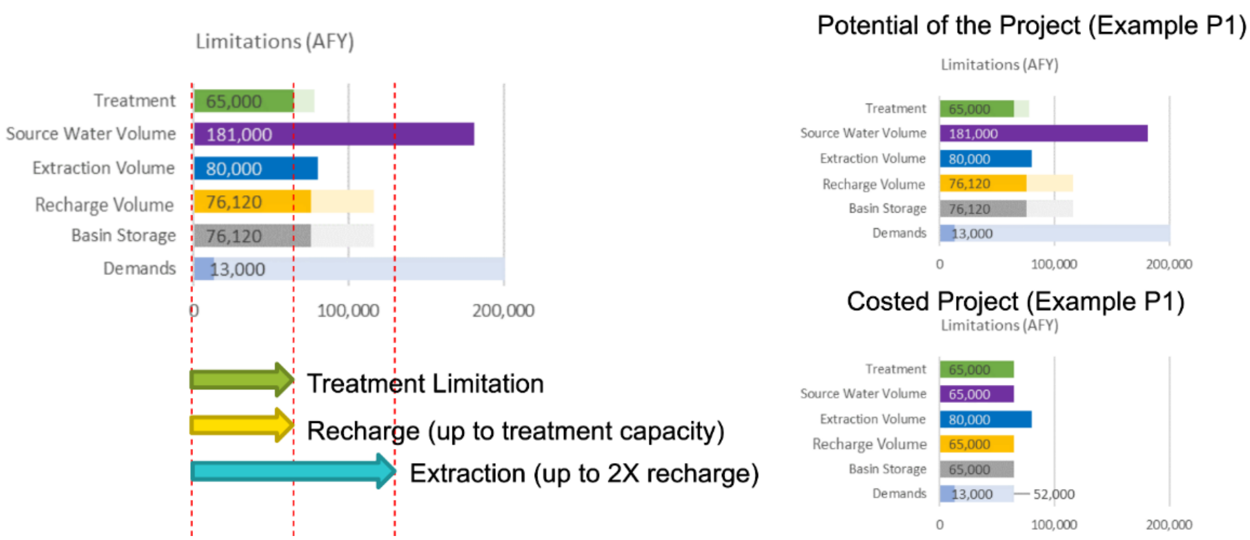


Figure 6. Example of How Initial Capacities Were Reduced for Cost Estimates

4. Project Cost Estimates

Project Concept cost estimates were developed based on the project details and conceptual layouts. Estimates were used to develop relative costs for project scoring, as Section 5 describes. This section describes the assumptions and methodology for the cost estimation process, including specific processes and assumptions associated with the treatment, conveyance, recharge, and extraction.

4.1 Basis and Assumptions

To develop cost estimates for the Project Concepts, Jacobs used its Conceptual and Parametric Engineering System (CPES) tool. This planning and design tool is based on successful design and construction projects collated over the past 20 years into a single design platform. CPES leverages these past project designs to develop quantity estimates from the bottom up, resulting in a more thorough cost estimate.

The accuracy of these cost estimates is considered Class 5 as defined by AACE International, which means they are suitable for a concept screening purpose. The expected cost range is -20 to -50% at the low end of the spectrum and +50 to +100% at the high end. Lifecycle costs were calculated for a duration of 30 years, based on the treatment facility and pump station design lifespans.

The following points summarize the overarching assumptions used within the CPES tool to develop the complete cost estimates for each Project Concept:

- Construction cost markups
  - Contractor overhead (12%)
  - Profit (10%)
  - Mobilization, bonds, and insurance (3%)
  - Contingency (40%)
- Capital cost
  - Permitting (1%)
  - Engineering (6%)
  - Services during construction (SDC) (6%)
  - Commissioning (1%)
- Net present value (NPV) economics
  - 30 years
  - Interest (4.5%)
  - Inflation (2.5%)

CPES was used to generate cost estimates for the treatment, conveyance pump stations, and recharge and extraction well components for each Project Concept. The conveyance pipeline costs were estimated separately, as Section 4.3 describes.

4.2 Treatment

Process flow diagrams (PFDs) were developed to identify the level of treatment and capacities required for each Project Concept. The process selection was based on best practices and industry requirements for groundwater augmentation that include the following unit processes:

- Membrane filtration
- Reverse osmosis (RO)
- Ultraviolet light advanced oxidation process
- Post-treatment
- Disinfection

For concepts that include MBR at Hyperion, the MBR system was assumed to serve as the membrane pretreatment step for RO; for concepts without MBR, microfiltration and ultrafiltration were included at the AWT for pretreatment before RO. For the raw water augmentation concept (that is, Project Concept P11), for which the California Division of Drinking Water has not yet defined regulations, additional pretreatment (ozone and biologically activated carbon) were included based on the San Diego Pure Water project's treatment process, which has been permitted for reservoir augmentation and is representative of what could be adequate in the future.

Given the similarities in capacity and final use of the various concepts that require advanced treatment, six AWT PFDs were developed and used as a basis to prepare AWT costs in CPES. Attachment 2 presents these PFDs, along with key process design criteria assumptions.

The MBR process design was selected to meet both the process treatment requirements (for example, screening) and the reuse water's effluent requirements. Each Project Concept design contains the following process elements:

- Fine screening provided for primary effluent flows down to 2-millimeter spacing
- Design total solids retention time of 10 days for reliable MBR treatment
- Design forward flow hydraulic retention time (including membrane zone) of 5.9 hours
- Process design based on the Modified Ludzack-Ettinger process for effective nitrate removal:
  - Anoxic zone sized at approximately 20% of bioreactor volume
  - Average return sludge pumping rate of 200% of influent flow
  - Average internal mixed liquor recycle rate of 250% to support denitrification
  - Methanol dosage to meet effluent nitrate requirements

Process and equipment sizing were carried out using Jacobs' Professional Process Design (Pro2D) software. Pro2D was subsequently linked to CPES to develop the cost estimates for each Project Concept.

4.3 Conveyance

The conveyance pipeline alignments were developed by conducting a desktop study and aligning pipelines from inlet to outlet locations for each Project Concept using existing roads to estimate pipeline lengths. To identify the most effective pipe alignments, however, pipe routing studies are recommended for future analysis.

The conveyance cost estimate is based on the following assumptions:

- Pipe material is welded steel pipe.
- Open-cut installation will be used throughout the pipeline alignment.
- Tunneling installation will be implemented at locations of major freeway, highway, railroad, and river crossings, including a 50-foot buffer.

The unit costs used for the conveyance pipelines cost estimate used the LADWP *Trunk Line Design Group Design Manual*, Chapter 3, Section K, Table 1 (LADWP 2019a) unit costs for welded steel pipe and open-cut or tunneling pipeline installation. The unit cost for open-cut installation for welded steel pipelines less than 30 inches in diameter was assumed to be $25 per diameter inch per foot of pipe length (dia-in/ft). The unit cost of open-cut installation for welded steel pipelines equal to or greater than 30 inches in diameter was assumed to be $37 per dia-in/ft. The unit cost of tunneling pipelines at major river, railroad, and freeway and highway crossings was assumed to be $125 per dia-in/ft.

Pipe diameters were calculated using both the continuity equation and the Hazen-Williams equation. The continuity equation calculated pipe diameter based on flow rate, pipe length, and a maximum velocity of 5 feet per second. A second diameter was calculated using an assumed maximum head loss of 3 feet per 1,000 feet of pipeline using the Hazen-Williams friction loss equation where the Hazen-Williams Constant, C, was assumed to be 130 for a conservative value for new steel pipe. The maximum diameter was used to round up to the nearest manufactured welded steel pipe diameter size in inches. The final estimated pipeline diameter designated the open-cut installation unit cost. The total construction cost was calculated for each Project Concept using the estimated pipe length, estimated pipe diameter, and respective unit cost for installation of welded steel. The operation and maintenance (O&M) cost was assumed to be 0.5% of the total construction cost for each of the conveyance pipelines.

Existing recycled water distribution was considered for conveyance of tertiary treated water. Where existing recycled water distribution exists, the calculated pipeline diameter was compared to the diameter of the existing pipeline. If the existing recycled water pipeline had a diameter equal to or greater than the calculated pipeline diameter required to convey the flow considered, it was assumed the existing system has enough capacity, and thus no new conveyance would be needed. If the existing recycled water distribution pipeline diameter was less than the calculated pipeline diameter, then it was assumed a new conveyance pipeline would be installed to meet the capacity needed.

For Project Concepts that incorporated the use of well sites for recharge and extraction, the length of conveyance piping needed in between the wells was estimated using the number of wells and well spacing assumed for each well site. The same methodology for calculating pipe diameter was used for the major trunk line. All well piping was calculated to be under 30 inches in diameter and assumed to be open-cut installation.

Pump station cost estimates were developed by determining approximate discharge head requirements based on logical locations for placement of conveyance pump stations along the pipeline alignments. Multiple sequential pump stations were assumed in cases where conveyance required high head, long distances with a variety of high and low points, or both. Generally, total dynamic head of the pump stations was kept at less than 140 pounds per square inch (psi). The number of pumps was estimated based on flow rate and horsepower with a single standby pump.

4.4 Recharge and Extraction

Recharge and extraction costs were primarily based on installation and O&M of the wells. Postextraction groundwater treatment was not considered at this point in the planning process. For new LADWP wellfields costs, the same assumptions the Draft Groundwater Development and Augmentation Plan (GDAP) Report (LADWP 2019b) presented were also applied to this analysis. These assumptions include the following:

- Well total depths
- Screen intervals
- Static water levels
- Pumping water level
- Estimated water levels during injection

Injection well sites were assumed to be completed with below-grade wellhead vaults to house the following components:

- Wellhead
- Discharge piping
- Flow meter
- Control valve(s)
- Pressure transmitters
- Traffic-rated waterproof access hatches

This wellhead completion is similar to injection wells designed for Orange County Water District, which was assumed to be a comparable application. The unit costs for injection well drilling and construction were obtained from engineering estimates prepared for similar projects in California and escalated to current costs. Unit costs were adjusted for proposed well depths and diameters. The costs associated with injection wells based on well depths, inject interval, and estimated water levels ranged from $1,036,000 to $1,533,000.

Extraction well sites were assumed to be constructed with above-grade wellhead completions and a concrete pad equipped with vertical line-shaft turbine pump and motors. Wellhead discharge piping was assumed to include the following:

- Flow meter
- Butterfly valve
- Check valve
- Control valve(s)
- Pressure gauge
- Sample tap
- Air vacuum and release valve

The costs associated with extraction wells based on well depths, extraction interval, and estimated water levels ranged from $813,000 to $2,341,000.

A precast electrical control building was assumed to house the electrical and instrumentation and controls equipment. Unit costs for extraction well drilling and construction were obtained from a contractor bid estimate for a similar well design in California (dated 2018), and these unit costs were also adjusted for proposed well depths and diameters. Horsepower requirements for each extraction well were estimated based on the pumping water levels from the Draft GDAP Report and an assumed system pressure of 30 psi. The unit costs associated with vertical line-shaft turbine pump, motor, column pipe, and discharge head for each extraction well were obtained from budgetary costs pump suppliers provided for other wellfield projects in California with similar flow rate and horsepower requirements (dated 2011 to 2018) and escalated to current costs.

Allowances were assumed for instrumentation and controls (10%), mechanical (5%), and electrical (15%) for both extraction and injection well sites. The unit costs for mechanical wellhead improvements (piping, flow meter, and valving) were obtained from 2019 RSMeans (Gordian 2019), and a 10% allowance was assumed to account for miscellaneous pipes and fittings.

The following assumptions for O&M were considered:

- Mechanical integrity testing would be conducted on the injection wells every 5 years.
- The injection and extraction wells would be redeveloped every 5 years.
- The packer would be replaced in the injection wells every 10 years.
- The pump, motor, or both in the extraction wells would be replaced every 15 years.

4.5 Cost Estimate Summary

Project costs were developed to score and compare projects relative to each other. Project Concept estimates were developed based on treatment, conveyance, recharge, and extraction needs identified for each concept. The cost estimates also accounted for contractor markups associated with overhead, profit, and insurance, as well as contingency costs. The nonconstruction costs considered included the following:

- Permitting
- Engineering
- SDC
- Commissioning
- Startup

Project Concept estimates were converted to a relative cost based on project P1 (cost estimates for each Project Concept were divided by the cost of Project Concept P1). P1 is a robust Project Concept that includes many necessary attributes to accomplish the Joint Master Plan goals. Figure 7 shows the scaled cost ratios for each of the Project Concepts where Project Concepts P2, P3, and P6 have very similar cost ratios to Project Concept P1, and Project Concept P8 is the costliest.

Project Concepts P14a and P14b were not analyzed due to lack of available information. Project Concept P10 was not analyzed because it is an Add-on Project, and costs would vary depending on the Project Concept it is combined with.

When comparing the costs, project size, and attributes, Project Concepts P1, P2, P3, P6, and P7 are the most comparable. Project Concept P7 considers the highest treatment flow at 78,500 AFY, compared to that of 65,000 AFY for the other four Project Concepts.

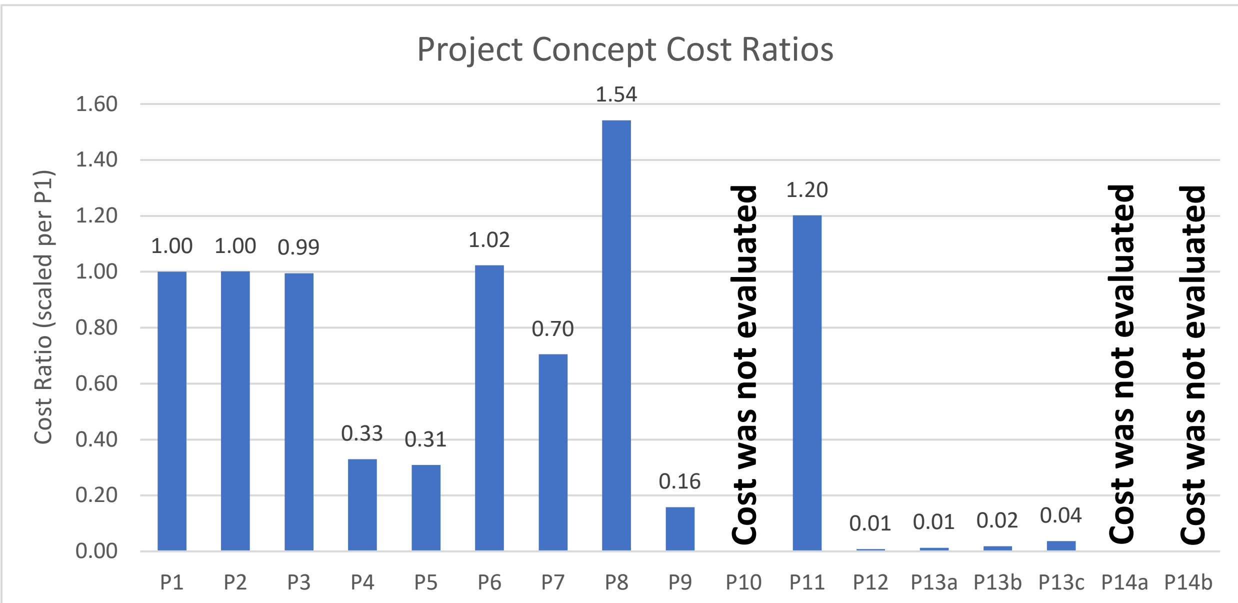


Figure 7. Cost Estimates Relative to P1

5. Project Selection and Decision Science

The ultimate objective of the project selection process was to identify up to five implementable projects for further development. As Section 2 described, a number of Project Concepts were developed (to less than 5% design concepts) and initially screened based on overall feasibility and discussion among the Joint Master Plan team. The Project Concepts were scored and ranked in an iterative process to collaboratively determine which should be selected for further development and serve as the overall recommended projects in the Joint Master Plan. Based on discussions, 17 Project Concepts (listed in Table 1) were selected for screening. This section describes the decision science methodology behind the selection process.

Decision science is a way to make the best possible decision based on the best currently available data. It can be described as a collection of techniques, including the following:

- Concept analysis
- Simulation modeling
- Cost and benefit analysis
- MODA
- Statistical analysis

Decision science provides transparency and a structured and defensible decision-making process.

MODA was used as the decision science method for selecting preferred projects for the Joint Master Plan. The following steps were used in the decision-making process:

1) Define the project and options – Described in Section 2, this step defined all the Project Concepts that would be considered in the selection process.
2) Define the evaluation criteria – Based on multiple Joint Master Plan team discussions, the criteria list determined the different dimensions used to evaluate the projects (for example, cost, ability to meet basin demands, and time to implement the project).
3) Determine the performance metric for each evaluation criterion and each project – Once the criteria or dimensions to evaluate the projects were known, it was necessary to measure each criterion for each project. Measurements can be quantitative or qualitative (for example, basin recharge per year in AFY, cost of the project in dollars, number of years to conclude, and permitting difficulty).
4) Transform the different performance metric units into a unitless value score – The goal of this step was to have consistency across the multiple possible units identified under the performance metric step. The transformation consisted of converting the performance metric to a percentage of the range of values observed. For example, if a metric had a range from 10,000 to 110,000 AFY, 10,000 AFY would now have a 0% unitless score, and 110,000 AFY would have a 100% score.
5) Weight the criteria – Once all criteria were measured and consistent units derived (0% to 100%), a weight was applied to each criterion as a function of the importance given to that item. Weights can be different and a function of Joint Master Plan team preferences or overall project goals, or they could be used to understand different scenarios.
6) Rank projects based on project scores – Project scores were obtained by adding the product of the project unitless value score and the weight of each criterion. Once a score was obtained for each Project Concept, the projects were ranked.
7) Conduct a consensus discussion including a sensitivity analysis and score refinement – With the ranks and scenarios available, the full Joint Master Plan team reviewed scoring and discussed the options and impacts of different criteria priorities.
8) Make a decision – The decision was the last step, when all relevant options and scenarios were evaluated, important aspects of the analyses were covered, and the Joint Master Plan team reached consensus on the best projects to carry forward.

The following subsections further explain the key decision-making steps.

5.1 Multi-objective Decision Analysis

A MODA process was used to rank the Project Concepts according to the weighted criteria from the Joint Master Plan team and the performance of each project against the criteria (project score).

The MODA process is a decision science evaluation method used to aid the decision-making process and considers both financial (cost) and nonfinancial criteria. The nonfinancial criteria are defined to establish a common understanding of how they would apply to the Project Concepts, and measurement scales are assigned to score the performance of each project relative to each criterion. The relative importance of each criterion is then established via weighting factors. LADWP and WRD were asked to weight the set of criteria. The weightings, along with further refined project costs, enabled the Joint Master Plan partners to consider the benefits of the potential projects relative to their estimated costs.

5.2 Criteria

The following six criteria were defined to be the most relevant and important for the evaluation of the projects:

1) Joint Master Plan objectives – Measure of how well the project meets the Joint Master Plan needs, purpose, and objectives. Among many criteria, the following subcriteria define how well a project meets the Joint Master Plan objectives:
    a) Use of full pumping rights by pumpers in the WRD service area
    b) Identification and development of new replenishment sources and locations available to WRD
    c) 100% reliance on groundwater by 2040 within the WRD service area
    d) Reduction of imported water purchases by 50% by 2025 (LADWP goals for the city of Los Angeles). Based on recent imported water values (MWD 2018), the target translates into approximately 223,500 AFY (50% of 447,000 AFY, the recent purchased imported water amount)
    e) Recycling 100% of wastewater from Hyperion WRP by 2035 (LADWP goal)
2) Cost – The cost of a project is a significant criterion in the ranking and selection of the best projects. A high-level net present value (capital plus O&M costs) assuming 30 years, at 4.5% interest rate, with 2.5% inflation was used to develop the cost estimates. Section 4 provides more detail. These planning level cost estimates should not be regarded as absolute values but are rather intended to enable relative comparisons between the projects; therefore, all costs were ranked and proportionally assigned a value between 0% and 100% of the cost range.
3) Permitting difficulty – This is a relative indicator of whether a project is expected to face permitting hurdles or will require significant time to permit, resulting in delays.
4) Regulatory pathway – Dependency of project implementation on future regulations.
5) Institutional complexity – Project implementation requires coordination with several other agencies and is based on the number of agencies involved, number of agreements required, rights-of-way requirements, and political considerations.
6) Potential project phasing – Ability of the project to be implemented in phases.

5.3 Project Metrics

Project metrics measure the performance of each Project Concept with respect to each of the criteria defined under Subsection 5.2. Metrics can be quantitative (for example, total recharge per year or cost of a project) or qualitative (for example, high, medium, or low benefits). Each metric was transformed into a unitless value score. A linear transformation converted metrics to unitless values by assigning 0% to the lowest metric value and 100% to the highest metric value, and interpolating all the other values between. This was done for consistency across the different metrics and to allow the application of weights to each of the criteria.

The bases for the project metrics for the criteria are as follows:

- Joint Master Plan objectives – Quantitative metric, where a higher metric value is favorable for project selection. The metric was the average of all normalized subitems Subsection 5.2 described.
- Cost – Quantitative metric, where a higher metric value is favorable for project selection. The metric was a high-level cost estimate determined under Section 4.

- Permitting difficulty – Qualitative metric, where a higher metric value is detrimental to a project being selected.
- Regulatory pathway – Qualitative metric, where a higher metric value is detrimental to a project being selected.
- Institutional complexity – Qualitative metric, where a higher metric value is detrimental to a project being selected.
- Potential project phasing – Quantitative metric, where a higher metric value is favorable for project selection.

Table 2 shows the metric values for each criterion and each Project Concept evaluated. The project index (P1, P2, P3…) corresponds to the project index Table 1 presented. Green values in the table indicate that a higher value would be beneficial for the project (for example, a project with a higher basin replenishment volume would be more likely to be selected). Red values in the table indicate that a higher value would be detrimental to the project (for example, a project with high costs would have less chance of being selected).

Metric 2 in Table 2 is a relative cost metric. Project costs were computed as Section 4 described and then comparatively used as a fraction of the project P1 cost.

5.4 Criteria Weighting

Each criterion can have a different importance. For example, the project's overarching goals might give preference to less expensive projects, even if those projects rank higher for other criteria. Therefore, it is necessary to determine how relevant each criterion is, and its relative importance to the overall project goals. WRD and LADWP provided weightings for each of the criteria that best represented each organization's priorities. An average of these weightings was applied to each criterion to indicate their combined relative importance. Through this structure, it is possible to create what-if scenarios, where weights are shifted among criteria to understand their individual sensitivity to the project rankings. The Joint Master Plan team conducted this exercise during one of the project workshops.

Table 2. Project Metrics

Metric	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13a	P13b	P13c	P14a	P14b
1. Joint Master Plan objectives (a through e):	Average of the normalized metrics 1a to 1e																
a) Basin extractions (AFY)	65,000	65,000	54,500	11,200	11,200	65,000	41,400	90,000	9,500	0	0	0	0	0	0	0	0
b) Basin replenishment using new facilities (AFY)	65,000	65,000	65,000	11,200	0	16,600	10,000	58,600	4,700	0	0	0	0	17,000	13,000	0	16,900
c) Imported water offset in the basin, excluding Los Angeles (AFY by 2040)	13,000	13,000	10,500	7,000	11,200	65,000	40,000	90,000	9,500	0	0	0	4,500	0	13,000	40,000	22,500
d) Imported water reduction for LADWP related to target (% of target reduction)	0.233	0.233	0.244	0.019	0	0	0.172	0	0	0	0.351	0	0	0	0	4.294	0
e) Hyperion usage (AFY by 2035)	65,000	65,000	65,000	11,200	11,200	65,000	41,400	33,600	0	0	78,470	0	0	0	0	0	0
2. NPV capital cost presented as a fraction of P1 NPV cost	1	1	0.99	0.33	0.31	1.02	0.7	1.54	0.16	1.54	1.2	0.01	0.01	0.02	0.04	1.54	1.54
3. Permitting difficulty: – CEQA, NEPA, and other permits: Scale 0-5	3	3	3	3	3	3	3	3	4	0	5	0	3	3	3	5	5
4. Undefined regulatory pathways: Scale 0-2	1	2	1	1	1	1	1	1	1	0	2	0	0	0	0	2	2
5. Institutional complexity: Scale 0-2	1	1	1	1	0	1	1	2	0	0	2	0	0	0	0	2	2
6. Can the project be phased and still achieve significant benefits? No. of different locations for recharge and extraction (count of new facilities)	7	5	12	6	2	6	4	14	3	0	0	0	1	3	4	0	4

Notes:

Green values represent metrics where a higher value is favorable to project selection.

Red values represent metrics where a higher value is detrimental to project selection.

CEQA = California Environmental Quality Act

NEPA = National Environmental Policy Act

No. = number

Table 3. Weight Structure of the Scenarios Considered in the Project Concept Selection

Criteria	Weight Structure Scenarios						
	Average WRD and LADWP Base Structure (%)	Permitting Weight Set at the Maximum of Its Range from 5% to 15%	Institutional Weight Set at the Maximum of Its Range from 7.5% to 15%	Project Goals at the Maximum of Their Range from 42.5% to 50%	Cost (%) from 27.5% to 35%	WRD (%)	LADWP (%)
1. Joint Master Plan objectives, including:	42.5	38.0	39.1	50.0[a]	38.1	40.0	45.0
a) Use of full pumping rights by pumpers (WRD)	–	–	–	–	–	–	–
b) New replenishment sources available to WRD	–	–	–	–	–	–	–
c) 100% reliance on groundwater by 2040 (WRD)	–	–	–	–	–	–	–
d) Reduce purchased imported water	–	–	–	–	–	–	–
e) Recycle 100% of wastewater from Hyperion	–	–	–	–	–	–	–
2. Cost	27.5	24.6	25.3	23.9	35.0[a]	25.0	30.0
3. Permitting difficulty	5.0	15.0[a]	4.6	4.3	4.5	5.0	5.0
4. Regulatory pathway	7.5	6.7	6.9	6.5	6.7	10.0	5.0
5. Institutional complexity	7.5	6.7	15.0[a]	6.5	6.7	10.0	5.0
6. Potential project phasing	10.0	8.9	9.2	8.7	9.0	10.0	10.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] Values changed from baseline weight structure.

When weighting values were changed from the baseline weight structure Table 3 presents (for example, permitting scenario had a 15% weight on permitting instead of 5%), the remaining weights were adjusted proportionally to their weights in the baseline weight structure.

5.5 Project Scores and Ranking

The final Project Concept score was determined by the sum of the unitless value scores with weights applied to them. Projects were ranked based on their scores (metrics with weights assigned to each one of the evaluation criteria). Seven different weighting scenarios shown in Table 3 were used to understand the sensitivity of project ranking due to different criteria.

The first step in the project ranking process was based on project scoring. Scores were developed by multiplying the unitless value score by the weight assigned to the criterion, and then adding the values for all of the criteria. Equation 1 shows how the score for each project was computed:

$$u_p = \sum_{j=1}^{c} v_{p,j} w_j$$

Equation 1. Calculation of Project Concept Score

Where:

u_p= Project ("p") score

j= Metric criteria

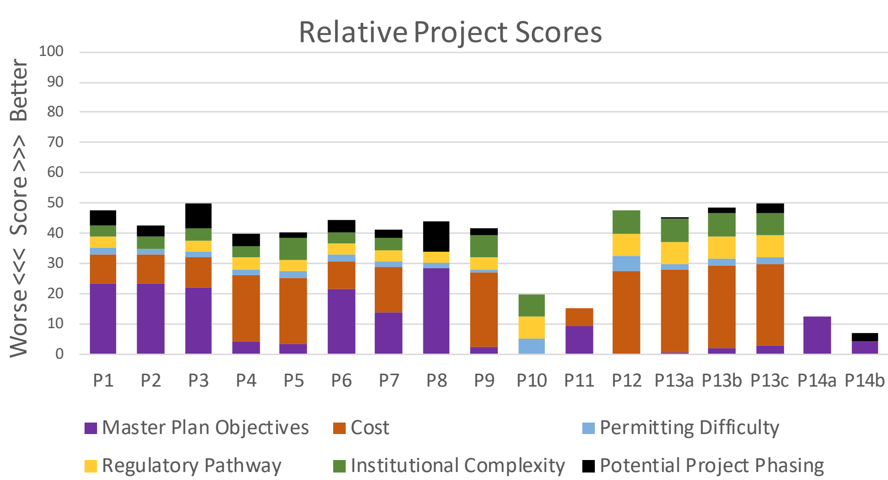
c= Number of metric criteria (six)

v= Project metric value

p = Project Concept

w= Weight

Figure 8 shows the results of the MODA analysis for the average WRD and LADWP weight scenarios, also referred as the baseline weight structure scenario. The highest score in the chart is the project with the most overall benefits when all metrics and weights are considered. The figure also shows the contribution of each criterion to the overall score of each project. A table on the right side of Figure 8 shows the rank of the projects and the main water source.



Rank#	Project	Main Source
1	P3	Hyperion
2	P13c	Los Coyotes
3	P13b	Los Coyotes
4	P1	Hyperion
5	P12	Other
6	P13a	Los Coyotes
7	P6	Hyperion
8	P8	Hyperion
9	P2	Hyperion
10	P9	Los Coyotes
11	P7	Hyperion
12	P5	Hyperion
13	P4	Hyperion
14	P10	Other
15	P11	Hyperion
16	P14a	LA River
17	P14b	LA River

Figure 8. Project Scores for the Average WRD and LADWP Baseline Weight Scenarios

The MODA sensitivity analysis revealed that a few projects were consistently ranked in the top three positions regardless of the criteria weighting. Those projects are:

- P1 – Hyperion AWT with recharge at Montebello Forebay, new spreading grounds and Confluence area, and extraction at Confluence area
- P3 – Hyperion AWT with recharge and extraction at Confluence, Clovis, Manhattan, Slauson, and Soto areas
- P13 a,b,c – Los Coyotes WRP Project Concepts
- P12 – Connect WBMWD and CBMWD recycled water distribution systems

Table 4 shows the MODA results for the different weighting scenarios. Although Table 4 lists all project rankings for all of the weighting scenarios, it can be difficult to identify projects that are consistently in the top rankings. Figure 9 was developed to summarize how often a Project Concept would appear at a given rank; it multiplies the number of times a project appeared in a given rank by the rank value. This approach allows for a better view of the project ranking across different weighting scenarios. The smallest, top bars on Figure 9 represent the best Project Concepts.

Table 4. Project Concept Ranking for the Different Weighting Scenarios

Rank No.	Average WRD and LADWP	Permitting from 5% to 15%	Institutional from 7.5% to 15%	Project Goals from 42.5% to 50%	Cost from 27.5% to 35%	WRD	LADWP
1	P3	P12	P13c	P3	P13c	P13c	P3
2	P13c	P3	P13b	P1	P13b	P13b	P13c
3	P13b	P13c	P12	P8	P12	P3	P1
4	P1	P13b	P3	P6	P13a	P12	P13b
5	P12	P1	P13a	P13c	P3	P13a	P12
6	P13a	P13a	P1	P2	P9	P1	P8
7	P6	P6	P9	P13b	P1	P6	P6
8	P8	P8	P6	P12	P5	P8	P2
9	P2	P2	P5	P7	P4	P9	P13a
10	P9	P7	P2	P13a	P6	P5	P7
11	P7	P5	P7	P9	P7	P7	P9
12	P5	P4	P4	P4	P2	P2	P4
13	P4	P9	P8	P5	P8	P4	P5
14	P10	P10	P10	P10	P10	P10	P11
15	P11	P11	P11	P11	P11	P11	P10
16	P14a	P14a	P14a	P14a	P14a	P14a	P14a
17	P14b	P14b	P14b	P14b	P14b	P14b	P14b

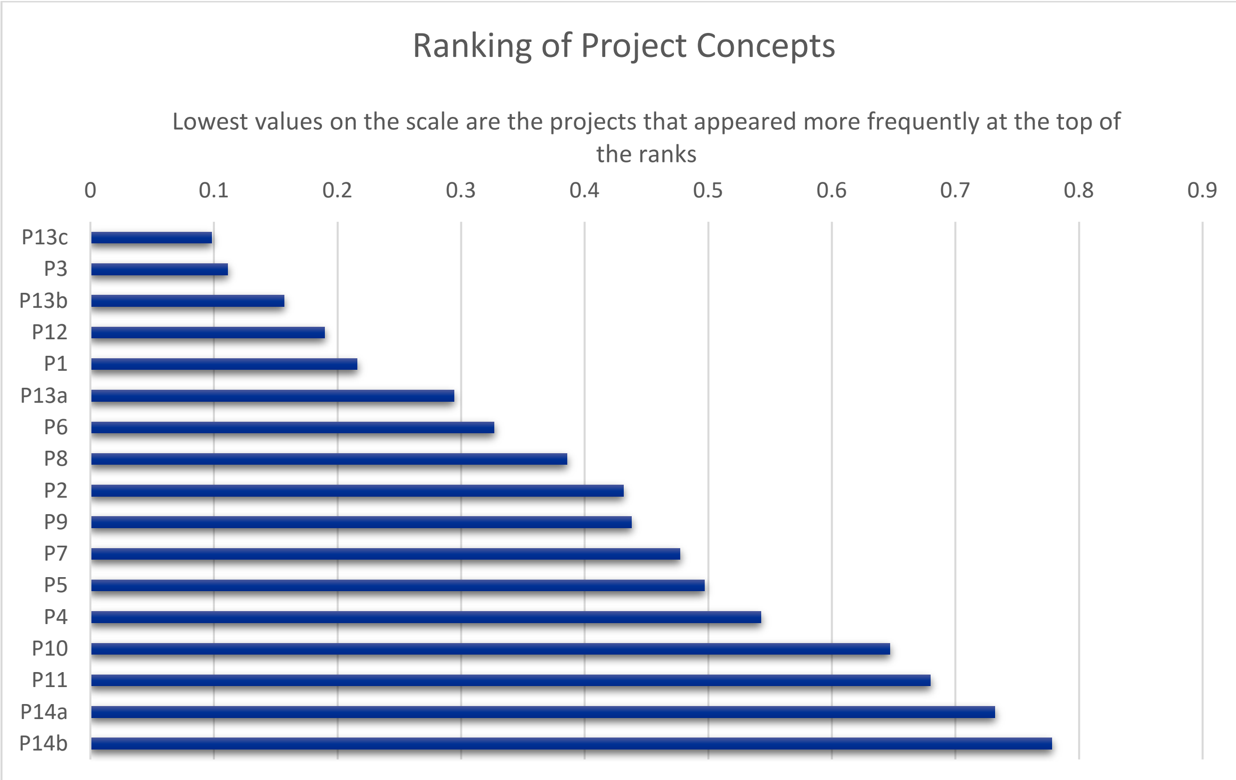


Figure 9. Overall Ranking of Projects, Considering All Seven Weighting Scenarios

Project Concept 13 was related to the usage of the Los Coyotes WRP flows, and it had three variations: a, b, and c. Project Concept 12 was focused on closing gaps in the recycled water pipeline connectivity for a regional system. These two projects ranked high on all weighting scenarios mainly because of the high cost-to-benefit ratio in comparison with other Project Concepts.

Project Concepts 1 and 2 also ranked high on all weighting scenarios because both projects have Hyperion as the main source of water. Both projects are ranked high mainly because of their abilities to meet the project objectives.

5.6 Consensus Discussion and Decision

Workshop 2 was held on August 8, 2019, to review the final list of Project Concepts and the project screening process, and to select projects for further development. The primary purpose of the workshop was to review the initial results of the screening and identify refinements needed to the assumptions or project scoring. Based on the group discussion, the following refinements were made to the MODA scores that led to the results presented in Table 4 and on Figures 8 and 9:

- The size of project P13a was initially limited by the 2,000-AFY available treatment capacity at LVL AWTF, which was limiting the score for use in basin replenishment using new facilities and the imported water offset. WRD provided updated information that LVL AWTF has an available treatment capacity of 4,000 to 4,500 AFY. This score was adjusted for project P13a.
- Project P2 received a poor score for undefined regulatory capacity because existing regulations are not in place for raw water augmentation. This score was improved because regulations are now scheduled to be in place by 2023 and are thus expected to exist by the time the project would be implemented.

- Project P2 received a poor score for institutional complexity due to the coordination required with Metropolitan. In July 2019, LADWP and Metropolitan signed a Letter of Intent (LOI) to collaborate on advanced water delivery systems between Metropolitan and LADWP. As a result of this LOI and continued collaboration between LADWP and Metropolitan, the score for institutional complexity for this project improved.

The Joint Master Plan team reached consensus about the projects that should be carried forward after reviewing the MODA analysis, the different components that would result in the final Project Concept goals, the weight structures, and the metrics of each criterion.

Nine projects were selected from the initial 17 projects considered in the MODA analysis. Table 5 presents the updated project status after the Joint Master Plan team workshop discussions.

Table 5. Project Concepts after the Joint Master Plan Team Workshop Discussions

Project	Description	Results	Reasoning
P1	Hyperion WRP flows are advanced treated at new Hyperion WRP AWT for injection and extraction at new Confluence area and spreading at Montebello Forebay and new spreading facilities at Los Angeles Forebay and Beverly. Confluence recharge capacity was limited to 40,000 AFY to account for years that the city of Los Angeles might not have demands for more than 40,000 AFY. Assumes that 13,000 AFY of imported water demands could be offset with more extraction from existing wells in the Central Basin. This project is limited by the advanced treatment capacity at Hyperion WRP.	Selected	High scoring
P2	Hyperion WRP flows are advanced treated at new Hyperion WRP AWT for injection and extraction at new Confluence area and spreading at Montebello Forebay. Additional flows are sent to the Metropolitan Regional Recycled Water Backbone Pipeline. This project assumes that Confluence extraction targets (at minimum, equal to recharge volume) will be achievable due to the connection with the Metropolitan Regional Recycled Water Backbone Pipeline. This project is limited by the advanced treatment capacity at Hyperion WRP.	Selected	High scoring
P3	Hyperion WRP flows are advanced treated at new Hyperion WRP AWT for injection and extraction at new Confluence, Clovis, Soto, Slauson, and Manhattan areas. Recharge at Confluence location assumed to be 40,000 AFY. Assumes that 10,500 AFY of imported water demands could be offset with more extraction from existing wells in the Central Basin. This project is limited by the advanced treatment capacity at Hyperion WRP.	Selected	High scoring
P4	Hyperion MBR NdN flows are advanced treated at ECL for injection and extraction at Clovis and Manhattan areas. This project is limited by the available expansion capacity at ECL.	Removed	AWT at Hyperion WRP is preferred
P5	Hyperion MBR NdN flows are advanced treated at ECL for injection at the WCB Barrier. This project is limited by treatment capacity.	Selected	Need to maintain flows to WCB Barrier

Table 5. Project Concepts after the Joint Master Plan Team Workshop Discussions

Project	Description	Results	Reasoning
P6	Hyperion WRP flows are advanced treated at new Hyperion WRP AWT for injection at WCB and DG Barriers. New injection and extraction facilities are constructed along the conveyance route. An existing 42-inch-diameter pipeline from Hyperion to Carson RWRF could be used. This project is limited by treatment capacity at Hyperion WRP.	Removed	Project does not help to offset Los Angeles imported water demand
P7	Hyperion MBR NdN flows are advanced treated at Carson RWRF for injection at DG Barrier and used to feed the Harbor area's advanced treated recycled water demands. Extraction would be used to meet demands upstream of Dominguez Barrier. Project is limited by storage capacity.	Removed	AWT at Hyperion WRP is preferred, but project does not help to offset Los Angeles imported water demand
P8	Hyperion MBR NdN and JWPCP flows are advanced treated at Carson RWRF. Hyperion flows would be conveyed through the current recycled water pipeline (42-inch diameter). Carson RWRF would be expanded to 97 MGD. Land is potentially available for above-ground storage to accommodate diurnal flow variations.	Removed	AWT at Hyperion WRP is preferred, but additional flows from JWPCP are not feasible
P9	Los Coyotes WRP flows are advanced treated at new Los Coyotes WRP AWT for injection at Alamitos Barrier with new injection and extraction in Long Beach.	Removed	AWT at Los Coyotes WRP is not feasible
P10	An Add-on Project that would site new injection and extraction facilities along the main AWT pipeline alignment.	Selected	To be incorporated with resulting project
P11	Hyperion WRP flows are advanced treated at new Hyperion WRP AWT and conveyed to Los Angeles Aqueduct Filtration Plant for raw water augmentation. This project is limited by the advanced treatment capacity at Hyperion WRP. Conveyance for this project was not evaluated.	Removed	Low scoring; standalone project does not meet replenishment and extraction goals of the Joint Master Plan
P12	Connect WBMWD and CBMWD recycled water distribution systems for improved connectivity.	Selected	To be incorporated with resulting project
P13a	Los Coyotes WRP flows are advanced treated at LVL AWTF for injection at the Alamitos Barrier. Assumes use of existing extraction facilities.	Selected	Can be combined with P13b and P13c
P13b	Los Coyotes WRP flows are conveyed to Montebello Forebay for spreading. Assumes use of existing extraction facilities.	Selected	High scoring
P13c	Los Coyotes WRP flows are advanced treated at ARC for spreading and injection at Montebello Forebay. Assumes use of existing extraction facilities.	Selected	High scoring
P14a	Los Angeles River flows are advanced treated (undefined location) for injection into the Central Basin.	Removed	Low scoring; concept needs more information to evaluate
P14b	Los Angeles River flows are treated to Title 22 standards and put into CBMWD for delivery to ARC to be advanced treated and recharged at Montebello Forebay.	Removed	Low scoring; concept needs more information to evaluate

After refinements to the MODA scores, workshop participants discussed combining aspects of the similar, high-scoring nine projects selected into two distinct projects, thereby maximizing the benefits of the resulting projects. Based on this discussion, the following projects were developed to serve as the overall recommended projects in the Joint Master Plan:

- **Hyperion WRP Project:** Projects P1, P2, P3, P5, and P10 were combined into one project, with a focus on maximizing the use of Hyperion WRP flows through injection and extraction in the Central Basin, spreading at the Montebello Forebay and siting of new spreading facilities, and with excess flows connected to the Metropolitan advanced treated recycled water backbone conveyance system. Maintaining existing flows to ECL for injection at the WCB Barrier is assumed. Figure 10 shows a conceptual overview of this project.
- **Los Coyotes WRP Project:** Projects P12, P13a, P13b, and P13c were combined into one project, with a focus on finding the best use of available Los Coyotes WRP flows. The project will evaluate whether Los Coyotes flows should be sent north to the Montebello Forebay, or south for AWT at LVL AWTF for injection at the Alamitos Barrier or new injection and extraction facilities in the Long Beach area. If the flows are best used by going south toward Long Beach, then connection of the WBMWD and CBMWD recycled water conveyance systems would be considered to convey flows using existing conveyance infrastructure. Figure 11 shows a conceptual overview of this project.

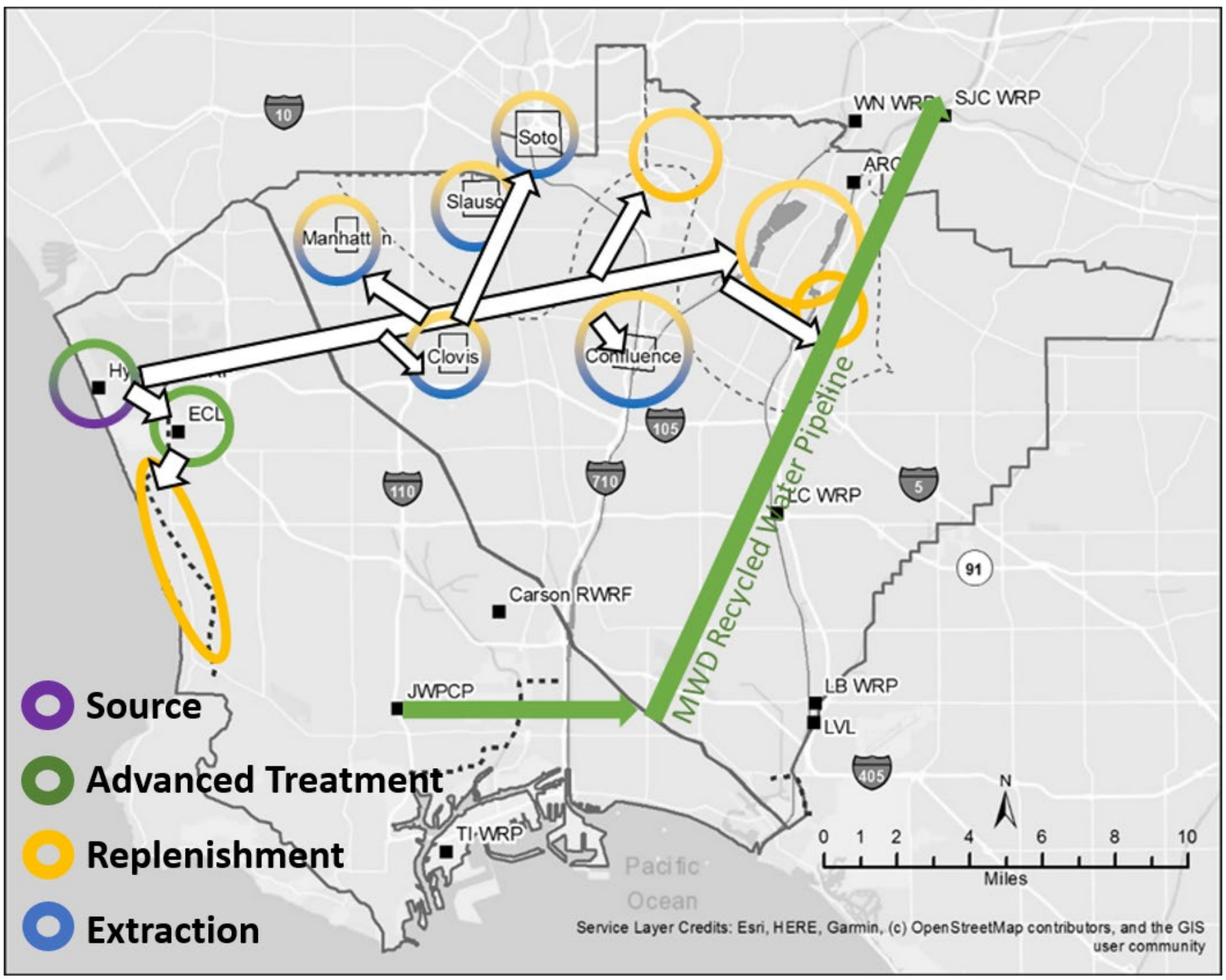


Figure 10. Conceptual Overview of the Hyperion Water Reclamation Plant Project

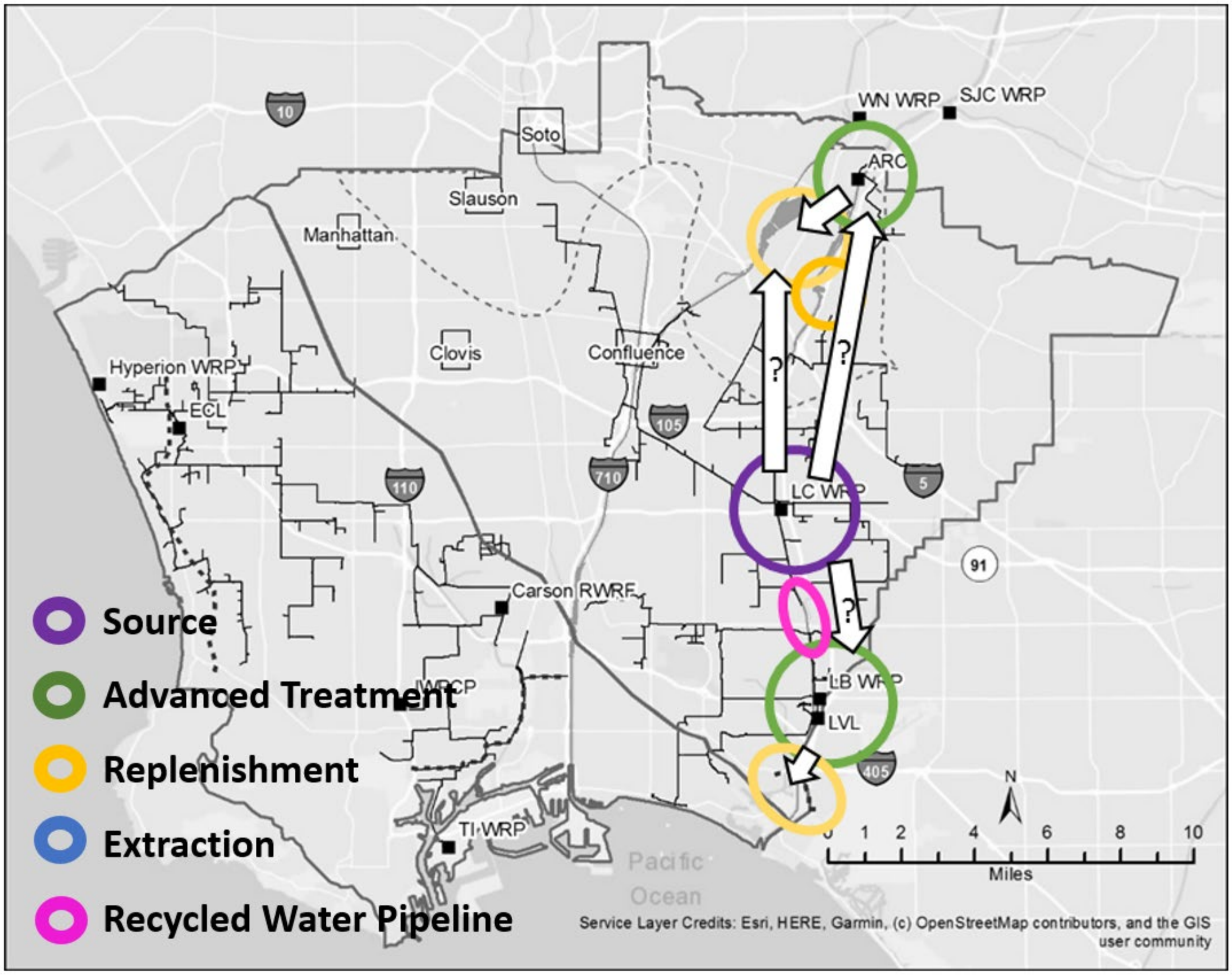


Figure 11. Conceptual Overview of the Los Coyotes Water Reclamation Plant Project

6. Summary and Next Steps

The system components TM 1 identified were used to develop 30 Project Concepts and Add-on Projects. These Project Concepts were initially screened based on overall feasibility and discussion among the Joint Master Plan team. After screening, the remaining 17 Project Concepts were scored and ranked in an iterative process to collaboratively determine which should be selected for further development.

Workshop 2 was held to present the initial Project Concept ranking and discuss refinements with the Joint Master Plan team. After refinements to the MODA scores, nine projects were combined into two distinct projects: (1) Hyperion WRP Project and (2) Los Coyotes WRP Project.

The following next steps are recommended for project development:

- **Groundwater modeling:** Groundwater modeling is recommended to understand the range of replenishment and extraction that can be achieved with each project. The groundwater modeling conducted under Task 1 provided a conservative estimate of the lower bound for volumes that could be replenished and extracted. Additional analysis is needed to understand maximum volumes that can be achieved. Modeling can also be used to run and optimize storage management scenarios. Particle tracking is also recommended to understand the potential impacts to known contamination sites.

- **Hyperion Backbone route development:** The Hyperion Backbone route is an important component of the Hyperion WRP Project for logistics, cost, and phasing of the project. This pipeline will be a major cost component and provide a basis for smaller conveyance lines needed to connect to the replenishment facilities. Aside from cost, route development and selection should be based on other factors, including constructability, environmental impacts, and utility conflicts.
- **Hyperion non-Backbone conceptual conveyance design:** Based on selection of the preferred Hyperion Backbone concept, conceptual alignments for conveyance to the replenishment facilities are needed to estimate conveyance costs.
- **En route injection facilities:** Based on selection of the preferred Hyperion Backbone concept and using information from the groundwater model, potential injection sites should be identified along the Backbone alignment to provide opportunities for additional recharge within the West Coast Basin and Central Basin.
- **Hyperion WRP Project replenishment and extraction siting study:** To build upon the facility locations the GDAP Report identified, it is recommended to verify the viability of these properties and identify potential alternative sites. The Hyperion WRP Project also includes new spreading grounds in the Los Angeles Forebay for which suitable property needs to be identified.
- **Postextraction treatment requirements:** Based on water quality data and known contaminants near proposed extraction facilities, treatment may be required prior to the distribution of potable water.
- **Los Coyotes WRP Project Concepts analysis:** A concepts analysis is needed to determine the best use of available flows from the Los Coyotes WRP. Flows may be directed north for injection and spreading, or injection in the Alamitos Barrier or in Long Beach. Based on the outcome of this analysis, evaluation of existing conveyance and treatment infrastructure is needed.

7. References

Jacobs. 2019. *Technical Memorandum 1 – Identification of System Components. Water Replenishment District and Los Angeles Department of Water and Power Joint Los Angeles Basin Replenishment and Extraction Master Plan*. Draft. April 30.

Los Angeles Department of Water and Power (LADWP). 2019a. *Trunk Line Design Group Design Manual: A Guide to the Management, Design and Construction Support of Trunk Line Design Projects.* April.

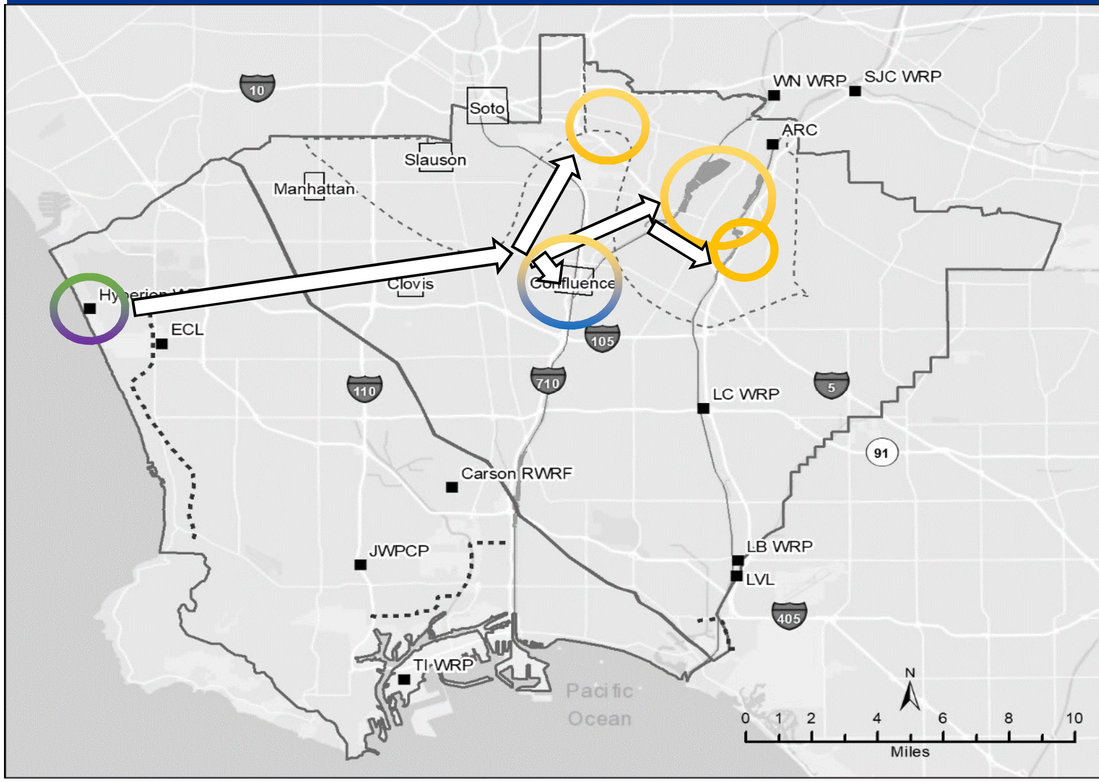
Los Angeles Department of Water and Power (LADWP). 2019b. *Groundwater Development and Augmentation Plan. Phase 1 Report. Central Basin, Los Angeles. Review draft.* March 14.

Metropolitan Water District of Southern California (Metropolitan). 2018. *Annual Report for the Fiscal Year July 1, 2017 to June 30, 2018*. Los Angeles, California. http://www.mwdh2o.com/PDF_Who_We_Are/2018_AnnualReport.pdf.

Mewis, Robert, ed. 2019. *Building Construction Costs with RSMeansData*.

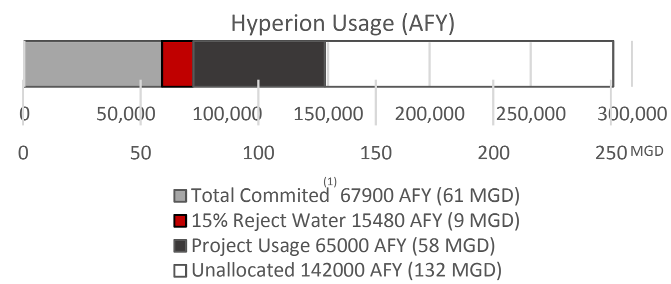
Attachment 1
Project Descriptions

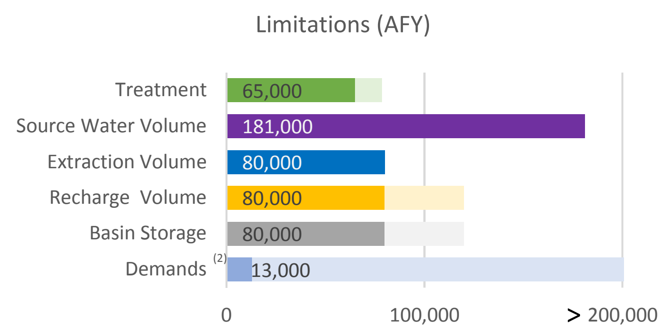
Project P1: Hyperion AWT with recharge at Montebello Forebay, new spreading grounds, and Confluence and extraction at Confluence



Potential Project Size: 65000 AFY (58 MGD)

Potential Limitation: Treatment





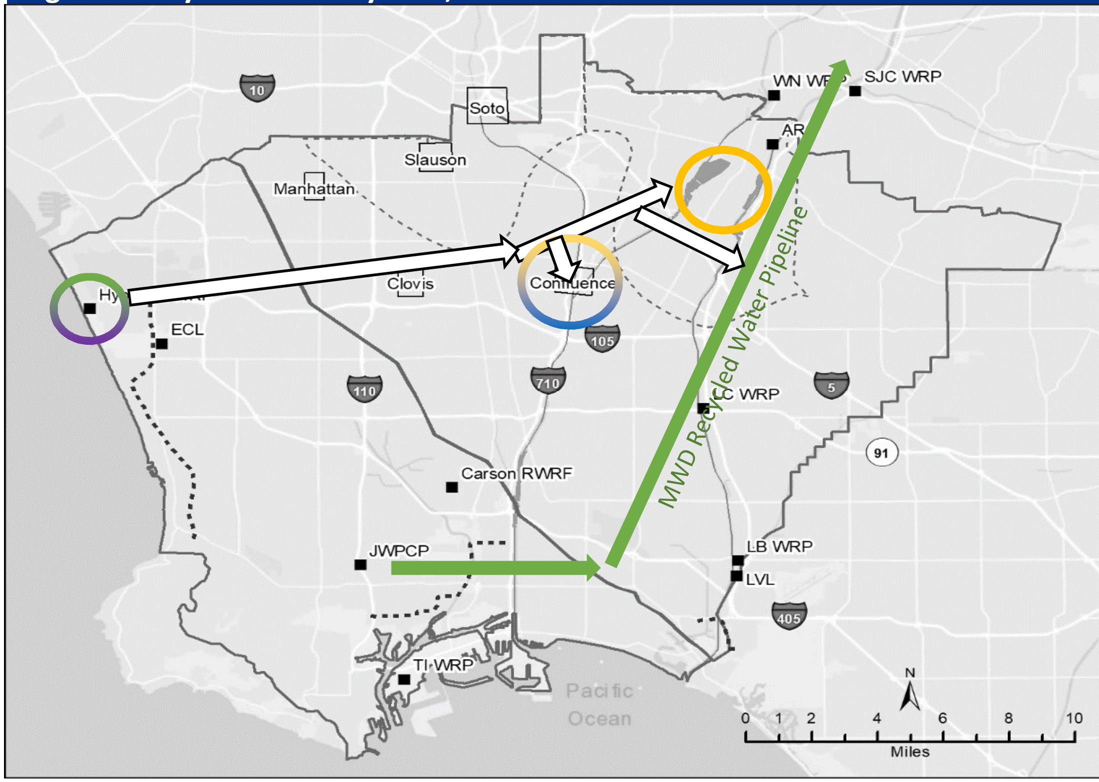
Project Details: Hyperion AWT to the Montebello FB recharge with the Confluence area as main extraction location. Presented as Item #3 on the June 13th meeting.

Demands: Central Basin imported demands north of the 105 freeway (13,000 AFY), excludes City of LA.
Basin Storage: This project could be limited by groundwater storage if extraction at Confluence/Montebello forebay areas is less than the recharge.
Recharge: Montebello Forebay spreading grounds and Confluence locations are limited by the extraction amounts. Recharge could be greater at spreading grounds. Montebello Forebay spreading. Beverly Parcel recharge project. New Spreading grounds upstream or west of the Montebello FB.
Extraction: Only extractions at Confluence were considered, potential to extract in current Central Basin wells need to be evaluated
Source Water: Hyperion
Treatment: New Hyperion WRP MBR NdN AWTF. Limiting factor could be above ground storage at Hyperion (Assuming that 14 MG of primary storage is possible based on Hyperion Reuse Feasibility Study) and assuming that a minimum of 20 MGD flows through the secondary treatment at any time (20 MGD flow needs further evaluation)

Notes:

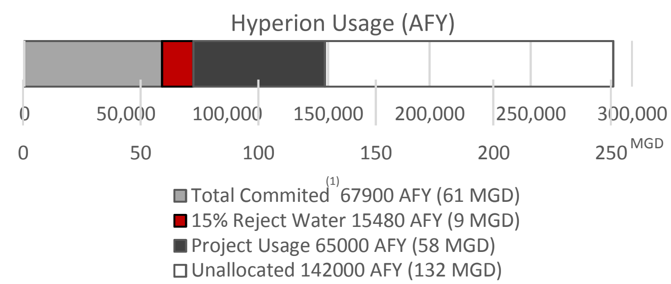
(1) Includes committed secondary effluent flow to West Basin, Influent flow to DCTWRP, and influent flow to LAWA AWPF
(2) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los

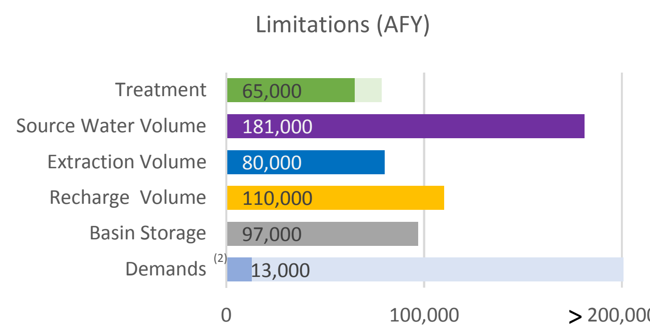
Project P2: Hyperion AWT with recharge at Montebello Forebay and Confluence area, excess advanced treated flows to MWD Regional Recycled Water System, and extraction at Confluence



Potential Project Size: 65000 AFY (58 MGD)

Potential Limitation: Treatment





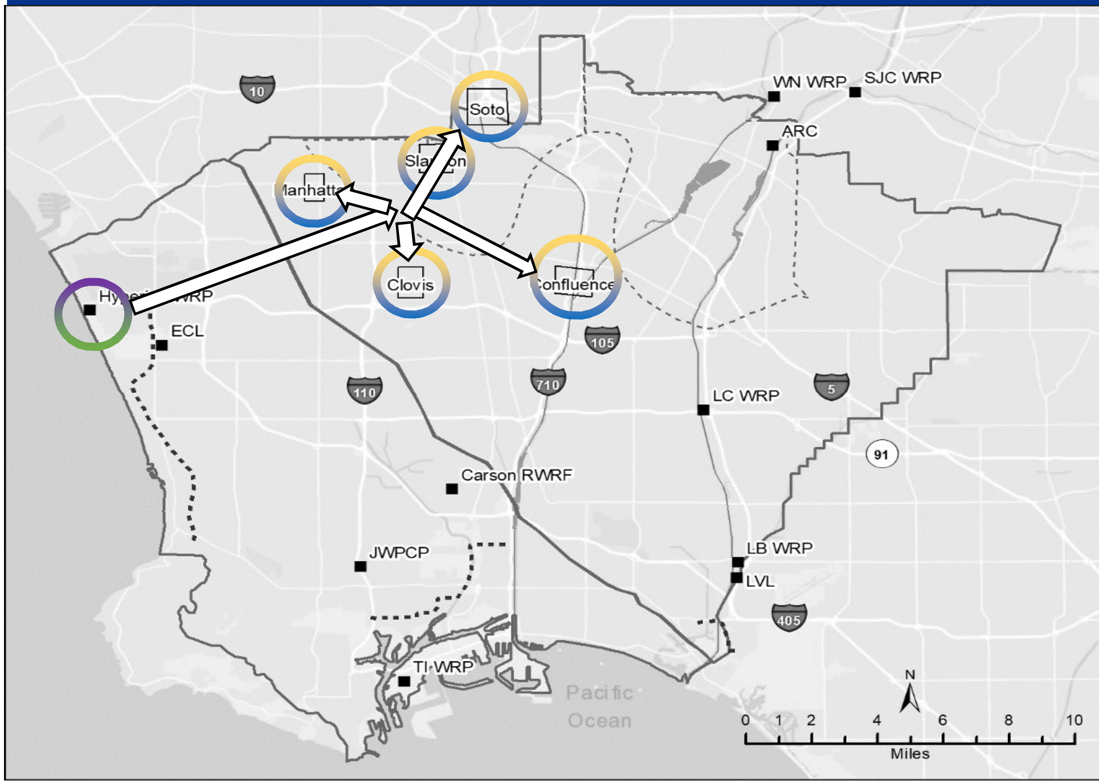
Project Details: Hyperion AWT to the Confluence area, Montebello FB, and MWD Regional Recycled Water System. Presented as Item #4 on the June 13th meeting.

Demands: Central Basin imported demands north of the 105 freeway (13,000 AFY), excludes City of LA
Basin Storage: This project increases the consistency of exports from the confluence and Montebello forebay area (Based on connection with MWD pipeline) increasing the recharge capability of these areas
Recharge: Assumes that the connection to the MWD Recycled Water pipeline will result in more consistent extraction from Confluence. Montebello Forebay spreading grounds and Confluence locations are limited by the extraction amounts
Extraction: Assuming extractions to demands and to MWD Recycled Water pipeline will be at Confluence, potential to extract from current Central Basin wells (needs to be evaluated).
Source Water: Hyperion
Treatment: New Hyperion WRP MBR NdN AWTF. Limiting factor could be above ground storage at Hyperion (Assuming that 14 MG of primary storage is possible based on Hyperion Reuse Feasibility

Notes:

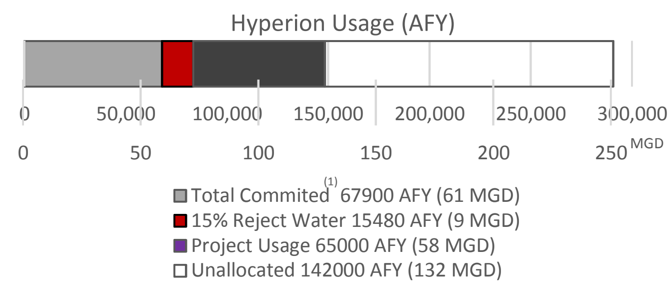
(1) Includes committed secondary effluent flow to West Basin, Influent flow to DCTWRP, and influent flow to LAWA AWPF
(2) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los

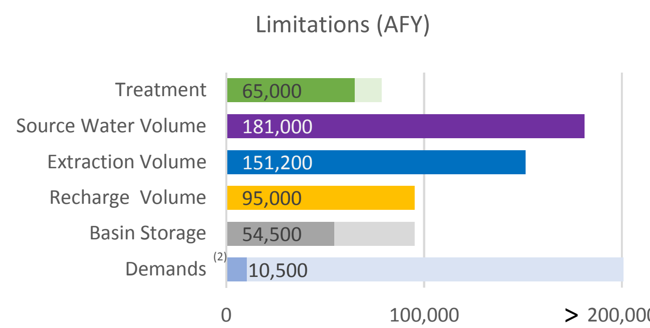
Project P3: Hyperion AWT with recharge and extraction at Confluence, Clovis, Manhattan, Slauson, and Soto



Potential Project Size: 54500 AFY (49 MGD)

Potential Limitation: Basin Storage





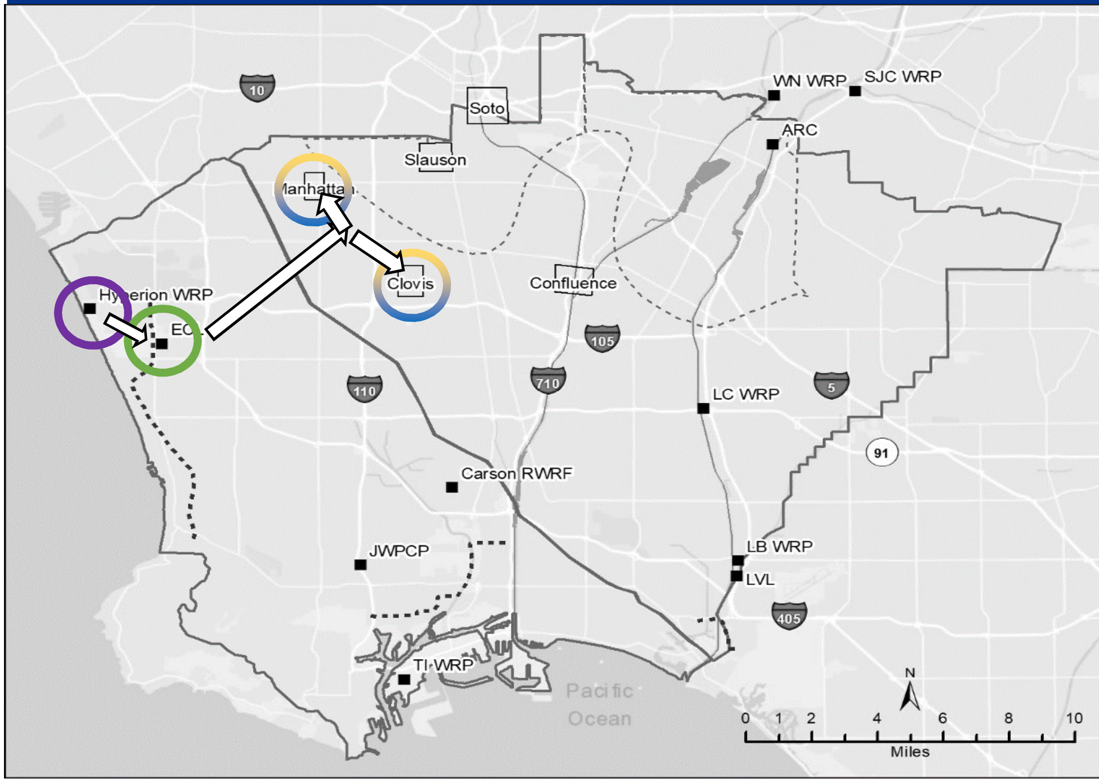
Project Details: Hyperion AWT to be injected in the Central Basin.

Demands: Central Basin imported demands West of 710 freeway (10,500 AFY), excludes City of LA
Basin Storage: This project could be limited by groundwater storage if extraction at Confluence/Montebello forebay areas is less than the recharge
Recharge: Based on GDAP proposed recharge areas
Extraction: Based on GDAP proposed recharge areas
Source Water: Hyperion
Treatment: New Hyperion WRP MBR NdN AWTF. Limiting factor could be above ground storage at Hyperion (Assuming that 14 MG of primary storage is possible based on Hyperion Reuse Feasibility Study) and assuming that a minimum of 20 MGD flows through the secondary treatment at any time (20 MGD flow needs further evaluation)

Notes:

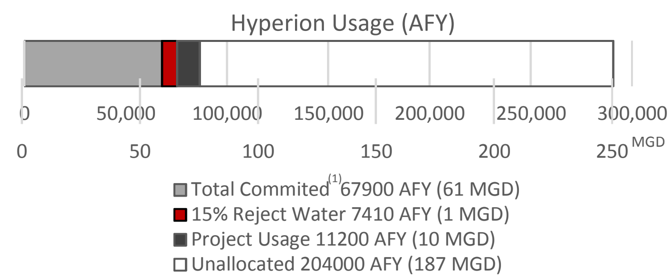
(1) Includes committed secondary effluent flow to West Basin, Influent flow to DCTWRP, and influent flow to LAWA AWPF
(2) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los

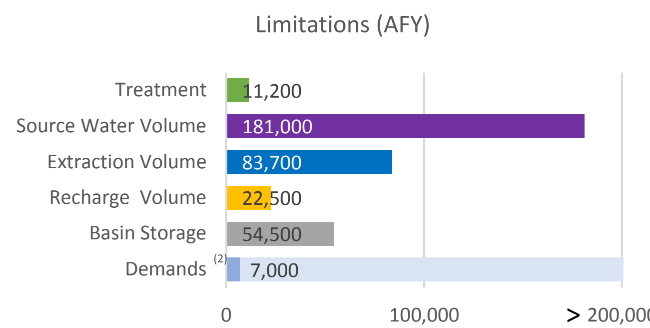
Project P4: Hyperion MBR NdN to ECL AWT with recharge and extraction at Clove and Manhattan



Potential Project Size: 11210 AFY (10 MGD)

Potential Limitation: Treatment





Project Details: Hyperion secondary effluent or MBR NdN to ECL for AWT to be injected in the LA Forebay. This project concept is limited by available expansion capacity at Ed. C. Little and was presented as Item #1 from June 13th meeting.

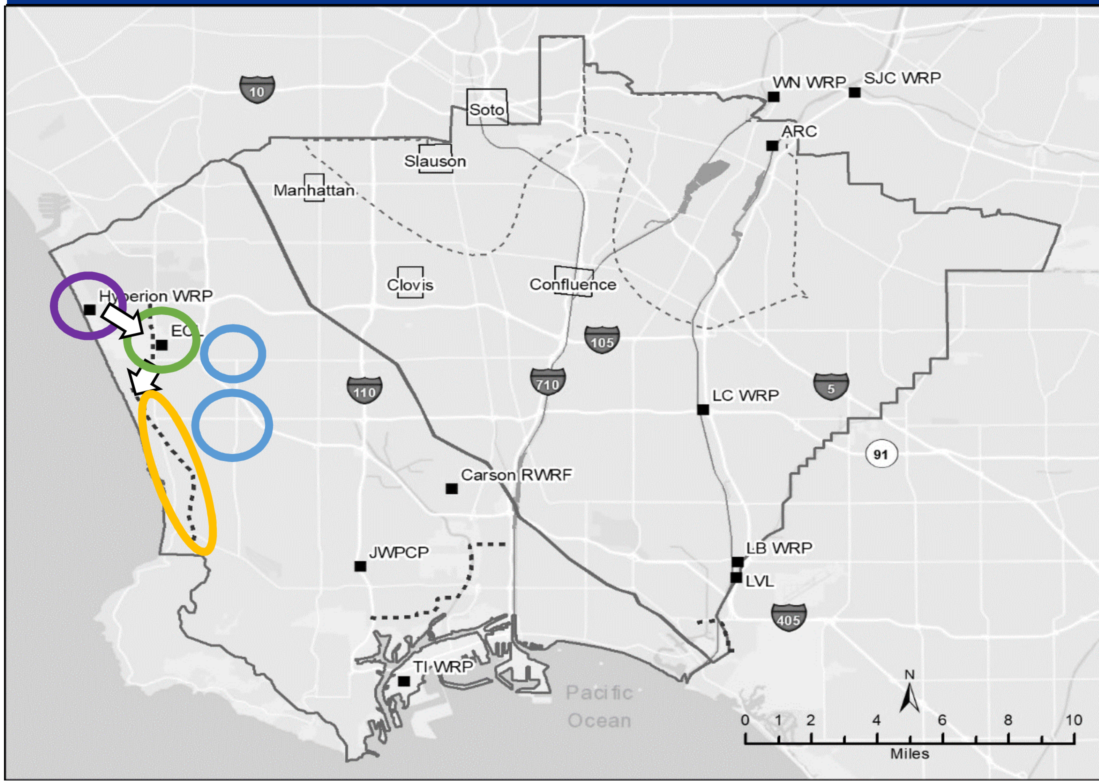
Demands: Central Basin imported demands North of 105 and west of 710 freeways (7,000 AFY)
Basin Storage: Storage needed in one year without extractions, limited by extraction amount
Recharge: Based on GDAP proposed recharge areas
Extraction: Based on GDAP proposed recharge areas
Source Water: Hyperion
Treatment: MBR and NdN at Hyperion and AWT at ECL. Limiting factor based on current expansion capabilities of ECL (10 MGD)

Notes:

(1) Includes committed secondary effluent flow to West Basin, Influent flow to DCTWRP, and influent flow to LAWA AWPF.

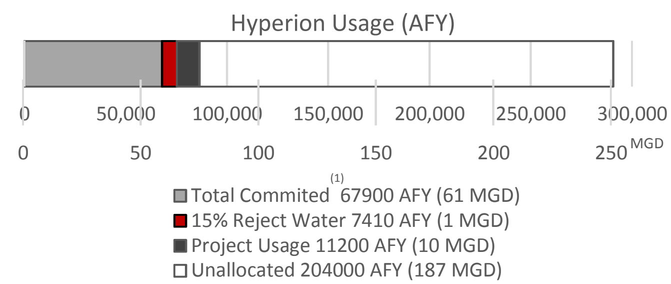
(2) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los

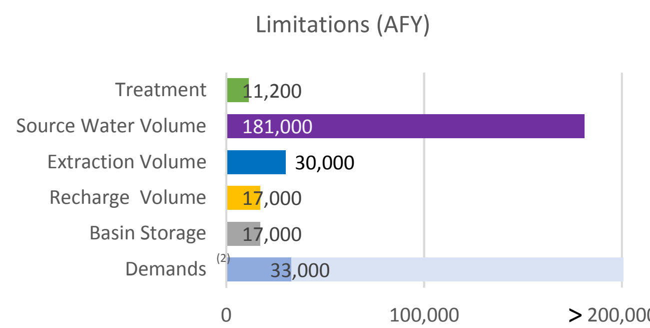
Project P5: Hyperion MBR NdN to ECL AWT with recharge at WCB Barrier



Potential Project Size: 11210 AFY (10 MGD)

Potential Limitation: Treatment





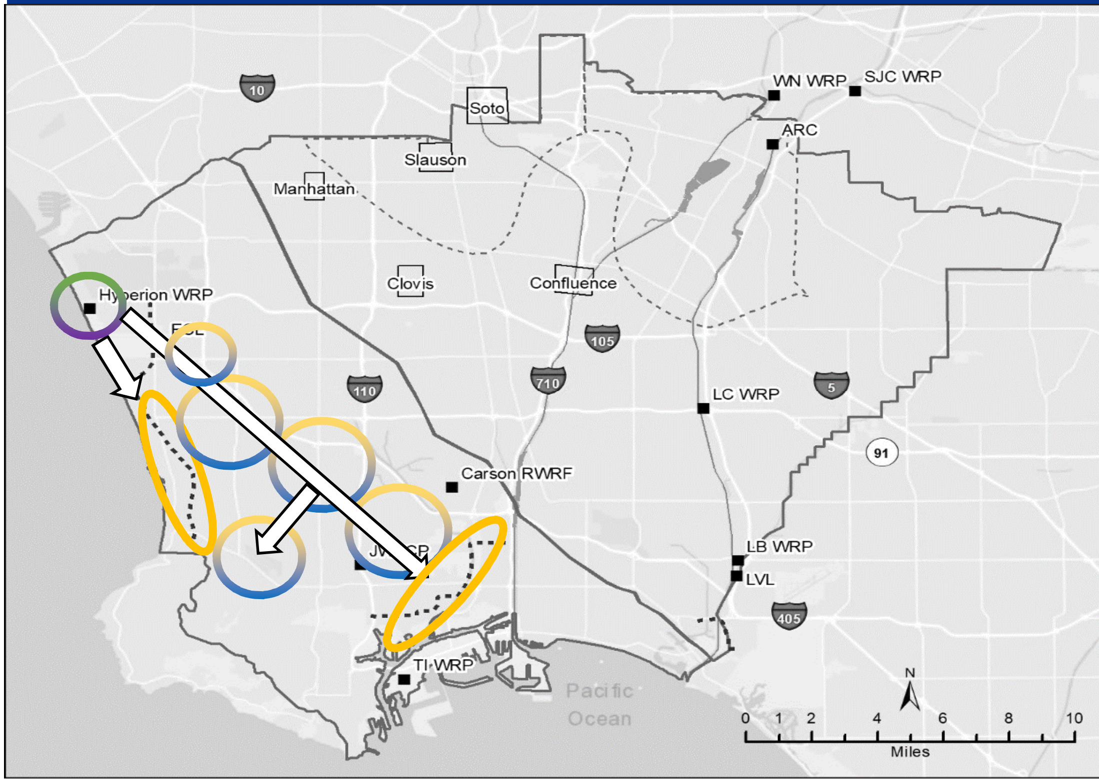
Project Details: Hyperion AWT to the WCB Barrier through the West Basin pipeline, upstream of the WBMWD meter. Presented as Item #5 on the June 13th meeting.

Demands: Imported water demands in WCB (WBMWD) within a 4-mile radius from Ed. C. Little. Based on WBMWD last 10 yr average deliveries of imported water
Basin Storage: Assumed to be the recharge needed in one year without extraction
Recharge: West Coast Basin Barrier
Extraction: WB-1 and WB-2 extraction locations. Potential for more extraction to be evaluated, likely it will not be a limitation
Source Water: Hyperion
Treatment: Limiting factor based on current expansion capabilities of Ed. C. Little (10 MGD)

Notes:

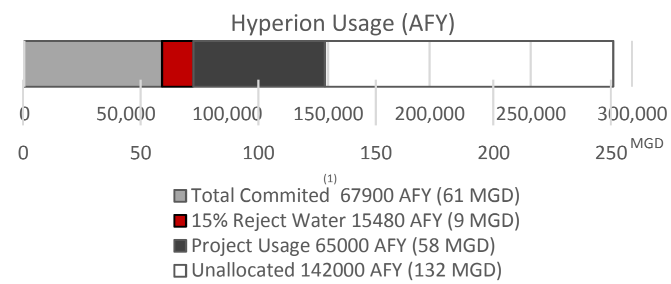
(1) Includes committed secondary effluent flow to West Basin, Influent flow to DCTWRP, and influent flow to LAWA AWPF
(2) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los

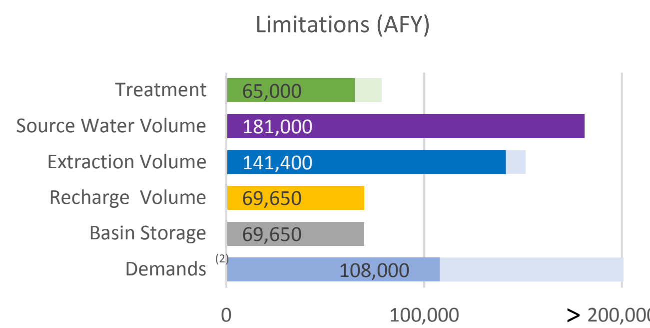
Project P6: Hyperion AWT with recharge at WCB Barrier and DG Barrier and injection and extraction along pipe route



Potential Project Size: 65000 AFY (58 MGD)

Potential Limitation: Treatment





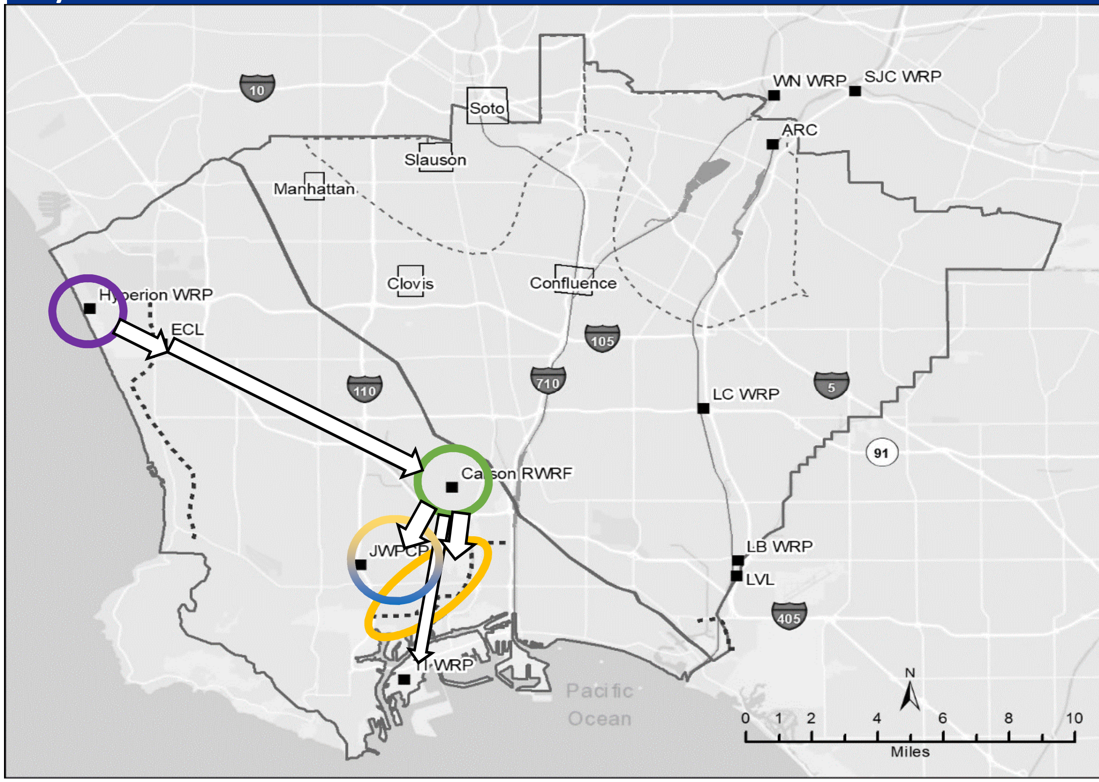
Project Details: Hyperion MBR NdN AWT to the WCB Barrier (upstream of the WBMWD meter), Dominguez GAP barrier, and West Coast Basin. Presented as a variation of Item #5 on the June 13th meeting.

Demands: Imported water demands in WCB South of 105 and West of 710 freeways. Based on WBMWD last 10 yr average deliveries
Basin Storage: Assumed to be the recharge needed in one year without extraction
Recharge: Assumes new injection wells (21,250 AFY) and recharge at West Coast and Dominguez Gap barriers
Extraction: WB-1,2,3,4 and 5. New Regional Brackish Groundwater Desalter. It is believed that extraction can be increased but further analysis is needed.
Source Water: Hyperion
Treatment: MBR NdN and AWT at Hyperion. Limiting factor could be above storage at Hyperion (Assuming that 14 MG of primary storage is possible based on Hyperion Reuse Feasibility Study) and assuming that a minimum of 20 MGD flows through the secondary treatment at any time (20 MGD flow needs further evaluation).

Notes:

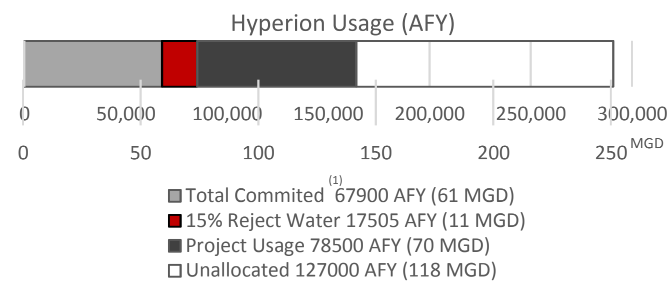
(1) Includes committed secondary effluent flow to West Basin, Influent flow to DCTWRP, and influent flow to LAWA AWPF
(2) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los

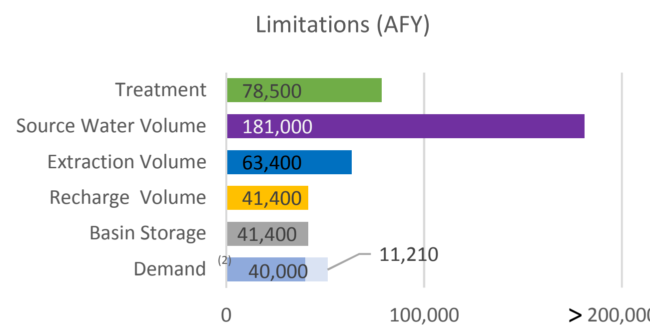
Project P7: Hyperion MBR NdN to Carson RWRF for AWT to be injected at Dominguez Gap Barrier and delivered to Harbor area recycled water demands



Potential Project Size: 41400 AFY (37 MGD)

Potential Limitation: Basin Storage





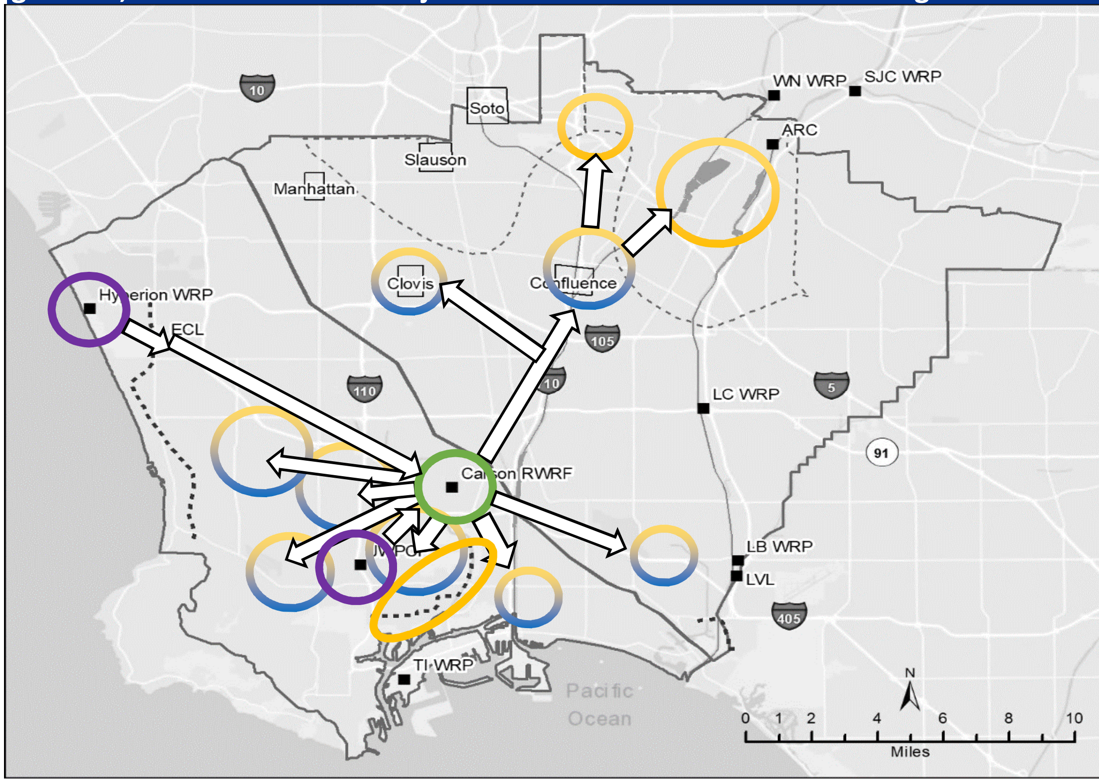
Project Details: Hyperion MBR NdN to WBMWD Carson Facility for AWT to inject at Dominguez Gap Barrier and to feed Harbor area recycled water demands. Presented as Item #2 on the June 13th meeting.

Demands: Upstream Dominguez Gap Barrier. Assumed 11,210 AFY of recycled water demand at the Harbor, seasonality of demands to be evaluated.
Basin Storage: Assumed to be the recharge needed in one year without extraction.
Recharge: Based on Dominguez Gap available capacity and new recharge at areas as long as extraction could be mantained at same rate of recharge (avoid flooding).
Extraction: Upstream Dominguez barrier. Potential for more extraction to be evaluated, likely not to be a limiting factor.
Source Water: Hyperion
Treatment: Not a limitation if Juanita Millender-McDonald (Carson) treatment plant can be expanded

Notes:

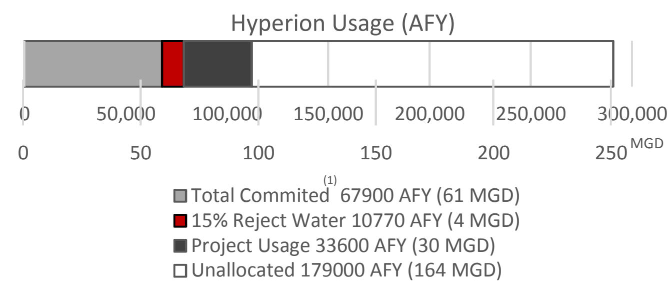
(1) Includes committed secondary effluent flow to West Basin, Influent flow to DCTWRP, and influent flow to LAWA AWPF
(2) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents Harbor area recycled water demands.

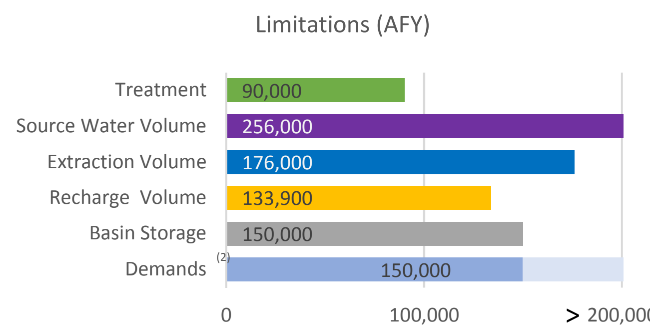
Project P8: Hyperion MBR NdN and JWPCP secondary to Carson RWRF AWT with recharge at Montebello Forebay, new spreading grounds, and DB Barrier and injection and extraction facilities throughout West Coast and Central Basins



Potential Project Size: 90000 AFY (80 MGD)

Potential Limitation: Treatment





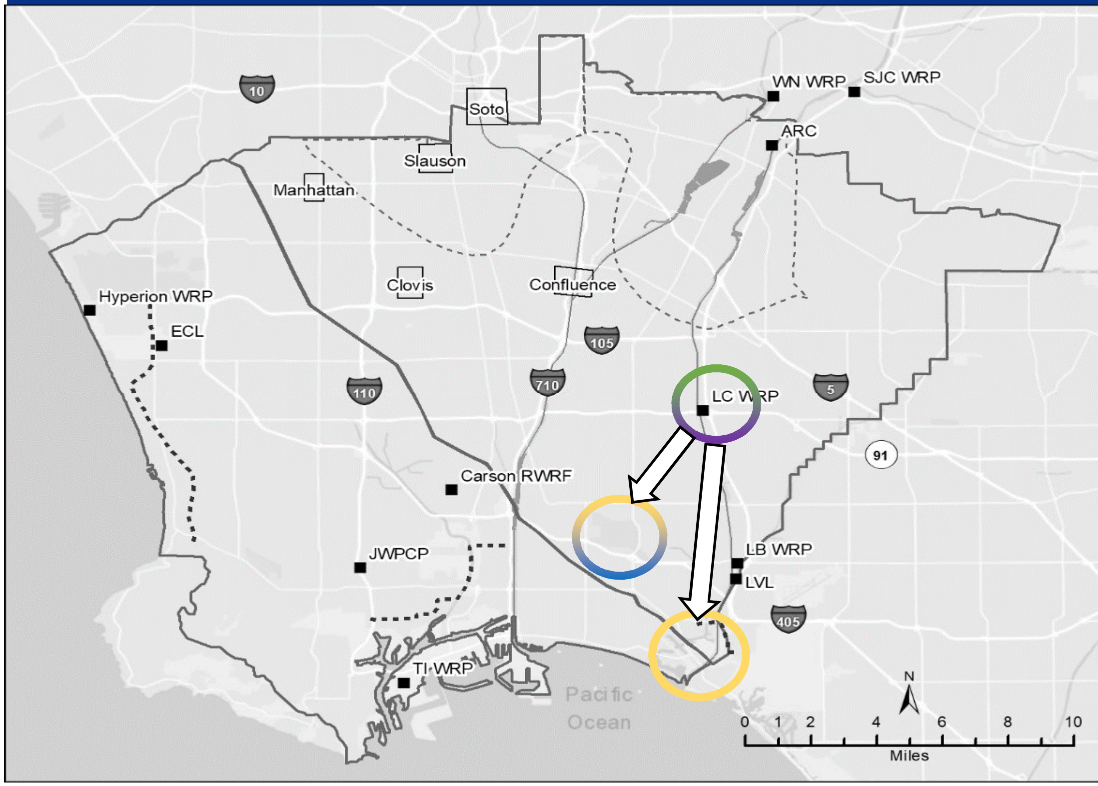
Project Details: Hyperion secondary or MBR NdN to AWT at Carson WBMWD with expanded recharge in Central and West Coastal Basins

Demands: Most basin imported demands (10 yr average deliveries) considered except City of LA
Basin Storage: Matching Basin Demands. Limitation if there is no extraction at confluence and Montebello forebay area or extraction is less than recharge
Recharge: Recharge capacity at confluence is a function of extraction
Extraction: 50,000 AFY is extraction capacity in the WCB+Long Beach areas
Source Water: Hyperion (up to 30 MGD based on 42 in pipeline from Hyperion to Carson Juanita Millender-McDonald (JMM)) and 50 MGD from JWPCP
Treatment: Not a limitation if Juanita Millender-McDonald (Carson) treatment plant is expanded. Assuming that there is land availability for 24MG or more of above ground storage necessary for 100 MGD

Notes:

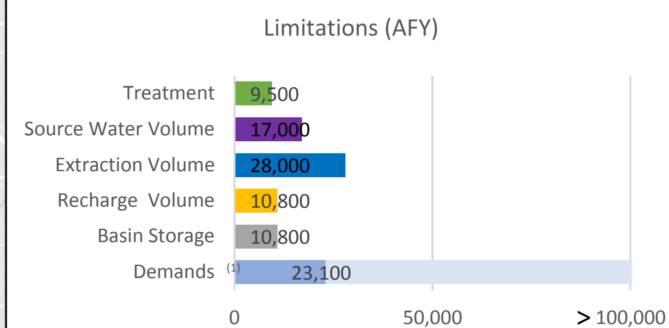
(1) Includes committed secondary effluent flow to West Basin, Influent flow to DCTWRP, and influent flow to LAWA AWPF
(2) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los

Project P9: LC WRP AWT with recharge at AG Barrier and injection and extraction in Long Beach and Central Basins



Potential Project Size: 9500 AFY (8 MGD)

Potential Limitation: Treatment

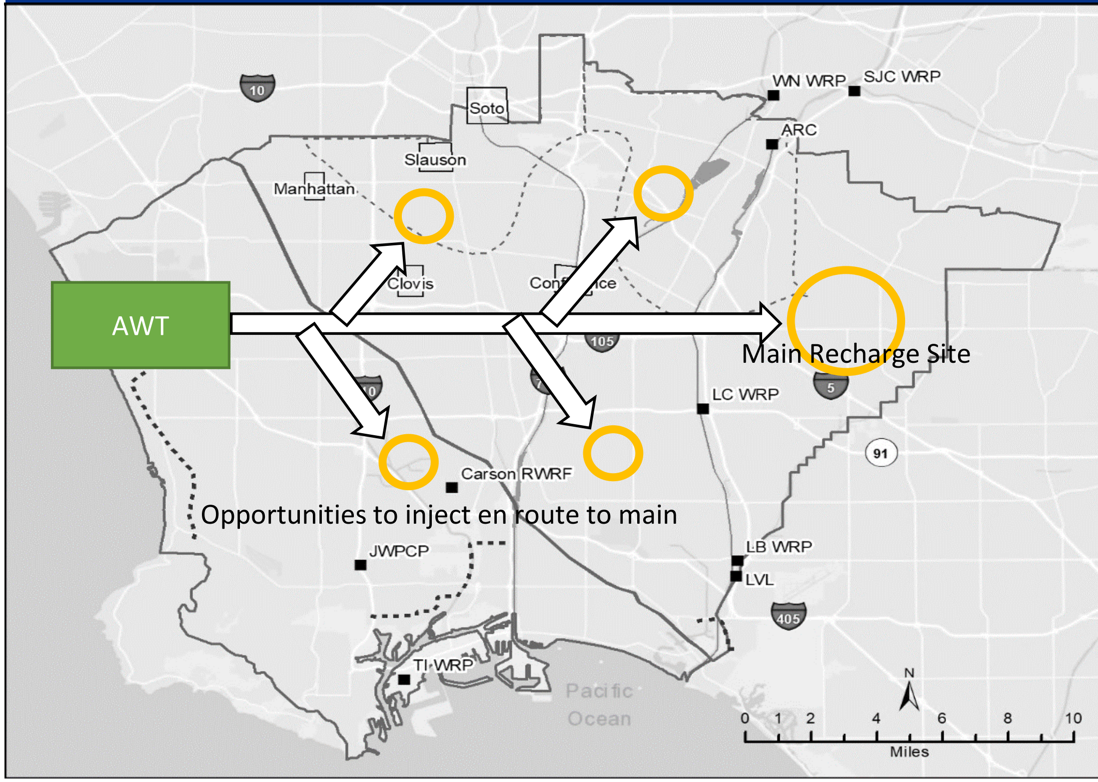


Project Details: New LCWRP AWT to be sent to Alamitos GAP Barrier or for injection/extraction in the Long Beach area.

Demands: Central Basin and Long Beach imported demands at the 405 freeway and east of the 710 freeway (23,100 AFY)
Basin Storage: Assumed to be the recharge needed in one year without extraction. Might not be limiting factor if extraction matches recharge.
Recharge: Alamitos Gap Barrier Injection Wells (4,800 AFY) plus Long Beach
Extraction: CB-6 area (Long Beach)
Source Water: Los Coyotes
Treatment: New LCWRP AWT (9,500 AFY)

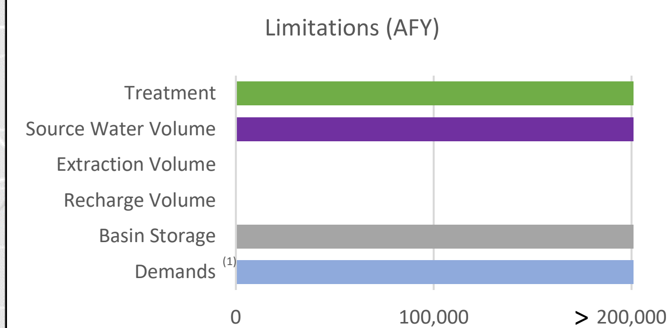
Notes:
(1) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los Angeles that could be potentially be supplied by a Master Plan project

Project P10: Recharge along pipe routes (general concept)



Potential Project Size: TBD

Potential Limitation: Recharge Volume



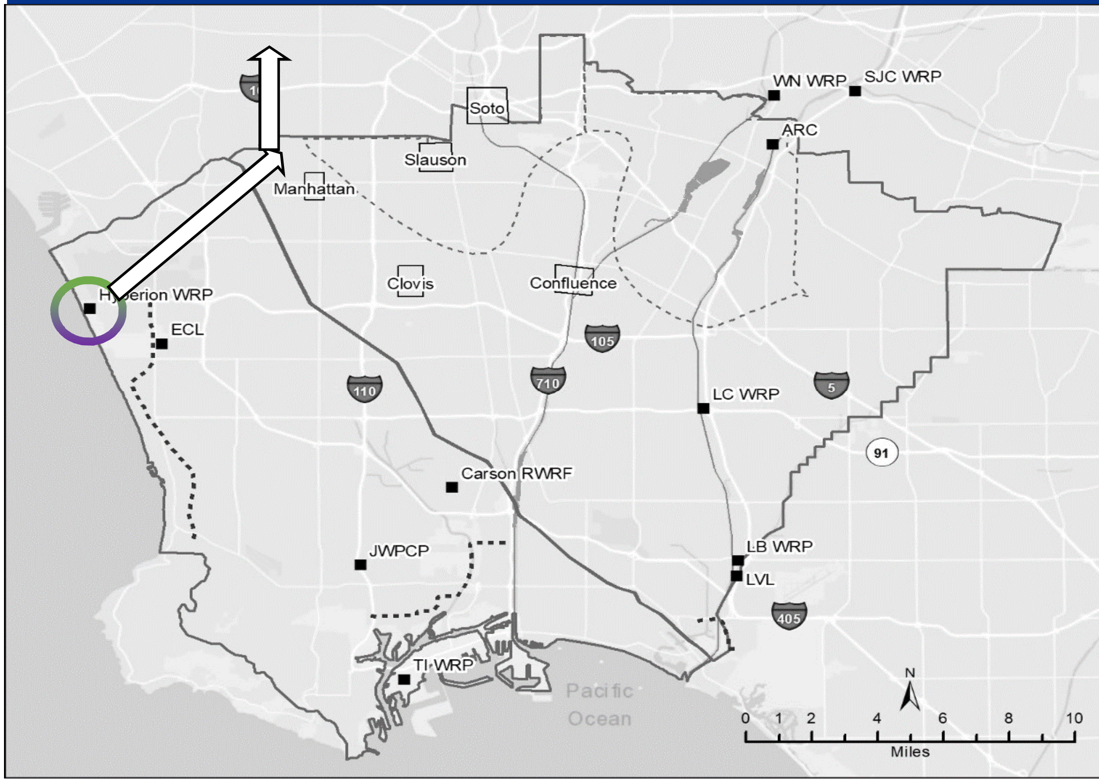
Project Details: Utilize available pumping capacity from existing extraction wells along pipeline en route to main recharge site. Item #7 from June 13, 2019 meeting. This is also a general idea, not fixed to a geographic location, opportunities for recharge should be considered along pipelines that will move the water across the basin.

Demands: Not Applicable
Basin Storage: Not Applicable
Recharge: TBD based on current wells capacity
Extraction: TBD based on current wells capacity
Source Water: Not Applicable
Treatment: Not Applicable

Notes:

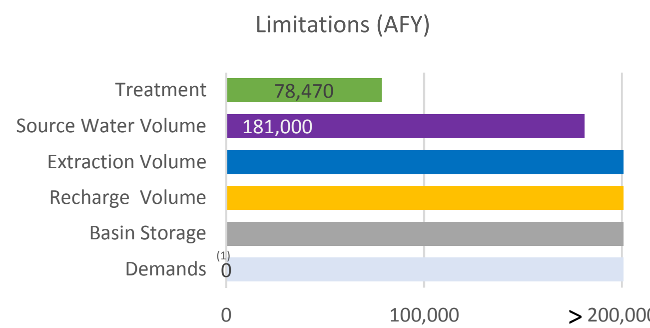
(1) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los Angeles that could be potentially be supplied by a Master Plan project

Project P11: Hyperion AWT to LA Aqueduct Filtration Plant (raw water augmentation)



Potential Project Size: 78470 AFY (70 MGD)

Potential Limitation: Treatment



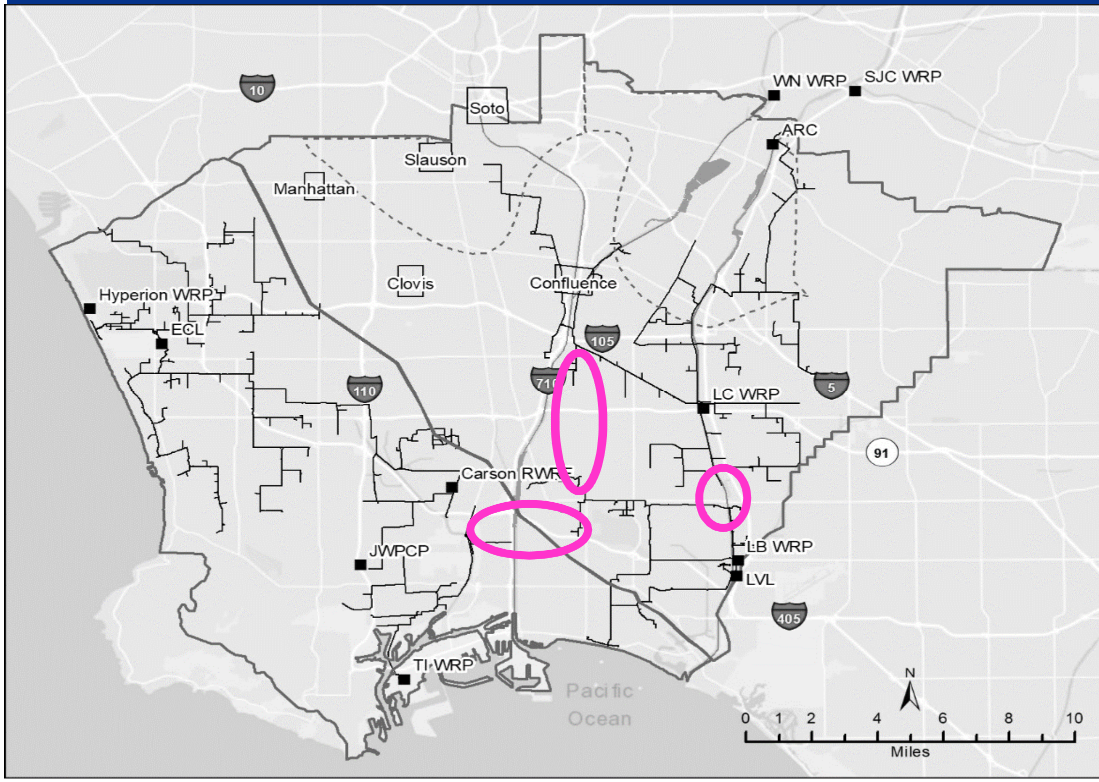
Project Details: Hyperion AWT and JWPCP AWT flows are used for raw water augmentation at the LA Aqueduct Filtration Plant or Jensen Water Treatment Plan. Metropolitan agencies/cities would receive these flows in-lieu of Metropolitan water. Metropolitan would pay pumpers not to pump. This would apply only to augmentation project "above the line". Item #8 from June 13, 2019 meeting.

Demands: CB and WCB Demands excluding City of LA
Basin Storage: Not Applicable
Recharge: Not Applicable
Extraction: Not Applicable
Source Water: Hyperion and JWPCP
Treatment: Assumes that 65,000 AFY would be treated at Hyperion based on above ground storage limitation and 75,000 AFY would be treated at JWPCP (to be confirmed)

Notes:

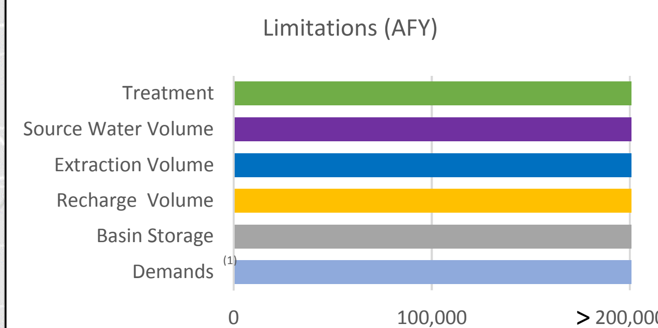
(1) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los Angeles that could be potentially be supplied by a Master Plan project

Project P12: Connect WBMWD and CBMWD recycled water distribution systems



Potential Project Size: NA

Potential Limitation: NA



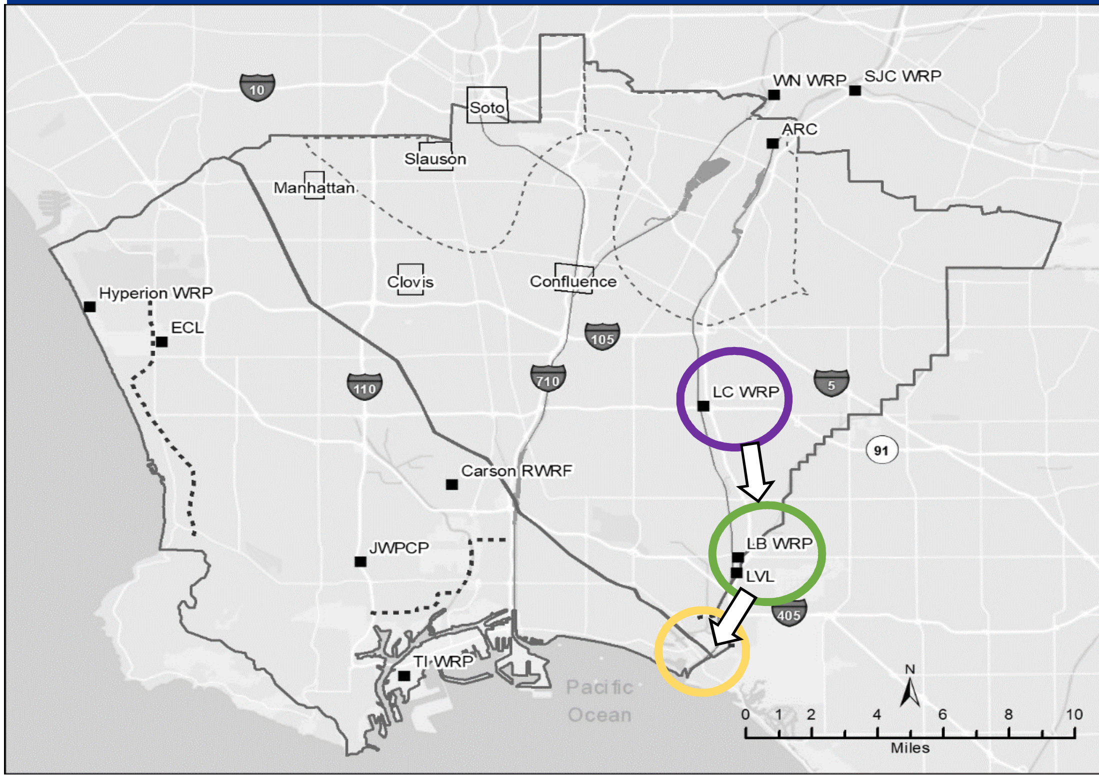
Project Details: Improve Recycled water system connectivity.

Demands: Not Applicable
Basin Storage: Not Applicable
Recharge: Not Applicable
Extraction: Not Applicable
Source Water: Not Applicable
Treatment: Not Applicable

Notes:

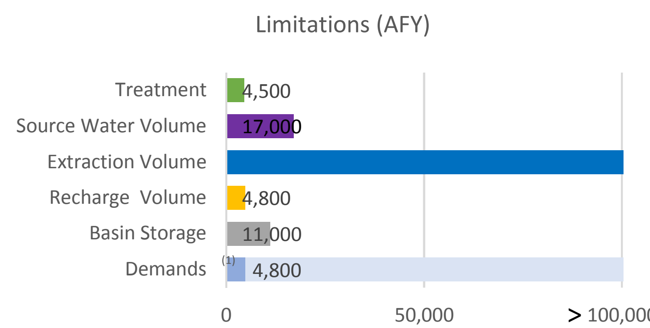
(1) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los Angeles that could be potentially be supplied by a Master Plan project

Project P13a: LC WRP tertiary to LVL AWT with recharge at AG Barrier



Potential Project Size: 4500 AFY (4 MGD)

Potential Limitation: Recharge Volume



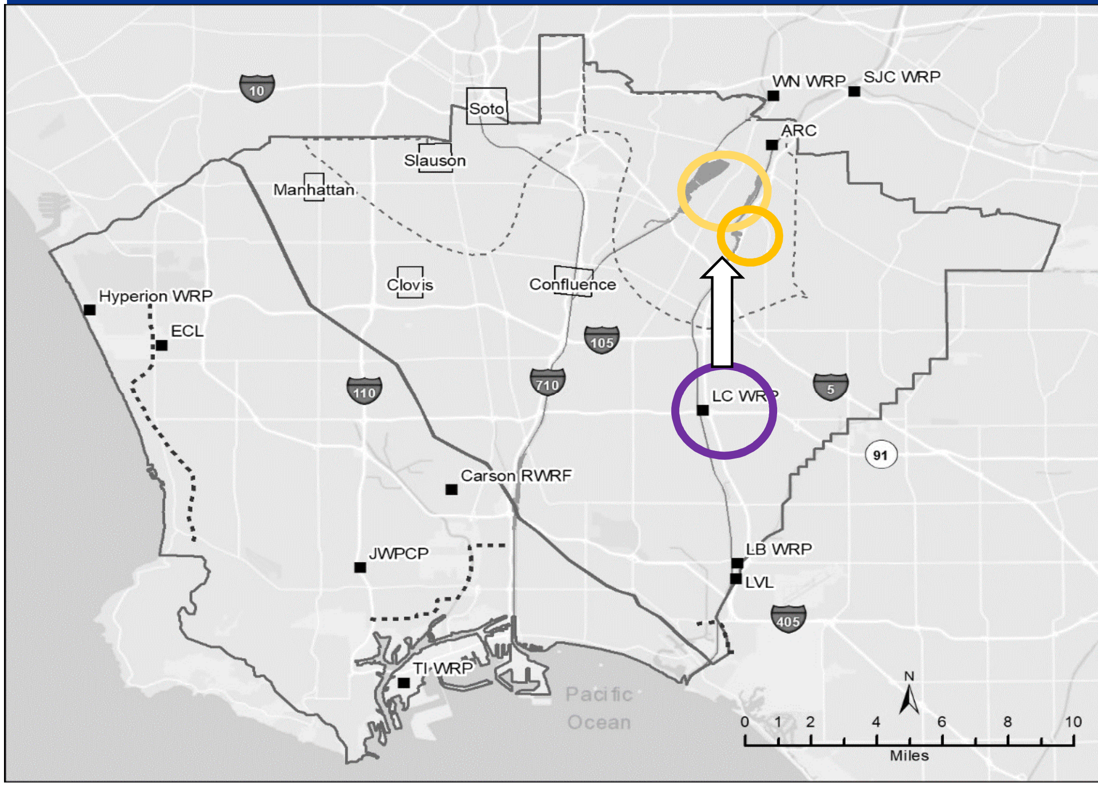
Project Details: Los Coyotes tertiary effluent to LVL for AWT to be injected at Alamitos Gap Barrier. Item #13 from June 13, 2019 meeting.

Demands: Alamitos Gap Barrier
Basin Storage: Assumed to be the recharge needed in one year without extraction
Recharge: Assumed Alamitos Barrier available capacity
Extraction: This project is not limited by extraction
Source Water: Los Coyoted Water Reclamation Plant (17,000 AFY)
Treatment: Leo Vander Lans Water Treatment Facility (4,500 AFY)

Notes:

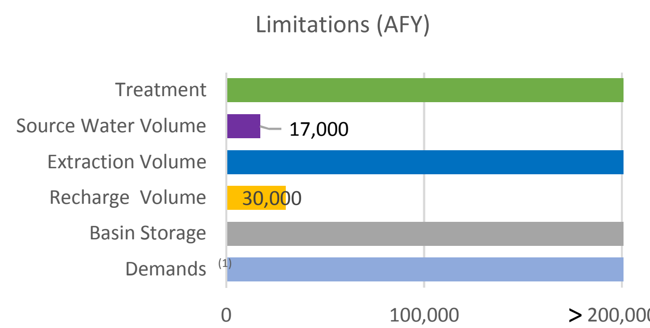
(1) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los Angeles that could be potentially be supplied by a Master Plan project

Project P13b: LC WRP tertiary with recharge at Montebello Forebay and new spreading grounds



Potential Project Size: 17000 AFY (15 MGD)

Potential Limitation: Source



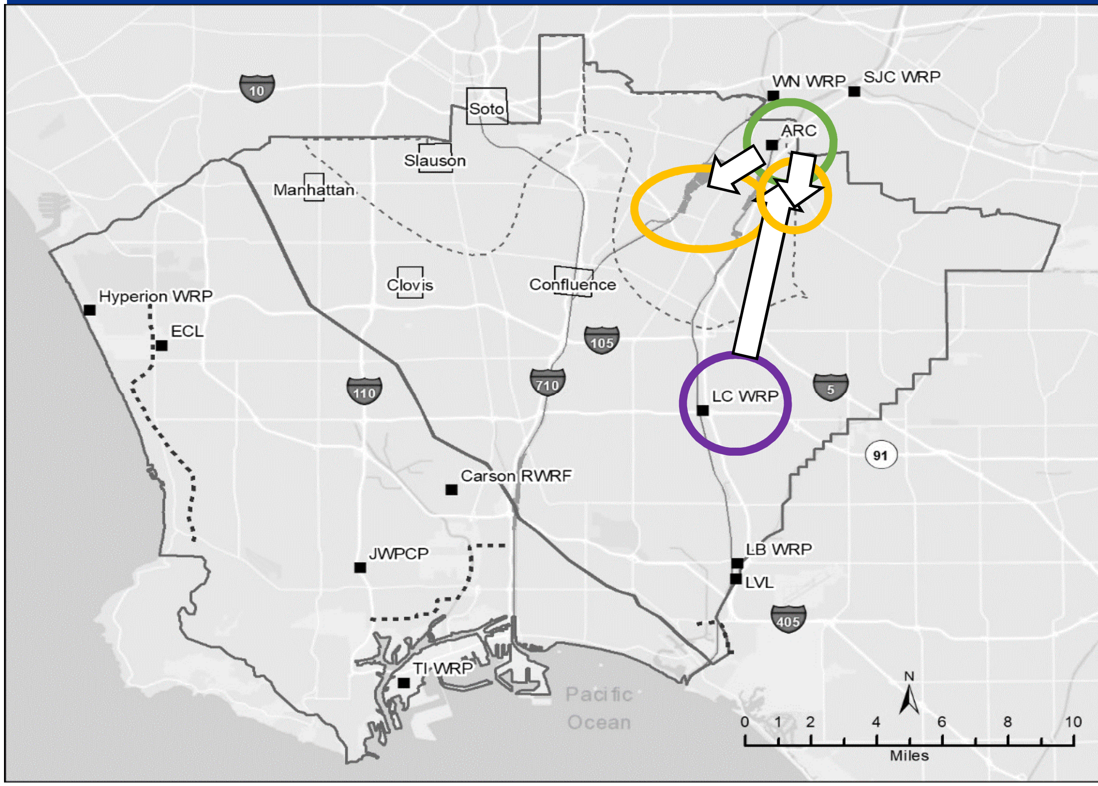
Project Details: Los Coyotes tertiary effluent to Montebello Forebay for spreading or sent via existing CBMWD recycled water pipelines to ARC for AWT for spreading or injection.Item #14 from June 13, 2019 meeting.

Demands: Not applicable
Basin Storage: To be evaluated
Recharge: Based on estimated Montebello forebay idle capacity plus Baverly Parcel recharge
Extraction: Not applicable
Source Water: Los Coyotes Water Reclamation Plant (17,000 AFY)
Treatment: Not applicable

Notes:

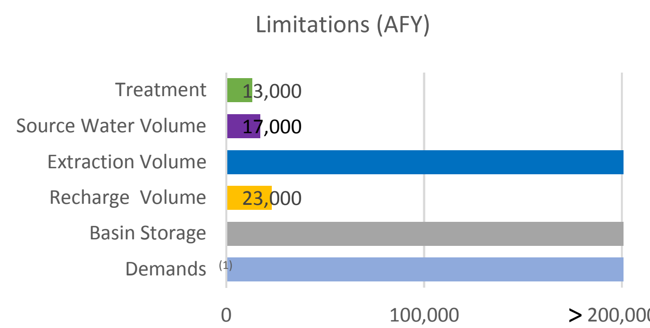
(1) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los Angeles that could be potentially be supplied by a Master Plan project

Project P13c: LC WRP tertiary to ARC AWT with recharge at Montebello Forebay



Potential Project Size: 13000 AFY (10 MGD)

Potential Limitation: Treatment



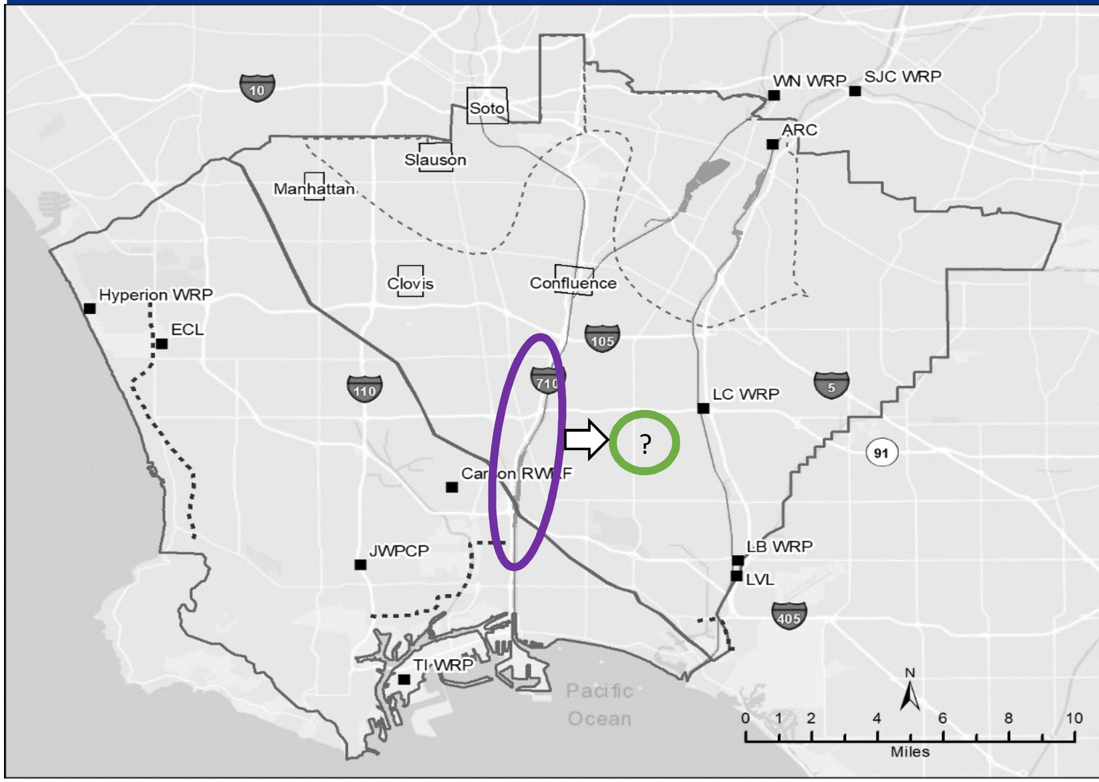
Project Details: Los Coyotes tertiary effluent to Montebello Forebay for spreading or sent via existing CBMWD recycled water pipelines to ARC for AWT for spreading or injection.Item #14 from June 13, 2019 meeting.

Demands: Not applicable
Basin Storage: To be evaluated
Recharge: Based on estimated Montebello forebay idle capacity plus injection at Montebello and ARC
Extraction: Not applicable
Source Water: Los Coyotes Water Reclamation Plant (17,000 AFY)
Treatment: Albert Robles Center for Water Recycling (13,000 AFY)

Notes:

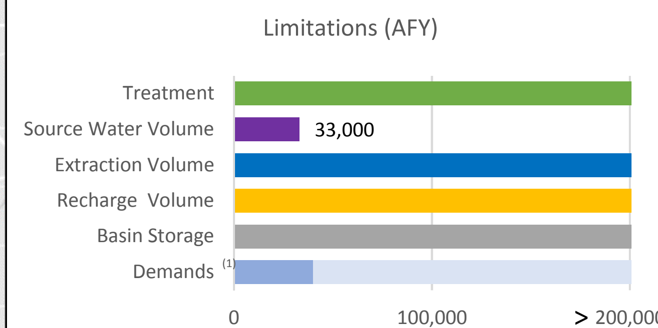
(1) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los Angeles that could be potentially be supplied by a Master Plan project

Project P14a: LA River flows are advanced treated and injected into Central Basin



Potential Project Size: 33000 AFY (30 MGD)

Potential Limitation: Source



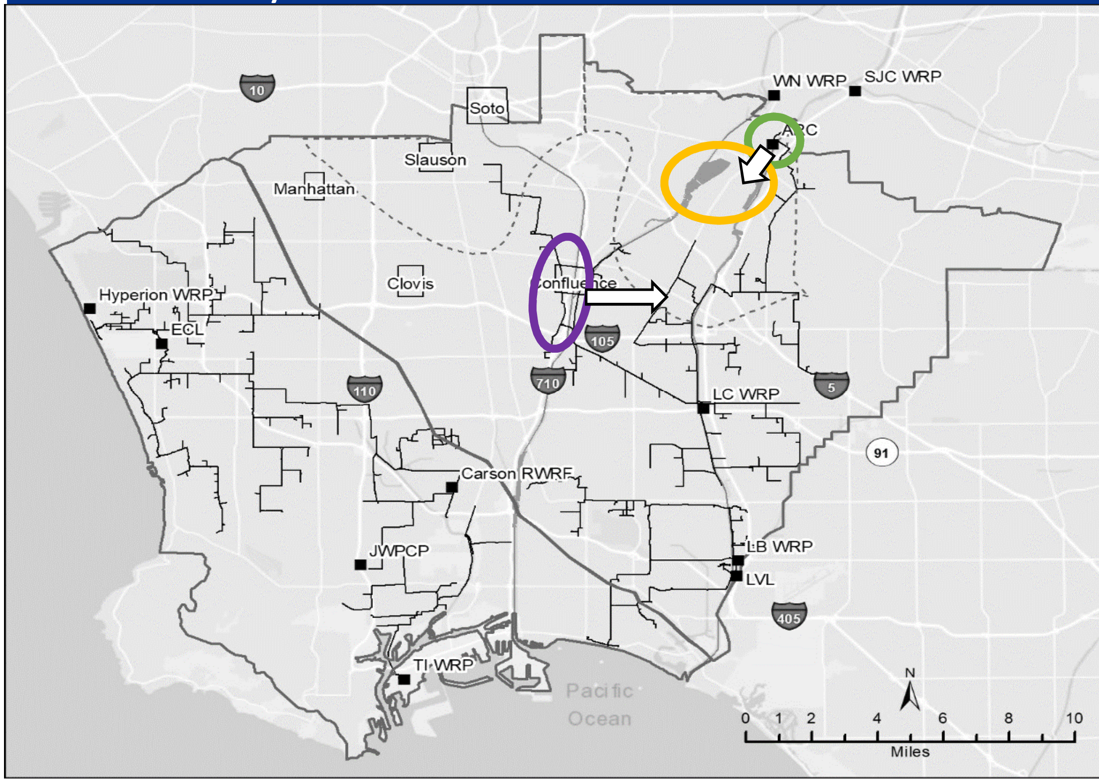
Project Details: LA River flows are advanced treated (undefined location) for injection into Central Basin. Presented as Item #22 from June 13th meeting.

Demands: Not Applicable
Basin Storage: Not Applicable
Recharge: Not Applicable
Extraction: Not Applicable
Source Water: LA River, average flow
Treatment: Undefined location

Notes:

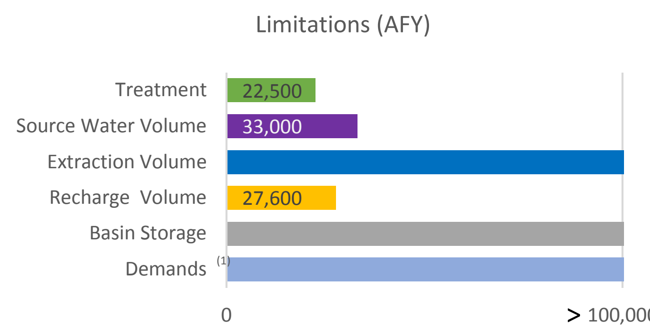
(1) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los Angeles that could be potentially be supplied by a Master Plan project

Project P14b: LA River flows are Title 22 treated for distribution using CBMWD recycled water pipelines to ARC AWT for recharge at Montebello Forebay



Potential Project Size: 22500 AFY (20 MGD)

Potential Limitation: Treatment



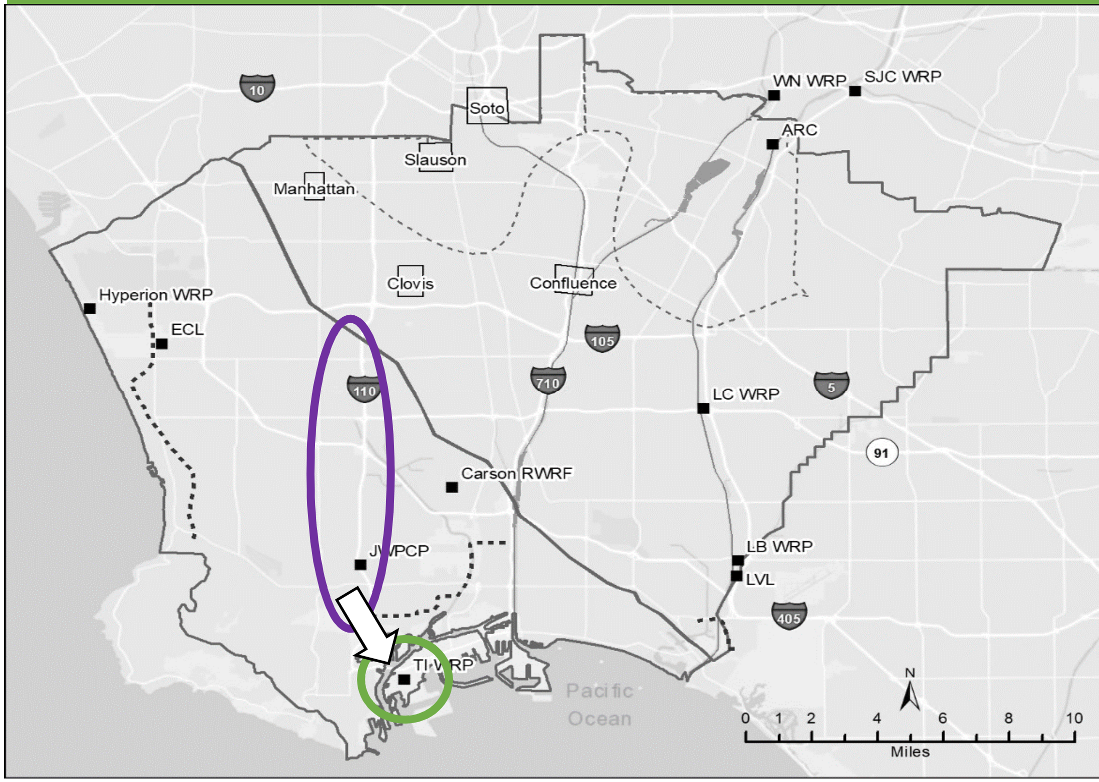
Project Details: LA River flows are treated to Title 22 standards and put into CBMWD for delivery to ARC to be advanced treated and recharged at Montebello Forebay. Presented as Item #23 on the June 13th meeting.

Demands: Not Applicable
Basin Storage: Not Applicable
Recharge: Includes recharge at Montebello Forebay (17,000 AFY)
Extraction: Not Applicable
Source Water: LA River, average flow
Treatment: Additional ARC treatment plus new LCWRP AWT. Treatment capacity would have to be evaluated as a function of LA river flow. A significant amount of above ground storage might be needed obtain banefits from highly variable flows

Notes:

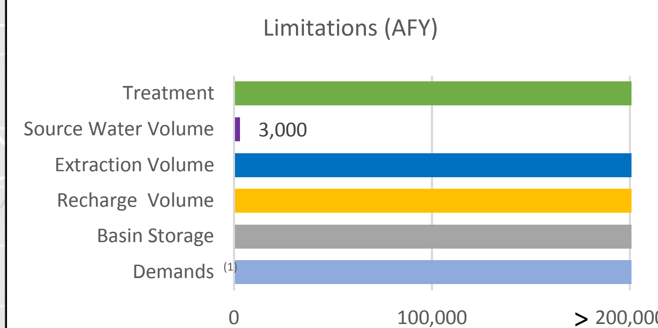
(1) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los Angeles that could be potentially be supplied by a Master Plan project

Optional Project O2: Sewer collection intertie and treatment at Terminal Island



Potential Project Size: 3000 AFY (3 MGD)

Potential Limitation: Source



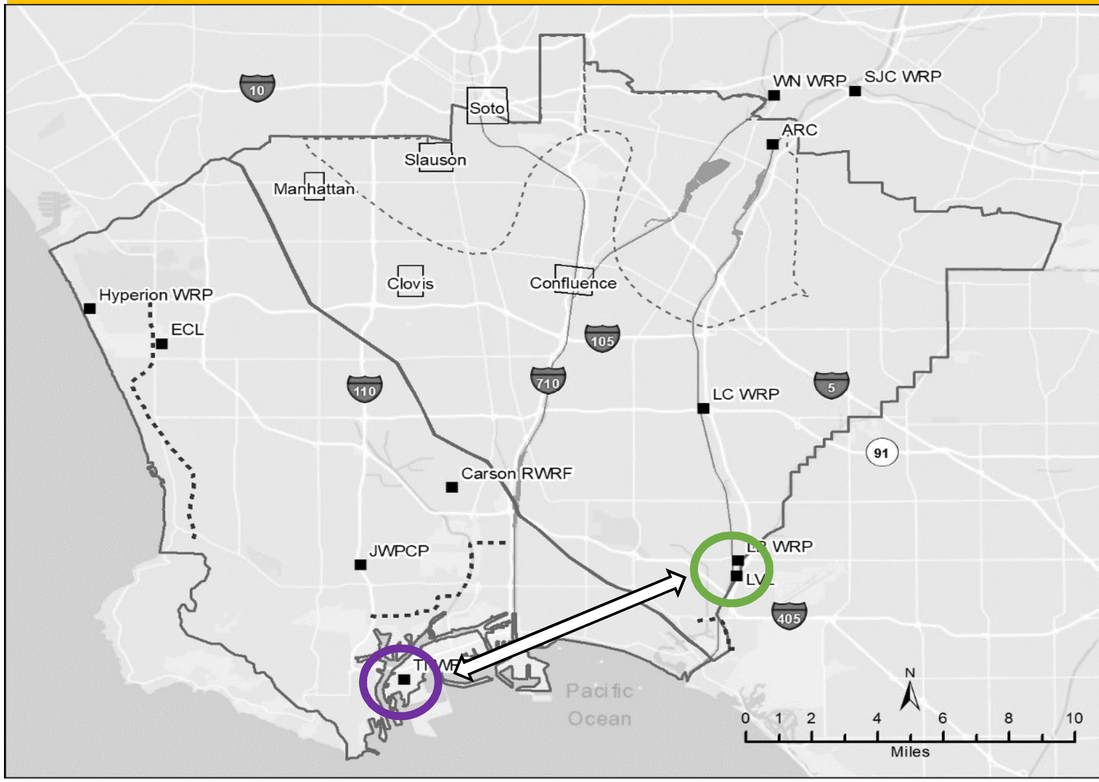
Project Details: Interception of part of JWPCP sewer flows to increase influent at Terminal Island.

Demands: Not applicable
Basin Storage: Not applicable
Recharge: Not applicable
Extraction: Not applicable
Source Water: Sewer collection intertie. Approximatelly 19.8 square miles of the JWPCP sewershed within the City of LA boundaries
Treatment: Terminal Island Water Reclamation Plant

Notes:

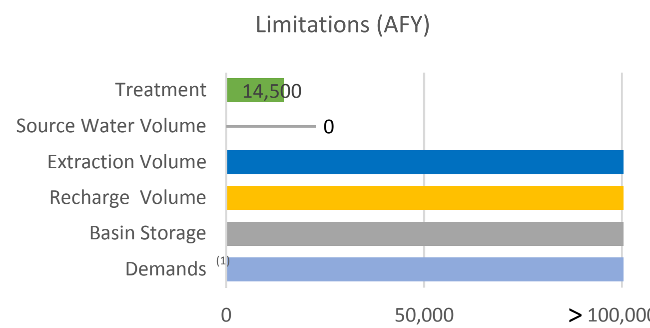
(1) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los Angeles that could be potentially be supplied by a Master Plan project

Optional Project 6 : Connect LVL to/from Terminal Island to provide operation flexibility



Potential Project Size: NA

Potential Limitation: NA



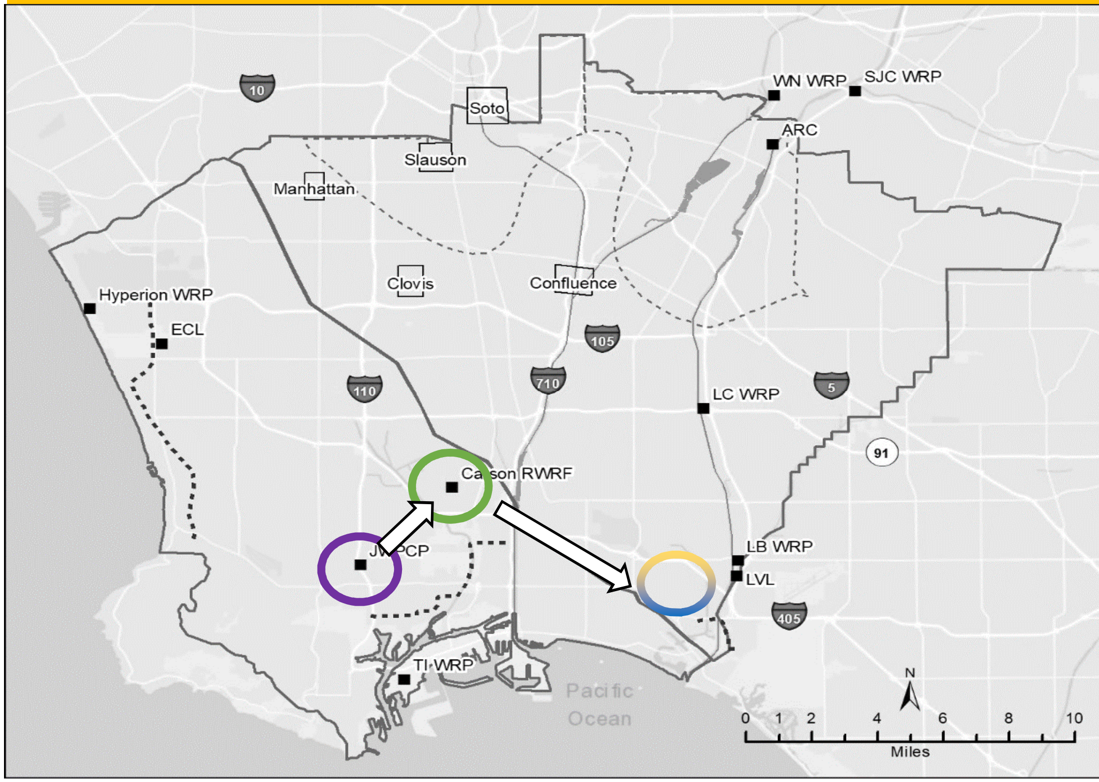
Project Details: Item #15 from June 13th meeting. Connect LVL to/from Terminal Island to provide operation flexibility.

Demands: Not Applicable
Basin Storage: Not Applicable
Recharge: Not Applicable
Extraction: Not Applicable
Source Water: Terminal Island 12,500 AFY based on 2015 treated tertiary flow minus recycled water within service area (discharged treated water)
Treatment: LVL available capacity

Notes:

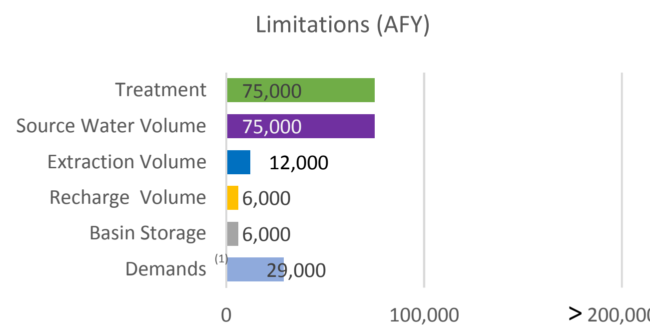
(1) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los Angeles that could be potentially be supplied by a Master Plan project

Optional Project 9 : JWPCP AWT or JWPCP MBR NdN to WBMWD Carson Facility for AWT to serve Long Beach



Potential Project Size: 6000 AFY (10 MGD)

Potential Limitation: Basin Storage

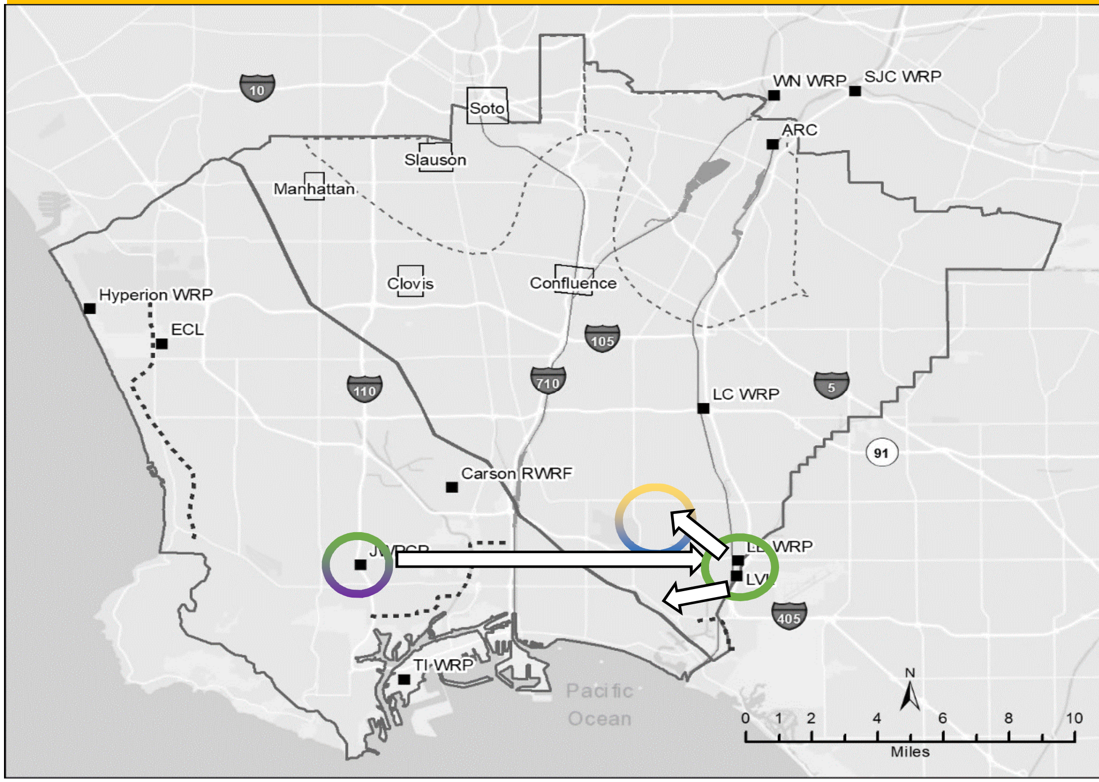


Project Details: JWPCP AWT or JWPCP MBR NdN to WBMWD Carson Facility for AWT to serve Long Beach. Presented as Item #9 from June 13th meeting.

Demands: Long Beach Demands
Basin Storage: Limited to Long Beach storage area, assumed to be the recharge needed in one year without extraction
Recharge: CB-06
Extraction: CB-06
Source Water: JWPCP
Treatment: Juanita Millender-McDonald (Carson)

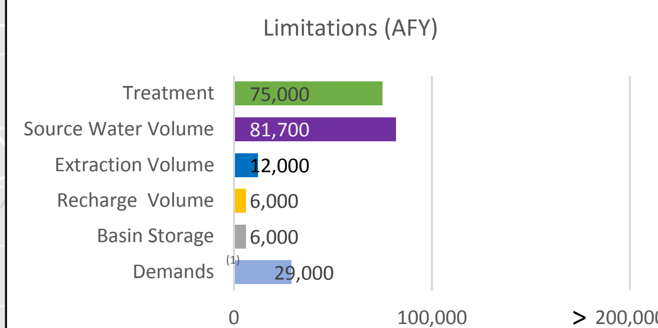
Notes:
(1) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los Angeles that could be potentially be supplied by a Master Plan project

Optional Project 10 : JWPCP AWT to Long Beach Area, potential to GW augmentation at LB treatment Plant



Potential Project Size: 6000 AFY (5 MGD)

Potential Limitation: Basin Storage



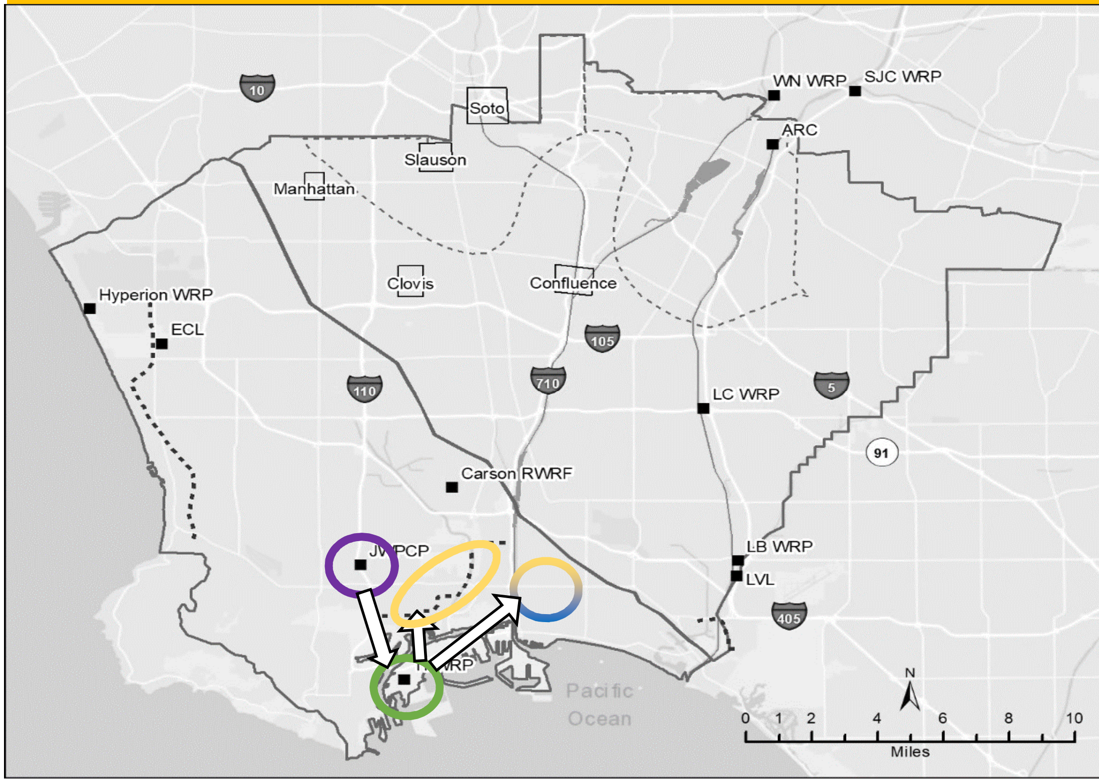
Project Details: Connection of JWPCP to Long Beach area. Presented as Item #10 from the June 13th meeting. JWPCP AWT used to blend water at the Long Beach Groundwater Treatment Plant for drinking water distribution for raw water augmentation. (This concept will be documented but not evaluated as part of the Master Plan)

Demands: Long Beach Area
Basin Storage: CB-06
Recharge: CB-06
Extraction: CB-06
Source Water: JWPCP
Treatment: JWPCP

Notes:

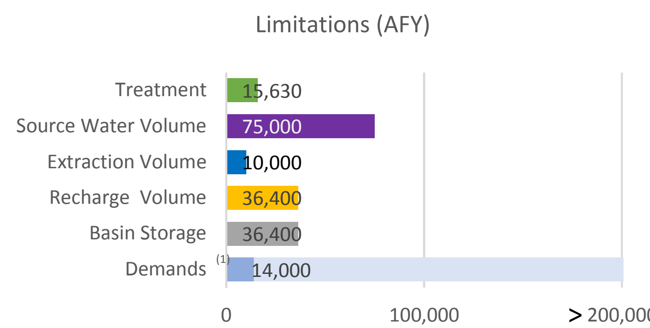
(1) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los Angeles that could be potentially be supplied by a Master Plan project

Optional Project 11 : JWPCP MBR NdN to Terminal Island for AWT for injection at the Dominguez Gap Barrier or new injection wells in the West Coast Basin



Potential Project Size: 10000 AFY (9 MGD)

Potential Limitation: Extraction Volume



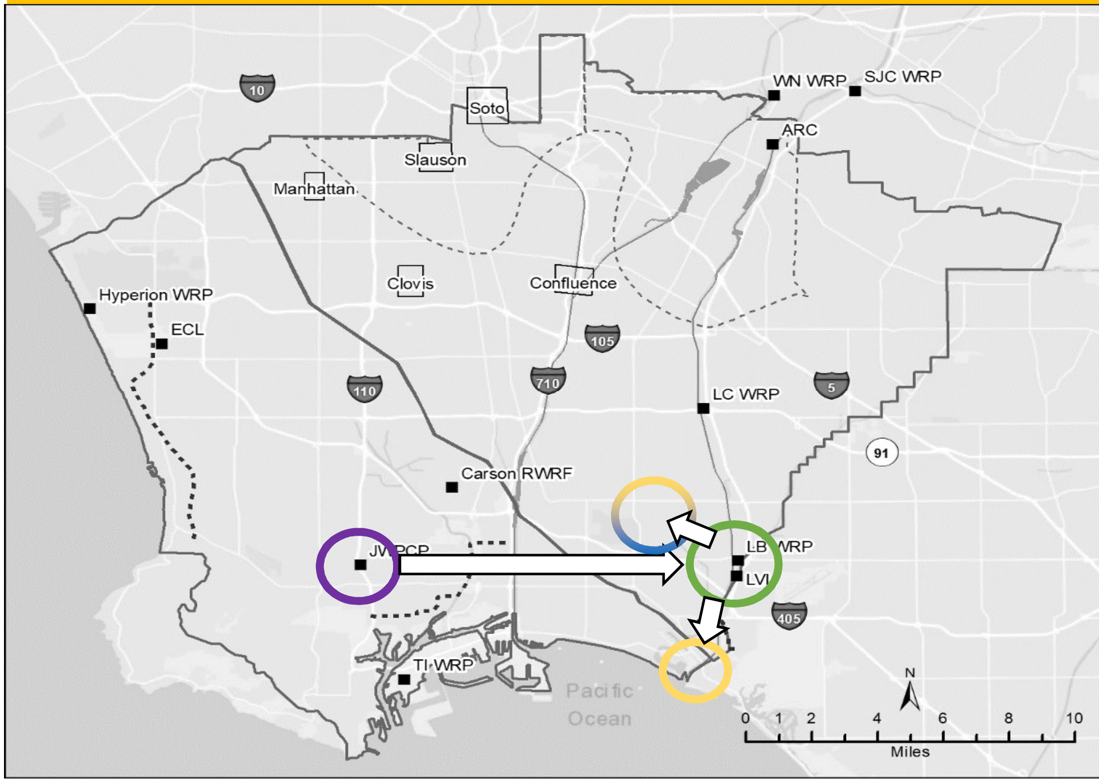
Project Details: JWPCP MBR NdN to Terminal Island for AWT for injection at the Dominguez Gap Barrier or new injection wells in the West Coast Basin. Presented as Item #11 from the June 13th meeting.

Demands: North of Dominguez Gap Barrier
Basin Storage: Assumed to be the recharge needed in one year without extraction
Recharge: New wellfield WB-8
Extraction: WB-8
Source Water: JWPCP
Treatment: Terminal Island Assumed to be 30mgd 33630 (AFY)- 2015 reported wastewwater treated (18000 AFY)=15630 AFY

Notes:

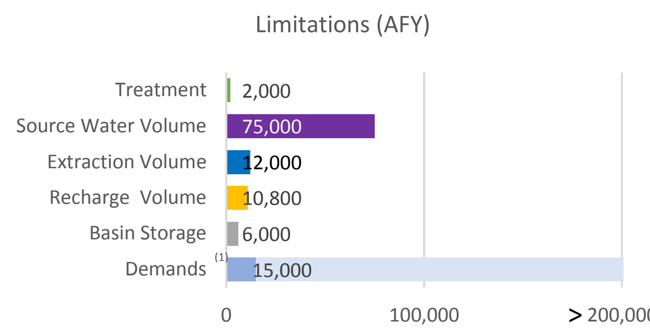
(1) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los Angeles that could be potentially be supplied by a Master Plan project

Optional Project 12 : JWPCP MBR NdN to LVL for AWT for injection at the Alamitos Gap Barrier or new injection wells in the Central Basin



Potential Project Size: 2000 AFY (2 MGD)

Potential Limitation: Treatment

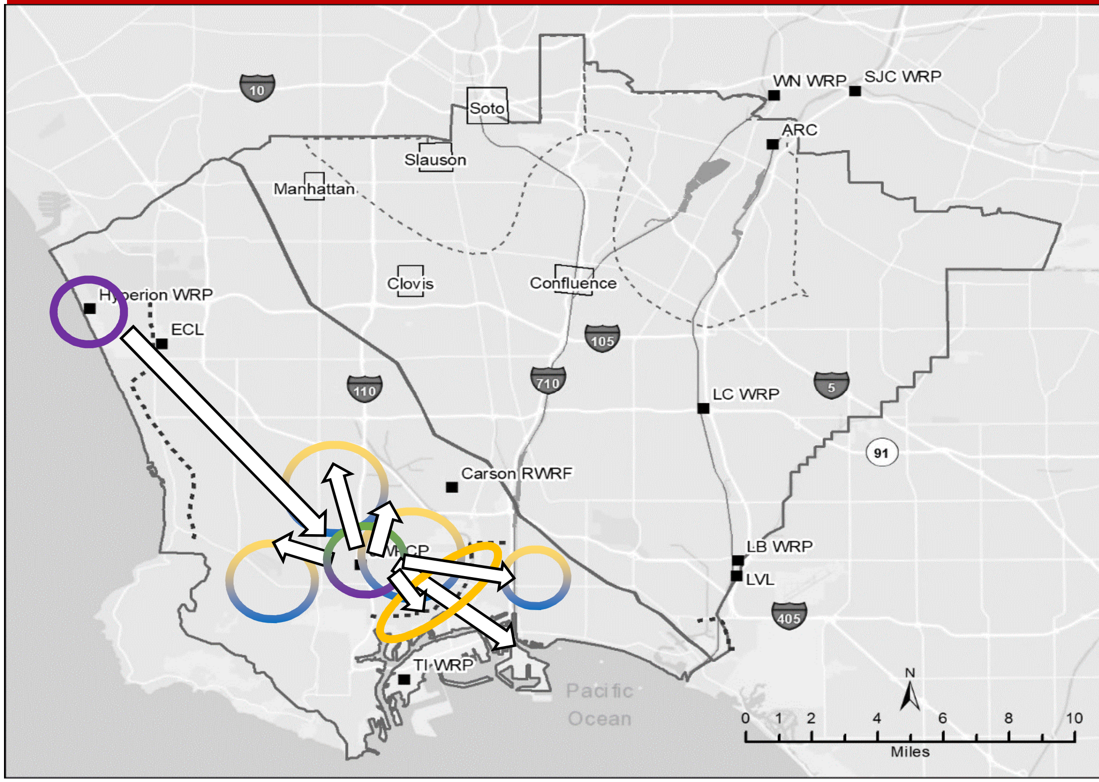


Project Details: Item #12 from June 13th meeting. JWPCP MBR NdN to LVL for AWT for injection at the Alamitos Gap Barrier or new injection wells in the Central Basin.

Demands: CB-8 area
Basin Storage: Assumed to be the recharge needed in one year without extraction
Recharge: CB-8
Extraction: CB-8
Source Water: JWPCP
Treatment: LVL

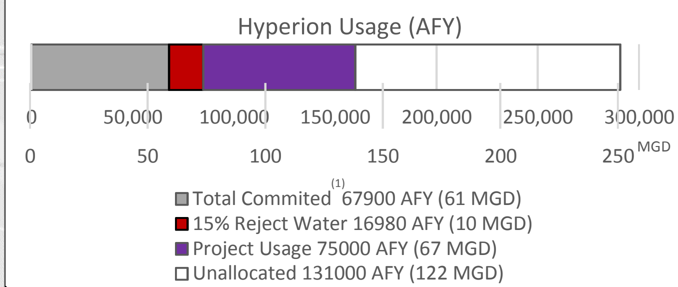
Notes:
(1) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los Angeles that could be potentially be supplied by a Master Plan project

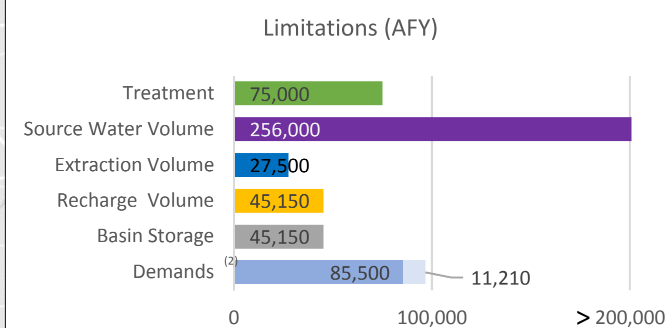
Project O17 : Hyperion MBR NdN to JWPCP for AWT



Potential Project Size: 27500 AFY (25 MGD)

Potential Limitation: Extraction Volume





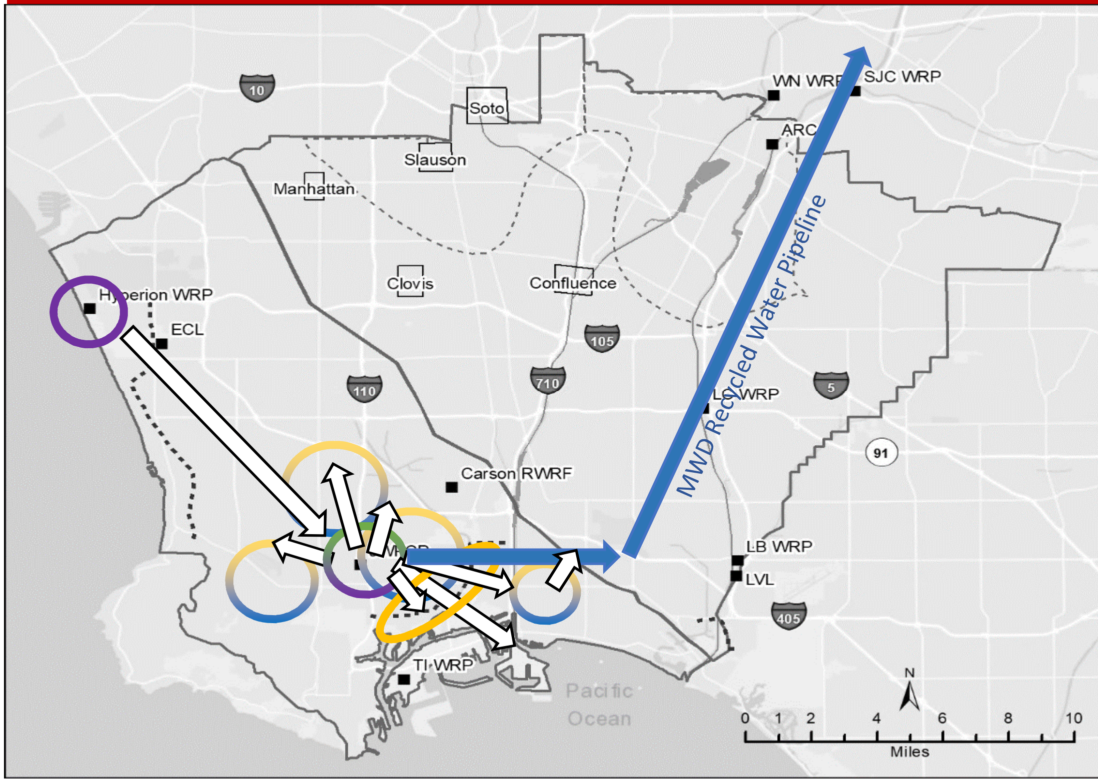
Project Details: Hyperion secondary or MBR NdN to JWPCP for AWT

Demands: West Coast Basin demand south of 91 (85,000 AFY) plus Harbor Recycled water demands
Basin Storage: Assumed to be the recharge needed in one year without extraction
Recharge: Dominguez barrier capacity (31,400 AFY) plus new well fields up to treatment capacity
Extraction: Areas WB-3,4,5 and 8. Potential for more extraction to be evaluated
Source Water: Hyperion
Treatment: Limiting Factor based on AWT at JWPCP (assumed that they have 75,000 AFY based on average JWPCP flow minus 180MGD to MWD Recycled Water Program) Needs to be verified

Notes:

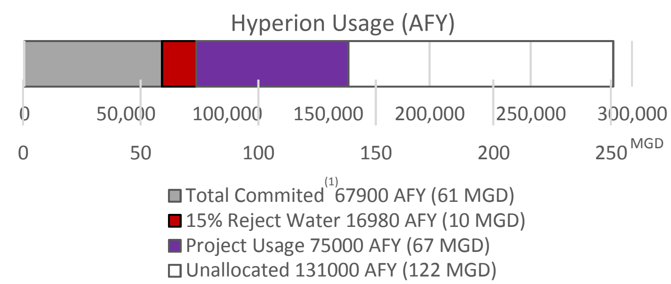
(1) Includes committed secondary effluent flow to West Basin, Influent flow to DCTWRP, and influent flow to LAWA AWPF
(2) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents Harbor area recycled water demands.

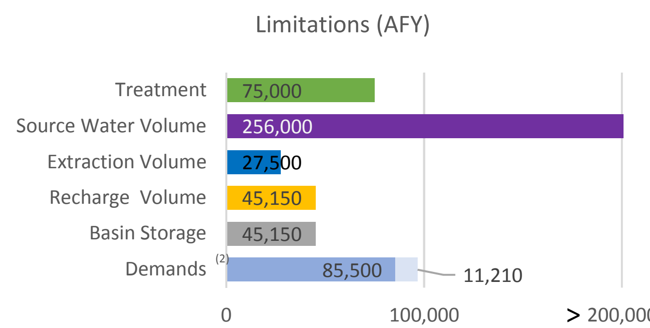
Project O17a : Hyperion MBR NdN to JWPCP for AWT and connection to the MWD Recycled Water Pipeline



Potential Project Size: 27500 AFY (25 MGD)

Potential Limitation: Extraction Volume





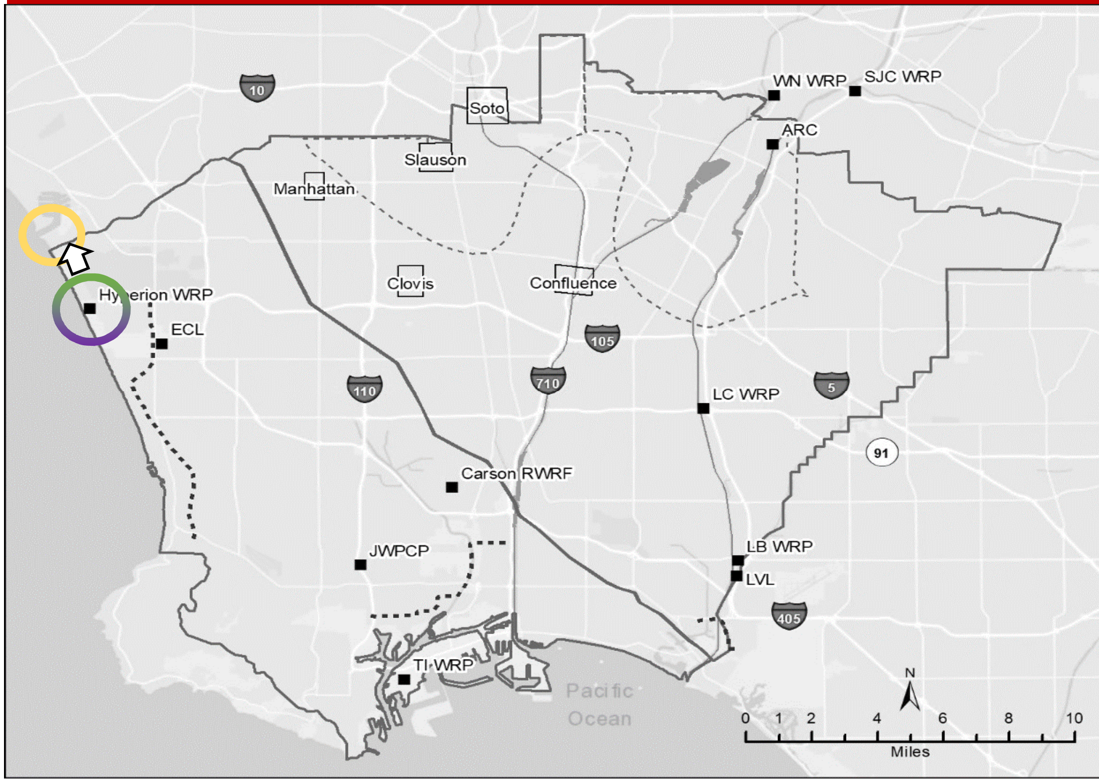
Project Details: Hyperion secondary or MBR NdN to JWPCP for AWT and connection to the MWD Recycled Water pipeline. Connection to the MWD RWP could result in more consistent recharge/extraction operation. The additional extraction/recharge needs to be quantified.

Demands: West Coast Basin demand south of 91 (85,000 AFY) plus Harbor Recycled water demands
Basin Storage: Assumed to be the recharge needed in one year without extraction
Recharge: Dominguez barrier capacity (31,400 AFY) plus new well fields up to treatment capacity. Recharge could be increased at WB-8 if Extraction is also increased due to connection with MWD system
Extraction: New Extraction capacity going to MWD Recycled Water Pipeline can improve recharge capacity
Source Water: Hyperion
Treatment: Limiting Factor based on JWPCP (assumed that they have 75,000 AFY based on average JWPCP flow minus 180MGD to MWD Recycled Water Program) Needs to be verified

Notes:

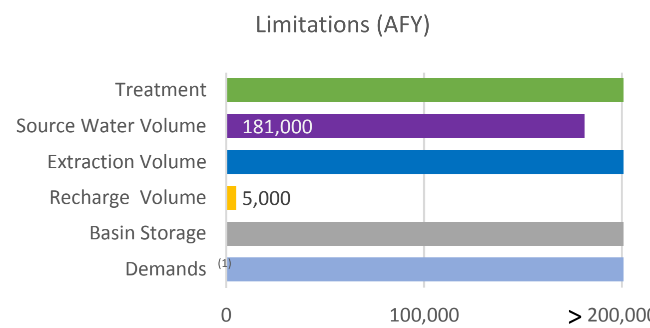
(1) Includes committed secondary effluent flow to West Basin, Influent flow to DCTWRP, and influent flow to LAWA AWPF
(2) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents Harbor area recycled water demands.

Optional Project O3: Decrease underflow from Santa Monica's Charnock Basin to WCB by sending Hyperion AWT water to Santa Monica



Potential Project Size: 5000 AFY (4 MGD)

Potential Limitation: Recharge Volume



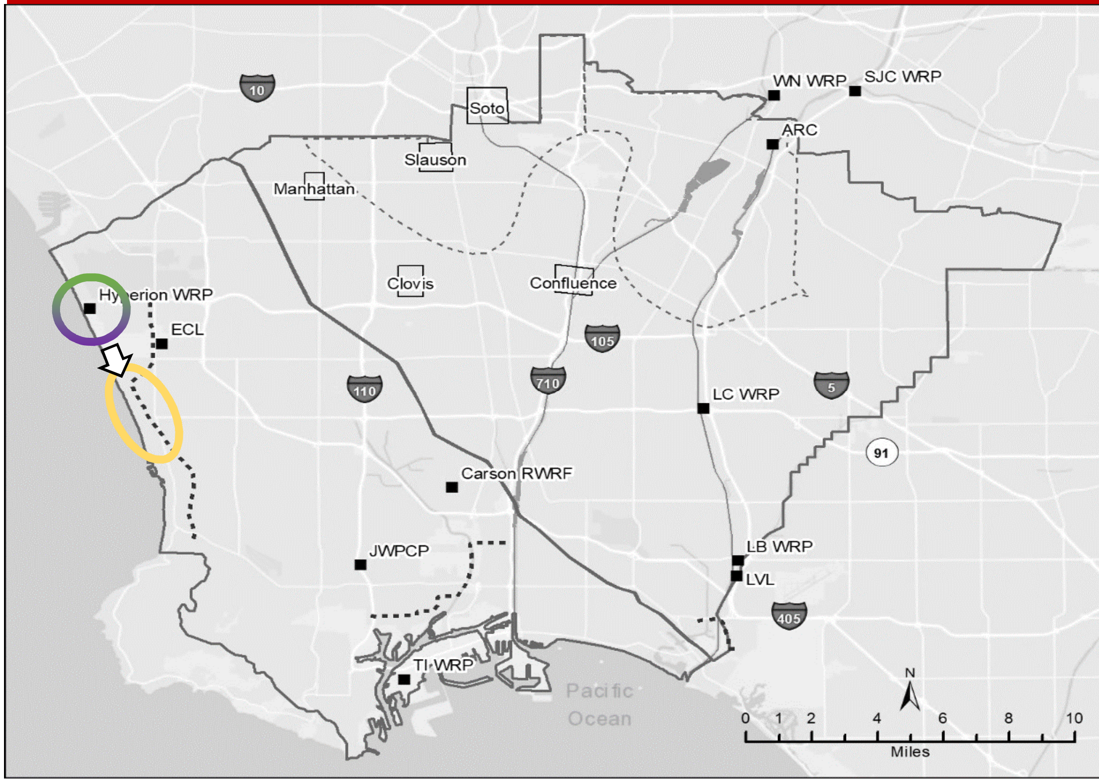
Project Details: Hyperion AWT injected north of LAX to make up for decreased underflow from Santa Monica's Charnock Basin to WCB. Injection would be in new wellfield or at WCB Barrier. Assumes additional pumping by Santa Monica. Item #6 from June 13, 2019 meeting.

Demands: Not Applicable
Basin Storage: Not applicable
Recharge: Based on underflow from Santa Monica Basin to WCB, TBD but estimated to be less than 5,000 AFY
Extraction: Not applicable
Source Water: Hyperion (181,000 AFY)
Treatment: New Hyerion WRP AWTF and NdN MBR

Notes:

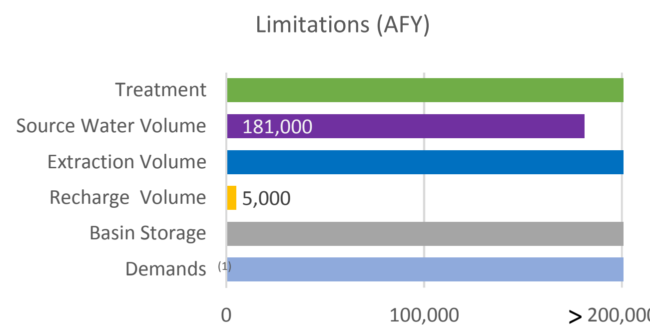
(1) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los Angeles that could be potentially be supplied by a Master Plan project

Optional Project O3a: Indirectly Decrease underflow from Santa Monica's Charnock Basin to WCB by increasing recharge at the WCB barrier



Potential Project Size: 5000 AFY (4 MGD)

Potential Limitation: Recharge Volume



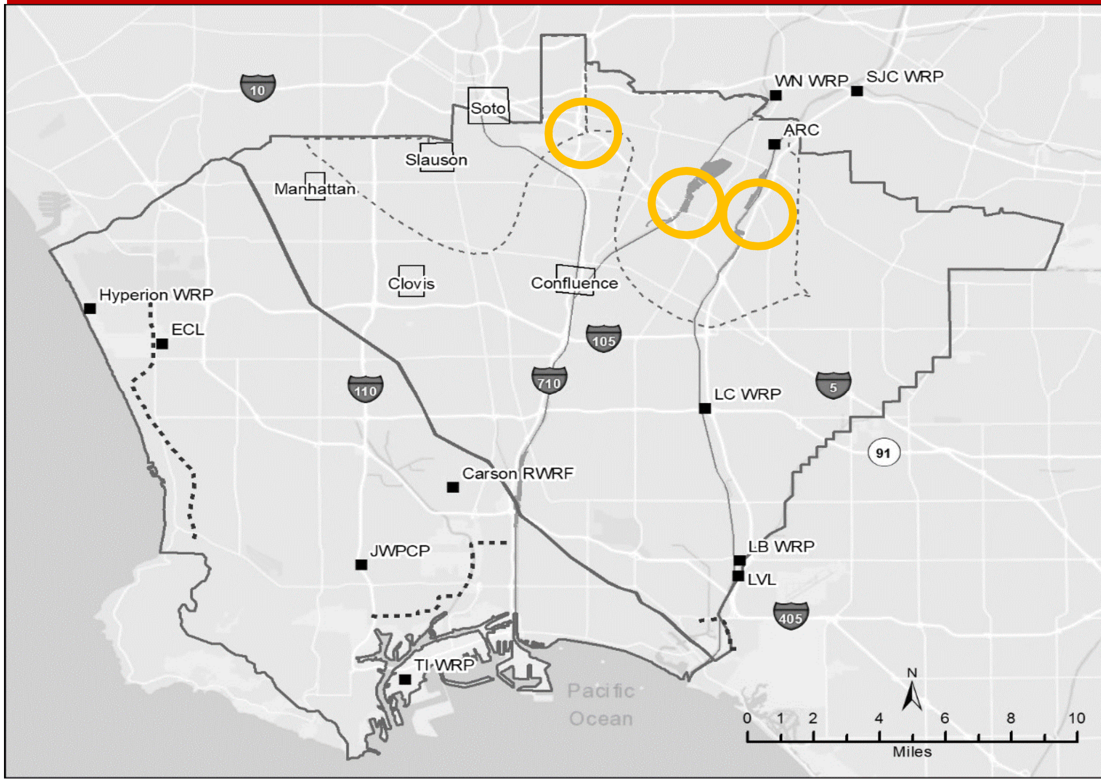
Project Details: Hyperion AWT injected north of LAX to make up for decreased underflow from Santa Monica's Charnock Basin to WCB. Injection would be in new wellfield or at WCB Barrier. Assumes additional pumping by Santa Monica. Presented as a variation of Item #6 from June 13, 2019 meeting.

Demands: Not Applicable
Basin Storage: Not applicable
Recharge: Based on underflow from Santa Monica Basin to WCB, TBD but estimated to be less than 5,000 AFY
Extraction: Not applicable
Source Water: Hyperion (181,000 AFY)
Treatment: New Hyerion WRP AWTF and NdN MBR

Notes:

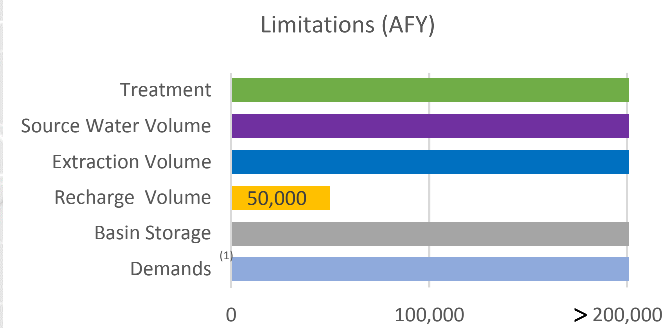
(1) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los Angeles that could be potentially be supplied by a Master Plan project

Optional Project 14 : Dedicated AWT Basins at spreading grounds



Potential Project Size: 50000 AFY (40 MGD)

Potential Limitation: Recharge Volume



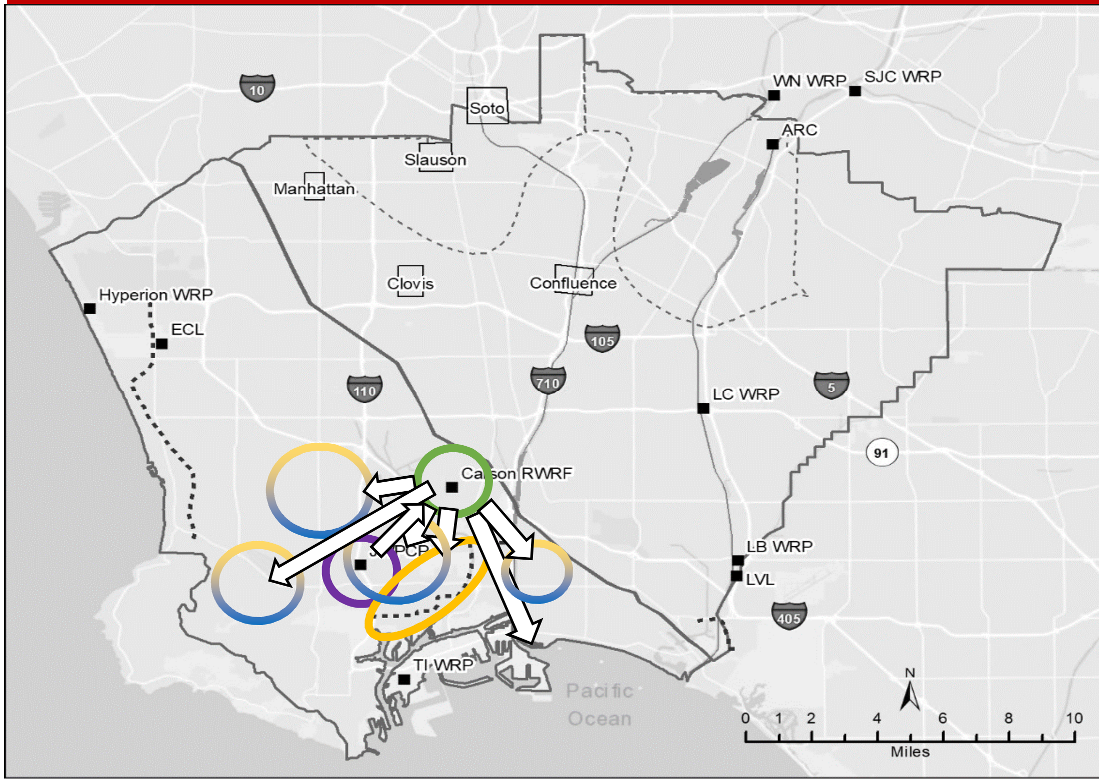
Project Details: Use of dedicated basins for AWT spreading, potential for high recharge capacity. The most downstream Montebello basins would be used to decrease the chances of mixing with stormwater during storm peak events.

Demands:
Basin Storage:
Recharge: Needs to be analyzed.
Extraction:
Source Water:
Treatment:

Notes:

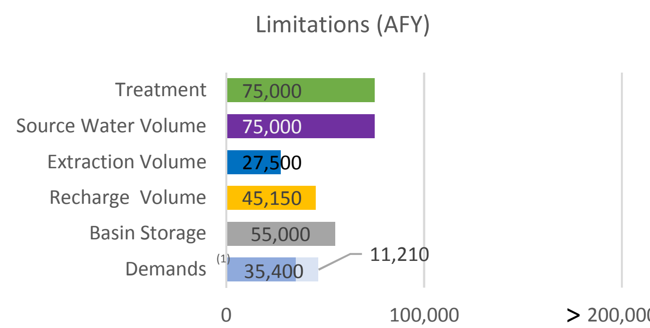
(1) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los Angeles that could be potentially be supplied by a Master Plan project

Optional Project 15 : JWPCP AWT or JWPCP MBR NdN to WBMWD Carson Facility for AWT to serve Long Beach



Potential Project Size: 27500 AFY (25 MGD)

Potential Limitation: Extraction Volume



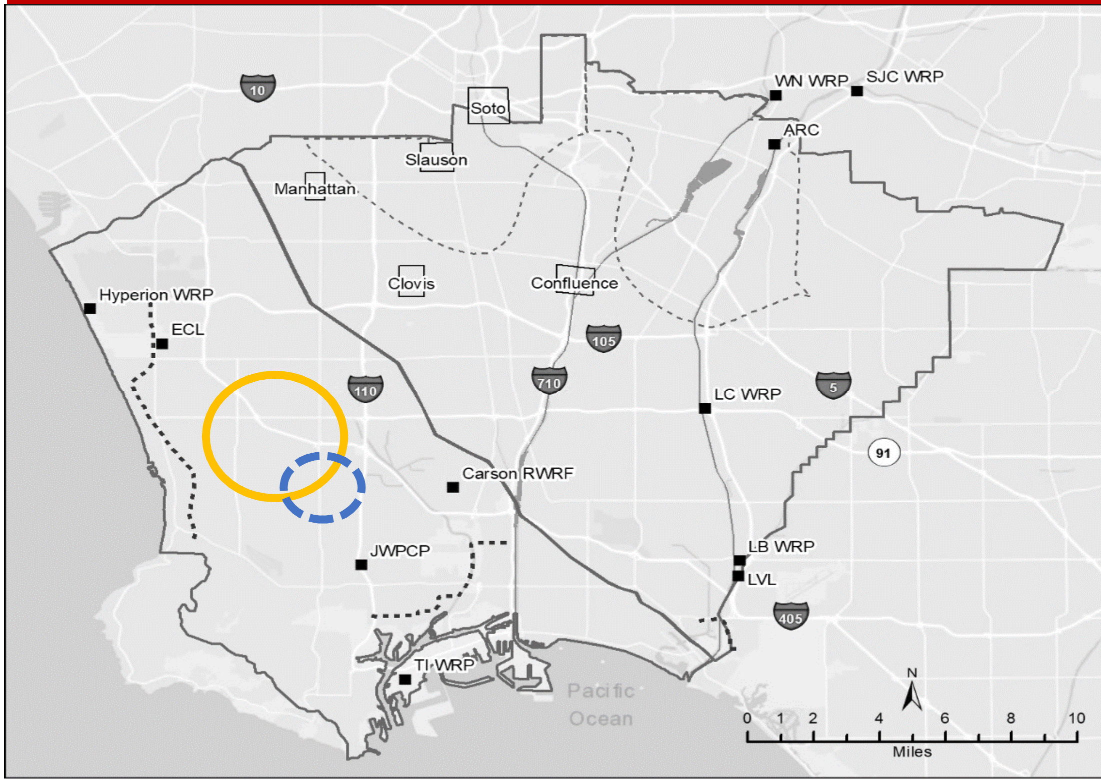
Project Details: Variation of H4 project, instead of Hyperion use of JWPCP flows as source. Carson Facility for AWT to inject at Dominguez Gap Barrier and to feed Harbor area recycled water demands. Presented as a variation of Item #9 on the June 13th meeting.

Demands: WBMWD south of 105. Assumed 11,210 AFY of recycled water demand at the Harbor
Basin Storage: Assumed to be the recharge needed in one year without extraction
Recharge: Based on Dominguez Gap available capacity and new recharge at areas WB-3,4,5 and 8
Extraction: Areas WB-3,4,5 and 8
Source Water: JWPCP
Treatment: Not a limitation if Juanita Millender-McDonald (Carson) treatment plant is expanded. Assuming that there is land availability for 24MG or more of above ground storage necessary for up to 100 MGD

Notes:

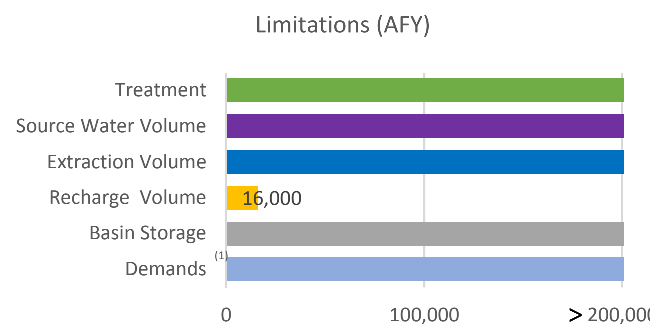
(1) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents Harbor area recycled water demands.

Optional Project 16 : Recharge in WCB for Regional Brackish Water Reclamation Facility



Potential Project Size: 16000 AFY (10 MGD)

Potential Limitation: Recharge Volume



Project Details: Recharge in WCB for Regional Brackish Water Reclamation Facility

Demands:
Basin Storage:
Recharge: Needs to be analyzed.
Extraction: Needs to be analyzed.
Source Water:
Treatment:

Notes:

(1) Darker blue represents the imported demands in the basin that are not City of LA and that could be supplied by this project. Lighter blue represents the average last 10 years of purchased imported water by the City of Los Angeles that could be potentially be supplied by a Master Plan project

Attachment 2
Treatment Processes and Assumptions for AWT Cost Estimating

Figure 1
Advanced Water Treatment Flow Diagrams

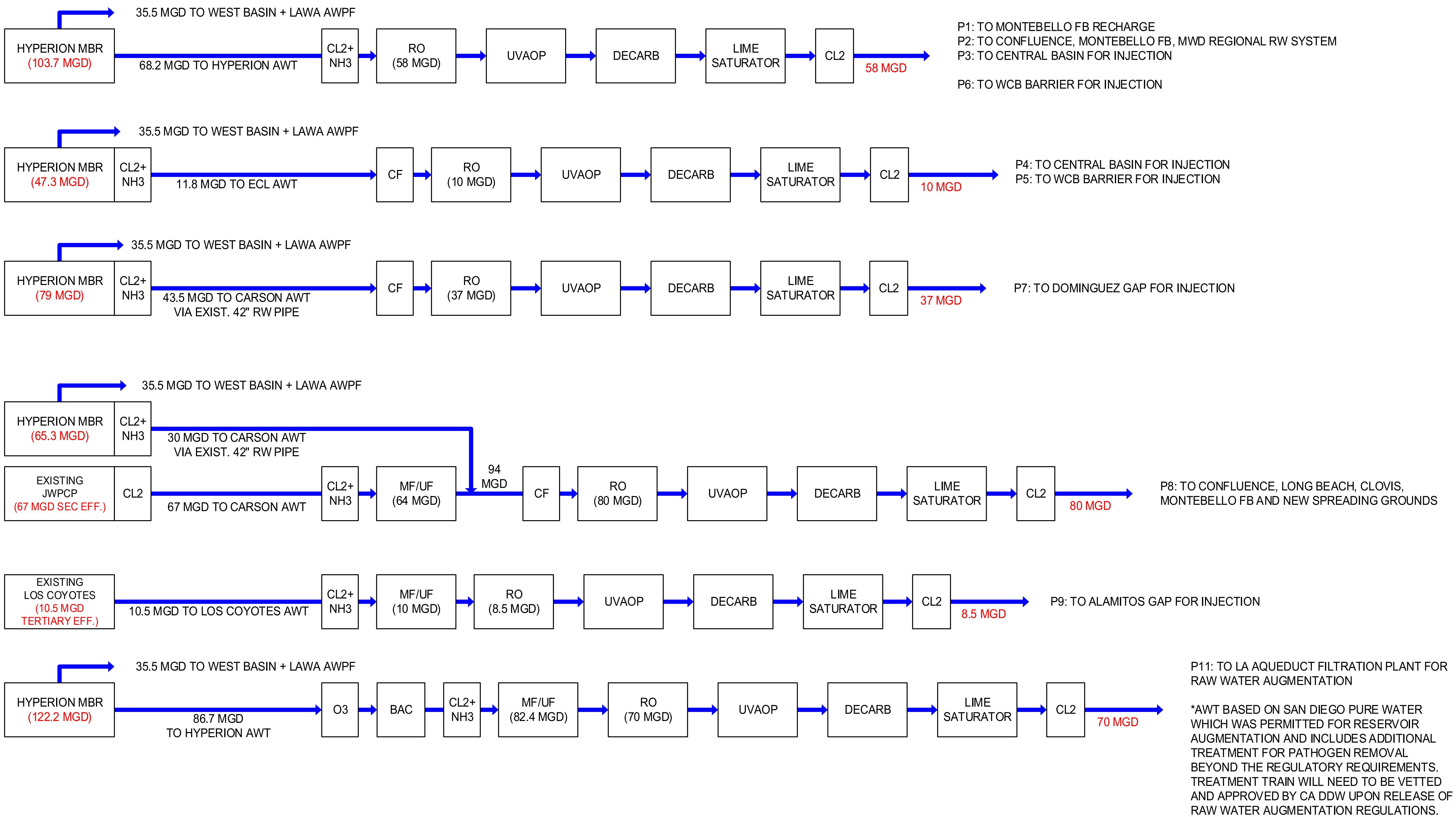


Table 4
Advanced Water Treatment Key Assumptions

1	Monochloramine addition required for biofouling control of MF/UF and RO systems. Dosing assumed at WRP and not at AWT.
2	Monochloramine addition assumed at WRP and not at AWT. Higher doses assumed for alternatives with offsite AWT (ECL or Carson) to provide adequate residual during conveyance. Disinfection by-product formation during conveyance will need to be further evaluated.
3	RO flux = 12 gfd for all systems.
4	Post-treatment includes partial decarbonation (50% UVAOP product) and lime addition via lime saturator clarifier to achieve appropriate LSI and pH.
5	Cartridge filters assumed ahead of RO for alternatives with offsite AWT (ECL or Carson) to protect from particle and biofilm sluffing in conveyance pipeline. No cartridge filters assumed ahead of RO for Hyperion AWT.
6	MF/UF assumed for treating secondary effluent (JWPCP) at 25 gfd and 95% recovery.
7	MF/UF assumed for treating non-MBR tertiary effluent (LC WRP) at 35 gfd and 96% recovery.
8	Treatment train for raw water augmentation (P11) based on Pure Water San Diego, which was permitted for reservoir augmentation and includes additional treatment for pathogen removal beyond regulatory requirements. Treatment train will need to be vetted and approved by DDW upon release of raw water augmentation regulations.
9	O_3 dose for P11 assumes O_3:TOC ratio of 1:1 and TOC of 8 to 12 mg/L in MBR effluent.
10	BAC for P11 assumes EBCT of 10 minutes.
11	MF/UF for P11 assumes 60 gfd and 97% recovery based on Pure Water San Diego.
12	For alternatives including MF/UF, backwash waste equalization and pumping to sewer is assumed and included. Backwash waste treatment is excluded from AWT costs.

Notes:
'% = percent
AWT = advanced water treatment
BAC = biologically activated carbon
CA = California
CF = catridge filter
CL2 = Chlorine
CL2 + NH3 = Chloramination
DDW = California Division of Drinking Water
DECARB = decarbonation
EBCT = Empty Bed Contact Time
ECL = Edward C. Little
FB = Forebay
gfd = gallons per day per square foot
JWPCP = Joint Water Pollution Control Plant
LA = Los Angeles
LAWA AWPF = Los Angeles World Airports Advanced Water Purification Facility
LC = Los Coyotes
LSI = Langelier Saturation Index
MBR = membrane bioreactor
MF = microfiltration
mg/L = milligram(s) per liter

MGD = million gallon(s) per day
MWD = Metropolitan Water District
NH_3 = Ammonia
O_3 = ozone
PS = pump station
RO = reverse osmosis
RW = recycled water
TOC = total organic carbon
UF = ultrafiltration
UVAOP =ultraviolet light advanced oxidation process
W CB = West Coast Basin
WRP = water reclamation plant

Appendix C
TM 3.1-Basis of Project Development

Jacobs

Memorandum

1000 Wilshire Boulevard, Suite 1140
Los Angeles, California 90017-2457
United States
T +1.213.538.1388
F +1.213.538.1399
www.jacobs.com

Subject	**Technical Memorandum 3.1 – Basis of Project Development – Final**
Project Name	WRD and LADWP Joint Los Angeles Basin Replenishment and Extraction Master Plan
Date	May 12, 2020 (Revised)

1. Introduction

The Water Replenishment District of Southern California (WRD) and the Los Angeles Department of Water and Power (LADWP) have initiated a partnership to identify solutions to maximize use of the Central Basin and West Coast Basin through development of the Joint Los Angeles Basin Replenishment and Extraction Master Plan (Joint Master Plan). The Joint Master Plan was developed over multiple workshops and uses a regional approach to identify a comprehensive list of existing and potential new replenishment water sources, treatment facilities, and replenishment and extraction locations, herein referred to as "project components," as described in Technical Memorandum (TM) 1 (Appendix A).

Workshop 1 was held on March 29, 2019, to discuss project goals, the Joint Master Plan project setting including boundaries, and project drivers. The workshop also presented the initial list of "dots" or projects to be considered in the Joint Master Plan. The result of Workshop 1 was the system components list presented in TM 1 and used to develop 30 Project Concepts and Add-on Projects. These Project Concepts were initially screened based on overall feasibility and discussion between WRD, LADWP, and Jacobs (the Joint Master Plan team). After screening, the remaining 17 Project Concepts were scored and ranked in an iterative process to collaboratively determine which projects should be selected for further project development.

Workshop 2 was held on August 1, 2019, to present the initial Project Concept ranking and discuss refinements with the Joint Master Plan team. A multi-objective decision analysis (MODA) process was used during Workshop 2 to aid the decision-making process. The MODA process considers financial (cost) and nonfinancial criteria during the ranking of project alternatives based on scores (Appendix B). After defining and refining the MODA scores, nine projects were combined into two distinct projects: (1) the Hyperion Water Reclamation Plant (WRP) Project and (2) the Los Coyotes WRP Project, as described in TM 2 (Appendix B) and summarized as follows:

- **Hyperion WRP Project:** Focus of maximizing the use of Hyperion WRP flows through injection and extraction in the Central Basin, spreading at the Montebello Forebay, and siting of new spreading facilities, with excess flows connected to the planned Metropolitan Water District of Southern California's (Metropolitan's) Regional Recycled Water Program advanced treated recycled water backbone conveyance system. Maintaining existing flows to Edward C. Little Water Recycling Facility (ECL) for injection at the West Coast Basin Barrier (WCB Barrier) is assumed. Figure 1 provides a conceptual overview of this project.
- **Los Coyotes WRP Project:** The focus of this project was to find the best use of available Los Coyotes WRP flows for groundwater replenishment. Initially, this included an evaluation of whether Los

Coyotes flows should be sent north to the Montebello Forebay, or south for advanced water treatment at the Leo J. Vander Lans Advanced Water Treatment Facility (LVL AWTF) for injection at the Alamitos Barrier Project or new injection and extraction facilities in the Long Beach area. Based on discussion with WRD, the focus of the project shifted to a peer review of preliminary design documents for the pipeline and pump station between the Los Coyotes WRP and the LVL AWTF. The review will also include updating estimated costs, identifying fatal flaws, and potentially evaluating storage needs (Appendix F). Figure 2 provides a conceptual overview of this project.

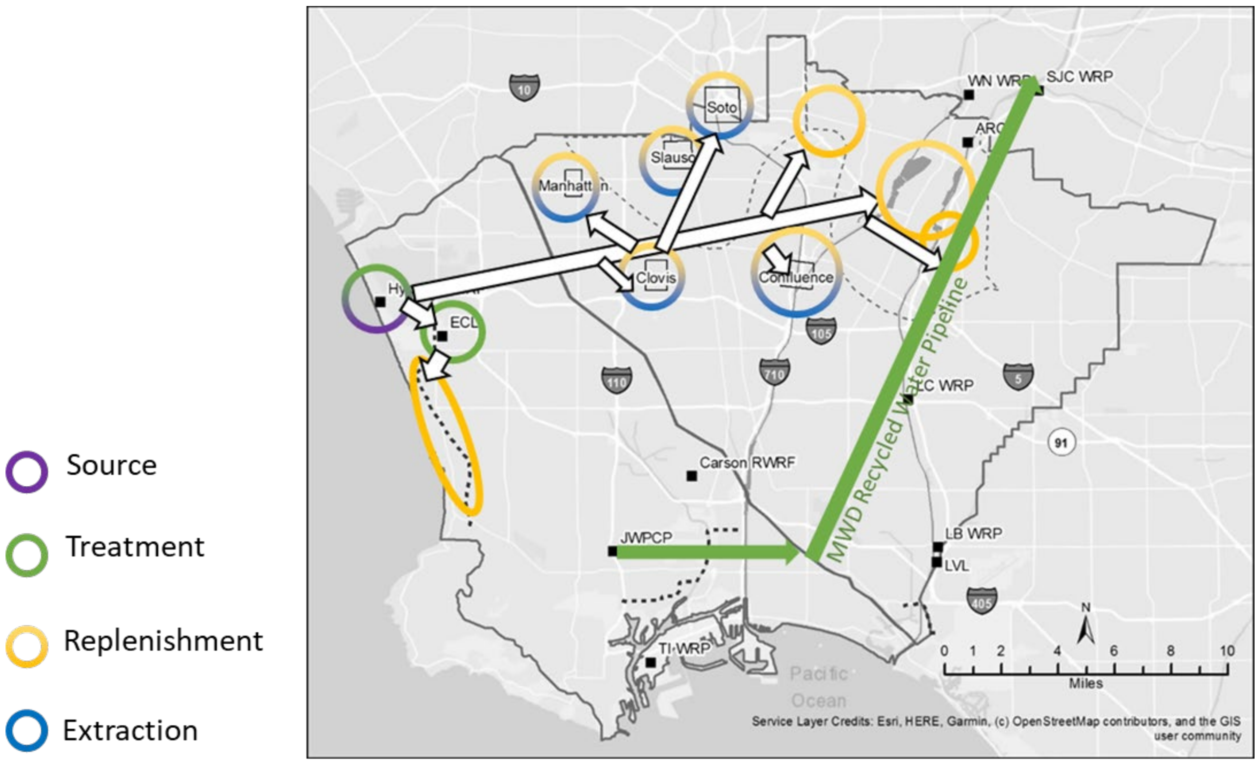


Figure 1. Hyperion Water Reclamation Plant Project

WN	*Whittier Narrows*
SJC	*San Jose Creek*
LB	*Long Beach*

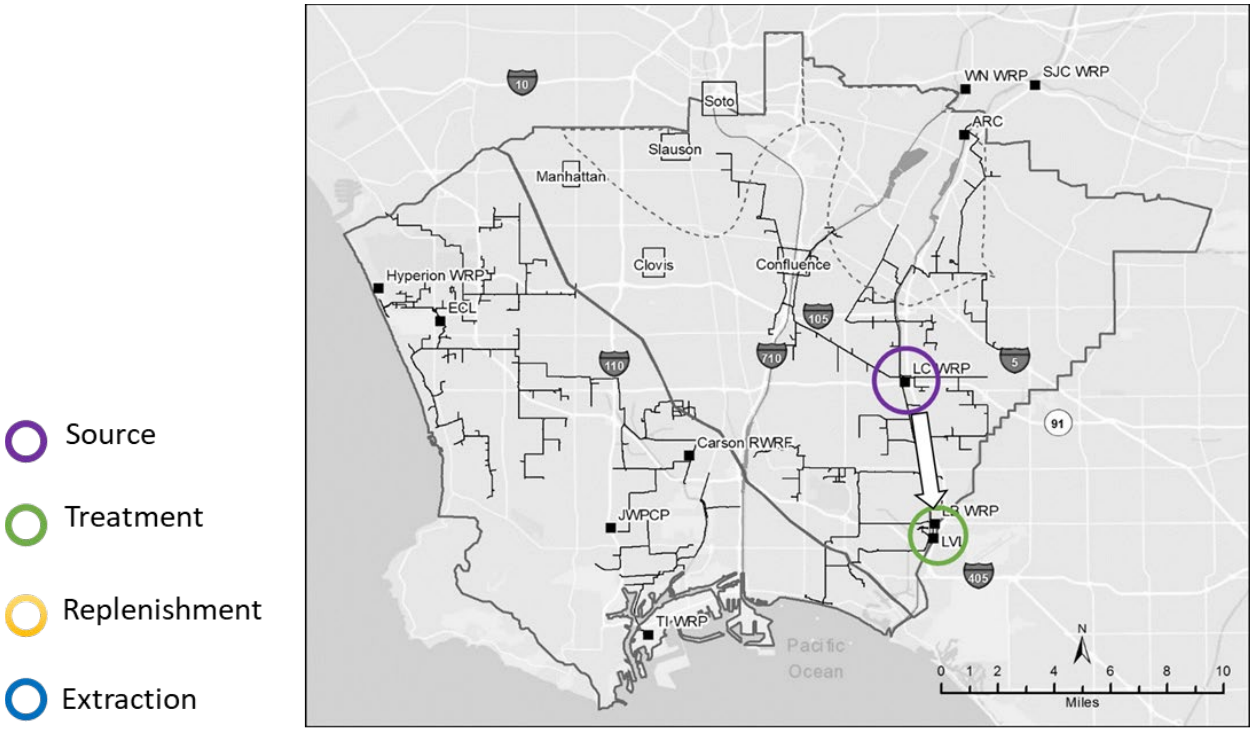


Figure 2. Los Coyotes Water Reclamation Plant Project

TM 3.1 is the third deliverable of the Joint Master Plan study and corresponds to the numbering of the subtasks within the scope of work. It describes the basis of project development and key assumptions to be used in subsequent development of the Hyperion WRP Project and the Los Coyotes WRP Project. Project development and analysis will be documented in a separate TM 3.2.

This TM is organized in the following sections:

- Section 1 – Introduction
- Section 2 – Hyperion WRP Project Model Basis
- Section 3 – Hyperion WRP Project Backbone Alternative Route Development Basis
- Section 4 – Los Coyotes WRP Project
- Section 5 – References

Central Basin storage and extraction management assumptions are based on the Central Basin Third Amended Judgment (Superior Court of California 2013), hereinafter referred to as the Judgment.

2. Hyperion WRP Project Model Basis

Modeling of the Hyperion WRP Project is useful for understanding the relationships of the complex system components and operational limitations. Results from modeling efforts will provide the basis for subsequent project planning and design. Different models can be used to answer different questions. To build upon the Resource Allocation Model developed by LADWP (LADWP 2019), a Water Balance Model and a Groundwater Model will be developed under this Joint Master Plan to simulate operational scenarios and identify physical groundwater basin limitations.

The following three types of models will be applied in the development of this Joint Master Plan and are summarized in Table 1:

- **Resource Allocation Model:** This spreadsheet model was developed by LADWP to evaluate Los Angeles demands, supplies, and resulting extraction limitations (LADWP 2019). The 30-year demand period provided by this model will serve as input to the Water Balance Model.
- **Water Balance Model:** This systems model will be used to simulate recharge, extraction, and storage based on historical and predictive management scenarios, keeping within the Judgment requirements. This model will also provide a time series with extraction and recharge as an input to the Groundwater Model.
- **Groundwater Model:** This groundwater flow model will verify physical limitations of injection, storage, and extraction within the groundwater basins.

Table 1. Hyperion Water Reclamation Plant Project Model Summary

Model	General Inputs and Outputs	Example Questions Used to Develop Model
Resource Allocation Model (previously developed by LADWP) (LADWP 2019)	Input: Extraction locations, volumes, and rates Production and augmentation scenarios Output: Extractions to meet basin demands	How much, where, and when will water be extracted? What are the physical impacts from new extraction?
Water Balance Model	Input: LADWP (and other pumpers) demand pattern(s) Management rules Extraction and replenishment scenarios Output: Flow time series to be used as input to the Groundwater Model	When will regional or individual storage allocation, community storage, and WRD's managed operation reserve be used? What are the changes required for acquisitions or leased storage? How often will replenished water be lost to carryover limitations?
Groundwater Model	Input: Replenishment locations, volumes, and rates Extraction locations, volumes, and rates Output: Changes to groundwater levels from new replenishment and extraction	What are the physical impacts from recharge and extraction? What additional artificial replenishment can the basin accommodate?

The following subsections describe the basis for development of the Water Balance Model and Groundwater Model as a result of feedback and data provided by WRD and LADWP.

2.1 Water Balance Model

The purpose of the Water Balance Model is to simulate management scenarios and indicate how flows between system components work to balance supply, demand, and storage within the Central Basin. Figure 3 illustrates the main components of the Water Balance Model. The model will also be used to identify limitations caused by variations in demands and hydrology. Output from the model will be used to inform the groundwater modeling and conveyance needs.

The Water Balance Model results will focus on overall system mass balance and storage accounting. Water Balance Model results will be used as input to the Groundwater Model, where physical limitations of the system will be tested. Some iterations are expected between the Water Balance and Groundwater Model runs, depending on the model results; for example, it is possible that the Groundwater Model results would flag physical limitations of the basin related to recharge, and these limitations would then need to be reflected in the Water Balance Model.

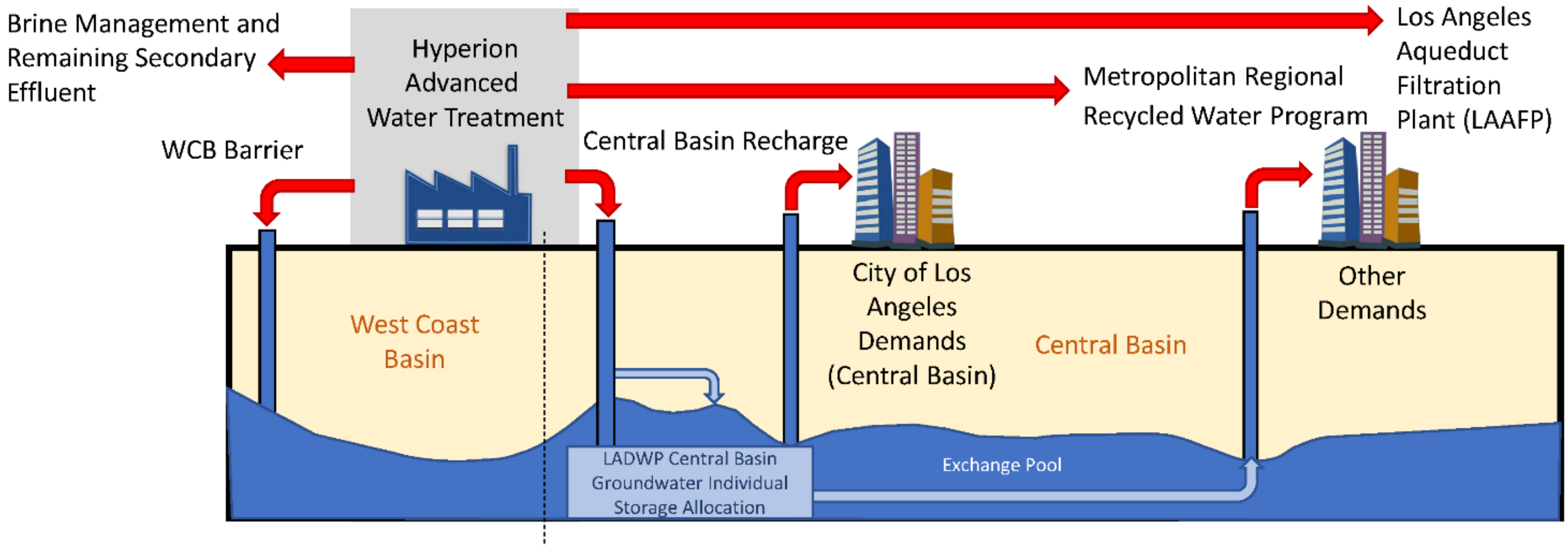


Figure 3. Water Balance Model System Components

2.1.1 Water Balance Model Inputs

Demands for Hyperion WRP flows are dependent on seasonal variability and hydrologic patterns. Based on the inputs, including historical hydrology, historical storage usage, and future changes in demands, the Water Balance Model will indicate how much storage might be needed; the results will be used to inform the Groundwater Model.

The overall modeling approach is to use monthly historical measured values for inputs corresponding to the 1986-2015 period that are independent of project changes and assumptions. Other variables will change as a function of modeling scenario and project activities. For example, the historical LADWP groundwater production in the Central Basin will be replaced by an expected production from the basin upon project implementation.

The new 30-year annual demands to be used in the modeling scenarios were generated from the Resource Allocation Model and will be provided in a monthly time step (presented on Figure 4 as annual total flows). Figure 4 shows the new LADWP demands that will be used in modeling scenarios compared with the historical LADWP usage of water rights in the Central Basin. The new LADWP demands in the Central Basin system are assumed to be significantly higher than the historical pumping from the basin: the average historical LADWP Central Basin pumping for the 1986-2015 period was 11,200 acre-feet per year (AFY), and the new demand average is approximately 43,000 AFY.

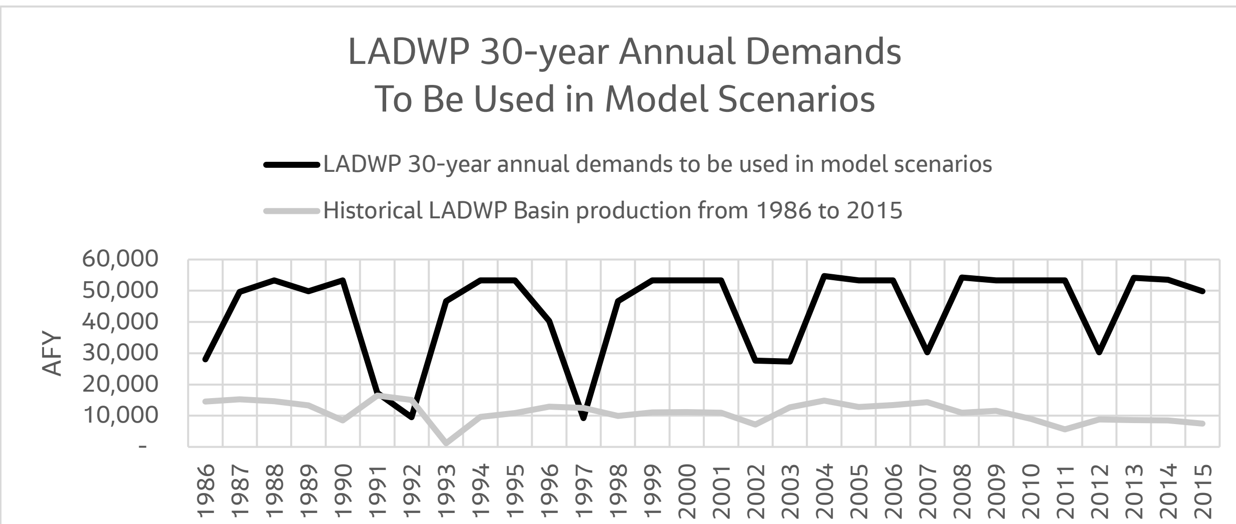


Figure 4. 30-year LADWP Demands for Central Basin Model Scenarios

Figure 5 shows the LADWP historical production in the Central Basin in comparison with the total basin production and maximum Central Basin Annual Pumping Allocation (APA). Figures 4 and 5 show that, with the new expected LADWP demands from the basin, it is possible that the basin extractions will exceed the APA; in that case, a water augmentation program could be considered among other options. Figure 5 also shows a value for the Central Basin's natural safe yield of 137,300 AFY as defined in a 1962 report for the year 1957 by the California Department of Water Resources (WRD 2019).

WRD is responsible for replenishing the Central Basin groundwater difference between the adjudicated rights (217,367 AFY) and the natural safe yield (137,300 AFY) values established for the basin, including any changes to the natural safe yield since 1957 (WRD 2019). Many sources contribute to the basin recharge, and WRD does not have control of the natural recharge conditions driven largely by flows in the

San Gabriel and Rio Hondo rivers, excluding the active diversion of stormwater flows into the San Gabriel and the use of rubber dams in the unlined San Gabriel River for ponding and percolation (system operated by the Los Angeles County Flood Control District). WRD provides artificial recharge to the Central Basin with tertiary recycled water that discharges to San Jose Creek, advanced treated recycled water from WRD's LVL AWTF and Albert Robles Center for Water Recycling and Environmental Learning (ARC), imported water and in-lieu pumping in the basin; these sources comprise WRD's Management Aquifer Recharge (MAR) for the Central Basin. For this project, it is important to understand project flows and limitations to minimize the amount of Hyperion WRP effluent sent to the ocean.

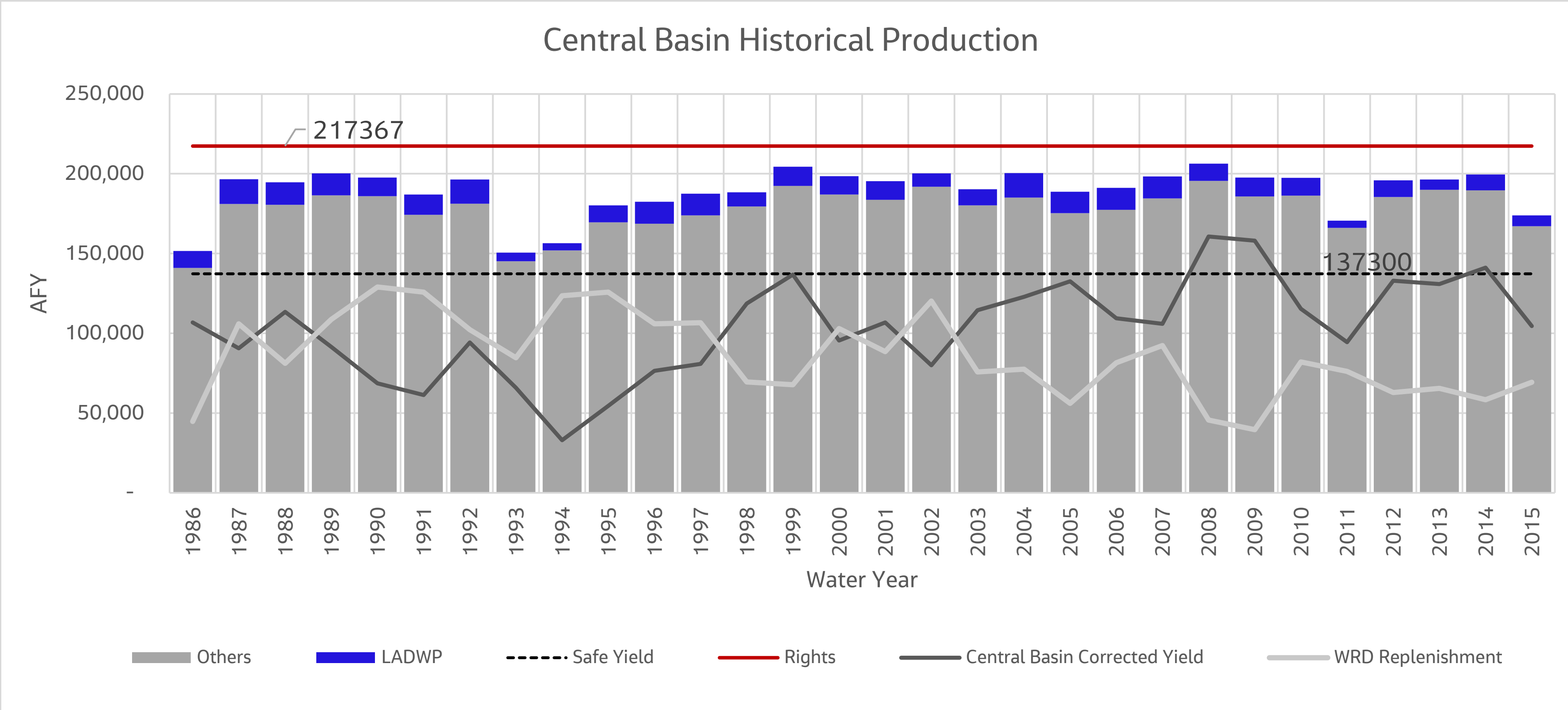


Figure 5. LADWP's Share of the Total Central Basin Historical Groundwater Production

Figure 6 shows the initial Water Balance Model input data set for the historical replenishment of the basin. The initial model assumptions start with the same historical replenishment pattern, but future model scenarios could reflect alternative replenishment sources and volumes to be more representative of anticipated future conditions. The figure shows that from 1986-1998, replenishment was more than 150,000 AFY, which resulted in an overall basin surplus. During the second part of the time series, from 1999-2015, replenishment was on average less than 200,000 AFY.

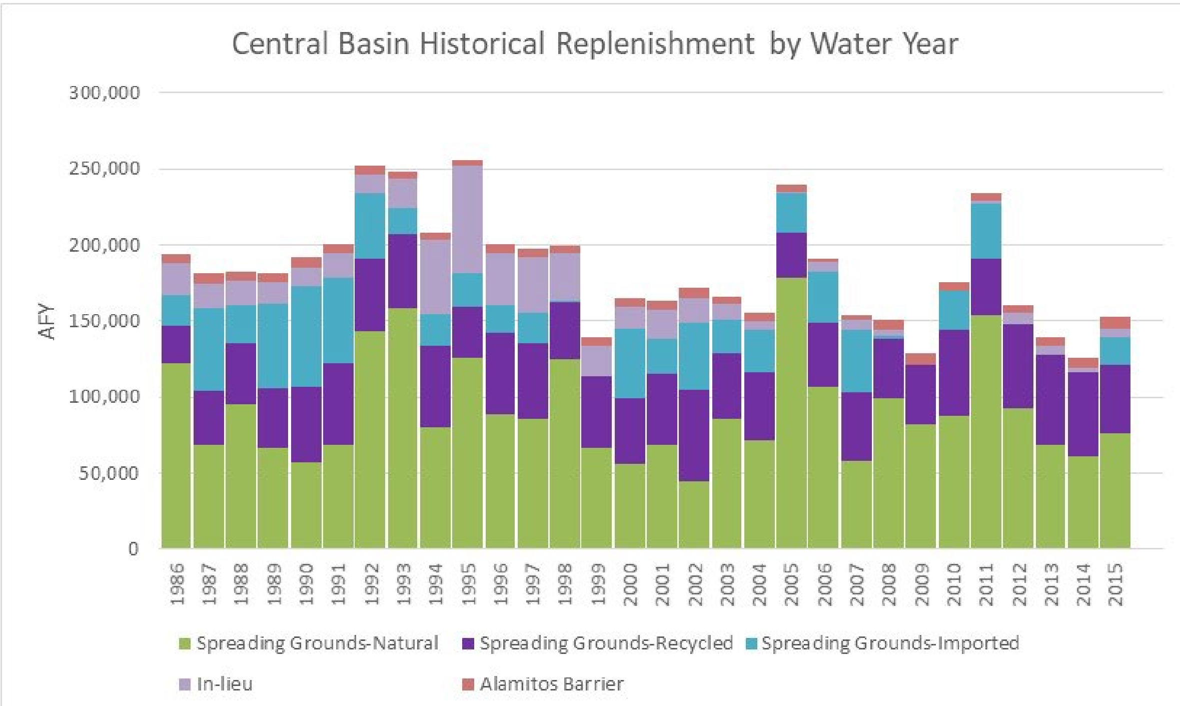


Figure 6. Central Basin's Historical Replenishment Sources

2.1.2 Water Balance Model Assumptions

The Water Balance Model will consider a 30-year simulation period. Although the model runs in a daily time step, model results will be reported for a monthly time step from October 1985 to October 2015. Diurnal variations of inputs are not considered.

The Water Balance Model domain will include the Central Basin area defined in the 2013 Judgment. The model will assume all historical inflows and outflows from the basin as a baseline condition. Inputs and outputs will be adjusted with the modeling scenario variables.

The Hyperion WRP is the primary new water supply source added within the Central Basin boundaries. Available supply will be distributed to meet current commitments and future demands. Maximum water production from the Hyperion WRP advanced water purification facility will be assumed to be 125 million gallons per day (MGD). Initial assumptions about the allocation of the Hyperion WRP water were provided by LADWP and are described as follows:

- Central Basin Expected Recharge Range (as a function of LADWP basin demands and water augmentation):
  - Low Range: 0 AFY
  - Medium Range: 8,400 AFY (11.6 cubic feet per second [cfs], 7.5 MGD)

  - High Range: 20,900 AFY (29 cfs, 18.7 MGD)
- WCB Barrier replenishment for the Regional Brackish Water Reclamation Program (RBWRP):
  - 10,000 AFY (14 cfs, 9 MGD)
- Metropolitan Regional Recycled Water Program:
  - Excess flows remaining after all other uses
  - Low Range: 0 AFY
  - High Range: 56,000 AFY (77 cfs, 50 MGD)
- LAAFP:
  - Excess flows remaining after replenishment
  - Low Range: 111,000 AFY (153 cfs, 99 MGD)
  - High Range: 150,000 AFY (207 cfs, 134 MGD)
- Brine Management and Remaining Secondary Effluent:
  - Assumed 85% reverse osmosis recovery
  - Low Range (125 MGD from Hyperion WRP): 21 MGD brine plus remaining secondary (approximately 50 MGD) equals 71 MGD
  - High Range (170 MGD from HTP): 31 MGD brine

Some of the initial assumptions presented above were modified during the development of the modeling scenarios presented in Attachment 1. For example, the expected range of Central Basin recharge was extended to 39 MGD and the connection with the Metropolitan Regional Recycled Water Program was not included in these scenarios.

The Water Balance Model will track two storage user volumes: storage used by LADWP and storage used by other water rights holders in the Central Basin. The model will also have placeholders for equations to keep track of the storage in the Community Pool, as well as that in the Basin Operating Reserve managed by WRD. Although the Basin Operating Reserve storage is in the model, it is not fully implemented and not used at this time. The rules assumed for storage are described under the Basin Management Assumptions in Section 2.1.3.

Figure 7 is a draft schematic of the Water Balance Model and illustrates the relationships among the various system components. The final Water Balance Model tool could have a dashboard similar to Figure 7 to report results. Table 2 lists the model inputs that could be changed in the scenarios.

Basin extraction limitations are related to maximum infrastructure capacity (well and distribution system capacities), Judgment limitations, and water usage priority. Well and conveyance capacities can be input variables in the Water Balance Model if determined necessary at the time of the simulation runs. Based on the Judgment, the maximum amount a Central Basin pumper can extract in any single year is up to 140% of the sum of its APA plus or minus any leased water. Additional extractions require approval by the Water Rights Panel, but in no case can the annual extraction exceed its total extraction right (APA plus leases plus carryover [normal and drought], plus stored water).

Unless a party elects otherwise, extractions are subtracted from a party's total extraction rights in the following order of pools (based on the Judgment):

1) Increased extractions beyond APA covered under Section IV(K) of the Judgment (not modeled)
2) Exchange Pool
3) Carryover Water

4) Leased Water
5) APA
6) Stored Water
7) Drought Carryover
8) Water under agreement with WRD

Based on the Judgment, community storage water does not have to be extracted in any order of priority for up to 10 years; after that, community storage water becomes a priority, and it is subjected to losses.

Table 2. Water Balance Model Input Assumptions

Input Number	Model Input	Assumption
Model Inputs Related to System Inflows		
I1	Recycled water	Monthly historical flows (tertiary-treated recycled water) from 1986-2015, and necessary corrections based on input I4 (ARC Facility)
I2	Imported water	Monthly historical flows from 1986-2015, and potential changes to this input based on modeling scenarios
I3	In-lieu	Annual historical flows from 1986-2015
I4	ARC	Estimated constant 10,000 AFY, supplied by San Jose Creek WRP
I5a	Stormwater capture plus areal recharge (local water)	Monthly historical flows from 1986-2015, defined as “local water” in WRD’s database
I5b	Net groundwater underflow	Based on U. S. Geological Survey Groundwater Model values
I6	Los Coyotes WRP	Variable model input to be determined; general rule is to use Los Coyotes WRP supply (4,000 AFY) before any Hyperion WRP water for water augmentation, and use up to 4,000 AFY as MAR when not using as a water augmentation source
I6a	Los Coyotes WRP to MAR	Up to 4,000 AFY to be determined by project scenario
I6b	Los Coyotes WRP to water augmentation	Up to 4,000 AFY to be determined by project scenario
I7	Hyperion advanced water treatment production	Variable model input determined by different model scenarios (125-170 MGD range); model will assume constant flow from Hyperion
Model Inputs Related to System Operation		
A1	LADWP rights	Variable model input; minimum 17,236 AFY (current LADWP APA)
A2	Other rights	Variable model input; function of LADWP rights
A3	LADWP limitations	Distribution and wellfield extraction limitations
A4	LADWP water augmentation rules	Maximum annual or monthly value; to be determined by modeling scenarios
A5	LADWP Central Basin storage	Maximum storage (rules on Community Pool to be applied)
A6	Storage from other Central Basin pumpers	Maximum storage (rules on Community Pool to be applied)
A7	Hyperion to MAR	Active only in future model versions and only if there are no demands for Hyperion water from the Metropolitan connection or LAAFP

Table 2. Water Balance Model Input Assumptions

Input Number	Model Input	Assumption
Model Inputs Related to System Outflows		
O1	LADWP demands	30-year monthly average time series of estimated demands and pumping provided by LADWP
O2	Other demands	Variable model input capacity determined by different model scenarios; initial assumption is monthly historical demands from 1986-2015
O3	WCB Barrier for RBWRP	Initial assumption 20,000 AFY; 50% of the RBWRP replenishment flow (10,000 AFY or 8.9 MGD) to be from Hyperion
O4	Hyperion to LAAFP	Variable model input capacity determined by different modeling scenarios (99-134 MGD); limited by pipe capacity, and in future model versions, could be limited by LAAFP capacity and LA Aqueduct flows
O5	Hyperion to Metropolitan	Initial assumption is maximum 50 MGD

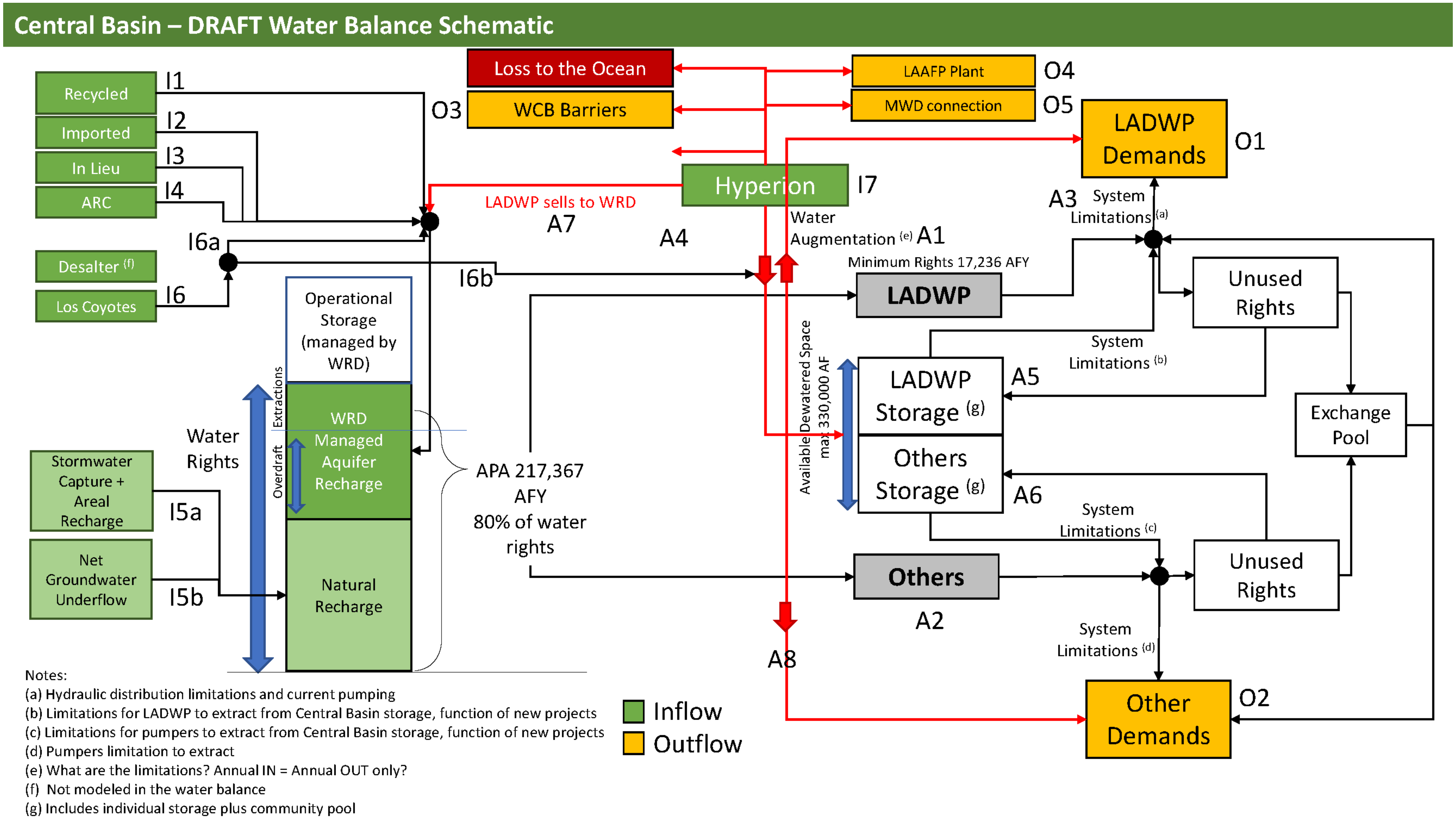


Figure 7. Draft Water Balance Model System

2.1.3 Basin Management Assumptions

Central Basin management assumptions are based on the Judgment requirements. Other assumptions include limitations on extractions, use of Hyperion WRP water, and use of basin storage.

Many different volumes are defined in the Judgment. The different volumes available for Central Basin groundwater storage, and a summary of the storage pools included in the Water Balance Model include:

- Normal Carryover (also known as One-Year Carryover) – APA that is not extracted may be carried over to the next year for extraction with the following conditions: up to the maximum cap of the greater of 1) 60% of the APA plus (minus) leases with flex, or 20 acre-feet (AF), whichever is greater, less the amount in storage, or 2) 20% of the party's APA plus (minus) leases with flex. Normal Carryover is lost if not used after 1 year unless converted to storage (Conversion of Carryover to Stored Water, paragraph on page 30 of the Judgment). The allowable carryover volume is determined by Equation 1.
- Drought Carryover (not modeled) – In exceptional cases (drought conditions) determined by the WRD Board of Directors and described in the Judgment, parties are allowed to store drought carryover water, which never expires until used. Drought Carryover cannot be converted to storage.
- Individual Storage – Each party can store water in the basin for an indefinite amount of time up to a maximum of 50% of the party's APA. Normal Carryover rights can be converted to Individual Storage. The model assumes that all Carryover rights are converted to Individual Storage (limited to Equation 1), which was not the historical condition but is the more conservative assumption.
- Community Storage – Storage to be allocated on a first-in-time, first-in-right basis. A party that has first filled its Individual Storage Account can then request to store water in the Community Storage Pool. A party can store up to 150% of its APA in the Community Storage Pool if space is available. If the party's water in the Community Storage Pool is occupied for 10 consecutive years, that water will be considered extracted first in the subsequent years. Any quantity of water stored in this pool for more than 10 years will be subjected to an annual loss equal to 5% of the lowest quantity of water held within the party's Community Pool to account for the immediately preceding 10-year period. The losses will be transferred to the Basin Operating Reserve.
- Exchange Pool (not modeled) – Pool that allows the transfer of unused APA from parties willing to sell to parties willing to purchase additional extraction from the basin.
- Basin Operating Reserve – Pool to be managed by WRD, giving the agency more flexibility in fulfilling its basin replenishment function. The Basin Operating Reserve is for use by WRD and may also be available for temporary use for a party's stored water per the terms of the Judgment.

The maximum storage a party can hold in the Central Basin, within all the pools, cannot exceed 200% of the party's APA, as follows:

$$\boldsymbol{Carryover\ Storage} = \mathbf{max}(\mathbf{0.6} * \boldsymbol{unused\ APA}, \mathbf{20}\boldsymbol{AF}) - \mathbf{max}(\boldsymbol{Storage\ held\ in\ Individual\ Account\ Storage\ held\ in\ Community\ Pool}, \mathbf{0.2} * \boldsymbol{APA})$$

Equation 1. Carryover Storage Calculation

The goal for LADWP is to use all of its rights every year (based on scenarios, this will vary from 17,236 to 25,000 AFY in the Central Basin). Guidance on how the water rights and storage should be used are outlined in the Judgment. The annual water rights that are not used within an administrative year can be carried over to the next administrative year. After 1 year, the remaining annual water rights will have to be moved to Individual or Community Storage (if available); otherwise, rights will be lost. The total stored water cannot exceed 200% of a pumper's rights in the basin.

The individual LADWP storage in the basin would be used to attenuate year-to-year variation in the demands that would be caused mainly by hydrological patterns. Unused rights from a year can be carried over to the next year only unless converted to Storage. Beyond 1 year, the water would have to be converted into Individual Storage or Community Storage, or lost opportunity. Hyperion water could be stored in the LADWP Individual account and Community Storage Pool for a maximum of 200% of LADWP's annual rights. After LADWP's Individual Storage Account and Community Storage Pool are filled (that is, 200% of their APA), they could not store any more water.

The logic for LADWP's use of storage can be considered under two conditions:

1) **Wet Conditions –** Under this condition, the APA in the basin will be greater than the demands, and unused APA will be carried over as Normal Carryover into the following year or converted to Individual Storage or the Community Storage Pool. Modeling scenarios will evaluate the risk of placing water in the Community Storage Pool. Excess Hyperion water could be temporarily placed in the Basin Operating Reserve pool upon approval by WRD and the Watermaster.
2) **Dry Conditions –** Under this condition, the APA in the basin will be less than the demands, and additional water would be needed to supply demands. The order of preference for demands exceeding the APA is to use any stored water first (sometimes this could be even before using APA rights) and then enter a water augmentation program with Hyperion.

There are two more strategies related to the use of Hyperion WRP water and storage in addition to those described earlier: Hyperion WRP effluent water could also be used in a Water Augmentation program or used as a MAR source.

- **Water Augmentation –** Water augmentation is defined in section N of chapter IV, Provisions for the Storage of Water and the Extraction of Stored Water, of the Judgment. It states that the amount of additional groundwater extraction due to a water augmentation project shall be equal to the quantity of new water in the basin attributable to the water augmentation project. It is assumed that any water augmentation projects will not require storage, and the same volume of recharge water will need to be extracted during the same year.
- **Hyperion Water as Artificial Replenishment Source –** The option of using Hyperion WRP effluent as one of the WRD's sources of MAR for basin replenishment may be considered in the modeling scenarios. In this case, WRD would purchase Hyperion WRP replenishment water from LADWP as a source of replenishment supply.

2.2 Groundwater Model

The Water Balance Model processes the different scenario data into a time series of volumes associated with each of the different replenishment, injection, extraction, and water transfer components, subject to the respective adjudication and storage rules in the Central Basin. The Groundwater Model comprises both the West Coast and Central Basins and is then used to evaluate the physical limitations of each scenario's proposed replenishment, injection, and extraction locations and volumes. The physical or hydrogeologic limitations of a scenario are assessed by computing a Groundwater Model-simulated head for the respective scenario and comparing that against threshold water levels. Depending on the component that exceeds the threshold, the Groundwater Model provides an upper or lower bound that can then be subsequently adjusted in the Water Balance Model. The adjusted Water Balance Model output is then used to revise the Groundwater Model and check other physical limitations in an iterative manner. The

Groundwater Model used for this study is the Los Angeles Coastal Plain Groundwater Model (LACPGM), recently developed by the U.S. Geological Survey (USGS) (Paulinski 2021).

The LACPGM spatial extent covers the entire West Coast and Central Basins, the Santa Monica Basin, the Hollywood Basin, and a portion of the Orange County Basin. The model structure is based on a new sequence stratigraphy geologic model (Paulinski 2021) and consists of 13 layers representing the different geologic sequences. The grid resolution within each layer is a uniform 1/8 mile, and spatial extent of the individual model layers is dependent on the respective sequence. Temporally, the model simulates the period covering calendar years 1971-2015, with a temporal resolution of quarterly (91.25-day) stress periods. The model simulates areal recharge from both mountain-front recharge on the perimeter of the model from bordering tributary drainages and direct precipitation. Simulated recharge also includes focused recharge in the Montebello Forebay and injection at the three barrier projects: the WCB Barrier, the Dominguez Gap Barrier, and the Alamitos Barrier. The model uses a specified head boundary to represent underflow through the Los Angeles Narrows from the San Fernando Valley and head-dependent boundaries to represent flow across boundaries at Whittier Narrows, Orange County, and the Palos Verdes Hills. Model nodes in the offshore areas underlying San Pedro Bay and Santa Monica Bay are also represented using head-dependent boundaries. Simulated outflow includes groundwater pumping and drained runoff caused by rising water levels from the Whittier Narrows Dam conservation pool, the San Gabriel River, Rio Hondo, the Dominguez Channel, the northern part of Ballona Creek, Coyote Creek, and areas of runoff in the Santa Monica Mountain foothills.

Groundwater Model inputs for evaluating Joint Master Plan scenarios include locations and flow rates of injection and production for the existing and proposed new wells, and the recharge basins. The predictive model scenarios also require assumptions for the baseline hydrology, as reflected in the model boundary conditions and initial conditions.

2.2.1 Baseline Hydrology

The 30-year calendar year period 1986-2015 was selected as the baseline hydrology for scenario evaluations. This 30-year period includes a sequence of dry (1986-1992), wet (1992-2007), and dry (2007-2015) precipitation periods. The hydrology impacts areal recharge, mountain-front recharge, and underflows in the model; therefore, these model inputs will remain the same for the predictive model as the 30-year period simulated in the LACPGM.

2.2.2 Simulated Production

The Joint Master Plan model scenarios specify different groundwater production totals by LADWP, and other pumpers in the West Coast and Central Basins, including the following:

- Production at Non-LADWP Wells – The baseline scenario specifies annual production by non-LADWP pumpers as an average annual total volume over the entire 30-year period. This average volume is to be determined based on the average total production by non-LADWP pumpers for the 5-year period from 2015-2019. To simulate the specified total production by non-LADWP pumpers at the specified average annual total, non-LADWP production as simulated in the historical 30-year period will be scaled accordingly. For the predictive scenarios, the scaled (non-LADWP) production will be applied to wells active through the period 2015-2019.
- Transient LADWP Production Rates – LADWP production rates will be transient and based on results from the Water Balance Model. New LADWP extraction well locations will be based on the Groundwater Development and Augmentation Plan study (LADWP 2019). Additional extraction wells may be added, as needed, in areas with favorable hydrogeologic conditions. Any areas preferred by LADWP for extraction wells will be prioritized when adding new extraction wells.

2.2.3 Simulated Recharge and Injection

The USGS model incorporates recharge and injection volumes at the spreading grounds and barrier wells, respectively, for the 30-year period from 1986-2015. The predictive model will incorporate projected MAR volumes based on the results from the Water Balance Model. The 30-year historical spreading grounds' recharge and injection volumes in the USGS model will be scaled to be consistent with results from the Water Balance Model. New injection wells will be added to the model in areas with favorable hydrogeologic conditions (high aquifer transmissivities and sufficient depth to groundwater). Areas preferred by WRD will be prioritized when adding new injection wells. The volumes and spatial distribution of recharge and injection may need to be adjusted to avoid groundwater mounding at the injection wells and spreading grounds.

2.2.4 Initial Conditions

The initial conditions for the scenarios are reflective of basin storage conditions at the start of the 30-year simulation. The initial storage condition from the Water Balance Model will be used to identify the initial groundwater levels for the model simulation.

2.2.5 Integration with the Water Balance Model

As described previously, the Groundwater Model is used to assess the hydrogeological limitations of the proposed scenarios, specifically the injection, spreading grounds recharge, and extraction volumes provided by the Water Balance Model for each scenario. At existing and proposed new extraction locations, this hydrogeological limitation is a maximum drawdown condition to prevent water levels from reaching the top of well perforations. At the existing and proposed new injection locations and recharge areas, this limitation is a maximum drawup condition to prevent flooding (and other Material Physical Harm). Inputs for the Groundwater Model can be categorized into the time-varying volumes associated with:

- Groundwater pumping by LADWP
- Augmentation by LADWP
- Groundwater pumping by non-LADWP pumpers
- MAR replenishment by WRD
- Other replenishment, including stormwater capture by Los Angeles County Department of Public Works and natural replenishment

Because the West Coast Basin and Central Basin have separate adjudication and storage rules, the model requires these categories of data for each basin.

The primary Groundwater Model output to determine the limitation of proposed scenarios is the simulated head across the model domain. For each scenario, injection and recharge locations where the thresholds are exceeded will help determine whether additional new locations need to be identified before lowering the simulated volume. Likewise, extraction locations where the thresholds are exceeded will help determine whether new locations need to be identified before lowering the simulated volume.

In the case where new locations with suitable hydrogeologic conditions cannot be identified, a subsequent reduction in the volume could then be simulated to estimate an upper bound for the particular component. The estimated upper bound could then be incorporated into the Water Balance Model to provide a revised set of injection, spreading, and extraction volumes. Subsequently, the Groundwater Model would then be used to assess the physical limitations of the revised scenario volumes. This iterative procedure ultimately will yield a revised scenario that conforms to the storage and adjudication rules and does not exceed physical basin limitations.

2.3 Modeling Scenarios

The Water Balance Model scenarios were identified by WRD and LADWP. Attachment 1 provides the details of these scenarios. The variables that change across scenarios are related to water rights of extraction, extraction capacity and timing, recharge, and water augmentation. The scenarios presented in Attachment 1 are summarized as follows:

- **Scenario 1:** Baseline scenario with historical extractions and historical recharge, and additional RBWRP operation (20,000 AFY of extraction and replenishment).
- **Scenario 2:** Same assumptions as Scenario 1, with increase of LADWP water rights. Change (increase) in LADWP water demands in the Central Basin. Additional recharge available from ARC and Los Coyotes WRP.
- **Scenario 3:** Same as Scenario 2, with increase of LADWP water rights and corresponding increases of recharge from Hyperion WRP and LADWP extraction.
- **Scenario 3a:** Same as Scenario 3, with changes to the extraction pattern and limits for LADWP.
- **Scenario 4**: Same as Scenario 3, with expansion of Central Basin extractions by all pumpers to full APA rights and corresponding increase of recharge.
- **Scenario 5:** Same assumptions as Scenario 4, with an increase of West Coast Basin extraction by all pumpers to full water rights and corresponding increase in recharge.
- **Scenario 6:** Same assumptions as Scenario 5, with changes to the LADWP extraction pattern and capacity, as well as addition of a water augmentation program.
- **Scenario 7:** Same as Scenario 6, with changes to the LADWP extraction pattern and capacity.

3. Hyperion WRP Project Backbone Alternative Route Development Basis

The purpose of the Hyperion WRP Project Backbone Alternative Route Development is to develop three alternative routes to deliver advanced treated flows from the Hyperion WRP to replenishment facilities and the Metropolitan Regional Recycled Water Program Backbone pipeline. A preferred alternative will be selected in future phases of this Joint Master Plan study.

The criteria and general assumptions described in this section will be used as the basis for the initial pipe segment development prior to the route screening process. Criteria development and route screening will be documented in subsequent TMs.

3.1 Connections

The Hyperion Backbone was assumed to begin at the Hyperion WRP just south of the secondary clarifiers, about 1,200 feet north of the intersection of Vista Del Mar and Grand Avenue.

The Hyperion Backbone was assumed to end at the San Gabriel River at a connection point with the future Metropolitan Backbone, the location of which is still being determined by Metropolitan and is planned to parallel either the Los Angeles River or the San Gabriel River. The final location and type of connection will need to be coordinated with Metropolitan during the next phase of this project, as it will impact the length of pipe required and potential route adjustments.

Additionally, the routing of the Hyperion Backbone assumed that flow will be delivered to future turnouts or connections accommodating the following facilities:

- LAAFP Pipeline Connection – The location of the future LAAFP turnout is assumed to be the northwestern-most point along a given alternative route.
- Five potential well injection sites identified in the Draft Groundwater Development and Augmentation Plan Phase 1 Report for the Central Basin (LADWP 2019):
  1) Clovis
  2) Confluence
  3) Manhattan
  4) Slauson
  5) Soto
- Existing or new spreading ground sites, including:
  - Los Angeles Forebay:
    - New Los Angeles Forebay spreading grounds
  - Montebello Forebay:
    - Existing Rio Hondo spreading grounds
    - Existing San Gabriel spreading grounds

3.2 Pipe Diameter

The pipe diameter of the Hyperion Backbone was conceptually determined by LADWP based on its capacity to deliver anticipated flows from the Hyperion WRP to the various connections along the pipeline route, assuming a maximum velocity of 7 feet per second.

Preliminary assumptions based on discussions held with LADWP during the first phase of this project included a maximum diameter of 96 inches between the Hyperion WRP and the connection for the LAAFP. The sections of the Hyperion Backbone downstream of the LAAFP connection are currently assumed by LADWP to range from 48 to 60 inches in diameter and will be dependent on the flows delivered to each injection well and spreading ground site. The assumption of a 96-inch diameter for the entire Hyperion Backbone is conservative and allows flexibility once the final diameters are determined in the next phase of the study.

3.3 Pipe Material

In conformance with LADWP requirements, the Hyperion Backbone will be welded steel pipe in accordance with American Water Works Association (AWWA) standard *AWWA C200, Steel Water Pipe, 6 In. (150 mm) and Larger* and lined with cement mortar in accordance with *AWWA C205, Cement–Mortar Protective Lining and Coating for Steel Water Pipe 4 In. (100 mm) and Larger—Shop Applied* (AWWA 2017, AWWA 2018).

3.4 Routing Within Public Right-of-Way

In accordance with LADWP recommendations and best practices, the Hyperion Backbone will be located mostly within public right-of-way (ROW) and will avoid longitudinal routing within California Department of Transportation ROW. However, crossing California Department of Transportation ROW is necessary and will be allowed.

3.5 Pipeline Construction Methods

Trenchless construction methods are assumed to be used by as much as 80% of an alternative route's total length in accordance with LADWP criteria and initial budgetary assumptions. It is assumed that open-trench construction will be used where practicable and more cost-effective than trenchless construction.

Roadways with relatively wide ROWs will be identified and used as preferred corridors for the pipeline. This will provide larger working limits and adequate space for tunnel launching and reception shafts.

3.6 Work Area Requirements

3.6.1 Open-Trench Work Area

The work area required for open-trench pipe installation was assumed to be a minimum of 36 feet wide. To arrive at this width, it was assumed that 12-foot-wide, vertically shored trenches will be used and that all excavated material would need to be transported and stockpiled offsite.

3.6.2 Trenchless Construction Work Area

Preliminary assumptions for trenchless construction and work areas required for 96-inch-diameter pipeline trenchless construction include:

- Size of rectangular shafts: 32 feet long by 22 feet wide
- Size of circular shafts: 32 feet in diameter
- Area required for launching shafts: 27,000 square feet
- Area required for receiving shafts: 14,000 square feet
- Without restriction, site can be accessed by semi-trucks with trailers and dump trucks
- Existing overhead and subsurface utilities can be relocated to facilitate trenchless installation

After initial analysis of the potential pipeline corridors, it is assumed the following three trenchless construction methods could be used for the Hyperion Backbone. All methods are assumed to require double-pass installation with a casing and carrier pipe.

1) Closed face tunneling using an earth pressure balance machine with maximum straight distance between launch and reception shafts of 35,000 linear feet, assuming cutter-head access for maintenance from the surface, or under compressed air, is feasible. Curved installations of similar lengths are feasible with a minimum horizontal radius of 1,200 feet.

2) Closed face tunneling using a microtunnel boring machine with maximum straight distance between launch and reception shafts of 3,000 linear feet. Curved installations of similar lengths are feasible with a minimum horizontal radius of 1,200 feet.

3) Open face tunneling using a tunnel boring machine with a maximum straight distance between shafts of 2,000 linear feet. Curved installations of similar lengths are feasible with a minimum horizontal radius of 1,200 feet.

3.7 Avoidance of Existing Utilities

To the fullest extent possible, attempts will be made to avoid conflicts with existing utilities. However, due to the number of utilities expected to be encountered in the project study area, avoidance of all existing utilities may not be feasible.

For this phase of the study, utilities were reviewed in a geographic information system to identify routes that minimize potential large-diameter utility relocations. In cases where utilities within a segment have diameters equal to or greater than 24 inches, the horizontal clearance between the Hyperion Backbone (assumed to be 96 inches in diameter) and existing utilities was reviewed at a high-level using Google Earth to optimally provide a minimum separation of 10 feet.

The next phase of the study will include determining the candidate routes, determining locations of recommended open-cut and trenchless reaches, and locating tunneling shafts to minimize the amount of potential large-diameter utility relocations (for those utilities 24 inches and larger).

4. Los Coyotes WRP Project

The Los Coyotes WRP has been considered as supplemental source of recycled water supply for the LVL AWTF and the Montebello Forebay Spreading Grounds. In 2011, a preliminary design for expansion of the LVL AWTF from 3 MGD to 8 MGD was completed by CH2M HILL, now Jacobs (CH2M HILL 2011), followed by final design and commissioning of the 8-MGD facility in 2014 (CDM Smith 2014). Expansion of up to an additional 8 MGD is now being considered and would include the same advanced treatment processes that are currently used at the facility: microfiltration, reverse osmosis, and ultraviolet advanced oxidation.

A preliminary design of the pipeline and pump station to convey Los Coyotes WRP effluent to the LVL AWTF was prepared by CDM Smith (CDM Smith 2012a, CDM Smith 2012b). A review of the preliminary design was conducted as a part of TM 3.2 to identify modifications or updates needed to the previous design and provide an updated cost estimate. Based on discussion with WRD, the evaluation of the pipeline and pump station is based on an average flow rate of 8.7 MGD (required for 8.0-MGD production capacity) and peak flow rate of 10.5 MGD.

A flow model will also be built and used to evaluate the need for storage and potential storage scenarios. Flow modeling will simulate the historical effluent flows from 2015 through 2019 provided by the Sanitation Districts of Los Angeles County. The total existing equalization volume at the LVL AWTF is 180,000 gallons, which equates to approximately 30 minutes of storage assuming an 8.7-MGD flow rate. Refer to TM 3.2.4 for the details of this analysis.

5. References

American Water Works Association. 2017. *AWWA C200, Steel Water Pipe, 6 In. (150 mm) and Larger*. Accessed May 2020. https://www.awwa.org/Portals/0/files/publications/documents/standards/C200-17LookInside.pdf.

American Water Works Association. 2018. *AWWA C205, Cement–Mortar Protective Lining and Coating for Steel Water Pipe 4 In. (100 mm) and Larger—Shop Applied*. Accessed May 2020. https://www.awwa.org/Portals/0/files/publications/documents/standards/C205-18LookInside.pdf.

CDM Smith Inc. 2012a. *Final Design for the Leo J. Vander Lans Water Treatment Facility for the Water Replenishment District of Southern California: Pump Station Preliminary Design Report*. June 28.

CDM Smith Inc. 2012b. *Final Design for the Leo J. Vander Lans Water Treatment Facility for the Water Replenishment District of Southern California: Pipeline Preliminary Design Report*. August 10.

CH2M HILL. 2011. *Preliminary Design Report Expansion of Leo J. Vander Lans Water Treatment Facility*. July.

Los Angeles Department of Water and Power (LADWP). 2019. Draft Groundwater Development and Augmentation Plan, Phase 1 Report, Central Basin, Los Angeles. Review Draft. March 14.

Paulinski, S., ed. 2021. Development of a groundwater-simulation model in the Los Angeles Coastal Plain, Los Angeles County, California: U.S. Geological Survey Scientific Investigations Report 2021-5088, 489 p. https://doi.org/10.3133/sir20215088.

Superior Court of California. 2013. Central and West Basin Water Replenishment District v. Charles E. Adams. 2013. Third Amended Judgment. https://rights.wrd.org/docs/CB_Third_Amended_Judgement.pdf.

Water Replenishment District (WRD). 2019. Cost of Service Report. April 3, 2019.

Attachment 1
Modeling Scenarios

Modeling Scenarios

			Rights	Extraction				Replenishment					Storage	
			LADWP	Central Basin		West Coast Basin		Natural Recharge and Underflow	MAR	Hyperion	ARC	LC	Initial CB and WCB Storage	LADWP Maximum Storage Assumption
Scenario	Title	Notes (from original matrix)		LADWP	All Other Pumpers	All Pumpers	RBWRP							
Scenario 1	Baseline - Historical plus RBWRP	Baseline conditions	CB APA = 17,236 AFY WCB WR = 1,503 AFY Total = 18,739 AFY	Historical extraction, annual average 3,671 AFY	Historical extraction volume and monthly pattern from 1986-2015 (178,848 AFY average)	Historical extraction volume and monthly pattern from 1986-2015 (31,631 AFY average)	20,000 AFY, location and potential patterns to be provided by Jacobs (Jacobs to provide location of extraction wells - constant pumping assumed)	Historical recharge from 1986-2015 baseline hydrology	Historical recharge from 1986-2015 (MFB + Barriers + in-lieu); increase barrier recharge for RBWRP by 20,000 AFY (matching extraction rate)	Assume 50% (or 10,000 AFY) of the increased replenishment for RBWRP is from Hyperion, and the remaining 50% would be from another source	No ARC	No LC	Historical 1985 levels	CB APA =17,236 AFY maximum storage = 200% of APA (34,472 AFY) in CB
Scenario 2	Scenario 1 + Initial WR Leasing in CB (LADWP) OR LADWP on the way to maximum target rights in CB	LADWP begins acquiring additional rights (goal = 25,000 total) LADWP Leases 6,896 as needed	CB APA of 24,132= 17,236 (own)+6,896 (leased) WCB WR = 1,503 AFY Total = 25,635 AFY	LADWP 30-year demand monthly pattern (averaged to be 24,132 AFY); limit extraction to 140% of APA or to 40 cfs for 10 months	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1 + remaining Hyperion water to be sent to barriers and potentially to the LAAFP for flows in excess of LADWP's extractions in the CB	10,000 AFY	LC to provide up to 4,000 AFY to CB MAR	Same as Scenario1	CB APA = 24,132 AFY maximum storage = 200% of CB APA (48,264 AFY)
Scenario 3	Scenario 1 + WCB WR Transfer to CB (LADWP) + WR Leasing (LADWP) OR LADWP at maximum target rights	APA Transfer of 5,000 AFY to CB by LADWP LADWP now owns 25,000 rights total LADWP leases 7,500 rights	CB APA: 25,000 AFY (own) = 17,236 + 5,000 (transfer from WCB) + 2,764 (purchase) + 7,500 (lease) WCB WR = 0 (goes to zero because LADWP is buying and transferring rights from the WCB) Total = 32,500 AFY	LADWP 30-year demand monthly pattern (averaged to be 32,500 AFY); limit extraction to 140% of APA or to 90 cfs for 6 months	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	28,829 AFY (25.72 MGD) (due to LADWP increase in CB) (difference between 32,500 and 3,671 historical LADWP pumping). Any excess flow from Hyperion AWT will be sent to the LAAFP	Same as Scenario 2	Same as Scenario 2	Same as Scenario 1	CB APA = 25,000 AFY maximum storage = 200% of CB APA (50,000 AFY)
Scenario 3a	Scenario 3 variation with change in LADWP's extraction schedule	Same as Scenario 3	Same as Scenario 3	No extraction in December and January; 4 months at 40 cfs, and 6 months at 90 cfs	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 1	Same as Scenario 3
Scenario 4	Scenario 3 + maximum APA extraction in CB (other pumpers) OR LADWP at maximum target rights plus full CB rights utilization	Maximize APA in CB, WCB average pumping with RBWRP	Same as Scenario 3	Same as Scenario 3	Full APA extraction (189,867 AFY average)	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 3 + need additional recharge to satisfy increased CB extraction by other pumpers; LADWP's increase in extraction will be covered by Hyperion AWT, and other increases will be covered by WRD	Hyperion AWT will be used to cover LADWP's increase in extractions only; any excess flow from Hyperion AWT will be sent to the LAAFP	Same as Scenario 3	Same as Scenario 2	Same as Scenario 1	Same as Scenario 3
Scenario 5	Scenario 4 + maximum WR extraction in WCB (other pumpers) OR LADWP at maximum target rights plus full CB and WCB rights utilization	Replenishment calculation = [(WCB APA - 5000) + (CB APA + 5000)] - 20000	Same as Scenario 3	Same as Scenario 3	Same as Scenario 4	WCB full WRs 39,468 AFY= 64,468 AFY - 5,000 AFY (WCB-CB transfer) - 20,000 AFY (RBWRP)	Same as Scenario 1	Same as Scenario 1	Same as Scenario 4 + need additional recharge to satisfy increased WCB extraction by other pumpers	Hyperion AWT will be used to cover LADWP's increase in extractions only. Any excess flow from Hyperion AWT will be sent to the LAAFP	Same as Scenario 4	Same as Scenario 2	Same as Scenario 1	Same as Scenario 3
Scenario 6	Scenario 5 + Ph 1 augmentation (LADWP) OR LADWP CB Augmentation Phase 1	LADWP begins augmentation program in CB	Same as Scenario 3	LADWP 30-year demand monthly pattern (averaged to be 32,500 AFY); limit extraction to 140% of APA or to 90 cfs for 9 months + 12,500 AFY in same year as augmentation replenishment	Same as Scenario 5	Same as Scenario 5	Same as Scenario 1	Same as Scenario 1	Same as Scenario 5	Same as Scenario 3 + 12,500 AFY (11.15 MGD) as an augmentation project	Same as Scenario 5	Use up to 4,000 AFY from LC first, then Hyperion; model assumes that LC augmentation will be for WCB	Same as Scenario 1	Same as Scenario 3
Scenario 7	Scenario 5 + Ph 2 augmentation (LADWP) OR LADWP CB Augmentation Phase 2	LADWP begins augmentation program in CB	Same as Scenario 3	LADWP 30-year demand monthly pattern (averaged to be 32,500 AFY); limit extraction to 140% of APA or to 90 cfs for 12 months + 30,000 AFY in same year as augmentation replenishment	Same as Scenario 5	Same as Scenario 5	Same as Scenario 1	Same as Scenario 1	Same as Scenario 5	Same as Scenario 6 + 17,500 AFY (15.6 MGD) as augmentation project	Same as Scenario 6	Same as Scenario 6	Same as Scenario 1	Same as Scenario 3

Notes:

% = percent

AFY = acre-foot (feet) per year

APA = Allowed Pumping Allocation

AR = Adjudicated Right

ARC = Albert Robles Center for Water Recycling and Environmental Learning

AWT = Advanced Water Treatment

CB = Central Basin

cfs = cubic foot (feet) per second

GW = groundwater

LAAFP = Los Angeles Aqueduct Filtration Plant

LADWP = Los Angeles Department of Water and Power

LC = Los Coyotes

MAR = Managed Aquifer Recharge

MFB = Montebello Forebay

MGD = million gallons per day

Ph = phase

RBWRP = Regional Brackish Water Reclamation Program

WB = water balance

WCB = West Coast Basin

WR = Water Right

WRD = Replenishment District of Southern California

Appendix D
TM 3.2.1-Phase 1 Groundwater Modeling

Memorandum

1000 Wilshire Boulevard, Suite 1140
Los Angeles, California 90017
United States
T +1.213.538.1388
F +1.230.538.1399
www.jacobs.com

Subject	**Technical Memorandum 3.2.1 – Phase 1 Groundwater Modeling – Final**
Project Name	WRD and LADWP Joint Los Angeles Basin Replenishment and Extraction Master Plan
Date	May 20, 2019 (Revised)

1. Introduction

This Technical Memorandum (TM) documents results of groundwater modeling and preliminary water quality data compilation, in support of the Water Replenishment District (WRD) and Los Angeles Department of Water and Power (LADWP) Joint Los Angeles Basin Replenishment and Extraction Master Plan. TM 3.2.1 is one of the deliverables under Task 3.2, and companion to the Water Balance Model developed by Jacobs, documented in a separate TM 3.1 (Appendix C).

TM 3.1 documented the procedure and assumptions for development and evaluation of the Hyperion Water Reclamation Plant (WRP) project components. To support the Hyperion WRP project evaluation, a Water Balance Model for the Central Basin and a Groundwater Model were developed to simulate operational scenarios and identify hydrogeologic limitations. With input from WRD and LADWP, seven scenarios were developed to assess the feasibility of different project alternatives.

The Water Balance Model processes the individual scenario data into a time series of volumes associated with each of the different replenishment, injection, extraction, and water transfer components, subject to the respective adjudication and general storage rules in the Central Basin (Superior Court of California 2013). A summary of the scenarios and the respective components is included as Attachment 1. The Groundwater Model used for this study is the Los Angeles Coastal Plain Groundwater Model (LACPGM), recently developed by the U.S. Geological Survey (USGS) (Paulinski 2021). The LACPGM is a regional model that comprises the West Coast Basin and Central Basin. The LACPGM is used as a predictive tool to assess the physical limitations of each scenario's proposed replenishment, injection, and extraction locations and volumes. The LACPGM hydraulic properties are used to estimate parameters for future preliminary wellfield siting and design. Additional analytical calculations were performed to estimate maximum groundwater drawup at a resolution finer than the LACPGM grid-scale. Model results documented in this TM were presented during weekly update and monthly progress meetings with WRD and LADWP.

This TM also presents a summary of the groundwater quality data compiled as part of Task 3.2. The water quality datasets will be used to support a subsequent phase of the refined modeling and site-specific evaluations. Suggested next steps for incorporating water quality data to further evaluate the groundwater modeling results are discussed.

2. Groundwater Modeling

2.1 Los Angeles Coastal Plain Groundwater Model

The USGS groundwater model for the Los Angeles Coastal Plain, referred as the LACPGM is a MODFLOW unstructured grid model (Panday et al. 2013). Salient aspects of the model are summarized as follows:

- The LACPGM spatial extent covers the entire Central and West Coast Basins, the Santa Monica Basin, the Hollywood Basin, and a portion of the Orange County Basin.
- The model structure is based on a newly developed sequence stratigraphy geologic model (Paulinski 2021) and consists of thirteen layers representing the different geologic sequences. The geologic sequences are unlike lithostratigraphic model layers and can be discontinuous. As such, several sequences do not extend over the entire model domain.
- The grid resolution within each layer is a uniform 1/8 mile, and spatial extent of the individual model layers is dependent on the respective sequence.
- Temporally, the model simulates the period covering calendar years 1971 to 2015, with a temporal resolution of quarterly (91.25 days) stress periods.
- The model simulates areal recharge from mountain-front recharge on the perimeter of the model from bordering tributary drainages and direct precipitation.
- Simulated recharge also includes focused recharge in the Montebello Forebay, and injection at the three barrier projects: the West Coast Basin Barrier (WCB Barrier), the Dominguez Gap Barrier, and the Alamitos Barrier.
- The model uses specified head boundary to represent underflow through the Los Angeles Narrows, from the San Fernando Valley, and head-dependent boundaries to represent flow across boundaries at Whittier Narrows, Orange County, and the Palos Verdes Hills.
- Model nodes in the offshore areas underlying San Pedro Bay and Santa Monica Bay are also represented using head-dependent boundaries.
- Simulated outflow includes groundwater pumping, and drained runoff caused by rising water levels from the Whittier Narrow Dam spreading grounds, the San Gabriel River, Rio Hondo, Dominguez Channel, the northern part of Ballona Creek, Los Coyotes Creek, and areas of runoff in the Santa Monica Mountain foothills.

The groundwater modeling process entails modifying specific LACPGM model inputs for a selected baseline period with output from the Water Balance Model. Scenarios were evaluated using the most current 30-year calendar year period (1986-2015) as the baseline hydrology. The selected baseline hydrology period includes a sequence of dry years (1986-1992), wet years (1993-2007), and dry years (2008-2015). The selected 30-year period was considered representative enough to capture the different water level conditions in the Central and West Coast Basins. The input hydrology impacts areal recharge, mountain-front recharge, and underflows in the model; therefore, these model inputs remain the same for the predictive model as the 30-year period simulated in the LACPGM. Modifications to the LACPGM for the predictive scenario evaluations are discussed in Section 2.6.

2.2 Mapping of Water Balance Model Output to Groundwater Model Inputs

Table 1 provides a brief description of the evaluated scenarios, as they are referred to in the Water Balance Model (Attachment 1).

Table 1. Summary of Scenarios Evaluated by the Groundwater Model[a]

Scenario 1	Baseline: Historical plus Regional Brackish Water Reclamation Project
Scenario 2	Scenario 1 plus initial water rights leasing in Central Basin (by LADWP) OR LADWP on the way to maximum target rights in Central Basin
Scenario 3	Scenario 1 plus West Coast Basin water rights transfer to Central Basin (by LADWP) plus water rights leasing (by LADWP) OR LADWP at maximum target rights
Scenario 4	Scenario 3 plus maximum Annual Pumping Allocation extraction in Central Basin (other pumpers) OR LADWP at maximum target rights plus full Central Basin rights utilization
Scenario 5	Scenario 4 plus maximum water rights extraction in West Coast Basin (other pumpers) OR LADWP at maximum target rights plus full Central Basin and West Coast Basin rights utilization
Scenario 6	Scenario 5 plus Phase 1 augmentation (LADWP) OR LADWP Central Basin augmentation Phase1
Scenario 7	Scenario 5 plus Phase 2 augmentation (LADWP) OR LADWP Central Basin augmentation Phase 2

[a] Additional details on scenario assumptions, including total pumping in the Central and West Coast Basins and augmentation for each scenario, are included in Attachment 1.

For each of the scenarios, results from the Water Balance Model were translated to groundwater model inputs for different categories of existing and new wells (injection and extraction) and existing recharge areas in the Central and West Coast Basins. Table 2 lists the mapping of Water Balance Model outputs to corresponding Groundwater Model inputs.

Table 2. Water Balance Model Outputs to Corresponding Groundwater Model Inputs

Water Balance Model Output Name	Groundwater Model Input
Central Basin LADWP Pumping APA	Applied to existing and new LADWP extraction wells
Central Basin LADWP Pumping Water Augmentation	Applied to new LADWP injection wells
Central Basin Others Pumping	Applied to existing non-LADWP extraction wells in the Central Basin
Additional MAR by Hyperion (from Historical)	Applied to new LADWP injection wells
Other Additional MAR (from Historical)	Added to existing Montebello Forebay recharge facilities
Los Coyotes WRP for Augmentation	Applied to new WRD injection wells near LVL AWTF

Table 2. Water Balance Model Outputs to Corresponding Groundwater Model Inputs

Water Balance Model Output Name	Groundwater Model Input
Los Coyotes WRP for MAR	Applied to new WRD injection wells near LVL AWTF

Notes:

APA = Annual Pumping Allocation

LVL AWTF = Leo J. Vander Lans Advanced Water Treatment Facility

MAR = Managed Aquifer Recharge

The Water Balance Model provides a monthly output volume in acre-feet (AF) for each of the categories. To be consistent with the stress-periods and units of the Groundwater Model, the monthly volumes are aggregated to quarterly volumes and converted to cubic-feet per day (ft^3/day) rates for Groundwater Model input.

2.3 Simulation of New Injection and Extraction Wells, and Additional Recharge

Several existing extraction wells in the Central and West Coast Basins and barrier injection wells are screened across multiple model layers. Scenarios 1 through 7 include new injection and extraction wells that are also screened across multiple layers. Locations of the different categories of wells are shown on Figure 1.

The LACPGM uses a Connected Linear Network (CLN) package to represent the multi-layer wells. A new CLN well is added to model input by connecting groundwater nodes in multiple layers and specifying the well injection/extraction rate. A CLN well simulates specified injection/extraction across multiple layers by internally computing individual layer contribution based on local transmissivity of the layers and groundwater gradients across model layers. As such, a CLN well represents "aggregated" inflows and outflows at the model grid scale (1/8 mile). The head values computed for groundwater nodes in the CLN well are representative of the spatial and temporal scale of the model grid cells and *not* representative of head inside the well-bore. The LACPGM does not simulate hydraulics of flow inside a well-bore.

New wells are added by specifying the spatial location, elevation of the top of the screen and bottom of the screen, and groundwater nodes closest to the location in each layer between the screened elevations. The new wells are simulated as CLN wells, with the same parameters as those used in the LACPGM.

New wells added to the scenarios include the following:

1) New LADWP injection wells: Two injection CLN wells were added within Slauson and Soto Central Treatment Facilities (CTF) areas (Figure 1) identified in LADWP's Groundwater Development and Augmentation Plan (LADWP 2019). The CLN wells are simulated with screen elevation from -100 feet to -1,000 feet below mean sea level (ft msl) roughly corresponding to the model layers with high transmissivity at the respective locations. At the Slauson location, the modeled screen interval corresponds to approximately 300 feet below ground surface (ft bgs) to 1,200 ft bgs. At the Soto location, the modeled screen interval corresponds to approximately 350 ft bgs to 1,250 ft bgs. Figure 2a shows the locations of model layer cross-sections. Figure 2b shows the cross-section connecting the Soto and Slauson locations. At the Soto location, the injection CLN well is screened in model layer 8, and layers 10 through 13. The shallowest active layer at the Soto location is model layer 6, as the other layers are discontinuous in that region. At the Slauson location, the injection CLN well is screened from model layers 4 through 9.

2) New LADWP extraction wells: One extraction CLN well is simulated within the Confluence area Groundwater Development and Augmentation Plan location. The extraction well is simulated with screen elevation from -100 ft msl to -2,000 ft msl, or approximately 200 ft bgs to 2,100 ft bgs. The modeled screen intervals correspond to model layers 3 through 8 with high transmissivity.
3) New WRD injection wells, near the LVL AWTF: Three injection CLN wells were added at locations provided by WRD. The CLN wells are simulated with screen elevation from -200 ft msl to -1,400 ft msl, or approximately 230 ft bgs to 1,430 ft bgs. The modeled screen intervals correspond to model layers 5 through 9.
4) New Regional Brackish Water Reclamation Program (RBWRP) extraction wells: Ten extraction CLN wells were added at locations provided by Jacobs. The CLN wells are simulated with screen elevation from -150 ft msl to -980 ft msl, or approximately 250 ft bgs to 1,060 ft bgs. The modeled screen intervals correspond to model layers 5 through 10.

For all the scenarios, a total of 20,000 acre-feet per year (AFY) is extracted at the new RBWRP CLN wells, and an additional 20,000 AFY is injected at the WCB Barrier wells. The LACPGM simulates recharge at the Montebello Forebay spreading grounds by specifying the volumetric rates at the underlying groundwater nodes. For scenarios that include additional recharge at the Montebello Forebay, the additional volume is equally distributed across the groundwater nodes. For all the scenarios, LADWP extraction is simulated at existing LADWP well locations in the LACPGM and the new Confluence location.

2.4 Simulation of non-LADWP Extraction

The Water Balance Model output “CB Others Pumping” corresponds to pumpers other than LADWP and is referred to as non-LADWP extraction. For all scenarios, Water Balance Model output for non-LADWP extraction volume in the Central Basin is applied to existing extraction wells that are active during the 5-year period from 2011-2015. This assumption ensures that the non-LADWP extraction volume for the predictive period is not applied to wells that have been inactive since 2011 or earlier. The non-LADWP extraction volume is apportioned to the active wells based on their average historical pumping rates. For Scenarios 1 through 4, the historical total extraction in the West Coast Basin is left unchanged. In Scenarios 5 through 7, pumping in the West Coast Basin is set to maximum adjudicated water rights of 39,468 AFY. The extraction volume is apportioned to wells that were active during 2011-2015, based on their average historical pumping rates. For all scenarios, extraction by pumpers in the adjoining Hollywood, Orange County, and Santa Monica Basins is left unchanged.

2.5 Evaluation of Exceedance of Thresholds

For each scenario, groundwater head simulation results are evaluated for exceedance of water level thresholds at the new injection wells, new and existing LADWP extraction wells and select WCB Barrier injection wells. For injection wells, the simulated head is compared with elevation of the shallowest groundwater node at the location to evaluate potential flooding. The threshold for injection locations is exceeded if the simulated water level is less than 50 feet below the threshold water level. For extraction wells, the simulated head is compared with the bottom elevation of the shallowest layer in which the well is screened. The placement of well screens to target specific intervals and optimization of well performance is not attempted in Phase 1. More stringent criteria, including potential for air entrainment and subsidence, are envisioned for a subsequent phase. The threshold for extraction locations is considered exceeded if the simulated water level falls below the threshold bottom elevation.

2.6 Revisions to Scenario Inputs

There were four significant revisions made to the scenario inputs based on a preliminary round of evaluations. The revisions are summarized as follows:

- Threshold water levels were exceeded for Scenario 2, at the Soto injection well location. For subsequent revisions of scenario inputs, the Soto location was removed, and injection was not simulated at this location. The exceedance plot for the Soto location from an earlier Scenario 2 is presented on Figure 3a.
- Injection of the additional 20,000 AFY was simulated at all the WCB Barrier wells. This led to threshold exceedance at a few wells in the northern portion of WCB Barrier (with limited drawdown impacts from the RBWRP extraction wells). For subsequent scenario runs, the additional injection was limited to wells in southern portion of the WCB Barrier and closest to the RBWRP extraction wells.
- Following additional input from LADWP, extraction volumes at the Confluence, 99th Street, and Manhattan locations were apportioned as 56%, 11%, and 33% of the specified extraction, respectively. The ratios correspond to target extraction rates of 50 cubic feet per second (cfs), 30 cfs, and 10 cfs at the three locations, respectively.
- The Water Balance Model output time series corresponding to injection at the LADWP injection wells varies significantly, with high volumes in some quarters and zero in other quarters within the same year. This leads to high groundwater levels during the quarters with non-zero injection. To lower the maximum groundwater levels, total injection time series was averaged within each year, and a uniform value is applied during the four, quarterly stress-periods within the year. The resulting "smoothed" injection time series input data are shown for Scenarios 2 through 7 on Figures 3b through 3g, respectively.

The following sections present the results of the threshold evaluation at the different categories of wells for the revised scenario inputs.

2.7 Scenario Results

This section summarizes groundwater modeling results for each of the scenarios (Table 1).

Scenario 1: Historical plus Regional Brackish Water Reclamation Program
Scenario 1 is the Baseline simulation and does not include injection at LADWP wells and WRD wells. Exceedance of threshold water levels was evaluated at the LADWP extraction wells, RBWRP extraction wells and selected WCB Barrier wells. Simulated hydrographs and threshold water levels for the wells and recharge areas are shown on Figures 4a through 4f. At extraction well locations (Figures 4a, 4c), the respective threshold water level at the location is shown as continuous red line at the bottom of the plots.

Scenario 2: Scenario1 plus Initial Water Rights Leasing in Central Basin (LADWP)
Starting with Scenario 2, all the well categories are active and have non-zero inputs from the Water Balance Model. Scenario 2 includes injection at the LADWP Slauson well location and at the WRD injection locations near the LVL AWTF. Exceedance of threshold water levels was evaluated at the LADWP injection and extraction wells, WRD injection wells, RBWRP extraction wells, and selected WCB Barrier wells. Thresholds are exceeded at the WRD injection wells, potentially because of historically high water levels at the selected injection locations and low extraction at nearby wells. Simulated hydrographs and the threshold water levels for the wells and recharge areas are shown on Figures 5a through 5f. At extraction well locations (Figures 5a, 5c), the respective threshold water level at the location is shown as continuous red line at the bottom of the plots.

Scenario 3: Scenario 1 plus West Coast Basin Water Rights Transfer to Central Basin (LADWP) + Water Rights Leasing (LADWP)
Scenario 3 represents maximum target rights for LADWP and simulates higher extraction and injection at the LADWP wells. Exceedance of threshold water levels was evaluated at the LADWP injection and extraction wells, WRD injection wells, RBWRP extraction wells, and selected WCB Barrier wells. Thresholds are exceeded at the WRD injection wells, potentially because of historically high water levels at the selected injection locations and low extraction at nearby wells. Simulated hydrographs and the threshold water levels for the wells and recharge areas are shown on Figures 6a through 6f. At extraction well locations (Figures 6a, 6c), the respective threshold water level at the location is shown as continuous red line at the bottom of the plots.

Scenario 4: Scenario 3 plus Maximum APA Extraction in Central Basin (Other Pumpers)
Scenario 4 represents maximum target rights for LADWP, and full utilization of Central Basin pumping rights by non-LADWP pumpers. Exceedance of threshold water levels was evaluated at the LADWP injection and extraction wells, WRD injection wells, RBWRP extraction wells, and selected WCB Barrier wells. Thresholds are exceeded at the WRD injection wells, potentially because of historically high water levels at the selected injection locations and low extraction at nearby wells. Simulated hydrographs and the threshold water levels for the wells and recharge areas are shown on Figures 7a through 7f. At extraction well locations (Figures 7a, 7c), the respective threshold water level at the location is shown as continuous red line at the bottom of the plots.

Scenario 5: Scenario 4 plus Maximum Water Rights Extraction in West Coast Basin (Other Pumpers)
Scenario 5 represents maximum target rights for LADWP, and full utilization of Central Basin and West Coast Basin pumping rights by non-LADWP pumpers. Exceedance of threshold water levels was evaluated at the LADWP injection and extraction wells, WRD injection wells, RBWRP extraction wells, and selected WCB Barrier wells. Thresholds are exceeded at the WRD injection wells, potentially because of historically high water levels at the selected injection locations and low extraction at nearby wells. Simulated hydrographs and the threshold water levels for the wells and recharge areas are shown on Figures 8a through 8f. At extraction well locations (Figures 8a, 8c), the respective threshold water level at the location is shown as continuous red line at the bottom of the plots.

Scenario 6: Scenario 5 plus Phase 1 Augmentation (LADWP)
Starting with Scenario 6, augmentation by LADWP is added to the Slauson injection well location. Exceedance of threshold water levels was evaluated at the LADWP injection and extraction wells, WRD injection wells, RBWRP extraction wells, and selected WCB Barrier wells. Thresholds are exceeded at the WRD injection wells, potentially because of historically high water levels at the selected injection locations and low extraction at nearby wells. Simulated hydrographs and the threshold water levels for the wells and recharge areas are shown on Figures 9a through 9f. At extraction well locations (Figures 9a, 9c), the respective threshold water level at the location is shown as continuous red line at the bottom of the plots.

Scenario 7: Scenario 5 plus Phase 2 Augmentation (LADWP)
Scenario 7 is similar to Scenario 6 and includes additional augmentation at the LADWP Slauson well location. Exceedance of threshold water levels was evaluated at the LADWP injection and extraction wells, WRD injection wells, RBWRP extraction wells, and selected WCB Barrier wells. Thresholds are exceeded at the WRD injection wells, potentially because of historically high water levels at the selected injection locations and low extraction at nearby wells. Simulated hydrographs and the threshold water levels for the wells and recharge areas are shown in Figures 10a through10f. At extraction well locations (Figures 10a, 10c), the respective threshold water level at the location is shown as continuous red line at the bottom of the plots.

2.8 Applied Pumping in the Vicinity of WRD Injection Wells at LVL AWTF

For Scenarios 2 through 7, the water level thresholds were exceeded at all the WRD injection well locations at LVL AWTF (Figure 1). This is primarily because of historically high water levels in the vicinity of the injection wells, as can be seen in Scenario 1 (Figure 4d). To further examine potential reasons for the exceedances, assigned pumping at wells near the WRD injection wells was compiled for each of the scenarios. Figure 11a shows selected wells in the vicinity of the proposed WRD injection wells. Note that only two of the five wells were active since 2011; therefore, the water balance output corresponding to "CB Others Pumping" is applied only to the two active wells. These wells are represented as CLN 616 and CLN 1595 in the LACPGM. Figures 11b and 11c show the applied additional extraction at CLN 616 and CLN 1595, respectively. The maximum additional extraction at the wells is approximately 132 AF and becomes significantly lower toward the end of the simulation. Additionally, the Water Balance Model output includes several months when the Baseline Scenario 1 "CB Others Pumping" is greater than Scenarios 2 through 7. As a consequence, Scenarios 2 through 7 do not show significant difference in water levels at the WRD injection wells compared to the Baseline Scenario 1.

2.9 Drawup/Drawdown Contours

Scenario modeling results are further processed to calculate drawup (+) and drawdowns (-) relative to the Baseline Scenario 1. These results will be used in subsequent phases of refined modeling to identify areas of influence of the LADWP injection and extraction wells, and to prioritize additional water quality data collection and evaluation. The drawdown/drawup calculations are performed for each scenario and include all 12 active layers and 120 stress periods. For conciseness, results are presented here for representative stress periods when the extraction and injection volumes at the LADWP well locations are high. Additionally, the results presented here are limited to model layers 5 and 7 that correspond to the layers with maximum proportion of injection and extraction at the LADWP well locations. Figures 12a and 12b show the drawup (+) and drawdown (-) contours for Scenario 2, model layer 5, and stress periods 142 and 155, respectively. Figures 12c and12d show the drawup/drawdown contours for Scenario 2, model layer 7, and stress periods 142 and 155, respectively. Likewise, Figure sets 13 through 17 show the results for Scenarios 3 through 7. In general, the drawup (+)/drawdown (-) contours show the area of influence of the LADWP Slauson injection well and the other extraction wells. A higher drawdown (-) is generally computed for the 99th Street Wellfield in model layer 5, potentially because of lower transmissivity at the well locations. In comparison, the drawdown (-) at the Confluence location is higher in model layer 7, and less than the computed drawdown in layer 5.

2.10 Analytical Downscaling

The LACPGM head values computed for groundwater nodes in the CLN well are representative of the scale of the model grid cells (660 feet) and not representative of head in the vicinity of the well and inside the well-bore. Further downscaling is required to support a preliminary design of an injection wellfield, including the number and spacing of injection wells, based on the groundwater drawup. Additional downscaling calculations using the standard Theis' solution are performed here to estimate the head buildup in formation immediately adjacent to the injection zone. The analytical calculations do not account for additional head build up due to any well inefficiency and hydraulic losses inside the wellbore.

Hydraulic parameters for the analytical simulation are obtained from the LACPGM corresponding to the Slauson injection location. The analytical simulation assumes a 2-foot diameter borehole (that is, radius at 1 foot) and injection into multiple stratigraphic zones (as represented by the sequences in the LACPGM) with injection rates partitioned based on overall interval transmissivity of each interval to reflect the expected interval partitioning that would occur if the well were screened across all intervals.

At the Slauson injection location, the LACPGM simulated maximum injection rate is approximately 28,000 gallons per minute (GPM) in Scenario 7. Assuming a well injection capacity of approximately 2,170 GPM, an analytical simulation was performed assuming an array of 13 wells with 100-foot spacing (Figure 18). The simulated wellfield with the pattern shown on Figure 18 covers an area of approximately 0.6 acres. The simulated well spacing of 100 feet is considered sufficiently conservative.

Table 3 presents a summary of the simulation model input parameters.

Table 3. Summary of Simulation Model Input Parameters for Analytical Downscaling

Layer	Node	Horizontal Conductivity (feet per day)	Thickness (feet)	Transmissivity (square feet per day)	Specific Storage (1/foot)	Maximum Injection Rate (GPM)
4	104565	88.3	119.4	10,542	0.000001	-222.6
5	121194	395.8	196.7	77,831	0.000001	-1770.2
6	155109	4.0	284.3	1,137	0.000001	-26.9
7	187319	57.1	61.0	3,484	0.000002	-84.8
8	221086	11.9	197.4	2,342	0.000001	-57.4
9	250028	7.0	41.2	289	0.000001	-7.4

The analytical calculation assumes continuous injection at the maximum rate for a period of 30 years. The calculated maximum drawup across all the layers is approximately 92 feet. These maximum drawups are still below the upper water level threshold shown on Figures 4b, 5b, 6b, 7b, 8b, 9b, and 10b. Therefore, the expected head buildup within the bore hole is within acceptable range for the Slauson Wellfield. Additional consideration of the hydraulic impact of the buildup in relation to the pump intake will be part of the next phase of detailed and site-specific modeling for the wellfield. Note that this analysis does not account for any loss of well efficiencies, which would increase the drawup at the well. Therefore, regular well maintenance and rehabilitation would be essential to ensure the well performance is within the expected range.

3. Summary of Groundwater Scenario Evaluations

This section presents a summary of the results from the scenario runs and threshold.

- LADWP injection and extraction locations:
  - Preliminary modeling showed that thresholds were exceeded at the new Soto injection location.
  - Thresholds are not exceeded at the new Slauson injection location, even at the bore hole scale.
  - Thresholds are not exceeded at the new Confluence location, and existing Manhattan and 99th Street locations.
- WRD injection locations:
  - For all scenarios, thresholds are exceeded at injection locations near the LVL AWTF. Simulated high water levels are potentially because of low extraction volumes at nearby extraction wells.

- Montebello Forebay:
  - For all scenarios, potential flooding was observed at select recharge nodes during a few stress-periods representing high groundwater level conditions in the predictive simulation period.
- WCB Barrier:
  - Thresholds at the WCB Barrier injection wells are not exceeded after limiting the injection of an additional 20,000 AFY to the southern portion of the WCB Barrier.

Analytical downscaling calculations were applied to the Slauson injection well location to estimate the maximum drawup in the immediate vicinity of the injection well. A project configuration consisting of 13 equally spaced wells covering a footprint of approximately 0.6 acre was simulated. The calculated maximum drawup is approximately 92 feet and is within the acceptable range of values for injection wells.

These model results provide the basis to evaluate and prioritize existing Project Concepts, identify new or alternative future concepts, and undertake refined site-scale analysis to better define project specifications and preliminary design. Alternative locations or injection rates for wells with exceedance are envisioned for the next phase of modeling and will be undertaken with input from WRD and LADWP. Injection of additional volume at the WCB Barrier wells in the southern portion was assumed to be feasible and was not evaluated for any additional operational constraints or the barrier capacity. This assumption may need to be revised based on the WCB Barrier constraints. The simulated WRD injection wells near the LVL AWTF were based on preliminary estimates for the number of wells and conceptual locations. Additionally, simulated extraction rates from the nearby extraction wells were based on average historical pumping rates and not actual capacities. For the next phase, a further refined hydrogeological assessment of WRD's injection near the LVL AWTF will be conducted based on any updated plans for the LVL AWTF and nearby pumpers. Future expansion at the LVL AWTF will include an injection well and two monitoring wells. Geologic, water level, and water quality data from these new wells will provide new information on prevailing hydrogeological conditions in and around the LVL AWTF. These data will be incorporated into future modeling and evaluation of hydrogeologic and hydraulic constraints for potential replenishment and augmentation facilities.

4. Summary of Groundwater Quality Data

Groundwater quality is an important consideration when siting and designing groundwater injection and extraction wells. Injection wells may mobilize existing groundwater contamination plumes, potentially affecting groundwater quality at surrounding production wells. Impaired groundwater quality would also influence the wellhead concentration at production wells. This phase of the evaluation was focused on compiling and summarizing the primary groundwater contamination datasets as described in this section. A summary is presented here, with further evaluation planned for the next phase of work with more detail and input from WRD and LADWP.

Figures 19a to 19e show concentration distributions for perchloroethylene (PCE), trichloroethylene (TCE), 1-4 dioxane, perfluorooctanesulfonic acid (PFOS), and perfluorooctanoic acid (PFOA) at different locations and depths within the Central and West Coast Basins from 2018 - 2019, measured at WRD nested monitoring wells (WRD 2019). Data from the WRD monitoring wells Huntington Park 1 and Los Angeles 1 indicate elevated levels (above 10 micrograms per liter [μg/L]) of TCE near the Slauson injection wellfield location (Figure 19e). While concentrations at Los Angeles 1 are higher in the shallow screen intervals, concentrations at Huntington Park 1 are highest in the middle screen intervals. Data from well Los Angeles 2 show elevated (above 5 μg/L) 1-4 dioxane concentrations near the Soto injection wellfield location (this location was screened out because of water level threshold exceedance from preliminary modeling). Monitoring well data near the Confluence extraction well location indicates elevated levels of 1-4 dioxane (above 1 µg/L), PFOS (above 6.5 µg/L), and PFOA (above 5.1 µg/L) at several depth intervals.

Data were also obtained for WRD priority contaminated sites. As part of WRD's contamination prevention program, regulated environmental sites deemed as high priority are tracked and ranked according to several criteria such as depth of contamination, contaminant concentration and flow and transport characteristic of species, preferential flow and transport pathways to deeper aquifers, and distance to the nearest drinking water well. Figure 20 shows the 46 WRD priority contamination sites within the Central and West Coast Basins. Based on this preliminary evaluation, several priority 1 and 2 sites are located near the proposed injection and extraction wellfield locations. Groundwater quality at these sites with associated interactions with proposed injection and extraction wells will be evaluated in the next phase of more detailed analysis.

Data collected from the State Water Quality Control Board's (SWRCB) Groundwater Ambient Monitoring and Assessment (GAMA) centralized public water quality database was also reviewed to evaluate water quality in the Central and West Coast Basins. The public database, also known as the Groundwater Information System, is a compilation of multiple regulatory datasets hosted through a web map accessible through the GAMA OnLine Tools.[1] The GAMA dataset includes wells from Regional Water Quality Control Board regulatory sites (GeoTracker), Department of Water Resources wells, Division of Drinking Water public supply wells, SWRCB regulated sites monitoring wells, and domestic drinking wells sampled by the SWRCB. The GAMA Groundwater Information System was queried for all available results within the West Coast Basin and Central Basin boundaries. The dataset was queried for the following chemicals/constituents: TCE, PCE, 1,2-DCE, perchlorate, Cr6, and 1,4 dioxane. The datasets were combined and filtered by depth (where the information was available) to further explore the water quality data and begin to determine important sources of contamination. Figures 21a through 21c are maps of the queried constituents from the GAMA water quality database for three depth intervals (shallower than 100 feet, between 100 feet and 500 feet, and deeper than 500 feet) in relation to the proposed injection and extraction wellfields and WRD's priority contamination sites. Figure 21a shows that most of the contamination is at shallow depths (less than 100 feet). However, Figures 21b and 21c show that there are still some areas with impaired groundwater at depth near the proposed injection and extraction wellfields. In particular, the GAMA data show contamination at depths greater than 500 feet near the Confluence location (however, these results are of relatively low concentration). Note that several of the wells with data in the GAMA database do not have depth information available. Figure 21d shows the locations of sites queried from GAMA (based on the previously described criteria) without any depth information. The next phase of evaluation may entail a more comprehensive data search and review to obtain depth-specific information on groundwater contamination at these GAMA sites near the proposed wellfields.

Groundwater quality can be spatially variable, as different aquifer and aquitard zones within the groundwater basin may contain different levels of contamination. Groundwater quality is also temporally variable, with plumes moving, dispersing, and diluting over time. Therefore, the detailed evaluation of groundwater quality impacts on the proposed projects will be evaluated in the subsequent detailed modeling phase.

[1] https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/.

5. References

Los Angeles Department of Water and Power (LADWP). 2019. *Draft Groundwater Development and Augmentation Plan, Phase 1 Report, Central Basin, Los Angeles*. Review Draft. March 14.

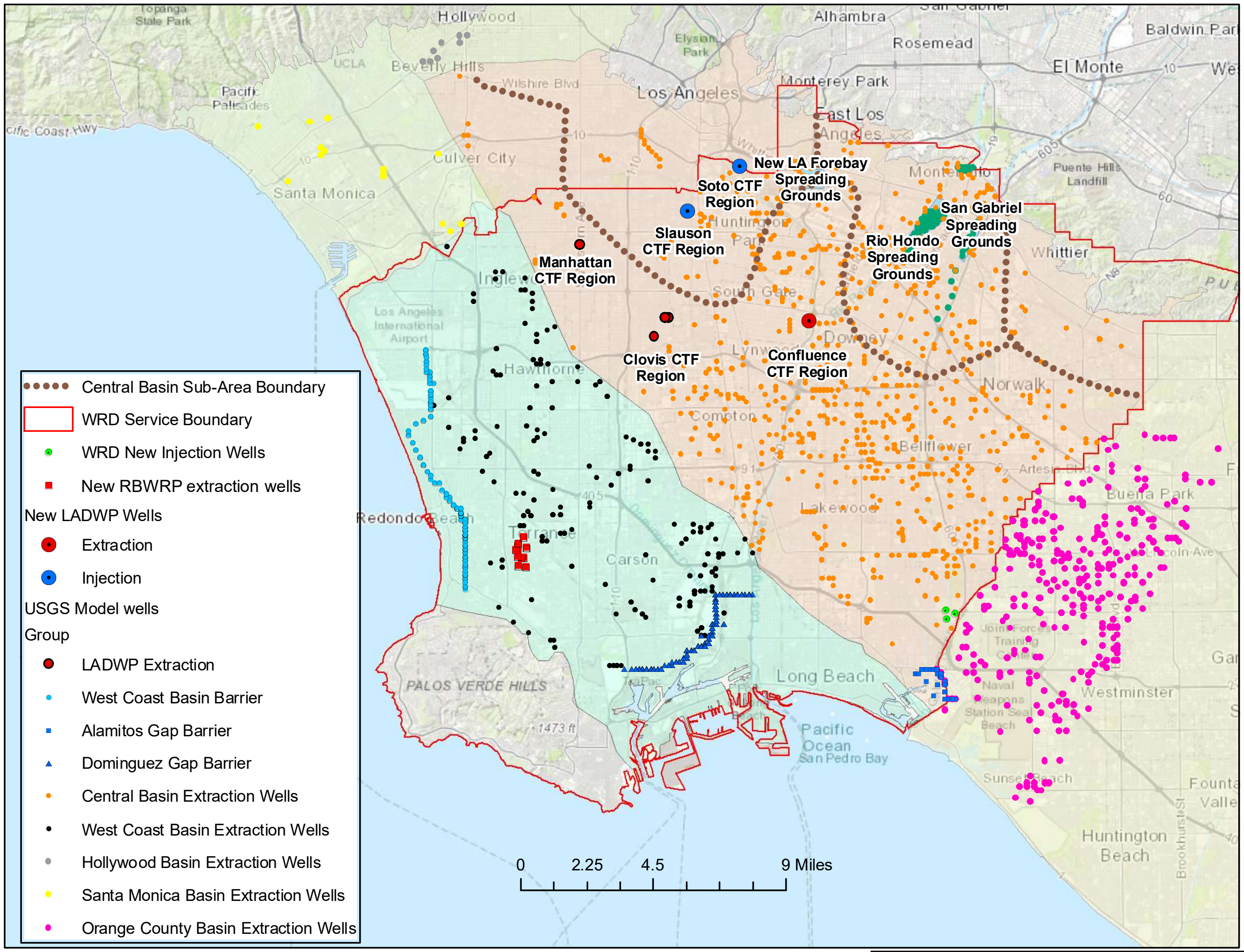
Panday, S., Langevin, C.D., Niswonger, R.G., Ibaraki, M., and Hughes, J.D., 2013. MODFLOW-USG version 1: An unstructured grid version of MODFLOW for simulating groundwater flow and tightly coupled processes using a control volume finite-difference formulation: U.S. Geological Survey Techniques and Methods, 6-A45, 66p.

Paulinski, S., ed. 2021. Development of a groundwater-simulation model in the Los Angeles Coastal Plain, Los Angeles County, California: U.S. Geological Survey Scientific Investigations Report 2021-5088, 489 p., https://doi.org/10.3133/sir20215088.

Superior Court of California. 2013. Central and West Basin Water Replenishment District v. Charles E. Adams. 2013. Third Amended Judgment.
https://rights.wrd.org/docs/CB_Third_Amended_Judgement.pdf.

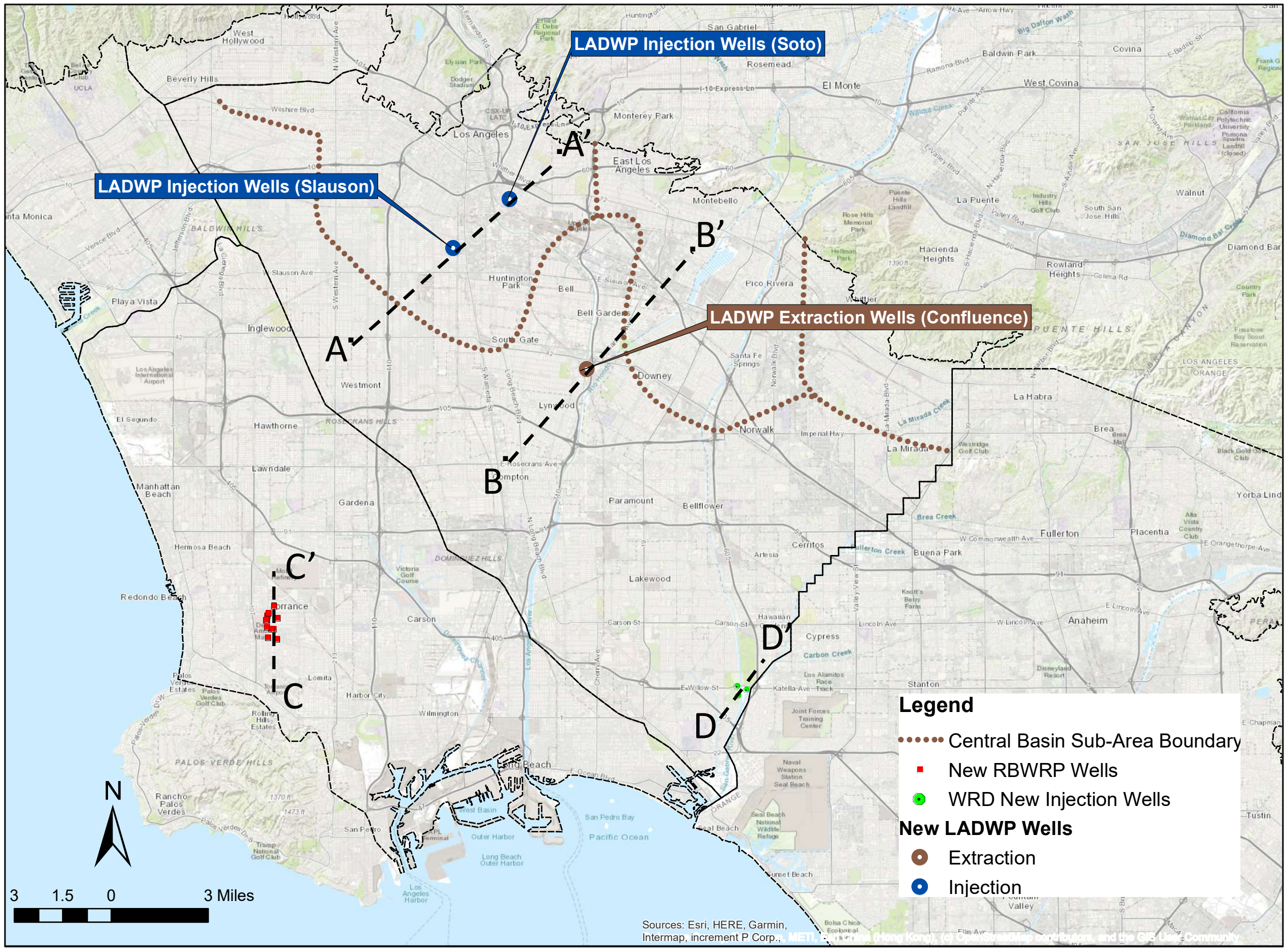
Water Replenishment District of Southern California (WRD). 2019. Regional Groundwater Monitoring Report Water Year 2017-2018. March.

Figures



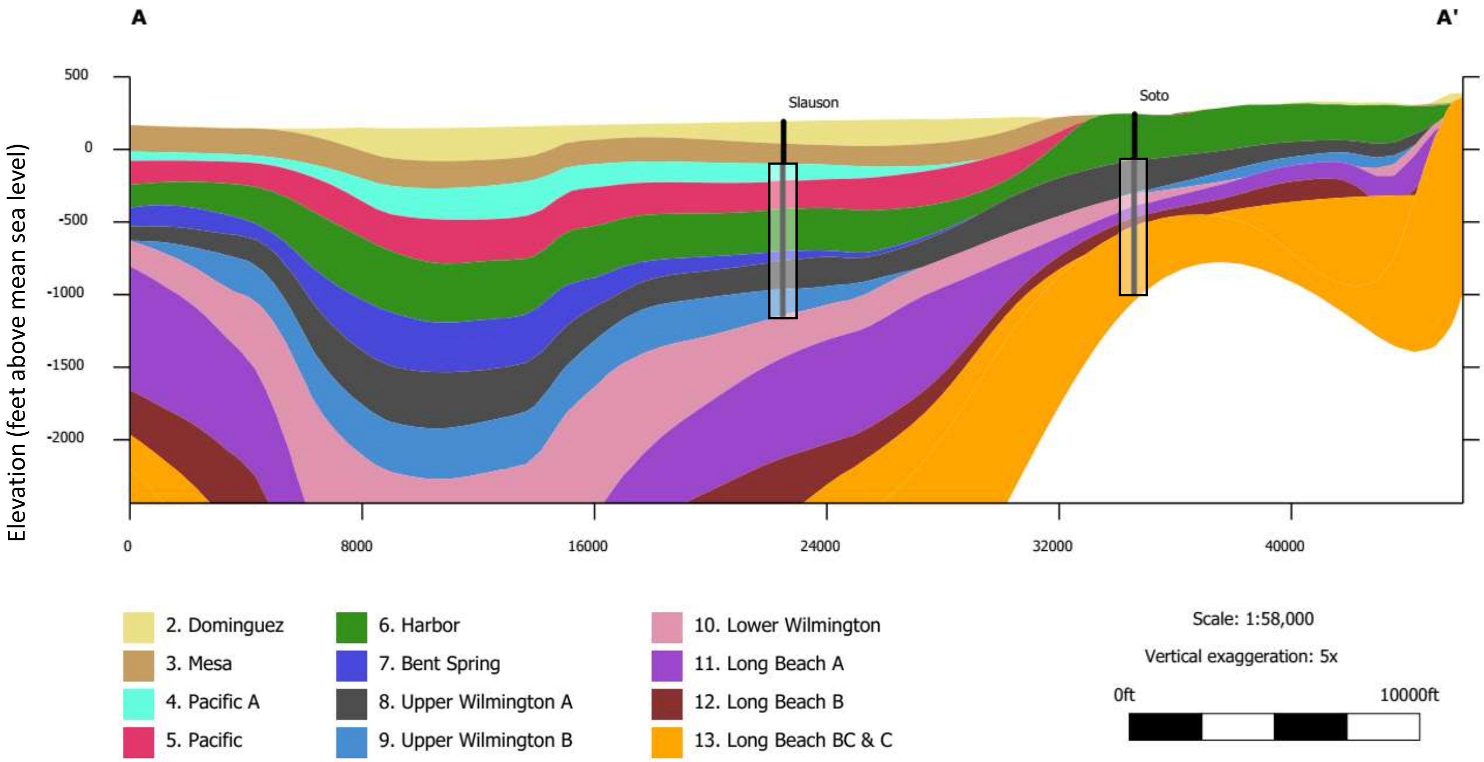
INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Figure 1.
Location of New Wells and Existing Wells in the LACPGM model



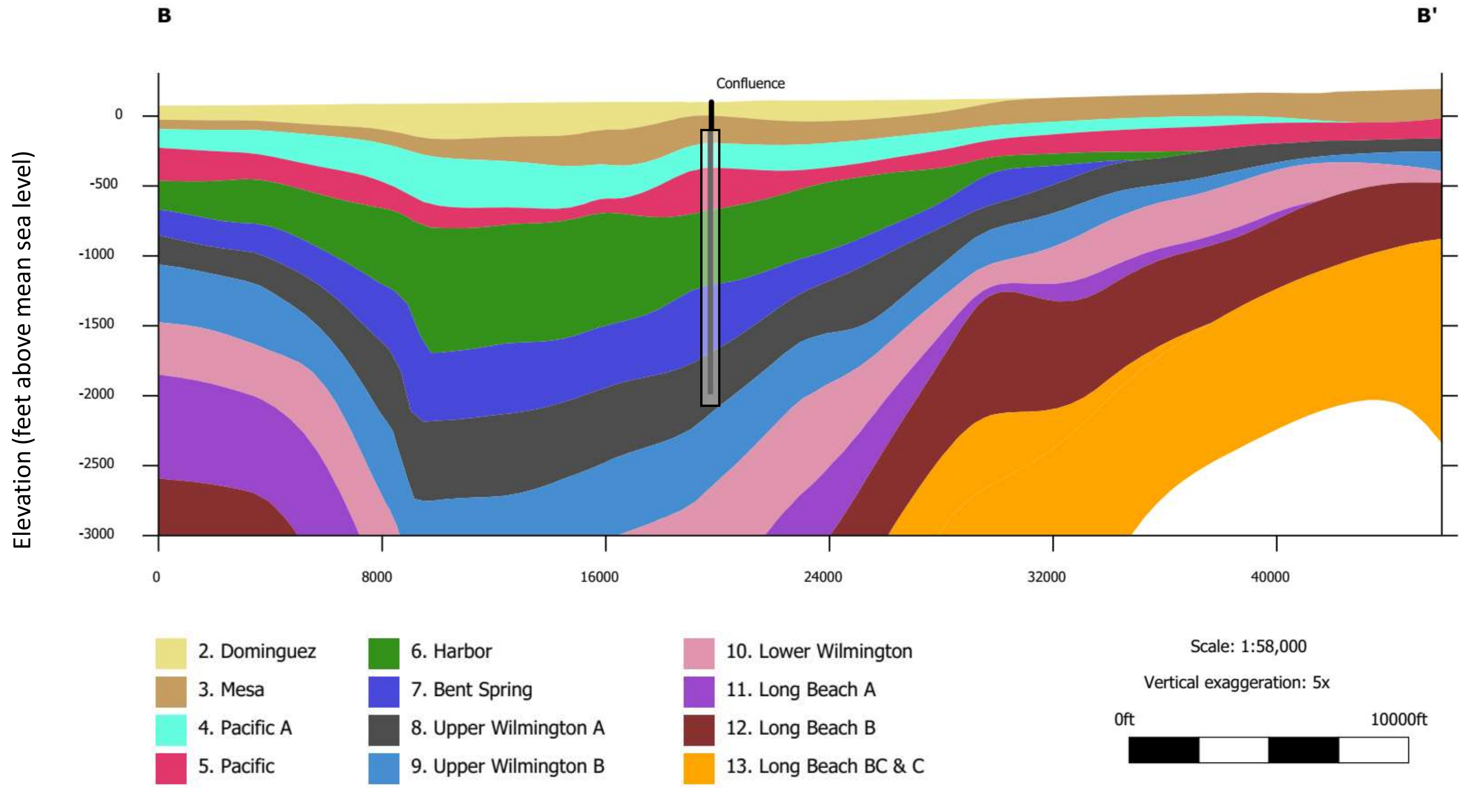
INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Figure 2a.
Model Cross-section Locations



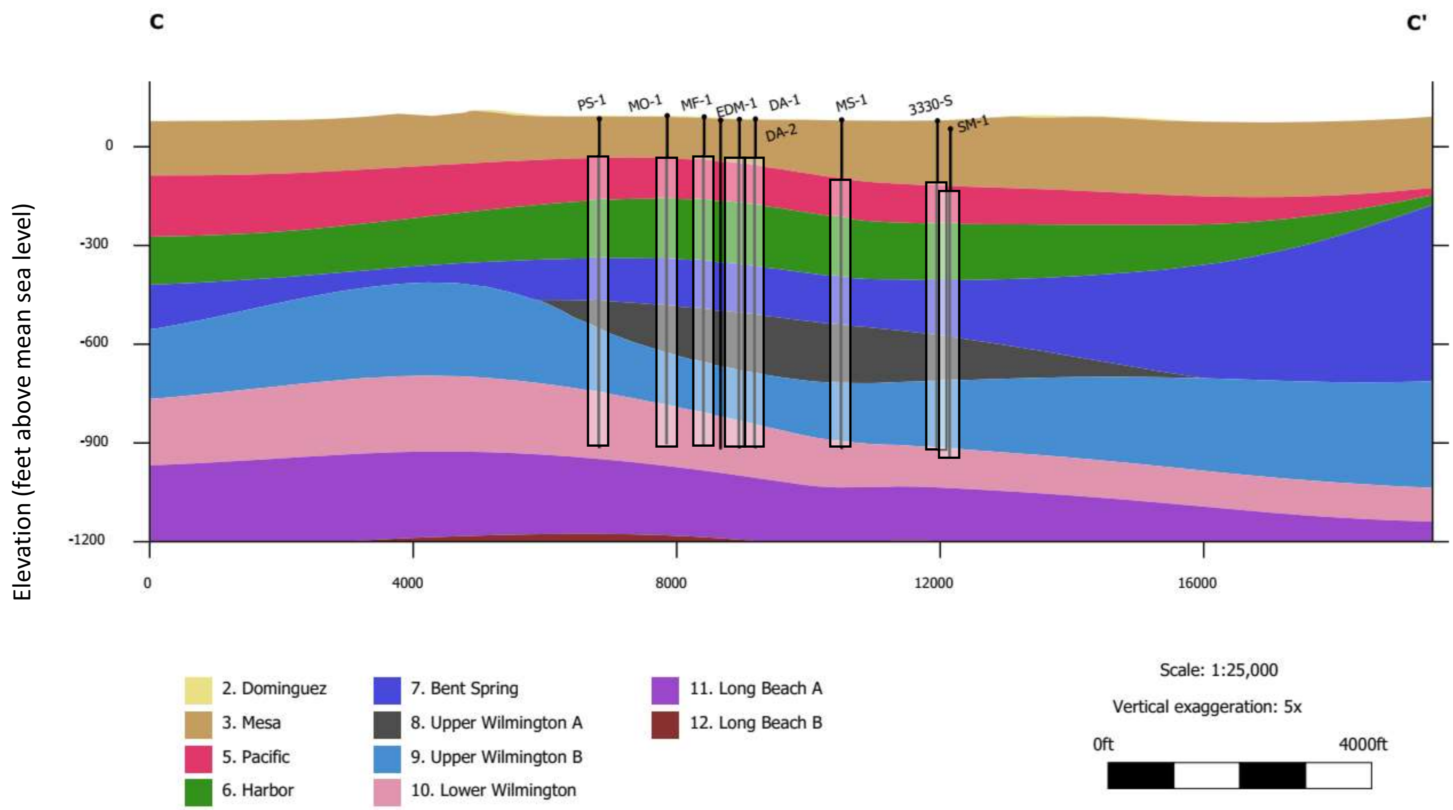
INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Figure 2b.
Model Cross-section A-A'
Soto and Slauson Injection Locations



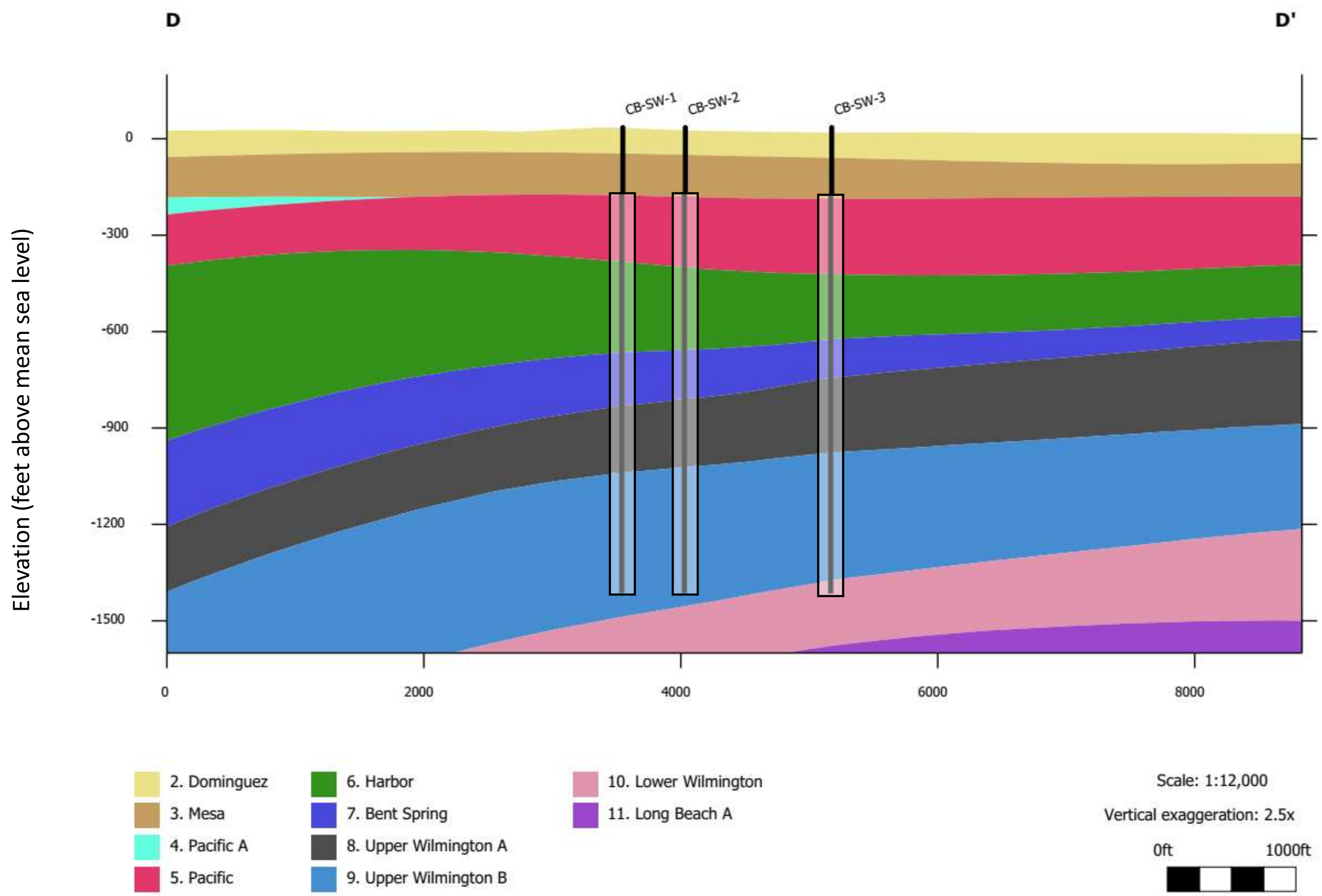
INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Figure 2c.
Model Cross-section B-B'
Confluence Extraction Location



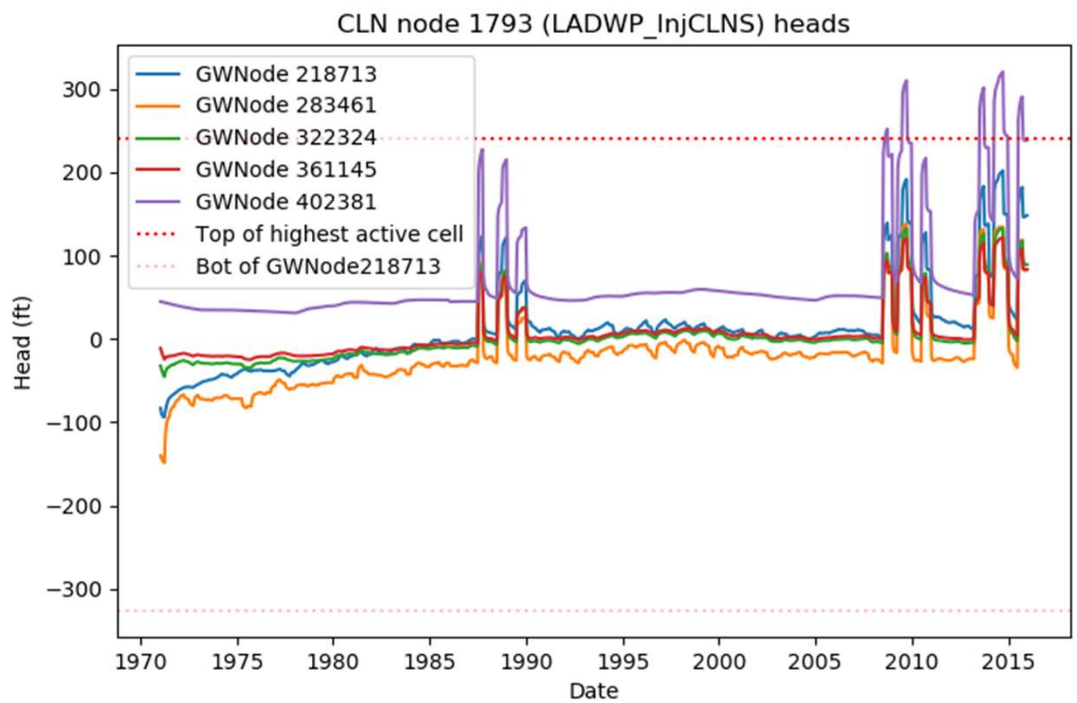
INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Figure 2d.
Model Cross-section C-C'
Proposed Regional Brackish Project Wells



INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

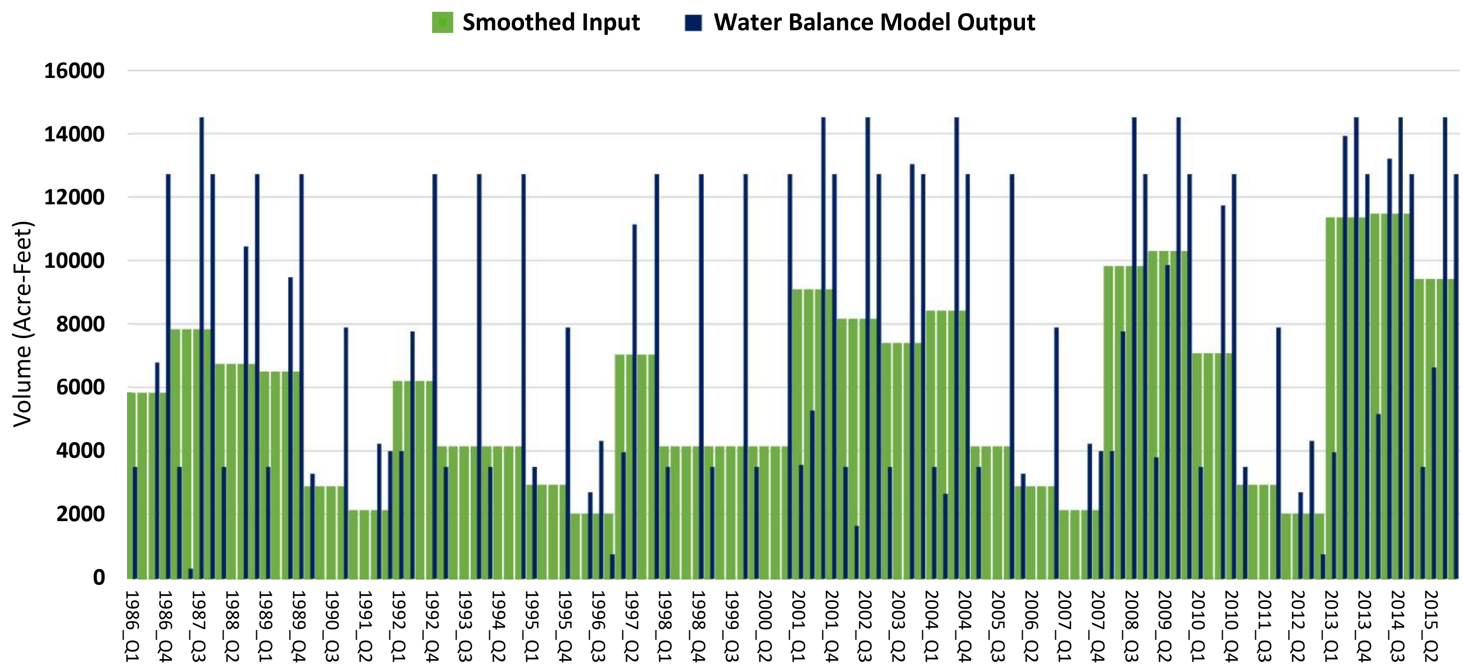
Figure 2e.
Model Cross-section D-D'
WRD Injection Locations Near LVL Facility



FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario1_final\postprocessing\clnheads\png

Figure 3a.
Exceedance of Threshold
LADWP Soto Injection Well

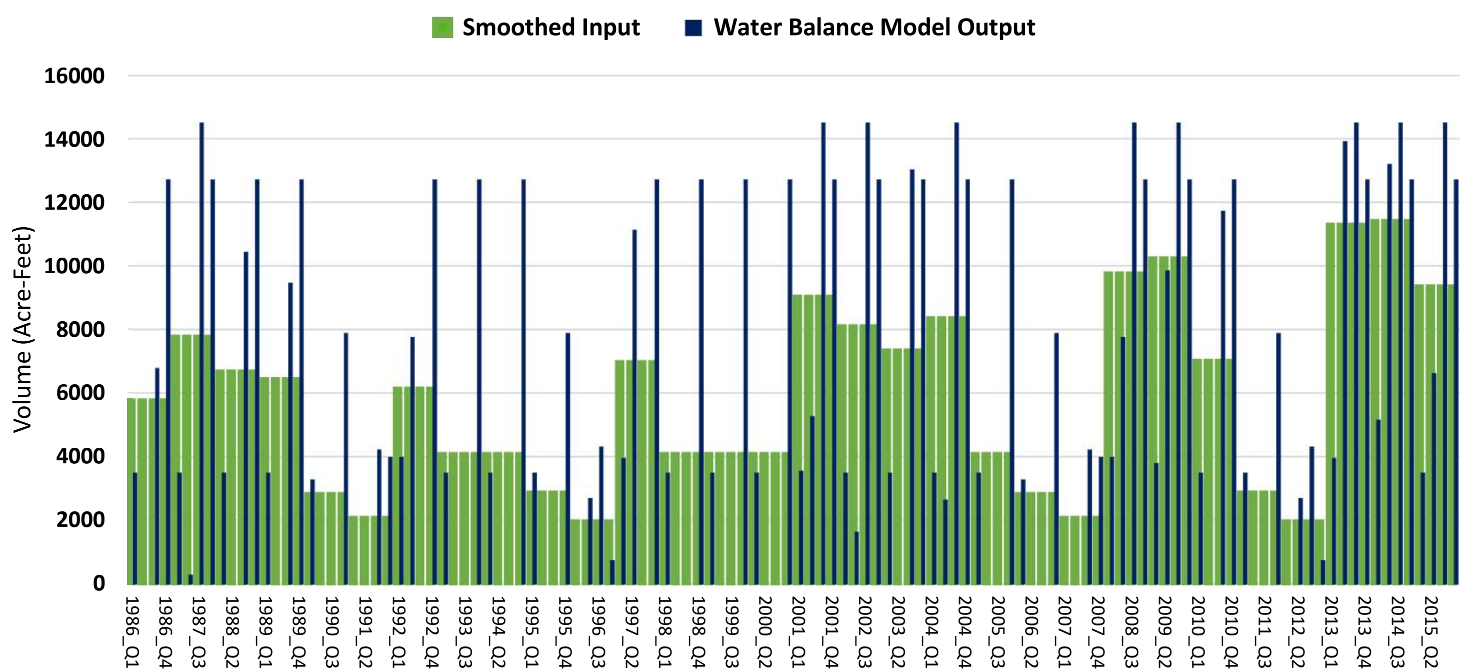
Scenario 2



INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Figure 3b.
Scenario 2 Smoothed Input
LADWP Slauson Injection Well

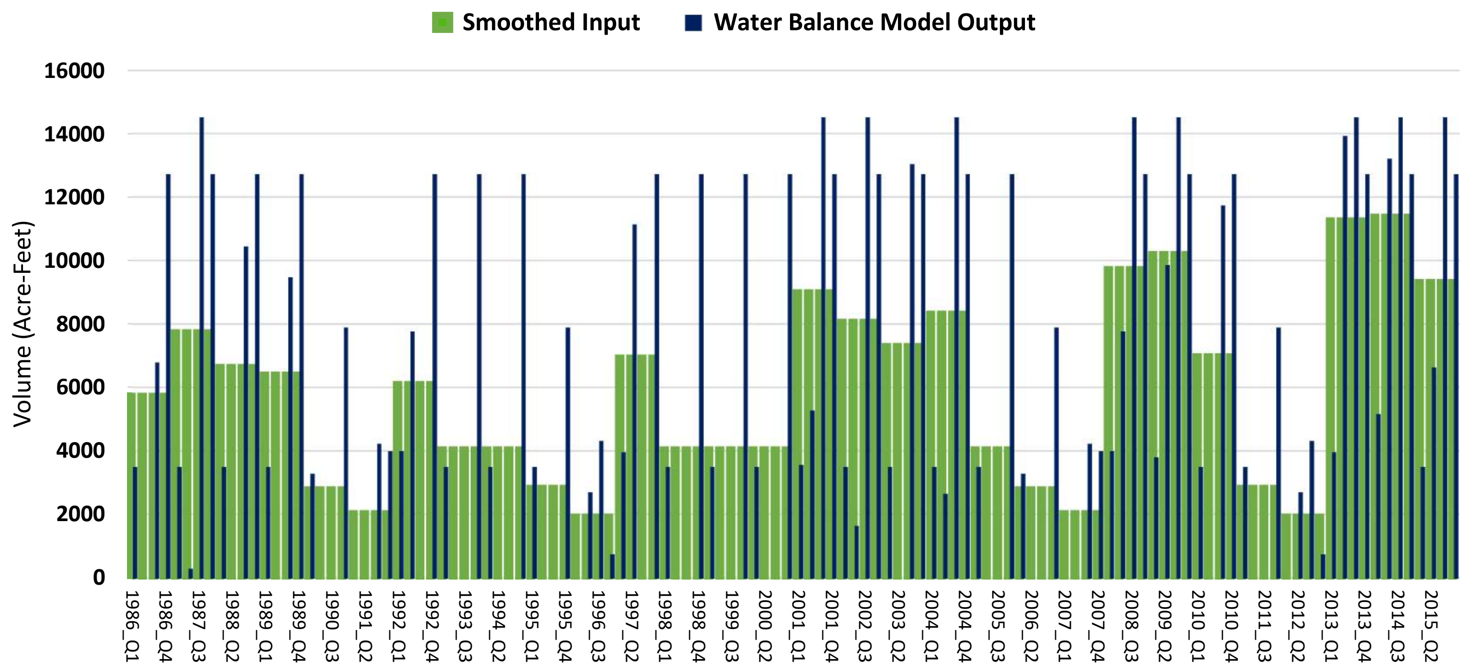
Scenario 3



INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Figure 3c.
Scenario 3 Smoothed Input
LADWP Slauson Injection Well

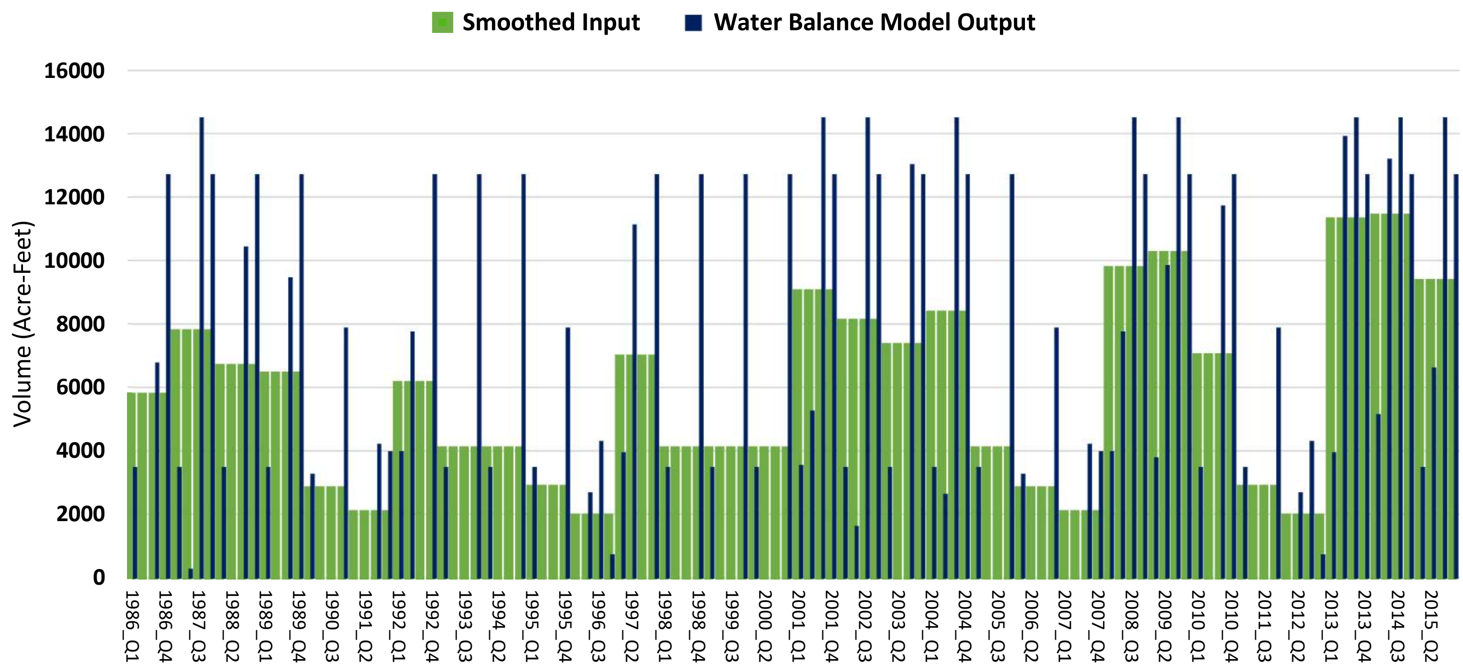
Scenario 4



INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Figure 3d.
Scenario 4 Smoothed Input
LADWP Slauson Injection Well

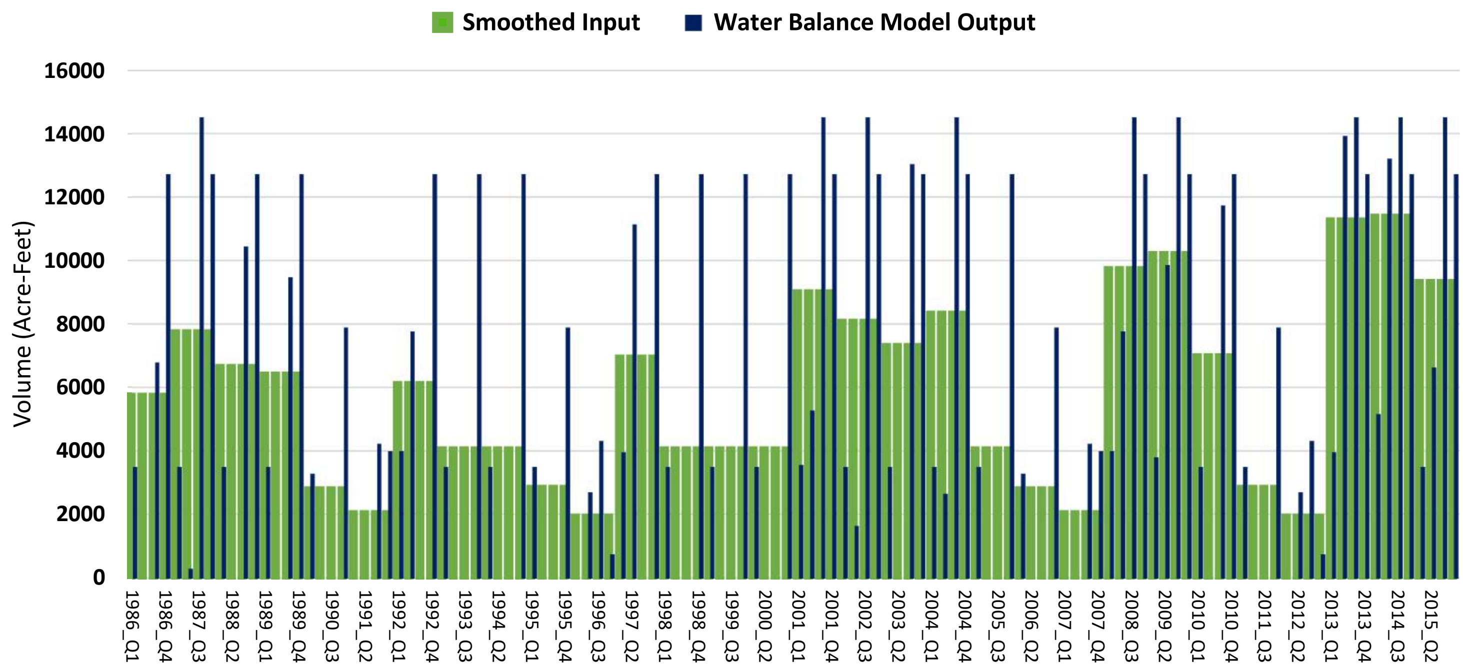
Scenario 5



INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Figure 3e.
Scenario 5 Smoothed Input
LADWP Slauson Injection Well

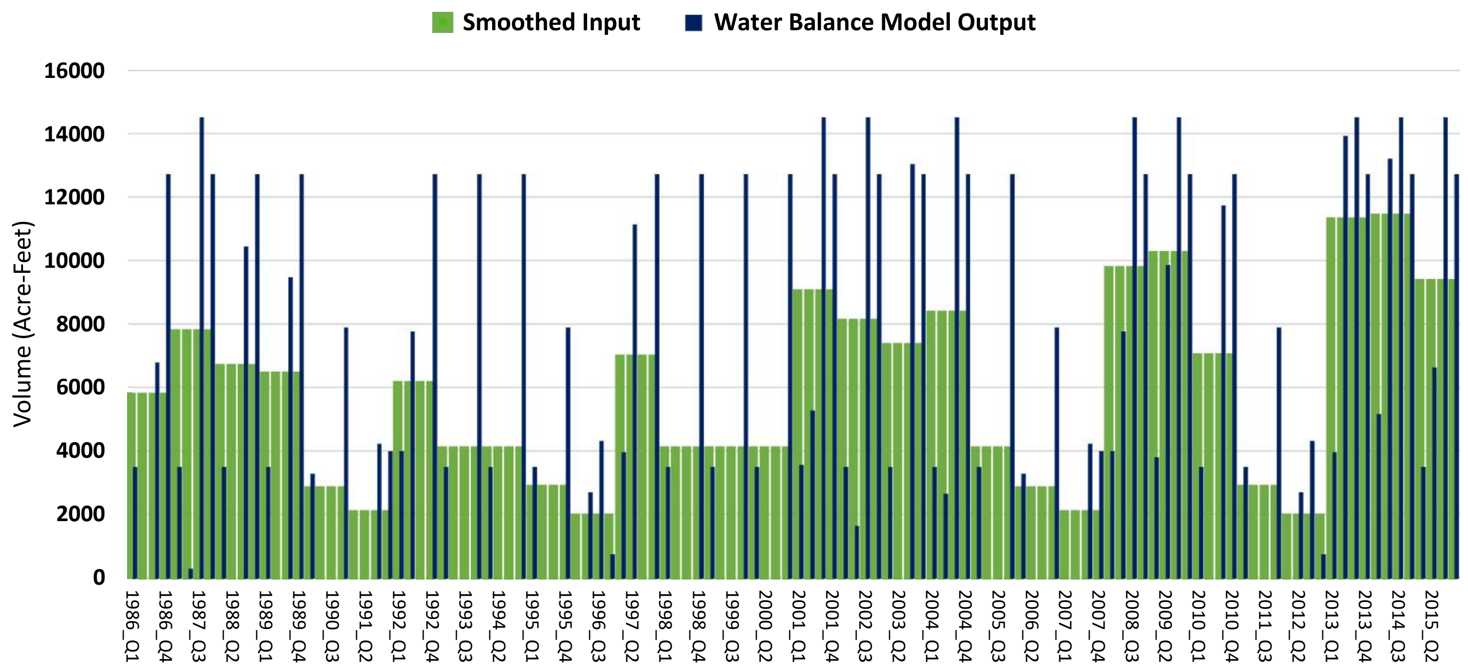
Scenario 6



INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Figure 3f.
Scenario 6 Smoothed Input
LADWP Slauson Injection Well

Scenario 7



INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Figure 3g.
Scenario 7 Smoothed Input
LADWP Slauson Injection Well

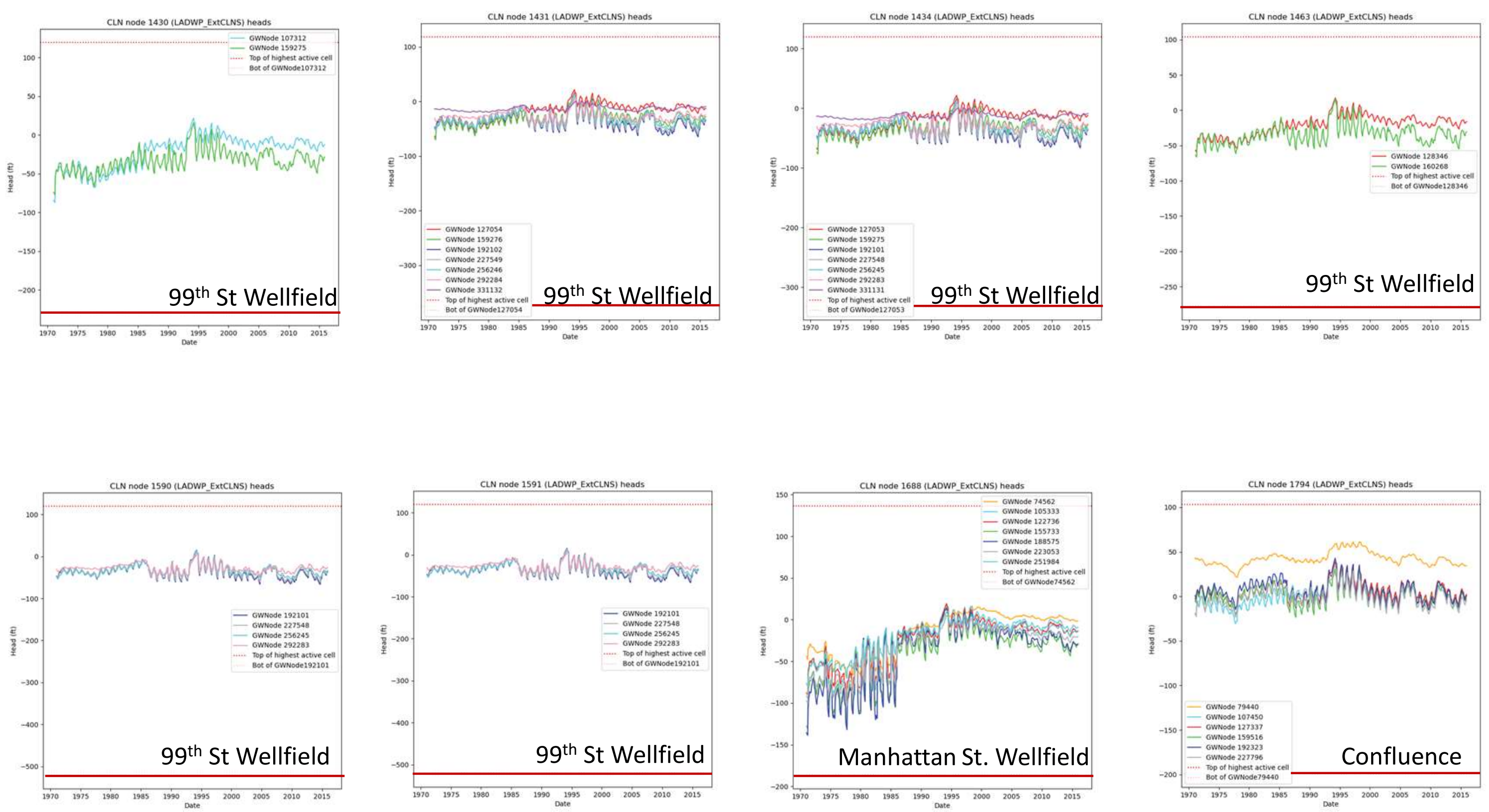
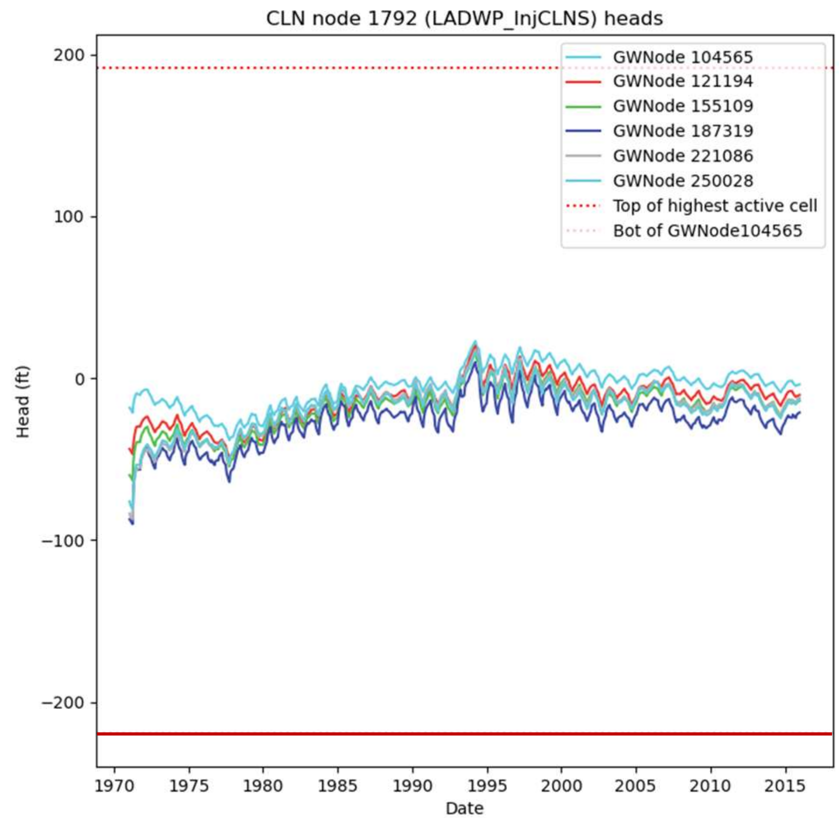


Figure 4a.
Scenario 1 Threshold Evaluation
LADWP Extraction Wells

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario1_final_final\postprocessing\clnheads\png



INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario1_final\postprocessing\clnheads\png

Figure 4b.
Scenario 1 Threshold Evaluation
LADWP Slauson Injection Well

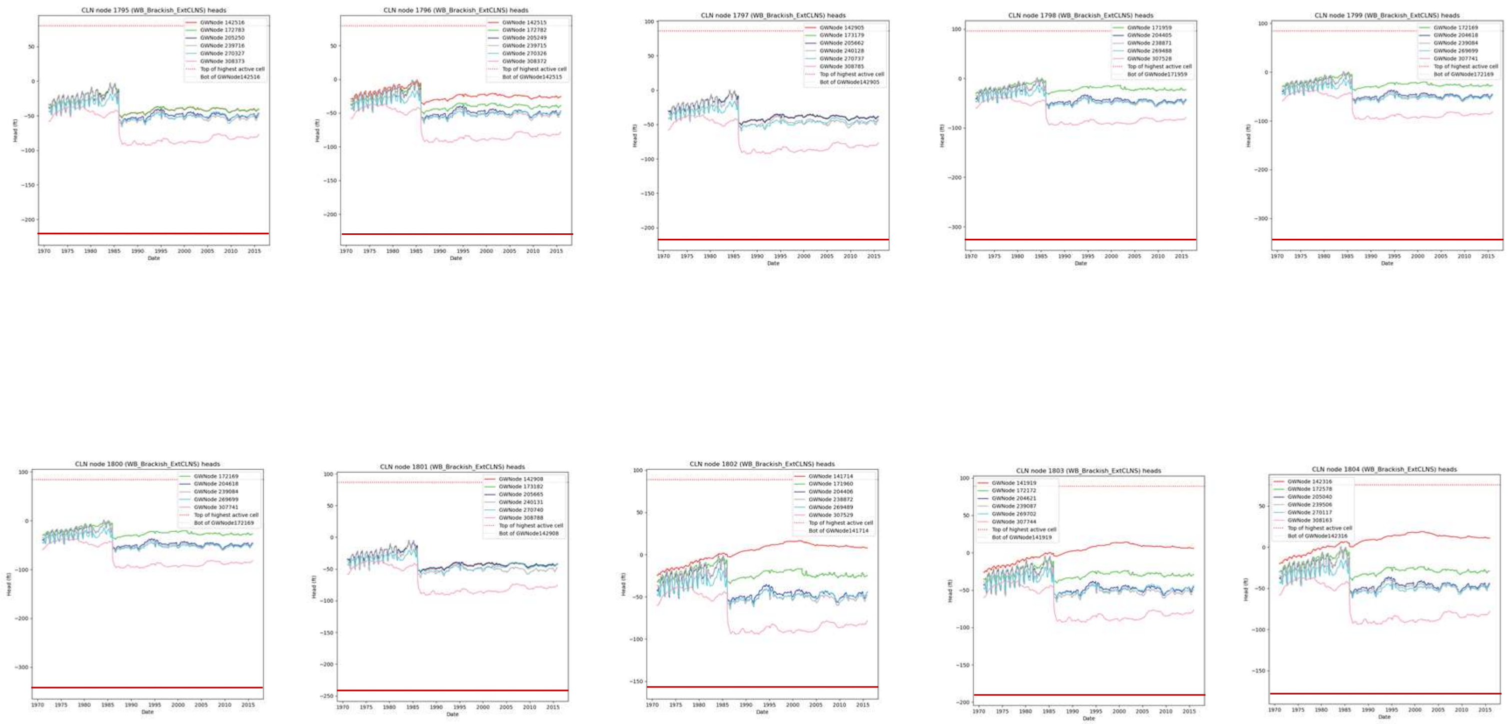
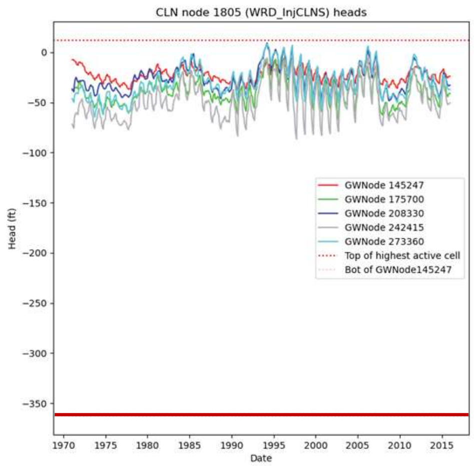
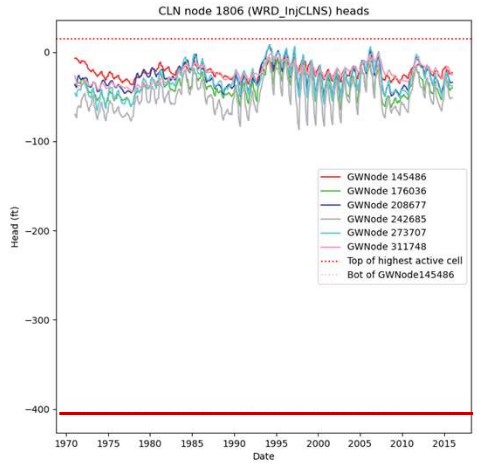
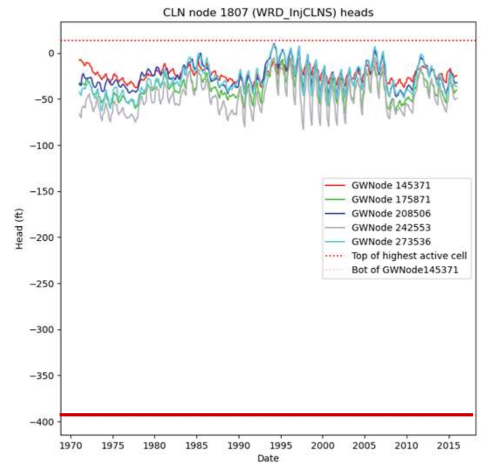


Figure 4c.
Scenario 1 Threshold Evaluation
RBWRP Extraction Wells

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario1_final\postprocessing\clnheads\png



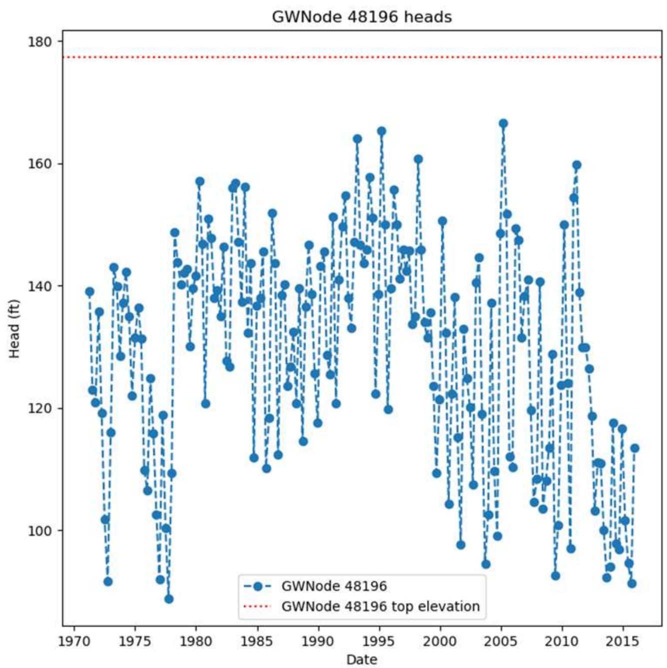


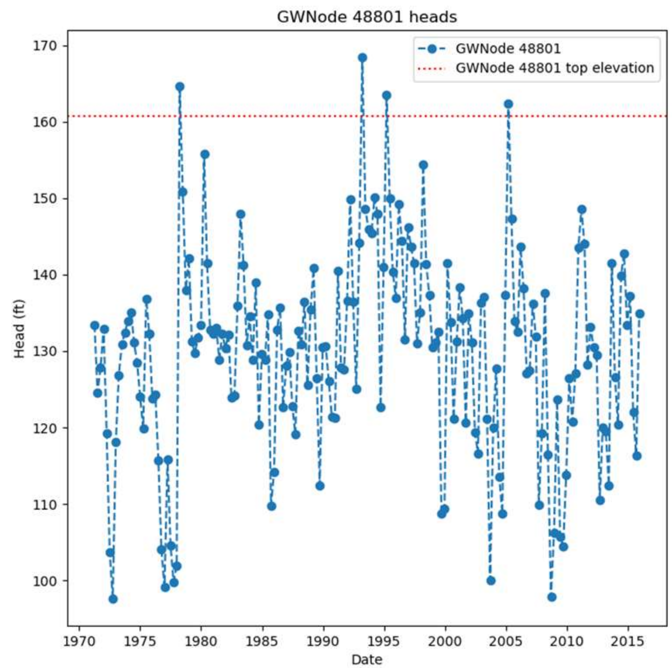


INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario1_final\postprocessing\clnheads\png

Figure 4d.
Scenario 1 Threshold Evaluation
WRD Injection Wells near LVL Facility





INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario1_final\postprocessing\barrier_recharge\png

Figure 4e.
Scenario 1 Threshold Evaluation
Selected Groundwater Nodes in
Montebello Forebay Spreading Grounds

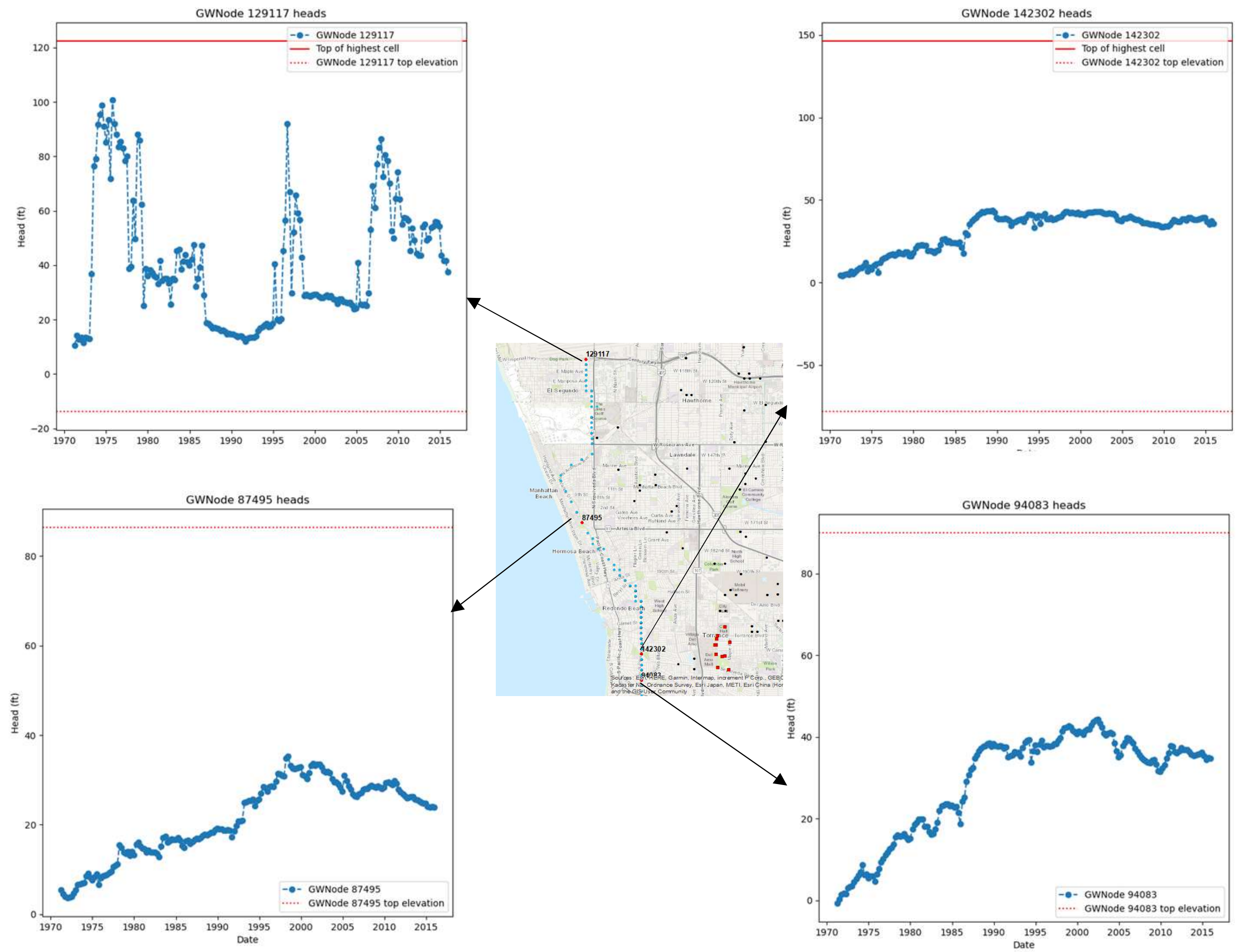
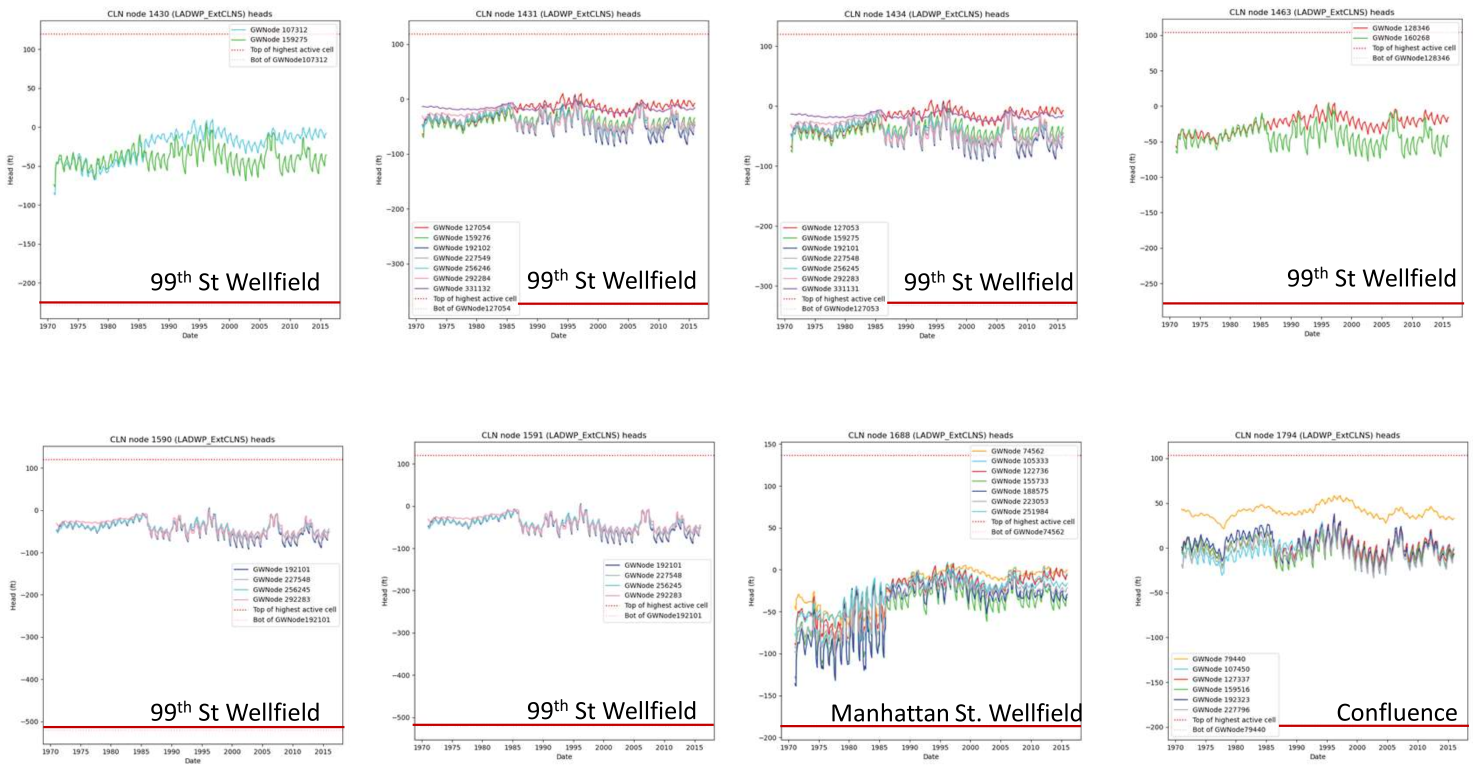


Figure 4f.
Scenario 1 Threshold Evaluation
Selected WCBB Well Locations

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

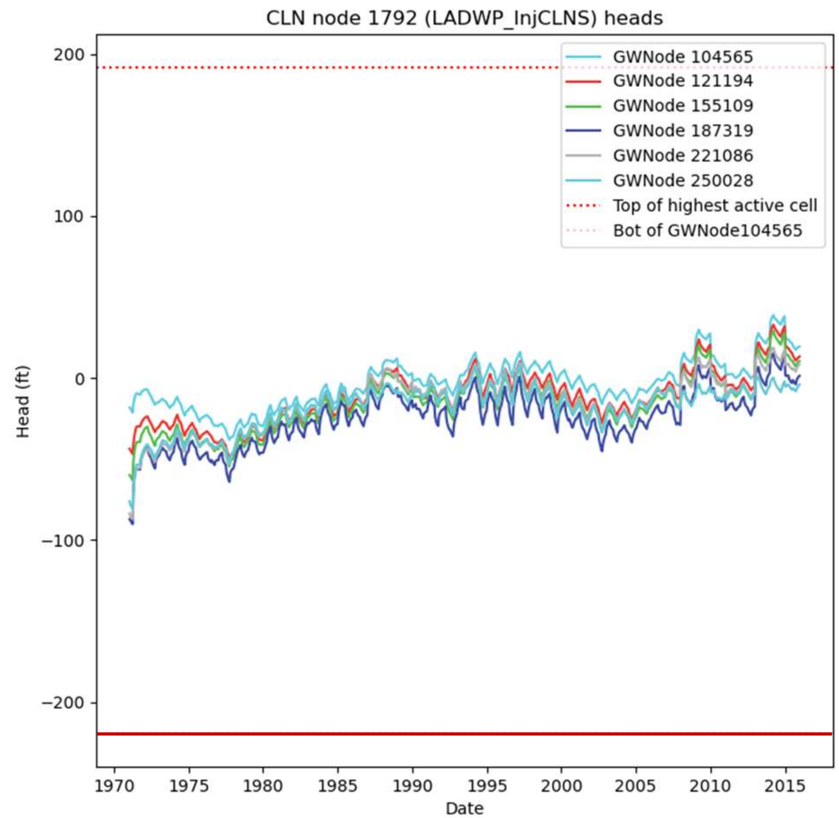
FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario1_final\postprocessing\barrier_recharge\png



INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario2_final\postprocessing\clnheads\png

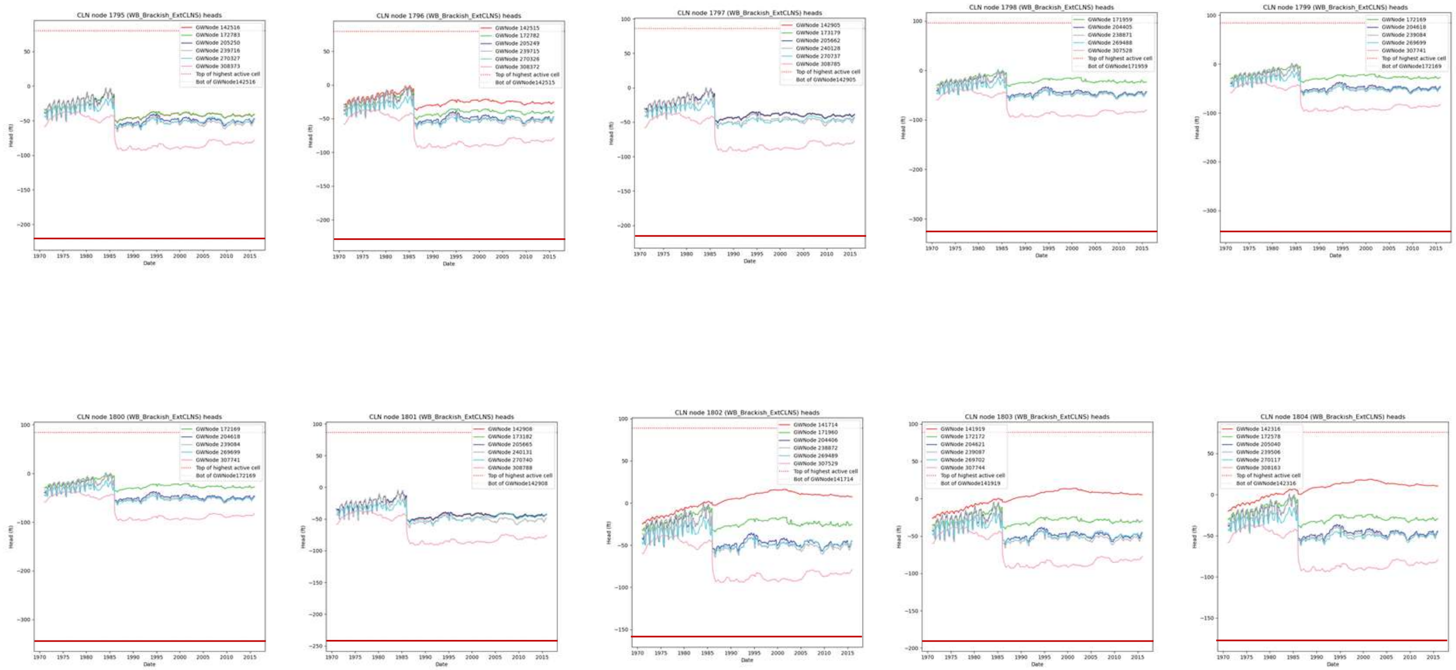
Figure 5a.
Scenario 2 Threshold Evaluation
LADWP Extraction Wells



INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario2_final\postprocessing\clnheads\png

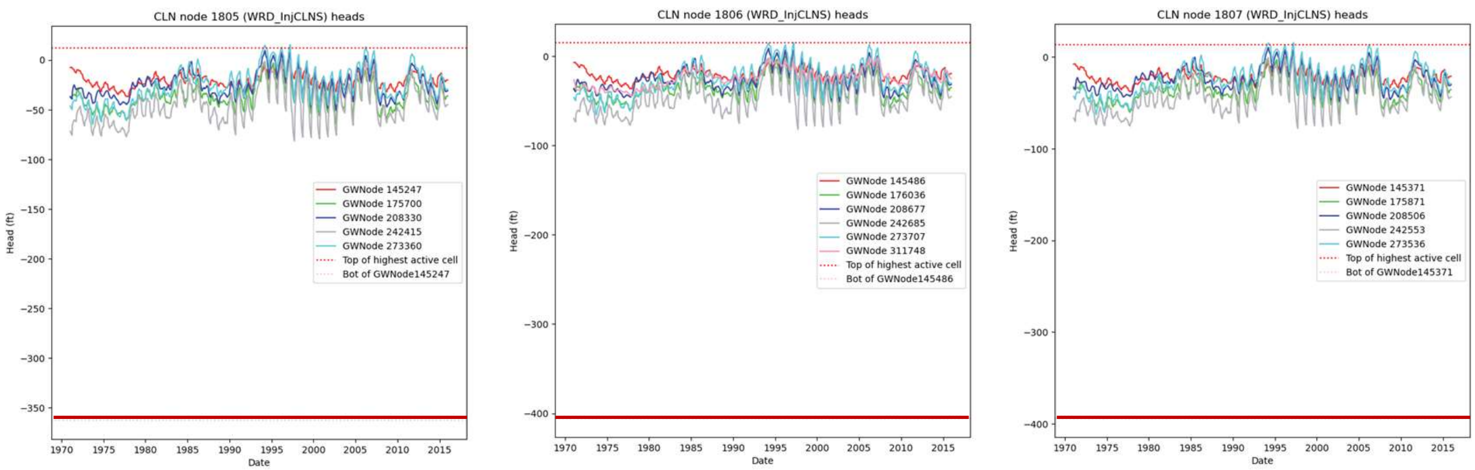
Figure 5b.
Scenario 2 Threshold Evaluation
LADWP Slauson Injection Well



INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario2_final\postprocessing\clnheads\png

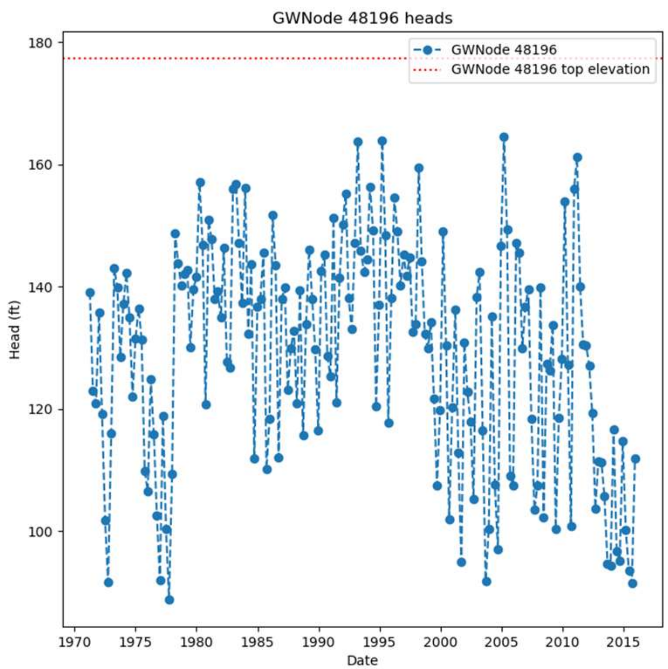
Figure 5c.
Scenario 2 Threshold Evaluation
RBWRP Extraction Wells

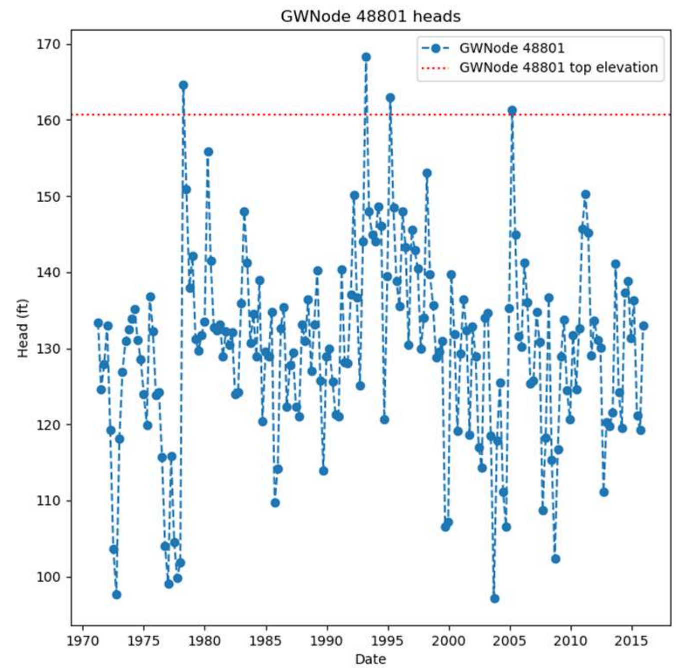


INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario2_final\postprocessing\clnheads\png

Figure 5d.
Scenario 2 Threshold Evaluation
WRD Injection Wells near LVL Facility.

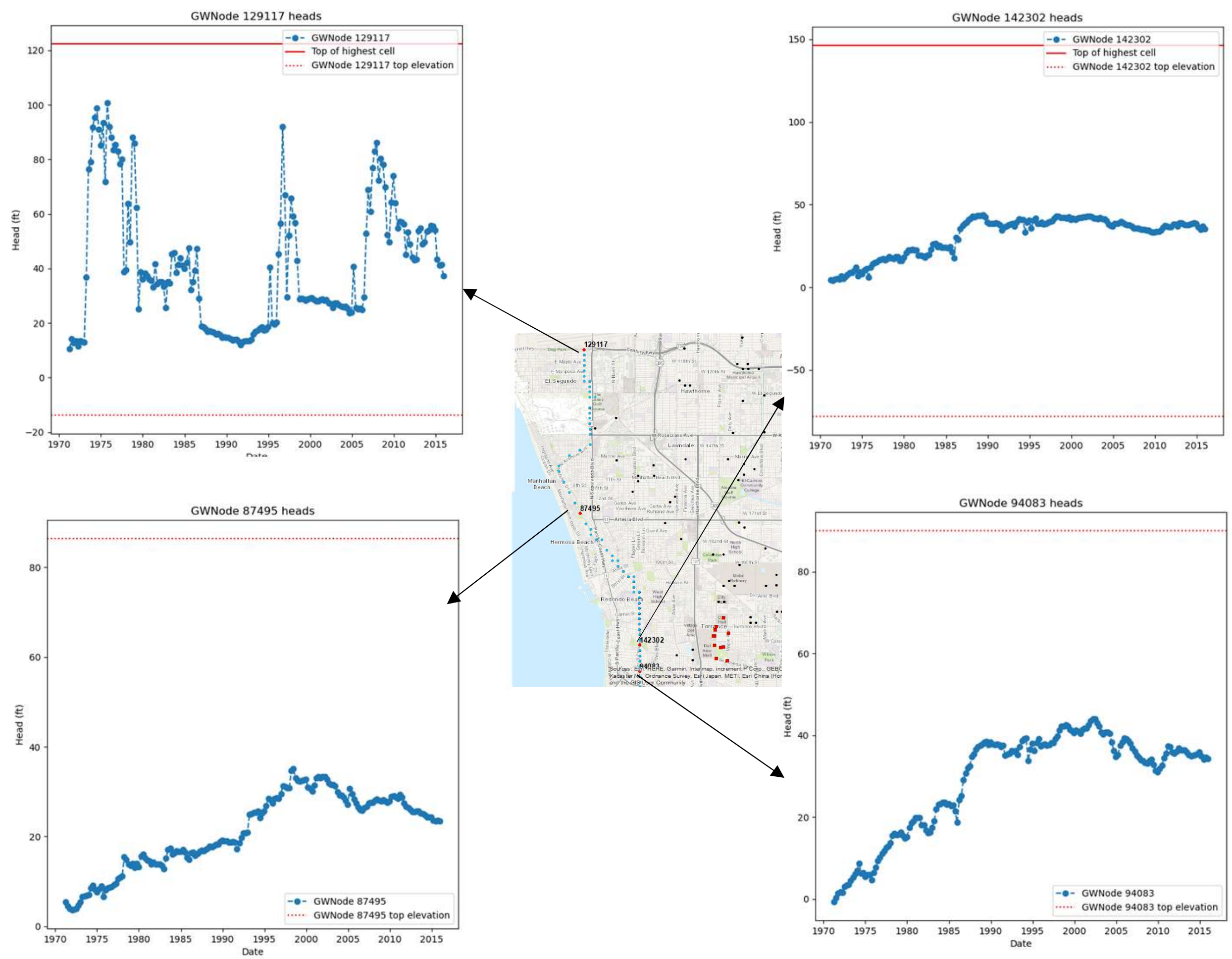




INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

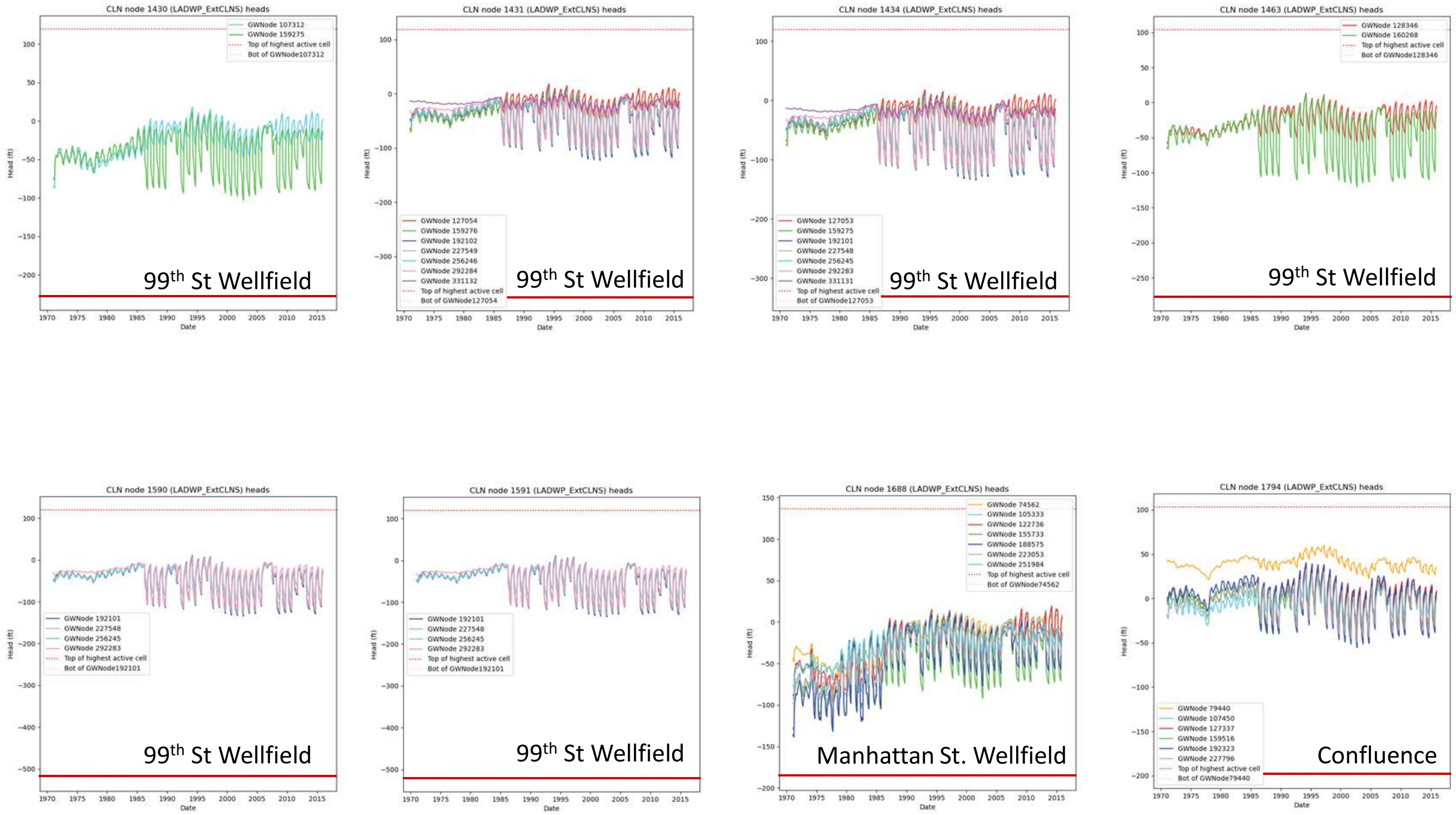
FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario2_final\postprocessing\barrier_recharge\png

Figure 5e.
Scenario 2 Threshold Evaluation
Selected Groundwater Nodes in
Montebello Forebay Spreading Grounds



FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario2_final\postprocessing\barrier_recharge\png

Figure 5f.
Scenario 2 Threshold Evaluation
Selected WCBB Well Locations



FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario3_final\postprocessing\clnheads\png

Figure 6a.
Scenario 3 Threshold Evaluation
LADWP Extraction Wells

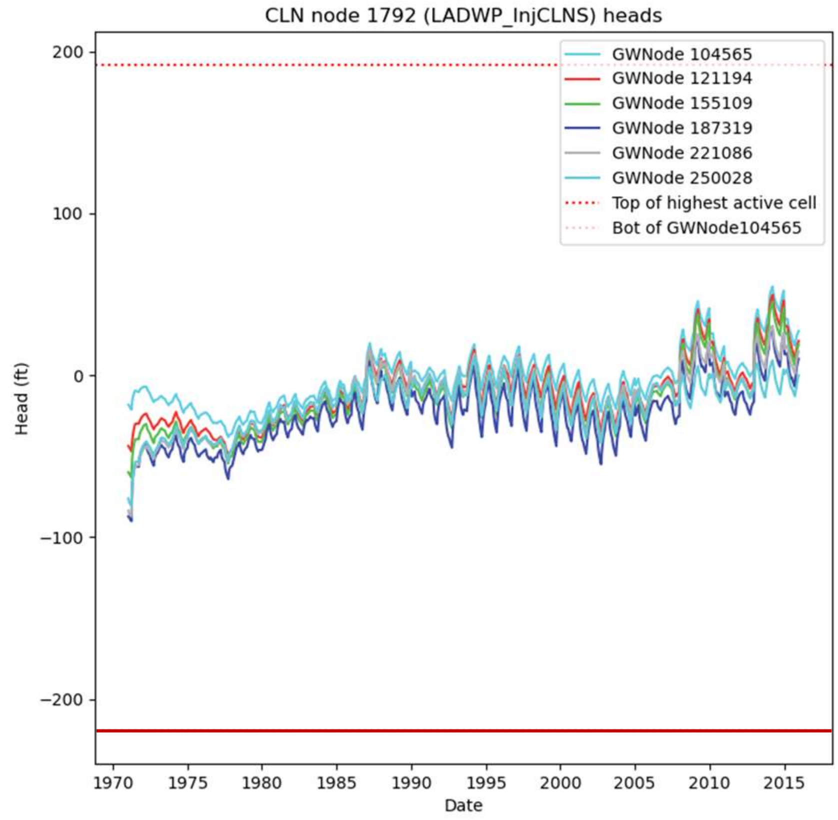
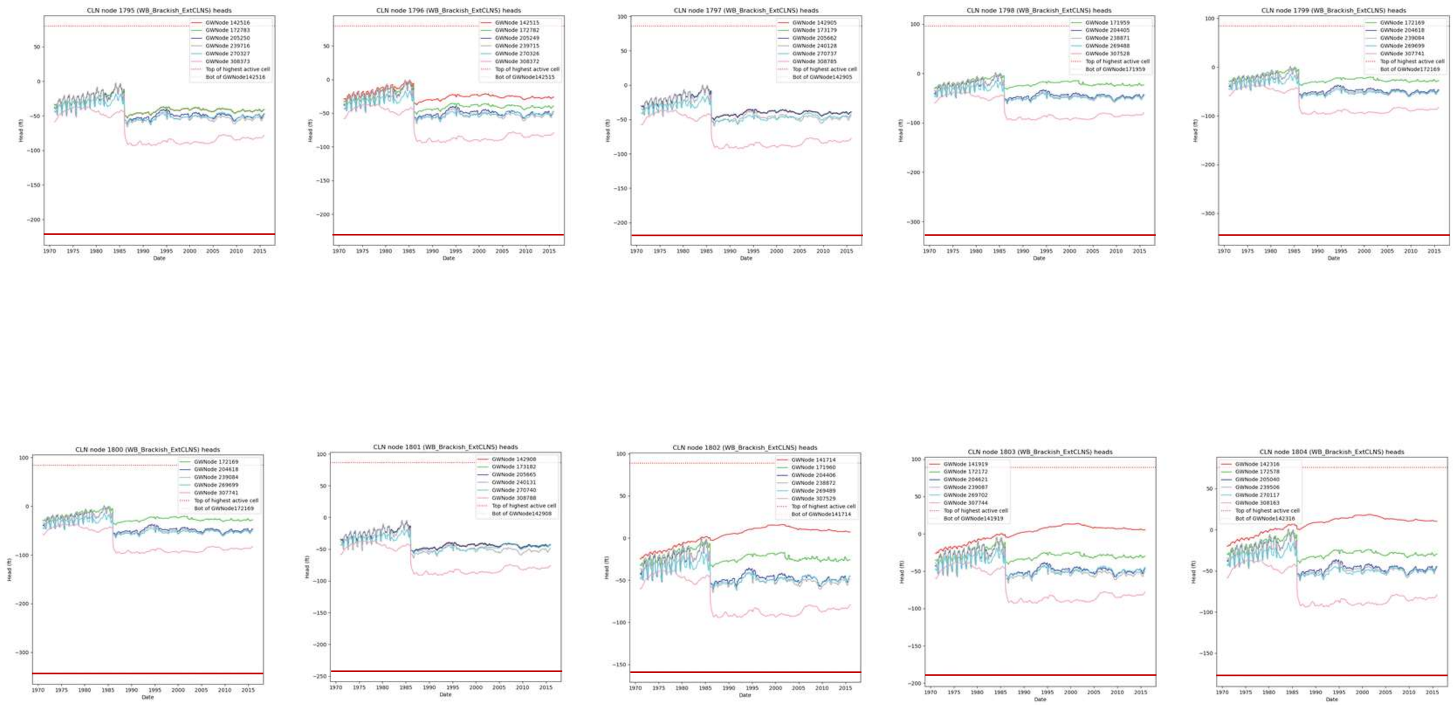


Figure 6b.
Scenario 3 Threshold Evaluation
LADWP Slauson Injection Well

INTERA GEOSCIENCE & ENGINEERING SOLUTIONS

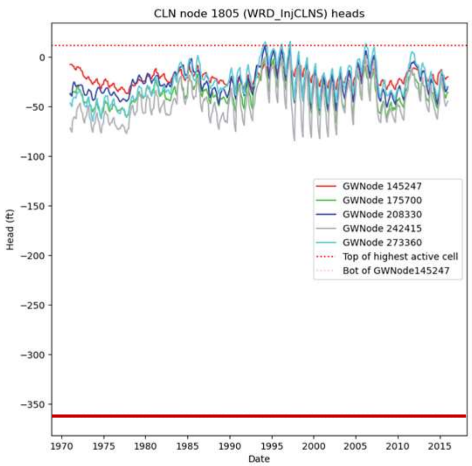
FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario3_final\postprocessing\clnheads\png

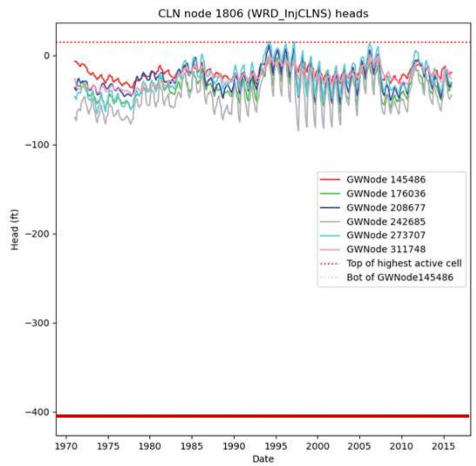


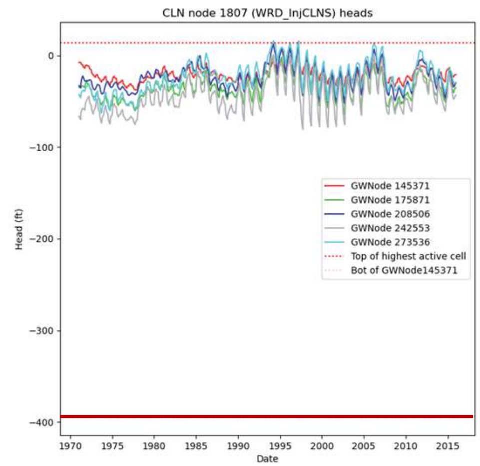
INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario3_final\postprocessing\clnheads\png

Figure 6c.
Scenario 3 Threshold Evaluation
RBWRP Extraction Wells



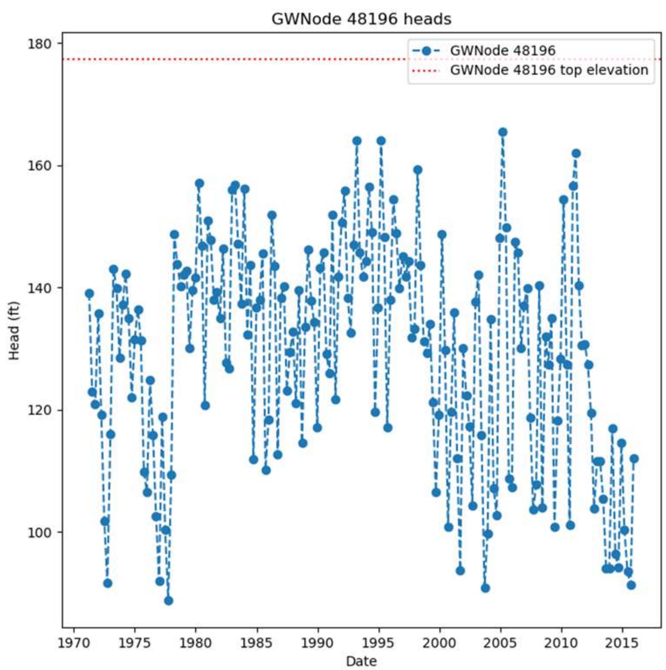




INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario3_final\postprocessing\clnheads\png

Figure 6d.
Scenario 3 Threshold Evaluation
WRD Injection Wells near LVL Facility



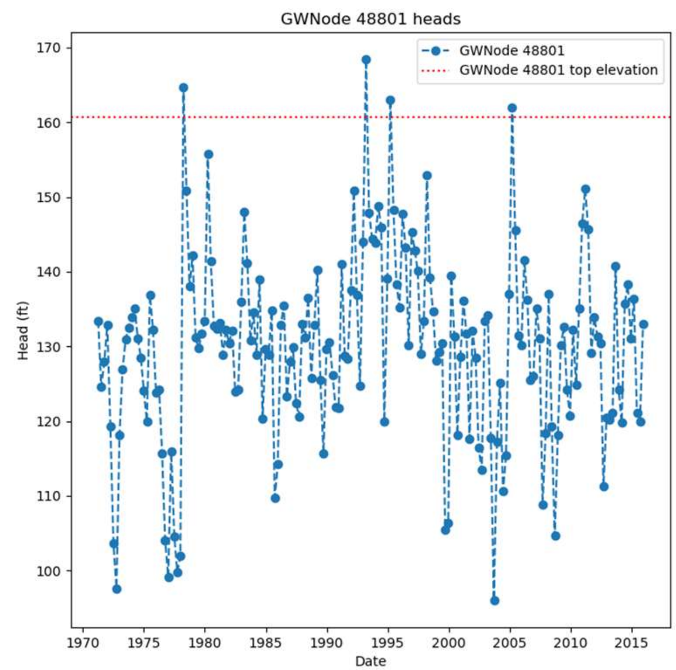
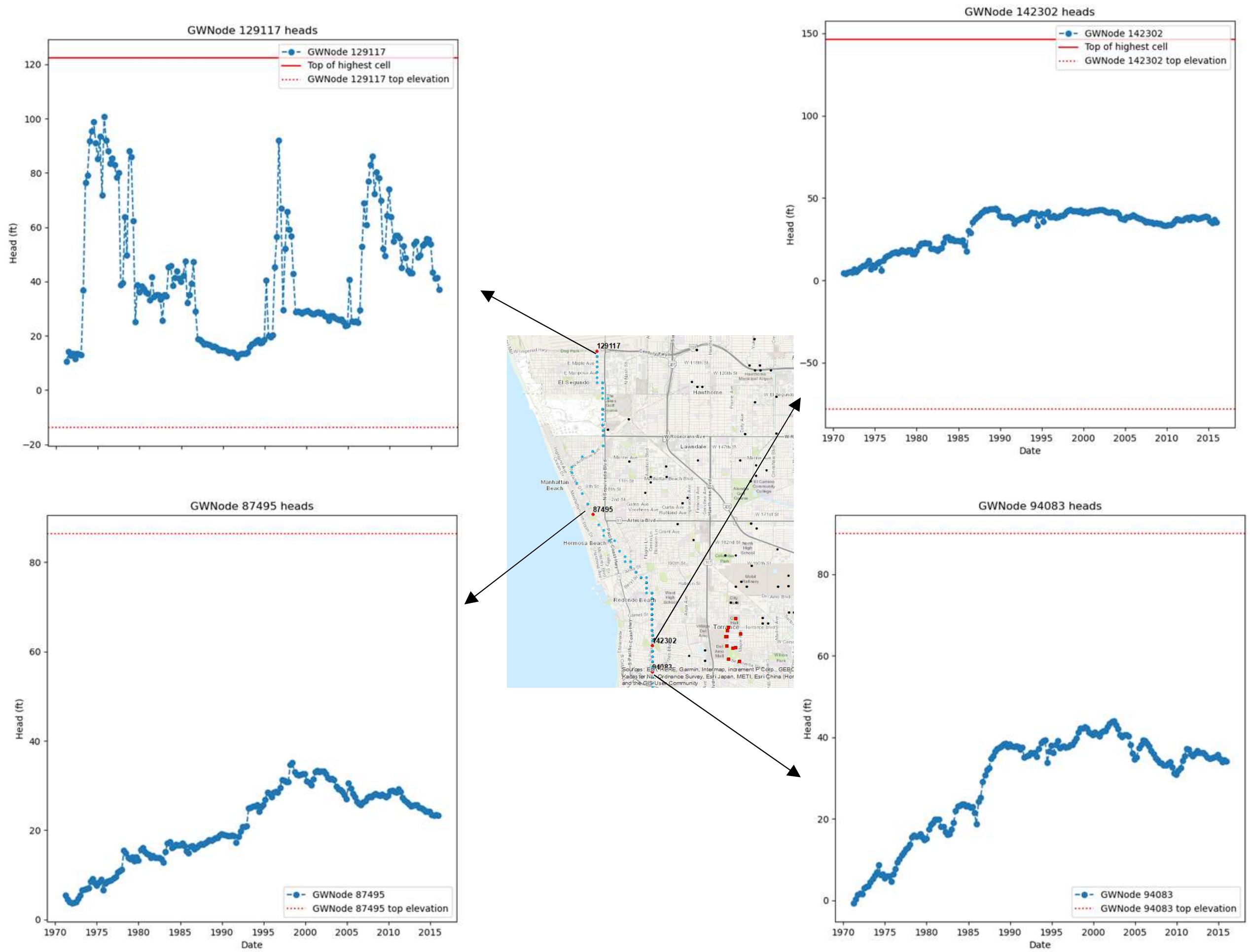


Figure 6e.
Scenario 3 Threshold Evaluation
Selected Groundwater Nodes in Montebello
Forebay Spreading Grounds

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario3_final\postprocessing\barrier_recharge\png



FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario3_final\postprocessing\barrier_recharge\png

Figure 6f.
Scenario 3 Threshold Evaluation
Selected WCBB Well Locations

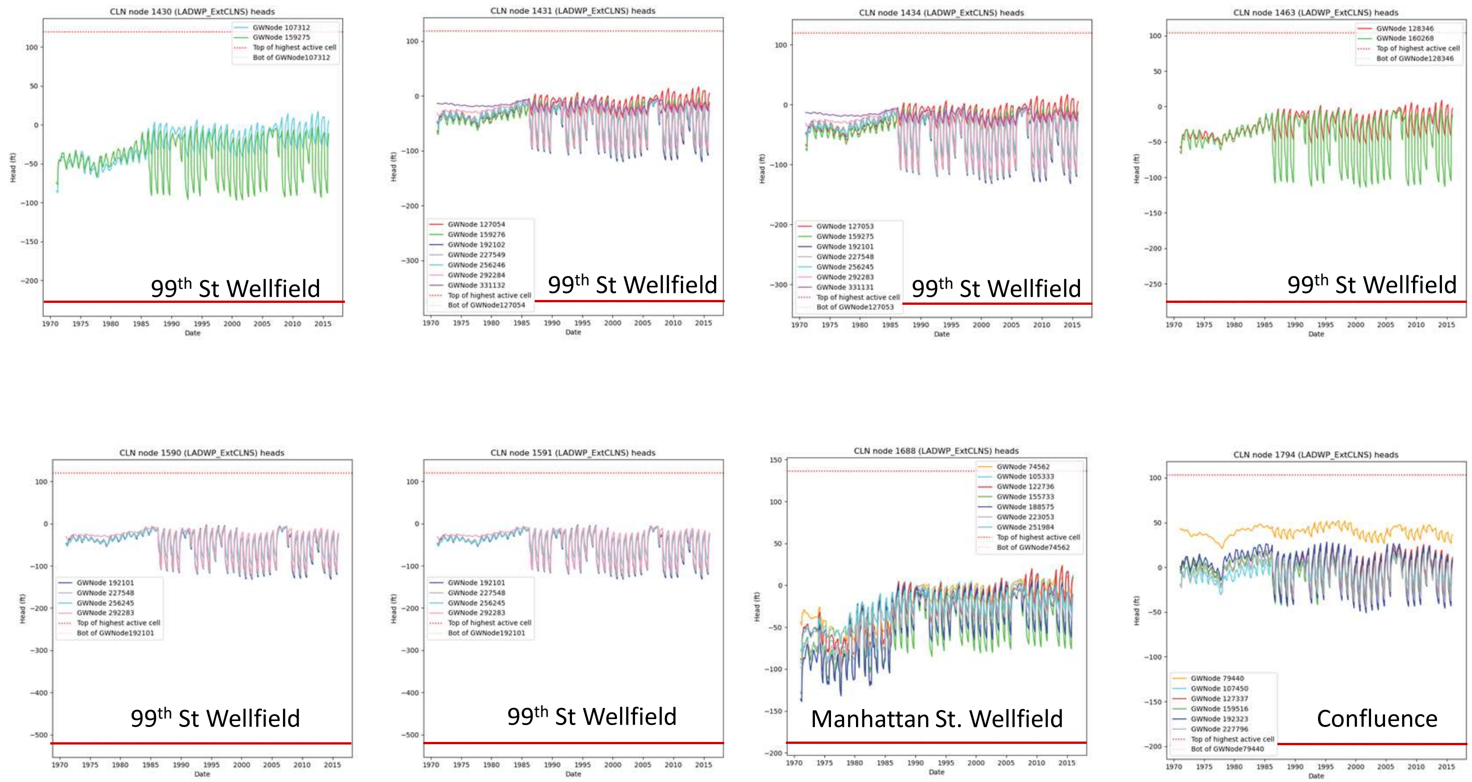
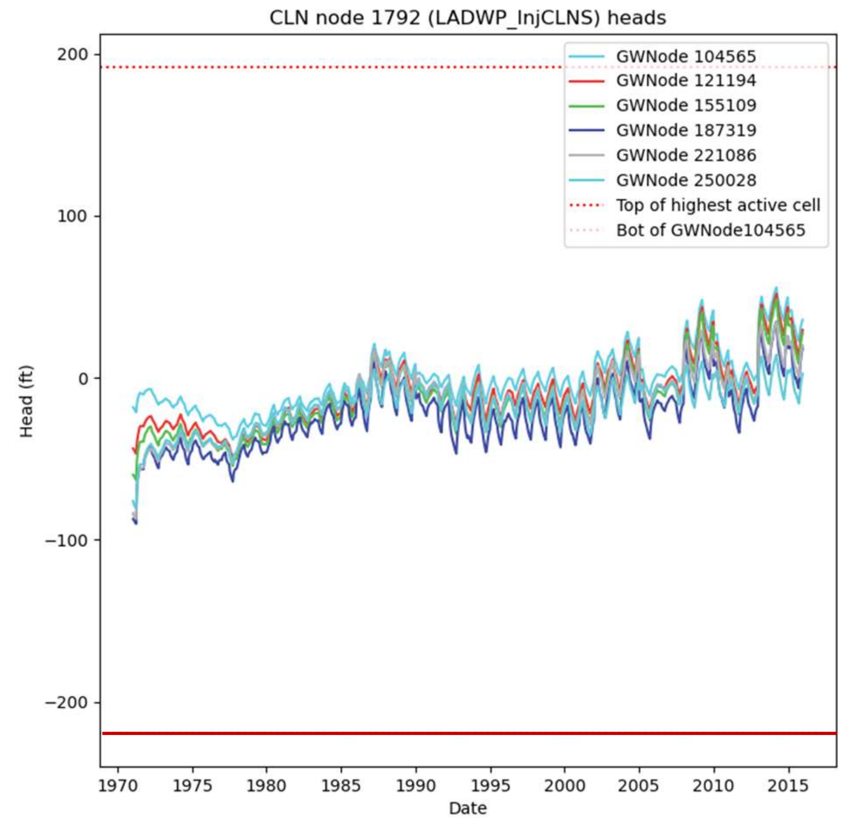


Figure 7a.
Scenario 4 Threshold Evaluation
LADWP Extraction Wells

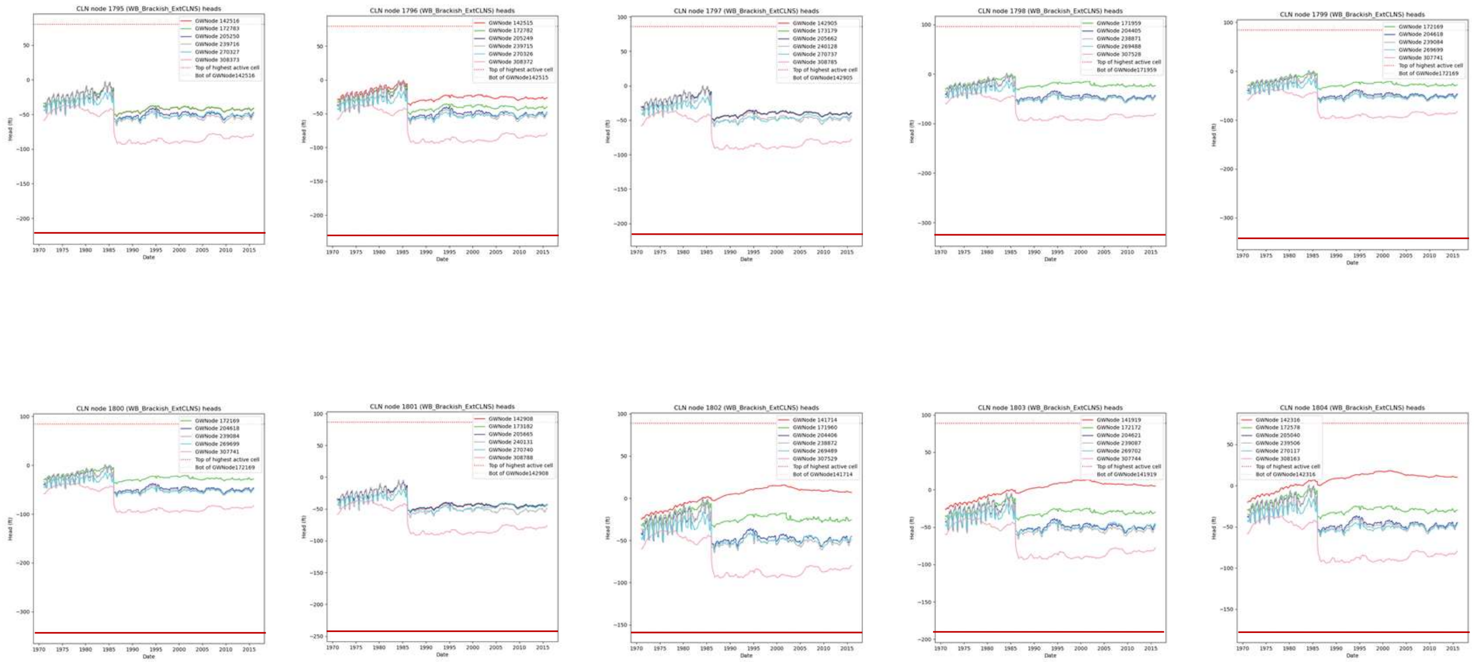
FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario4_final\postprocessing\clnheads\png



INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario4_final\postprocessing\clnheads\png

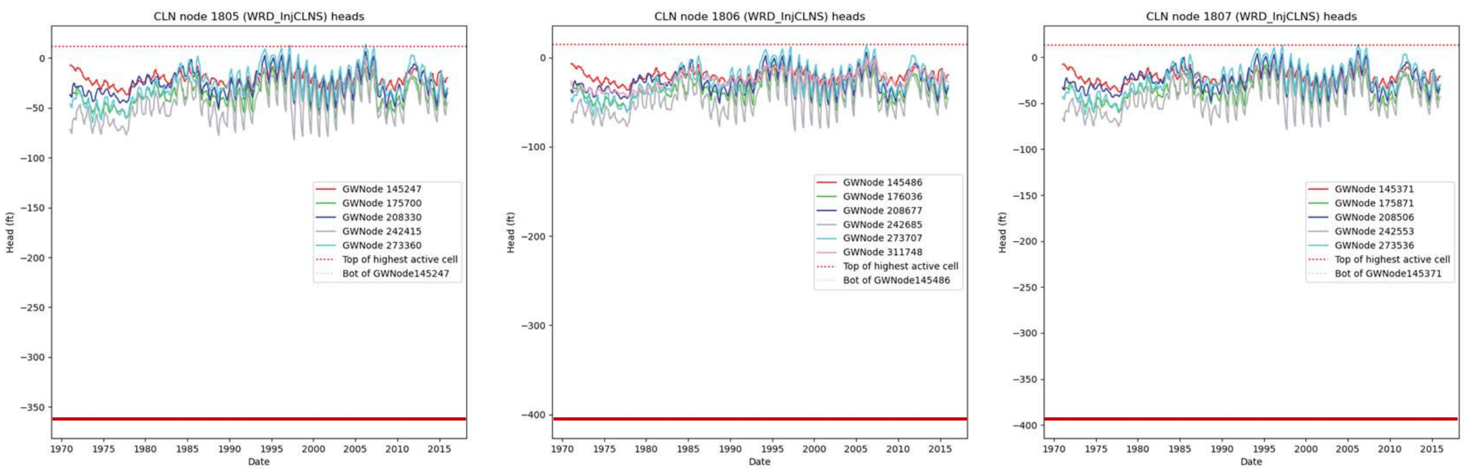
Figure 7b.
Scenario 4 Threshold Evaluation
LADWP Slauson Injection Well



INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario4_final\postprocessing\clnheads\png

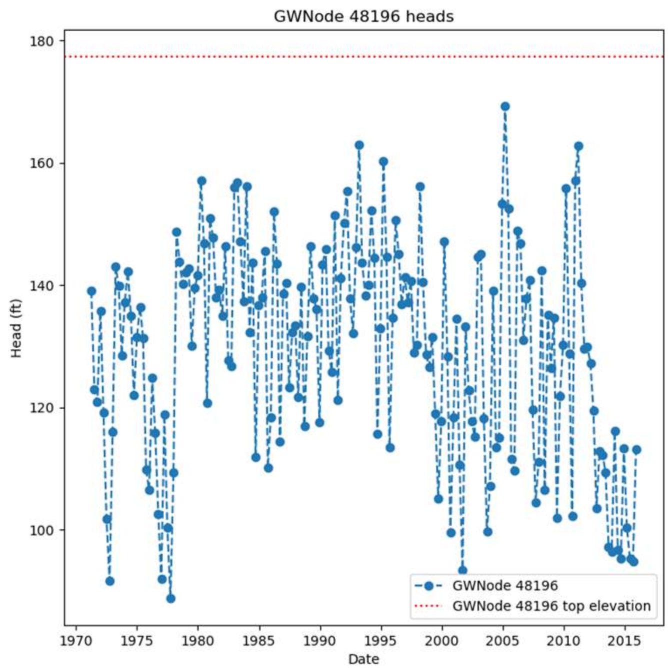
Figure 7c.
Scenario 4 Threshold Evaluation
RBWRP Extraction Wells

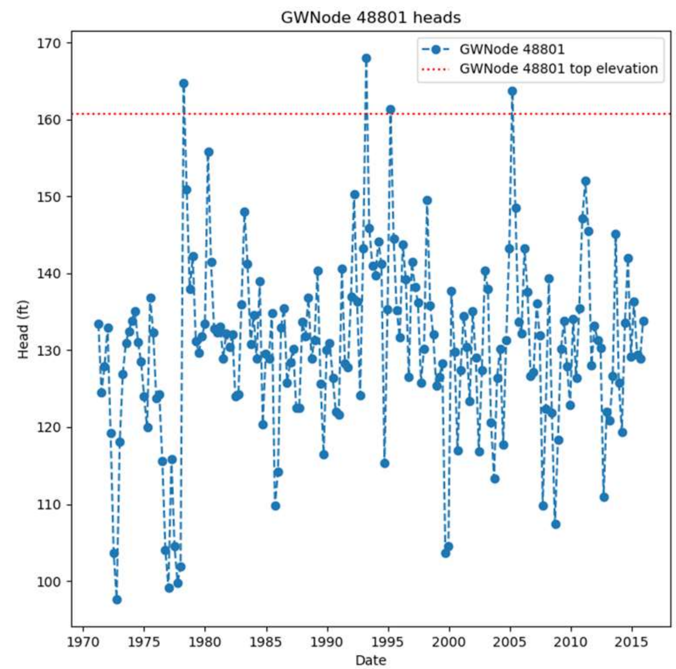


INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario4_final\postprocessing\clnheads\png

Figure 7d
Scenario 4 Threshold Evaluation
WRD Injection Wells near LVL Facility





FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario4_final\postprocessing\barrier_recharge\png

Figure 7e.
Scenario 4 Threshold Evaluation
Selected Groundwater Nodes in
Montebello Forebay Spreading Grounds

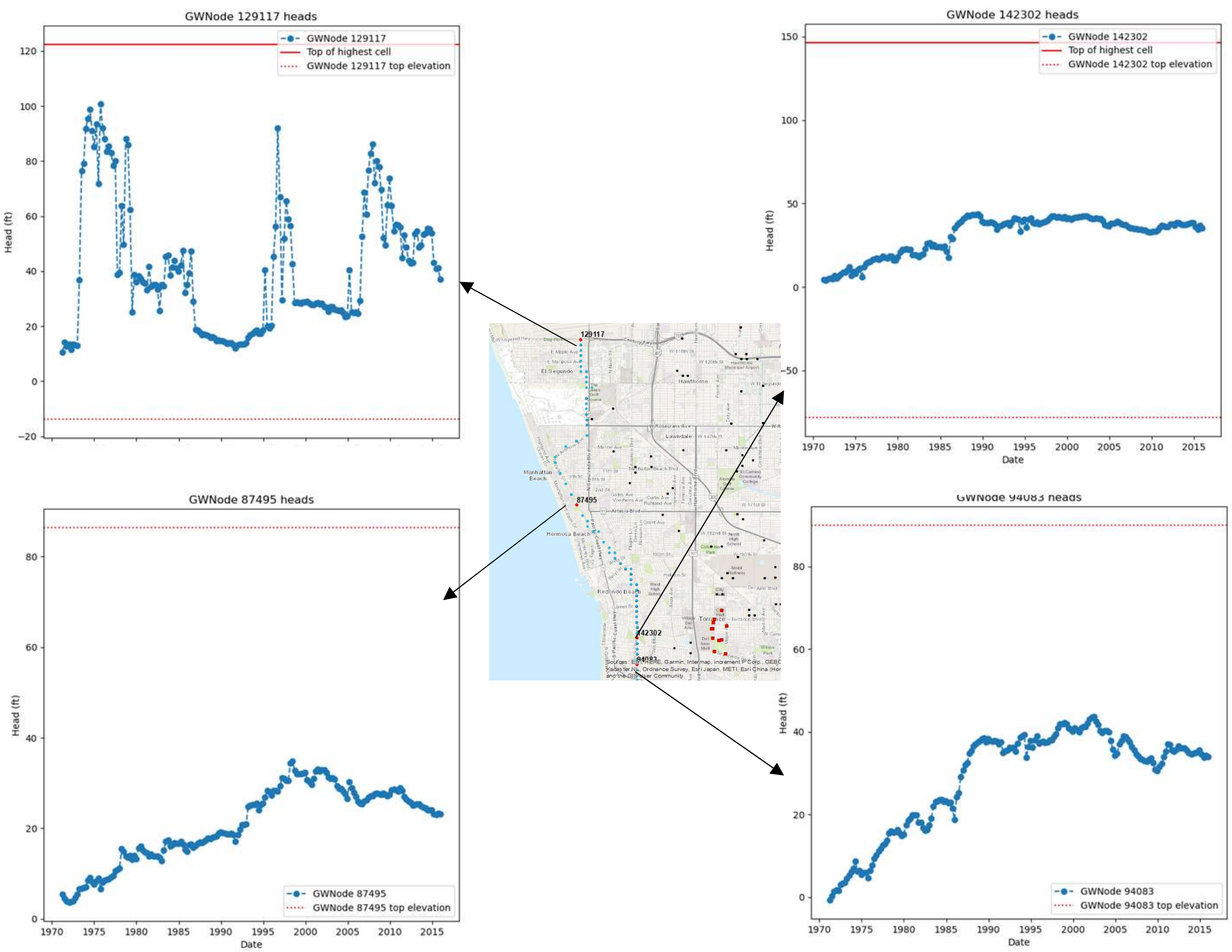
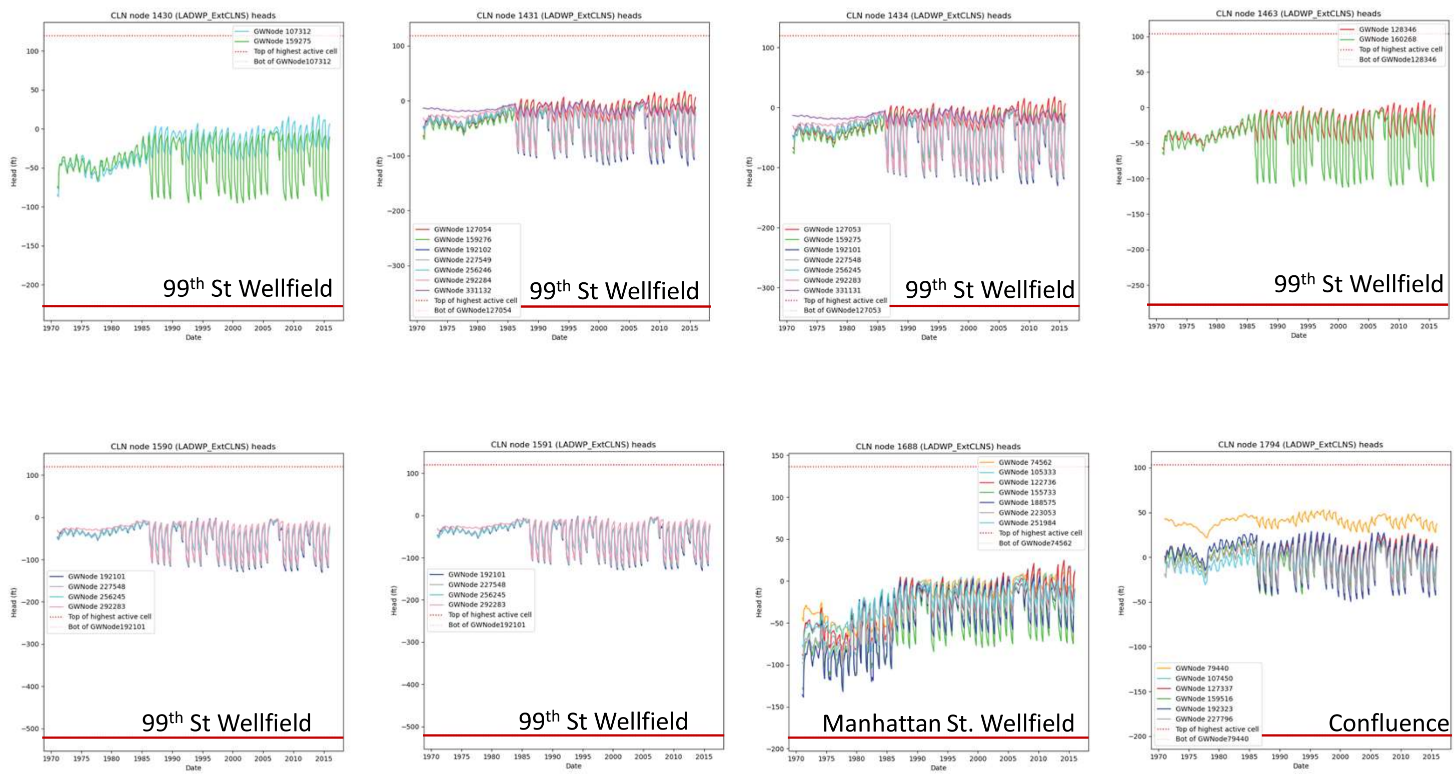


Figure 7f.
Scenario 4 Threshold Evaluation
Selected WCBB Well Locations

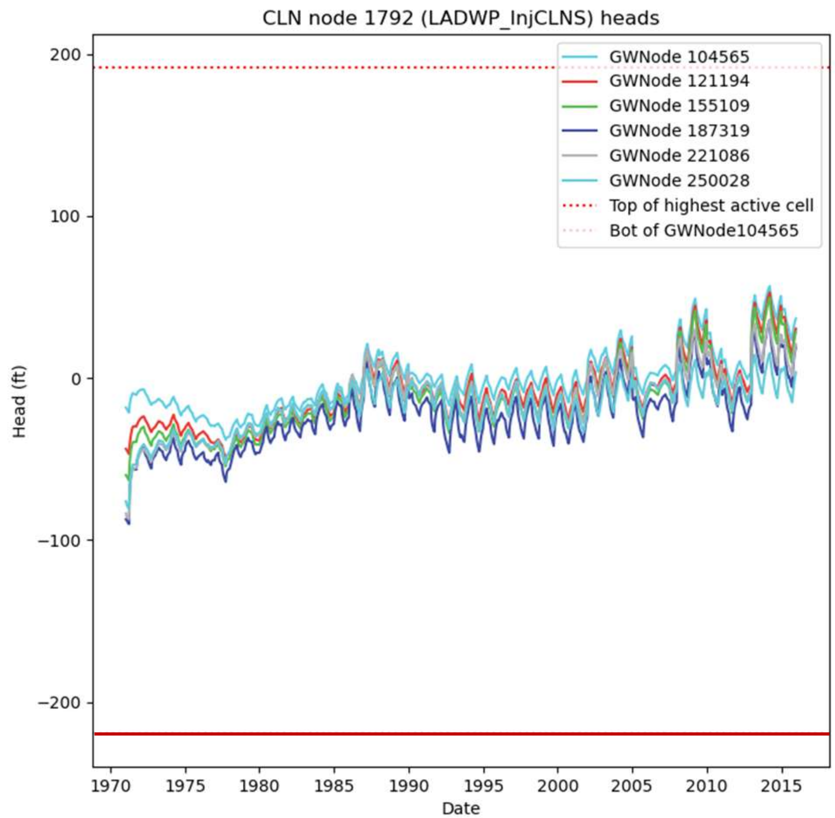
INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario4_final\postprocessing\barrier_recharge\png



FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario5_final\postprocessing\clnheads\png

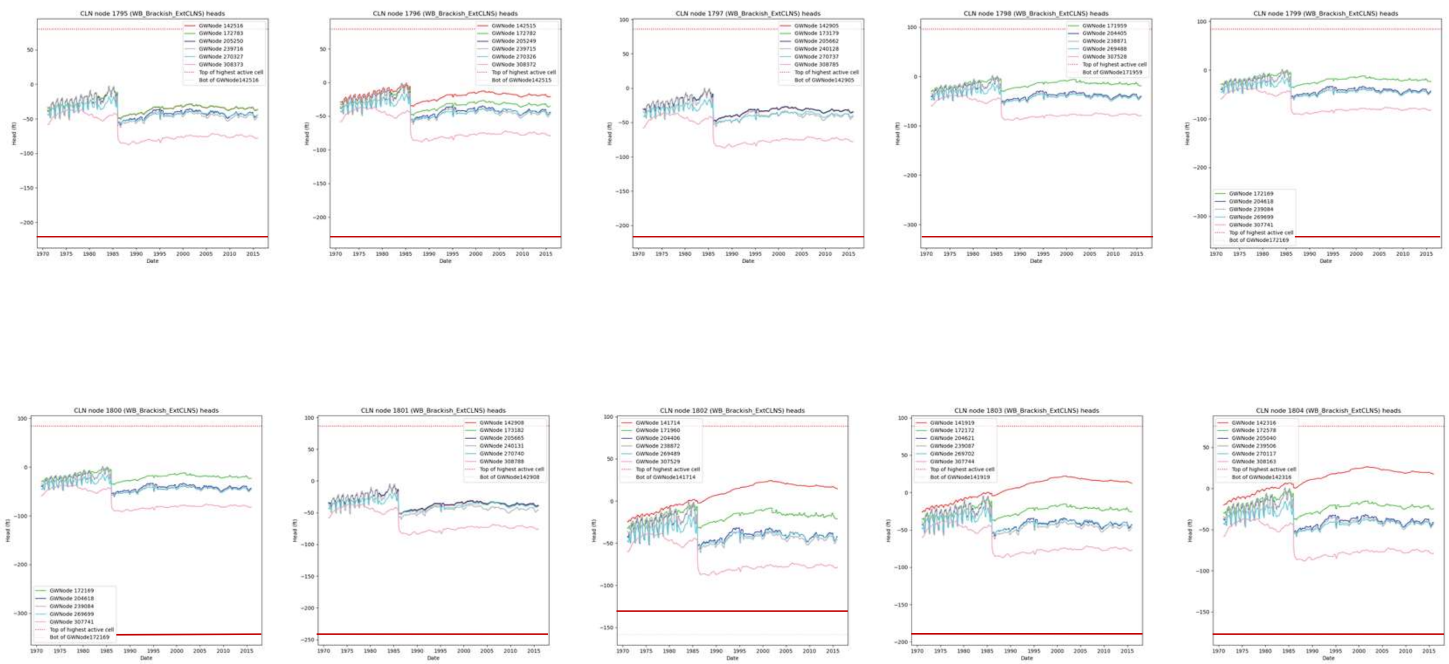
Figure 8a.
Scenario 5 Threshold Evaluation
LADWP Extraction Wells



INTERA GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario5_final\postprocessing\clnheads\png

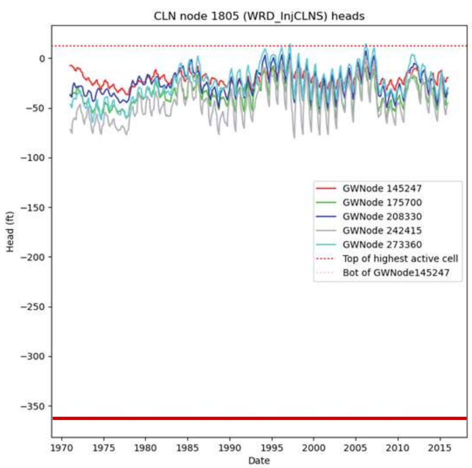
Figure 8b.
Scenario 5 Threshold Evaluation
LADWP Slauson Injection Well

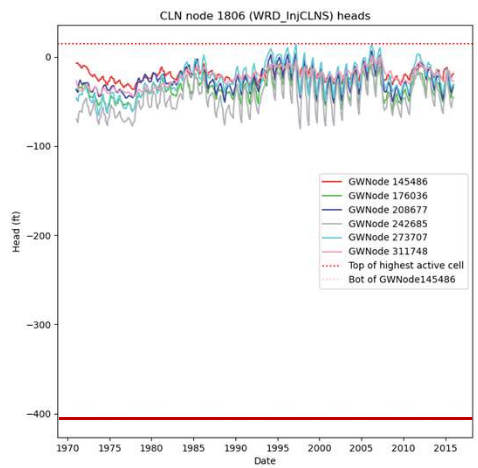


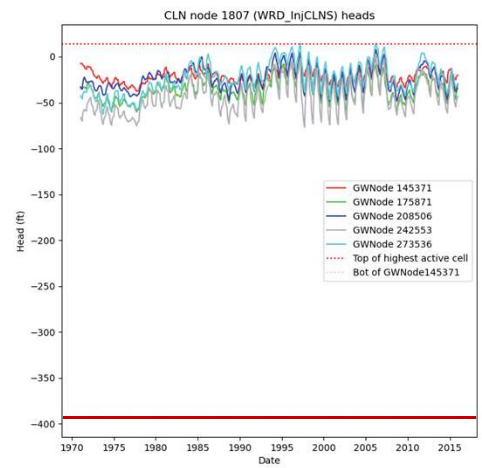
INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario5_final\postprocessing\clnheads\png

Figure 8c.
Scenario 5 Threshold Evaluation
RBWRP Extraction Wells



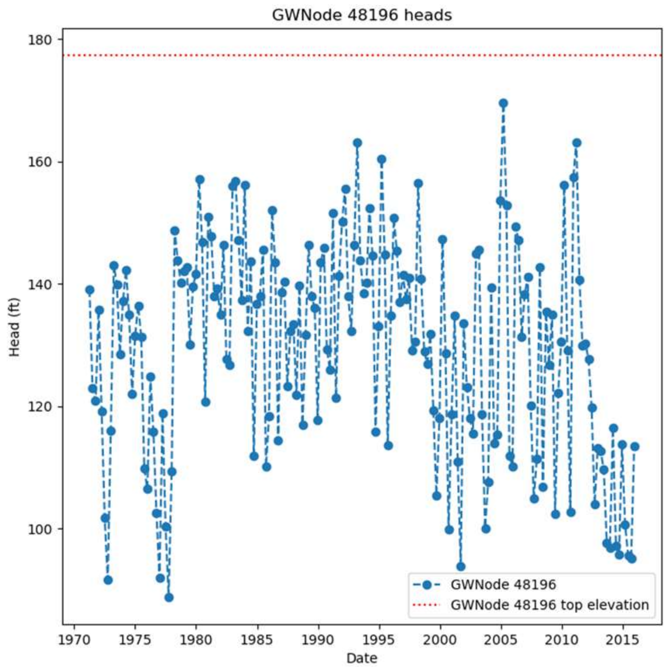


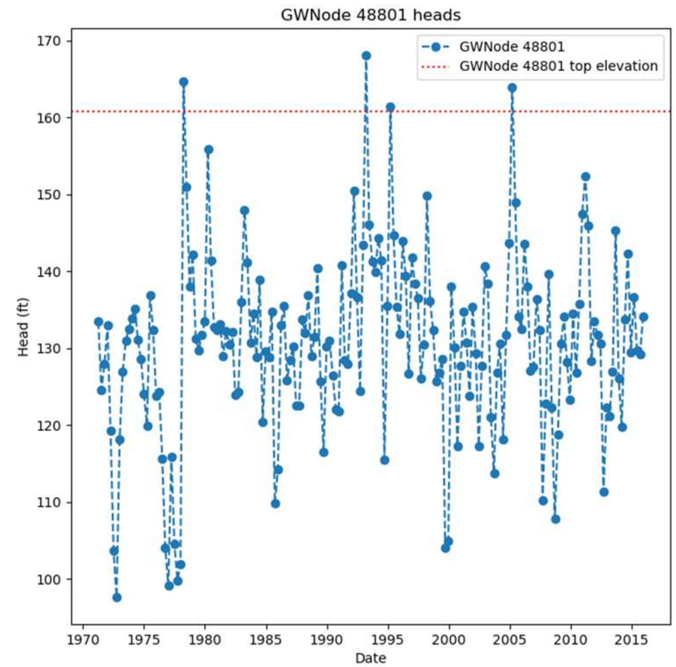


INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario5_final\postprocessing\clnheads\png

Figure 8d.
Scenario 5 Threshold Evaluation
WRD Injection Wells near LVL Facility





INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario5_final\postprocessing\barrier_recharge\png

Figure 8e.
Scenario 5 Threshold Evaluation
Selected Groundwater Nodes in
Montebello Forebay Spreading Grounds

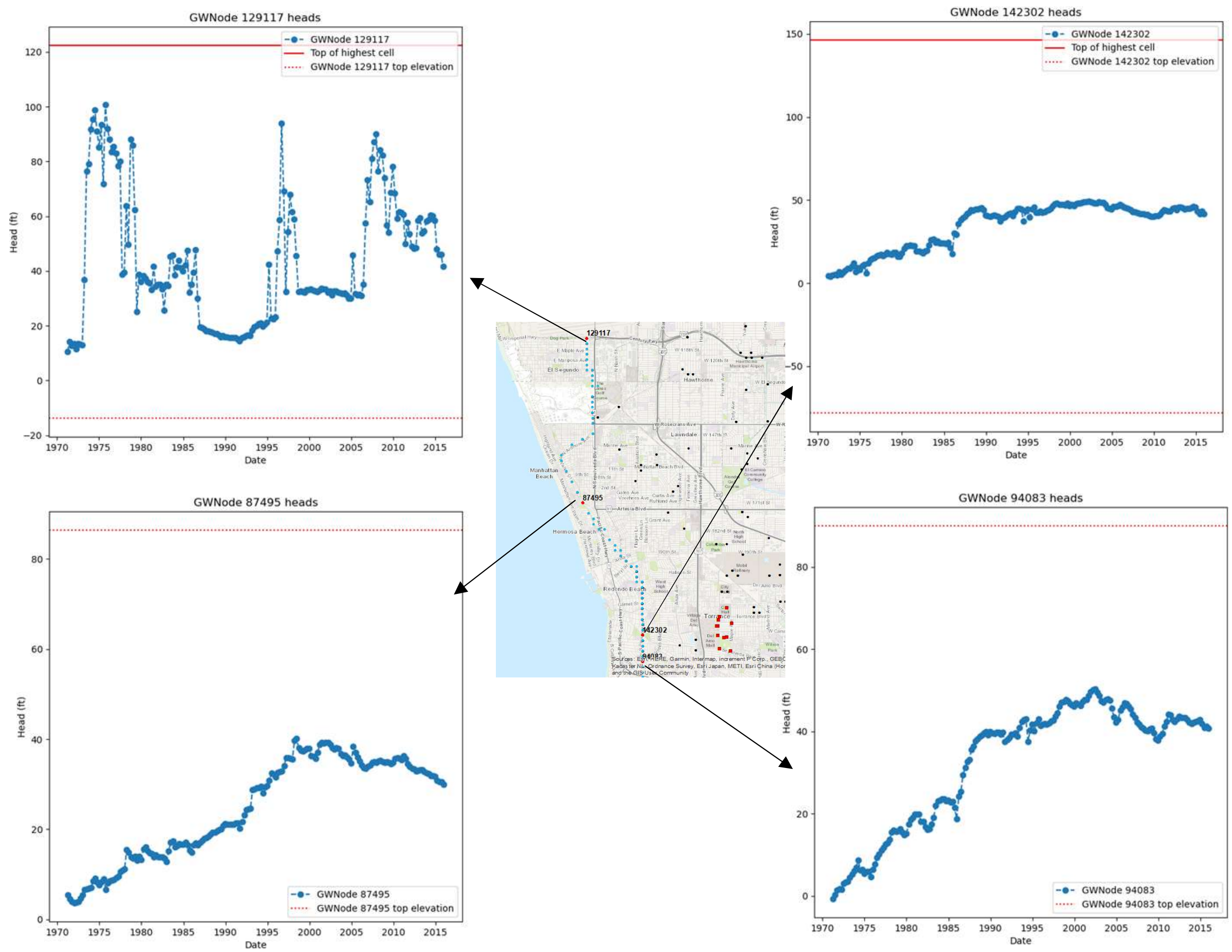
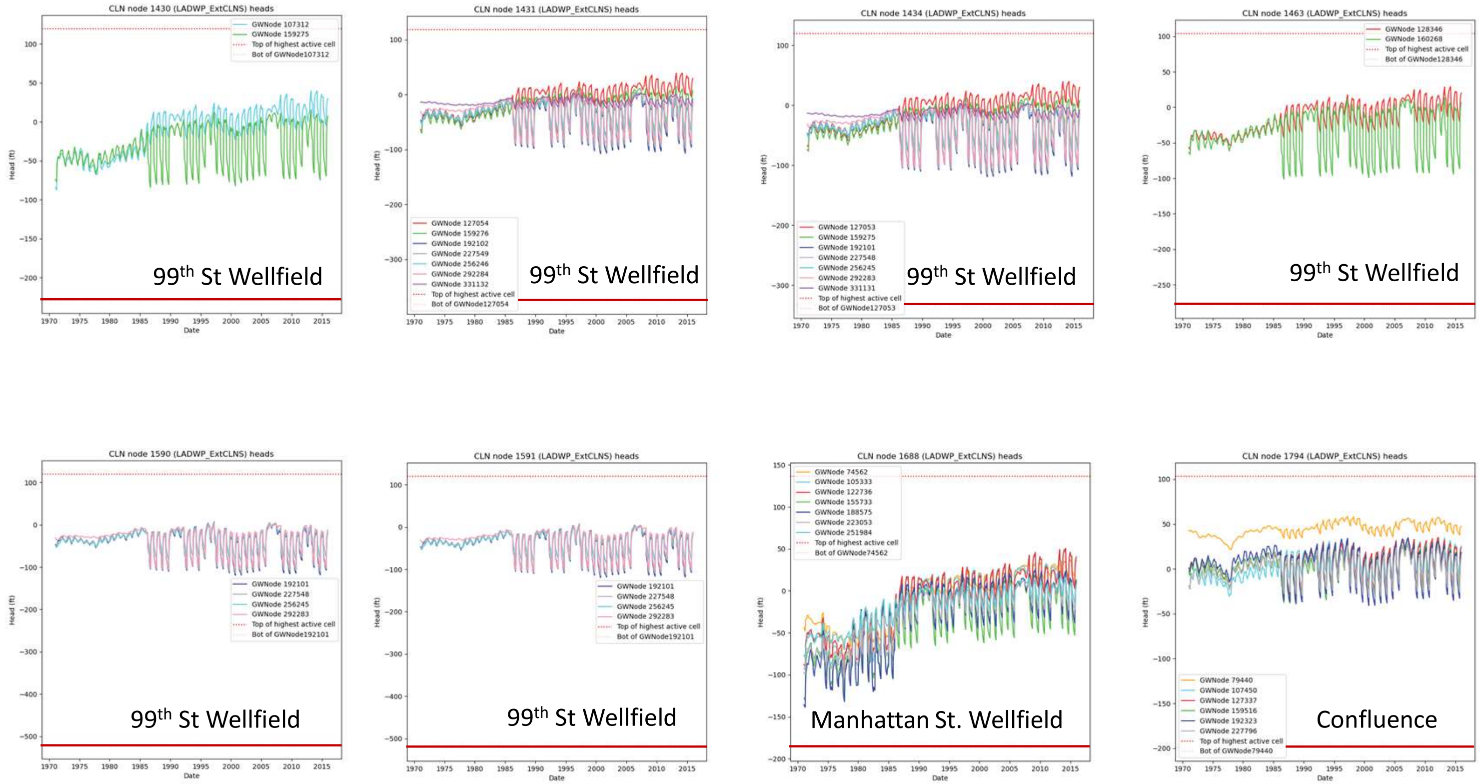


Figure 8f.
Scenario 5 Threshold Evaluation
Selected WCBB Well Locations

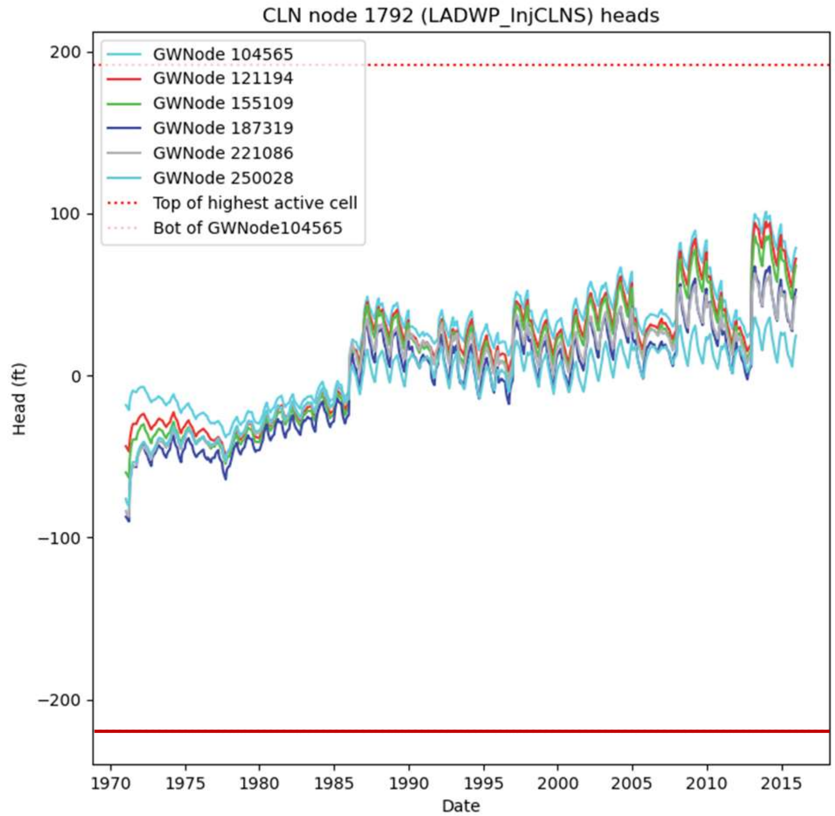
FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario5_final\postprocessing\barrier_recharge\png



INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario6_final\postprocessing\clnheads\png

Figure 9a.
Scenario 6 Threshold Evaluation
LADWP Extraction Wells



FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario6_final\postprocessing\clnheads\png

Figure 9b.
Scenario 6 Threshold Evaluation
LADWP Slauson Injection Well

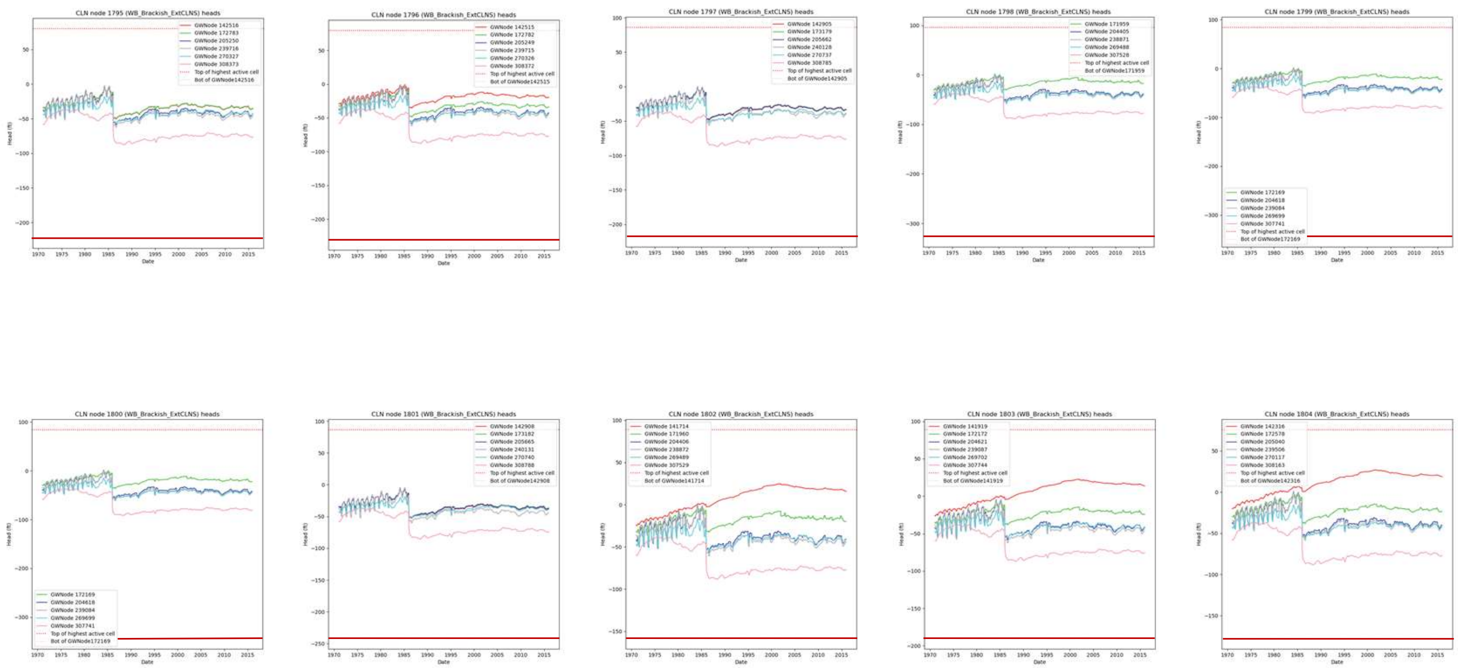
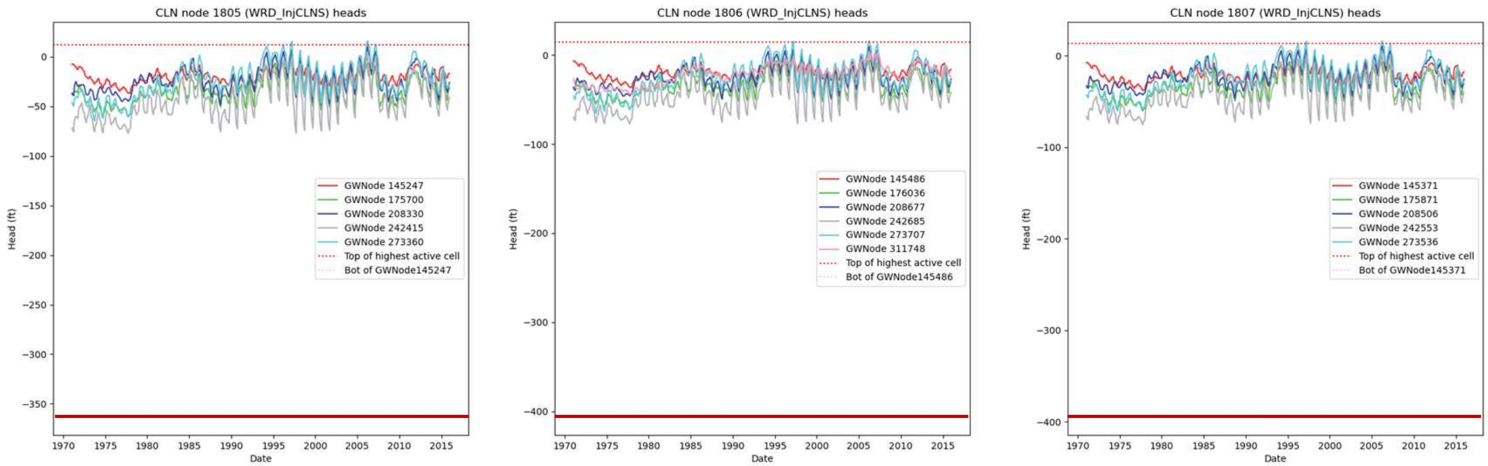


Figure 9c.
Scenario 6 Threshold Evaluation
RBWRP Extraction Wells

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

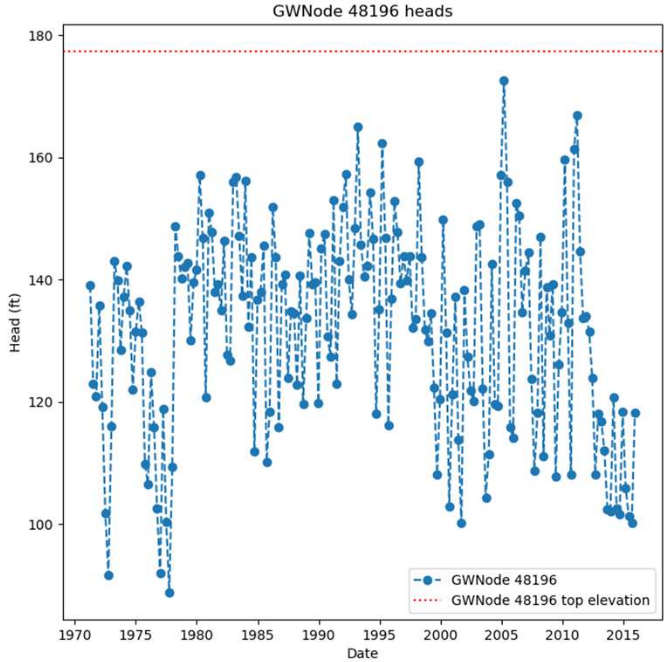
FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario6_final\postprocessing\clnheads\png

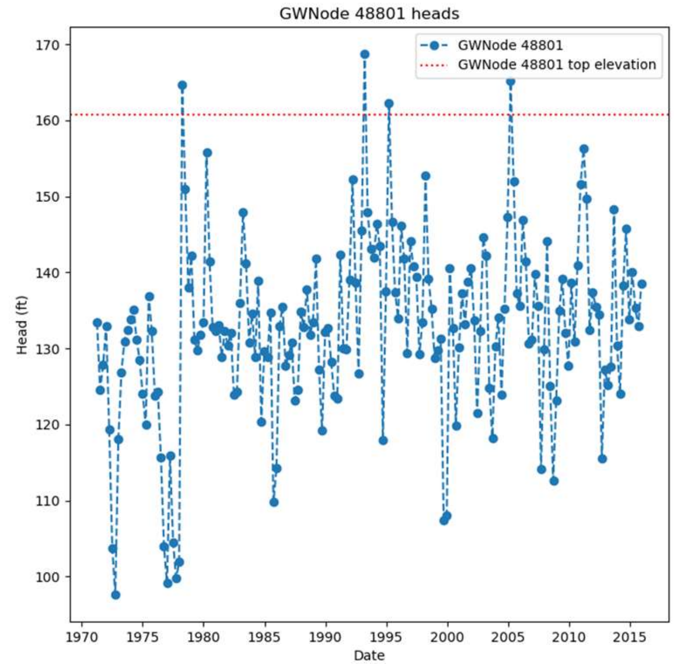


INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario6_final\postprocessing\clnheads\png

Figure 9d.
Scenario 6 Threshold Evaluation
WRD Injection Wells near LVL Facility





FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario6_final\postprocessing\barrier_recharge\png

Figure 9e.
Scenario 6 Threshold Evaluation
Selected Groundwater Nodes in
Montebello Forebay Spreading Grounds

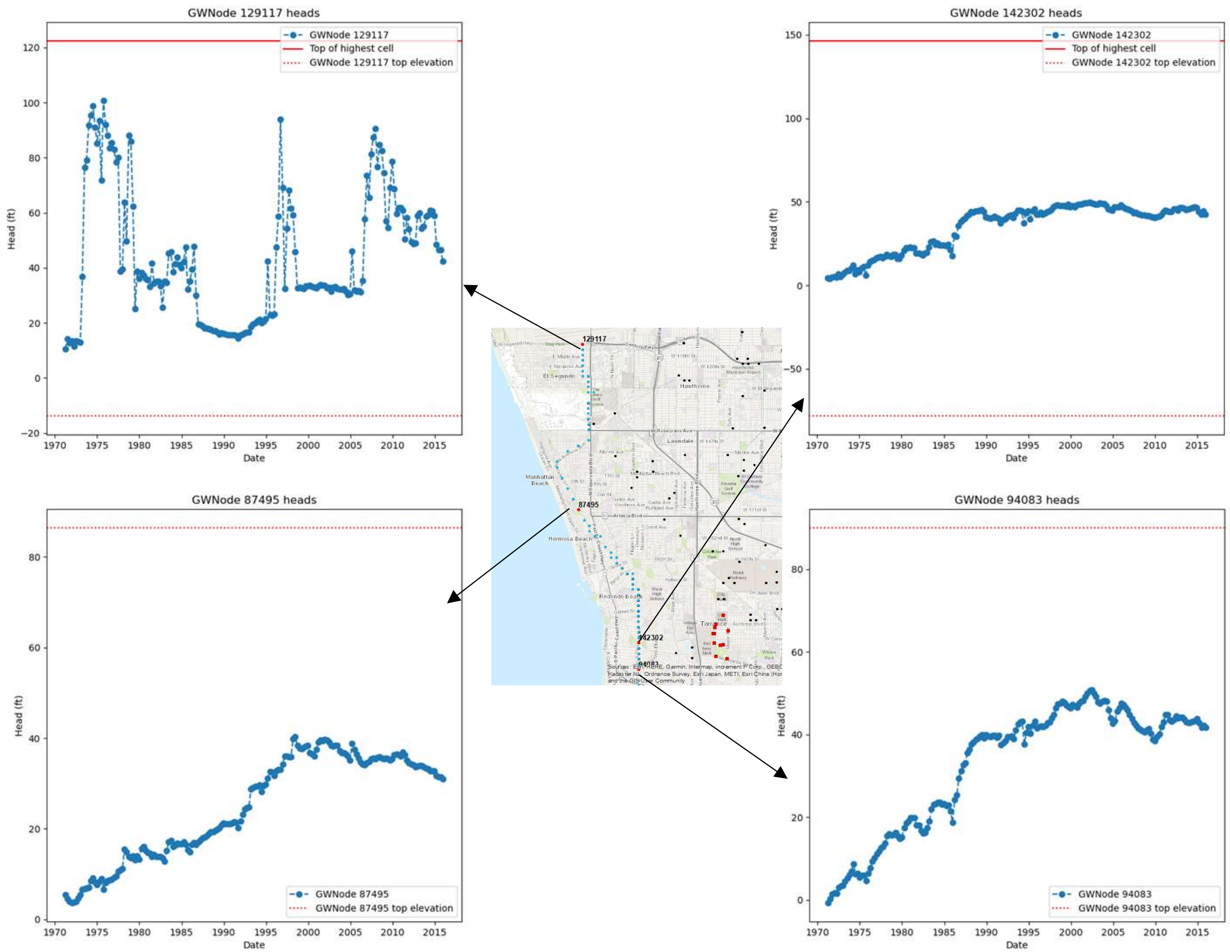
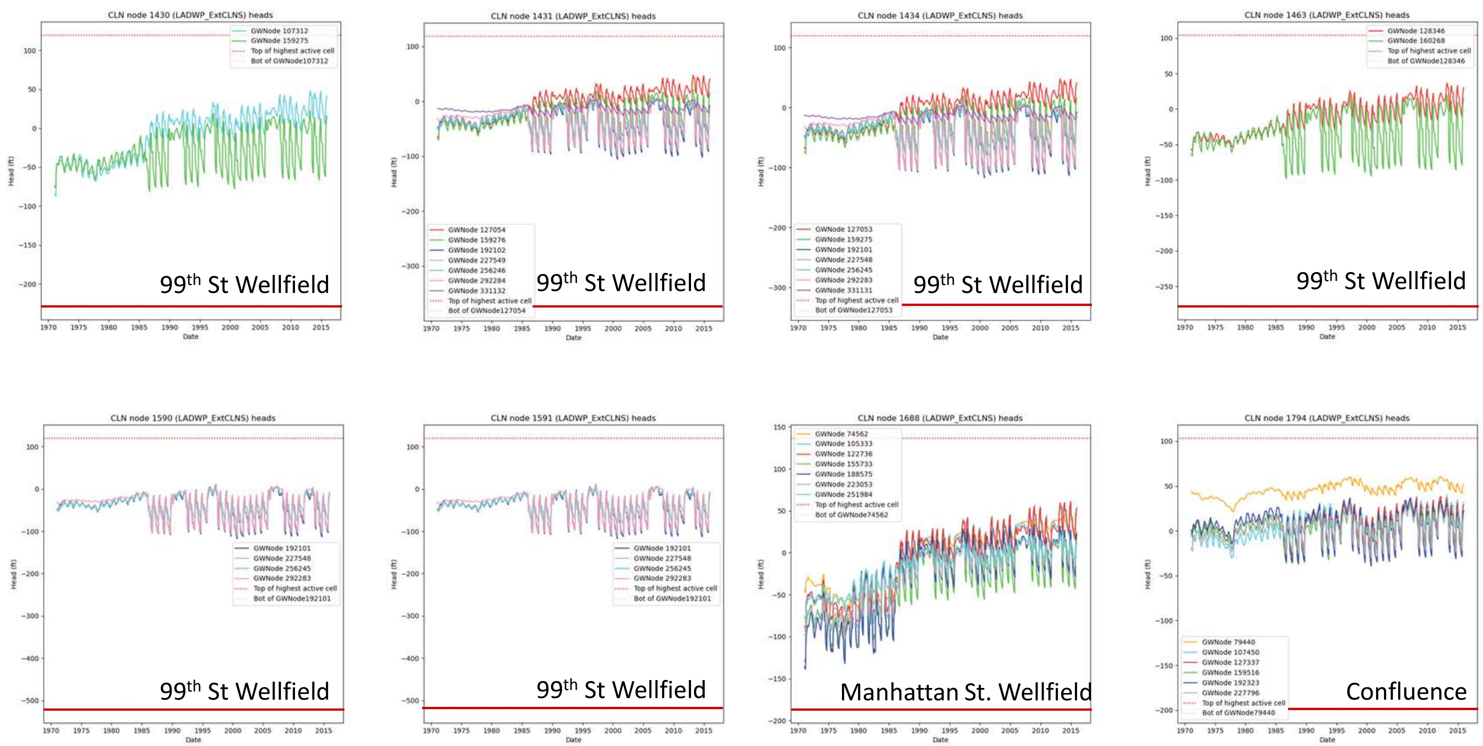


Figure 9f.
Scenario 6 Threshold Evaluation
Selected WCBB Well Locations

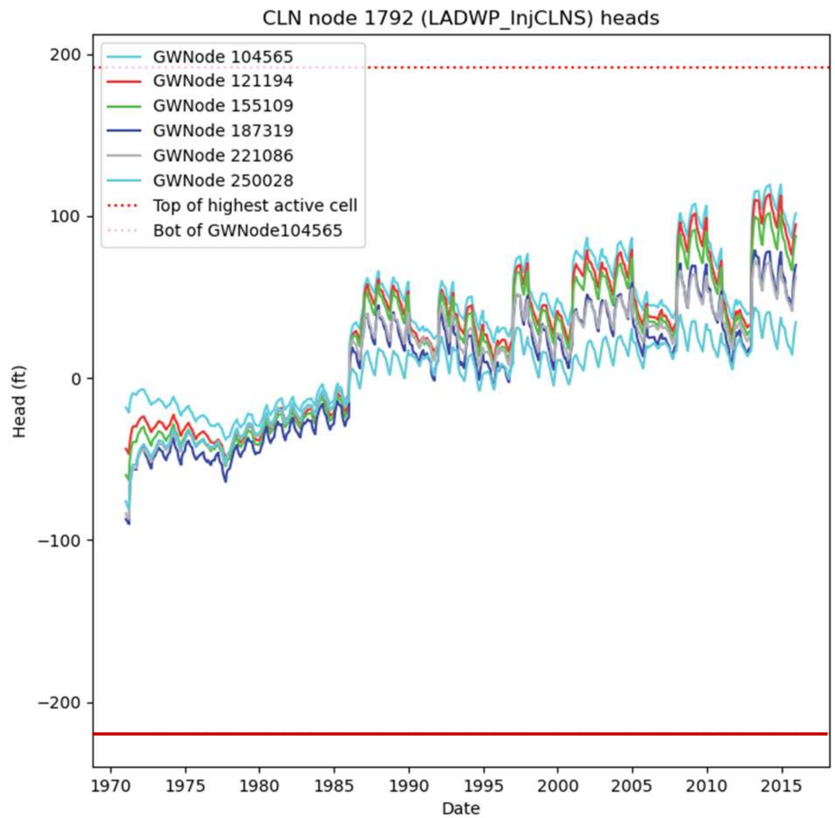
FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario6_final\postprocessing\barrier_recharge\png



INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

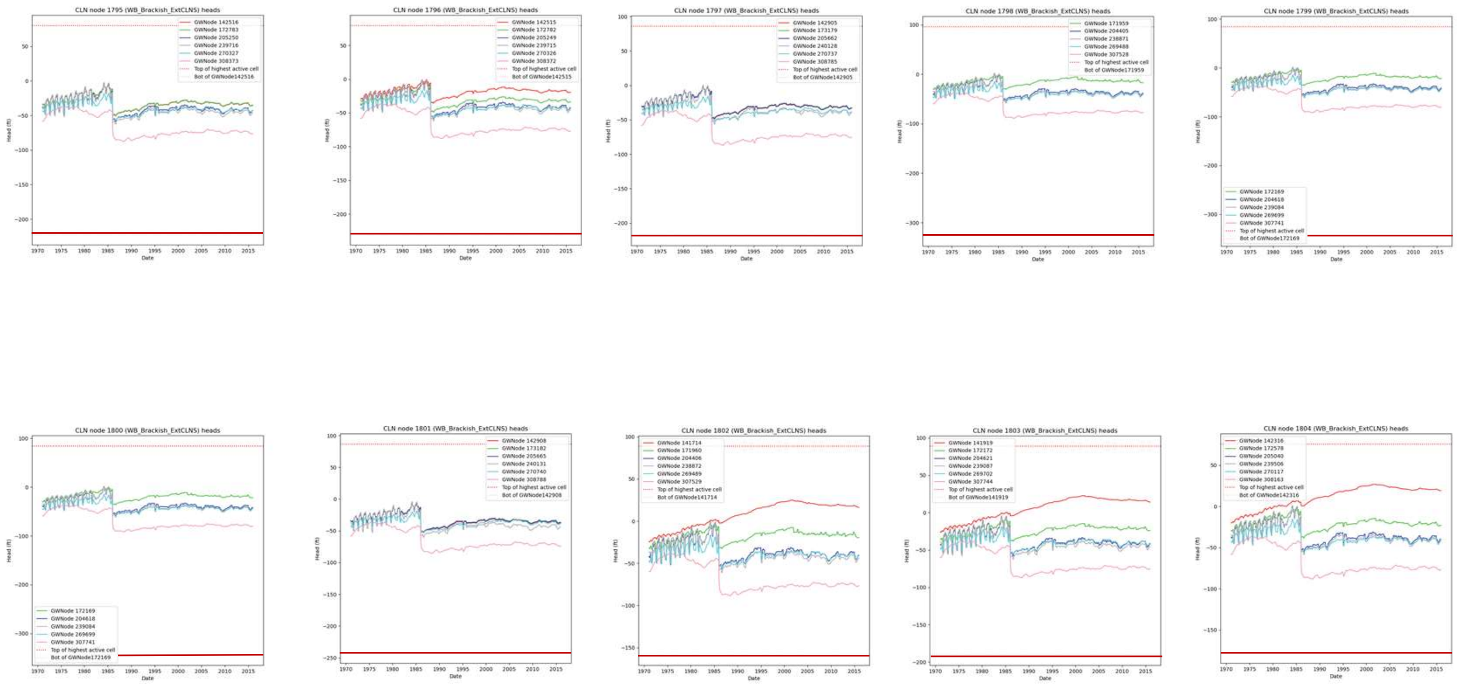
FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario7_final\postprocessing\clnheads\png

Figure 10a.
Scenario 7 Threshold Evaluation
LADWP Extraction Wells



FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario7_final\postprocessing\clnheads\png

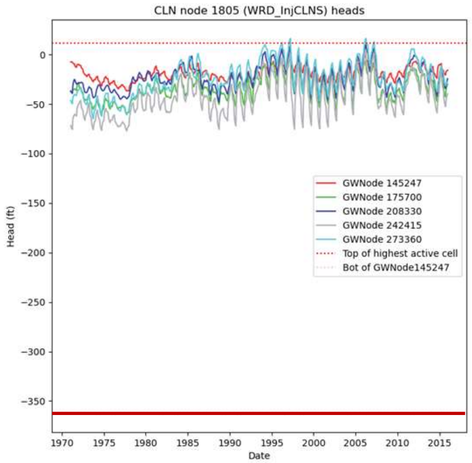
Figure 10b.
Scenario 7 Threshold Evaluation
LADWP Slauson Injection Well

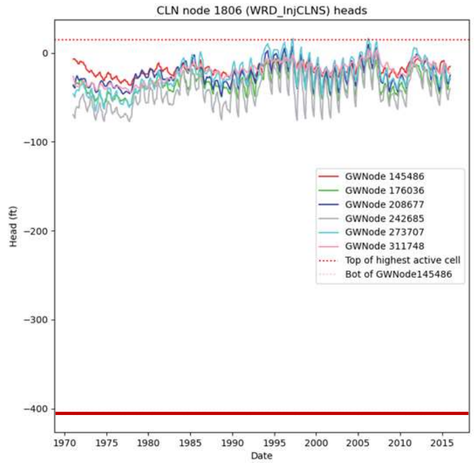


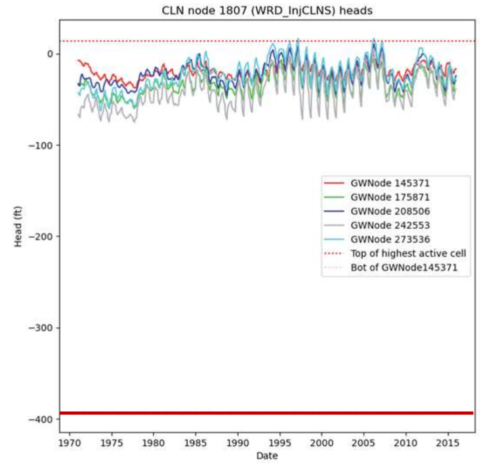
INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario7_final\postprocessing\clnheads\png

Figure 10c.
Scenario 7 Threshold Evaluation
RBWRP Extraction Wells



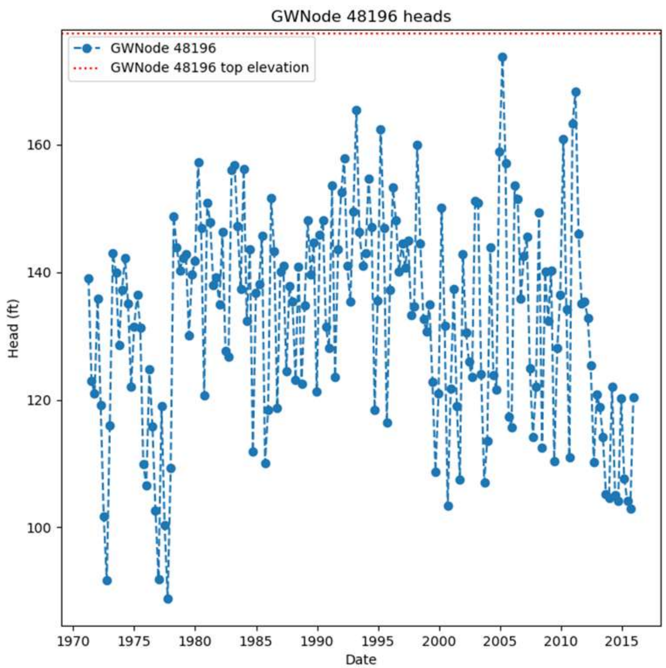


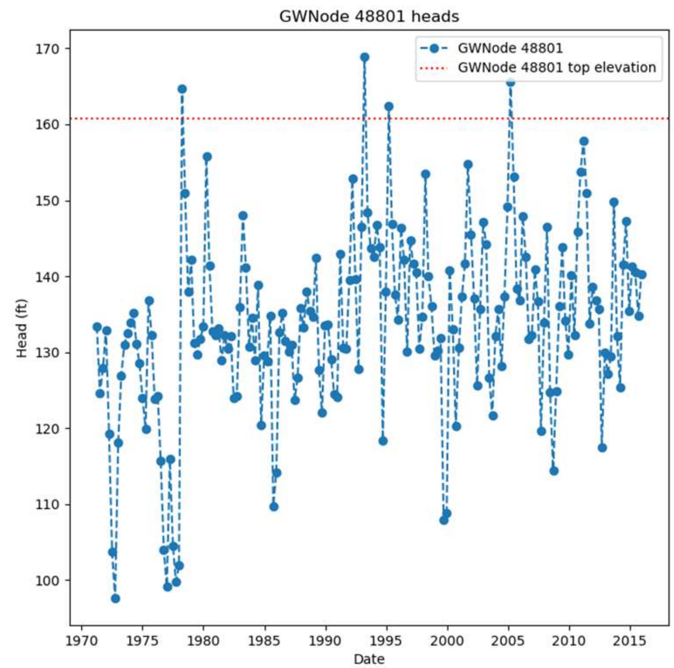


INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario7_final\postprocessing\clnheads\png

Figure 10d.
Scenario 7 Threshold Evaluation
WRD Injection Wells near LVL Facility

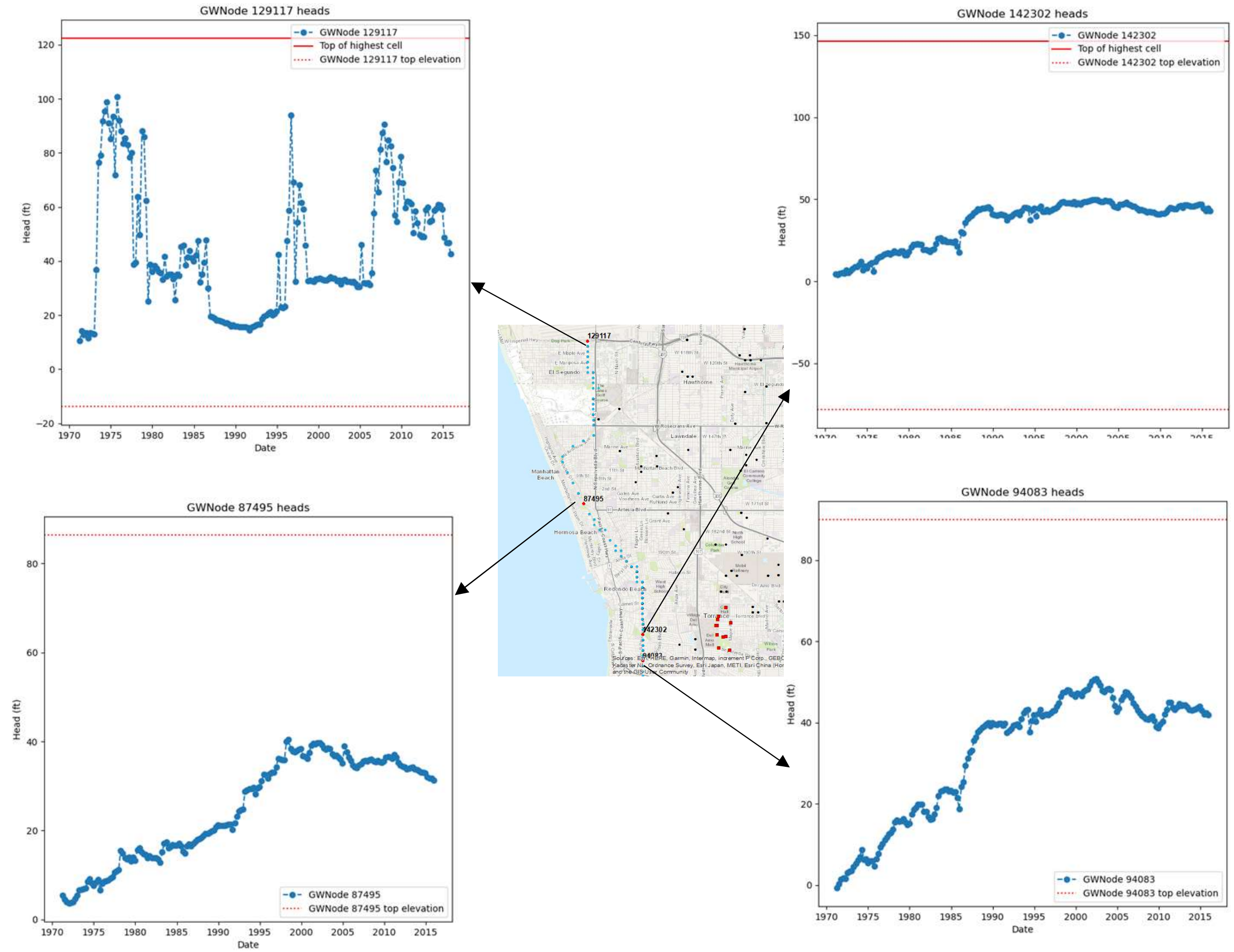




INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario7_final\postprocessing\barrier_recharge\png

Figure 10e.
Scenario 7 Threshold Evaluation
Selected Groundwater Nodes in
Montebello Forebay Spreading Grounds



FilePath: S:\LAX\JACOBS.C001.CNSLT\Task 3\INTERA_models\scenario7_final\postprocessing\barrier_recharge\png

Figure 10f.
Scenario 7 Threshold Evaluation
Selected WCBB Well Locations

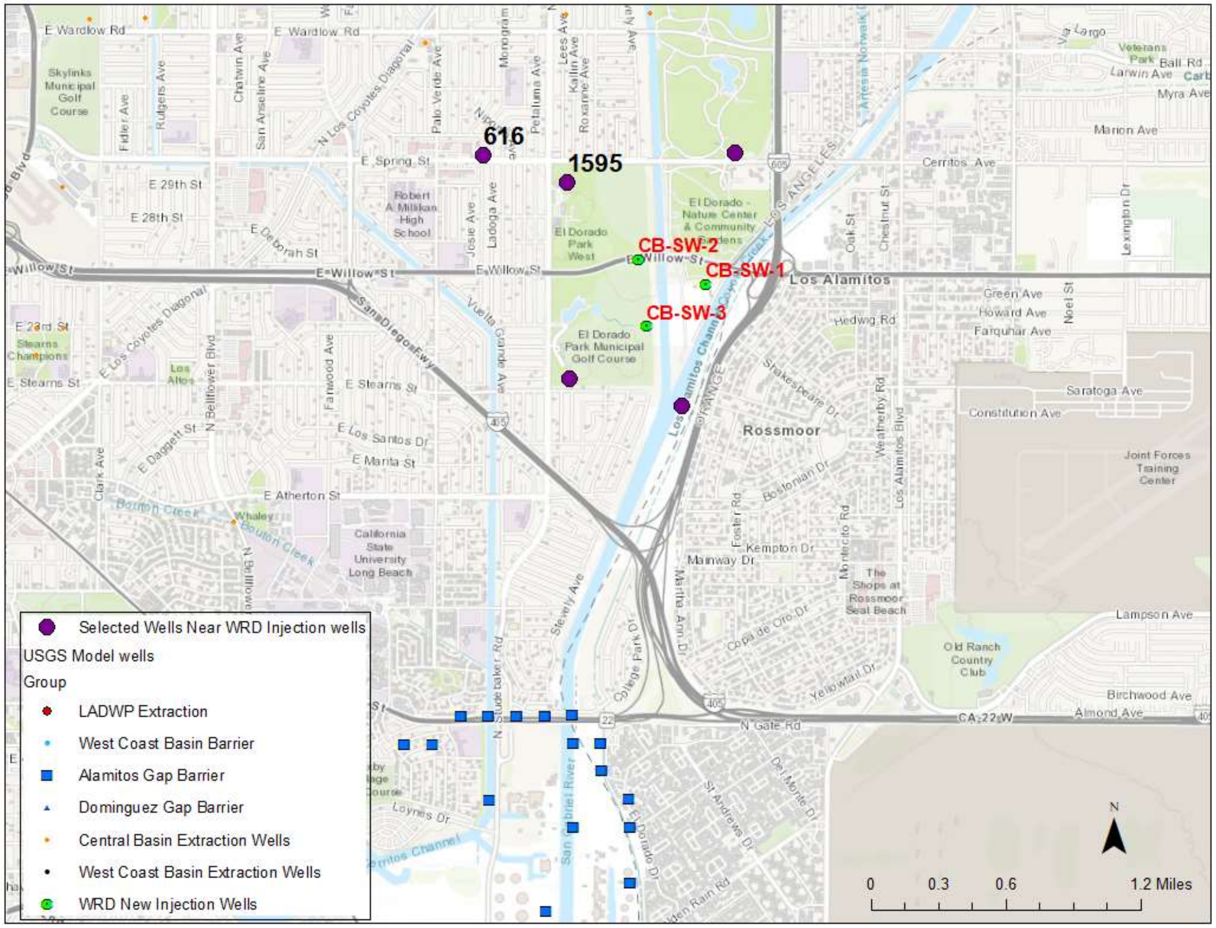
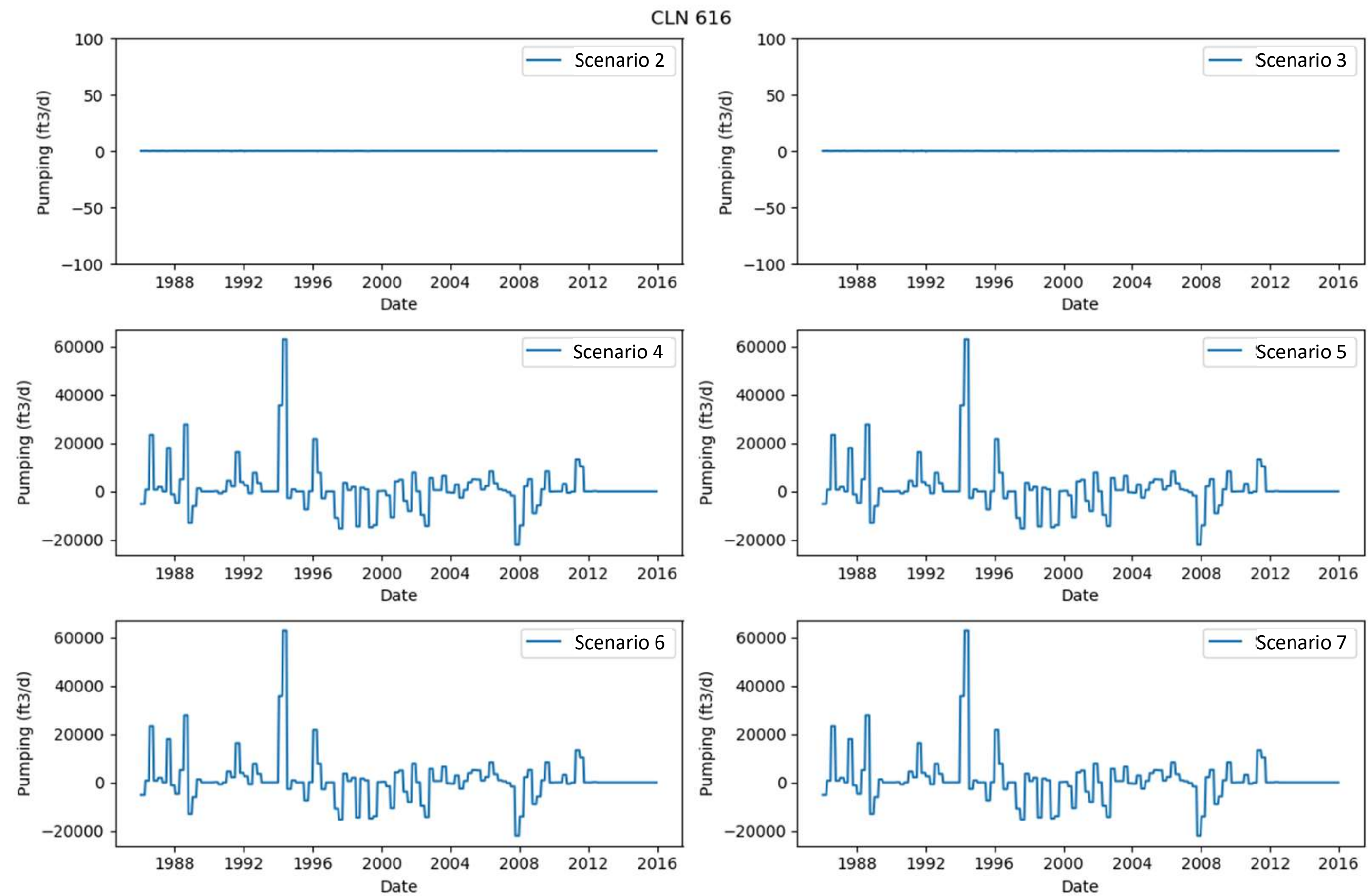
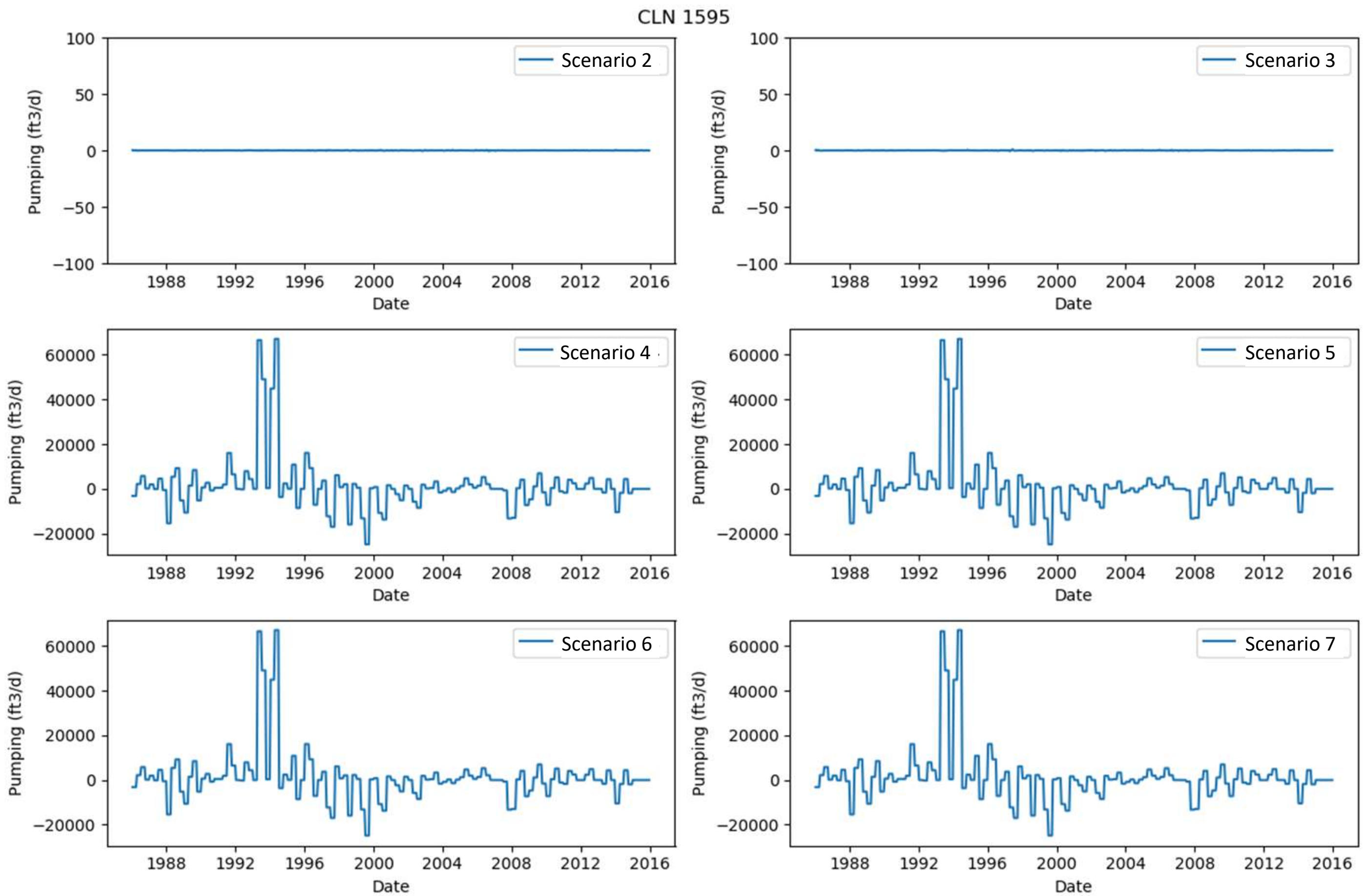


Figure 11a.
Central Basin Extraction Wells near proposed WRD Injection Wells



INTERA GEOSCIENCE & ENGINEERING SOLUTIONS

Figure 11b.
Applied Additional Extraction at well CLN 616 Near WRD Injection Wells



INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Figure 11c.
Applied Additional Extraction at well CLN 1595 Near WRD Injection Wells

Scenario 2 – Layer 5 – Stress Period 142 (2006 Q2)

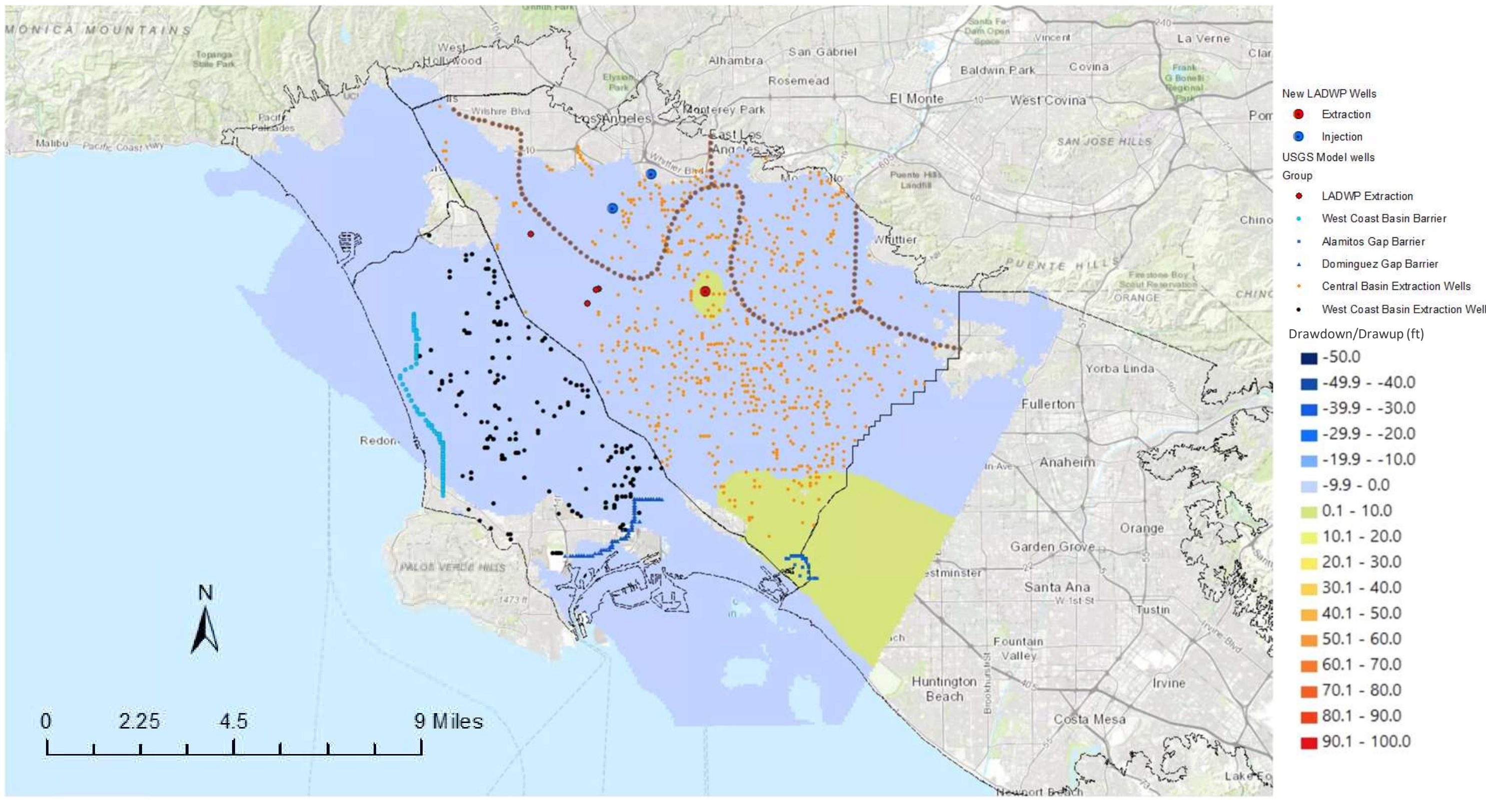


Figure 12a.
Scenario 2 Drawdown
Layer 5, Stress Period 142 (2006 Q2)

Scenario 2 – Layer 5 – Stress Period 155 (2009 Q3)

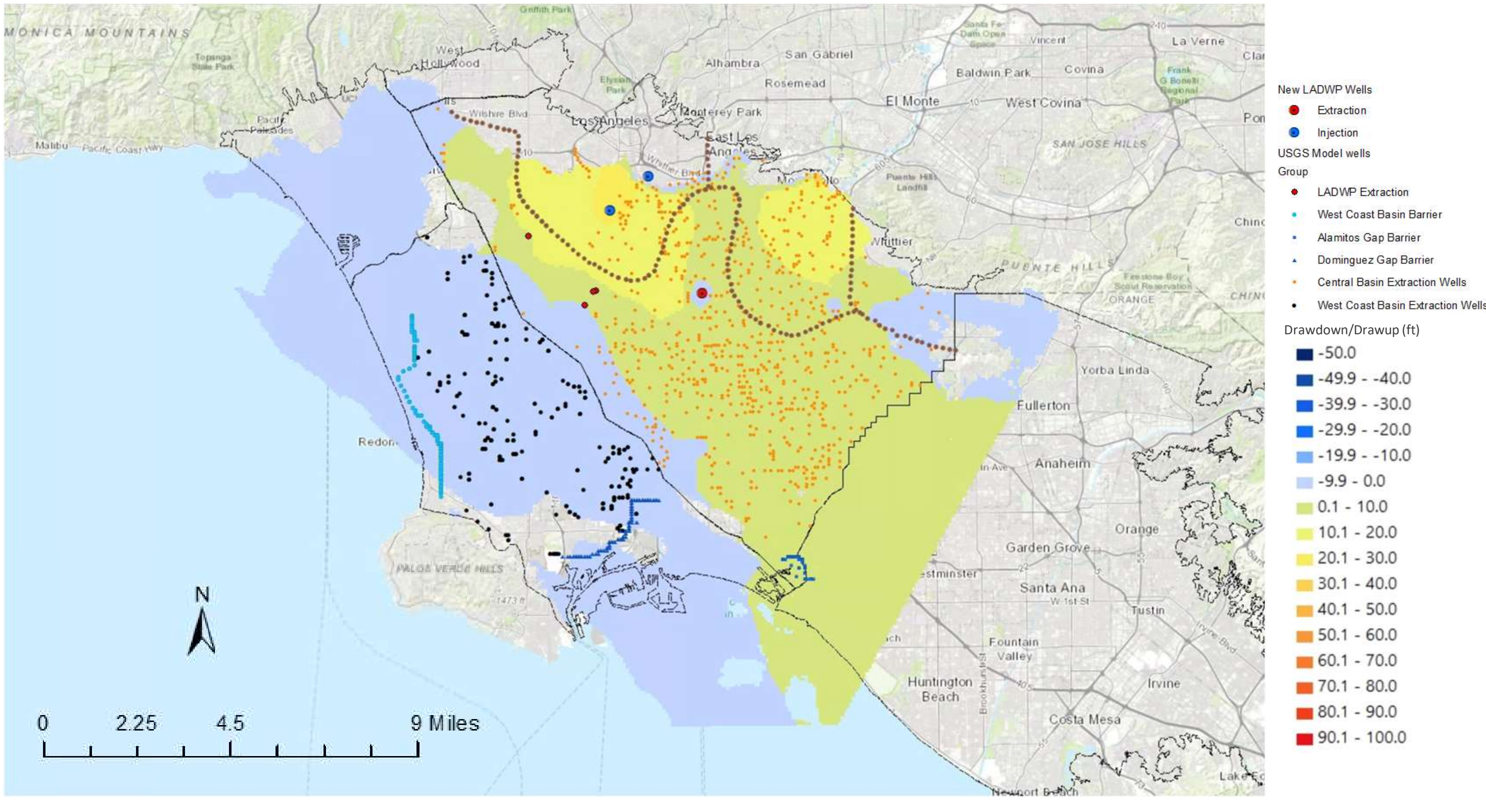


Figure 12b.
Scenario 2 Drawdown
Layer 5, Stress Period 155 (2009 Q3)

Scenario 2 – Layer 7 – Stress Period 142 (2006 Q2)

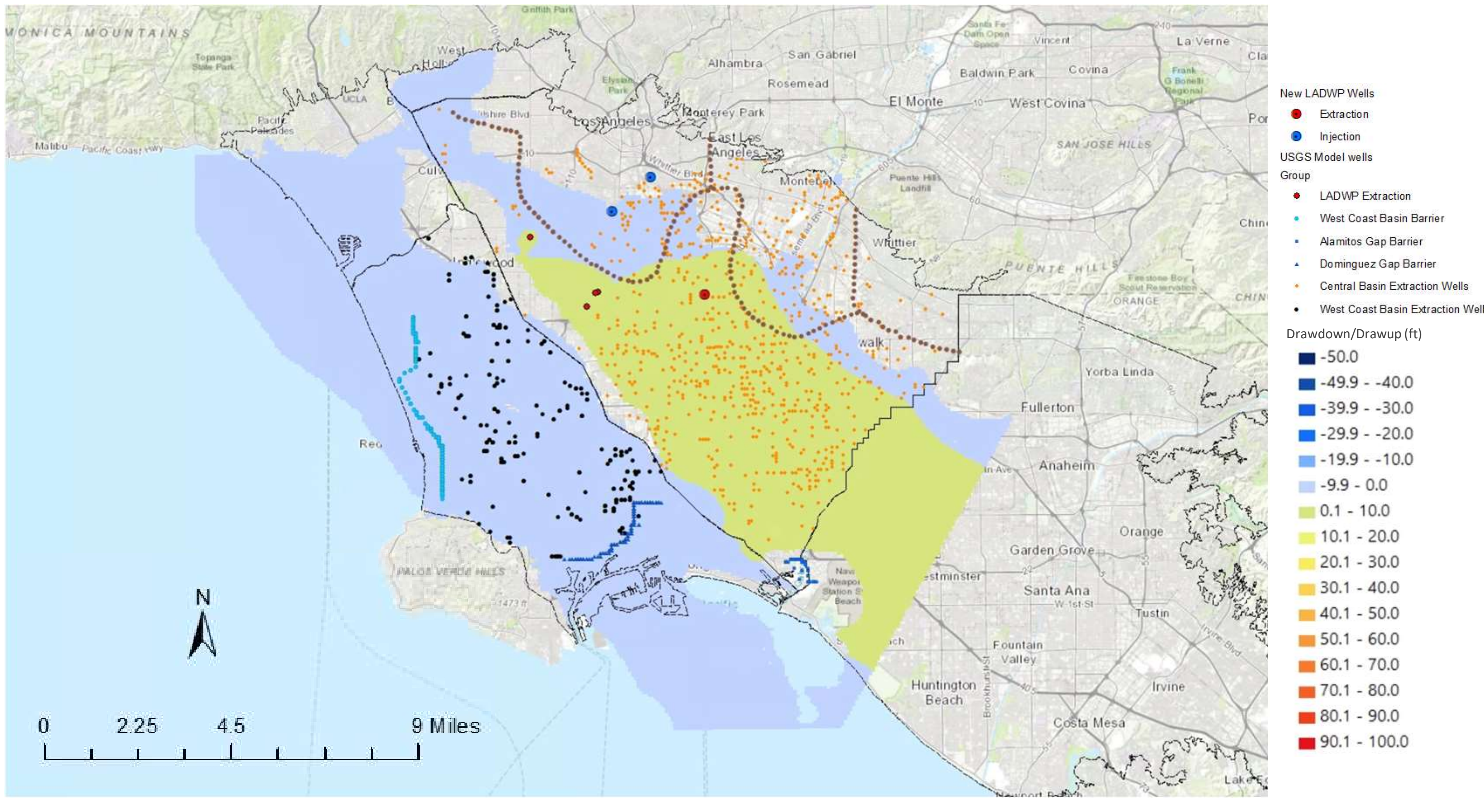


Figure 12c.
Scenario 2 Drawdown
Layer 7, Stress Period 142 (2006 Q2)

Scenario 2 – Layer 7 – Stress Period 155 (2009 Q3)

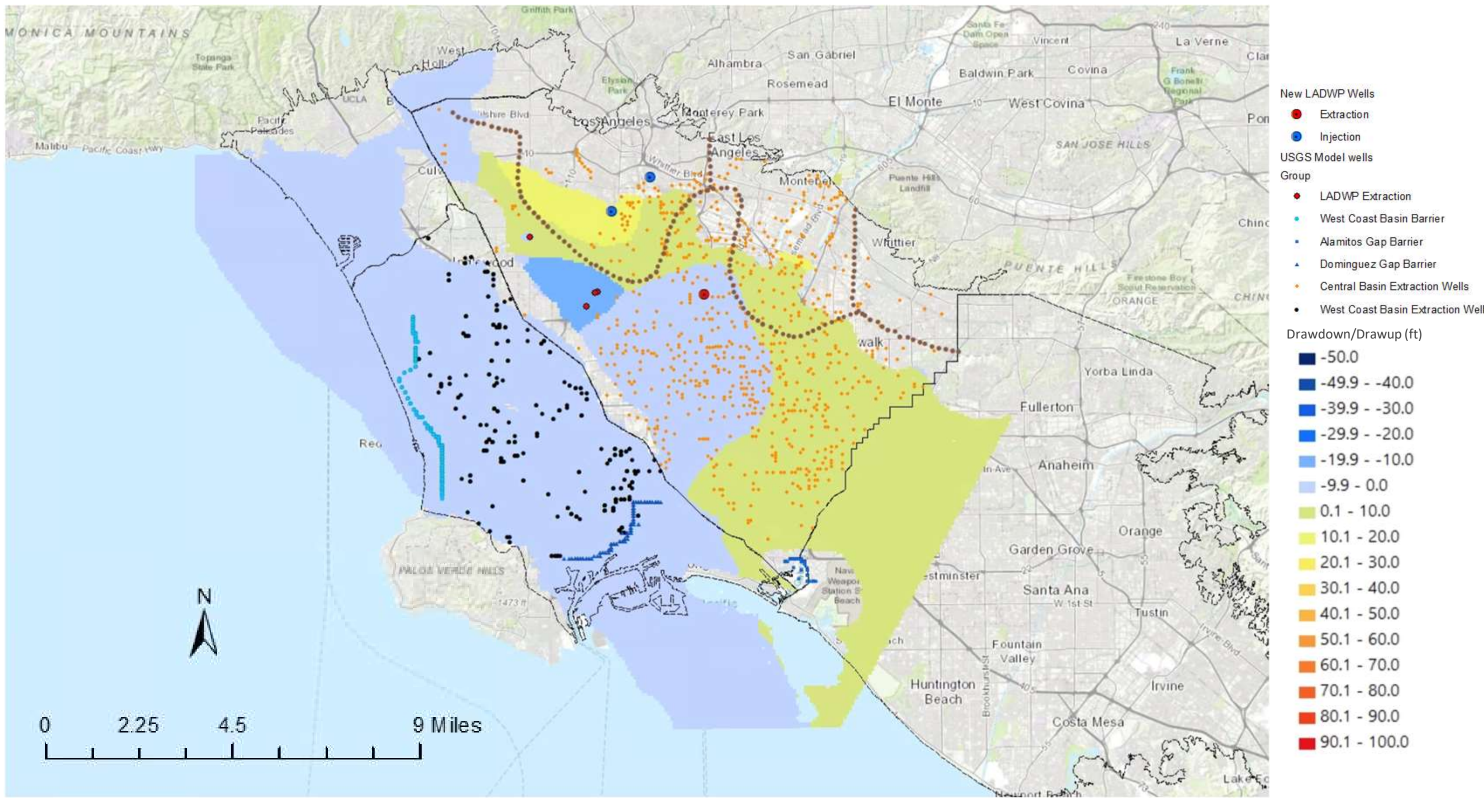


Figure 12d.
Scenario 2 Drawdown
Layer 7, Stress Period 155 (2009 Q3)

Scenario 3 – Layer 5 – Stress Period 142 (2006 Q2)

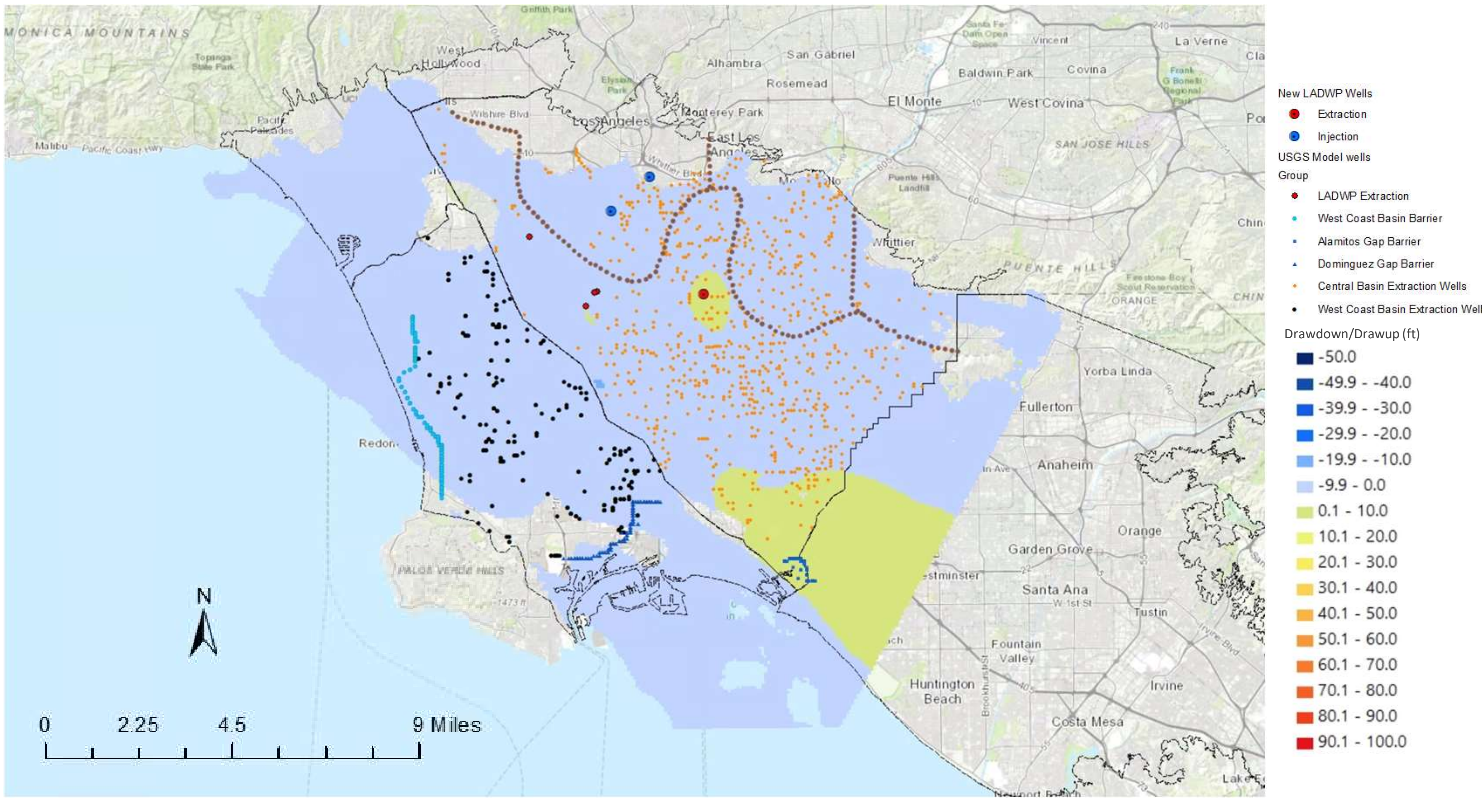


Figure 13a.
Scenario 3 Drawdown
Layer 5, Stress Period 142 (2006 Q2)

Scenario 3 – Layer 5 – Stress Period 155 (2009 Q3)

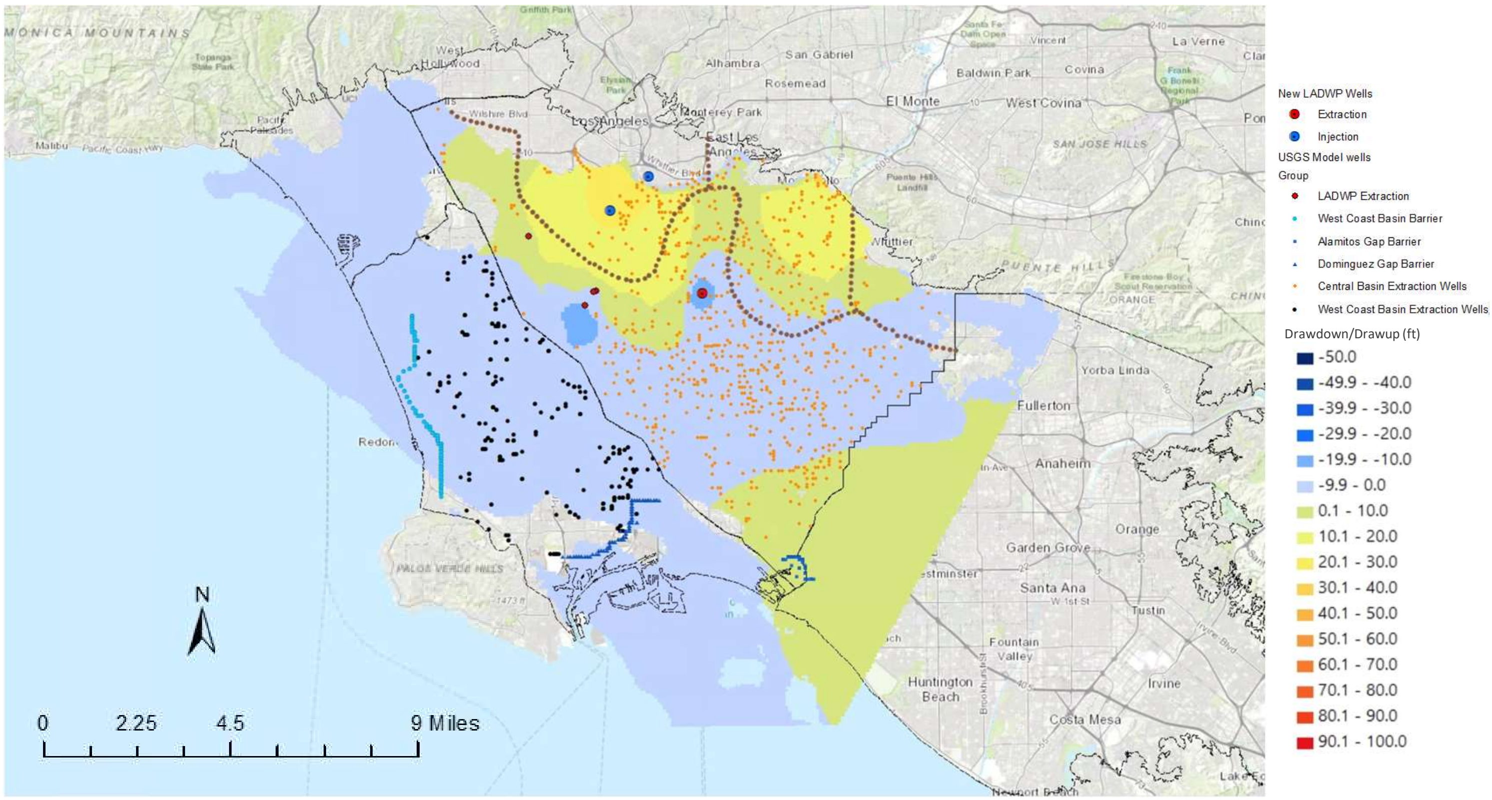


Figure 13b.
Scenario 3 Drawdown
Layer 5, Stress Period 155 (2009 Q3)

Scenario 3 – Layer 7 – Stress Period 142 (2006 Q2)

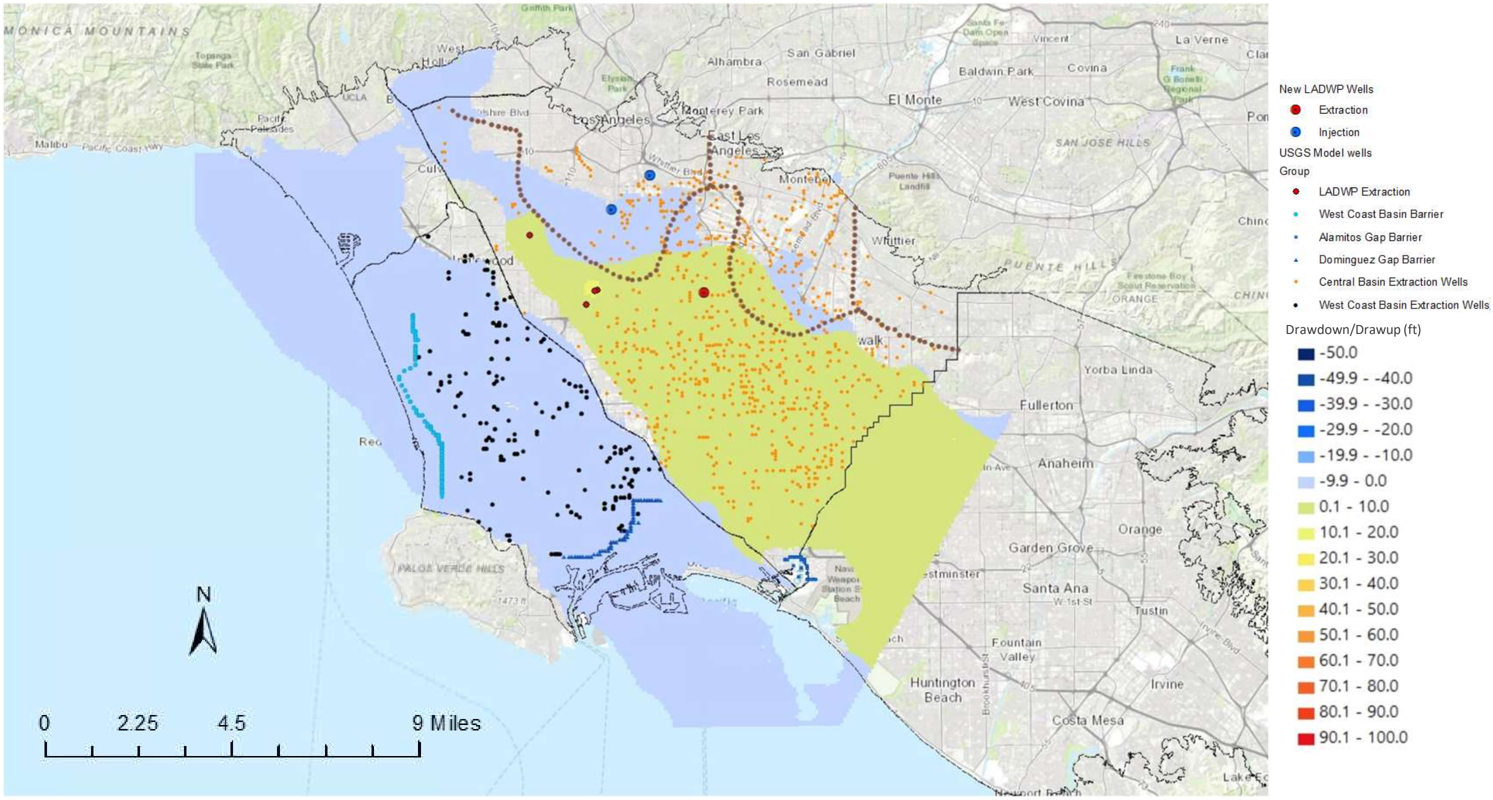


Figure 13c.
Scenario 3 Drawdown
Layer 7, Stress Period 142 (2006 Q2)

Scenario 3 – Layer 7 – Stress Period 155 (2009 Q3)

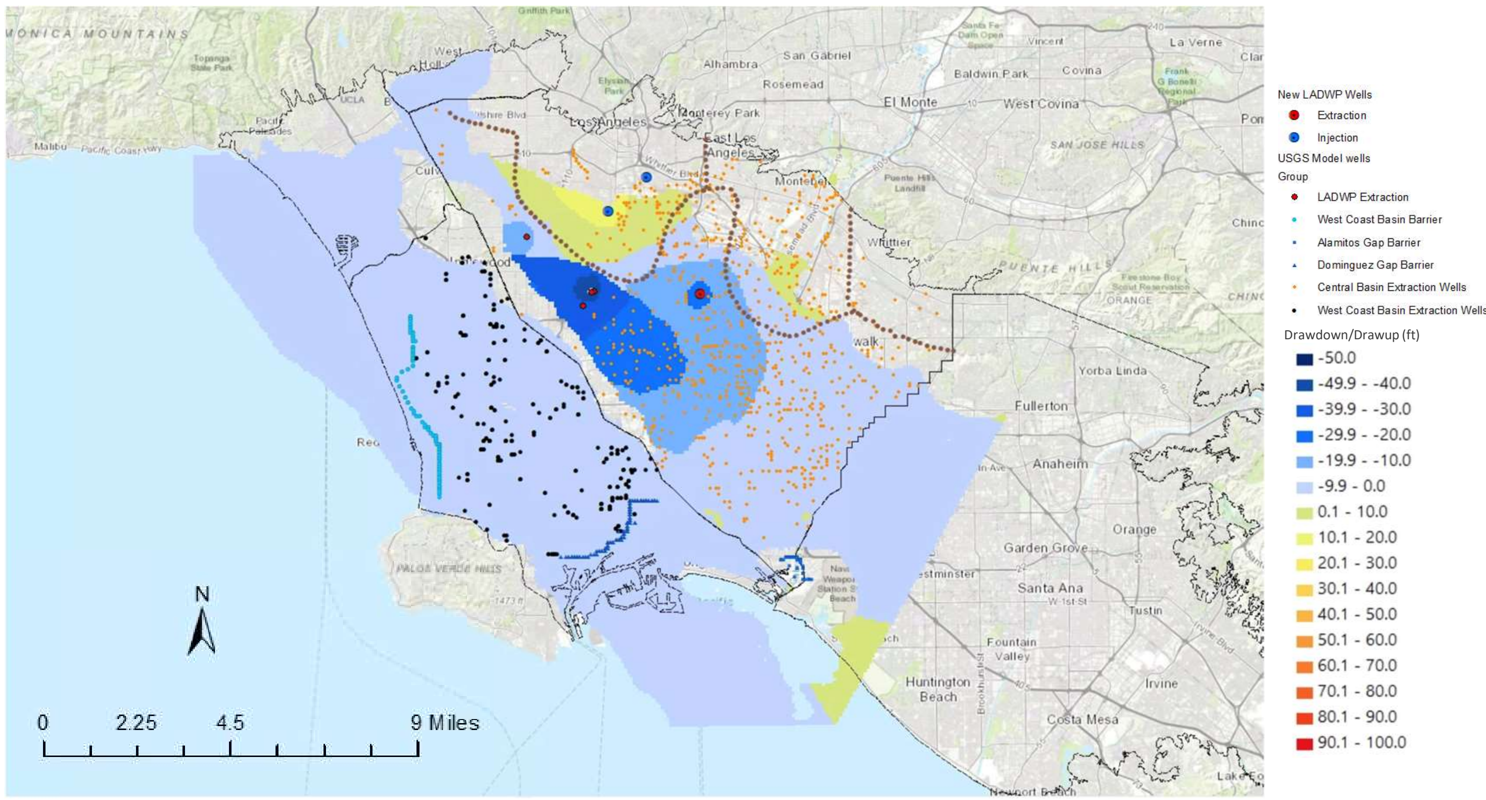


Figure 13d.
Scenario 3 Drawdown
Layer 7, Stress Period 155 (2009 Q3)

Scenario 4 – Layer 5 – Stress Period 142 (2006 Q2)

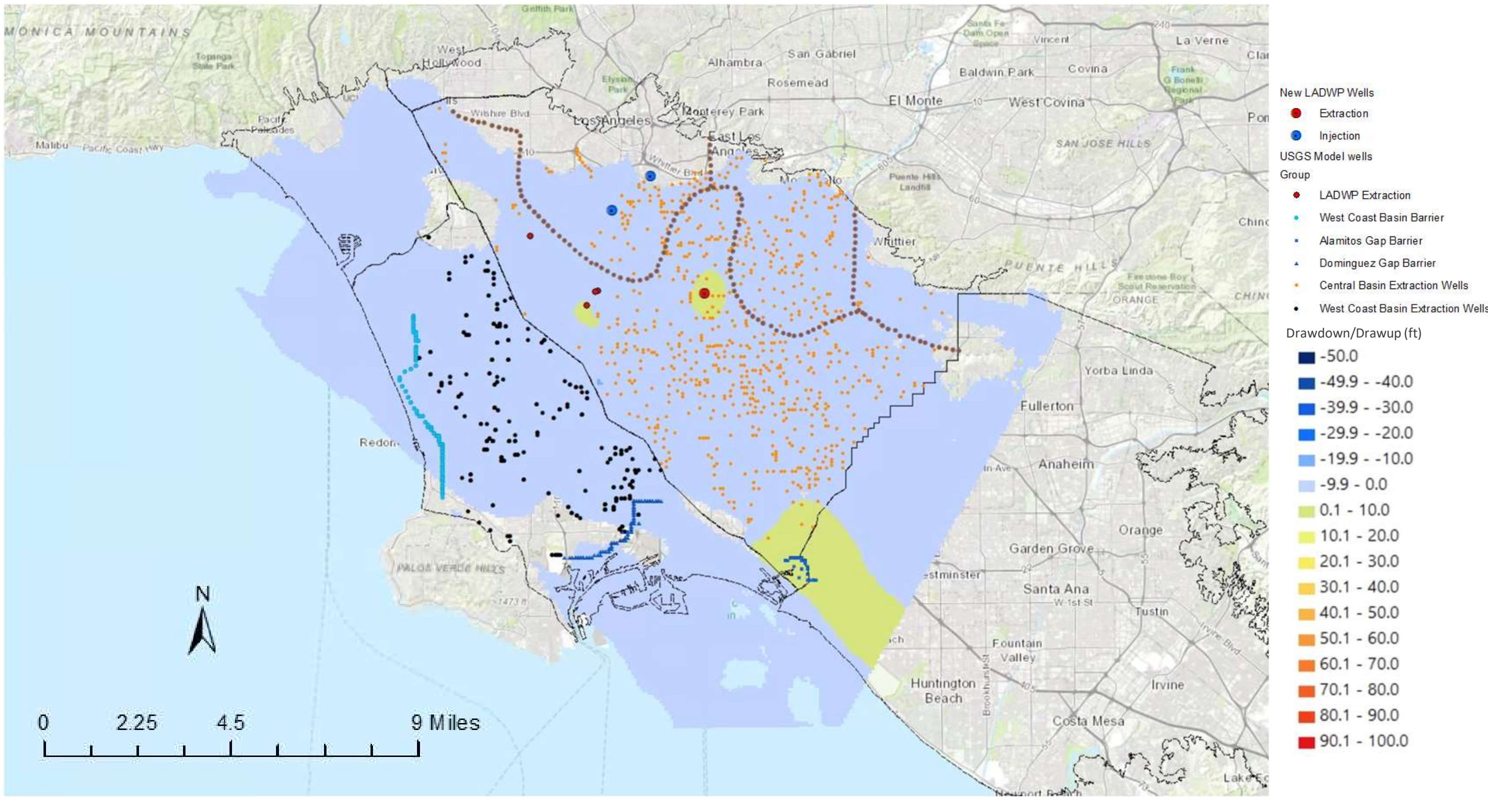


Figure 14a.
Scenario 4 Drawdown
Layer 5, Stress Period 142 (2006 Q2)

Scenario 4 – Layer 5 – Stress Period 155 (2009 Q3)

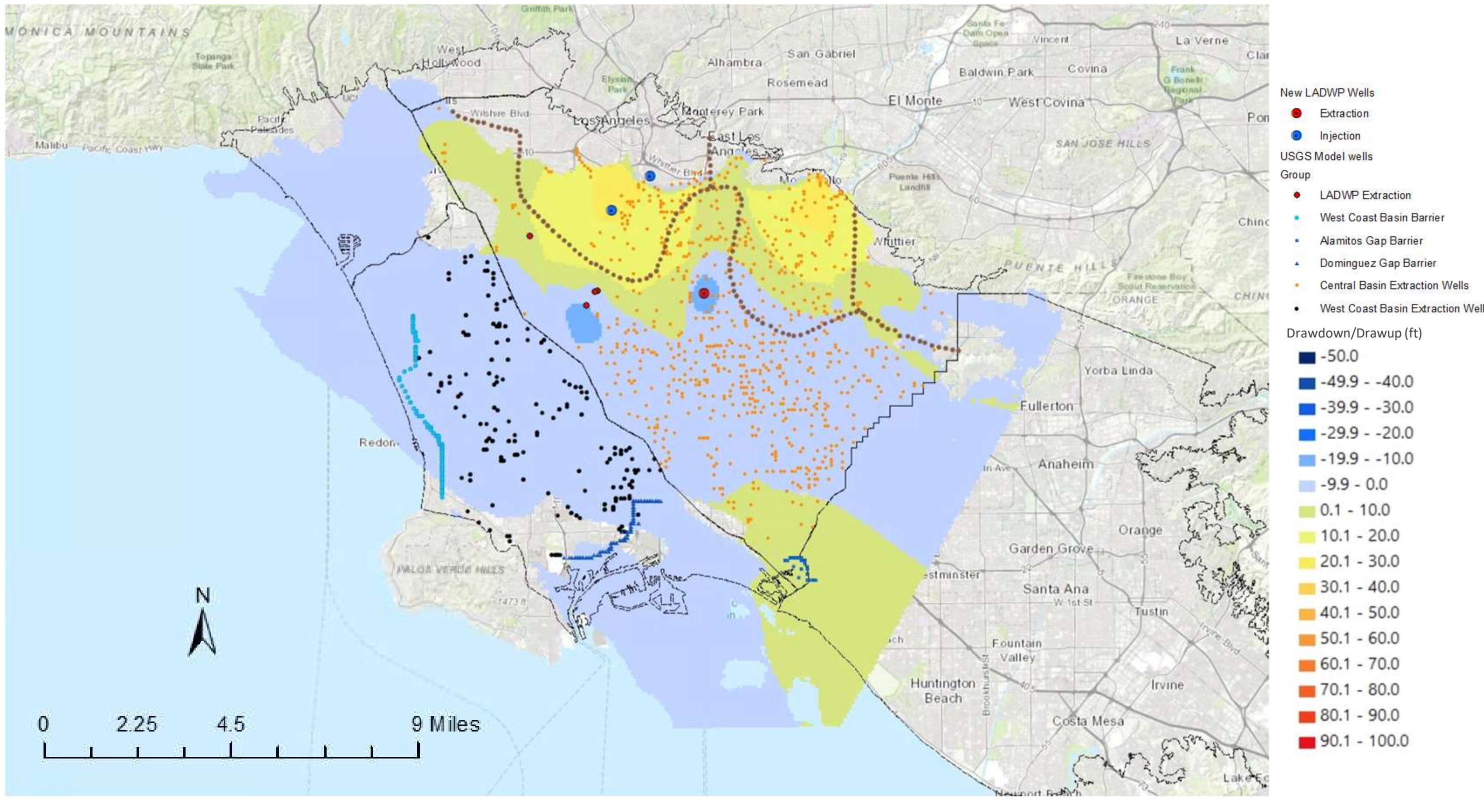


Figure 14b.
Scenario 4 Drawdown
Layer 5, Stress Period 155 (2009 Q3)

Scenario 4 – Layer 7 – Stress Period 142 (2006 Q2)

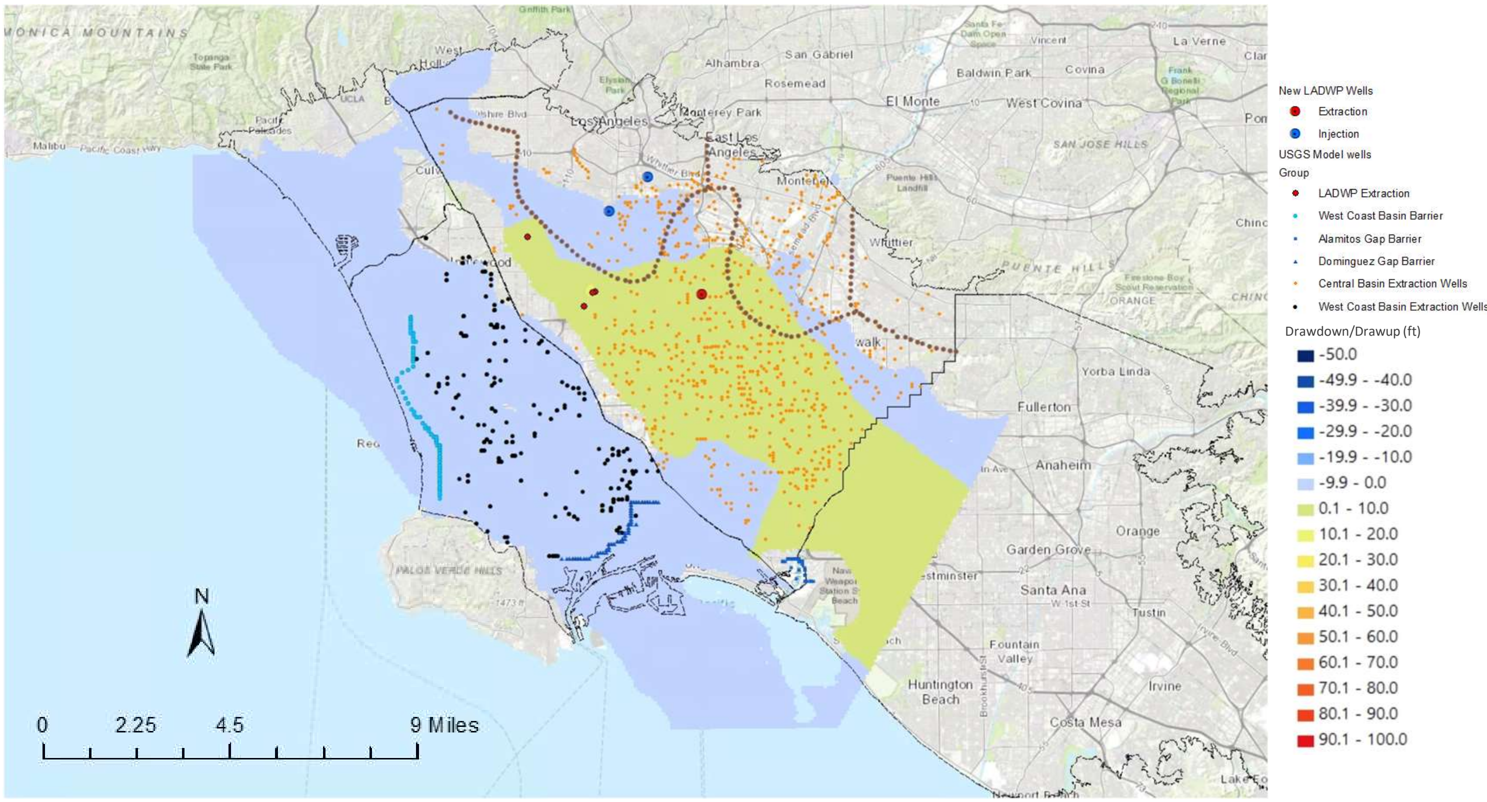


Figure 14c.
Scenario 4 Drawdown
Layer 7, Stress Period 142 (2006 Q2)

Scenario 4 – Layer 7 – Stress Period 155 (2009 Q3)

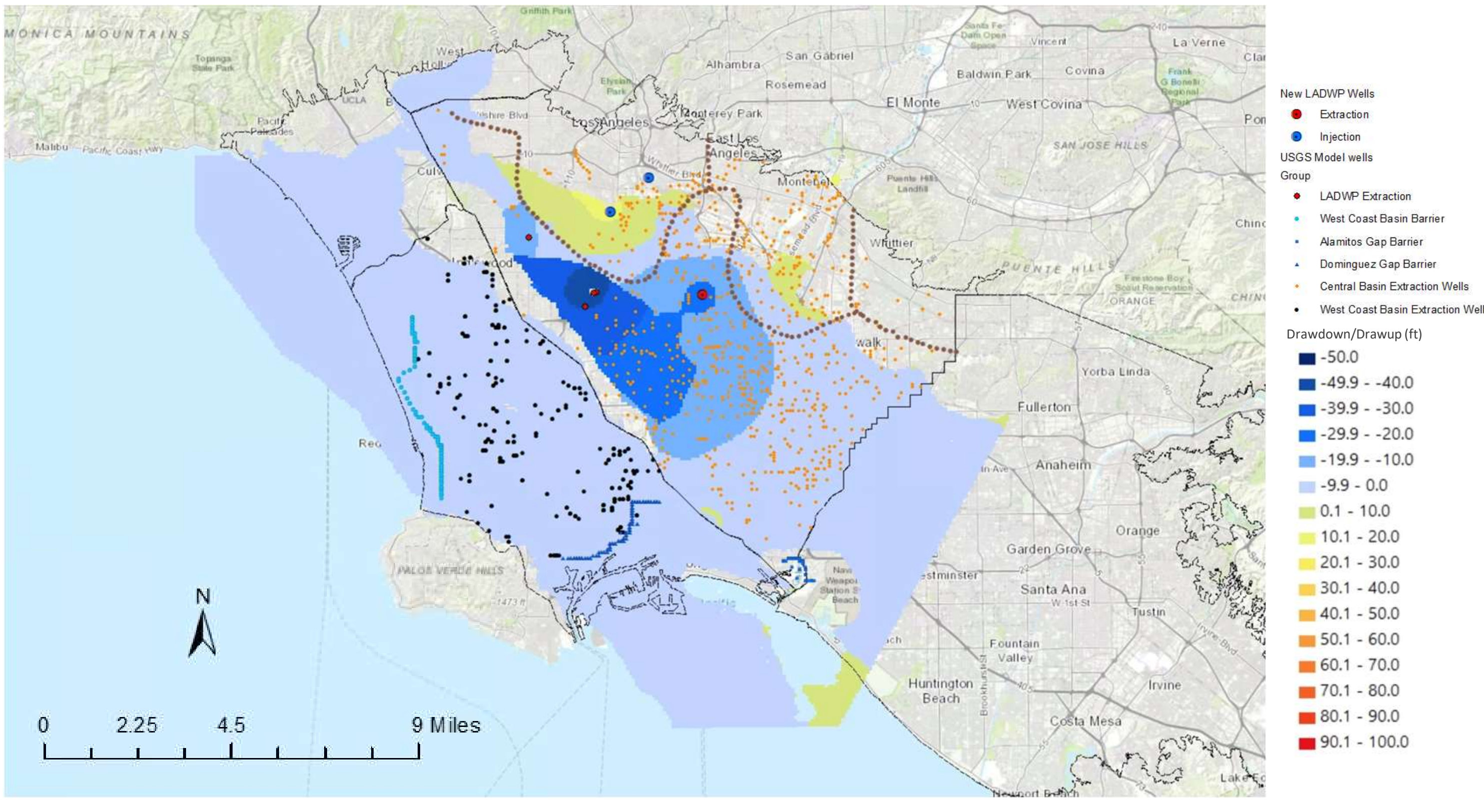


Figure 14d.
Scenario 4 Drawdown
Layer 7, Stress Period 155 (2009 Q3)

Scenario 5 – Layer 5 – Stress Period 142 (2006 Q2)

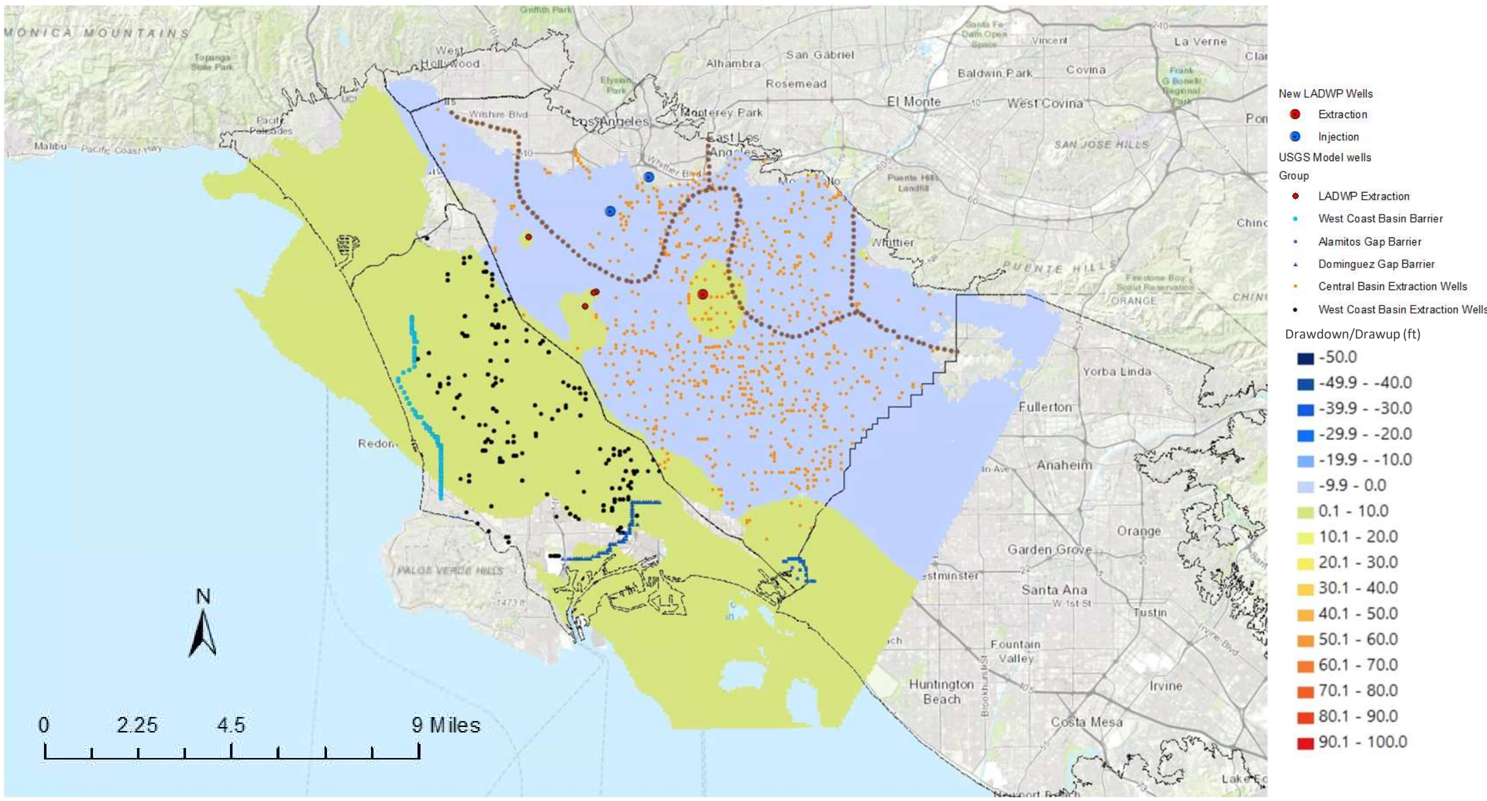


Figure 15a.
Scenario 5 Drawdown
Layer 5, Stress Period 142 (2006 Q2)

Scenario 5 – Layer 5 – Stress Period 155 (2009 Q3)

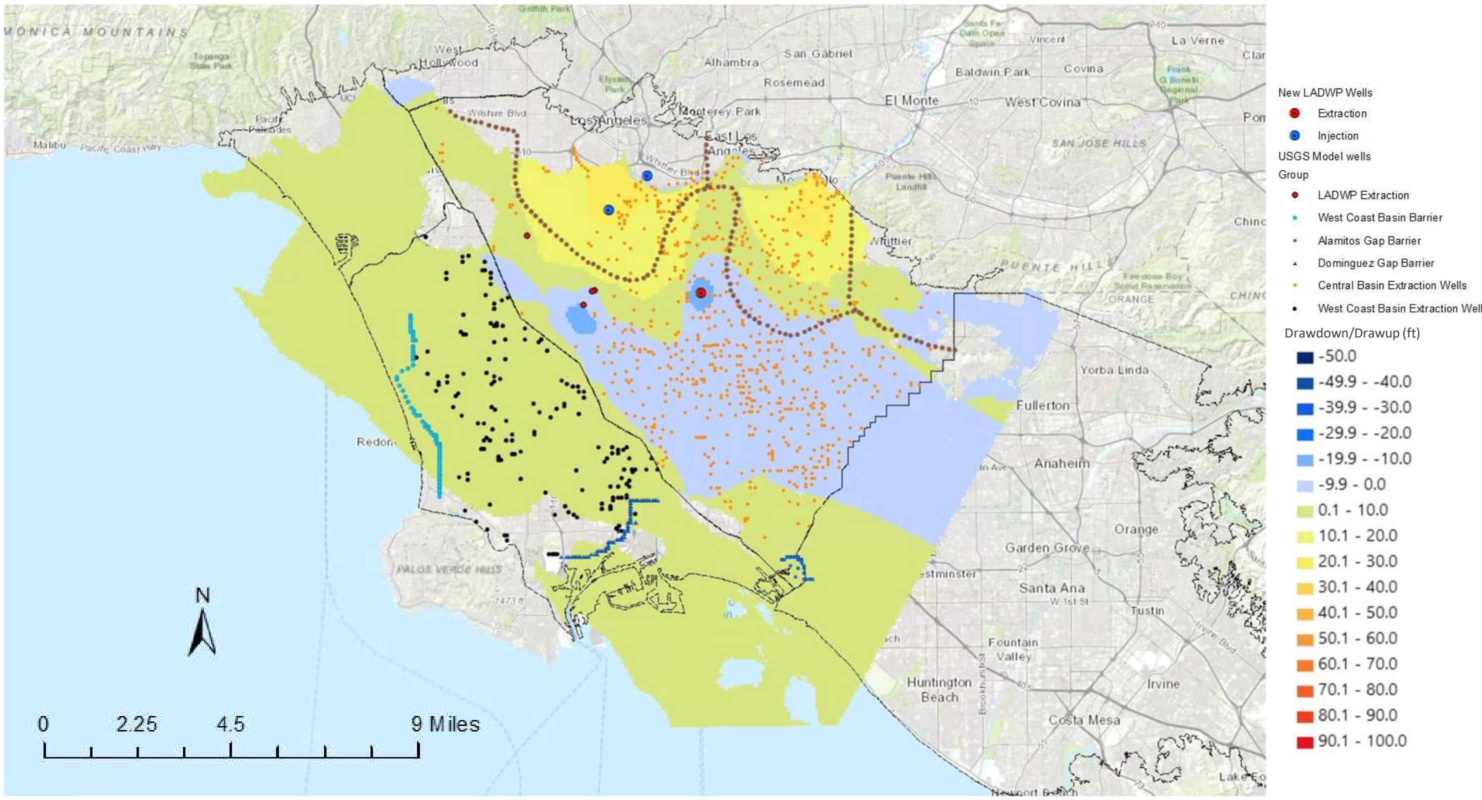


Figure 15b.
Scenario 5 Drawdown
Layer 5, Stress Period 155 (2009 Q3)

Scenario 5 – Layer 7 – Stress Period 142 (2006 Q2)

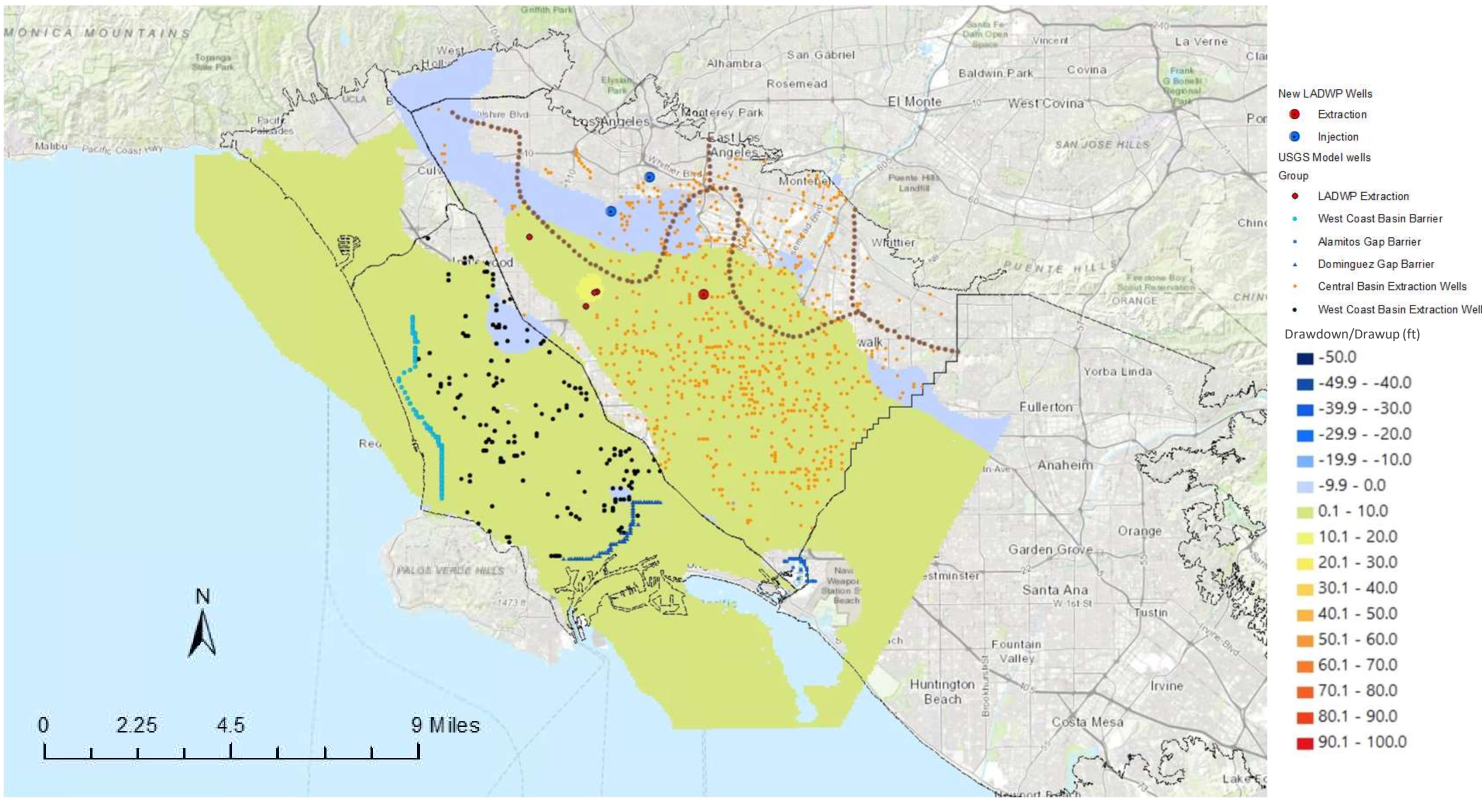


Figure 15c.
Scenario 5 Drawdown
Layer 7, Stress Period 142 (2006 Q2)

Scenario 5 – Layer 7 – Stress Period 155 (2009 Q3)

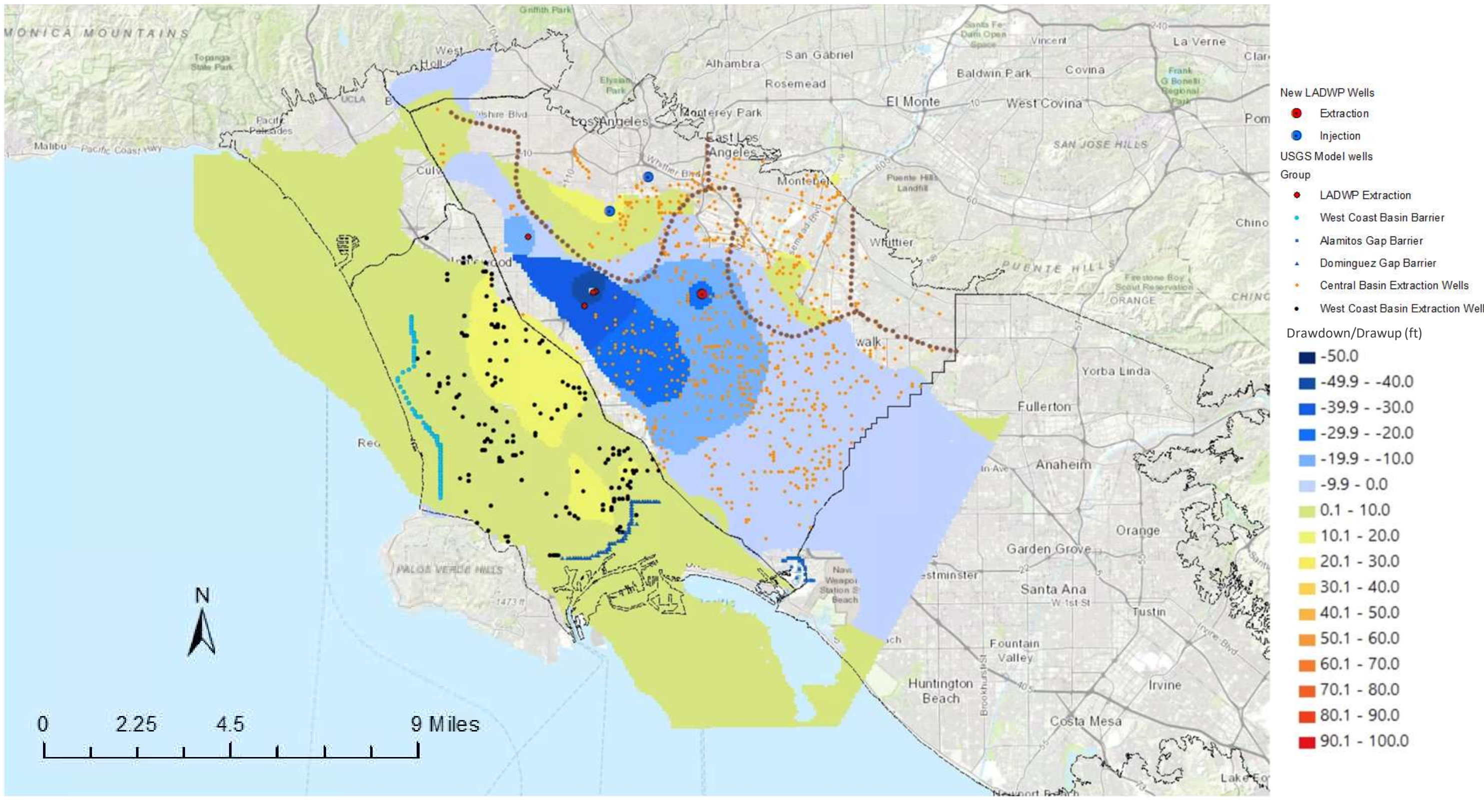


Figure 15d.
Scenario 5 Drawdown
Layer 7, Stress Period 155 (2009 Q3)

Scenario 6 – Layer 5 – Stress Period 142 (2006 Q2)

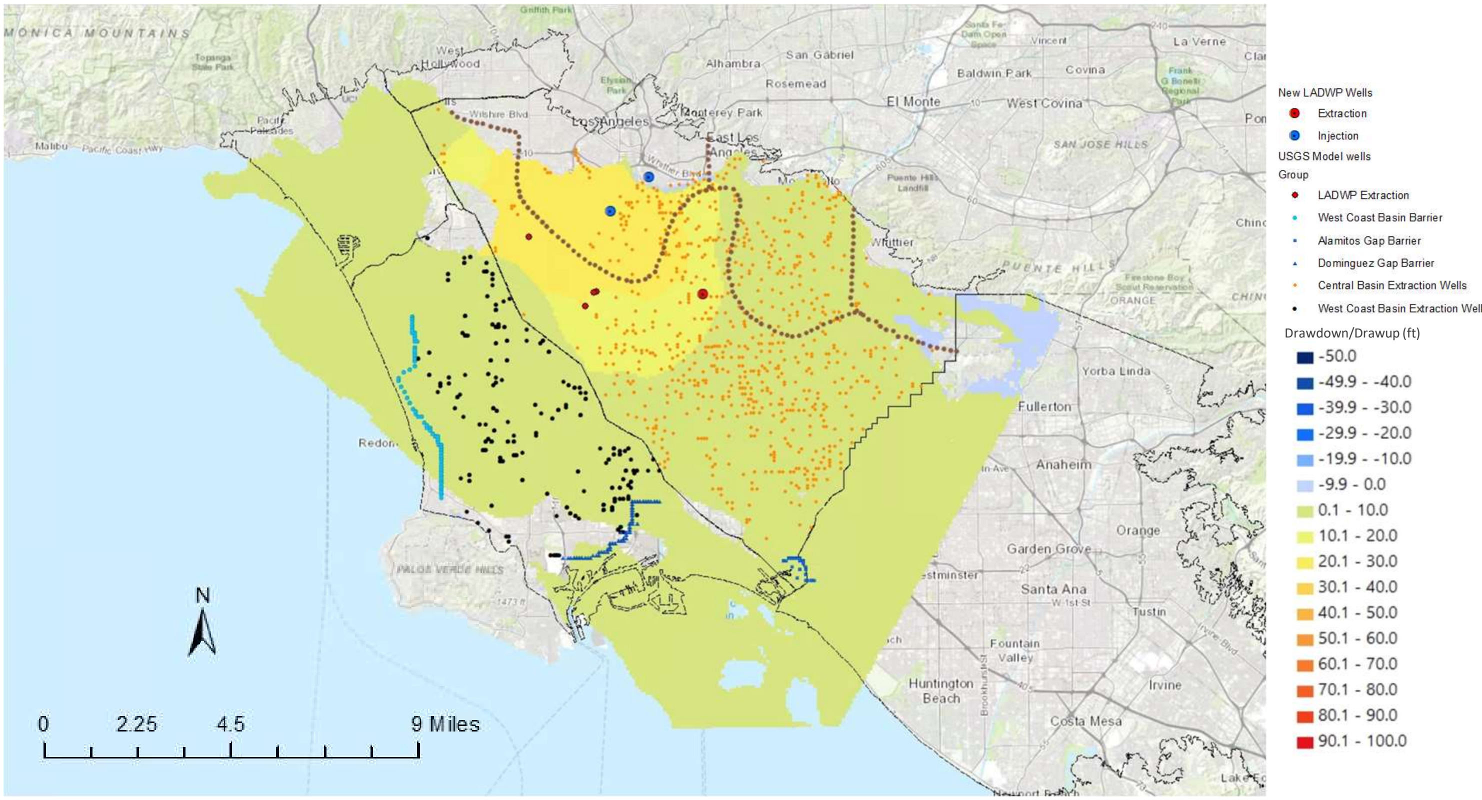


Figure 16a.
Scenario 6 Drawdown
Layer 5, Stress Period 142 (2006 Q2)

Scenario 6 – Layer 5 – Stress Period 155 (2009 Q3)

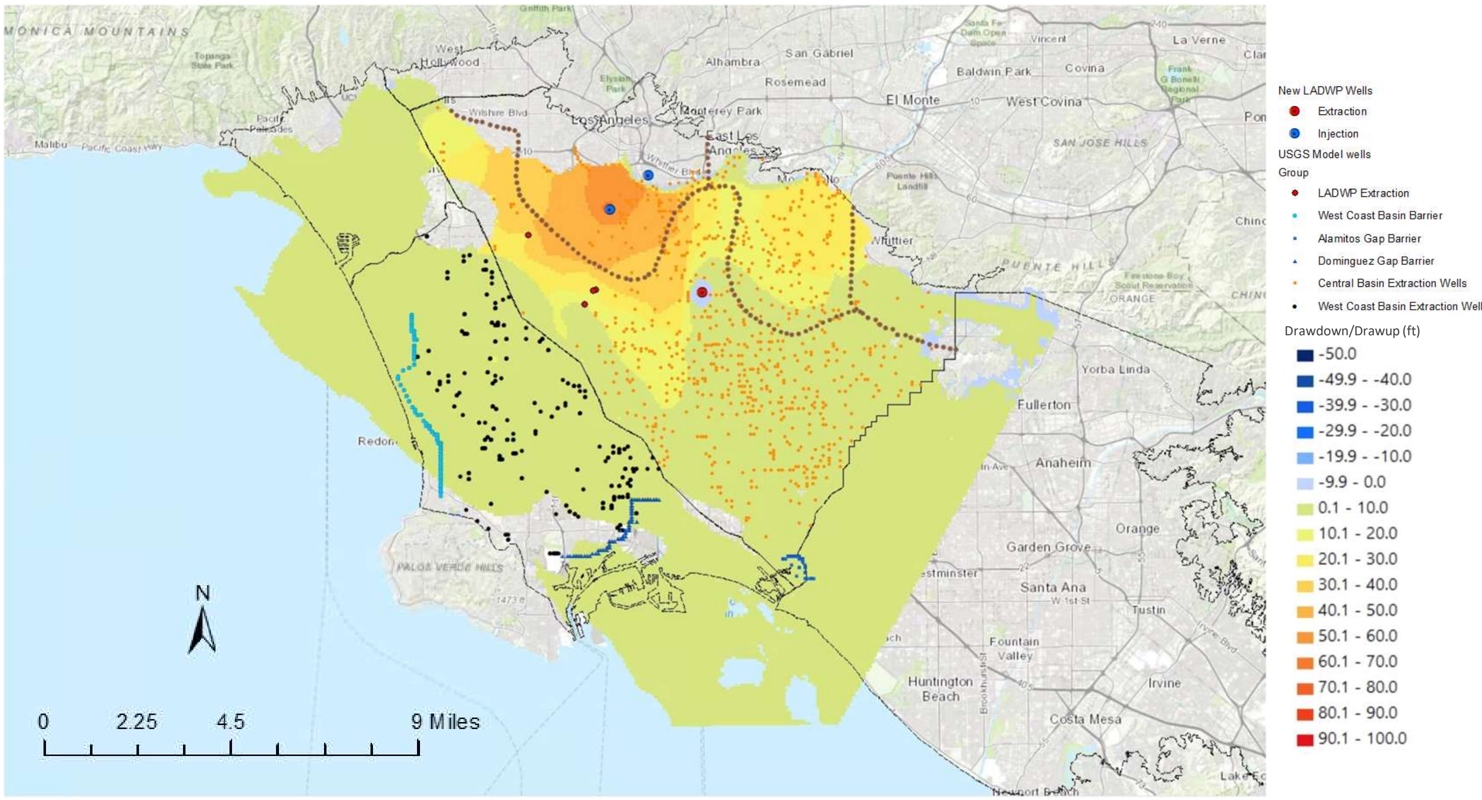


Figure 16b.
Scenario 6 Drawdown
Layer 5, Stress Period 155 (2009 Q3)

Scenario 6 – Layer 7 – Stress Period 142 (2006 Q2)

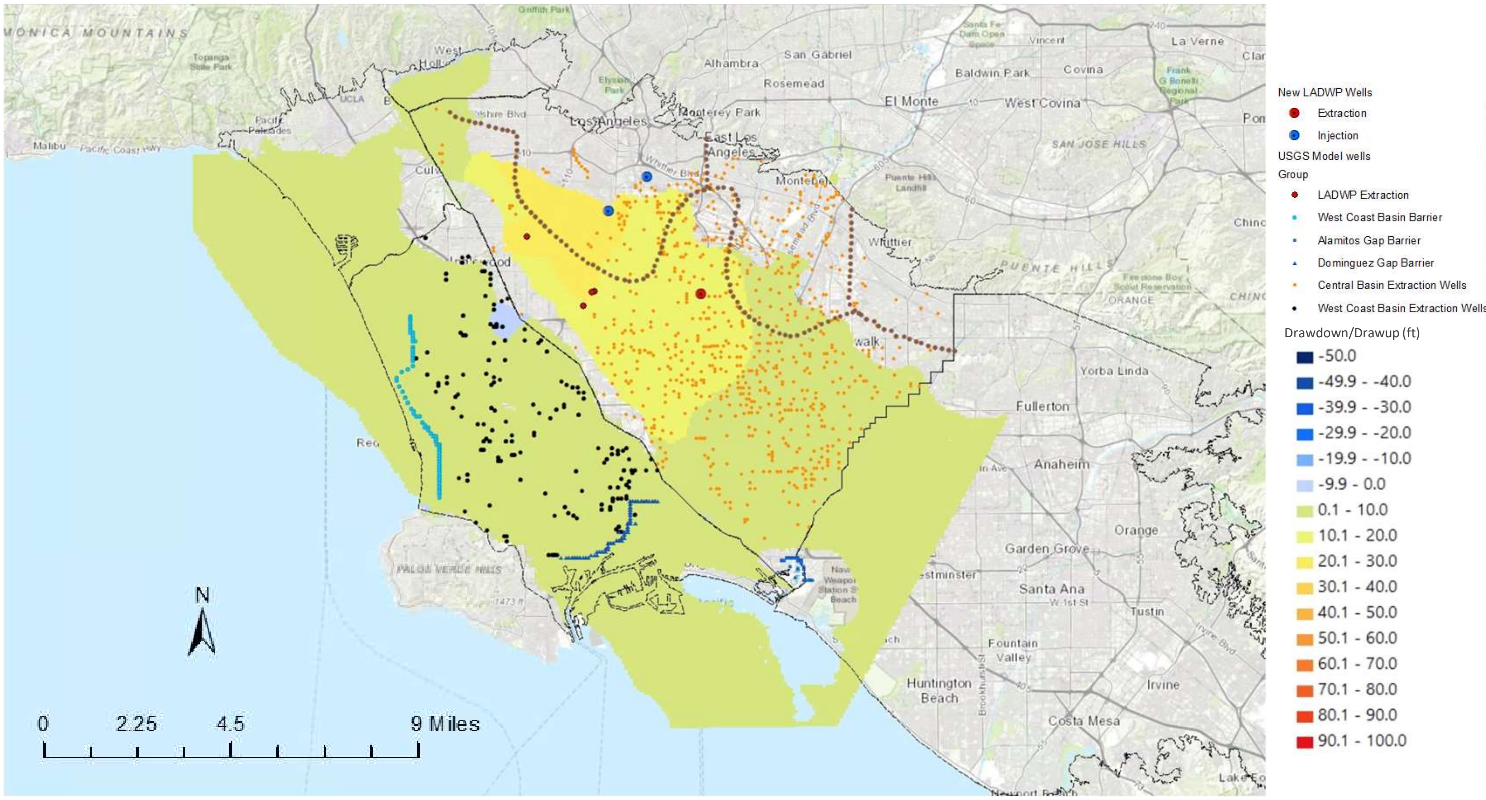


Figure 16c.
Scenario 6 Drawdown
Layer 7, Stress Period 142 (2006 Q2)

Scenario 6 – Layer 7 – Stress Period 155 (2009 Q3)

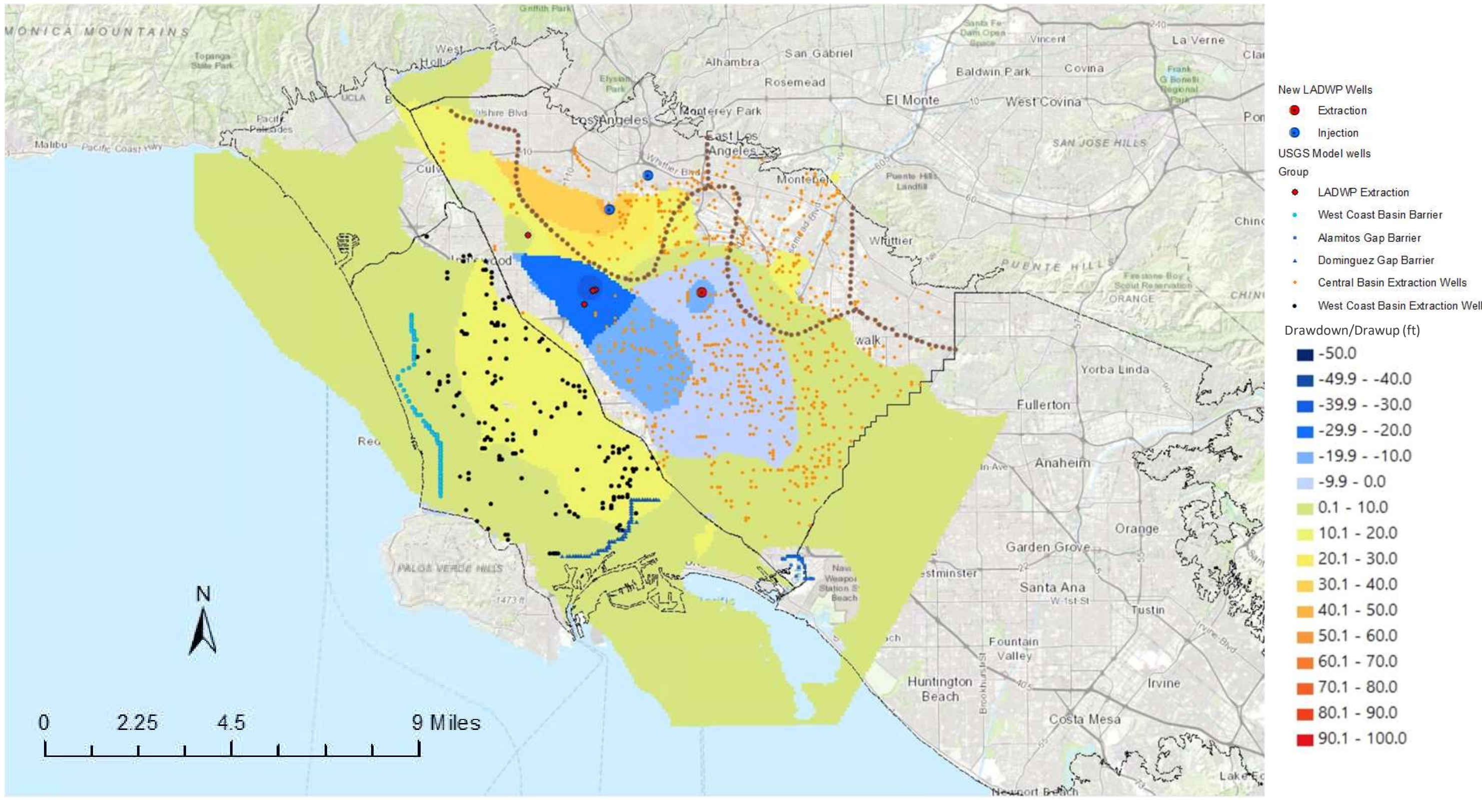


Figure 16d.
Scenario 7 Drawdown
Layer 7, Stress Period 155 (2009 Q3)

Scenario 7 – Layer 5 – Stress Period 142 (2006 Q2)

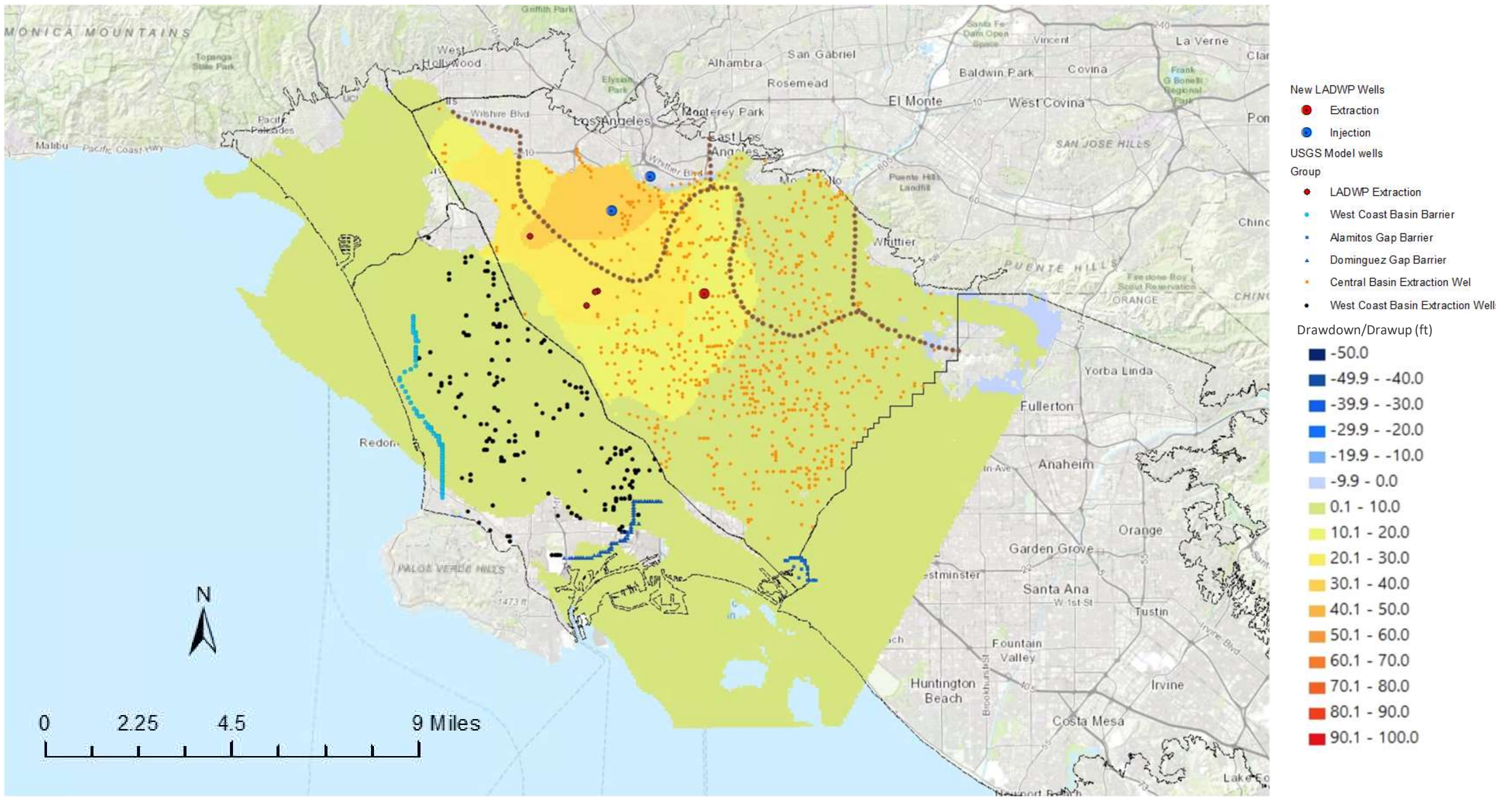


Figure 17a.
Scenario 7 Drawdown
Layer 5, Stress Period 142 (2006 Q2)

Scenario 7 – Layer 5 – Stress Period 155 (2009 Q3)

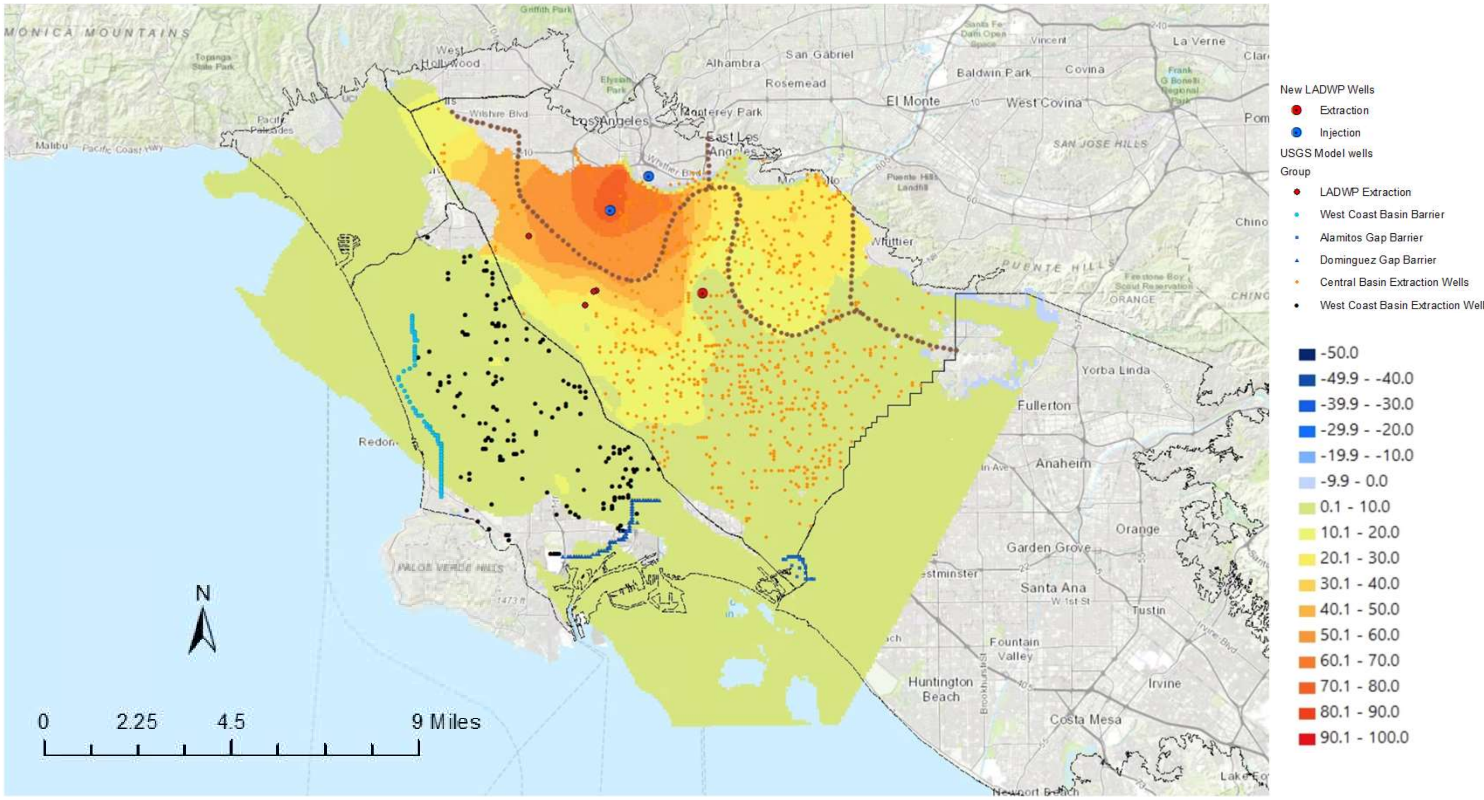


Figure 17b.
Scenario 7 Drawdown
Layer 5, Stress Period 155 (2009 Q3)

Scenario 7 – Layer 7 – Stress Period 142 (2006 Q2)

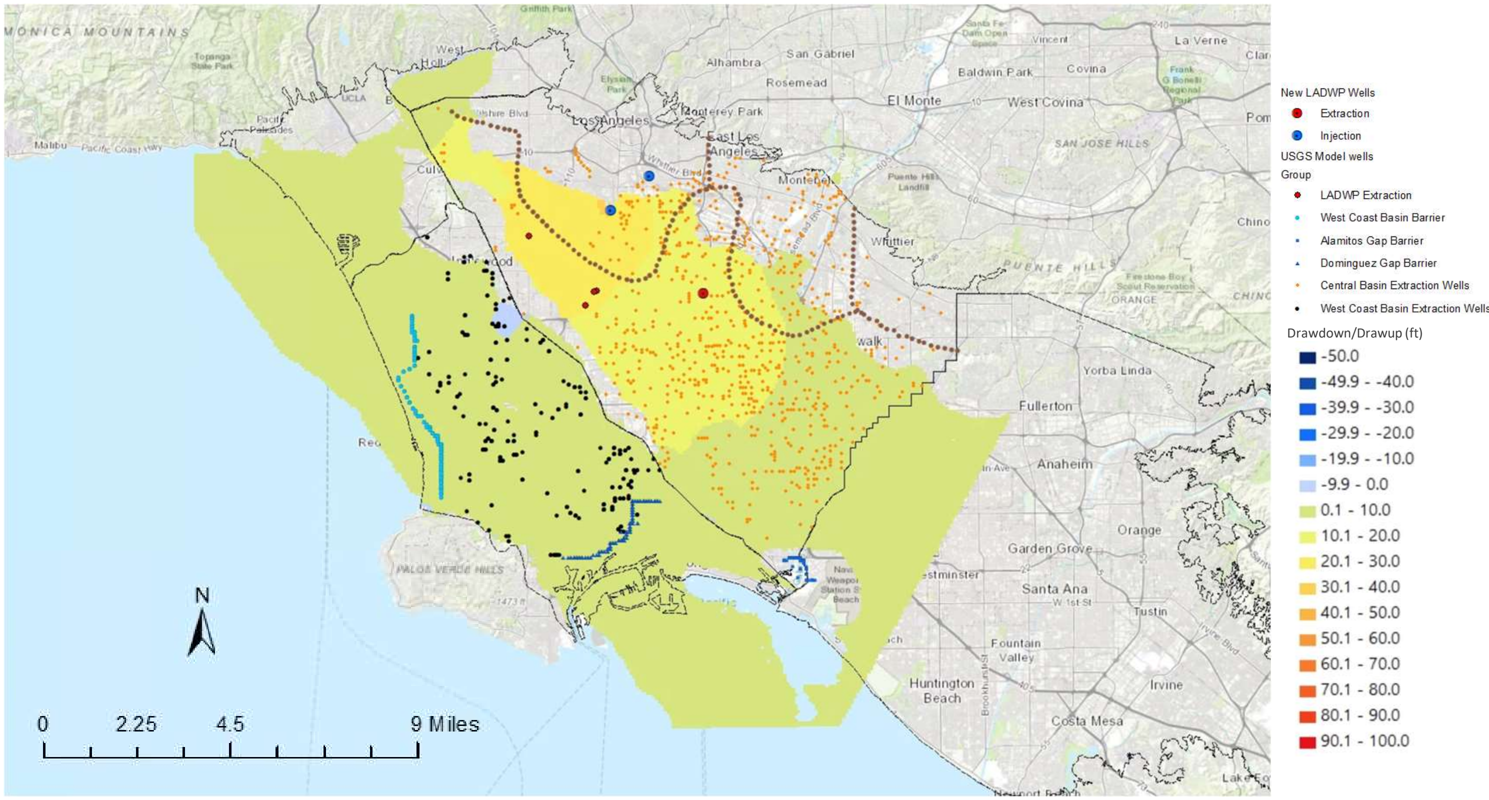


Figure 17c.
Scenario 7 Drawdown
Layer 7, Stress Period 142 (2006 Q2)

Scenario 7 – Layer 7 – Stress Period 155 (2009 Q3)

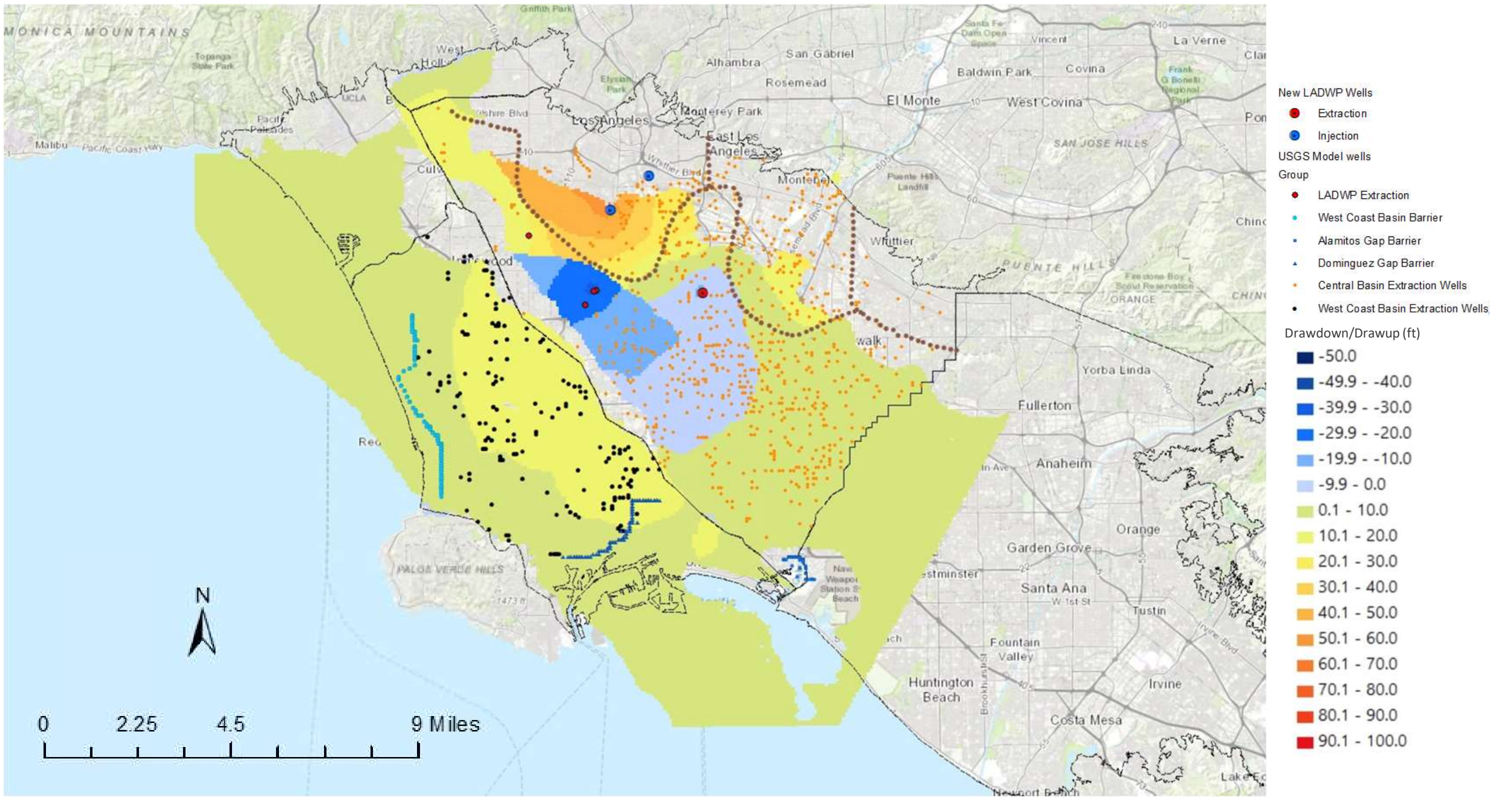


Figure 17d.
Scenario 7 Drawdown
Layer 7, Stress Period 155 (2009 Q3)

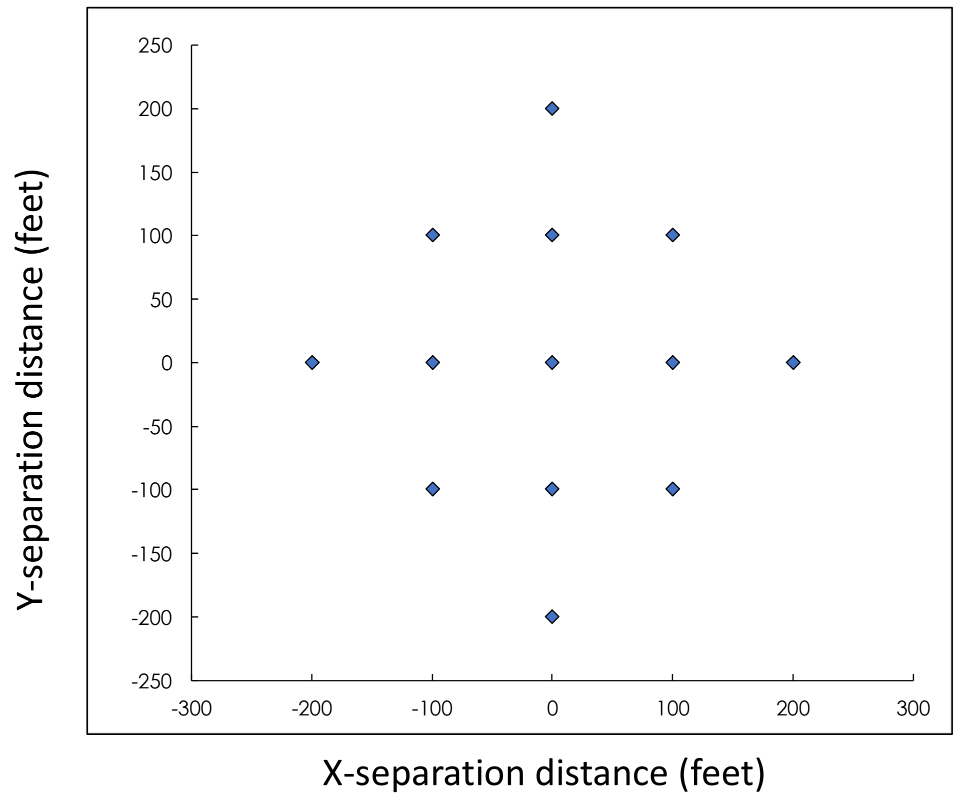


Figure 18.
Simulated Layout of Injection Wells for Analytical Calculations

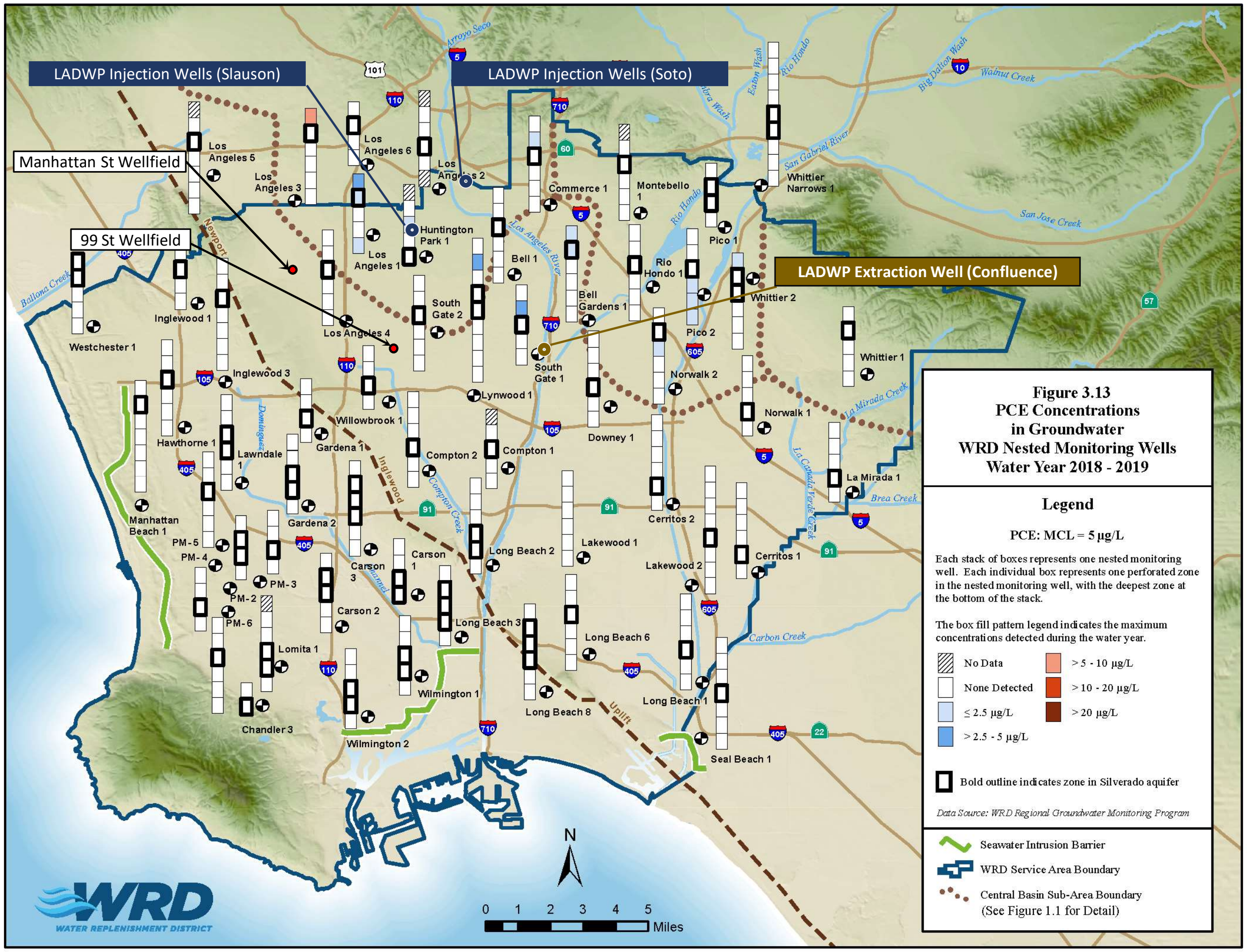


Figure 19a.
WRD 2018-2019 RGWMR Figure 3.13 Digitized
PCE

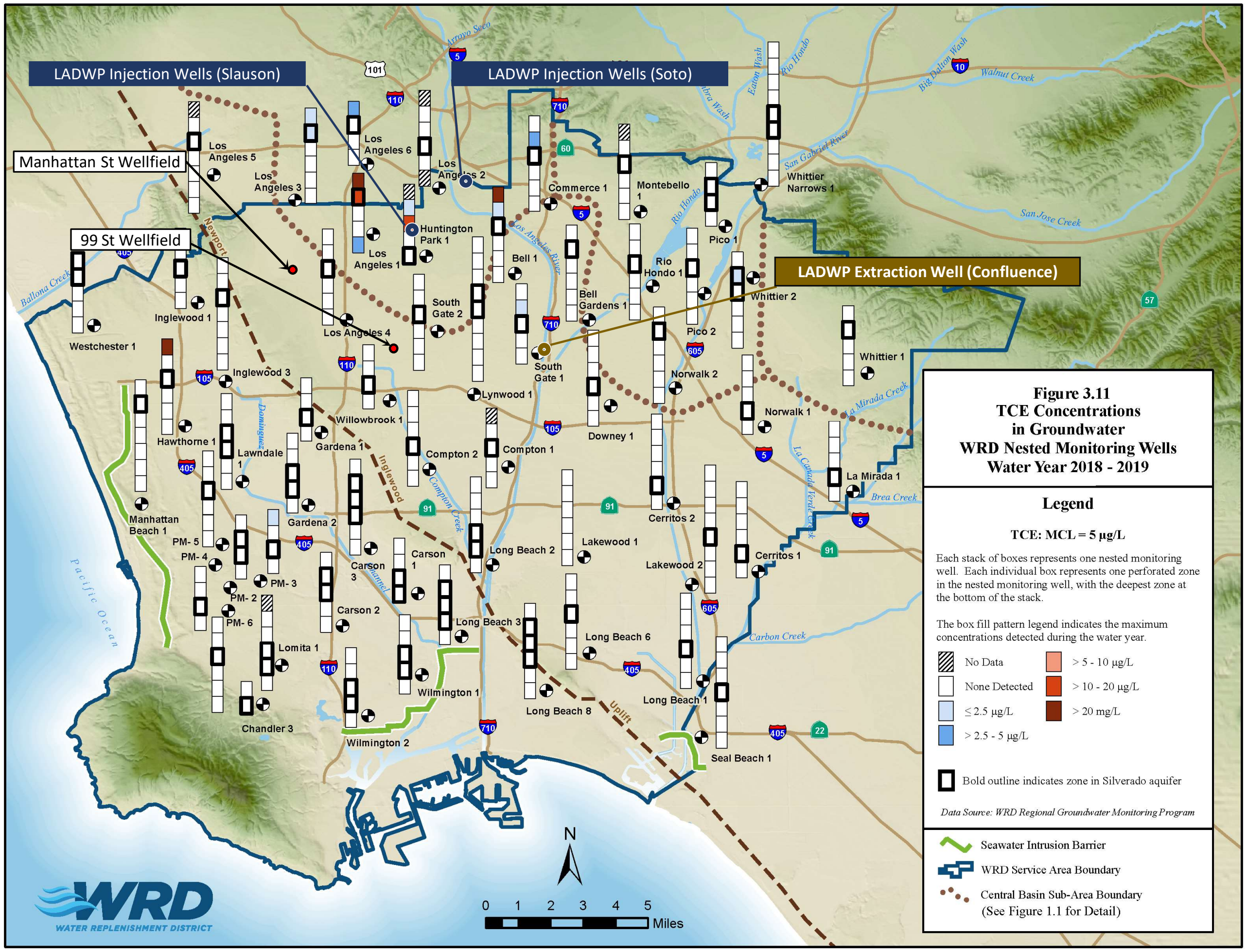


Figure 19b.
WRD 2018-2019 RGWMR Figure 3.13 Digitized
TCE

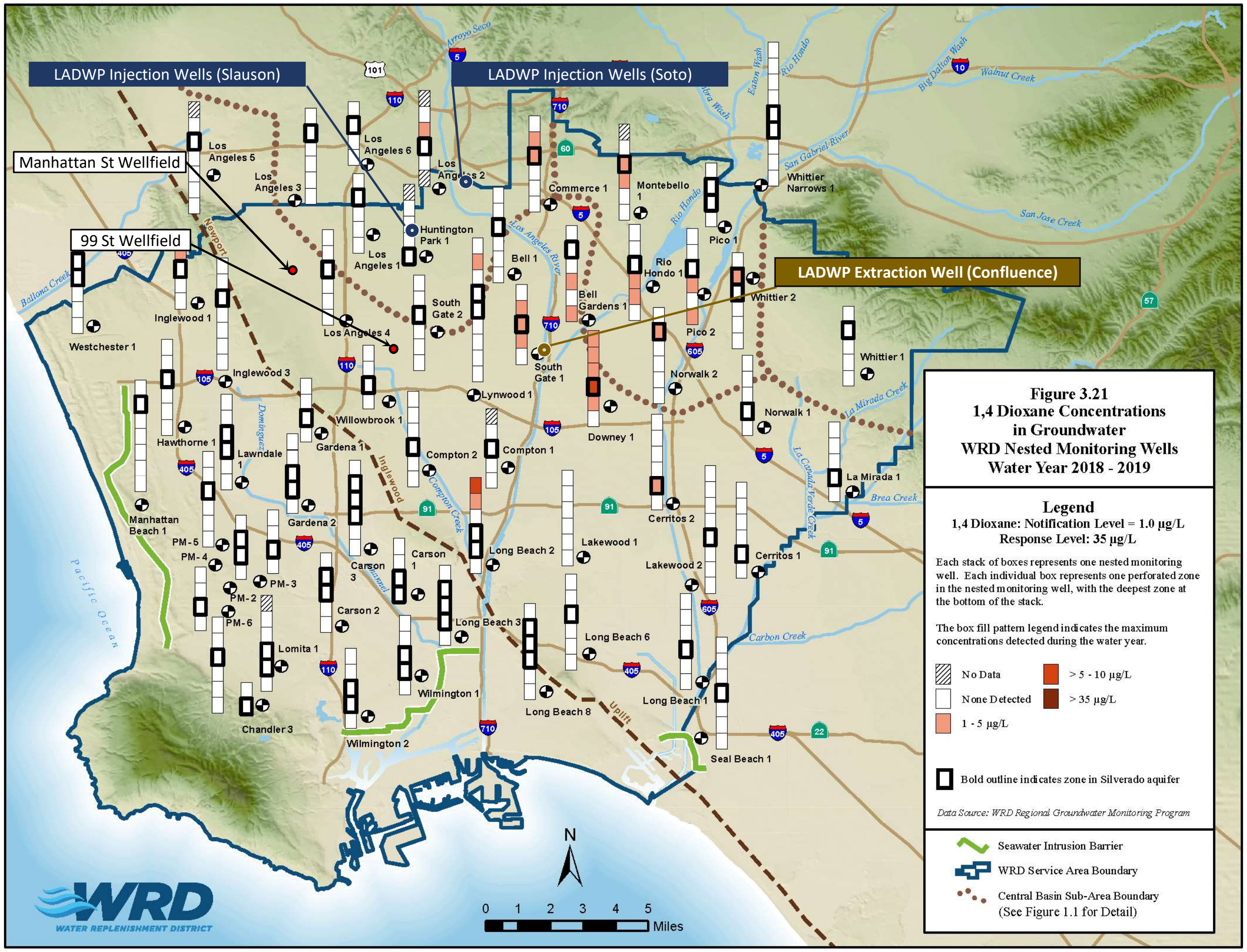
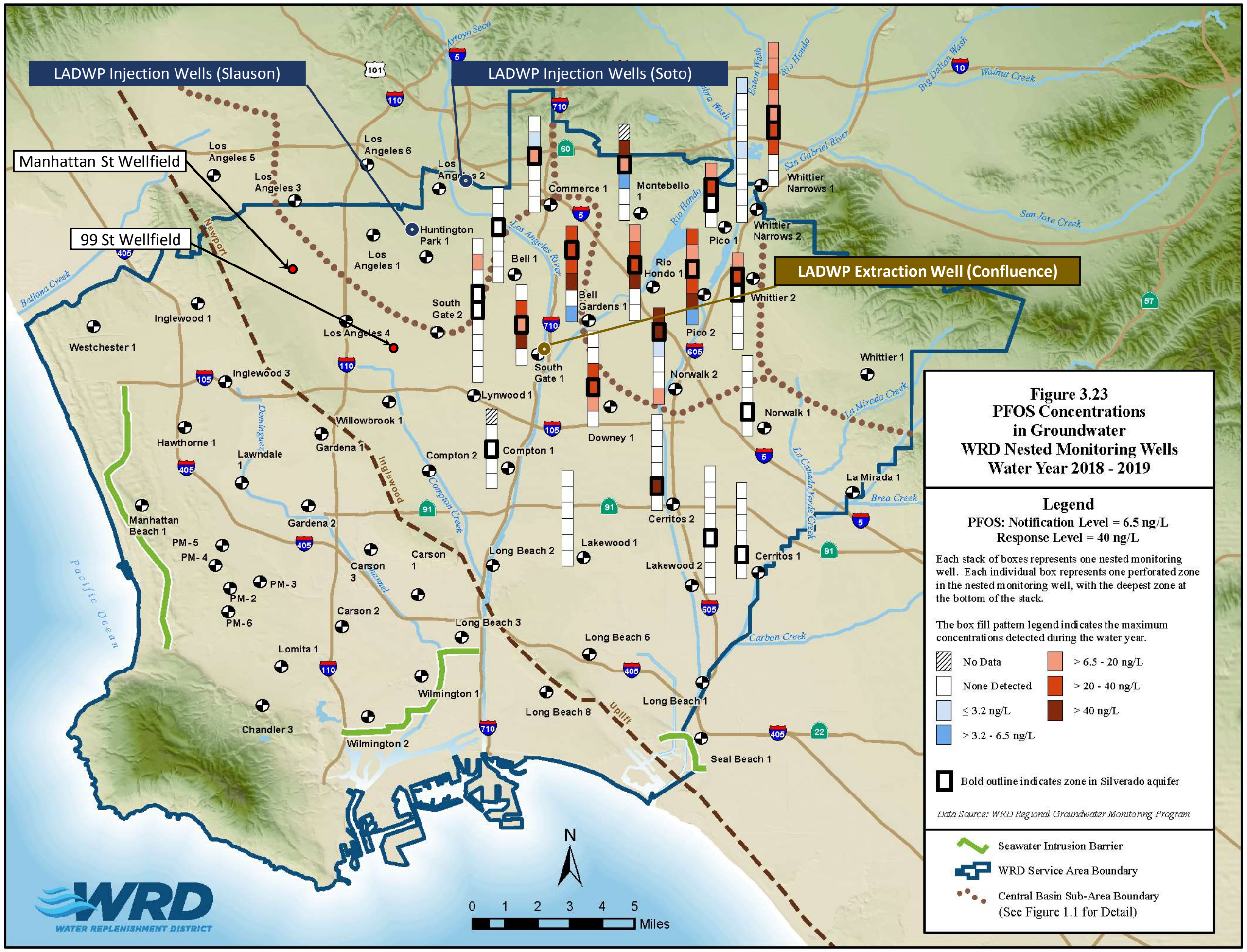
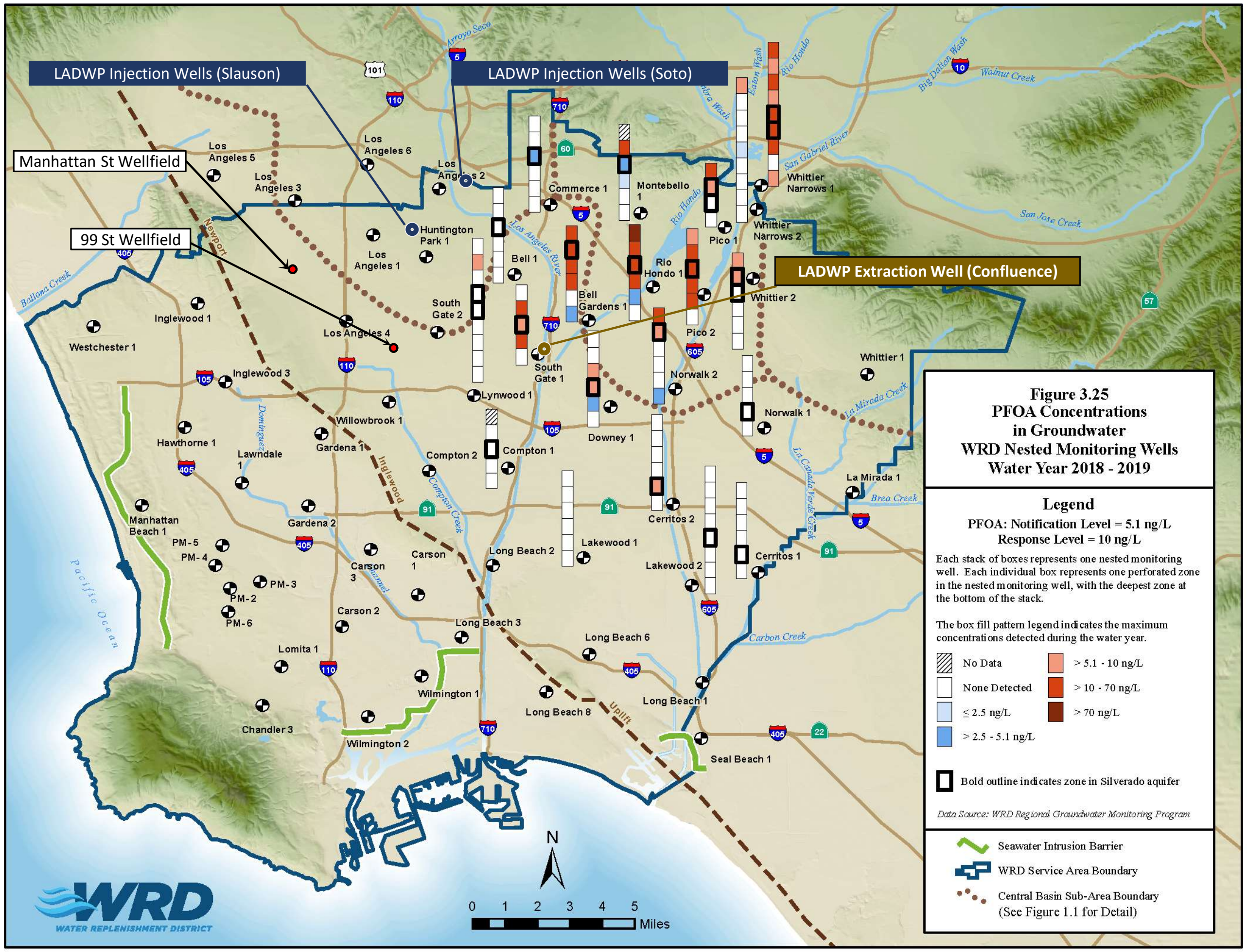


Figure 19c.
WRD 2018-2019 RGWMR Figure 3.13 Digitized
1,4 Dioxane



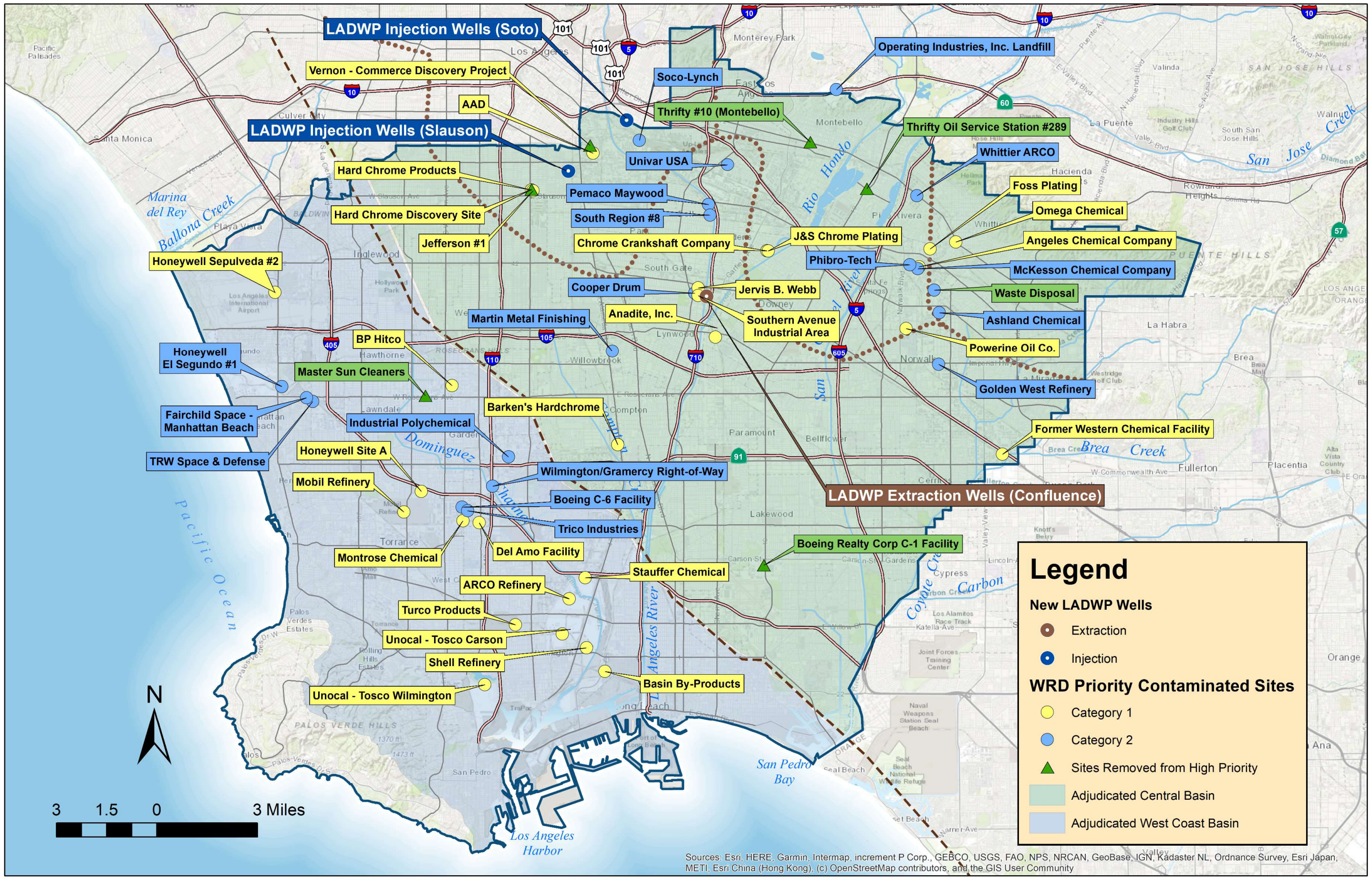
INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Figure 19d.
WRD 2018-2019 RGWMR Figure 3.13 Digitized
PFOS



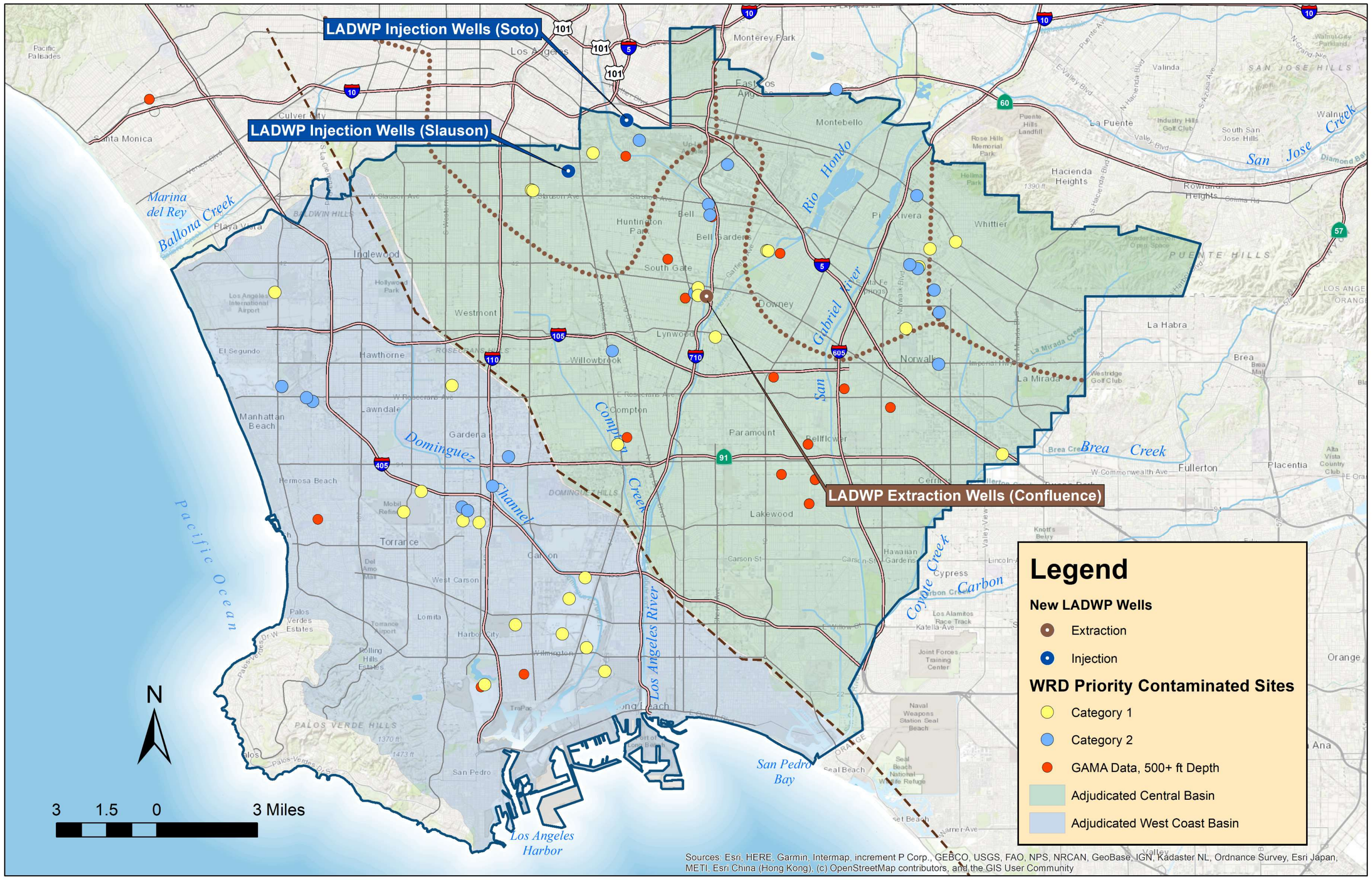
INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Figure 19e.
WRD 2018-2019 RGWMR Figure 3.13 Digitized
PFOA



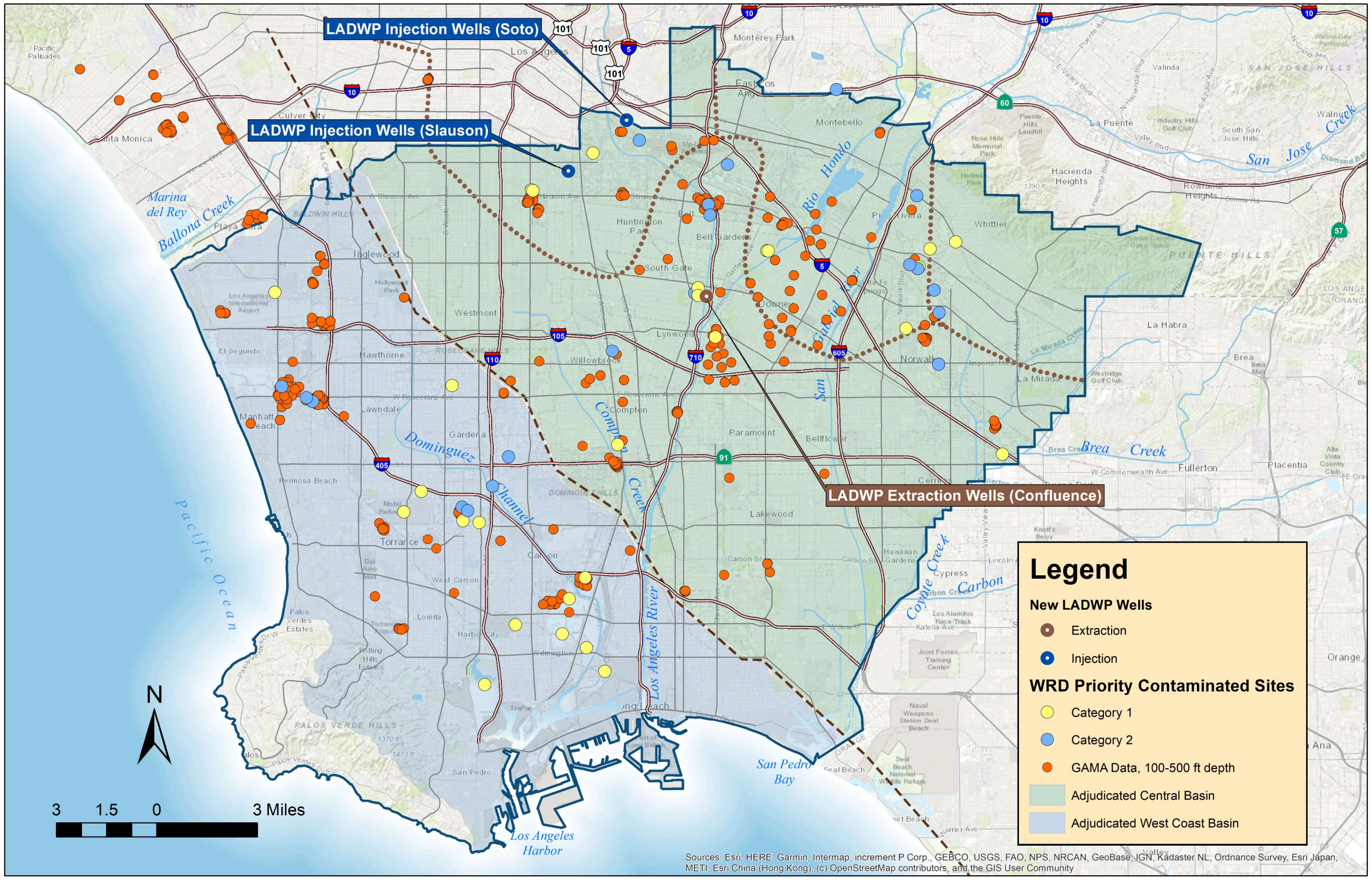
INTERA GEOSCIENCE & ENGINEERING SOLUTIONS

Figure 20.
WRD Priority Contaminated Sites



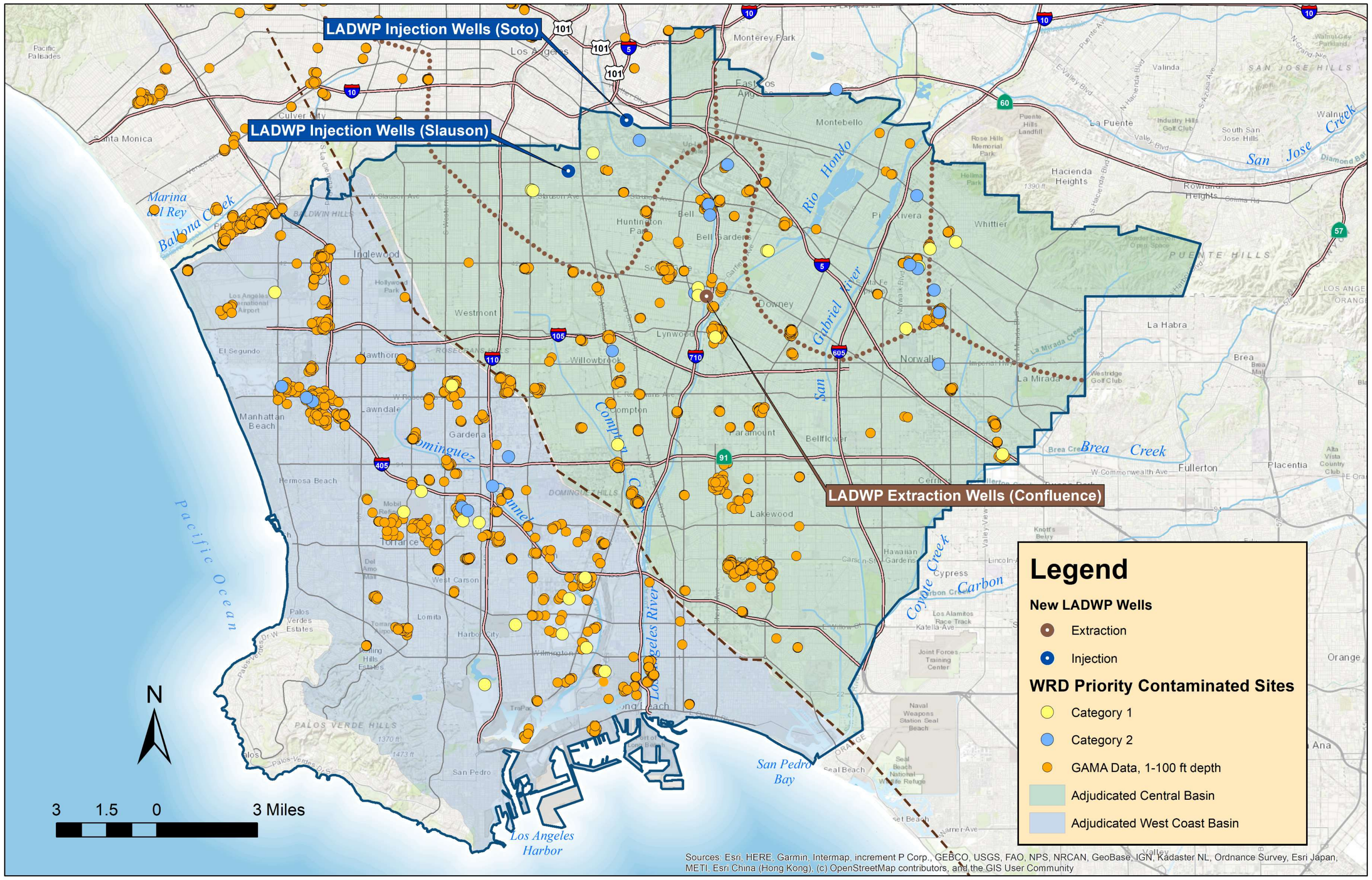
INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Figure 21a.
GAMA Online Tools Downloaded Water Quality Data
500+ ft depth



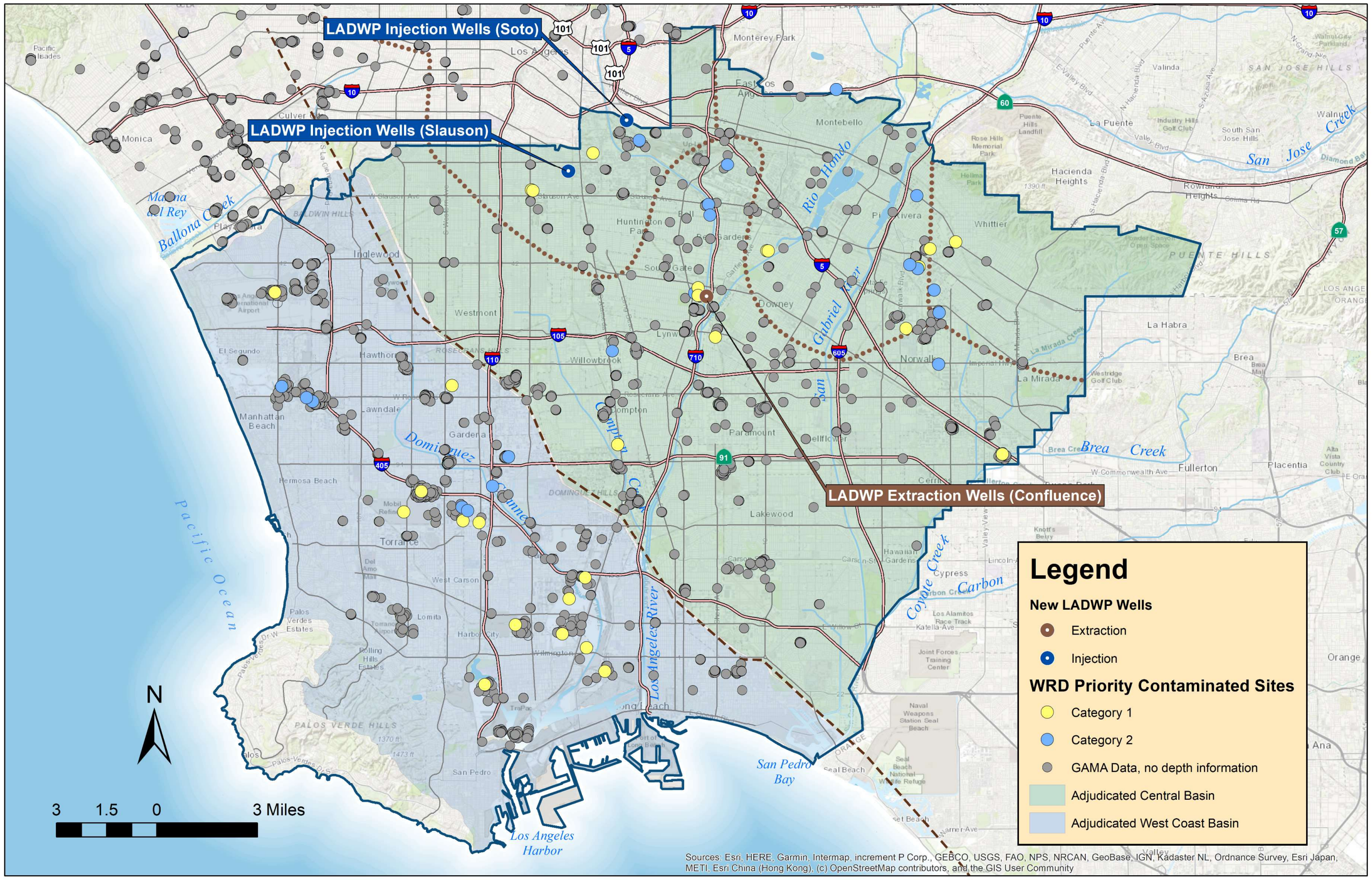
INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Figure 21b.
GAMA Online Tools Downloaded Water Quality Data
100-500 ft depth



INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Figure 21c.
GAMA Online Tools Downloaded Water Quality Data
1-100 ft depth



INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Figure 21d.
GAMA Online Tools Downloaded Water Quality Data
No Depth Information

Attachment 1
Water Balance Model Assumptions Summary Sheet

Modeling Scenarios

			Rights	Extraction				Replenishment					Storage	
			LADWP	Central Basin		West Coast Basin		Natural Recharge and Underflow	MAR	Hyperion	ARC	LC	Initial CB and WCB Storage	LADWP Maximum Storage Assumption
Scenario	Title	Notes (from original matrix)		LADWP	All Other Pumpers	All Pumpers	RBWRP							
Scenario 1	Baseline - Historical plus RBWRP	Baseline conditions	CB APA = 17,236 AFY WCB WR = 1,503 AFY Total = 18,739 AFY	Historical extraction, annual average 3,671 AFY	Historical extraction volume and monthly pattern from 1986-2015 (178,848 AFY average)	Historical extraction volume and monthly pattern from 1986-2015 (31,631 AFY average)	20,000 AFY, location and potential patterns to be provided by Jacobs (Jacobs to provide location of extraction wells - constant pumping assumed)	Historical recharge from 1986-2015 baseline hydrology	Historical recharge from 1986-2015 (MFB + Barriers + in-lieu); increase barrier recharge for RBWRP by 20,000 AFY (matching extraction rate)	Assume 50% (or 10,000 AFY) of the increased replenishment for RBWRP is from Hyperion, and the remaining 50% would be from another source	No ARC	No LC	Historical 1985 levels	CB APA =17,236 AFY maximum storage = 200% of APA (34,472 AFY) in CB
Scenario 2	Scenario 1 + Initial WR Leasing in CB (LADWP) OR LADWP on the way to maximum target rights in CB	LADWP begins acquiring additional rights (goal = 25,000 total) LADWP Leases 6,896 as needed	CB APA of 24,132= 17,236 (own)+6,896 (leased) WCB WR = 1,503 AFY Total = 25,635 AFY	LADWP 30-year demand monthly pattern (averaged to be 24,132 AFY); limit extraction to 140% of APA or to 40 cfs for 10 months	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1 + remaining Hyperion water to be sent to barriers and potentially to the LAAFP for flows in excess of LADWP's extractions in the CB	10,000 AFY	LC to provide up to 4,000 AFY to CB MAR	Same as Scenario1	CB APA = 24,132 AFY maximum storage = 200% of CB APA (48,264 AFY)
Scenario 3	Scenario 1 + WCB WR Transfer to CB (LADWP) + WR Leasing (LADWP) OR LADWP at maximum target rights	APA Transfer of 5,000 AFY to CB by LADWP LADWP now owns 25,000 rights total LADWP leases 7,500 rights	CB APA: 25,000 AFY (own) = 17,236 + 5,000 (transfer from WCB) + 2,764 (purchase) + 7,500 (lease) WCB WR = 0 (goes to zero because LADWP is buying and transferring rights from the WCB) Total = 32,500 AFY	LADWP 30-year demand monthly pattern (averaged to be 32,500 AFY); limit extraction to 140% of APA or to 90 cfs for 6 months	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	28,829 AFY (25.72 MGD) (due to LADWP increase in CB) (difference between 32,500 and 3,671 historical LADWP pumping). Any excess flow from Hyperion AWT will be sent to the LAAFP	Same as Scenario 2	Same as Scenario 2	Same as Scenario 1	CB APA = 25,000 AFY maximum storage = 200% of CB APA (50,000 AFY)
Scenario 3a	Scenario 3 variation with change in LADWP's extraction schedule	Same as Scenario 3	Same as Scenario 3	No extraction in December and January; 4 months at 40 cfs, and 6 months at 90 cfs	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 1	Same as Scenario 3
Scenario 4	Scenario 3 + maximum APA extraction in CB (other pumpers) OR LADWP at maximum target rights plus full CB rights utilization	Maximize APA in CB, WCB average pumping with RBWRP	Same as Scenario 3	Same as Scenario 3	Full APA extraction (189,867 AFY average)	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 3 + need additional recharge to satisfy increased CB extraction by other pumpers; LADWP's increase in extraction will be covered by Hyperion AWT, and other increases will be covered by WRD	Hyperion AWT will be used to cover LADWP's increase in extractions only; any excess flow from Hyperion AWT will be sent to the LAAFP	Same as Scenario 3	Same as Scenario 2	Same as Scenario 1	Same as Scenario 3
Scenario 5	Scenario 4 + maximum WR extraction in WCB (other pumpers) OR LADWP at maximum target rights plus full CB and WCB rights utilization	Replenishment calculation = [(WCB APA - 5000) + (CB APA + 5000)] - 20000	Same as Scenario 3	Same as Scenario 3	Same as Scenario 4	WCB full WRs 39,468 AFY= 64,468 AFY - 5,000 AFY (WCB-CB transfer) - 20,000 AFY (RBWRP)	Same as Scenario 1	Same as Scenario 1	Same as Scenario 4 + need additional recharge to satisfy increased WCB extraction by other pumpers	Hyperion AWT will be used to cover LADWP's increase in extractions only. Any excess flow from Hyperion AWT will be sent to the LAAFP	Same as Scenario 4	Same as Scenario 2	Same as Scenario 1	Same as Scenario 3
Scenario 6	Scenario 5 + Ph 1 augmentation (LADWP) OR LADWP CB Augmentation Phase 1	LADWP begins augmentation program in CB	Same as Scenario 3	LADWP 30-year demand monthly pattern (averaged to be 32,500 AFY); limit extraction to 140% of APA or to 90 cfs for 9 months + 12,500 AFY in same year as augmentation replenishment	Same as Scenario 5	Same as Scenario 5	Same as Scenario 1	Same as Scenario 1	Same as Scenario 5	Same as Scenario 3 + 12,500 AFY (11.15 MGD) as an augmentation project	Same as Scenario 5	Use up to 4,000 AFY from LC first, then Hyperion; model assumes that LC augmentation will be for WCB	Same as Scenario 1	Same as Scenario 3
Scenario 7	Scenario 5 + Ph 2 augmentation (LADWP) OR LADWP CB Augmentation Phase 2	LADWP begins augmentation program in CB	Same as Scenario 3	LADWP 30-year demand monthly pattern (averaged to be 32,500 AFY); limit extraction to 140% of APA or to 90 cfs for 12 months + 30,000 AFY in same year as augmentation replenishment	Same as Scenario 5	Same as Scenario 5	Same as Scenario 1	Same as Scenario 1	Same as Scenario 5	Same as Scenario 6 + 17,500 AFY (15.6 MGD) as augmentation project	Same as Scenario 6	Same as Scenario 6	Same as Scenario 1	Same as Scenario 3

Notes:

% = percent

AFY = acre-foot (feet) per year

APA = Allowed Pumping Allocation

AR = Adjudicated Right

ARC = Albert Robles Center for Water Recycling and Environmental Learning

AWT = Advanced Water Treatment

CB = Central Basin

cfs = cubic foot (feet) per second

GW = groundwater

LAAFP = Los Angeles Aqueduct Filtration Plant

LADWP = Los Angeles Department of Water and Power

LC = Los Coyotes

MAR = Managed Aquifer Recharge

MFB = Montebello Forebay

MGD = million gallons per day

Ph = phase

RBWRP = Regional Brackish Water Reclamation Program

WB = water balance

WCB = West Coast Basin

WR = Water Right

WRD = Replenishment District of Southern California

Appendix E
TM 3.2.2-Hyperion Backbone Alternative Routes Development

Jacobs

Memorandum

1000 Wilshire Boulevard, Suite 1140
Los Angeles, California 90017
United States
T +1.213.538.1388
F +1.230.538.1399
www.jacobs.com

Subject	**Technical Memorandum 3.2.2 – Hyperion Backbone Alternative Routes Development – Final**
Project Name	WRD and LADWP Joint Los Angeles Basin Replenishment and Extraction Master Plan
Date	April 10, 2020 (Revised)

1. Background

The Los Angeles Department of Water and Power (LADWP) and the Water Replenishment District of Southern California (WRD) entered into a cooperative agreement on September 19, 2018, for the development of a Joint Los Angeles Basin Replenishment and Extraction Master Plan (Joint Master Plan). The intent of the Joint Master Plan is to identify projects and strategies for groundwater basin replenishment and water resource development to improve the resilience and sustainability of local water supplies for Los Angeles and Southern Los Angeles County.

As an accelerated goal implemented by L.A.'s Green New Deal Sustainable City pLAn 2019 (Garcetti 2019), LADWP has embarked on a recycled water initiative at the Hyperion Water Reclamation Plant (WRP) with the objective of recycling 100% of available treated wastewater for beneficial reuse by the year 2035 as part of the Operation NEXT Water Supply Program. This program would use recycled water treated at Hyperion WRP in a collaborative effort with City of Los Angeles (City) and regional agencies to replenish groundwater resources in the West Coast and Central Basins, provide a local sustainable influent supply to the Los Angeles Aqueduct Filtration Plant (LAAFP), and a potential to connect to the proposed Metropolitan Water District of Southern California's (Metropolitan's) Regional Recycled Water Program Backbone System (Metropolitan Backbone) to provide supplemental flow to future connections. The mode of transmission to deliver flow treated at Hyperion WRP is through a large diameter pipeline known as the Hyperion Backbone.

As part of the Joint Master Plan, a two-phase alternative route development, evaluation, and selection project is being conducted for the Hyperion Backbone. The work being performed as part of the first phase of the project includes the completion of the alternative route development process, which will identify and develop recommendations for three alternative routes for the Hyperion Backbone. These alternatives will be further detailed and evaluated in the next phase of the project during the preferred alternative route evaluation and selection process. This report covers the process and results of the Alternative Route Development Phase for the Hyperion Backbone.

1.1 Project Location

The Hyperion Backbone will be routed within Los Angeles County, primarily southwest of downtown Los Angeles, and spanning the general area between Hyperion WRP and Interstate 605 near the San Gabriel River. Figure 1 shows an overview of the anticipated project location.

1.2 Project Collaboration

The route development process for the Hyperion Backbone involved coordination efforts between LADWP, WRD, and Jacobs Engineering Group Inc. (Jacobs) through regularly scheduled monthly meetings and three collaborative workshops held on November 20, 2019; January 9, 2020; and February 13, 2020. The November 20, 2019 workshop was the project kickoff meeting with stakeholders to provide an understanding of the proposed approach. The January 9 and February 13 workshops provided stakeholders with a progress update and solicited input. The workshops included participation and input from LADWP's Master Plan management team, LADWP's Trunk Line Design Group, WRD, and Jacobs' conveyance team. The purpose of these workshops was to provide a forum where the group could discuss ideas and provide critical input and technical expertise for the development of the Hyperion Backbone alternative routes.

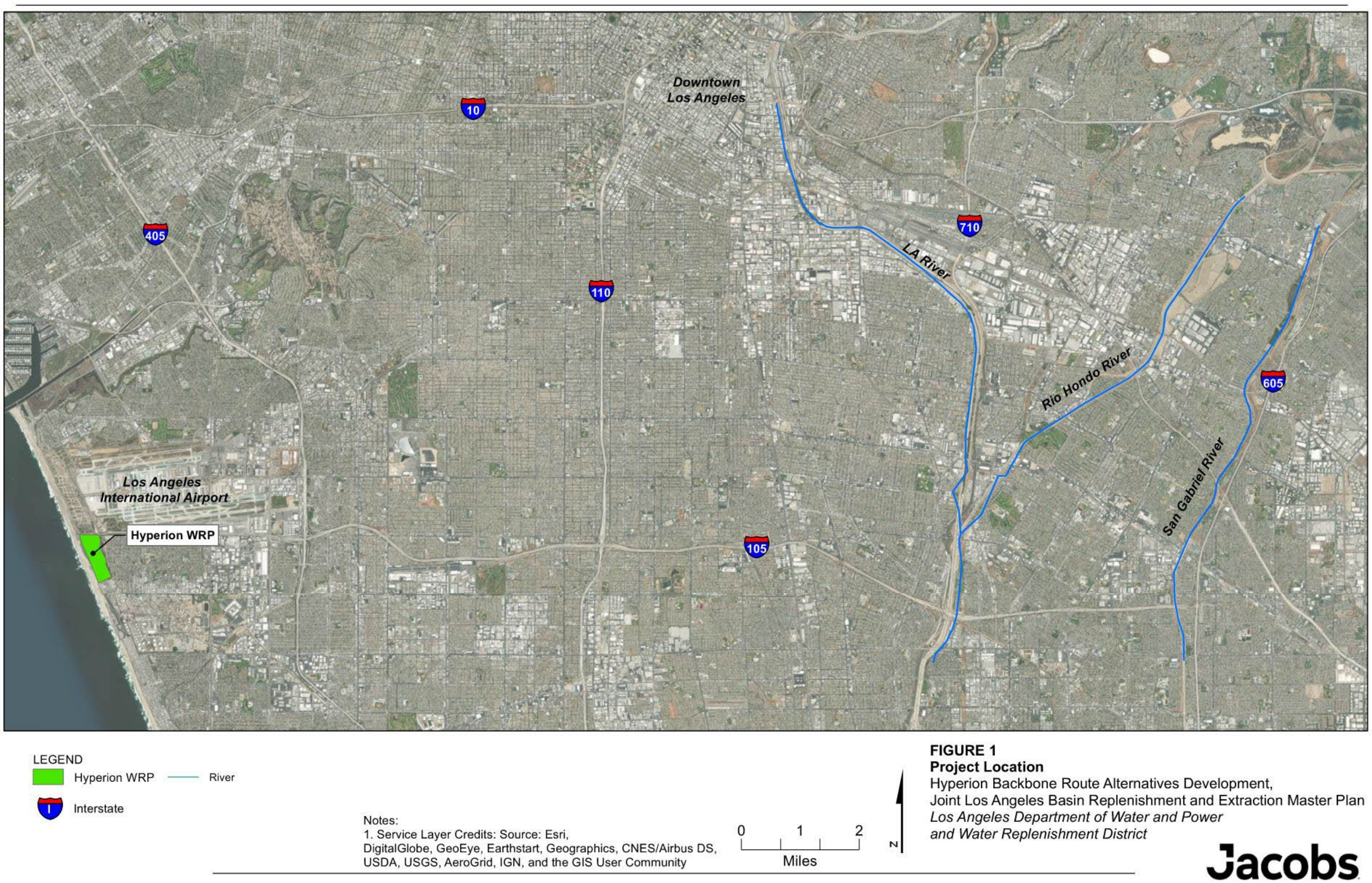


Figure 1. Project Location

2. Overall Route Development, Evaluation, and Selection Process

2.1 Definitions

The following concepts and terminology were used in the route development process to provide identifiable and distinguishable elements that promoted ease of visualization and management of the overall process:

- *Route segments (or segments)* are portions of the alternative routes that can be assembled into various combinations to create overall alternative routes. These route segments represent the smallest route pieces. The route segments are designated alphanumerically (for example, AA-1, AA-2, AA-3).
- *Alternative routes (or alternatives)* are the various reasonable combinations of contiguous route segments assembled to create the routes between the beginning and end points of the project.

2.2 Route Selection Process Description

Figure 2 illustrates the five steps that comprise the first phase of this project (Alternative Route Development Phase), along with the next phase of this project (the Alternative Route Evaluation and Selection Phase). Descriptions of these phases and how they apply to the pipe routing process are presented in this section.

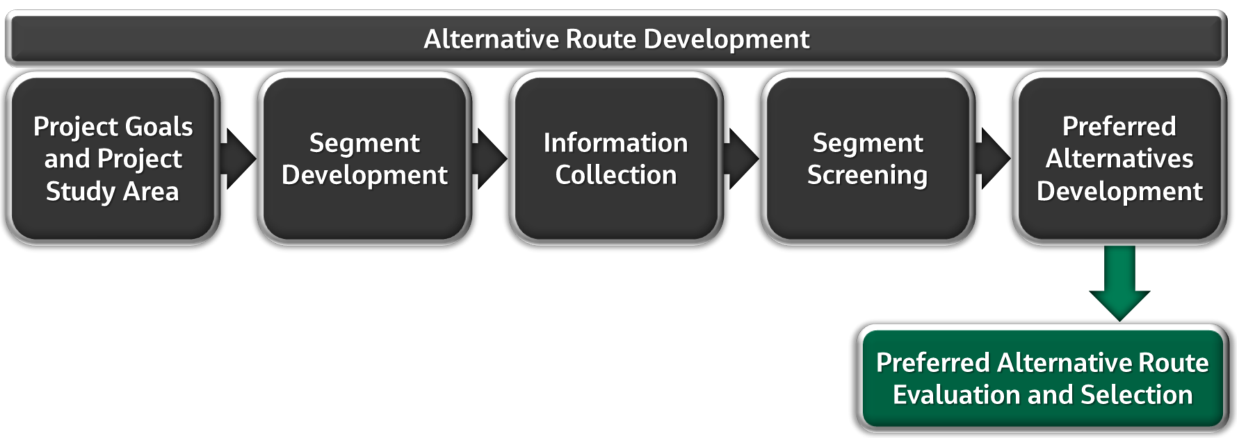


Figure 2. Alternative Route Development, Evaluation, and Selection Process

2.3 Alternative Route Development Phase

The Alternative Route Development Phase consists of the following steps:

1) Project goals and project study area definition
2) Segment development
3) Information collection
4) Segment screening
5) Preferred alternatives development

2.3.1 Project Goals and Project Study Area Definition

Project goals were established at the start of the process to identify the issues and requirements for the Hyperion Backbone. Defining project goals early results in the development of segments and routes that best meet the needs of project stakeholders and the general public. The goals for this project were developed with WRD and LADWP and are discussed in detail in Section 3.1.

The project study area was created by using the project goals to identify important Hyperion Backbone areas and delivery needs. These include:

- Where the pipeline begins (Hyperion WRP)
- The pipeline's farthest east possible endpoint: the Metropolitan Backbone near the San Gabriel River)
- Future connection points (delivery to LAAFP, to potential well injection sites, and to new and existing spreading grounds in the Montebello Forebay and Los Angeles Forebay)

The project study area encompasses all these locations and was expanded as needed to accommodate segments for alternatives. The project study area is described in detail in Section 3.2.

2.3.2 Segment Development

Within the project study area, segments were developed in relatively wide, practicable streets (public rights-of-way [ROWs]) that could accommodate the construction of a large diameter pipeline. The segment development process for the Hyperion Backbone is discussed in detail in Section 4.

2.3.3 Information Collection

As part of the information collection, existing underground utility information was collected within the project study area in parallel with the previous three steps. Agencies, cities, and private utility companies that own or maintain underground utilities were contacted to obtain shapefiles, drawings, and other readily available information depicting location and size. Additional resources, such as previously collected utility information obtained by Jacobs, utility information provided by WRD and LADWP, and publicly available online data, were also used. City jurisdictions, parcel data, and existing geotechnical information were also collected from publicly available sources. Information collection is described in further detail in Section 5.

2.3.4 Segment Screening

Segment screening consisted of reviewing individual segments for potential pipeline locations and eliminating the less favorable choices. Segment screening is discussed in Section 6.

2.3.5 Preferred Alternatives Development

Segments that remained after screening were used to develop the three preferred alternative routes for the Hyperion Backbone. Alternatives were created by piecing together segments and traversing across the project study area from the Hyperion WRP while incorporating future connections and potential endpoints near the Los Angeles River or the San Gabriel River. Section 7 discusses the three preferred alternative routes developed as part of the first phase of the project.

2.4 Next Phase: Preferred Alternative Route Evaluation and Selection Phase

This report describes the development of three preferred alternative routes for the Hyperion Backbone. The comparison of the preferred alternatives and the selection of a single preferred alternative will be completed in the next phase of the project: the Preferred Alternative Route Evaluation and Selection Phase. This phase will include developing specific criteria to assess the alternatives, conducting a comprehensive scoring methodology to evaluate each alternative, and comparing the alternatives to identify a preferred alternative.

3. Project Goals and Project Study Area

3.1 Project Goals

The overall goals of the Hyperion Backbone Project include:

- Replenish groundwater resources in the Central Basin through injection at various sites determined in the Draft Groundwater Development and Augmentation Plan Phase 1 Report (LADWP 2019) and potentially at new and existing spreading ground facilities within the Montebello Forebay and Los Angeles Forebay.
- Provide an alternative source water supply for the LAAFP by providing a connection point for another future pipeline.
- Connect to the future Metropolitan Backbone at a location yet to be determined near the Los Angeles River or San Gabriel River to provide supplemental flow for Metropolitan's Regional Recycled Water Program.

The goal of this phase of the route development, evaluation, and selection project is to develop three preferred alternatives to move forward to the next phase.

3.2 Project Study Area

The location of the Hyperion Backbone and the development of its various proposed segments and alternative routes are contained within the project study area shown on Figure 3. The area extends south to Rosecrans Avenue, north to Hollenbeck Park, west to the Hyperion WRP, and east to the San Gabriel River. Figure 3 also shows the various proposed Los Angeles Forebay and Montebello Forebay spreading grounds and injection well sites (denoted as Centralized Treatment Facility [CTF] Regions), the general location of a connection point for a future pipeline for delivery to the LAAFP, and the approximate location of the Metropolitan Backbone.

For this current phase and to provide the most options moving forward once the location of the Metropolitan Backbone is finalized, it was conservatively assumed that the Hyperion Backbone will connect to the Metropolitan Backbone at the San Gabriel River.

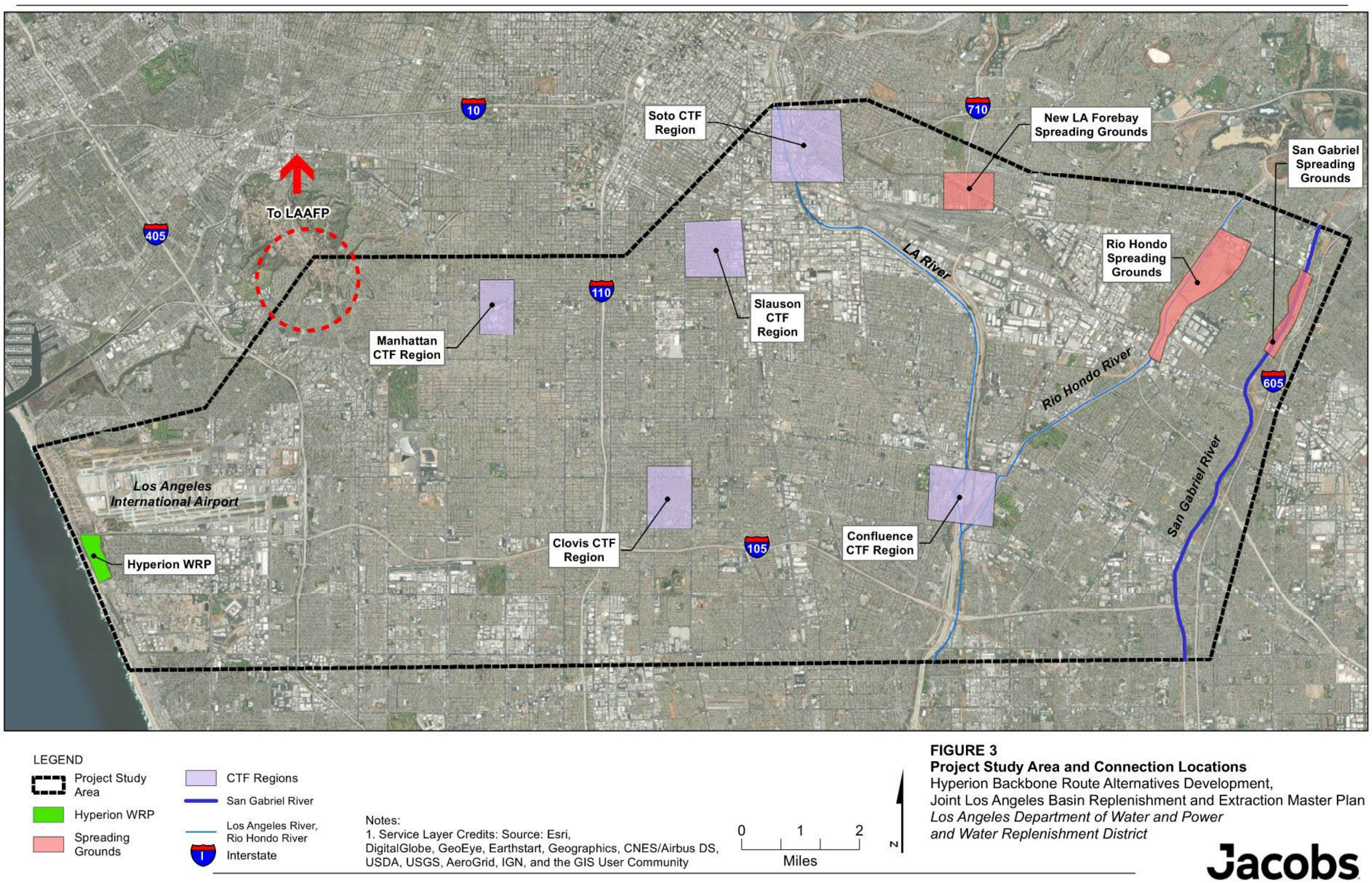


Figure 3. Project Study Area and Connection Locations

4. Segment Development

The first step in identifying alternative routes is the development of segments within the project study area. Segments are short reaches of a potential route that can span a distance as short as a city block; they typically start and end where they can connect to another segment. In general, segments were sited in major, wide roadways spanning and encompassing the project study area. Additionally, preliminary routes previously studied by LADWP were also considered.

The segment development process included a desktop study using the assumptions discussed in Section 4.1 and field activities where the project team conducted windshield studies while driving through the streets containing each segment to understand the local surroundings, identify potential impacts on the public, visually verify constructability concerns, and observe other features and potential concerns.

4.1 Assumptions for Segment Development and Screening

The criteria and general assumptions detailed in this section were created and used as the basis for development of route segments and of the segment screening process presented in Section 6. Criteria were used to evaluate, screen, refine, and finalize alternative pipe routes that will be carried forward to the next phase of the project.

4.1.1 Connections

The Hyperion Backbone was assumed to begin at the Hyperion WRP just south of the secondary clarifiers, about 1,200 feet north of the intersection of Vista Del Mar and Grand Avenue.

The Hyperion Backbone was assumed to end at the San Gabriel River at a connection point with the future Metropolitan Backbone. The location of this connection is still being determined by Metropolitan and is planned to parallel either the Los Angeles River or the San Gabriel River. The final location and type of connection will need to be coordinated with Metropolitan during the next phase of this project, as it will impact the length of pipe required and potential route adjustments.

Additionally, the routing of the Hyperion Backbone assumed that flow will be delivered to future turnouts or connections accommodating the following facilities:

- LAAFP Pipeline Connection – The location of the future LAAFP turnout is assumed to be the northwestern most point along a given alternative route
- Five potential well injection sites identified in the Draft Groundwater Development and Augmentation Plan Phase 1 Report for the Central Basin (LADWP 2019), which are:
  - Clovis
  - Confluence
  - Manhattan
  - Slauson
  - Soto
- New and existing spreading ground sites, including:
  - Los Angeles Forebay:
    - New Los Angeles Forebay spreading grounds

- Montebello Forebay:
  - Rio Hondo spreading grounds
  - San Gabriel spreading grounds

4.1.2 Pipe Diameter

The pipe diameter of the Hyperion Backbone was conceptually determined by LADWP based on its capacity to deliver anticipated flows from the Hyperion WRP to the various connections along the pipeline route, assuming a maximum velocity of 7 feet per second.

Preliminary assumptions based on discussions held with LADWP during the first phase of this project included a maximum diameter of 96 inches between the Hyperion WRP and the connection to the LAAFP. The Hyperion Backbone sections downstream of the LAAFP connection are currently assumed by LADWP to range between 48 and 60 inches in diameter and will be dependent on the flows delivered to each injection well and the Montebello Forebay and Los Angeles Forebay spreading ground sites. The assumption of a 96-inch diameter for the entire Hyperion Backbone is conservative and allows flexibility once the final diameters are determined in the next phase of the project.

4.1.3 Pipe Material

In conformance with LADWP requirements, the Hyperion Backbone will be welded steel pipe in accordance with American Water Works Association (AWWA) standards AWWA C200, Steel Water Pipe, 6 In. (150 mm) and Larger (American Water Works Association 2017), and lined with cement mortar in accordance with AWWA C205, Cement–Mortar Protective Lining and Coating for Steel Water Pipe 4 In. (100 mm) and Larger—Shop Applied (American Water Works Association 2018).

4.1.4 Routing within Public Right-of-Way

In accordance with LADWP recommendations and best practices, the Hyperion Backbone will be located primarily within public ROWs and will avoid longitudinal routing within California Department of Transportation (Caltrans) ROW. However, crossing Caltrans ROWs is necessary and will be allowed.

4.1.5 Pipeline Construction Methods

Trenchless construction methods are assumed to be used by as much as 80% of a route alternative's total length in accordance with LADWP criteria and initial budgetary assumptions. It is assumed that open-trench construction will be used where practicable and more cost effective than trenchless construction.

Roadways with relatively wide ROWs will be identified and used as preferred corridors for the pipeline. This will afford larger working limits and adequate space for tunneling launching and receiving shafts.

4.1.6 Work Area Requirements

4.1.6.1 Open-Cut Work Area

The work area required for open-cut trench pipe installation was assumed to be a minimum of 36 feet wide and would include the minimum space required for the trench, pipe staging, spoils, and equipment. To arrive at this width, it was assumed that 12-foot-wide, vertical, shored trenches will be used and that most of the excavated material would need to be transported and stockpiled offsite.

4.1.6.2 Trenchless Construction Work Area

Preliminary assumptions for minimum required trenchless work areas for 96-inch-diameter pipeline construction include:

- Size of rectangular shafts: 32 feet long by 22 feet wide
- Size of circular shafts: 32 feet in diameter
- Area required for launching shafts: 27,000 square feet
- Area required for receiving shafts: 14,000 square feet
- Site can be accessed by semi-trucks with trailers and dump trucks without restriction
- Existing overhead and subsurface utilities can be relocated to facilitate trenchless installation

After initial analysis of the potential pipeline corridors, it is assumed the following three trenchless construction methods could be used for the Hyperion Backbone:

- Closed face tunneling using an earth pressure balance machine with maximum straight distance between launch and reception shafts of 35,000 linear feet, assuming cutter-head access for maintenance from the surface, or under compressed air, is feasible. Curved installations of similar lengths are feasible with a minimum horizontal radius of 1,200 feet.
- Closed face tunneling using a microtunnel boring machine with maximum straight distance between launch and reception shafts of 3,000 linear feet. Curved installations of similar lengths are feasible with a minimum horizontal radius of 1,200 feet.
- Open-face tunneling using a tunnel boring machine with a maximum straight distance between shafts of 2,000 linear feet. Curved installations of similar lengths are feasible with a minimum horizontal radius of 1,200 feet.

All methods are assumed to require double-pass installation with a casing and carrier pipe.

4.1.7 Avoidance of Existing Utilities

To the fullest extent possible, conflicts with existing utilities will be avoided. However, because of the number of utilities expected to be encountered in the project study area, avoiding all existing utilities may not be feasible.

For this phase of the study, utilities were reviewed in a geographic information system (GIS) to identify routes that minimize potential large-diameter utility relocations. In cases where utilities within a segment have diameters equal to or larger than 24 inches, the horizontal clearance between the Hyperion Backbone (assumed to be 96 inches in diameter) and existing utilities was reviewed at a high level using Google Earth to provide an optimal minimum separation of 10 feet. For the purposes of this study, it is assumed that the pipeline will need to meet the standard 2 feet of separation. This assumption will need to be verified with each utility owner during the design phase.

The next phase of the study will include determining the candidate routes, determining locations of recommended open-cut and trenchless reaches, and locating tunneling shafts to minimize the amount of potential large-diameter utility relocations (for utilities 24 inches and larger).

4.2 Initial Segments

Workshops were held with LADWP’s Water Resources Division, LADWP’s Trunk Line Group, and WRD so that assumptions and criteria for developing route segments satisfied the stakeholders’ requirements and were consistent with the agencies’ best practices and experience on previous pipeline projects.

Using the criteria summarized in Section 4.1, the initial route segments for the Hyperion Backbone were developed using a multi-step process that included a comprehensive desktop study using Google Earth and GIS, in conjunction with utility data obtained from the various cities, agencies, and utility companies. More details are provided in Section 5. Additionally, the path of each segment developed in the desktop study was driven to gain a visible real-world perspective of ROW width and possible obstructions and construction conditions, and to visually assess potential impacts on residents, businesses, and services. Figure 4 shows the initial route segments from Hyperion WRP to the San Gabriel River.

5. Information Collection

This section summarizes information collected during the first phase of the project and used to develop and screen Hyperion Backbone route segments. The information collected included:

- Existing utilities
- Existing geotechnical subsurface information
- Opportunities for collaboration (rail-to-rail project)
- Parcel data
- City boundaries

Parcel data and city boundary GIS shapefiles were collected online via publicly available Los Angeles County portals and are not discussed in detail in this section; however, delineations of City boundaries within the project study area are shown on Figure 5.

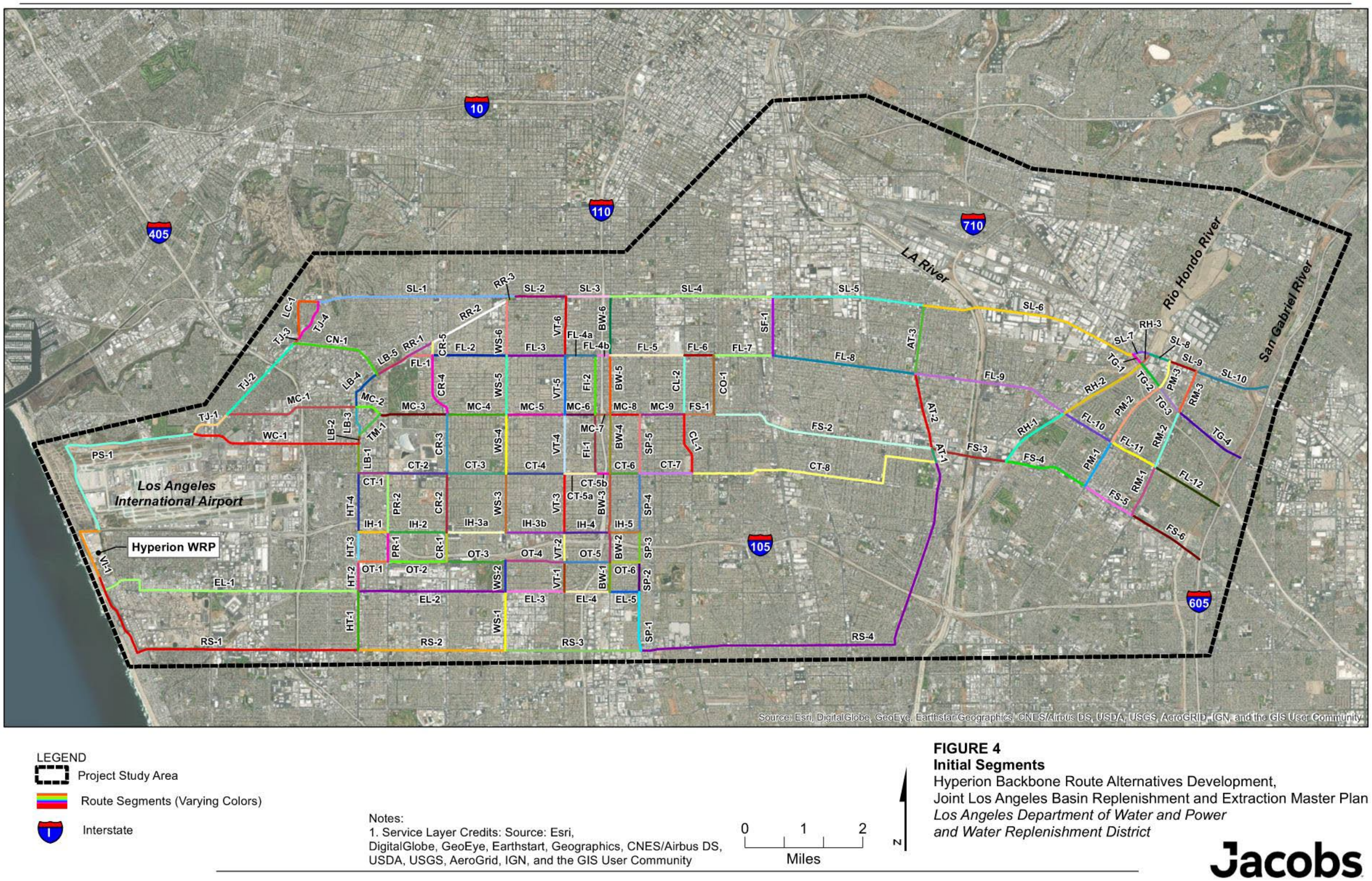


Figure 4. Initial Segments

5.1 Utilities

The study team gathered as much information as possible about underground utilities within the project study area. Information was obtained early in the process and represents most of the large-diameter utilities expected to be encountered in the project study area. Information included public GIS files and other information for the following infrastructure:

- Los Angeles County storm drains
- Metropolitan pipelines
- Los Angeles Sanitation and Environment (LASAN) sewers
- LADWP pipelines and underground electric lines
- WRD recycled water pipelines

All other cities and known private utility providers within the project study area were contacted for their respective underground utility information. The locations of pipelines with a diameter equal to or larger than 24 inches were prioritized.

Private providers with underground utilities within the project study area were also contacted for utility information and GIS shapefiles. These companies included:

- California Water Service Company
- Golden State Water Company
- Southern California Edison
- Southern California Gas Company

Public utility information that can be viewed online was also gathered and assessed. Navigate LA, an online public platform that contains data on City-owned utilities, was used to cross-check and verify Los Angeles County and LASAN sewer and storm drain GIS data (City 2020). The National Pipeline Mapping System was used to gather oil and gas pipeline GIS data (U.S. Department of Transportation 2020). Miscellaneous underground electric lines unaccounted for in other sources were viewed via an online U.S. Energy Mapping System maintained by the U.S. Energy Information Administration (2020). It was through this resource that the location of underground electric lines owned by Southern California Edison were identified.

The utility data collected are summarized in the Utility Information Collection Table in Attachment 1. The cities within the project study area were previously shown on Figure 5. The following subsections discuss the City utilities that were not collected and the pending city utilities.

5.1.1 City Utilities Not Analyzed

This section discusses the utilities not analyzed during the first phase of the study for each of the pertinent cities shown on Figure 5.

The City of Bell provided images of utility drawings, but complete as-built drawing sets or GIS data were not provided. A full review of the City of Bell's utilities was not possible because of the incomplete data set and legibility of the drawing images. A review of the information provided did not show utilities with pipe sizes larger than 24 inches in diameter, so the images will be further investigated in the next phase.

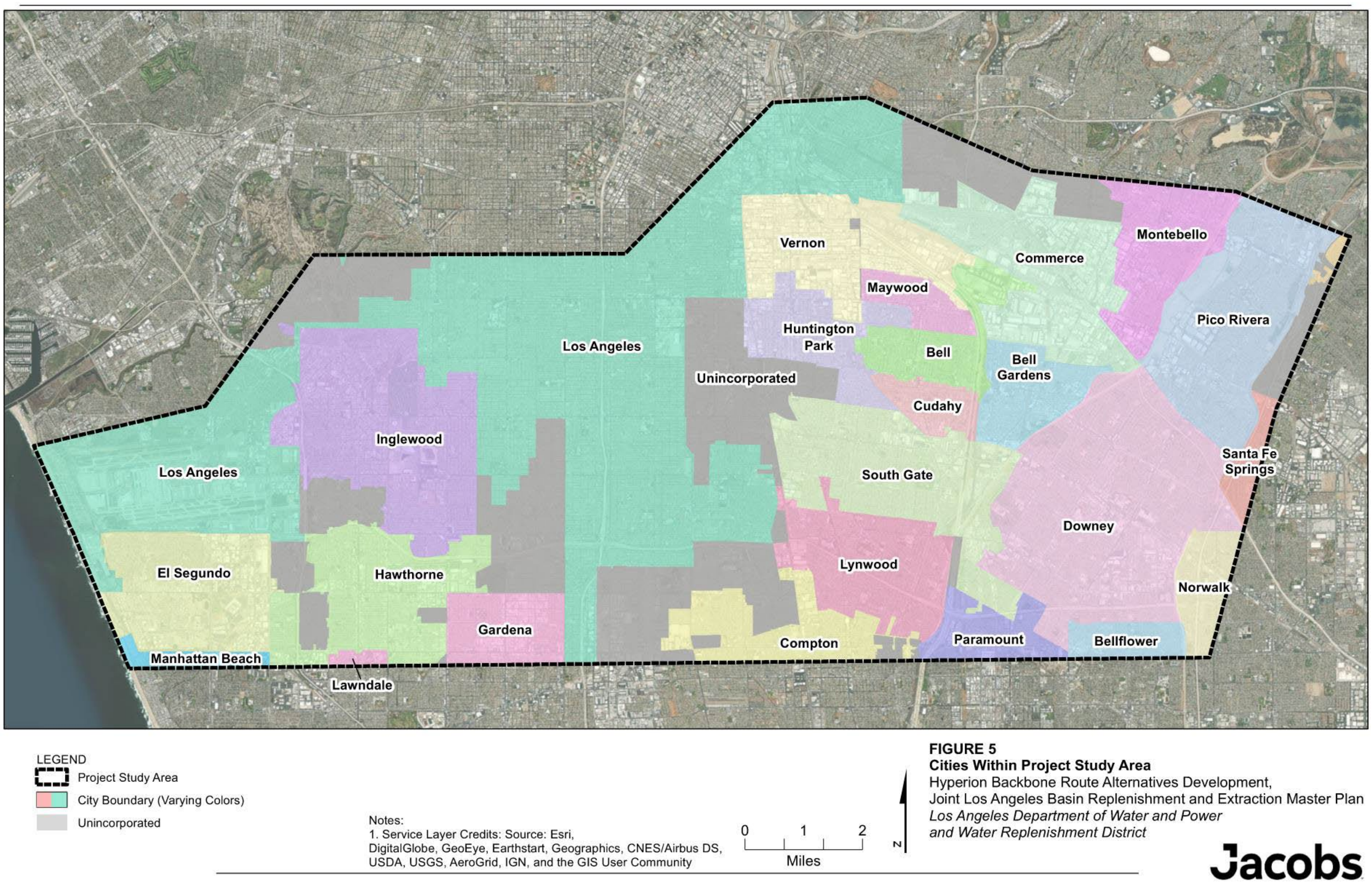


Figure 5. Cities within Project Study Area

After contacting each of the cities and analyzing the collected data, we determined that Bell Gardens and Hawthorne only have underground utilities 24 inches in diameter or smaller. As previously mentioned, it is assumed that utilities less than 24 inches in diameter could potentially be relocated as part of Hyperion Backbone construction; therefore, they were not considered further for this route study.

The Cities of Commerce, Cudahy, Lawndale, Florence, and Lennox do not own or maintain utilities within their boundaries and rely on private providers for utility services.

There are several cities located in pockets of the project study area that have little to no effect on the Hyperion Backbone. Utilities in Bellflower, Norwalk, Paramount, Santa Fe Springs, and Whittier were not analyzed.

5.1.2 Pending City Utility Files

The City of Downey has indicated it is in the process of collecting, organizing, and transcribing its underground utility files, with plans to convert the information into GIS shapefiles. As a result, Downey utility information was not available to the project team during the development of this routing study. In the meantime, Jacobs provided the City of Downey with a list of prioritized street segments within its boundaries to help expedite the information request for the next phase of the project.

The Cities of Pico Rivera and Montebello did not respond to requests for information and will require in-person visits during the next phase of the project.

5.2 Existing Geotechnical Subsurface Information

5.2.1 Geotechnical Data and Reports Collected

We conducted a preliminary review of readily available geotechnical information to determine the potential subsurface conditions that could be encountered in the project study area. The following geotechnical information was collected from LADWP during this phase of the project:

- 99th Street Chloramination Station Boring Logs
- 99th Street Wells Filtration Plant Boring Logs
- Century Trunk Line – Unit 1 and 2 Boring Logs
- Manhattan Wells Ammoniation Station Boring Logs
- Western Trunk Line Boring Logs
- Westside Water Recycling Project Boring Logs

A further in-depth review of these data will occur during the next phase of the project.

The following sources were used to develop the summary of soil types and summary of groundwater data discussed in this section:

- *California Department of Conservation Special Report 217 (Revised) Geologic Compilation of Quaternary Surficial Deposits in Southern California* (California Geological Survey 2012)
- *Underground Storage Tank (UST) – Depth to Groundwater Database* (Los Angeles Regional Water Quality Control Board 2018)

5.2.2 Summary of Soil Types

The coast of the project study area is generally underlain by poorly graded, slightly consolidated to unconsolidated eolian sand and some coarse-grained sandstone and conglomerate bedrock. Inland from the coast, the surficial deposits generally consist of artificial fill and slightly to moderately consolidated eolian sands.

Farther inland, and still within the western half of the project study area, the soil is characterized as being mostly underlain by old alluvial deposits consisting of slightly to moderately consolidated clay, silt, sand, and gravel. Some young alluvial deposits with cobble and boulder are also present.

Few coarse- and fine-grained sandstone and conglomerate bedrock formations may be encountered near the northern border in the western half of the project study area. The eastern half of the project study area generally consists of young alluvial deposits consisting of unconsolidated to slightly consolidated clay, silt, sand, gravel, cobble, and boulder. Alluvial wash deposits consisting of loose to moderately loose sandy and gravelly sediments near channels, rivers, and streams may be present.

This information was used as a baseline to identify tunneling methods that could be used given the nature of the soils examined during this preliminary analysis.

5.2.3 Summary of Groundwater Data

Groundwater summary data for Los Angeles County obtained from the Los Angeles Regional Water Quality Control Board (Regional Board) UST Depth to Groundwater table generally indicated that the groundwater depths within the project study area range from 11 feet below ground surface (bgs) to 223 feet bgs, with an average groundwater depth of 51 feet bgs. These data have not been verified by the Regional Board (2018), and groundwater levels may vary due to seasonal fluctuation, rainfall, and irrigation usage.

5.3 Opportunities for Collaboration: Rail-to-Rail Corridor Project

The Los Angeles County Metropolitan Transportation Authority (Metro) is planning to construct a bike and pedestrian path corridor within an abandoned 5-mile-long, 40-foot-wide railroad ROW in the northwestern and northern portions of the project study area. Also known as the Rail-to-Rail Corridor, this green space project will use the Harbor Subdivision Rail Corridor ROW beginning at Crenshaw Boulevard, and parallels Slauson Avenue from Denker Avenue to Santa Fe Avenue (Metro et al. 2017).

This corridor had the potential for a possible project collaboration between LADWP and Metro, with an opportunity to install a portion of the Hyperion Backbone in a corridor with little to no utility conflicts and minimal disruption to the public. However, after discussions between LADWP and Metro, it was determined that the timing of construction for the projects was not compatible. Moving forward, LADWP will continue to look for other opportunities for collaboration.

6. Segment Screening

6.1 Possible Route Segments

The initial route segments described in Section 4.2 were screened and evaluated based on various high-level criteria, including:

- Potential major utility interferences
- Distance to connection locations
- Fatal flaws, such as being within Caltrans ROW and possible major disruptions to the public

Figure 4 shows the initial route segments evaluated. The route segments cover corridors north and south of the Hyperion WRP, following several east-west major roadways bounded by Rosecrans Avenue and Slauson Avenue.

6.2 Approach

After development of the initial route segments, each segment was reviewed to identify and eliminate those with major flaws. The following criteria were used in this screening process:

- Segments located within Caltrans ROW
- Distance from future connections
- Street width
- Overall length when combined into a complete alternative route
- Proximity to emergency service facilities and schools
- Residential frontage
- Conflicts with utilities equal to or larger than 24 inches in diameter and overall utility congestion

The screening process included three steps:

- **Step 1** consisted of screening and eliminating segments if they were located within Caltrans ROW or were the farthest from future connections. For example, segments within Imperial Highway, which is maintained by Caltrans, were eliminated. Additionally, segments in Rosecrans Avenue were eliminated because the distance between future connections and Rosecrans Avenue was significantly longer than other east-west thoroughfares and provided no added value in comparison to other segments.
- **Step 2** consisted of comparing adjacent segments using criteria such as constructability, street width and length, proximity to emergency service facilities and schools, utility congestion, and relative disturbance to residents and businesses. For example, when comparing adjacent segments along Compton Avenue and Central Avenue, the segments along Compton Avenue would interfere with the access to a school and more residencies when compared to Central Avenue. Therefore, Compton Avenue was eliminated in Step 2. This process was repeated for situations where segments were adjacent to one another.
- **Step 3** eliminated the residual segments that were previously connected to segments eliminated in Steps 1 and 2 that are now no longer connected to other segments (no continuity). For example, the segments that connected perpendicularly to segments along Imperial Highway were eliminated, as they no longer provided continuity.

6.3 Eliminated Segments

Figure 6 shows the progression of segments that were eliminated after the screening process using Steps 1 through 3. The segments depicted in red are those that were eliminated in Step 1, segments in yellow were eliminated in Step 2, and segments in blue were eliminated in Step 3. Table 1 provides a summary of the segments eliminated after the screening process. Refer to Attachment 2 for a detailed summary of the criteria that led to eliminating segments shown on Figure 6 and in Table 1.

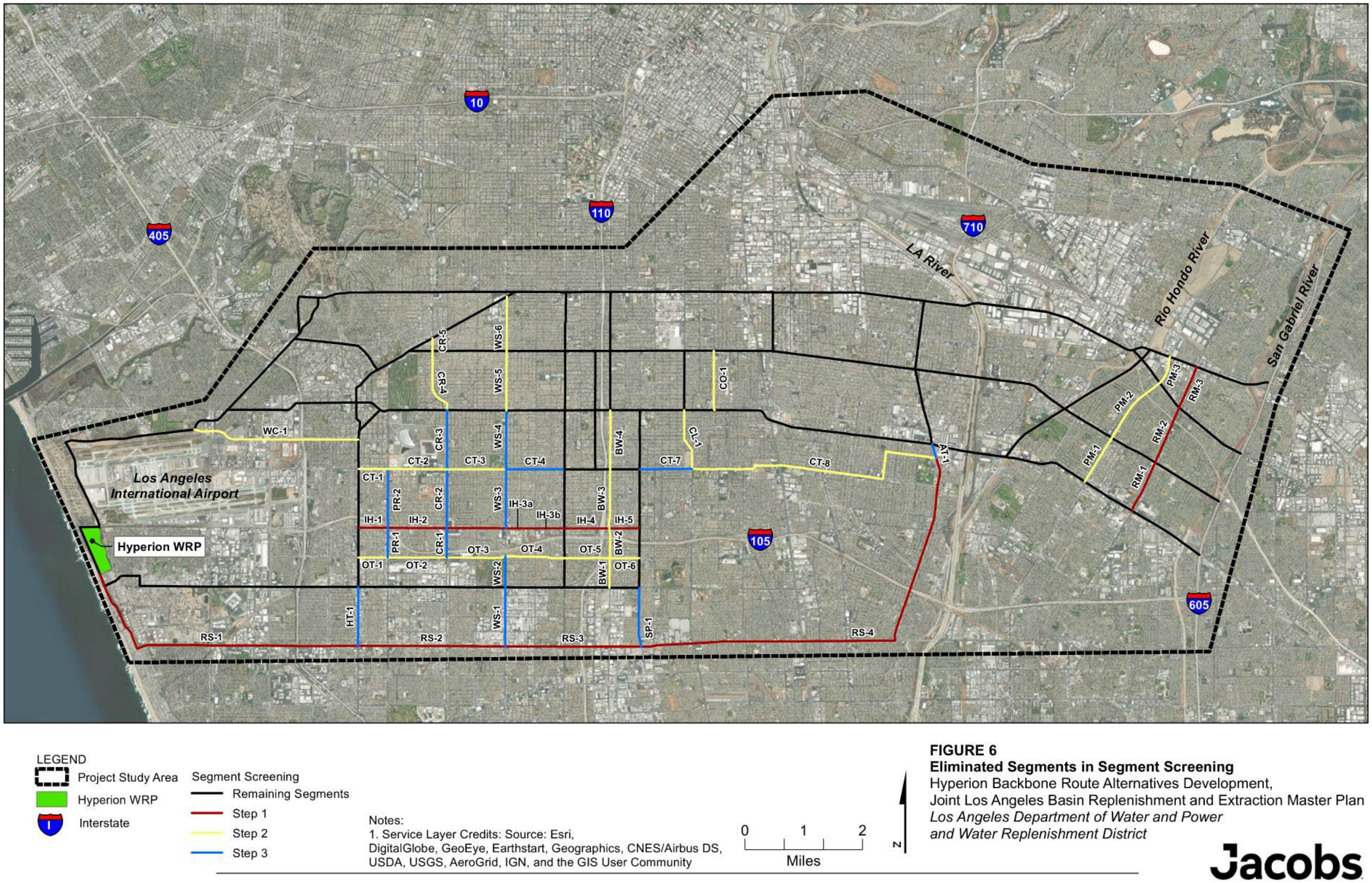


Figure 6. Eliminated Segments in Segment Screening

Table 1. Steps 1, 2, and 3 Eliminated Segments

Roadway Name	Eliminated Segment Identification Number	Segment Screening Criteria				
		Step 1		Step 2		Step 3
		Caltrans ROW	Distance from Future Connections	Constructability: Street Width, Length, and Future Construction	Emergency Services, Public Utilities, Schools, and Residential Frontage	Resulting Disconnected Segments
Imperial Highway	IH 1-5	•				Western Avenue WS-3
Rosemead Boulevard	RM 1-3	•				
Rosecrans Avenue	RS 1-4		•	•	•	San Pedro Street SP-1 Western Avenue WS-1 Hawthorne Boulevard HT-1
120th Street	OT 1-6			•	•	Western Avenue WS-2 Crenshaw Boulevard CR-1, CR-2 Prairie Avenue PR-1, PR-2
Westchester Parkway	WC-1			•	•	
Crenshaw Boulevard	CR 4-5			•	•	
Century Boulevard	CT-3			•	•	Century Boulevard CT-4 Western Avenue WS-4
Century and Tweedy Boulevards	CT-8			•	•	Atlantic Avenue AT-1
Century Boulevard	CT 1-2			•		Crenshaw Boulevard CR-3

Table 1. Steps 1, 2, and 3 Eliminated Segments

Roadway Name	Eliminated Segment Identification Number	Segment Screening Criteria				
		Step 1		Step 2		Step 3
		Caltrans ROW	Distance from Future Connections	Constructability: Street Width, Length, and Future Construction	Emergency Services, Public Utilities, Schools, and Residential Frontage	Resulting Disconnected Segments
Western Avenue	WS 5-6			•	•	
Broadway Boulevard	BW 1-4			•	•	
Central Avenue	CL-1			•	•	Century Boulevard CT-7
Compton Avenue	CO-1			•	•	
Paramount Boulevard	PM 1-3			•	•	

6.4 Remaining Segments

Figure 7 shows the remaining segments after the segment screening process. The number of segments was reduced from 142 to 89, and the remaining segments were used to develop Hyperion Backbone's preferred alternatives.

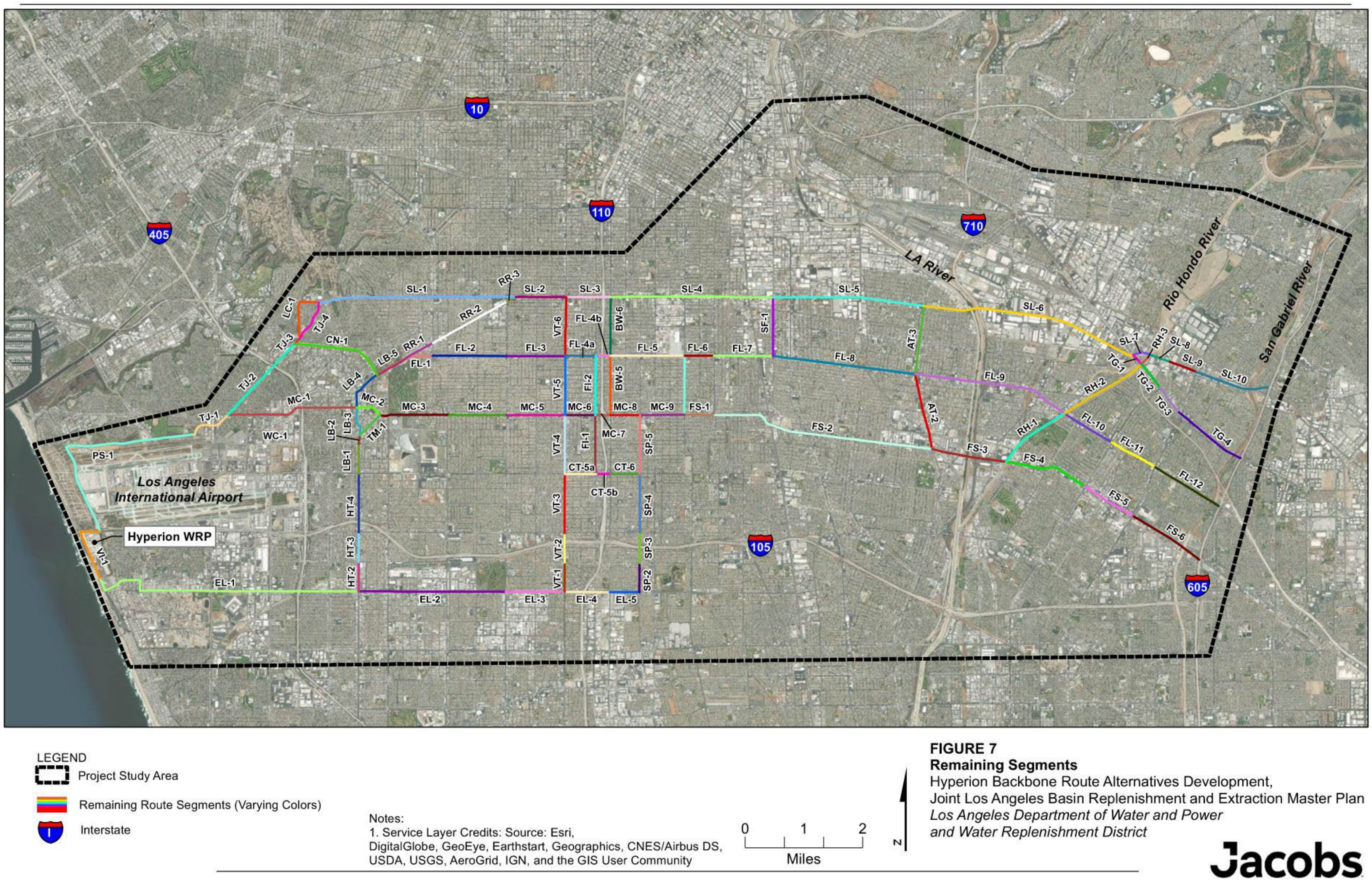


Figure 7. Remaining Segments after Screening Process

7. Preferred Alternative Routes

From the remaining segments following the segment screening and elimination process, three preferred alternatives were created. These alternative routes were developed by joining segments to create contiguous pipeline routes in the general direction from the Hyperion WRP to the San Gabriel River. Jacobs recommends these three preferred alternatives to meet the project goals. Additionally, Jacobs recommends these three alternatives because they provide flexibility to circumvent any one city in case a certain jurisdiction needs to be avoided when further analysis is conducted during the next phase of the project. For example, although Alternatives 2 and 3 traverse Inglewood, Alternative 1 does not. Figure 8 shows the three preferred alternatives recommended by Jacobs for the first phase of the project, while Figure 9 shows the alternatives overlaying the city and jurisdictional boundaries for the municipalities within the project study area.

Although not all segments were used in the creation of the three alternative routes, all segments that remained after the screening and elimination process are still viable and can be used to modify an alternative route as needed and will be considered when determining the final route in the next phase of the project. This next phase will include a deeper analysis, scoring, and evaluation of the three alternatives discussed here, as well as all the individual remaining segments. It is possible that alternatives could change, be combined, or be modified as this next phase occurs. A benefit of the three preferred alternative routes is that there is enough flexibility for any one of them to be revised if new criteria or conditions arise from the findings resulting from the next phase.

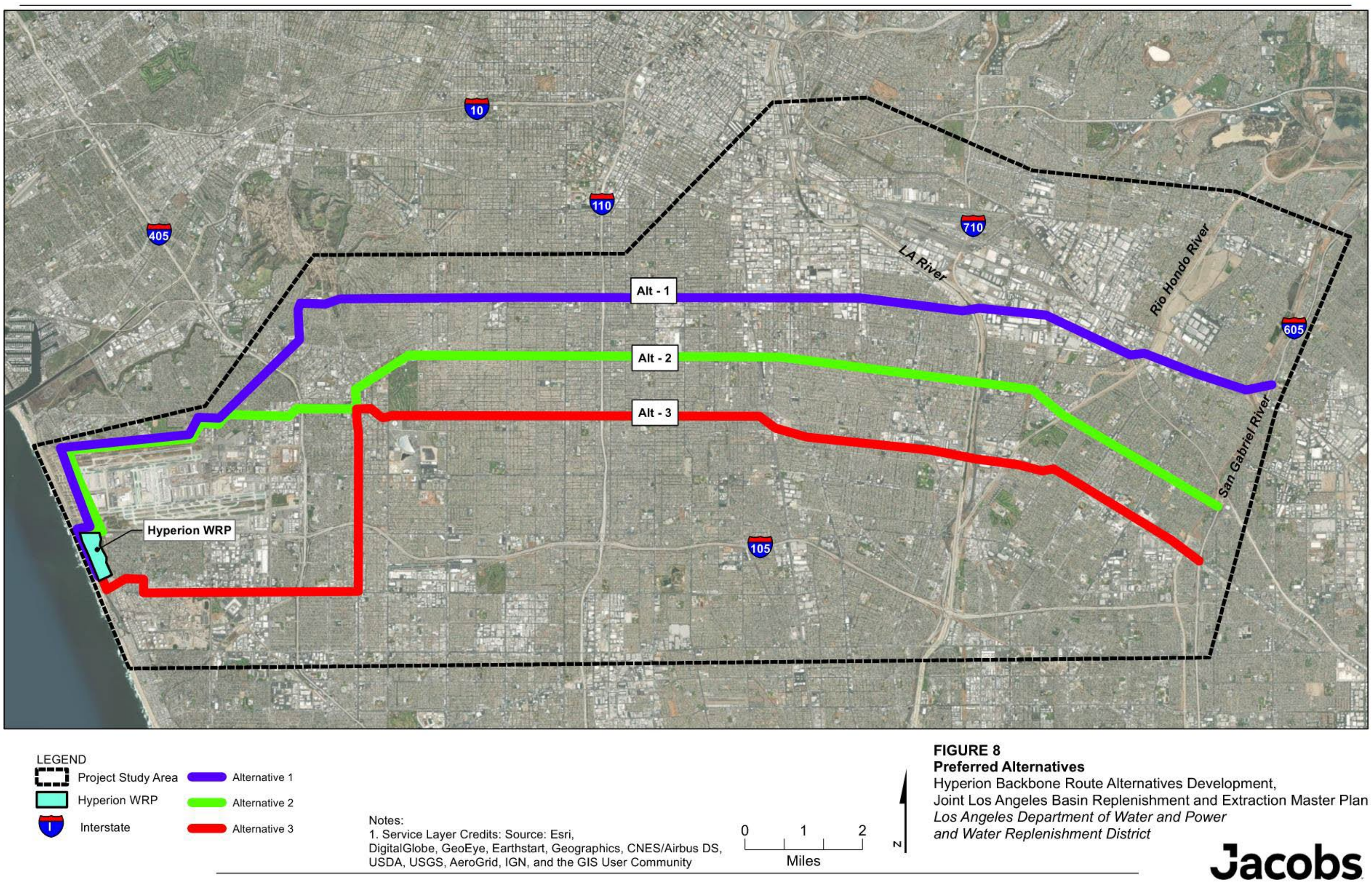


Figure 8. Preferred Alternatives

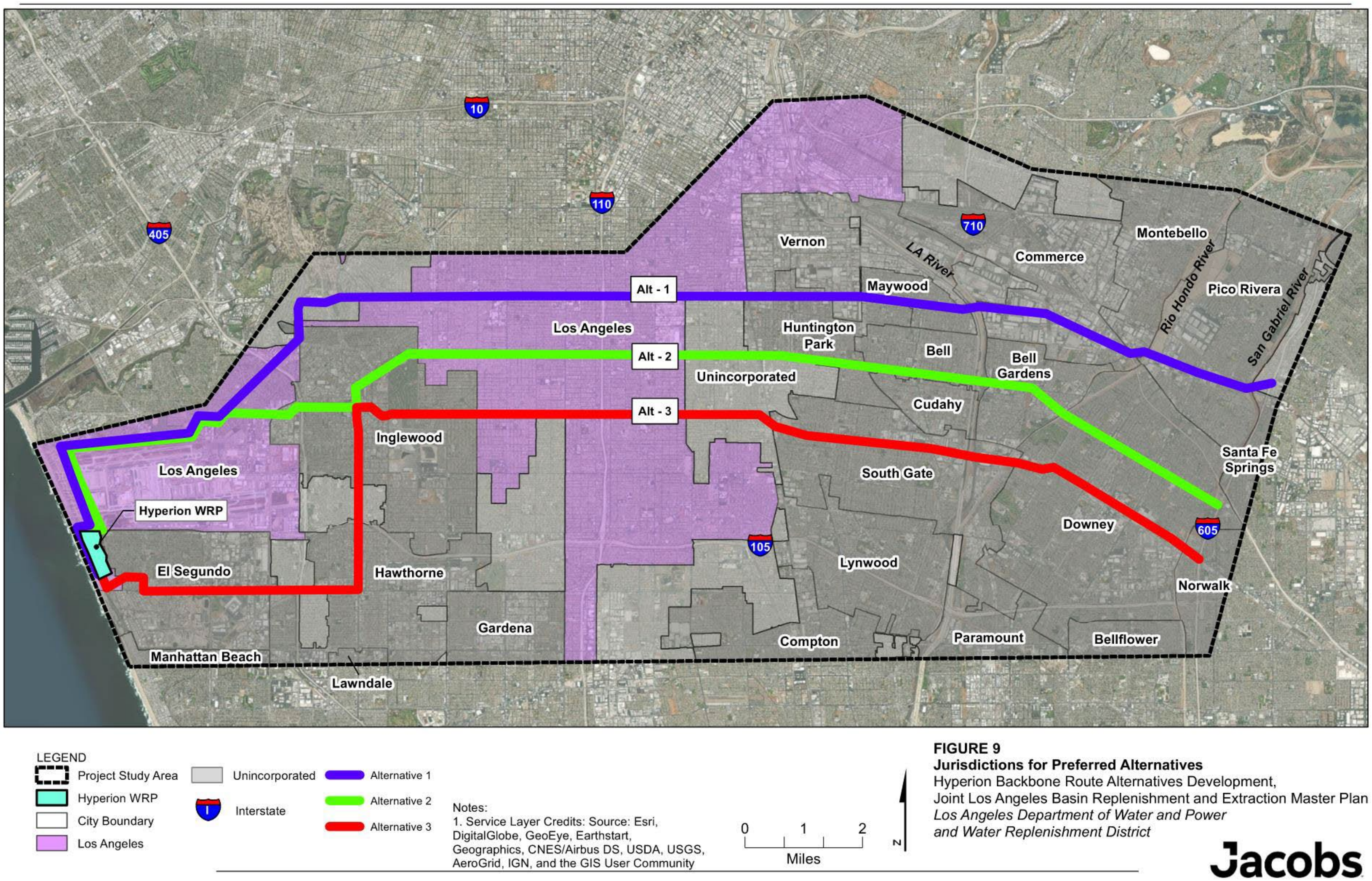


Figure 9. Jurisdictions for Preferred Alternatives

7.1 Alternative 1: Pershing – La Tijera – Slauson

7.1.1 Description

Alternative 1 begins at the Hyperion WRP and takes the following route:

1) Heads north along Vista Del Mar
2) Turns east on Hyperion WRP property (paralleling Imperial Highway)
3) Heads north on Pershing Drive
4) Heads east on Westchester Parkway
5) Heads north on La Tijera Boulevard
6) Heads north on La Cienega Boulevard
7) Turns east onto Slauson Avenue
8) Continues along Slauson Avenue before terminating at the San Gabriel River.

This alternative is approximately 25 miles long and includes the following segments: VI-1, PS-1, TJ-1, TJ-2, TJ-3, LC-1, SL-1, SL-2, SL-3, SL-4, SL-5, SL-6, SL-7, SL-8, SL-9, SL-10, and SL-11.

7.1.2 Potential Major Utility Interferences

The following potential major utility interferences were identified for this alternative:

- Segment TJ-2: LADWP Power Distribution Station #58 (DS 58 Westchester) and several power distribution lines are located at the intersection of La Tijera Boulevard and Airport Boulevard. Also, potential congestion is a concern because of power lines at the intersection of La Tijera Boulevard and Interstate 405.
- Segment SL-1: Significant utility congestion was identified from the intersection of Slauson Avenue and 4th Avenue to the intersection of Slauson Avenue and Van Ness Avenue. This location will be considered for trenchless construction methods in the next phase.
- Segment SL-4: Along Slauson Avenue, from Main Street to Pacific Boulevard, there are abandoned oil pipelines in the southern side of the street. The pipelines could present potential soil contamination issues within Slauson Avenue and will be considered in the next phase of the project.

Attachment 3 provides a summary of all utilities within each segment of the alternative.

7.1.3 Jurisdiction and Rights-of-Way

The entire route is assumed to be within road ROWs, and although it is not anticipated that easements will be required, any potential land acquisition will be assessed in the next phase. This alternative will be within ROWs owned by the following entities:

- Los Angeles County
- Cities of:
  - Los Angeles
  - Vernon
  - Huntington Park
  - Maywood
  - Bell
  - Commerce
  - Montebello
  - Pico Rivera

7.1.4 Potential Issues

This alternative will run perpendicular with the Los Angeles International Airport (LAX) runways in Pershing Drive between Imperial Highway and Westchester Parkway, located approximately 1,000 feet west of the nearest runway. However, there are light poles along Pershing Drive through this reach that are taller than the largest equipment expected to be used during construction. This issue will require confirmation and coordination with LAX to determine whether there are any restrictions and requirements for construction adjacent to the airport through Pershing Drive.

At the intersection of La Cienega Boulevard and Slauson Avenue, complex construction could be encountered through the Slauson on-ramp that will require thoughtful location of the final route and potential tunneling shafts to minimize disruption to traffic and the general public.

Along Slauson Avenue, in addition to the potential contamination from the aforementioned abandoned oil pipelines, soil conditions will need to be investigated to determine the extent (if any) of contamination from the adjacent Harbor Subdivision abandoned railroad ROW. Another challenge that will require planning and coordination through Slauson is the significant amount of business and industrial frontage that the Hyperion Backbone will encounter along this route. It its assumed that disruptions to these frontages and entrances can be reduced with tunneling and proper pipeline route planning.

The Community Hospital of Huntington Park is located near the intersection of Slauson Avenue and Pacific Boulevard. Its main entrance, however, is on 58th Street, not Slauson Avenue. Consideration will need to be given to avoiding emergency vehicle access during pipeline construction.

As is the case with each of the three alternatives, this alternative will have several trenchless crossings underneath Caltrans overpasses, roads, concrete channels, and other interferences. This alternative, however, will not cross Interstate 105, which Alternative 3 does.

7.2 Alternative 2: Pershing – Manchester – Florence

7.2.1 Description

Alternative 2 follows the same route as Alternative 1 between Hyperion WRP and the intersection of La Tijera Boulevard and Manchester Boulevard. At the intersection of La Tijera and Manchester, the alternative follows this route:

1) Heads east on Manchester to South La Brea Avenue
2) Heads north on South La Brea Avenue before turning northeast on Florence Avenue
3) Stays on Florence Avenue until it reaches the San Gabriel River

This alternative is approximately 23.9 miles long and includes the following segments: VI-1, PS-1, TJ-1, MC-1, LB-4, LB-5, FL-1, FL-2, FL-3, FL-4, FL-5, FL-6, FL-7, FL-8, FL-9, FL-10, FL-11, and FL-12.

7.2.2 Potential Major Utility Interferences

The following potential major utility interference was identified for this alternative:

- FL-8 through FL-11: There are a few large diameter storm drains that appear to alternate locations within the street ROW between the westbound lanes, the median, and the eastbound lanes. These storm drains will need to be avoided when considering the final route through this reach.

Attachment 3 provides summary of all utilities within each segment of the alternative.

7.2.3 Jurisdiction and Rights-of-Way

The entire route is assumed to be within road ROWs, and although it is not anticipated that easements will be required, any potential land acquisition will be assessed in the next phase. This alternative will be within ROWs owned by the following government entities:

- Los Angeles County
- Cities of:
  - Los Angeles
  - Inglewood
  - Huntington Park
  - Bell
  - Bell Gardens
  - Downey

7.2.4 Potential Issues

As with the case for Alternative 1, Alternative 2 is within Pershing Drive between Imperial Highway and Westchester Parkway and is located approximately 1,000 feet west of the nearest LAX runway. Coordination will be required with LAX to determine whether there are any restrictions and requirements for construction adjacent to the airport through Pershing Drive.

Along Florence Avenue, there is a significant amount of business and industrial frontage that the Hyperion Backbone will encounter along this route. Potential issues are expected from the impacts on businesses and the potential for contamination. There are also several schools and some residential frontage along Florence Avenue. It is assumed that disruptions to these frontages and entrances can be reduced with tunneling and proper pipeline route planning.

As is the case with each of the three alternatives, this alternative will have several trenchless crossings underneath Caltrans overpasses, roads, concrete channels, and other interferences. This alternative, however, will not cross Interstate 105, which Alternative 3 does.

7.3 Alternative 3: El Segundo – Hawthorne – Manchester – Firestone

7.3.1 Description

Unlike Alternatives 1 and 2, Alternative 3 heads south from the Hyperion WRP along Vista Del Mar. The alternative then follows this route:

1) Turns east on Grand Avenue
2) Turns south along Richmond Street
3) Turns east along El Segundo Boulevard
4) At the intersection of El Segundo and Hawthorne Boulevard, the alternative heads north along Hawthorne Boulevard (which eventually becomes La Brea Avenue)
5) At the intersection of La Brea Avenue and Manchester Boulevard, the alternative heads east on Manchester Boulevard (which eventually becomes Firestone Boulevard at the intersection with Compton Avenue)
6) Remains in Manchester Boulevard (Firestone Boulevard) until reaching the San Gabriel River

This alternative is approximately 23 miles long and includes the following segments: EL-1, HT-2, HT-3, HT-4, LB-1, LB-2, LB-3, MC-2, MC-3, MC-4, MC-5, MC-6, MC-7, FS-1, FS-2, FS-3, FS-4, FS-5, and FS-6.

7.3.2 Potential Major Utility Interferences

The following potential major utility interferences were identified for this alternative:

- EL-1:
  - There is significant utility congestion in Grand Avenue from Vista Del Mar to Richmond Street.
  - Eight recycled water lines, in addition to oil and gas lines, vary in location within the roadway along El Segundo Boulevard.
  - There is major utility congestion in El Segundo Boulevard from the intersection of Richmond Street to the intersection with Aviation Way, including storm drains, two natural gas lines, and recycled water lines.
- MC-5 and MC-6: There is significant utility congestion in street ROW primarily because of two sewers and one storm drain spaced approximately 30 feet apart.

Attachment 3 provides a summary of all utilities within each segment of the alternative.

7.3.3 Jurisdiction and Rights-of-Way

The entire route is assumed to be within road ROWs, and although it is not anticipated that easements will be required, any potential land acquisition will be assessed in the next phase.

This alternative will be within ROWs owned by the following government entities:

- Los Angeles County
- Cities of:
  - Los Angeles
  - El Segundo
  - Hawthorne
  - Inglewood
  - South Gate
  - Downey
  - Norwalk (potentially)

7.3.4 Potential Issues

As mentioned, Grand Avenue between Vista Del Mar and Richmond Street, and El Segundo Boulevard have several recycled water pipelines already within the street ROWs. In addition, the West Basin Ocean Water Desalinization Project is planning to install a 48-inch to 54-inch-diameter desalter pipeline in El Segundo Boulevard or Grand Avenue (Environmental Science Associates 2019). This new construction would congest the streets even further. However, it is assumed that the Hyperion Backbone could be installed via trenchless methods beneath the existing utilities, which include the recycled water pipelines and the future desalter pipeline.

Alternative 3 crosses Interstate 105 along Hawthorne Boulevard (Segment HT-4). Interstate 105 is lower in elevation than Hawthorne Boulevard by about 30 feet. A trenchless crossing involving deep shafts will be required to cross the freeway. Alternative 3 is the only alternative that requires crossing Interstate 105.

Along Manchester Boulevard (Firestone Boulevard), there is a significant amount of business and industrial frontage that the Hyperion Backbone will encounter along this route. Potential issues are expected from the impacts to businesses and the potential for contamination. There are also several schools and some residential frontage along Manchester Boulevard (Firestone Boulevard). It is assumed that disruptions to these frontages and entrances can be reduced with tunneling and proper pipeline route planning.

From Paramount Boulevard to the San Gabriel River, Firestone Boulevard appears to be the main thoroughfare through Downey. The streets have recently been resurfaced, and the medians appear to be new. Construction through this reach is likely to require coordination with the City of Downey and will probably consist entirely of trenchless construction.

7.4 Remaining Optional Segments

Figure 10 shows the remaining segments not currently comprising any of the three preferred alternatives. These segments will remain as potential options in the next phase of work. These segments can provide flexibility in case modifications are required to a particular alternative during the in-depth evaluation process. For example, if the hospital on Slauson Avenue and Pacific Boulevard presents a major access issue, there is a segment on Santa Fe Avenue (west of the hospital) that would allow the route to head south on Santa Fe Avenue before continuing east on Florence Avenue to avoid conflicts with the hospital. There is ample flexibility that can allow for specific route changes along any of the three alternatives if these types of situations arise during the next phase of the study.

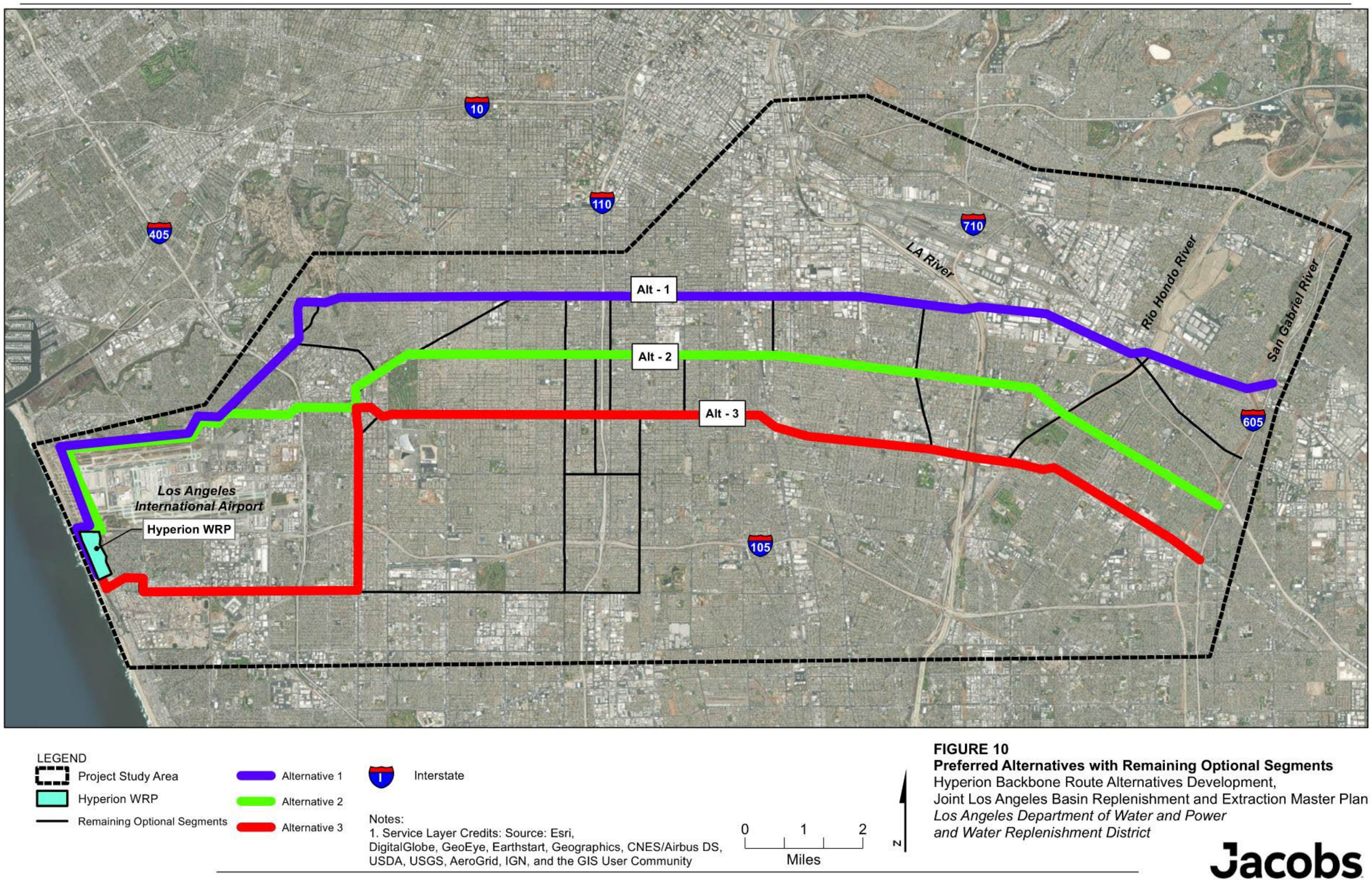


Figure 10. Preferred Alternatives with Remaining Optional Segments

8. Next Steps

The comparison of Jacobs' proposed preferred alternatives presented on Figure 8 will be analyzed further in the next phase of the project, which will result in the selection of a single preferred route. Each segment comprising the three preferred alternatives will be evaluated using weighted criteria developed by the Joint Master Plan team, and will be scored during collaborative workshops to support consistency and agreement by all parties. Then, the segment scoring for each alternative will be combined and presented in a graphical comparison of the alternatives to aid in identifying the preferred route. As discussed previously, additional remaining segments shown on Figure 10 will not be included in the next phase unless modifications are required to an alternative.

9. References

American Water Works Association. 2017. *AWWA C200, Steel Water Pipe, 6 In. (150 mm) and Larger*. Accessed May 2020. https://www.awwa.org/Portals/0/files/publications/documents/standards/C200-17LookInside.pdf.

American Water Works Association. 2018. *AWWA C205, Cement–Mortar Protective Lining and Coating for Steel Water Pipe 4 In. (100 mm) and Larger—Shop Applied*. Accessed May 2020. https://www.awwa.org/Portals/0/files/publications/documents/standards/C205-18LookInside.pdf.

California Geological Survey (CGS). 2012. *Geologic Compilation of Quaternary Surficial Deposits in Southern California*. California Department of Conservation Special Report 217 (Revised). December. https://maps.conservation.ca.gov/geology/.

City of Los Angeles (City). 2020. *NavigateLA*. Bureau of Engineering Department of Public Works. Accessed December 2019. https://navigatela.lacity.org/navigatela/.

Environmental Science Associates. 2019. *Final Environmental Impact Report. West Basin Ocean Water Desalination Project*. Accessed February 2020. http://westbasindesal.com/assets/Documents%20and%20Files/FEIR/11.0_Refinements%20to%20the%20Project%20Description.pdf.

Garcetti, Eric, Mayor. 2019. *L.A.'s Green New Deal. Sustainable City pLAn*. City of Los Angeles. https://plan.lamayor.org/sites/default/files/pLAn_2019_final.pdf.

Los Angeles County Metropolitan Transportation Authority (Metro), U.S. Department of Transportation, and Federal Transit Administration. 2017. "Volume 1, Rail to Rail Active Transportation Corridor." *Document for a Categorical Exclusion*. In association with Cityworks Design, EFI Global, Fehr & Peers, KPFF, Rincon Consultants, Inc., and Terry A. Hayes Associates Inc. April. http://media.metro.net/projects_studies/active_transportation/images/R2R_Segment_A_Environmental_Clearance_NEPA.pdf.

Los Angeles Department of Water and Power (LADWP). 2019. Draft Groundwater Development and Augmentation Plan – Phase 1 Report Central Basin, Los Angeles. March 14.

Los Angeles Regional Water Quality Control Board (Regional Board). 2018. *UST – Depth to Groundwater Database*. Microsoft Excel file last updated December 2005. August 28. https://www.waterboards.ca.gov/losangeles/water_issues/programs/ust/groundwater_database.html.

U.S. Department of Transportation. 2020. *National Pipeline Mapping System*. Pipeline and Hazardous Materials Safety Administration. Accessed December 2019. https://www.npms.phmsa.dot.gov/.

U.S. Energy Information Administration. 2020. U*.S. Energy Mapping System*. Accessed December 2019. https://www.eia.gov/state/maps.php.

Attachment 1
Utility Information Collection Summary

Attachment 1. Utility Information Collection Summary

City/Agency/ Company	Utility Information Collected			Utility Information Not Collected/Analyzed			Comments
	JPEG Images	PDF Maps	GIS Files	Only own utilities < 24" in diameter	Do not own or maintain utilities	No major impact to Hyperion Backbone	
City of Bell	Sewer, Storm						Incomplete dataset provided
City of Bell Gardens				X			<=14" in Diameter
City of Bellflower						X	
City of Commerce					X		
City of Compton		Sewer					
City of Cudahy					X		
City of Downey							Pending data (currently archiving)
City of El Segundo			Sewer, Storm, Water, Substructures				
City of Gardena		Sewer, Storm					
City of Hawthorne				X			<=12" in Diameter
City of Huntington Park		Sewer, Water					
City of Inglewood			Sewer, Storm, Water				
City of Lawndale					X		
City of Lynwood		Sewer, Water					
City of Manhattan Beach			Sewer, Storm, Water				
City of Maywood		Sewer					
City of Montebello							Unresponsive
City of Norwalk						X	
City of Paramount						X	
City of Pico Rivera							Unresponsive
City of Santa Fe Springs						X	
City of South Gate			Sewer, Storm, Water				
City of Vernon		Gas, Power, Water					
City of Whitter						X	

	Utility Information Collected			Utility Information Not Collected/Analyzed			Comments
City/Agency/ Company	JPEG Images	PDF Maps	GIS Files	Only own utilities < 24" in diameter	Do not own or maintain utilities	No major impact to Hyperion Backbone	
California Water Service Company			Water				
Golden State Water Company		Water					
Los Angeles County			Storm				
LADWP			Water, Power				
LASAN			Sewer				
MWD			Water				
National Pipeline Mapping System			Gas, Oil				
Southern California Edison							Able to see in viewer https://www.eia.gov/state/maps.php
Southern California Gas Company							Will not provide data for entire Project Study Area
WRD			Recycled Water				WRD does not own or operate but provided GIS pipeline data

Attachment 2
Hyperion Backbone Route Study – Summary of Eliminated Segments

Hyperion Backbone Alternative Development – Post-Workshop Summary of Eliminated Segments

Workshop Date: Thursday January 13, 2020

1. Imperial Highway (IH 1-5)

- Caltrans ROW

Resulting Step 3 Segments: WS-3 (S Western Ave)

2. Rosemead Blvd RM (1-3)

- SR 19, Caltrans ROW

3. W Rosecrans Ave (RS 1-4)

- Rosecrans corridor is much farther away from the LAAFP and GDAP site connections than the other corridors (El Segundo, Manchester/Firestone, and Slauson)
- Chevron gas pipeline corridor in Rosecrans Ave
- Segment Specific Issues:
  - RS-1: residential areas in Manhattan Beach are congested
  - RS-4 has unnecessarily long length for no apparent benefit

Resulting Step 3 Segments: SP-1 (S San Pedro St.), WS-1 (S Western Ave.), HT-1 (Hawthorne Blvd.)

4. E 120th (OT 1-6)

OT 1-3

- Proximity to the Hawthorne Municipal Airport
- Utility congestion: sewers (3), 16” oil, 45” storm drain and 36” recycled water

OT 4-6

- Residential frontage along segment
- Road width is ~53 ft wide in comparison with El Segundo Blvd width of ~83 ft
- No apparent benefit over El Segundo Blvd

Resulting Step 3 Segments: WS-2 (S Western Ave.), CR-1 & CR-2 (Crenshaw Blvd.), PR-1 & PR-2 (Prairie Ave.)

5. Westchester Pkwy and Arbor Vitae St (WC-1)

- Utility congestion – water, power, sewer, oil/gas pipelines
- Large LAX parking access on either side of the road
- LADWP is potentially putting a 48" trunkline in Arbor Vitae St
- Main road access to the Forum and the new stadium
- Narrow roadway width (~50 ft) in comparison with Manchester Blvd (~69 ft)
- Manchester Blvd is a preferred option for the LAAFP connection

6. Crenshaw Blvd (CR 4-5)

CR-4

- Segment has a westward jog that unnecessarily lengthens the segment
- Residential frontage along segment

CR-5

- More preferred options exist: Rail-to-Rail option or Florence Ave
- Residential frontage along segment

7. W Century Blvd (CT-3)

- Large diameter utilities: limited room
- Residential frontage along segment
- More preferred option: Manchester Blvd

Resulting Step 3 Segments: CT-4 (W Century Blvd.), WS-4 (S Western Ave.)

8. E Century Blvd and Tweedy Blvd (CT -8)

- Residential frontage along segment
- Does not increase proximity to a GDAP site over Manchester Blvd/Firestone Blvd
- Unnecessary bends in comparison with Manchester Blvd/Firestone Blvd
- Utility congestion: storm drains, sewer, crude oil pipeline, and powerlines

Resulting Step 3 Segments: AT-1 (Atlantic Ave.)

9. W Century Blvd (CT 1-2)

- Overall congestion as this road is the main entrance to LAX

Resulting Step 3 Segments: CR-3 (Crenshaw Blvd.)

10. S Western Ave (WS 5-6)

- Vermont Ave is a preferred option over S Western Ave:
  - Roadway width is narrower (~53 ft) than Vermont Ave (~100+ ft)
  - No direct connection to El Segundo Blvd

11. Broadway Blvd (BW 1-4)

- Traffic, surface street frequently used to avoid the freeway (I-110)
- Roadway width is narrower (~75 ft) than S Vermont Ave (~100+ ft)
- Utility Congestion with large trees in the median
  - Utilities – 80" and 108" storm drain on each side of the street
- Proximity to I-110 and I-105 Interchange causes longer undercrossing than other options

12. Central Ave (CL-1)

- Segment has a westward jog that unnecessarily lengthens the segment
- Power station at the corner of Central Blvd and Century Ave
- San Pedro St (SP-5) is a more preferred option

Resulting Step 3 Segments: CT -7 (E Century Blvd.)

13. Compton Ave (CO-1)

- Central Ave is preferred option to Compton Ave
  - Utility congestion is higher than in Central Ave
  - Impacts to entrance to school

14. Paramount Blvd (PM 1-3)

- Residential frontage along segment
- Sewer conflicts on PM-3
- I-5 undercrossing, exit and entrance ramps

		Segment Screening Criteria				
		Step 1		***Step 2***		***Step 3***
Roadway Name	***Eliminated Segment ID***	Caltrans ROW	Distance from Future Connections	Constructability: Street Width, Length, and Future Construction	Hospitals, Public Utilities, Schools, and Residential Frontage	Resulting Disconnected Segments
Imperial Hwy.	IH 1-5	•				*Western Ave. WS-3*
Rosemead Blvd.	RM 1-3	•				
Rosecrans Ave.	RS 1-4		•	•	•	*San Pedro St. SP-1* *Western Ave. WS-1* *Hawthorne Blvd. HT-1*
120th St.	OT 1-6			•	•	*Western Ave. WS-2* *Crenshaw Blvd. CR-1 CR-2* *Prairie Ave. PR-1 PR-2*
Westchester Pkwy.	WC-1			•	•	
Crenshaw Blvd.	CR 4-5			•	•	
Century Blvd	CT-3			•	•	*Century Blvd. CT-4* *Western Ave. WS-4*
Century Blvd. & Tweedy Blvd.	CT-8			•	•	*Atlantic Ave. AT-1*
Century Blvd.	CT 1-2			•		*Crenshaw Blvd. CR-3*
Western Ave.	WS 5-6			•	•	
Broadway Blvd.	BW 1-4			•	•	
Central Ave.	*CL-1*			•	•	*Century Blvd. CT-7*
Compton Ave.	CO-1			•	•	
Paramount Blvd.	PM 1-3			•	•	

Attachment 3
Summary of Utilities in Preferred Alternatives

LADWP Route Study Utilities Review – Draft Notes

The notes in this attachment are working notes and are in progress.

The data collected from each of the different cities, as well as companies and agencies that own and/or maintain underground utilities within the Project Study Area, are described in Appendix A of this report.

Some details on the following utilities review:

- All major utility or roadway crossings are assumed to be tunneled under and are not discussed in this document. Any utilities in conflict are assumed to be able to be crossed underneath within a tunnel and will be further analyzed in the next phase.
- Short segments of pipe (< 400 ft) parallel with the roadway are not included in this summary.
- Notations were provided for all utilities owned by LADWP. All other owners will be detailed in the following phase.

EL-1

EL-1 – El Segundo & Vista Del Mar

- **Existing Utilities**
  - Grand Ave.
    - N (North) – WB (Westbound)
      - Two Unk. Dia. Recycled Water
      - 60” Recycled Water
      - 20” Recycled Water
    - S (South) -EB (Eastbound)
      - 18” Recycled Water
      - 12” Recycled Water
      - Three Unk. Dia. Recycled Water
      - Unk. Dia. Gas
  - Richmond St.
    - Appears to be clear of utilities with the occasional Recycled Water Line crossing perpendicular to the roadway.

Potential pipe location: Grand Avenue is congested with Recycled Water and gas line utilities. For this portion, utility relocation or tunneling may be required. Richmond is clear of utilities, but this should be verified after a review of the city utilities (if applicable).

EL-1 – El Segundo Blvd. to Hawthorne

- **Existing Utilities**
  - El Segundo Blvd. to Sierra St.
    - N-WB
      - 6” Oil and Gas starts in the N-WB lane and transitions to the S-EB lane.
      - 12” Oil and Gas starts in the N-WB lane and transitions to the S-EB lane.

        - S-EB
            - 54” Storm Drain in the S-EB lane
            - 15” Natural Gas
            - 16” Natural Gas
            - Two Unk. Dia. Recycled Water lines
    - Sierra St. to N. Sepulveda Blvd. (location denoted below is starting location. Some pipelines cross into other parts of the roadway.)
        - N-WB
            - 20” Recycled Water
            - Unk. Dia. Recycled Water
            - 60” Recycled Water
            - Unk. Dia. Recycled Water
        - S-EB
            - Unk. Dia. Recycled Water
            - 18” Recycled Water
            - 16” Natural Gas
            - 15” Natural Gas
            - 16” Recycled Water
            - 12” Recycled Water
            - Unk. Dia. Recycled Water
    - Sepulveda Blvd. to N Douglas St.
        - N-WB
            - 42” Recycled Water
        - S-EB
            - 42” Recycled Water
            - Unk. Dia. Recycled Water
            - 30” Recycled Water
            - Unk. Dia. Recycled Water
            - 15” Natural Gas
            - 16” Natural Gas
    - N Douglas St. to Hawthorne Blvd.
        - N-WB
            - 66” Storm Drain
            - Unk. Dia. Recycled Water
            - 42” Recycled Water
            - 60” Water
            - 39” Storm Drain
        - S-EB
            - 15” Natural Gas
            - 8” Recycled Water
            - 30” Storm Drain
            - 60” Water
- Not much room in El Segundo from Sierra Street to Illinois. (0.6 mi, 3500 ft). Consider **tunneling**.

Potential pipe location: Significant utility congestion is observed from W Grand Ave. to Richmond St., and utility relocations or tunneling may be required. Richmond St. appears to be clear. Between Richmond St. and Sierra St., the proposed location is in the N-WB lanes to avoid the Recycled Water and Oil and Gas lines in the S-EB lanes. Significant utility congestion from Sierra Street to Illinois Street. Tunneling or relocation of the Recycled Water lines may be required. From Illinois St. to Ramona Ave., stay in the N-WB lanes. Switch to the S-EB lanes at Ramona Ave. to avoid the Storm Drain and Water lines in the N-WB lane.

Florence Ave Utilities

- Bear to San Luis –
  - 4" Sewer in the N-WB lane
  - 8" Sewer in the S-EB lane
- Intersection of Corona Ave
  - 4" Sewer N-WB lane
  - 16" Water S-EB lane
  - 8"Sewer in the S-EB lane
- Flora to Pine
  - 2" Water Main in the N-WB
  - 4" Sewer N-WB lane
  - 8"Sewer in the W-EB lane
- Otis to Flora
  - 4" Gas main in the N-EB lane
  - 8" Swere in the N-EB
  - Unk Dia Water in the N-EB lane
  - 8" Sewer in the S-EB
- Pine to Atlantic
  - 8" Sewer in the N-WB
  - 4" Gas in the N-WB
  - 8" Sewer in the S-EB
- Salt Lake
  - 15" Sewer in the N-WB
  - 16" Water in the S-EB lane
  - 18" Water in the S-EB
  - 21" Sewer in the S-EB
- West of Bear
  - Unk Dia sewer in the N-WB
  - 20" Water in the S-EB

FL-1

In Florence Ave. from Harbor Subdivision Railroad Crossing to Crenshaw Blvd.

- **Existing Utilities**
  - 96" Potable Water in the N-WB lane
  - 51" Storm Drain in the S-EB lane
  - Minor Water and Sewer present

Potential pipe location: Median is clear. There is utility congestion between West Blvd. and Victoria Ave., trenchless methods will be considered in the next phase.

FL-2

In Florence Ave. from Crenshaw Blvd to 8th Ave.

- Median
  - 8″ Sewer
- S-EB
  - 30″ Storm Drain

Potential pipe location: Room available in N-WB lanes.

In Florence Ave from 8th Ave. to 4th Ave.

- N-WB
  - 8″ Sewer
- S-EB
  - 12″ Water
  - 24″ CI Storm Drain in southern lane between 7th and 5th Ave.

In Florence Ave. from Van Ness Ave. to Western Ave.

- Median
  - 8″ Sewer

Potential pipe location: Room available in S-EB lanes (relocate Water main). After the intersection with Van Ness Ave., there is room available in N-WB lanes.

FL-3

In Florence Ave. from Western Ave. to Vermont Ave.

- **Existing Utilities**
  - Some stretches of greater than 24″ Storm Drain
  - Median
    - 30″ Sewer
  - Minor Water and Sewer present

Potential pipe location: Room available in N-WB lanes for the entirety of the segment.

FL-4

In Florence Ave. from Vermont Ave. to Broadway

- **Existing Utilities**
  - Minor Water and Sewer present
  - Median
    - 20″ Sewer
  - Three Storm Drains alternate between N-WB and S-EB lanes

Potential pipe location: Room available in N-WB and S-EB lanes, will need to alternate between N-WB and S-EB lanes where room is available. alternate between north and south lanes based on where room is available.

FL-5

In Florence Ave. from Broadway to Central Ave.

- **Existing Utilities**
  - Median
    - 20" Sewer
  - S-EB
    - 12" Water
    - Segments of Unk. Dia. Storm Drains

Potential pipe location: Room available in N-WB lanes for the entirety of the segment.

FL-6

In Florence Ave. from Central Ave. to Compton Ave.

- **Existing Utilities**
  - N-WB
    - Unk. Dia. Sewer
  - 8" Sewers on both sides

Potential pipe location: Room available in median for the entirety of the segment.

FL-7

In Florence Ave. from Compton Ave. to Atlantic Ave.

- **Existing Utilities**
  - 8" Sewers on both sides
  - Short segment of 48" Storm Drain

Potential pipe location: Room available in median for the entirety of the segment, this needs to be verified after review of the city utilities (if applicable).

FL-8

FL-8: In Florence Ave. from Santa Fe Ave. to Middleton

- **Existing Utilities**
  - N-WB
    - 33", 69" and other segments of large diameter Storm Drains
  - S-EB
    - Sewer in Curb

Potential pipe location: Room available in median or northern S-EB lanes, this needs to be verified after review of the city utilities (if applicable).

FL-8: In Florence Ave. from Middleton to Seville

- **Existing Utilities**
  - N-WB
    - 39" Storm Drain
  - S-EB
    - 8" Sewers in the south curb

Potential pipe location: Room available in median or northern S-EB lanes, this needs to be verified after review of the city utilities (if applicable).

FL-8: In Florence Ave. from Seville to Plaska Ave.

- **Existing Utilities**
  - Median
    - Unk. Dia. Sewer in the median
    - Short section of 72" Storm Drain between the median.
  - Short stretch of 30" Storm Drain after Mission Place

Potential pipe location: Room available in N-WB or S-EB lanes. Between Miles Ave. and Mountain View Ave., move to the S-EB lane to avoid sections of Storm Drain. After east of Passaic Street, there is room available in the N-WB lanes. This needs to be verified after review of the city utilities (if applicable).

FL-8: In Florence Ave. from Plaska Ave. to Salt Lake Ave.

- **Existing Utilities**
  - N-WB/Median
    - 69" Storm Drain
  - S-EB
    - Unk. Dia. Sewer
- Potential tunnel at Salt Lake Ave. to avoid Sewers and railroad.

Potential pipe location: Room available in N-WB lanes, this needs to be verified after review of the city utilities (if applicable).

FL-8: Salt Lake Ave. – Atlantic

- **Existing Utilities**
  - Median
    - Segments of 78", 33" Storm Drain
  - Some Sewer in the north and south curbs

Potential pipe location: Room available in median, this needs to be verified after review of the city utilities (if applicable).

FL-9

FL-9: In Florence from Atlantic Blvd. to Rives Ave.

- **Existing Utilities**
  - Median
    - 84", 96" Storm Drain mostly in the median
  - 8" Sewers. Relocation of some Sewers might be required.
- Tunnel between the intersection with Scout Ave. and intersection with Tecum under the Rio Hondo River.

Potential pipe location: Room available in S-EB lanes, this needs to be verified after review of the city utilities (if applicable).

FL-9: In Florence Ave. from Rives Ave. to Paramount Blvd.

- **Existing Utilities**
  - Multiple Sewers unknown diameter in the north and south lanes
  - Median
    - Unk. Dia. Sewer
- Tunnel between intersection with Rives Ave. and intersection with Tweedy Blvd. to avoid Sewers

Potential pipe location: Room available in N-WB lanes, this needs to be verified after review of the city utilities (if applicable).

FL-10

In Florence Ave. from Paramount Blvd. to Lakewood Blvd.

- **Existing Utilities**
  - N-WB
    - 42" Storm Drain between Bellder Dr. and Lakewood Blvd.
  - Median
    - 39", 72" Storm Drain between Paramount Blvd. to Downey Ave.

Potential pipe location: Room available in S-EB lanes, this needs to be verified after review of the city utilities (if applicable).

FL-11

In Florence Ave. from Lakewood to San Gabriel River

- **Existing Utilities**
  - N-WB
    - 48", 72" Storm Drain

Potential pipe location: Room available in S-EB lanes, this needs to be verified after review of the city utilities (if applicable).

FS-1

In Firestone Blvd. from Central Ave. to Compton Ave.

- **Existing Utilities**
  - One small section of small Sewer (8") at Zamora Ave.

Potential pipe location: Street ROW appears to be clear. Potential pipe location to be evaluated in detail in next phase.

FS-2

In Firestone Blvd. from Compton Ave. to Atlantic Ave.

- **Existing Utilities**
    - N-WB
      - 24" Storm Drain between Compton Ave. and Bell
      - 42" Storm Drain from Bell to Hickory
      - 27" Storm Drain Hickory and Lou Dillon Ave.
      - 8" Sewer from Fir to Ivy St.
      - 42" Storm Drain between Calden and Santa Fe Ave.
      - 39" – 60" Storm Drain from Long Beach Ave. to Gate Ave.
      - 30" Storm Drain between Gate Ave. and State St.
      - 30" Storm Drain between Virginia and San Gabriel
      - 36" Storm Drain between San Juan and Miguel
      - 48" – 81" Storm Drain
    - S-EB
      - 8" Sewer between Compton and Hickory St.
    - Sewer between Chestnut and Evergreen Ave.
- Light rail blue line at Gram Ave. and Firestone. Tunnel potentially due to low overhead clearance.
- No utilities noted between Ivy and Calden Ave.
- No utilities noted between Santa Fe Ave. and Long Beach Blvd.
- No utilities between State and Virginia Ave.

Potential pipe location: From the intersection with Compton Ave. to the intersection with Ivy St., there is room available in the median to avoid the Storm Drain in the north and Sewer in the south lanes. The street ROW appears to be clear between Ivy St. and Long Beach Blvd., this needs to be verified after review of the city utilities (if applicable). There is room available in S-EB lanes between the intersection with Long Beach Blvd. and the intersection with State Street. There is room available in S-EB lanes from the intersection with State Street to the intersection with Atlantic Ave.

FS-3

In Firestone Blvd. from Atlantic Ave. to Rio Hondo River

- **Existing Utilities**
  - Downey and Southgate seem sparse with utilities. Need to revisit.
  - Some large diameter Storm Drains but plenty of room

Potential pipe location: There is room available to avoid the large diameter Storm Drains. Existing utility data needs to be further reviewed in GIS files from City of South Gate.

FS-4

In Firestone Blvd. from Rio Hondo River to Paramount Blvd.

- **Existing Utilities**
  - N-WB
    - 84" Storm Drain

Potential pipe location: There is room available to avoid large diameter Storm Drain. Existing utility data needs to be further reviewed in GIS files from City of Downey.

FS-5

In Firestone Blvd. from Paramount Blvd. to Lakewood Blvd.

- **Existing Utilities**
  - Median
    - Unk. Dia. Sewer

Potential pipe location: There is room available to avoid the Sewer. Existing utility data needs to be further reviewed in GIS files from City of Downey.

FS-6

In Firestone Blvd. from Lakewood Blvd. to San Gabriel River

- **Existing Utilities**
  - S-EB
    - 102" Storm Drain

Potential pipe location: There is room available to avoid the Storm Drain. Existing utility data needs to be further reviewed in GIS files from City of Downey.

HT-2

HT-2 El Segundo to 120th

- **Existing Utilities**
    - 24" Storm Drain on both sides of the road.
    - 63" Storm Drain crosses Hawthorne Blvd. from Broadway to the south railroad.

Potential pipe location: There is room available in the median.

HT-3

HT-3 120th to Imperial Highway

- **Existing Utilities**
    - Unk. Dia. Sewer between 120th and 117th in the E-NB lane near median.

Potential pipe location: Room is available in the W-SB lane to avoid the Unk. Dia. Sewer.

HT-4

HT-4 Imperial Highway to Century Blvd.

- **Existing Utilities**
  - No apparent utilities from Imperial Highway to W 111th Street.
  - 21"-24" Storm Drain along the E-NB lanes from I-105 to W 111th Street.
  - 24" Storm Drain in the W-SB lanes at the intersection of Hawthorne Blvd. and W 111th Street.
  - 8" – 12" Sewer near center median in the E-NB lanes from W 111th St. to 103rd St.
  - Unk. Dia. Storm Drains along the W-SB lanes starting 600 ft south of Lennox Blvd.
  - 96" – 108" Storm Drain in the E-NB lane from West 106th to Century Blvd.
- **Tunnel** across I-105

Potential pipe location: W-SB lanes to avoid Sewer and Storm Drain utilities in the Median and W-NB lanes. The street ROW appears to be clear in this lane excluding the Unk. Dia. Storm Drain between Lennox Blvd. and W 111th St. This needs to be verified after review of the city utilities (if applicable).

LB-1

LB-1 – La Brea Ave. from Century to E. Arbor Vitae

- **Existing Utilities**
  - 60" Storm Drain in the E-NB lanes for the entire segment.
  - Unk. Dia. Storm Drain in the E-NB lane.
  - 8" Sewer in the E-NB lane.
  - 12" Water in the W-SB lane.

Potential pipe location: The median appears to be the best location for the future pipeline.

LB-2

LB-2 – La Brea Ave. from Century to Tamarack

- **Existing Utilities**
  - 12" Water in the W-SB lane.
  - Unk. Dia. along the median/E-SB lane.
  - 8" Sewer along the E-NB lane
  - 12" Water in the E-NB lane

Potential pipe location: The street ROW appears to be clear along the median in the W-SB lane. This is proposed to avoid the Water and Sewer lines in the E-NB lanes.

LB-3

LB-3 – Tamarack to Manchester

- Existing Utilities
    - 12" Water in the W-SB lane (continues along S. Market St, while the segment turns left to continue along S. La Brea Ave.)
    - 8" Sewer in the W-SB lane (continues along S Market St, while the segment turns left to continue along S. La Brea Ave.)
    - Unk. Dia. Storm Water along the median in the E-NB lane. (Starts on La Brea Ave., and turns left to continue along S. La Brea Ave and does not continue straight along S. Market St. Ends at approximately E Nutwood St.)
    - 12" Water starts at the intersection of S. Market St. and S. La Brea Ave.

Potential pipe location: The median appears to be the best location for a future pipeline.

LB-4

LB-4 – Manchester to Florence

- Existing Utilities
    - Manchester to the intersection of Florence
        - Unk. Dia. Storm Drain along the median/W-SB lane
    - Intersection of N. La Brea Ave. and Florence Ave. to the intersection of Centinela Ave. and Florence.
        - Unk. Dia. starts in the median and moves east to the E-NB lane
        - 8" Water along the W-SB lane
        - 8" Water in the median between N Locust St. and N Hillcrest Blvd.
        - 12" Water along the E-NB lane
        - Unk. Dia. Storm Drain from N Hillcrest Blvd. and Centinela Ave.

Potential pipe location: The north side along the W-SB lane appears to be the best location.

LC-1

LC-1 – In La Cienega Blvd. from La Tijera Blvd. to Slauson Ave.

- E-NB
    - 12" Sewer

LC-1 – In Slauson Ave. from La Cienega Blvd. to La Tijera Blvd.

- N-WB
    - 54" Water

Potential pipe location: In La Cienega, room in the median or W-SB. In Slauson Avenue, room in median or S-EB lanes. Route is along ramp from La Cienega Blvd. to Slauson Ave., will need to consider for construction.

MC-1

In Manchester Ave. from La Tijera Blvd. to La Brea Ave.

- **Existing Utilities**
  - N-WB
    - Short sections of 39" and 30" Storm Drain
    - 6" Water
  - S-EB
    - 8" Water
  - Assumed to have 12" and smaller diameter utilities owned by the City of Inglewood

Potential pipe location: Room in median and S-EB lanes. This will be verified upon review of City of Inglewood's GIS files.

MC-2

In Manchester Ave. from La Brea Ave. to E Tamarack Ave.

- **Existing Utilities**
  - Clear of utilities, assumed to have 12" and smaller diameter utilities owned by the City of Inglewood

Potential pipe location: Room in median and S-EB lanes. This will be verified upon review of City of Inglewood's GIS files.

MC-3

In Manchester Ave from Tamarack Ave. to Crenshaw Blvd.

- **Existing Utilities**
  - Median
    - Unk. Dia. Sewer
  - Assumed to have 12" and smaller diameter utilities owned by the City of Inglewood.

Potential pipe location: Room available in N-WB and S-EB lanes. This will be verified upon review of City of Inglewood's GIS files.

MC-4

In Manchester Ave. from Crenshaw Blvd. to Western Ave.

- **Existing Utilities**
  - Crenshaw to Gramercy
    - Small Water and Sewer
  - Gramercy and St. Andrews Place
    - 33" Storm Drain
- Crenshaw to Gramercy may need to locate small diameter utilities

Potential pipe location: Room available in the N-WB lanes from Gramercy to St. Andrews Place. From Saint Andrews to Western Ave., there is room on both N-WB and S-EB, there is a possibility of relocation of small utilities.

MC-5

In Manchester Ave. from Western Ave. to Vermont Ave.

- **Existing Utilities**
  - N-WB
    - 8″ Sewer
    - 24″ Water
  - Median
    - 8″ Sewer
  - S-EB
    - 24″ Storm Drain
    - 8″ Water
    - 8″ Sewer

Potential pipe location: Room available in S-EB lanes, utility congestion because of spacing of Sewers.

MC-6

In Manchester Ave. from Vermont Ave. to Figueroa St.

- **Existing Utilities**
  - N-WB
    - 24″ Water
  - Median
    - 8″ Sewer
    - 10″ Sewer
  - S-EB
    - 16″ Sewer
    - 8″ Water
- Significant utility congestion at Vermont Ave. and Figueroa St.

Potential pipe location: Room available in the N-WB lanes for entirety of the segment, utility congestion because of spacing of Sewers.

MC-7

In Manchester Ave. from Figueroa St. to Broadway

- **Existing Utilities**
  - N-WB
    - 39″ Sewer
    - 16″ Water
    - 18″ Sewer
  - Median
    - 81″ Storm Drain
  - S-EB
    - 8″ Water

- In next phase, trenchless construction will be considered for intersection with Figueroa St. and under I-110

Potential pipe location: Room available in S-EB lanes for entirety of segment.

MC-8

In Manchester Ave. from Broadway to San Pedro St.

- **Existing Utilities**
  - N-WB
    - 33″ Sewer (moves to median)
    - 16″ Water
    - 18″ Sewer
  - Median
    - 81″ Storm Drain
  - S-EB
    - 6″ Water

Potential pipe location: Room available in S-EB lanes for the entirety of the segment. Starting at the intersection with Main St., there is room available in both N-WB and S-EB lanes.

MC-9

In Manchester Ave. from San Pedro St. to Central Ave.

- **Existing Utilities**
  - N-WB
    - 8″ Water
    - 15″ Sewer
    - 16″ Water
  - Median
    - 30″ Sewer
  - S-EB
    - 8″ Water

Potential pipe location: Room available in S-EB lanes for the entirety of the segment.

PS-1

PS-1 - In Pershing Drive from Imperial Highway to Westchester Parkway

- **Existing Utilities**
  - East , northbound (E-NB)
    - Power line
    - 12″ Water
    - 24″ Water
    - Unk. Dia. Trunk line
    - 15″ Sewer
    - Power line

- Median
  - (42" - 132") Storm Drain
  - 33" Storm Drain
- West, southbound (W-SB)
  - Clear of utilities

Potential pipe location: In the W-SB lane in Pershing Drive: approximately 36 feet of available space from the edge of shoulder to the median.

PS-1 - In Westchester Parkway from Pershing Drive to La Tijera Boulevard

- **Existing Utilities**
  - N-WB
    - 16" Water
    - LADWP Power
  - S-EB
    - 18" Storm Drain
  - Median
    - Segments of < 24" Storm Drain laterals
    - Separate 8",12", 15" and 18" Sewer identified moving east along Westchester Parkway - Pipelines located in the median
  - N-WB (all utilities do not occur at the same time)
    - Separate 33", 42", and 48" Storm Drains identified as moving east along Westchester Parkway - Located in the N-WB lanes
    - 57" Storm Drain
    - 18" Storm Drain

Potential pipe location: E-SB lanes of Westchester Parkway, both E-SB lanes are relatively clear for the majority of the segment in Westchester Parkway.

SL-1

In Slauson Ave. from La Tijera Blvd. to east of Western Ave. (Harbor Subdivision Railroad Crossing)

- **Existing Utilities**
  - N-WB
    - 54" Water (transitions to median at La Brea Ave.)
    - 8" Water (near sidewalk)
    - 8" Sewer (near sidewalk)
  - Median
    - 54" Water (La Brea Ave. to Verdun Ave.)
  - S-EB
    - 39" Storm Drain
    - 30" to 24" Water
    - 27" Storm Drain
    - 8" Sewer
    - 6" Water

- North side
  - 54" Water line (south side)
- South side
  - 27" Storm Drain
- Near Intersection of Edgemar Ave. & Slauson
  - 24" Water distribution main
- North curb and centerline
  - Sewer
- Slauson gets more congested after Deane Ave.
  - 27" Storm Drain

- Intersection of Slauson Ave. & 4th Ave.
  - 84" Storm Drain turns south on 4th Ave.
- 4th Ave. to Van Ness Ave.
  - Heavy utility congestion for about 1300 feet including the two Sewers, and one Storm Drain) – Trenchless methods will be considered in the next phase
  - 75" Sewer
  - 24" Storm Drain
  - 10" Sewer
- Slauson & Deane Ave.
  - Overhead powerlines running parallel to Slauson on the south side to the remainder SL-2.

Potential pipe location: From the intersection with La Tijera Blvd. to the intersection with La Brea Ave., room in median. From the intersection with La Brea Ave. to intersection with Verdun Ave., room in N-WB lanes. From the intersection with Verdun Ave. to the intersection with Crenshaw Blvd. there is limited room E-WB lanes. At the intersection with Crenshaw Blvd., the S-EB lanes only have 1-6" LADWP Water. From the intersection with 4^{th} Ave. through the intersection with Van Ness Ave., there is significant utility congestion and trenchless methods will be considered in the next phase. From the intersection with Van Ness Ave. to the intersection with Western Ave., there is room available in the northern S-EB lanes (relocation of LADWP 12" Water may be required).

SL-2

In Slauson Ave. from east of Western Ave. (Harbor Subdivision Railroad Crossing) to Vermont Ave.

- **Existing Utilities**
  - N-WB
    - 42" Sewer
  - S-EB
    - 12" Water

Potential pipe location: Room available in the median for the entirety of the segment.

SL-3

In Slauson Ave. from Vermont Ave. to Broadway

- **Existing Utilities**
  - N-WB
    - 42" Sewer
  - Median
    - 24" Storm Drain
  - S-EB
    - 12" Water

Potential pipe location: Room available in the median and northern S-EB lanes for the entirety of the segment.

SL-4

In Slauson Ave. from Broadway to Santa Fe Ave.

- **Existing Utilities**
  - N-WB
    - 42" Sewer
  - Median
    - 24" Storm Drain
  - S-EB
    - 16" Water
  - **Abandoned Gas**
    - Starts east of Main St. and finishes at Pacific Blvd.
    - Three abandoned gas lines between Makee Ave. to Alameda Ave. along Slauson Ave. (2x4.5" and 1x8") in the N-WB lanes.
  - East of Alcoa Ave., minimal utilities noted (not many existing utilities)
- Utilities from Huntington Park were only available in PDF form and will be evaluated in the next phase.
- Tunnel under the underground railroad at Alameda Ave.

Potential pipe location: Room available in the median from the intersection with Broadway to the intersection of Slauson Ave. and Main St. At the intersection with Main St., there is room in the N-WB lanes to avoid the abandoned gas mains near the media and S-EB lanes. Trenchless construction methods will be considered from the intersection with Compton Ave. to east of the intersection with Regent St. to avoid the three abandoned gas mains spread out in the Slauson St. ROW.

SL-5

In Slauson Ave. from Santa Fe Ave. to Atlantic Blvd.

- **Existing Utilities**
  - Intersection with Pacific Blvd.
    - No more oil lines

  - N-WB
    - 36” Storm Drain
  - Alcoa Ave and Boyle
    - 96” pipe
    - Unk. Dia. Sewer
- Limited room between Soto Street and Boyle Ave. Need to know the size of the recycled Water pipeline. SCE transmission lines are also present.
- Utilities from Huntington Park, Vernon, and Maywood were only available in PDF form and will be evaluated in the next phase.

Potential pipe location: Room in the S-EB lanes for entirety of segment. This needs to be verified after review of the city utilities.

SL-6

In Slauson Ave. from Atlantic Blvd. to Telegraph Rd.

- **Existing Utilities**
  - N-WB
    - 54” Storm Drain
    - Further east – 42” Storm Drain
  - Median
    - Short segments of Storm Drain
    - City of LA Recycled Water (Not Constructed)
  - At intersection with Eastern Ave: Abandoned gas line starts
- There is a possible SCE between Woodlawn to Oxford.
- Utilities from Maywood and Bell were only available in PDF form and will be evaluated in the next phase.

Potential pipe location: The S-EB lanes are clear through the entirety of the segment. This needs to be verified after review of the city utilities (if applicable).

SL-7

In Slauson Ave. from Telegraph to Rio Hondo River

- **Existing Utilities**
  - N-WB
    - 39” Storm Drain

Potential pipe location: The median and S-EB lanes are clear through the entirety of the segment. This needs to be verified after review of the city utilities (if applicable).

SL-8

In Slauson Ave. from Rio Hondo River to Paramount Blvd.

- **Existing Utilities**
  - Rio Hondo to Birchleaf Ave. is congested with utilities
    - 78” Storm Drain
    - Unk. Dia. Gas Transmission

Potential pipe location: Room available in median, this needs to be verified after review of the city utilities (if applicable). Potential pipe location to be evaluated in detail in next phase.

SL-9

In Slauson Ave. from Paramount Blvd. to Rosemead Blvd.

- **Existing Utilities**
    - Both sides of the street
        - Storm Drains

Potential pipe location: Room available in median, this needs to be verified after review of the city utilities (if applicable). Potential pipe location to be evaluated in detail in next phase.

SL-10

In Slauson Ave. from Rosemead Blvd. to San Gabriel River

- **Existing Utilities**
        - Clear

Potential pipe location: Room available in median, this needs to be verified after review of the city utilities (if applicable). Potential pipe location to be evaluated in detail in next phase.

TJ-1

In La Tijera Blvd. from Westchester Parkway to Manchester Ave.

- **Existing Utilities**
    - W-SB
        - 12″ Water
        - Further north, 6″ Water
    - Median
        - 69″ Storm Drain
        - 18″ Sewer
    - E-NB
        - Power
        - Power include some unidentified appurtenances
        - 8″ Water

Potential pipe location: Between Westchester Parkway and El Manor Avenue, there is room in the W-SB lanes. North of El Manor Avenue, the median appears to be clear.

TJ-2

In La Tijera Blvd. from Manchester Ave. to Centinela Ave.

- **Existing Utilities**
    - Appears to be clear of utilities from the intersection of Manchester Avenue to south of the intersection of Airport Boulevard.
    - At the intersection of Airport Boulevard and La Tijera Boulevard, there are several LADWP power lines along Airport Boulevard and on La Tijera Boulevard for approximately 750 feet. Approx. 7 lines crossing and 5 parallel

- W-SB
  - 8″ Sewer
- Median
  - Power
- E-NB
  - 4″ Water
  - 12″ Water
  - 8″ Sewer

Potential pipe location: Between Manchester Avenue and Airport Boulevard, the road ROW is clear. From Airport Boulevard to Centinela Ave., there is room in the W-SB lanes. The congested area of the intersection of Airport Boulevard and La Tijera Boulevard is assumed to be tunneled.

TJ-3

In La Tijera Blvd. from Centinela Ave. to La Cienega Blvd.

- **Existing Utilities**
  - W-SB
    - 8″ Water

Potential pipe location: Median and E-NB lanes are clear.

VI-1

- **Existing Utilities**
  - Vista Del Mar
    - E-NB
      - 18″ Brine
      - 126″ Sewer
      - Unk. Dia. Storm Drain close to E-NB ROW
    - W-SB
      - 16″ Water
      - 72″ Sewer
      - (left of ROW) 42″ Brine, two 42″ Recycled Water
      - 4″ lateral Sewer
    - 54″, 33″, Unk. Dia. Stormwater crossing at Imperial Hwy intersection
  - Imperial Hwy
    - N-WB
      - 108″ Stormwater
      - 150″ Sewer
    - Median
      - 8″ -12″ Water
      - 33″ Stormwater
    - S-EB
      - 16″ Water
      - 60″ Sewer
      - Unk. Dia. Stormwater

Potential pipe location: The proposed location for the pipe in Vista Del Mar is in the median. It is assumed that the pipe can be placed within the Hyperion WRP ROW along Imperial Highway, and this will be confirmed in the future phase.

Appendix F
TM 3.2.4-Los Coyotes WRP to LVL AWTF Review

Jacobs

Memorandum

1000 Wilshire Boulevard, Suite 1140
Los Angeles, California 90017
United States
T +1.213.538.1388
F +1.230.538.1399
www.jacobs.com

Subject	**Technical Memorandum 3.2.4 – Los Coyotes Water Reclamation Plant to Leo J. Vander Lans Advanced Water Treatment Facility Review – Final**
Project Name	WRD and LADWP Joint Los Angeles Basin Replenishment and Extraction Master Plan
Date	October 2, 2020 (Revised)

1. Introduction

The Water Replenishment District of Southern California (WRD) and the Los Angeles Department of Water and Power (LADWP) have initiated a partnership to identify solutions to maximize use of the Central Basin and West Coast Basin through development of the Joint Los Angeles Basin Replenishment and Extraction Master Plan (Joint Master Plan). The Joint Master Plan uses a regional approach to identify a comprehensive list of existing and potential new replenishment water sources, treatment facilities, and replenishment and extraction locations, herein referred to as “project components,” as described in Technical Memorandum (TM) 1 (Appendix A).

The system components identified in TM 1 were used to develop 30 Project Concepts and Add-on Projects. These Project Concepts were initially screened based on overall feasibility and discussion among members of the Joint Master Plan team (WRD, LADWP, and Jacobs). After screening, the remaining 17 Project Concepts were scored and ranked using a multi-objective decision Analysis (MODA) to collaboratively determine which projects should be selected for further project development. Workshop 2 was held on August 8, 2018, to present the initial Project Concept ranking and discuss refinements with the Joint Master Plan team. After refinements to the MODA scores, nine projects were combined into two distinct projects (Appendix B):

- **Hyperion Water Reclamation Plant (WRP) Project:** The focus of this project is to maximize the use of Hyperion WRP flows through injection and extraction in the Central Basin, spreading at the Montebello Forebay, and siting of new spreading facilities, with excess flows connected to the Metropolitan Water District of Southern California advanced treated recycled water backbone conveyance system. Maintaining existing flows to the Edward C. Little Water Recycling Facility for injection at the West Coast Basin Barrier is assumed. A conceptual overview of this project is shown on Figure 1.
- **Los Coyotes WRP Project:** The original focus of this project is to find the best use of available Los Coyotes WRP flows and evaluate whether they should be sent north to the Montebello Forebay or south for advanced water treatment at the Leo J. Vander Lans Advanced Water Treatment Facility (LVL AWTF) for injection at the Alamitos Barrier or new injection and extraction in the Long Beach area. The initial focus of the project consisted of a peer review of preliminary design documents for the pipeline and pump station between the Los Coyotes WRP and LVL AWTF. The review also includes updating estimated costs and fatal flaws, and an evaluation of storage needs. A conceptual overview of this project is shown on Figure 2.

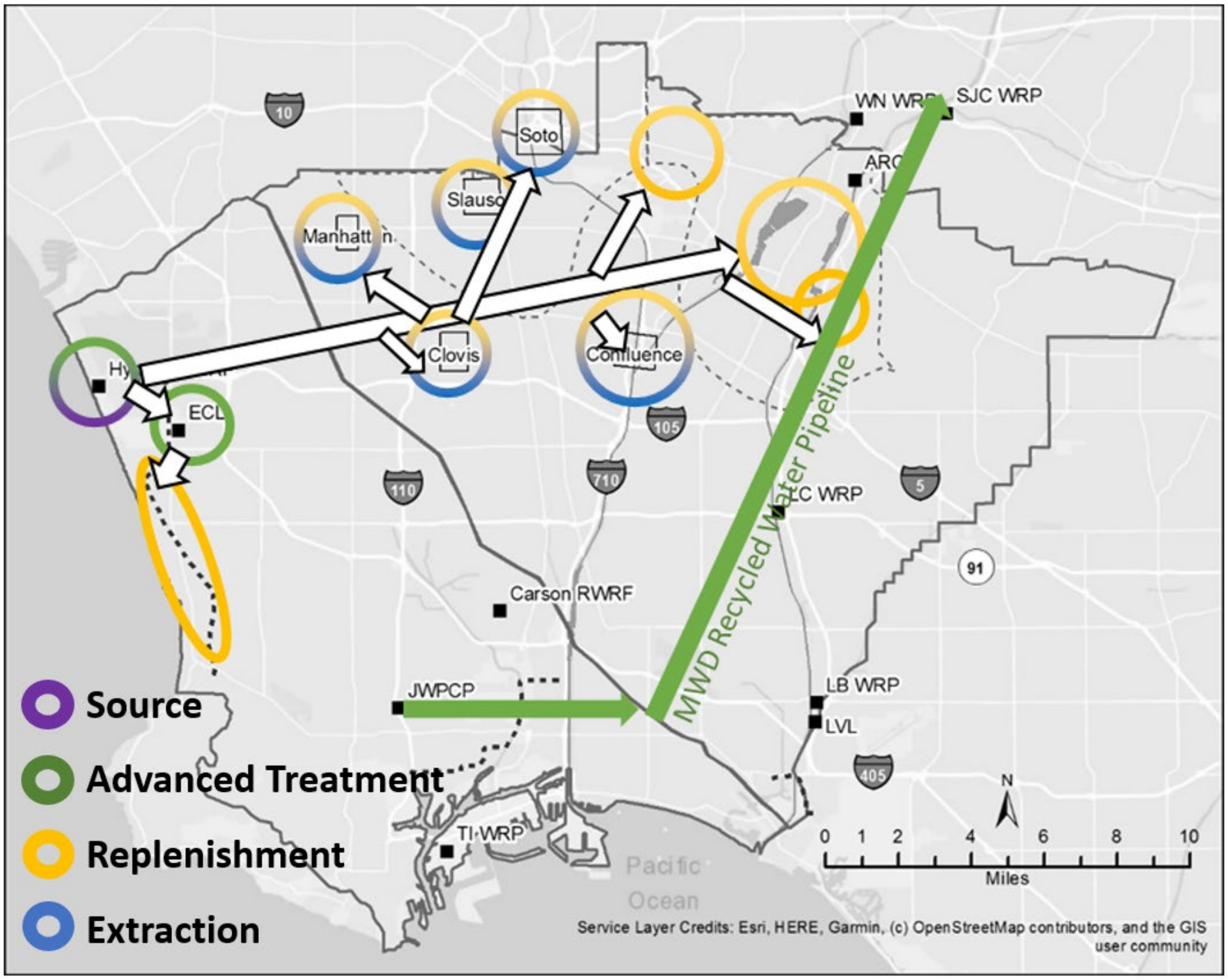


Figure 1. Conceptual Overview of the Hyperion Water Reclamation Plant Project

WN *Whittier Narrows*
SJC *San Jose Creek*
LB *Long Beach*

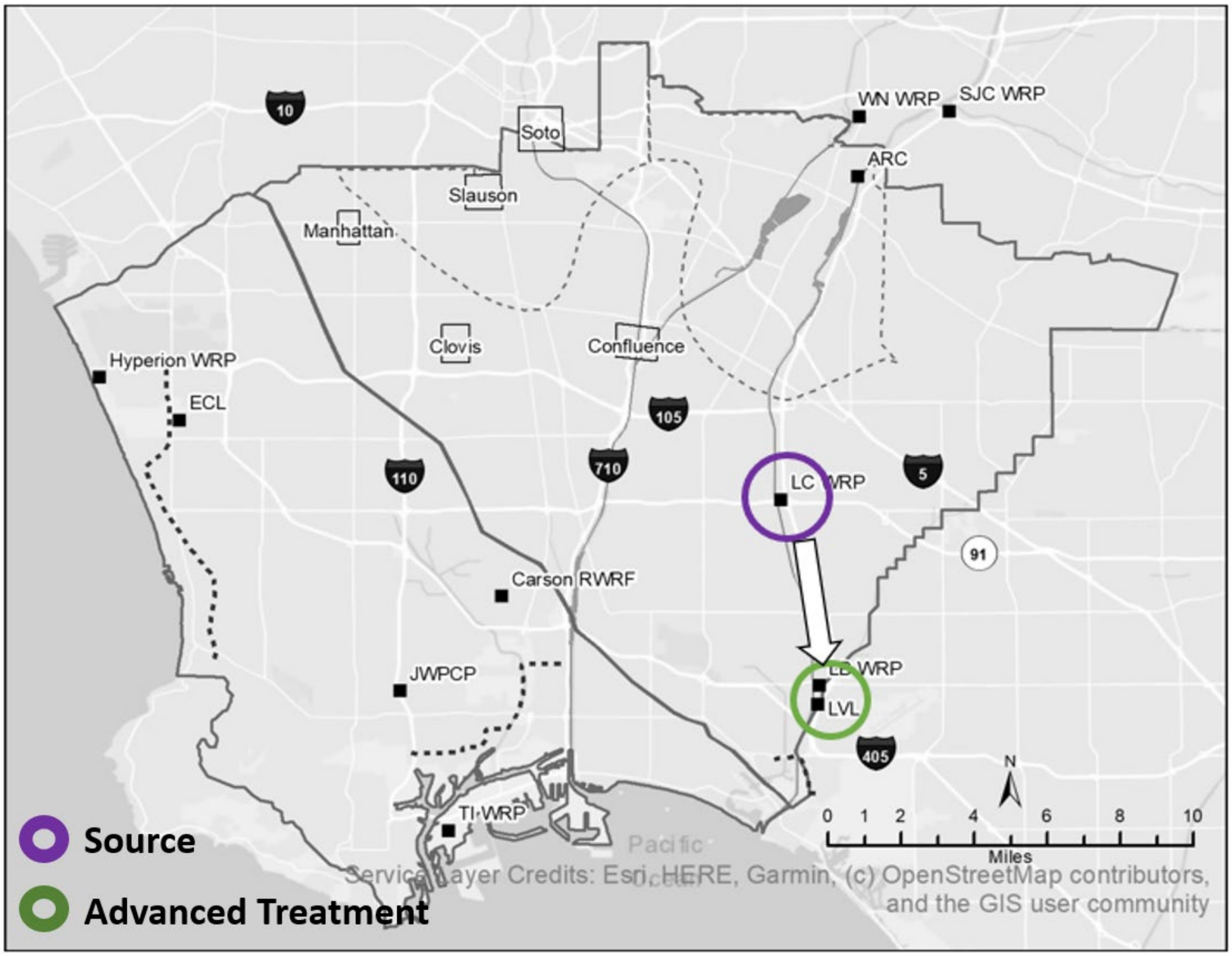


Figure 2. Conceptual Overview of the Los Coyotes Water Reclamation Plant Project

This TM documents the effluent flow analysis, preliminary design document review, and cost estimate for the Los Coyotes WRP Project. Specifically, this TM is organized in the following sections:

- Section 1 – Introduction
- Section 2 – Project Background and Assumptions
- Section 3 – Effluent Flow Analysis
- Section 4 – Pump Station Technical Review
- Section 5 – Pipeline Technical Review
- Section 6 – Permitting and Environmental Review
- Section 7 – Estimated Project Cost
- Section 8 – Summary of Conclusions and Recommended Next Steps

2. Project Background and Assumptions

2.1 Leo J. Vander Lans Advanced Water Treatment Facility

The LVL AWTF is owned by WRD and located at 7380 East Willow Street in Long Beach. The LVL AWTF was constructed on a rectangular site in a triangular parcel of land south of East Willow Street with Coyote Creek to the east-southeast and the San Gabriel River to the west. The facility was constructed to produce advanced treated recycled water for injection into the Alamitos Barrier. The LVL AWTF receives tertiary treated (Title 22) recycled water from the Sanitation Districts of Los Angeles County's (LACSD's) Long Beach WRP (CDM Smith 2013). The facility became operational in 2003, with an initial effluent capacity of 3 million gallons per day (MGD). It was expanded in 2014 to 8 MGD to further offset the use of imported water at the Alamitos Barrier (WRD 2020).

During design of the expansion, WRD began evaluating Los Coyotes WRP as a supplemental source of supply for LVL AWTF to ensure sufficient source water to meet the expansion requirements.

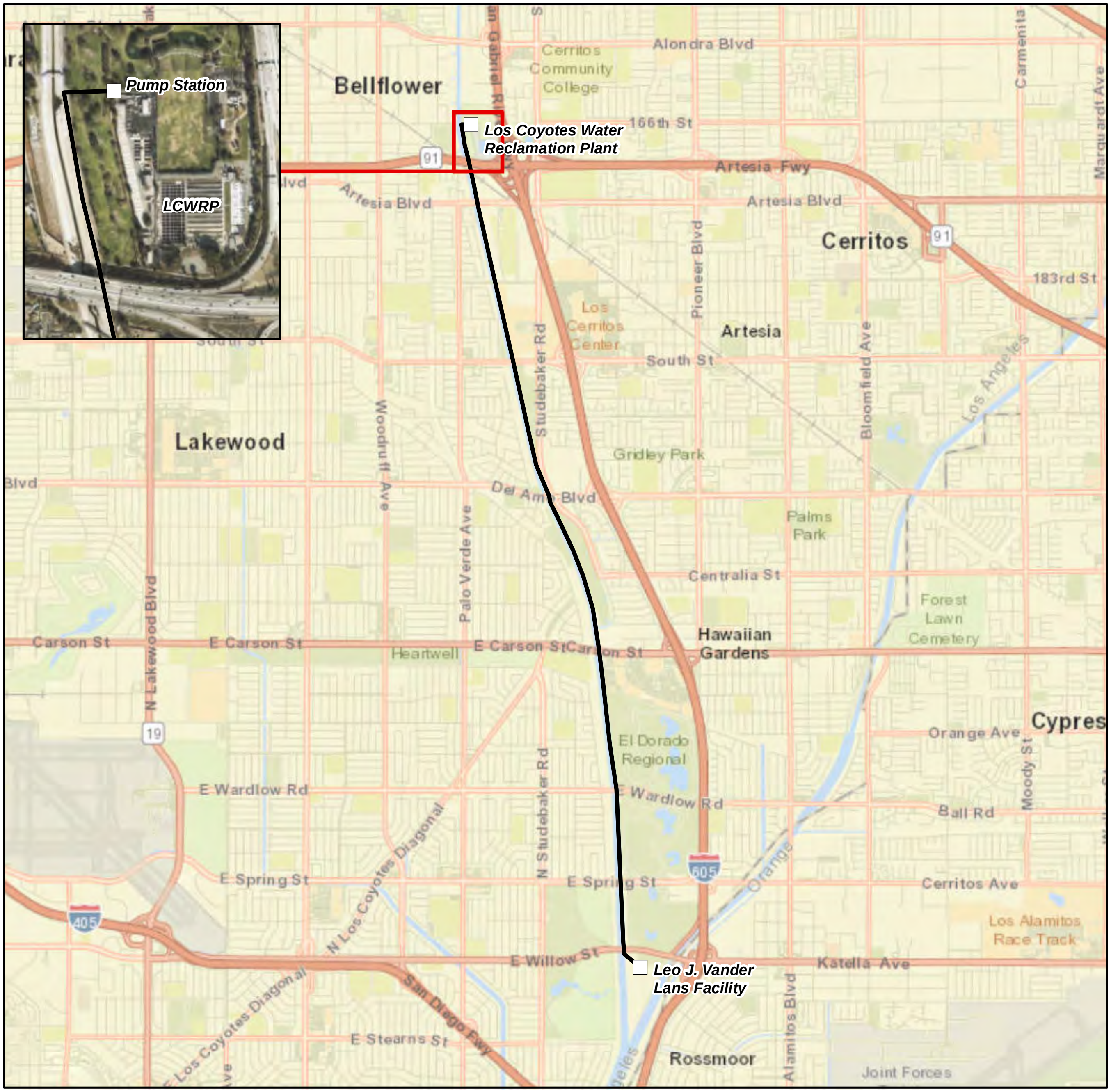
2.2 Los Coyotes Water Reclamation Plant

The Los Coyotes WRP is owned by the LACSD and is located at 16515 Piuma Avenue in Cerritos, occupying 34 acres at the northwest junction of Interstate 605 and State Route (SR) 91 Freeway. Of the 34 acres, 20 acres are occupied by the Iron-Wood Nine Golf Course, operated by the City of Cerritos and leased from Southern California Edison (SCE), which is built on adjoining LACSD property. The plant became operational in 1970, with an initial capacity of 12.5 MGD and consisted of primary treatment and secondary treatment with activated sludge. Currently, the Los Coyotes WRP provides primary, secondary, and tertiary treatment for up to 37.5 MGD and serves a population of approximately 370,000 people (ESA 2019).

LACSD has proposed to reduce surface water discharges of recycled water to the San Gabriel River from the Los Coyotes WRP, along with four other WRPs, to supply recycled water programs implemented by other agencies. Historically, an average of approximately 17 MGD is discharged from the Los Coyotes WRP to the San Gabriel River. The LACSD's plan to reduce this discharge to a minimum flow of 2 MGD will prevent the low-flow channel from going completely dry downstream of the facility (ESA 2019).

2.3 2012 Preliminary Pump Station and Pipeline Design

To convey tertiary effluent from the Los Coyotes WRP to LVL AWTF, a new pump station and pipeline are required. In 2012, a preliminary design for the pump station and pipeline were prepared by CDM Smith (CDM Smith 2012a, 2012b). However, because of limited resources at the time, WRD chose to delay the project. Figure 3 shows existing locations for Los Coyotes WRP and LVL AWTF, and proposed locations of the pump station and pipeline alignment.



Legend

Los Coyotes Proposed Pipeline

Sources:
1) ESRI World Street Map
2) ESRI World Imagery

Version: 5/21/2020

N

0 1 2
Miles

Figure 3
Project Location
Los Coyotes Pipeline Project
Water Replenishment District
Los Angeles County, California

Jacobs

\\galt\proj\WRD\W9Y23900\MapFiles\Overview_200504.mxd kgrant1 5/21/2020 2:18:34 PM

2.4 Document Review

This TM focuses on a review of the following documents:

- Final Design for the Expansion of the Leo J. Vander Lans Water Treatment Facility for the Water Replenishment District of Southern California, Pump Station Preliminary Design Report (CDM Smith 2012a)
- Final Design for the Expansion of the Leo J. Vander Lans Water Treatment Facility for the Water Replenishment District of Southern California, Pipeline Preliminary Design Report (CDM Smith 2012b)

The following documents were also provided by WRD as resources to aid in the review:

- Contract Drawings for the Los Coyotes Water Reclamation Plant City of Cerritos Reclaimed Water Pump Station (LACSD 1983)
- Preliminary Design Report for the Expansion of the Leo J. Vander Lans Water Treatment Facility (CH2M HILL 2011)
- Amended Title 22 Engineering Report for the Leo J. Vander Lans Water Treatment Facility Expansion: Alamitos Barrier Recycled Water Project (CDM Smith 2013)
- WRD Hydraulic Analysis, Operational Efficiencies, and Optimization Alternative Study Task 3 – Alternative Evaluation for Long-Term Operations (RMC, Woodard & Curran, and KEH 2017)

2.5 Overall Project Assumptions

Based on discussions with WRD, the following assumptions will be used for the project:

- LVL AWTF has an anticipated recovery rate of 92.5%; therefore, the facility requires an average influent flow of 8.7 MGD to produce the full 8.0-MGD capacity. The pipeline and pump station will be evaluated for a peak flow of 10.5 MGD.
- The total existing equalization volume at LVL AWTF is 180,000 gallons, which equates to approximately 30 minutes of storage, assuming an 8.7-MGD flow rate.
- The flow model is based on Los Coyotes WRP flow data from 2015 through 2019, provided by LACSD.

3. Effluent Flow Analysis

An effluent flow analysis was necessary because of the high variability in flows from the Los Coyotes WRP that could feed the LVL AWTF. The Los Coyotes WRP could provide treated tertiary effluent flows to the LVL AWTF; however, the flows would be driven by diurnal and seasonal patterns of wastewater and recycled water usage flows.

The flow analysis goals included:

- Creating a Water Balance Model based on recent historical flow production, diurnal patterns, and current flow delivery commitments from the Los Coyotes WRP to recycled water costumers
- Determining whether equalization storage is needed to achieve up to 8.7 MGD of steady flow from Los Coyotes WRP to LVL AWTF
- Determining time periods when 8.7 MGD of flow is not available and the LVL AWTF will need to turn down production
- Discussing results from this analysis with WRD prior to moving forward with further project development

The LVL AWTF/Los Coyotes WRP Water Balance Model was developed as a tool to accomplish these goals. Figure 4 shows the system schematic with the system components modeled. Water from the Los Coyotes WRP supplies local recycled water demands and provides 2 MGD of monthly average flows to the San Gabriel River. The remaining Los Coyotes WRP effluent can be conveyed through a pipeline to the LVL AWTF.

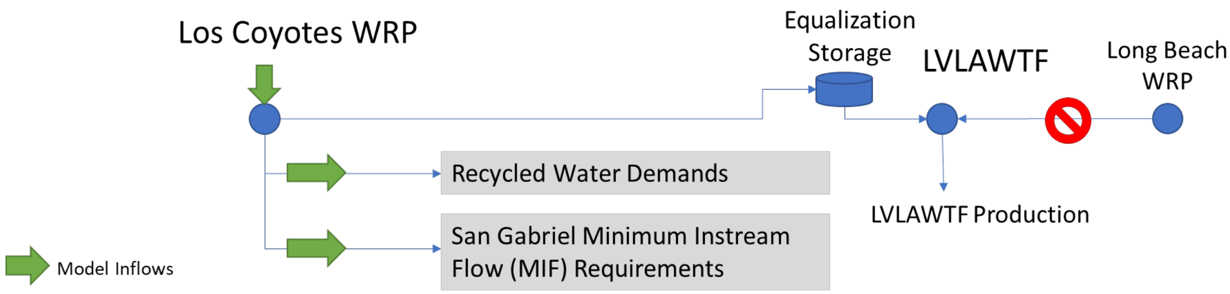


Figure 4. System Schematic

3.1 LACSD Los Coyotes WRP Data

Los Coyotes WRP flow data provided by LACSD included:

- Hourly and daily average flows from January 1, 2015, to January 1, 2020
- Los Coyotes WRP filter effluent (flow going into the chlorine contact tanks)
- Discharge to the river calculated as the filter effluent minus reuse deliveries
- Reuse deliveries calculated by adding the flows to two distribution systems, Bellflower and Cerritos; Bellflower data are inputted to the system as a daily total from manual readings, whereas the Cerritos flow is continuously metered and recorded
- The daily total effluent and Cerritos flows calculated from the values for the operational day (7 a.m. to 7 a.m.)
- Missing values or consistent flow values for certain periods in the hourly data may be the result of communication or other errors; the daily totals can help determine estimated values
- In summer 2019, construction at the plant required half of the plant to shut down, so flows were roughly half of normal
- 2019 was a wet and cool year; so, although there were added reuse sites, reuse demand was lower than in hotter years (for example, 2016)
- A 2-MGD monthly average flow will need to be maintained for the San Gabriel River after the California Water Code 1211 petition (that is, a request to divert recycled water flow from being discharged to surface water) is approved
- Los Coyotes WRP may supply more recycled water demands in the future, but it uncertain when this will be implemented; the other recycled water contractors have a total of approximately 15,000 acre-feet per year (AFY) of Los Coyotes WRP recycled water allocated, yet there are only approximately 1,000 AFY of projected new reuse projects planned by the recycled water contractors

It was assumed that the flow data provided were sufficiently accurate for this study. No input data analysis was conducted to check for potential database errors, except for the following:

- Some negative flow numbers were identified and reset to zero, per LACSD's suggestion.
- Data gaps on the hourly dataset were replaced by daily average value times the diurnal average pattern for the hour the data were missing.

Input data were provided in two different time steps, hourly and daily averages. The hourly average time series had many data gaps and did not include the Bellflower demands. The daily time series was understood to be a more complete dataset.

The use of hourly data to provide more accurate results for equalization storage was preferred; therefore, hourly data gaps in the Cerritos dataset were replaced by the daily average flow data available multiplied by a diurnal average pattern obtained from the hourly dataset. The Bellflower data available were on a daily average time step. The Bellflower daily average was converted to hourly flows based on an average diurnal flow pattern obtained from Cerritos; this assumes that the water usage pattern was similar for both Cerritos and Bellflower. The correction of the hourly time step dataset for data gaps was significant in some years varying from 300 to 3,200 AFY, and is presented on Figure 5, where "hourly raw data" represents the hourly dataset with gaps, "daily average" represents the more reliable dataset in a daily average time step, and "hourly flow fixed for data gaps" represents the final hourly dataset corrected and used in the model. Additionally, the hourly dataset included total effluent flow out of the Los Coyotes WRP, deliveries to the reuse distribution network (Cerritos only), and flows to San Gabriel River.

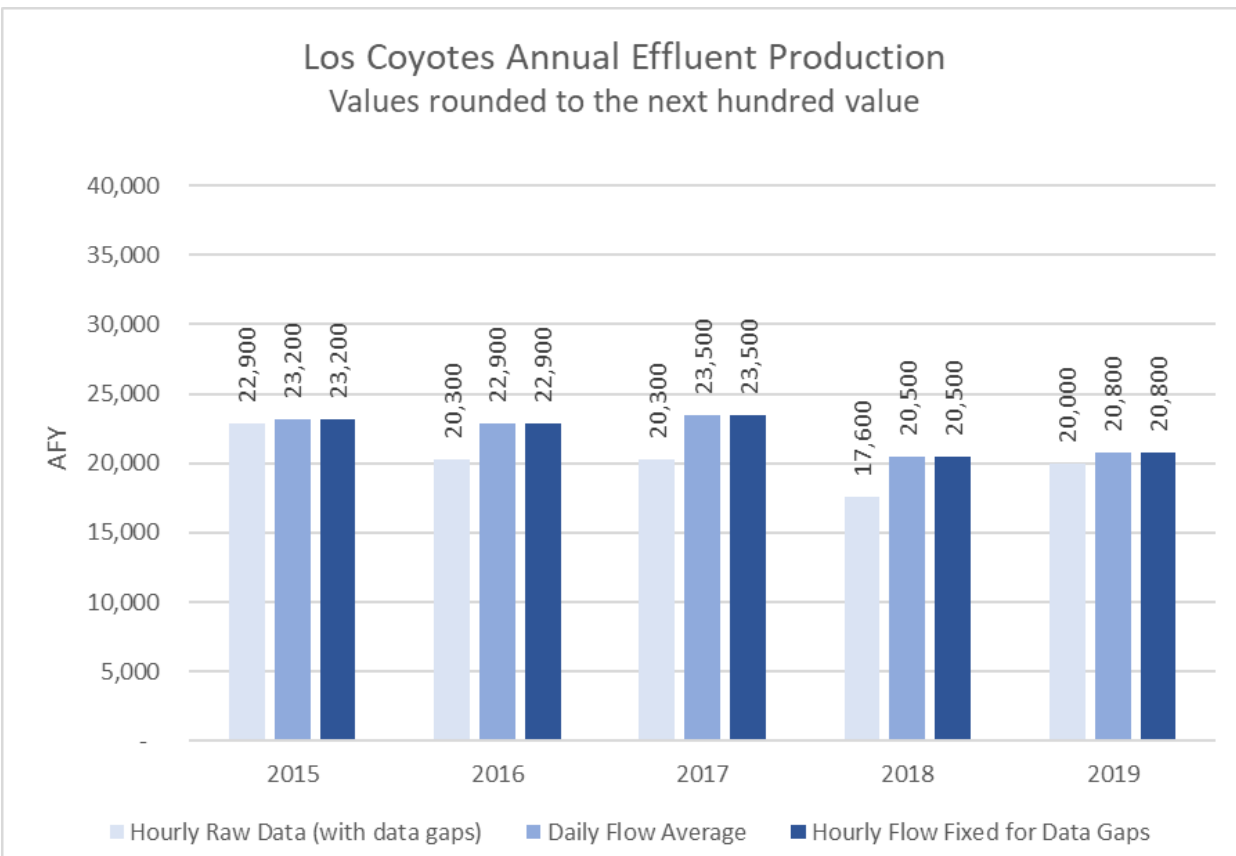
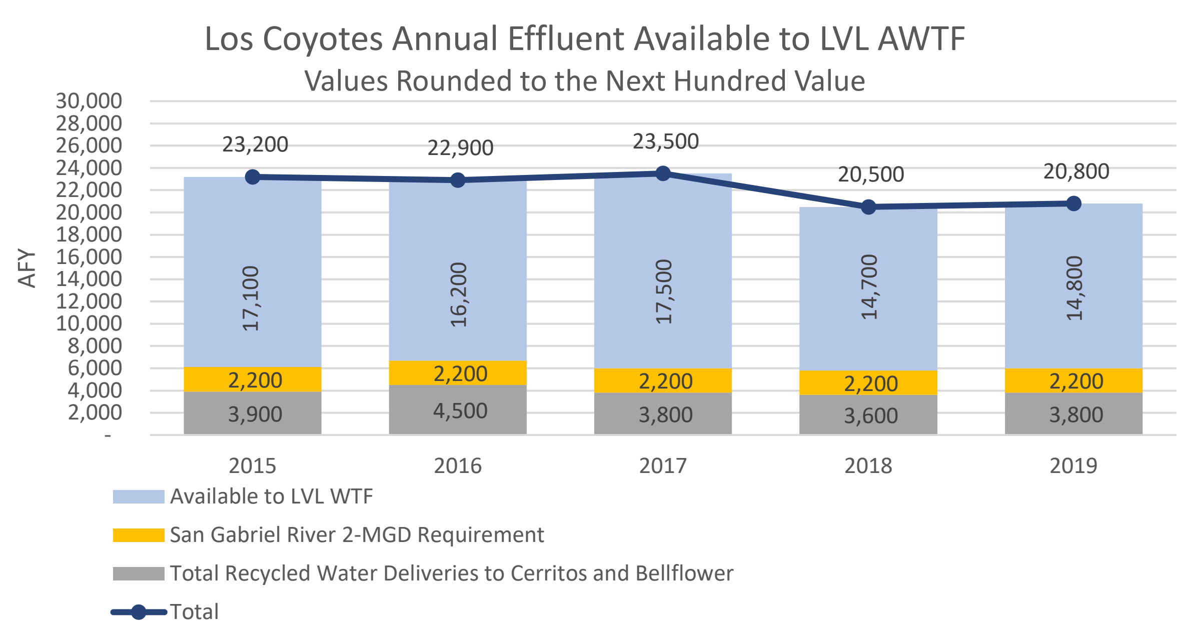


Figure 5. Data Gap Correction of Los Coyotes WRP Flows Provided by LACSD

The Los Coyotes WRP is a recycled water treatment plant with a nominal capacity of 37.5 MGD (42,020 AFY). Effluent flow data for 2015 to 2019 are presented on Figure 5, averaging 22,240 AFY. The Los Coyotes WRP provides recycled water to the cities of Cerritos and Bellflower. The average deliveries from 2015 to 2019 were 3,787 AFY. In addition to meeting these recycled water demands, Los Coyotes WRP must maintain a 2-MGD (2,242 AFY) monthly average flow to the San Gabriel River. Los Coyotes WRP flows can be sent to LVL AWTF only after meeting these recycled water demands and the San Gabriel River minimum flow requirement; therefore, based on the values presented on Figure 5, an average of 16,211 AFY remains available to be delivered to the LVL AWTF. Figure 6 shows a breakdown of annual effluent volumes delivered from 2015 to 2019. The available flows to LVL AWTF varied from 14,700 to 17,500 AFY. The lower average flow in 2019 can be attributed to construction at the plant that required half of the plant to be shut down, so flows were roughly half of normal. The entire time series was used without filtering low- or high-flow events, weeks, or months. The assumption was that 2015-2019 data were representative of future flow conditions. At the time of the analysis, no information was provided regarding the similarly low 2018 flows relative to the previous 3 years. (Later it was learned that flows at Los Coyotes WRP were reduced from June to November 2018 to accommodate construction of the Stage One Return Activated Sludge Piping Replacement project.) Because of this uncertainty, it is assumed that similar flows are possible. Thus, the flows for 2018 and 2019 were included in the 5-year average flow calculation, thereby lowering the potential flow volume from Los Coyotes WRP. Figure 6 illustrates the magnitude of the 2018 and 2019 reductions in flows, showing that during 2015, 2016, and 2017, the average flow was 23,200 AFY, and during 2018 and 2019, the average was 20,650, a reduction of 2,550 AFY from the first 3 years to the last 2 years of data.

The resulting flow from Los Coyotes WRP was assumed to be the only inflow available to LVL AWTF for the analysis reported in this document. The LVL AWTF/Los Coyotes WRP Water Balance Model was created to determine how much of the approximately 16,000 AFY available to LVL AWTF could be used, assuming a maximum capacity of 8.7 MGD (9,752 AFY) at LVL AWTF, and assuming limitations of diurnal flow patterns and storage capacity.



Note: 2019 was a wet and cool year; so although there were added reuse sites, reuse demand was lower when compared to hotter years (for example, 2016).

Figure 6. Potential Available Los Coyotes WRP Effluent Based on Effluent Flows from 2015 to 2019

3.2 Assumptions and Model Inputs

The main model inputs and variables controlled by the user include the following:

- **Los Coyotes WRP effluent:** Historical hourly time series from January 1, 2015, to January 1, 2020. This was considered as the only inflow available to LVL AWTF.
- **Recycled water demands:** Los Coyotes WRP provides tertiary recycled water to Cerritos and Bellflower. The flow deliveries were provided as time series data provided by LACSD. Data gaps in the historical hourly time series were replaced by daily average flows with a diurnal pattern. Los Coyotes WRP may supply more recycled water demands in the future, but at this time, there is uncertainty as to the magnitude of those demands. Other recycled water contractors have a total of approximately 15,000 AFY of Los Coyotes WRP recycled water allotted; however, there is currently only 1,000 AFY of projected new reuse projects planned by these other contractors.
- **San Gabriel River minimum flows:** Minimum flow that needs to be provided by Los Coyotes WRP to the San Gabriel River is a user-defined stream requirement, set to 2 MGD. The San Gabriel River flow requirement is expected to be a minimum monthly average flow of 2 MGD. The model computes a moving monthly average of flow discharges to San Gabriel River to maintain a minimum 2-MGD average discharge. The model computes the last 30-day moving average at every time step to determine whether additional flow needs to be discharged from the Los Coyotes WRP to the San Gabriel River to maintain the monthly average minimum of 2 MGD.
- **Equalization storage:** The LVL AWTF/Los Coyotes WRP Water Balance Model logic includes equalization storage with a maximum capacity that can be changed by the model user. The model also has the capability to run the simulation multiple times, each time with a different storage capacity. The current available storage at the site at LVL AWTF is 0.18 million gallons (MG).
- **LVL AWTF capacity:** The LVL AWTF capacity is a user-input variable; it can be a fixed value or a variable for stochastic runs where different capacities are used for each stochastic simulation run. The LVL AWTF options available in the model include capability to treat a fixed amount of flow, variable inflows, or user-defined flows based on a schedule.

The steps in a model simulation include:

- Water from the Los Coyotes WRP flows into equalization storage.
- The LVL AWTF has two different modes of operation: treatment can be adjusted as a function of the available plant influent flows (Baseline Scenario) or it can treat at a specific plant capacity.
- If the specific plant capacity mode is selected, the model will first check whether there is enough influent water (in storage and from the Los Coyotes WRP pipeline) to support the fixed plant capacity (fixed to one value or to a schedule determined by the user).
- If there is not enough water for production of the fixed plant capacity, the plant will shut off for a certain amount of time (the time can be determined by the user).
- For the scenarios presented in this analysis, a 24-hour delay between plant shut down and restart was selected.

Figure 7 illustrates an example of how the modeled system could work. The figure illustrates a typical operation where on July 17 at 9:00 p.m., the system filled up its storage with the available water from Los Coyotes WRP. Lack of flows from the Los Coyotes WRP after 9:00 p.m. resulted in the LVL AWTF using all stored water by 4:00 a.m. Between 4 a.m. and 10 a.m., the LVL AWTF was at idle capacity and could have produced effluent if water was available. The idle capacity is accumulated by the model as a metric for the system performance. At 10 a.m., there was flow available for WRP production and storage filling.

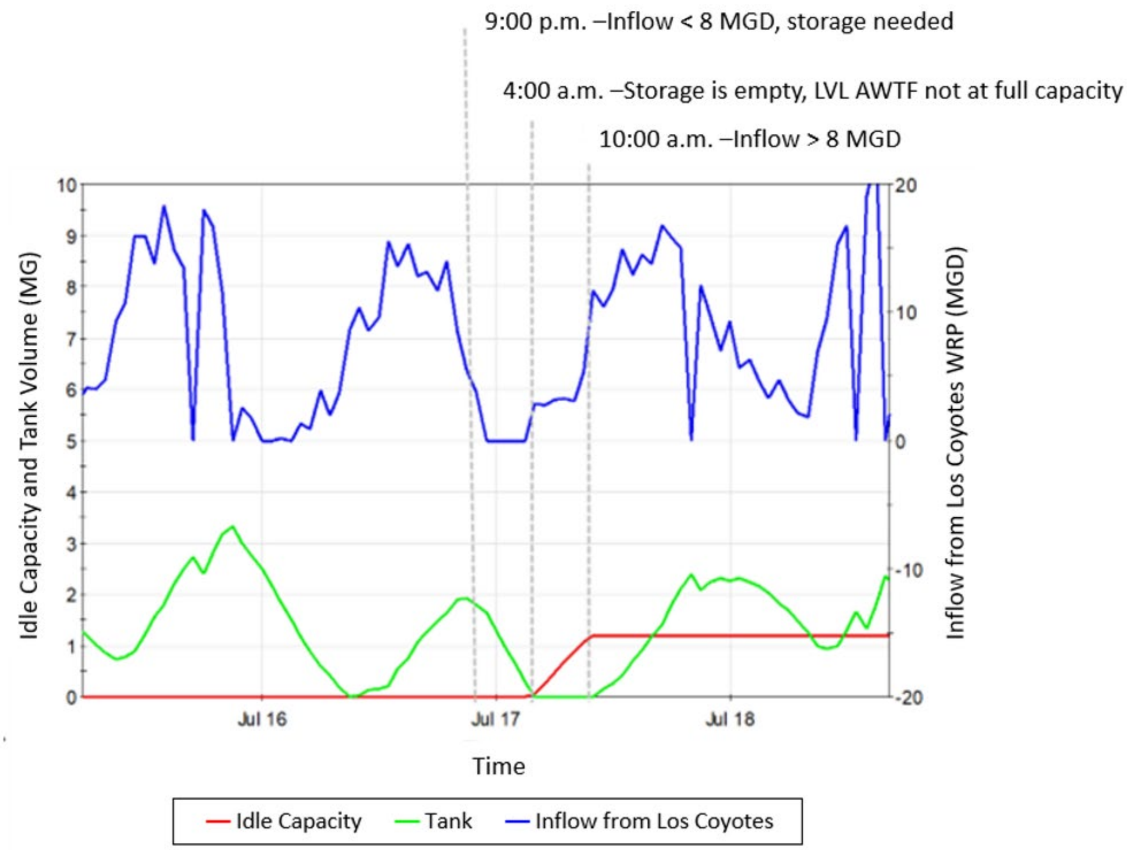


Figure 7. Typical LVL AWTF Operation Using an Equalization Tank

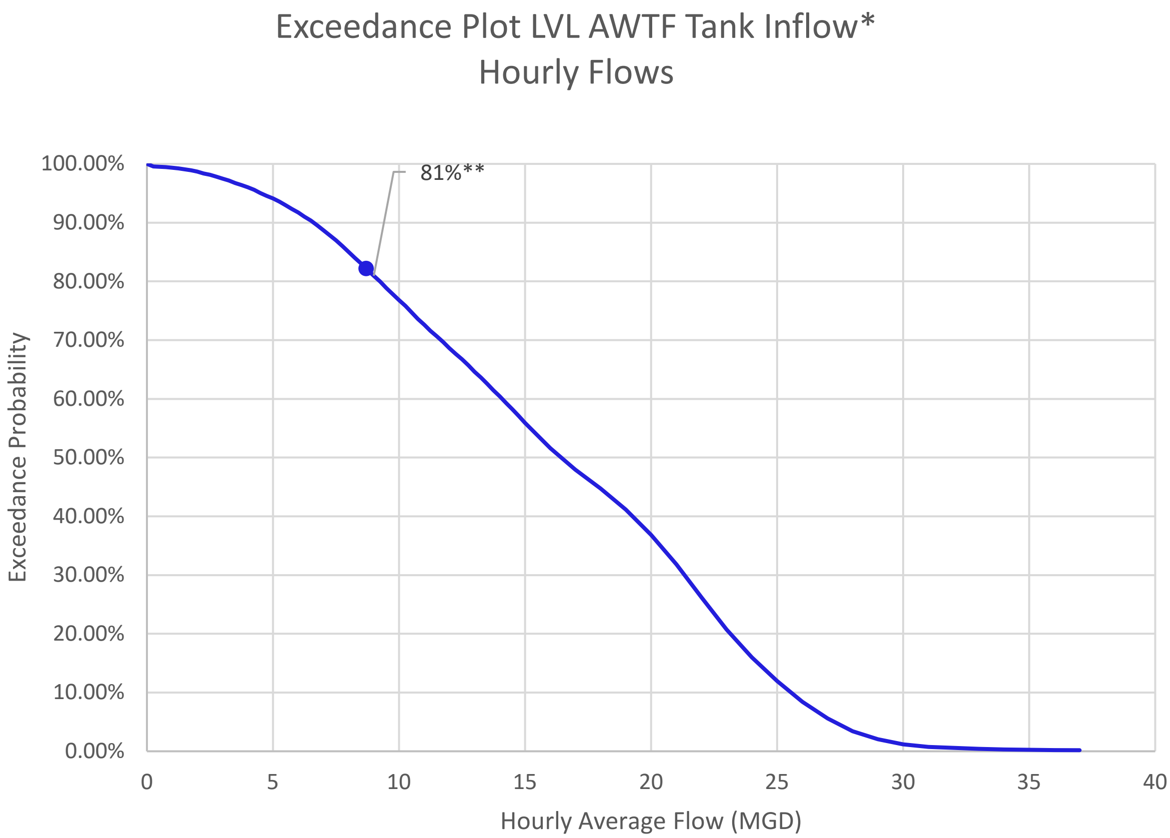
3.3 Scenarios

Four main scenarios with sub-scenarios were evaluated.

3.3.1 Baseline Flow Scenario

The goal of the Baseline Flow Scenario was to determine available flow from the Los Coyotes WRP after meeting Cerritos and Bellflower deliveries and minimum instream flow (MIF) requirement to the San Gabriel River (2-MGD minimum monthly average).

The Baseline Flow Scenario model results are presented in an exceedance plot (Figure 8), where the probability to exceed a certain hourly average flow is presented for the entire model simulation run from January 1, 2015, to January 1, 2020. Figure 8 shows that flows from the Los Coyotes WRP available to LVL AWTF exceed 8.7 MGD (maximum LVL AWTF capacity) 81% of the model simulation time. The other 19% of the time, when flows would be lower than 8.7 MGD, LVL AWTF would have to use storage to maintain constant production from the plant. There is a significant variation of flows during the day and the 81% of the time that flows exceed the maximum plant capacity is not constant for long hours; it fluctuates during the day.



*Flows from Los Coyotes WRP minus deliveries to Cerritos and Bellflower minus MIF for San Gabriel River
**Inflows to LVL AWTF tank are highly variable on an hourly time step and the AWTF could not adjust its production as a function of hourly flows

Figure 8. LVL AWTF Equalization Tank Inflow Exceedance Probability

Two additional model scenarios were run as variations of the Baseline Flow Scenario. The two additional scenarios included storage at LVL AWTF, with a minimum storage of 0.18 MG (that is, the current available storage at LVL AWTF) and a maximum storage of 5 MG. These two scenarios assumed that the LVL AWTF capacity could be adjusted to the flows available from the storage tank plus the pipeline connecting the Los Coyotes WRP to LVL AWTF. Although throttling of the LVL AWTF to accommodate hourly variations on flows is probably not realistic, these two scenarios provided an initial estimate of storage benefits to the system. Figure 9 shows the benefit of storage, where 0.18 MG of storage could support an 8.7-MGD production 90% of the time, and 5 MG of storage could support an 8.7-MGD production 98% of the simulation time.

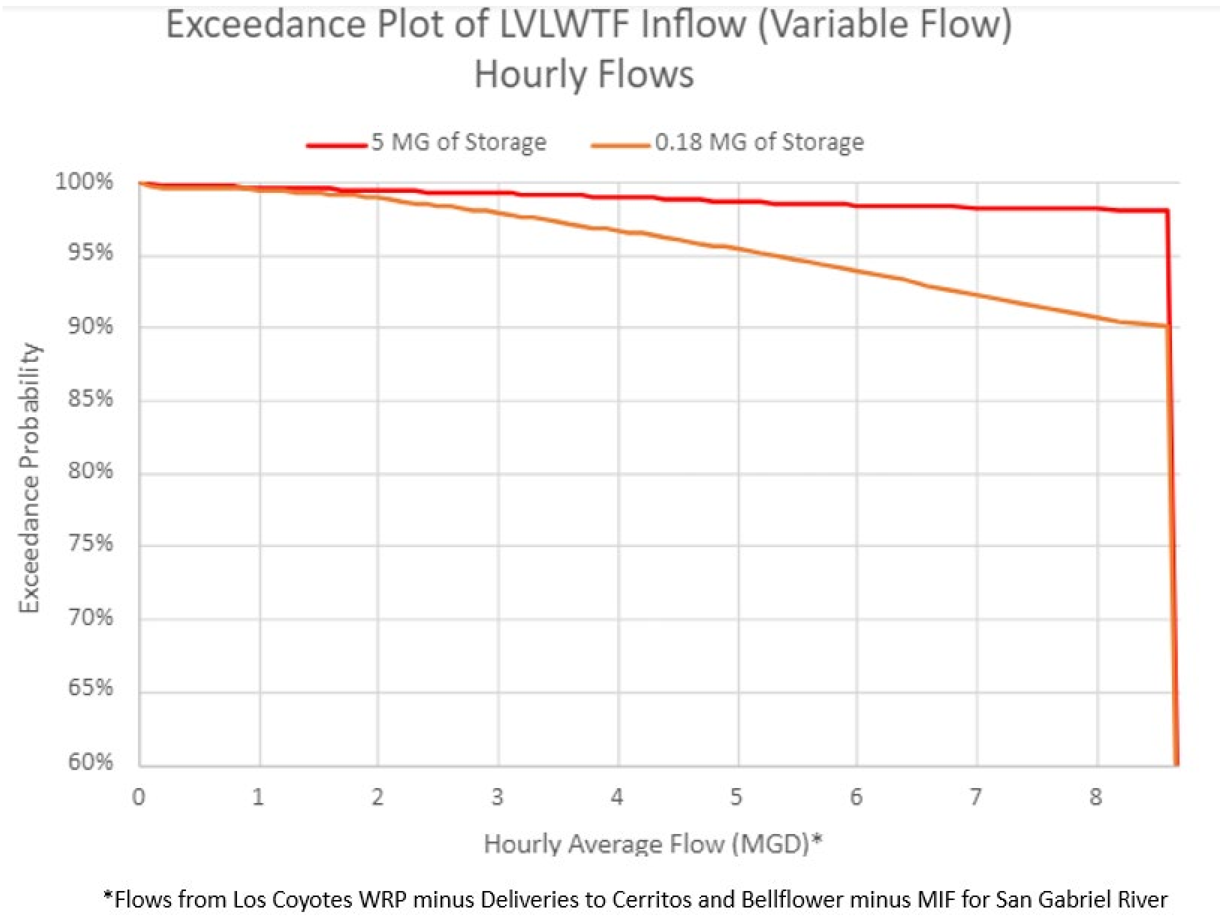


Figure 9. Exceedance Probability of LVL AWTF Inflows for Two Storage Scenarios

3.3.2 Scenario 1

Scenario 1 was conceived as a more realistic modeling scenario, where storage was considered and plant shutdown extended for 24 hours if 8.7 MGD of influent flow to the LVL AWTF was not available. This scenario considered that LVL AWTF could only operate at its maximum capacity of 8.7 MGD.

This modeling scenario was run as a stochastic simulation, in which the model ran 200 times from January 1, 2015, to January 1, 2020, each time selecting a different storage capacity between 0.18 and 5 MG. This approach allowed the model results to be plotted on Figure 10, where average annual inflow is plotted as a function of equalization storage. The figure also shows the percentage of simulation time that the plant will be idle (that is, turned off).

Model results presented on Figure 10 show that:

- Approximately 6,100 AFY of average LVL AWTF inflow could be sustained with 0.18 MG of storage.
- LVL AWTF would be idle 37% of the time (approximately 136 days per year) with 0.18 MG of storage.
- The system would see significant increase in LVL AWTF inflows with additional storage up to approximately 2 MG. After 2 MG, annual production by the system would increase at a lower rate.

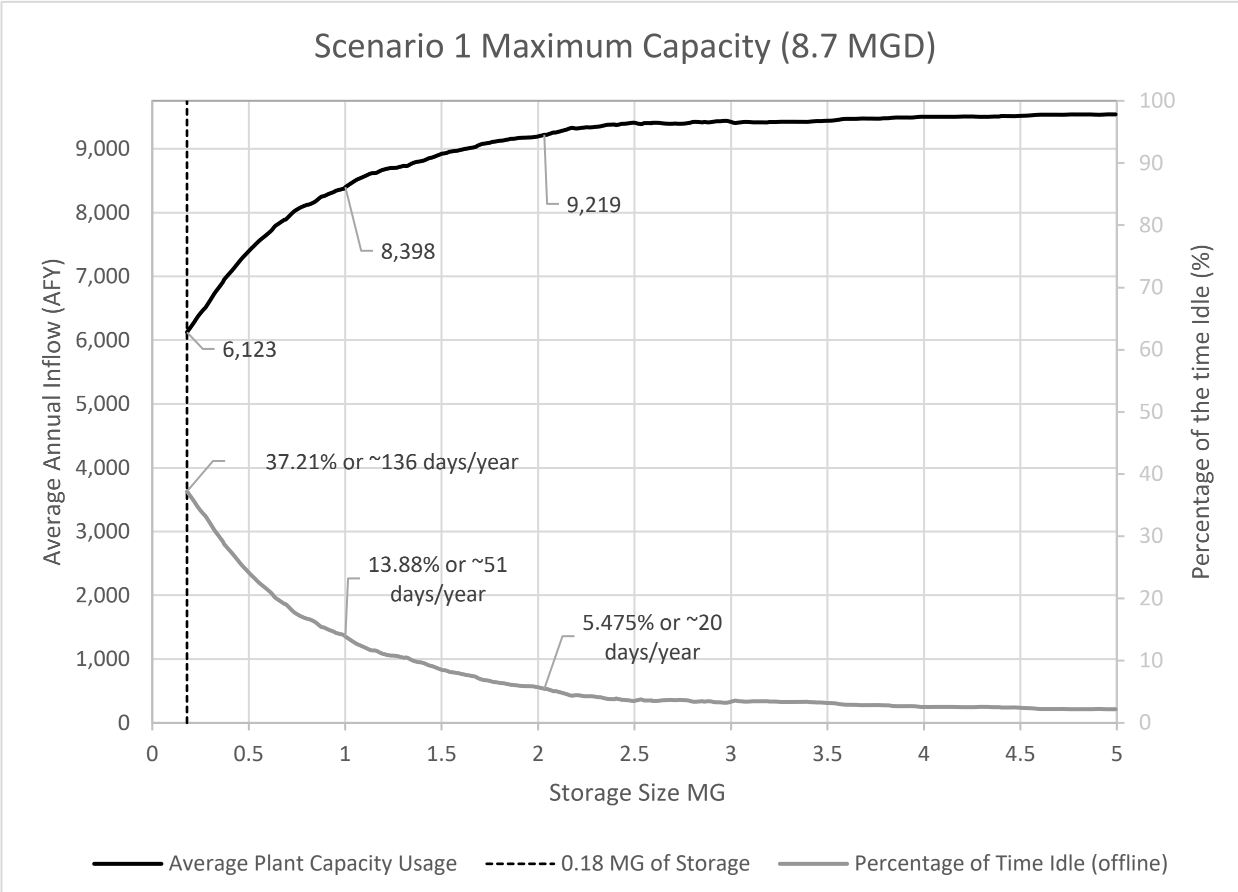


Figure 10. Scenario 1 Results Presenting Average LVL AWTF Inflows and the Percentage of Time Idle as a Function of Equalization Storage

Another version of Scenario 1 was run to estimate the frequency of different storage uses. This simulation variation assumed unlimited storage for Scenario 1, and a postprocessing spreadsheet quantified how much storage was actually needed or used throughout the simulation to keep LVL AWTF running at its maximum 8.7-MGD capacity. The results of this analysis are presented on Figure 11.

Figure 11 shows that, most of the time, the LVL AWTF is able to run with minimal storage (less than 1 MG). However, it appears that the Los Coyotes WRP went through abnormal periods of low flows during late summer/fall 2018 and late summer/fall 2019. LACSD reported that in summer 2019, there was construction at the plant that required half the plant to shut down, so flows were roughly half of normal. (The explanation for the summer/fall 2018 flow reduction was later provided during the review of the documentation and is attributed to the construction of the Stage One Return Activated Sludge Piping Replacement Project.) During these abnormal periods, flow drops to less than 8.7 MGD for most of the day and a large amount of storage would be needed to keep the LVL AWTF operating at full capacity. In practicality, plant operations would be reduced to accommodate the adjusted flows, thus avoiding turning the plant on and off every 24 hours (the assumed condition that was programmed in the model).

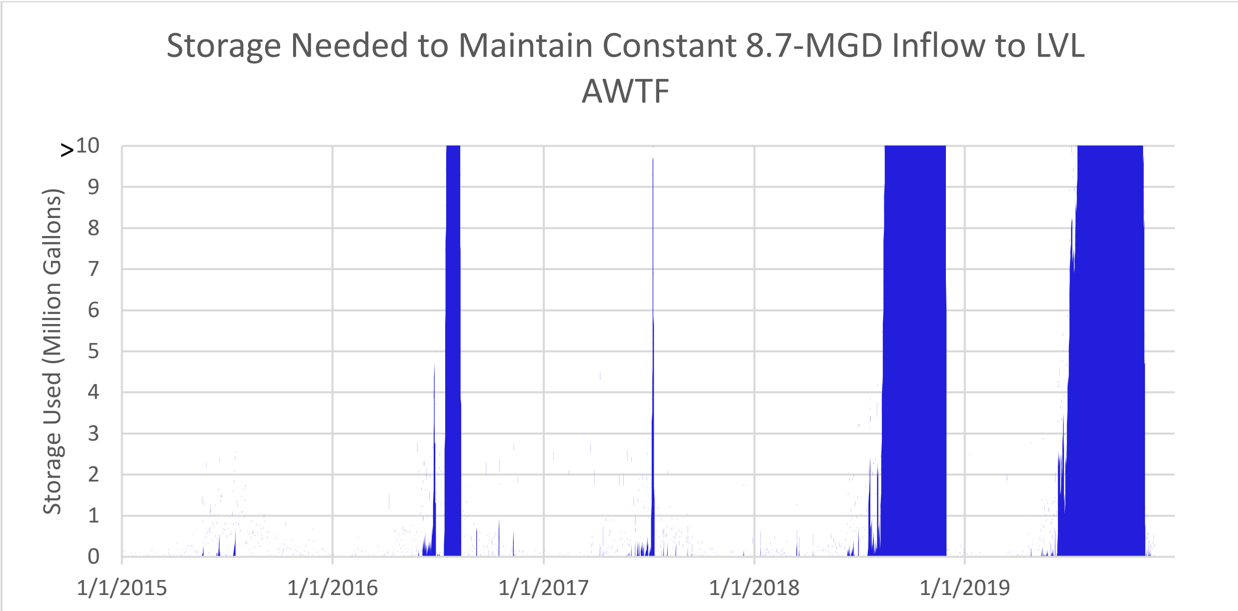


Figure 11. Storage Usage for Scenario 1

3.3.3 Scenario 2

Scenario 2 was conceived as a more realistic modeling scenario than Scenario 1, where the plant would still shut down for 24 hours if flows were not available. However, this scenario allows for a maximum plant capacity that can be changed during the day based on a prescribed schedule. Ideally, the maximum plant capacity would be defined by the number of plant trains available. This information was not available at the time of the model development; therefore, the schedule was developed based on seasonal average flows verified from historical data. The schedules considered are presented on Figure 12. For example, during spring, from 10:00 p.m. to 10:00 am, the LVL AWTF maximum capacity is set at 6 MGD, and the plant will shut down for 24 hours if 6 MGD are not available. After that, from 10:00 a.m. to 10:00 p.m., the plant has the full capacity available (8.7 MGD), but will still shut down for 24 hours if flows are not available.

This modeling scenario also runs as a stochastic simulation, in which the model ran 200 times from January 1, 2015, to January 1, 2020, each time selecting a different storage capacity between 0.18 and 5 MG. This approach allowed the model results to be plotted , where average annual inflow is plotted as a function of equalization storage (Figure 12). The figure also shows the percentage of simulation time that the plant will be idle.

Model results presented on Figure 12 show that:

- Approximately 7,200 AFY of average LVL AWTF inflow could be sustained with a 0.18 MG of storage.
- LVL AWTF would be idle 8.4% of the time (approximately 31 days per year) with 0.18 MG of storage.
- The system would see some increase (from 7,200 to 7,800 AFY) in LVL AWTF inflows with additional storage up to approximately 1 MG. After 1 MG, annual production by the system would cap at 7,800 AFY because of low flow schedules applied during some hours of the day.
- A scheduled capacity would have more optimal operation at lower storage values relative to Scenario 1.

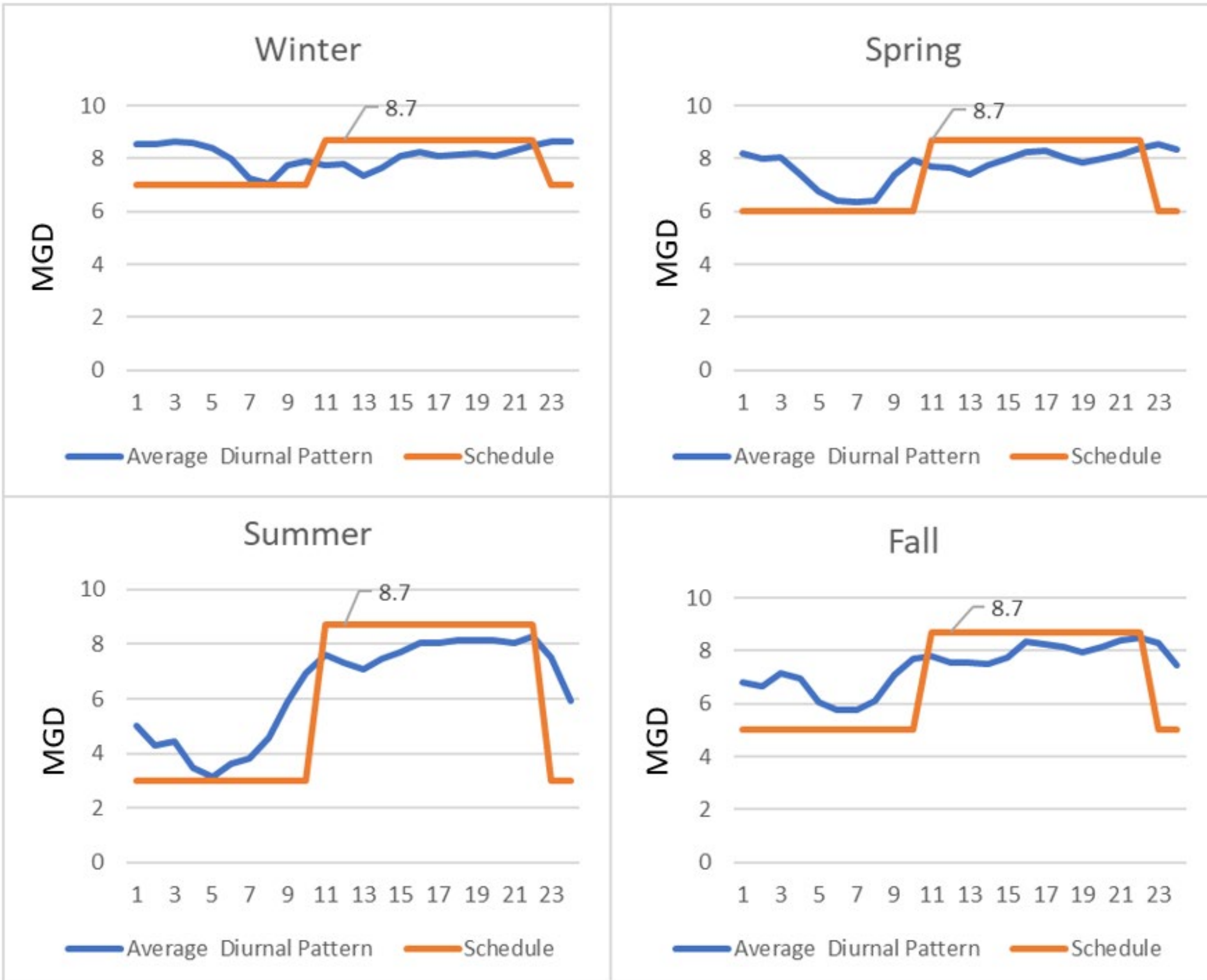


Figure 12. LVL AWTF Operation Schedules for Maximum Capacity Considered in Scenario 2

One additional scenario was run (Scenario 2a) to understand the impact of having to shut down the LVL AWTF for 24 hours. Scenario 2a included a modified assumption that LVL AWTF would shut down for only 12 hours from the time in which flows were not available to sustain the scheduled capacity. Model results show improvement to annual average LVL AWTF inflows at low-storage conditions (Figure 13).

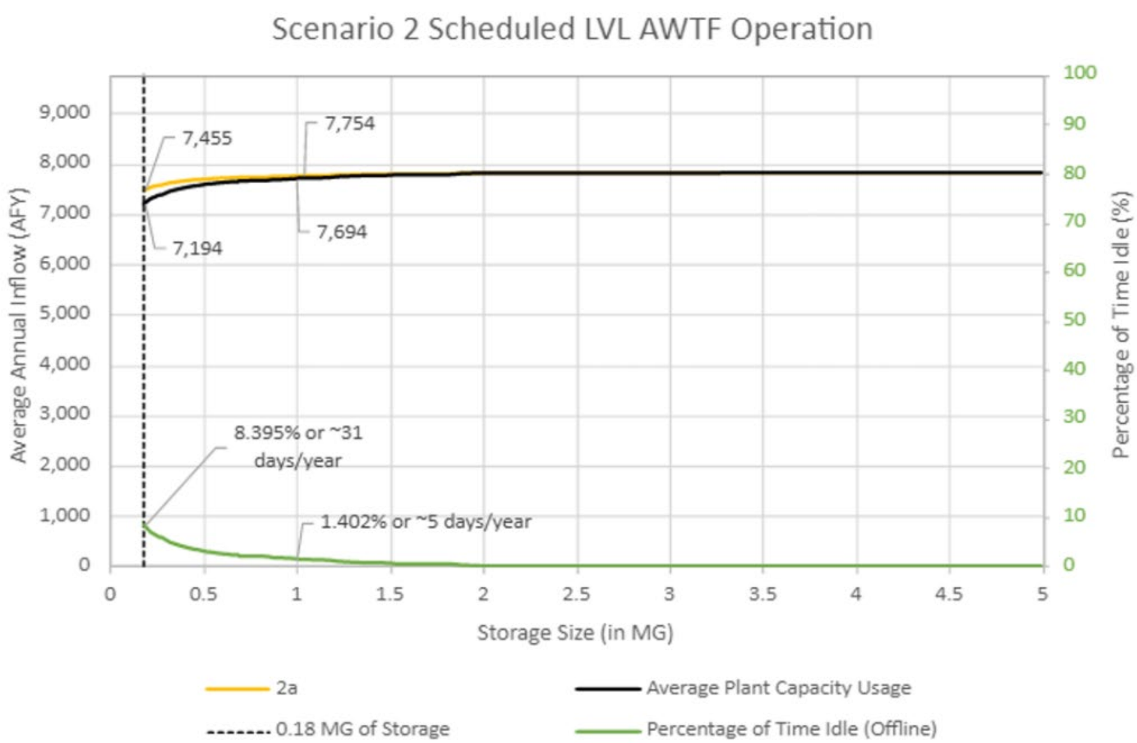


Figure 13. Scenario 2 Results Presenting Average LVL AWTF Inflows and the Percentage of Time Idle as a Function of Equalization Storage

3.3.4 Scenario 3

The Scenario 3 analysis was distinct from Scenarios 1 and 2. This scenario had a fixed storage volume of 0.18 MG, and the goal was to identify the optimal LVL AWTF treatment capacity for the fixed storage that would yield the maximum inflow to LVL AWTF yearly.

Scenario 3 assumptions were the same as Scenario 1, except that the model ran 200 times with the LVL AWTF maximum capacity changing for each one of the 200 simulations. The results are presented on Figure 14. Results show that average annual LVL AWTF inflows increase with an increase of LVL AWTF maximum capacity up to 8.7 MGD. Figure 14 shows that the maximum average LVL AWTF inflow value is approximately 6,000 AFY at 8.7 MGD, resulting in the plant being idle approximately 37% of the time or approximately 135 days per year.

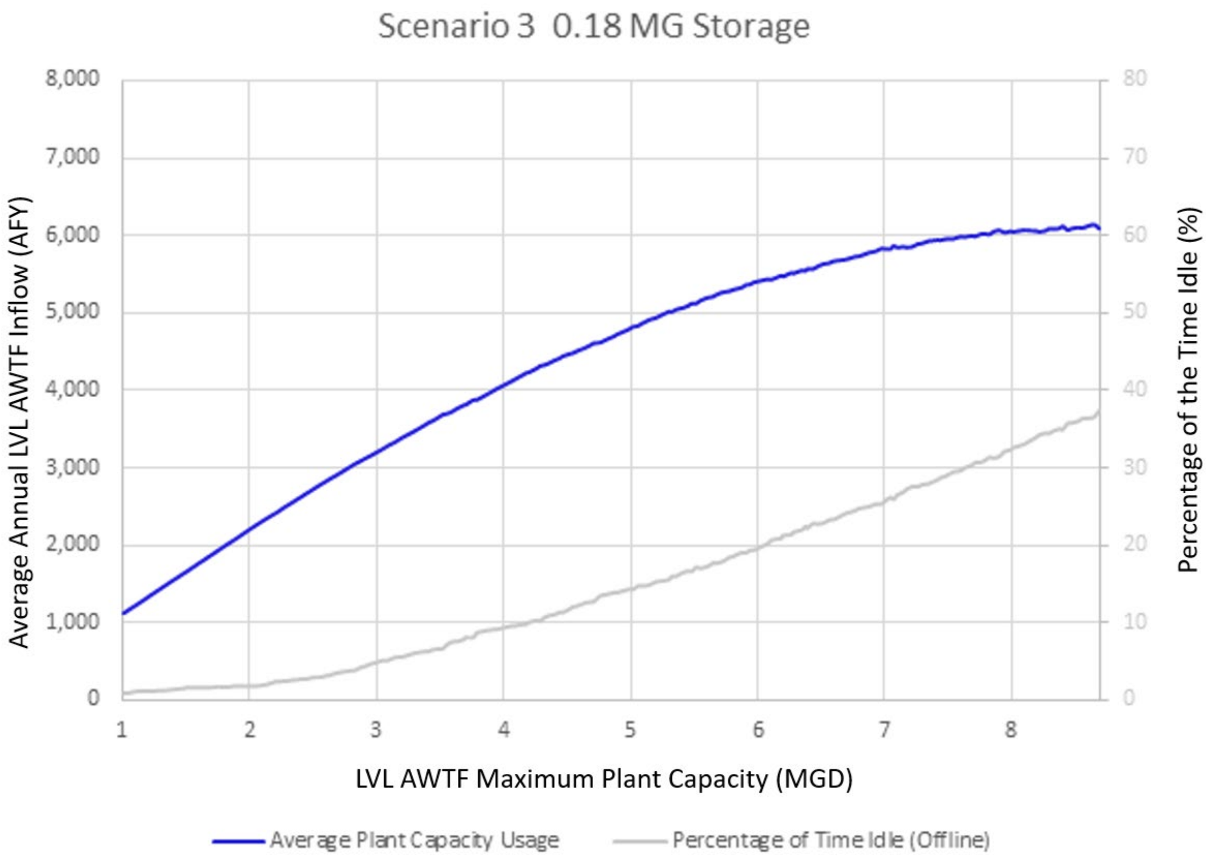


Figure 14. Average LVL AWTF Inflow Value as a Function of Plant Capacity

3.3.5 Summary of Scenarios

Table 1 presents a summary of model simulations. The table shows the approximate annual average inflow available to the LVL AWTF for different scenarios and different equalization storage capacities. Scenario 3 shows the maximum annual average inflow to LVL AWTF with 0.18 MG of storage, and that a maximum value of 6,100 AFY would be obtained with a plant capacity of 8.7 MGD.

Table 1. Scenario Results Summary on Average Annual Inflow to the LVL AWTF Tank[a] (in AFY)

Scenario	0.18 MG of Storage	1 MG of Storage	2 MG of Storage	3 MG of Storage	4 MG of Storage	5 MG of Storage
1	6,100	8,400	9,200	9,400	9,500	9,500
2	7,200	7,700	7,800	7,800	7,800	7,800
3	6,100[a]	N/A	N/A	N/A	N/A	N/A

[a] Maximum annual inflow to LVL AWTF is obtained with a plant capacity of 8.7 MGD.

Note:

N/A = not applicable

Table 2 presents the average number of days that the LVL AWTF would be offline. The average number of days were calculated by adding all hours that the plant was offline and dividing by the total number of hours in the simulation. It does not necessarily represent entire days offline because the model allows the plant to come back online after 24 hours from the time that flows were not available.

Table 2. Scenario Results Summary on Average Number of Days that LVL AWTF Would Be Offline (in days per year)

Scenario	0.18 MG of Storage	1 MG of Storage	2 MG of Storage	3 MG of Storage	4 MG of Storage	5 MG of Storage
1	136	51	21	12	9	8
2	31	6	0	0	0	0
3	136	N/A	N/A	N/A	N/A	N/A

Note:

N/A = not applicable

The following is a summary of the initial effluent flow analysis goals with corresponding brief explanations of how the goals were achieved.

- **Goal: Determine whether equalization storage is needed to achieve up to 8.7 MGD of steady flow from the Los Coyotes WRP to the LVL AWTF.** An unrealistic amount of storage would be needed to keep LVL AWTF producing 8.7 MGD 100% of the time between January 1, 2015, and January 1, 2020, because of long periods of time when inflows were below 8.7 MGD. The Baseline Scenario indicated that hourly average flows from the Los Coyotes WRP were greater than 8.7 MGD 81% of the time between January 1, 2015, and January 1, 2020. Aside from not being available 100% of the time, the flow is not constant as a result of diurnal wastewater flows and diurnal recycled water demands. Scenario 1 results show that 3 MG of storage could result in more than 95% of maximum plant capacity or 9,400 AFY; however, the 3 MG would be used less than 15% of the time, mostly during the abnormal low-flow periods that Los Coyotes WRP was under construction. The water age in the tank would have to be considered in the next phase of the project (depending on the size of the tank). The model assumes that all the inflows from Los Coyotes WRP will flow through the storage.
- **Goal: Determine time periods when 8.7 MGD of flow is not available and LVL AWTF will need to turn down.** The Baseline Scenario indicated that the LVL AWTF would need to be offline at least 19% of the time if the plant was able to shut off and restart multiple times within a day. The more realistic Scenario 1 shows that the plant would have to be idle 37% of the time with 0.18 MG of storage, assuming that the plant can restart only after 24 hours from the last shutdown.
- **Goal: Discuss results from this analysis with WRD prior to moving forward with the project**. The LVL AWTF utilization is highly dependent on its operations schedule because of the variability of Los Coyotes WRP effluent flows. More information about operation of the plant (for example, capacity per treatment train) would be needed for a more accurate estimate. Current storage in the system (0.18 MG) could result in an average annual LVL AWTF inflow being more than 6,100 AFY if the schedule of plant operations is controlled. Results suggest that additional storage might be needed or an additional supply source other than Los Coyotes WRP (during low-flow periods of the day) to:
  - Sustain more than 60% of LVL AWTF production capacity (more than 6,100 AFY).
  - Provide plant operational flexibility.
  - Compensate for some potential shifts of Los Coyotes WRP deliveries to recycled water demands.

3.4 Effluent Flow Analysis Conclusions and Next Steps

Conclusions and recommendations from the effluent flow analysis are as follows:

- Flow data from the Los Coyotes WRP for 2015 to 2019 suggest that LVL AWTF could be supplied with 8.7 MGD from the Los Coyotes WRP 81% of the time. If LVL AWTF could adjust the production rate, use the current 0.18 MG of available storage, and be turned on and off multiple times during the day, the plant average annual inflow could reach 8,800 AFY (that is, 90% of plant capacity); however, this operation is not realistic.
- An 8.7-MGD plant and the current 0.18 MG of equalization storage could provide an average of 6,100 AFY of LVL AWTF inflows; however, this conclusion assumes the plant will be able to quickly adjust production rate to match plant inflows. This analysis should be refined based on actual plant flow adjustment capabilities.
- The addition of system storage between 1 and 2 MG could increase average LVL AWTF inflows to between 8,400 and 9,200 AFY.
- Storage volumes greater than 1 to 2 MG (depending on the scenario) will have less of an impact on the additional average LVL AWTF inflow to the plant and will be used less than 20% of the time. A cost analysis and assessment of site availability to build storage should be conducted to determine the optimal size of storage.
- It is not clear how flexible the LVL AWTF can be regarding flow and daily plant operations. A better understanding of these limitations could help identify the storage size needed.

4. Pump Station Technical Review

Jacobs reviewed the Pump Station Preliminary Design Report (PDR) for *the Final Design for the Expansion of the Leo J. Vander Lans Water Treatment Facility* (CDM Smith 2012a). The Pump Station PDR was for a new effluent pump station (EPS) located at the Los Coyotes WRP. The pump station was part of a conveyance system to provide tertiary effluent from the Los Coyotes WRP to the LVL AWTF. The Pump Station PDR considered the EPS design flows of 4, 6, and 10 MGD. The Pump Station PDR evaluated three pump station alternatives:

1) **Pump Station Alternative 1:** Three submersible pumps in the effluent channel along the north wall.
2) **Pump Station Alternative 2:** Three vertical turbine pumps near the south property line that would take suction from a connection to the filter effluent pipeline.
3) **Pump Station Alternative 3:** Three vertical turbine pumps in a new wet well that is connected to the dechlorination channel downstream from the effluent channel.

CDM Smith selected Alternative 3 as the recommended alternative in the Pump Station PDR. This TM will only discuss the technical review pertaining to Alternative 3. In the Pump Station PDR, two duty pumps and one standby pump were selected based on the maximum design flow of 10 MGD; however, this analysis will also review the feasibility of the proposed pumps to deliver a maximum design flow of 10.5 MGD.

4.1 Review Assumptions

The Pump Station PDR technical review includes the following assumptions:

- Analysis is based on the PDR (CDM Smith 2012a).

- The Pump Station PDR was reviewed for major design flaws and not for any minor inconsistencies.
- Hydraulic analysis did not include the development of a hydraulic model.
- Civil, heating, ventilation, and air conditioning, geotechnical, and corrosion control design were not reviewed.
- The EPS project schedule was not reviewed.

4.2 Pump Intake Design

The proposed intake design was reviewed to check compliance against the guidelines provided in the American National Standards Institute's (ANSI's) and the Hydraulic Institute's (HI's) *American National Standard for Rotodynamic Pumps for Pump Intake Design* (ANSI/HI 9.8-2018) for a rectangular intake design, as shown on Figure 15. The ANSI/HI 9.8-2018 applies to the design of new intakes, as well as the modification of existing designs used with rotodynamic pumps. It outlines standard intake designs based on certain criteria, beyond which require a physical model study to comply with the standard.

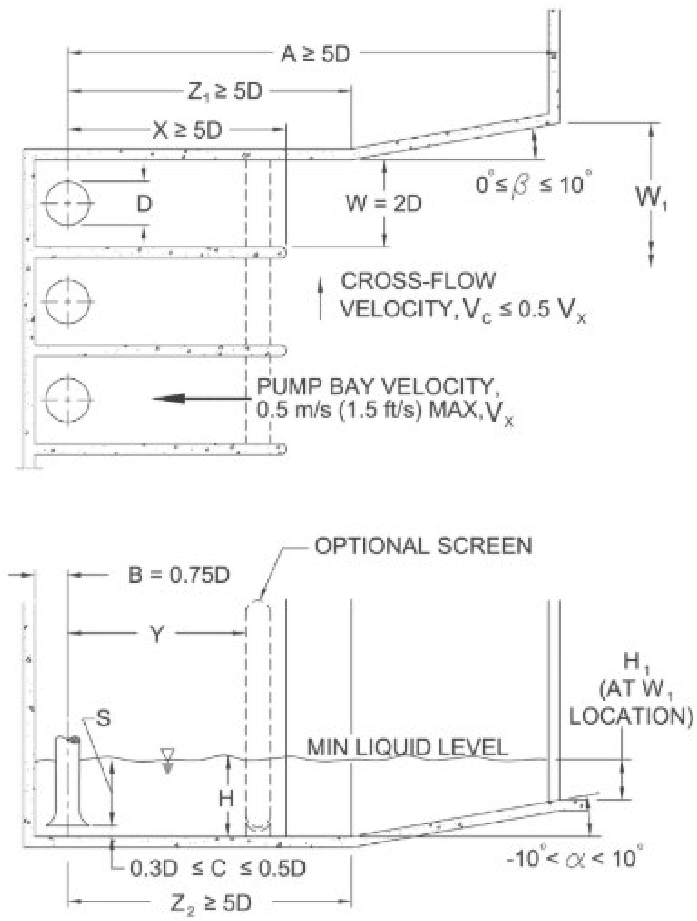


Figure 15. Rectangular Intake Structure Layout Recommended by ANSI/HI 9.8-2018

Figure 16 shows the proposed pump intake design presented in the Pump Station PDR. It shows the rectangular intake structure layout using individual pump bays with divider walls. The flow approaches the wet well through a channel perpendicular to the pump bays. One of the most critical considerations of pump intake design is the characteristic of the flow approaching an intake structure. According to ANSI/HI 9.8-2018, Section 3.1.1:

> "*The ideal conditions – and the assumptions on which the geometry and dimensions recommended for rectangular intake structures are based – are that the structure draws flow so that there are no cross-flows in the vicinity of the intake structure that create asymmetric flow patterns approaching any of the pumps, and the structure is oriented so that the supply boundary is symmetrical with respect to the centerline of the structure*."

Based on the factors discussed herein, the proposed intake design is not in compliance with ANSI/HI 9.8-2018:

- The intake design deviates from standard intake designs discussed in ANSI/HI 9.8-2018.
- The 90-degree drop from the channel into the wet well exceeds the allowable floor slope range of -10 degrees < α < 10 degrees

As shown on Figure 15, the length of each pump bay is a function of the pump inlet bell diameter installed in that bay. The pump bay length could not be verified because the pump inlet bell diameter information was not provided in the Pump Station PDR, and Figure 16 is not to scale.

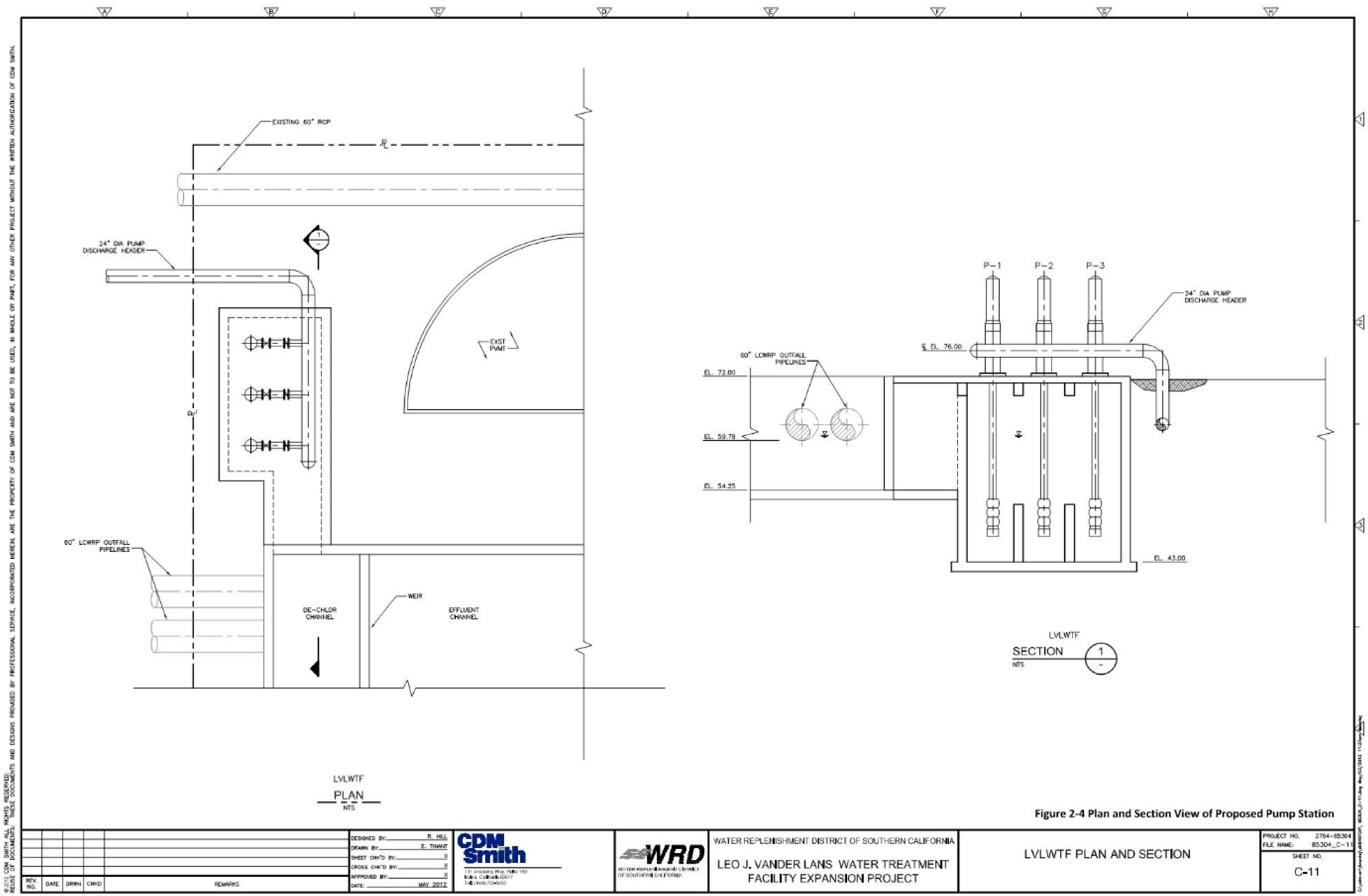


Figure 16. Proposed Pump Intake Layout Presented in the Pump Station PDR ***(Source: CDM Smith 2012a, included with permission from WRD)***

It is recommended that the pump wet well be redesigned to comply with ANSI/HI Standards recommendations (ANSI/HI 2018). A trench-style intake is a viable option that would be similar in construction cost to that shown in the Pump Station PDR for the proposed intake design.

4.3 Mechanical Design

4.3.1 Pumps

CDM Smith recommended three (two duty and one standby) constant-speed, two-stage, 1,180-revolution-per-minute, vertical turbine pumps by Goulds (Model 18LHC) (CDM Smith 2012a). The Pump Station PDR indicated the rated condition of 4,200 gallons per minute at 125 feet of total dynamic head for each pump. However, the 125 feet of total dynamic head seems to be a typographical error. According to the Pump Station PDR (Figure 15, Pump Operations with [Los Coyotes] EPS Control Valve), as presented on Figure 17 in this TM, the quoted 125 feet of total dynamic head is approximately equal to the pump shutoff head.

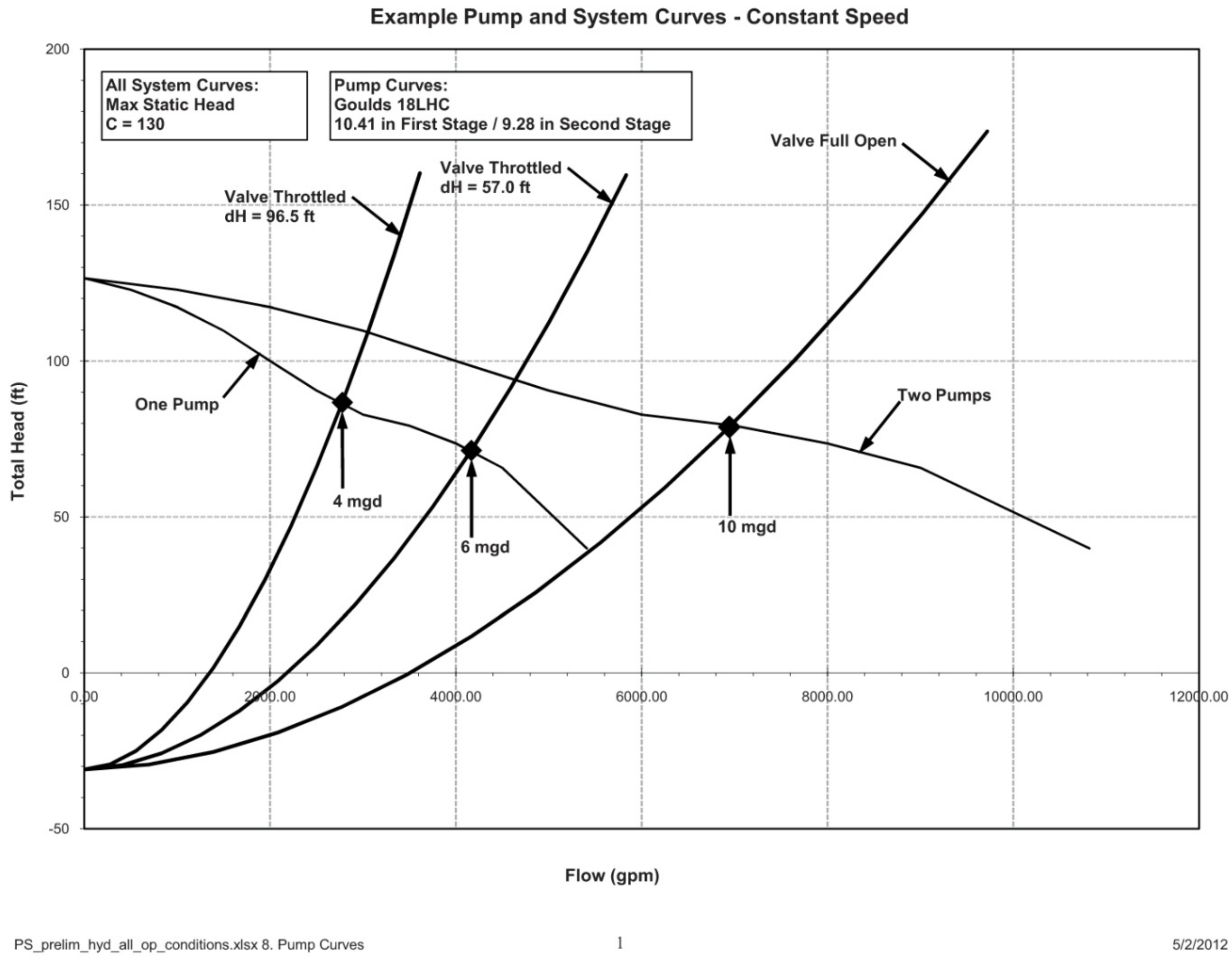


Figure 17. Example Pump and System Curves – Constant Speed *(Source: CDM Smith 2012a, included with permission from WRD)*

As shown on Figure 17, one pump will be required to deliver flows of 4 and 6 MGD, whereas two pumps running in parallel will be required to deliver 10 MGD. The proposed pumps will not be able to meet the maximum design flow condition of 10.5 MGD based on the system head curve information shown.

The following information was not provided in the Pump Station PDR:

- Pump performance curve from the manufacturer
- Pump efficiency
- Net positive suction head required
- Minimum submergence
- Pump inlet bell diameter
- Motor horsepower
- Best efficiency point
- Preferred operating region of the pump
- Allowable operating region of the pump

In the absence of this information, the pump performance at different flow conditions could not be verified. We recommend further evaluation of pump selections for possibly better pump hydraulic performance, equipment longevity, and energy savings.

According to the Pump Station PDR, the variable frequency drives are not considered to be cost-effective for this application because of the initial capital cost and the operations and maintenance cost over the life of the project. However, based on Figure 17, throttling valves are used to induce 96.5 and 57.0 feet of head at 4 and 6 MGD, respectively. A 4-MGD flow scenario with assumed values of 81% pump efficiency, 93% motor efficiency, $0.10 per kilowatt hour electric cost, and 4-hour pumping operation per day will yield an estimated total power consumption of 97,865 kilowatt hours per year and an energy cost of $9,786 per year. It is recommended to re-evaluate the use of variable frequency drives for this project.

4.3.2 Valves

Two hydraulic flow-control scenarios are discussed in the Pump Station PDR: a fully pressurized pipeline and a gravity flow pipeline. The fully pressurized pipeline scenario uses an existing butterfly control valve at the influent equalization basin in LVL AWTF; however, the suitability of the existing control valve to meet different design hydraulic scenarios without cavitation is not discussed in the Pump Station PDR. It is likely that the existing butterfly control valve will cavitate at the 4-MGD design flow scenario with the pressure drop of approximately 96.5 feet across the valve. The gravity flow pipeline scenario uses a new butterfly control valve at the Los Coyotes EPS discharge header. Further investigation should be performed during final design to confirm the type and size of the control valves.

4.3.3 Isolation Gate

A new isolation gate will be installed at the Los Coyotes EPS so the pump station can be isolated during construction and shutdown, and for maintenance purposes. The Pump Station PDR does not indicate the size and type of the isolation gate; however, the cost of an isolation gate is included in the cost estimate.

4.4 Structural Design

It cannot be determined from the information provided in the Pump Station PDR whether the pump foundation is adequately sized to form a permanent and rigid support for the pump equipment baseplate. The pump foundation should be adequately sized to provide an acceptable separation margin between the critical structural natural frequency and the normal operating speed range of the pump. As a general rule, according to the ANSI *Standard for Rotodynamic Vertical Pumps for Manuals Describing Installation, Operation, and Maintenance* (ANSI/HI 2.4-2014), Article A.4.3:

> *"The mass of the foundation should be sufficient, preferably five times that of the pumping equipment, to form a permanent and rigid support for the baseplate."*

4.5 Electrical Design

The proposed electrical design seems reasonable, given the listed assumptions that:

- It is unknown what interface will be required with the serving utility. This is typical of any design and will require typical coordination.
- The lighting criteria is not wrong but should consider light-emitting-diode-type lighting, which is much more available now and is more energy efficient.
- Pump motor information, including horsepower and full-load amperes is not provided in the Pump Station PDR.
- The 2020 edition of the National Electrical Code (National Fire Protection Association 70) is available now. The Pump Station PDR uses the 2008 edition.

There are several conflicts and discrepancies in the proposed control scheme. Some of these are noted in Section 4.6, Instrumentation and Control Design, of this report.

4.6 Instrumentation and Control Design

Review of the instrumentation and control section of the Pump Station PDR identifies the following:

- The proposed pump controls, as described, are not coordinated with the representation on the process and instrumentation diagram.
- There are two different flow scenarios discussed in the Pump Station PDR: a fully pressurized pipeline and a gravity flow pipeline. However, the process and instrumentation diagram is only provided for a fully pressurized pipeline option.
- The PDR (Section 4.6.1) identifies an existing ultrasonic flow meter at Los Coyotes EPS, whereas it should be at LVL AWTF.

4.7 Surge

Jacobs reviewed the Surge Analysis provided as Appendix E to the PDR. In general, there is inadequate information to determine whether the surge analysis correctly identifies the potential surge characteristics and whether the proposed mitigation is adequate. There were no exceptions noted to the information provided. However, there were a few discrepancies in the documentation, such as the friction factor and valve closing times. These should be clarified for consistency; the results could be sensitive to the input parameters, especially for the valve closing times.

It also appears that the surge analysis was performed for an assumed pump selection that is different from the currently selected pumps. The current surge analysis should not be considered adequate for developing the appropriate mitigation alternatives, and a new surge analysis should be performed using the proposed pump selection.

4.8 Pump Station Conclusions and Recommended Next Steps

The following are the conclusions and recommendations from the Pump Station PDR review:

- The pump station intake design is not in compliance with ANSI/HI 9.8-2018. It is recommended that the pump wet well be redesigned to comply with HI Standards recommendations. A trench-style intake compliant with ANSI/HI, as shown on Figure 15, is a viable option that would be similar in construction cost to that shown in the Pump Station PDR for the proposed intake design.
- The recommended vertical turbine pumps by Goulds (Model 18LHC) can deliver the maximum design flow of 10 MGD, as discussed in the Pump Station PDR. However, these pumps cannot meet an additional demand to deliver the maximum design flow of 10.5 MGD. It is recommended to further evaluate pump selections for possibly better pump hydraulic performance, equipment longevity, and energy savings.
- It is recommended to re-evaluate the use of variable frequency drives for this project.
- It is recommended to further investigate the type and size of the new and existing control valves for all hydraulic conditions during final design.
- There is not adequate information to determine whether the surge analysis correctly identifies the potential surge characteristics and whether the proposed mitigation is adequate. There were some discrepancies in the documentation, such as the friction factor and valve closing times. It also appears that the surge analysis was performed for an assumed pump selection that is different than the currently selected pumps. The current surge analysis should not be considered adequate for developing the appropriate mitigation alternatives, and a new surge analysis should be performed using the proposed pump selection.

5. Pipeline Technical Review

Jacobs reviewed the Pipeline PDR completed by CDM Smith (2012b). The purpose of the review was to verify pipe sizing, identify issues with the proposed horizontal alignment, and update the preliminary cost estimate for the construction of the pipeline. Four proposed pipeline alternative alignments were evaluated in the Pipeline PDR:

1) **Pipeline Alignment 1:** San Gabriel River Levee
2) **Pipeline Alignment 2:** Parallel to the San Gabriel River Levee
3) **Pipeline Alignment 3a:** Street route in the parking lot and South Street
4) **Pipeline Alignment 3b:** Street route on Allington Street and Studebaker Road

Alignment 1 was indicated in the Pipeline PDR as the recommended route alternative, which is verified and discussed in detail in Section 5.3.

5.1 Review Assumptions

The following assumptions were made for the purposes of this review:

1) The review of the pipeline alignment was conducted on the recommended alternative identified in the Pipeline PDR and was conducted as a desktop review.
2) Site visits were not performed as part of this review.
3) The hydraulic analysis of the pipeline verified the recommended size of the pipeline and did not involve the development of a hydraulic model.

4) The maximum and average daily flow used for the analysis were 10.5 and 8.7 MGD, respectively, which were verified by WRD as the desired flow setpoints, assuming no additional storage would be required as part of the project.

5.2 Pipe Sizing

A nominal pipe diameter of 24 inches was recommended in the Pipeline PDR for the delivery of flow ranging from 4 to 10 MGD, resulting in a minimum velocity of 2 feet per second (ft/s) and a maximum velocity of 5 ft/s.

The pipe materials considered as part of the review of the Pipeline PDR included high-density polyethylene (HDPE) pipe and welded steel pipe (WSP). For the purposes of this analysis, the HDPE pipe was assumed to be ductile iron pipe size PE4710 with a dimension ratio of 11. This material is suitable for the maximum working pressure of 115 pounds per square inch indicated in the Pipeline PDR. WSP fabricated with A1018, Grade 36, Type 1 structural steel with a wall thickness of 3/16 inch and cement mortar lining thickness of 3/8 inch is a conceptual steel pipe design criterion typically used for applications for this pipe size and pressure requirement.

Table 3 shows the inside pipe diameter and resulting velocity for the minimum, average design, and peak flow requirements.

Table 3. Pipeline Material and Corresponding Diameters and Calculated Velocities

	Diameter (inches)		Velocity (ft/s)			
Pipe Material	**Nominal**	**Actual ID**	**Low (Q = 4 MGD)**	**Average (Q = 8.7 MGD)**	**High (Q = 10.5 MGD)**	**Recommended Maximum**
HDPE – PE 4710, ductile iron pipe size, dimension ratio 11	24	20.829	3.14	6.83	8.24	10
WSP – 3/16-inch wall with cement mortar lining	24	24	2.37	5.15	6.21	7

Notes:

ID = inner diameter

Q = flow rate

The resulting velocities for the anticipated flows for both pipe materials are within an acceptable range that meet typical design standards. Decreasing pipe diameter in either instance would exceed the recommended maximum velocity for sustained usage should a flow of 10.5 MGD be required to be delivered on a regular basis, and as a result, it is not recommended to decrease pipe size at this time.

5.3 Horizontal Alignment

The Pipeline PDR proposed four pipeline alignment alternatives between the Los Coyotes WRP and the LVL AWTF, where Alignment 1 was recommended to be carried forward for further consideration. It was rated the highest by WRD per the scoring criteria, which included overall length, traffic and community disruption, sensitive receptors, business disruption, utility conflicts, constructability, geotechnical conditions, permitting requirements, and capital costs. Alignment 1 is approximately 6 miles long and is routed along the San Gabriel River Levee beneath the San Gabriel River Trail bike path, as shown on Figure 18.

Figure 18. Alternatives and Study Corridor

(Source: Adapted from Figure 1-1 with permission from WRD, Map of the Alternative Alignments and Preferred Alignment [CDM Smith 2012b])

The following horizontal clearances from existing utilities, including gas, potable water, storm drain, sanitary sewer, fiber optic, and overhead power lines were as reported in the Pipeline PDR, as shown in Table 4.

Table 4. Minimum Separation from Existing Utilities

Facility	Preferred Minimum Separation (feet)	Absolute Minimum Separation (feet)
Overhead electric	45	10
Buried fiber optic	10	5
Gas	10	5
Potable water	12	5
Storm drain	12	5
Sanitary sewer	12	< 10 with concrete encasement

Table 4. Minimum Separation from Existing Utilities

Facility	Preferred Minimum Separation (feet)	Absolute Minimum Separation (feet)
Edge of pavement	5	3

Source: Adapted from Table 4-1, Minimum Separation from Existing Facilities (CDM Smith 2012b), included with WRD permission.

Note:

< = less than

The only existing utility that appears to parallel Alignment 1 is a 24-inch-diameter recycled water pipeline owned by the City of Cerritos. Immediately east of this pipeline is a utility easement owned by SCE.

In general, Alignment 1 is a viable alternative that: has minimal to no utility congestion, does not disrupt traffic or the general public, is constructible, and is mostly linear throughout its entire length. However, it does present some permitting challenges, which are discussed in Section 5.3.1.

5.3.1 Permitting Challenges

The Pipeline PDR included meeting minutes from discussions held on March 8, 2012, between the United States Army Corps of Engineers (USACE) and WRD regarding the installation of a pressurized pipeline within or near the San Gabriel River Levee (CDM Smith 2012b, Appendix J). USACE indicated that the Los Angeles County Flood Control District (LACFCD) owns and maintains the reach of the levee that spans the entire length impacted by the preferred alternative Alignment 1. According to the USACE, LACFCD would oversee the issuance of the initial permit and design review. If approved by LACFCD, the design documents would be submitted to USACE for subsequent review.

According to the March 8, 2012 meeting minutes, WRD will coordinate with LACFCD to inquire about the requirements for installation of a pressurized pipeline within a levee in its jurisdiction. LACFCD's requirements should be documented and established prior to the next phase of the project to determine the viability of Alignment 1. If LACFCD does not allow the installation of the pipeline through the proposed corridor within the levee, a new preferred alternative will need to be identified.

If LACFCD allows for the installation of a pressurized pipeline within the San Gabriel River Levee, a 408 Permit – Modification of Corps Structures would be required from USACE per the March 8, 2012 meeting minutes. This process could be time consuming, and the appropriate timetable for permit approval would need to be accounted for in the project schedule through coordination with USACE. Further discussion regarding permitting requirements is provided in Section 6.

5.3.2 California Department of Transportation and Los Angeles County Metropolitan Transportation Authority Railroad Right-of-Way

Alignment 1 will cross beneath an SR-91 freeway overpass under the jurisdiction of the California Department of Transportation (Caltrans), and a railroad right-of-way (ROW) owned by the Los Angeles County Metropolitan Transportation Authority (Metro). SR 91 and the Metro railroad ROW are adjacent to each other and could be crossed in one continuous trenchless installation. Although the Pipeline PDR indicates that this portion of the pipeline could be installed using an open-cut trench, Caltrans' policy typically requires all pipelines crossing their ROWs, especially in situations where overpasses are encountered, to be installed via a steel-cased trenchless installation. Recent coordination with Caltrans on other projects requiring overpass crossings verifies this requirement.

The conceptual crossing of SR 91 and the Metro ROW is presented on Figure 19 (CDM 2012b, Appendix F).

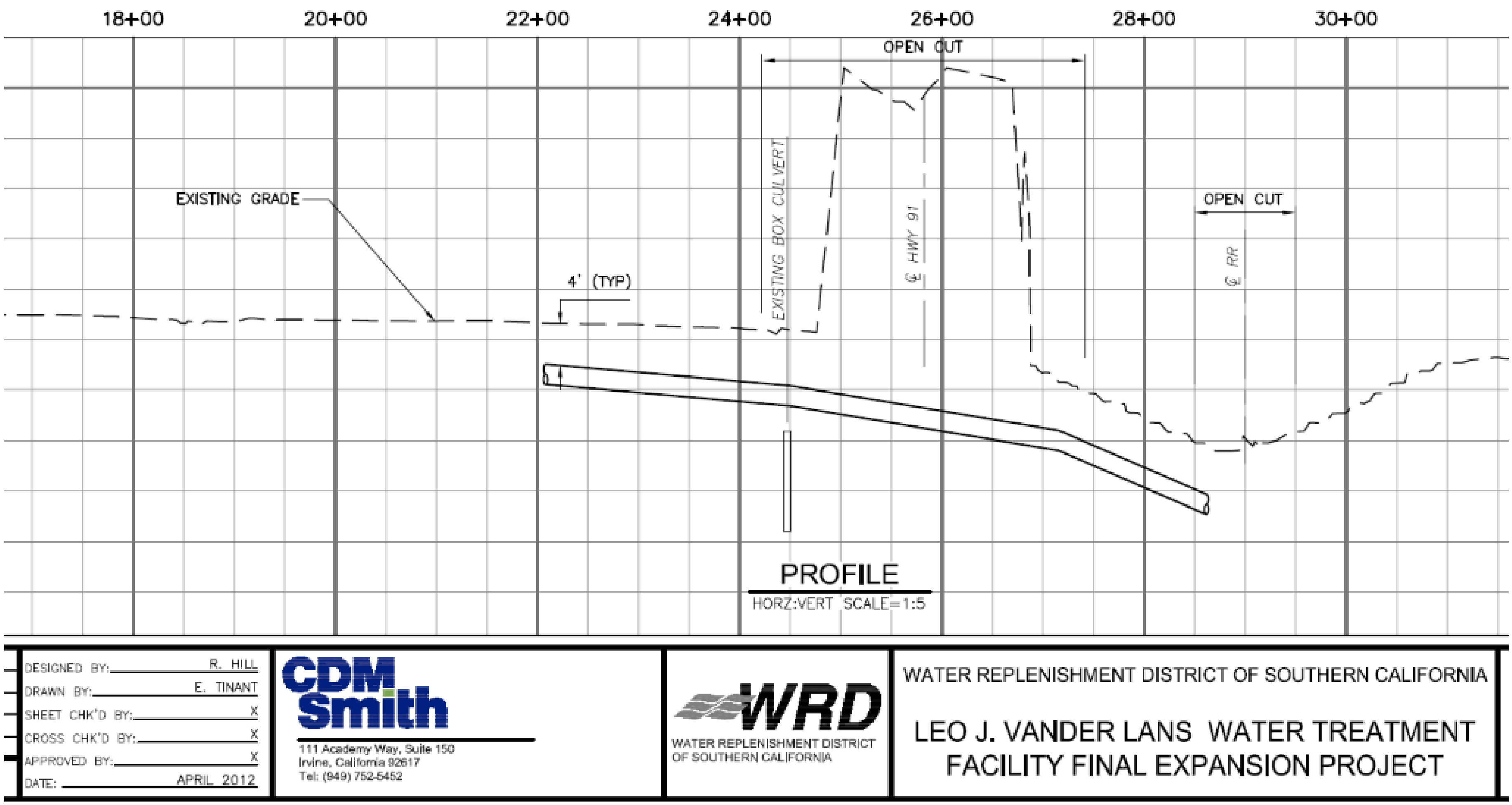


Figure 19. Caltrans and Railroad Crossings

(Source: CDM Smith [2012b], included with WRD permission)

It is recommended that approximately 600 feet of pipeline crossing SR 91 and the Metro ROW be included in the cost estimate as a trenchless installation, which will represent an increase in the overall cost of construction. A typical trenchless installation for this crossing would include installing the carrier pipe (24-inch-diameter WSP or HDPE pipe) in a 48-inch steel casing via an open-face rotary tunnel boring machine. This method could accommodate either pipe material (WSP or HDPE) recommended for the 24-inch line. The total assumed tunneled crossing required for this project is estimated at approximately 1,540 feet.

5.4 Pipeline Conclusions and Recommended Next Steps

The following are the conclusions and recommendations from the Pipeline PDR technical review:

- A nominal pipeline diameter of 24 inches is appropriate for the Los Coyotes WRP pipeline.
- Coordination with LACFCD and USACE will be required to determine whether Alignment 1 is feasible and permittable under the project schedule, and whether HDPE pipe can be used for the project.
- Coordination with Caltrans and Metro is also required to determine the necessary permits and technical requirements for the crossings of SR 91 and the Metro ROW, respectively.
- As final design begins, the method of trenchless installation and the extent of open-cut trench work areas within the San Gabriel River Levee will need to be determined to facilitate coordination with each of the aforementioned agencies.
- If Alignment 1 is not determined to be permittable, a new preferred alignment will need to be determined as quickly as possible to prevent delays.

6. Permitting and Environmental Review

A desktop permitting and environmental resource analysis was performed for the proposed conveyance route (Alternative 1) and pump station, as presented in the Pump Station and Pipeline PDRs (CDM Smith 2012a, 2012b).

6.1 Review Assumptions

The permitting and environmental review includes the following assumptions:

- Analysis is based on the design information provided in the Pump Station and Pipeline PDRs (CDM Smith 2012a, 2012b). Exact ground disturbance limits and complete construction activity description were not available.
- No agencies were contacted to confirm permit requirements; additional coordination with agencies is required.
- Permitting and environmental review consists of a desktop analysis; no field surveys were performed.
- A literature search for cultural resources was not performed.

6.2 Permits or Approvals and Acquisition Schedule

Table 5 includes a preliminary identification of potential permits or regulatory approvals, and associated acquisition schedule, that have been or may be required before project components can be constructed. Further discussion is provided later in this section.

Table 5. Preliminary Summary of Environmental Permits and Approvals

Activity	Permit and Approval[a]	Technical Studies	Acquisition Schedule[b]
Encroachment into a USACE-regulated facility	Section 408 permit, including NEPA review.	Engineering design to support the application, hydrologic and hydraulics system analysis, technical studies for NEPA review, including species surveys, habitat assessments, and cultural resource surveys.	Section 408, including NEPA review: 12 to 18 months
Project undertaking as a whole (that is, construction and operations of pump station and conveyance pipelines)	CEQA environmental review and public disclosure. An IS/MND would likely be adequate, as it is not anticipated that the project or any of its aspects would cause a significant effect on the environment.[c]	Construction and operations air emissions calculations, biological reconnaissance field survey and desktop data review, cultural resources records search of CHRIS within a 0.5-mile buffer zone, cultural resources field survey, as well as water supply and water quality technical studies.	CEQA (IS/MND): 9 to 12 months
Acquisition of CWSRF financing	CEQA-Plus environmental review, in lieu of the NEPA associated with federal nexus for partial funding of the CWSRF program by the U.S. Environmental Protection Agency. CEQA-Plus would include a project CEQA document plus completion of the CWSRF program's Evaluation Form for Environmental Review and Federal Coordination.[d]	Technical studies identified for IS/MND.	CEQA-Plus (IS/MND): 9 to 12 months
Impacts on jurisdictional wetlands or waters	Impacts on San Gabriel River Channel may require a CWA Section 404 permit (NWP 12), CWA Section 401 WQC and WDR, and an SAA.	Jurisdictional delineation of wetlands and waters, and a biological resources assessment. Activities within the regulated OHWM would trigger a Section 401 WQC and a Section 404 permit. Activities within bed or banks would trigger an SAA.	Section 404 permit (NWP 12): 9 to 12 months[e] Section 401 WQC: 9 to 12 months SAA: 9 to 12 months

Table 5. Preliminary Summary of Environmental Permits and Approvals

Activity	Permit and Approval[a]	Technical Studies	Acquisition Schedule[b]
Change in the point of discharge, place of use, or purpose of use of treated wastewater, applicable for applicants seeking grant funds for water pollution control and water recycling projects	Section 1211 of the Water Code requires that, before making a change in the point of discharge, place of use, or purpose of use of treated wastewater, the owner of the treatment plant must seek approval from the Division of Water Rights, which is accomplished by filing a Petition for Change.	To determine whether it is necessary to file a petition with the Division of Water Rights, an agency may discuss a proposed water pollution control or water recycling project with Division of Water Rights staff. Based on this discussion, the Division of Water Rights would issue a letter of determination indicating whether no further action is required or if a petition must be filed.	Petition for Change: 6 to 9 months Note: SWRCB approved the Section 1211 Petition for Los Coyotes WRP on May 29, 2020.
Conveyance pipeline within public and private utility ROWs	LACFCD encroachment permit for activities within a flood control facility ROW. City encroachment and excavation permits from Cerritos, Lakewood, and Long Beach, including traffic control plans, for activities in a public ROW. Caltrans encroachment permits for crossing under SR 91. Metro railroad encroachment permit. Private utility encroachment permit (SCE and SoCal Gas crossing).	Pipeline design sheets and associated traffic control plans.	LACFCD encroachment: 9 to 12 months City encroachment/ excavation permits (and traffic control plans): 3 to 6 months Caltrans encroachment permit: 3 to 6 months Metro encroachment permit: 3 to 6 months Private encroachment permits: 3 to 6 months
Pump station and use of recycled water	Agreement between LACSD and WRD	TBD	TBD
Pump station	Local building permits from the City of Cerritos.	Design to support a building permit application.	Building permit: 4 to 6 months
Construction and operations of treatment plant equipment and power generation equipment, including pump station emergency backup power generation equipment	SCAQMD Permit to Construct/Operate for construction and operations of treatment plant equipment and power generation equipment, including emergency backup power generation equipment.	Treatment plant and power generation equipment inventory. Technical evaluation to confirm compliance with SCAQMD's source-specific rules and new source review rules for emission control.	Permit to construct and operate for treatment plant equipment and power generation equipment, including emergency backup power generation equipment: 6 to 12 months
Soil disturbance of one or more acres, applicable to all project soil disturbance	SWRCB and Los Angeles Regional Board Water Quality Order 2012-0006-DWQ (General Construction Permit).	SWPPP drawings, including BMP placement identification.	SWPPP preparation and Notice of Intent filing: 1 to 2 months

Table 5. Preliminary Summary of Environmental Permits and Approvals

Activity	Permit and Approval[a]	Technical Studies	Acquisition Schedule[b]
Construction near an aviation facility	FAA 7460 Notice required due to the project proximity to the Joint Forces Training Base Los Alamitos.	FAA Notice form.	FAA Notice: 45 days prior to construction
Discharge of hydrostatic testing water	Los Angeles Regional Board Order No. R4-2019-0052 WDR for Discharges of Low Threat Hydrostatic Test Waters to Surface Waters (General NPDES Permit No. CAG674001).	Notification, including analytical data of test water and a pollution prevention plan specifying BMPs, to ensure testing vessels are free of pollutants prior to filling with test water.	Notice of Intent filing along with supporting studies: 2 to 4 months
Tree removal, as needed	Tree removal permits from the City of Cerritos .	Tree survey, design to support the application, and a tree replacement plan, as necessary.	Tree removal: 1 to 3 months

[a] State agency CEQA review is required before state agencies can issue discretionary permits.

[b] The estimated total acquisition duration is 12 to 18 months following selection of a defined project and development of a complete project description.

[c] A draft IS/MND was prepared by CDM Smith in 2012. An updated CEQA environmental review document would need to be prepared and circulated for public review. The ultimate decision to proceed with an MND (and not an environmental impact report) should be made following selection of a proposed project.

[d] Applicable only if the program receives federal funds via the CWSRF.

[e] On April 15, 2020, the U.S. District Court vacated (invalidated) NWP 12, stating that the USACE failed to uphold its obligations under Section 7 of the Endangered Species Act when it reissued NWP 12 in 2017. The court order vacated future use of NWP 12 until the USACE completes programmatic consultation with the services.

Notes:

BMP = best management practice
CEQA = California Environmental Quality Act
CHRIS = California Historical Resources Information System
CWA = Clean Water Act
CWSRF = Clean Water State Revolving Fund
FAA = Federal Aviation Administration
IS = Initial Study
MND = Mitigated Negative Declaration
NEPA = National Environmental Policy Act
NPDES = National Pollutant Discharge Elimination System
NWP = nationwide permit
OHWM = ordinary high water mark
Petition for Change = Petition for Change for Owners of Waste Water Treatment Plants
RWQCB = Regional Water Quality Control Board
SAA = Streambed Alteration Agreement
SCAQMD = South Coast Air Quality Management District
SoCal Gas = Southern California Gas
SWPPP = stormwater pollution prevention plan
SWRCB = California State Water Resources Control Board
TBD = to be determined
WDR = waste discharge requirements
WQC = Water Quality Certification

6.2.1 Federal Permits or Regulatory Approvals

6.2.1.1 USACE Section 408 Review

The proposed Alternative 1 alignment follows the San Gabriel River Channel and is within an LACFCD easement. An encroachment permit is required from LACFCD for all work within a flood control district's easement (LACDPW 2020), as further discussed in Section 6.2.3. The San Gabriel River Channel is also a USACE-regulated facility. USACE maintains authority under U.S. Code Section 408 to grant permission for the alteration or occupation or use of a USACE civil works project (Section 408 Review). The term alteration is defined to include encroachment, which is permitted by local sponsors (also called nonfederal sponsors) (USACE 2020). The LACFCD is the local (nonfederal) sponsor for the San Gabriel River Channel. Therefore, an encroachment permit from LACFCD would require Section 408 Review.

According to the revised USACE Engineering Circular for Section 408 Review, which provides policies and procedural guidance of the overall review process, published by USACE in 2018, environmental clearance under the National Environmental Policy Act (NEPA) and consultation with federal resource agencies for potential effects under the Endangered Species Act and the National Historic Preservation Act would be required for Section 408 Review (USACE 2018a). The NEPA review could be prepared as a streamlined categorical exemption document, but further consultation with USACE is required to determine the level of analysis required.

Jacobs estimates that Section 408 Review, inclusive of USACE Regulatory and Civil Works Divisions review, NEPA review, and final notification of approval to LACFCD, may add approximately 12 to 18 months to the encroachment permit process.

6.2.1.2 USACE Clean Water Act Section 404 Permit

Although the San Gabriel River is a federally regulated water, the conceptual alignment does not route through wetlands or waters of the United States below the ordinary high water mark (OHWM). With a narrow disturbance corridor and implementation of BMPs, the project may avoid permitting under Section 404 of the Clean Water Act (CWA) with USACE. However, once a project footprint has been determined, a site-specific wetland delineation would need to be conducted to verify the boundaries of United States waters or wetlands features in the vicinity. The OHWM is anticipated to be located partway down the slope of the channel. If engineering constraints require the project footprint to extend into the OHWM, the project may require a nationwide permit under Section 404. Nationwide Permit (NWP) 12 for Utility Line Activities is anticipated to be the applicable NWP. Acquisition of NWP 12 is anticipated to take 9 to 12 months. If a Section 404 permit is required, it is anticipated that the application would be processed concurrently with the Section 408 application in coordination with USACE (USACE 2018b).

On April 15, 2020, U.S. District Court Judge, Brian Morris, from the District of Montana vacated (invalidated) NWP 12 stating that the USACE failed to uphold its obligations under Section 7 of the Endangered Species Act when it reissued NWP 12 in 2017. Although the USACE completed Endangered Species Act consultation with the United States Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (together, the Services) prior to authorization of the NWP program in 2007 and 2012, USACE did not complete formal Endangered Species Act programmatic consultation (that is, Section 7(a)(2) consultation) with the Services prior to authorizing the NWP program in 2017. The court order vacated future use of NWP 12 until USACE completes programmatic consultation with the Services. Additional coordination with USACE is needed to determine permitting procedures for projects that would otherwise utilize NWP 12.

6.2.1.3 Additional NEPA Review

NEPA review may also be required if the project will utilize federal funding. Certain sources of funding may have streamlined review processes. For example, for use of the Clean Water State Revolving Fund (CWSRF), the California State Water Resources Control Board (SWRCB) has developed a NEPA-like process known as California Environmental Quality Act (CEQA)-Plus. The CEQA-Plus process would include a project CEQA document plus completion of the CWSRF program's Evaluation Form for Environmental Review and Federal Coordination, which includes a need for specific review and documentation in conformance with federal laws (for example, the Clean Air Act, the Endangered Species Act , and the National Historical Preservation Act).

6.2.1.4 Federal Aviation Administration 7460 – Notice of Proposed Construction or Alteration

Additionally, based on the Federal Aviation Administration (FAA) Notice Criteria Tool, FAA 7460 Notice of Proposed Construction or Alteration is required because of the project's proximity to a navigation facility (FAA 2020). The southern portion of the alignment is approximately 1.5 miles from the Joint Forces Training Base Los Alamitos. The FAA notice would need to be filed at least 45 days prior to construction and should include details of all structures required for construction and operations activities.

6.2.2 State Permits or Regulatory Approvals

6.2.2.1 CEQA Review

CEQA requires state and local agencies to identify the significant environmental impacts of their actions and to avoid or mitigate those impacts, if feasible. A public agency must comply with CEQA when it undertakes an activity defined by CEQA as a project. A project is an activity undertaken by a public agency or a private activity that must receive some discretionary approval (meaning that the agency has the authority to deny the requested permit or approval) from a government agency, which may cause either a direct physical change in the environment or a reasonably foreseeable indirect change in the environment. If the proposed project does not fit within a CEQA Categorical or Statutory Exemption, an IS must be conducted by the lead agency to determine whether a project may have a significant effect on the environment. If the IS does not identify a significant impact, the lead agency would prepare a Negative Declaration or an MND. If the project will have significant impacts on the environment that cannot be mitigated to a less-than-significant level, an environmental impact report (EIR) must be prepared.

The LACSD prepared an EIR to analyze the environmental effects of the San Gabriel River Watershed Project to Reduce River Discharge in Support of Increased Recycled Water Reus*e* (State Clearinghouse No. 2018071021) (ESA 2019). A Notice of Determination was issued on November 18, 2019. This EIR analyzed the reduction in surface water discharge to the San Gabriel River or its tributaries from five WRPs, including from the project (ESA 2019). Therefore, aside from cumulative effects, the effects related to a reduction of surface water discharge from the proposed project's pipeline do not need to be further analyzed under CEQA. However, the project must abide by the mitigation measures included in the EIR.

An analysis of environmental impacts pursuant to the CEQA is required for construction and operation of the proposed water conveyance system from the Los Coyotes WRP to the LVL AWTF. In 2012, CDM Smith prepared an administrative draft IS/MND for the WRD. An updated and finalized IS would need to be prepared. Jacobs anticipates that an updated IS/MND document would take approximately 12 months to finalize.

6.2.2.2 SWRCB or Regional Board Clean Water Act Section 401 Water Quality Certification

If the project will require a Section 404 permit from USACE (Section 6.2.1) for activities within the OHWM, a Section 401 Water Quality Certification (WQC) that the project will not degrade waters of the state or violate state water quality standards would also need to be obtained. Recent changes to state procedures require additional review of impacts on Waters of the State leading to the issuance of waste discharge requirements (WDRs). If the project can avoid impacts on the San Gabriel River Channel, a WQC or WDR, or both, would likely not be required.

6.2.2.3 SWRCB or Regional Board Clean Water Act Section 402

Based on the preliminary design, the total area of temporary disturbance associated with project construction would be greater than 1 acre. Therefore, project-specific coverage under the Construction General Permit, development of a project-specific Stormwater Pollution Prevention Plan, and submittal to the Regional Board's Storm Water Multiple Application and Report Tracking System would be required.

6.2.2.4 California Department of Fish and Wildlife Lake or Streambed Alteration Agreement

California Department of Fish and Wildlife (CDFW) jurisdiction extends beyond a stream channel to the riparian corridor on or adjacent to the banks (CDFW 2019). The project may require a Notification of Lake or Streambed Alteration to be filed with CDFW for activities within the bed or banks of the San Gabriel River Channel pursuant to California Fish and Game Code Section 1602. It is anticipated that a Streambed Alteration Agreement may be issued. Approval of the Streambed Alteration Agreement may require additional environmental surveys to be conducted to determine potential impacts to the surrounding area.

6.2.2.5 SWRCB Petition for Change for Owners of Wastewater Treatment Plants

Section 1211 of the California Water Code requires that, before making a change in the point of discharge, place of use, or purpose of use of treated wastewater, the owner of the treatment plant must seek approval from the Division of Water Rights, which is accomplished by filing a Petition for Change. The SWRCB approved the Section 1211 Petition for Change for the Project on May 29, 2020.

6.2.2.6 Caltrans Encroachment Permit

Caltrans issues encroachment permits for construction within Caltrans ROWs. An encroachment permit would be required to cross under SR 91. It is anticipated that issuance of an encroachment permit would require approximately 6 months to process.

6.2.2.7 Regional Board WDRs for Discharges of Low-Threat Hydrostatic Test Water to Surface Waters

Discharges of wastewater generated from hydrostatic testing (structural integrity testing) using potable water to the San Gabriel River Channel would need to be completed in accordance with Regional Board Order No. R4-2019-0052 WDRs for Discharges of Low-Threat Hydrostatic Test Waters to Surface Waters (General National Pollutant Discharge Elimination System Permit No. CAG674001), adopted on May 9, 2019, and expiring on July 9, 2024.

6.2.2.8 South Coast Air Quality Management District Permit to Construct/Operate

Construction and operations of treatment plant equipment and power generation equipment, including pump station emergency backup power generation equipment, if necessary, would require a Permit to

Construct/Operate for emission of air contaminants. If the Los Coyotes WRP already has a permit with the South Coast Air Quality Management District (SCAQMD), an alteration or modification may be filed.

6.2.3 Local Permits or Regulatory Approvals

6.2.3.1 Los Angeles County Sanitation Districts

An easement must be granted from LACSD for construction of the pump station and a portion of the pipeline within the Los Coyotes WRP. A memorandum of understanding or agreement with LACSD will be required for operation of these facilities.

6.2.3.2 Los Angeles County Flood Control District

LACFCD manages the San Gabriel River Channel for the entire reach from the Los Coyotes WRP to LVL AWTF. The channel can be described as having a 16-foot top width, including a 10-foot-wide paved bike/walking path. The ROW fence beyond the channel varies along the route, but generally only encompasses another 10 feet or so, unless the channel is substantially built up above grade, in which case the distance can be somewhere between 20 and 30 feet. As the pipeline alignment is within LACFCD easement, an encroachment permit from LACFCD would be required. Since the San Gabriel River Channel is also a USACE-regulated facility, an encroachment from LACFCD would also require Section 408 Review, as previously discussed in Section 6.2.1.

Los Angeles County Department of Public Works (LACDPW) issues encroachment permits on behalf of the City of Lakewood. Metro owns a decommissioned railroad bridge that crosses the San Gabriel River south of SR 91. An encroachment permit would be required to cross under the bridge.

6.2.3.3 Cities of Cerritos, Lakewood, and Long Beach

Encroachment and excavation permits with the Cities of Cerritos and Long Beach would be required for crossing through public ROWs and facilities, such as the Iron-Wood Nine Golf Course managed by the City of Cerritos and leased from SCE. The City of Lakewood does not issue encroachment permits; encroachment permits within the City of Lakewood are obtained through LACDPW with City of Lakewood review. No conditional use permits or zone change permits are anticipated to be required from any of the three municipalities. If tree trimming or removal of a City of Cerritos tree is required, a tree removal permit may also be necessary. The City of Long Beach would also require a facility/pipeline permit and a public works permit.

6.2.4 Additional Permits

Additional encroachment permits would be required to cross private easements. An SCE easement runs parallel to the LACFCD easement. The alignment also crosses an existing Southern California Gas pipeline.

6.3 Environmental Review

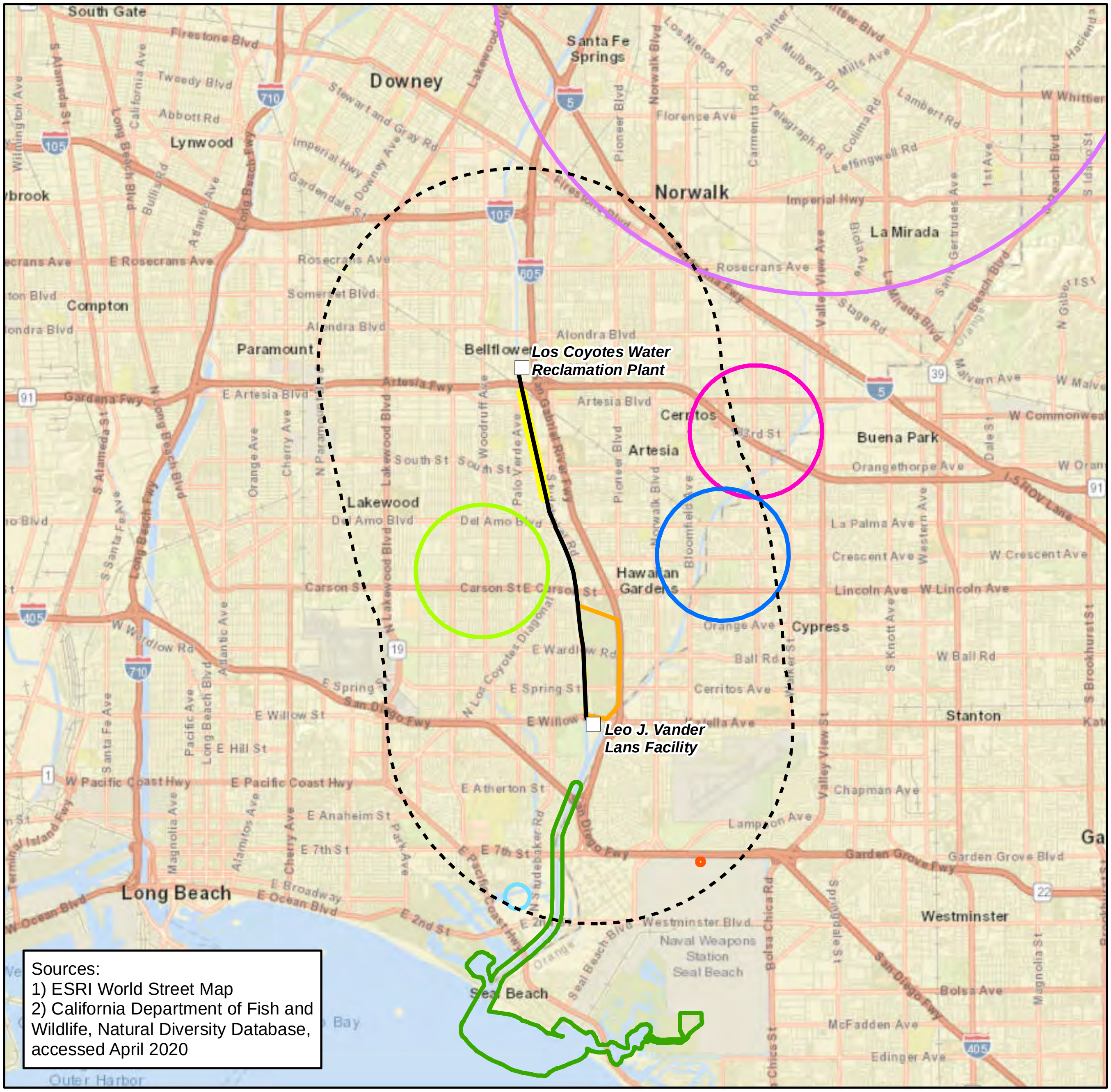
This section includes a desktop environmental review of the project by resource area. The desktop review was completed using publicly available data, as identified within each resource area subsection herein.

6.3.1 Biological Resources

The project location was reviewed for sensitive biological resources, including USFWS-designated critical habitat, special-status plant and wildlife species, and sensitive vegetation communities. The results of the review identified that there is no USFWS-designated critical habitat within 3 miles of the project location (USFWS 2020a). A query using the USFWS Information for Planning and Consultation (IPaC) dataset and critical habitat mapper indicated that seven federally listed species have the potential to occur within 3 miles of the project area, as listed in Table 6 (USFWS 2020b). The project is also within 3 miles of nine previously recorded California Natural Diversity Database (CNDDB) occurrences of listed plant and wildlife species, as shown on Figure 20 and in Table 6 (CDFW 2020).

Table 6. Listed Species within 3 miles

Species Name	Listing Status	Database Recorded
Pacific pocket mouse (*Perognathus longimembris pacificus*)	Federally Listed as Endangered	IPaC
Green turtle (*Chelonia mydas)*	Federally Listed as Threatened	CNDDB
Bank swallow (*Riparia riparia*)	State Listed as Threatened	CNDDB
Belding's savannah sparrow (*Passerculus sandwichensis beldingi)*	State Listed as Endangered	CNDDB
California least tern (*Sterna antillarum browni)*	Federally Listed as Endangered, State Listed as Endangered	IPaC
Coastal California gnatcatcher (*Polioptila californica californica*)	Federally Listed as Threatened	IPaC
Least Bell's vireo (*Vireo bellii pusillus*)	Federally Listed as Endangered, State Listed as Endangered	IPaC and CNDDB
Swainson's hawk (*Buteo swainsoni*)	State Listed as Threatened	CNDDB
Tricolored blackbird (*Agelaius tricolor*)	State Listed as Threatened	CNDDB
Western snowy plover (*Charadrius nivosus nivosus*)	Federally Listed as Threatened	IPaC
Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*)	Federally Listed as Threatened, State Listed as Endangered	CNDDB
California Orcutt grass (*Orcuttia californica*)	Federally Listed as Endangered, State Endangered	CNDDB
Salt marsh bird's-beak (*Cordylanthus maritimus* ssp. *maritimus*)	Federally Listed as Endangered, State Listed as Endangered	IPaC and CNDDB
Ventura marsh milk-vetch (*Astragalus pycnostachyus* var. *lanosissimus*)	Federally Listed as Endangered	IPaC



Sources:
1) ESRI World Street Map
2) California Department of Fish and Wildlife, Natural Diversity Database, accessed April 2020

Legend

Los Coyotes Proposed Pipeline

3-mile Project Buffer

CNDDB Occurrences

- Bank swallow
- Belding's savannah sparrow
- California Orcutt grass
- Green turtle
- Least Bell's vireo
- Salt marsh bird's-beak
- Swainson's hawk
- Tricolored blackbird
- Western yellow-billed cuckoo

Version: 5/21/2020

N

0 2.5 5
Miles

Figure 20
California Natural Diversity Database - T&E Occurrences within 3 Miles
Los Coyotes Pipeline Project
Water Replenishment District
Los Angeles County, California

Jacobs

\\galt\proj\WRD\W9Y23900\MapFiles\CNDDB_200413.mxd kgrant1 5/21/2020 2:29:06 PM

No suitable habitat for special-status species appears to be present within the project area. However, as design progresses, site-specific field surveys, including an evaluation of biological resources, should be conducted to confirm.

Potential habitat for nesting birds protected under the Migratory Bird Treaty Act is located in and around the project site. Potential nesting sites at this location include trees, shrubs, culvert eaves, and open (unpaved) ground. A preconstruction nesting bird survey is recommended within 1 week of mobilization to the site if construction is scheduled between January 1 and August 31.

During preconstruction surveys, buffers would be established around active bird nests if they are close to the work area. Work inside the buffer would be excluded until the nest is vacated. Alternatively, a biological monitor would be onsite to observe whether the birds are being disturbed by construction activity. If disturbed, the monitor could stop work until the birds have fledged. If other special-status wildlife species are observed in the work area, a qualified biologist would determine whether species removal, exclusion fencing, or work stoppage is required.

6.3.2 Cultural Resources

The project site is located within the existing Los Coyotes WRP, LVL AWTF, and San Gabriel River Channel. Based on the proposed alignment, ground-disturbing activities would likely be limited to areas within the existing facilities and excavations into undisturbed areas would not be conducted. For purposes of this preliminary desktop review, a comprehensive cultural resources literature search, including a search of the California Historical Resources Information System database, was not conducted. However, to support resource evaluation for an updated IS/MND, a cultural resources records search is recommended. Based on the results of the cultural resources records search and as determined by a cultural resources specialist, a field assessment may be required.

As with any ground-disturbing project, the potential exists for the accidental discovery of buried archaeological resources. If cultural resources or materials are discovered during ground-disturbing activities, work in the vicinity of the discovery should cease and the area should be protected until the find can be evaluated by a qualified archaeologist, as appropriate.

In addition, tribal consultation would need to be completed in accordance with guidelines on Assembly Bill 52 and Tribal Cultural Resources. Assembly Bill 52 consultation requirements went into effect on July 1, 2015. This would include a sacred land file search request to the Native American Heritage Commission to obtain a list of tribal contacts to consult with on the project. Notification to request tribal consultation would need to be sent to applicable tribal contacts, and tribal consultation meetings would be conducted, if requested.

6.3.3 Hazardous Materials

An evaluation of hazardous material regulatory data, including leaking underground storage tank cleanup, other cleanup program sites, and military and land disposal sites tracked through the GeoTracker and EnviroStor databases, was conducted for the project. Eight sites listed on GeoTracker and one site listed on EnviroStor are present within 1,000 feet of the project (SWRCB 2020; California Department of Toxic Substances Control 2020). All sites are closed or inactive except the Los Coyotes WRP, LVL AWTF, and one open leaking underground storage tank on the corner of South Street and Studebaker Road in Cerritos.

There is the potential for impacted soil or groundwater to be encountered on the site during construction. If groundwater or soil contamination is encountered, additional hazardous waste management measures, including characterization and appropriate handling and disposal in accordance with federal and state regulations, would be implemented.

6.3.4 Hydrology and Water Quality

Aquatic resources potentially falling under the jurisdiction of USACE, CDFW, or the Regional Board were identified through geographic information system analysis. The project follows the San Gabriel River Channel, which is maintained by LACFCD, and listed as a flood control project (that is, a USACE-regulated facility). According to the National Wetlands Inventory (NWI) and the National Hydrography Dataset (NHD) (USFWS 2020c; USGS 2020, respectively), seven additional riverine/canal features, including Coyote Creek, a tributary to the San Gabriel River that connects south of the project, five areas of freshwater emergent or forested wetlands, and 12 freshwater ponds are located in the vicinity of the project site, as shown on Figures 21a, 21b, and 21c.

- All riverine features except for the San Gabriel River Channel (R4SBCx) and Gridley Drain (R4SBAx) are located outside the proposed alignment and project area. The alignment follows the San Gabriel River Channel and crosses Gridley Drain, which drains to the San Gabriel River via three reinforced concrete pipes. Both the San Gabriel River Channel and Gridley Drain are maintained by LACFCD. It is not anticipated that the project would affect Gridley Drain. Impacts on the San Gabriel River Channel related to change in discharge were previously analyzed in the San Gabriel River Watershed Project to Reduce River Discharge in Support of Increased Recycled Water Reuse – Environmental Impact Report (ESA 2019, Section 6.2.2).
- The five freshwater emergent or forested or shrub wetland areas are located east of the project in El Dorado East Regional Park, north of LVL AWTF. These areas are not anticipated to be impacted by the project.
- The 12 freshwater ponds are located in surrounding parks near the project site and are also not anticipated to be impacted by the project.

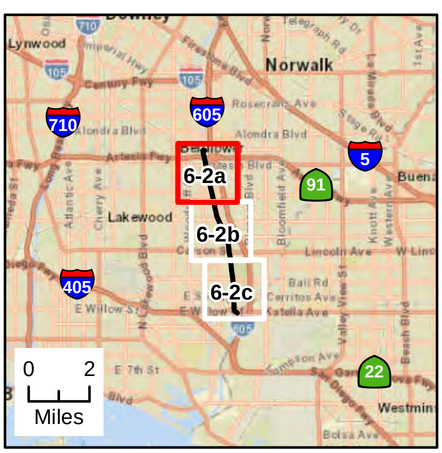
As design progresses, site-specific surveys, including a field delineation of wetland and water resources, should be conducted to confirm mapped National Wetlands Inventory and National Hydrography Dataset boundaries in relation to the project footprint, and to confirm if activities are within jurisdictional areas regulated by USACE, Regional Board, and CDFW.

6.3.5 Land Use

The project is located in Cerritos, Lakewood, and Long Beach in Los Angeles County, California. The project areas are zoned as Open Space or Automall/Restricted Commercial (Area Development Plan 5 for Cerritos Auto Square) in Cerritos, Open Space in Lakewood, and Park or Public ROW in Long Beach. The project areas are designated in municipal general plans as Utility and Flood Control in Cerritos, Open Space in Lakewood, and Open Space in Long Beach. Public utilities are permitted uses in all the existing zones; therefore, no discretionary land use permits are anticipated to be required.(City of Cerritos 2019a, 2019b; City of Lakewood 2017, 2018; City of Long Beach 2020a, 2020b)

Encroachment permits for work within city ROWs would be required.

The project would also need to abide by each municipality’s noise ordinances for construction unless an exemption is provided (see Section 6.3.8).



Version: 5/21/2020

Legend

Los Coyotes Proposed Pipeline

National Hydrography Dataset

Stream/River

Canal/Ditch

National Wetlands Inventory

Freshwater Emergent Wetland

Freshwater Forested/Shrub Wetland

Freshwater Pond

Riverine

N

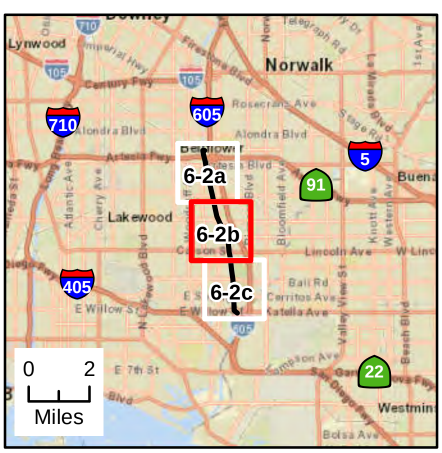
0 1,500 3,000

Feet

Figure 21a
National Wetlands Inventory and National Hydrography Dataset
Los Coyotes Pipeline Project
Water Replenishment District
Los Angeles County, California

Jacobs

\\galt\proj\WRD\W9Y23900\MapFiles\NWI_NHD_200413.mxd kgrant1 5/21/2020 2:23:57 PM



Version: 5/21/2020

Legend

Los Coyotes Proposed Pipeline

National Hydrography Dataset

Stream/River

Canal/Ditch

National Wetlands Inventory

Freshwater Emergent Wetland

Freshwater Forested/Shrub Wetland

Freshwater Pond

Riverine

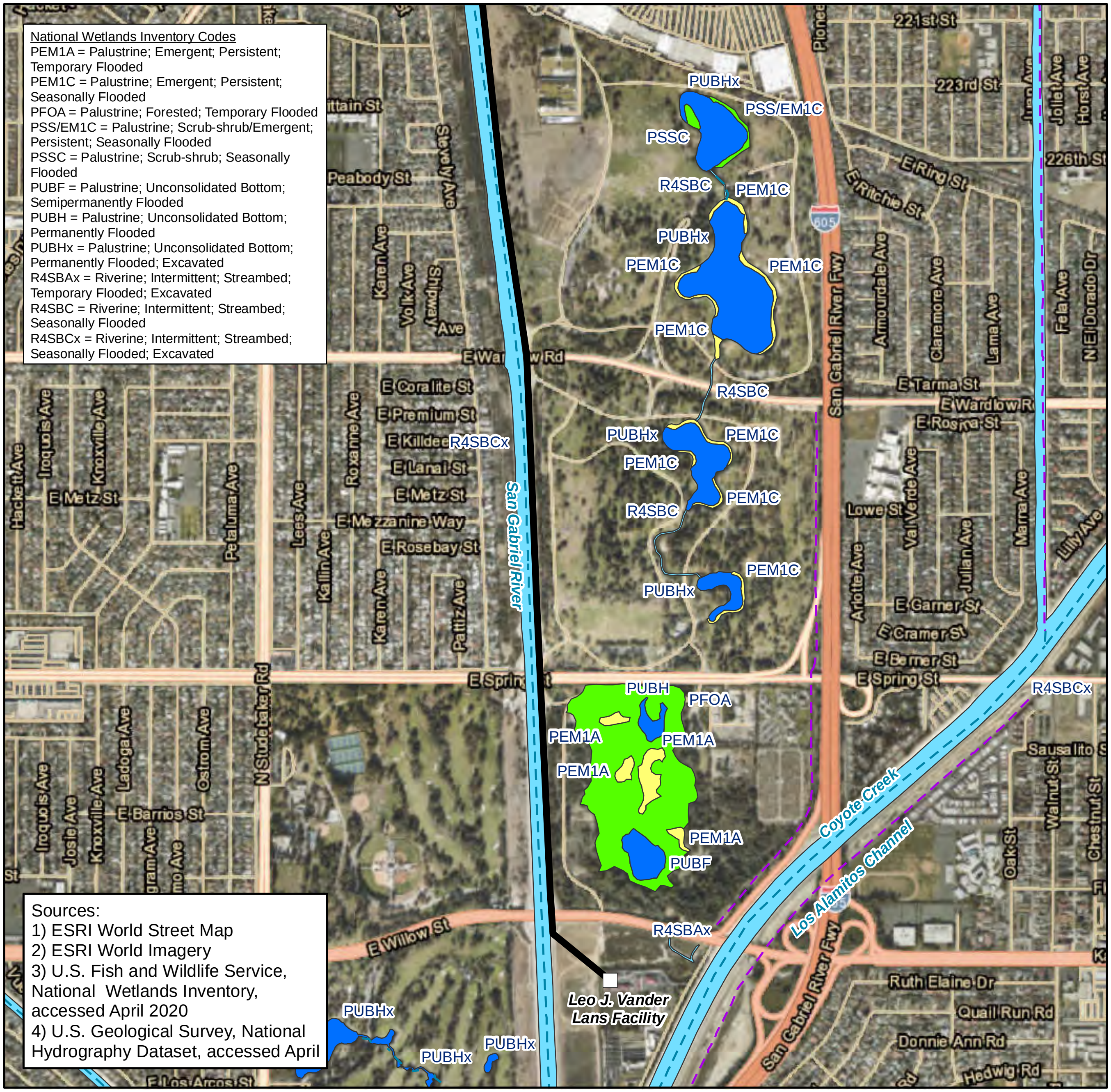
N

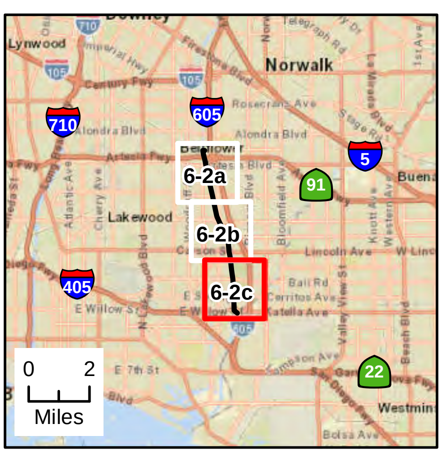
0 1,500 3,000
Feet

Figure 21b
National Wetlands Inventory and
National Hydrography Dataset
Los Coyotes Pipeline Project
Water Replenishment District
Los Angeles County, California

Jacobs

\\galt\proj\WRD\W9Y23900\MapFiles\NWI_NHD_200413.mxd kgrant1 5/21/2020 2:23:57 PM





Version: 5/21/2020

Legend

Los Coyotes Proposed Pipeline

National Hydrography Dataset

Stream/River

Canal/Ditch

National Wetlands Inventory

Freshwater Emergent Wetland

Freshwater Forested/Shrub Wetland

Freshwater Pond

Riverine

N

0 1,500 3,000

Feet

Figure 21c
National Wetlands Inventory and National Hydrography Dataset
Los Coyotes Pipeline Project
Water Replenishment District
Los Angeles County, California

Jacobs

\\galt\proj\WRD\W9Y23900\MapFiles\NWI_NHD_200413.mxd kgrant1 5/21/2020 2:23:57 PM

6.3.6 Recreation

Most of the recreation impacts caused by the proposed alignment is to the existing San Gabriel River Mid Trail bike path. The pipeline alignment traverses under the San Gabriel River Trail bike path until it reaches the LVL AWTF. As proposed by CDM Smith (2012a) in the draft IS/MND, a "detour, subject to approval by the Los Angeles County Parks and Recreation Department, of the San Gabriel River Trail shall be installed while any portion of the trail is closed for construction. Once construction is completed the bicycle path shall be restored to its original condition."

Numerous additional recreational facilities are located adjacent to both sides of the San Gabriel River Channel, including ten public parks, two golf courses, and another trail, as listed in Table 7. The proposed pipeline would traverse through the Iron-Wood Nine Golf Course from the Los Coyotes WRP to the San Gabriel River. Construction of the pipeline segment within the Iron-Wood Nine Golf Course would temporarily disrupt use of the portion of the golf course where the construction occurs. Full use of the facility would be available once construction of the pipeline segment was completed.

Table 7. Recreational Facilities near the Los Coyotes WRP Project

Recreational Facility	City	Approximate Distance to Project (in feet)[a]
Iron-Wood Nine Golf Course	Cerritos	0
San Gabriel River Trail	Cerritos	0
Bellflower Skate Park	Bellflower	210
Bellflower City Caruthers Park/Flora Vista Park	Bellflower	330
Westgate Park	Cerritos	170
Liberty Park	Cerritos	0
West San Gabriel River Parkway Nature Trail	Lakewood	180
Mae Boyar Park North	Lakewood	225
Mae Boyar Park South	Lakewood	160
Rynerson Park	Lakewood	0
Monte Verde Park	Lakewood	150
El Dorado East Regional Park	Long Beach	0
El Dorado West Regional Park	Long Beach	390
El Dorado Park Golf Course	Long Beach	390

[a] Distances are approximate based on the proposed alignment and do not include the construction zone, access routes, or temporary work areas.

The project is directly adjacent to Liberty Park, Rynerson Park, and El Dorado East Regional Park. Other nearby recreational facilities may experience noise, air quality, and visual impacts while construction is occurring, but with compliance with local noise and air quality ordinances, user experience impacts are anticipated to be minimal and temporary.

6.3.7 Air Quality

The San Gabriel River Channel and the project route is lined with numerous sensitive receptors to air quality impacts, including recreational and residential areas. As described in Section 6.3.6, 14 recreational facilities are adjacent to the San Gabriel River Channel. On the north end of the project, more than 60 residences border the San Gabriel River Channel within 250 feet of the project. These sensitive receptors may experience air quality impacts related to construction activities.

The project is located within the jurisdiction of the SCAQMD. The SCAQMD regulates emissions through the Permit to Construct/Operate, which may be required for construction and operations of treatment plant equipment and power generation equipment, including emergency backup power generation equipment. Additionally, air quality is regulated through Rule 401, 402, and 403 of the SCAQMD Rule Book for visible emissions, nuisance, and fugitive dust (SCAQMD 2020a). The SCAQMD also has identified multiple mitigation measures and BMPs to limit impacts related to fugitive dust, greenhouse gases, and on- and off-road engines (SCAQMD 2020b). With compliance with SCAQMD rules and implementation of standard construction BMPs, air quality impacts are anticipated to be minimal and temporary.

6.3.8 Noise

Noise impacts are anticipated to potentially occur on the nearby sensitive recreational and residential receptors that border the San Gabriel River Channel and the project. Noise is regulated by each municipality. The City of Cerritos limits construction activities to Monday through Friday between 7 a.m. and 6 p.m. and Saturday between 10 a.m. and 5 p.m. (City of Cerritos 2020). The City of Lakewood limits construction activities to Monday through Saturday between 7 a.m. and 7 p.m. and Sunday between 9 a.m. and 7 p.m. (City of Lakewood 2002). The City of Long Beach limits construction activities to Monday through Friday between 7 a.m. and 7 p.m. and Saturday between 9 a.m. and 6 p.m. (City of Long Beach 2020c).

With compliance with local noise regulations, noise impacts are anticipated to be minimal and temporary.

6.3.9 Other Resources

The project is not anticipated to significantly impact other environmental resources, including aesthetics, agriculture and forestry resources, energy, geology and soils, greenhouse gas emissions, mineral resources, population and housing, public services, transportation, utilities and service systems, and wildfire.

6.4 Permitting and Environmental Conclusions and Next Steps

The following are the key results of the evaluation and recommendations from the permitting and environmental review:

- An encroachment permit from LACFCD would be required for work within the flood control district easement. This is expected to trigger Section 408 Review, which would require 1 to 2 years to process, including NEPA review and agency consultation.
- An updated environmental analysis pursuant to CEQA and NEPA would need to be prepared. The NEPA review would generally be focused to support issuance of the Section 408 permit and could follow a streamlined process. It is anticipated that WRD would be the CEQA lead agency, and that USACE would be the NEPA lead agency.

- As currently proposed, project activities would not likely result in conditions subject to a CWA Section 404 permit or a Section 401 WQC. If engineering constraints require the project footprint to extend into the slope of the San Gabriel River Channel, specifically within the regulated OHWM, the project would likely require a nationwide permit (NWP 12 Utility Line Activities) under Section 404 from USACE and a Section 401 WQC from the Regional Board. Potential USACE and Regional Board jurisdictional impacts would be determined following a more advanced project design. See the note in Section 6.2.1.2 regarding the April 15, 2020 invalidation of USACE NWP 12 by a U.S. District Court Judge.
- On April 2, 2019, the SWRCB adopted the State Wetland Definition and Procedures for Discharges of Dredged or Fill Material to Waters of the State. The procedures, which were revised on April 6, 2021, require additional consideration of impacts on Waters of the State over and above recent Section 401 WQC requirements.
- The project may require a Streambed Alteration Agreement from CDFW for activities within the bed or banks of the San Gabriel River. Potential CDFW jurisdictional impacts would be determined following a more advanced project design.
- Additional analysis and consultation with each agency are recommended to determine additional potential permitting constraints associated with the project design and permitting process.
- Updated site-specific studies, including a wetland delineation and biological resources survey, should be conducted, as needed, to identify project-specific impacts and additional potential impact avoidance measures via design alterations or changes in construction methods.

7. Estimated Project Cost

7.1 Pump Station Project Cost Estimate

The Opinion of Probable Construction Cost Estimate for the proposed pump station was prepared by CDM Smith in April 2012. The overall construction cost was estimated to be $2,641,891. According to the Pump Station PDR, the cost estimate included all modifications to existing facilities and improvements required for the fully operational pump station using a Class 4 estimating approach.

Jacobs reviewed the Opinion of Probable Construction Cost Estimate prepared by CDM Smith in April 2012. The cost of each line item is verified against the quantities shown on the cost estimate. The cost for instrumentation and control appeared to be low based on Jacobs' historical averages. The quantities shown on the cost estimate are not compared with the quantities shown on the drawings. The instrumentation and control cost is adjusted to reflect current historical averages and then the overall proposed cost estimate is escalated from April 13, 2012, to May 12, 2020, including the construction duration of 54 months. The cost estimate escalated from $2,641,891 to $3,405,000, as shown in Table 8, with the low and high ranges of -30 to +50%.

Table 8. Overall Escalated Cost

Low Range (-30%)	Estimated Cost	High Range (+50%)
$2,384,000	$3,405,000	$5,108,000

Note:

The impacts of the COVID-19 pandemic on the construction industry are not known at this time and will likely have affect the costs presented.

The proposed estimate is presented in the Unit Price Detail level. A detailed independent estimate was not prepared for a comparison. Refer to the original estimate prepared by CDM Smith for any assumptions or items that are included or excluded from this estimate.

A trench-style intake is a viable option that would be similar in construction cost to that shown in the Pump Station PDR for the proposed intake design.

7.2 Pipeline Project Cost Estimate

The pipeline construction cost presented in the Pipeline PDR was estimated at $14.7 million (in April 2012 dollars). As part of this task, the pipeline construction cost estimate was updated to incorporate current pipe material and anticipated installation costs using material quotes and estimates from other similar recent projects in Southern California. As indicated in the previous section, the trenchless installation length required for the project was increased by 600 feet to account for the crossing of SR 91 and the Metro ROW. The estimate presented in this TM assumes that Alignment 1 will be approved by the LACFCD and USACE, and it will remain the preferred alternative moving forward. The estimate is a capital construction cost and does not account for costs associated with design, permitting, or engineering services during construction.

7.2.1 Pipeline Preliminary Design Report Cost Estimate

The pipeline cost estimate presented in the Pipeline PDR is shown in Table 9.

Table 9. Summary of Opinion of Probable Construction Cost

Pipeline			
Description	Amount (in 2020 dollars)	Rate (in %)	Totals
Labor	$1,310,129		
Material	$4,956,883		
Equipment	$874,114		
Subcontract	$832,032		
Other	$7,059		
Subtotal	$7,980,217		
Maintenance of traffic allowance	$399,011	5.00	$8,379,228
General conditions	$837,923	10.00	$9,217,151
Building permits	$92,172	1.00	
Sales tax	$510,830	8.75	
Subtotal	$603,001		$9,820,152
Construction contingency	$2,455,038	25.00	$12,275,190
Contractor total overhead and profit	$1,227,519	10.00	$13,502,709
Builder's risk insurance	$29,469	0.20	

Table 9. Summary of Opinion of Probable Construction Cost

Pipeline			
Description	**Amount (in 2020 dollars)**	**Rate (in %)**	**Totals**
General liability insurance	$147,346	1.00	
General contractor bonds	$221,019	1.50	
Subtotal	$397,834		$13,900,543
Escalation to midpoint of construction	$834,033	6.00	
Total			$14,734,575

Source: Adapted from CDM Smith 2012b, Table 14-1.

The pipeline material included as part of the estimate was not specifically stated in the Pipeline PDR. The Pipeline PDR suggests that the pipe material is out of the author's control and states that actual bids may result in a variety of pipeline materials. For the purposes of this study, pipe material and installation costs are assumed based on the use of HDPE pipe as the baseline condition and are used as a comparison to the use of WSP.

7.2.2 Los Coyotes Pipeline Cost Estimate

The total length of Alignment 1 indicated in the Pipeline PDR is 29,780 linear feet. Approximately 1,540 feet are anticipated to be constructed via a trenchless installation method, with the remainder installed via open trench construction.

The unit costs for pipe material and installation from the LADWP's Trunk Line Design Group Design Manual: A Guide to the Management, Design and Construction Support of Trunk Line Design Projects (LADWP 2019) states the following unit cost assumptions:

- WSP material cost is estimated from $12 to $15 per diameter-inch per linear foot (dia-in/lf) for pipelines ranging in size from 30 to 96 inches with cement mortar lining, cement mortar coating, and a wall thickness of 0.5 inch. In a separate effort, Jacobs obtained a unit cost of $12 per dia-in/lf for steel pipe from a recent (2020) price quote from the largest steel pipe supplier in the western United States. Because these two sources correlate to similar unit costs, it is assumed for the purposes of this estimate that a cost of $12 per dia-in/lf would suffice since the diameter and wall thickness for the Los Coyotes WRP pipeline will be smaller than the assumptions used by LADWP, and as a result, would provide a basis for a conservative estimate.
- Open-cut pipe installation is estimated by LADWP to range from $20 to $25 per dia-in/lf. This results in a total construction unit cost (when combined with the pipe material unit cost) ranging from $32 to $37 per dia-in/lf. Typically, conceptual level unit costs for steel pipe construction in an urban environment can be expected to be in the $25 per dia-in/lf range. This unit cost is based on recent (2020) pricing that Jacobs observed for a steel pipeline construction project in another urban center within the western United States. Although the current Engineering News-Record Construction Cost Index for Los Angeles is approximately 5% higher than the national Construction Cost Index, it is not unreasonable to see a larger increase for pipeline construction in Los Angeles compared to many other areas in the country. Using a $32 per dia-in/lf unit cost compared to a $25 per dia-in/lf unit

cost, which results in a 28% increase, seems conservatively reasonable considering that pipe material, labor, equipment costs, and contractor markups would be higher in the greater Los Angeles area than in most other places.

- Cost for pipe jacking or microtunneling is estimated by LADWP to range from $80 to 100 per dia-in/lf.

The overall estimate could be considered conservatively high because many of the installation assumptions in an urban environment assume traffic control and utility congestion, both of which are prevalent for typical pipeline construction in Los Angeles. However, the utility congestion within Alignment 1 is minimal, and the main element of traffic control anticipated to be required during construction would be to detour bicyclists and pedestrians.

LADWP also applies a 50% contingency for designs that are at least 30% complete. This is consistent, although more conservative, with the recommendations of the Association for the Advancement of Cost Engineering International for Class 4 cost estimates, which are defined as study or planning level estimates where project definition and design is between 1% and 15% complete. Because there is some conservatism built into the previously noted construction cost, Jacobs recommends using a 40% contingency at this stage of the project. At the 30% design level, Jacobs recommends using a 30% contingency, followed by a 20% contingency at 90% design, and a 10% contingency during 100% design.

A unit cost for HDPE pipe of $5.96 per dia-in/lf was determined based on a pipe material quote for ductile iron pipe size, dimension ratio 11, PE4710 HDPE pipe received from one of the largest HDPE pipe suppliers in the United States and typical contractor markups expected in Southern California. An installation cost for HDPE pipe was obtained through recent (2020) construction cost estimates for similar HDPE pipe installations in Southern California, resulting in a pipe installation cost (including contractor markups, but excluding pipe material cost and contingency) of $11.03 per dia-in/lf. The total all-in construction cost using HDPE pipe and including contingency is estimated at $23.79 per dia-in/lf.

An open-face rotary tunnel boring machine is recommended and assumed at this stage of the project for trenchless installations. The cost to install a 48-inch-diameter steel casing for a 24-inch-diameter pipeline is $75 per dia-in/lf based on recent project costs of similar trenchless installations.

Table 10 shows the updated total pipeline construction cost estimate for HDPE pipe, as well as a percent-cost increase for WSP and a comparison against the cost estimate presented in the Pipeline PDR.

Table 10. Pipeline Construction Cost Estimates

24-inch Pipeline Cost Estimates			
HDPE Pipe	**WSP Cost Percent Increase Relative to HDPE Pipe**	**Pipeline PDR Estimate (2012 Dollars)**	**Pipeline PDR Estimate (May 2020 Dollars)**
$20,004,000	76%	$14,734,575	$17,279,277

Note:

The impacts of the COVID-19 pandemic on the construction industry are not known at this time and will likely have some impact on the costs presented.

The opinion of probable construction cost for the conceptual design of Alignment 1 of the Los Coyotes WRP pipeline, assuming HDPE pipe is used, is $20 million. If WSP is used instead of HDPE pipe, the construction cost is anticipated to increase by 76%. This is expected because WSP typically provides more value with larger pipe sizes as opposed to a 24-inch diameter pipe.

As a Class 4 estimate, this cost is generally prepared based on limited information and subsequently has a wide accuracy range. This level of estimate is typically used for project screening; determination of economic or technical feasibility, or both; concept evaluation; and preliminary budget approval. The Pipeline PDR utilized an estimating class of Class 4; therefore, it is utilized for the pipeline cost estimate here. As previously mentioned, the level of project definition is usually 1% to 15% complete and is defined by the Association for the Advancement of Cost Engineering International as 15 to 30% on the low side, and 20 to 50% on the high side, as summarized in Table 11.

Table 11. HDPE Pipe Estimate Range

Low Range (-30%)	Estimated Cost	High Range (+50%)
$14,003,000	$20,004,000	$30,006,000

Note:

The impacts of the COVID-19 pandemic on the construction industry are not known at this time and will likely have some impact on the costs presented.

7.3 Storage Unit Cost Estimate

Typical preliminary level unit cost assumptions used to price above-ground prestressed concrete circular tanks is $1 per gallon. Construction costs for buried cast-in-place concrete installations usually range 20 to 40% higher. Facility siting, available space, and considerations of above-ground versus buried tanks will need to be determined to fine-tune cost assumptions moving forward.

8. Summary of Conclusions and Recommended Next Steps

Based on the review and analysis discussed in Sections 3, 4, 5, and 6, the conclusions and recommended next steps are summarized in this section.

8.1 Effluent Flow Analysis Conclusions and Recommended Next Steps

The following are the conclusions and recommendations from the effluent flow analysis:

- Flow data for 2015 to 2019 from the Los Coyotes WRP suggest that LVL AWTF could be supplied with 8.7 MGD from the Los Coyotes WRP 76% of the time. If LVL AWTF could adjust the production rate, use the current 0.18 MG of available storage, and be turned on and off multiple times during the day, the plant average annual inflow could reach 8,800 AFY (that is, 90% of plant capacity).
- An 8.7-MGD plant and the current 0.18 MG of equalization storage could provide an average of 6,100 AFY of LVL AWTF inflows; however, this condition assumes the plant will be able to quickly adjust production rate to match plant inflows. This analysis should be refined based on actual plant flow adjustment capabilities.
- The addition of system storage between 1 and 2 MG could increase average LVL AWTF inflows to between 8,400 to 9,200 AFY.

- Storage volumes greater than 1 to 2 MG (depending on the scenario) will have less of an impact on the additional average LVL AWTF inflow to the plant and will be used less than 20% of the time. A cost analysis and assessment of site availability to build storage should be conducted to determine the optimal size of storage.
- It is not clear how flexible the LVL AWTF can be regarding flow and daily plant operations. A better understanding of these limitations could help identify the storage size needed.

8.2 Pump Station Conclusions and Recommended Next Steps

The following are the conclusions and recommendations from the Pump Station PDR review:

- The pump station intake design is not in compliance with ANSI/HI 9.8-2018. It is recommended that the pump wet well be redesigned to comply with HI Standards recommendations. A trench-style intake compliant with ANSI/HI, as shown on Figure 15, is a viable option that would be similar in construction cost to that shown in the Pump Station PDR for the proposed intake design.
- The recommended vertical turbine pumps by Goulds (Model 18LHC) can deliver the maximum design flow of 10 MGD, as discussed in the Pump Station PDR. However, these pumps cannot meet an additional demand to deliver the maximum design flow of 10.5 MGD. It is recommended to further evaluate pump selections for possibly better pump hydraulic performance, equipment longevity, and energy savings.
- It is recommended to re-evaluate the use of variable frequency drives for this project.
- It is recommended to further investigate the type and size of the new and existing control valves for all hydraulic conditions during final design.
- There is inadequate information to determine whether the surge analysis correctly identifies the potential surge characteristics and whether the proposed mitigation is adequate. There were some discrepancies in the documentation, such as the friction factor and valve closing times. It also appears that the surge analysis was performed for an assumed pump selection that is different from the currently selected pumps. The current surge analysis should not be considered adequate for developing the appropriate mitigation alternatives, and a new surge analysis should be performed using the proposed pump selection.

8.3 Pipeline Conclusions and Recommended Next Steps

The following are the conclusions and recommendations from the Pipeline PDR technical review:

- A nominal pipeline diameter of 24 inches is appropriate for the Los Coyotes WRP pipeline.
- Coordination with LACFCD and USACE will be required to determine whether Alignment 1 is feasible and permittable under the project schedule, and whether HDPE pipe can be used for the project.
- Coordination with Caltrans and Metro is also required to determine the necessary permits and technical requirements for the crossings of SR 91 and the Metro ROW, respectively.
- As final design begins, the method of trenchless installation and the extents of open-cut trench work areas within the San Gabriel River Levee will need to be determined to facilitate coordination with each of the aforementioned agencies.
- If Alignment 1 is not determined to be permittable, a new preferred alignment will need to be determined as quickly as possible to prevent delays.

8.4 Permitting and Environmental Next Steps

The following are the key results of the evaluation and recommendations from the permitting and environmental review:

- An encroachment permit from LACFCD would be required for work within the flood control district easement. This is expected to trigger Section 408 Review, which would require 1 to 2 years to process, including NEPA review and agency consultation.
- An updated environmental analysis pursuant to CEQA and NEPA would need to be prepared. The NEPA review would generally be focused to support issuance of the Section 408 permit and could follow a streamlined process. It is anticipated that WRD would be the CEQA lead agency, and that USACE would be the NEPA lead agency.
- As currently proposed, project activities would not likely result in conditions subject to a CWA Section 404 permit or a Section 401 WQC. If engineering constraints require the project footprint to extend into the slope of the San Gabriel River Channel, specifically within the regulated OHWM, the project would likely require a nationwide permit (NWP 12 Utility Line Activities) under Section 404 from USACE and a Section 401 WQC from the local RWQCB. Potential USACE and RWQCB jurisdictional impacts would be determined following a more advanced project design. See the note in Section 6.2.1.2 regarding the April 15, 2020 invalidation of USACE NWP 12 by a U.S. District Court Judge.
- On April 2, 2019, the SWRCB adopted the State Wetland Definition and Procedures for Discharges of Dredged or Fill Material to Waters of the State. The procedures, which were revised on April 6, 2021, require additional consideration of impacts on Waters of the State over and above recent Section 401 WQC requirements.
- The project may require a Streambed Alteration Agreement from CDFW for activities within the bed or banks of the San Gabriel River. Potential CDFW jurisdictional impacts would be determined following a more advanced project design.
- Additional analysis and consultation with each agency are recommended to determine additional potential permitting constraints associated with the project design and permitting process.
- Updated site-specific studies, including a wetland delineation and biological resources survey, should be conducted, as needed, to identify project-specific impacts and additional potential impact avoidance measures via design alterations or changes in construction methods.

9. References

American National Standards Institute/Hydraulic Institute (ANSI/HI). 2014. Standard 2.4. 2014. *Rotodynamic Vertical Pumps for Manuals Describing installation, Operation, and Maintenance.*

American National Standards Institute/Hydraulic Institute (ANSI/HI). 2018. Standard 9.8. *Rotodynamic Pumps for Pump Intake Design*.

California Department of Fish and Wildlife (CDFW). 2019. *Notification of Lake of Streambed Alteration: Notification Instructions and Process.* Accessed April 2020. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=3773&inline.

California Department of Fish and Wildlife (CDFW). 2020. *CNDDB Maps and Data*. Accessed April 2020. https://www.wildlife.ca.gov/Data/CNDDB/Maps-and-Data.

California Department of Toxic Substances Control. 2020. EnviroStor. https://www.envirostor.dtsc.ca.gov/public/. Accessed April 2020.

California State Water Resources Control Board (SWRCB). 2020. GeoTracker. https://geotracker.waterboards.ca.gov/. Accessed April 2020.

CDM Smith. 2012a. *Final Design for the Expansion of the Leo J. Vander Lans Water Treatment Facility for the Water Replenishment District of Southern California, Pump Station Preliminary Design Report*. Final. June 28.

CDM Smith. 2012b. *Final Design for the Expansion of the Leo J. Vander Lans Water Treatment Facility for the Water Replenishment District of Southern California, Pipeline Preliminary Design Report*. August 13.

CDM Smith. 2013. *Amended Title 22 Engineering Report for the Leo J. Vander Lans Water Treatment Facility Expansion: Alamitos Barrier Recycled Water Project*. Prepared for Water Replenishment District of Southern California. March 29.

CH2M HILL. 2011. *Preliminary Design Report for the Expansion of the Leo J. Vander Lans Water Treatment Facility*. July 2011.

City of Cerritos. 2019a. *City of Cerritos General Plan Land Use Map* [map]. Updated December 16, 2019. Accessed April 2020. http://www.cerritos.us/BUSINESSES/_pdfs/zoning_map.pdf.

City of Cerritos. 2019b. *City of Cerritos Zoning Map* [map]. Updated December 16, 2019. Accessed April 2020. http://www.cerritos.us/BUSINESSES/_pdfs/zoning_map.pdf.

City of Cerritos. 2020. *Planning and Building Permits*. Updated June 3, 2020. Accessed September 2020. http://www.cerritos.us/BUSINESSES/planning_and_building_permits.php.

City of Lakewood. 2002. *Lakewood Municipal Code Section 8019*. Accessed September 2020. http://weblink.lakewoodcity.org/WebLink/DocView.aspx?id=68349&dbid=0&repo=CityofLakewood.

City of Lakewood. 2017. *City of Lakewood General Plan* [map]. Updated February 2017. Accessed April 2020. https://www.lakewoodcity.org/civicax/filebank/blobdload.aspx?BlobID=22728.

City of Lakewood. 2018. *City of Lakewood Zoning Designations* [map]. Updated October 2018. Accessed April 2020. https://www.lakewoodcity.org/civicax/filebank/blobdload.aspx?BlobID=22744.

City of Long Beach. 2020a. Land Use District Maps. Accessed April 2020. http://www.longbeach.gov/lbds/planning/advance/maps/land-use-district-maps2/.

City of Long Beach. 2020b. Zoning Maps. Accessed April 2020. http://www.longbeach.gov/lbds/planning/advance/maps/zoning/.

City of Long Beach. 2020c. *Construction Noise*. Accessed September 2020. http://www.longbeach.gov/lbds/building/inspection/construction-noise/.

Environmental Science Associates (ESA). 2019. *San Gabriel River Watershed Project to Reduce River Discharge in Support of Increased Recycled Water Reused – Environmental Impact Report*. State Clearinghouse Number 2018071021. Prepared for Sanitation Districts of Los Angeles County. Draft. August. Accessed April 2020. https://ceqanet.opr.ca.gov/2018071021/3.

Federal Aviation Administration (FAA). 2020. *Obstruction Evaluation / Airport Airspace Analysis (OEAAA)*. Accessed April 2020. https://oeaaa.faa.gov/oeaaa/external/gisTools/gisAction.jsp.

Los Angeles County Department of Public Works (LACDPW). 2020. *Flood Control District Permits*. Accessed April 2020. https://pw.lacounty.gov/ldd/lddservices/floodpermits.shtml.

Los Angeles County Sanitation Districts (LACSD). 1983. *Contract Drawings for the Los Coyotes Water Reclamation Plant City of Cerritos Reclaimed Water Pump Station*. January 1983.

Los Angeles Department of Water and Power (LADWP). 2019. *Trunk Line Design Group Design Manual: A Guide to the Management, Design and Construction Support of Trunk Line Design Projects*. April.

RMC, Woodard & Curran, and KEH. 2017. *WRD Hydraulic Analysis, Operational Efficiencies, and Optimization Alternative Study: Task 3 – Alternative Evaluation for Long Term Operations*. July.

South Coast Air Quality Management District (SCAQMD). 2020a. *South Coast AQMD Rule Book/ Regulation IV – Prohibitions*. Accessed September 2020. http://www.aqmd.gov/home/rules-compliance/rules/scaqmd-rule-book/regulation-iv.

South Coast Air Quality Management District (SCAQMD). 2020b. *Mitigation Measures and Control Efficiencies*. Accessed September 2020. http://www.aqmd.gov/home/rules-compliance/ceqa/air-quality-analysis-handbook/mitigation-measures-and-control-efficiencies.

U.S. Army Corps of Engineers (USACE). 2018a. *Water Resources Policies and Authorities: Policy and Procedural Guidance for Processing Requests to Alter US Army Corps of Engineering Civil Works Projects Pursuant to 33 USC 408*. EC 1165-2-220. Accessed April 2020. https://www.publications.usace.army.mil/Portals/76/Users/227/19/2019/EC_1165-2-220.pdf?ver=2018-09-13-114714-120.

U.S. Army Corps of Engineers (USACE). 2018b. S*trategy for Synchronization of the Regulatory and 408 Programs*. DPM CW 2018-10. Accessed April 2020. https://planning.erdc.dren.mil/toolbox/library/MemosandLetters/DPM%20CW%202018-10.pdf.

U.S. Army Corps of Engineers (USACE). 2020. *Section 408 Permitting Information*. Accessed April 2020. https://www.spl.usace.army.mil/Missions/Section-408-Permits/.

U.S. Geological Survey (USGS). 2020. National Hydrography. http://nhd.usgs.gov/. Accessed April 2020.

U.S. Fish and Wildlife Service (USFWS). 2020a. ECOS Environmental Conservation Online System. *USFWS Threatened & Endangered Species Active Critical Habitat Report*. Accessed April 2020. https://ecos.fws.gov/ecp/report/table/critical-habitat.html.

U.S. Fish and Wildlife Service (USFWS). 2020b. Information for Planning and Consultation. Accessed April 2020. http://ecos.fws.gov/ipac/.

U.S. and Wildlife Service (USFWS). 2020c. National Wetlands Inventory. https://www.fws.gov/wetlands/data/data-download.html. Accessed April 2020.

Water Replenishment District of Southern California (WRD). 2020. *Other Projects and Programs*. May 2020. https://www.wrd.org/content/other-projects-and-programs.

Appendix G
TM 6.1.1-Phase 2 Groundwater Modeling

Memorandum

1000 Wilshire Boulevard, Suite 1140
Los Angeles, California 90017
United States
T +1.213.538.1388
F +1.230.538.1399
www.jacobs.com

Subject	**Technical Memorandum 6.1.1 – Phase 2 Groundwater Modeling-Hyperion WRP Project – Final**
Project Name	WRD and LADWP Joint Los Angeles Basin Replenishment and Extraction Master Plan
Date	March 7, 2022 (Revised)

1. Introduction

The Water Replenishment District of Southern California (WRD) and the Los Angeles Department of Water and Power (LADWP) have initiated a partnership to identify solutions to maximize use of the Central Basin and West Coast Basin through the development of the Joint Los Angeles Basin Replenishment and Extraction Master Plan (Joint Master Plan). Figure 1.1a provides an overview of the project area in the context of the different components of the Joint Master Plan. The Joint Master Plan uses a regional approach to identify a comprehensive list of existing and potential new replenishment water sources, treatment facilities, and replenishment and extraction locations, herein referred to as "project components," as described in Technical Memorandum (TM) 1 (Appendix A).

The Joint Master Plan document is a compilation of several TMs that were prepared through the various stages of the plan. Summaries of the TMs relevant to this TM are as follows:

- TM 1 – Identification of System Components (Appendix A)

  TM 1 documented the process for identifying a comprehensive list of all potential replenishment sources, treatment locations, replenishment locations, and extraction locations. A set of defined criteria were used to identify the most feasible components to carry forward as projects to consider in the Joint Master Plan. The TM concludes with a final list of project components to be considered; a list of project components that were not recommended; the criteria used to determine projects that would not be recommended; and a matrix grouping the different individual projects from the supply, treatment, replenishment, and extraction project component groups into single projects that could be evaluated.

- TM 2 – Project Concept Development and Selection (Appendix B)

  The system components identified in TM 1 were used to develop 30 Project Concepts and Add-on Projects. These Project Concepts were initially screened based on overall feasibility and discussion among WRD, LADWP, and Jacobs. After screening, 17 Project Concepts were selected, having been scored and ranked in an iterative process to collaboratively determine which projects should be selected for further project development and serve as the overall recommended projects in the Joint Master Plan.

- TM 3.1 – Basis of Project Development (Appendix C)

  TM 3.1 describes the basis of project development and key assumptions to be used in subsequent development of the Hyperion Water Reclamation Plant (WRP) Project and the Los Coyotes WRP Project that were selected after the screening process described in TM 2. A simplified Water Balance Model was developed for Hyperion WRP Project with the goal of running many different scenarios that required different basin operations. The Water Balance Model scenarios were created in conjunction with WRD and LADWP.

- TM 3.2.1 – Phase 1 Groundwater Modeling Results (Appendix D)

  TM 3.2.1 documents results of Phase1 groundwater modeling conducted to evaluate hydrogeologic feasibility of the injection and extraction wellfield locations. Groundwater modeling inputs were based on the water balance model scenarios developed in TM 3.1. A summary of the results is provided in Section 1.1 of this TM.

The Hyperion WRP Project focuses on maximizing the use of Hyperion WRP flows and advanced treatment for groundwater replenishment. The project components include conveyance pipelines and injection and extraction in the Central Basin (Figure 1.1b), The project also considered additional injection along the West Coast Basin Barrier, additional surface spreading at the Montebello Forebay, and connection to the Metropolitan Water District of Southern California's proposed Regional Recycled Water Program (RRWP) Backbone pipeline (Figure 1.1a).

Groundwater modeling was undertaken in two phases to evaluate the hydrogeologic feasibility of potential groundwater injection and extraction components of the Hyperion WRP Project. Phase 1 groundwater modeling evaluated several conceptual areas for potential groundwater replenishment and augmentation with volumes provided by a regional Water Balance Model developed by Jacobs (documented in TM 3.1,Appendix C). Phase 2 further refined this analysis to examine more specific wellfield locations and incorporated alternative wellfield locations and additional considerations such as parcel availability, groundwater quality impacts, and recycled water recharge permitting requirements.

This TM documents the results of Phase 2 groundwater modeling. Groundwater modeling performed as part of Phase 2 builds upon the Phase 1 preliminary groundwater modeling, documented in TM 3.2.1 (Appendix D). Under Phase 2, preliminary wellfield locations evaluated during Phase 1 were refined to identify the hydrogeologic feasibility of preliminary injection and extraction locations that also met additional regulatory, permitting, and basin-management criteria. These additional criteria in Phase 2 modeling included:

- State Water Resources Control Board (SWRCB) Code of Regulations, Title 22, Article 5.2 residence time requirements for recycled water recharge
- Material Physical Harm (MPH)[1] assessments to meet Central Basin adjudication requirements

[1] MPH is defined under the Central Basin adjudication as *"…material physical injury or a material diminution in the quality or quantity of groundwater available within the Basin to support extraction of Total Water Rights or Stored Water, that is demonstrated to be attributable to the placement, recharge, injection, storage or recapture of Stored Water in the Central Basin, including, but not limited to, degradation of water quality, liquefaction, land subsidence and other material physical injury caused by elevated or lowered groundwater levels. Material Physical Harm does not include "economic injury" that results from other than direct physical causes, including any adverse effect on water rates, lease rates, or demand for water. Once fully mitigated, physical injury shall no longer be considered to be material."* (*Superior Court of California* 2013)

Furthermore, INTERA collaborated with Epic Land Solutions, Inc. (Epic) to identify underutilized and accessible land parcels near Phase 2 wellfield areas that could be used to site new injection and extraction wells. These parcels are located between Western Avenue and Interstate 710, and between Slauson Avenue and South Manchester Avenue (Figure 1.1b). The groundwater modeling was subsequently refined to evaluate the number of wells that could be placed on each parcel. Potential wellfield configurations were developed for the injection and extraction wells considering well interference, parcel size and access, and drilling and construction constraints. The wellfield locations identified during Phase 2 modeling also form the basis for a work plan for installation of pilot injection wells, prepared concurrently as TM 6.1.2 (Appendix H).

1.1 Summary of Phase 1 Modeling

Groundwater modeling performed during Phase 1 was based on inputs from the Water Balance Model developed specifically to identify and evaluate the different Hyperion WRP Project components. TM 3.1 documented the procedure and assumptions for development and evaluation of the Hyperion WRP Project components (Appendix C). With input from WRD and LADWP, seven scenarios were developed to assess the feasibility of different project alternatives.

The Water Balance Model processed individual scenario data into a time series of volumes associated with each of the different replenishment, injection, extraction, and water transfer components, subject to the respective adjudication pumping, storage, and carryover rules in the Central and West Coast Basins. Attachment 1 provides a summary of the scenarios and the respective components. The different Water Balance Model components (Hyperion advanced treated water volumes for LADWP injection wells, water for recharge to the West Coast Basin Barrier, Albert Robles Center for Water Recycling and Environmental Learning facility, and Montebello Forebay, as well as extraction volumes for LADWP and other basin pumping, including for the Regional Brackish Water Reclamation Program) were mapped to corresponding model inputs as described in TM 3.1 (Appendix C) and summarized in Tables 1 and 2 (see Section 2 for discussion). The primary objective of Phase 1 groundwater modeling was to evaluate the hydrogeologic feasibility of preliminary injection and extraction areas, and scenario-specific injection and extraction volumes.

The Groundwater Model used for Phase 1 and Phase 2 is the Los Angeles Coastal Plain Groundwater Model (LACPGM), recently developed by the U.S. Geological Survey (USGS) (Paulinski 2021). The LACPGM is a regional model that comprises four groundwater basins including the Central and West Coast Basins. The LACPGM was used as a predictive tool to assess the physical limitations of each scenario's proposed replenishment, injection, and extraction locations and pumping rates.

During Phase 1, three preliminary wellfield areas (Figure 1.1b) in the Central Basin were evaluated for hydrogeologic feasibility:

1. Slauson injection area (labeled as "Slauson")
2. Soto injection area (labeled as "Soto")
3. Confluence extraction area (labeled as "Confluence")

The preliminary wellfield areas were based on LADWP's Groundwater Development and Augmentation Plan (Geosyntec et al. 2019) and input from LADWP staff. In addition to the three new wellfield areas, additional extractions at the existing Manhattan and 99th Street Wellfields were also simulated (based on input from LADWP staff). To account for future regional groundwater projects, new extraction wells were included to simulate WRD's Regional Brackish Water Reclamation Program's desalter in the West Coast Basin, and new injection wells were added to simulate injection near the Leo J. Vander Lans Advanced Water Treatment Facility (LVL AWTF). The locations and volumes for these facilities were based on prior modeling conducted by INTERA and input from WRD staff. The new Regional Brackish Water Reclamation Program and LVL AWTF well locations were not evaluated for hydrogeologic feasibility in Phase 1 based on discussions with WRD and LADWP.

For each scenario, groundwater head simulation results were evaluated for exceedance of water level thresholds at the new injection wells, new and existing LADWP extraction wells, and select West Coast Basin Barrier injection wells. For injection wells, the simulated head was compared with the elevation of the shallowest groundwater node (representative of ground surface elevation) at the location to evaluate potential for flooding, liquefaction, or excessive mounding in the area. The threshold for injection locations was considered exceeded if the simulated water level was shallower than 50 feet below the elevation of the highest groundwater node (representative of the ground surface elevation). For extraction wells, the simulated head was compared with the bottom elevation of the shallowest layer in which the well was screened. The threshold for extraction locations was considered exceeded if the simulated water level was below the threshold bottom elevation, indicating potential for desaturation of the upper portion of the screens and (screened) aquifer, which could lead to air entrainment, loss of efficiencies, and pump failures in the well.

During Phase 1, simulated water levels were not compared with the historical low water levels to evaluate the potential for subsidence. This particular threshold exceedance evaluation was subsequently added as an additional criterion in Phase 2.

Based on results from initial modeling runs, and with additional input from LADWP, the following revisions were made:

1. The Soto injection area was removed from further consideration, as the modeled water levels exceeded thresholds for maximum water levels at this location.
2. LADWP extraction volumes at the new Confluence area and at the existing Manhattan and 99th Street Wellfield locations were apportioned as 56%, 33%, and 11% of the specified extraction, respectively. The ratios corresponded to maximum target extraction rates of 50 cubic feet per second (cfs), 30 cfs, and 10 cfs at the three locations, respectively.

Phase 1 modeling concluded that the Slauson area and the Confluence extraction area showed no exceedances of respective thresholds and met the hydrogeologic feasibility constraints for the Joint Master Plan.

1.2 Approach for Phase 2

The Phase 2 study built on the modeling done in Phase 1 and entailed a more detailed feasibility assessment including hydrogeologic feasibility, potential MPH (from subsidence, liquefaction, and groundwater quality impacts), and Title 22 (Section 3.3) evaluations for injection and extraction facilities in areas deemed viable by LADWP. Apart from the injection and extraction well locations, all other modeling inputs were kept the same as Phase 1 model (described in detail in TM 3.1).

The Phase 2 modeling was initiated with a reexamination of the Confluence and Slauson areas evaluated during Phase 1. Following input from LADWP, the Confluence area was deemed not ideal due to its distance from LADWP's distribution network and was removed from further consideration during Phase 2.

Additional locations were added to the list of preliminary areas based on their proximity to LADWP's distribution network and the three potential future alignments of the Hyperion Backbone (see Appendix C for details). The preliminary locations were identified for injection or extraction based on their location and evaluated for hydrogeologic feasibility. As locations were evaluated for hydrogeologic feasibility, the failure or success of a location determined whether the groundwater modeling needed to be revised through new configurations. Once the locations were deemed feasible, particle tracking analyses were conducted to assess travel time compliance with Title 22 requirements for recycled water and potential groundwater quality impacts for MPH assessment. Adjustments to the preliminary locations and pumping rates were made following results of these analyses and a final set of locations was developed.

This final set of potential wellfield locations (based on the analysis described) was provided to Epic to identify underused parcels in and around the potential wellfield locations. Once nearby parcels were identified, another round of simulations was conducted to confirm the parcels satisfied Title 22 and MPH requirements. Figure 1.2 shows the general approach for Phase 2 groundwater modeling.

The following sections present results from the steps outlined on Figure 1.2 and revisions to preliminary wellfields made during the modeling evaluation. An overview of the Water Balance Model scenarios, which provided input to the groundwater model, is presented in Section 2.

2. Water Balance Model Scenarios Summary

Table 1 provides a summary of Water Balance Model scenarios, documented in TM 3.1 (Appendix C). Scenario 1 was a baseline scenario representing historical LADWP pumping in the Central Basin and did not include the new proposed LADWP injection or extraction wells. This baseline scenario was considered a No Project alternative for comparison with all of the other scenarios. The subsequent scenarios had progressively higher volumes of LADWP pumping supported by leasing or transfer of water rights and augmentation.

Table 2 provides an overview of the Water Balance Model outputs in terms of how they mapped to groundwater model inputs and the average rates of injection and extraction applied to the groundwater model inputs. Scenario 7 had the highest volume of pumping by LADWP and other pumpers, and highest volume of injection by LADWP.

During Phase 1, all seven of the Water Balance Model scenarios were simulated. During Phase 2, only Scenario 7 was used to evaluate the feasibility of the wellfield and parcel locations. Scenarios 2 through 6 were associated with lower volumes and were not explicitly simulated if the locations were deemed feasible using Scenario 7, based on the assumption that feasibility in Scenario 7 (with the maximum injection and extraction volumes) implies feasibility across the lower volume scenarios (Scenarios 2 through 6) for the same locations. The groundwater model using Scenario 7 applies an average of 23,300 acre-feet per year (32.1 cfs), with a maximum rate of 45,500 AFY (62.8 cfs), of injection at new wellfields. An average rate of 41,600 AFY (57.5 cfs), with a maximum of 59,700 AFY (82.4 cfs) is extracted in Scenario 7 from new and existing LADWP wellfields. In each simulation, 33% and 11% of extraction is applied at the Manhattan Wellfield and the 99th Street Wellfield, respectively, leaving 56% of total extraction for the new wellfields.

3. Groundwater Modeling

Groundwater modeling was organized into different evaluations, at various scales, and, eventually, into specific evaluations of a final project configuration. Initially, a wellfield-scale feasibility evaluation (Section 3.1) was conducted to identify areas within the region of interest where injection and extraction are feasible. Different configurations of injection and extraction wellfield layouts were tested. Centralized injection and extraction facilities near the Hyperion Backbone were preferred to minimize conveyance costs. Different locations for the centralized facilities were evaluated to minimize exceedance of thresholds. When thresholds were exceeded alternative configurations (centralized injection and distributed pumping, distributed injection, and distributed pumping) and locations were tested. Next, individual land parcels in an around locations selected from the wellfield-scale evaluation were analyzed to identify specific properties that could be feasible for well siting (Section 3.2). Once a final configuration of parcels was developed, Title 22 (Section 3.3) and groundwater quality impacts (Section 3.4) were evaluated with respect to project Scenario 7.

3.1 Hydrogeologic Feasibility Evaluation – Wellfield Scale

3.1.1 New Injection and Extraction Wellfield Locations

Following Phase 1, an expanded set of wellfield locations was considered for new extraction and injection wellfields. Based on the output from the Water Balance Model, new extraction and injection wellfields were allocated average (over the project simulation period) fluxes of approximately 23,100 AFY and 23,300 AFY, respectively. Additionally, average total extraction allocated to the existing Manhattan and 99th Street Wellfields was approximately 18,500 AFY. The maximum total rates of extraction and injection at new wellfields over the project simulation period were 33,200 AFY (45.8 cfs), and 45,500 AFY (62.8 cfs), respectively. Eighteen locations were initially identified based on the total transmissivity and refined further based on the layer-specific transmissivity, including Slauson and Soto (Figure 1.1b). Of those 18 locations, four were tested as potential injection locations (Figueroa Pump Station Area, Wellfield 11 Area, Wellfield 2 Area, and Slauson), and all but Slauson were tested as potential extraction locations.

Figures 3.1.1a through 3.1.1h show the spatial distribution of model transmissivity (measured in square feet per day [ft^2/d]) for the eight individual sequences in the area of interest from ground surface to approximately 2,500 feet below ground surface (ft bgs). The model layers, listed sequentially by increasing depth, are :

1) Dominguez Sequence, Model Layer 2 (Figure 3.1.1a)
2) Mesa Sequence, Model Layer 3 (Figure 3.1.1b)
3) Pacific A Sequence, Model Layer 4 (Figure 3.1.1c)
4) Pacific Sequence, Model Layer 5 (Figure 3.1.1d)
5) Harbor Sequence, Model Layer 6 (Figure 3.1.1e)
6) Bent Spring Sequence, Model Layer 7 (Figure 3.1.1f)
7) Upper Wilmington A Sequence, Model Layer 8 (Figure 3.1.1g)
8) Upper Wilmington B Sequence, Model Layer 9 (Figure 3.1.1h)

Model Layer 1 is not representative of a geologic unit and is only used in the model to receive recharge across the entire model domain. A detailed description of the age and boundaries of each sequence is available in the LACPGM model development report (Paulinski 2021).

Figure 3.1.2 shows the location of the new wellfields evaluated in Phase 2. Twenty wellfield configurations were tested. The configurations consisted of multiple wellfields and can be categorized into three groups:

1) Centralized injection wellfield at the Slauson location and centralized extraction from the new wellfield (in addition to increased extractions from the existing Manhattan and 99th Street Wellfields)

2) Centralized injection wellfield at the Slauson location and distributed extractions from several new wellfields (in addition to increased extractions from the existing Manhattan and 99th Street Wellfields)

3) Distributed injection and distributed extractions from several new wellfields (in addition to increased extractions from the existing Manhattan and 99th Street Wellfields)

The main consideration for identifying potential locations of extraction wellfields was model transmissivity. Other considerations included proximity to the injection wellfields, distance from other extraction locations, and feasibility of connection to future LADWP transmission and distribution infrastructure. Other extraction locations, including LADWP extraction locations, were avoided to minimize low water level impacts. The modeled screened depth intervals were initially chosen based on relative transmissivities of the model layers at each location. Layers where the transmissivity exceeded 10,000 ft^2/d were considered suitable for placement of well screens. The most transmissive layers in the model are the layers representative of the Pacific A sequence (Figure 3.1.1c) and Pacific Sequence (Figure 3.1.1d), with model transmissivities up to 186,000 ft^2/d in the area of interest. Figures 3.1.3a through 3.1.3d demonstrate the stratigraphy of the sequences in the potential wellfield locations and also show the range of depths considered for injection/extraction. Model wells were screened at depths ranging from approximately 220 ft bgs to 2,200 ft bgs.

An additional qualitative criterion used at this preliminary stage was to evaluate and minimize the potential effects of injection and extraction on a known deep perchlorate groundwater plume located northeast of the study area in the Los Angeles Forebay. WRD is currently building a groundwater treatment system to capture and prevent further migration of the perchlorate groundwater plume into the Central Basin. The approximate lateral extent of perchlorate groundwater plume core is shown in light blue contours on Figure 3.1.2.

The process for evaluating the different configurations and layouts is discussed in more detail in Section 3.1.3. Various configurations of the extraction locations were initially tested with the Slauson injection location. The goal of the initial runs was to identify locations and configurations near the backbone that satisfy the water level thresholds (described in Section 3.1.2) without disrupting major contamination plumes or remediation efforts. In general, centralized extraction led to exceedances of thresholds in several areas. Therefore, distributed extraction was found to be a more feasible alternative for the project. Although centralized injection did not lead to exceedance of thresholds, distributing injection closer to the distributed extraction locations (while maintaining required distance between the injection and extraction wellfields for Title 22 residence time purposes) was found to reduce impacts on regional gradients and the potential to mobilize existing plumes in the area of interest. Throughout this process, input from LADWP and WRD was solicited while selecting and changing wellfield configurations and locations.

3.1.2 Water Level Thresholds

Hydrogeologic feasibility of a wellfield within a particular configuration was evaluated by comparing simulated water levels at the new and existing LADWP well locations against water level thresholds, which were developed to minimize excessive mounding (for injection wells) or excessive drawdowns (for extraction wells).

For injection locations, high water levels are the primary concern. High water levels can be an issue of concern because of surface flooding at wellheads, increased potential for liquefaction, and excessive head buildup or mounding in and around the wells. Simulated water levels were compared with the elevation of the shallowest groundwater node at the injection location to evaluate potential flooding. The threshold for an injection location was considered exceeded if the highest simulated water level was shallower than 50 ft bgs. This threshold is a conservative engineering threshold based on professional judgment to avoid excessively high water levels in and around injection wells. Additionally, the 50 ft bgs threshold was applied for the estimation of storage space (Johnson and Njuguna 2003) in the Central and West Coast Basins that was considered for the respective 2013 and 2014 Judgment Amendments that enabled use of the available storage space with augmentation projects.

For extraction locations, low water levels are the primary concern. Two thresholds were established:

- The first threshold was the top elevation of the highest screened groundwater node at that location, representing the top of the well-screen (that is, top of shallowest screened node in associated figures).
- The second threshold was the lowest simulated historical water level (that is, historical simulate low in associated figures).

If the simulated water level fell below the first threshold (top elevation of the highest screened node), this represented a potential for loss of efficiency and air entrainment in a submersible pump, exposing well screens, and leading to pump failures. If the simulated water level fell below the second threshold (simulated low historical water level), this represented a potential for local subsidence because of preconsolidation stresses in the aquifer or aquitard being exceeded. The bottom of the well screen was also included as a reference on each associated figure (that is, bottom of shallowest screen node).

Basin-wide historical low water levels occurred in the 1960s (WRD 2005); however, data from the 1960s were not available at the wellfield locations tested, and the model simulation only began in 1971. Therefore, simulated historical low water levels from 1971 (the beginning of the model simulation period) were taken as a conservative representation of the historical low and used as a low water level threshold to avoid potential subsidence. For conservative purposes, the higher of the two thresholds (top elevation of the highest screened groundwater node or simulated historical low from 1971) was the limiting factor for water levels at extraction wells.

3.1.3 Tested Configurations

Twenty injection and extraction wellfield configurations were modeled to evaluate centralized and distributed injection and extraction locations as described in the following sections. Note that the locations tested in all the configurations were meant to represent generalized areas and *did not* correspond to specific sites or parcels. Hydrogeologically feasible locations were used as the basis for the parcel evaluation (discussed in Section 3.2) to identify several feasible sites for future injection and extraction wellfields. Given that this was a feasibility-level evaluation, no optimization of injection or extraction rates was undertaken to avoid exceedance of thresholds.

Grouping of wellfields and percentage distribution of injection and extraction within each configuration, and a summary of the simulation results are presented in Table 3. Given the number of model simulations involved, results from configurations with viable injection or extraction locations are presented in the following sections. Results from configurations where neither injection nor extraction locations were found viable are not included for the sake of brevity.

3.1.3.1 Centralized Extraction Configurations

Centralized extraction close to LADWP's distribution center and centralized injection near the Hyperion Backbone (Figures 1.1a and 1.1b) were preferred to minimize project conveyance and distribution costs. As such, the first set of scenarios tested centralized extraction and injection wellfield layouts. Configurations 1 to 8 tested centralized extraction at various wellfields with different injection configurations. Of these, Configurations 1 to 5 were set up with centralized extraction at different locations and centralized injection at the Slauson location; Configuration 6 specified centralized extraction at Wellfield 7 and centralized injection at Wellfield 2; and Configurations 7 to 8 tested centralized extraction at Wellfield 7 and distributed injection at Wellfields 2 and 11.

Several extraction locations were tested as shown in Table 3. Based on input from LADWP, the initial centralized extraction locations were:

- Wellfield 11 Area (Configuration 1)
- Parcel 1 (Configuration 2)
- Parcel 6 (Configuration 3)
- Wellfield 7 Area (Configuration 4)
- Parcel 5 (Configuration 5)

The Slauson location was identified as a preferred centralized injection location by LADWP. Hence, the first five extraction configurations (Configurations 1 to 5) were simulated with centralized injection occurring at the Slauson location (Figure 1.1b). Model results indicated that with only one extraction location, the simulated water levels could fall below the historical low water levels, indicating a potential for subsidence using Configurations 1 to 5. Figure 3.1.4 shows the layout of extraction and injection for Configuration 2. Simulated water levels for Configuration 2 comprising the Slauson injection location (Figure 3.1.5a), the Parcel 1 extraction location (Figure 3.1.5b), and the Manhattan Wellfield location (Figure 3.1.5c) are presented here. Parcel 1 has the highest model transmissivity and was selected as the best-case scenario for Configurations 1 to 5. The simulated hydrographs indicate that the Slauson location injection water level thresholds were not exceeded, but the extraction water level thresholds were exceeded for both Parcel 1 (Figure 3.1.5b) and the Manhattan Wellfield location (Figure 3.1.5c). Amongst the tested locations, Parcel 1 and the Wellfield 7 Area resulted in less drastic threshold exceedances because of the high transmissivity at these locations. The Manhattan Wellfield is included in the hydrographs for this configuration only and omitted for the other configurations discussed further. The simulated extraction rate at the Manhattan Wellfield is the same across all the configurations. Simulated water levels are also very similar across the configurations because of its distance from the other simulated wellfields. Consequently, the simulated water levels at the Manhattan Wellfield do not satisfy the water level threshold requirement in all the configurations.

As an alternative to Configurations 1 to 5 that had centralized injection at the Slauson location, another configuration (Configuration 6) was tested with centralized injection in the Wellfield 2 Area. Wellfield 2 was a preferred location by LADWP and WRD due to its distance from the perchlorate groundwater plume and its relatively high transmissivity. Centralized extraction was simulated at the Wellfield 7 Area, which had the least exceedance in the prior centralized extraction scenarios (Section 3.1.3.1). Preliminary modeling showed water level exceedances at the extraction site (with water levels in the Wellfield 7 Area dropping below simulated historical lows) as well as the injection site (with water levels in the Wellfield 2 Area going above the 50-foot threshold). Because neither the injection nor extraction areas were conducive, this configuration was removed from further consideration, and additional analysis of results (wellfield specific hydrographs) was not undertaken for this simulation.

Finally, based on input from LADWP, two additional Configurations (7 and 8) with centralized extraction at Wellfield 7 and distributed injection at Wellfields 2 and 11 were tested with different proportions of injection at the two locations. Configuration 7 used 26% and 76% at Wellfields 2 and 11, respectively, and Configuration 8 used 40% and 60% for Wellfields 2 and 11, respectively. Similar to other centralized extraction configurations, these simulations also showed water levels dropping below the simulated historical lows. As such, these configurations were not further analyzed, and results are not included in this TM.

Overall, centralized extraction was seen to lead to high drawdowns in and around the wellfield, with water levels falling below the simulated historical low, indicating potential for subsidence.

3.1.3.2 Distributed Extraction with Centralized Injection Wellfields Configurations

Based on the results described in Section 3.1.3.1, centralized extraction at the target extraction volumes was not found to be hydrogeologically feasible. Therefore, distributed extraction options were evaluated in the next round of simulations. Five additional extraction configurations (Configurations 9 to 13) were simulated with centralized injection at the Slauson location (seen to be feasible in prior simulations) and distributed extractions from a grouping of three extraction wellfields. Closely clustered extraction wellfields were initially grouped into a configuration. Extraction at new wellfields was spread uniformly across the three wellfields (that is, the proportion of pumping at each wellfield is one-third the total extraction at the new wellfields). The clustered extraction wellfield locations were:

- Wellfield 1 Area, Wellfield 2 Area, Wellfield 11 Area (Configuration 9)
- Parcel 1, Lanzit Site, DS-41 Area (Configuration 10)
- Parcel 6, Parcel 7, Soto (Configuration 11)
- Parcel 2, Parcel 3, Wellfield 7 Area (Configuration 12)
- Parcel 4, Parcel 5, Wellfield 8 Area (Configuration 13)

Simulation of Configurations 9 to 13 resulted in threshold exceedances at nine extraction locations even with one-third of the total extraction volume. These locations included (Figure 1.1b):

- DS-41 Area
- Parcel 7
- Parcel 5
- Parcel 2
- Wellfield 8 Area
- Parcel 4
- Lanzit Site
- Wellfield 1 Area
- Soto

These locations were found to be infeasible because of low transmissivity. Configurations 9-13 simulation results are summarized in Table 3. Simulated hydrographs for five representative wells exceeding the project thresholds are shown on Figures 3.1.7a through 3.1.7d.

Configuration 10 is discussed here because it had the best relative performance of Configurations 9 to 13. Configuration 10 includes Parcel 1, which is among the most feasible sites for extraction because of the high transmissivity at the location. The layout of extraction and injection for Configuration 10 is shown on Figure 3.1.6. Other configurations and wellfield locations for extraction performed similarly or worse compared to Configuration 10; therefore, results are not included for these configurations for the sake of brevity. Similar to previous configurations, the injection location at Slauson was found to be conducive for Configuration 10, with water levels within thresholds (Figure 3.1.7a). Parcel 1 water levels were improved with lows remaining above the simulated historical lows and above the top of the shallowest screened layer (Figure 3.1.7b). Simulated water levels fell below the simulated historical lows, indicating a potential for subsidence at extraction locations DS-41 Area (Figure 3.1.7c) and Lanzit Site (Figure 3.1.7d). At the Lanzit Site, the simulated water levels also fell below the minimum elevation threshold (that is, the elevation of the top of Pacific A sequence, which was the shallowest screened model layer at this location).

A potential concern about the Slauson injection well location was its proximity to the perchlorate groundwater plume located northeast of the study area. Based on input from WRD and LADWP, it was determined the injection at this location may potentially influence remediation system operations and was subsequently deprioritized from further consideration. Alternative injection locations were identified from among the preliminary wellfield locations, and additional configurations were evaluated as discussed in Section 3.1.3.3.

Similar to the alternative tested for the centralized injection and extraction configurations, centralized injection in the Wellfield 2 area was tested again with distributed extraction at different wellfield locations (DS-41 and Parcel 1 and Wellfield 7 and Wellfield 11 – Configurations 14 and 15, respectively). Similar to the prior results, preliminary modeling showed exceedances in the Wellfield 2 Area and several of the extraction locations. Because neither the injection nor extraction areas were found feasible in these simulations, the configurations were not evaluated further. Overall, centralized injection in the Wellfield 2 Area was not found to be viable with either centralized or distributed extraction.

The Figueroa Pump Station area was also tested as a centralized injection location because of its proximity to the extraction wellfield locations and high transmissivity (Configuration 16). For this configuration, extraction was distributed evenly at Parcel 1 (33%), DS-41 Area (33%), and the Wellfield 7 Area (33%). Figure 3.1.8 shows the layout of extraction and injection for this configuration. Figures 3.1.9a through 3.1.9d show the hydrographs at these locations. The Figueroa Pump Station Area did not exceed high water level thresholds in this configuration; therefore, it was found to be a feasible alternative to the Slauson injection location. The distance of the Figueroa Pump Station area from the perchlorate groundwater plume (Figure 3.1.8) alleviated concerns about influence on remediation activities for the perchlorate plume.

3.1.3.3 Distributed Injection with Distributed Extraction Wellfields Configurations

Based on discussions with WRD and LADWP, it was decided to evaluate distributed injection and distributed extraction configurations because spreading out injection and extraction facilities would reduce excessive mounding and drawdowns, as well as project impacts on regional gradients. As such, distributed injection was evaluated at Wellfield 2 Area and Figueroa Pump Station Area (Configurations 17 to 20). Extraction locations that had performed well in previous configurations (including Parcel 1 and Wellfield 7) were kept for further evaluation of distributed extraction configurations. The Figueroa Pump Station Area was chosen as a second injection location to be paired with the Wellfield 2 Area because of its proximity to the extraction locations under consideration so as to reduce drawdowns at the extraction locations.

Configurations 17 to 20 consisted of distributed injection at Wellfield 2 Area (40%) and the Figueroa Pump Station Area (60%), using different combinations of extraction at the DS-41 Area, Parcel 1, and the Wellfield 7 Area. Simulated water levels at the injection wellfield locations did not exceed high water level thresholds in any of these configurations. However, thresholds at extraction wellfields frequently exceeded thresholds for configurations consisting of one or two extraction locations. Configurations 17 and 20 consisting of extraction at three wellfield locations performed the best, with only intermittent exceedances of the low water level thresholds.

The wellfields used in Configuration 20 were used as a basis for the parcel search and consisted of distributed injection at the Wellfield 2 Area (40%) and the Figueroa Pump Station Area (60%) with distributed extraction split evenly between DS-41 Area (33%), Wellfield 7 Area (33%), Parcel 1 (33%). This layout is shown on Figure 3.1.10. Injection at the Figueroa Pump Station Area was simulated in the Pacific A and Pacific sequences. At the Wellfield 2 Area, injection was simulated in the Mesa, Pacific A, Pacific, and Bent Spring sequences. At the Wellfield 7 Area and Parcel 1 locations, extraction was simulated from the Pacific A and Pacific sequences only. The DS-41 Area's threshold exceedances in previous simulations were mitigated partially by limiting the extraction to the shallow Pacific A and Pacific sequences. The DS-41 Area's exceedances were also intermittent, indicating that perhaps its low water level concerns could be mitigated by adjusting pumping rates during operation. For Configuration 18, extraction was simulated from the Pacific A and Pacific sequences at the DS-41 Area.

Figures 3.1.11a through 3.1.11e present the hydrographs at these locations. At the injection locations, the simulated water levels do not exceed the thresholds. At the extraction locations, the simulated water levels periodically fall below the simulated historical low water levels, indicating potential for subsidence. At the DS-41 Area, this threshold is exceeded more frequently than at the Parcel 1 and the Wellfield 7 Area locations. Likewise, at the Manhattan Wellfield location, the low water level threshold was exceeded, similar in pattern to that presented previously (Figure 3.1.5c).

3.2 Hydrogeologic Feasibility Evaluation – Parcel Analysis

The locations tested for hydrogeological feasibility (from Configuration 20) with the groundwater model (Section 3.1) represented generalized areas for injection and extraction wellfields. These were further analyzed to identify specific sites and parcels in the vicinity of the areas. Section 3.2.1 describes the parcel investigation and identification process. These parcels were then prioritized based on various criteria, as described in Section 3.2.2. Section 3.2.3 describes downscaling calculations undertaken to evaluate wellbore-scale drawdown effects for representative parcels to assess limitations on pumping and injection rates and water levels with respect to the well screens and wellheads, respectively.

3.2.1 Parcel Investigation

A set of parcels in the vicinity of the final wellfield-scale configuration was vetted by Epic and provided to INTERA (Figure 3.2.1). These parcels were considered potentially available for the siting of injection or extraction wells. INTERA and Epic analyzed each parcel to evaluate its potential feasibility by identifying possible restrictions including:

- Permitting
- Acquisition
- Site access
- Title 22 compliance (0.5-mile buffer between injection and extraction locations)
- Well drilling and construction constraints

The main criteria for this evaluation were:

- Area of the parcels
- Potential number of injection and extraction wells based on estimated well capacity
- Minimum separation distance
- Ease of access
- Proximity to sites identified by the California Department of Toxic Substances Control (DTSC) that may be potentially contaminated (complicating the permitting and drilling process)

Parcel GIS boundary and ownership data were obtained from the Los Angeles County Assessor for the areas surrounding the five locations. Initially, parcel data were obtained within one-eighth of a mile from each of the final wellfield locations; however, it was determined that the resulting parcel list was likely not large enough to yield sufficient sites. The search was expanded to include parcels within one-quarter mile of each location, which resulted in lists ranging from 500 to 700 parcels per location. These lists were then refined based on the set of initial screening criteria. Real estate-specific considerations included land use and zoning, utilization, and property ownership.

Land use and zoning were important factors in the initial screening of potential parcels. In general, residential properties were eliminated from consideration because it was not considered desirable to impact residential dwellings to construct wells, or to collocate wells on residential properties because of noise and aesthetic concerns. Parcels with residential zoning code prefixes, as well as parcels with residential use codes in the GIS layers for each target location, were selected and removed them from the data set. Industrial and light industrial properties were targeted for well sites as they are often larger, contain some undeveloped or vacant areas, and were generally assumed to be more compatible with construction and operation of well facilities.

After the parcel data were filtered for land use, the remaining properties were evaluated for utilization. Utilization was determined using improvement percentage which, in turn, was determined by dividing assessed value of the improvements (buildings) by the assessed value of the entire parcel. Assessed values were available in the Assessor's parcel data and the calculations were performed in GIS. Parcels that had improvement percentages less than 15% were considered underutilized and, thus, good candidates for hosting wells. Properties with higher improvement percentages were assumed to contain improvements that would require demolition or protection that would increase cost and impacts on existing infrastructure. Underutilized properties were isolated from the broader parcel list and presented as initial candidates for refined screening.

Parcel ownership data were also used in several ways to evaluate the viability of parcels for potential well sites. First, properties owned by public agencies (including LADWP and other City of Los Angeles departments) were targeted as potential sites. It was assumed that agency-owned parcels could present opportunities to obtain rights required to construct and operate wells without the need to purchase private property interests. In some cases, LADWP staff were able to inquire within the City regarding prospective uses for parcels identified by the screening and advise whether the parcels should be maintained for or eliminated from further consideration. Property ownership data were also useful in identifying large, contiguous properties consisting of multiple tax lots. These "larger parcels" were considered desirable in that negotiations to acquire the necessary rights would be limited to fewer owners for a given number of parcels. It was assumed this would minimize the cost and complexity of the acquisition process. Once each potential wellfield location was filtered using these criteria, the resulting parcel list was further reviewed in a series of workshops with participants from Epic and INTERA.

INTERA's registered professional geologists recommended a minimum area of 8,000 square feet to fit all the components of the drilling rig setup with a minimum width that allows for the rig to transit to and from the site. A maximum injection or extraction capacity was calculated for each parcel using representative model parameters. Well design thresholds for permissible drawdown (or drawup) were used in the analysis to inform capacity limits. A single well was assumed to have a maximum capacity of 1,500 gallons per minute (gpm) for injection wells and 2,000 gpm for extraction wells; the difference is because of lower well efficiency typically observed at injection wells.

During the parcel investigation, well spacing requirements were used to evaluate the maximum number of wells possible to be located at each parcel. The well spacing requirements included a minimum of 100-foot spacing to account for drilling logistics. This spacing was adjusted based on a calculated mounding at injection wells and drawdown at extraction wells. The spacing was increased as necessary to not exceed a maximum allowable mounding of 100 feet for injection well spacing, and maximum allowable drawdown of 100 feet for extraction. The total maximum capacity was then calculated based on the number of wells at that site and the type of wells they would be (injection or extraction). Attachment 2 includes further details of the parcel capacity evaluation. Access was evaluated using Google™ Earth imagery to identify whether there were existing buildings or utilities that would limit the usable area of the parcel. In addition to spacing and access requirements, mapping of environmentally impacted sites through ArcGIS facilitated the proximity analysis.

The parcels were classified into three tiers (Figure 3.2.2) using the following criteria:

- **Tier 1:** Sufficient access and well spacing; low likelihood of onsite or adjacent contamination (see Section 3.4); adjacent parcels treated as one site
- **Tier 2:** Apparent access and construction concerns, with a medium likelihood of contamination (see Section 3.4)
- **Tier 3:** Removed from current consideration because of significant hurdles relating to access and construction constraints or high likelihood of onsite contamination (see Section 3.4)

Adjacent parcels were also grouped together as one wellfield site to maximize the potential capacity of all sites. Figure 3.2.3 shows the estimated maximum number of wells for each parcel, with the assumption of wells to the north of Gage Avenue being assigned to injection and wells to the south being assigned to extraction.

3.2.2 Parcel Prioritization

3.2.2.1 Tier 1 Configuration

A preliminary configuration was created using only Tier 1 parcels, which are the most feasible locations. This configuration is shown on Figure 3.2.4. Following the final wellfield-scale simulation, injection was maintained in the northern parcels, and extraction was simulated at the southern parcels. This configuration also ensured a minimum distance between injection and extraction of 0.5 mile, which was the conservative estimate to satisfy Title 22 compliance as discussed in Section 3.3.

The injection or extraction rates were distributed among parcels such that the maximum capacity of each parcel was used as much as possible. Each parcel's flux was then assigned to the nearest model node; in some cases, multiple parcels were assigned to the same node. Based on previous modeling at the wellfield scale and relative transmissivities, all new injection and extraction nodes were screened in only the Pacific A and Pacific sequences. The top depth of the modeled wells' screens ranged from 290 to 480 ft bgs and the bottom depth of modeled wells' screens ranged from 640 to 1,140 ft bgs.

Table 4 summarizes Tier 1 parcels used for modeling and their extraction and injection capacity. Twelve Tier 1 parcels were chosen for siting of injection wells, and eight Tier 1 parcels were used for siting extraction wells. There were nine model node locations used for the 12 injection parcels and eight model node locations used for the eight extraction parcels. Table 4 also shows the well identifier assigned to each parcel selected.

Extraction Well Results

Under the Tier 1 configuration, simulated water levels at the extraction wells did not drop below the bottom of any node in the Pacific A sequence, passing the first extraction well threshold. Simulated water levels at the extraction wells did, however, intermittently drop below simulated historical low water levels. The maximum percentage of the project simulation period when the simulated historical low water level threshold was exceeded was 4.7% for all extraction wells. The intermittent nature of the threshold exceedance is controlled by the fluctuating rates of injection and extraction. As such, injection and extraction rates will need to be optimized to avoid dropping below historical low water levels. Figures 3.2.5a through 3.2.5h show the hydrographs of each extraction location (EW01 to EW08).

Injection Well Results

All injection locations satisfied the high water level threshold by not exceeding 50 feet below the elevation of the topmost model grid (representative of ground surface elevation). Figures 3.2.5i through 3.2.5q show the hydrographs of each injection well.

3.2.2.2 Tier 1 and Tier 2 Configurations

A second configuration was developed that used parcels from both Tier 1 and Tier 2. Specific locations were chosen to place injection wells and extraction wells strategically to mitigate the intermittent low water levels simulated in the Tier 1 configuration extraction locations. Figure 3.2.6 shows this configuration. The fluxes were distributed similarly to the Tier 1-only parcels, maximizing each parcel's capacity. All selected nodes were screened in only the Pacific A and Pacific sequences. Twelve parcels were used for injection, with only one of the parcels being allocated from Tier 2. The 12 parcels allocated for injection were mapped to 10 model node locations. For extraction, 17 parcels were used with three of the 17 being from Tier 2. The 17 parcels allocated for extraction were mapped to 14 model node locations.

Extraction Well Results

The simulated water levels at each extraction well did not drop below the shallowest layer, Pacific A. Similar to the Tier 1 configuration, simulated water levels at extraction well locations did intermittently drop below the simulated historical water level low. There was a marginal increase overall in the water levels of several feet because of injection wells being placed closer to extraction wells, but it was not enough to mitigate this difference, as the average exceedance of this lower threshold was approximately 10 feet. Figures 3.2.7a through 3.2.7n show the hydrographs of each extraction location.

Injection Well Results

There was no exceedance of thresholds for any injection wells in this configuration. Figures 3.2.7o through 3.2.7x show the hydrographs of each injection well.

Given that including Tier 2 parcels, which brought extraction and injection locations closer together, did not mitigate the intermittent low water levels simulated at extraction locations, only the Tier 1 configuration was used as the configuration for the particle tracking analyses conducted for Title 22 compliance and MPH evaluation, described in the subsequent sections.

3.2.3 Analytical Downscaling to Assess Wellbore Effects

The LACPGM simulated groundwater levels to the resolution of its grid spacing (660 feet) which is not representative of the actual water level near the well or inside the bore. Downscaling is the process of adjusting the drawdown (or drawup) at the local scale to account for the local effects at the well and is required to support the preliminary design of these hypothetical wellfields. The downscaling calculations applied the Peaceman correction to adjust the simulated drawup and drawdown for model injection and extraction wells, respectively. The downscaling calculations were performed for the Tier 1-only parcel configuration as it was the preferred configuration from the parcel scale analysis.

Downscaled water levels were evaluated against the same water level exceedance thresholds as the model simulated water levels. Historical simulated low water level thresholds were exceeded at extraction locations prior to adjusting drawdown so the water levels at extraction locations were evaluated against the top of the shallowest screened model node (in the sequence Pacific A). At injection locations, the water levels were evaluated against the 50 ft bgs threshold. The increase in drawdown or drawup from the downscaling calculations was calculated for all sequences that the model wells were screened in (Pacific A and Pacific). Figures 3.2.8a and 3.2.8b show hydrographs for representative extraction and injection locations, respectively, with both the simulated water level and the downscaled result. The additional drawdown at extraction locations ranged from 22 to 29 feet, and the additional drawup at injection locations ranged from 27 to 43 feet (Table 5). The downscaling calculations indicated no exceedance of the threshold water levels at the injection (50 ft bgs) or extraction locations (water levels above top of the shallowest screened sequence).

3.3 Title 22 Residence Time Requirements

The SWRCB Code of Regulations, Title 22, Article 5.2, *Indirect Potable Reuse: Groundwater Replenishment – Subsurface Application,* directs applicants of indirect potable reuse programs through subsurface injection to demonstrate, at minimum, 6 months of residence time for water injected into the subsurface before being extracted, if demonstrating through a numerical model.

The particle tracking tool MODPATH 7 (Pollock 2016) was used to simulate residence time of injected water through analysis of the USGS's MODFLOW model simulations representing project scenarios. A porosity of 0.25 was assumed for the particle tracking simulation, which was informed by literature values and a previous model of the Los Angeles Coastal Plain (Reichard et al. 2003). The particles' starting locations were placed at the center of all groundwater nodes where water was injected (that is, only in layers that were screened). The particle tracking simulation was started from the stress period when project extraction and injection begin (corresponding to the historical model date January 1986).

Figures 3.3.1a and 3.3.1b show the complete path of the particles' first 6 months. The maximum lateral displacement traveled from the injection wells was less than 0.01 mile in the Pacific A sequence and approximately 0.2 mile in the Pacific Sequence. The nearest extraction well is 0.75 mile away in the model, and Figures 3.3.1a and 3.3.1b show that the particles are not extracted by any new or existing extraction wells.

3.4 Groundwater Quality Impacts

MPH is defined under the Central Basin adjudication (Superior Court of California 2013) as:

> "…*material physical injury or a material diminution in the quality or quantity of groundwater available within the Basin to support extraction of Total Water Rights or Stored Water, that is demonstrated to be attributable to the placement, recharge, injection, storage or recapture of Stored Water in the Central Basin, including, but not limited to, degradation of water quality…*"

To evaluate potential degradation to water quality from project scenarios, the particle tracking tool MODPATH 7 was also used to simulate advective migration of water from known contaminant depths. The same porosity of 0.25 was assumed as was used in the Title 22 assessment. The evaluation was performed by tracking particle flow paths from locations with known potential contamination in both the baseline and project scenario and comparing the differences in the flow paths between the two scenarios. The baseline scenario corresponds to Water Balance Model Scenario 1 with no new extraction or injection locations (that is, the No Project alternative). The project scenario used is the Scenario 7 simulation configured using only Tier 1 parcels. Figure 3.4.1 shows the locations of different sites related to potential contamination used for the MPH analysis.

INTERA obtained readily available data from DTSC's EnviroStor database (DTSC 2022) and the Groundwater Ambient Monitoring and Assessment Program (California Water Boards 2022). GAMA data was considered more robust because responsible parties under active regulatory oversight for the past two decades have been required to submit data electronically to the Los Angeles Regional Water Quality Control Board (Regional Board). This resource provided staff with easy access to numerous investigation reports, water level data for evaluating depth to contamination, and various water quality data for those sites actively managed by the Regional Board. However, there still remains a considerable amount of uncertainty as not all known sites are readily available or easily accessible because they may not be actively managed by the Regional Board.

The DTSC does not require responsible parties to provide data electronically like the Regional Board. Therefore, data are not readily available, and only limited information is available on EnviroStor. To identify depth of potential contamination at DTSC sites, WRD staff communicated with DTSC staff to collect this information. INTERA prepared a buffer zone map based on initial particle tracking results, and then further refined it using input from WRD. A list of 179 sites within the buffer zone and their respective DTSC project managers was prepared and provided to DTSC. These were further filtered based on the status of sites (Active, Inactive-Action Required, Needs Evaluation, Withdrawn) to a total of 65 active or action-required DTSC sites. The filtered sites were then provided to DTSC staff to evaluate and provide additional information on the potential for deep groundwater contamination and any active or planned remediation activities. Figure 3.4.2 shows the DTSC locations considered. Attachment 3 includes the DTSC responses for the subset of sites provided for evaluation.

DTSC provided responses regarding depth information for 13 of the 179 sites in the buffer zone, with only five of those 13 sites having known depth information. However, many of the sites had no depth information so they could not be assumed to suggest deep contamination. None of these sites with known depths were reported at depths below the surficial model layers 2 and 3, so DTSC sites were only evaluated for these shallow layers. None of the DTSC sites with available data were found to be deeper than 250 ft bgs.

The data gathered from all readily available sources were used as the particle starting locations as shown on Figures 3.4.3a through 3.4.3d, along with the relevant water quality sites described for the sequences Mesa through Pacific. The Mesa and Dominguez sequences represent shallow, surficial layers, where most contamination is found and is generally contained within the upper 350 ft bgs. The new injection and extraction zones are contained within the Pacific A and Pacific sequences.

4. Results of Particle Tracking

Figures 3.4.4a and 3.4.4b show the results for the Mesa and Dominguez sequences for the baseline (No Project alternative) and Scenario 7 (with project). As indicated by overlapping particle traces for both scenarios, there are no project impacts in depths corresponding to the Mesa and Dominguez sequences. This is to be expected because the sequences that the injection and extraction wells are screened in are confined with minimal hydraulic connection with the shallow subsurface in the area of interest, which is generally located at the boundary of the fine-grained sediments typical of the confined pressure area and coarse-grained sediments of the predominantly unconfined Los Angeles Forebay.

The Pacific A and Pacific sequences, however, do show some potential impact near the new extraction and injection wells. In some cases, particularly near injection wells, the flow direction may change. The particle just north of the cluster of injection wells demonstrates the impact of injection, changing its flow path's direction compared to the baseline scenario as shown on Figures 3.4.4c and 3.4.4d. In other cases, the travel distance may simply be farther for the project scenario as extraction draws the particles in with greater speed. The increased pumping at LADWP extraction wells, predominantly the Manhattan Wellfield, primarily causes an increase in capture. Other Central Basin wells do not seem to increase their capture. Outside the buffer zone around the new project wells, there is very little to no impact.

5. Recommendations and Conclusions

Phase 2 modeling was performed to identify and evaluate potential wellfields and underused parcels for placement of new injection and extraction wells. The evaluation used a comprehensive set of hydrogeologic, regulatory, permitting, and basin management criteria. The Phase 2 modeling results indicate the following:

- Centralized extraction locations were not found to be hydrogeologically feasible with simulated future water levels dropping below simulated historical lows, indicating potential subsidence risk.
- Distributed extraction was found to be more feasible, with intermittent exceedance of extraction thresholds that would need to be managed by modulating extraction rates and distributions across the wellfields in relation to background groundwater levels.
- All injection locations, except for Wellfield 2, were found to be hydrogeologically feasible with simulated future water levels staying below 50 feet of ground surface.
- Injection wells evaluated at the parcel scale (Figure 3.2.4) were found to be feasible at the locations and capacities evaluated. The modeling did not indicate potential for flooding, liquefaction, or excessive mounding.
- Extraction wells evaluated at the parcel scale (Figure 3.2.4) have intermittent periods of water levels going below the simulated historical low, but have general rising water level trends, which is an operational consideration for LADWP. It is recommended that transducers be installed in all wells, and injection and extraction rates be controlled to avoid going below (or above) established water level thresholds.
- Modeling results suggest there will be little to no impact on shallow contaminated sites generally less than 250 ft bgs.
- Injection and extraction could potentially impact areas with groundwater contamination at depths generally greater than 250 ft bgs. Model results show that the injection and extraction could cause some of this contamination to move toward LADWP wells. Therefore, it would be prudent for LADWP to plan for groundwater treatment of extracted water in the long-term. No apparent impacts on other pumpers or groundwater quality MPH were apparent from the modeling. However, given the lack of depth-specific information on groundwater contamination, it is recommended that pilot boreholes be drilled and site-specific groundwater quality data be collected to confirm these findings. Based on the data from the next phase of work for this project, the groundwater quality assessment and modeling analysis may need to be revaluated.
- All the identified parcel locations (Figure 3.2.4) meet Title 22 residence time criteria. However, this should be confirmed during the final siting of the extraction and injection facilities.

6. Limitations and Uncertainty

Phase 2 groundwater modeling was conducted as a desktop study to evaluate the Hyperion water balance scenarios using a set of hydrogeologic, permitting, regulatory, and basin management criteria in place at the time of this TM. The LACPGM is a regional model and was used as a decision support tool to provide an assessment of the hydrogeologic feasibility of different locations and volumes of injection and extraction wells. As with any groundwater model of this scale, the LACPGM is a numerical approximation of the hydrologic variability and geologic complexity, at a scale that is appropriate for regional-scale assessments, such as the one described in this Joint Master Plan.

The LACPGM has inherent limitations because of the spatial and temporal discretization, along with uncertainties in model inputs and parameters. These model hydraulic parameters were an important factor in identifying potential locations and evaluating wellfield feasibility. In particular, the LACPGM layer transmissivities and storage coefficients were estimated using model calibration (Paulinski 2021) and represent average aquifer properties at the one-eighth-mile grid scale. As such, the LACPGM does not explicitly simulate any well or site-scale geologic heterogeneities that may impact flow and transport at the field scale.

An MPH investigation (based on results from particle tracking simulations) was conducted to evaluate groundwater quality data compiled from two readily available environmental databases, EnviroStor and GeoTracker GAMA. There is significant uncertainty in the depth and location of potential contaminants (known and unknown) because a comprehensive readily available database in not current available from various regulatory agencies that oversee environmentally impacted sites (that is, U.S. Environmental Protection Agency, DTSC, and the Regional Board). Its plausible there are other sites in the study area that are currently unknown and as such were not evaluated by INTERA. Additionally, the particle tracking tool was used to simulate advective transport with no dispersion or retardation, is only representative of the average path taken by a particle from the starting location, and is considered sufficient at this stage of the Joint Master Plan.

Identification of parcels for siting wells was based on the ownership, type of land use, and their assessed values as of year 2021. The status and ownership of underutilized parcels identified in this study may change in the future and will need to be reevaluated. For the identified parcels, any constraints to drill-rig access and well construction will also need to be evaluated via site visits.

Results from the Phase 2 desktop study should be complemented with data from field investigations, including data from boreholes, pumping tests, and other hydrogeologic and water quality data.

7. References

California Department of Toxic Substances Control (DTSC). 2022. *EnviroStor*. Accessed April 8, 2021. https://www.envirostor.dtsc.ca.gov/public/.

California Water Boards. 2022. *GAMA Groundwater Information System*. Accessed April 23, 2021. https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/.

Geosyntec Consultants, Arcadis, Environmental Science Associates, GSI Water Solutions, Hazen and Sawyer, and Kris Helm Consulting. 2019. *Review Draft Groundwater Development and Augmentation Plan (GDAP): Phase 1 Report Central Basin, Los Angeles*. March 14.

Johnson, T. and Njuguna, W. 2003. Aquifer Storage Calculations Using GIS and MODFLOW. Los Angeles County, California.

Paulinski, S., ed. 2021. *Development of a groundwater-simulation model in the Los Angeles Coastal Plain, Los Angeles County, California: U.S. Geological Survey Scientific Investigations Report 2021-5088*. https://doi.org/10.3133/sir20215088.

Pollock, D.W. 2016. *User guide for MODPATH Version 7—A particle-tracking model for MODFLOW*. U.S. Geological Survey Open-File Report 2016–1086. p. 35. http://dx.doi.org/10.3133/ofr20161086.

Reichard, Eric G., Michael Land, Steven M. Crawford, Tyler D. Johnson, Rhett R. Everett, Trayle V. Kulshan, Daniel J. Ponti, Keith L. Halford, Theodore A. Johnson, Katherine S. Paybins, and Tracy Nishikawa. 2003. *Geohydrology, Geochemistry, and Ground-Water Simulation-Optimization of the Central and West Coast Basins, Los Angeles County, California*. U.S. Geological Survey Scientific Investigations Report 2003-4065. p. 196. https://doi.org/10.3133/wri034065.

Superior Court of California. 2013. Central and West Basin Water Replenishment District v. Charles E. Adams. 2013. Third Amended Judgment.
https://rights.wrd.org/docs/CB_Third_Amended_Judgement.pdf.

Water Replenishment District of Southern California (WRD). 2005. *A Century of Groundwater Changes in the Central and West Coast Basins*. Technical Bulletin Vol 4, Summer 2005.

Tables

Table 1: Summary of Hyperion Water Balance Model Scenarios

Scenario	Title	Brief Description
1	Baseline - Historical plus RBWRP	Baseline conditions
2	Scenario 1 + Initial WR Leasing in Central Basin (LADWP) or LADWP on the way to maximum target rights in Central Basin	LADWP begins acquiring additional rights and leases 6,896 AFY as needed
3	Scenario 1 + West Coast Basin WR Transfer to Central Basin (LADWP) + WR Leasing (LADWP) or LADWP at maximum target rights	APA transfer of 5,000 AFY to Central Basin by LADWP
4	Scenario 3 + maximum APA extraction in Central Basin (other pumpers) or LADWP at maximum target rights plus full Central Basin rights utilization	Maximize APA in Central Basin
5	Scenario 4 + maximum WR extraction in West Coast Basin (other pumpers) or LADWP at maximum target rights plus full Central Basin and West Coast Basin rights utilization	Maximize APA in Central Basin and West Coast Basin
6	Scenario 5 + Phase 1 augmentation (LADWP) or LADWP Central Basin Augmentation Phase 1	LADWP begins Phase 1 augmentation program in Central Basin
7	Scenario 5 + Phase 2 augmentation (LADWP) or LADWP Central Basin Augmentation Phase2	LADWP begins Phase 2 augmentation program in Central Basin

AFY = acre-foot (feet) per year
APA = allowed pumping allocation
WR = water rights

Table 2:Hyperion Water Balance Mapping to Groundwater Model Inputs

Water Balance Model Output Name	**Groundwater Model Input**	**Average AFY (rounded)**						
		Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 4**	**Scenario 5**	**Scenario 6**	**Scenario 7**
CB LADWP Pumping APA	Applied to existing and new LADWP extraction wells	11,200	20,100	22,300	22,300	22,300	22,300	25,900
CB LADWP Pumping Water Augmentation	Applied to new LADWP injection wells and added to extraction at existing and new LADWP extraction wells	-	-	-	-	-	10,800	15,700
Los Coyotes Water Augmentation Pumping	Applied to new WRD injection wells near LVL Facility	-	-	-	-	-	1,700	1,400
CB Others Pumper's Production	Applied to existing non-LADWP extraction wells in the CB	179,700	179,700	179,700	185,100	185,100	185,100	185,100
Additional MAR provided by Hyperion (additional to Historical)	Applied to new LADWP injection wells	-	3,300	4,700	6,100	6,100	6,500	7,500
Other Additional MAR (additional to Historical)	Added to existing Montebello Forebay recharge facilities	6,200	8,700	9,600	13,600	13,600	14,900	17,200
Los Coyotes for MAR	Applied to new WRD injection wells near LVL Facility	-	4,000	4,000	4,000	4,000	2,300	2,600
Recycled Water Recharge (Tertiary)	No Groundwater Model Input	45,200	34,400	34,400	34,400	34,400	34,400	34,400
ARC Recharge	No Groundwater Model Input	-	10,000	10,000	10,000	10,000	10,000	10,000

Table 3: Configurations of Injection and Extraction Locations Evaluated using the Groundwater Model

Configuration	**Extraction Wellfield Location (Total Extraction %)**	**Injection Wellfield Locations (Total Injection %)**	**Extraction Well Threshold Evaluation**	**Injection Well Threshold Evaluation**
1	Wellfield 11 (100)	Slauson (100)	Frequent exceedance	No exceedance
2	Parcel 1 (100)	Slauson (100)	Frequent exceedance	No exceedance
3	Parcel 6 (100)	Slauson (100)	Frequent exceedance	No exceedance
4	Wellfield 7 (100)	Slauson (100)	Frequent exceedance	No exceedance
5	Parcel 5 (100)	Slauson (100)	Frequent exceedance	No exceedance
6	Wellfield 7 (100)	Wellfield 2 (100)	Frequent exceedance	Frequent Exceedance
7	Wellfield 7 (100)	Wellfield 2 (26), Wellfield 11 (74)	Frequent exceedance	No exceedance
8	Wellfield 7 (100)	Wellfield 2 (40), Wellfield 11 (60)	Frequent exceedance	No exceedance
9	Wellfield 1 (33), Wellfield 2 (33), Wellfield 11 (33)	Slauson (100)	Intermittent exceedance: Wellfield 11 Frequent exceedance: Wellfield 1, Wellfield 2	No exceedance
10	Parcel 1 (33), Lanzit (33), DS-41 (33)	Slauson (100)	Intermittent exceedance: Parcel 1 Frequent exceedance: DS-41, Lanzit Site	No exceedance
11	Parcel 6 (33), Parcel 7 (33), Soto (33)	Slauson (100)	Intermittent exceedance: Parcel 6 Frequent exceedance: Parcel 7, Soto	No exceedance
12	Parcel 2 (33), Parcel 3 (33), Wellfield 7 (33)	Slauson (100)	Intermittent exceedance: Wellfield 7 Frequent exceedance: Parcel 2, Parcel 3	No exceedance
13	Parcel 4 (33), Parcel 5 (33), Wellfield 8 (33)	Slauson (100)	Frequent exceedance: Parcel 4, Parcel 5, Wellfield 8	No exceedance
14	DS-41 (50), Parcel 1 (50)	Wellfield 2 (100)	Intermittent exceedance: Parcel 1 Frequent exceedance: DS-41	Frequent Exceedance
15	Wellfield 11 (50), Wellfield 7 (50)	Wellfield 2 (100)	Frequent exceedance: Wellfield 11, Wellfield 7	Frequent Exceedance
16	DS-41 (33, screened in Pacific and Pacific A), Wellfield 7 (33), Parcel 1 (33)	Figueroa (100)	Intermittent exceedance: DS-41, Wellfield 7, Parcel 1	No exceedance
17	DS-41 (33), Wellfield 7 (33), Parcel 1 (33)	Wellfield 2 (40), Figueroa (60)	Intermittent exceedance: Wellfield 7, Parcel 1 Frequent exceedance: DS-41	No exceedance
18	Parcel 1 (100)	Wellfield 2 (40), Figueroa (60)	Frequent exceedance	No exceedance

19	Parcel 1 (50), Wellfield 7 (50)	Wellfield 2 (40), Figueroa (60)	Intermittent exceedance: Parcel 1 Frequent exceedance: Wellfield 7	No exceedance
20	DS-41 (33, screened in Pacific and Pacific A), Wellfield 7 (33), Parcel 1 (33)	Wellfield 2 (40), Figueroa (60)	Intermittent exceedance: DS-41, Wellfield 7, Parcel 1	No exceedance

Table 4: Tier 1 Parcels with Capacities and Modeled Well Associations

Parcel No.	**Wells Per Parcel**	**Parcel Area (ft^2)**	**Parcel Capacity (AFY)**	**Parcel Capacity (gpm)**	**Corresponding Well ID**
1	1	5,526	2,420	1,500	IW05
2	1	11,850	2,420	1,500	IW08
3	1	10,800	2,420	1,500	IW08
4	1	14,055	2,420	1,500	IW07
5	2	10,800	4,839	3,000	IW06
6	4	92,102	9,678	6,000	IW01
7	3	137,988	7,259	4,500	IW03; IW04
8	1	9,036	3,226	2,000	EW02
9	1	8,241	3,226	2,000	EW02
10	1	12,026	2,420	1,500	IW09
11	1	6,976	2,420	1,500	IW09
12	2	13,259	6,452	4,000	EW08
13	1	9,062	3,226	2,000	EW08
14	1	4,549	3,226	2,000	EW07
15	1	9,504	3,226	2,000	EW05
16	1	5,122	3,226	2,000	EW06
17	1	15,406	3,226	2,000	EW04
18	4	91,685	9,678	6,000	IW01; IW02
19	1	10,400	3,226	2,000	EW03
20	1	10,054	3,226	2,000	EW01

AFY = acre-feet per year

ft^2 = square feet

gpm = gallons per minute

ID = identification

No. = number

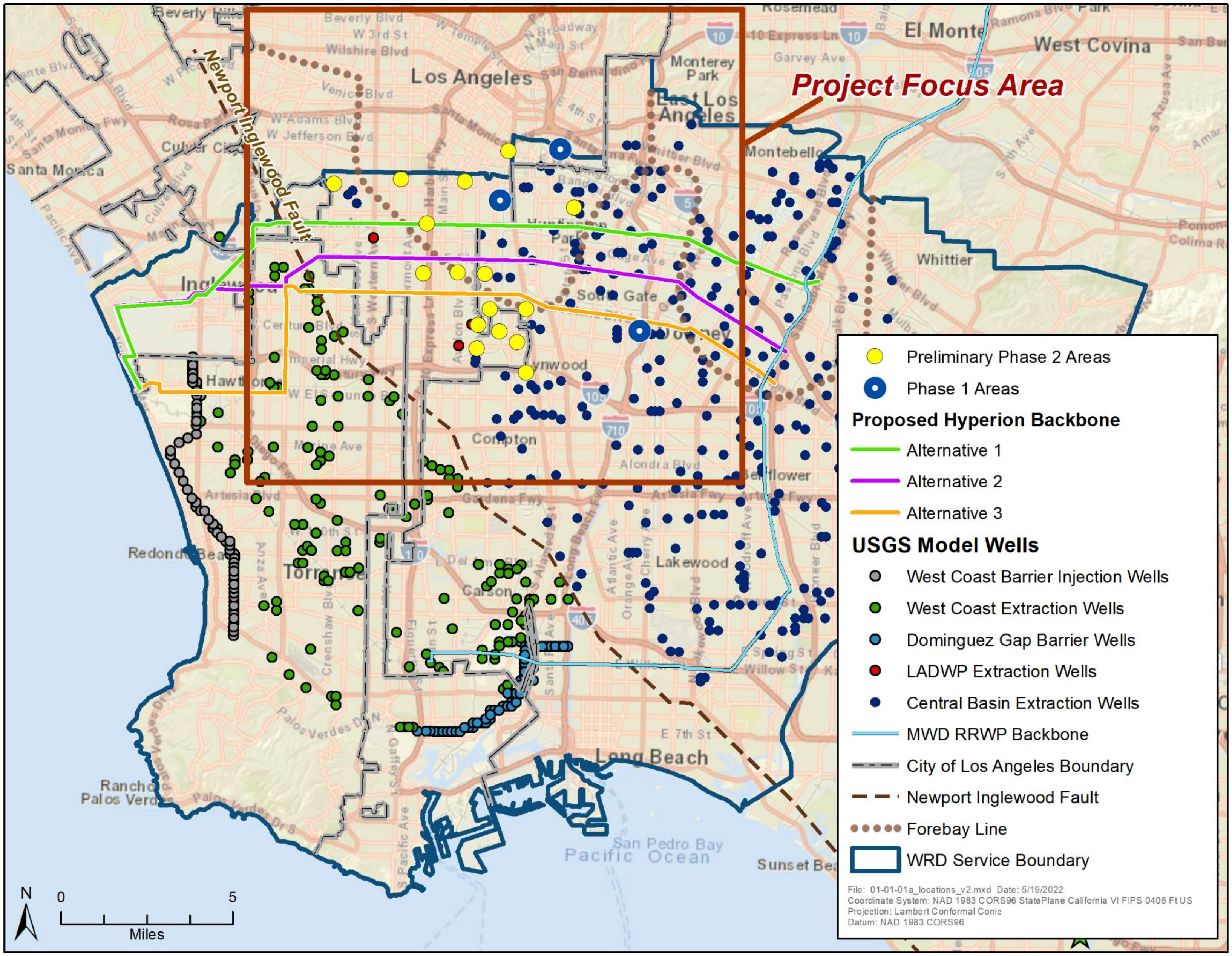
IW = Injection Well

EW = Extraction Well

Table 5: Downscaling Calculation Summary

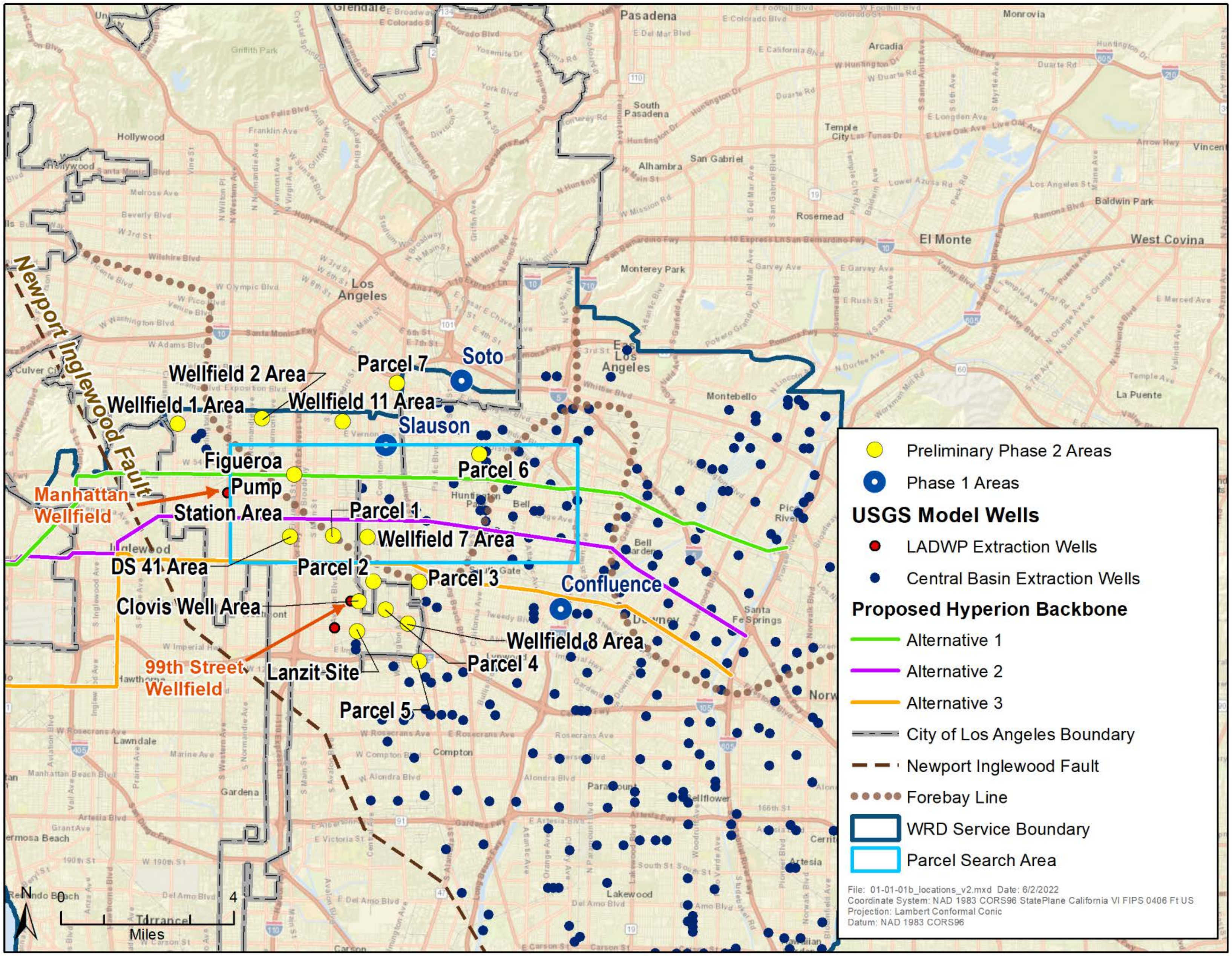
Type	**Well Name**	**Largest Head Decrease/Increase in Pacific A Due to Downscaling (ft)**	**Largest Head Decrease/Increase in Pacific Due to Downscaling (ft)**	**Lowest/Highest Water Level in Pacific A with Downscaling (ft)**	**Lowest/Highest Water Level in Pacific with Downscaling (ft)**	**Top Elevation of Pacific A/50 ft bgs (ft)**
Extraction	EW01	-22.7	-25.2	-87.9	-89.9	-150.0
Extraction	EW02	-25.9	-28.7	-90.8	-94.6	-148.5
Extraction	EW03	-22.9	-25.5	-82.4	-88.6	-257.1
Extraction	EW04	-22.4	-25.4	-80.8	-88.5	-243.2
Extraction	EW05	-22.5	-25.6	-80.8	-89.1	-266.9
Extraction	EW06	-22.4	-25.7	-80.8	-89.5	-272.1
Extraction	EW07	-22.6	-24.9	-82.0	-87.6	-295.6
Extraction	EW08	-24.8	-27.4	-84.9	-91.1	-304.9
Injection	IW01	+37.6	+43.1	+73.3	+88.3	+113.3
Injection	IW02	+29.6	+34.8	+61.9	+76.2	+113.1
Injection	IW03	+30.5	+35.8	+62.9	+78.2	+106.9
Injection	IW04	+28.1	+33.5	+59.1	+74.6	+106.1
Injection	IW05	+26.8	+32.2	+55.9	+71.5	+104.1
Injection	IW06	+29.9	+35.1	+60.5	+76.2	+105.7
Injection	IW07	+27.6	+33.1	+56.2	+73.4	+102.6
Injection	IW08	+28.7	+34.5	+56.7	+75.2	+101.7
Injection	IW09	+27.3	+33.5	+52.5	+72.4	+96.9

Figures



INTERA

Figure 1.1a
Overview of Project Area



INTERA

Figure 1.1b

Location of Phase-1 and Phase-2 Wells

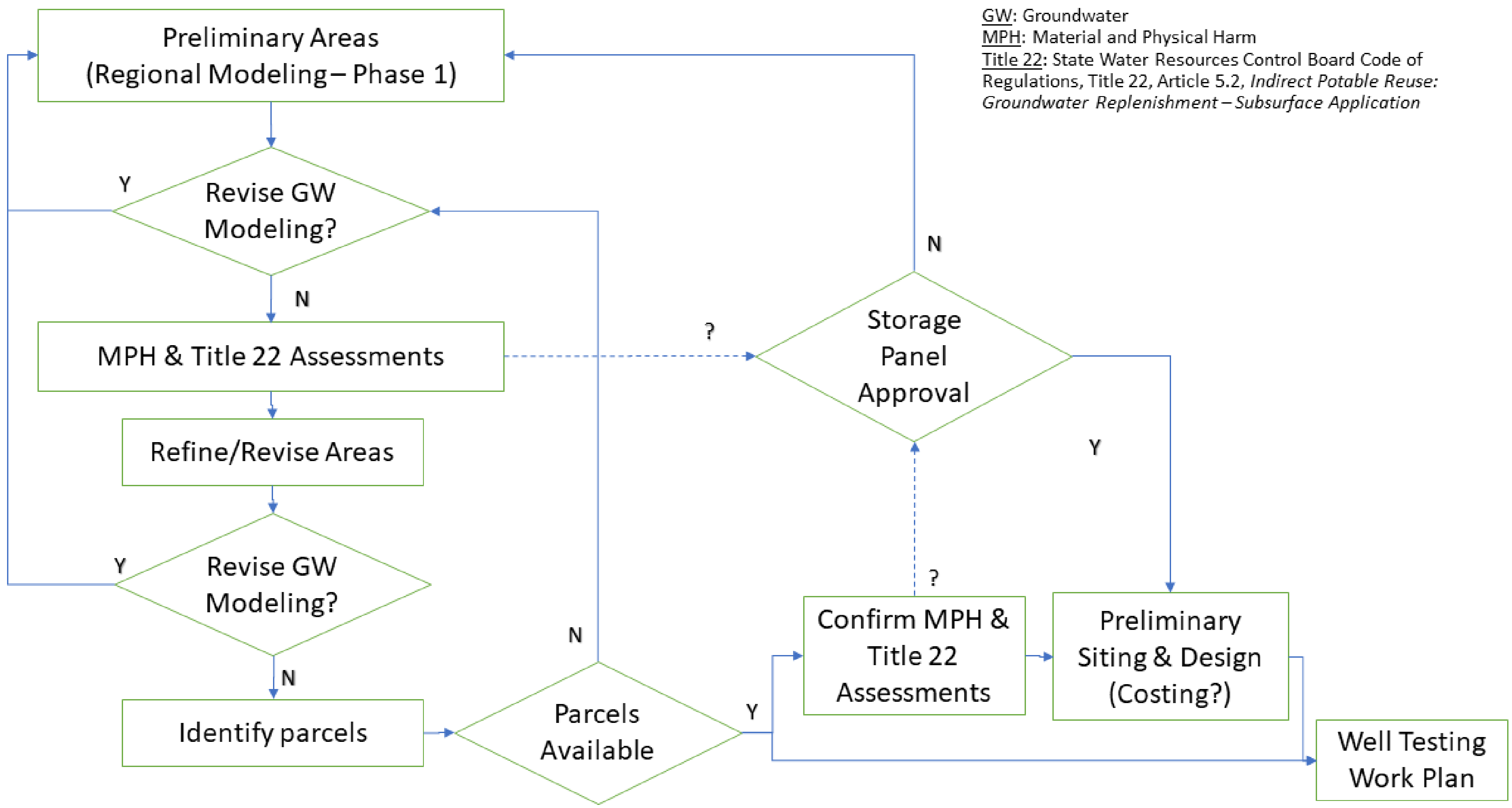
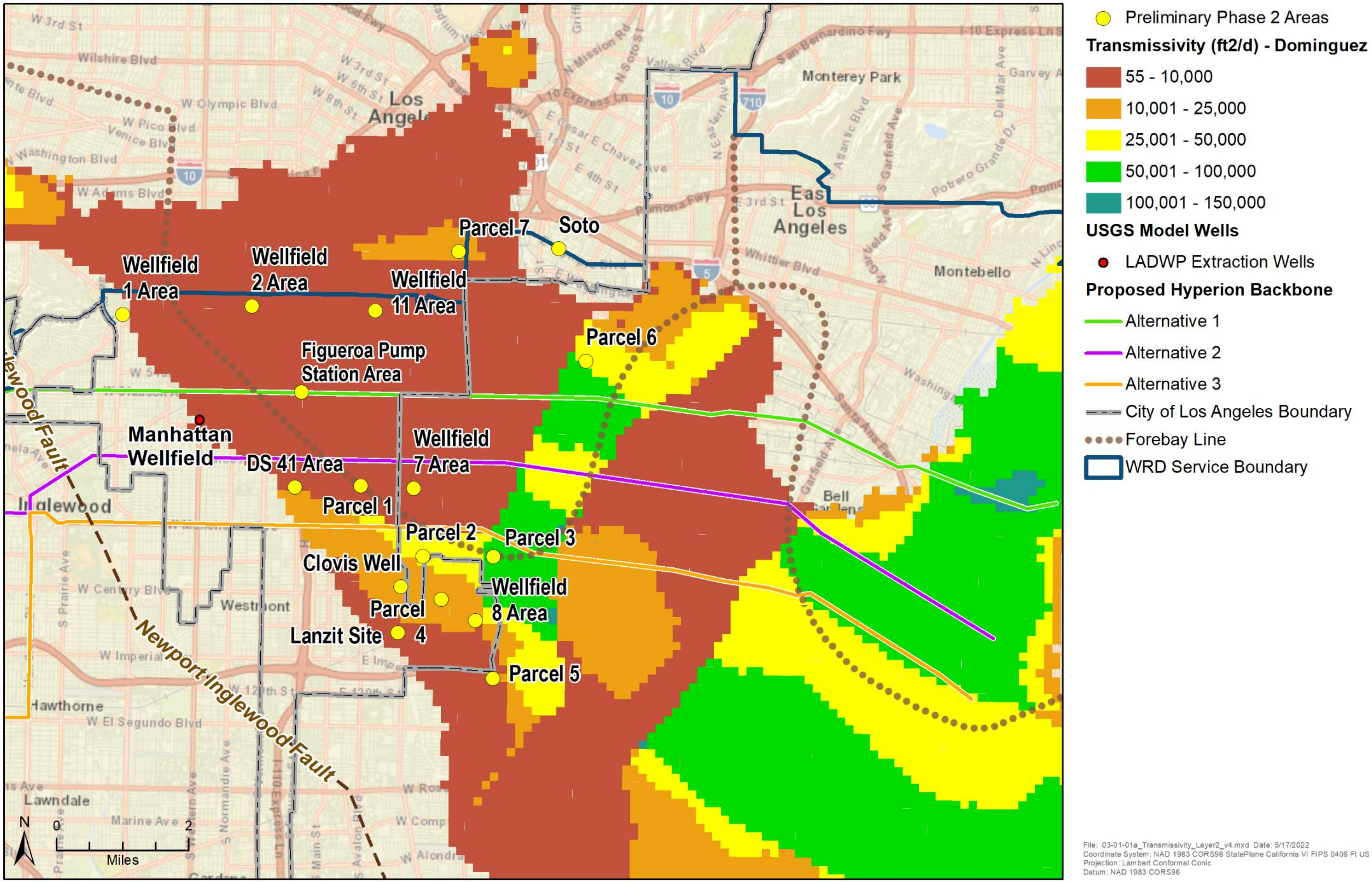


Figure 1.2
Phase 2 Groundwater Modeling Approach



INTERA

Figure 3.1.1a
Transmissivity (ft2/d) - Dominguez Sequence, model layer 2

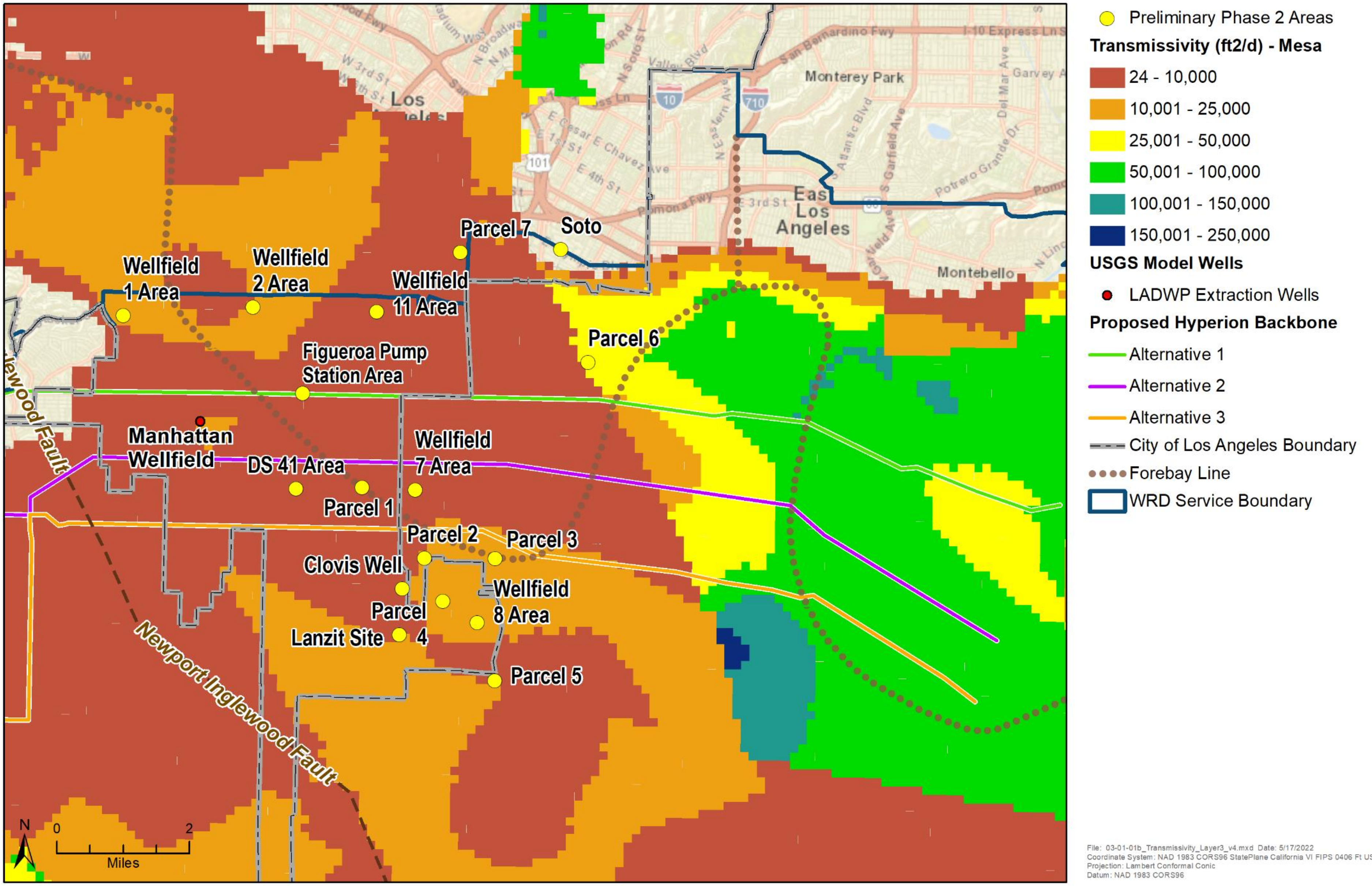
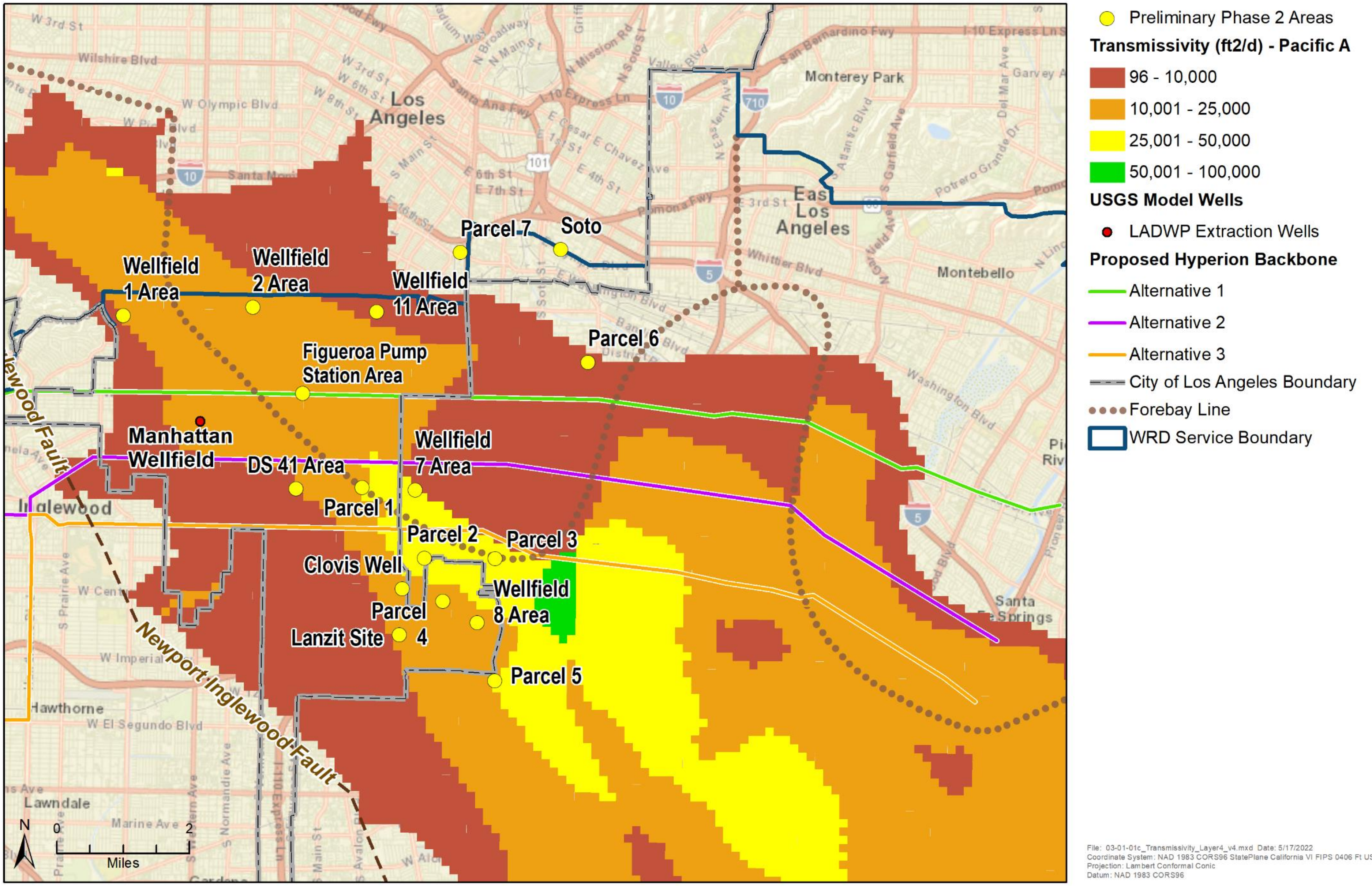
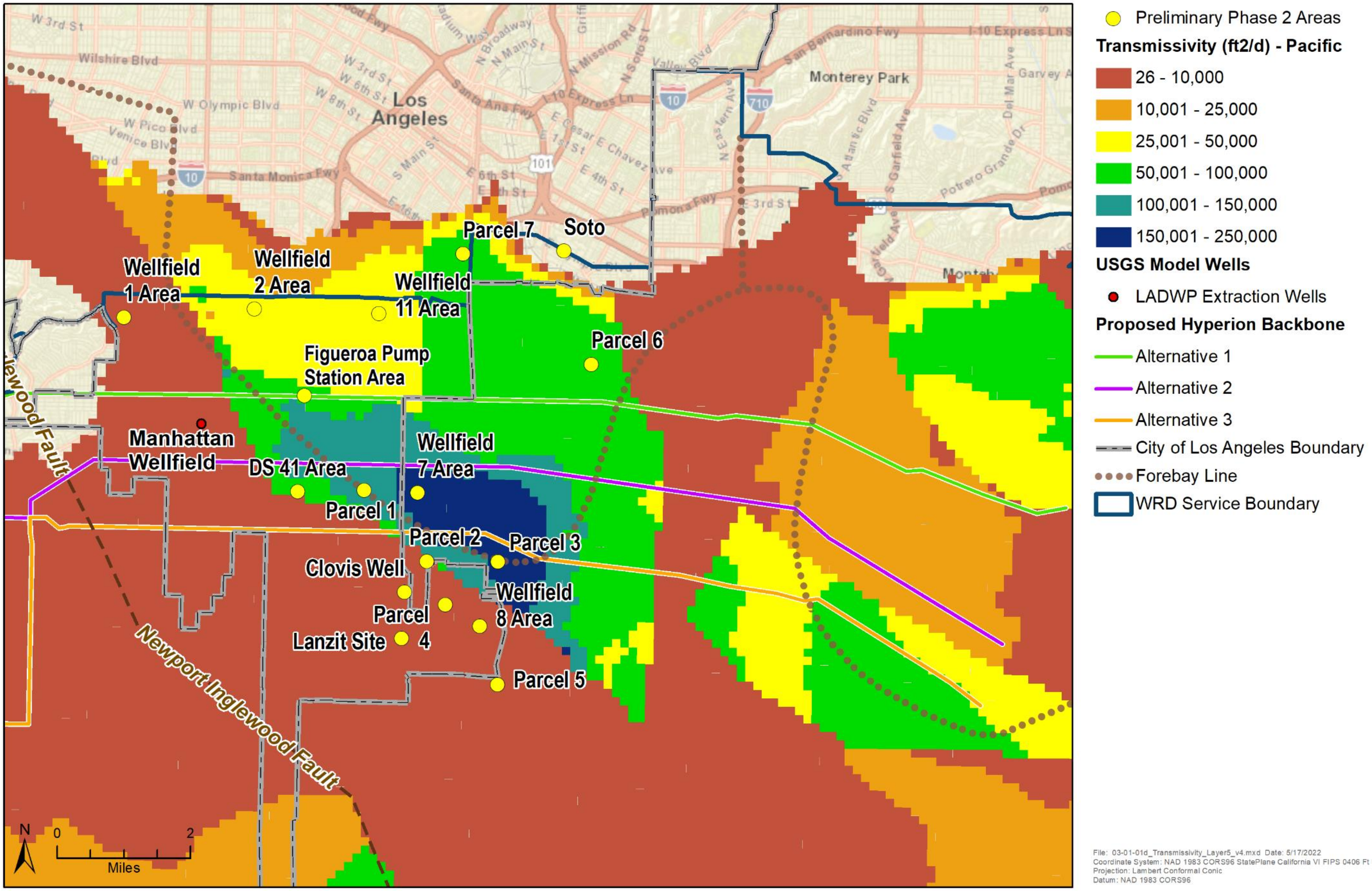


Figure 3.1.1b
Transmissivity (ft2/d) - Mesa Sequence, model layer 3



INTERA

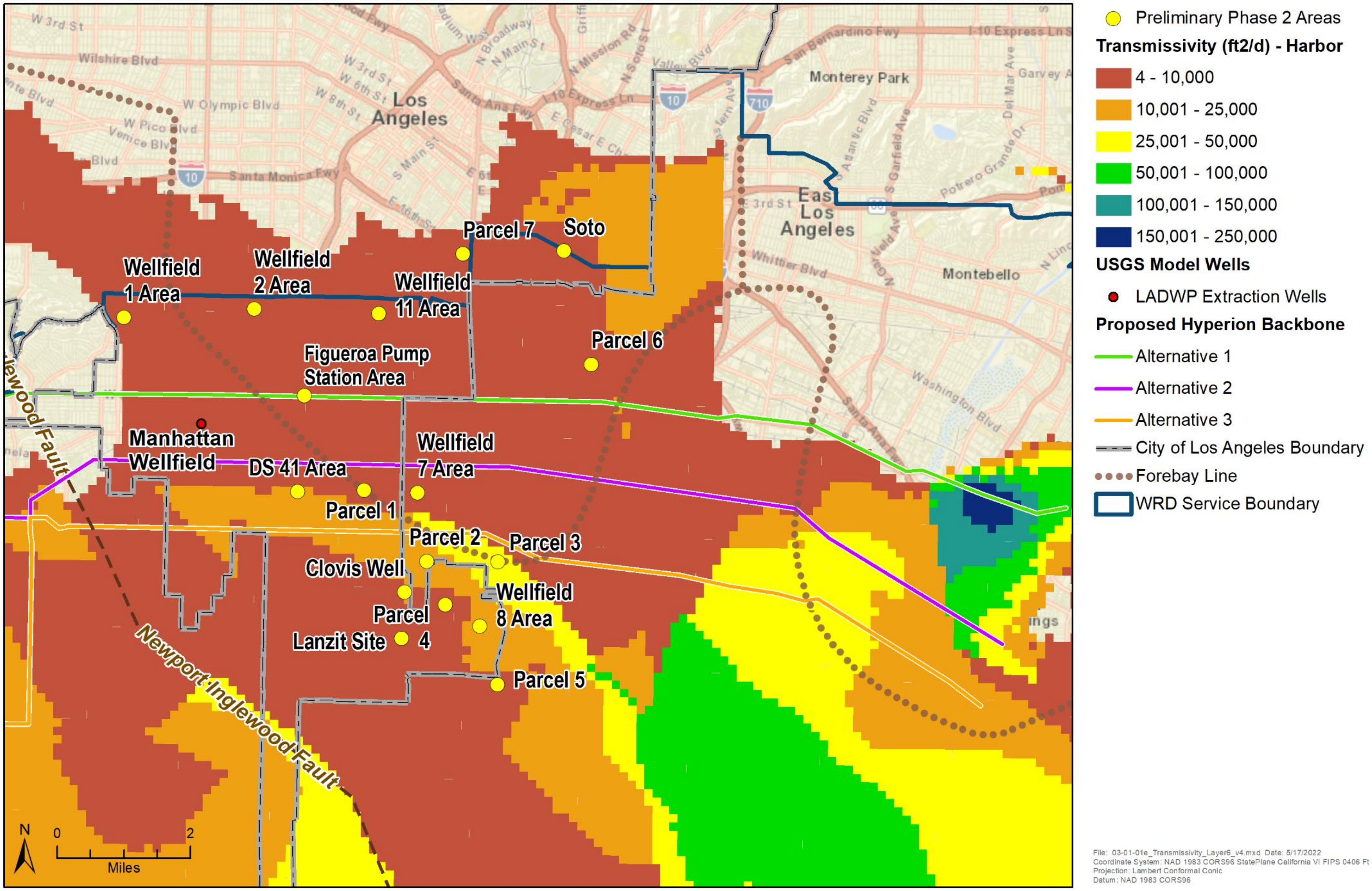
Figure 3.1.1c
Transmissivity (ft2/d) - Pacific A Sequence, model layer 4



File: 03-01-01d_Transmissivity_Layer5_v4.mxd Date: 5/17/2022
Coordinate System: NAD 1983 CORS96 StatePlane California VI FIPS 0406 Ft US
Projection: Lambert Conformal Conic
Datum: NAD 1983 CORS96

INTERA

Figure 3.1.1d
Transmissivity (ft2/d) - Pacific Sequence, model layer 5



INTERA

Figure 3.1.1e
Transmissivity (ft2/d) - Harbor Sequence, model layer 6

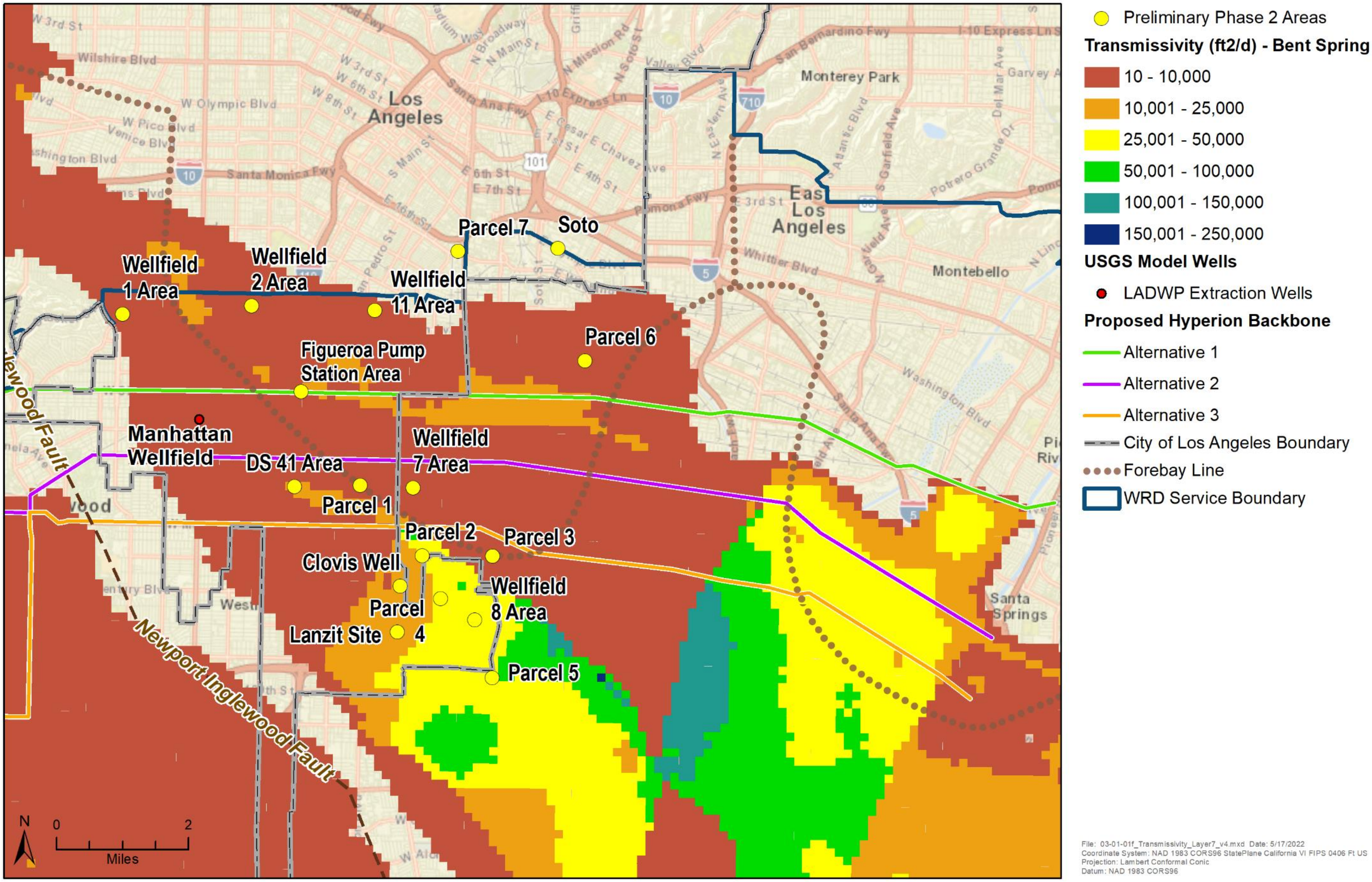
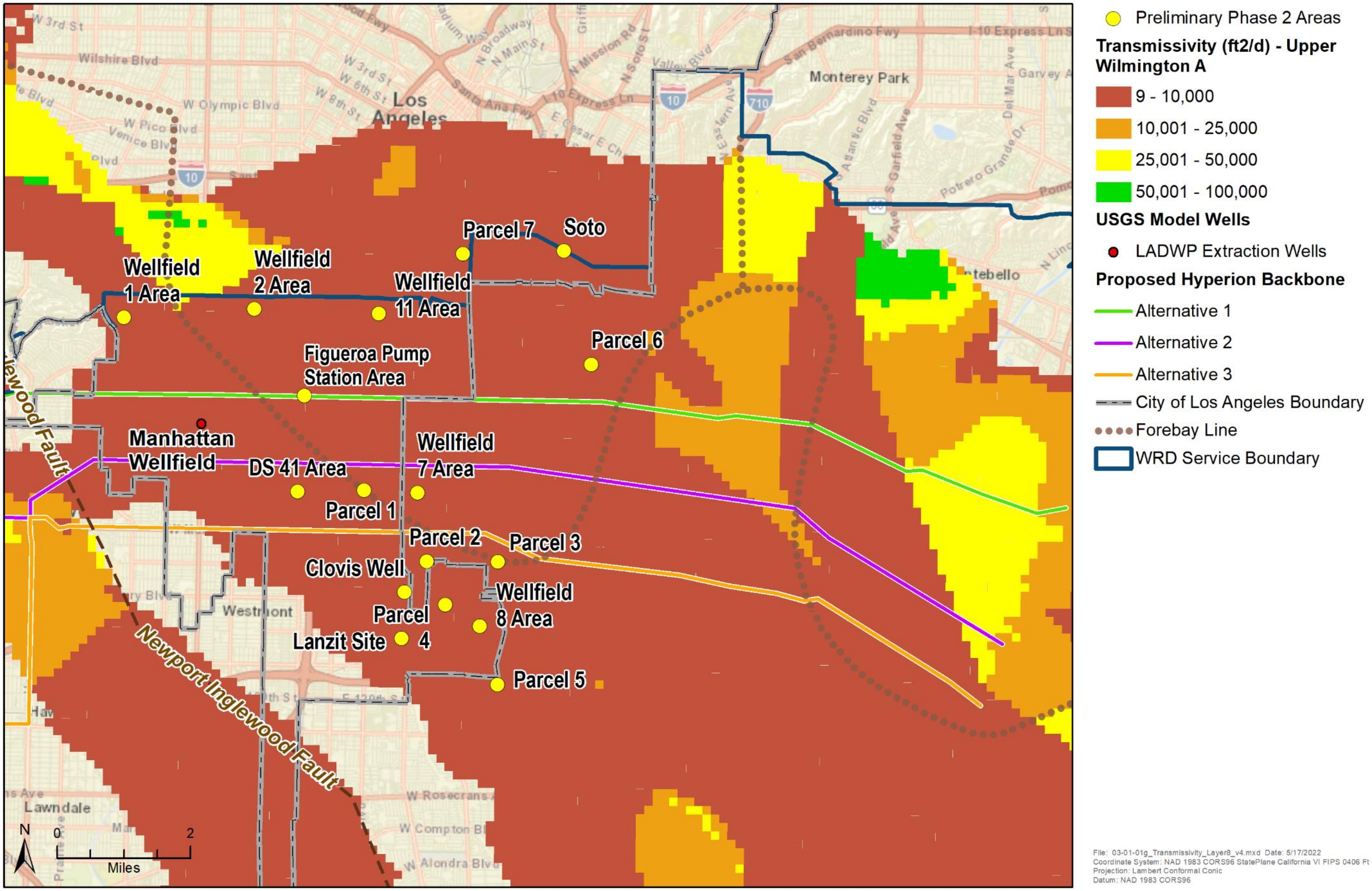


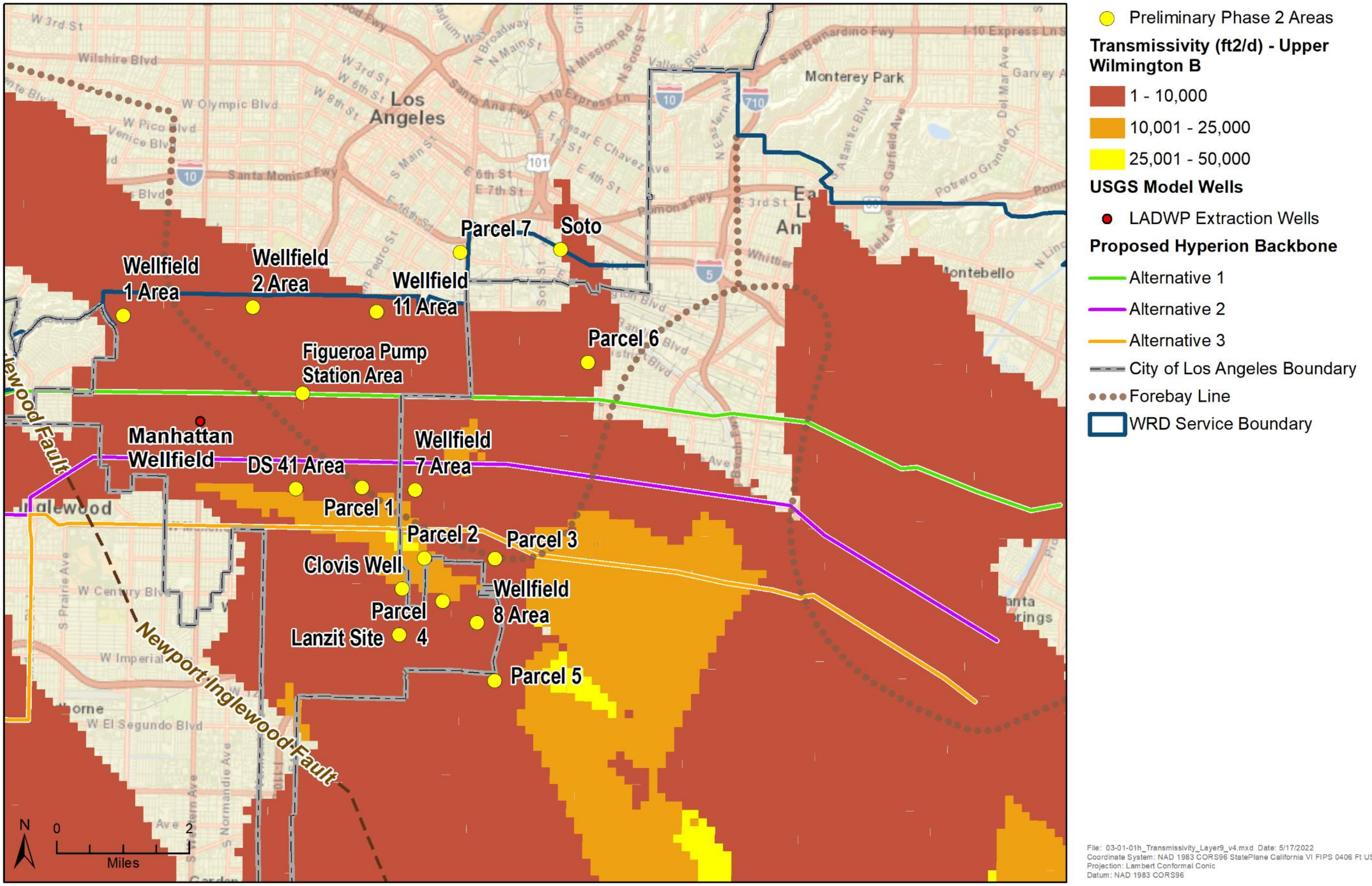
Figure 3.1.1f
Transmissivity (ft2/d) - Bent Spring Sequence, model layer 7



File: 03-01-01g_Transmissivity_Layer8_v4.mxd Date: 5/17/2022
Coordinate System: NAD 1983 CORS96 StatePlane California VI FIPS 0406 Ft US
Projection: Lambert Conformal Conic
Datum: NAD 1983 CORS96

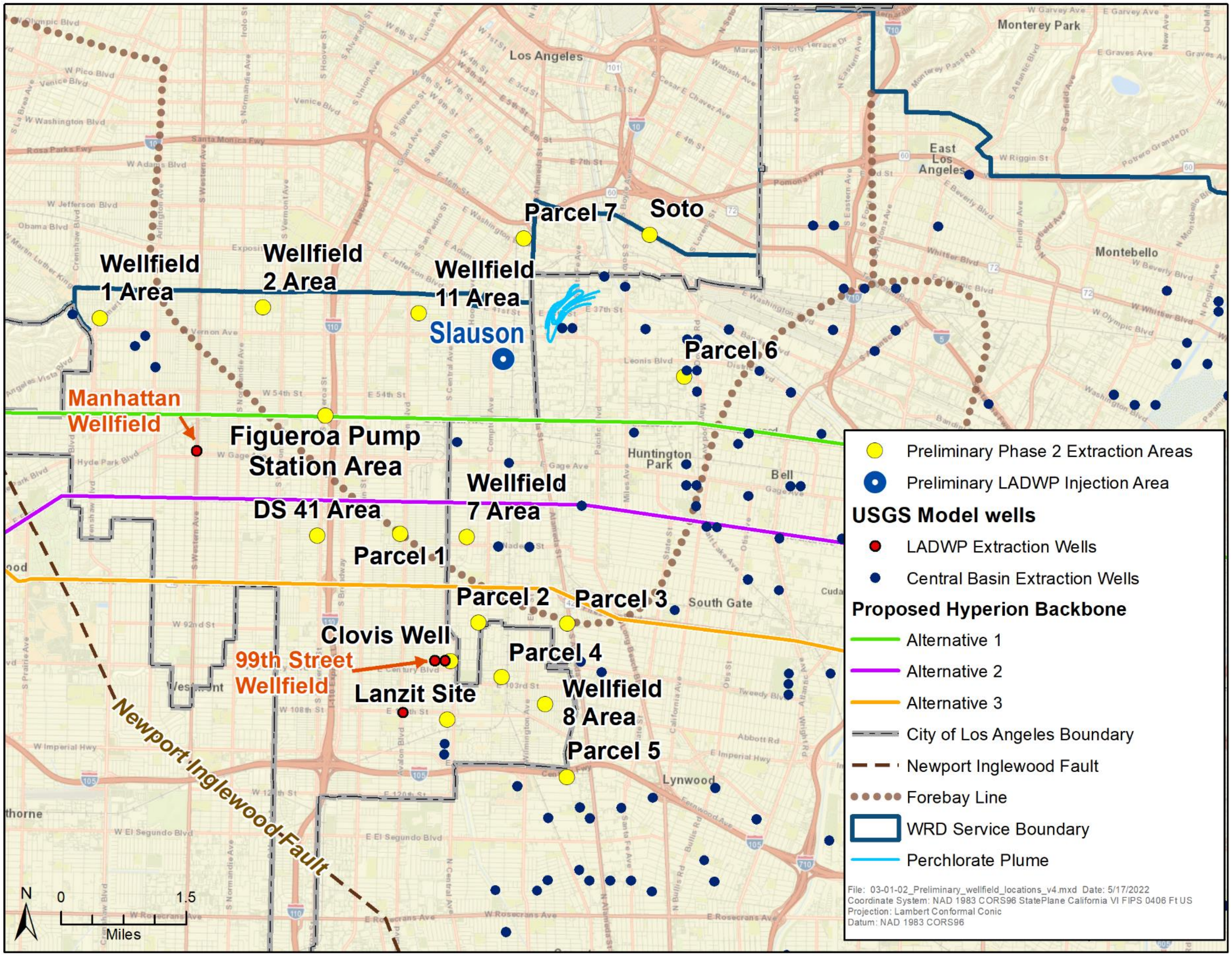
INTERA

Figure 3.1.1g
Transmissivity (ft2/d) - Upper Wilmington A Sequence, model layer 8



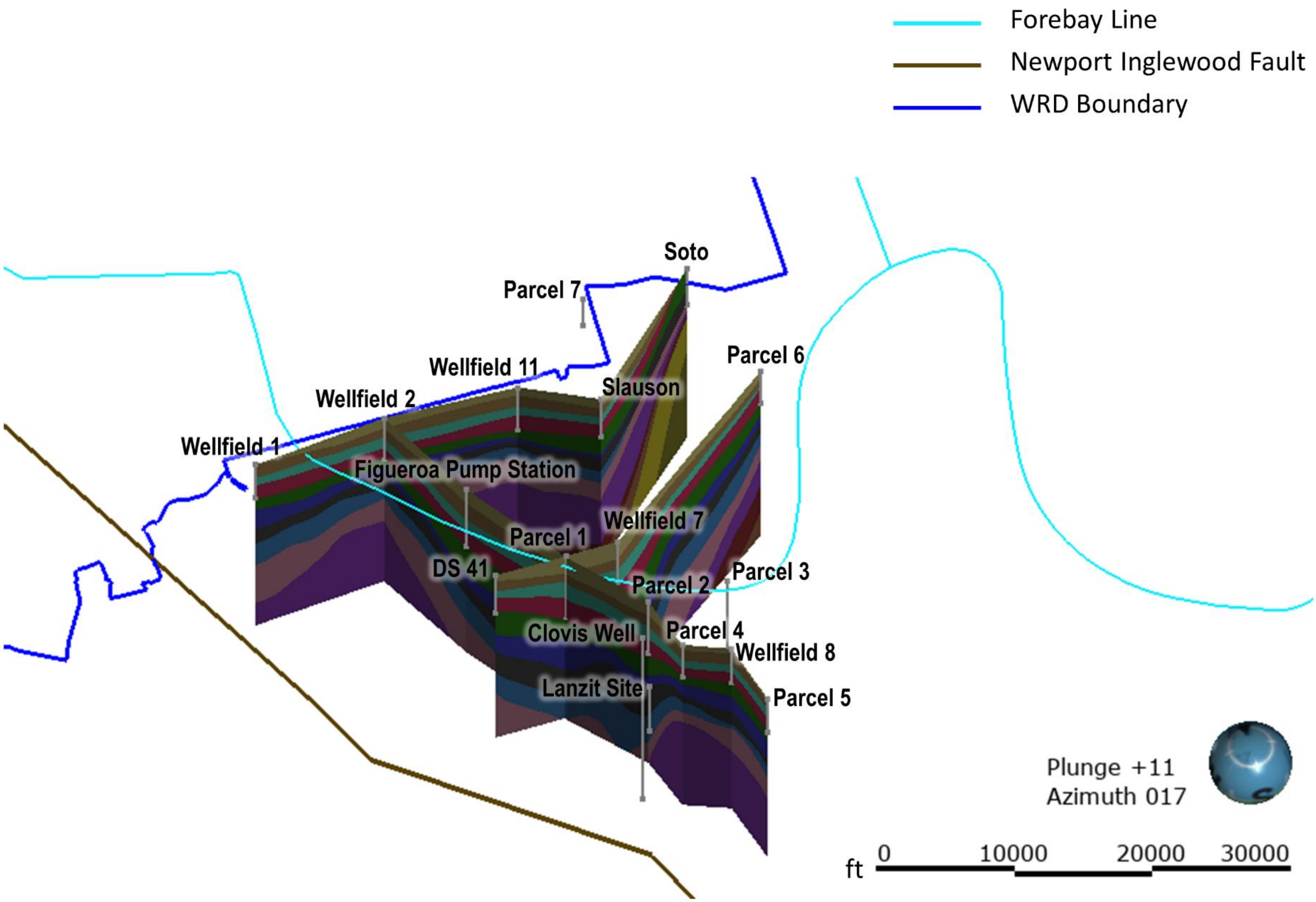
INTERA

Figure 3.1.1h
Transmissivity (ft2/d) - Upper Wilmington B Sequence, model layer 9



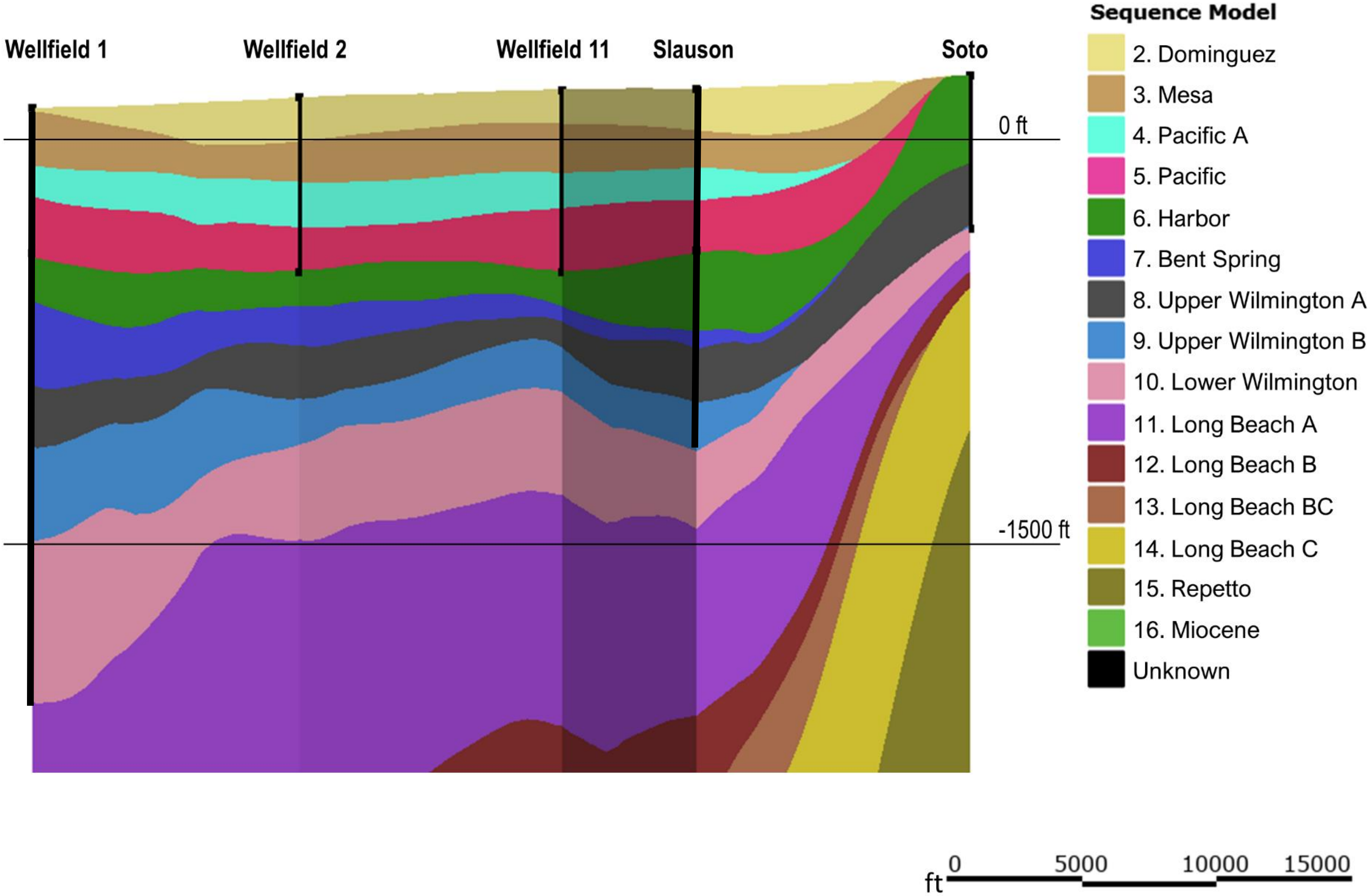
INTERA

Figure 3.1.2
Map of Preliminary Locations for Phase-2 Wellfield Evaluations



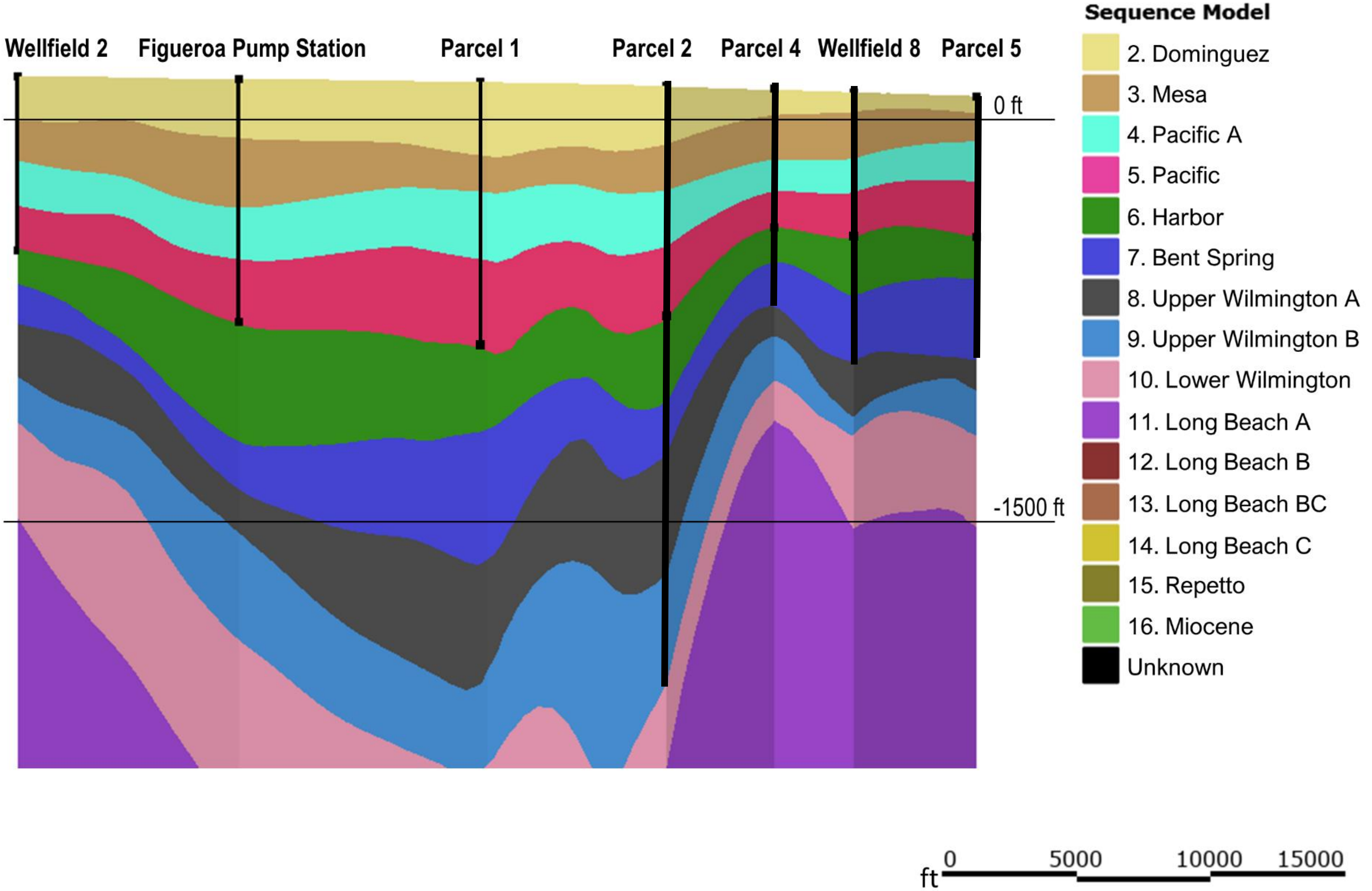
INTERA

Figure 3.1.3a
Phase-2 Wellfield Locations and Fence Sections



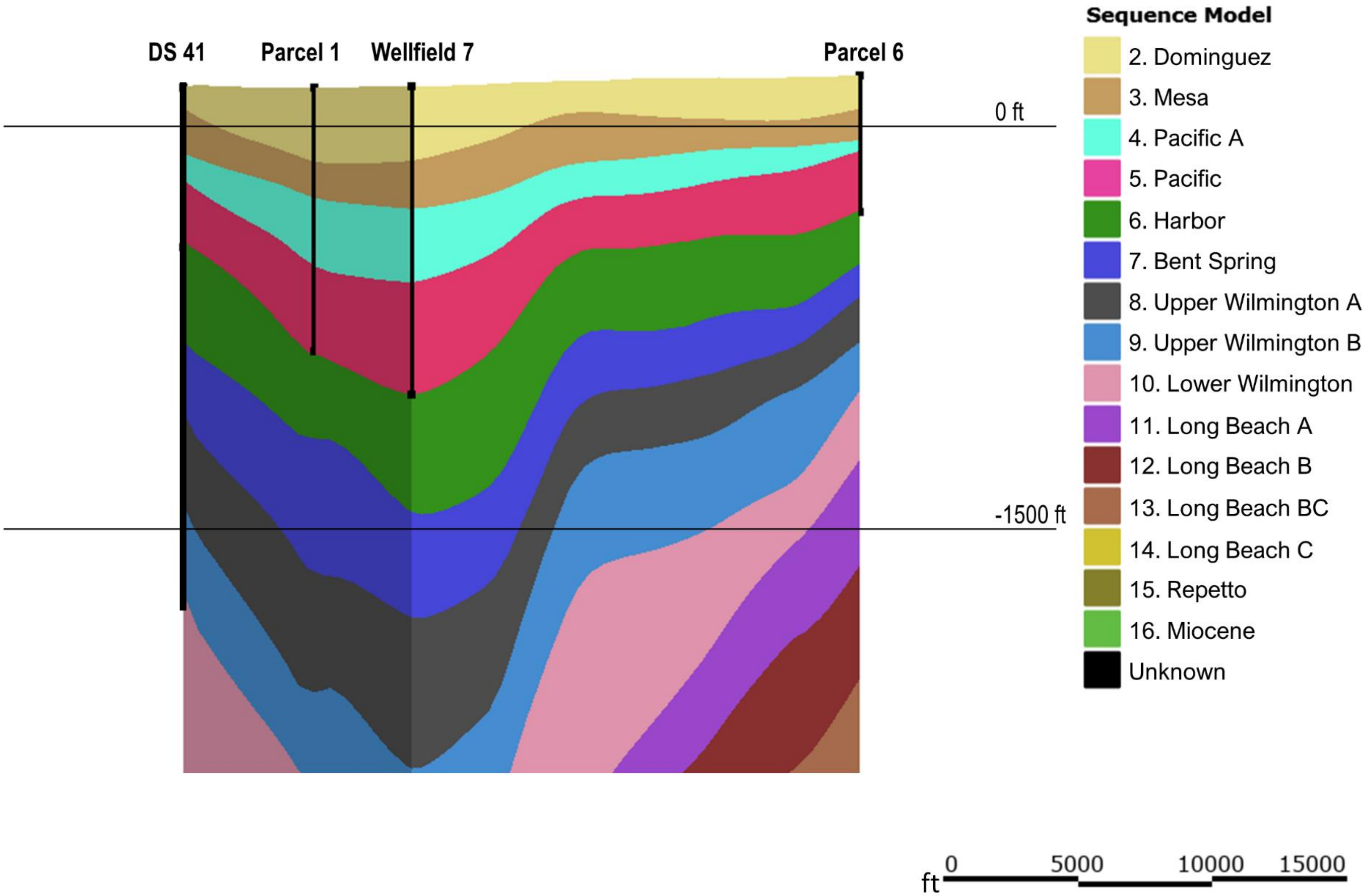
INTERA

Figure 3.1.3b
Wellfield Fence-sections - Wellfield 1, Wellfield 2, Wellfield 11, Slauson, Soto



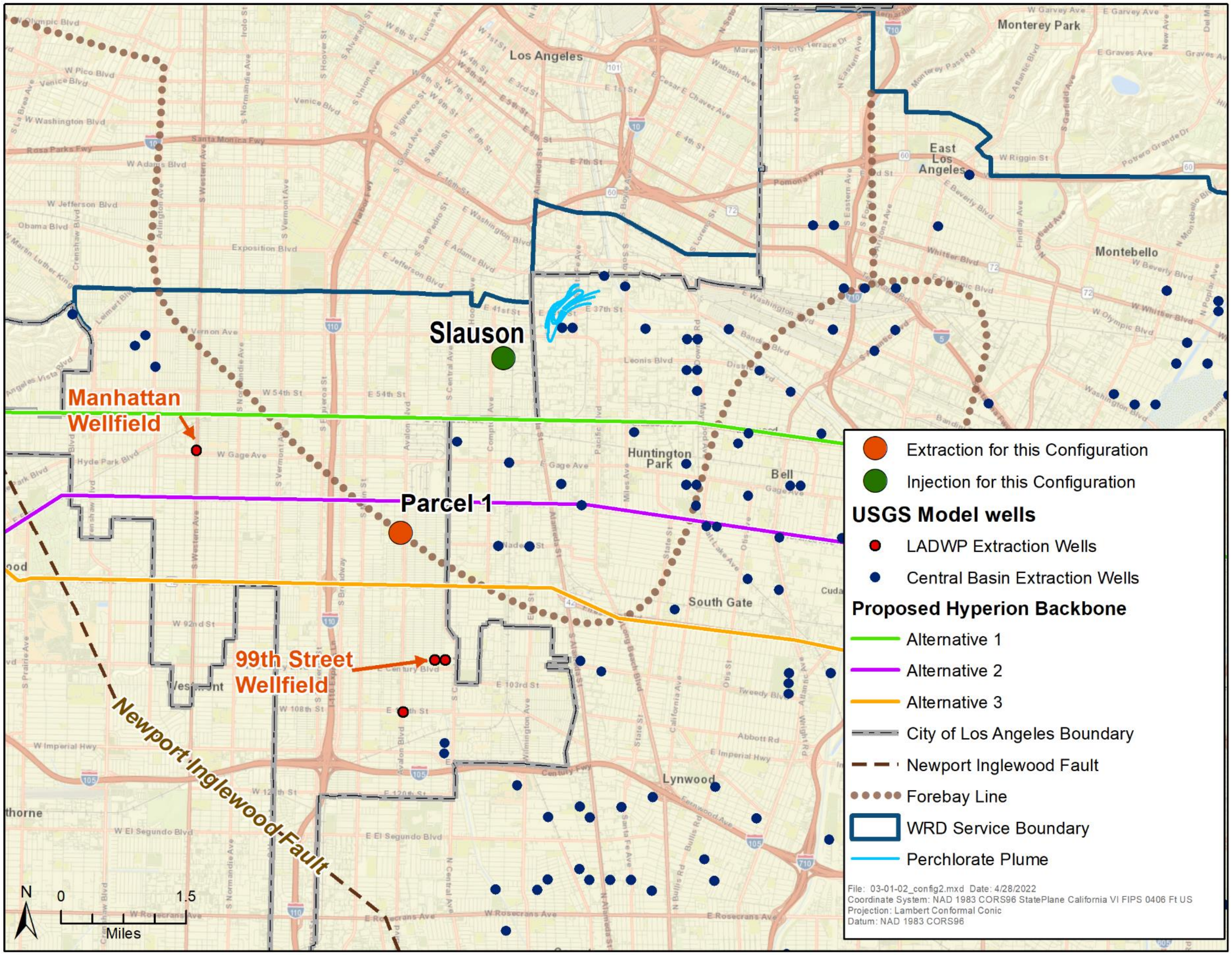
INTERA

Figure 3.1.3c
Wellfield Fence-sections - Wellfield 2, Figueroa Pump Station, Parcel 1, Parcel 2, Parcel 4, Wellfield 8, Parcel 5



INTERA

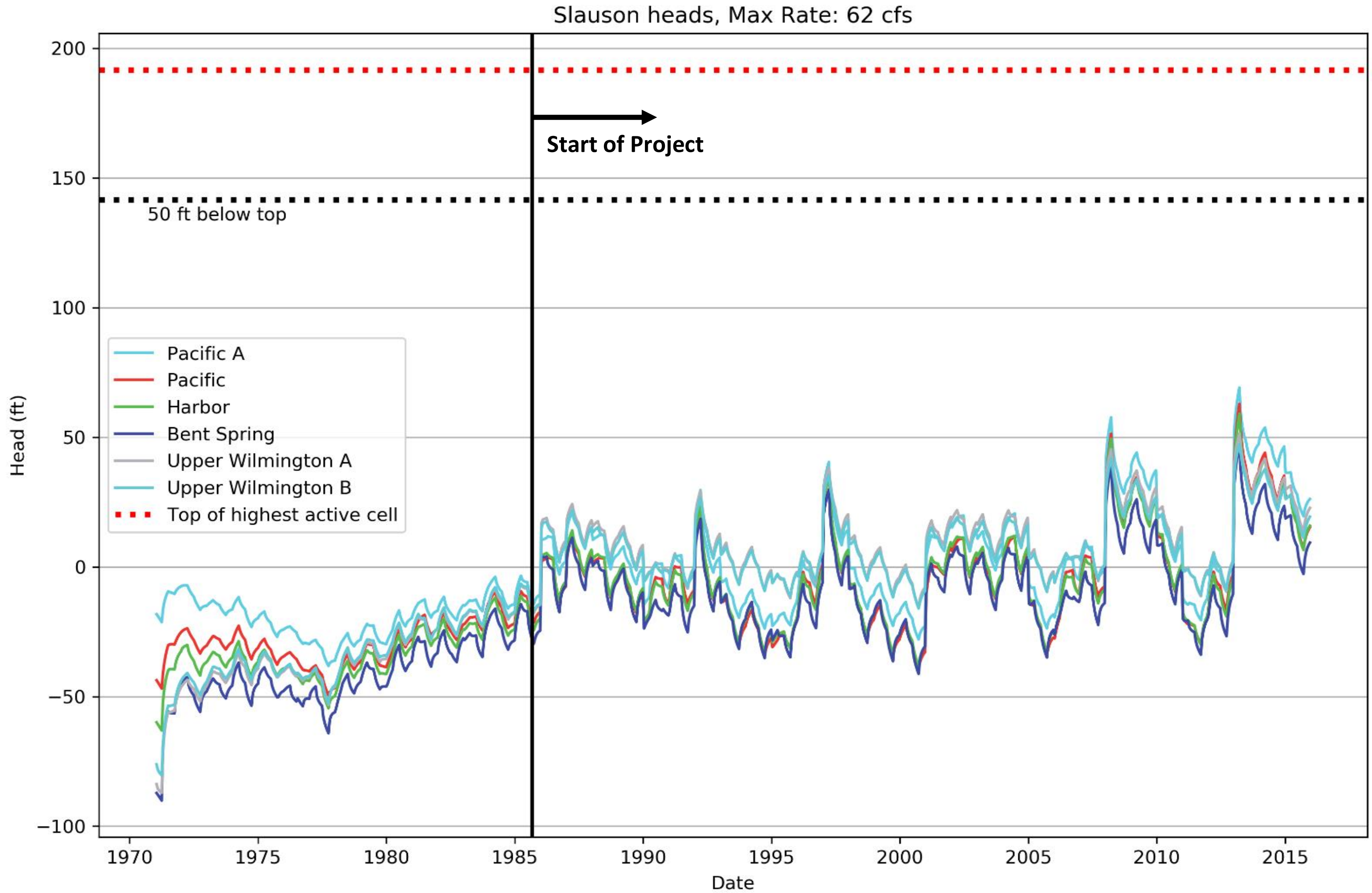
Figure 3.1.3d
Wellfield Fence-sections - DS-41, Parcel 1, Wellfield 7, Parcel 6



INTERA

Figure 3.1.4
Wellfield Configuration Map: Centralized Injection at Slauson Location with Centralized Extraction at Parcel 1

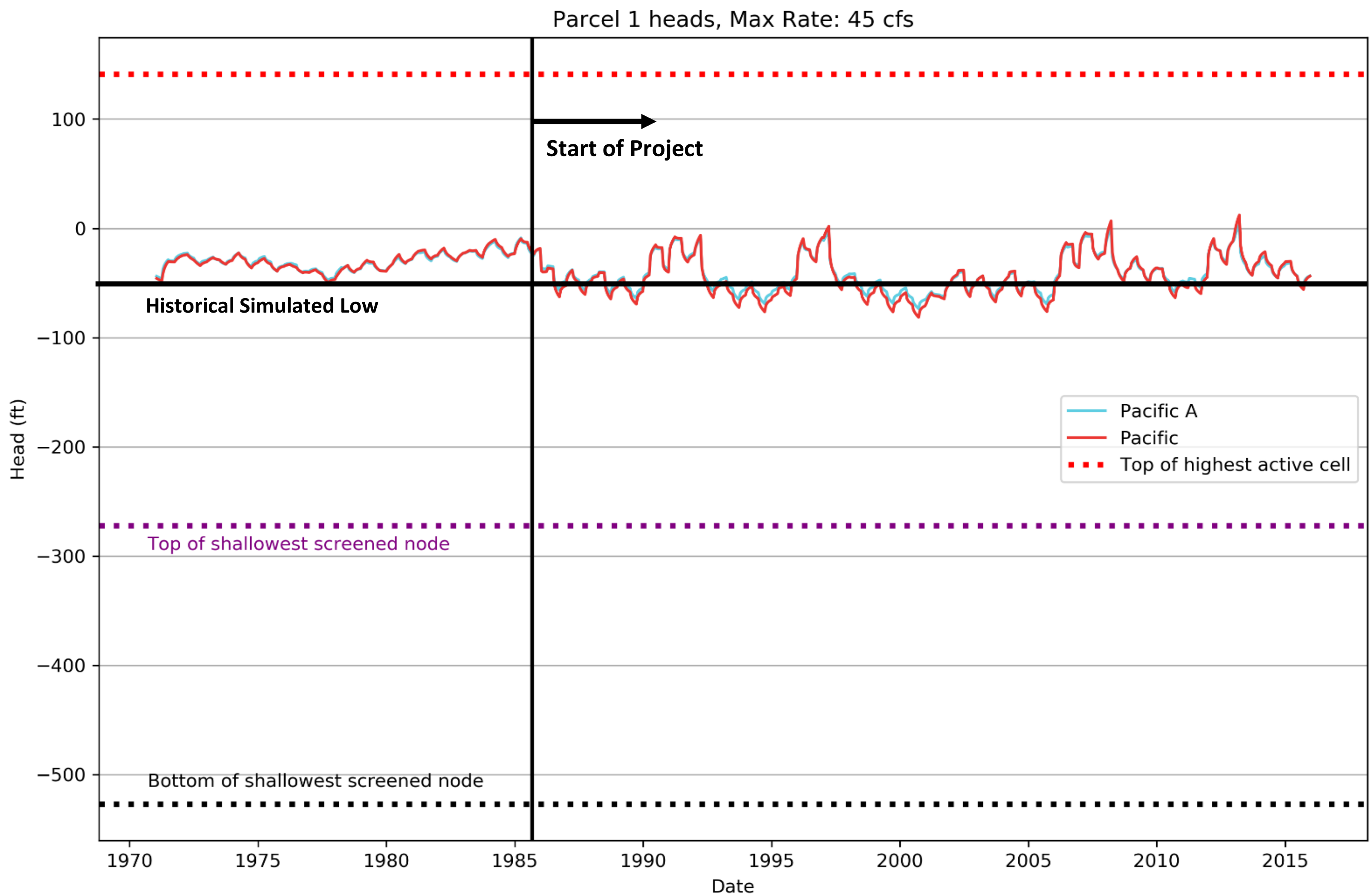
<u>Centralized Injection at Slauson Location with Centralized Extraction at Parcel 1</u>



INTERA

Figure 3.1.5a
Hydrograph at Injection Well - Slauson

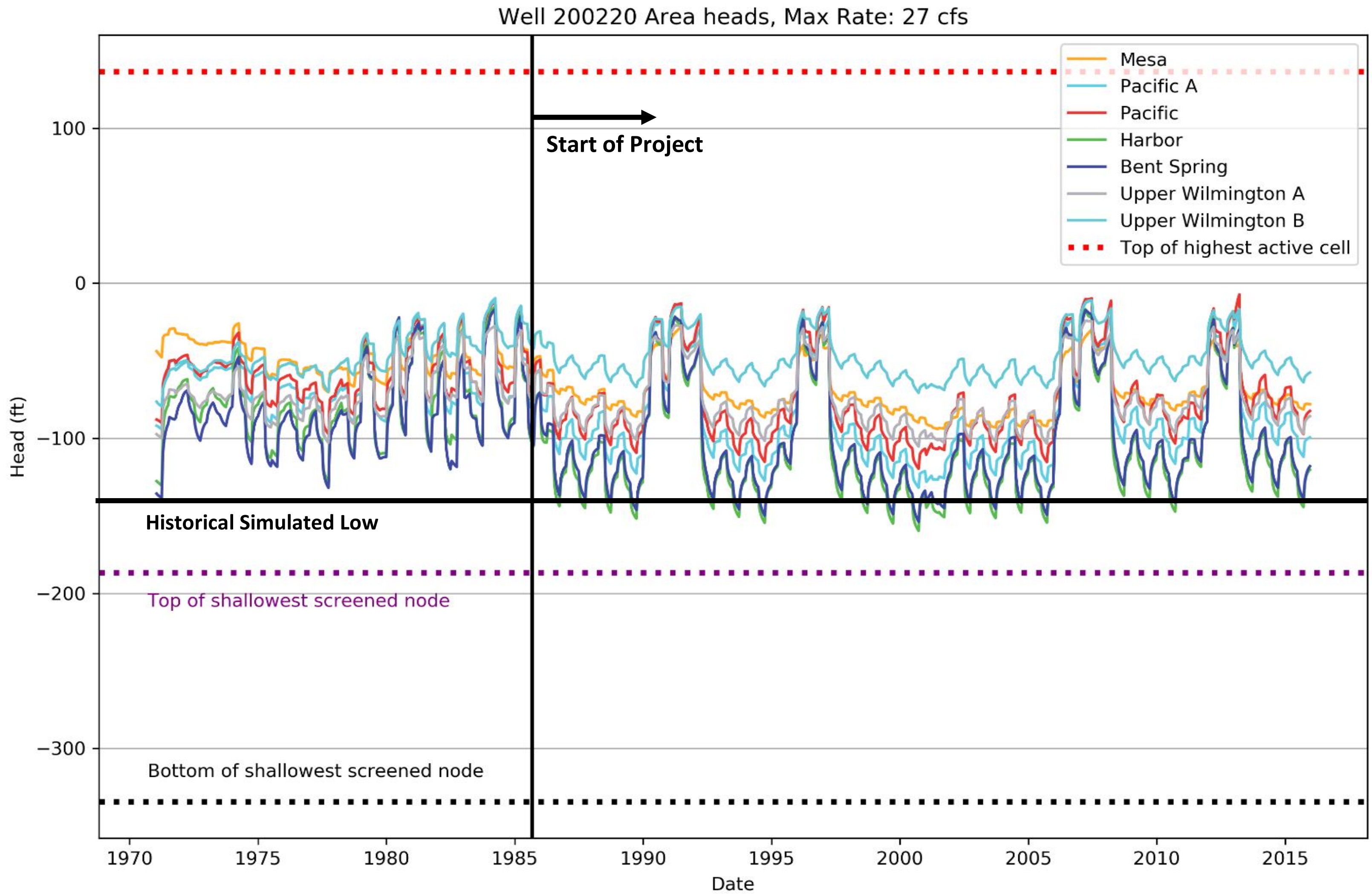
Centralized Injection at Slauson Location with Centralized Extraction at Parcel 1



INTERA

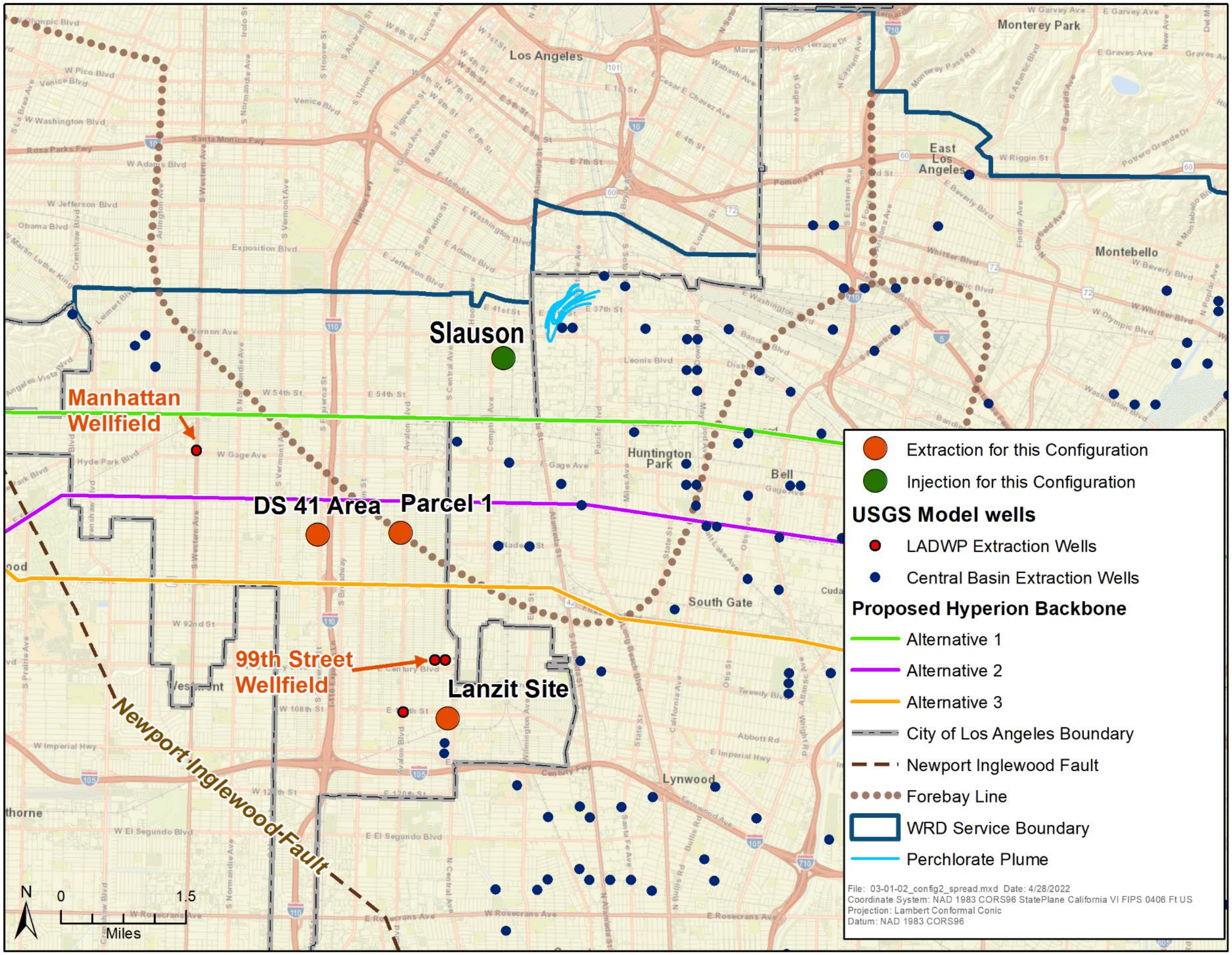
Figure 3.1.5b
Hydrograph at Extraction Well - Parcel 1

Centralized Injection at Slauson Location with Centralized Extraction at Parcel 1



INTERA

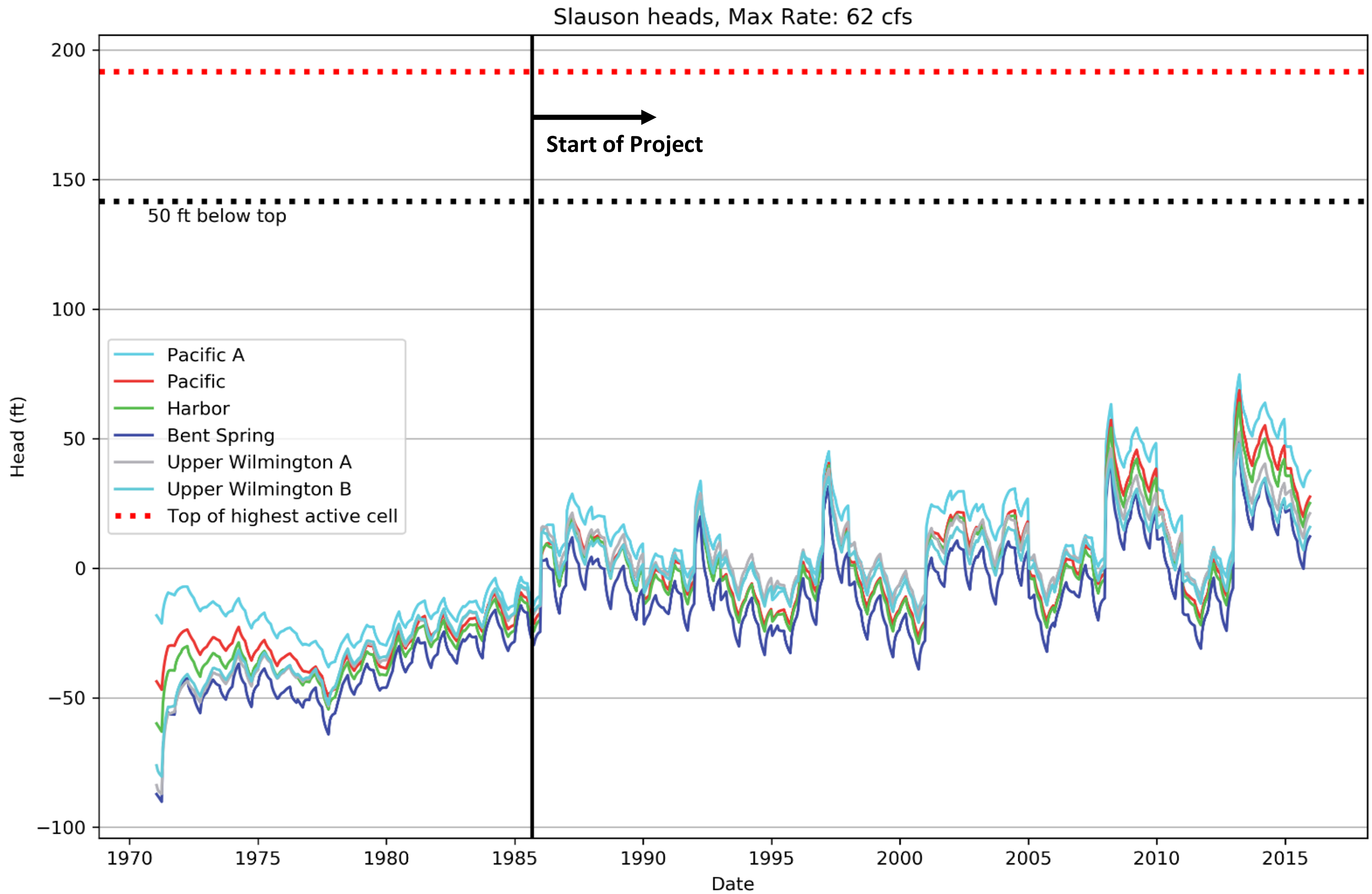
Figure 3.1.5c
Hydrograph at Extraction Well - Manhattan



INTERA

Figure 3.1.6
Wellfield Configuration Map: Centralized Injection at Slauson Location with Distributed Extraction at Parcel 1, Lanzit Site Area, and DS-41 Area

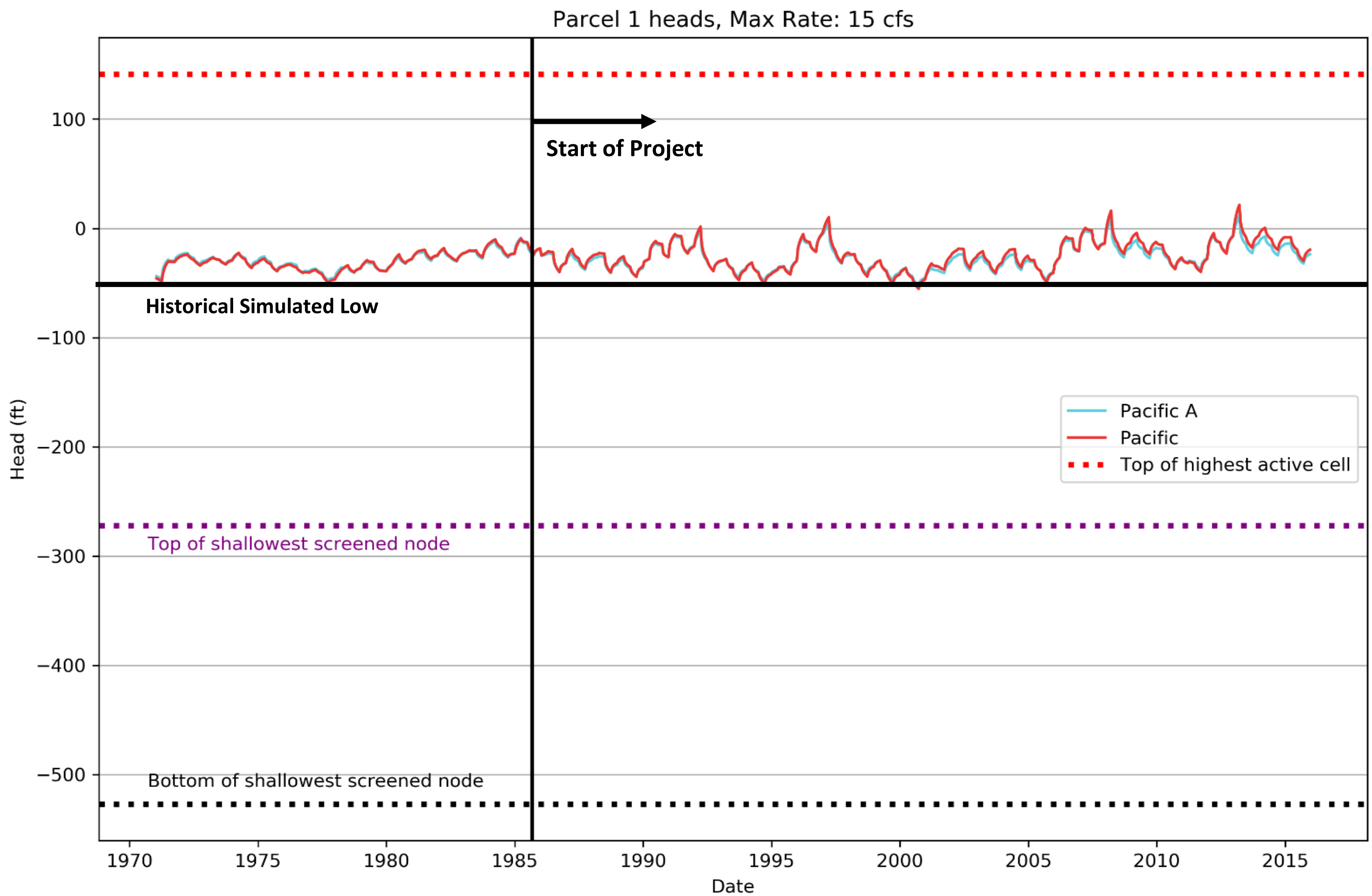
Centralized Injection at Slauson Location with Distributed Extraction at Parcel 1, Lanzit Site Area, and DS-41 Area



INTERA

Figure 3.1.7a
Hydrograph at Injection Well - Slauson

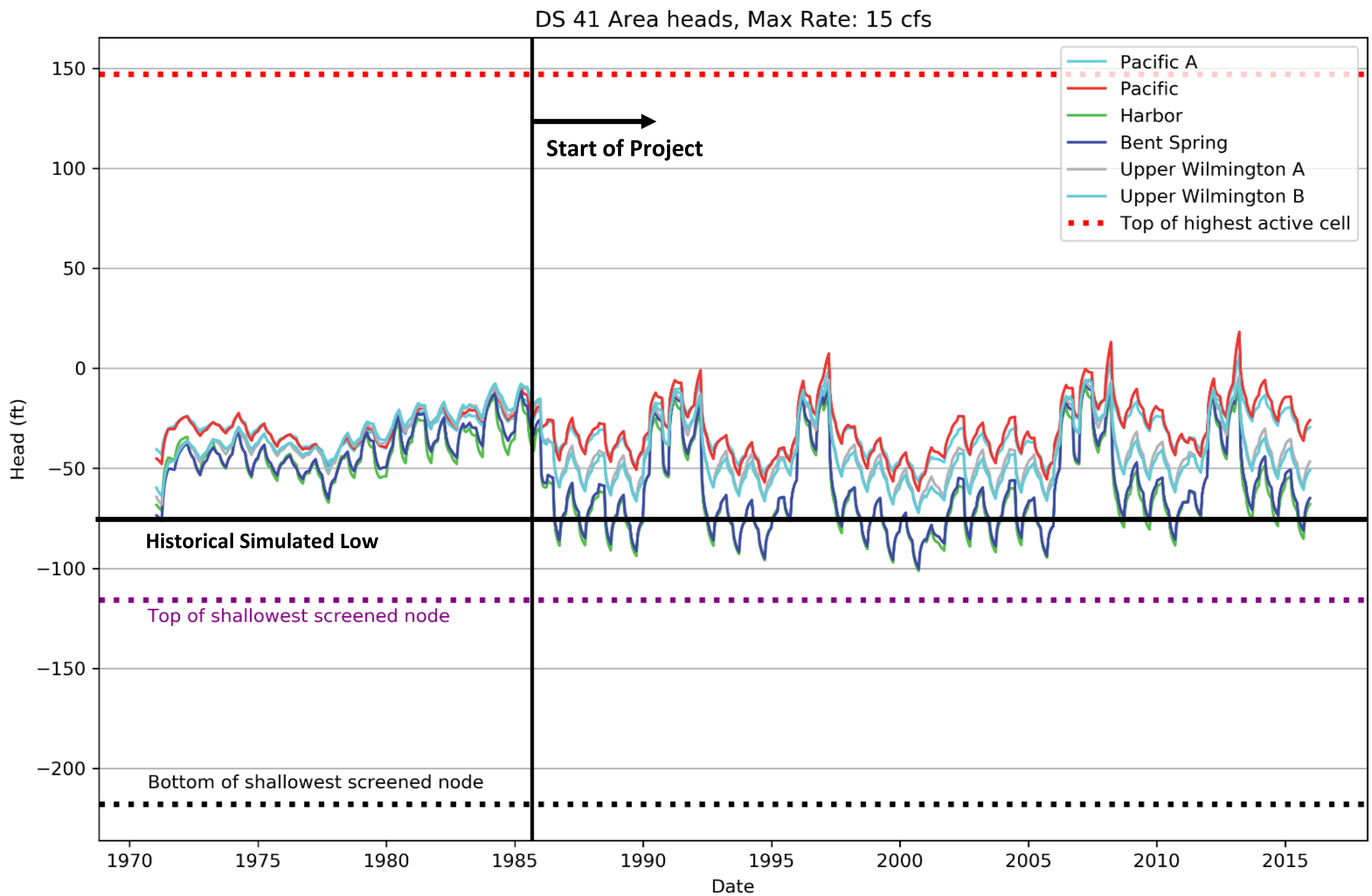
Centralized Injection at Slauson Location with Distributed Extraction at Parcel 1, Lanzit Site Area, and DS-41 Area



INTERA

Figure 3.1.7b
Hydrograph at Extraction Well - Parcel 1

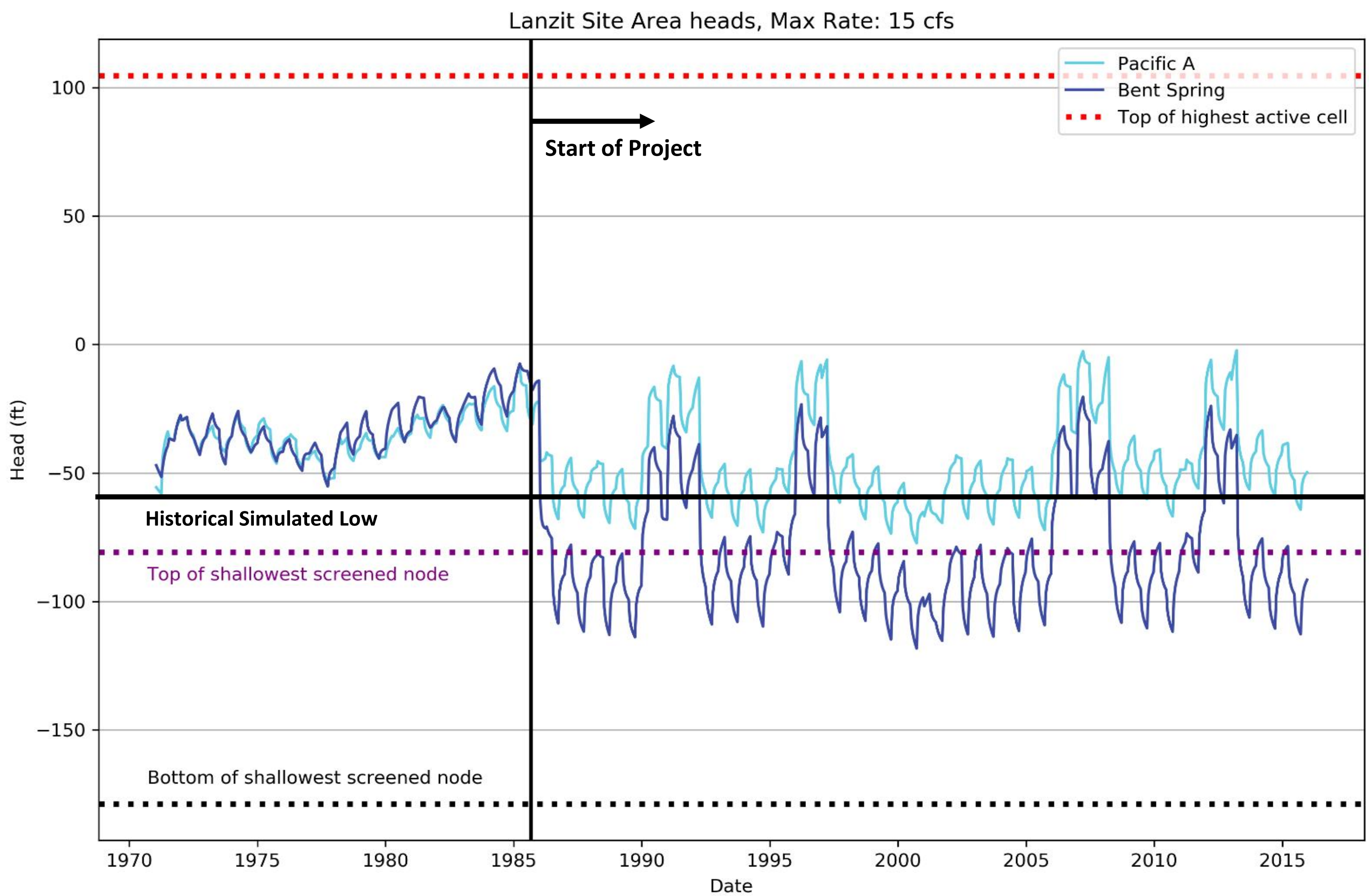
Centralized Injection at Slauson Location with Distributed Extraction at Parcel 1, Lanzit Site Area, and DS-41 Area



INTERA

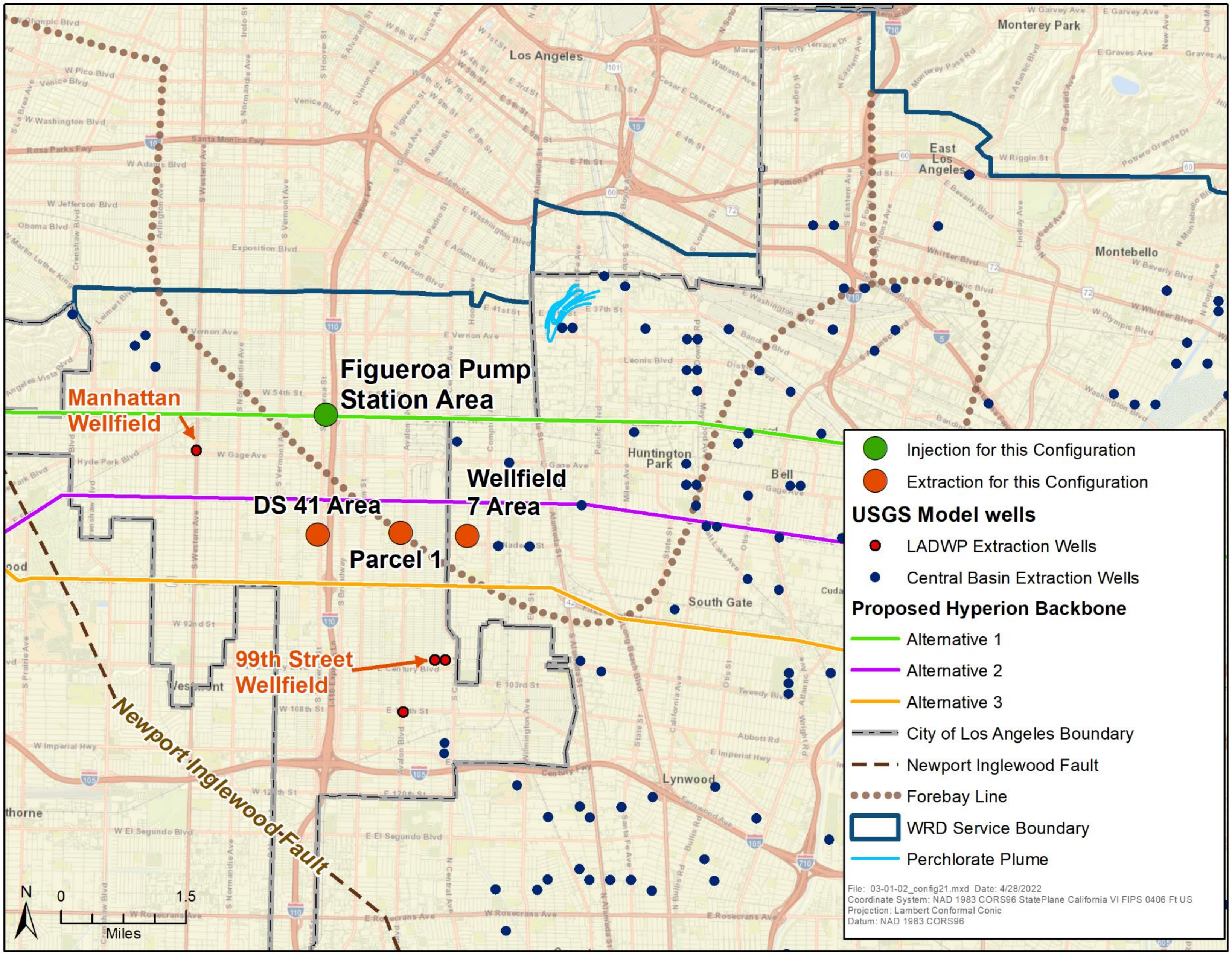
Figure 3.1.7c
Hydrograph at Extraction Well - DS-41 Area

Centralized Injection at Slauson Location with Distributed Extraction at Parcel 1, Lanzit Site Area, and DS-41 Area



INTERA

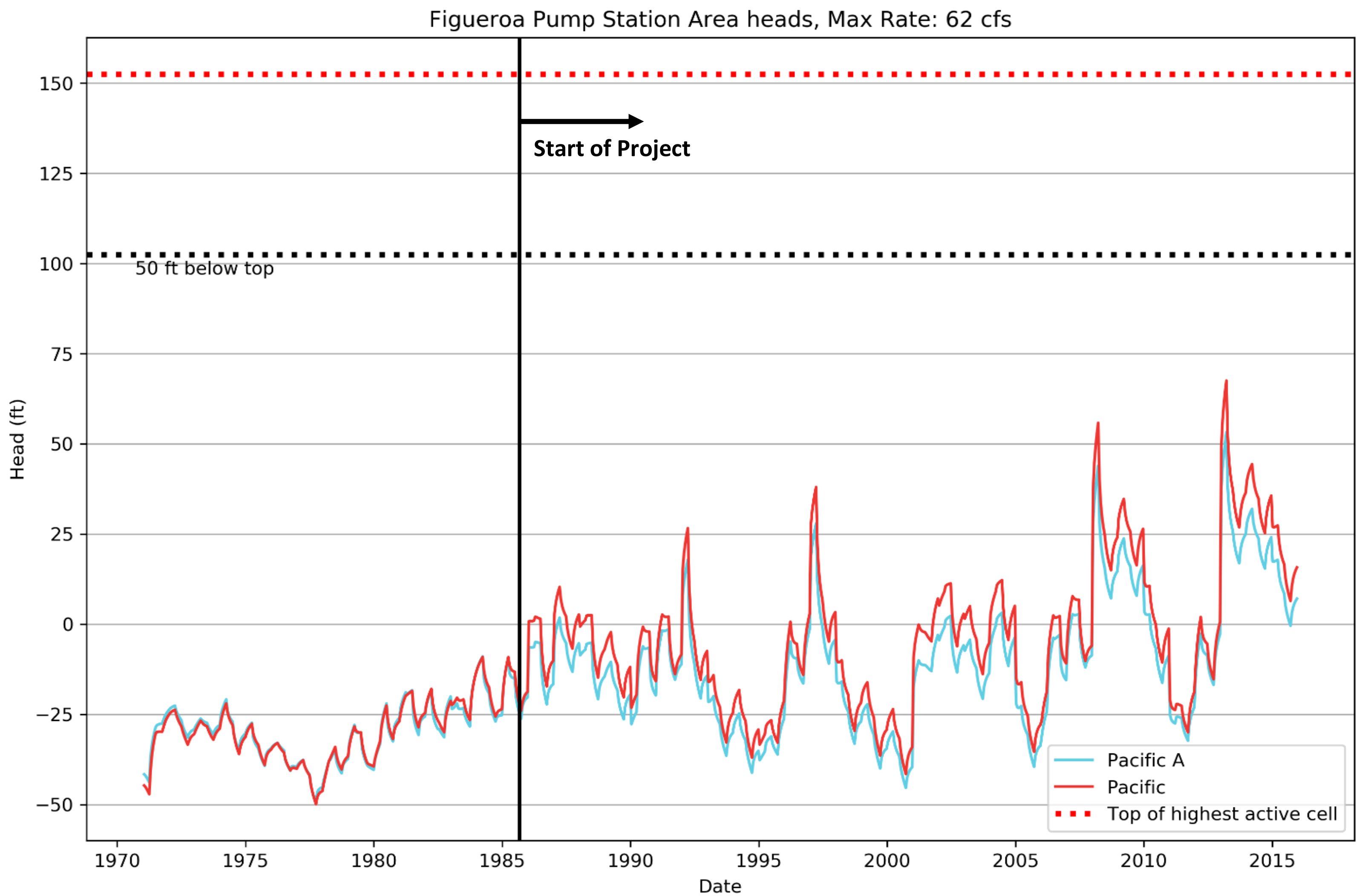
Figure 3.1.7d
Hydrograph at Extraction Well - Lanzit Site



INTERA

Figure 3.1.8
Wellfield Configuration Map: Centralized Injection at Figueroa Pump Station Area with Distributed Extraction at Parcel 1, Wellfield 7 Area, and DS-41 Area

Centralized Injection Figueroa Pump Station Area with Distributed Extraction at Parcel 1, Wellfield 7 Area, and DS-41 Area



INTERA

Figure 3.1.9a
Hydrograph at Injection Well - Figueroa Pump Station Area

Centralized Injection Figueroa Pump Station Area with Distributed Extraction at Parcel 1, Wellfield 7 Area, and DS-41 Area

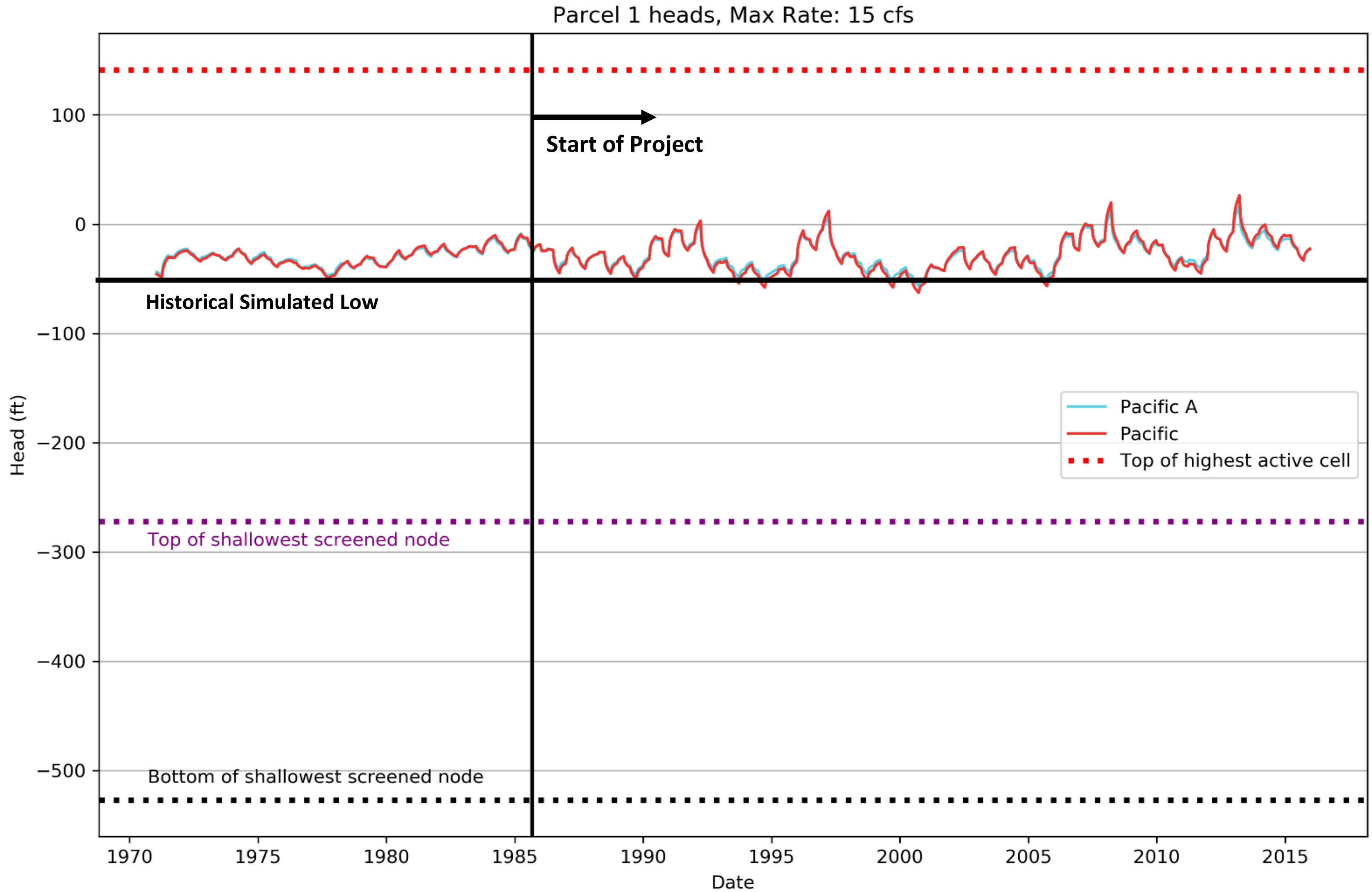


Figure 3.1.9b
Hydrograph at Extraction Well - Parcel 1

Centralized Injection Figueroa Pump Station Area with Distributed Extraction at Parcel 1, Wellfield 7 Area, and DS-41 Area

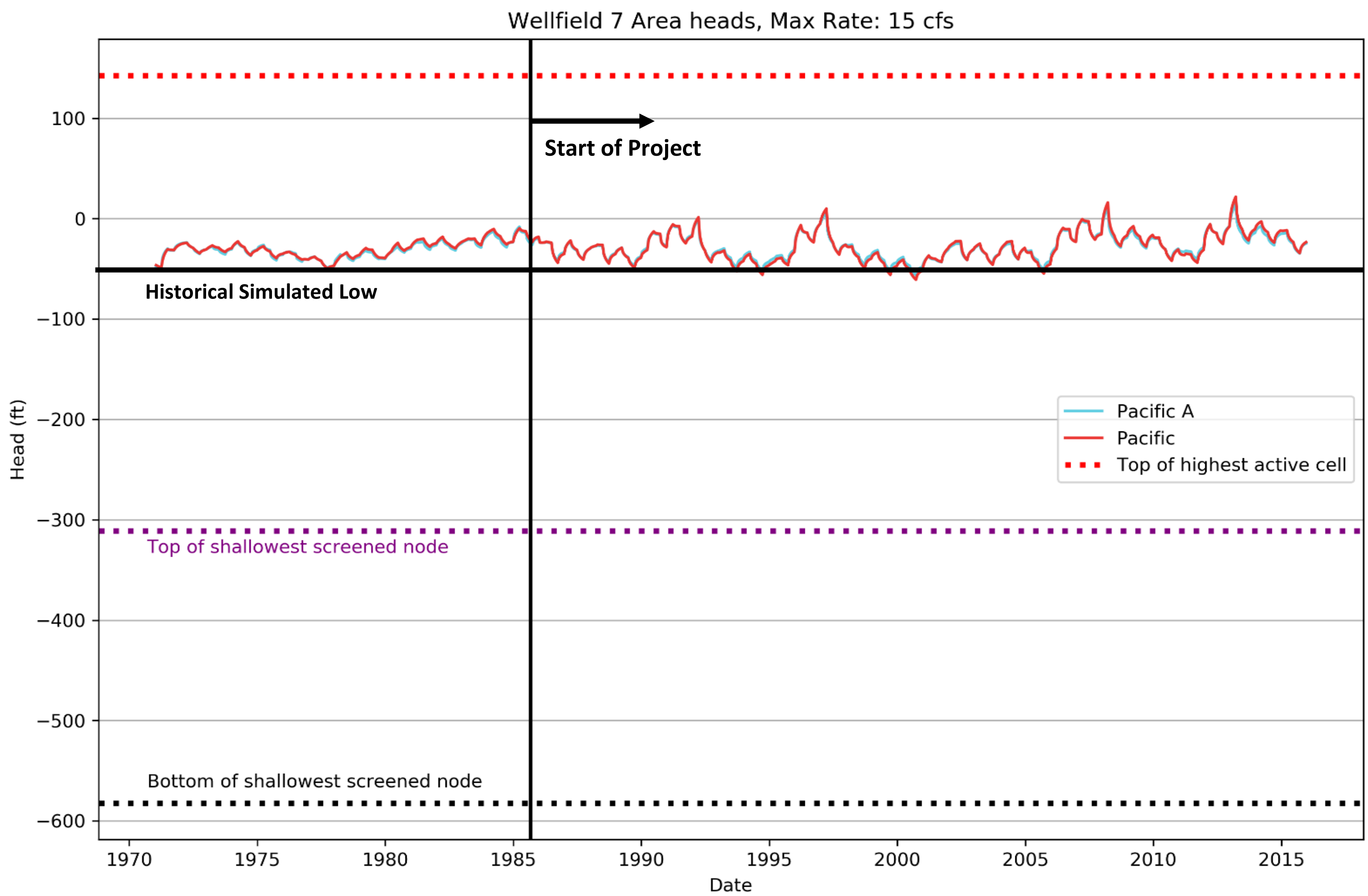
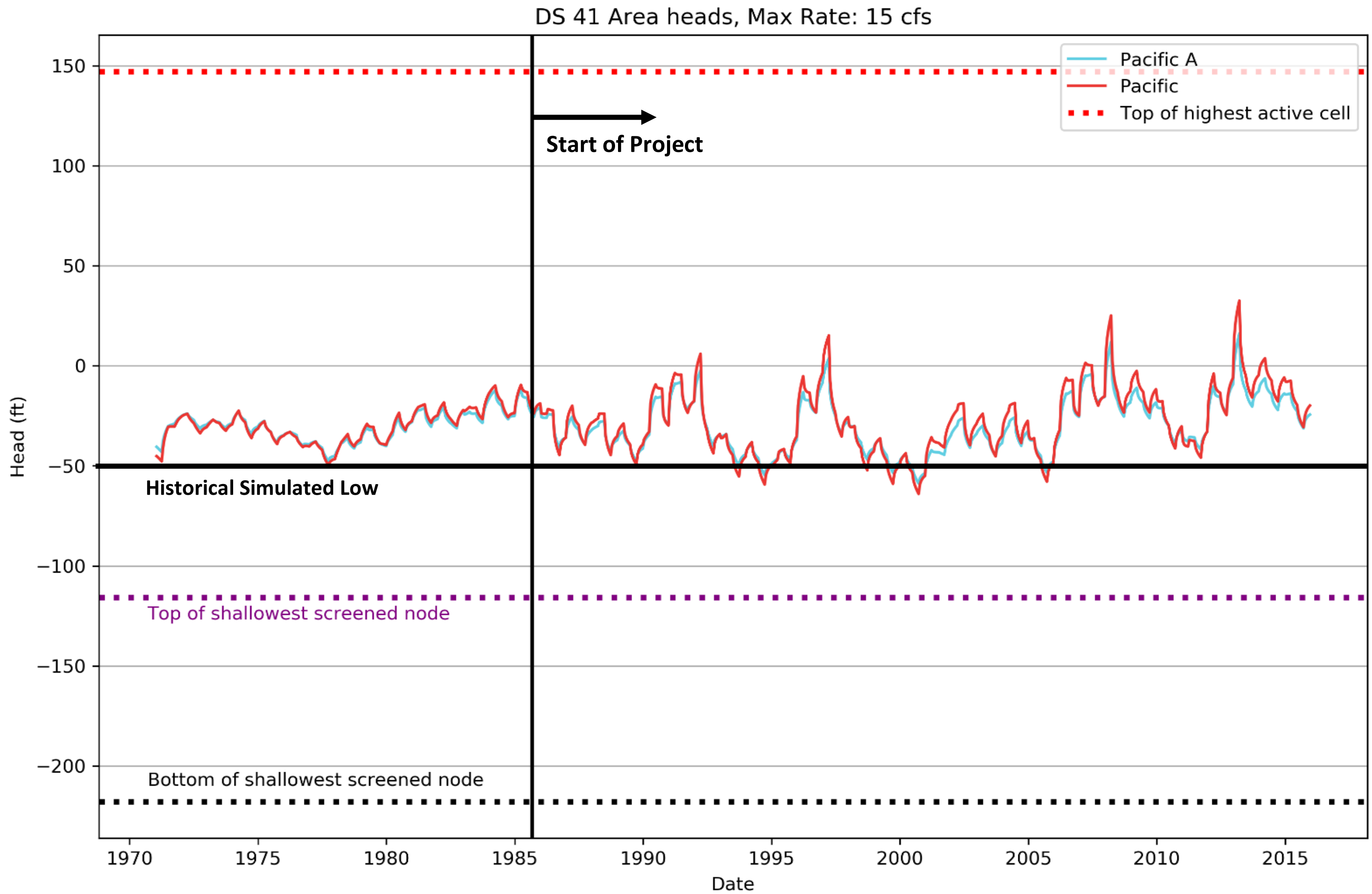


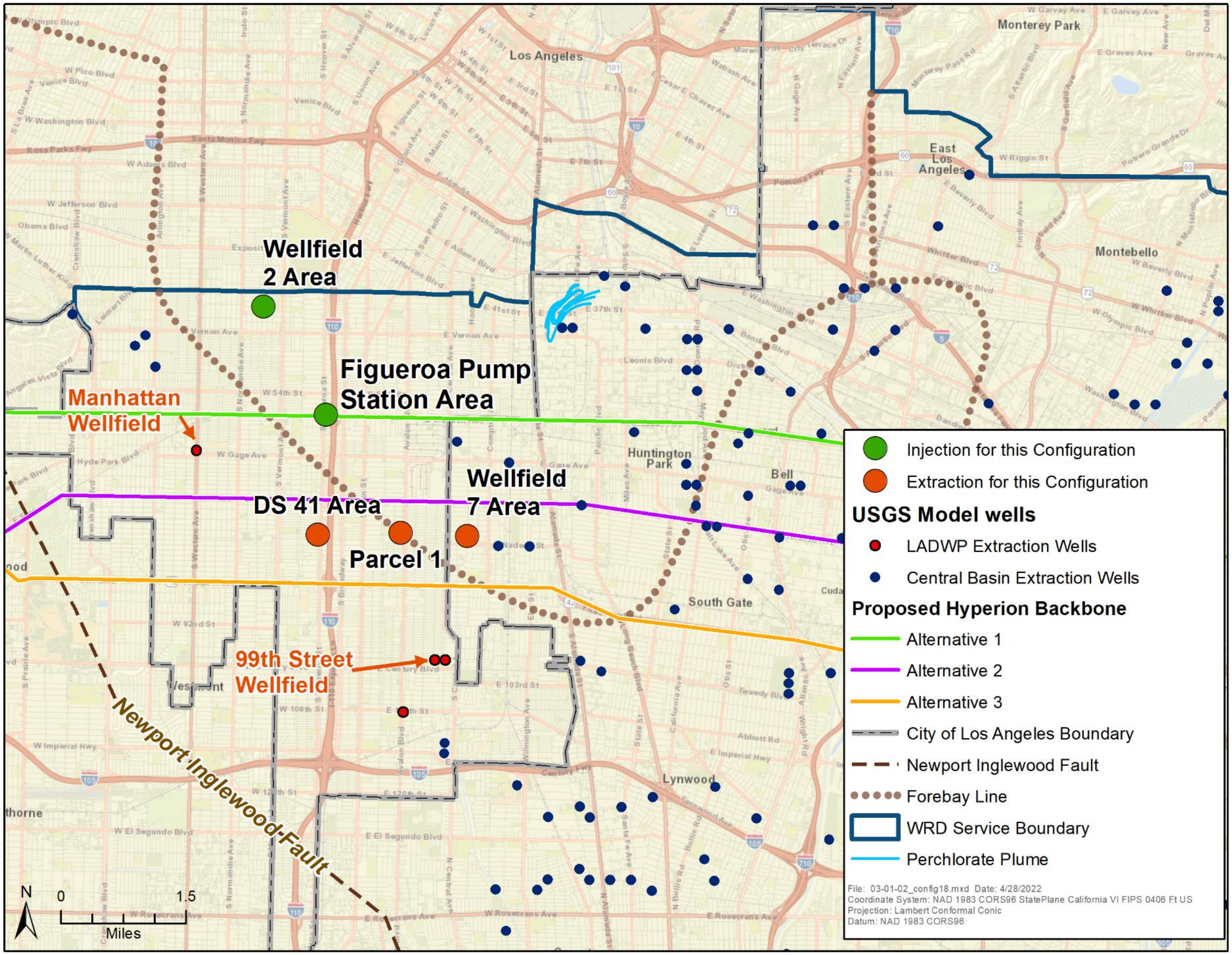
Figure 3.1.9c
Hydrograph at Extraction Well - Wellfield 7 Area

<u>Centralized Injection Figueroa Pump Station Area with Distributed Extraction at Parcel 1, Wellfield 7 Area, and DS-41 Area</u>



INTERA

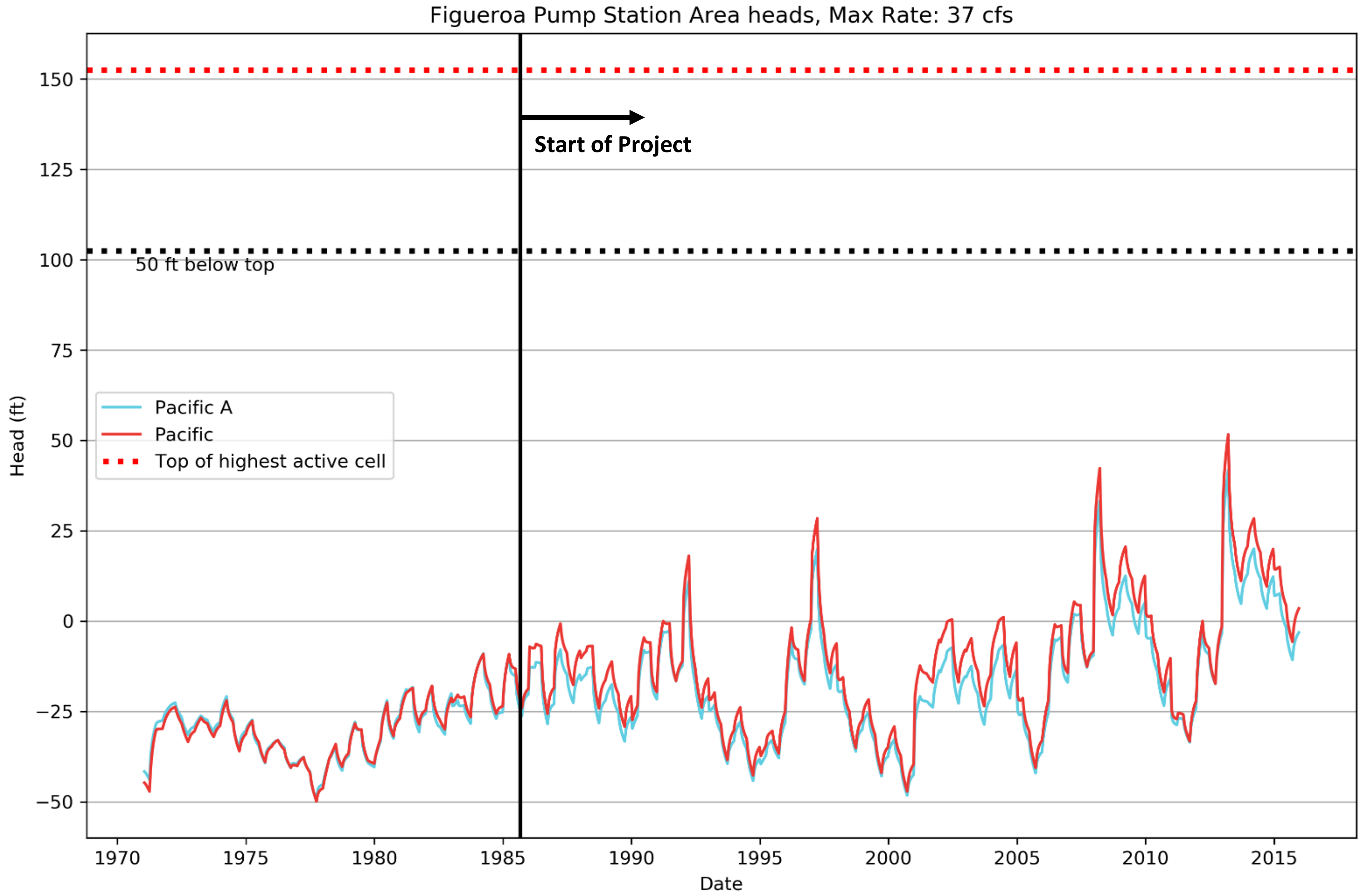
Figure 3.1.9d
Hydrograph at Extraction Well - DS-41 Area



INTERA

Figure 3.1.10
Wellfield Configuration Map: Distributed Injection at Wellfield 2 Area and Figueroa Pump Station Area with Distributed Extraction at Parcel 1, Wellfield 7 Area, and DS-41 Area

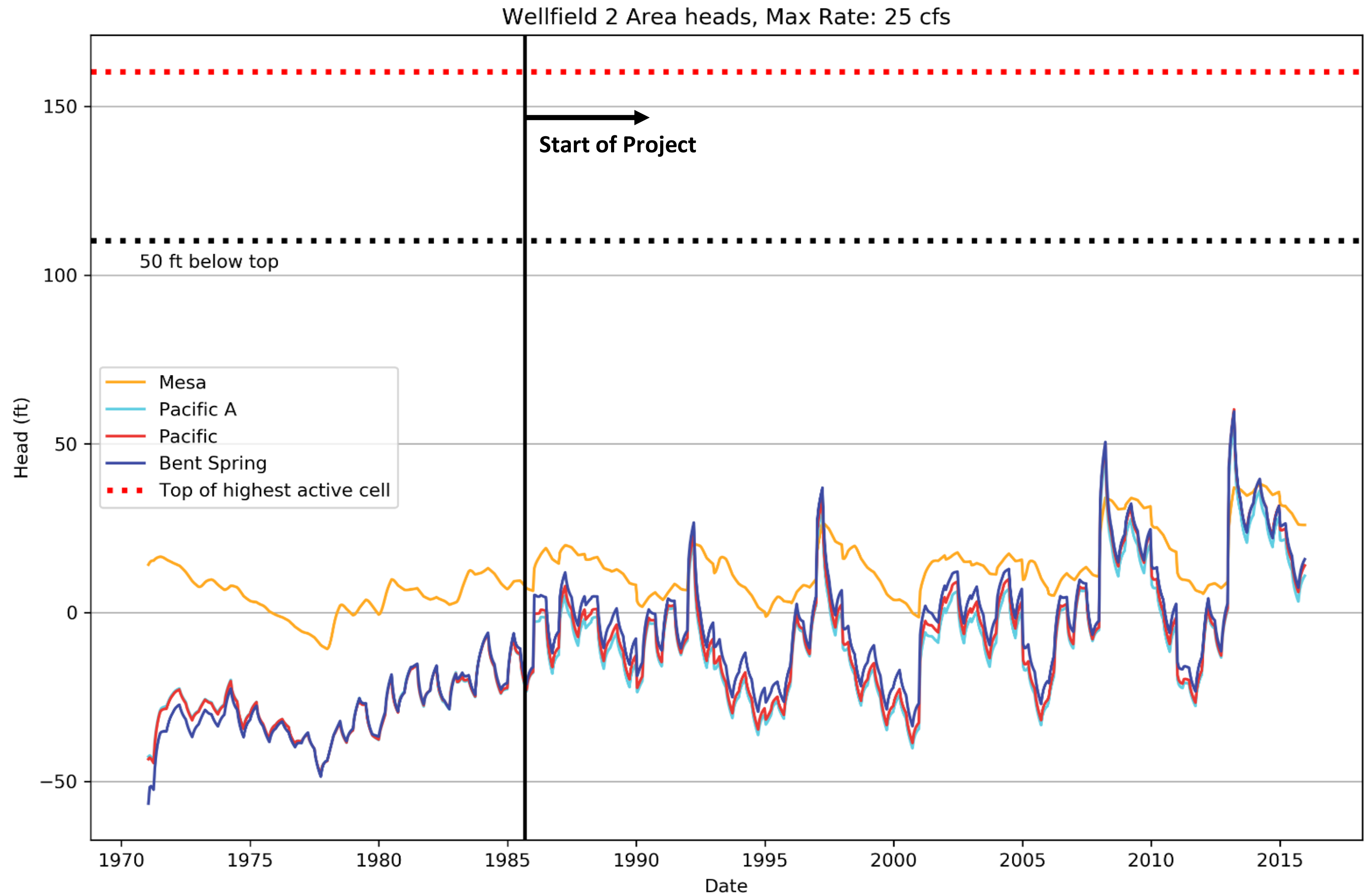
Distributed Injection at Wellfield 2 Area and Figueroa Pump Station Area with Distributed Extraction at Parcel 1, Wellfield 7 Area, and DS-41 Area



INTERA

Figure 3.1.11a
Hydrograph at Injection Well - Figueroa Pump Station Area

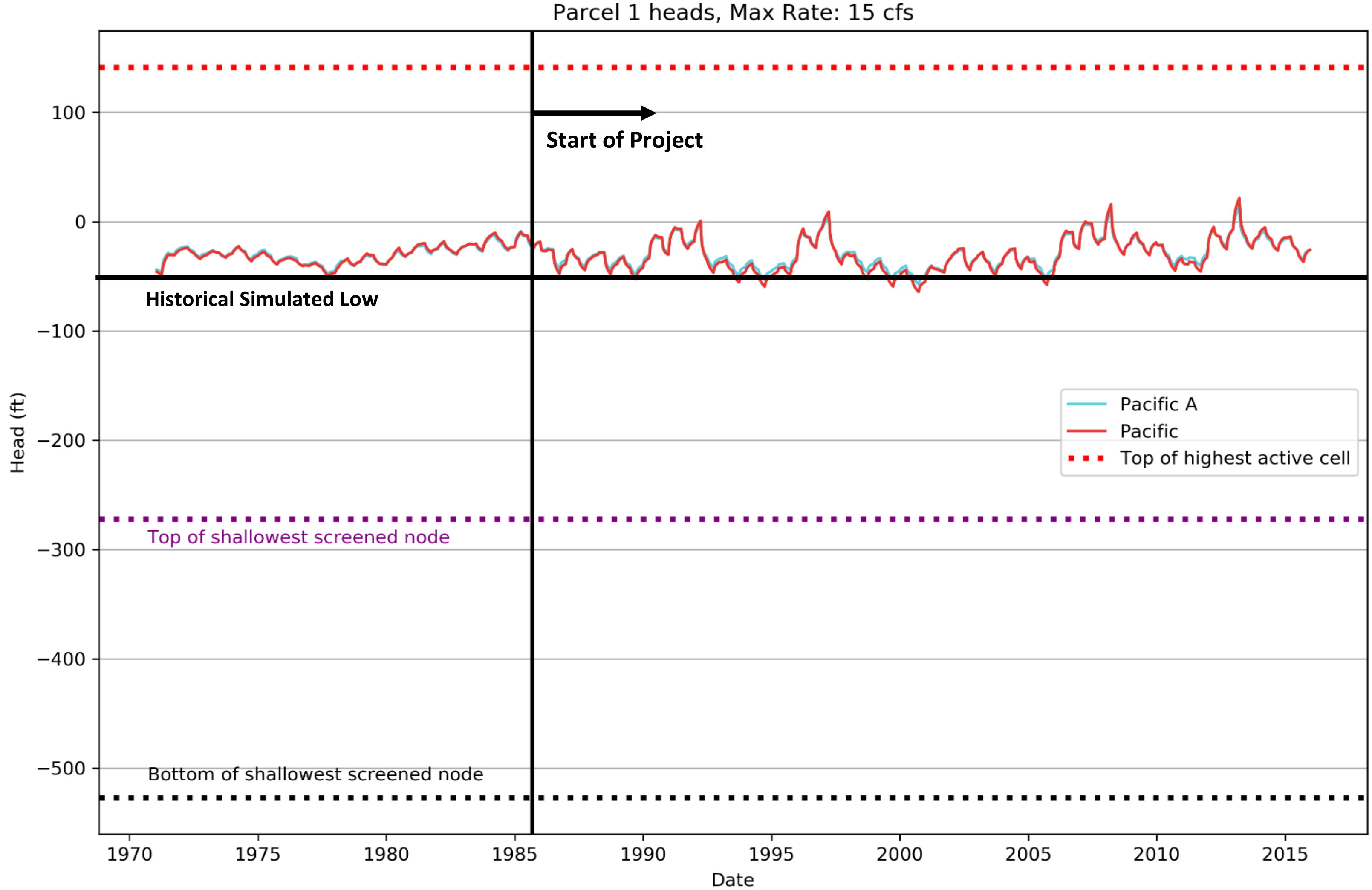
Distributed Injection at Wellfield 2 Area and Figueroa Pump Station Area with Distributed Extraction at Parcel 1, Wellfield 7 Area, and DS-41 Area



INTERA

Figure 3.11b
Hydrograph at Injection Well - Wellfield 2 Area

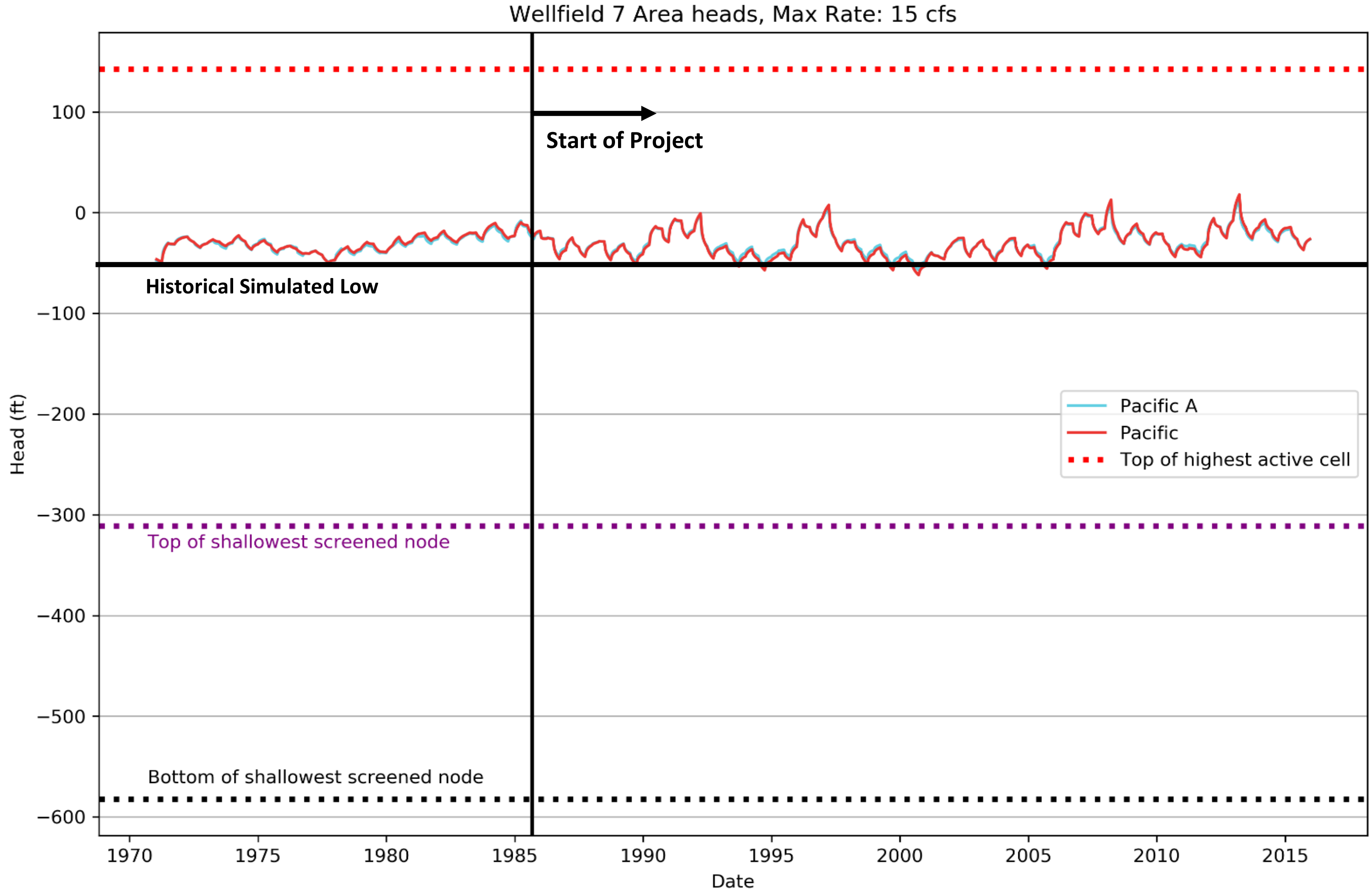
Distributed Injection at Wellfield 2 Area and Figueroa Pump Station Area with Distributed Extraction at Parcel 1, Wellfield 7 Area, and DS-41 Area



INTERA

Figure 3.1.11c
Hydrograph at Extraction Well - Parcel 1

Distributed Injection at Wellfield 2 Area and Figueroa Pump Station Area with Distributed Extraction at Parcel 1, Wellfield 7 Area, and DS-41 Area



INTERA

Figure 3.1.11d
Hydrograph at Extraction Well - Wellfield 7 Area

Distributed Injection at Wellfield 2 Area and Figueroa Pump Station Area with Distributed Extraction at Parcel 1, Wellfield 7 Area, and DS-41 Area

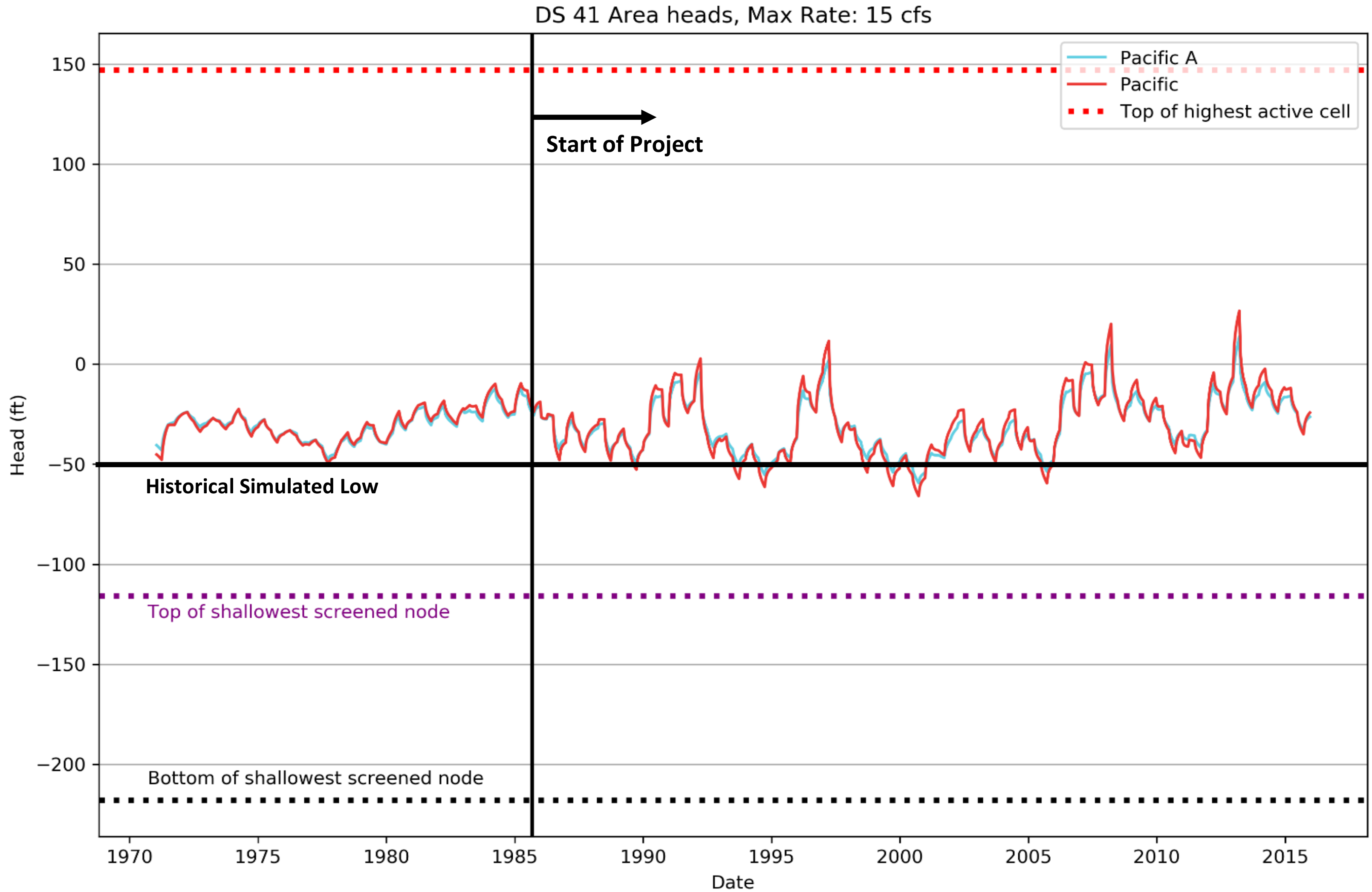
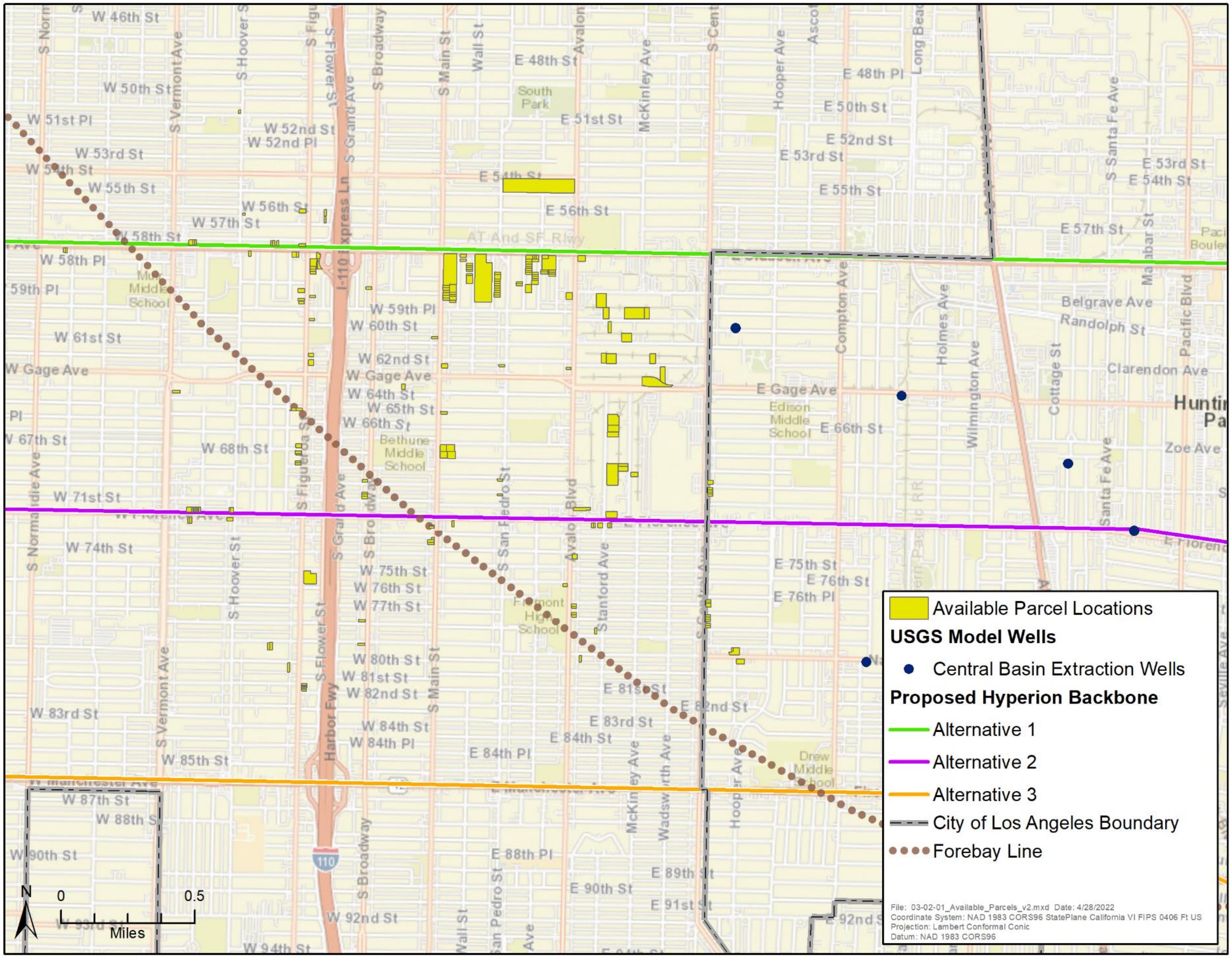
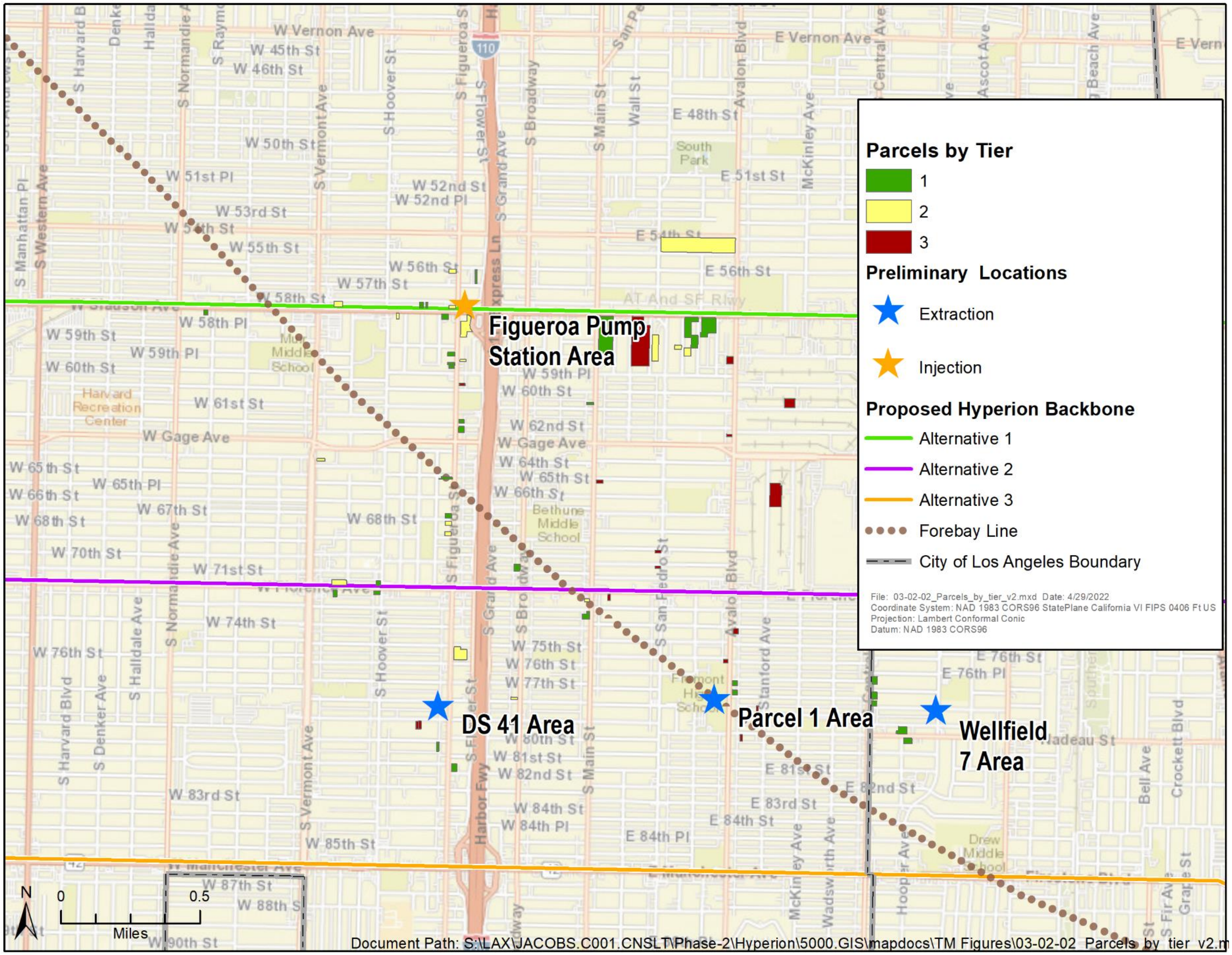


Figure 3.1.11e
Hydrograph at Extraction Well - DS-41 Area



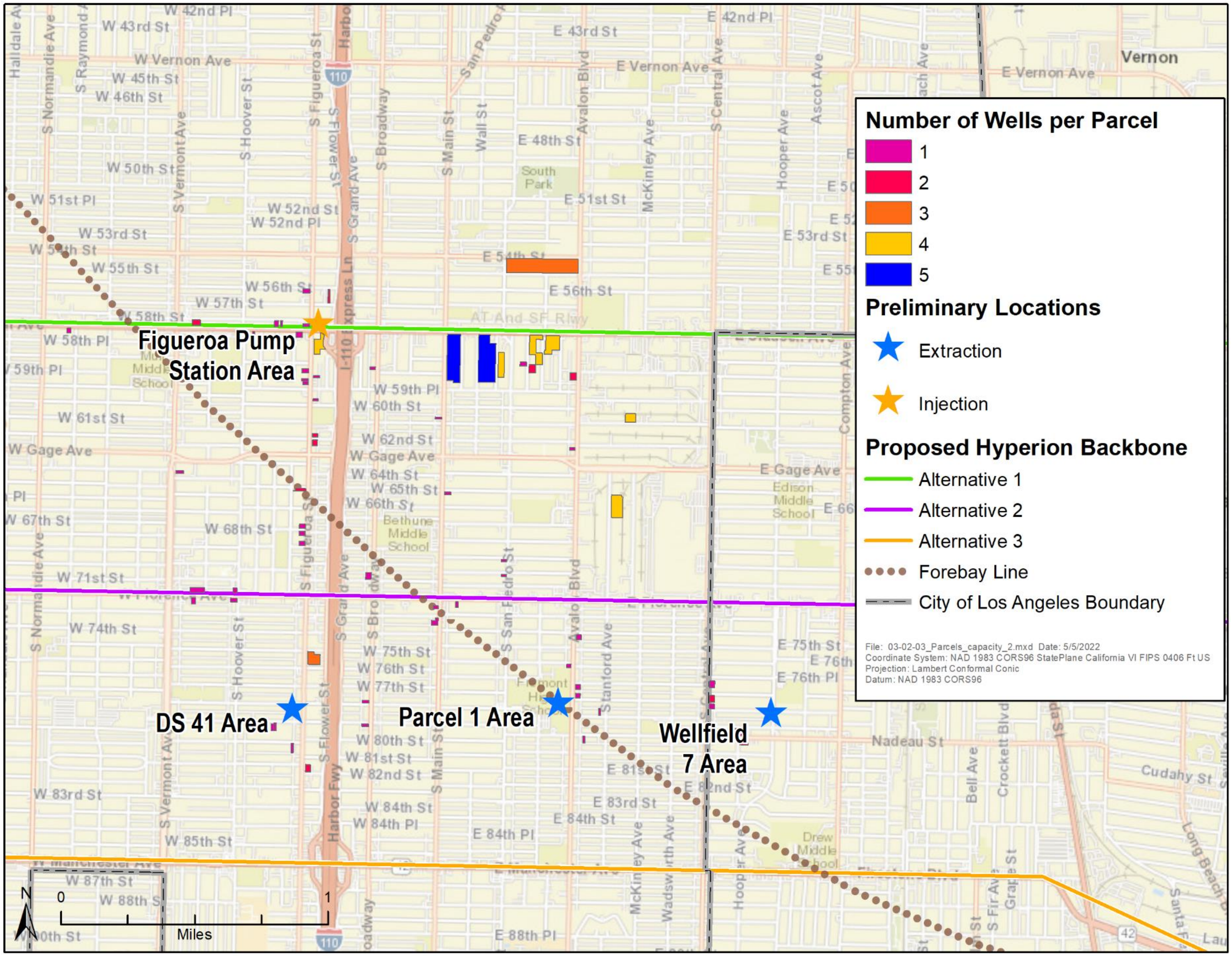
INTERA

Figure 3.2.1
Map of All Potential Parcel Locations



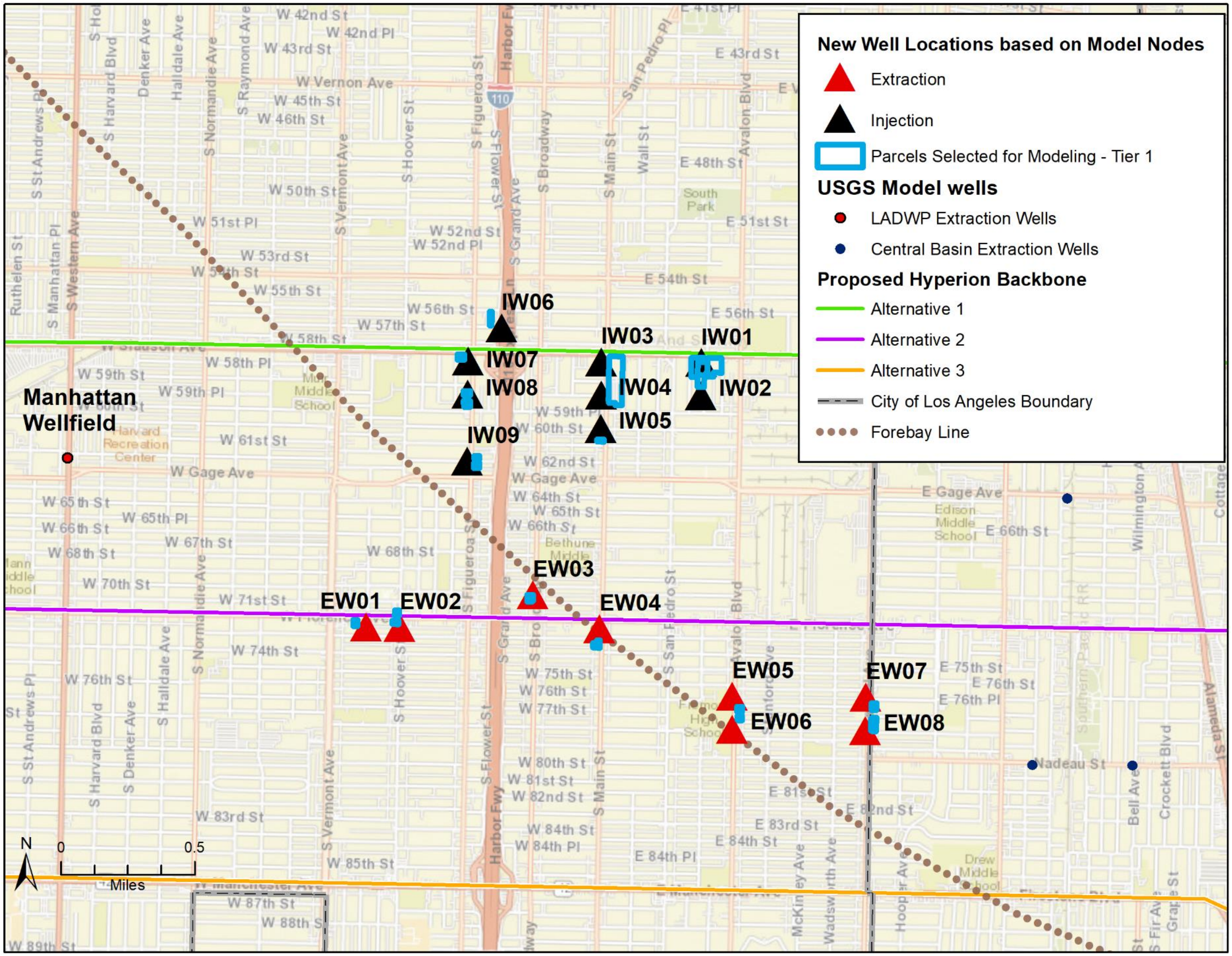
INTERA

Figure 3.2.2
Map of Parcels Classified by Tier



INTERA

Figure 3.2.3
Map of Parcels with Number of Wells per Parcel Area



INTERA

Figure 3.2.4
Map of Selected Tier 1 Parcels and Associated Model Nodes used for Injection and Extraction

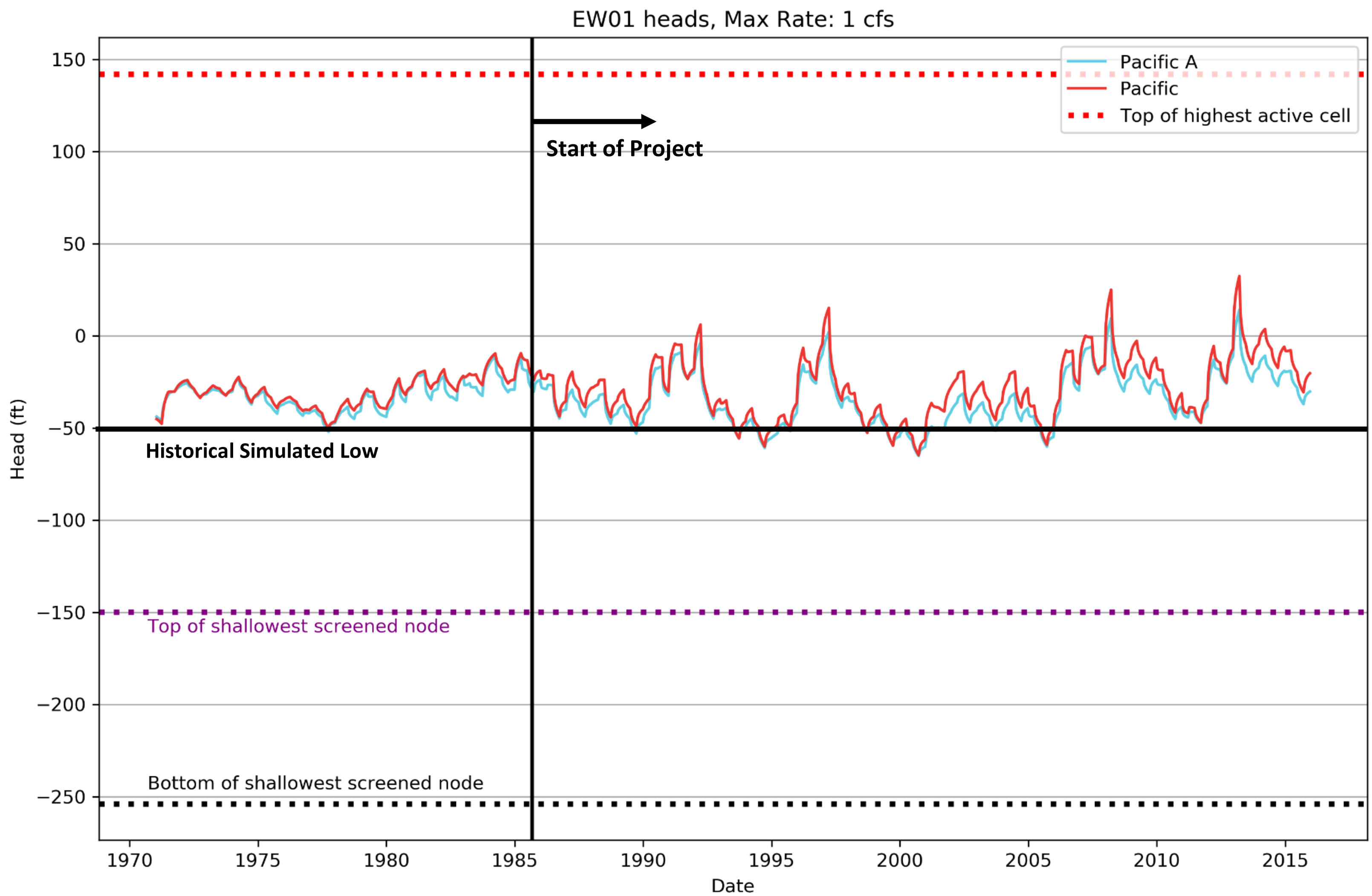
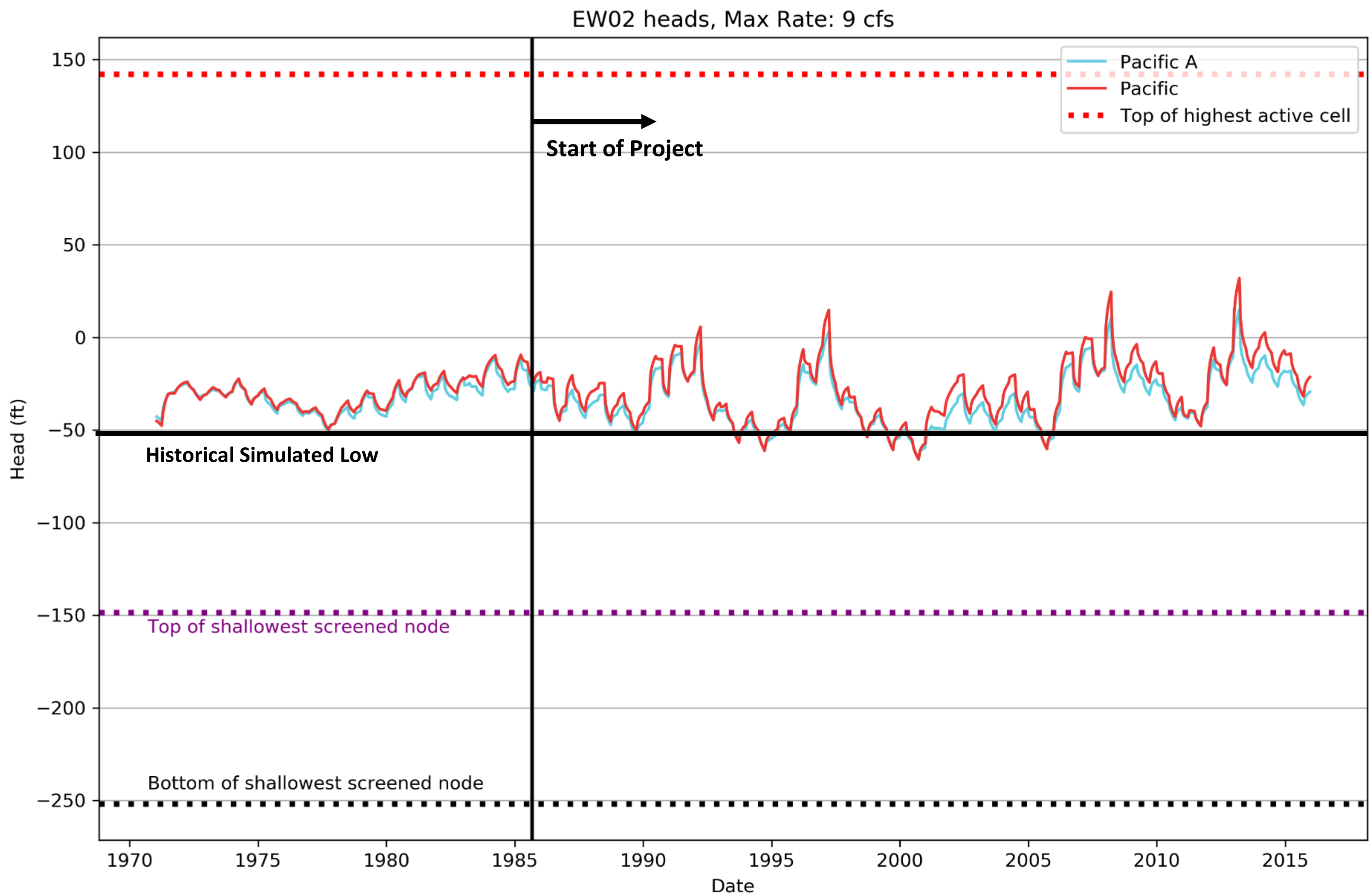


Figure 3.2.5a

Tier 1 Hydrograph at Extraction Well - EW01



INTERA

Figure 3.2.5b
Tier 1 Hydrograph at Extraction Well - EW02

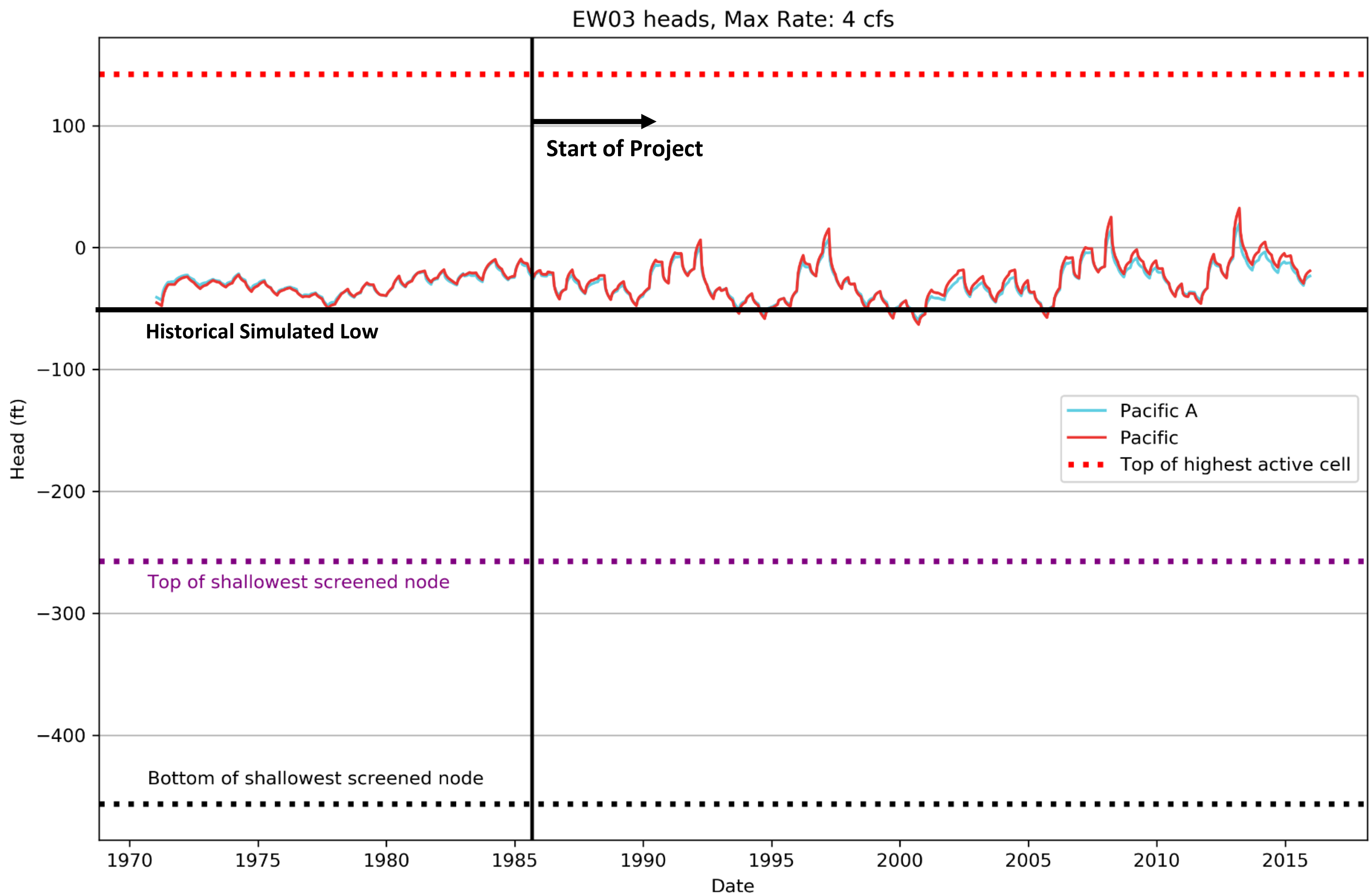
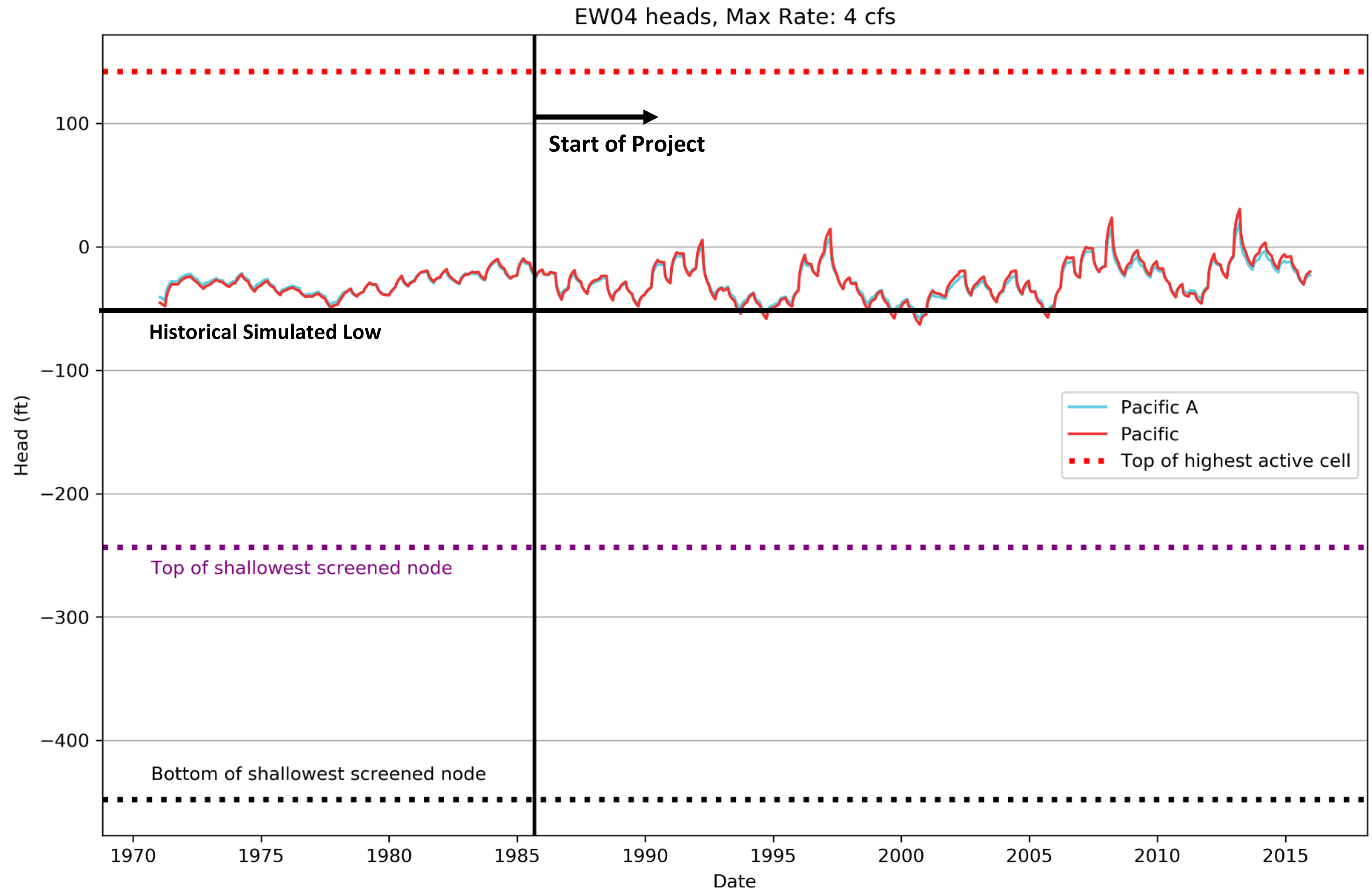


Figure 3.2.5c
Tier 1 Hydrograph at Extraction Well - EW03



INTERA

Figure 3.2.5d
Tier 1 Hydrograph at Extraction Well - EW04

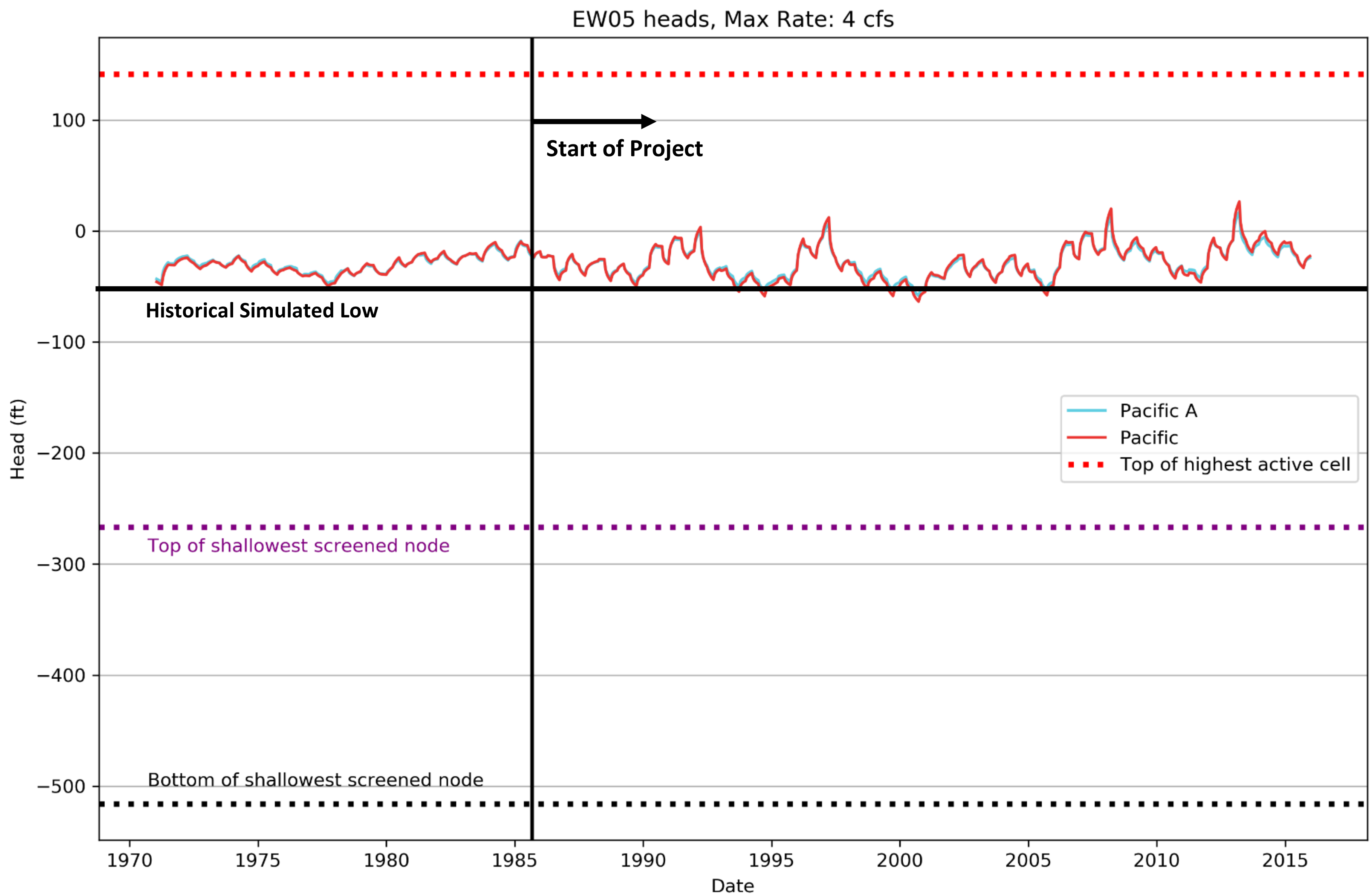


Figure 3.2.5e
Tier 1 Hydrograph at Extraction Well - EW05

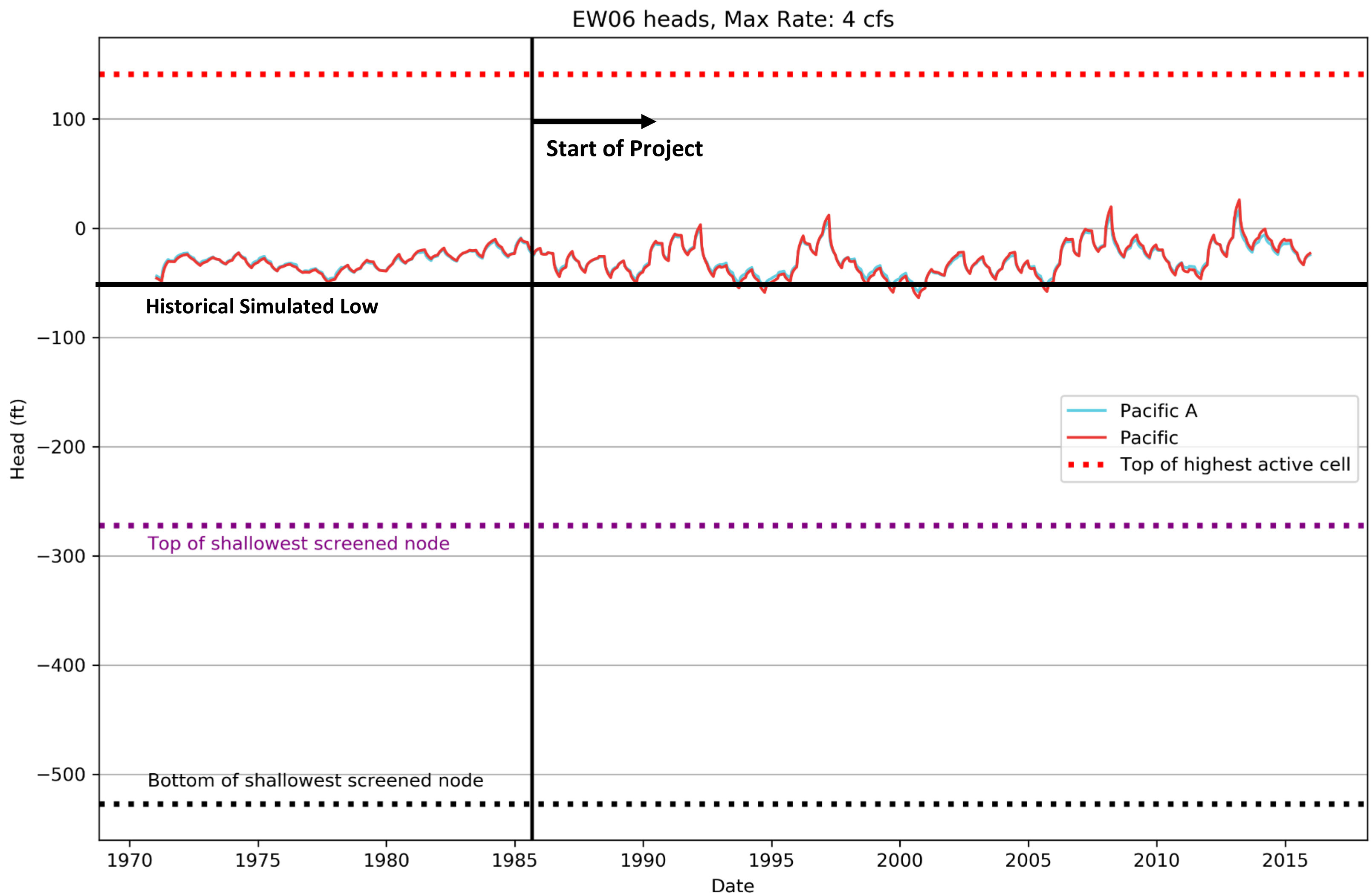


Figure 3.2.5f
Tier 1 Hydrograph at Extraction Well - EW06

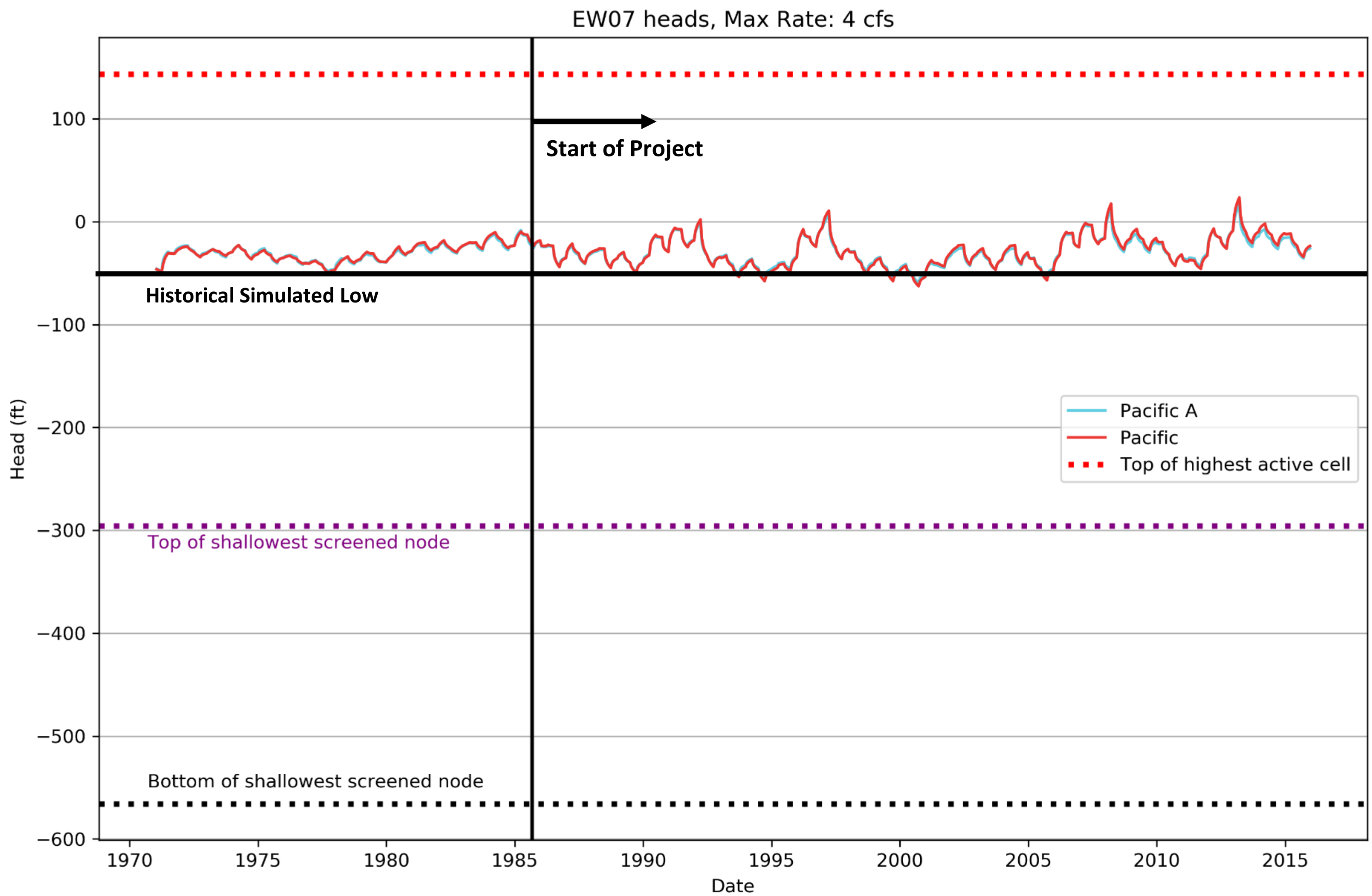


Figure 3.2.5g
Tier 1 Hydrograph at Extraction Well - EW07

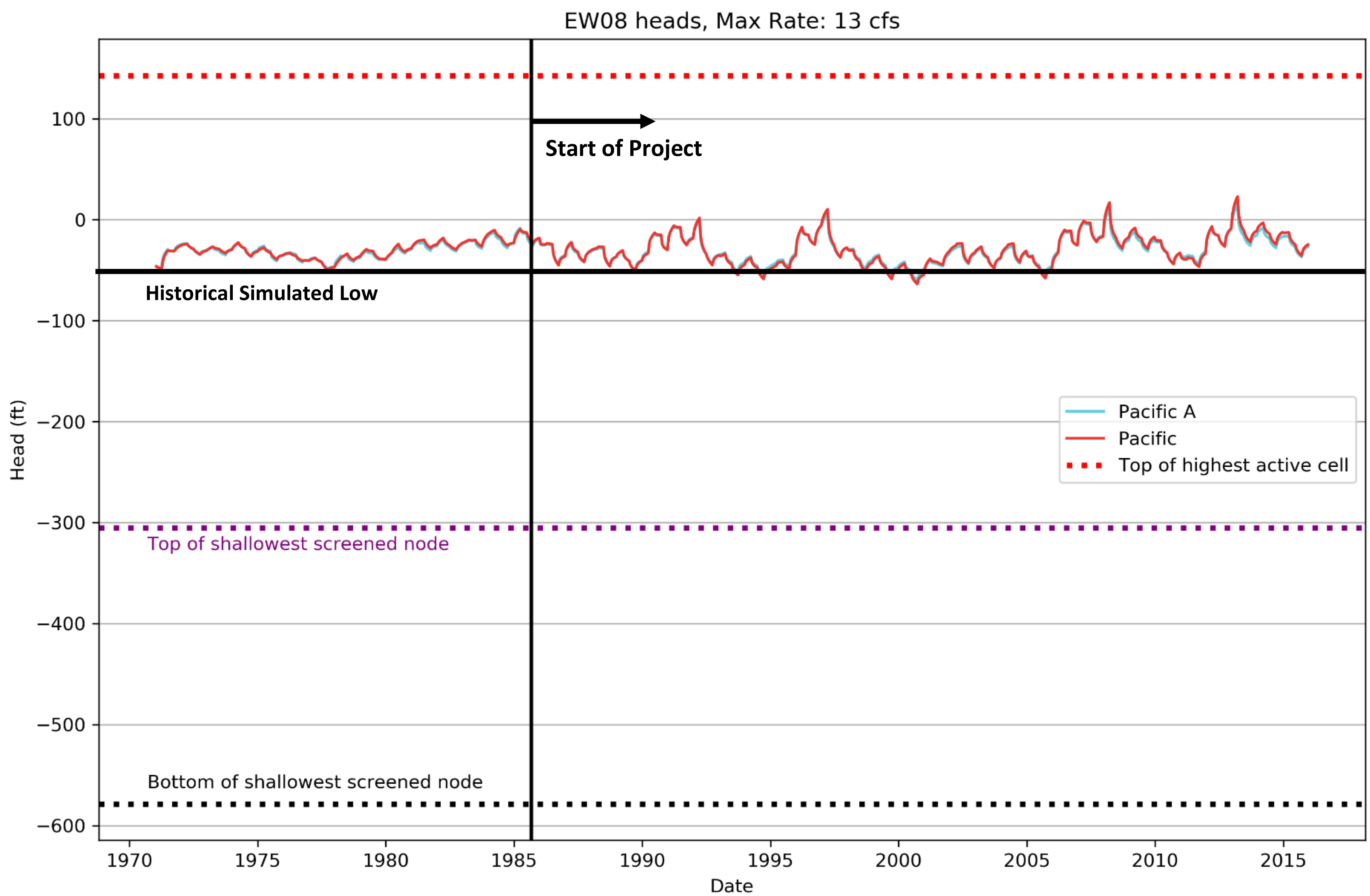
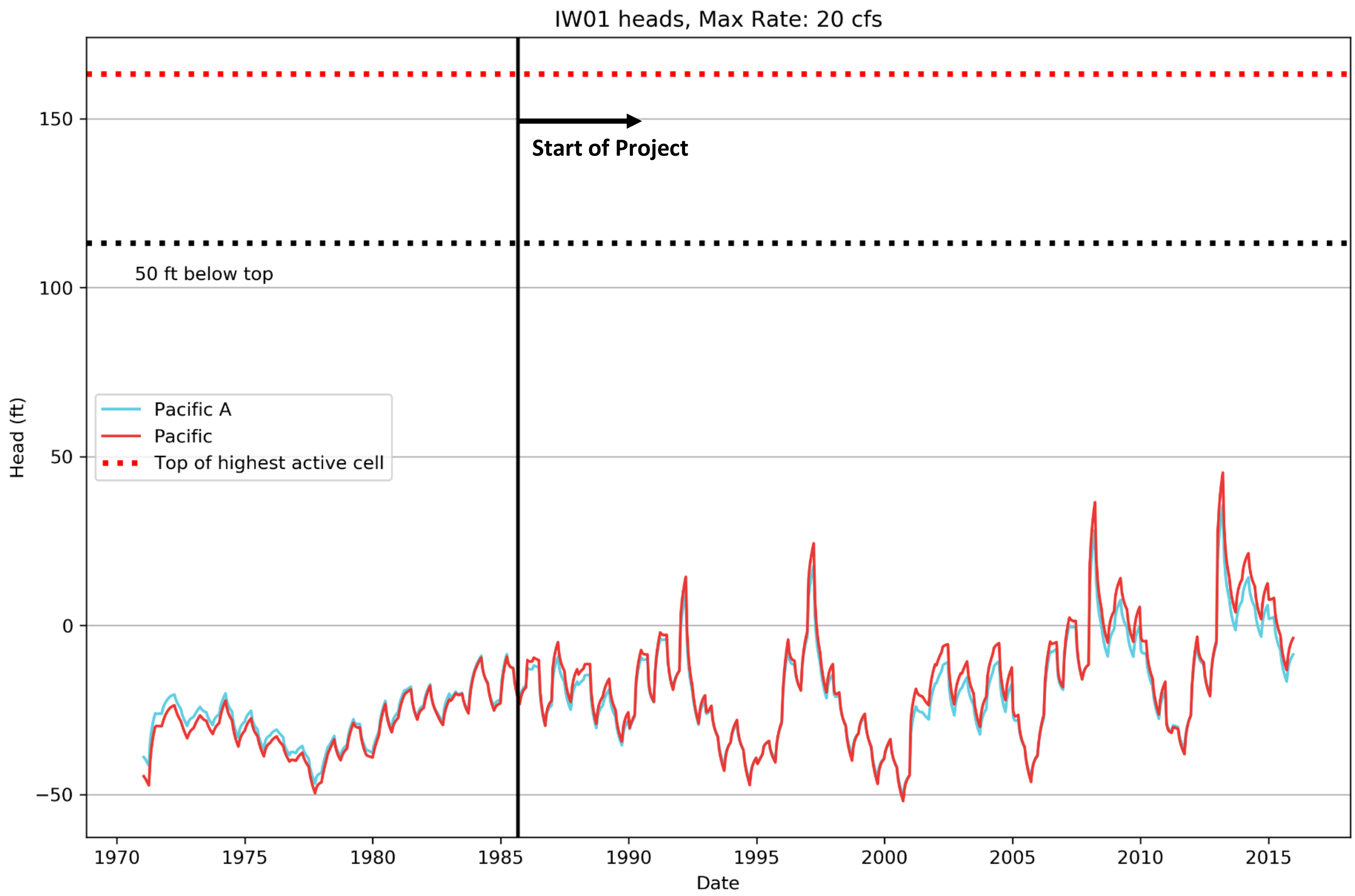


Figure 3.2.5h

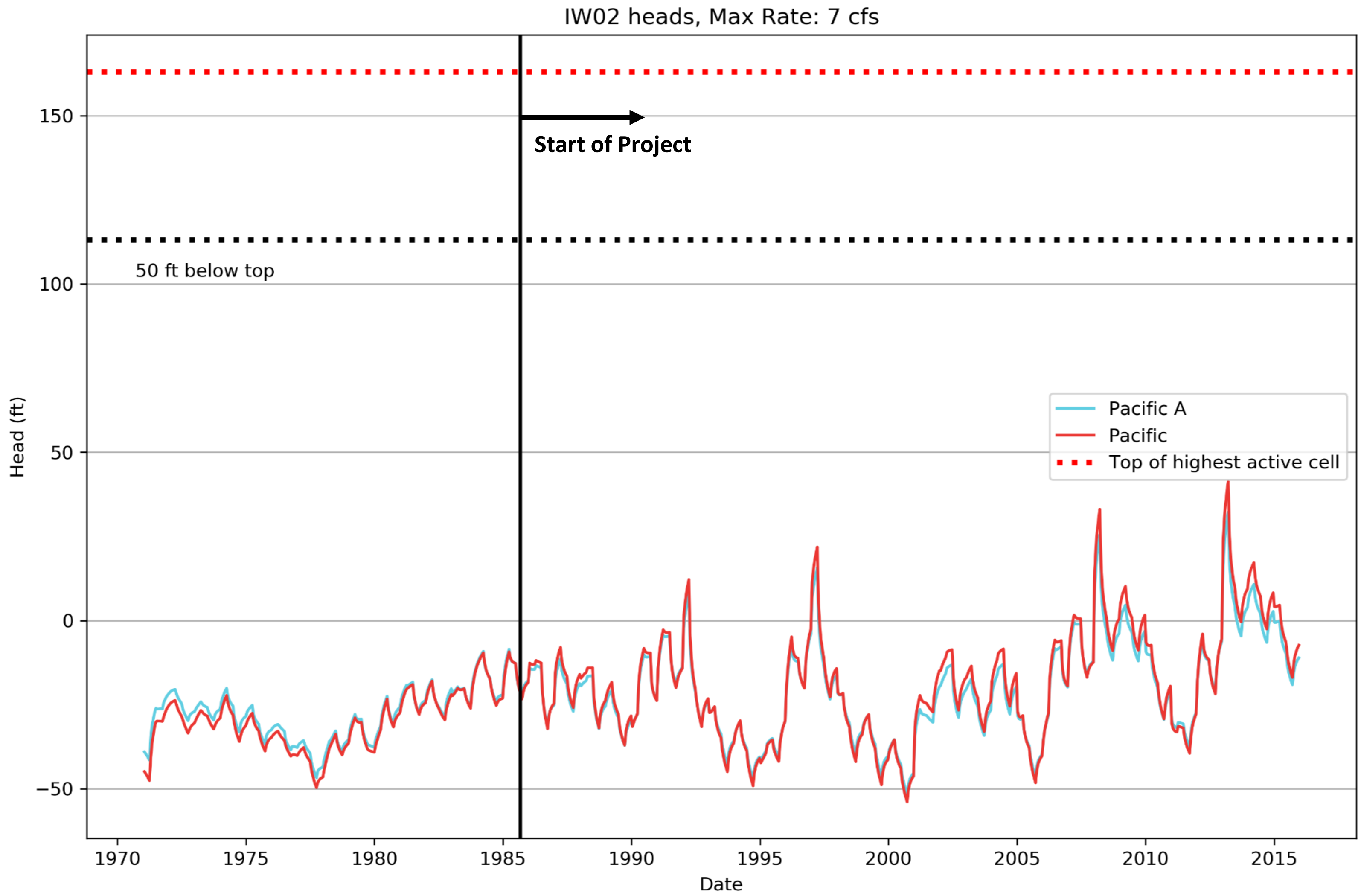
Tier 1 Hydrograph at Extraction Well - EW08



INTERA

Figure 3.2.5i

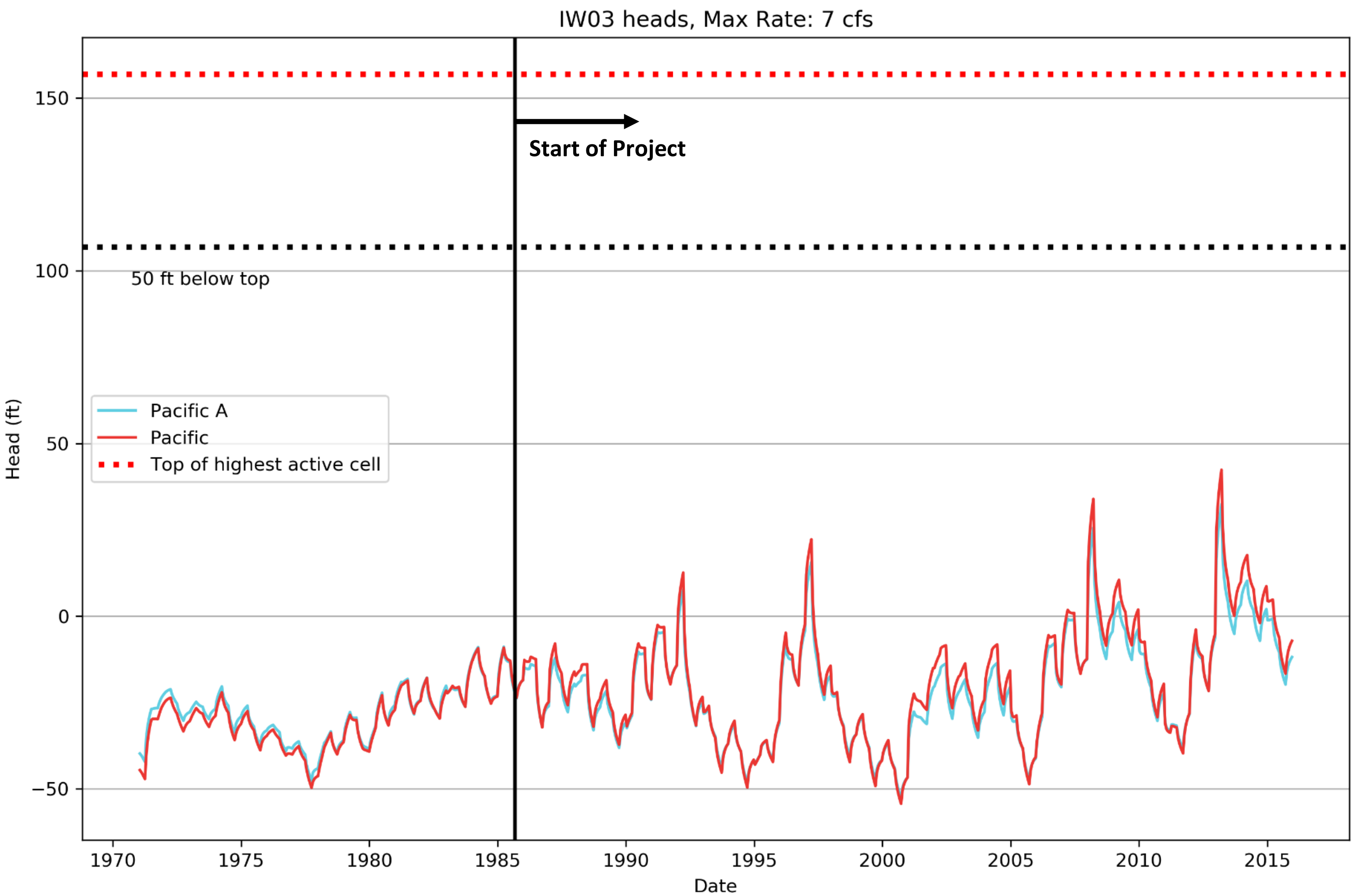
Tier 1 Hydrograph at Injection Well - IW01



INTERA

Figure 3.2.5j

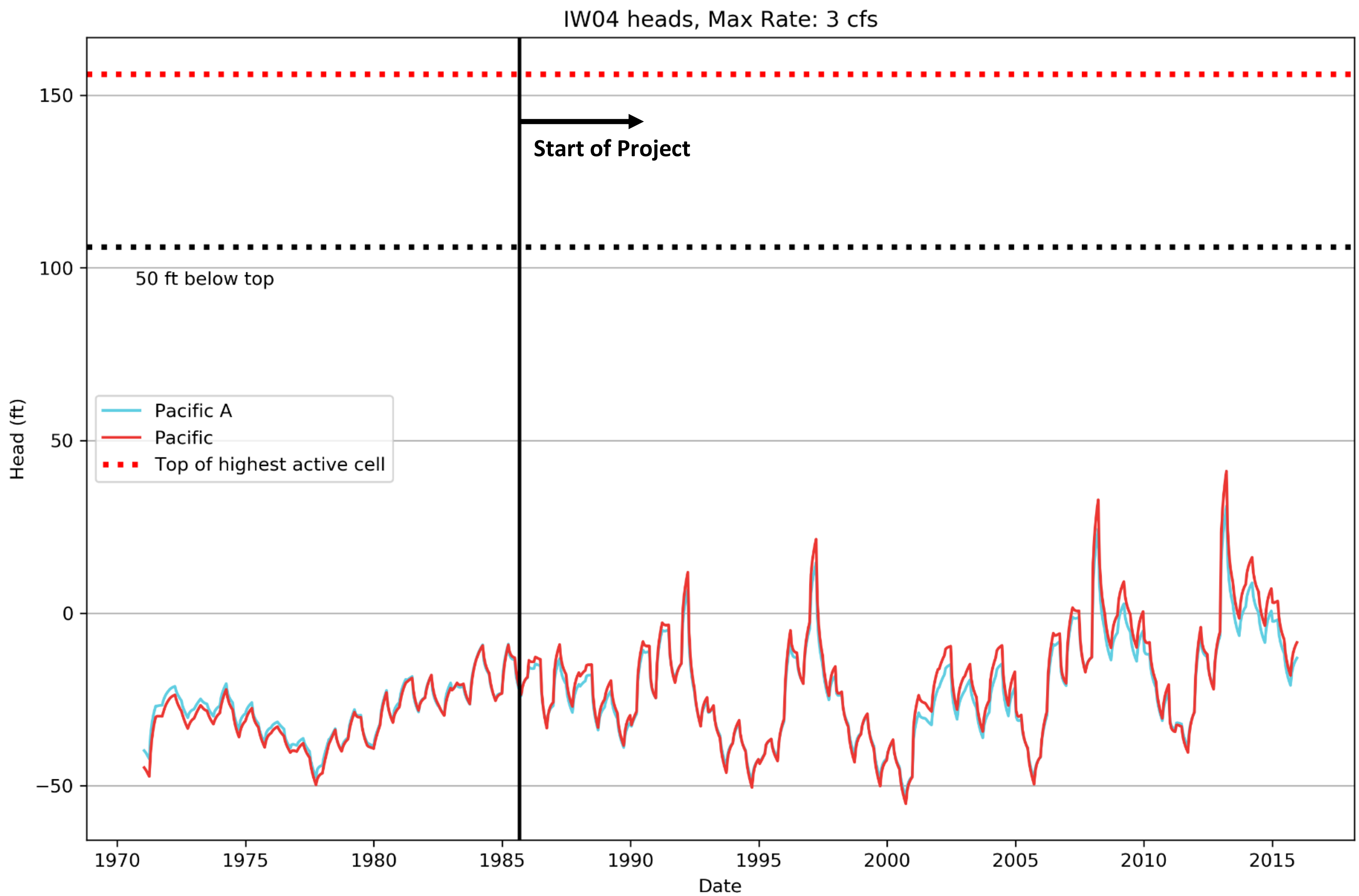
Tier 1 Hydrograph at Injection Well - IW02



INTERA

Figure 3.2.5k

Tier 1 Hydrograph at Injection Well - IW03



INTERA

Figure 3.2.5l
Tier 1 Hydrograph at Injection Well - IW04

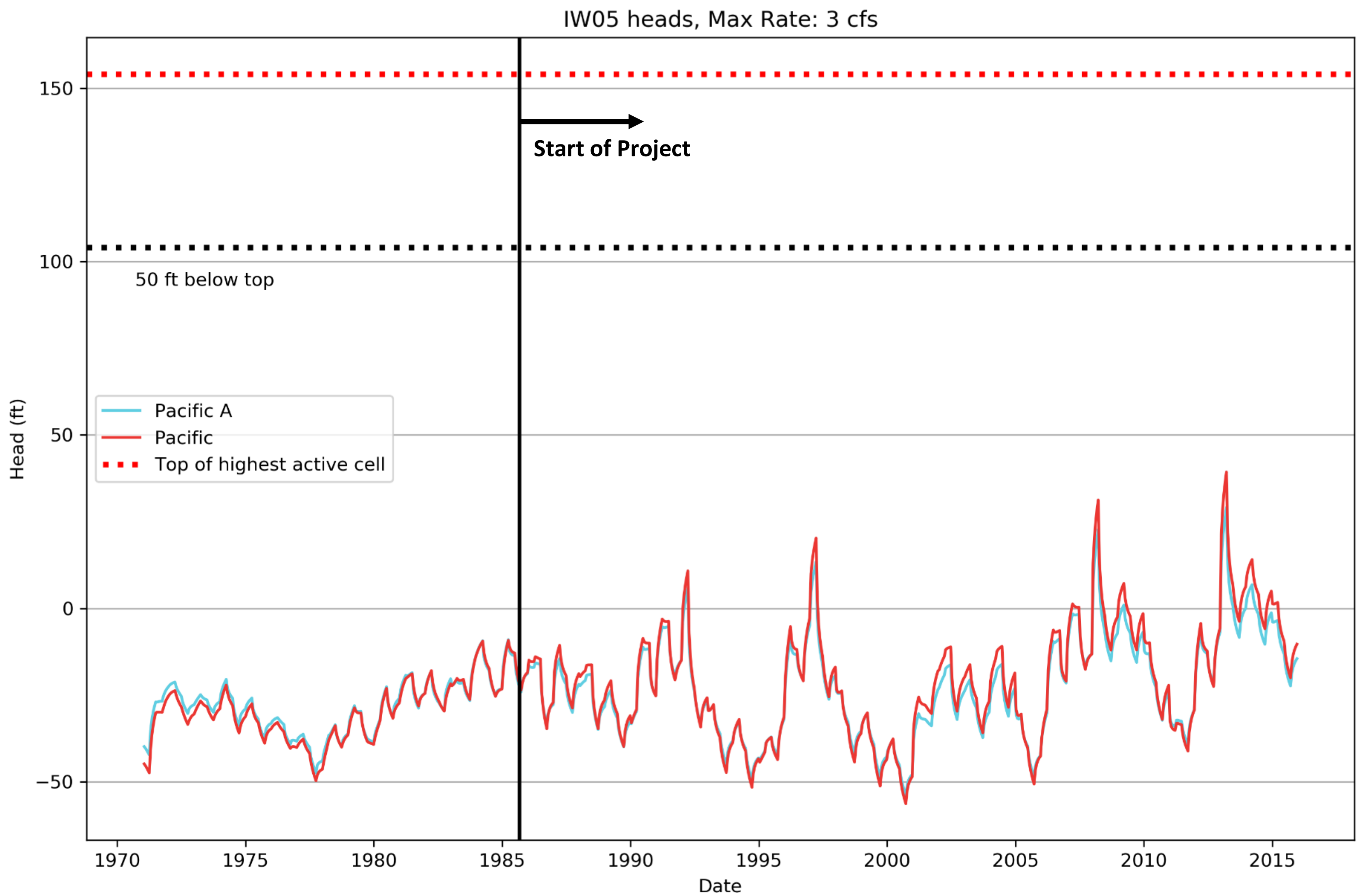
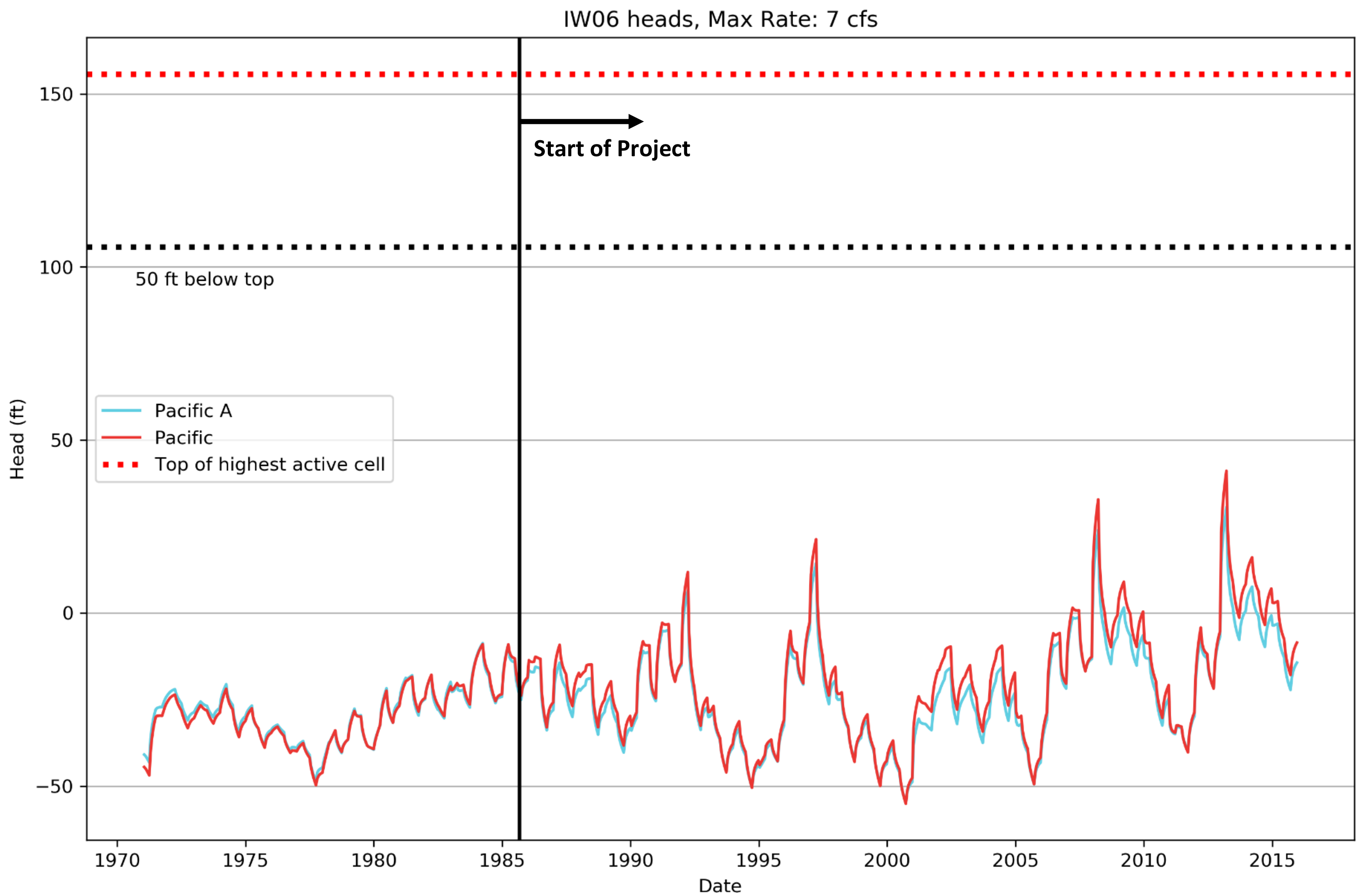


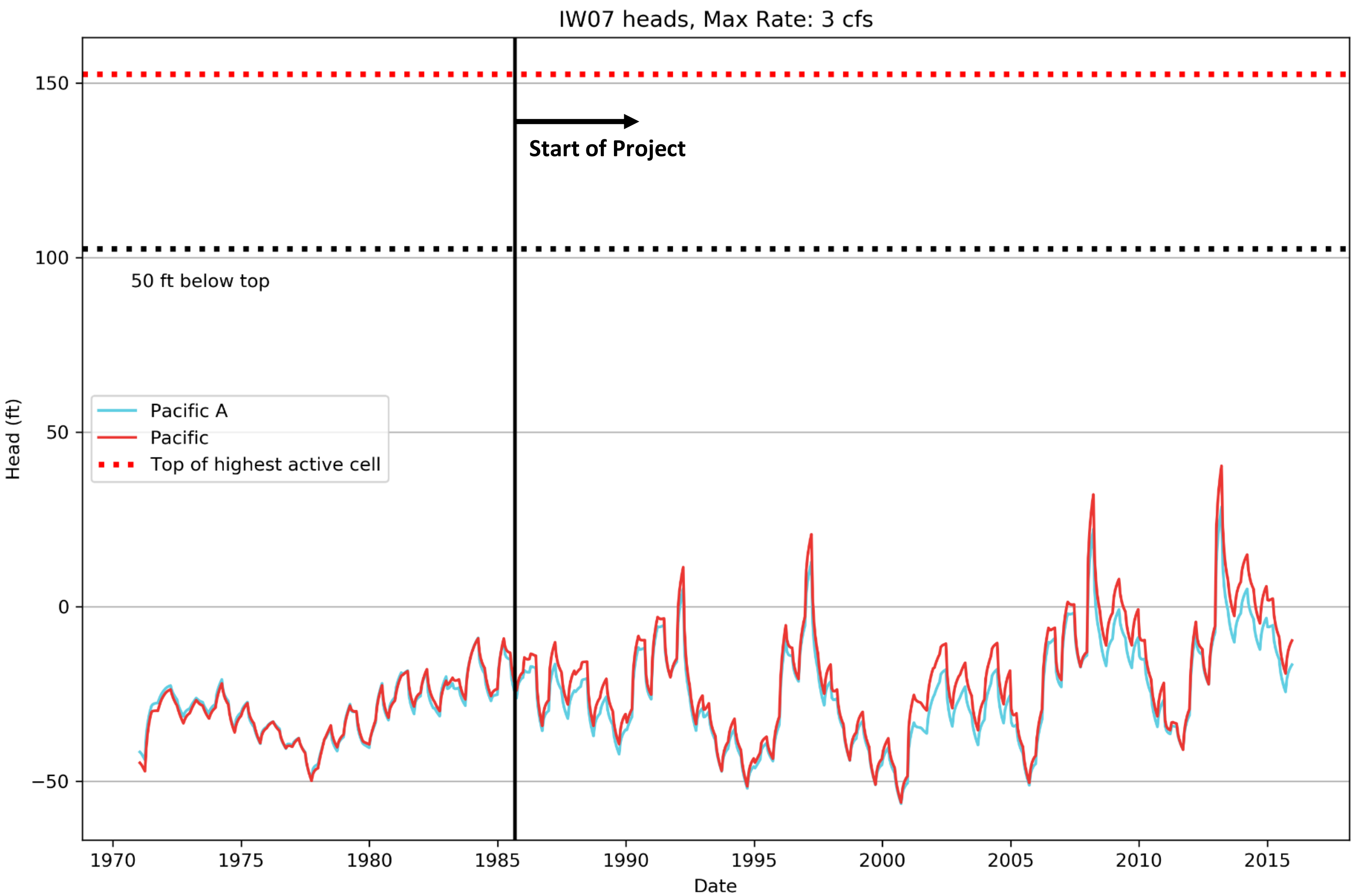
Figure 3.2.5m

Tier 1 Hydrograph at Injection Well - IW05



INTERA

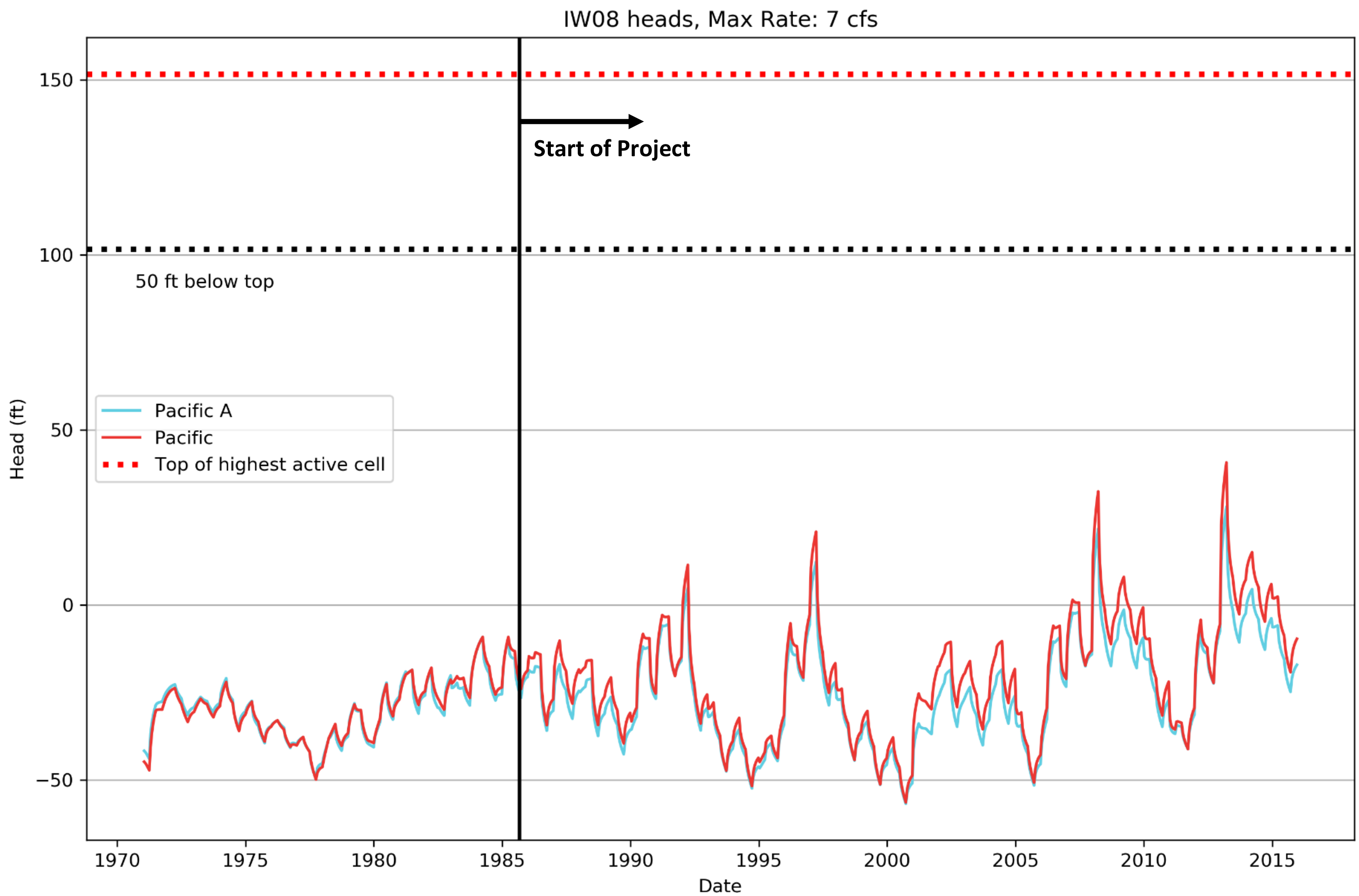
Figure 3.2.5n
Tier 1 Hydrograph at Injection Well - IW06



INTERA

Figure 3.2.5o

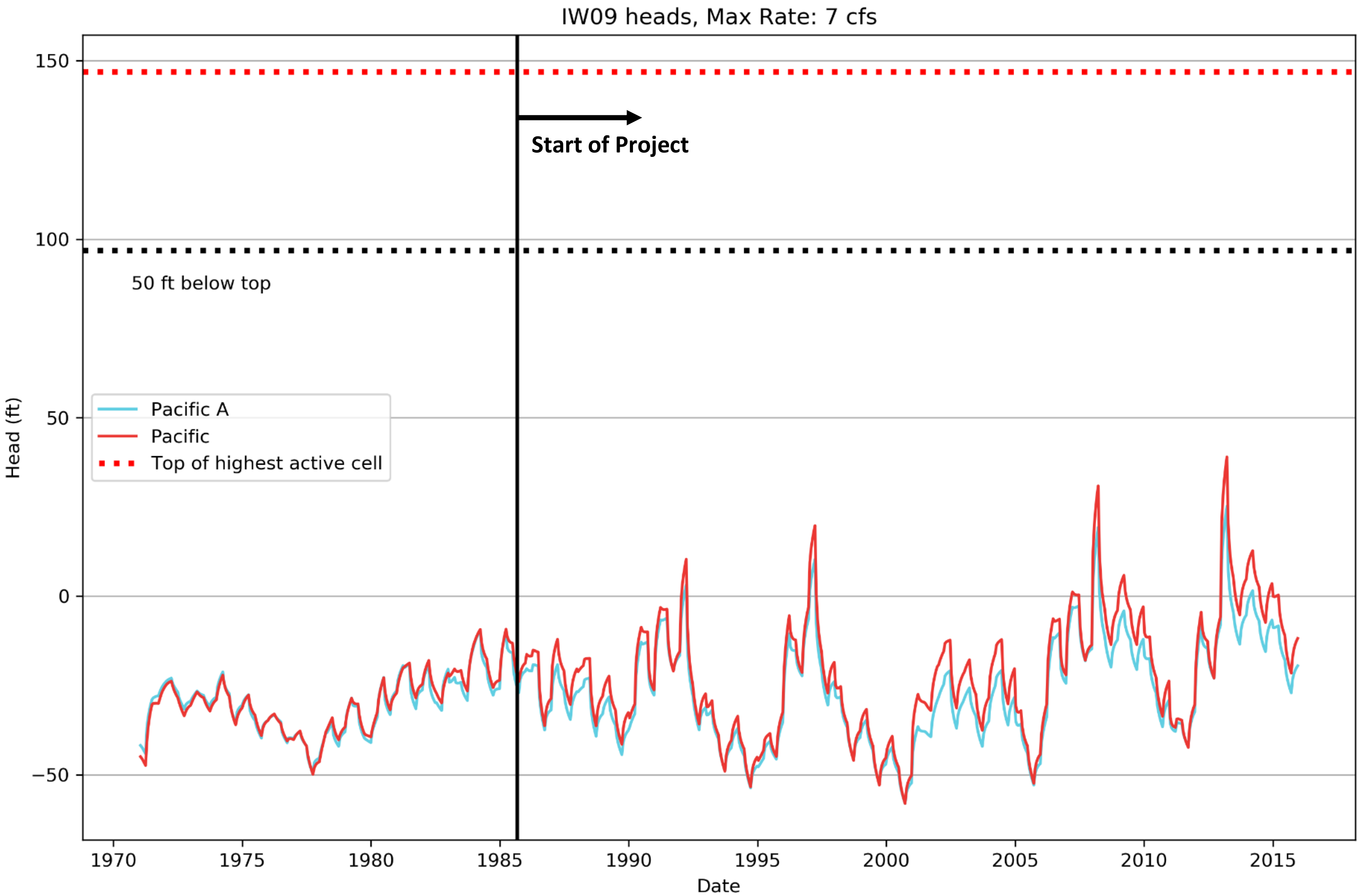
Tier 1 Hydrograph at Injection Well - IW07



INTERA

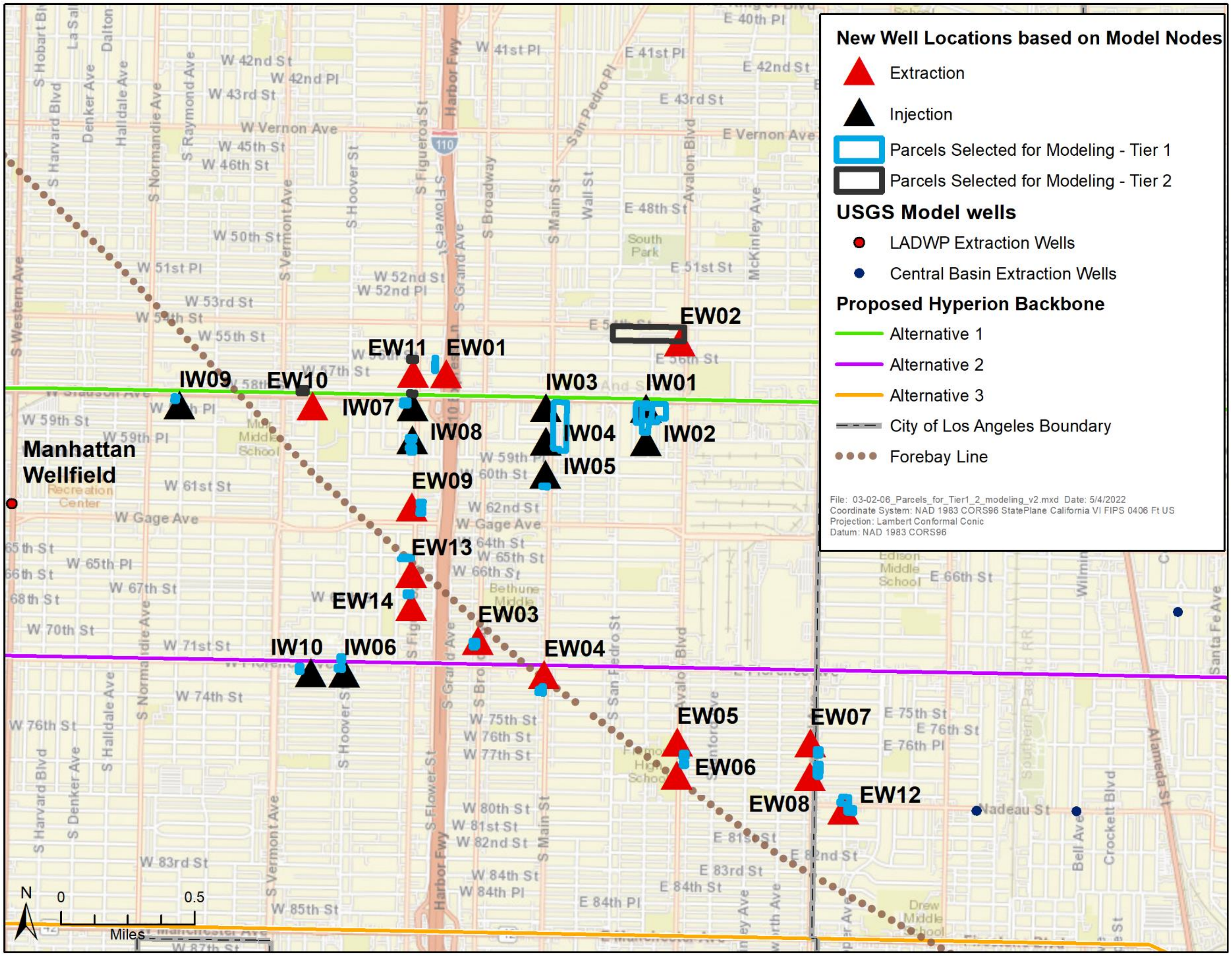
Figure 3.2.5p

Tier 1 Hydrograph at Injection Well - IW08



INTERA

Figure 3.2.5q
Tier 1 Hydrograph at Injection Well - IW09



INTERA

Figure 3.2.6
Map of Selected Tier 1 and 2 Parcels and Associated Model Nodes used for Injection and Extraction

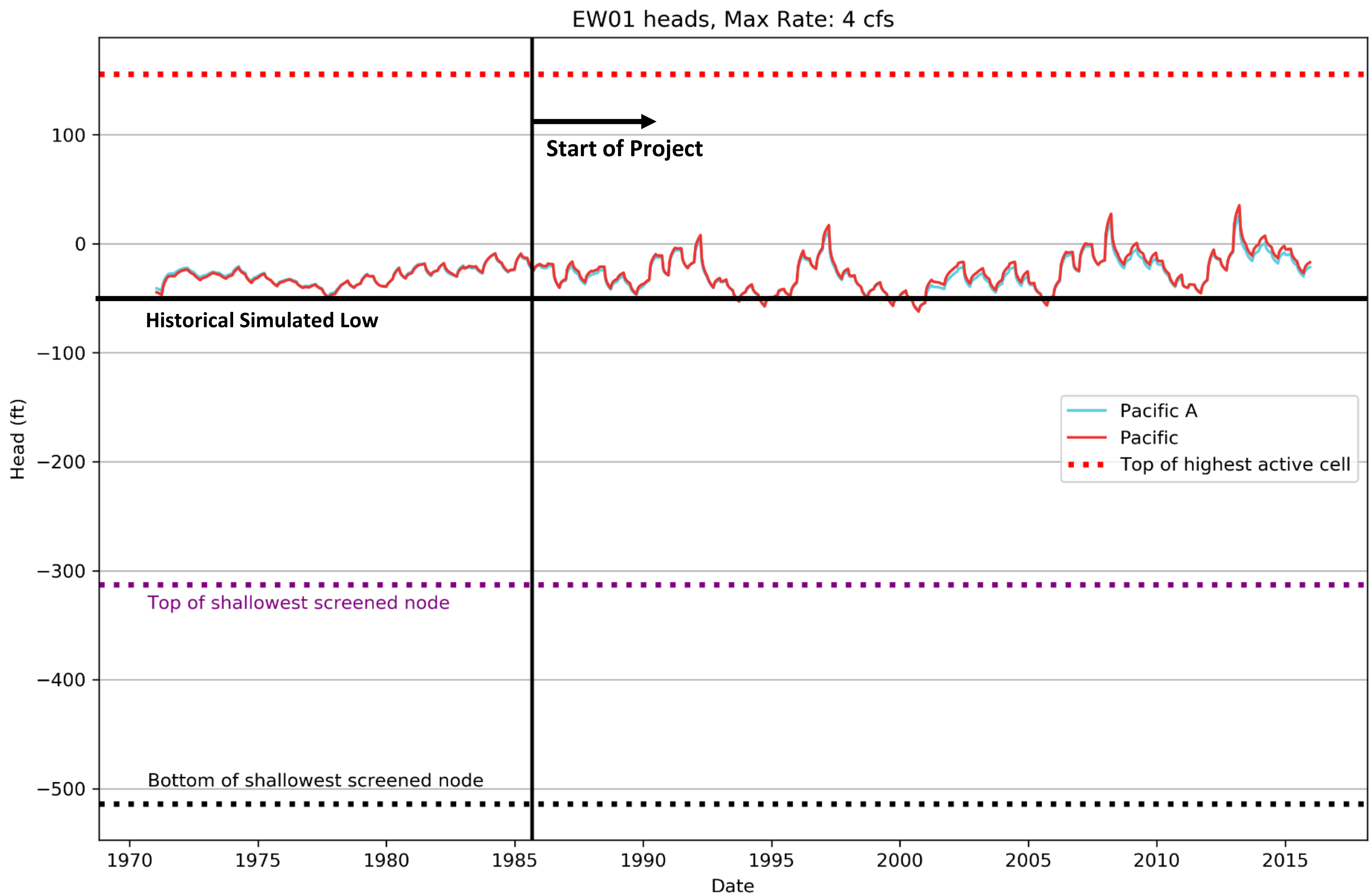
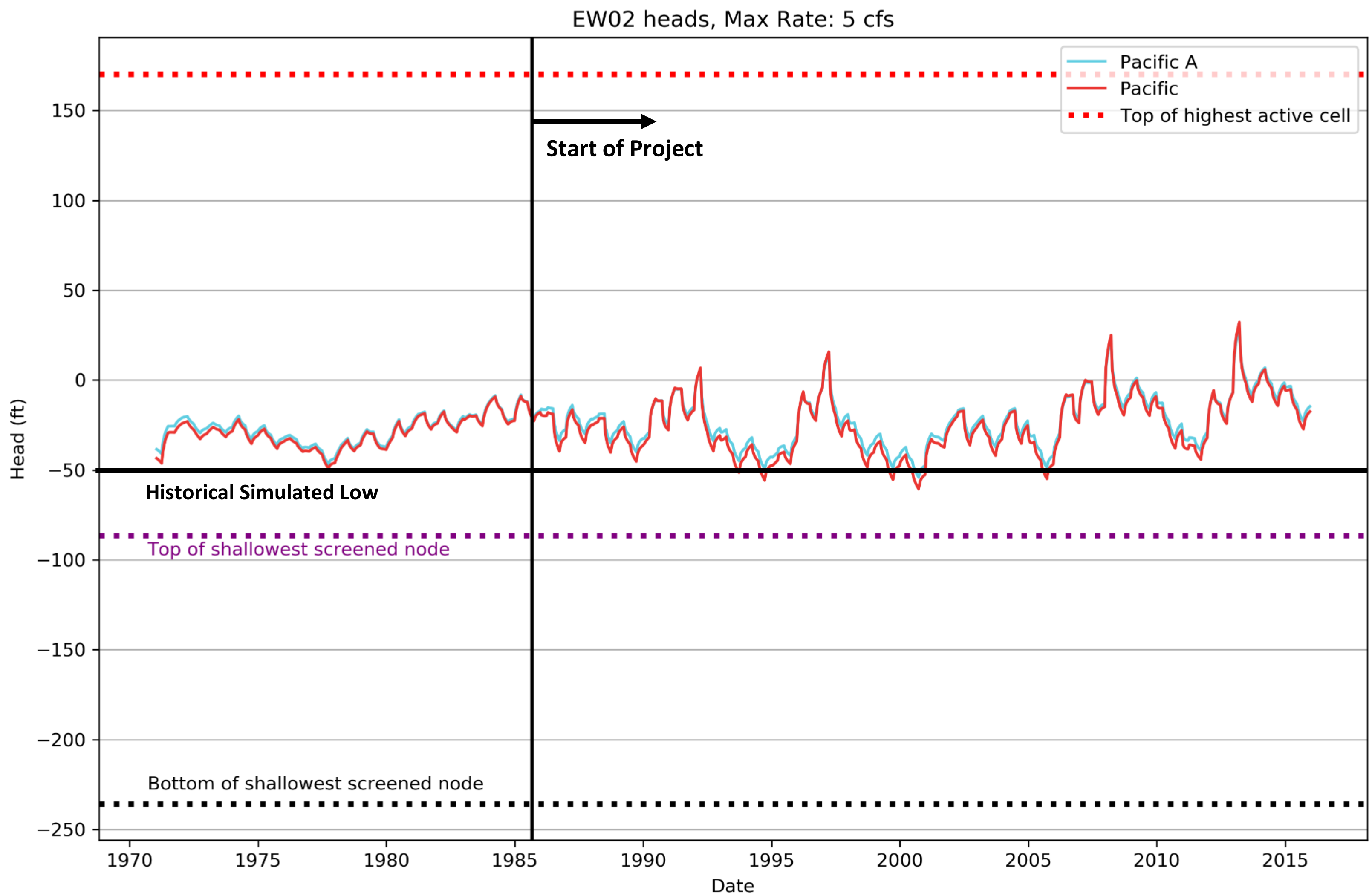
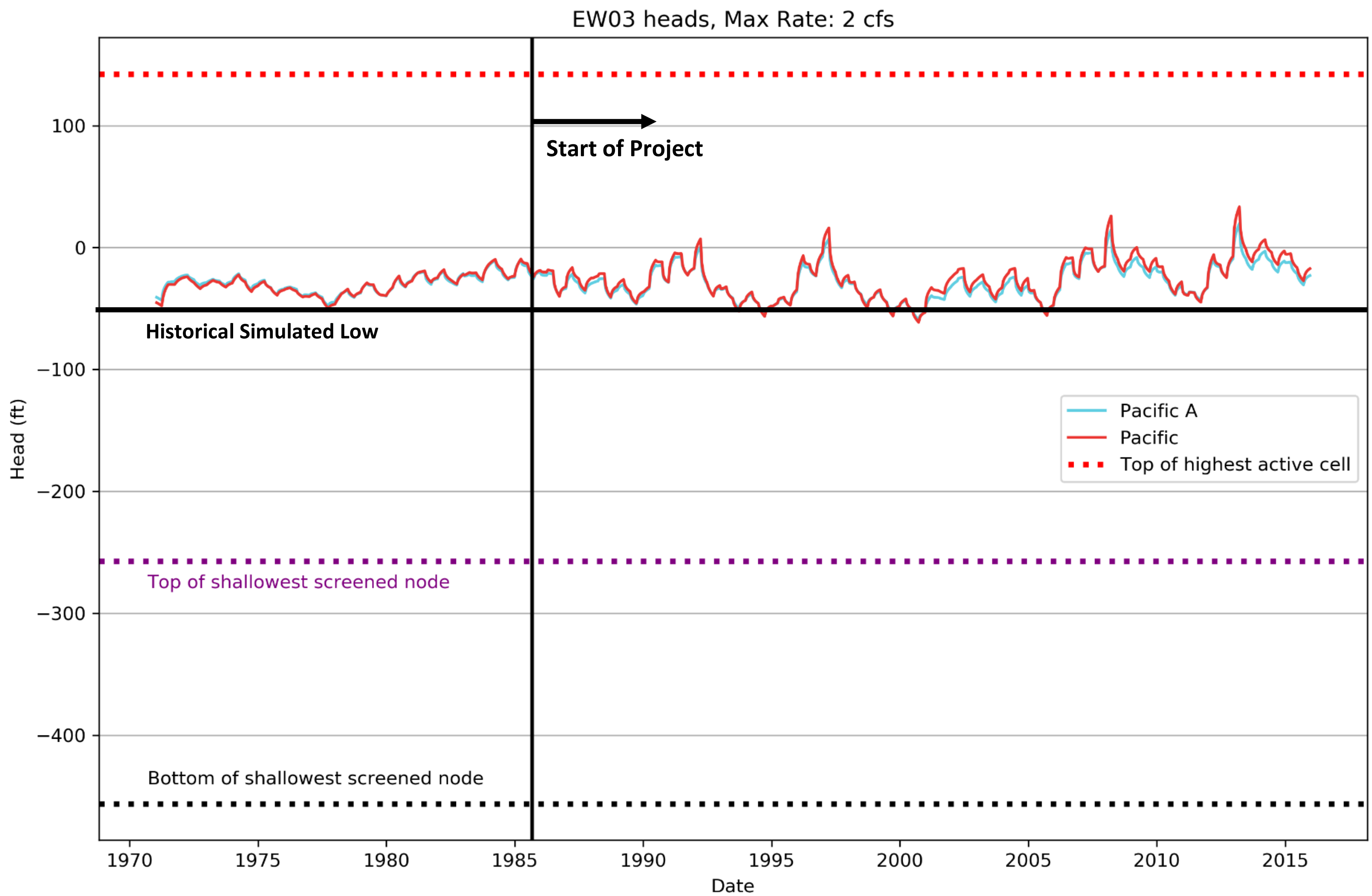


Figure 3.2.7a
Tier 1 Hydrograph at Extraction Well - EW01



INTERA

Figure 3.2.7b
Tier 2 Hydrograph at Extraction Well - EW02



INTERA

Figure 3.2.7c
Tier 1 Hydrograph at Extraction Well - EW03

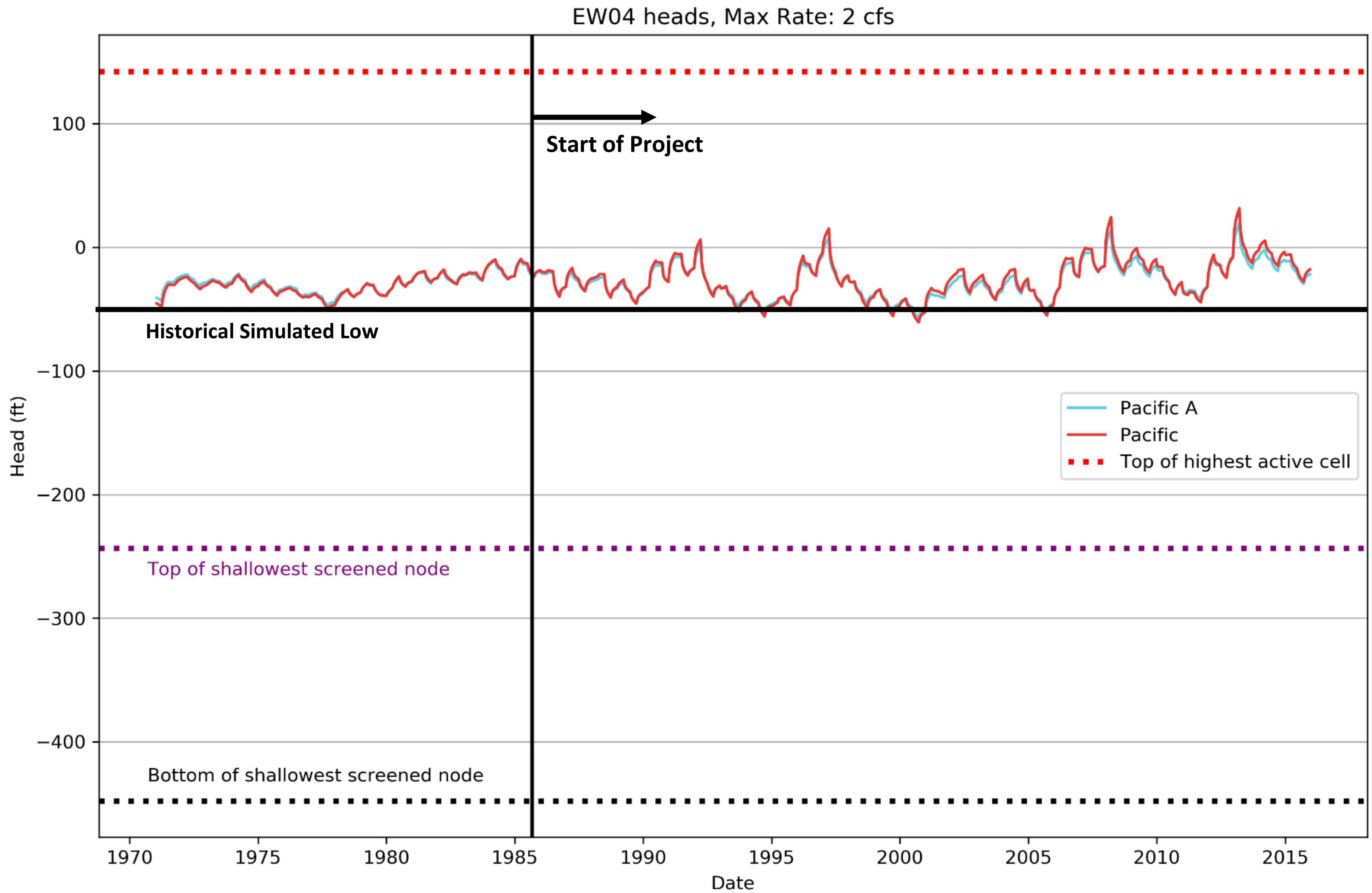
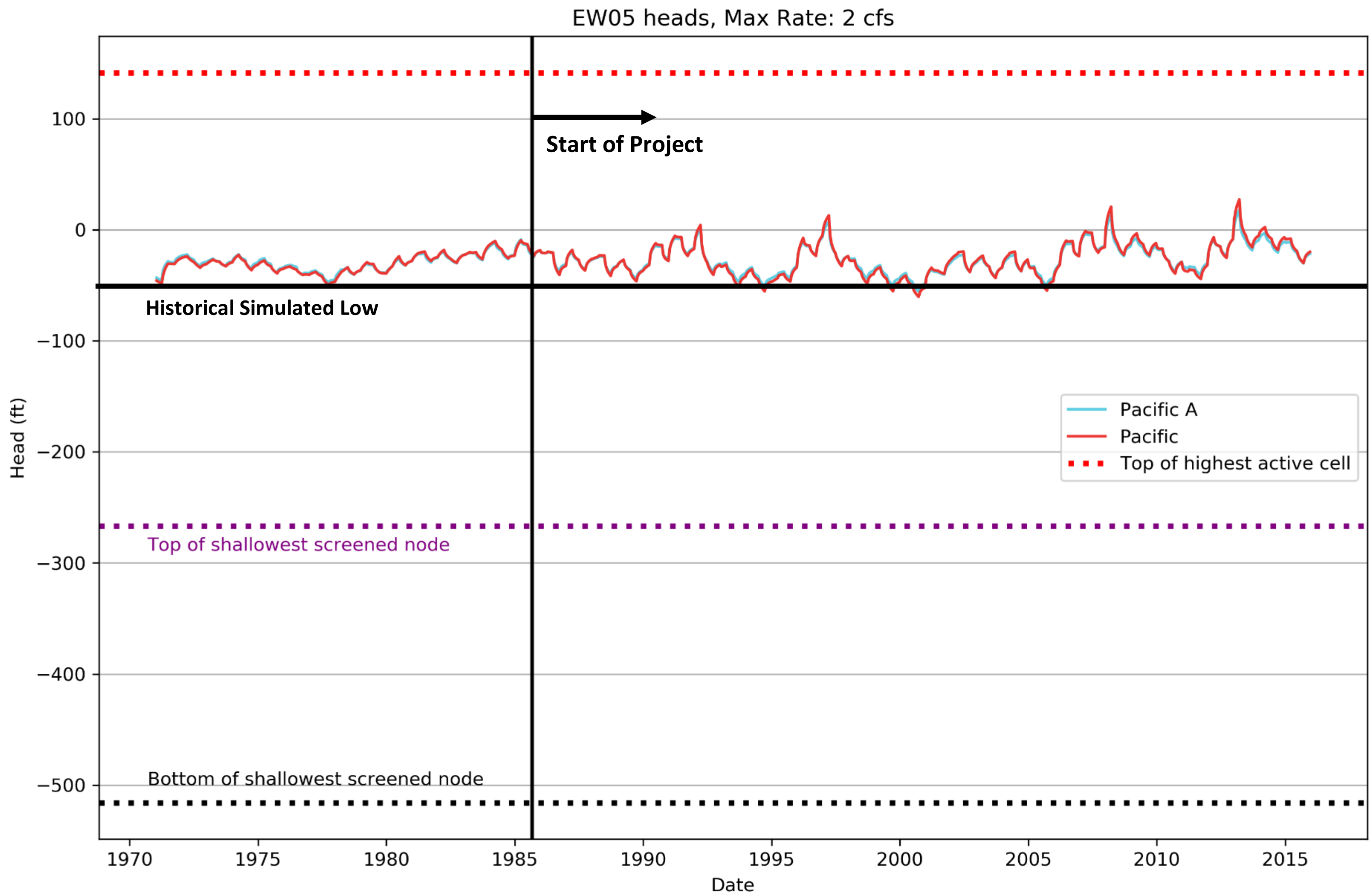


Figure 3.2.7d
Tier 1 Hydrograph at Extraction Well - EW04



INTERA

Figure 3.2.7e
Tier 1 Hydrograph at Extraction Well - EW05

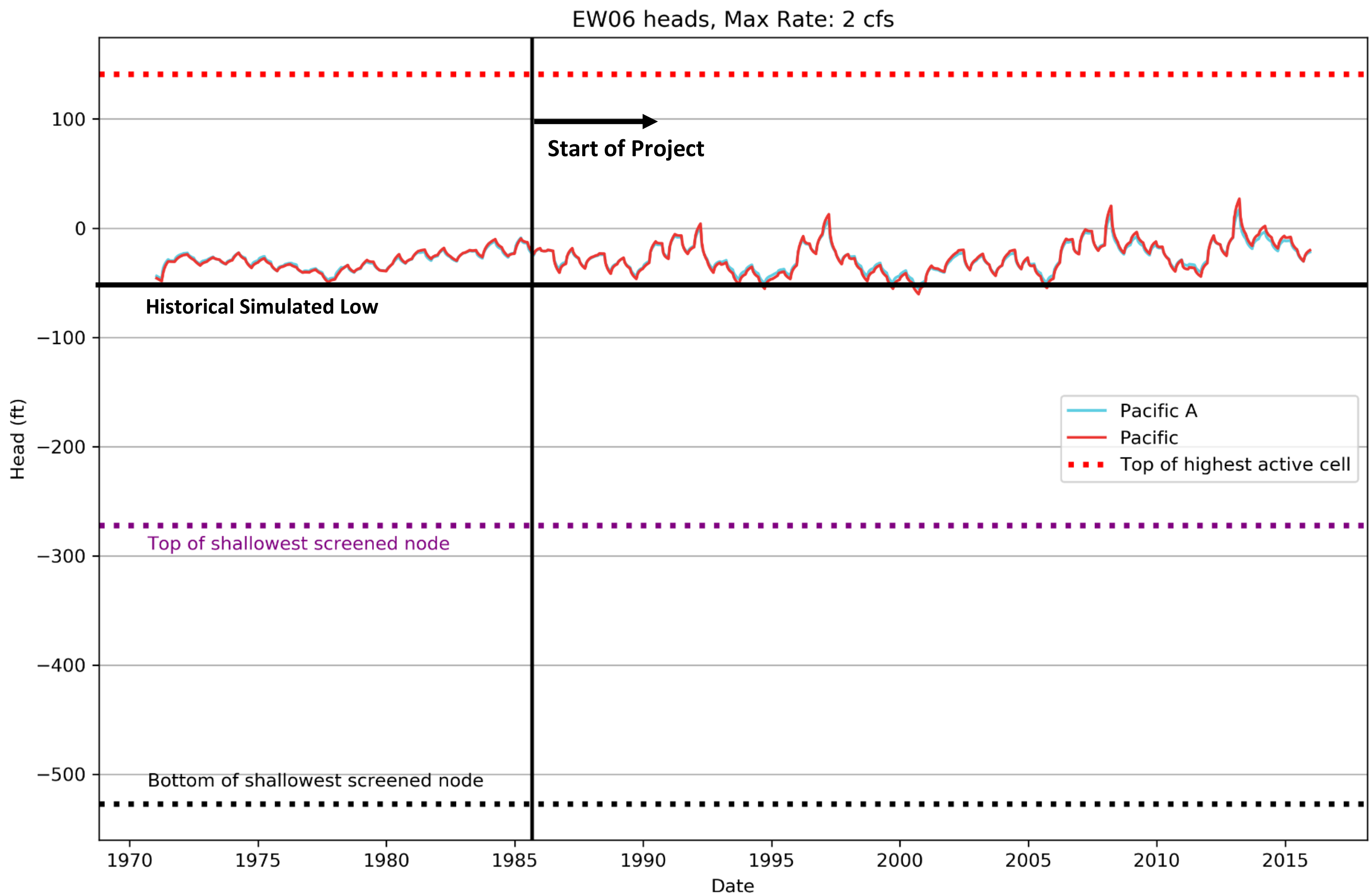


Figure 3.2.7f

Tier 1 Hydrograph at Extraction Well - EW06

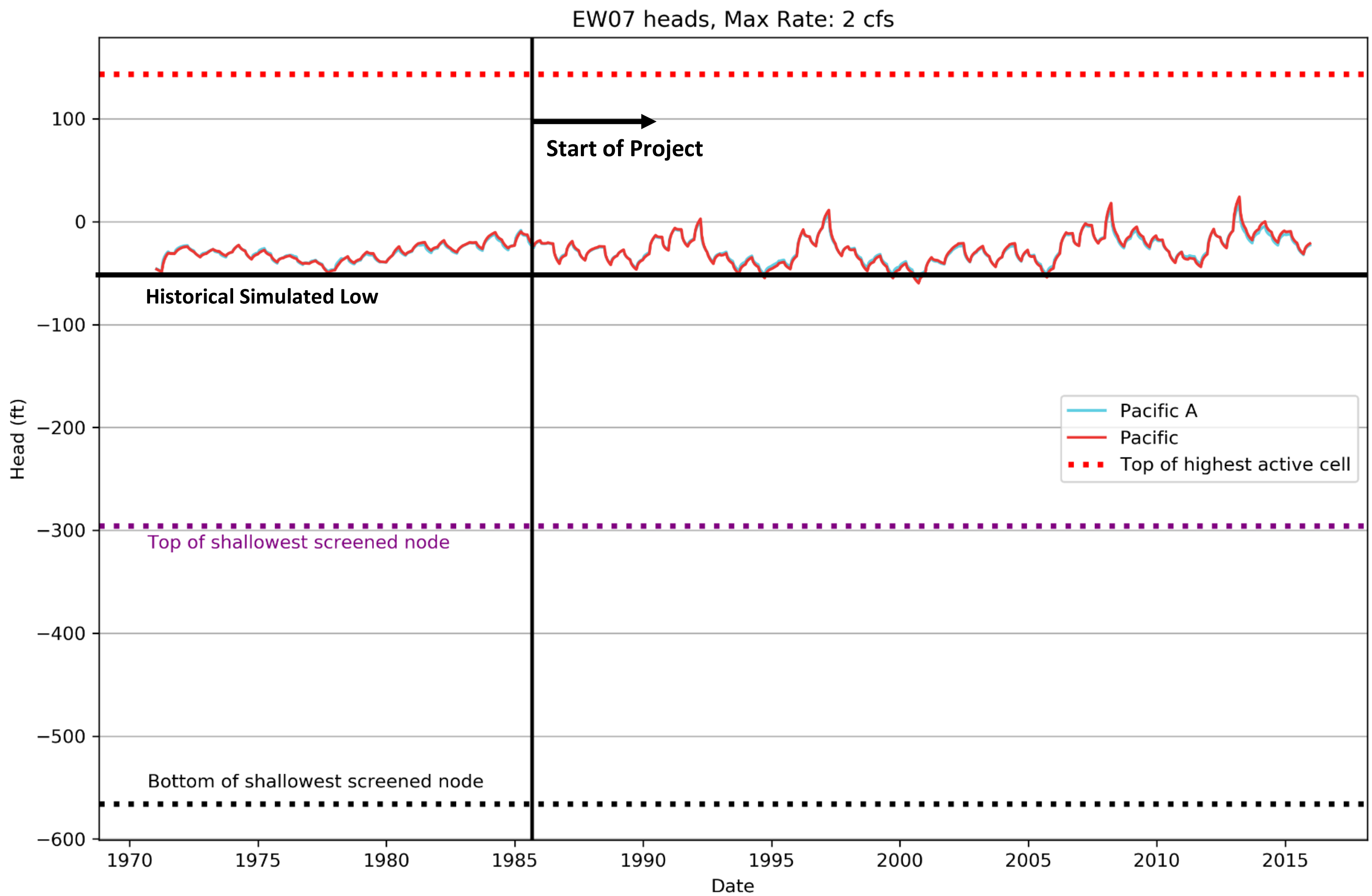


Figure 3.2.7g
Tier 1 Hydrograph at Extraction Well - EW07

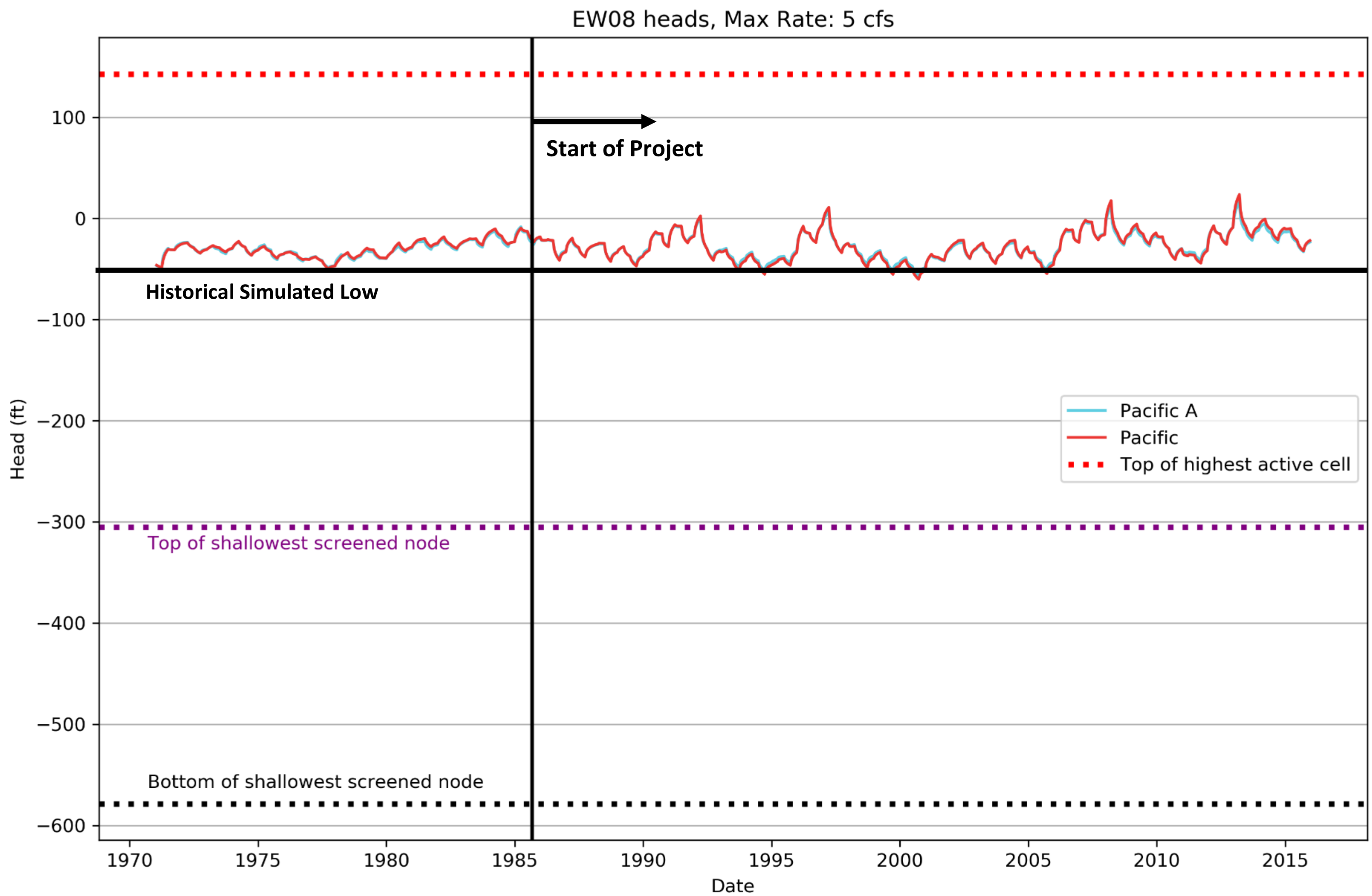
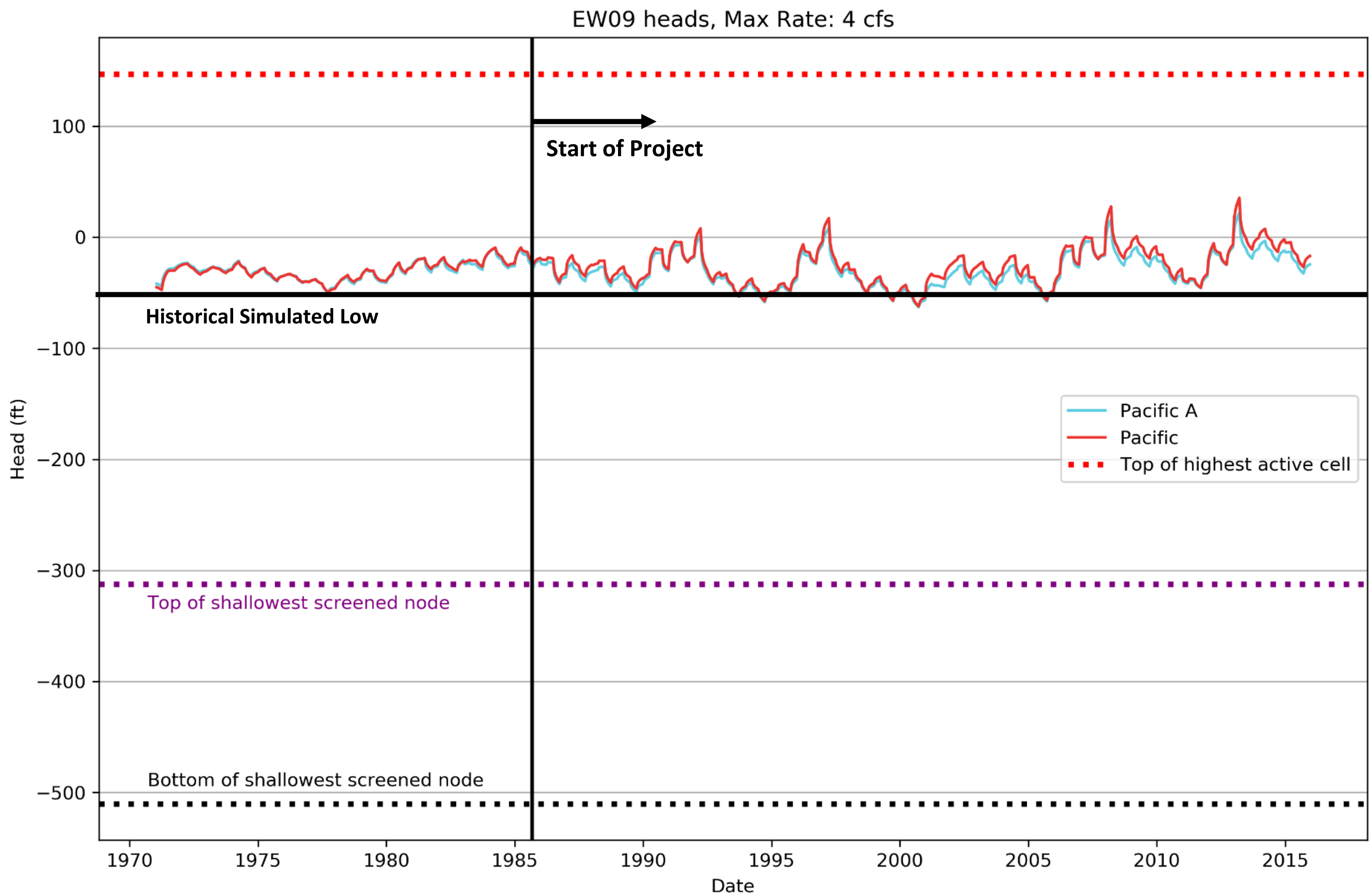


Figure 3.2.7h
Tier 1 Hydrograph at Extraction Well - EW08



INTERA

Figure 3.2.7i
Tier 1 Hydrograph at Extraction Well - EW09

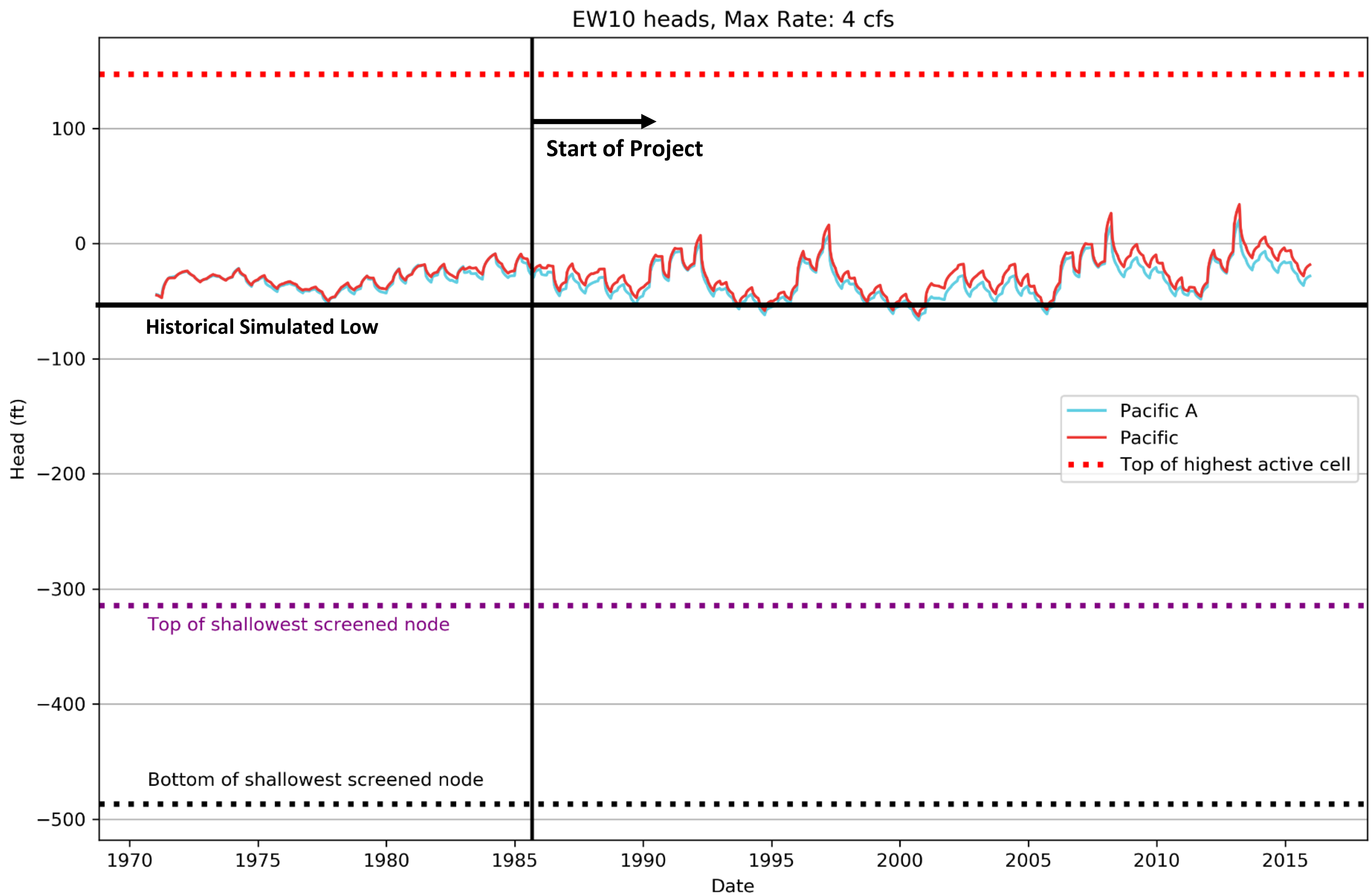
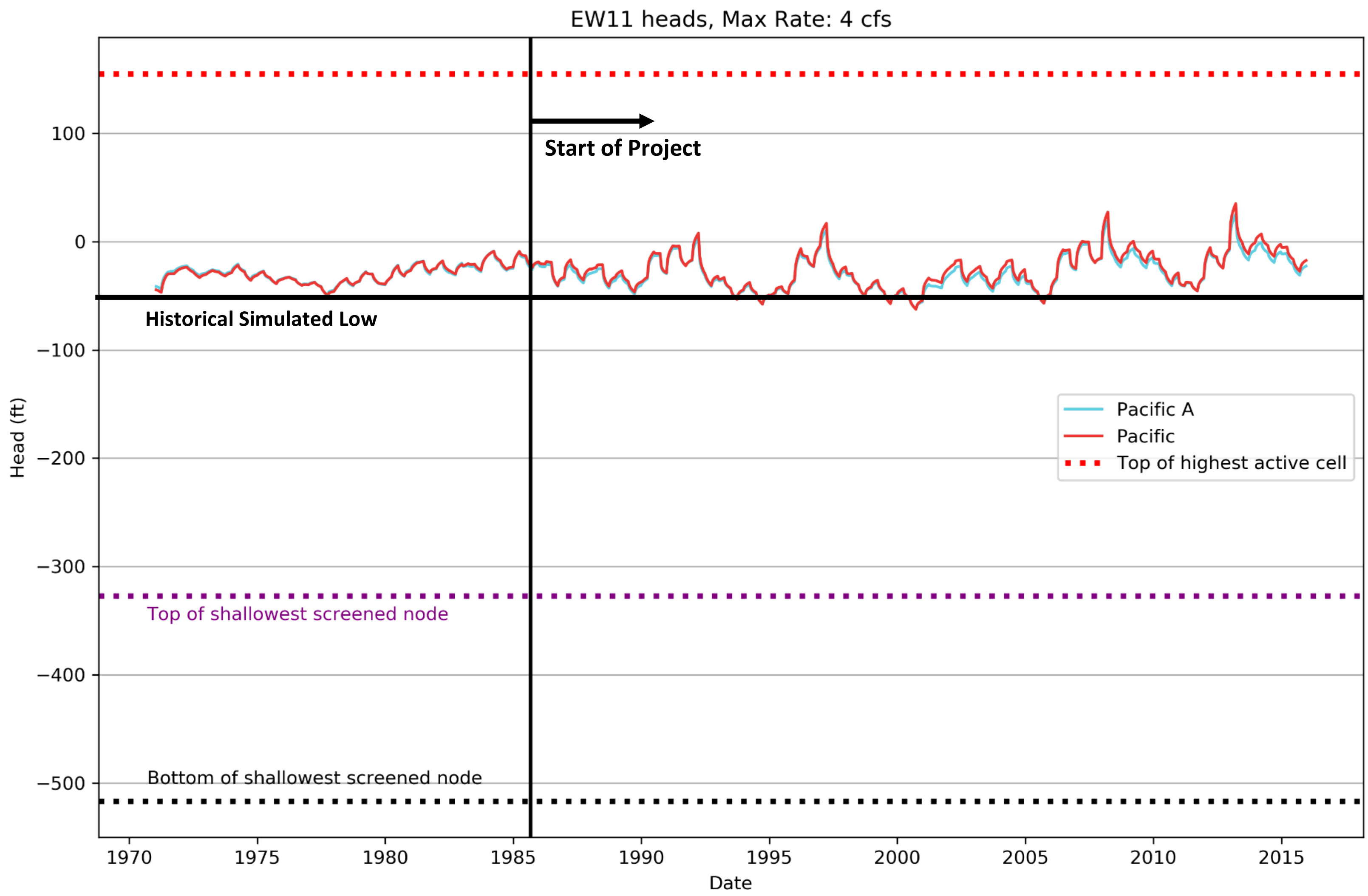


Figure 3.2.7j
Tier 2 Hydrograph at Extraction Well - EW10



INTERA

Figure 3.2.7k
Tier 2 Hydrograph at Extraction Well - EW11

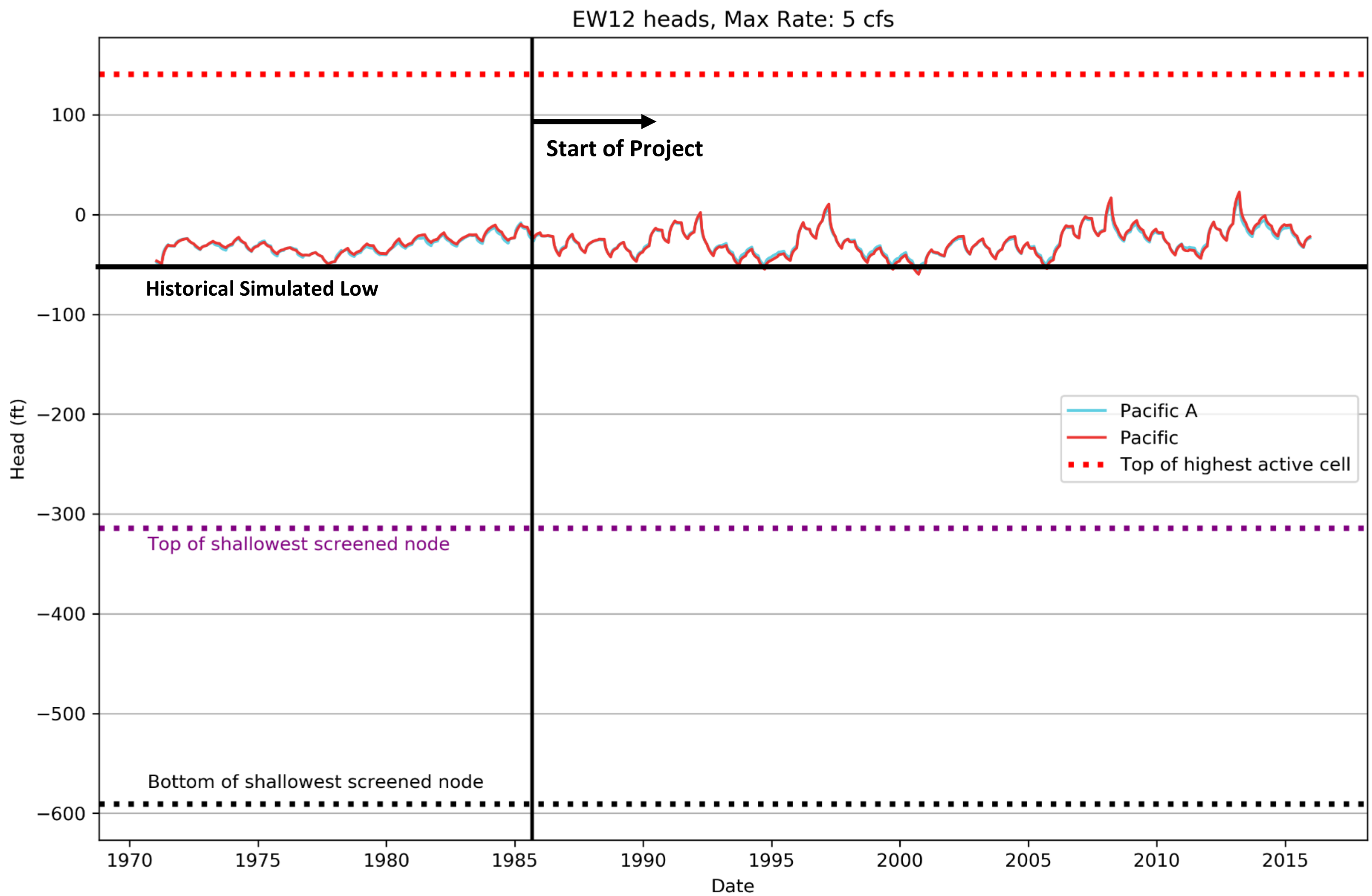
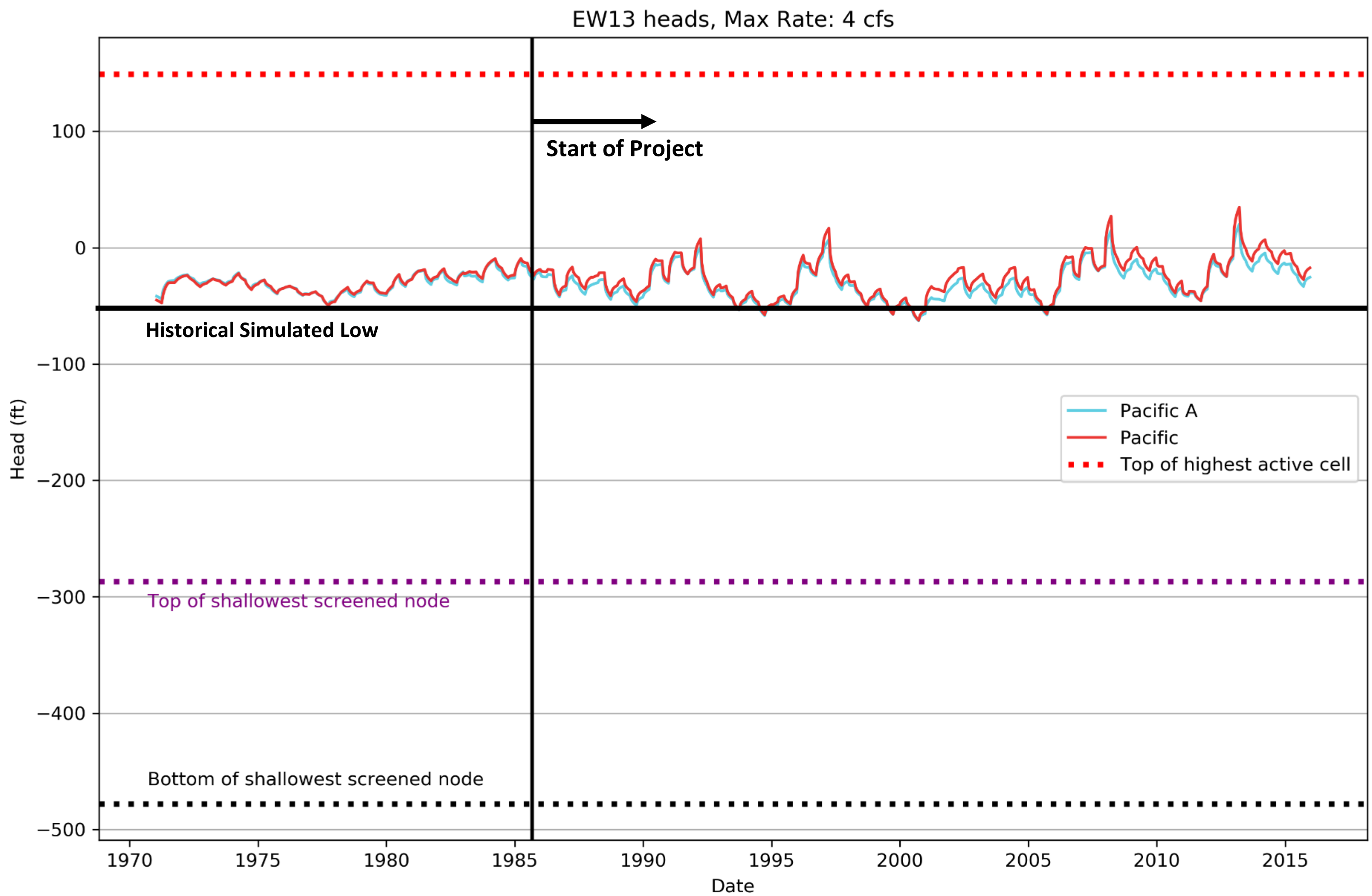
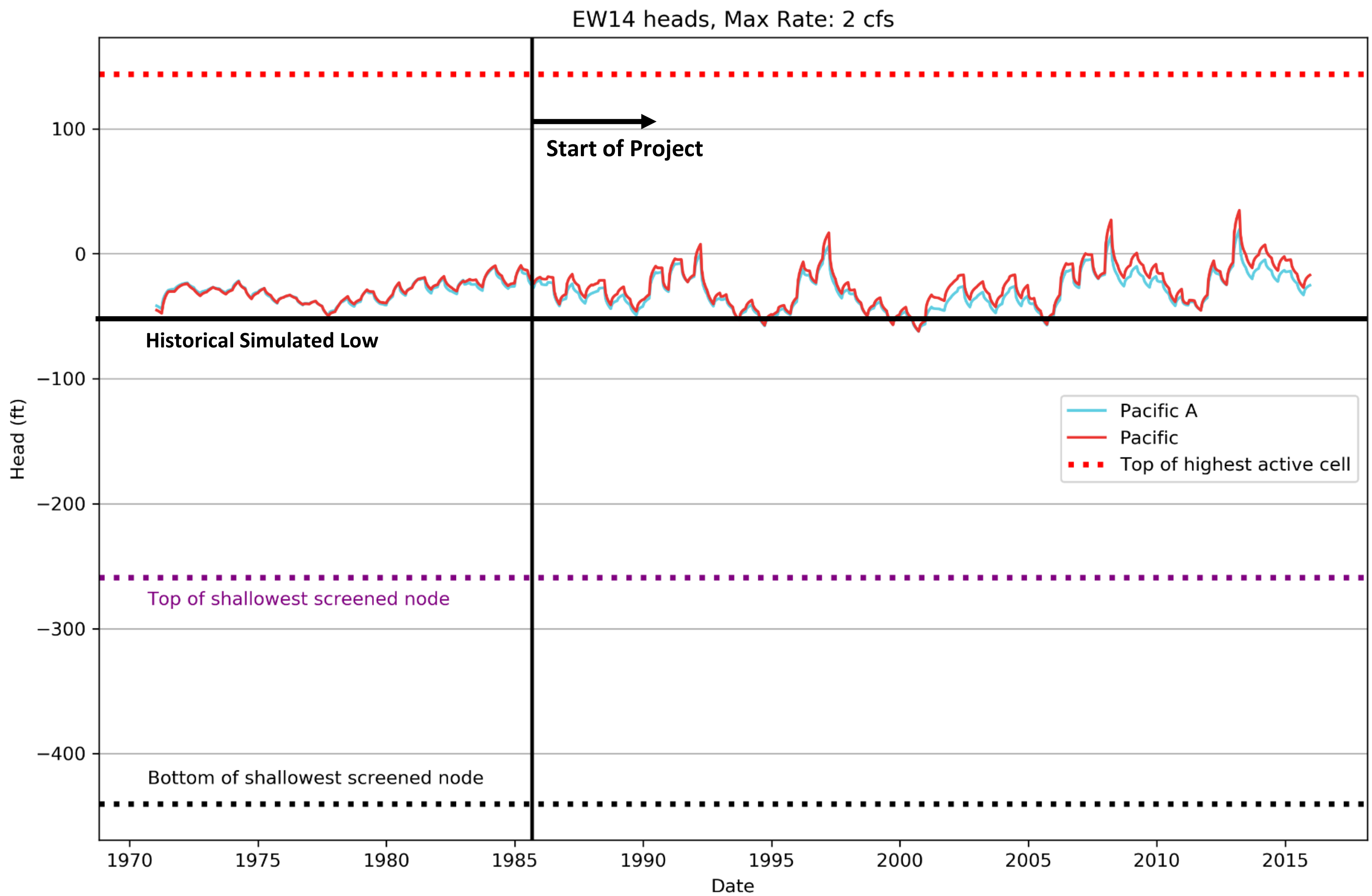


Figure 3.2.7l
Tier 1 Hydrograph at Extraction Well - EW12



INTERA

Figure 3.2.7m
Tier 1 Hydrograph at Extraction Well - EW13



INTERA

Figure 3.2.7n
Tier 1 Hydrograph at Extraction Well - EW14

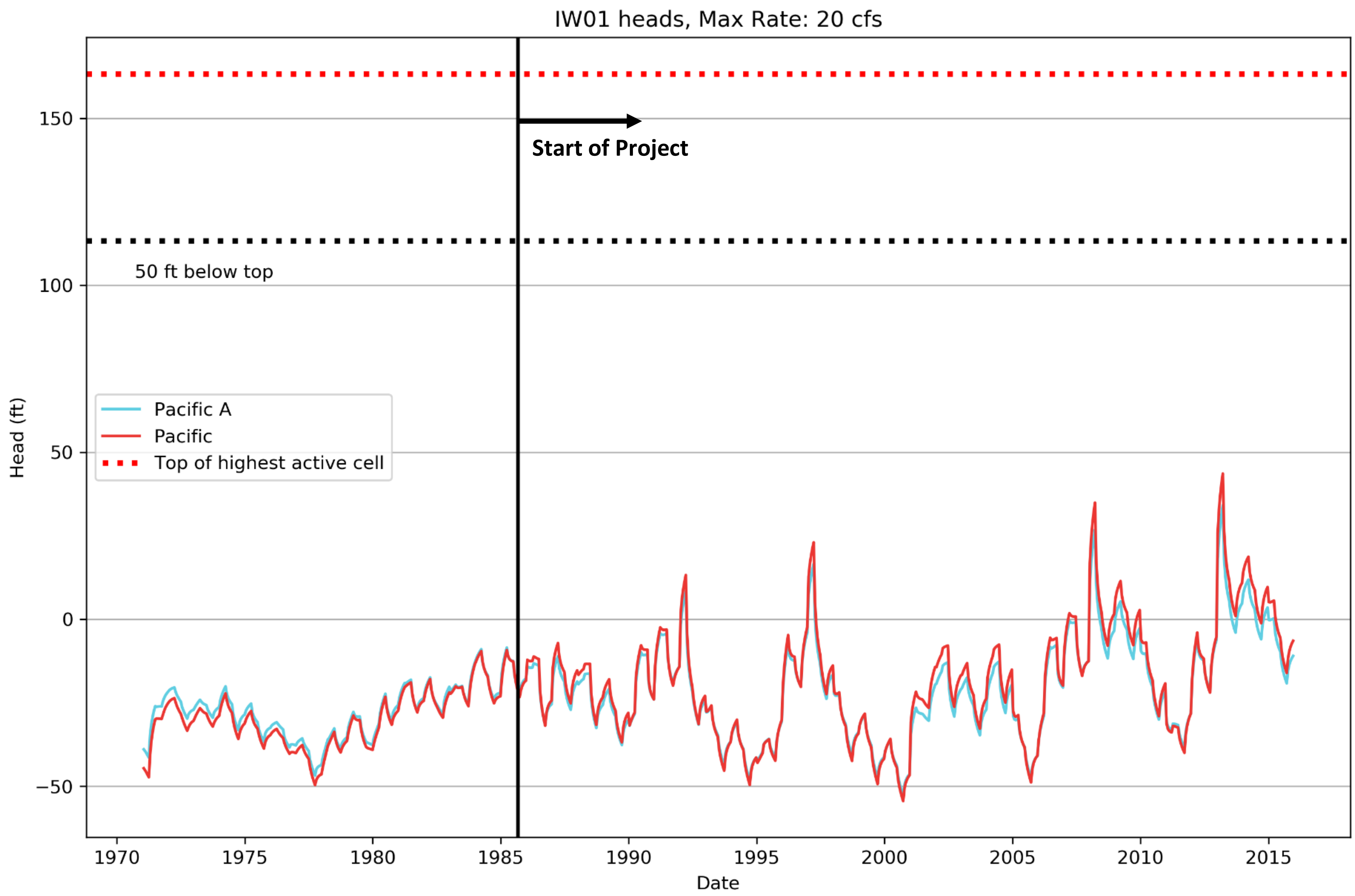


Figure 3.2.7o

Tier 1 Hydrograph at Injection Well - IW01

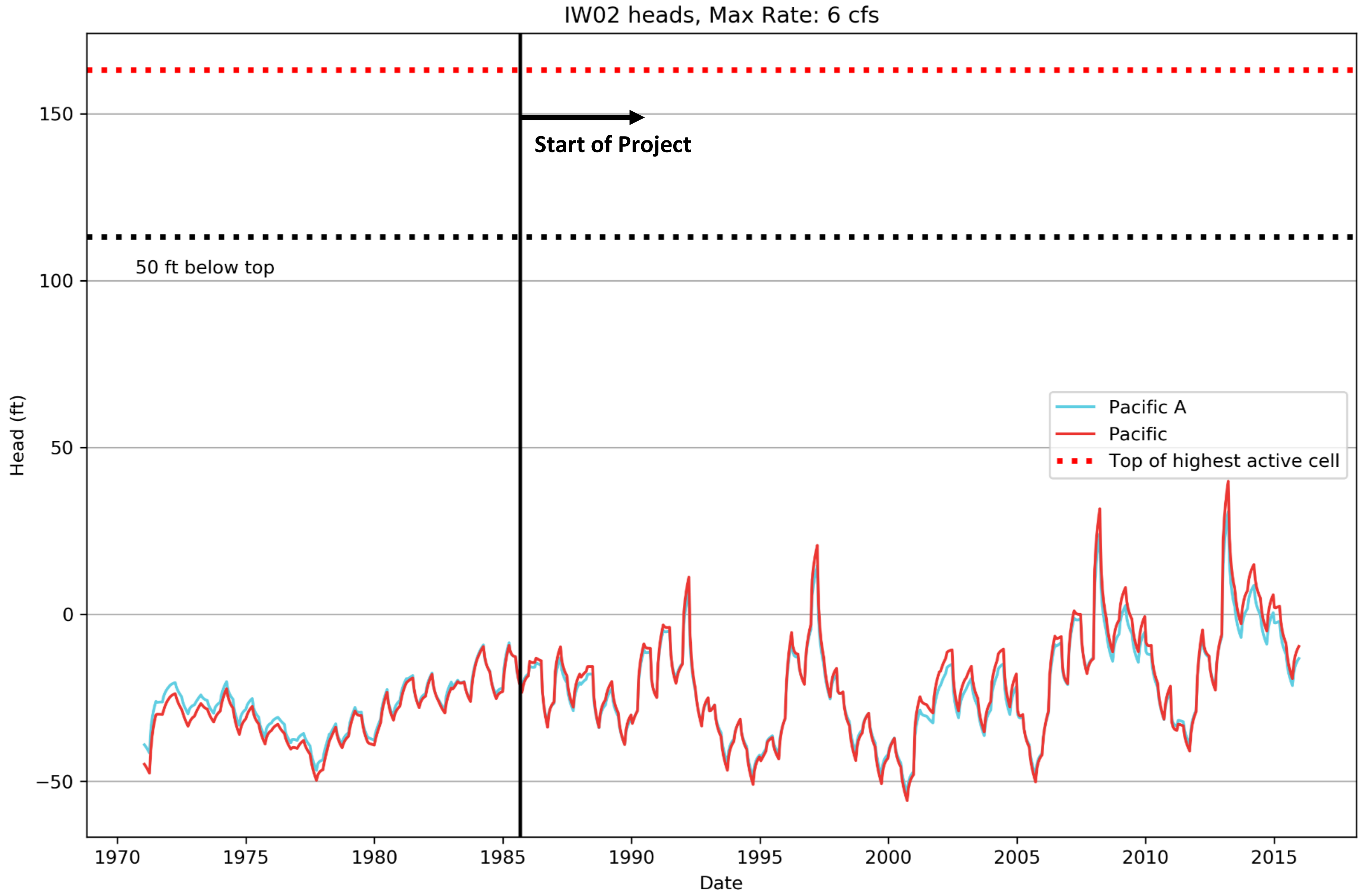
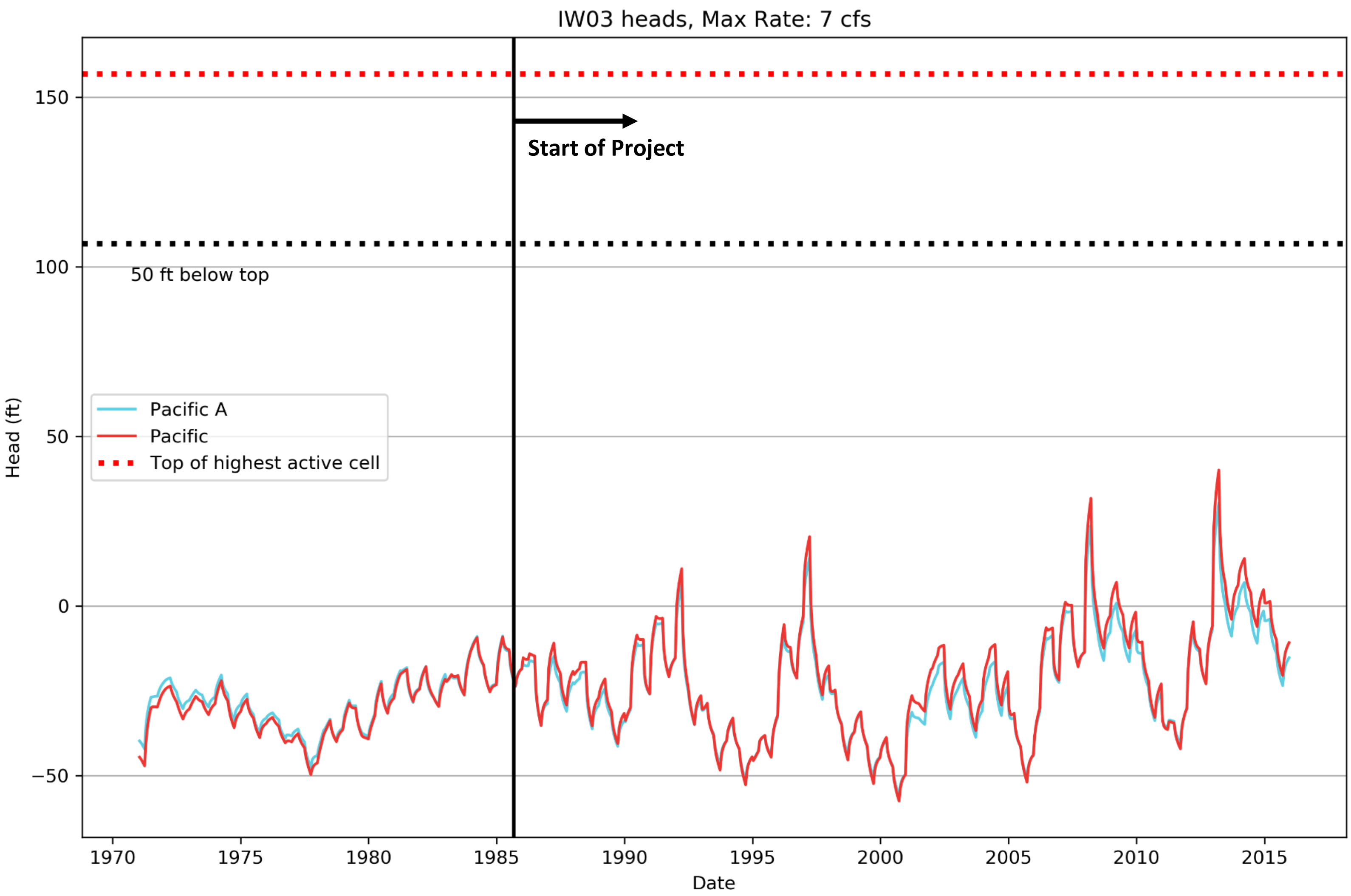


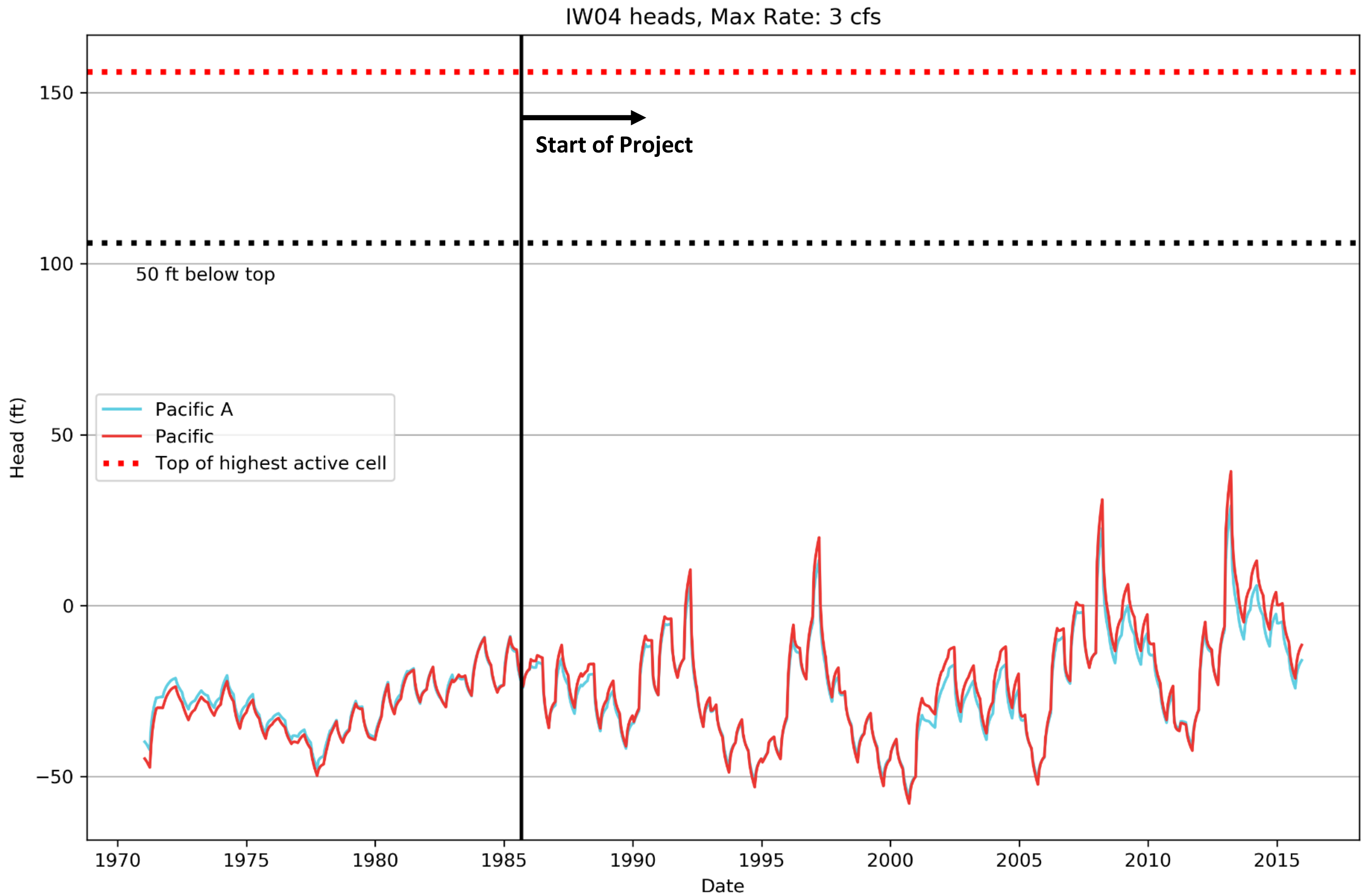
Figure 3.2.7p

Tier 1 Hydrograph at Injection Well - IW02



INTERA

Figure 3.2.7q
Tier 1 Hydrograph at Injection Well - IW03



INTERA

Figure 3.2.7r
Tier 1 Hydrograph at Injection Well - IW04

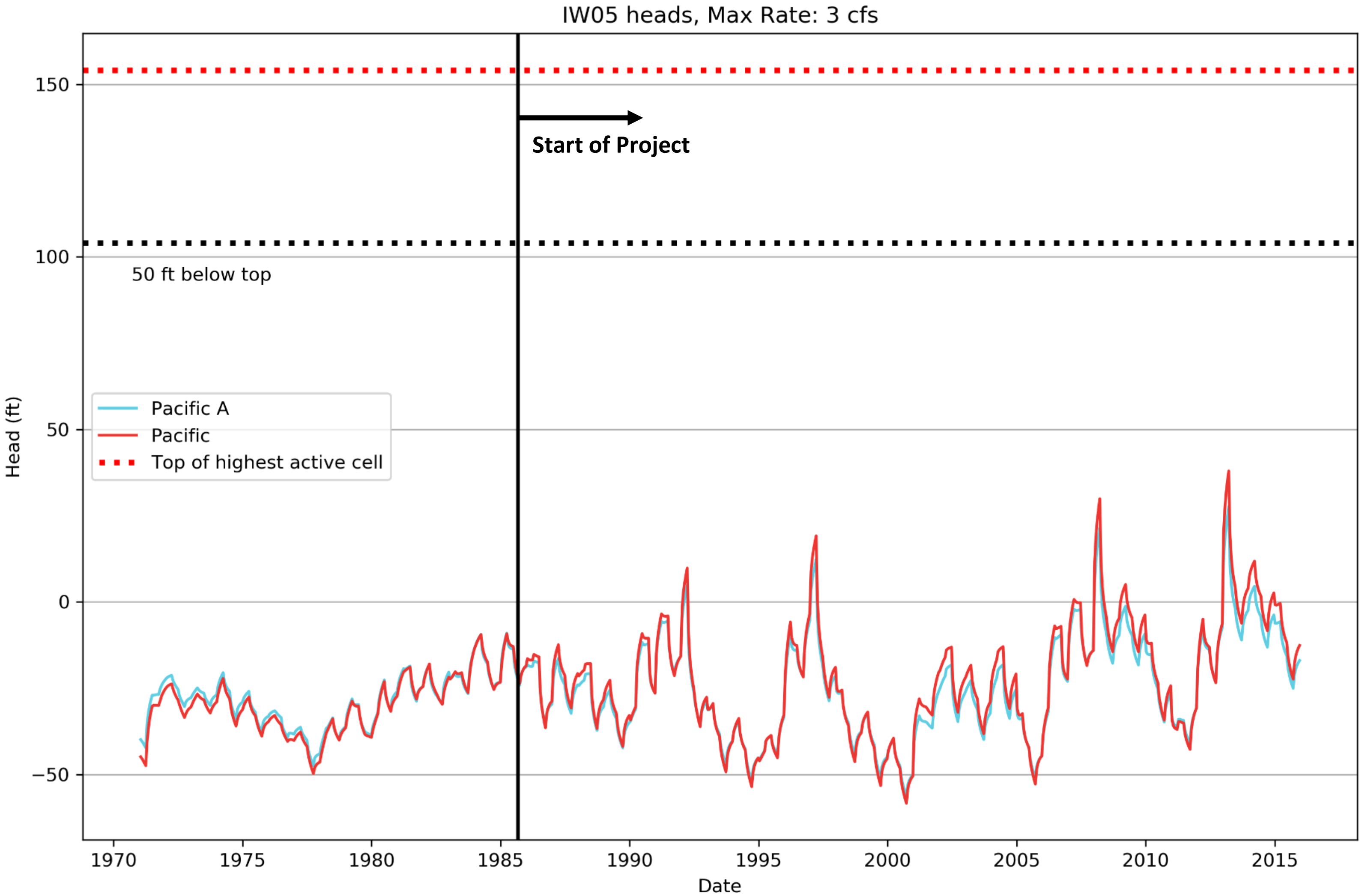
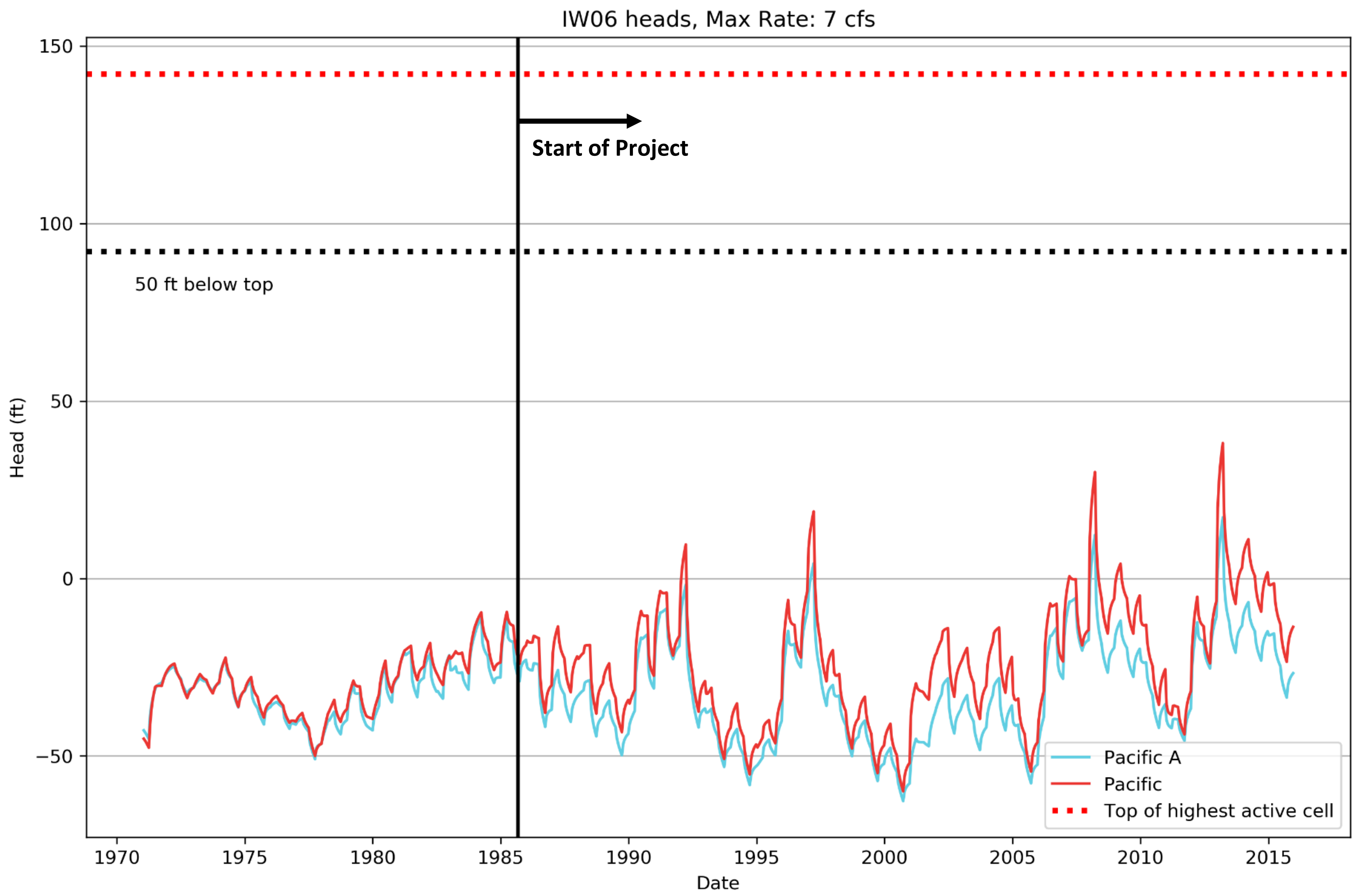


Figure 3.2.7s

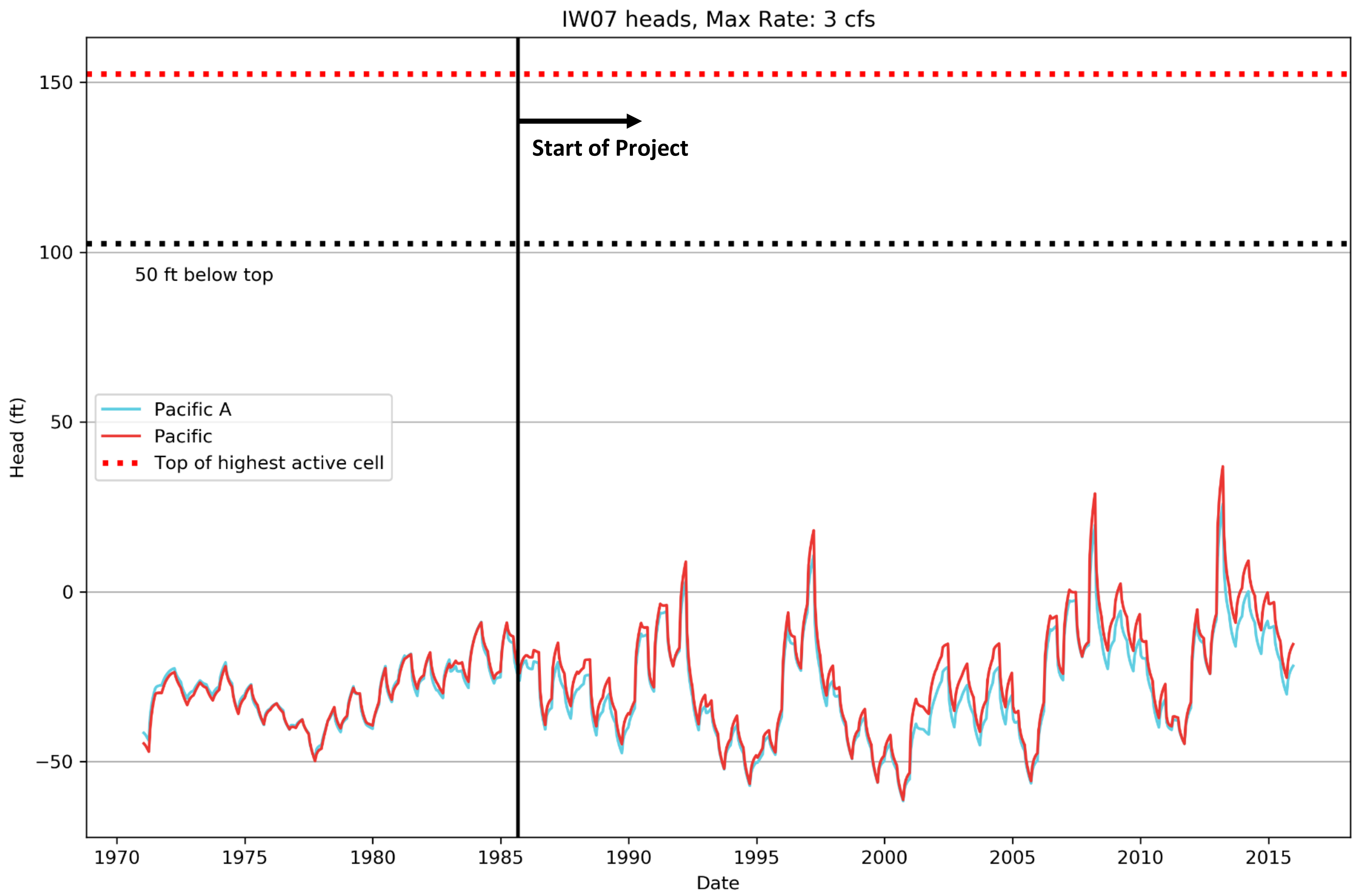
Tier 1 Hydrograph at Injection Well - IW05



INTERA

Figure 3.2.7t

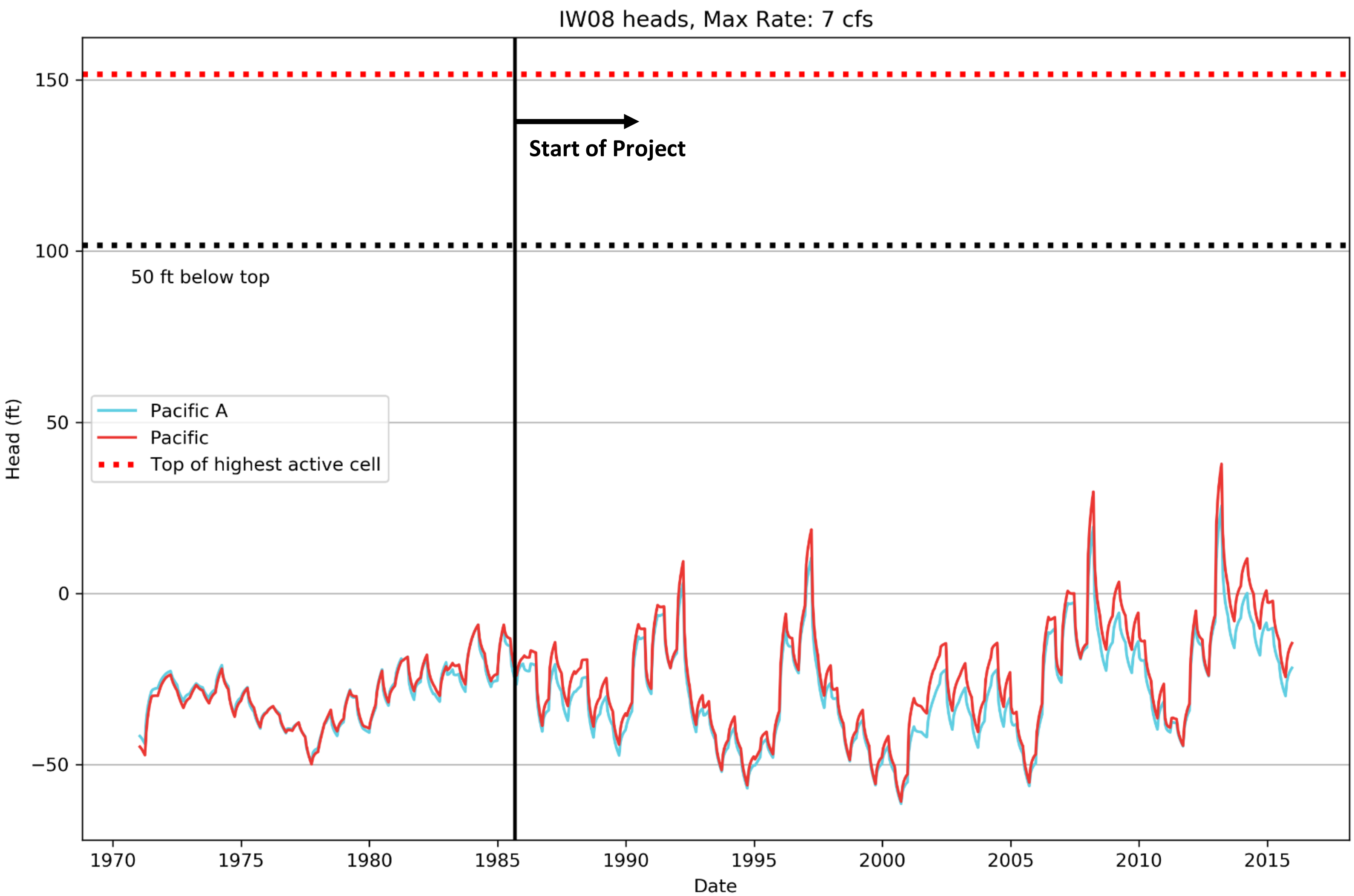
Tier 1 Hydrograph at Injection Well - IW06



INTERA

Figure 3.2.7u

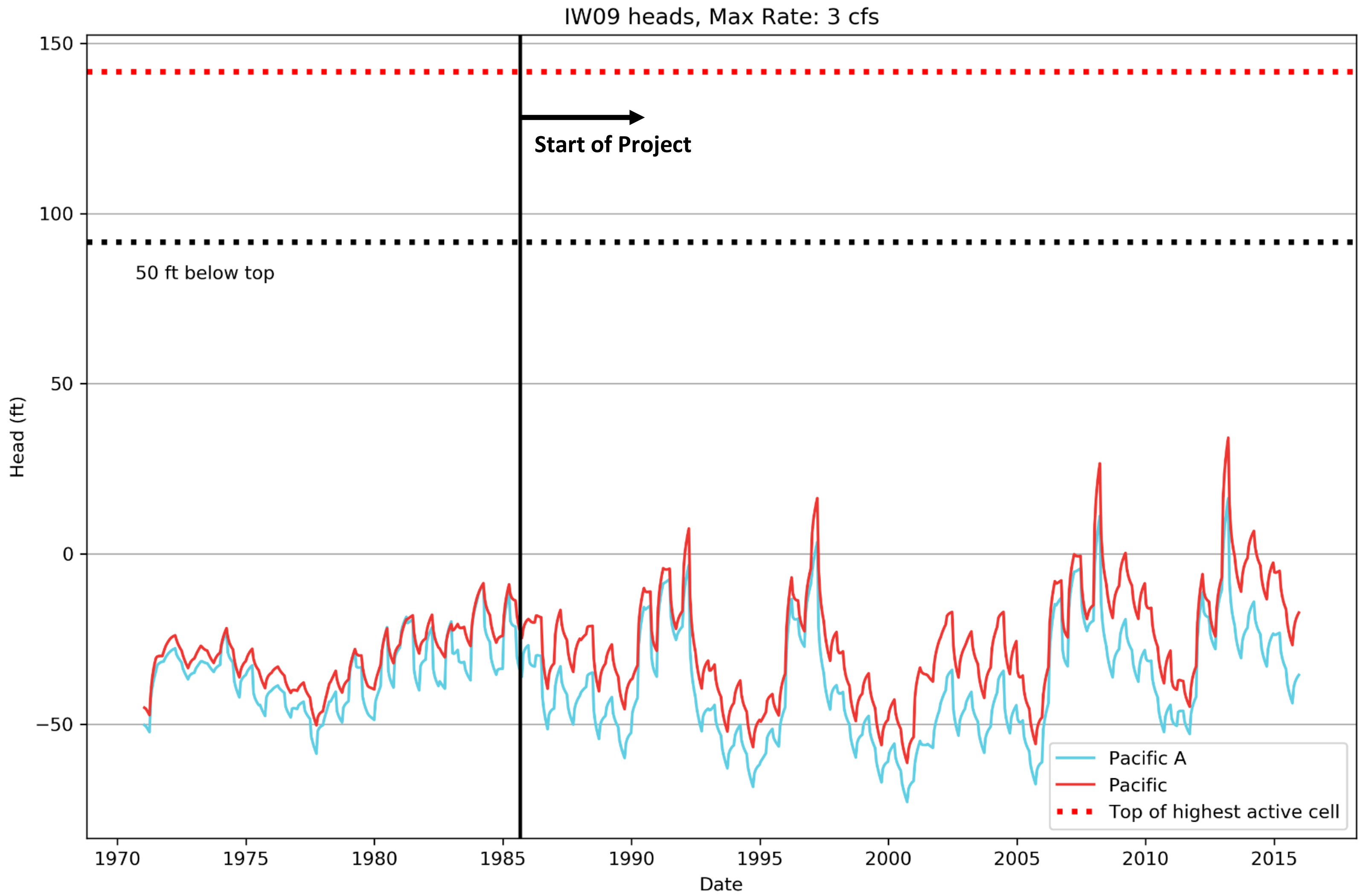
Tier 1 Hydrograph at Injection Well - IW07



INTERA

Figure 3.2.7v

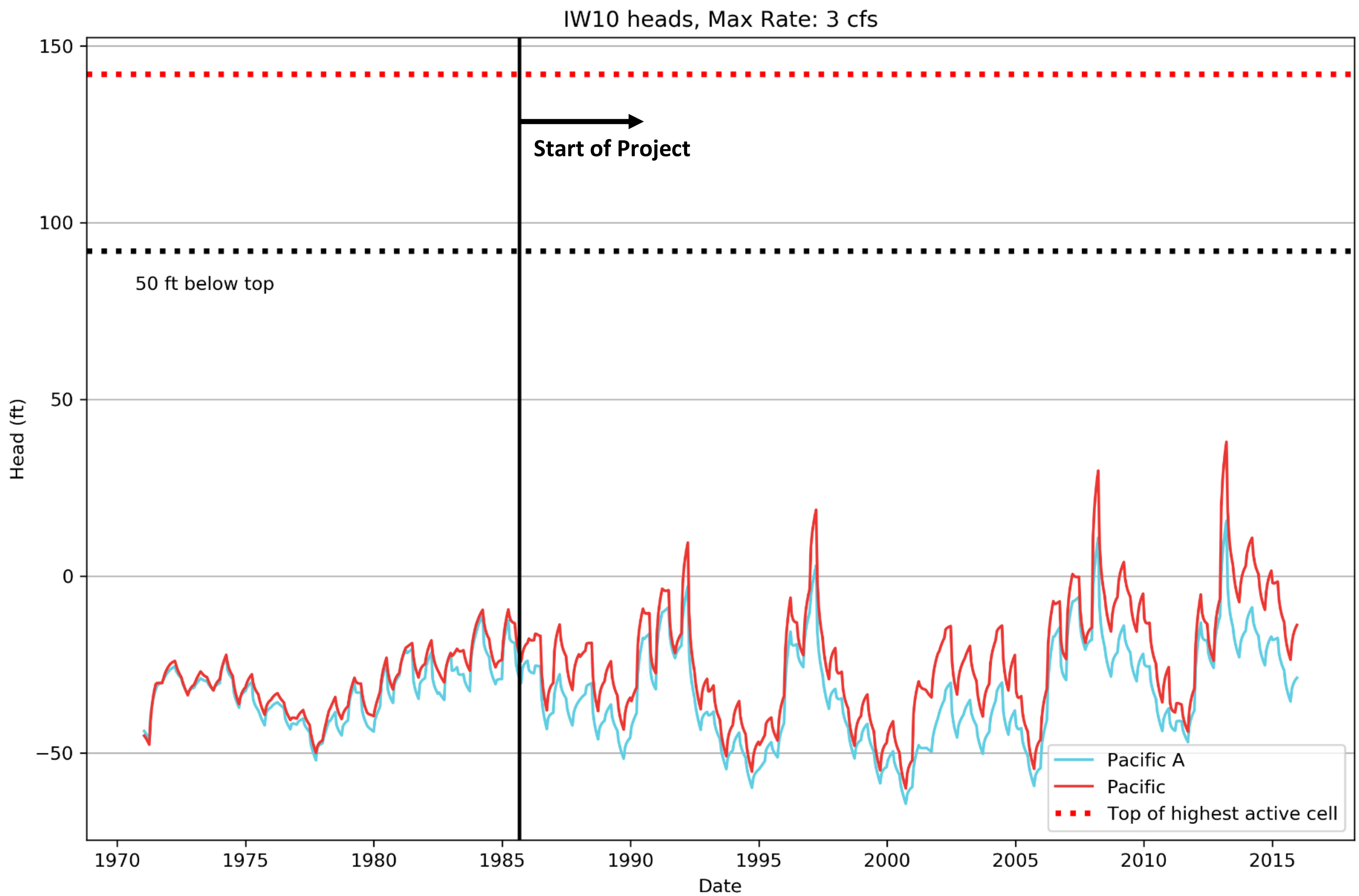
Tier 1 Hydrograph at Injection Well - IW08



INTERA

Figure 3.2.7w

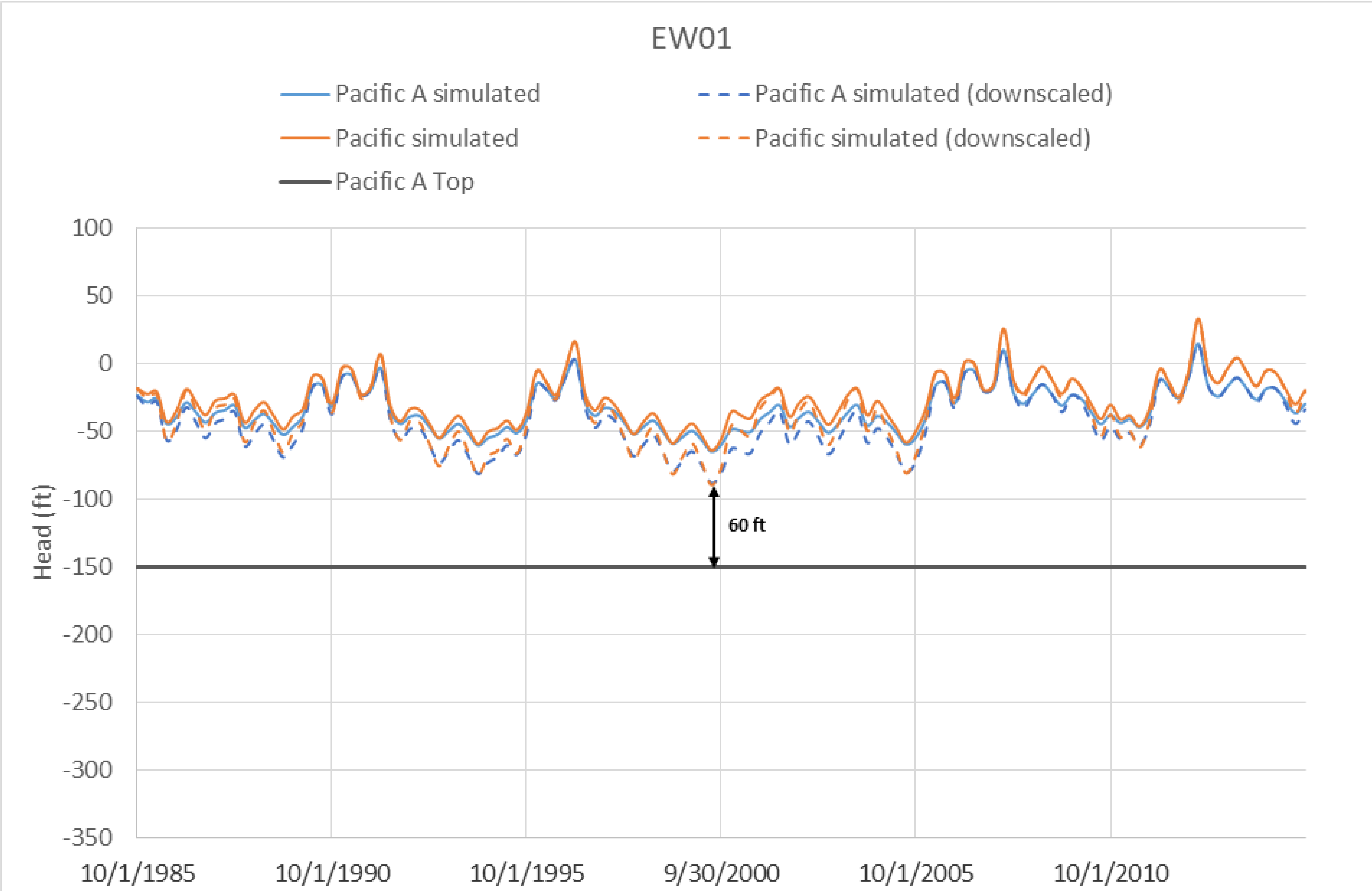
Tier 1 Hydrograph at Injection Well - IW09



INTERA

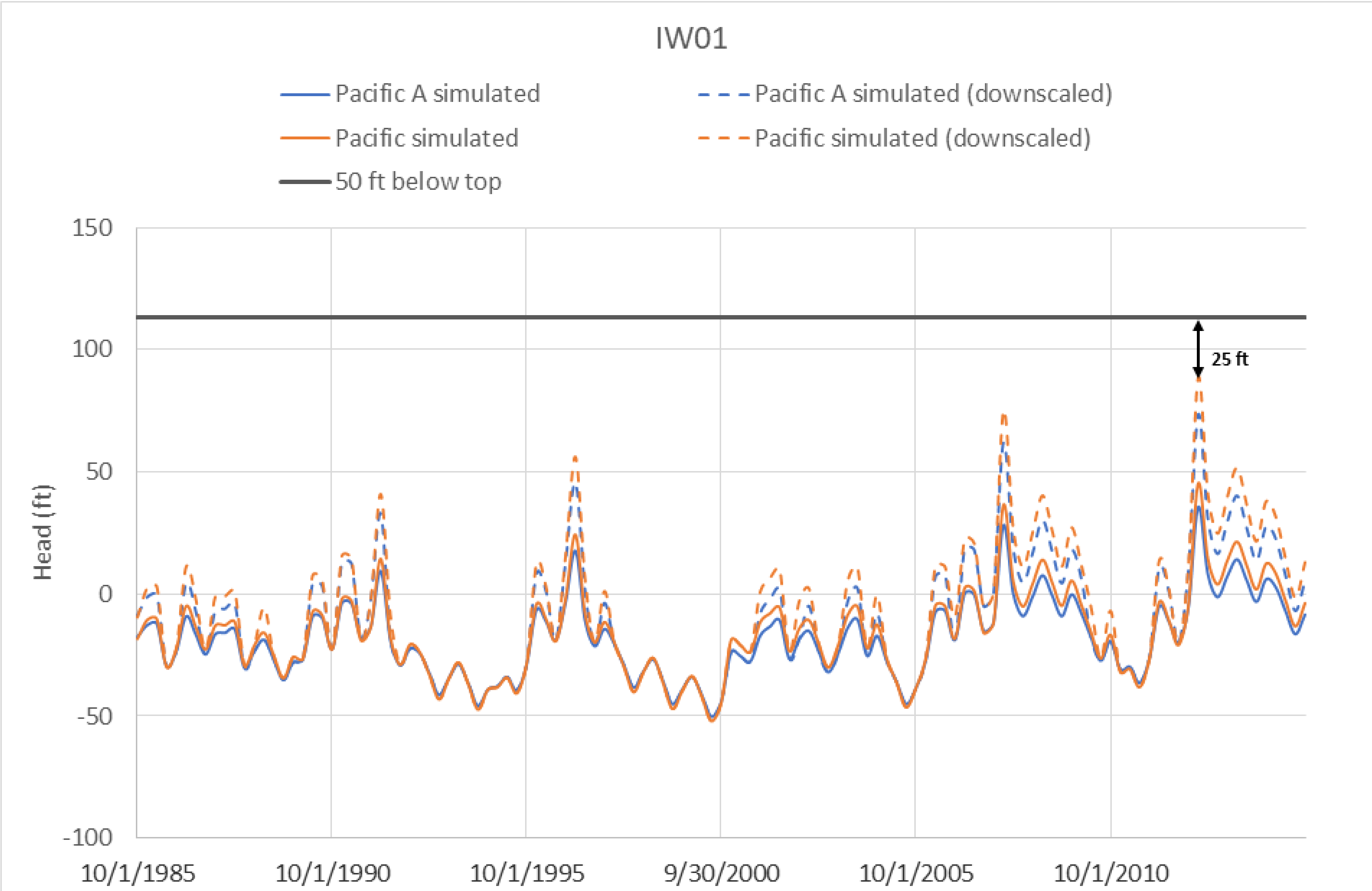
Figure 3.2.7x

Tier 1 Hydrograph at Injection Well - IW10



INTERA

Figure 3.2.8a
Downscaled Hydrograph at Representative Extraction Well for Project Period



INTERA

Figure 3.2.8b
Downscaled Hydrograph at Representative Injection Well for Project Period

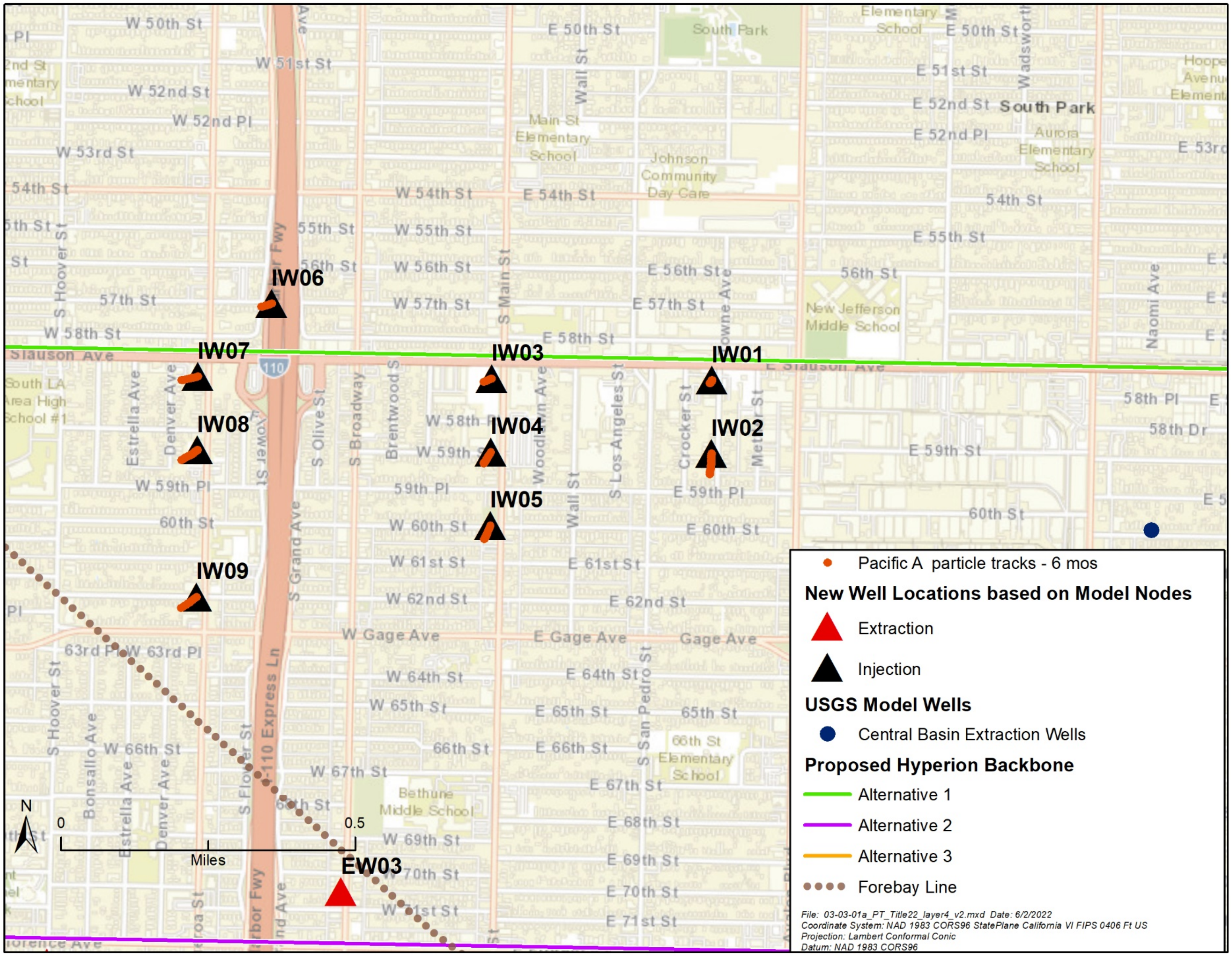
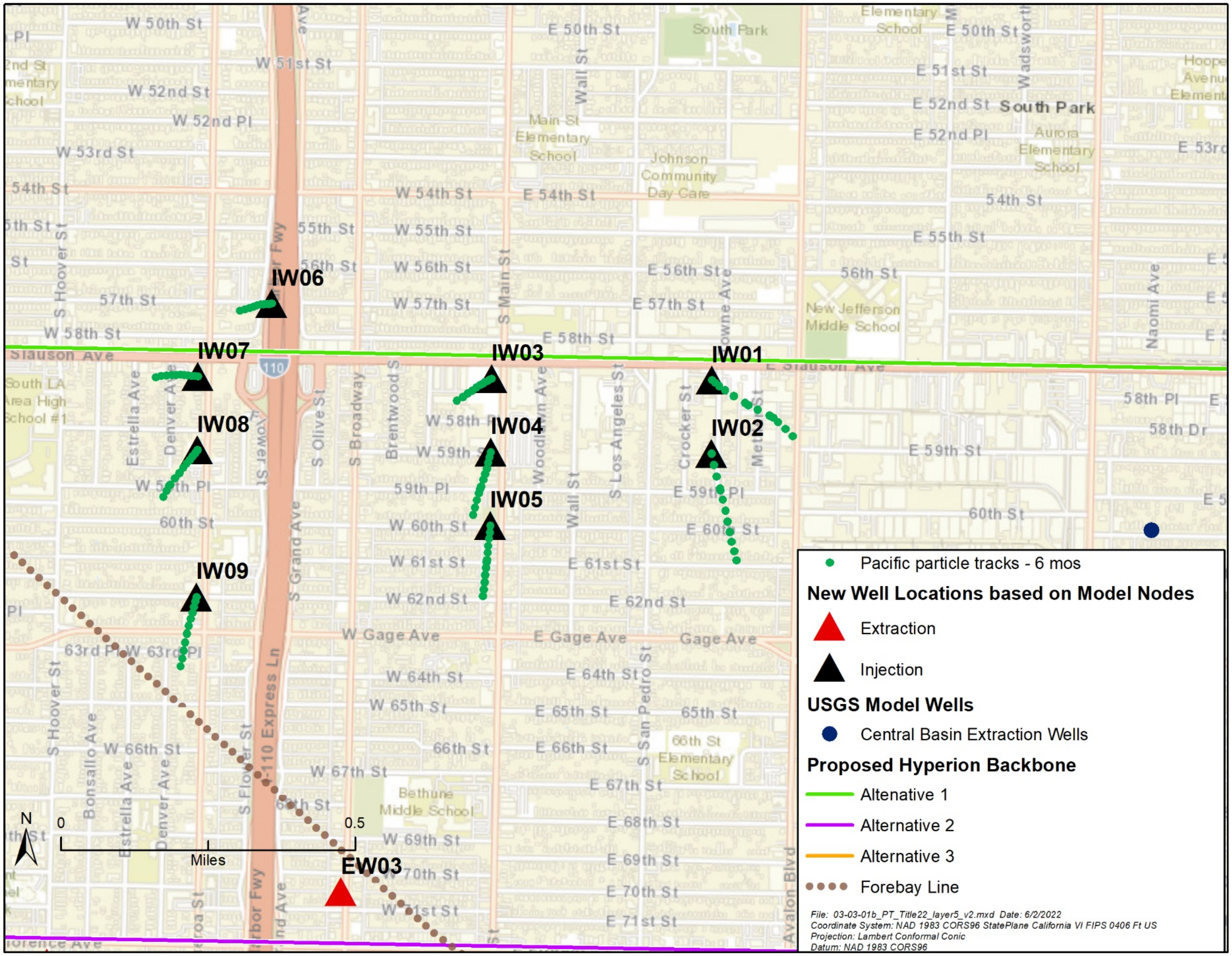
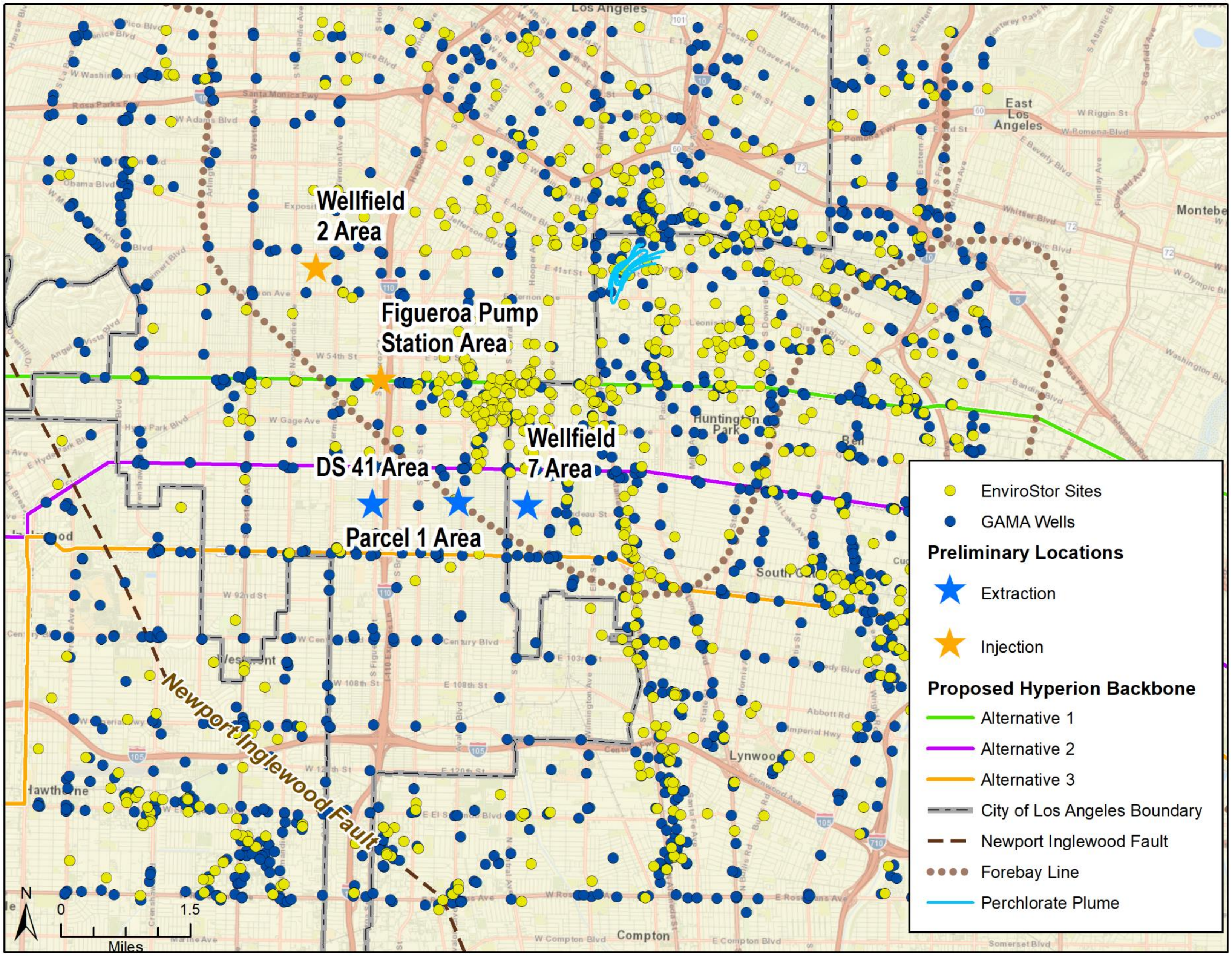


Figure 3.3.1a
Title 22 Particle Tracking Results - Pacific A Sequence



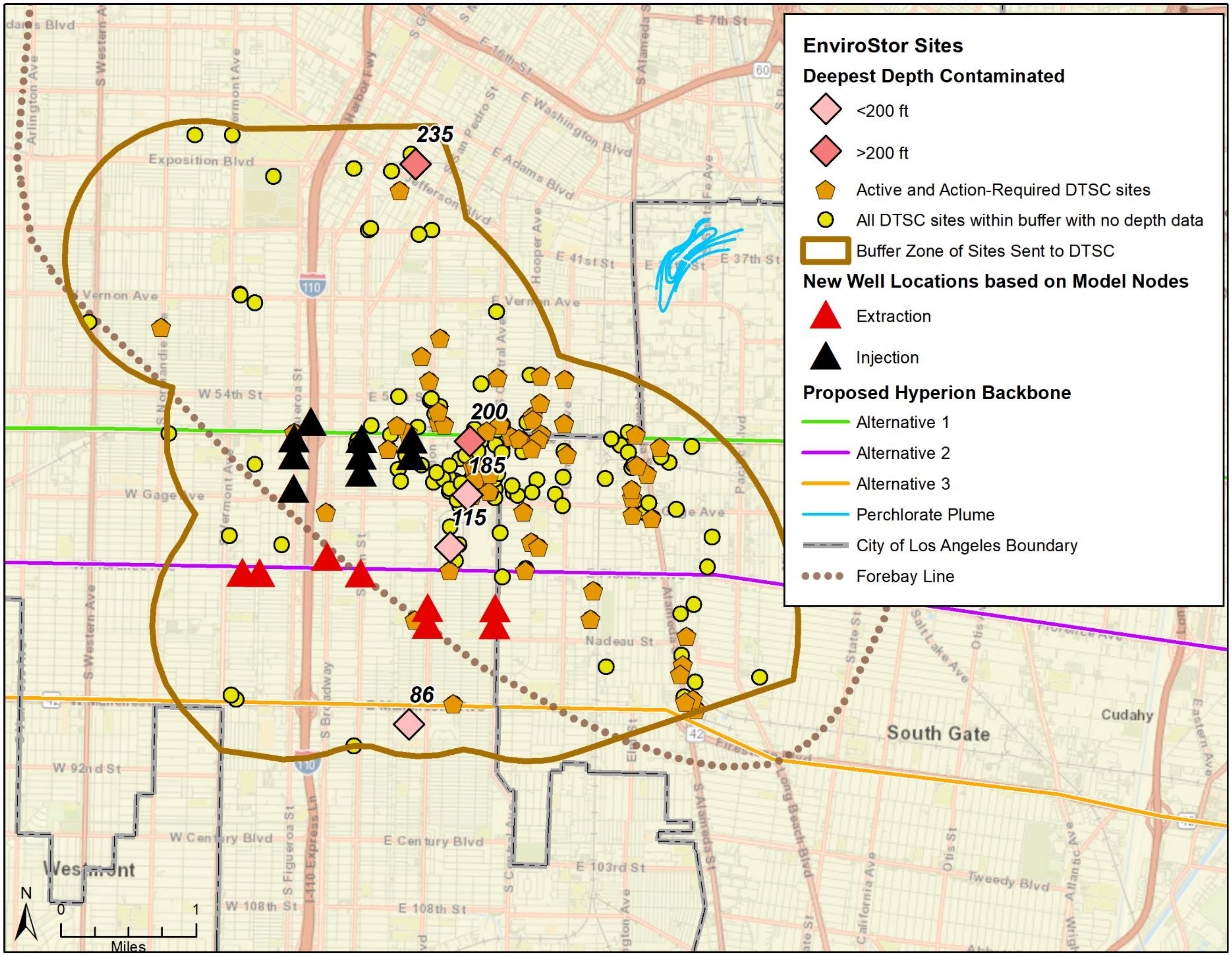
INTERA

Figure 3.3.1b
Title 22 Particle Tracking Results - Pacific Sequence



INTERA

Figure 3.4.1
Known Environmental Sites as of December 2021



INTERA

Figure 3.4.2
Map of DTSC Response with Depth Information

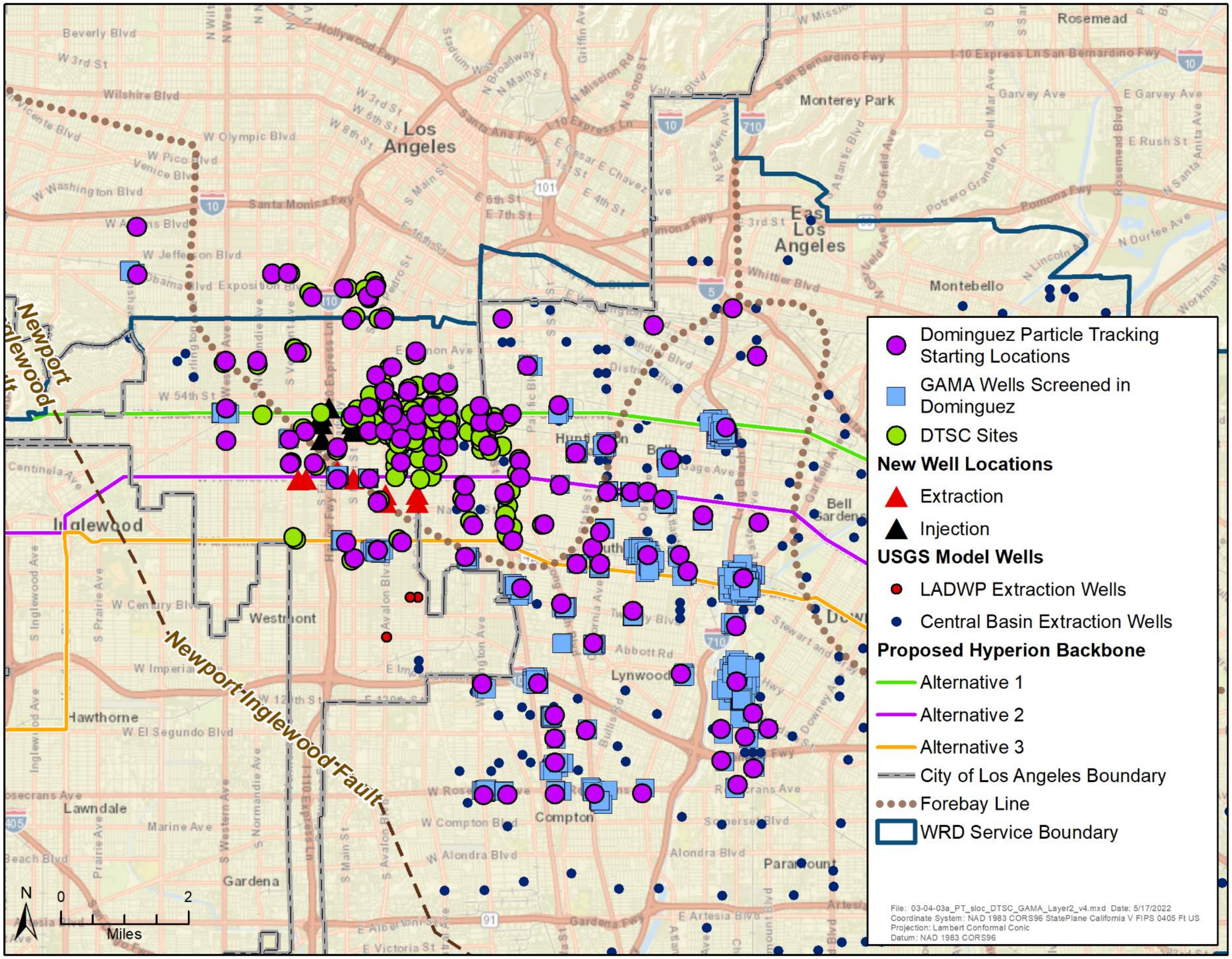


Figure 3.4.3a
Particle Tracking Starting Locations – Dominguez Sequence

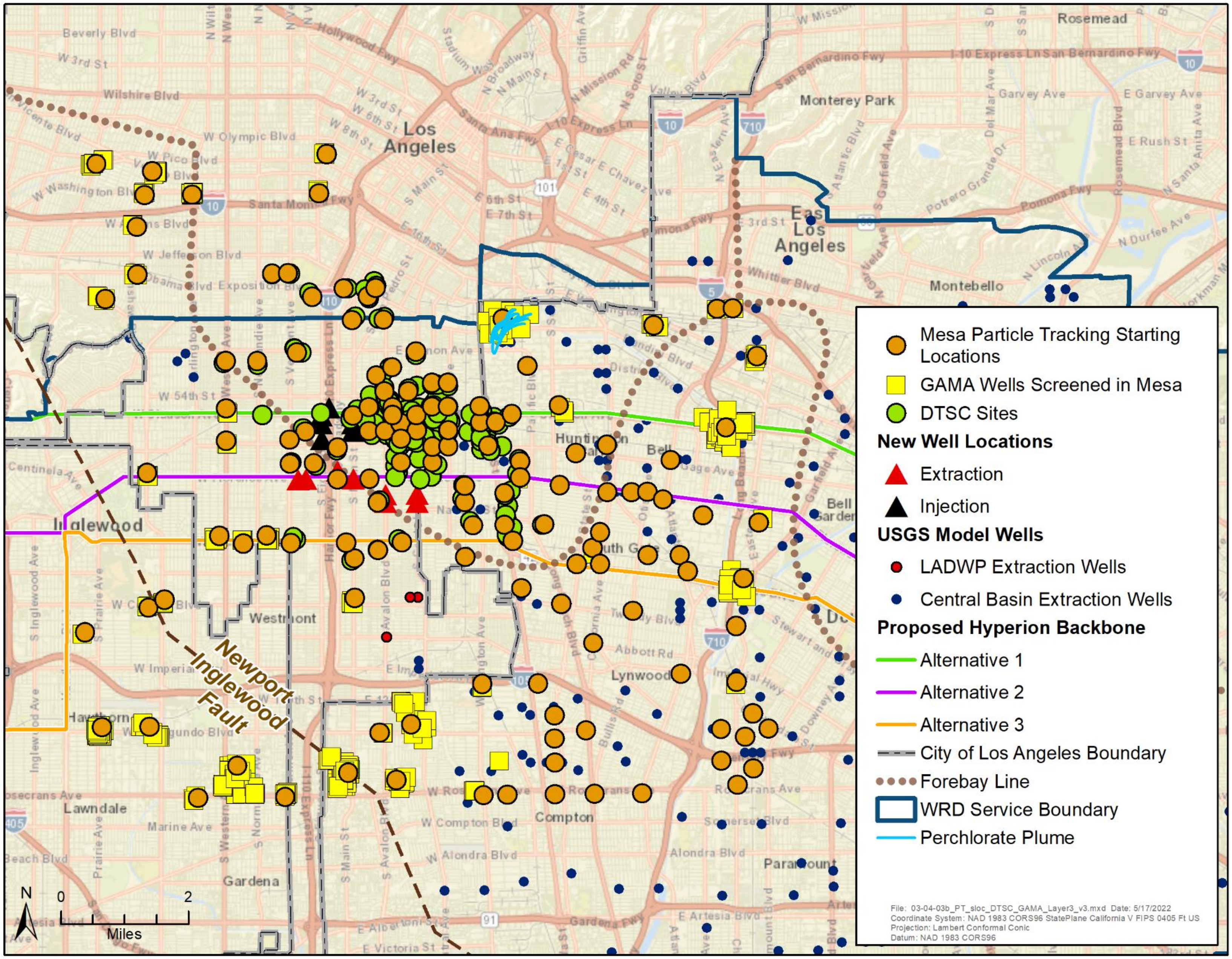
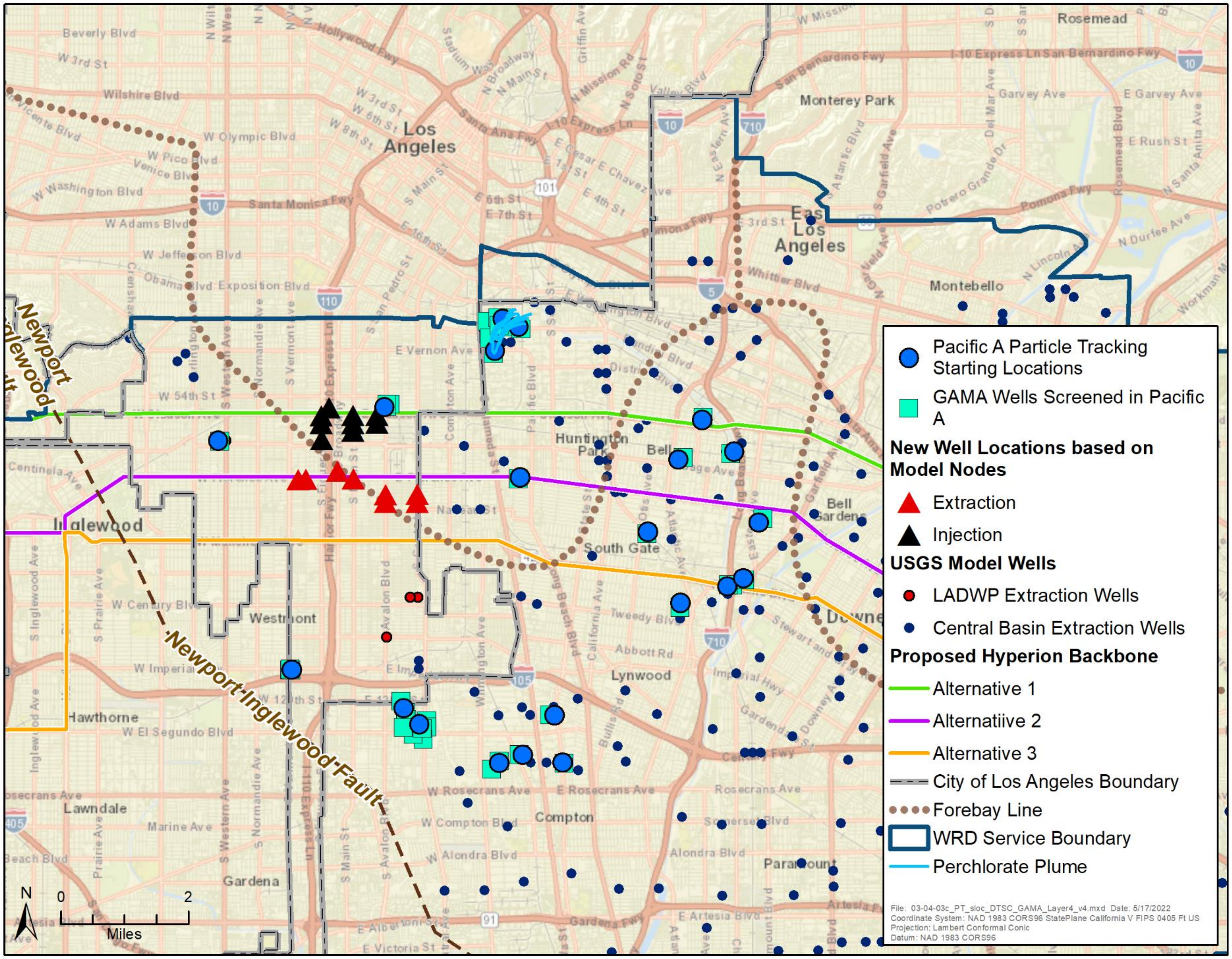
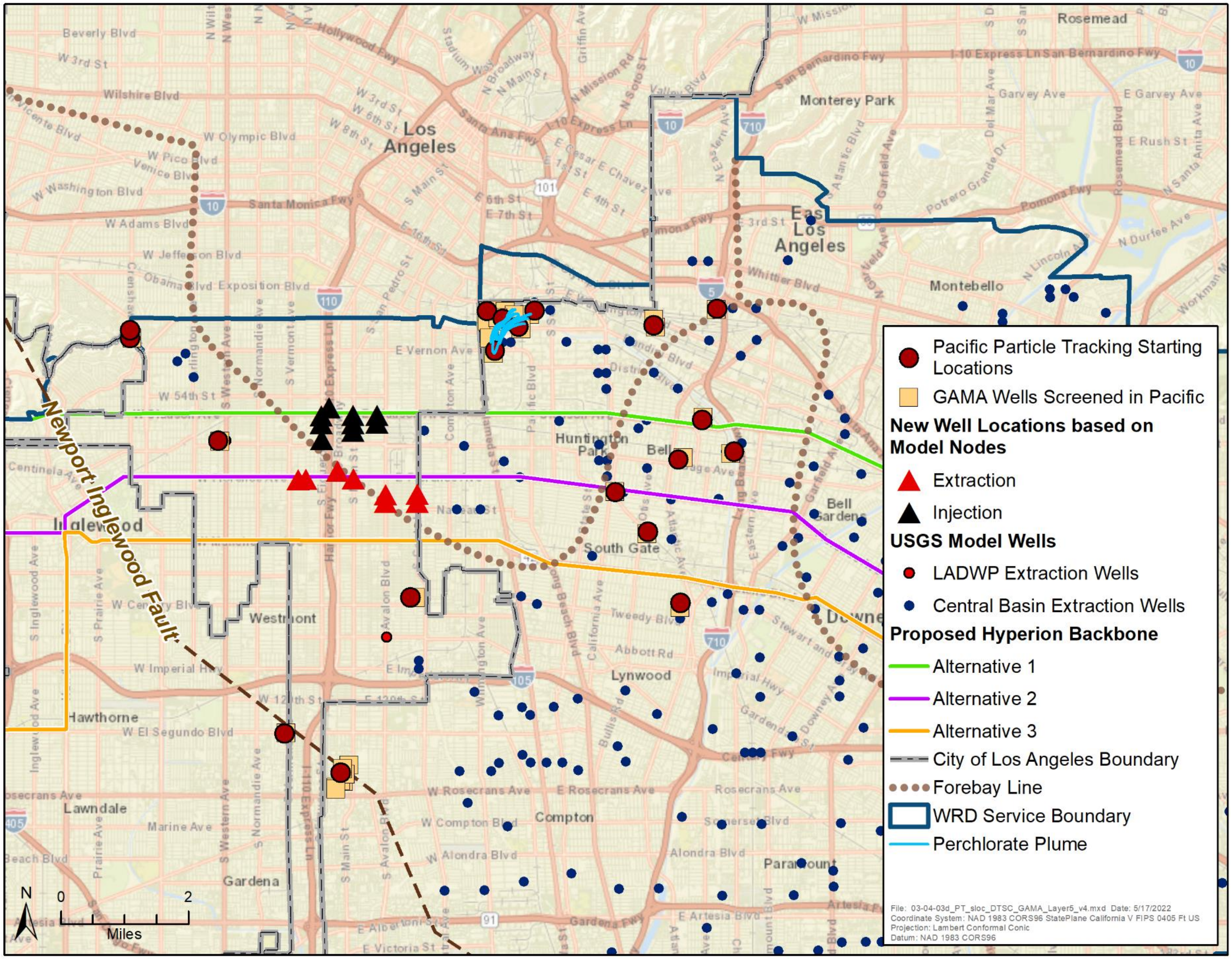


Figure 3.4.3b
Particle Tracking Starting Locations – Mesa Sequence



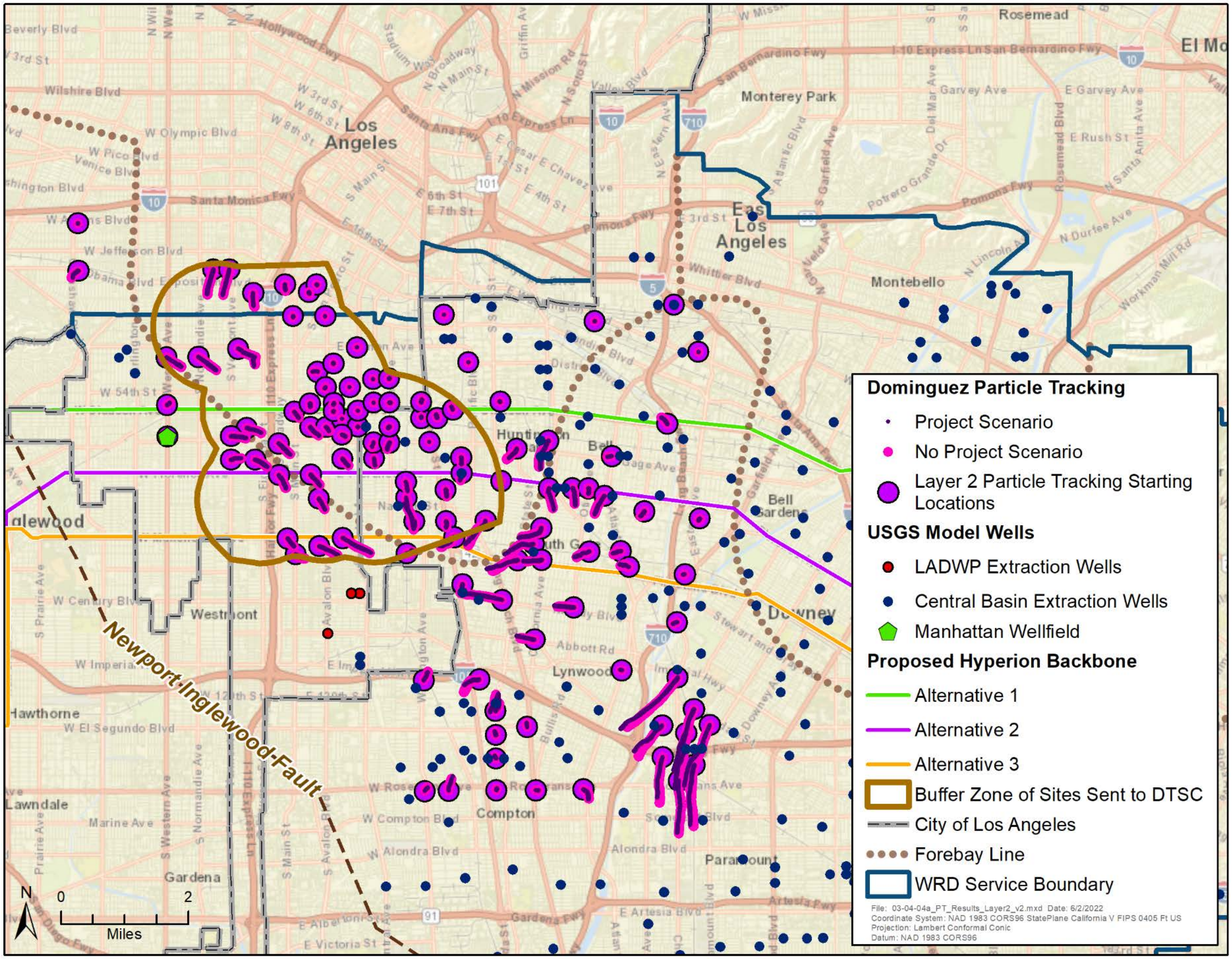
INTERA

Figure 3.4.3c
Particle Tracking Starting Locations – Pacific A Sequence



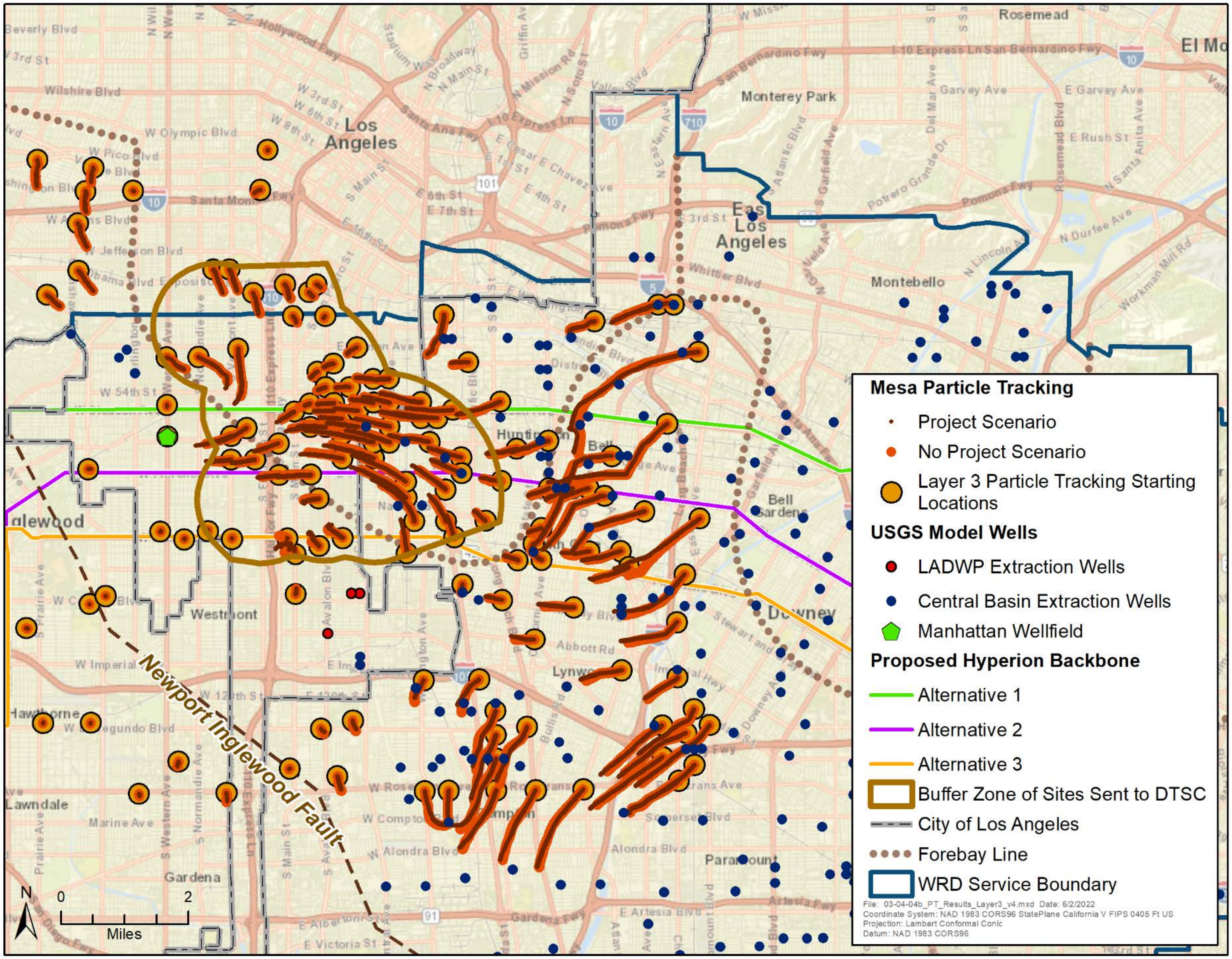
INTERA

Figure 3.4.3d
Particle Tracking Starting Locations – Pacific Sequence



INTERA

Figure 3.4.4a
Particle Tracking Results – Dominguez Sequence



INTERA

Figure 3.4.4b
Particle Tracking Results – Mesa Sequence

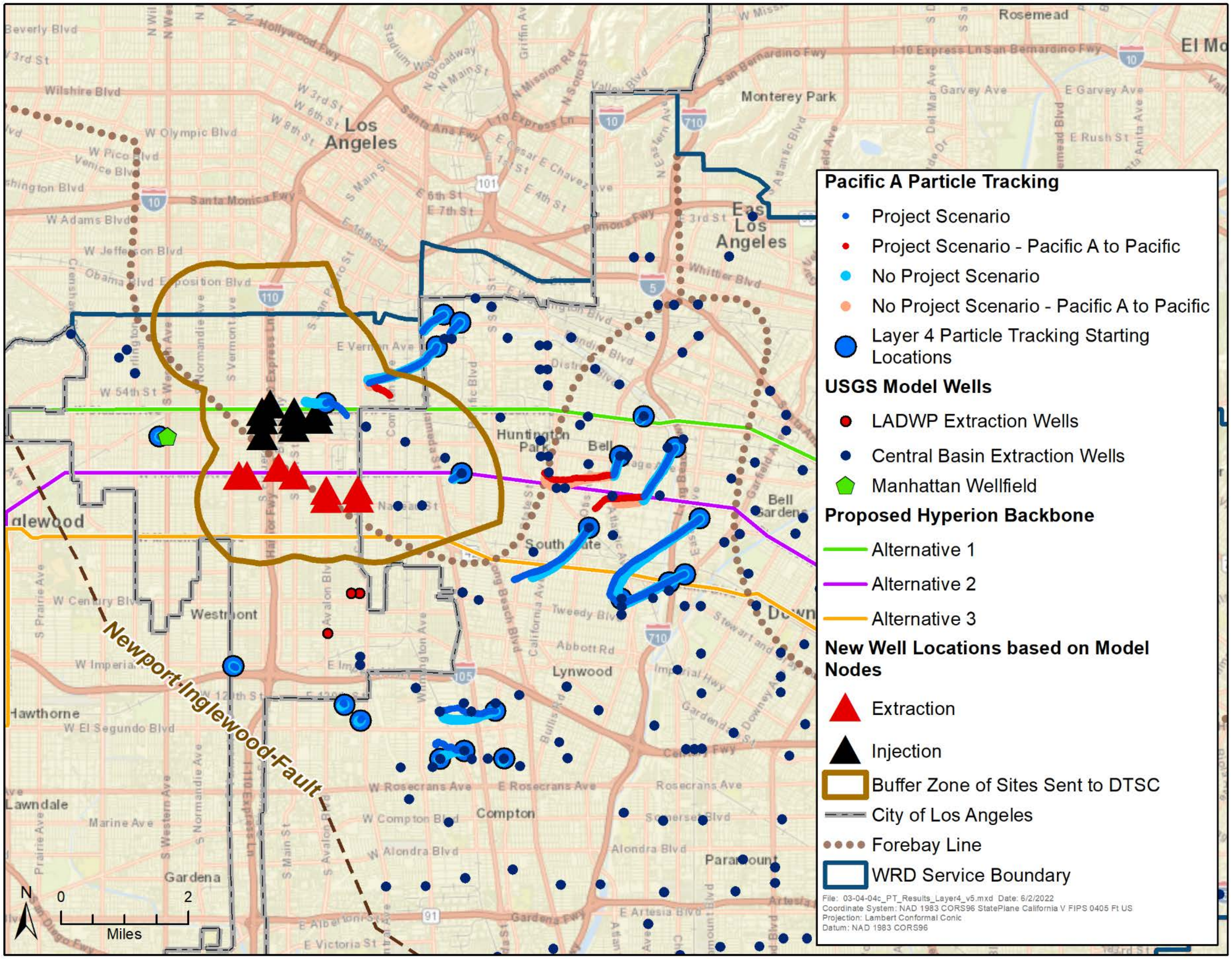
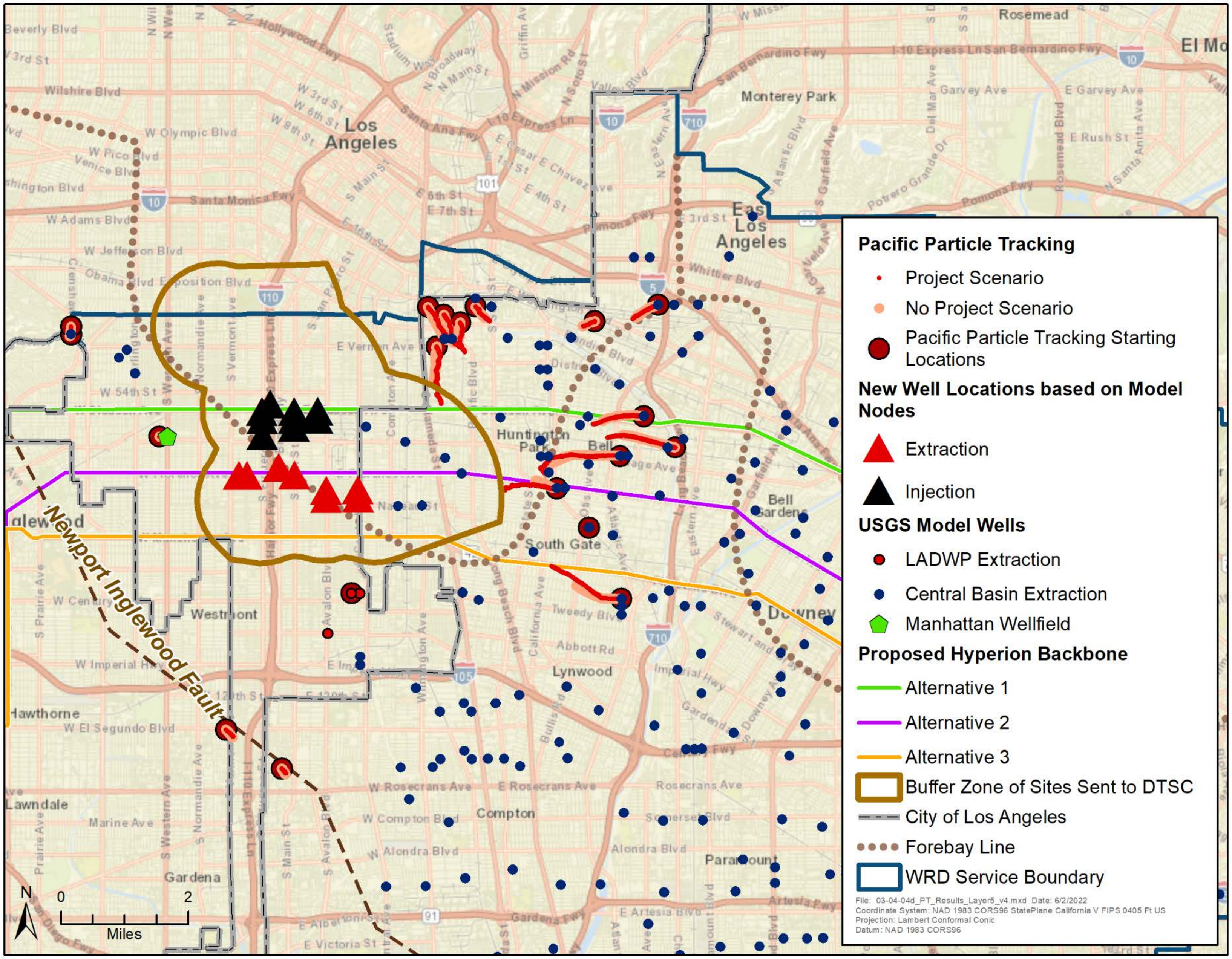


Figure 3.4.4c
Particle Tracking Results – Pacific A Sequence



INTERA

Figure 3.4.4d
Particle Tracking Results – Pacific Sequence

Attachment 1
Hyperion Water Balance Model Scenarios Table

Hyperion Water Balance Model Scenarios
(TM 3.1 Basis of Project Development)

Modeling Scenarios

			Rights	Extraction				Replenishment					Storage	
			LADWP	Central Basin		West Coast Basin		Natural Recharge and Underflow	MAR	Hyperion	ARC	LC	Initial CB and WCB Storage	LADWP Maximum Storage Assumption
Scenario	**Title**	**Notes (from original matrix)**		**LADWP**	**All Other Pumpers**	**All Pumpers**	**RBWRP**							
Scenario 1	**Baseline - Historical plus RBWRP**	Baseline conditions	CB APA = 17,236 AFY WCB WR = 1,503 AFY Total = 18,739 AFY	Historical extraction, annual average 3,671 AFY	Historical extraction volume and monthly pattern from 1986-2015 (178,848 AFY average)	Historical extraction volume and monthly pattern from 1986-2015 (31,631 AFY average)	20,000 AFY, location and potential patterns to be provided by Jacobs (Jacobs to provide location of extraction wells - constant pumping assumed)	Historical recharge from 1986-2015 baseline hydrology	Historical recharge from 1986-2015 (MFB + Barriers + in-lieu); increase barrier recharge for RBWRP by 20,000 AFY (matching extraction rate)	Assume 50% (or 10,000 AFY) of the increased replenishment for RBWRP is from Hyperion, and the remaining 50% would be from another source	No ARC	No LC	Historical 1985 levels	CB APA =17,236 AFY maximum storage = 200% of APA (34,472 AFY) in CB
Scenario 2	**Scenario 1 + Initial WR Leasing in CB (LADWP) OR LADWP on the way to maximum target rights in CB**	LADWP begins acquiring additional rights (goal = 25,000 total) LADWP Leases 6,896 as needed	CB APA of 24,132= 17,236 (own)+6,896 (leased) WCB WR = 1,503 AFY Total = 25,635 AFY	LADWP 30-year demand monthly pattern (averaged to be 24,132 AFY); limit extraction to 140% of APA or to 40 cfs for 10 months	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1 + remaining Hyperion water to be sent to barriers and potentially to the LAAFP for flows in excess of LADWP's extractions in the CB	10,000 AFY	LC to provide up to 4,000 AFY to CB MAR	Same as Scenario1	CB APA = 24,132 AFY maximum storage = 200% of CB APA (48,264 AFY)
Scenario 3	**Scenario 1 + WCB WR Transfer to CB (LADWP) + WR Leasing (LADWP) OR LADWP at maximum target rights**	APA Transfer of 5,000 AFY to CB by LADWP LADWP now owns 25,000 rights total LADWP leases 7,500 rights	CB APA: 25,000 AFY (own) = 17,236 + 5,000 (transfer from WCB) + 2,764 (purchase) + 7,500 (lease) WCB WR = 0 (goes to zero because LADWP is buying and transferring rights from the WCB) Total = 32,500 AFY	LADWP 30-year demand monthly pattern (averaged to be 32,500 AFY); limit extraction to 140% of APA or to 90 cfs for 6 months	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	28,829 AFY (25.72 MGD) (due to LADWP increase in CB) (difference between 32,500 and 3,671 historical LADWP pumping). Any excess flow from Hyperion AWT will be sent to the LAAFP	Same as Scenario 2	Same as Scenario 2	Same as Scenario 1	CB APA = 25,000 AFY maximum storage = 200% of CB APA (50,000 AFY)
Scenario 3a	**Scenario 3 variation with change in LADWP's extraction schedule**	Same as Scenario 3	Same as Scenario 3	No extraction in December and January; 4 months at 40 cfs, and 6 months at 90 cfs	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 1	Same as Scenario 3
Scenario 4	**Scenario 3 + maximum APA extraction in CB (other pumpers) OR LADWP at maximum target rights plus full CB rights utilization**	Maximize APA in CB, WCB average pumping with RBWRP	Same as Scenario 3	Same as Scenario 3	Full APA extraction (189,867 AFY average)	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 3 + need additional recharge to satisfy increased CB extraction by other pumpers; LADWP's increase in extraction will be covered by Hyperion AWT, and other increases will be covered by WRD	Hyperion AWT will be used to cover LADWP's increase in extractions only; any excess flow from Hyperion AWT will be sent to the LAAFP	Same as Scenario 3	Same as Scenario 2	Same as Scenario 1	Same as Scenario 3
Scenario 5	**Scenario 4 + maximum WR extraction in WCB (other pumpers) OR LADWP at maximum target rights plus full CB and WCB rights utilization**	Replenishment calculation = [(WCB APA - 5000) + (CB APA + 5000)] - 20000	Same as Scenario 3	Same as Scenario 3	Same as Scenario 4	WCB full WRs 39,468 AFY= 64,468 AFY - 5,000 AFY (WCB-CB transfer) - 20,000 AFY (RBWRP)	Same as Scenario 1	Same as Scenario 1	Same as Scenario 4 + need additional recharge to satisfy increased WCB extraction by other pumpers	Hyperion AWT will be used to cover LADWP's increase in extractions only. Any excess flow from Hyperion AWT will be sent to the LAAFP	Same as Scenario 4	Same as Scenario 2	Same as Scenario 1	Same as Scenario 3
Scenario 6	**Scenario 5 + Ph 1 augmentation (LADWP) OR LADWP CB Augmentation Phase 1**	LADWP begins augmentation program in CB	Same as Scenario 3	LADWP 30-year demand monthly pattern (averaged to be 32,500 AFY); limit extraction to 140% of APA or to 90 cfs for 9 months + 12,500 AFY in same year as augmentation replenishment	Same as Scenario 5	Same as Scenario 5	Same as Scenario 1	Same as Scenario 1	Same as Scenario 5	Same as Scenario 3 + 12,500 AFY (11.15 MGD) as an augmentation project	Same as Scenario 5	Use up to 4,000 AFY from LC first, then Hyperion; model assumes that LC augmentation will be for WCB	Same as Scenario 1	Same as Scenario 3
Scenario 7	**Scenario 5 + Ph 2 augmentation (LADWP) OR LADWP CB Augmentation Phase 2**	LADWP begins augmentation program in CB	Same as Scenario 3	LADWP 30-year demand monthly pattern (averaged to be 32,500 AFY); limit extraction to 140% of APA or to 90 cfs for 12 months + 30,000 AFY in same year as augmentation replenishment	Same as Scenario 5	Same as Scenario 5	Same as Scenario 1	Same as Scenario 1	Same as Scenario 5	Same as Scenario 6 + 17,500 AFY (15.6 MGD) as augmentation project	Same as Scenario 6	Same as Scenario 6	Same as Scenario 1	Same as Scenario 3

Notes:

% = percent

AFY = acre-foot (feet) per year

APA = Allowed Pumping Allocation

AR = Adjudicated Right

ARC = Albert Robles Center for Water Recycling and Environmental Learning

AWT = Advanced Water Treatment

CB = Central Basin

cfs = cubic foot (feet) per second

GW = groundwater

LAAFP = Los Angeles Aqueduct Filtration Plant

LADWP = Los Angeles Department of Water and Power

LC = Los Coyotes

MAR = Managed Aquifer Recharge

MFB = Montebello Forebay

MGD = million gallons per day

Ph = phase

RBWRP = Regional Brackish Water Reclamation Program

WB = water balance

WCB = West Coast Basin

WR = Water Right

WRD = Replenishment District of Southern California

Attachment 2
Parcel Capacity Evaluation Summary

Parcel Capacity Evaluation

As part of the parcel evaluations, preliminary calculations were performed to evaluate the maximum number of wells that can be sited within the area of the respective parcel. A minimum area of 8,000 ft^2 was used to screen out parcels with smaller areas. A "usable" area less than or equal to the total parcel area was estimated from aerial imagery review to ensure assignments of number of wells per parcel were realistic based on potential access constraints or prohibitive structures. The LACPGM transmissivity and storage coefficients were used to calculate maximum drawdown/draw-ups using the Cooper-Jacobs approximation. The transmissivity and storage coefficients were used for the Pacific A and Pacific sequences as those were the sequences the model wells were screened in. The drawdown/draw-up was calculated at the end of a 6-month period using constant injection or extraction rates of 1,500 gallons per minute (gpm) or 2,000 gpm, respectively. Well efficiency was assumed to be 65% and the effective well radius was assumed to be 1 ft. A maximum drawdown/draw-up of 100 ft was considered as the threshold. Based on this threshold, additional wells were added or removed from an area to estimate the maximum number of wells for the area. For parcels that could hypothetically fit two or more wells, additional calculations were exercised to account for potential well interference effects for hypothetical well spacing based on the parcel's area and geometry. The results of these calculations including model parameters for each parcel organized by FID are included in Table 1 of this attachment. Figure 1 shows the locations of the parcels used for the analysis in Table 1 labeled by each parcel's FID.

Table 1: Model Properties and Number of Wells by Parcel

FID	Type	Estimated Number of Wells	Estimated Capacity (gpm)	"usable" area (ft2)	total calculated area (ft2)	T (ft2/d)	S (-)	b (ft)	Pacific A T (ft2/d)	Pacific T (ft2/d)	Pacific A b (ft)	Pacific b (ft)	Pacific A K (ft/d)	Pacific K (ft/d)	Pacific A Ss (ft-1)	Pacific Ss (ft-1)	Pacific A Sy (-)	Pacific Sy (-)
0	Injection	1	1,500	5,526	5,526	116,813	9.71E-04	459	22,283	94,529	223	236	100	400	1.56E-06	2.67E-06	0.075	0.11111
1	Injection	1	1,500	11,850	11,850	120,912	9.43E-04	446	19,144	101,768	191	254	100	400	1.56E-06	2.67E-06	0.075	0.11111
2	Injection	1	1,500	10,800	10,800	120,912	9.43E-04	446	19,144	101,768	191	254	100	400	1.56E-06	2.67E-06	0.075	0.11111
3	Injection	1	1,500	14,055	14,055	116,034	9.00E-04	425	18,045	97,990	180	245	100	400	1.56E-06	2.67E-06	0.075	0.11111
4	Injection	1	1,500	13,537	13,537	119,213	9.10E-04	430	17,649	101,565	176	254	100	400	1.56E-06	2.67E-06	0.075	0.11111
5	Injection	2	3,000	10,800	10,800	107,750	8.89E-04	420	20,101	87,649	201	219	100	400	1.56E-06	2.67E-06	0.075	0.11111
6	Extraction	1	2,000	21,201	24,207	190,355	8.74E-04	683	27,622	162,733	276	407	100	400	1.56E-06	0.000001	0.075	0.075
7	Extraction	1	2,000	9,245	9,245	85,752	2.75E-04	275	8,023	77,729	80	194	100	400	0.000001	0.000001	0.075	0.025
8	Injection	4	6,000	92,102	92,102	101,629	7.76E-04	407	18,603	83,026	186	221	100	375	1.56E-06	2.25E-06	0.075	0.075633
9	Injection	5	7,500	137,988	249,486	110,547	9.34E-04	442	22,041	88,505	220	221	100	400	1.56E-06	2.67E-06	0.075	0.11111
10	Extraction	1	2,000	9,036	9,036	119,629	3.77E-04	377	10,330	109,299	103	273	100	400	0.000001	0.000001	0.075	0.025
11	Extraction	1	2,000	8,241	8,241	119,629	3.77E-04	377	10,330	109,299	103	273	100	400	0.000001	0.000001	0.075	0.025
12	Injection	1	1,500	12,026	12,026	126,724	9.84E-04	465	19,761	106,962	198	267	100	400	1.56E-06	2.67E-06	0.075	0.11111
13	Injection	1	1,500	6,976	6,976	126,724	9.84E-04	465	19,761	106,962	198	267	100	400	1.56E-06	2.67E-06	0.075	0.11111
14	Extraction	2	4,000	13,259	13,259	202,996	8.59E-04	671	44,039	158,958	274	397	161	400	1.56E-06	0.000001	0.075	0.075
15	Extraction	1	2,000	9,062	9,062	202,996	8.59E-04	671	44,039	158,958	274	397	161	400	1.56E-06	0.000001	0.075	0.075
16	Extraction	1	2,000	4,549	13,966	195,439	6.56E-04	656	41,077	154,362	270	386	152	400	0.000001	0.000001	0.075	0.075
17	Extraction	1	2,000	9,504	9,504	155,152	5.75E-04	575	24,901	130,251	249	326	100	400	0.000001	0.000001	0.075	0.075
18	Extraction	1	2,000	5,122	8,923	150,254	5.67E-04	567	25,482	124,772	255	312	100	400	0.000001	0.000001	0.075	0.075
19	Extraction	2	4,000	15,142	15,142	73,633	3.01E-04	235	6,794	66,839	68	167	100	400	1.56E-06	0.000001	0.075	0.025
20	Extraction	1	2,000	15,406	15,406	140,506	5.05E-04	505	20,447	120,059	204	300	100	400	0.000001	0.000001	0.075	0.025
	Total Estimated Injection Capacity (gpm)	27,000																
	Total Estimated Extraction Capacity (gpm)	26,000																
	Goal Injection (gpm)	**30,000**																
	Goal Extraction (gpm)	**25,000**																

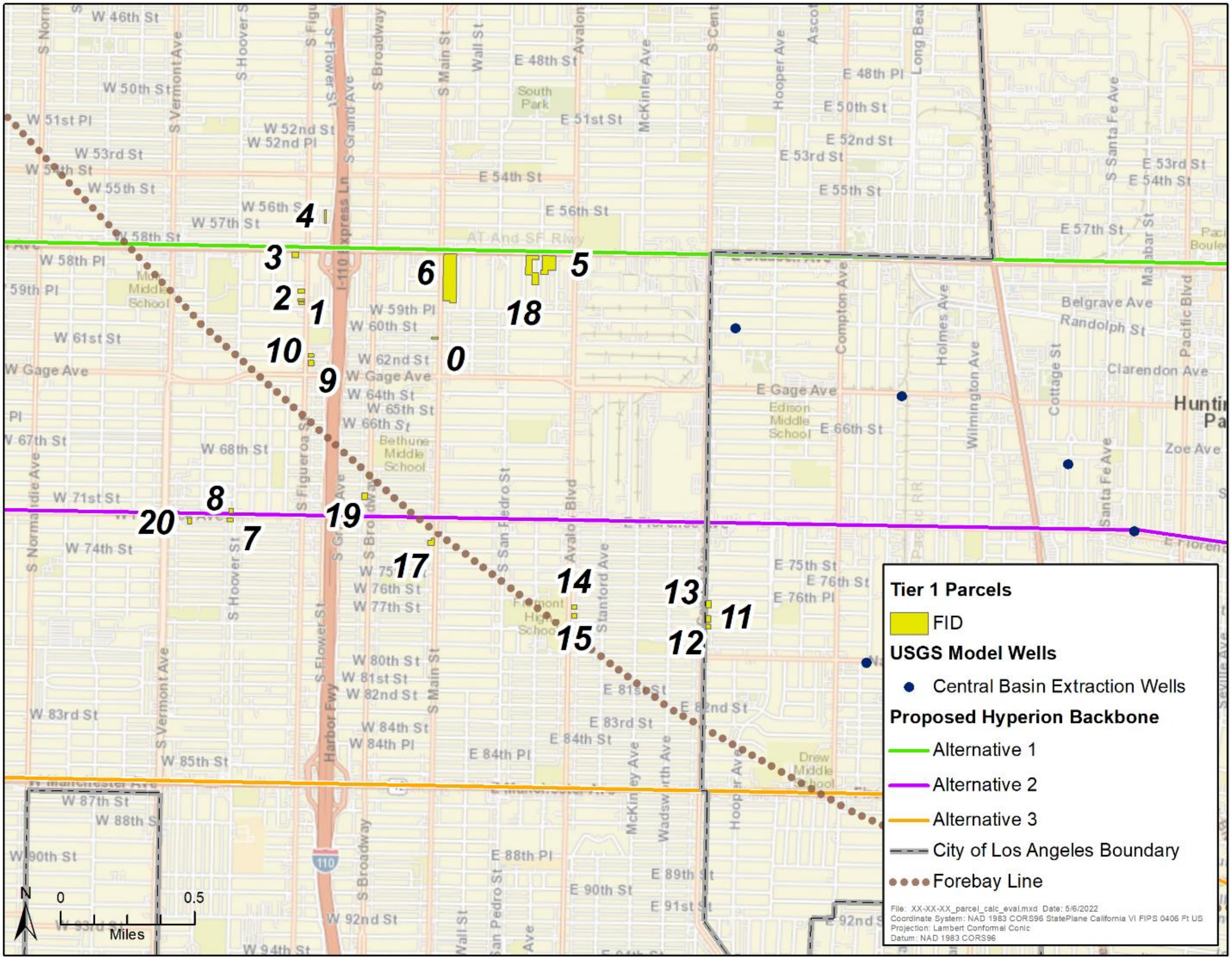


Figure 1: Locations of Parcels by FID for Capacity Evaluation

Attachment 3
DTSC Response for Sites within Buffer Area

PROJECT NAME	ENVIROSTOR ID	SITE CODE	Does the site have or has had groundwater monitoring wells (generally >200')? (dropdown menu)	Is there past or current deep groundwater contamination? (dropdown menu)	Has the nature and extent of contamination been determined? (dropdown menu)	What is the deepest depth where contamination has been detected above regulatory levels in soil, and in groundwater? (numeric value)	Are there any highly mobile contaminants present (e.g., perchlorate, 1,4 dioxane, VOCs, PFAS/PFOA, hexavalent chromium)? (dropdown menu)	Identify highly mobile contaminants present (e.g., perchlorate, 1,4 dioxane, VOCs, PFAS/PFOA, hexavalent chromium). (list compounds)	Do the past or current operations, treatment, storage or disposal indicate that releases of highly mobile contaminants (their precursors and industrial processes involving them) occurred at high enough concentrations to result in deep groundwater impacts (>200')? (dropdown menu)
PETERSON SHOWCASE & FIXTURE COMPANY	19250030	300873	No	No	No	Unknown	No	Unknown	No
AMERICAN ELECTROPLATING	19340525	0	No	No	No	No	No	No	No
GENERAL ELECTRIC - ENDURA	19340735	301776	Yes	Unknown	No	115	Unknown	TCE	Unknown
UNITED ALLOYS, INC.	19340754	301309	Yes	Unknown	Yes	200	Yes	Unknown	Unknown
LESLIE MARCY JOHNNY CUTTING AND FUSE SER	19390052	300776	No	No	Yes	N/A	No	N/A	No
South Region High School #12, Site 1	60000455	304545	Yes	Unknown	No	86	Yes	CrVI	Unknown
Hard Chrome Discovery Project	60000687	301354	No	Unknown	No	Unknown	Yes	CrVI, TCE	Unknown
Prpsd Charter School at 8145 & 8205 Beach St.	60001832	404882	No	No	No	Unknown	No	N/A	No
Slauson/Gage Corridor Discovery Project	60002232	301719	Yes	Unknown	No	Unknown	Unknown	Unknown	Unknown
410 E. 32nd Street & 317 E. 33rd Street	60002760	401862	Yes	Yes	No	235	Yes	PCE	Yes
Lee's Plating	60002793	301848	Unknown	Unknown	No	Unknown	Unknown	Unknown	Unknown
Standard Nickel Chromium Plating Co.	71003183	308401	Yes	Unknown	No	185	Yes	CrVI	Unknown
Graybill Metal Plating & Polishing	71003824	0	No	No	No	No	No	No	No

Appendix H
TM 6.1.2-Injection Test Well Work Plan

Jacobs

Memorandum

1000 Wilshire Boulevard, Suite 1140
Los Angeles, California 90017
United States
T +1.213.538.1388
F +1.230.538.1399
www.jacobs.com

Subject	**Technical Memorandum 6.1.2 – Injection Test Well Work Plan – Final**
Project Name	WRD and LADWP Joint Los Angeles Basin Replenishment and Extraction Master Plan
Date	April 10, 2022 (Revised)

1. Introduction

This technical memorandum (TM) outlines a work plan to install injection test well(s) and associated monitoring well(s) to verify the feasibility of injecting advanced treated water in the Los Angeles Forebay for the Hyperion Water Reclamation Plant (WRP) (Project). The work supports the Water Replenishment District of Southern California (WRD) and Los Angeles Department of Water and Power (LADWP) Joint Los Angeles Basin Replenishment and Extraction Master Plan (Joint Master Plan). The Joint Master Plan work is described in several other TMs. TM 6.1.2 is one of the deliverables under Task 6.1, Hyperion Replenishment/Extraction Siting Study, and a companion to the refined groundwater modeling, Title 22 and Material Physical Harm (MPH) assessments, and parcel investigations, which INTERA and Epic Land Solutions documented in separate TMs for Task 6.1.1. The Project area is shown on Figure 1.

1.1 Project Background

The Project focuses on maximizing the use of Hyperion WRP flows through injection and extraction in the Central Basin. To support the Project evaluation, a Water Balance Model for the Central Basin and a groundwater flow model were developed to simulate operational scenarios and identify hydrogeologic limitations for injection and extraction. Through input from WRD and LADWP, injection and extraction were modeled at various locations in the Los Angeles Forebay to meet the target injection and extraction rates for the Project while meeting Title 22 travel time and MPH requirements. A TM for Task 6.1.1 will document the procedure and assumptions for developing:

- Preferred extraction and injection locations for the Project
- Modeling results
- Title 22 and MPH assessments
- Parcel investigation for injection and extraction well sites

1.2 Injection Test Well Work Plan Objectives

This work plan describes the approach for drilling, installing, developing, and testing an injection test well and associated monitoring wells in the Los Angeles Forebay. The investigation executed under this work plan will provide information for detailed Project development and siting of permanent managed aquifer recharge (MAR) wells for the Project.

The specific objectives of the work plan include the following elements:

- Providing recommendations for the injection test well location, including:
  - Receiving aquifer(s)
  - Injection test well construction details
  - Monitoring well locations and construction requirements
  - Other Project infrastructure
- Developing an injection test well and monitoring well installation and testing plan.
- Outlining the required data, collection methods, and processes to evaluate local hydrogeologic conditions and to conduct a geochemical compatibility evaluation to assess the viability of full-scale MAR operations.
- Identifying the anticipated permits and approvals required to complete the injection test well installation and testing.
- Preparing a baseline schedule for implementing the injection test well program.

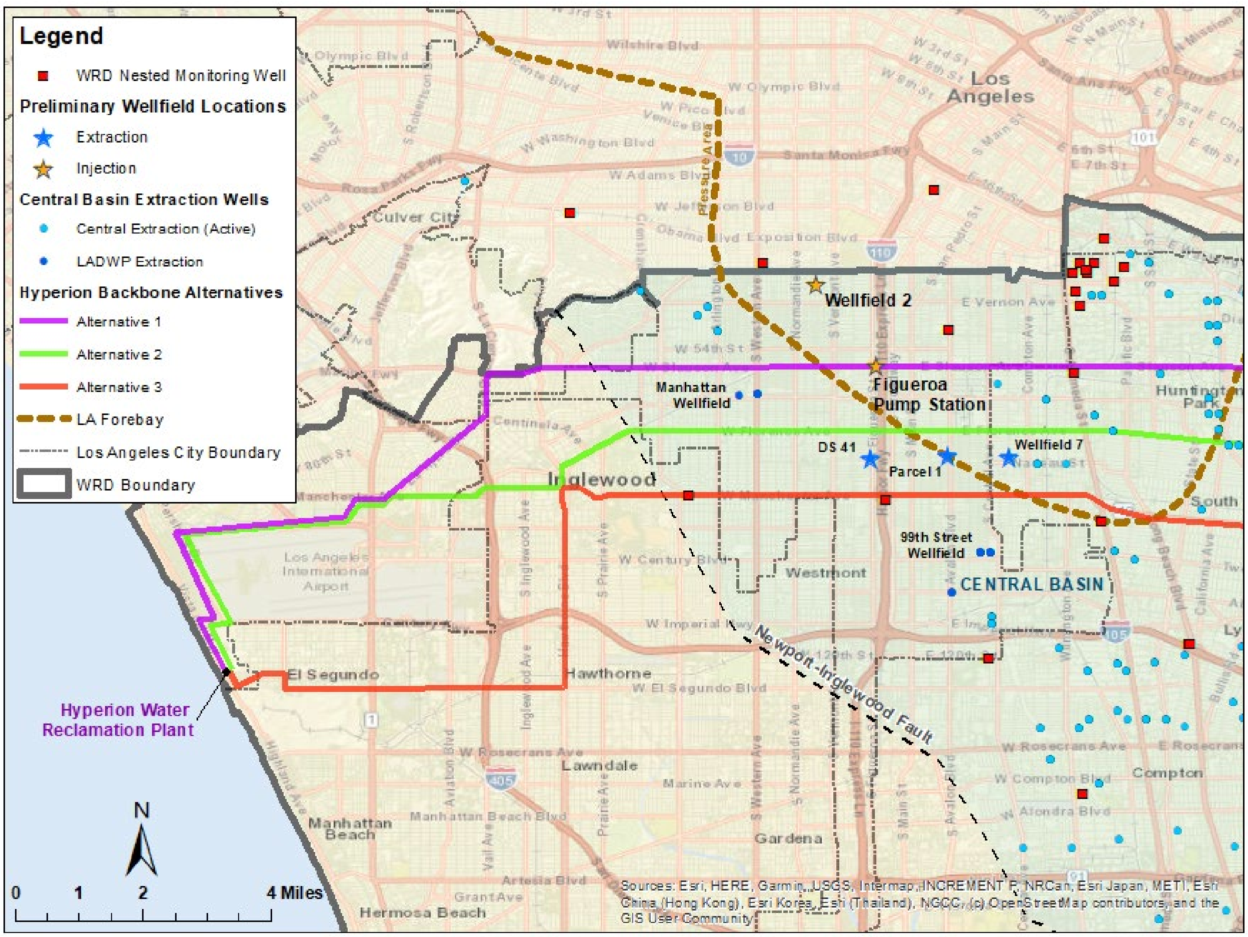


Figure 1. Project Area

As an important consideration to this plan, Hyperion WRP will not produce advanced treated water for recharge in the Los Angeles Forebay for approximately 15 to 20 years. The long-term performance and potential environmental implications of injecting advanced treated water, such as well clogging and mobilization of metals in the receiving aquifer, respectively, are highly contingent on physical characteristics of the recharge along with geochemical reactions between the recharge water and native groundwater chemistries. Potable water from the distribution system will display different chemical characteristics from advanced treated water produced by Hyperion and could display chemical characteristics that are geochemically incompatible with the native groundwater chemistry. Therefore, this work plan does not recommend using potable water from the distribution system as a source of recharge because of the following:

- Injection of potable water will not accurately inform potential operational issues related to future injection using Hyperion recharge water.
- Potable water may display differing physical characteristics from advanced treated water including pH, temperature, and total suspended solids concentrations, all of which are key constituents that influence the clogging of a MAR well.
- Incompatible chemistries between the potable water source and native groundwater or aquifer minerology could cause well clogging or leaching of undesirable constituents.
- Results from injection testing using potable water may misinform the feasibility of injecting advanced treated water from Hyperion in various aquifer units or full-scale wellfield design decisions.

Therefore, the activities outlined in the work plan focus on collecting data to evaluate the hydraulic feasibility of injecting into different aquifer units and characterizing the geochemistry of the native groundwater and minerology of the different aquifers. This information provides data to evaluate the feasibility of injecting advanced treated water from Hyperion in the Los Angeles Forebay and an initial criterion for MAR facility design and construction. The study will also identify data gaps that may hinder design and construction efforts. As intended, the plan contains contingencies to fill these data gaps using the most effective measures practical considering access constraints and the required depth of investigation within the Los Angeles Forebay.

1.3 Work Plan Organization

This injection test well work plan includes the following sections and attachments:

- Section 1 – Introduction
- Section 2 – Recommended Injection Test Well Facility Location
- Section 3 – Injection Test Well and Nested Monitoring Well Design
- Section 4 – Injection Test Wellfield Program
- Section 5 – Data Evaluation
- Section 6 – Permits and Approvals
- Section 7 – Implementation and Testing Schedule
- Section 8 – References
- Attachment 1 – Strater® Logs for WRD Regional Nested Monitoring Wells
- Attachment 2 – Well Construction Diagrams and Data Summaries for Manhattan Wells
- Attachment 3 – Preliminary Design Drawings for Injection Test Well and Nested Monitoring Wells
- Attachment 4 – Example Advanced Geophysical Logs
- Attachment 5 – Preliminary Implementation Schedule

2. Recommended Injection Test Well Facility Location

Groundwater flow modeling conducted during initial Project development identified and evaluated potential injection and extraction wells based on hydrogeologic criteria. Refined groundwater flow modeling completed under Task 6.1.1 included the following:

- Particle tracking simulations to assess flow paths, residence times, and areas of influence for the injection wells
- Title 22 assessment to evaluate residence time for the recycled water to reach nearby existing and proposed production wells
- MPH assessment to evaluate the potential for liquefaction (due to excessive drawup from injection), subsidence (due to excessive drawdown from extraction), and groundwater quality impacts due to the effects of injection on nearby contaminated sites

Preliminary modeling results indicated that injection had to be spread across two general areas, known as Figueroa Pump Station and Wellfield 2 (Figure 1), to mitigate potential MPH concerns due to excessive drawup. The groundwater model has 12 layers that correspond to the 13 chronostratigraphic sequences identified by the U.S. Geological Survey (USGS), with the bottom two sequences simulated as a single model layer unit (Paulinski 2021). Injection was focused in two model layers at Figueroa Pump Station, and four model layers at Wellfield 2. Injection was simulated at each location in layers that displayed higher transmissivity, which correspond to the following chronostratigraphic sequences:

- Mesa (only Wellfield 2)
- Pacific A
- Pacific
- Bent Spring (only Wellfield 2)

Results from a preliminary parcel investigation revealed a scarcity of large parcels where wellfields could be installed on a single parcel or in a focused area. As a consequence, the current approach involves spreading out the injection wells for the Project over many smaller parcels that are geographically dispersed. Revised groundwater flow modeling indicates that this geographically dispersed injection wellfield can be installed in the Figueroa Pump Station area provided it is hydraulically balanced by proximal extraction from new and existing production wells to the south.

WRD has three regional nested groundwater monitoring wells in the Figueroa Pump Station area: Huntington Park-1, Los Angeles-1, and Los Angeles-4. The three nested wells monitor the upper 10 chronostratigraphic sequences at depths between 114 and 1,780 feet below ground surface (bgs). The LADWP Manhattan Wellfield is approximately 2 miles west of Figueroa Pump Station. The deepest of the production wells at this location, MH-PW-12, extends to 1,520 feet bgs. LADWP also has one nested monitoring well at the Manhattan Wellfield, containing three individual well casings, with the deepest extending to 1,450 feet bgs. Figure 2 shows the location of Figueroa Pump Station and the nearby regional groundwater monitoring wells and production wells. Table 1 summarizes the well construction information for select wells shown on Figure 2 and at the Manhattan Wellfield, including the USGS chronostratigraphic sequences (Paulinski 2021) and corresponding local aquifer designations for each well (WRD 2021). Figures 3 and 4 are east-west and north-south cross-sections of the three-dimensional chronostratigraphic model, respectively, through the Figueroa Pump Station area. The USGS chronostratigraphic sequence designation for individual well screens are based on where each well projected onto the cross-sections (Figures 3 and 4) through the USGS chronostratigraphic model. Attachment 1 includes Strater® logs that contain select geophysical logs, general lithology, and well construction details for the WRD regional nested monitoring wells. Attachment 2 contains well construction diagrams and a data summary sheet with the generalized lithology, geophysical logs, and sample intervals for the recently constructed nested monitoring well and production wells at the Manhattan Wellfield.

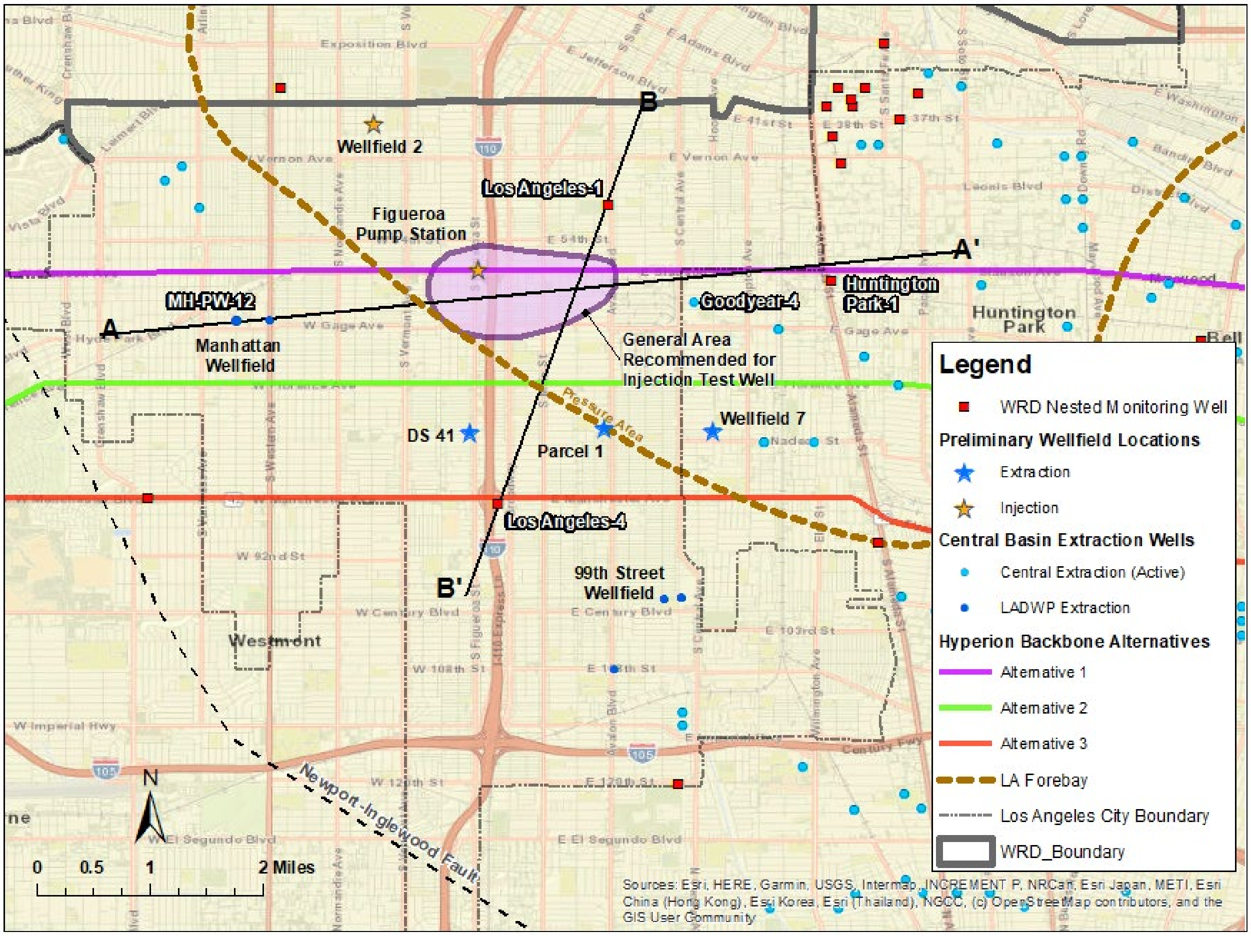


Figure 2. Well and Cross-section Locations

Table 1. Well Construction Information

Well	Well Owner	Type	Screen Number	Top of Screen (feet bgs)	Bottom of Screen (feet bgs)	USGS Sequence[a]	Aquifer Designation[b]
Huntington Park-1	WRD	MW	5	114	134	Dominguez	Gaspur
			4	275	295	Mesa	Gage
			3	420	440	Pacific A	Hollydale
			2	690	710	Harbor	Lynwood
			1	890	910	Bent Spring	Silverado
Los Angeles-1	WRD	MW	5	350	370	Pacific A	Lynwood
			4	640	660	Harbor	Silverado
			3	920	940	Bent Spring	Sunnyside
			2	1,080	1,100	Upper Wilmington A	Sunnyside
			1	1,350	1,370	Upper Wilmington B	Sunnyside

Table 1. Well Construction Information

Well	Well Owner	Type	Screen Number	Top of Screen (feet bgs)	Bottom of Screen (feet bgs)	USGS Sequence[a]	Aquifer Designation[b]
Los Angeles-4	WRD	MW	6 5 4 3 2 1	235 355 490 720 1,190 1,740	255 375 510 740 1,230 1,780	Pacific Harbor Harbor Upper Wilmington A Lower Wilmington Long Beach A	Gage Lynwood Silverado Sunnyside Sunnyside Pico Formation
Goodyear-4[c]	GSWC	PW	-	502	643	Pacific	-
MH-MW-01A	LADWP	MW	1 2 3	230 510 1,350	250 560 1,450	Mesa Pacific Upper Wilmington B	- - -
MH-PW-08[c]	LADWP	PW	-	665 975 1,340	860 1,140 1,410	Harbor/Bent Spring/ Upper Wilmington A/ Upper Wilmington B	-
MH-PW-10[c]	LADWP	PW	-	680 890 1,370	810 1,060 1,450	Harbor/Bent Spring/ Upper Wilmington A/ Upper Wilmington B	-
MH-PW-11[c]	LADWP	PW	-	230 425	400 590	Mesa/Pacific A/ Pacific	-
MH-PW-12[c]	LADWP	PW	-	690 1,390	1,130 1,520	Harbor/Bent Spring/ Upper Wilmington A/ Upper Wilmington B	-

Notes:

[a] USGS chronostratigraphic sequences (Paulinski 2021).

[b] WRD 2021.

[c] USGS sequences have been interpreted from cross-sections A-A′ and B-B′.

GSWC = Golden State Water Company

MW = monitoring well

PW = production well

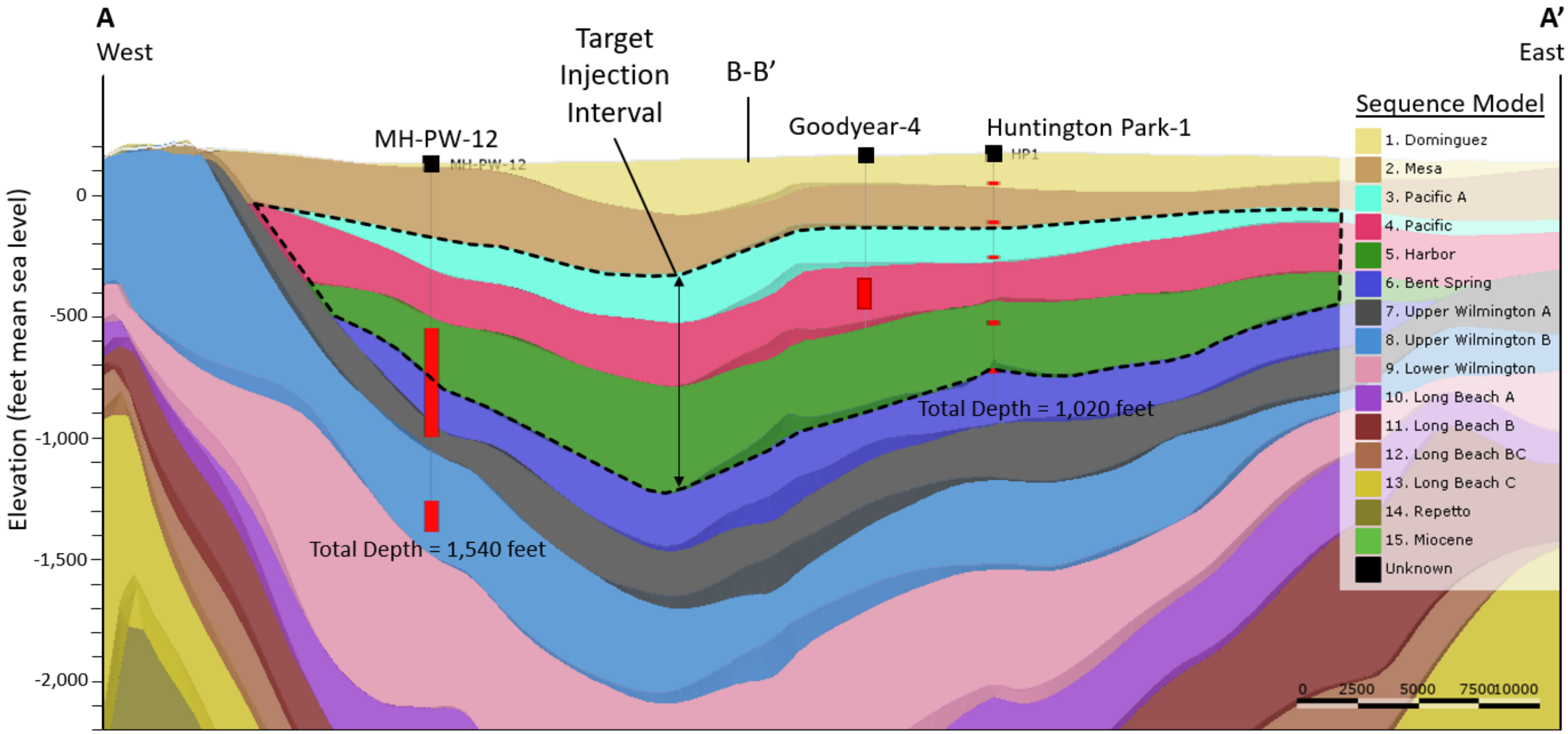


Figure 3. Cross-section A-A'

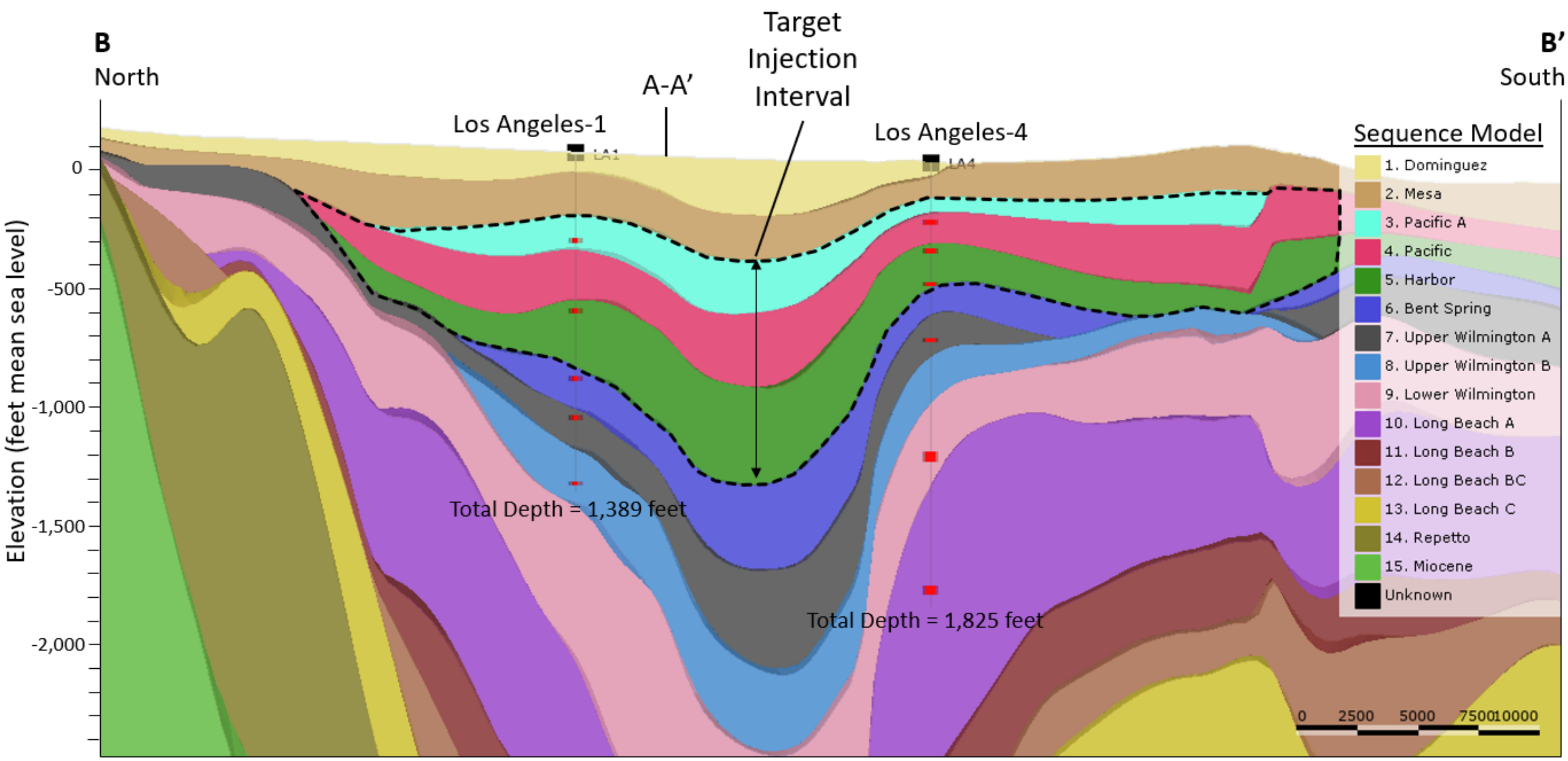


Figure 4. Cross-section B-B′

The following observations have been provided based on review of well completion information and cross-sections A-A′ and B-B′:

- Injection of advanced treated water at Figueroa Pump Station has been modeled in the Pacific A and Pacific sequences because of higher modeled transmissivities, which are more favorable for injection. The Harbor sequence is also shown as part of the target injection interval to be consistent with plans for future injection and extraction that will likely focus on similar zones to the existing Manhattan Wellfield. The combination of the Pacific A, Pacific, and Harbor sequences measures approximately 800 to 900 feet thick and occurs at depths ranging from approximately 250 to 1,450 feet bgs through the area.
- Three production wells located in the Manhattan Wellfield (MH-PW-08, MH-PW-10, and MH-PW-12) extract from deeper sequences, including Harbor, Bent Spring, Upper Wilmington A, and Upper Wilmington B, and one well (MH-PW-11) pumps from shallower sequences Mesa, Pacific A, and Pacific (Table 1). During installation of these wells, 40- to 98-hour constant-rate pumping tests were performed at rates between 2,250 and 2,700 gallons per minute (gpm), with resulting specific capacities ranging from approximately 17 to 25 gpm per foot of drawdown (LADWP 2021). The results of these pumping tests suggest that, in the vicinity of the Manhattan Wellfield, the transmissivity of the combined Pacific A and Pacific sequences compares to the transmissivity of the combined Harbor, Bent Spring, Upper Wilmington A, and Upper Wilmington B sequences. Therefore, sequences below the Pacific section (especially the Harbor and possibly through the Upper Wilmington B) could prove suitable for screening a MAR test well.
- The maximum depth and thickness of sequences that should be considered for the test MAR well and associated monitoring wells, from Pacific A to Upper Wilmington B at depth, appear south of cross-section A-A′ (Figure 3) and west of cross-section B-B′ (Figure 4).

Figure 2 shows the recommended area for siting the injection test well and associated nested monitoring well(s). The thickest and deepest portion of the basin can be observed in this area and, in a relative sense, it is closer to the Manhattan Wellfield, where transmissivity of deeper sequences appears favorable for injection. Pilot borehole drilling should be planned for up to 2,200 feet to evaluate hydrogeologic conditions at the selected location to depths corresponding to the Upper Wilmington B sequence, which is the deepest sequence that the Manhattan production wells extract from. The preference would be for the injection test well and nested monitoring well(s) to be installed on the same parcel for access consideration; however, at a minimum the monitoring wells should be located approximately 50 feet from the injection well and no farther than approximately 100 feet. Final monitoring well and injection test well designs should be based on field observations including lithology, results of geophysical logging, and water quality testing described in the field program in Section 4.

3. Injection Test Well and Nested Monitoring Well Design

This section intends to provide an initial basis for Project feature design and implementation, and a basis to develop detailed plans and specifications for implementing the injection test well and associated monitoring facilities.

The initial concept for the Project was to install an injection wellfield in a central location that could accommodate recharge rates of up to 30,000 gpm. Groundwater modeling results and subsequent parcel investigations have indicated that the Project will likely require a more geographically dispersed wellfield to mitigate MPH concerns due to excessive drawup and because of the general lack of available parcels in the area that are of adequate size to accommodate a large wellfield.

Exploratory drilling and installation of a nested monitoring well have been included in the work plan and should precede installation of the injection test well. The nested monitoring well will provide additional hydrogeologic and water quality information to assist in injection test well design; function as an observation well to monitor injection test well activities; and provide valuable data for conducting a complete analysis of aquifer test data, including calculation of storage coefficients. Because the injection test well may be screened over six chronostratigraphic sequences (Pacific A sequence [the shallowest sequence where injection was modeled at Figueroa Pump Station] through the Upper Wilmington B sequence [the deepest sequence that the Manhattan production wells extract from]), there may be a need for discrete monitoring of an equal number of depth intervals (via an individual well casing in a nested well). Jacobs recommends limiting the number of casings in each nested well to three or less and, consequently, monitoring for the injection test well may require two separate nested wells at the same location.

LADWP completed installation of four production wells and one nested monitoring well for the Manhattan Wellfield in 2014 and 2015. Many of the design concepts and construction materials used for that successful project have been integrated into the conceptual design of the nested monitoring well(s) and injection test well. Attachment 2 contains well construction diagrams and a data summary sheet with the generalized lithology, geophysical logs, and sample intervals for the recently constructed nested monitoring well and production wells at the Manhattan Wellfield.

The following sections provide the conceptual design details for the nested monitoring well(s) and injection test well. Once a site has been selected to implement the injection test wellfield program, preliminary design details, such as anticipated well and well screen depths, can be finalized.

3.1 Nested Monitoring Well Design Details

The nested monitoring well design should generally follow the design approach used for the deep nested monitoring well, MH-MW-01A, installed at the Manhattan Wellfield (Attachment 2). For planning purposes, Jacobs assumes that the MAR test well location will also include two, separate, triple-completion nested wells (three well casings in each nested well). Figure 5 shows the concept of shallow and deep nested monitoring wells adjacent to the injection test well that include six discrete screened sections. Attachment 3 includes tentative well construction diagrams for the nested wells.

The conceptual design details for the nested monitoring wells have been summarized here and in Table 2.

- Pilot borehole depth – 2,200 feet bgs (deep nested monitoring well); 1,200 feet bgs (shallow nested monitoring well)
- Pilot borehole diameter – 10 inches
- Reamed borehole diameter – 18 inches
- Well depths – Each nested monitoring well should accommodate up to three individual well casings. Preliminary well depths are conservatively estimated for the area where the target sequences are deepest. The shallow nested well includes three casings at 655; 855; and 1,155 feet bgs, and the deep well includes casings at 1,505; 1,755; and 2,055 feet bgs.
- Well screen intervals – The individual well screen intervals for each nested monitoring well casing should be of variable length and intended to correspond to the coarse-grained intervals encountered in the pilot borehole. For planning purposes, the preliminary screen lengths are each assumed to be 100 feet long. Table 2 summarizes the screen intervals.

- Casing design:
  - Conductor casing – The conductor casing should be installed to a minimum depth of 50 feet bgs and consist of 20-inch outside diameter (OD), 0.25-inch wall American Society for Testing and Materials (ASTM) A139 Grade B or ASTM A53 Grade B steel. The conductor casing should be centralized in the borehole and use sets of three centralizers, composed of the same material as the conductor casing, placed 120 degrees to one another, and installed approximately 10 feet below the top and above the bottom of the casing (at 10 and 40 feet for a conductor casing installed to 50 feet bgs) and a minimum of every 40 feet if a deeper conductor casing is installed.
  - Well casing – Individual well casings should consist of 4-inch diameter Schedule 80 polyvinyl chloride (PVC). An additional 1.25-inch diameter Schedule 80 PVC piezometer should accompany each casing for water level monitoring.
  - Well screen – The nested monitoring well screens should consist of a 4-inch diameter stainless-steel wire-wrap screen with 0.020-inch horizonal openings. The screen slot size may be adjusted during final design to accommodate a different filter pack gradation, as described below. The 1.25-inch diameter Schedule 80 PVC piezometer that accompanies each casing should have a Schedule 80 PVC screen with 0.020-inch horizonal mill slots with a stainless-steel bottom cap on the bottom of the screen.
  - Well sump – Each individual casing string should include a 5-foot-long sump constructed of 4-inch diameter Schedule 80 PVC with a stainless-steel bottom cap.
  - Casing spacers and centralizers – Individual nested well casings should be spaced 2 inches apart using casing spacers, and the entire casing string will be centralized in the borehole with centralizers. Centralizers should consist of stainless-steel bolt-on bow-type centralizers. The casing spacers and centralizers should be placed above and below each screened interval, at a minimum, and at 40- to 60-foot intervals throughout the remaining casing string.
- Filter pack – The filter pack should be No. 3 Monterey sand for planning purposes and may be adjusted during final design based on the lithology and grain size distribution analysis conducted on samples collected during pilot borehole drilling. If the filter pack gradation is modified in the final design, the project team should evaluate the well screen slot size to ensure it retains a minimum of 90% of the specified filter pack.
- Bentonite seals – Seals should be installed in the annulus between filter pack intervals for each well casing and above the filter pack of the shallowest well casing before placing the grout seal. Seals should consist of bentonite sealing material, such as bentonite chips or a mixture of bentonite and sand. The upper seal should be 20 feet thick (minimum).
- Surface completion details – Monitoring well surface completion will be contingent on the conditions at the final site selected for the wells. For planning purposes, a flush 24-inch round or square traffic-rated locking manhole cover should be used to secure the wells at ground surface.
- Instrumentation – Each well casing should be equipped with dedicated sampling equipment, a water level transmitter, and telemetry for remote data management. Because of the potentially long screened intervals for the nested monitoring wells, dedicated sampling equipment should consist of a high-volume bladder pump to collect water samples using standard low-flow sampling methods. Depending on the final as-built length of each well screen, low-flow samples may be collected at different depths to evaluate potential water quality variability within the well screen interval. In addition, monitoring well casing may contain vibrating wire piezometers strapped to the casing string to monitor water levels in sand units not screened by monitoring wells. These data would supplement water levels collected in the monitoring wells and could assist in evaluating potential MPH due to injection.

3.2 Injection Test Well Design Details

The conceptual design details for the injection test well have been provided here and in Table 2. Attachment 3 includes a tentative well construction diagram for the injection test well. The design details, including well depth, screened interval(s), and gravel pack gradation should be refined using data collected during installation and testing of the nested monitoring wells.

- Borehole depth – The depth of the borehole for the injection test well should be determined based on the results of the nested monitoring well installation. For planning purposes, the memorandum assumes 2,100 feet bgs.
- Borehole diameter – A 16- to18-inch-diameter pilot borehole and a 28- to 34-inch-diameter reamed borehole.
- Well depth – The depth of the injection test well should be determined by the results of the nested monitoring well installation. For planning purposes, 2,070 feet bgs has been assumed.
- Well screen intervals – The well screen for the injection test well may consist of multiple discrete screen sections of variable length, intended to correspond to the coarse-grained intervals identified in the pilot borehole, and separated by blank well casing. For planning purposes, one screened section corresponds to each USGS sequence, with the preliminary screen intervals from Table 2.
- Casing design:
  - Conductor – The conductor casing should be installed to a minimum depth of 50 feet bgs and consist of 36-inch OD, 0.375-inch wall ASTM A139 Grade B or ASTM A53 Grade B steel. The conductor casing will be centralized in the borehole and should use sets of three centralizers, composed of the same material as the conductor casing, placed 120 degrees to one another, and installed approximately 10 feet below the top and above the bottom of the casing (at 10 and 40 feet for a conductor casing installed to 50 feet bgs) and a minimum of every 40 feet if a deeper conductor casing is installed.
  - Well casing – The well casing should consist of 18-inch inside diameter (ID), 0.375-inch wall 316L stainless steel with collars for field welding.
  - Well screen – The well screens should consist of an 18-inch ID, 316L stainless-steel louvered screen with collars for welding. Based on the slot size of the screens for the Manhattan wells, which range from 0.045 to 0.065 inch, a 0.060-inch aperture size is recommended for the preliminary design, with the final aperture size based on the filter pack designed from grain size distribution analysis of cuttings collected from the pilot borehole.
  - Well sump – The well should include a 20-foot-long sump constructed of 18-inch ID, 0.375-inch wall 316L stainless steel, and should include a bullnose bottom cap of the same material.
  - Gravel feed tube – The gravel feed tube should consist of 3-inch-diameter Schedule 40 316L stainless steel and should extend into the top 10 feet of the filter pack (tentatively, 490 feet bgs).
  - Camera access tube – The camera access tube should consist of 3-inch-diameter Schedule 40 316L stainless steel and should connect to the well casing approximately 10 feet above the shallowest perforated interval (tentatively, 490 feet bgs). The camera access tube should enter the well casing through an approximately 4-inch wide by 60-inch (minimum) splice in the well casing and should be constructed of the same materials as the well casing.
  - Centralizers – Centralizers should consist of either three steel guides, 2 inches wide by 2 feet long, or three C-type centralizers, welded to the well casing string at 120 degrees apart, at intervals of less than 80 feet. Centralizers should be composed of 316L stainless steel. Steel guides should be

used on sections of blank casing, and C-type centralizers should be welded near joints, when centralizers are required within continuous sections of well screen.

- Filter pack – The filter pack should consist of well-rounded sand with a uniformity coefficient of 2.5 or less and a high silica content (greater than 90%). Crushed or angular rock should be avoided for use as filter pack material. A standard 8x16 filter pack is recommended for the preliminary design, with the final gradation based on sieve analysis of cuttings collected from the pilot borehole. The filter pack and corresponding well screen slot size should be designed such that 90% of the filter pack is retained during well development. The filter pack should extend from the bottom of the reamed borehole to 20 feet above the uppermost screened section (tentatively 480 to 2,070 feet bgs). As an alternative, glass beads could be used for filter pack material. If glass beads are utilized, selecting the bead size(s)/gradation should follow a similar process as outlined above for silica sand.
- Bentonite seals – Seals should be installed in the annulus between screened sections and between the top of the filter pack and the grout seal. The seal should be 20 feet thick (minimum) and consist of bentonite sealing material, such as bentonite chips or a mixture of bentonite and sand.
- Surface completion details – The final well casing and all accessory tubing shall extend a minimum of 2 feet above grade to allow for potential future equipping of the injection test well as water supply well. Until the well is equipped for injection, Jacobs recommends that the well casing be equipped with a locking lid that allows access to the well for water levels or periodic testing, and that a concrete pad with protective bollards be installed around the well casing.

Advanced treatment of secondary treated wastewater at Hyperion will provide the source of recharge water for the Project full-scale injection wellfield. However, the conveyance of water undergoing advanced treatment process to the Central Basin will not likely be constructed for approximately 15 to 20 years.

Given that issues related to the long-term performance and potential environmental implications of MAR using injection wells (such as clogging and mobilization of metals, respectively) are highly contingent on the recharge water chemistry, injection testing using potable water from local fire hydrants could promote chronic operational or environmental problems long before a well goes into service. Accordingly, the work plan recommends delaying injection testing until advanced treated water becomes available from Hyperion. Testing activities for the injection test well should focus on collecting data to evaluate the hydraulic feasibility of injecting into different aquifer units via extensive aquifer testing outlined in Section 4.8, as well as characterizing the geochemistry of the native groundwater and minerology of the different aquifers. These data will support the data evaluation tasks in Section 5, including making recommendations for equipping future injection wells. The data evaluation should also describe injection testing for the period when representative water becomes available at the injection test well.

Items under consideration for equipping future injection test wells include:

- Downhole equipment, such as recharge piping, a downhole flow control valve, and a backflush pump
- Wellhead piping, valving, and instrumentation
- Chemical feed facilities for disinfection, reactive mineral stabilization, and aquifer conditioning

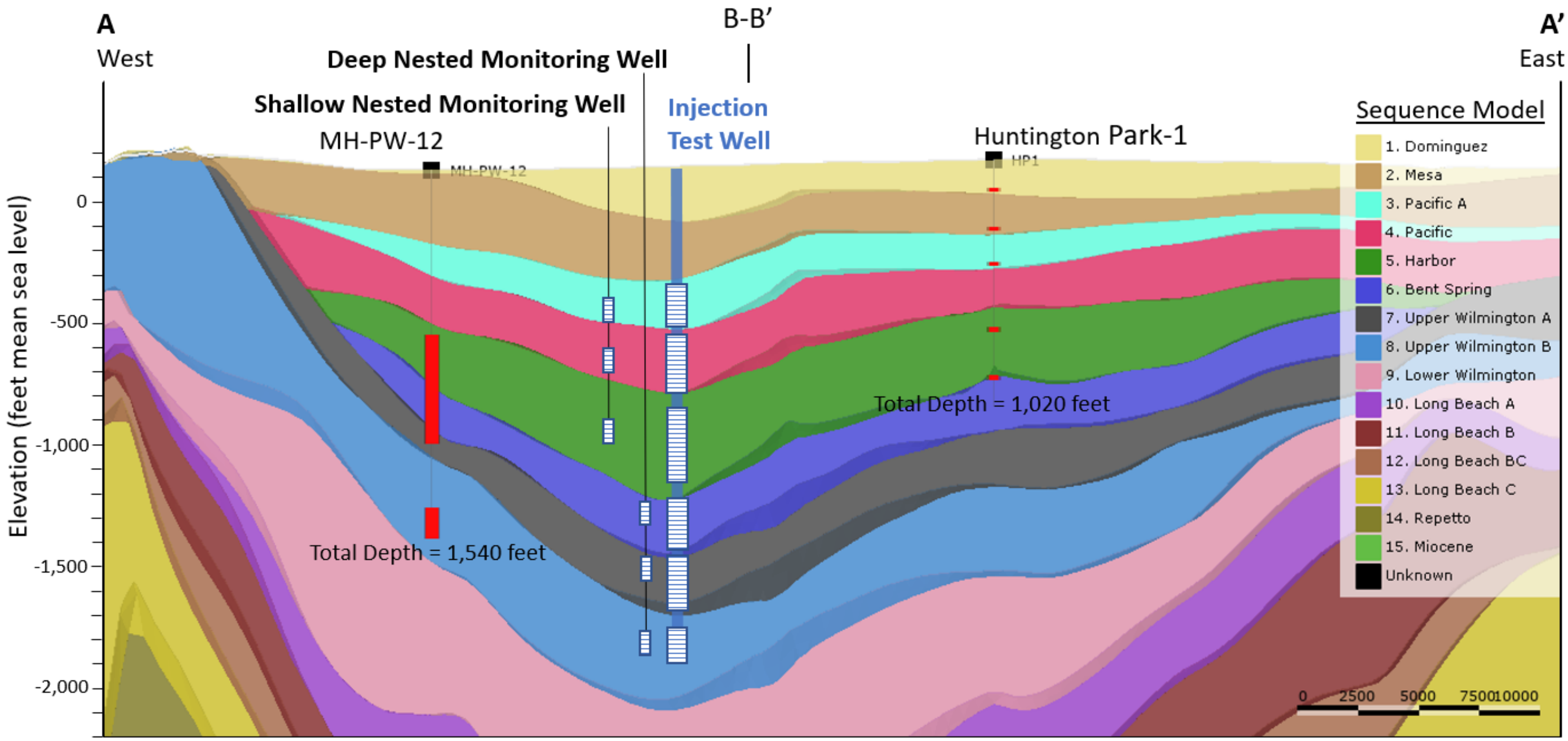


Figure 5. Cross-section A-A’ with Conceptual Well Construction Details

Table 2. Conceptual Injection Test Well and Nested Monitoring Well Construction

Well	Screen Number	Well Depth (feet bgs)	Top of Screen (feet bgs)	Bottom of Screen (feet bgs)	USGS Sequence*
Shallow Nested MW	3	655	550	650	Pacific A
	2	855	750	850	Pacific
	1	1,155	1,050	1,150	Harbor
Deep Nested MW	3	1,505	1,400	1,500	Bent Spring
	2	1,755	1,650	1,750	Upper Wilmington A
	1	2,055	1,950	2,050	Upper Wilmington B
Injection Test Well	-	2,070	500	650	Pacific A
			700	950	Pacific
			1,000	1,300	Harbor
			1,350	1,550	Bent Spring
			1,600	1,850	Upper Wilmington A
			1,900	2,050	Upper Wilmington B

Note :

* USGS chronostratigraphic sequences (Paulinski 2021).

4. Injection Test Wellfield Program

The anticipated injection wellfield for the Project will be located in the area surrounding Figueroa Pump Station (Figure 1). An injection test well and an associated nested monitoring well(s) will be constructed near Figueroa Pump Station on a property to be determined. Nested monitoring well installation should follow the general approach used to install nested monitoring well MH-MW-01A at the Manhattan Wellfield and ideally would precede installation, development, and testing of the injection test well. Depending on the subsurface geologic conditions encountered at the selected injection test well site, there may be a need for discrete monitoring of more depth intervals than can be accommodated by one nested well. Therefore, two separate nested wells may be required. Accordingly, data collected during installation and initial sampling of the monitoring well(s) would inform the design of the injection test well and would provide water quality data to assist in developing the discharge permit for injection test well development and aquifer testing.

Groundwater flow modeling was completed under Task 6.1.1 of the Joint Master Plan to assist in identifying the general areas that appeared favorable for injection and extraction. A component of the modeling included an MPH assessment to evaluate the potential for groundwater quality impacts due to the effects of injection on nearby contaminated sites. In general, the focus of the MPH evaluation involved sites where deeper contamination may be present in the target injection zone(s). Once the injection test well and monitoring well sites are identified, the Project team should review publicly available data, such as data in the State Water Resources Control Board GeoTracker and Department of Toxic Substances Control EnviroStor databases, to verify that there are not any nearby shallow impacts on soil or groundwater. If there are sites nearby where shallow soil or groundwater impacts are present, the Project team should review the data. If contaminant concentrations are at levels of concern, the team should consider changing out drilling fluids after drilling through the contamination to avoid potential impacts on deeper aquifer units. Additionally, this work plan includes provisions for sampling to evaluate the potential presence of anthropogenic contaminants in soil and groundwater while drilling the boreholes for the nested monitoring wells and injection test well.

This work plan identifies the general area to implement the injection test wellfield program (Figure 2); however specific locations for the nested monitoring wells and injection test well have not been identified. The injection test well will likely require property acquisition or negotiation of an access agreement, while the monitoring wells may be installed on the same parcel as the injection test well or adjacent to the parcel in the public right-of-way, Therefore, the sequencing of the activities outlined in the plan remain uncertain and will be contingent on securing sites for the wells. Also, LADWP may elect to install additional monitoring wells in the surrounding area that could provide valuable information related to the presence of contamination in the area and better refine the target investigation depths and sampling activities outlined in the work plan. Prior to implementing the field program, any new data from regional monitoring well installation activities should be considered to establish the remaining data needs, refine the sampling activities, and evaluate the optimal sequencing of the work, as needed.

4.1 Mobilization

Mobilization to the sites will consist of the drilling contractor (Contractor) positioning drilling equipment for the installation of conductor casing and the pilot borehole. Additional equipment associated with drilling includes flat-bed trailers for hauling pipe, bits, and tools along with compressors, generators, well development and pump rigs, sanitary facilities, and water tanks and roll-off bins to contain waste generated during well drilling, development, and testing.

Additional site-specific considerations for the drilling activities include:

- Permitting:
  - Various permits or plans will be required for installation, development, and testing of the nested monitoring wells and injection test well and are discussed in detail in Section 6. Permits may include well permits; local encroachment, excavation, or traffic control permits; sediment erosion control plan; a noise variance for nighttime drilling activities; and discharge permits.
- Noise mitigation measures:
  - Working in residential areas may require erecting sound barrier walls around the injection test well site during 24-hour a day, 7-day a week (24/7) operations to maintain acceptable noise levels at the property boundary with adjacent neighbors. Barrier walls should be designed to minimize noise levels outside of the well site and to meet local building code requirements to preclude structural failure due to factors including winds, earthquakes, and erosion.
- Utility conflicts:
  - The Contractor will be required to notify Underground Service Alert to identify potential underground utility conflicts at the proposed borehole locations and in the surrounding work area. Jacobs recommends that the borehole location also be independently cleared for subsurface utilities by reviewing readily available subsurface utility plans, using a private utility locator and a soft-dig technique of compressed air and a vacuum (air-knifing). Air-knifing should include clearing the borehole location with a hole 10% larger in diameter than the largest tool to be used during drilling and to a depth of 10 feet bgs.

- Source water for drilling:
  - During borehole drilling and well construction activities, the Contractor will require a potable water source that is capable of supplying approximately 200 gpm for mixing and maintaining drilling fluid.
- Soil and fluid disposal requirements:
  - All soil, drilling fluids, and groundwater generated during development and sampling of the nested monitoring well(s) should be contained at the well site, pending analytical profiling. Soil cuttings should be contained in roll-off bins, and fluids should be contained in aboveground tanks. Groundwater generated during development and aquifer testing at the injection test well should be discharged to a storm drain or a sanitary sewer as described in this TM.
- Discharge location:
  - The injection test well location should have access to a storm drain or a sanitary sewer for discharge of water generated during development and aquifer testing. Based on review of production records for the Manhattan Wellfield, the peak flows produced during development and testing of the injection test well could approach 3,000 gpm. Water quality results from the nested monitoring wells will assist in determining the final discharge location and evaluating the compliance with water quality requirements for the discharge. The Contractor should employ settling tanks during injection test well development to remove fines and suspended solids from the water prior to discharging. Accumulated fines and solids from the development and testing should be removed from the tanks and hauled offsite for disposal. A water quality sample should be collected from the water produced during initial well development activities prior to discharging.

Depending on the location and size of the drill site(s), the Contractor may require additional space to stage equipment, materials, and roll-off bins that contain drill cuttings during the drilling and development phases of the injection test wellfield program. Nearby properties should be evaluated as potential staging areas. Any staging area should be secured by fencing and may require 24-hour site security.

4.2 Conductor Casing

The Contractor will require conductor or surface casings while drilling the nested monitoring well(s) and injection test well to stabilize the borehole near the ground surface for circulating drilling fluids. The conductor casings should consist of the following:

- Nested monitoring well(s) – Install a permanent 20-inch-diameter conductor casing to a minimum of 50 feet bgs.
- Injection test well – Conductor casings for municipal water wells should extend to a minimum depth of 50 feet bgs (DWR 1981, 1991) and, thus, should represent the minimum depth of the conductor casing for the injection test well. Similarly, the conductor casing ID should measure 2 inches (minimum) greater than the intended maximum borehole diameter. A 36-inch OD conductor casing has been planned for the injection test well.
- The Contractor can recommend deeper settings for conductor casing, should they land well casing on the conductor during well installation as a matter of practice.

Because of the relatively deep anticipated depth to water (approximately 150 feet bgs), the conductor casings for the monitoring well and injection test well may terminate in the vadose zone. Once site(s) for the injection test well and monitoring well are selected, the Project team should review any available nearby boring logs to identify the potential presence of shallow gravel lenses that could cause difficulty during drilling and, if shallow enough, consider extending the conductor casing to isolate them. As an option, LADWP may elect to drill a small-diameter borehole using a hollow-stem auger drill rig to collect soil samples and screen for shallow soil contamination prior to drilling and installing conductor casing. Shallow soil samples should be collected as described in Section 4.3.3. Submitting grab samples from soil cuttings should be avoided.

The borehole diameter for each conductor casing should measure a minimum of 6 inches greater than the OD of the casing to be installed. Centering guides (centralizers), composed of the same material as the casing, should be securely welded to the conductor casing with a minimum of two sets of guides installed (one near the bottom and one near the top). Each set should consist of three guides equally spaced (at approximately 120 degrees) on the outside of the conductor casing. Grout that consists of neat cement or sand cement should be placed between the borehole and the casing by using a tremie pipe to install the seal from the bottom of the borehole to the top, and should be allowed to cure for a minimum of 24 hours prior to positioning the drill rig over the casing.

4.3 Pilot Borehole Drilling and Sampling

The pilot boreholes for the nested monitoring well(s) should be drilled using a combination of air rotary casing hammer (ARCH) and direct mud rotary, while the pilot borehole for the injection test well should be drilled using flooded reverse rotary drilling techniques. The technical specifications for drilling should outline the requirements for the circulation system and drilling fluid program to assist in maintaining fluid properties and borehole stability, including requirements for a shale shaker and desander/desilter cones. All drilling fluid additives should conform with National Sanitation Foundation (NSF) Standard 60, *Drinking Water Treatment Chemicals – Health Effects*, certified (NSF 2021). Excavation of mud pits should not be permitted. The following sections summarize additional considerations for drilling the pilot boreholes for the monitoring well(s) and injection test well.

4.3.1 Nested Monitoring Well Pilot Borehole Drilling

The pilot borehole for the nested monitoring well(s) should measure 10 inches (nominal) in diameter, drilled using a combination of ARCH and direct mud rotary methods, and should extend to a total depth of 2,200 feet bgs for a deep nested well and tentatively to 1,200 feet bgs, assuming a second shallow nested well is installed. ARCH drilling methods should be used to advance the pilot borehole from the base of the conductor casing to the regional water table, which will assist in evaluating the presence of any intervals of perched groundwater and provide certainty in the depth of the regional water table. After the borehole has been advanced to the regional water table, drilling should switch direct mud rotary and continue with this method to the total depth of the borehole.

The Contractor should collect cuttings samples every 10 feet or at changes in sediment type, and should store the samples onsite in 1-gallon plastic bags for inspection and lithologic logging. The Contractor shall mark each bag with the following information:

- Pilot borehole name/number
- Depth interval
- Date and time sample collected

Cuttings samples should be collected from the cyclone for ARCH drilling and from the drilling fluid return prior to being discharged to the solids separation equipment when drilling using mud rotary. Collection of cutting samples from the shaker table will not be acceptable. When drilling direct mud rotary, the Contractor should use a lag chart, or other approved procedure, to identify the appropriate sampling timeframe to sample cuttings for a given interval to account for the lag time in cuttings return. The field geologist should describe soil samples using the Unified Soil Classification System (USCS) in accordance with ASTM D2488, *Standard Practice for Description and Identification of Soils* (*Visual-Manual Procedures*), as described in Section 5.1.1.

In addition to collecting samples of drill cuttings for lithologic logging, additional soil and water samples may be collected, at the discretion of LADWP, to: provide more detailed lithologic information; investigate the presence of contamination; and support final well design and geochemical evaluations. Sections 4.3.3 through 4.3.6 describe specialized methods and procedures to sample groundwater and soil in the pilot boreholes.

4.3.2 Injection Test Well Pilot Borehole Drilling

A 16- to 18-inch-diameter pilot borehole should be drilled for the injection test well. If installed prior to drilling the injection test well, results of the monitoring well drilling and testing will assist in refining the final injection test well design and the required total borehole depth to construct the well. If LADWP elects to install the injection test well first, additional activities such as isolated aquifer zone testing (described in Section 4.3.5) and coring (described in Section 4.3.6) may precede or be incorporated in the pilot borehole drilling activities.

The Contractor should collect soil cuttings samples from the injection test well pilot borehole using the same methods and frequency as described above for the monitoring well borehole. Samples should be retained and stored onsite in 1-gallon plastic bags for inspection by the field geologist and be logged according to the USCS and procedures described in Section 5.1.1. Sediment samples should be submitted for sieve analysis to confirm the filter pack gradation and well screen aperture size.

The Contractor should retain a drilling fluid specialist to develop and monitor the fluid program, including recommended products and procedures to be used during drilling and chemical development.

4.3.3 Soil Sampling

Soil samples may be collected using a hollow-stem auger drill rig prior to installing the conductor casing or while drilling ARCH from the base of the conductor to the regional water table. Soil samples should be collected using a California-modified split-spoon sampler, or equivalent, at a regular interval (such as every 5, 10, or 20 feet) until reaching the regional water table.

Soil samples should be submitted for the laboratory analyses describes in Section 4.3.7 and follow industry standard sampling procedures for each analysis, such as using specialized sampling devices/containers for volatile organic compounds (VOCs). Soil samples should also be screened in the field for VOCs using a calibrated photoionization detector.

4.3.4 SimulProbe Sampling

SimulProbe sampling methods may be used to obtain soil and groundwater samples from the formation while advancing the pilot boreholes for the monitoring wells. If SimulProbe sampling is employed, samples should be collected while drilling ARCH where perched groundwater is encountered and at the regional water table and while drilling mud rotary on a regular depth interval, such as every 20 to 50 feet, once the pilot borehole has been advanced into the regional water table.

The SimulProbe sampling tool should be prepared using the written standard operating procedures of the manufacturer, and should be lowered into the borehole on drill pipe. The Contractor should drive the SimulProbe into an undisturbed formation using a drill rig equipped with a casing hammer. After the sampler has been allowed time to fill with groundwater from the formation, the Contractor will remove the sampler from the borehole and assist the onsite geologist will retrieving the soil and groundwater samples. The field geologist should describe soil samples using the USCS, as described in Section 5.1.1.

Multiple SimulProbe canisters can be stacked in series to maximize the volume of water retrieved for each sample. However, because the sample volume is limited, and because of the potentially turbid nature of the sample, laboratory analysis of groundwater from SimulProbe samples should focus on contaminants that are prominent in the region, as discussed in Section 4.3.7. The SimulProbe sampler utilizes components/fittings constructed of Teflon™ and Viton™ that may come into contact with the groundwater samples. Teflon™ and Viton™ are potential sources of per-and polyfluoroalkyl substances (PFAS) and could influence results for analysis of PFAS compounds. If SimulProbe samples will be submitted for analysis of PFAS, equipment blanks that are exposed to these components should be collected and also submitted for PFAS analysis to evaluate their potential influence on the analytical results of groundwater samples.

4.3.5 Isolated Aquifer Zone Testing

Based on preliminary modeling, the modeled interval of injection corresponds to the Pacific A and Pacific sequences, and ranges from approximately 450 to 850 feet bgs near Figueroa Pump Station. Isolated aquifer zone testing should be conducted in the pilot borehole for the deep nested monitoring well or injection test well to evaluate the vertical distribution of water quality parameters and to qualitatively assess the specific capacity within the proposed injection interval, in the underlying aquifer units that are utilized for groundwater production at the Manhattan Wellfield, and, potentially, in overlying aquifer units. The results of zone testing will assist in determining the intervals to construct the monitoring well(s), and will provide data to inform the design of the injection test well, as well as to detect the presence of any anthropogenic contamination.

Ideally, zone testing should be implemented at the first location that is drilled to assist in identifying potential fatal flaws, such as the presence of contamination or unfavorable transmissivity. In addition, if results are favorable, the project team can apply a mass balance approach using the specific capacity data and water quality results from each zone test interval to identify any potential compliance issues or need for treatment to meet discharge permit requirements for various well design options.

Following geophysical logging in the pilot borehole (Section 4.4), intervals should be selected for isolated aquifer zone testing. Isolated aquifer zone tests will be performed starting with the deepest interval, with successively shallower intervals constructed as the borehole is backfilled using the processes outlined in the following sections. Isolated aquifer zones should be constructed by lowering a 10- to 20-foot-long slotted tool/slotted pipe (with an endcap) on drill pipe or a temporary well casing to the desired test interval. Zone testing tools used in the monitoring well and injection test well pilot boreholes should be of sufficient ID to accommodate 3-inch and 4-inch submersible pumps, respectively, for purging. After the tool has landed at the desired depth, the annular space between the borehole and the tool should be backfilled with materials to construct a seal below the slotted tool, a filter pack surrounding the slotted openings, and a seal above the filter pack interval. After installing the upper sealing material, the Contractor should allow sufficient time (approximately 12 hours) for the seals to hydrate.

Following construction, each zone should be developed and sampled using a combination of airlifting and pumping using a submersible pump. The zone should be developed by airlifting until the discharge is free of drilling fluids and fine sediment. Zones constructed at shallower depths where there is not adequate submergence for airlifting may require initial development via conventional swabbing and bailing. While performing initial development, the Contractor should monitor fluid levels in the borehole to verify the seals are competent and the zone construction has isolated the target aquifer depth interval. If the Contractor determines the seal has been compromised, they should repair or reconstruct the zone using an approach approved by the project team, such as adding additional sealing material, pulling the zone sampling tool up and constructing a new zone, or removing the tool and drilling out the construction materials to rebuild the zone at the same depth. The following sections outline specific zone testing requirements and procedures that should be implemented for zone testing in the monitoring well and injection test well boreholes.

4.3.5.1 Monitoring Well Pilot Borehole

The Contractor should be required to provide an air compressor with sufficient capacity and an air line with adequate submergence to airlift at a minimum rate of 10 to 20 gpm. Following airlift development, a submersible pump should be installed in the sampling tool approximately 50 feet below the static water level in the tool to facilitate the collection of water quality samples.

The target pumping rate for purging should exceed 5 gpm. Field personnel should measure field water quality parameters, such as pH, electrical conductivity (EC), temperature, turbidity, dissolved oxygen (DO), and oxidation-reduction potential (ORP), which should be monitored at 15-minute intervals using a flow-through cell during purging. Prior to sample collection, purging should proceed until the turbidity declines below 10 nephelometric turbidity units (NTUs); field parameters are stable, as determined by the field geologist; and a minimum purge volume of 10 times the volume of the sampling tool/temporary well has been purged. Water quality samples should be collected and submitted for the target list of contaminants and analytical parameters summarized in this TM. After receipt and review of the water quality results from isolated aquifer zone testing, the monitoring well design will be finalized.

Water levels should be monitored in the sampling tool prior to pumping (establish baseline), during pumping (measure drawdown), and after pumping (measure recovery) to qualitatively assess the potential yield or specific capacity within the isolated aquifer zone test interval. A data logging pressure transducer should be used to record water levels at a high frequency during pumping, while manual water level measurements with an electric sounder should be recorded approximately every 15 minutes to verify the transducer measurements. The transducers may be set to record water levels on a logarithmic scale at the beginning of the pumping and recovery periods to maximize the recording frequency when the rate of water level change is highest.

4.3.5.2 Injection Test Well Pilot Borehole

The Contractor should be required to provide an air compressor with sufficient capacity and an air line with adequate submergence to airlift at minimum rates of 100 gpm. Following airlift development, a submersible pump should be installed in the sampling tool, approximately 50 to 100 feet below the static water level in the tool, to facilitate pumping to evaluate aquifer properties and the collection of water quality samples.

The target pumping rate for purging should range from 50 to 200 gpm, depending on the productivity of the zone. As outlined earlier, field personnel should measure field water quality parameters at 15-minute intervals using a flow-through cell during purging. Purging should proceed until the turbidity declines below 10 NTUs or the field geologist determines the discharge has adequately cleared up, and field parameters have stabilized. After the discharge has cleared, the Contractor pump each zone at a constant rate for up to 6 hours to obtain depth-discrete drawdown data to estimate aquifer properties. The Contractor should collect water quality samples at the end of the pumping period and submit for the target list of analytes summarized herein.

Water levels should be monitored in the sampling tool using a data logging pressure transducer and electric water level sounder, as described above, prior to pumping (establish baseline), during pumping (measure drawdown), and after pumping (measure recovery) to qualitatively assess the potential yield or specific capacity within the isolated aquifer zone test interval.

4.3.6 Coring

A coring method may be used to collect continuous lithologic information from the pilot borehole of nested monitoring well or the injection test well location prior to drilling the pilot borehole. Collection of continuous core would target the intended injection interval and provide samples for additional mineralogical and physical analysis of the aquifer materials, and better characterize the quantity, size, mineral filling, shape, and interconnectivity of pore spaces in the aquifer and aquitard materials. To focus the coring activities within the intended screened interval for the injection test well, it is recommended that coring proceed after data have been reviewed from the initial pilot borehole drilling, geophysical logging, and zone testing at either the monitoring well or injection test well location. Core samples should be equally spaced throughout each proposed screened interval for the injection test well, as well as through confining bed material within 5 to 10 feet of their contact with aquifer sands.

If coring is performed at the monitoring well location, the same drill rig planned for drilling the 10-inch pilot borehole may be equipped with a 94-millimeter or HQ wireline core system to provide detailed lithologic information for targeted intervals through the depth interval being considered for injection. When implementing this approach, the core hole should be smaller in diameter than the previously described 10-inch borehole for the monitoring well pilot borehole, and an intermediate ream will be required to complete the isolated aquifer zone testing described in this TM. The 94-millimeter coring method does not work well in consolidated sediments, so poor recovery may be observed at depth for this method. HQ coring would provide better recovery but may not be practical if long coring intervals are desired.

If coring is performed at the injection test well location or if the desired coring intervals exceed the limitations described for coring using the rotary rig for the monitoring well, a specialized core rig will be required and a combination of HQ and potentially NQ core pipe (for deeper intervals) should be used. A pre-collar should be installed to the top of the shallowest core interval to stabilize the borehole.

Coring unconsolidated sediments can prove to be challenging for recovering sample material, particularly in coarse-grained lithologies. Drilling expertise, weight, bit speed, catcher position, sample lithification or compaction can all influence recovery. Often, for recovery in sands and gravels, the lithology of most interest usually falls below 50%. Therefore, the procedure mentioned earlier regarding handling cuttings returned from the drilled intervals should be followed. Although not as accurate as core regarding the sample's depth of origin, cuttings provide a viable substitute if a Contractor fails to recover core from important intervals.

Core should be handled in such a manner as to maintain the integrity of the core during inspection, and the moisture content during storage. The amount of recovery should be recorded, and the core should be photographed in the field, logged using the USCS (as described in Section 5.1.1), placed in liners, wrapped in plastic to preserve moisture, labeled with the appropriate depth on each end, and retained for evaluation once total depth has been achieved. Some projects require more specialized techniques to maintain the redox and anoxic characteristics of the sample. In these situations, the Contractor may equip the core barrel with polycarbonate tubing that the field crew can seal before processing or shipment to the lab. Moreover, nitrogen-purged glove boxes maintain an anoxic environment while handling the core sample.

4.3.7 Laboratory Analysis

Select soil and groundwater samples collected from the pilot boreholes should be submitted to a California state-certified laboratory for analysis to evaluate the potential presence of contamination, to assist with completing the final design for the injection test well and nested monitoring well(s), and to provide analytical data to perform the geochemical compatibility evaluations in Section 5.2. Shallow soil and groundwater samples should be submitted for known and emerging contaminants. Deeper soil samples within the intended injection intervals should be tested for physical properties, such as grain size analysis, and mineralogical testing. Groundwater samples obtained through depth discrete testing should be analyzed for known and emerging contaminants, metals, important non-metals, nutrients, silica, and general chemical parameters. The latter groups of analytes support geochemical compatibility evaluations.

4.3.7.1 Soil Sample Chemical Analysis

Soil samples collected between ground surface and the regional water table should be analyzed for select contaminants that are prevalent in the mixed industrial and residential areas of the Central Basin. Samples should be submitted to a state-certified laboratory for analysis of the following:

- Metals, including hexavalent chromium
- Perchlorate
- Semi-volatile organic compounds (SVOCs), including 1,4-Dioxane
- VOCs, including select fuel oxygenates (tertiary butyl alcohol and methyl tertiary butyl ether)
- 1,2,3-Trichrloropropoane (1,2,3-TCP)
- PFAS compounds

4.3.7.2 Soil Sample Physical and Mineralogical Analysis

Select samples of cuttings, portions of continuous core, or soil core retrieved in the SimulProbe sampler, primarily throughout the depth of the anticipated screen interval of the monitoring wells and injection test well, should be submitted to a state-certified laboratory for grain-size distribution analyses. To the extent practical, the samples should be analyzed with the following American Screen Sizes:

- #4
- #10
- #30
- #50
- #70
- #100
- #140
- #200
- #230
- Pan

The suite of screen sizes should be adjusted depending on results from analyses at other local sites. The results of the grain size analyses should be used to specify filter pack grade(s) and appropriate well screen aperture size. Moreover, several analytical techniques allow for the estimations of aquifer permeability from grain size distribution data. These data will assist in confirming aquifer coefficients calculated from the conventional pumping tests.

The onsite geologist should select and prepare cuttings, core, or SimulProbe samples for shipment to a laboratory specializing in mineralogical analyses. In addition to samples evenly distributed across each proposed screened interval for the injection test well, Project personnel should target samples for analysis that exhibit special characteristics, such as a diversity of minerals, color, or grain size. Tentative samples for laboratory analysis shall be selected by applying the following criteria:

- One sample of confining bed material above each aquifer or significant coarse-grained sequence, preferably within 5 feet of contact
- One sample of confining bed material below each aquifer or significant coarse-grained sequence, preferably within 5 feet of contact
- Intervals distributed equally through a permeable fraction of aquifer material
- Intervals displaying mineral-rich zones within a permeable fraction of aquifer material

Table 3 summarizes the target mineralogic analyses, including X-ray diffraction (XRD) and thin section petrographic analysis, to identify the type and amount of minerals that compose aquifer sands. Because the unconsolidated nature of the aquifers beneath the basin precludes conducting pneumatic permeability testing, petrographic analysis proves invaluable for characterizing the quantity, size, mineral filling, shape, and interconnectivity of pore spaces. Petrographic analysis also allows for description of interstitial pore spaces in aquifer samples. X-ray fluorescence, energy dispersive X-ray (EDX), and analysis by inductive coupled plasma mass spectrometry (ICP MS) characterize the elemental composition of core samples. In most rocks and sediments, ICP MS represents the most effective analysis for obtaining accurate concentrations of trace metals such as arsenic, chromium, cadmium, and selenium.

Other mineralogical analyses that benefit MAR projects include:

- Scanning electron micrograph (SEM)
- Cation exchange capacity (CEC)
- Bulk density
- Acid insoluble residue analysis
- Core slab description

The CEC analysis helps to quantify the tendency for clay minerals to exchange cations. Cation exchange between recharge water and a clay mineral can promote structural instability in the mineral. In MAR applications, clay fragments that migrate through the porous aquifer materials can accumulate in pore throats between individual grains, reducing the intrinsic permeability of the aquifer.

If core recovery is poor or is not collected at a depth interval of interest, field personnel may submit cuttings for mineralogical analysis. Analyses that are focused on identifying the bulk mineralogy, elemental composition, carbonate content, bulk density work effectively on cuttings. However, other analyses can produce questionable results. Petrophysical analysis to define permeability and porosity does not work effectively on cutting samples. Furthermore, the destruction of sample structures inherent with cuttings renders petrographic analyses used in characterizing the interstitial mineralogy and porosity structure as ineffective.

Table 3. Mineralogical Analyses of Soil Samples

Sample Type	Analysis								
Hydrostratigraphic Units	**XRD**	**EDX**	**Compositional Petrographic Modal Analysis**	**SEM Analysis**	**CEC**	**Laser Particle Size - English**	**Specific Gravity**	**Acid Insoluble Analysis**	**ICP MS**
Aquifer sand	x	x	x	x	x	x	x	x	x
Confining bed	x	x		x	x		x		x

4.3.7.3 Groundwater Sample Analysis

Water quality samples from SimulProbe sampling, if collected, should be submitted to a laboratory for analysis of the following:

- General minerals and physical parameters
- Dissolved metals, including hexavalent chromium
- Perchlorate
- SVOCs, including 1,4-Dioxane
- VOCs, including select fuel oxygenates (tertiary butyl alcohol and methyl tertiary butyl ether)
- 1,2,3-TCP
- PFAS compounds

In addition to the previously listed analyses, groundwater samples collected during isolated aquifer zone testing and samples from the newly constructed monitoring wells and injection test well should be submitted for the analysis of the parameters outlined in Table 4. Often, permit requirements dictate sampling the test MAR well and monitoring wells over several quarters to characterize seasonal variations in groundwater quality. Additional details regarding water quality testing for the monitoring wells and injection test well are provided in Section 4.9.

Table 4. Preferred Analytes for Geochemical Evaluations during Field Investigation

Constituent	Units	MDL
pH	standard units	0.1
ORP	mV	50
Specific conductivity	mS/cm	10
DO	mg/L	0.01
Temperature	°C	0.1
Turbidity	NTU	0.1
Field sulfate	mg/L	5
Field iron (ferrous)	mg/L	0.01
Field iron (total)	mg/L	0.01
Field manganese	mg/L	0.01
Field sulfide	mg/L	0.01
Field alkalinity	mg/L	20
Field chloride	mg/L	1
Field carbon dioxide	mg/L	1
Aluminum dissolved	mg/L	0.01
Aluminum total	mg/L	0.01
Arsenic dissolved	µg/L	0.001
Arsenic total	µg/L	0.001

Table 4. Preferred Analytes for Geochemical Evaluations during Field Investigation

Constituent	Units	MDL
Iron dissolved	mg/L	0.01
Iron total	mg/L	0.01
Manganese dissolved	mg/L	0.005
Manganese total	mg/L	0.005
Magnesium total	mg/L	1
Potassium total	mg/L	1
Sodium total	mg/L	1
Calcium total	mg/L	1
Sulfate	mg/L	1
Sulfide	mg/L	0.01
Chloride	mg/L	1
Alkalinity	mg/L	1
Nitrate as N	mg/L	0.01
Ammonia	mg/L	0.1
Total Kjeldahl nitrogen	mg/L	0.1
Fluoride	mg/L	0.01
Silica	mg/L	1
Total organic carbon	mg/L	0.5
Dissolved organic carbon	mg/L	0.5
Total phosphorus	mg/L	0.1
Ortho-phosphate	mg/L	0.1
Total dissolved solids	mg/L	10
Total suspended solids	mg/L	0.5
Hardness	mg/L	10
Total trihalomethanes	µg/L	1
Chloroform	µg/L	1
Bromoform	µg/L	1
Bromodichloromethane	µg/L	1
Dibromochloromethane	µg/L	1
Total haloacetic acid	µg/L	0.1

Table 4. Preferred Analytes for Geochemical Evaluations during Field Investigation

Constituent	Units	MDL
Uranium	µg/L	1
Gross alpha	pCi/L	1
Gross beta	pCi/L	1
Ra 226	pCi/L	1
Ra 228	pCi/L	1

Notes:

°C = degree(s) Celsius

µg/L = microgram(s) per liter

MDL = method detection limit

mg/L = milligram(s) per liter

mS/cm = millisiemen(s) per centimeter

mV = millivolt(s)

pCi/L = picocurie(s) per liter

Ra = radium

4.4 Geophysical Logging

Geophysical logging should be completed in the pilot borehole drilled to construct the deep nested monitoring well and injection test well. Upon reaching the total depth, and conditioning the pilot borehole, geophysical logging should commence immediately. At a minimum, the logging suite should include:

- Short-normal, long-normal, and lateral (guard) resistivity
- Natural and spectral gamma ray
- Spontaneous potential
- Single-point resistance
- Dual induction
- Sonic velocity/variable density

In addition, the Contractor should run caliper and borehole deviation surveys in the pilot boreholes for the monitoring well and injection test well. The Contractor should be required to evaluate deviation survey results using methods in American Water Works Association (AWWA) Standard A100-20, *Water Wells* (July 1, 2020), to ensure that any borehole deviation will not prevent a completed well from meeting AWWA guidelines.

The results from the logging will aid with final well design, such as selecting intervals for isolated aquifer zone testing and screen zones for the monitoring well and injection test well, as well as identifying portions of the borehole that may require remediating or straightening out during reaming.

In lieu of completing the previously noted logging suite, and at the discretion of LADWP, advanced geophysical logging by Schlumberger may be completed in the pilot borehole for the deep nested monitoring well or injection test well. WRD has adopted the advanced geophysical logging as a standard for deep regional monitoring wells because of the additional detailed information they provide for regional hydrogeologic evaluations and well design. Advanced geophysical logging would provide additional parameters (such as estimated porosity, salinity, and hydraulic conductivity) that are useful in designing the injection test well and would also complement the WRD regional dataset to evaluate the hydrostratigraphy of the Los Angeles Basin. If advanced logging is conducted in the nested monitoring well or injection test well pilot borehole at a given location, the reduced logging suite should be performed in the pilot borehole for associated adjacent well to verify the depths of hydrogeologic contacts used to finalize the well design.

Attachment 2 includes the data summary sheets for the Manhattan wells, which show examples of the previously noted base geophysical logs. Attachment 4 provides an example of the advanced geophysical logging suite from Schlumberger.

4.5 Borehole Reaming

Borehole reaming will precede construction of the monitoring wells and injection test well. Borehole reaming should be completed on a 24/7 schedule to reduce the amount of time in which drilling fluids remain in the final borehole and to minimize the risk of borehole collapse. The reamed diameter of the pilot boreholes for well construction should be as follows:

- Nested monitoring well – 18 inches
- Injection test well – anticipating an 18.75-inch OD well casing with a 3.5-inch OD camera access tube connecting to the well casing 10 feet above the perforated interval, a telescoped ream should be utilized with the following diameters:
  - 34 inches from the bottom of the conductor casing to the bottom of the camera access tube entry box (10 feet above the top of the perforated interval)
  - 28 inches from the bottom of the camera access tube entry box to total depth

After reaming each borehole, the Contractor should conduct a caliper survey to confirm the borehole diameter and volume of the annular space for calculating material volumes for installing filter pack, intermediate seals, and grouting. In addition to the caliper log, a borehole deviation survey should be completed in the reamed borehole to evaluate the plumbness and alignment of the borehole prior to installing casing.

4.6 Well Design and Construction

The final design of the monitoring well should be based on the lithology observed in the pilot borehole, the geophysical logs, and results of SimulProbe sampling and isolated aquifer zone testing. This information from the monitoring well drilling and the results of initial groundwater samples for the monitoring well will enable final design for the injection test well. The observed lithology , geophysical logs, water quality results, and sieve analysis of samples from the pilot borehole drilling for the injection test well will then confirm the injection test well design.

4.6.1 Nested Monitoring Well

The monitoring well should be completed as a nested well that consists of up to three individual monitoring well casings installed in a single borehole. The monitoring well should be installed using a method such that the individual casing strings are assembled into a single unit, where the individual casings are fastened together, spaced apart, a minimum of 2 inches, using casing spacers, and centralized as they are lowered into the reamed borehole.

After the well casing has been installed, the Contractor should fill the borehole from the bottom up using a tremie pipe. Annular materials should consist of alternating intervals of filter pack material surrounding the well screens, and bentonite sealing material, such as bentonite chips or a mixture of bentonite and sand, in the intervals between well screens. Filter pack should extend approximately 10 feet below and above each well screen interval, and may be adjusted to be closer to the top and bottom of screens in the final design, if determined to be feasible. After filter pack has been placed around the shallowest monitoring well screen, a 20-foot-thick (minimum) bentonite seal should be placed prior to installing an upper annular grout seal. Sealing material consisting of bentonite chips or a mixture of bentonite and sand, as previously described, may be used for the upper annular seal to mitigate potential deformation of PVC casing during the roughly 30-day heat of hydration period.

Annular materials should be placed in approximately 20-foot lifts, and the Contractor should monitor the progress using a weighted tagline. Volumes of annular materials will be continuously tracked and compared to the calculated annular volume based on the caliper log to assess the potential for bridging or sloughing during well construction. The Contractor should notify the Los Angeles County Department of Public Health, Environmental Health, Drinking Water Program, prior to the placement of the seal, as outlined in the well permit.

The Contractor will install either a below-grade well vault or an above-grade surface completion to protect the monitoring well. Final well site constraints will dictate the type of surface completion selected for each monitoring well.

4.6.2 Injection Test Well

The process of constructing the injection test well is time sensitive and should be performed on a 24/7 schedule through completion. After reaming the borehole, the Contractor will install the well screen with the end cap, blank well casing, and accessory tubing, according to the final well design. The well will be constructed sequentially from the bottom up and lowered into the borehole as each additional section of pipe is welded to the casing string.

Annular materials should be installed after the well casing string and tubing have been landed at the depth determined in the final well design (Attachment 3). The filter pack should be installed using a tremie pipe, and should be pumped with fresh water in the annular space between the well casing and the reamed borehole, to a depth extending approximately 20 feet above the top of the well screen. The filter pack should be placed in approximately 20-foot lifts to minimize the risk of the filter pack forming a bridge between the screen and borehole wall, which can lead to voids in the annulus.

After installing the filter pack to a depth above the uppermost perforations, the Contractor should perform preliminary airlift pumping to remove residual mud, tighten the filter pack, and bring formation water into the well. Following airlifting, the Contractor should swab each screen section, from the bottom of the well to the top, to further consolidate the filter pack and remove fines. The filter pack level should also be continuously monitored in the gravel feed tube and in the borehole annulus and replenished, as needed, to ensure the filter pack level is maintained at the design depth. A 20-foot-thick layer of bentonite should be placed on top of the filter pack as a transition to the annular seal. The depth of the annular materials should be frequently measured using a weighted tagline, and installed material volumes should be compared to the annular volume on the caliper log to monitor the backfilling progress.

The sanitary annular seal should be continuously placed from the top of the transition sand to ground surface using the tremie method. The material should be 10.3 sack sand cement (7 gallons of water per 94 pounds of cement). The Los Angeles County Department of Public Health, Environmental Health, Drinking Water Program should be notified prior to the placement of the seal, as outlined in the well permit.

4.7 Well Development

4.7.1 Nested Monitoring Well

The individual monitoring well casings should be developed using a combination of bailing, swabbing, airlifting, and pumping. The first phase of developing the monitoring wells should consist of removing heavy drilling fluid and sediment from each well casing by bailing or open-ended airlifting. Following this phase, the Contractor should develop each well by swabbing and airlifting. Swabbing and airlifting should be performed at 20-foot intervals across the entire section of the monitoring well screen and should continue until the water produced is free of drilling fluids and sediment. At the deep nested monitoring well, airlift development may be performed using the drill rig, prior to moving over to drill and construct the shallow nested monitoring well.

The final phase of development should involve installation of a submersible pump and over-pumping the well. Pumping development may utilize packers to isolate the screen interval, as needed. Pumping should initially proceed at a restricted pumping rate, with the rate incrementally increased as the discharge clears. The final pumping development should consist of pumping at the capacity of the pump until a minimum of one casing volume has been removed and field parameters are stable, turning the pump off for 5 minutes, and then repeating the pumping cycle.

Pumping should continue until the field water quality parameters (pH, EC, temperature, turbidity, DO, and ORP) have stabilized, the discharge has a turbidity reading less than 10 NTUs, and a minimum of 10 well casing volumes have been removed. The static water level and total depth of the well should be recorded before pumping, and pumping water levels should be recorded at regular intervals (for example, every 15 minutes) during development. After completing pumping development, the total depth should be measured and any fill that may have accumulated during pumping should be removed using a bailer.

4.7.2 Injection Test Well

The injection test well should be developed using a combination of aggressive mechanical methods, chemical treatment, and pumping. This section describes each phase of development in detail.

4.7.2.1 Mechanical Development

Mechanical well development will represent the primary mechanism to remove residual drilling fluid and loose sediment from the well and filter pack, tighten the filter pack, and break down the wall cake deposited on the borehole wall during drilling. Mechanical development may include bailing, swabbing, jetting, and airlifting performed in a first phase (dry swabbing), in combination with chemical addition in a second phase (wet swabbing). The filter pack level in the gravel feed tube should be frequently monitored during mechanical development to assess settlement and replenished with additional filter pack material, as needed.

The first phase of mechanical development should be performed with an open-ended single swab attached to the end of the drill pipe to remove sediment and heavy fluids from the well casing. Employing a single-swab tool, the Contractor should work each 10-foot interval of screen for up to 60 minutes while simultaneously airlifting. After working the tool to the bottom of the well, airlifting should continue until the discharge is free of sediment.

The second stage of mechanical development should be performed using a dual-swab tool comprising a piece of pipe, typically 10 to 20 feet long with thick rubber gaskets (swabs) at the top and bottom, with a diameter that is not more than 0.5 inch smaller than the ID of the well screen or casing. In between the swabs, the pipe should be perforated to allow a suction to be created by airlifting using the drill rig. During the process, the dual-swab tool should be continuously raised and lowered over a 20- to 40-foot section of well screen while simultaneously airlifting. Continuous swabbing and airlifting should consist of completing a minimum of 10 swab cycles, where a swab cycle consists of raising and lowering the swab tool across a given section of screened well casing, every 15 minutes, while simultaneously airlifting. This process should be repeated within the same interval until the discharge water becomes substantially clear and free of sediment and drilling mud, as determined by the field geologist. The process should then be repeated for subsequent sections of well casing until the entire screen section has been developed.

An additional phase of mechanical development could include jetting the well screen with high-pressure water to provide an additional mechanism for breaking down residual drilling fluids in the perforations and filter pack. Water used for jetting should be from a potable source and free of fine material and suspended solids. Jetting should either be performed while simultaneously airlifting or be followed by bailing or open-ended airlifting to remove solids dislodged during jetting.

4.7.2.2 Chemical Development

Following the initial dual-swab airlift development, chemical development and cleaning should be performed to break down any residual drilling fluids that remain in the filter pack or borehole walls. Chemicals that may be used and their application include:

- Sodium hypochlorite – A 12.5% solution can be used to introduce chlorine into the well and to break down certain polymers that are present in drilling fluid additives. Chlorine treatment should precede addition of dispersant polymers described herein.
- Dispersant polymers – Dispersant polymers (AQUA-CLEAR PFD, NuWell-220, or equivalent) can be used to break up clay particles from the formation and bentonite-based drilling additives, and can help remove them from the well.
- Acids – If development effluent displays persistent turbidity during mechanical swabbing, the Contractor should consider employing an acid to harden clay minerals around the wellbore. The treatment should consist of muriatic or sulfamic acid swabbed into each screen interval in a similar manner as other chemical additives.

Chemical treatment solutions should be mixed to achieve concentrations, as directed by the drilling fluid specialist. The chemicals should be added to the well, swabbed into the well screen, allowed to rest for a specified period to allow contact time, typically 12 to 24 hours, then removed by dual-swab airlifting, as previously described, until the discharge water is visually clear and free of solids. Each chemical solution that is used should be NSF Standard 60, certified, and should be added or removed prior to introducing other chemical products.

4.7.2.3 Pumping Development

Pumping development is the final phase of the development process and should be performed to further consolidate the filter pack and remove fine sediment from the formation adjacent to the filter pack. The process should be performed after mechanical development has been completed and the drill rig has been removed from the well location. The Contractor should install a test pump that is capable of producing a minimum of 1.5 times the anticipated (pumping) yield of the well.

The pump should not be equipped with a check valve, to allow for backwashing, or surging, when the pump has been turned off. This surging action causes water to flow back down the pump column into the well and out into the filter pack and formation. The bidirectional flow of pumping and backwashing facilitates removal of sediments and consolidates filter pack material. Pumping development (surging) should proceed on a continuous basis, utilizing cycles of active surging (including pump on, pump off, pump on again after backspin, and pump off) followed by periods of constant pumping until the discharge is clear and free of sand.

The depth of the pump intake should be determined by the depth of the well and the anticipated drawdown. Parameters such as depth to water (static and pumping), sand content, turbidity, pumping rate, and specific capacity should be monitored at 15-minute intervals during pumping development. The Contractor should terminate pumping development when the pumping level or specific capacity stabilizes, and when the production of fines and sand appears to be minimal upon startup.

4.8 Injection Test Well Testing

A source of recharge water for injection testing, consisting of advanced treated water from Hyperion, will not be available at the injection test well location for approximately 15 to 20 years. The long-term performance and potential environmental implications of injecting advanced treated water, such as well clogging and mobilization of metals in the receiving aquifer, respectively, are highly contingent on geochemical reactions between the recharge water and native groundwater chemistries. Therefore, injection testing using potable water from the distribution system will not accurately inform potential operational issues related to future injection using Hyperion recharge water. Moreover, potable water obtained from a local hydrant may display chemical characteristics that are not compatible with the native groundwater chemistry, potentially causing well clogging or leaching of undesirable constituents. At a minimum, injection testing that uses recharge water with a different chemical composition could misinform the feasibility of injection in various aquifer units or full-scale wellfield design decisions.

Additionally, performing injection tests by substituting potable water from hydrants that are local to the test sites for recharge presents technical difficulties that may negate the benefits of the testing. First, the small diameter of hydrant outlets, associated valves, and hosing increase friction losses are likely to limit injection rates used in the testing. Data obtained from pumping tests provide acceptably reliable hydraulic coefficients for use in evaluating injection well capacity, injection-specific capacity, and well losses (Pyne 1995, Stuyfzand and Osma 2019), precluding the need to obtain the additional long-lead permits and approvals (for example, Title 22 engineering report) required for injection testing; therefore, injection testing is not recommended during this phase of the Project.

Testing activities for the injection test well should focus on collecting data to evaluate the hydraulic feasibility of injecting into different aquifer units, as well as to characterize the geochemistry of the native groundwater and minerology of the different aquifers. However, in the future, when advanced treated water becomes available, the utility can use the injection test well to verify injection rates and actual feedwater compatibility, supplementing the results obtained from the pumping tests at the injection test well.

4.8.1 Aquifer Tests

Aquifer testing in the form of pumping tests should be performed to assess well efficiency and the hydraulic characteristics of the aquifers, and to evaluate the vertical flow and water quality profile within the well screen interval. Aquifer testing should include the following:

- Background testing: Static water levels should be continuously recorded for at least 1 week prior to conducting the aquifer testing to establish baseline conditions in and around the Project.

- Step-drawdown testing: A step-drawdown pumping test should be performed at four to five different pumping rates for durations of up to 3 hours per step. For planning purposes, the pumping rates for step-drawdown testing should cover a range of approximately 1,000 to 4,000 gpm.
- Constant-rate testing: A constant-rate pumping test should be performed for at least 72 hours at the highest sustainable pumping rate, as determined from the step-drawdown test results. A recovery test should be conducted for a duration generally equal to the pumping duration or when water levels recover to 95% of the original static water level.
- Flowmeter (spinner) survey: A spinner survey should be conducted near the end of the pumping period for the constant-rate test to evaluate the incremental flow contribution from each screen interval.

Water level data should be collected using data logging pressure transducers from the injection test well and in all well casings from the newly installed monitoring wells. Nearby WRD deep, nested groundwater monitoring wells should also be used and may include Huntington Park-1, Los Angeles 1, and Los Angeles 4. The wells already contain pressure transducers, so field staff should coordinate directly with WRD to adjust data logging frequency and obtain water level data from the testing period.

It is possible that pumping from nearby water supply wells could influence water levels in the pumping and observation wells during testing. To the extent practical, the Project should coordinate with nearby pumpers to cease pumping during aquifer testing activities. If pumping operations cannot be temporarily stopped, groundwater production records should be obtained for all nearby wells to evaluate water level responses observed during testing and to potentially incorporate them in the analysis of test data. If feasible, pressure transducers should be installed in nearby water supply wells to accurately document potential hydraulic response to pumping activities at the injection test well.

4.8.2 Flow Profiling

If the screen assembly spans more than one aquifer or formation, the screen length in the injection test well exceeds 100 feet, or the screen assembly contains more than two intervals separated by blanks, the Contractor should conduct a survey to map the baseline flow profile in the new well. The survey could be accomplished using a flowmeter (spinner) tool or an approach like the USGS's tracer-pulse method (USGS 1999). The Contractor should provide an analysis of the spinner survey data that presents the cumulative flow throughout the well screened interval from the bottom (zero flow) to the top (maximum flow), the zonal contributions to the total production, and the vertical fluid velocity profile in the well. Summaries of the two survey methods are provided below.

4.8.2.1 Flowmeter (Spinner) Survey

Most sources indicate that a spinner-type flowmeter survey requires a minimum vertical flow velocity of 10 feet per minute (ft/min) to initiate spinning of the impeller. However, vertical velocities 5 to 10 times the minimum work best to improve deflection and sensitivity on the log (Keys and MacCary 1985, Crowder and Mitchell 2002). Given the minimal space between the pumping equipment and the injection test well casing, the Contractor should install a small-diameter temporary access tube that is strapped to the pump column and terminates below the pump intake to access the well screen interval.

The baseline flowmeter surveys should consist of obtaining vertical velocities while running the tool down through the well screen interval (down runs) and with the spinner tool hanging stationary (stop counts) under pumping conditions in the well as follows:

- A survey run down through the screen assembly during the constant-rate pumping test at three different line speeds ranging between approximately 20 and 60 ft/min.

- A survey consisting of measurements conducted with the spinner tool hanging stationary in the well (stop counts) with the pump producing at its maximum capacity. The survey should be started at a depth equivalent to 100 feet above the top of the screen. Flow velocities should be measured at 20-foot intervals in the blank well casing and at every 5-foot interval inside the screen assembly.

4.8.2.2 Tracer-Pulse Method

The tracer-pulse method involves injecting a tracer into the well under pumping conditions at sequentially deeper depths and measuring the time required for the tracer to be detected at the surface. Rhodamine dye is often used as the tracer because it is NSF 60 compliant, and the peak dye concentration can easily be detected with a fluorometer connected to the sample discharge port at the wellhead. Profiling should consist of dye injections at depths distributed evenly across the screened intervals, with multiple injections at each depth to allow for averaging the associated travel times. The dynamic flow profile can then be calculated using the tracer travel times as follows:

- The average flow velocity at each injection depth can be calculated by dividing the distance between adjacent injection depths by the difference in their travel times. The cumulative flow is then calculated for each depth interval by multiplying average velocity by the cross-sectional area of the well casing.
- The flow contribution from each interval between injection depths is calculated by taking the difference in cumulative flow measured at each injection depth. The percent of the total flow is calculated by dividing the average discharge rate at the wellhead by the flow contribution from each interval.

4.9 Water Quality Testing

Water quality samples should be collected at various phases of the field activities to inform final well designs, conduct geochemical compatibility evaluations, and inform future planning and permitting activities. All water quality samples should be submitted under chain of custody to a California state-certified laboratory. The water quality sampling activities at the monitoring wells and injection test well are described in this section.

4.9.1 Monitoring Well Sampling

Water quality samples may be collected from each monitoring well at the completion of the pumping phase of well development to assist in waste classification or discharge permit compliance. Baseline water quality samples should be collected from each monitoring well following an equilibrium period of approximately 1 month after developing the well. Monitoring well samples should be analyzed for the field and laboratory chemistry parameters in Table 4. The sample results will support the evaluation of geochemical compatibility, as well as emerging and other anthropogenic contaminants, such as hexavalent chromium, perchlorate, and VOCs; contaminants affecting groundwater quality locally; and other water quality parameters that may be required to comply with discharge permits.

Additional water quality samples should be collected from each monitoring well approximately quarterly for 1 year. These samples should be submitted for the same list of analyses as baseline samples to confirm the water quality data and to evaluate seasonal variability. Groundwater sampling should be conducted using an electric submersible pump to remove three well casing volumes prior to sample collection.

4.9.2 Injection Test Well Sampling

Water quality samples should be collected from the injection test well during well development, pumping tests, and subsequent packer testing, as follows:

- Well development:
  - A representative sample should be collected from the well development discharge early in the mechanical phase of development. This sample should be submitted for all constituents required to comply with discharge permits, as well as any contaminants that may have been detected in monitoring well samples.
- Constant-rate pumping test:
  - A wellhead sample should be collected near the end of the 72-hour constant-rate pumping test. The sample should be collected after steady-state drawdown conditions have been achieved in the well and before introducing equipment for the flowmeter survey. The wellhead samples should be submitted for:
    - The list of water quality parameters in Table 4
    - The geochemical compatibility evolution, as well as emerging and other anthropogenic contaminants, such as hexavalent chromium, perchlorate, PFAS, 1,4-dioxane, 1,2,3-TCP, and VOCs, which are known to be present in regional groundwater
    - Other water quality parameters that may be required to comply with discharge permits
- Packer testing:
  - If the screen assembly spans more than one aquifer/formation, the screen length in the injection test well exceeds 100 feet, or the screen assembly contains more than two intervals separated by blanks, the Contractor should conduct packer tests in intervals deemed appropriate by the Project geologist.
  - After the pumping tests have been completed and the test pump has been removed, a submersible pump equipped with a straddle packer system consisting of inflatable packers above and below the pump should be used to characterize the vertical variability in the well screen interval for the key water quality parameters in Table 4.
  - The length between the packers should allow for positioning them against the blank section of well casing or at collars between individual pieces of well casing. After isolating each discrete interval of the well screen, the Contractor should conduct a drawdown test that lasts for 4 hours for each test interval at constant pumping rates that range from 50 to 90 gpm. After turning off the pump, the Contractor should measure recovering water levels until they approach 90% of the static level.
  - The Contractor should install pressure transducers in the test interval, above the test interval and below the test interval, to record water levels during the drawdown and recovery portion of each test. Sampling personnel (that is, the Project geologist or the Contractor) should measure important field chemistry parameters over the duration of each packer test and should collect a sample for water quality analysis at the end (Table 4).

4.10 Final Well Surveys

After removing the test pump, the Contractor should conduct video and gyroscopic surveys in the injection test well, and a land survey for the injection test well and nested monitoring well(s).

- Video survey:
  - A video survey should be performed to assess the condition of the injection test well; document screen intervals; and confirm that the casing joints are flush, no voids are present in the filter pack, and no damage occurred during well construction, development, or testing activities.
- Gyroscopic survey:
  - After the video survey, a gyroscopic survey should be conducted to evaluate the plumbness and alignment of the well casing. Plumbness and alignment data should be evaluated using methods in AWWA Standard A100-20, *Water Wells* (July 1, 2020), to ensure that the completed well meets AWWA guidelines and downhole equipment, such as backflush pumps, can be lowered to the desired depth without bending or inducing loading stresses against the casing. To ensure final acceptance of the injection test well, test results should meet the requirements of AWWA A100-20 to a depth equivalent to 5 feet above the top of the shallowest screen.
- Land survey:
  - After the wells have been fully developed and tested, and surface completions have been constructed, a land survey should be performed to provide coordinates and elevations for the newly installed wells. Horizontal data (x and y coordinates) should be reported in the California State Plane Coordinate System, in the North American Datum of 1983, U.S. Survey Feet, in the zone in which the Project site lies within. Vertical data (elevations) should be surveyed for ground level and the top of casing for each well, and should be reported on the North American Vertical Datum of 1988 current adjustment.

The results of the video and gyroscopic surveys will inform the well owner on the final acceptance of the injection test well.

4.11 Well Disinfection and Periodic Testing

The injection test well should be disinfected in two stages, once before the test pump is removed after aquifer testing and a second time before capping the well. The two-phase disinfection process will allow for initial disinfection and bacteriological sampling at a high flowrate using the test pump during phase 1, and a final chlorination of the well during phase 2 after the final well surveys and before securing the well. Disinfection activities performed by the Contractor should comply with disinfection procedures in AWWA A100-20 and AWWA Standard C654-13, *Disinfection of Wells* (July 1, 2013).

4.11.1 Phase 1 Disinfection

After completion of aquifer testing and water quality sampling, and before removing the test pump, a sodium hypochlorite solution should be introduced into the well by placement through a tremie, starting at the bottom and being continuously introduced as the tremie is withdrawn. The sodium hypochlorite solution should be worked throughout the water column and into the filter pack by surging (turning the pump on and off) while recirculating a portion of pump discharge. The chlorine residual of this water shall display a minimum residual concentration of 50 parts per million (ppm), and the well should rest for 12 to 24 hours following emplacement of the residual. After 24 hours, the Contractor should pump the well until residual concentrations fall below MDLs. After detecting no residual, the Contractor should pump the well for 15 minutes, followed by sampling for bacteriological analysis, including:

- Total coliform bacteria
- Fecal coliform bacteria
- Heterotrophic plate count

If the sampling results show the presence of bacteria, the well has not been adequately disinfected, and the preceding disinfection procedures should be repeated until analysis for the three bacterial constituents returns negative results. After a passing bacteriological analysis, the test pump will be removed.

4.11.2 Phase 2 Disinfection

After completing the final well surveys described in Section 4.10, the injection test well should be disinfected prior to its capping. A sodium hypochlorite solution should be introduced into the well by placement through a tremie, a double-swab tool, or a nylon brush to achieve a minimum chlorine residual of 50 ppm. Immediately after the chlorine solution has been introduced, the water column should be thoroughly agitated using the double-swab tool or nylon brush. The chlorine residual of the water in the well should be verified using a sampling bailer and, if the residual chlorine concentration is less than 50 ppm, the preceding procedures should be repeated. After final disinfection, the Contractor should cover the well casing and all accessory tubing openings to prevent entry into the well by unauthorized personnel and the introduction of foreign material or contaminating substances.

4.11.3 Periodic Testing

As discussed in Section 4.12, the injection test well may sit idle for several years before being commissioned as an injection well or potentially an extraction well. Regular inspection and testing will assist in preventing biofilm growth and ensuring water quality during this idle period. Regular testing should consist of removing any packer system that isolates screened intervals, installing a submersible pump to flush the well, followed by disinfection of the well using the procedures described for Phase 2 disinfection. Regular flushing and disinfection should initially be performed annually, with the frequency of these events being adjusted based on the results of each event.

4.12 Securing Injection Test Well

The work plan anticipates that the injection test well may sit idle for several years before the utility brings advanced treated water to the site for recharge or construction of full-scale facilities. The final well casing and all accessory tubing should extend a minimum of 2 feet above grade to allow for potential future equipping the injection test well as a water supply well. Until the well is equipped for injection or extraction, the well casing should be equipped with a locking lid that secures the well casing and allows access to the well for water levels or periodic testing and, at a minimum, a concrete pad with protective bollards should be installed around the well casing.

Additionally, the Project team should consider the potential for vertical flow in the well and potential mixing of undesirable water quality or contamination from a given screened interval to another interval within the injection test well. As a precaution, provisions should be made to isolate each individual screen section during the period the well remains idle. Isolation of individual screen sections could be accomplished by installing a packer system with packers positioned in each of the blank casing sections below the top of the perforated interval. Reviewing hydraulic head data (water levels) and depth-specific water quality results from monitoring well and injection test well sampling will assist in identifying intervals that may have problematic water quality or head conditions that could induce undesirable mixing of waters within the injection test well.

4.13 Borehole and Well Destruction

The work plan anticipates the potential for destroying a pilot borehole, monitoring well, or injection test well for reasons including causes such as:

- Loss of tools
- Damage to the well, borehole, or well misalignment
- Unfavorable transmissivity at a location
- Unacceptable water quality

Destroying borings or wells should proceed in accordance with applicable state well standards (DWR 1981, 1991) and Los Angeles County Department of Public Health, Environmental Health, Drinking Water Program requirements.

5. Data Evaluation

Data collected during the injection test wellfield program will be used to refine the understanding of the local geology, hydrogeology, and water quality; assist in determining the geochemical compatibility of the future Hyperion water, groundwater, and minerology of the receiving aquifer; and make recommendations for future pilot injection equipment.

5.1 Hydrogeologic Characterization

5.1.1 Lithologic Characterization

Lithologic characterization of the subsurface at the injection test well site will be based on visual observation and description of drill cuttings and core samples retrieved from SimulProbe samples, as well as the results of mineralogical and physical testing conducted on cutting samples. Visual characterization should include describing the materials encountered during drilling using the USCS in accordance with ASTM D2488, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)*. The descriptions of cuttings should include the following:

- USCS soil name with appropriate modifiers
- Group symbol
- Color (name and Munsell chart code)
- Relative density or consistency
- Grain sizes and their relative percentages
- Angularity, mineralogy, degree of weathering, or other descriptors

The lithology should be characterized with consideration of the results of geophysical logging. The depth corresponding to major changes in lithology (for example, from coarse sand interval to fine-grained silt or clay) should be compared to the geophysical logs to identify any significant discrepancies. In the event that there are discrepancies in major geologic contacts, the depth indicated on the geophysical logs should be considered more reliable.

Laboratory analysis of cuttings or core will provide information related to the chemical and physical properties of the aquifer units encountered during drilling, such as grain size distribution and the elemental composition of samples, including the type and amount of minerals that compose aquifer sands, where injection should be focused, and confining beds that are proximal to the receiving aquifer(s). However, core samples should only be used for other analyses such as petrophysical analysis to define permeability and porosity and petrographic analyses used in characterizing the interstitial mineralogy and porosity structure.

5.1.2 Hydrostratigraphic Characterization

The previously described lithologic characterization and the geophysical logs from the pilot boreholes should be used to correlate the observations at the injection test well site to the regional hydrostratigraphy, including assigning each monitoring well and the injection test well screen intervals to the corresponding local aquifer unit (including Lynwood, Silverado, and Sunnyside) and providing correlation to the USGS chronostratigraphic units.

WRD has adopted the advanced geophysical logging as a standard for deep regional monitoring wells in its service area, including the Project area, as the advanced logging suite provides additional parameters for correlating regionally extensive hydrogeologic units. In additional to the added value of correlating regional hydrostratigraphic units, advanced geophysical logging would provide additional parameters (such as estimated porosity, salinity, and hydraulic conductivity) that are useful in designing the monitoring well and injection test well, and would assist in evaluating potential major changes in water quality and aquifer properties.

The apparent thickness of each unit along with the corresponding lithology, degree of heterogeneity, and presence of significant fine-grained sequences should be noted. Water level data from the nested monitoring wells should be used to evaluate the potential presence, magnitude, and direction of vertical hydraulic gradients at the site. Additional information related to the interconnectedness of the aquifer units should be evaluated using the results of aquifer testing as described herein.

5.1.3 Aquifer Hydraulics

Results of isolated aquifer zone testing completed in the pilot borehole(s) and aquifer testing completed in the constructed well will be important for developing final well designs and evaluating future operation of injection facilities. Data evaluation related to each phase of testing is summarized in this section.

5.1.3.1 Isolated Aquifer Zone Test Data Analysis

Data collected during isolated aquifer zone testing will include static water levels, drawdown data during pumping (at a given discharge rate), and field and laboratory water quality results. Data analysis for the isolated aquifer zone tests should include the following:

- Evaluate vertical gradients by comparing static water level data from each of the zones. This analysis will assist in identifying the presence and approximate depth interval(s) of aquitards, determine the potential vertical movement of water within a well completed across multiple zone test intervals, and ultimately assist with selecting the depth intervals to include in the final monitoring and injection test well designs.
- Derive preliminary estimates of depth-discrete transmissivity or hydraulic conductivity by analyzing drawdown and recovery data recorded during zone testing. Then compare the hydraulic coefficients obtained from zone testing to estimates provided in the advanced geophysical logging, if performed, and refine the estimated transmissivity of a completed well over a given interval.
- Estimate the specific capacity of a given zone using the pumping rate and drawdown data recorded during zone testing. The specific capacity of each zone will provide an additional mechanism to compare the productivity between zones and, in conjunction with the water quality results, estimate the wellhead concentration for a well-constructed across multiple zone test intervals. Specific capacity can also provide a surrogate method for estimating transmissivity.

The results of this analysis will provide the most value in selecting intervals to include (or exclude) in the final injection test well design. Analysis of the pumping tests performed on the injection test well (described in the following section) should be considered more appropriate for assessing the feasibility, design, and operational considerations for the full-scale injection wellfield. If packer testing is employed in the completed injection test well, a similar approach described above may be used to analyze the packer test data and provide an additional means to estimate depth-discrete aquifer properties.

5.1.3.2 Aquifer Test Analysis

The results of the aquifer testing at the injection test well will provide valuable information to estimate the injection capacity of the well and aquifer coefficients to locally refine the groundwater flow model and assist in designing the full-scale wellfield for the Project. Drawdown data measured in the nested monitoring wells and in the injection test well during step-drawdown and constant-rate pumping tests should be analyzed using peer-reviewed analytical solutions for aquifer test analysis and may be facilitated using publicly available aquifer test analysis software (including AquiferWin32, AQTESOLV, and MLU). Flow profiling will provide the incremental flow contribution to the total discharge for various depth intervals (aquifer or chronostratigraphic units) within the screened interval of the well.

Data analysis for the aquifer tests should include the following:

- Analysis of step-drawdown data from the injection test well will provide data to estimate the aquifer losses, well losses, and well efficiency under pumping conditions, and as a function of pumping rate.
- Drawdown data collected at the nested monitoring wells during the constant-rate test, and the estimated flow contribution from the corresponding depth intervals at the injection test well, should be used to perform time-drawdown analysis to estimate transmissivity and storage coefficients for individual aquifer/chronostratigraphic units, as well as to estimate the composite properties for the full-screened section of the well.
- If responses to pumping are observed in the WRD regional monitoring wells or other wells, such as MHMW-01 at the Manhattan Wellfield, time drawdown and distance drawdown analyses should be performed to estimate transmissivity and storage coefficients that may be more representative of the average values over a larger geographic area.

Results from the aquifer test analyses should be summarized by well, aquifer unit, and chronostratigraphic unit. The individual unit thicknesses identified in the hydrostratigraphic characterization should be used to calculate the average hydraulic conductivity for each unit. The results of the analysis will assist in determining the hydraulic viability of injecting water into various aquifers and sequences, including estimating the injectivity as a function of the lithology, specific capacity, and transmissivity of each unit. The hydraulic viability coupled with the geochemical compatibility evaluation described in the following section will provide a basis for which units should be targeted for injection for the full-scale wellfield.

Because the groundwater flow model layering is consistent with the USGS chronostratigraphic sequences, the estimated aquifer coefficients from the testing can be compared to the values used in the groundwater flow model and can provide a basis for locally updating these values. If the results of drilling and testing warrant an update to the parameters or layering in the groundwater flow model, additional modeling is recommended to verify the results of the MPH and Title 22 evaluations that were initially conducted for the Project.

5.2 Geochemical Compatibility

Reactions during the mixing of injected recharge water (recharge or recharge water) and native groundwater, reactions between the recharge and reactive minerals in the aquifer matrix, or reactions that damage clay minerals can negatively influence the operation of injection wells by:

- Clogging the injection well and reducing its performance
- Damaging the intrinsic permeability of the accepting aquifer

- Leaching undesirable constituents, degrading the quality of recharge migrating in the aquifer, and creating environmental and regulatory implications for recovering the water at nearby production wells

Evaluating the geochemical compatibility of MAR using injection wells to recharge advanced treated water from Hyperion or other sources in the Los Angeles Forebay represents a major component of evaluating the viability of full-scale injection in the area and determining which aquifer units should be targeted for injection. This subsection discusses an approach for characterizing the geochemical compatibility between recharge, native groundwater, and aquifer mineralogy, and identifies potential fatal flaws related to the long-term viability of injection using data collected during the injection test well and nested monitoring well installation.

5.2.1 Water Quality and Aquifer Minerology Characterization

For MAR projects, geochemical compatibility evaluations rely on available water quality data for recharge water, native groundwater, and minerology of the receiving aquifer. The following summarizes the relevant data to assess the geochemical compatibility.

- Recharge water: The advanced treated water quality from Hyperion that represents the proposed recharge source for the Project will not become available at the site for more than 15 years. Therefore, geochemical compatibility evaluations prior to construction of advanced treated water at Hyperion will require mathematically simulating the recharge water quality. The analysis should utilize the current raw water chemistry at Hyperion and simulate the treated water chemistry by applying the expected treatment processes at the treatment plant. Inevitably, mathematical simulation of advanced treated water involves some amount of uncertainty. Therefore, analysts may employ a range of input water quality parameters or different processes to simulate the treated water quality.
- Native groundwater: Native groundwater quality will be available from the injection test well and the associated nested monitoring well(s).
- Aquifer matrix minerology: Data on the minerology of the receiving aquifer(s) will be provided through analysis of soil cuttings or cores collected from the pilot borehole for the nested monitoring well.

The previously noted data should be used for the conventional geochemical analyses and geochemical modeling described in the following subsections.

5.2.2 Conventional Geochemical Analysis

The analytical accuracy of the recharge and native groundwater chemistry data should be examined prior to conducting geochemical analyses. The vetting process should involve examining the cation-anion balance and the relationship between major ions, TDS, and specific conductivity, and assessing the accuracy of trace metal, nutrient, and general water quality concentrations. Typically, total cation and anion concentrations evaluated in milliequivalents per liter should fall within approximately 5% of each other. If the cation-anion concentrations vary by greater than 5%, the data should be qualified when used in the evaluation. Verification of mineralogical analyses may include review of calibration data, laboratory notes, and conventional data validation of ICP MS analyses.

Conventional geochemical analyses should include statistical, graphical, and other plotting techniques that use recharge and groundwater chemistry, and aquifer mineralogy. Such analyses include:

- Methods to describe the predominant ionic species and the relationship between samples should include preparing Piper diagrams and Stiff diagrams, and the use of cation ratios. Piper and Stiff diagrams plot cation and anion equivalent concentrations either as percentages (Piper) or absolute values (Stiff), to graphically display the predominant ionic species and the relationship between samples.

- Oxidation-reduction (redox) diagrams and redox constituent analysis (Jurgens et al. 2009) will inform the redox potential of the water samples. Redox line diagrams and redox constituent analysis help to describe redox conditions in the aquifer based on aqueous analysis. These techniques will assist in evaluating the mobility of metals in the receiving aquifer(s) under changing redox conditions caused by an oxygen-rich recharge water.
- Parametric statistics, correlation coefficients, regression analysis, predominance area diagrams, and phase diagrams will assist in assessing the stability of clays and metal-bearing minerals (including iron, manganese, chromium, aluminum, and arsenic) in the receiving aquifer(s). Phase diagrams will help to assess aqueous and mineral equilibria by plotting the path traversed between dissolved ions and minerals during storage in an aquifer. Publicly available software (PhreePlot, Kinniburgh and Cooper 2011; The Geochemist's Workbench®, Aqueous Solutions LLC 2021; Hydra-Medusa, Puigdomenech 2009) enable the preparation of various types of predominance area and phase diagrams.

5.2.3 Geochemical Modeling

Geochemical modeling should be employed to detect potential fatal flaws to injecting Hyperion water into the receiving aquifers while identifying data gaps that shape the scope of work for additional data collection, testing, and preliminary design activities.

5.2.3.1 Evaluating Recharge and Native Groundwater

The first modeling simulations should be run using the simulated advanced treated water quality from Hyperion and the analytical results from native groundwater samples as input. The modeling involves reacting minerals identified in the aquifer samples with constituents in the recharge water, such as DO, nitrate, dissolved iron, and others. The simulations assist in characterizing the mobility of common trace metals in the accepting aquifer during MAR operations. Once the metals that display greater mobility have been identified, additional modeling should be conducted to test the effectiveness of pretreatment schemes in stabilizing minerals containing these metals in situ. The previously noted modeling analyses should be performed using depth-specific water quality data from the nested monitoring wells and the corresponding depth-specific aquifer mineralogy to evaluate the potential for certain aquifer units/sequences to be particularly problematic from a geochemical standpoint.

5.2.3.2 Mitigating Metals Mobilization

The next phase of modeling involves adding agents to the recharge to precipitate minerals containing the targeted trace metals. Surface complexation functions support the assessment of the adsorption capacity of metal oxide surfaces developed from precipitating iron and manganese minerals. Adsorption often exhibits greater effectiveness in fixing trace metals or stabilizing reactive metal-bearing minerals in situ than precipitation reactions.

The following sequence describes the stepped approach applied to the second phase of modeling:

- React constituents in recharge with native groundwater (mixing) in the presence of aquifer minerals.
- Test pretreatment schemes to stabilize dissolved trace metals and reactive metal-bearing minerals.
- Assess the capacity of metal oxide minerals to adsorb trace metals that are migrating in the aquifer environment.

As with the first phase of modeling, this process should be repeated using data from discrete depth intervals within the screened interval of the injection test well.

5.2.3.3 Stabilizing Clay Minerals

The third modeling step involves evaluating the stability of clay minerals. Site-specific data gathered from the pilot boreholes should be used to simulate clay mineral reactions. The following sequence should be used to test ion exchange conditioning schemes to assess which scheme produces the greatest clay stability:

- Determine the native clay stability.
- Evaluate clay mineral stability after recharge.
- Evaluate conditioning schemes with the addition of di- and trivalent salts.

5.3 Pilot Injection Equipment Recommendations

After determining the sustainable injection rate from the evaluation of aquifer testing data and finishing the geochemical compatibility evaluation, the Project should develop recommendations on downhole, wellhead, and chemical feed equipment, including the following:

- Downhole equipment, such as:
  - Recharge piping to deliver recharge water, including diameter, material, and depth setting
  - Downhole flow control valve specifications to prevent entraining air during active recharge
  - Backflush pumping equipment to remove particulates that accumulate during injection and to maintain injection-specific capacity (injectivity)
  - Access piping for downhole sensors, including pressure transducers
  - Pressure rating for transducers
- Wellhead surface piping, valving, and instrumentation, such as:
  - Pipe diameters and materials to deliver the anticipated injection flows from the future recycled water backbone and for discharging backflush water to a nearby sewer
  - Valving and other wellhead instrumentation to maintain and monitor flows, water levels, and pressure during injection and backflushing
- Chemical feed facilities for:
  - Disinfecting
  - Stabilizing reactive minerals by adjusting the pH, buffering, or oxidant addition or removal
  - Aquifer conditioning to preclude clay dispersion or pretreating recharge to mitigate the release of metals

6. Permits and Approvals

This section provides a brief review of permits that may be applicable to the installation, development, and testing of the nested monitoring wells and injection test well. This section also discusses required permits or regulatory approvals for implementing injection testing activities when Hyperion water becomes available.

The following types of permits or approvals may apply to installation of the injection test well and nested monitoring wells.

- Well permit:
  - Well permit applications will be filed with Los Angeles County Department of Public Health, Environmental Health, Drinking Water Program for nonproduction wells. The permit application should include a written narrative that describes the details of the work and a well diagram that details the depth, size, and thickness of materials used in construction (that is, the casing and screen, the annular seal, and relevant geologic features). The permit should also identify the Contractor who holds the C-57 license for well drilling.
- City permits:
  - City permits may include standard ministerial permits (nondiscretionary), such as encroachment, excavation, and traffic control permits for activities within public roadways and rights-of-way. Temporary pipelines will likely be required for discharge of development and testing water and, potentially, to bring potable water to the site. These activities would require encroachment on the street or public right-of-way and could require excavation to construct a temporary connection point to a sewer or storm drain. Additionally, these activities may alter traffic flow, in which case a traffic control permit would be required.
- Sediment erosion and control plan:
  - Though soil disturbance of 1 or more acres is unlikely during installation and testing of the injection test well and monitoring wells, a Stormwater Pollution Prevention Plan or, at a minimum, best management practices will be required to manage potential stormwater runoff from the construction site.
- Noise variance:
  - A request to the Los Angeles Board of Police Commissioners for a variance to Los Angeles Municipal Code, Section 41.40, Noise Due to Construction, Excavation Work – When Prohibited, will be required to receive permission for nighttime construction.
- Discharge permit:
  - Water generated during development and testing of the injection test well and potentially the nested monitoring wells will be produced at rates that prohibit storage and offsite disposal. This groundwater should either be discharged to sanitary or storm sewers that require one of the following permits:
    - An Industrial Wastewater Permit from City of Los Angeles, Bureau of Sanitation, Industrial Waste Management Division, will be required if discharging water to the sewer system. The permit application will require a sewer capacity availability request to the Bureau of Sanitation to review the proposed discharge rates and duration. Discharging to the sewer system may be an option for water generated during zone testing, well development, and groundwater sampling of the nested monitoring wells; however, discharge rates from the injection test well will likely exceed the available capacity to the sewer system.
    - A National Pollutant Discharge Elimination System (NPDES) permit from the Los Angeles Regional Water Quality Control Board will be required for discharges to surface waters via the storm sewer. Consistent with discharges during installation of the recent production wells at the Manhattan Wellfield, discharge may occur under Order No. R4-2003-0108, Waste Discharge Requirements for Discharges of Groundwater from Potable Water Supply Wells to Surface Waters in Coastal Watersheds of Los Angeles and Ventura Counties (General NPDES Permit No. CAG994005). Though the site for injection test well activities has not been

selected, based on the general area recommended for the wells, discharge flows will likely drain to Ballona Creek.

- When the Hyperion advanced treated water and conveyance to the site have been constructed, additional permits, approvals, or areas of compliance will be required to inject recycled water for the Project. Pending any advancement of regulations for direct potable reuse, additional permits and approvals may include:
  - Title 22 of the California Code of Regulations:
    - Prepare a Title 22 engineering report and receive approval from the California State Water Resources Control Board to recharge recycled water.
  - Antidegradation Policy:
    - Demonstrate compliance with the California Antidegradation Policy (SWRCB 1968).
  - U.S. Environmental Protection Agency Underground Injection Control:
    - Comply with all federal rules and regulations related to Class V injection wells.

7. Implementation and Testing Schedule

The preliminary implementation and testing schedule for the activities in the work plan appears in Attachment 5. The schedule is considered to be conceptual in nature and is contingent on securing a parcel or an agreement specific to the location for installation of the wells. Property acquisition will likely form the first task on the critical path for installation and testing of the injection test well.

The following major phases of work would be completed, as follows (duration/completion date):

- Property acquisition (12 months/Fourth Quarter of Year 1)
- Permitting (5 months/First Quarter of Year 2)
- Bid documents and award of drilling contract (5 months/Second Quarter of Year 2)
- Field implementation (12 months/Second Quarter of Year 3)
- Data evaluation (5 months/Third Quarter of Year 3)
- Recommendations (3 months/Fourth Quarter of Year 3)

The work plan anticipates that the drilling, installation, development, and testing of the injection test well and associated monitoring wells, and the associated data evaluations, should require approximately 3 years to complete. This schedule and duration assume that a single drilling contractor completes the work, with injection test well drilling, construction, and mechanical development executed on a 24/7 schedule, while other injection test well development, testing and monitoring, well drilling, installation, and development activities should occur on a 5-days-per-week, 12-hours-per-day schedule.

8. References

Aqueous Solutions LLC. 2021 Geochemist's Workbench (GWB), Champaign, Illinois.

California Department of Water Resources (DWR). 1981. *Water Well Standards: State of California, Bulletin 74-81*. December.

California Department of Water Resources (DWR). 1991. *Water Well Standards: State of California, Bulletin 74-90*. June.

California State Water Resources Control Board (SWRCB). 1968. *Resolution No. 68-16 Statement of Policy with Respect to Maintaining High Quality of Waters in California*. October 28.

Crowder, R. E., and K. Mitchell. 2002. *Spinner Flowmeter Logging A Combination of Borehole Geophysics and Hydraulics*. Arizona Hydrological Society's Well Design and Installation Workshop. Phoenix, Arizona.

Jurgens, B. C., P. B. McMahon, F. H. Chapelle, and S. M. Eberts. 2009. *An Excel® workbook for identifying redox processes in ground water*. U.S. Geological Survey Open-File Report 2009–1004. 8 p.

Keys, W. S., and MacCary, M. 1985. "Application of Borehole Geophysics to Water Resources Investigations." *Techniques of Water Resources-Investigations of the United States Geological Survey*. Book 2 - Collection of Environmental Data. Alexandria, Virginia.

Kinniburgh, D. and D.M. Cooper. 2011. PhreePlot: Creating graphical output with PHREEQC. June.

Los Angeles Department of Water and Power (LADWP). 2021. Data transmittal of pumping test results from Manhattan wells. June 2.

National Sanitation Foundation (NSF) International. 2021. NSF/ANSI 60 – 2021, Drinking Water Treatment Chemicals – Health Effects.

Paulinski, S. 2021. *Development of a Groundwater-Simulation Model in the Los Angeles Coastal Plain, Los Angeles County, California*. U.S. Geological Survey Scientific Investigations Report 2021-5088. https://doi.org/10.3133/sir20215088.

Puigdomenech, I. 2009. Hydra-Medusa: Make Equilibrium Diagrams Using Sophisticated Diagrams, Royal Institute of Technology, Stockholm, Sweden.

Pyne, R. G. D. 1995. *Aquifer Storage Recovery: A Guide to Groundwater Recharge Through Wells*. New York: Lewis Publishers.

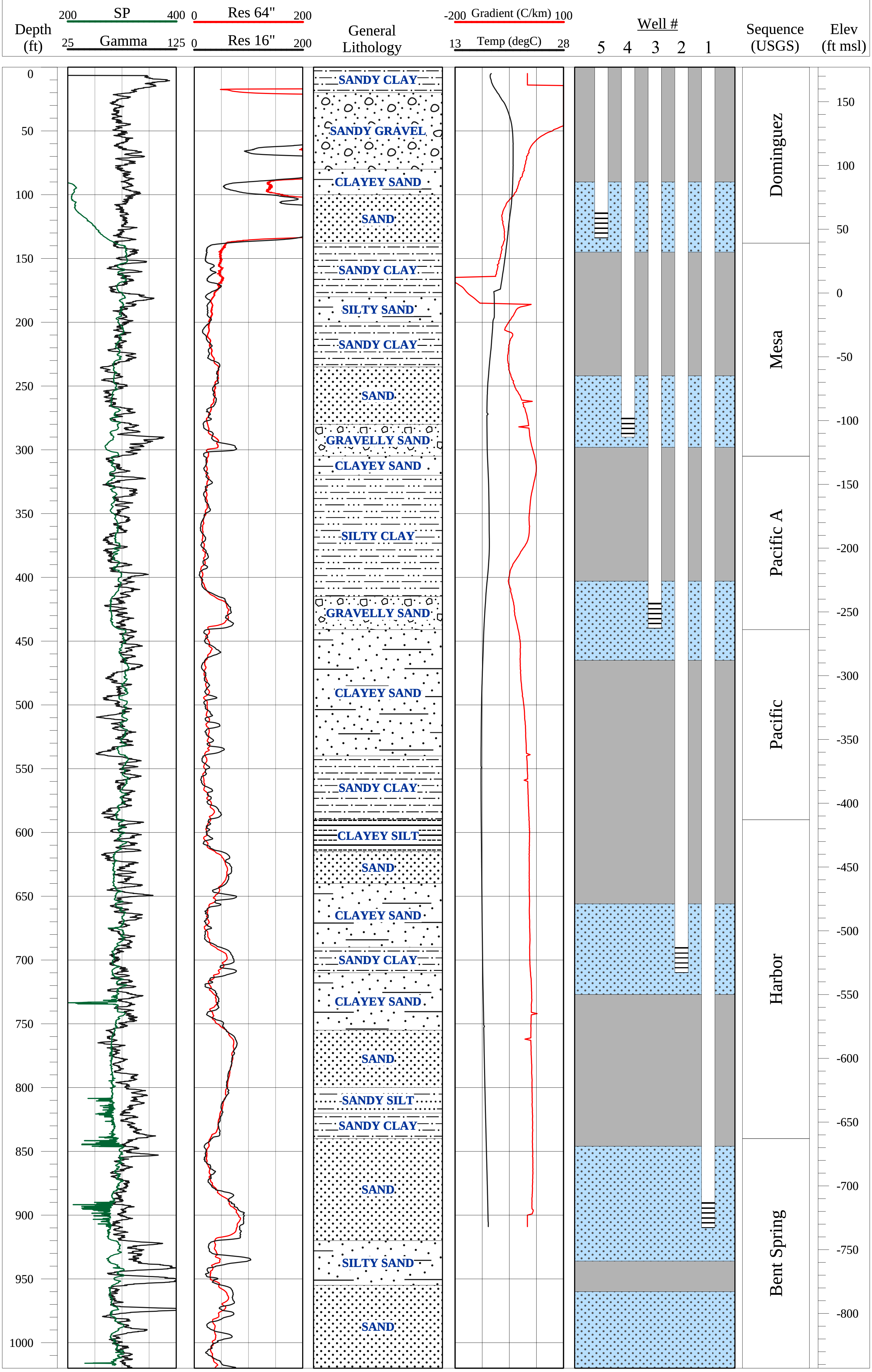
Stuyfzand, P. J., and J. Osma. 2019. "Clogging Issues with Aquifer Storage and Recovery of Reclaimed Water in the Brackish Werribee Aquifer, Melbourne, Australia." *Water (Switzerland)*. Vol. 11, No. 9). p. 1807.

U.S. Geological Survey (USGS). 1999. U.S. Geological Survey Combined Well-Bore Flow and Depth-Dependent Water Sampler. October.

Water Replenishment District of Southern California (WRD). 2021. *Regional Groundwater Monitoring Report Water Year 2019-2020, Central and West Coast Basins, Los Angeles County, California*. March.

Attachment 1
Strater® Logs for
WRD Regional Nested Monitoring Wells

HUNTINGTON PARK #1



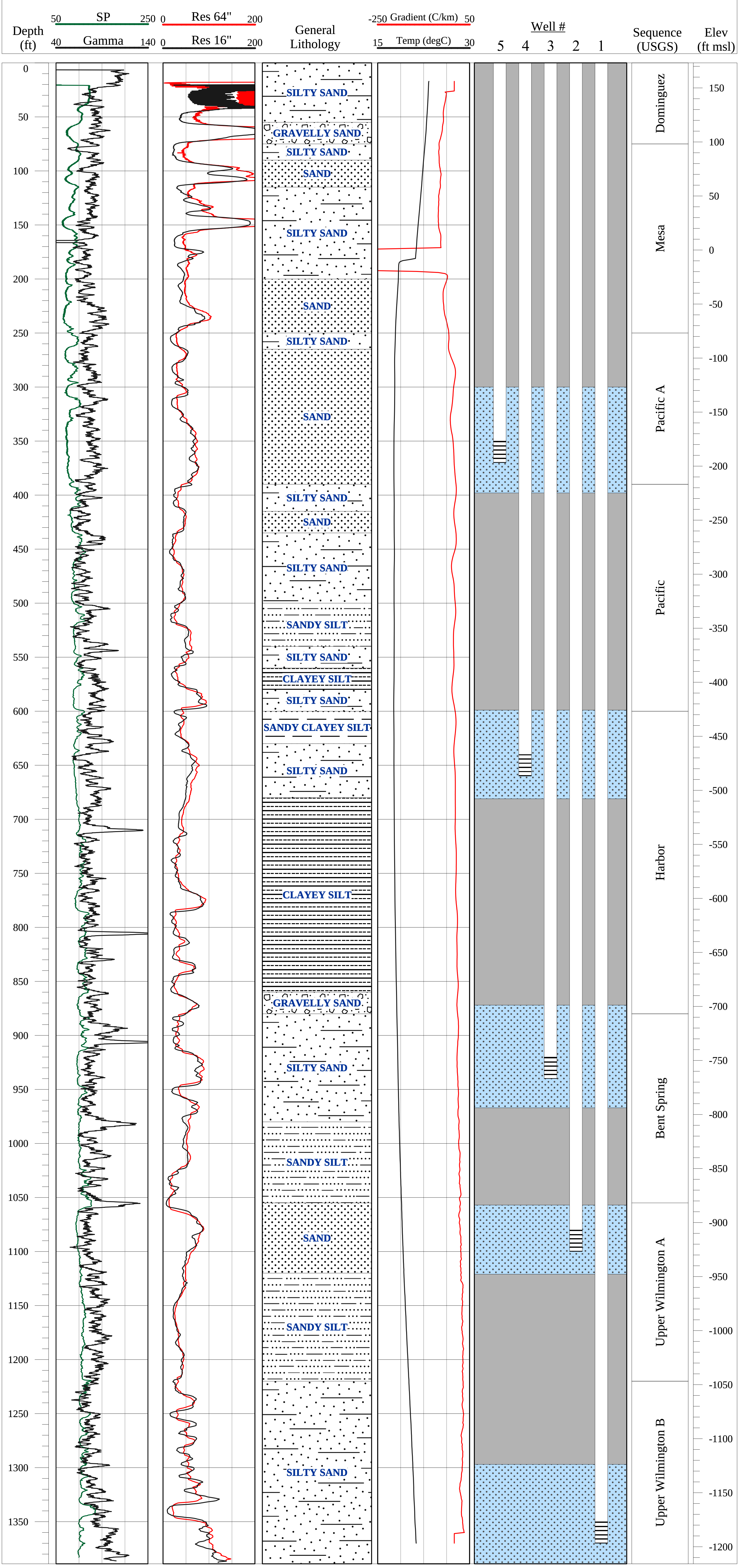
Date Completed: March 1996

Borehole Depth: 1,020 ft

Land Surface Elevation: 177.08 ft

Well Log Revised: 05/03/18

LOS ANGELES #1



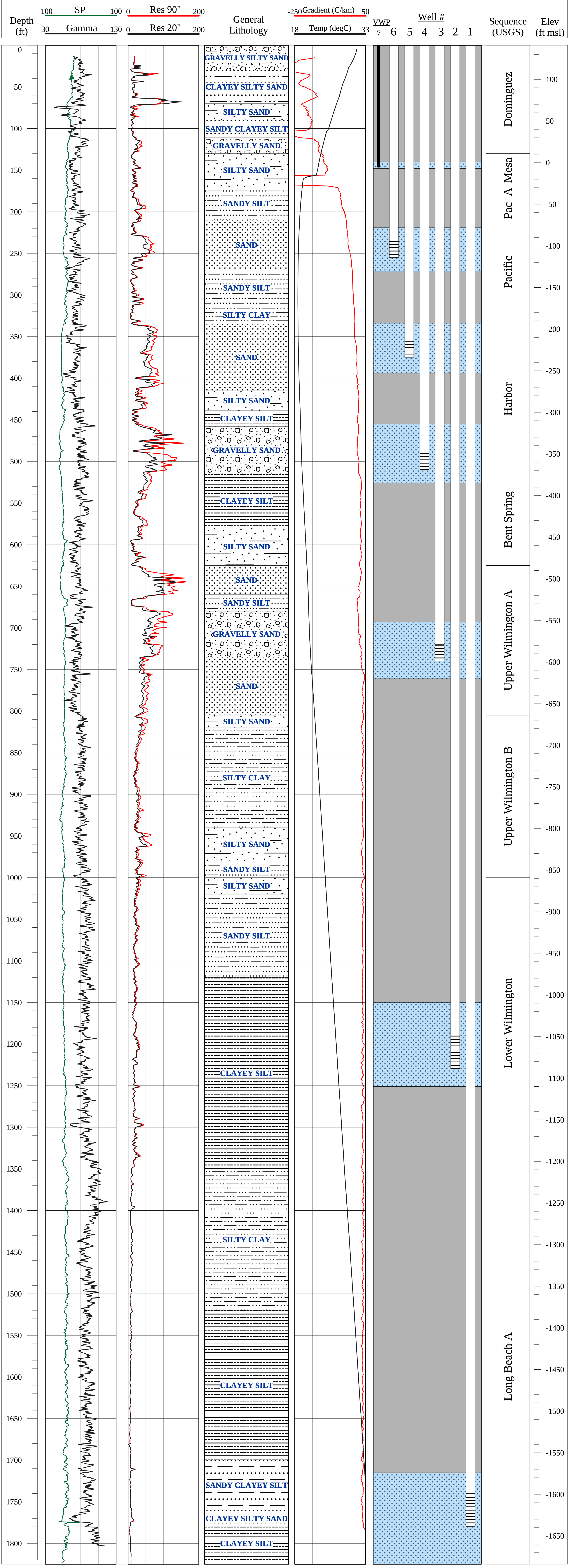
Date Completed: September 1999

Borehole Depth: 1,389 ft

Land Surface Elevation: 173.19 ft

Well Log Revised: 05/03/18

LOS ANGELES #4



Date Completed: May 2012

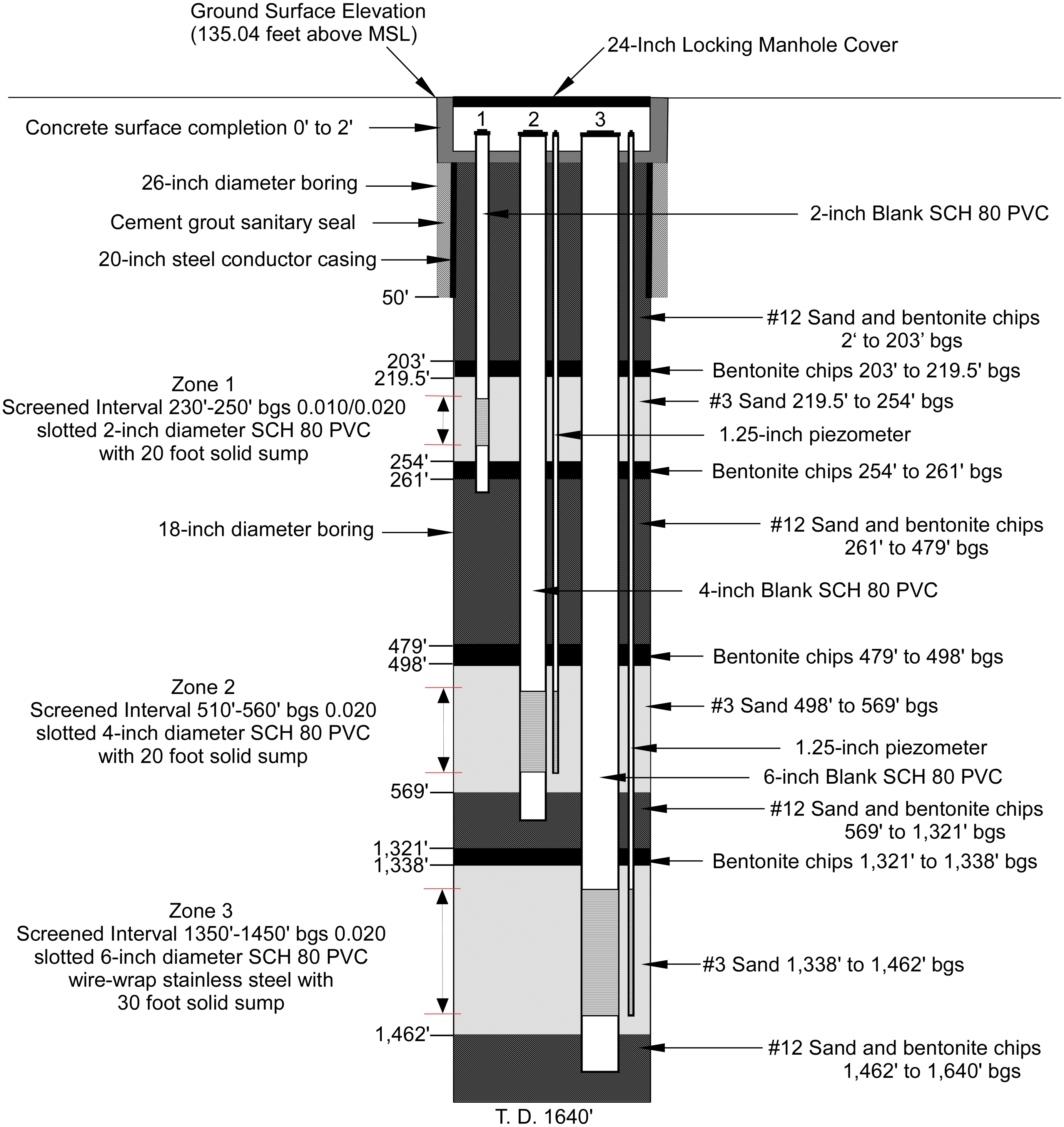
Borehole Depth: 1,825 ft

Land Surface Elevation: 141 ft

Well Log Revised: 04/24/18

Attachment 2
Well Construction Diagrams and Data Summaries for Manhattan Wells

MH-MW-01A



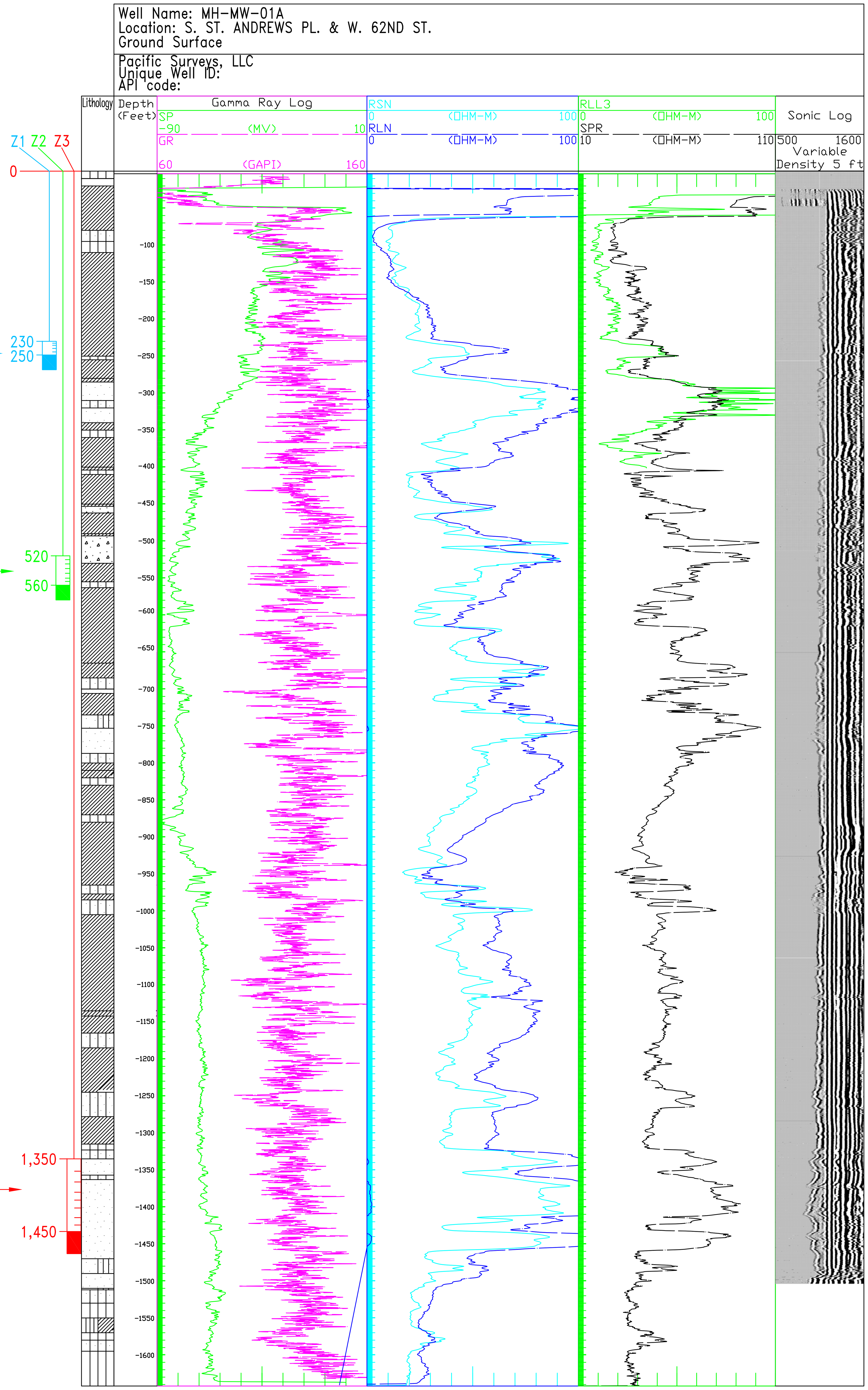
Monitoring Well Construction Diagram MH-MW-01A Manhattan Well Field Los Angeles, California	Leighton	**602858-008**
		Not To Scale
		September, 2015
		Figure 4

PLATE 1	**MH-MW-01A** MANHATTAN WELL FIELD LOS ANGELES, CALIFORNIA	
Leighton	Proj: 602858-005	Eng/Geol: JAR
	Scale: 1"=100'	Date: 01/2015

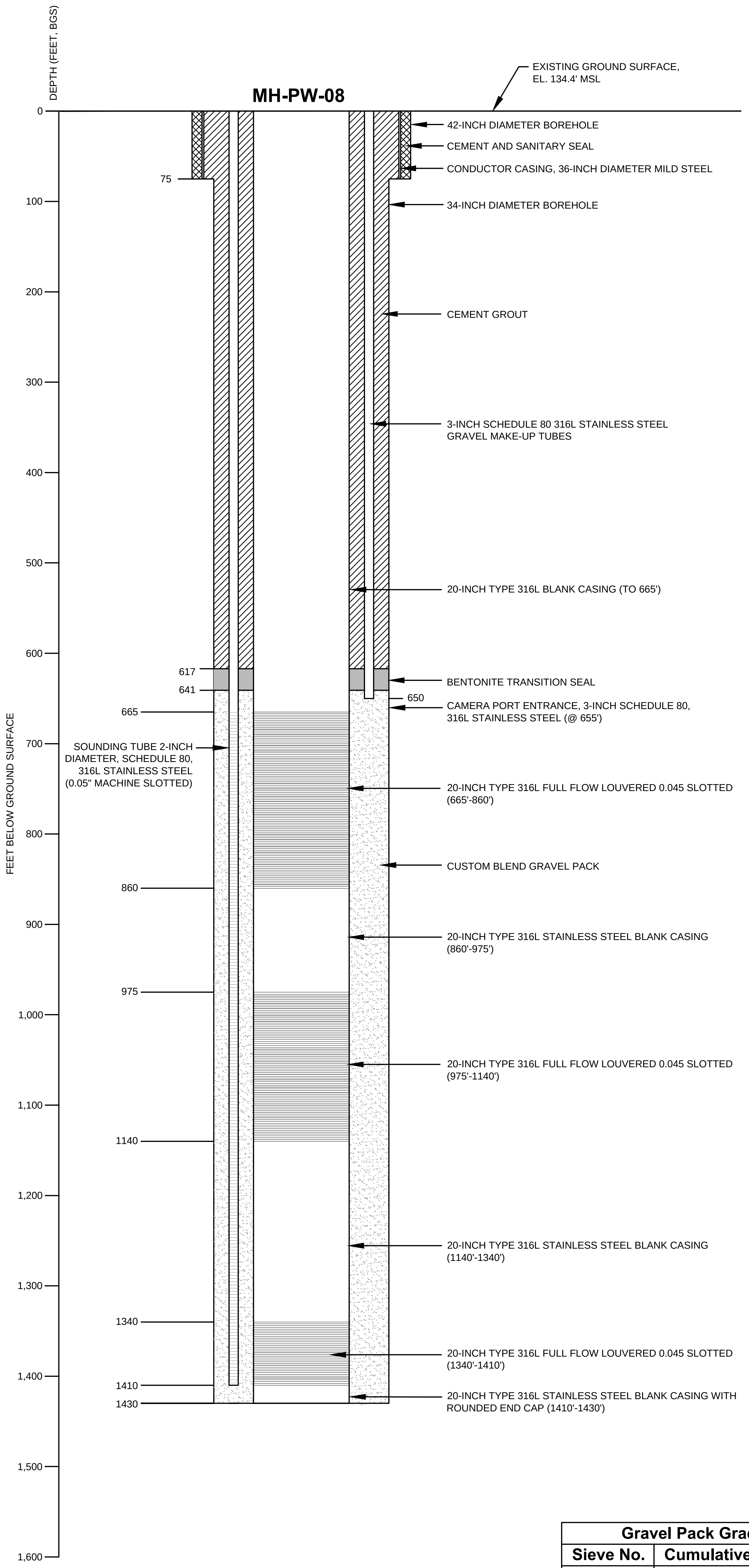
Zone 1–Upper Gage Formation–Aquiter
Screened Interval 230'–250'
0.010/0.020 Slotted 2–Inch Diameter
SCH 80 PVC. 20–foot Solid Sump

Zone 2–Lynnwood Formation–Aquiter
Screened Interval 510'–560'
.020 Slotted 4–Inch Diameter
SCH 80 PVC. 20–foot Solid Sump

Zone 3–Upper San Pedro Formation
Screened Interval 1,350'–1,450'
.020 Slotted 6–Inch Diameter
SCH 80 PVC.
Wire Wrap–Stainless Steel.
30–foot Solid Sump



Bottom of Pilot Borehole
at 1,640 Feet Below
Ground Surface



Gravel Pack Gradation Blend

Sieve No.	Cumulative Percent Passing	
	Low	High
#4	90	100
#8	76	90
#10	70	84
#12	51	65
#16	11	25
#20	3	17
#30	0	5

Project: 602858-008	Eng/Geol: CK/JAR	WELL CONSTRUCTION DIAGRAM MH-PW-08 MANHATTAN WELL FIELD LOS ANGELES, CALIFORNIA	Figure 4
Scale: NTS	Date: September 2015		Leighton
Reference: Author: MAM			

PLATE 1

Leighton

MH-PW-08 DATA SUMMARY

MANHATTAN WELL FIELD
LOS ANGELES, CALIFORNIA

Proj: 602858-005	Eng/Geol: JAR
Scale: 1"=100'	Date: 09/2015

Drafted By: BQT | Checked By: BQT | P:\DRAFTING\602858\005\DF_2015-02-24\602858-005-P01_PW-08_20150817.DWG (08-18-15 1:17:44PM) Plotted by: btran

LEGEND

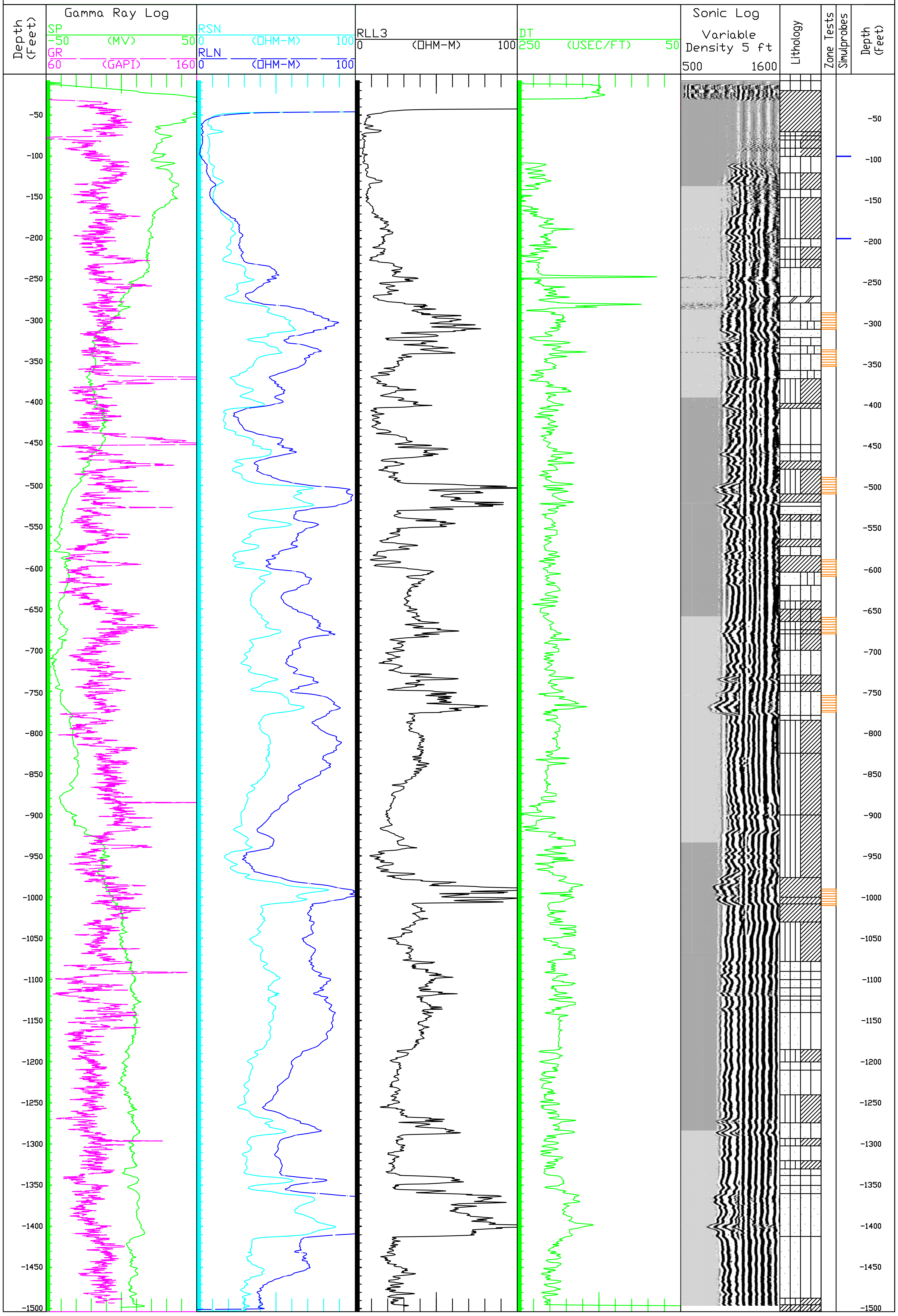
APPROXIMATE DEPTH OF SCREENED ZONE FOR TEMPORARY ZONE TEST. AS-BUILT DETAILS IN APPENDIX C

APPROXIMATE DEPTH OF SIMULPROBE SAMPLE. ANALYTICAL RESULTS IN APPENDIX B

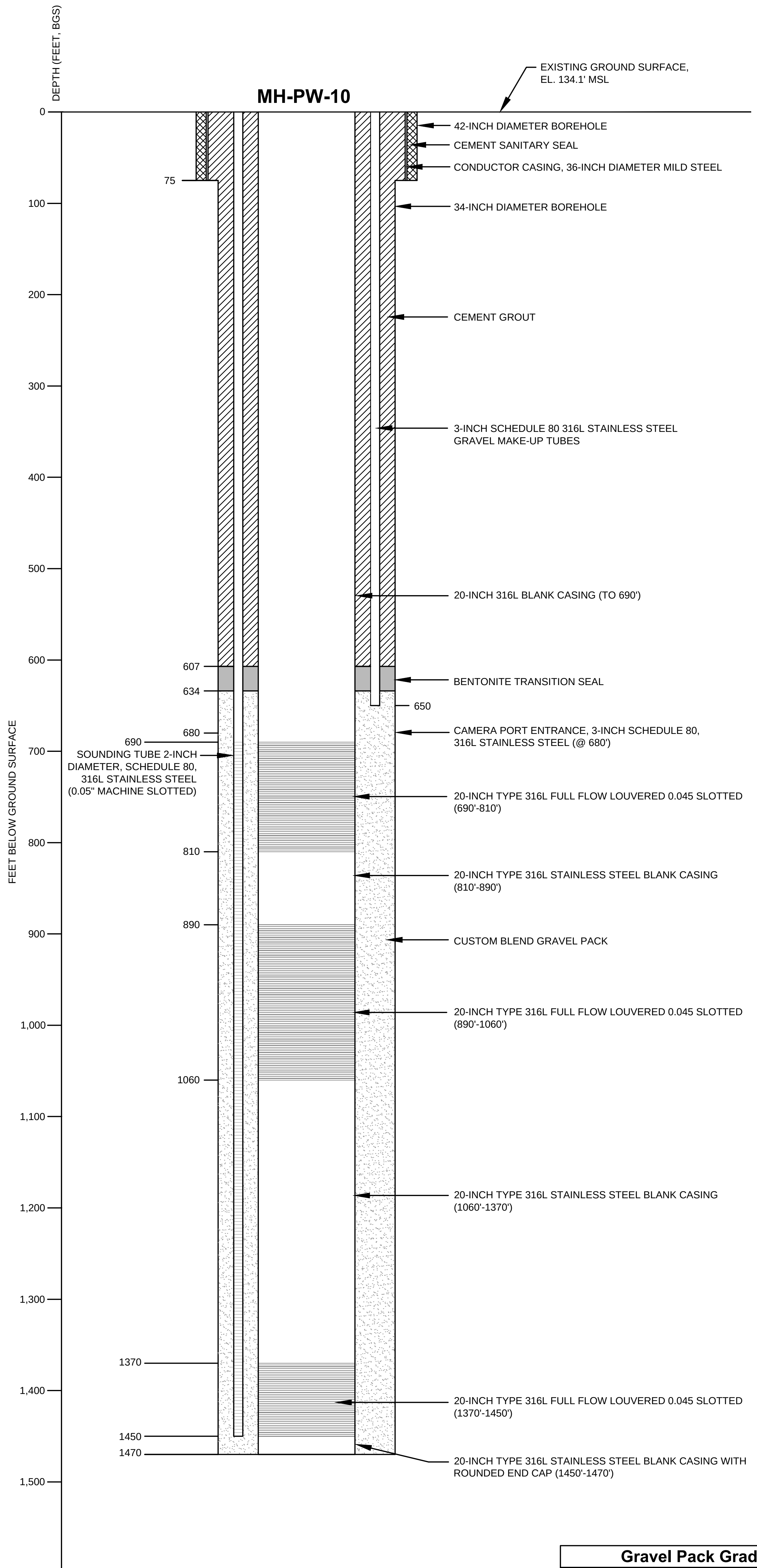
INDICATES NO GROUNDWATER RECOVERED DURING SIMULPROBE SAMPLING

Well Name: MH-PW-08
Location: EAST OF ST. ANDREWS PL. BETWEEN GAGE AVE. &--W. 62ND ST--GPS
Ground Surface: 134.4 ft (MSL)

Pacific Surveys, LLC
Unique Well ID:
API code:



Bottom of Pilot Borehole at 1,503 Feet Below Ground Surface



Gravel Pack Gradation Blend		
Sieve No.	**Cumulative Percent Passing**	
	Low	**High**
#4	**90**	**100**
#8	**76**	**90**
#10	**70**	**84**
#12	**51**	**65**
#16	**11**	**25**
#20	**3**	**17**
#30	**0**	**5**

Project: 602858-008	Eng/Geol: CK/JAR
Scale: NTS	Date: September 2015
Reference:	
Author: MAM	

WELL CONSTRUCTION DIAGRAM
MH-PW-10

MANHATTAN WELL FIELD
LOS ANGELES, CALIFORNIA

Figure 4

Leighton

PLATE 1

Leighton

MH-PW-10 DATA SUMMARY

MANHATTAN WELL FIELD
LOS ANGELES, CALIFORNIA

Proj: 602858-005	Eng/Geol: CCK/JAR
Scale: 1"=100'	Date: 09/2015

Drafted By: BQT | Checked By: BQT | P:\DRAFTING\602858\005\OF_2015-02-24\602858-005_P01_PW-10_20150817.DWG (08-18-15 1:19:14PM) Plotted by: btran

LEGEND

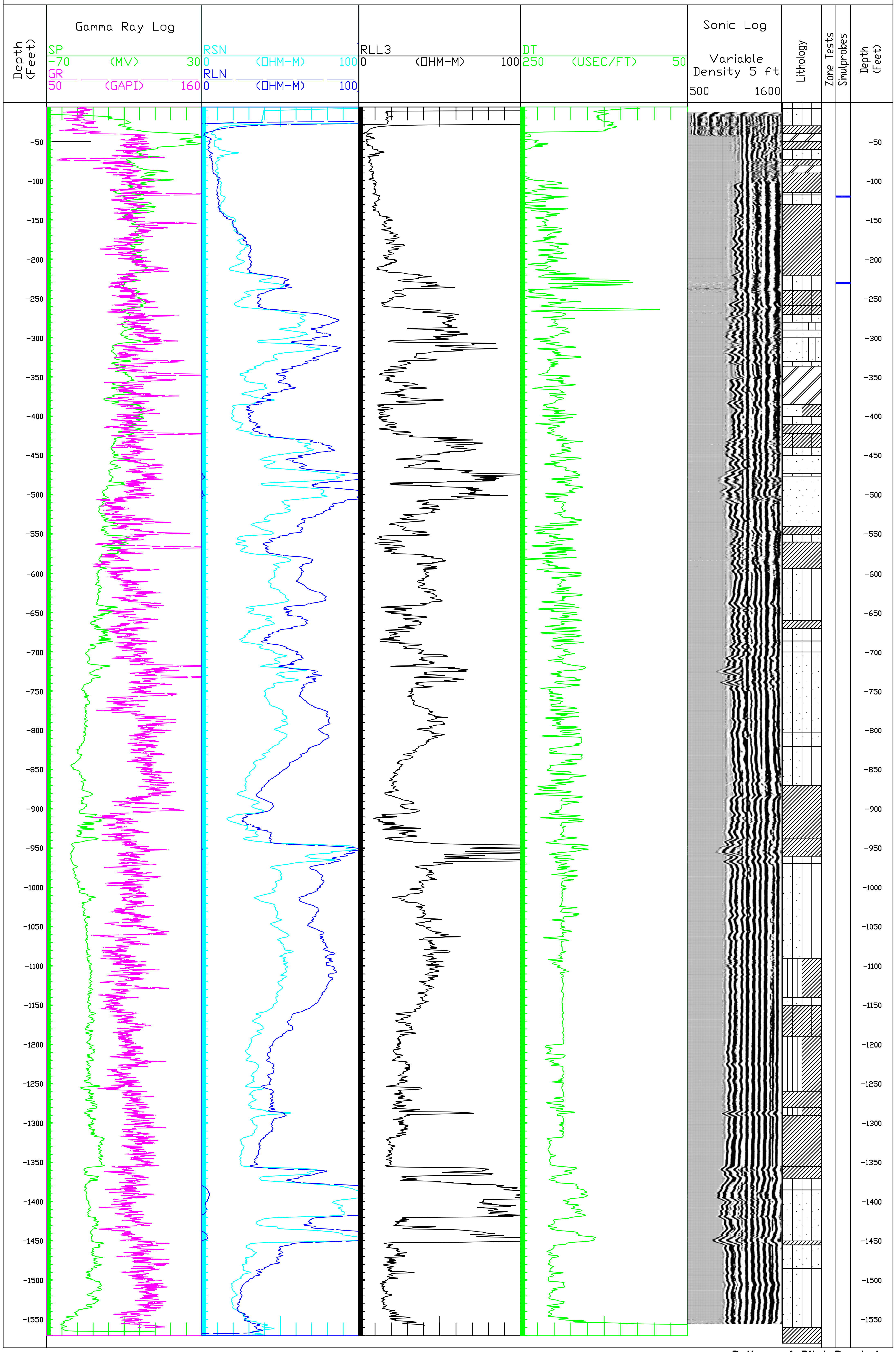
APPROXIMATE DEPTH OF SCREENED ZONE FOR TEMPORARY ZONE TEST. AS-BUILT DETAILS IN APPENDIX C

APPROXIMATE DEPTH OF SIMULPROBE SAMPLE. ANALYTICAL RESULTS IN APPENDIX B

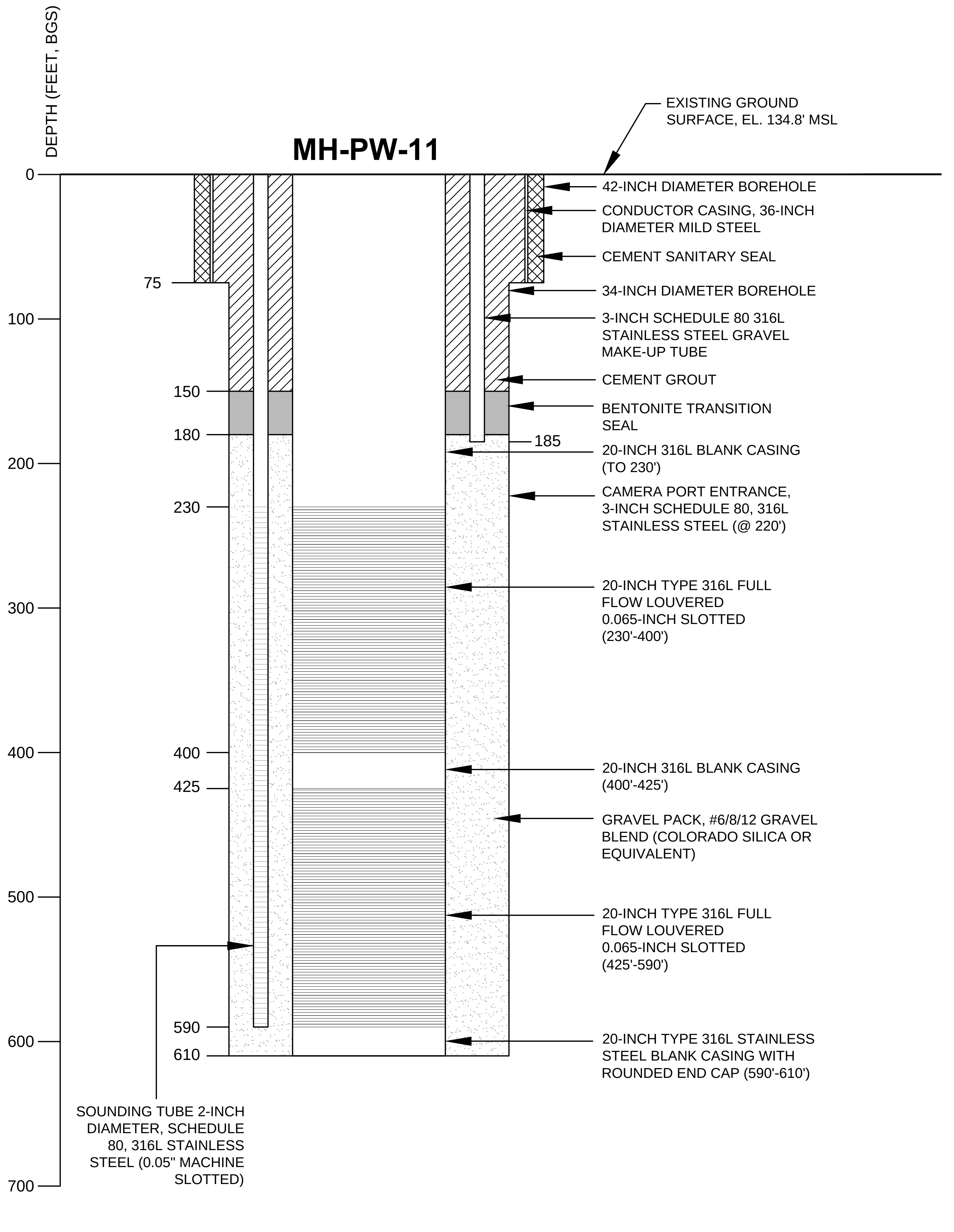
INDICATES NO GROUNDWATER RECOVERED DURING SIMULPROBE SAMPLING

Well Name: MH-PW-10
Location: OFF OF ST. ANDREWS PL. BETWEEN GAGE & W 62ND ST-
Ground Surface: 134.1 feet (MSL)

Pacific Surveys, LLC
Unique Well ID:
API code:



Bottom of Pilot Borehole at 1,580 Feet Below Ground Surface



Gravel Pack Gradation-#6/8/12 Gravel Blend		
Sieve No.	Cumulative Percent Passing	
	Low	High
#6	80	90
#8	60	70
#10	33	43
#12	12	22
#16	0	6

Project: 602858-008	Eng/Geol: CK/JAR
Scale: NTS	Date: September 2015
Reference:	
Author: MAM	

WELL CONSTRUCTION DIAGRAM
MH-PW-11
MANHATTAN WELL FIELD
LOS ANGELES, CALIFORNIA

Figure 4

Leighton

PLATE 1

Leighton

MH-PW-11 DATA SUMMARY

MANHATTAN WELL FIELD
LOS ANGELES, CALIFORNIA

Proj: 602858-005	Eng/Geol: CCK/JAR
Scale: 1"=50'	Date: 09/2015

Drafted By: BQT | Checked By: BQT

LEGEND

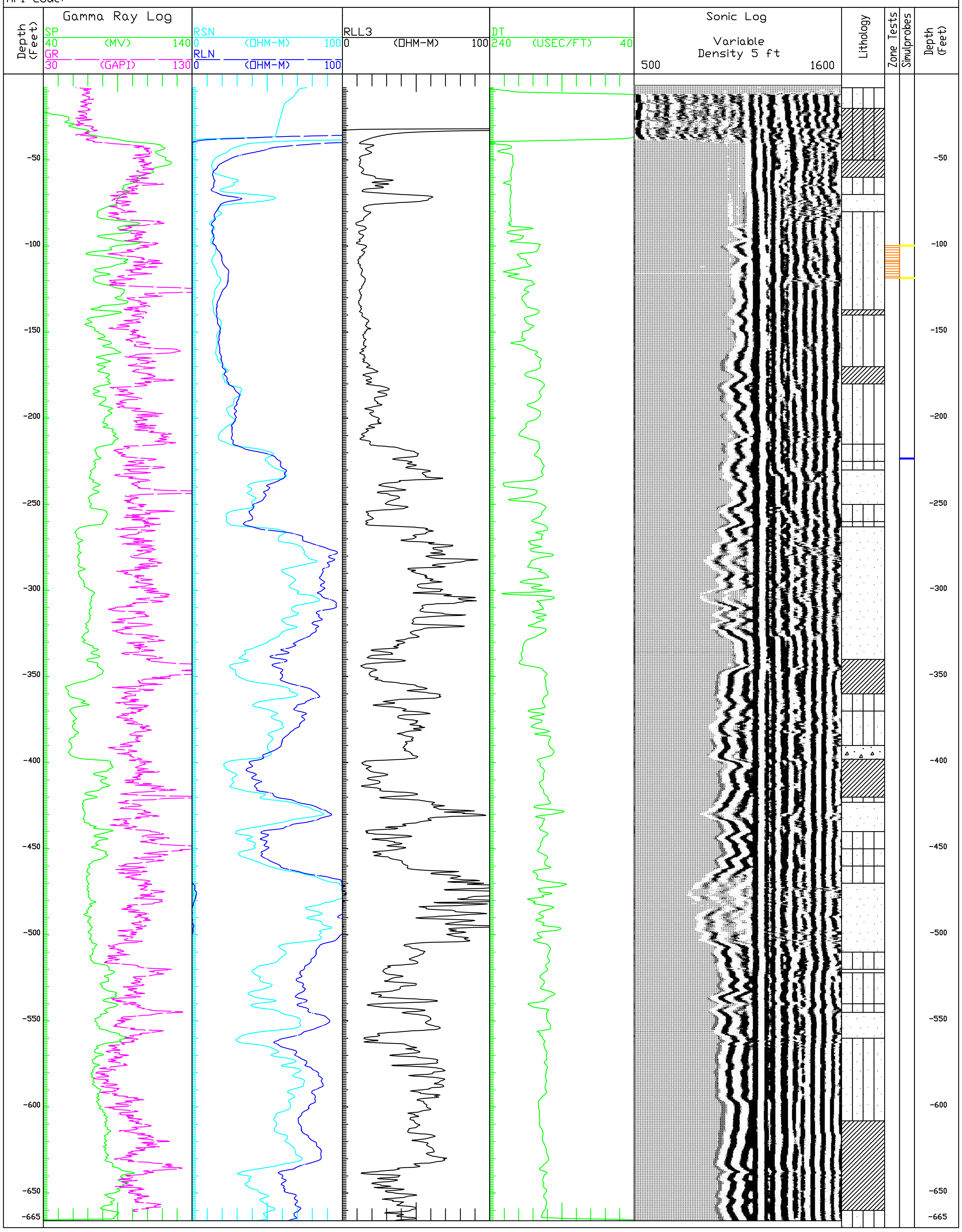
APPROXIMATE DEPTH OF SCREENED ZONE FOR TEMPORARY ZONE TEST. AS-BUILT DETAILS IN APPENDIX C

APPROXIMATE DEPTH OF SIMULPROBE SAMPLE. ANALYTICAL RESULTS IN APPENDIX B

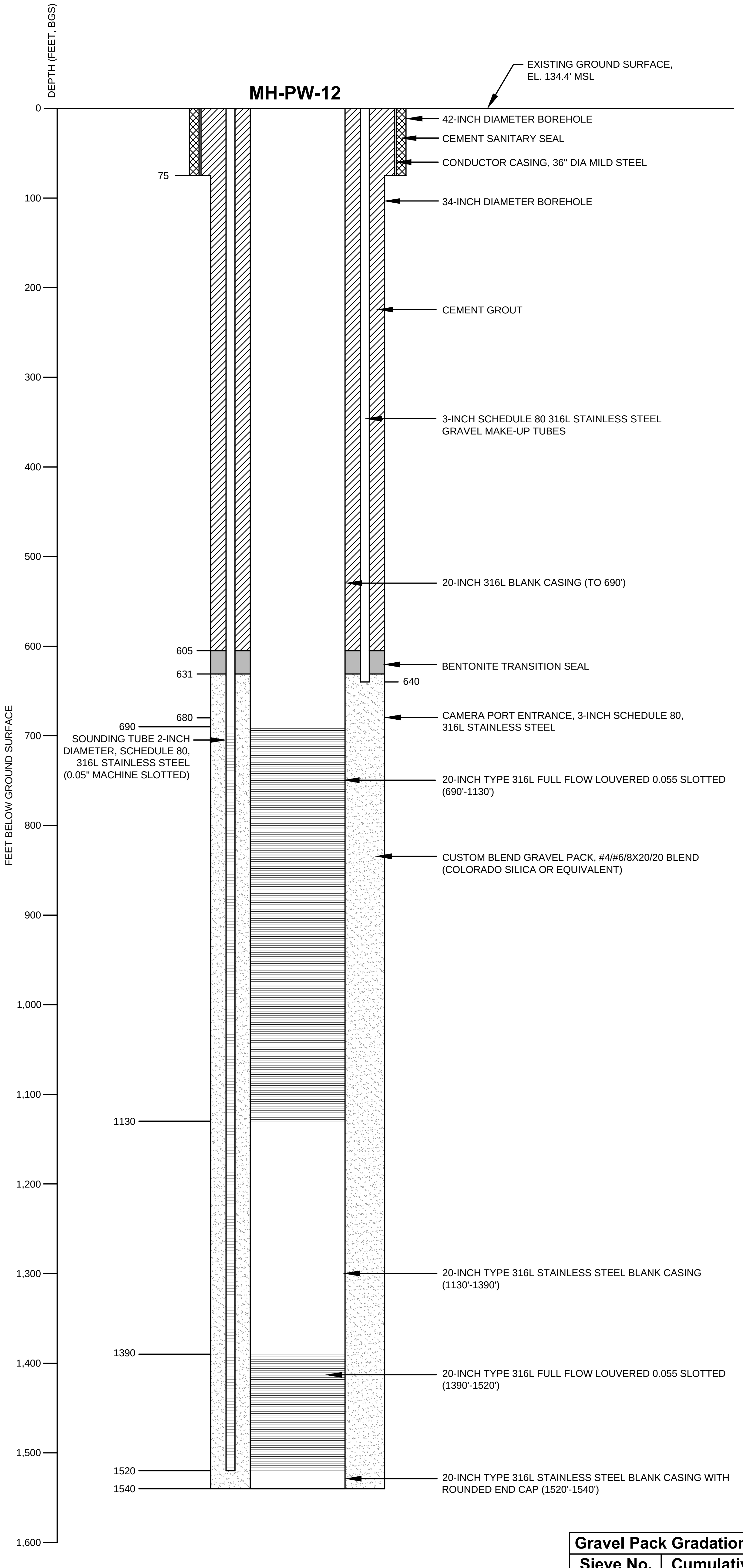
INDICATES NO GROUNDWATER RECOVERED DURING SIMULPROBE SAMPLING

Well Name: MH-PW-11
Location: WEST OF ST. ANDREWS PL. BETWEEN GAGE & W 62ND ST.
Ground Surface: 134.8 Feet (MSL)

Pacific Surveys, LLC
Unique Well ID:
API code:



Bottom of Pilot Borehole at 670 Feet Below Ground Surface



Gravel Pack Gradation #4/#6/8x20/20 Blend

Sieve No.	Cumulative Percent Passing	
	Low	High
#4	90	100
#8	49	65
#10	42	57
#12	35	50
#14	N/A	28
#16	10	23
#20	0	8
#30	0	5

Project: 602858-008	Eng/Geol: CK/JAR
Scale: NTS	Date: September 2015
Reference:	
Author: MAM	

WELL CONSTRUCTION DIAGRAM
MH-PW-12
MANHATTAN WELL FIELD
LOS ANGELES, CALIFORNIA

Figure 4

Leighton

PLATE 1

Leighton

MH-PW-12 DATA SUMMARY

MANHATTAN WELL FIELD
LOS ANGELES, CALIFORNIA

Proj: 602858-005	Eng/Geol: JAR
Scale: 1"=100'	Date: 09/2015

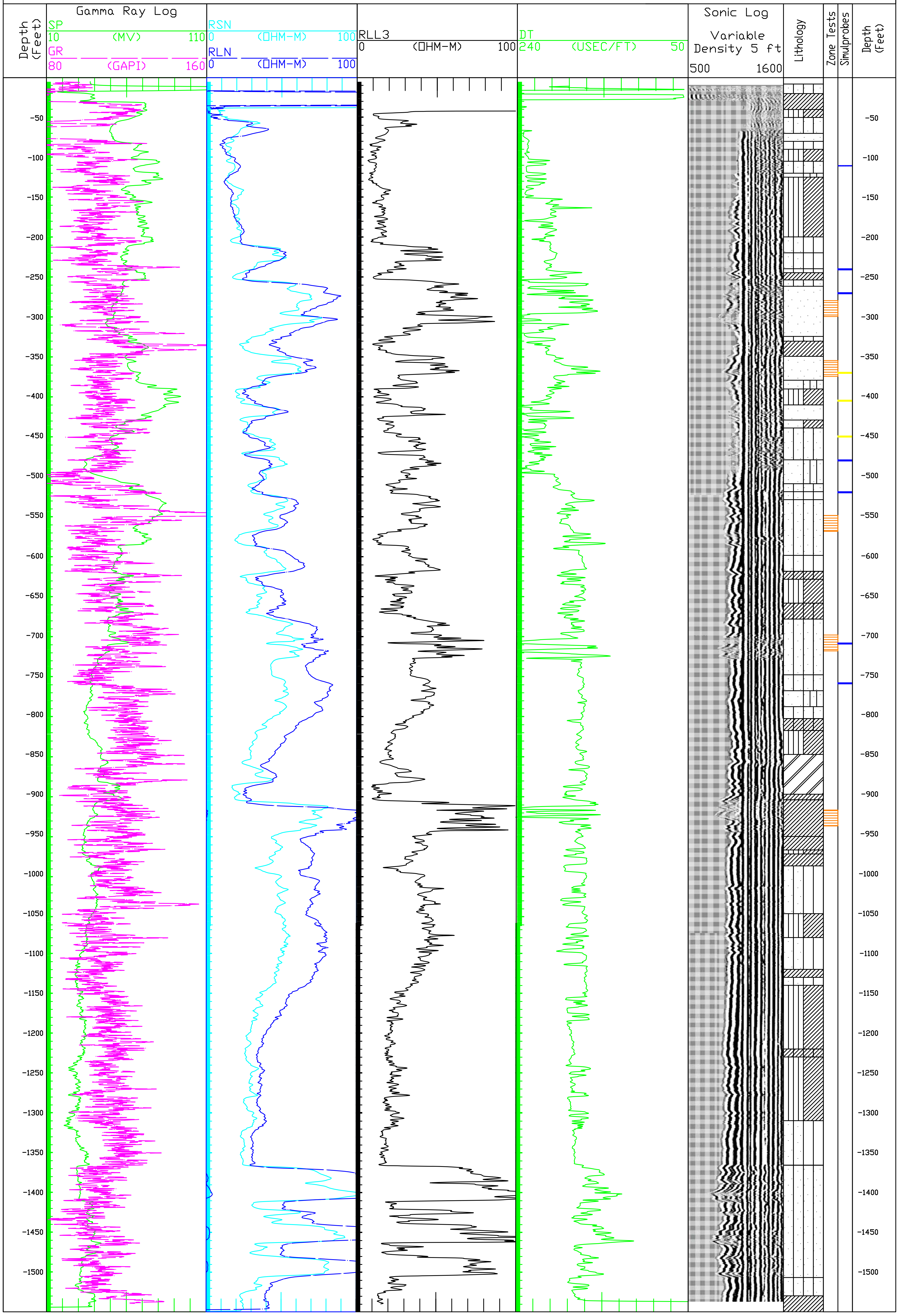
Drafted By: BQT | Checked By: BQT

LEGEND

- APPROXIMATE DEPTH OF SCREENED ZONE FOR TEMPORARY ZONE TEST. AS-BUILT DETAILS IN APPENDIX C
- APPROXIMATE DEPTH OF SIMULPROBE SAMPLE. ANALYTICAL RESULTS IN APPENDIX B
- INDICATES NO GROUNDWATER RECOVERED DURING SIMULPROBE SAMPLING

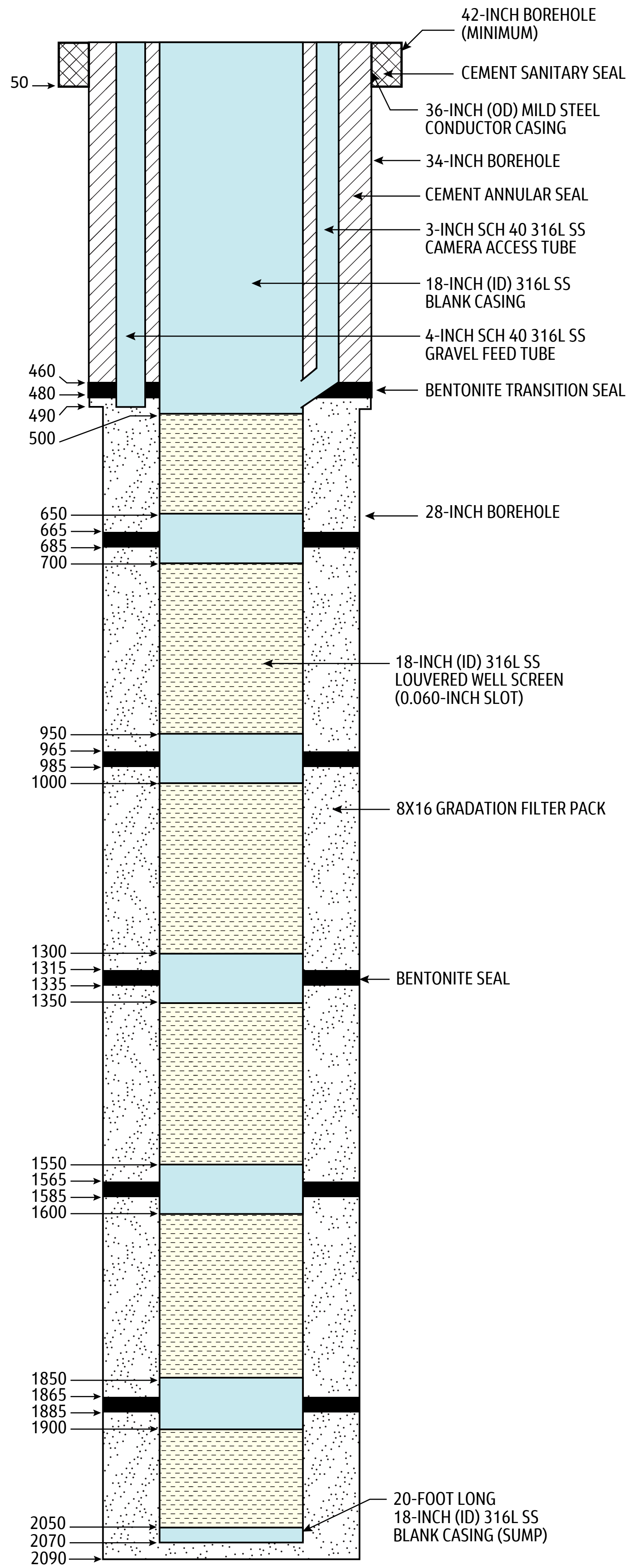
Well Name: MH-PW-12
Location: WEST OF ST. ANDREWS PL. BETWEEN W. GAGE AVE. & --W 62ND ST.-
Ground Surface: 134.4 feet (MSL)

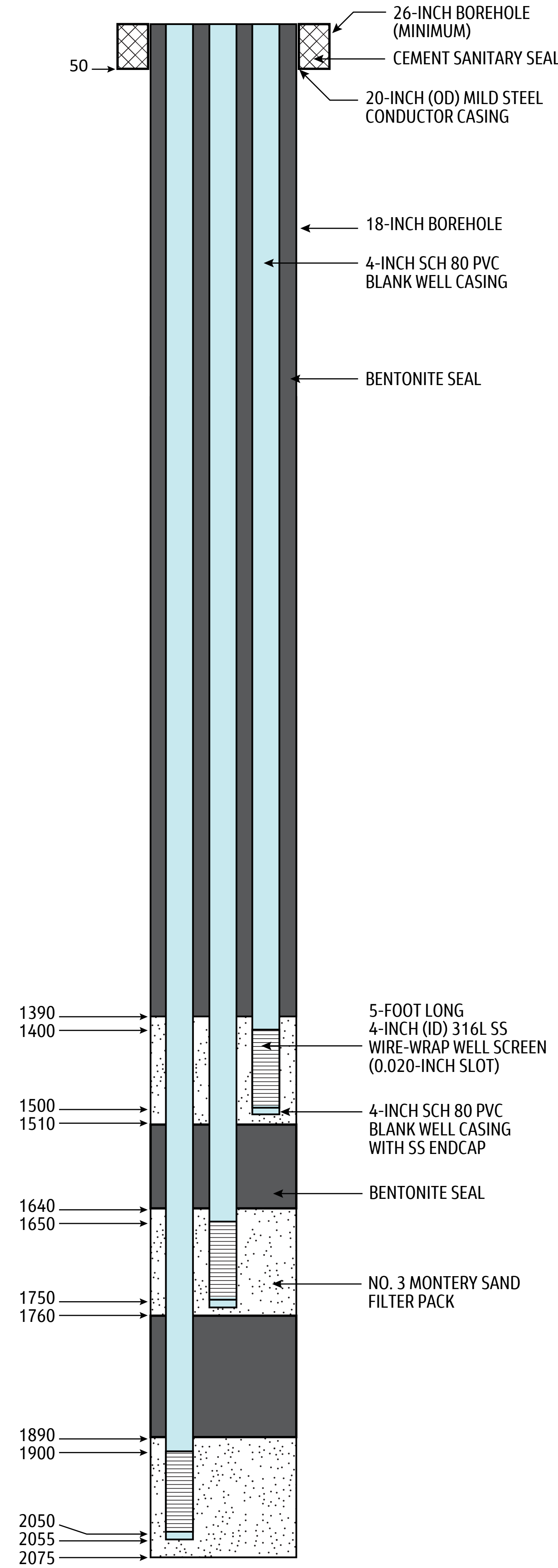
Pacific Surveys, LLC
Unique Well ID:
API code:

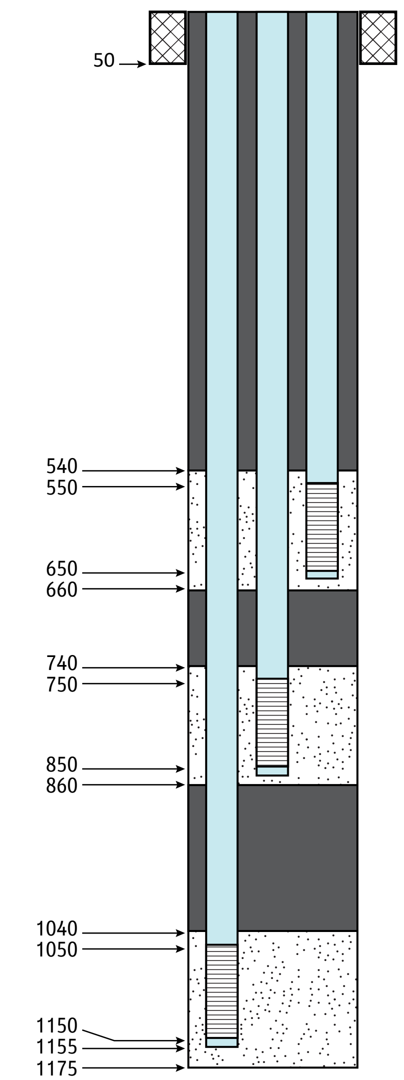


Bottom of Pilot Borehole at 1,550 Feet Below Ground Surface

Attachment 3
Preliminary Design Drawings for
Injection Test Well and Nested Monitoring Wells







Appendix C
Preliminary Design Drawings
Injection Test Well and Nested Monitoring Wells
Joint Los Angeles Basin Replenishment and Extraction Master Plan - Hyperion Water Reclamation Plant Injection Test Well Work Plan

Jacobs

Attachment 4
Example Advanced Geophysical Logs

Company:	Water Replenishment District
Well:	Montebello #2
Field:	Montebello
County:	Los Angeles
State:	California

Schlumberger

COMBINABLE MAGNETIC RESONANCE TOOL
GR

Location:	Lat: 34.016417 Long: -118.09164	Elev.:	K.B.
			G.L. 184.00 ft
			D.F. 190.00 ft
Permanent Datum:	Ground Level	Elev.:	184.00 ft
Log Measured From:	Ground Level	0.00 ft	above Perm.Datum
Drilling Measured From:	Ground Level		
API Serial No.	Max.Hole Deviation	Longitude:	Latitude:
N/A	0 deg	-118.09164	34.016417

County:	Los Angeles
Field:	Montebello
Location:	Lat: 34.016417 Long: -118.09164
Well:	Montebello #2
Company:	Water Replenishment District

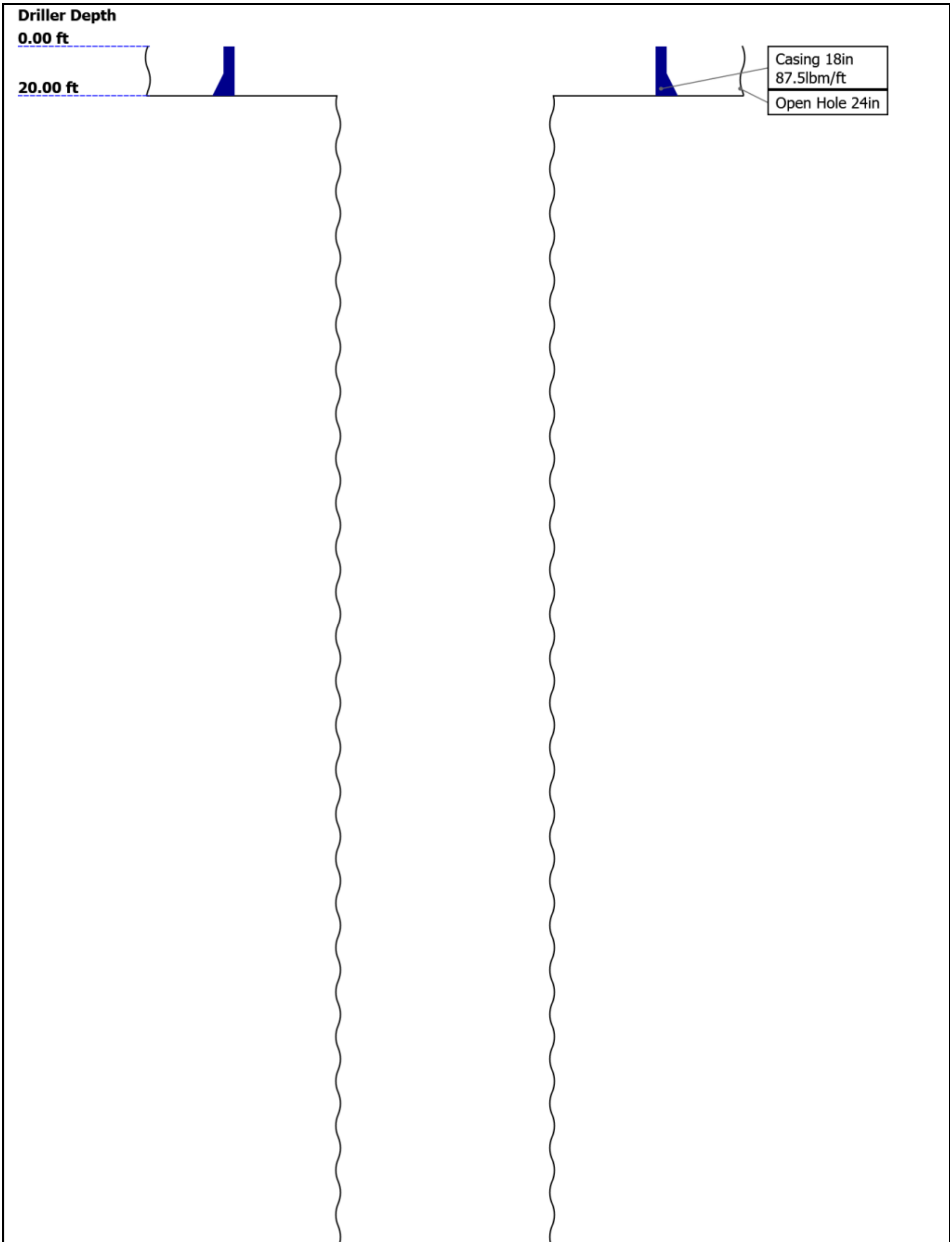
Logging Date	16-Feb-2021	
Run Number	1A	
Depth Driller	890.00 ft	
Schlumberger Depth	894.00 ft	
Bottom Log Interval	890.00 ft	
Top Log Interval	20.00 ft	
Casing Fluid Type	Water	
Salinity		
Density	9.1 lbm/gal	
Fluid Level	8.00 ft	
BIT/CASING/TUBING STRING		
Bit Size	8.50 in	
From	20.00 ft	
To	894.00 ft	
Casing/Tubing Size	18 in	
Weight	87.5 lbm/ft	
Grade	N/A	
From	0.00 ft	
To	20.00 ft	
Max Recorded Temperatures	87 degF	
Logger on Bottom Time	17-Feb-2021	14:58:00
Unit Number Location:	3080	Bakersfield, CA
Recorded By	M.Oloyede/J.Leon	
Witnessed By	Vinnie Robino	

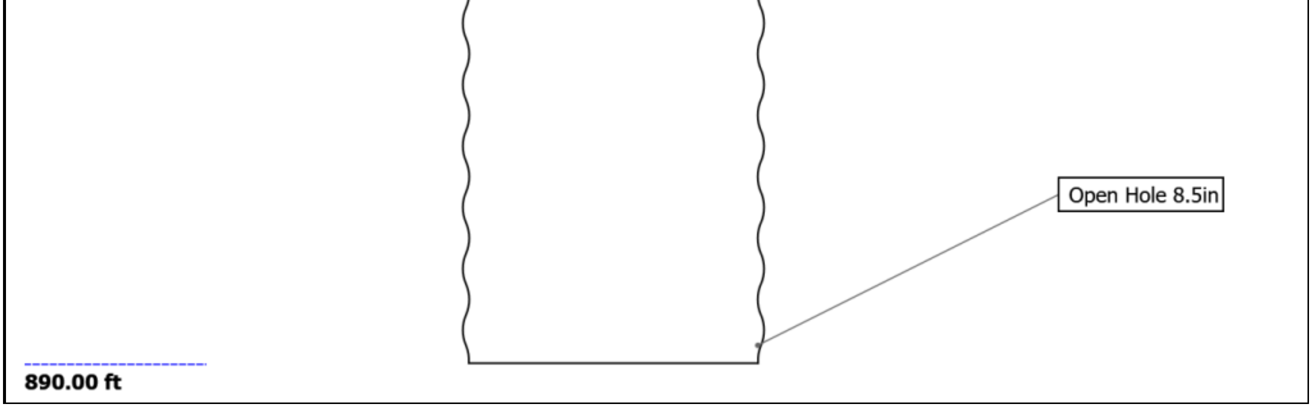
Disclaimer

THE USE OF AND RELIANCE UPON THIS RECORDED-DATA BY THE HEREIN NAMED COMPANY (AND ANY OF ITS AFFILIATES, PARTNERS, REPRESENTATIVES, AGENTS, CONSULTANTS AND EMPLOYEES) IS SUBJECT TO THE TERMS AND CONDITIONS AGREED UPON BETWEEN SCHLUMBERGER AND THE COMPANY, INCLUDING: (a) RESTRICTIONS ON USE OF THE RECORDED-DATA; (b) DISCLAIMERS AND WAIVERS OF WARRANTIES AND REPRESENTATIONS REGARDING COMPANY'S USE AND RELIANCE UPON THE RECORDED-DATA; AND (c) CUSTOMER'S FULL AND SOLE RESPONSIBILITY FOR ANY INFERENCE DRAWN OR DECISION MADE IN CONNECTION WITH THE USE OF THIS RECORDED-DATA.

Contents

Well Sketch


Driller Depth
0.00 ft
20.00 ft
Casing 18in
87.5lbm/ft
Open Hole 24in

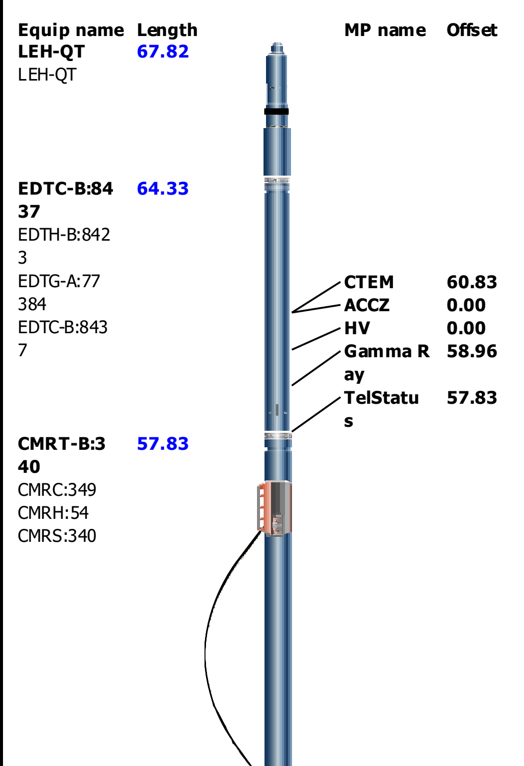


Borehole Size/Casing/Tubing Record

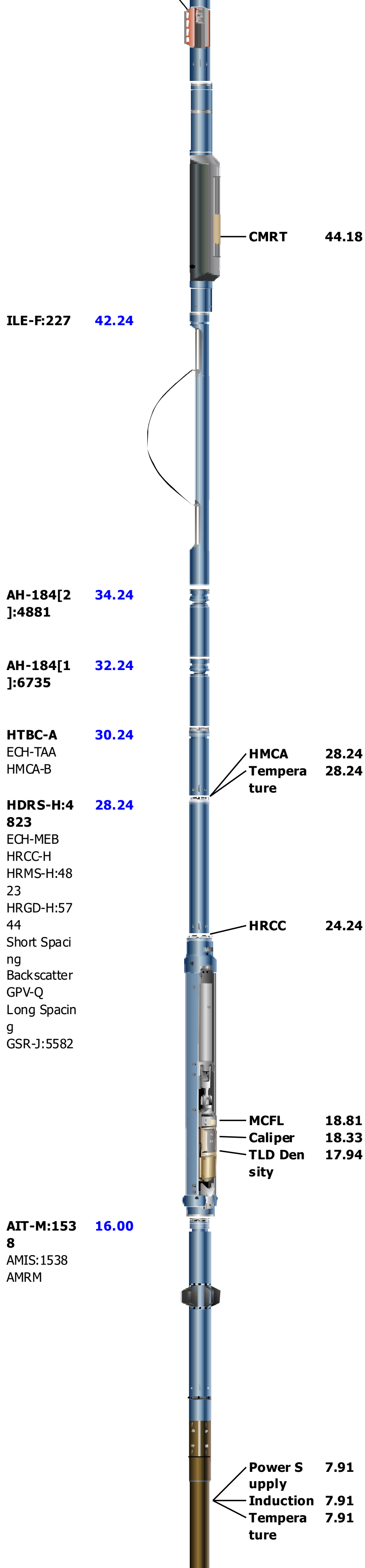
Bit							
Bit Size (in)	24	8.5					
Top Driller (ft)	0	20					
Top Logger (ft)	0	20					
Bottom Driller (ft)	20	890					
Bottom Logger (ft)	20	894					
Casing							
Size (in)	18						
Weight (lbm/ft)	87.5						
Inner Diameter (in)	17.087						
Grade	N/A						
Top Driller (ft)	0						
Top Logger (ft)	0						
Bottom Driller (ft)	20						
Bottom Logger (ft)	20						

Remarks and Equipment Summary

1A: Toolstring



1A: Remarks
Toolstring ran as per toolsketch.
Two 1" standoffs ran on AIT
Matrix: Sandstone; Density: 2.65 g/cc
FCD: 2.5"; ; Hole volume computation volume computed with density caliper
Repeat pass acquired 200' from bottom TDL
Main Pass from TDL to surface.
CMR removed from toolstring due to rig height contstraints; Subsequent descent in well to log remaining 10ft
Density caliper reads 16.9" in casing
Thank you for choosing Schumberger!!!


CMRT 44.18
ILE-F:227 42.24
AH-184[2]:4881 34.24
AH-184[1]:6735 32.24
HTBC-A 30.24
ECH-TAA
HMCA-B
HMCA 28.24
Temperature 28.24
HDRS-H:4823 28.24
ECH-MEB
HRCC-H
HRMS-H:4823
HRGD-H:5744
Short Spacing
Backscatter
GPV-Q
Long Spacing
GSR-J:5582
HRCC 24.24
MCFL 18.81
Caliper 18.33
TLD Density 17.94
AIT-M:1538 16.00
AMIS:1538
AMRM
Power Supply 7.91
Induction 7.91
Temperature 7.91

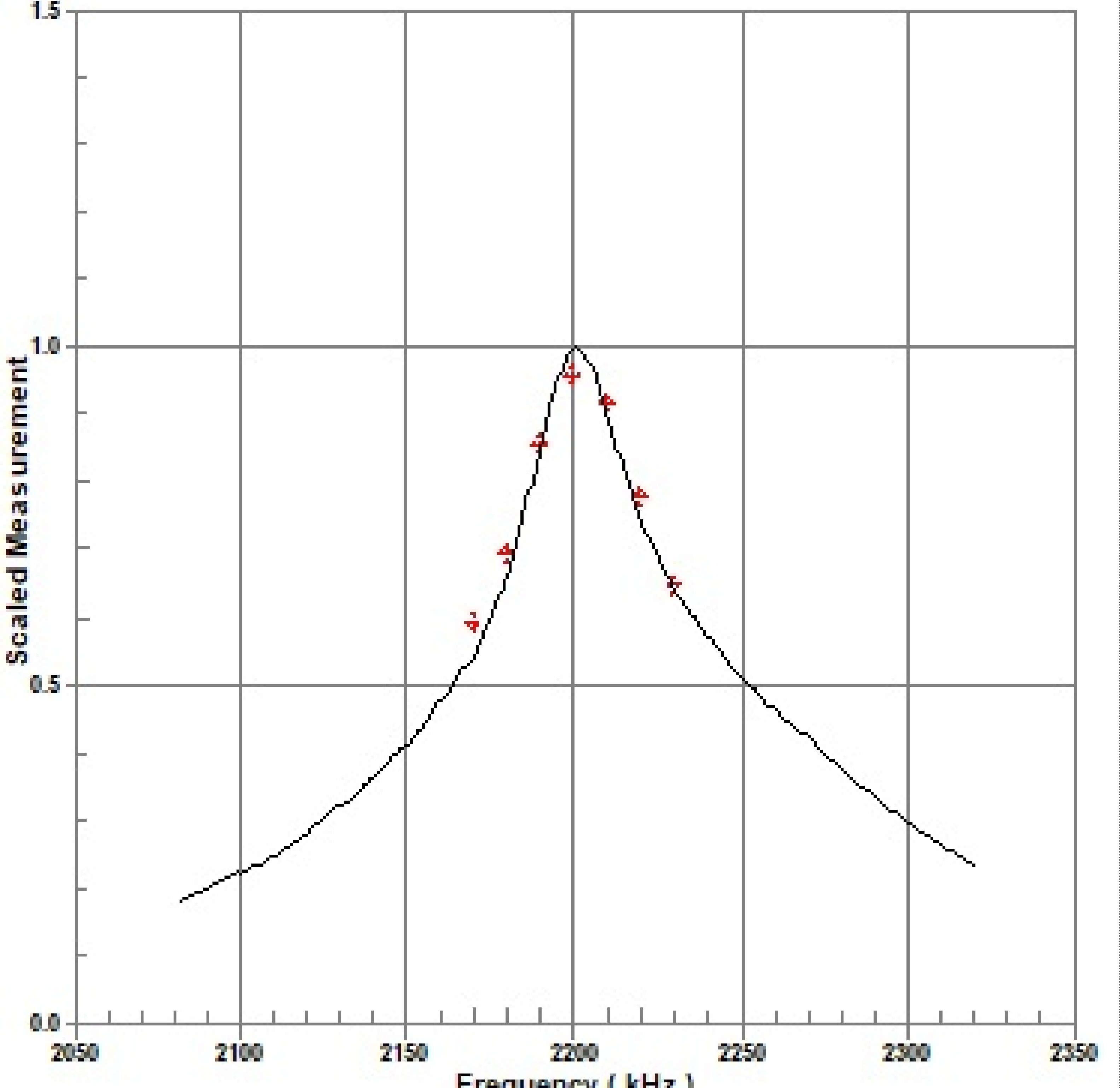
Lengths are in ft
Maximum Outer Diameter = 9.000 in
Line: Sensor Location, Value: Gating Offset
All measurements are relative to TOOL_ZERO

Depth Summary

	1A		
Depth Measuring Device			
Type	IDW-JA		
Serial Number	5845		
Calibration Date	30-AUG-2020		
Calibrator Serial Number	57		
Calibration Cable Type	7-46 A-XS		
Wheel Correction 1	-2		
Wheel Correction 2	-1		
Tension Device			
Type	CMTD-B/A		
Serial Number	2832		
Calibration Date	31-JAN-2021		
Calibrator Serial Number	80722		
Number of Calibration Points	10		
Calibration Root Mean Square Error	10		
Calibration Peak Error	17		
Logging Cable			
Type	7-46A-XS		
Serial Number			
Length	12500.00 ft		
Conveyance Type	Wireline		
Rig Type			

1A:Depth Control Parameters		**Depth Control Remarks**
Log Sequence	First Log In the Well	Schlumberger depth control procedures followed
Rig Up Length At Surface		IDW used as primary depth control system
Rig Up Length At Bottom		Z-Chart used as secondary depth control system
Rig Up Length Correction		
Stretch Correction		
Tool Zero Check At Surface		

Import of External Image



1A

MAIN

Pass Summary

Run Name	Pass Objective	Direction	Top	Bottom	Start	Stop	DSC Mode	Depth Shift	Include Parallel Data
1A	Log[6]:Up	Up	36.65 ft	898.23 ft	17-Feb-2021 3:23:51 PM	17-Feb-2021 4:17:33 PM	ON	1.76 ft	Yes

All depths are referenced to toolstring zero

Log Company:Water Replenishment District Well:Montebello #2

1A: Log[6]:Up:S014

Description: CMRTB Depth Log Main Format Format: Log (CMRTB Depth Log Main-bins) Index Scale: 5 in per 100 ft Index Unit: ft Index Type: Measured Depth Creation Date: 17-Feb-2021 22:24:21

Log Quality Control Display (LQC_DISPLAY) CMRT-B

1 - BHS - Bad Hole Flag :	Good	Bad		
2 - IWT - Wait Time :	OK	Insufficient		
3 - DB0 - Delta B0 :	OK	Warning	Error	
4 - EEN - Early Echo Noise :	OK	Warning	Error	
5 - HVL - High Voltage :	Normal	Too Low		
6 - ATS - Auto Tuning :	ALF	Ant	Temp	Off
7 - ATTS - AT Tracking :	OK	Warning		

TIME_1900 - Time Marked every 60.00 (s)

T2 < 3 ms
3 ms < T2 < 10 ms
10 ms < T2 < 33 ms
33 ms < T2 < 100 ms
100 ms < T2 < 300 ms
T2 > 300 ms

Capillary Bound Fluid Porosity
Small Pore Porosity

Free Fluid Volume (CMFF) CMRT-B
0.4 ft3/ft3 0

T2 Distribution (Diffusion Included)
0.02 ft3/ft3 -0.02
0 63

Gamma Ray (ECGR_EDTC) EDTC-B
0 gAPI 150

Cable Tension (TENS)
10000 0 lbf

Magnetic Resonance Free Fluid Volume from Cutoff 2 (CFF2) CMRT-B
0.4 ft3/ft3 0

Bit Size (BS) RT
6 in 16

Timur/Coates Permeability (KTIM) CMRT-B
0.001 mD 100

SDR Permeability (KSDR) CMRT-B
0.001 mD 100

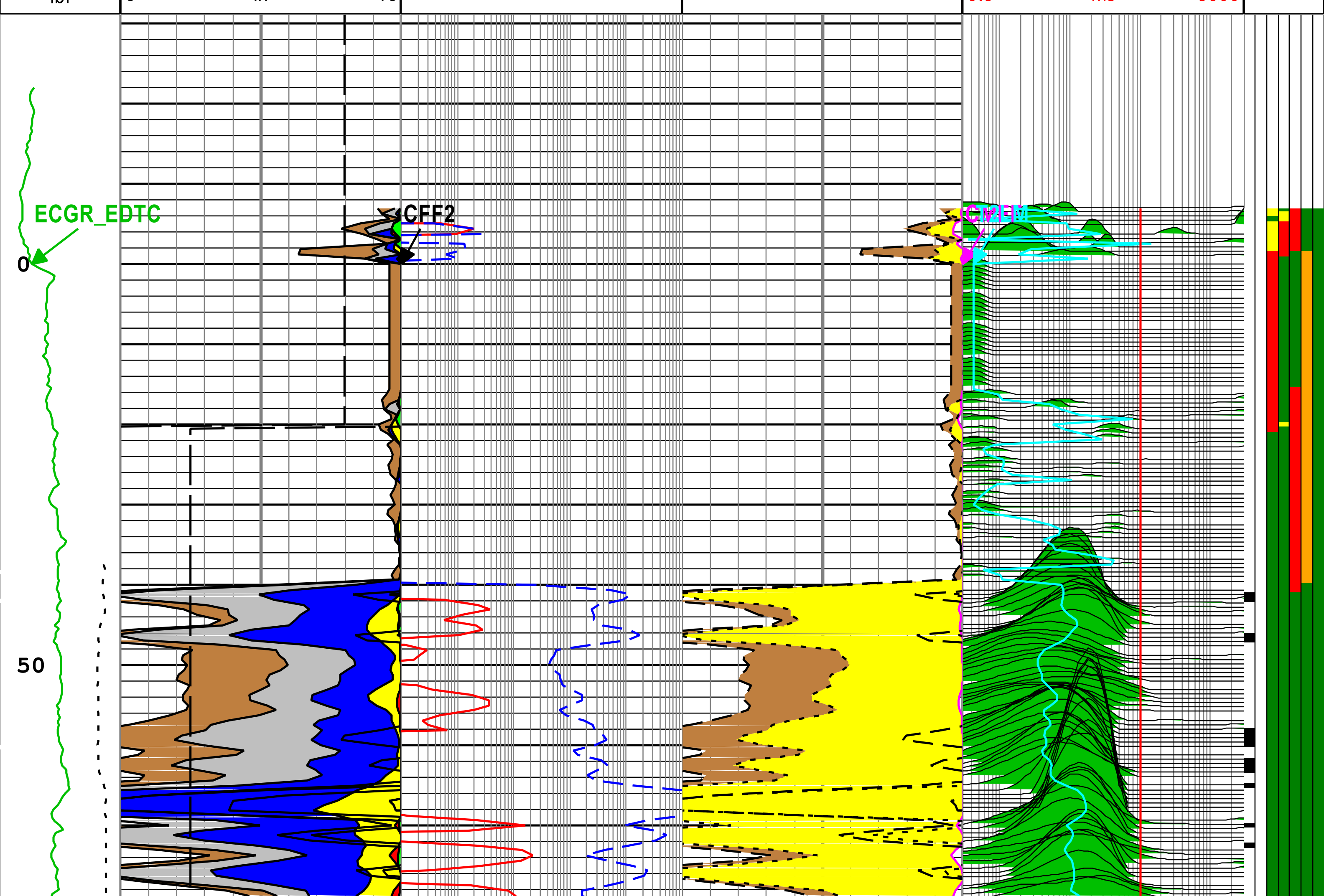
Free Fluid Volume using 3-ms Cutoff (CMRP_3MS) CMRT-B
0.4 ft3/ft3 0

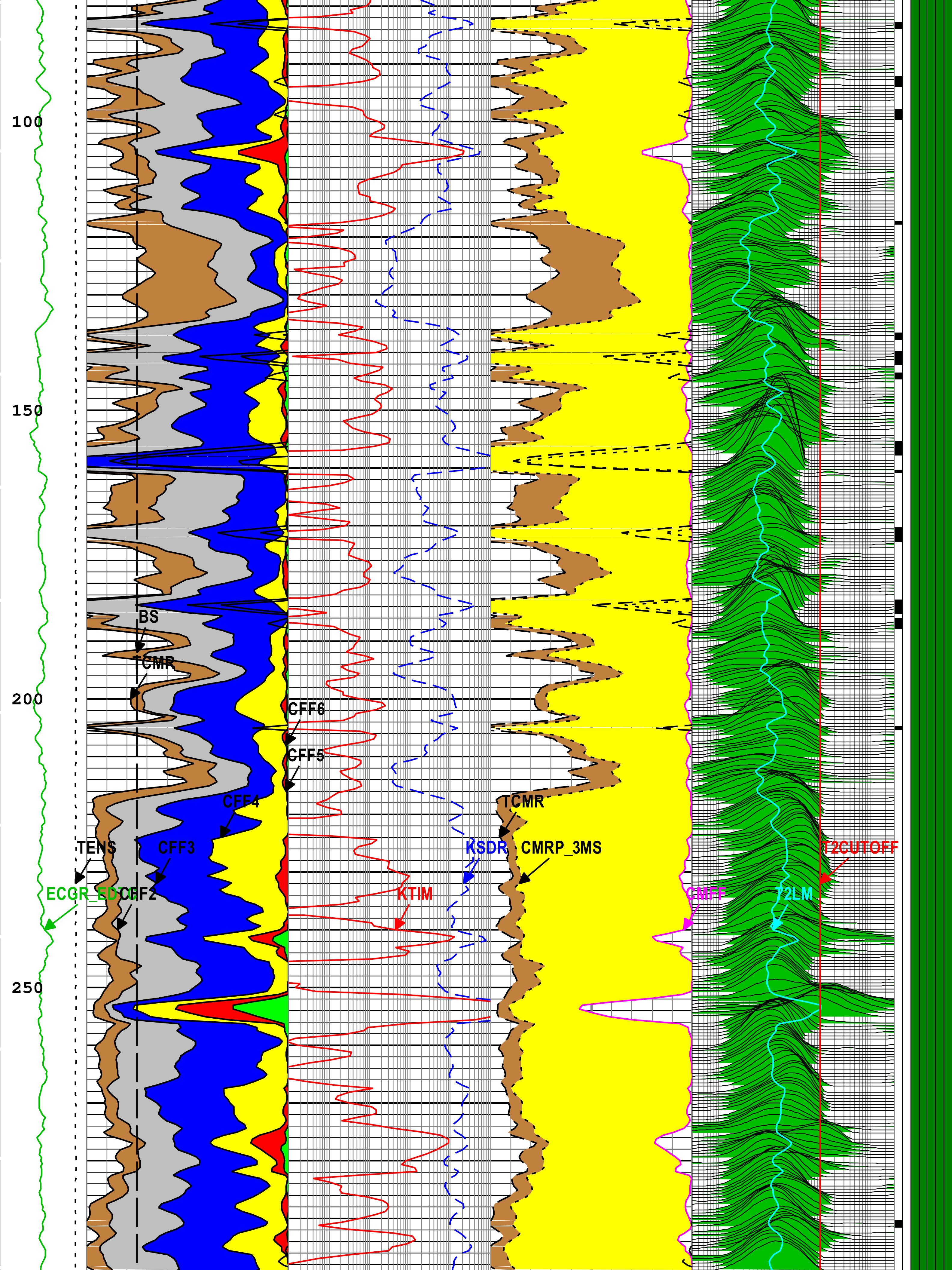
Magnetic Resonance Porosity (TCMR) CMRT-B
0.4 ft3/ft3 0

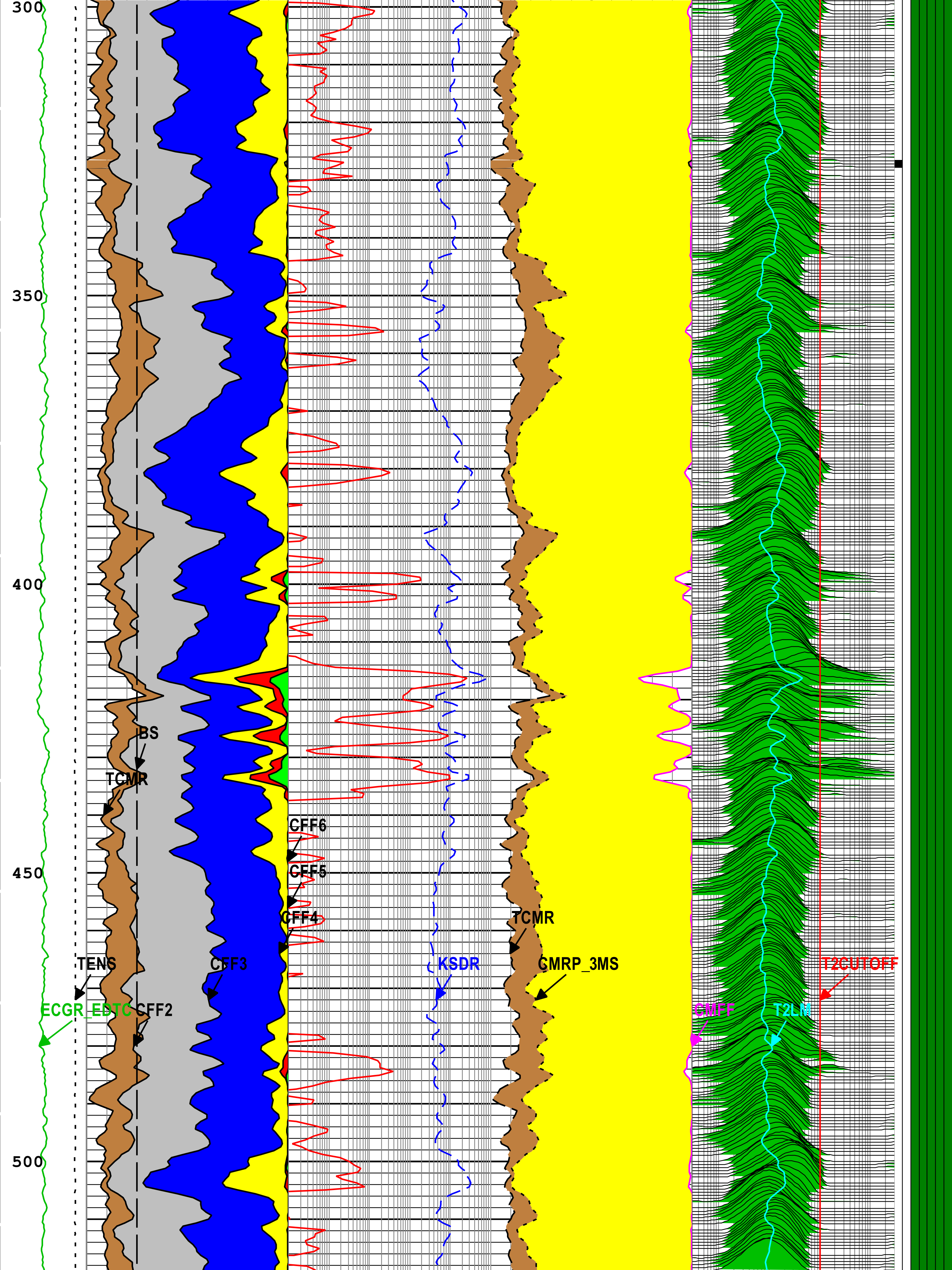
Logarithmic Mean of T2 Distribution (Diffusion Included) (T2LM) CMRT-B
0.3 ms 3000

T2 Cutoff (T2CUTOFF) CMRT-B
0.3 ms 3000

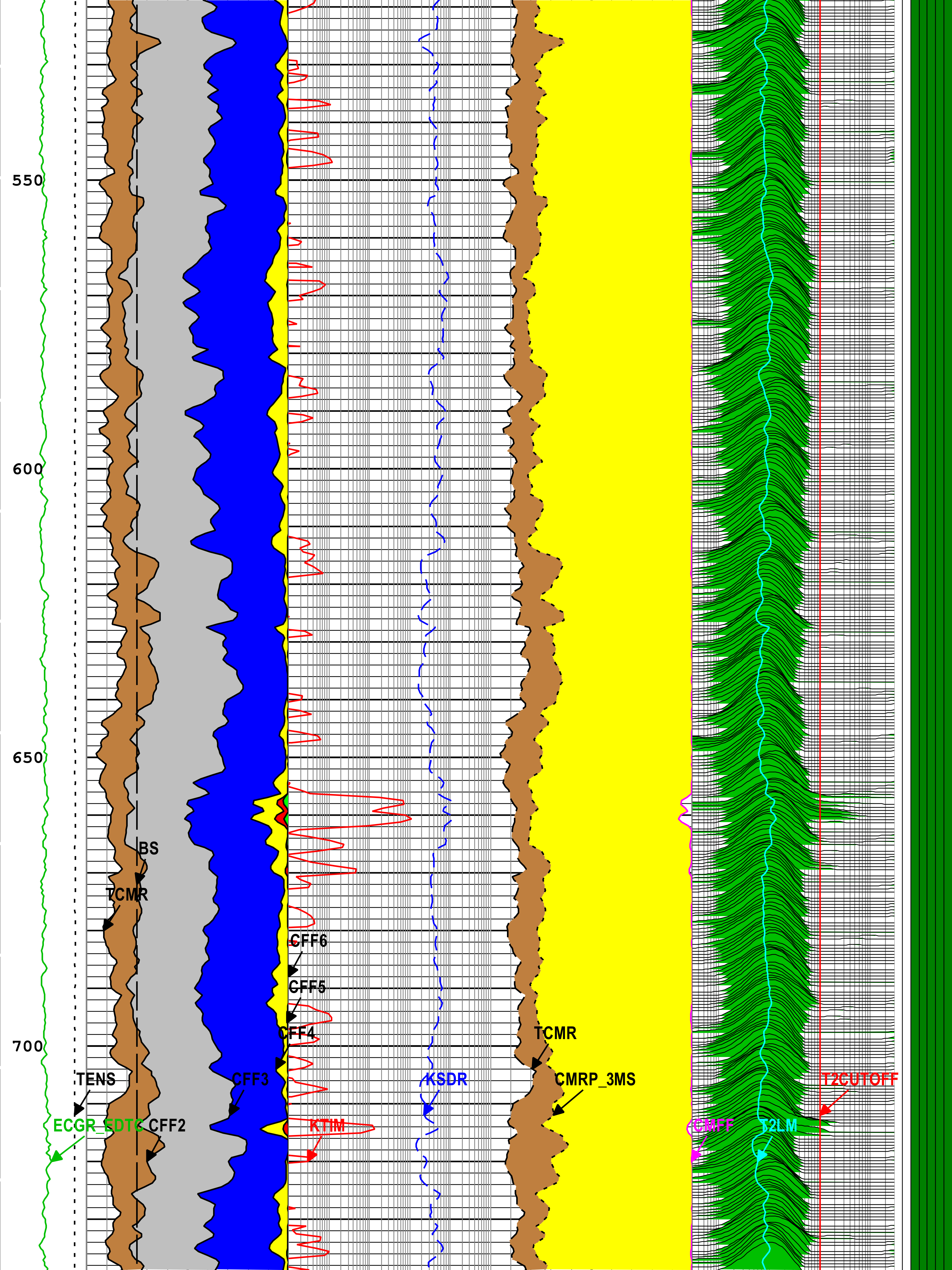
Log Quality Control Display (LQC_DISPLAY) CMRT-B
1 7

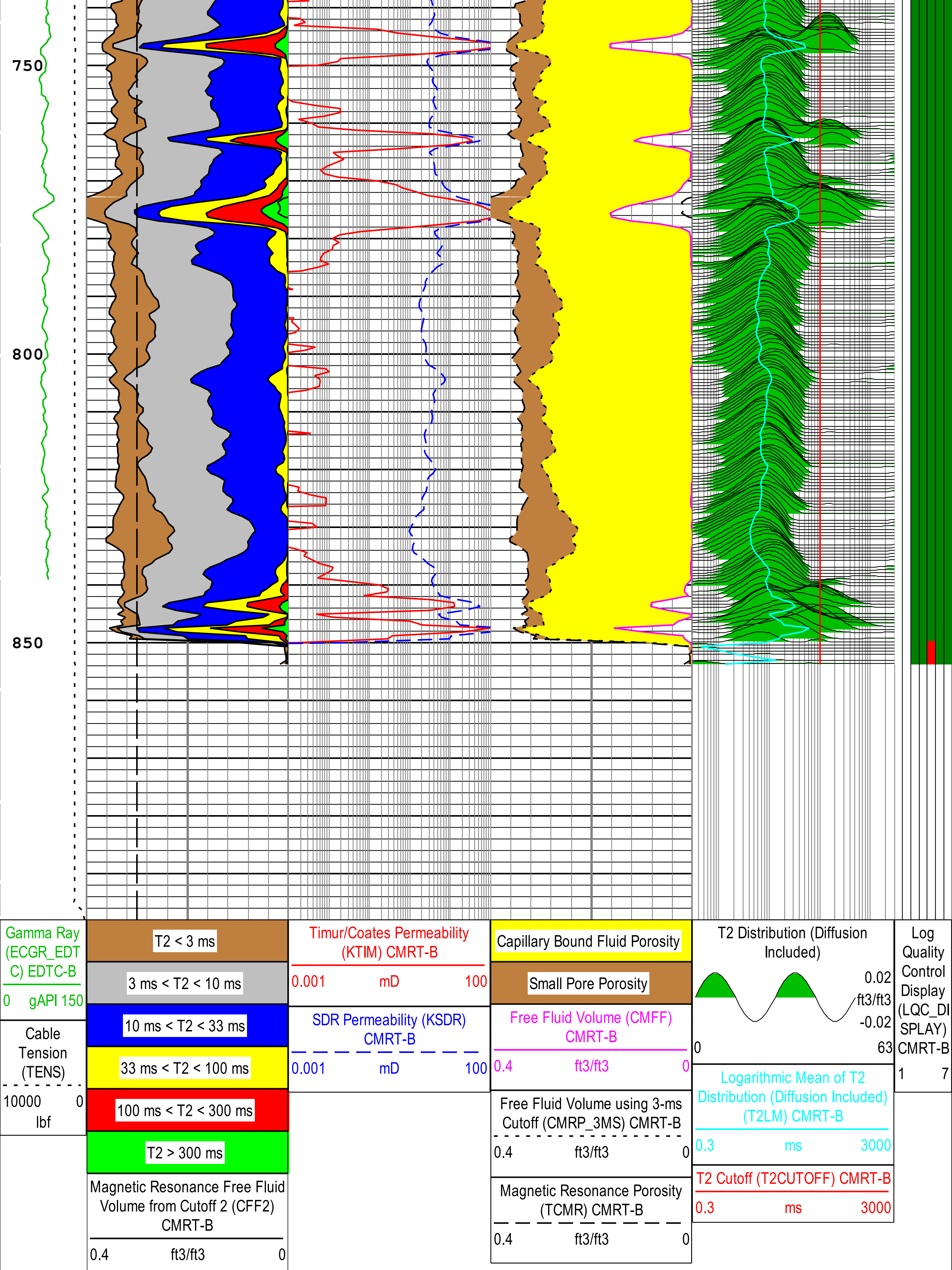



100
150
200
250
BS
TCMR
CFF6
CFF5
CFF4
TCMR
TENS
CFF3
KSDR
CMRP_3MS
T2CUTOFF
ECGR_ED
CFF2
KTIM
CMFF
T2LM



300
350
400
450
500
BS
TCMR
CFF6
CFF5
CFF4
TCMR
TENS
CFF3
KSDR
CMRP_3MS
T2CUTOFF
ECGR_EDTC
CFF2
CMFF
T2LM


550
600
650
700
BS
TCMR
CFF6
CFF5
CFF4
TCMR
TENS
CFF3
KSDR
CMRP_3MS
T2CUTOFF
ECGR_EDTC
CFF2
KTIM
CMFF
T2LM


750
800
850
Gamma Ray (ECGR_EDTC) EDTC-B
0 gAPI 150
Cable Tension (TENS)
10000 0
lbf
T2 < 3 ms
3 ms < T2 < 10 ms
10 ms < T2 < 33 ms
33 ms < T2 < 100 ms
100 ms < T2 < 300 ms
T2 > 300 ms
Magnetic Resonance Free Fluid Volume from Cutoff 2 (CFF2) CMRT-B
0.4 ft3/ft3 0
Timur/Coates Permeability (KTIM) CMRT-B
0.001 mD 100
SDR Permeability (KSDR) CMRT-B
0.001 mD 100
Capillary Bound Fluid Porosity
Small Pore Porosity
Free Fluid Volume (CMFF) CMRT-B
0.4 ft3/ft3 0
Free Fluid Volume using 3-ms Cutoff (CMRP_3MS) CMRT-B
0.4 ft3/ft3 0
Magnetic Resonance Porosity (TCMR) CMRT-B
0.4 ft3/ft3 0
T2 Distribution (Diffusion Included)
0.02
ft3/ft3
-0.02
0 63
Logarithmic Mean of T2 Distribution (Diffusion Included) (T2LM) CMRT-B
0.3 ms 3000
T2 Cutoff (T2CUTOFF) CMRT-B
0.3 ms 3000
Log Quality Control Display (LQC_DISPLAY) CMRT-B
1 7

Bit Size (BS) RT		
6	in	16

TIME_1900 - Time Marked every 60.00 (s)

Log Quality Control Display (LQC_DISPLAY) CMRT-B

1 - BHS - Bad Hole Flag :	Good	Bad		
2 - IWT - Wait Time :	OK	Insufficient		
3 - DB0 - Delta B0 :	OK	Warning	Error	
4 - EEN - Early Echo Noise :	OK	Warning	Error	
5 - HVL - High Voltage :	Normal	Too Low		
6 - ATS - Auto Tuning :	ALF	Ant	Temp	Off
7 - ATTS - AT Tracking :	OK	Warning		

Description: CMRTB Depth Log Main Format Format: Log (CMRTB Depth Log Main-bins) Index Scale: 5 in per 100 ft Index Unit: ft Index Type: Measured Depth Creation Date: 17-Feb-2021 22:24:21

Channel Processing Parameters

1A: Parameters

Parameter	Description	Tool	Value	Unit
BARI(ISSBAR)	Barite Mud Presence Flag	Borehole	No	
BHS	Borehole Status (Open or Cased Hole)	Borehole	Open	
BS	Bit Size	WLSESSION	Depth Zoned	in
CALI_SHIFT	CALI Supplementary Offset	HDRS-H	0	in
CBLO	Casing Bottom (Logger)	WLSESSION	20	ft
CDEN	Cement Density	EDTC-B	2	g/cm3
DC_MODE	Depth Correction Mode	DepthCorrection	Real-time	
DFD	Drilling Fluid Density	Borehole	9.1	lbm/gal
GAMMA_REG	Regularization Factors	CMRT-B	[1.5, 1.5, 0, 0, 0, 0]	
GCSE_DOWN_PASS	Generalized Caliper Selection for WL Log Down Passes	Borehole	BS(RT)	
GCSE_UP_PASS	Generalized Caliper Selection for WL Log Up Passes	Borehole	CALI	
JOBID	Job Identification	WLSESSION	water well	
DDFL	Number of Stacking Levels	CMRT-B	3	
POLC_SW	Polarization Correction Switch	CMRT-B	Yes	
T1CUT	T1 Cutoff between BFV and FFV	CMRT-B	50	ms
T1T2R_IN	T1/T2 Ratio Input	CMRT-B	2	
T1T2R_MAX	T1/T2 Ratio Maximum	CMRT-B	3	
T1T2R_MIN	T1/T2 Ratio Minimum	CMRT-B	1	
T2CUT	T2 Cutoff between BFV and FFV	CMRT-B	100	ms
T2CUT_TAPER	Start of Tapered T2 Cutoff	CMRT-B	25	ms

Depth Zone Parameters

Parameter	Value	Start (ft)	Stop (ft)
BS	24	0	20
BS	8.5	20	894

All depth are actual.

Tool Control Parameters

1A: Parameters

Parameter	Description	Tool	Value	Unit
ACQ_METHOD_OPT	Acquisition Method Option	CMRT-B	SEQ	
LFST_ALF_OFFSET	Average of Auto-Larmor-Frequency Phase Difference during LFST	CMRT-B	0.45	deg
LFST_ALF_OFFSET_SD	Standard Deviation of Auto-Larmor-Frequency Phase Difference during LFST	CMRT-B	0.12	deg

	Difference during LFST			
DHC_VERS	DH Controller Code Version	CMRT-B	17	
DLSR	Depth Log Sample Rate	CMRT-B	7.5	in
DSP_VERS	DH Signal Processing Code Version	CMRT-B	14	
EPM_OPT	Enhanced Precision Mode Option	CMRT-B	On	
FREQ_OP_PREV	Operating Frequency, prior to new LFST, at LFST Temperature	CMRT-B	2190	kHz
LFST_CENTER_FREQ	LFST Central Frequency	CMRT-B	2200	kHz
LFST_SEARCH_FREQ	LFST Frequency	CMRT-B	2201	kHz
LFST_TEMP	LFST Temperature	CMRT-B	85	degF
LFST_TEMP_DELTA	LFST Temperature Variation	CMRT-B	32.42	degF
LFST_TT_OFFSET	LFST Tune Table Offset	CMRT-B	1.5	kHz
CMR_LOG_DIRECTION	Logging Direction	CMRT-B	Up	
PPSS	Logging Mode for CMR	CMRT-B	DEPTH_B_MODE_CARBONATE	
CMR_LOG_SPEED	Optimal Logging Speed	CMRT-B	1200	ft/h
MAX_LOG_SPEED	Toolstring Maximum Logging Speed	WLSESSION	1440	ft/h
MAX_TOOL_SPEED	Maximum service speed allowed for, or attained by, a logging tool.	CMRT-B	1440	ft/h
NECH_V	Number of Echo Amplitudes Vector	CMRT-B	[1800, 30, 0, 0, 0, 0]	
NWT	Number of Wait Times	CMRT-B	2	
PT_V	Polarization Times Vector	CMRT-B	[4.8, 0.02, 0, 0, 0, 0]	s
RPTN_V	Number of Repetitions Vector	CMRT-B	[1, 10, 0, 0, 0, 0]	
SLUINT	Station Log Sample Rate	CMRT-B	0	s
TCP_V	Echo Spacings Vector	CMRT-B	[200, 200, 0, 0, 0, 0]	us
WT_V	Wait Times Vector	CMRT-B	[1.25, 0.02, 0, 0, 0, 0]	s

1A

REPEAT

Pass Summary

Run Name	Pass Objective	Direction	Top	Bottom	Start	Stop	DSC Mode	Depth Shift	Include Parallel Data
1A	Log[5]:Up	Up	602.37 ft	890.78 ft	17-Feb-2021 2:56:14 PM	17-Feb-2021 3:14:10 PM	ON	1.69 ft	Yes

All depths are referenced to toolstring zero

Log

Company:Water Replenishment District Well:Montebello #2

1A: Log[5]:Up:S014

Description: CMRTB Depth Log Main Format Format: Log (CMRTB Depth Log Main-bins) Index Scale: 5 in per 100 ft Index Unit: ft Index Type: Measured Depth Creation Date: 17-Feb-2021 22:24:31

Log Quality Control Display (LQC_DISPLAY) CMRT-B

1 - BHS - Bad Hole Flag :	Good	Bad		
2 - IWT - Wait Time :	OK	Insufficient		
3 - DB0 - Delta B0 :	OK	Warning	Error	
4 - EEN - Early Echo Noise :	OK	Warning	Error	
5 - HVL - High Voltage :	Normal	Too Low		
6 - ATS - Auto Tuning :	ALF	Ant	Temp	Off
7 - ATTS - AT Tracking :	OK	Warning		

TIME_1900 - Time Marked every 60.00 (s)

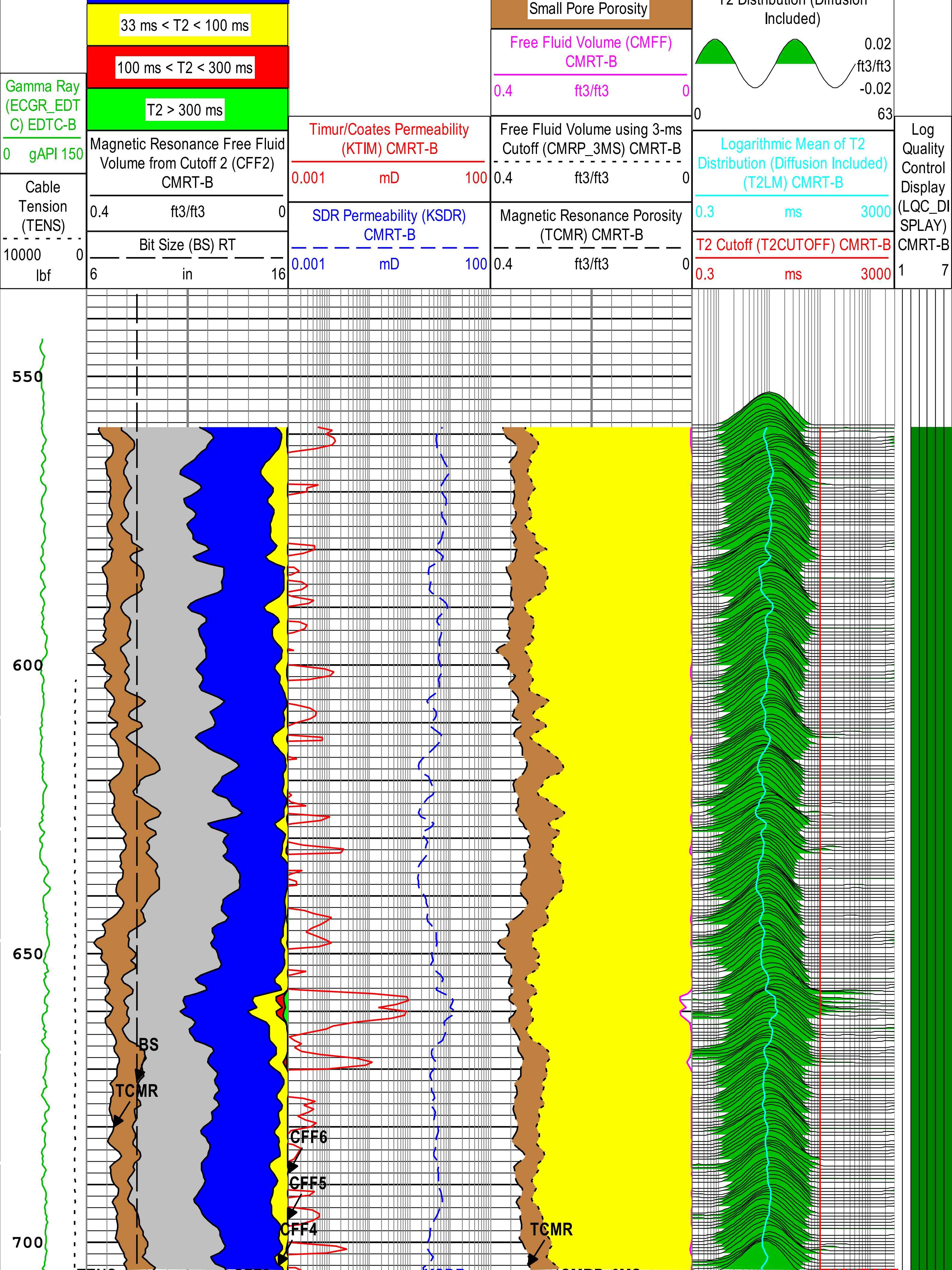
T2 < 3 ms

3 ms < T2 < 10 ms

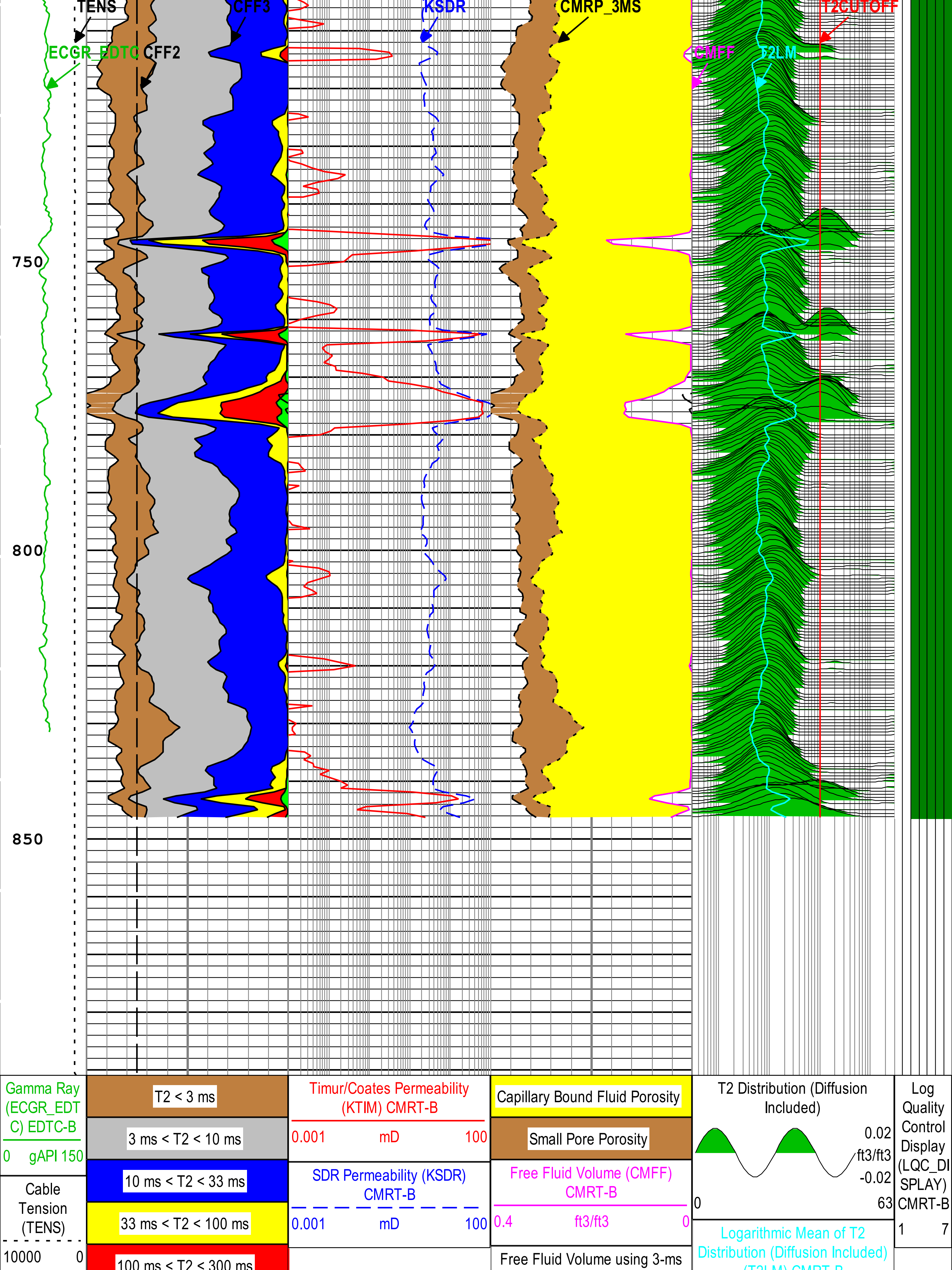
10 ms < T2 < 33 ms

Capillary Bound Fluid Porosity

T2 Distribution (Diffusion



33 ms < T2 < 100 ms
100 ms < T2 < 300 ms
T2 > 300 ms
Gamma Ray (ECGR_EDTC) EDTC-B
0 gAPI 150
Cable Tension (TENS)
10000 0
lbf
Magnetic Resonance Free Fluid Volume from Cutoff 2 (CFF2) CMRT-B
0.4 ft3/ft3 0
Bit Size (BS) RT
6 in 16
Timur/Coates Permeability (KTIM) CMRT-B
0.001 mD 100
SDR Permeability (KSDR) CMRT-B
0.001 mD 100
Small Pore Porosity
Free Fluid Volume (CMFF) CMRT-B
0.4 ft3/ft3 0
Free Fluid Volume using 3-ms Cutoff (CMRP_3MS) CMRT-B
0.4 ft3/ft3 0
Magnetic Resonance Porosity (TCMR) CMRT-B
0.4 ft3/ft3 0
T2 Distribution (Diffusion Included)
0.02
ft3/ft3
-0.02
0 63
Logarithmic Mean of T2 Distribution (Diffusion Included) (T2LM) CMRT-B
0.3 ms 3000
T2 Cutoff (T2CUTOFF) CMRT-B
0.3 ms 3000
Log Quality Control Display (LQC_DISPLAY) CMRT-B
1 7
550
600
650
700
BS
TCMR
CFF6
CFF5
CFF4
TCMR



TENS
CFF3
KSDR
CMRP_3MS
T2CUTOFF
ECGR_EDTC
CFF2
CMFF
T2LM
750
800
850
Gamma Ray (ECGR_EDTC) EDTC-B
0 gAPI 150
Cable Tension (TENS)
10000 0
T2 < 3 ms
3 ms < T2 < 10 ms
10 ms < T2 < 33 ms
33 ms < T2 < 100 ms
100 ms < T2 < 300 ms
Timur/Coates Permeability (KTIM) CMRT-B
0.001 mD 100
SDR Permeability (KSDR) CMRT-B
0.001 mD 100
Capillary Bound Fluid Porosity
Small Pore Porosity
Free Fluid Volume (CMFF) CMRT-B
0.4 ft3/ft3 0
Free Fluid Volume using 3-ms
T2 Distribution (Diffusion Included)
0.02
ft3/ft3
-0.02
0
63
Logarithmic Mean of T2 Distribution (Diffusion Included)
Log Quality Control Display (LQC_DISPLAY) CMRT-B
1 7

lbf	T2 > 300 ms
	Magnetic Resonance Free Fluid Volume from Cutoff 2 (CFF2) CMRT-B 0.4 ft3/ft3 0
	Bit Size (BS) RT 6 in 16

Cutoff (CMRP_3MS) CMRT-B
0.4 ft3/ft3 0

Magnetic Resonance Porosity (TCMR) CMRT-B
0.4 ft3/ft3 0

(T2LM) CMRT-B
0.3 ms 3000

T2 Cutoff (T2CUTOFF) CMRT-B
0.3 ms 3000

TIME_1900 - Time Marked every 60.00 (s)

Log Quality Control Display (LQC_DISPLAY) CMRT-B

1 - BHS - Bad Hole Flag :	Good	Bad		
2 - IWT - Wait Time :	OK	Insufficient		
3 - DB0 - Delta B0 :	OK	Warning	Error	
4 - EEN - Early Echo Noise :	OK	Warning	Error	
5 - HVL - High Voltage :	Normal	Too Low		
6 - ATS - Auto Tuning :	ALF	Ant	Temp	Off
7 - ATTS - AT Tracking :	OK	Warning		

Description: CMRTB Depth Log Main Format Format: Log (CMRTB Depth Log Main-bins) Index Scale: 5 in per 100 ft Index Unit: ft Index Type: Measured Depth Creation Date: 17-Feb-2021 22:24:31

Channel Processing Parameters

1A: Parameters

Parameter	Description	Tool	Value	Unit
BARI(ISSBAR)	Barite Mud Presence Flag	Borehole	No	
BHS	Borehole Status (Open or Cased Hole)	Borehole	Open	
BS	Bit Size	WLSESSION	8.5	in
CALI_SHIFT	CALI Supplementary Offset	HDRS-H	0	in
CBLO	Casing Bottom (Logger)	WLSESSION	20	ft
CDEN	Cement Density	EDTC-B	2	g/cm3
DC_MODE	Depth Correction Mode	DepthCorrection	Real-time	
DFD	Drilling Fluid Density	Borehole	9.1	lbm/gal
GAMMA_REG	Regularization Factors	CMRT-B	[1.5, 1.5, 0, 0, 0, 0]	
GCSE_DOWN_PASS	Generalized Caliper Selection for WL Log Down Passes	Borehole	BS(RT)	
GCSE_UP_PASS	Generalized Caliper Selection for WL Log Up Passes	Borehole	CALI	
JOBID	Job Identification	WLSESSION	water well	
DDFL	Number of Stacking Levels	CMRT-B	3	
POLC_SW	Polarization Correction Switch	CMRT-B	Yes	
T1CUT	T1 Cutoff between BFV and FFV	CMRT-B	50	ms
T1T2R_IN	T1/T2 Ratio Input	CMRT-B	2	
T1T2R_MAX	T1/T2 Ratio Maximum	CMRT-B	3	
T1T2R_MIN	T1/T2 Ratio Minimum	CMRT-B	1	
T2CUT	T2 Cutoff between BFV and FFV	CMRT-B	100	ms
T2CUT_TAPER	Start of Tapered T2 Cutoff	CMRT-B	25	ms

Tool Control Parameters

1A: Parameters

Parameter	Description	Tool	Value	Unit
ACQ_METHOD_OPT	Acquisition Method Option	CMRT-B	SEQ	
LFST_ALF_OFFSET	Average of Auto-Larmor-Frequency Phase Difference during LFST	CMRT-B	0.45	deg

LFST_ALF_OFFSET_SD	Standard Deviation of Auto-Larmor-Frequency Phase Difference during LFST	CMRT-B	0.12	deg
DHC_VERS	DH Controller Code Version	CMRT-B	17	
DLSR	Depth Log Sample Rate	CMRT-B	7.5	in
DSP_VERS	DH Signal Processing Code Version	CMRT-B	14	
EPM_OPT	Enhanced Precision Mode Option	CMRT-B	On	
FREQ_OP_PREV	Operating Frequency, prior to new LFST, at LFST Temperature	CMRT-B	2190	kHz
LFST_CENTER_FREQ	LFST Central Frequency	CMRT-B	2200	kHz
LFST_SEARCH_FREQ	LFST Frequency	CMRT-B	2201	kHz
LFST_TEMP	LFST Temperature	CMRT-B	85	degF
LFST_TEMP_DELTA	LFST Temperature Variation	CMRT-B	32.42	degF
LFST_TT_OFFSET	LFST Tune Table Offset	CMRT-B	1.5	kHz
CMR_LOG_DIRECTION	Logging Direction	CMRT-B	Up	
PPSS	Logging Mode for CMR	CMRT-B	DEPTH_B_MODE_CARBONATE	
CMR_LOG_SPEED	Optimal Logging Speed	CMRT-B	1200	ft/h
MAX_LOG_SPEED	Toolstring Maximum Logging Speed	WLSESSION	1440	ft/h
MAX_TOOL_SPEED	Maximum service speed allowed for, or attained by, a logging tool.	CMRT-B	1440	ft/h
NECH_V	Number of Echo Amplitudes Vector	CMRT-B	[1800, 30, 0, 0, 0, 0]	
NWT	Number of Wait Times	CMRT-B	2	
PT_V	Polarization Times Vector	CMRT-B	[4.8, 0.02, 0, 0, 0, 0]	s
RPTN_V	Number of Repetitions Vector	CMRT-B	[1, 10, 0, 0, 0, 0]	
SLUINT	Station Log Sample Rate	CMRT-B	0	s
TCP_V	Echo Spacings Vector	CMRT-B	[200, 200, 0, 0, 0, 0]	us
WT_V	Wait Times Vector	CMRT-B	[1.25, 0.02, 0, 0, 0, 0]	s

Calibration Report

CMRT-B (Combinable Magnetic Resonance Tool - BA/BB/VA/BAH) Calibration - Run 1A

Primary Equipment :

CMRT Normal Pressure Sonde	CMRS	340

Auxiliary Equipment :

CMRT Cartridge Element 30kpsi	CMRC	349

CMRT Water Bottle Calibration - Water Bottle Calibration

Master (EEPROM): 20:30:00 06-Jan-2021

Measurement	Unit	Phase	Nominal	Low Limit	Actual	High Limit	
Reciprocal of the MC Amplitude Corrected to 25 degC		Master	0.030	0.020	0.033	0.040	
Test Loop Amplitude During MC		Master	2350.000	1500.000	2170.157	3200.000	
Oper Freq During MC	kHz	Master	2240.000	2130.000	2199.000	2350.000	
Sonde Temp During MC	degF	Master	80.600	50.000	68.551	111.200	
Noise Per Echo - 0	ft3/ft3	Master	-----	-----	-----	-----	
Signal-to-Noise Ratio for MC - 0		Master	-----	-----	-----	-----	
Log Mean of the T2 Dist - 0	ms	Master	-----	-----	-----	-----	

EDTC-B (Enhanced Digital Telemetry Cartridge - Version B) Calibration - Run 1A

Primary Equipment :

EDTC-B	EDTC-B	8437

Calibration Parameter :

Plus Reference (Jig minus background reference)	150

EDTC-B Accelerometer Calibration - EDTC-B Accelerometer Calibration

Before (Measured): 12:42:27 17-Feb-2021

Measurement	Unit	Phase	Nominal	Low Limit	Actual	High Limit	
AZ Vertical Measurement	ft/s2	Before	32.19	31.53	31.55	32.84	

EDTC-B Memory Data - EDTC-B Memory Data

EDTC-B Memory Data - EDTC-B Memory Data

Master (EEPROM): 12:37:55 17-Feb-2021

Measurement	Unit	Phase	Nominal	Low Limit	Actual	High Limit
Initial PMT HV	V	Master			1515.000	
Accelerometer Serial Number		Master			580	
Accelerometer Coefficients - 0		Master	-----	-----	3.032E+000	-----
Accelerometer Coefficients - 1		Master	-----	-----	3.387E-004	-----
Accelerometer Coefficients - 2		Master	-----	-----	-4.036E-007	-----
Accelerometer Coefficients - 3		Master	-----	-----	-9.753E-008	-----
Accelerometer Coefficients - 4		Master	-----	-----	2.363E-009	-----
Accelerometer Coefficients - 5		Master	-----	-----	-1.798E-011	-----
Accelerometer Coefficients - 6		Master	-----	-----	4.607E-014	-----
Accelerometer Coefficients - 7		Master	-----	-----	-8.596E-003	-----
Accelerometer Coefficients - 8		Master	-----	-----	6.136E-005	-----
Accelerometer Coefficients - 9		Master	-----	-----	1.184E-008	-----
Accelerometer Coefficients - 10		Master	-----	-----	2.611E-010	-----
Accelerometer Coefficients - 11		Master	-----	-----	-2.798E-012	-----
Gamma-Ray Detector Serial Number		Master			7670	

EDTC-B Gamma-Ray Calibration - Gamma Ray Coefficients

Before (Measured): 16:48:39 16-Feb-2021

Measurement	Unit	Phase	Nominal	Low Limit	Actual	High Limit
Gamma Ray Gain		Before	1.000	0.900	0.931	1.100

EDTC-B Gamma-Ray Calibration - Gamma Ray Accumulations

Before (Measured): 16:48:39 16-Feb-2021

Measurement	Unit	Phase	Nominal	Low Limit	Actual	High Limit
RGR Zero Measurement	gAPI	Before		0	52.556	120.000
RGR Plus Measurement	gAPI	Before	150.000	135.000	161.160	165.000

County:	Los Angeles
State:	California

COMBINABLE MAGNETIC RESONANCE TOOL

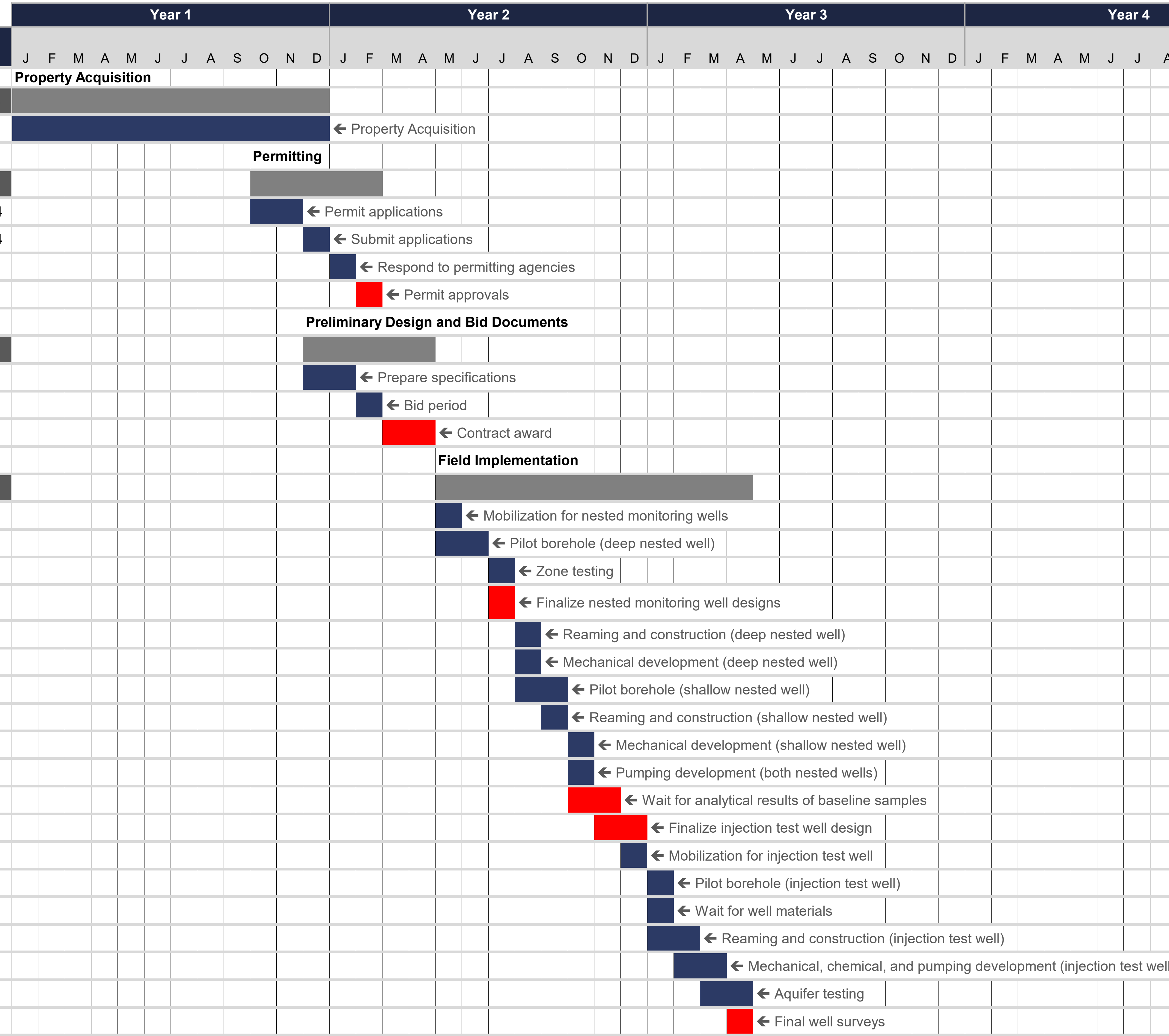
GR

Attachment 5
Preliminary Implementation Schedule

Injection Test Well Implementation Schedule

Joint Los Angeles Basin Replenishment and Extraction Master Plan

TASK DESCRIPTION	PLAN START	PLAN END
Property Acquisition	Year 1 Q1	Year 1 Q4
Secure property for injection test well	Year 1 Q1	Year 1 Q4
…		
Permitting	Year 1 Q 4	Year 2 Q1
Permit applications	Year 1 Q 4	Year 1 Q 4
Submit permit applications	Year 1 Q 4	Year 1 Q 4
Respond to questions and comments from permitting agency	Year 2 Q1	Year 2 Q1
Permit approvals	Year 2 Q1	Year 2 Q1
…		
Preliminary Design and Bid Documents	Year 1 Q 4	Year 2 Q2
Prepare specifications	Year 1 Q 4	Year 2 Q1
Bid period	Year 2 Q1	Year 2 Q1
Contract award	Year 2 Q1	Year 2 Q2
…		
Field Implementation	Year 2 Q2	Year 3 Q2
Utility clearance, mobilize drill rig, and install conductor casings	Year 2 Q2	Year 2 Q2
Drill pilot borehole for deep nested well and geophysics	Year 2 Q2	Year 2 Q2
Perform isolated aquifer zone testing	Year 2 Q3	Year 2 Q3
Receive analytical results for isolated aquifer zone test samples and finalize design of shallow and deep nested monitoring wells	Year 2 Q3	Year 2 Q3
Ream borehole and construct deep nested well	Year 2 Q3	Year 2 Q3
Initial mechanical development of deep nested well	Year 2 Q3	Year 2 Q3
Drill pilot borehole for shallow nested well	Year 2 Q3	Year 2 Q3
Ream borehole and construct shallow nested well	Year 2 Q3	Year 2 Q3
Initial mechanical development of shallow nested well	Year 2 Q4	Year 2 Q4
Pumping development and baseline sampling of nested wells	Year 2 Q4	Year 2 Q4
Receive analytical results for baseline water samples	Year 2 Q4	Year 2 Q4
Finalize design for injection test well	Year 2 Q4	Year 2 Q4
Mobilize rig for injection test well	Year 2 Q4	Year 2 Q4
Pilot borehole drilling and geophysics for injection test well	Year 3 Q1	Year 3 Q1
Well material manufacture and delivery	Year 3 Q1	Year 3 Q1
Ream and construct injection test well	Year 3 Q1	Year 3 Q1
Mechanical, chemical, and pumping development for injection test well	Year 3 Q1	Year 3 Q1
Aquifer testing and water quality sampling	Year 3 Q1	Year 3 Q2
Final surveys, disinfection, and capping	Year 3 Q2	Year 3 Q2



TASK DESCRIPTION	PLAN START	PLAN END	Year 1–Year 4 (J F M A M J J A S O N D …)
…			Data Evaluation
Data Evaluation	Year 3 Q2	Year 3 Q3	
Hydrogeologic characterization	Year 3 Q2	Year 3 Q3	← Hydrogeologic characterization
Geochemical compatibility evaluation	Year 3 Q2	Year 3 Q3	← Geochemical compatibility evaluation
Groundwater model refinement and additional modeling (if needed)	Year 3 Q3	Year 3 Q3	← Groundwater model refinement
…			Recommendations
Recommendations	Year 3 Q3	Year 3 Q4	
Report documenting findings	Year 3 Q3	Year 3 Q4	← Prepare report
Cost estimates for injection testing and full-scale wellfield	Year 3 Q4	Year 3 Q4	← Prepare cost estimate
Proposed implementation schedule	Year 3 Q4	Year 3 Q4	← Prepare implementation schedule
…			

Appendix I
TM 6.2.1-LVL Water Balance Model Summary

Jacobs

Memorandum

1000 Wilshire Boulevard, Suite 1140
Los Angeles, California 90017
United States
T +1.213.538.1388
F +1.230.538.1399
www.jacobs.com

Subject	**Technical Memorandum 6.2.1 – Leo J. Vander Lans Water Balance Model Technical Memorandum – Final**
Project Name	WRD and LADWP Joint Los Angeles Basin Replenishment and Extraction Master Plan
Date	July 14, 2021 (Revised)

1. Introduction

This technical memorandum provides interim documentation of the Leo J. Vander Lans Advanced Water Treatment Facility (LVL AWTF) water balance modeling effort. The contents of this document will be reviewed by WRD and their stakeholders for decision-making purposes regarding how to move forward with the expansion of advanced treated water production using available flows at the Long Beach Water Reclamation Plant (WRP), a10,000-acre-foot-per-year (AFY) allocation at the Los Coyotes WRP, and available space on either existing facility site. The goal of this document is to clarify assumptions and present the latest model scenarios from the LVL/Los Coyotes WRP Water Balance Model. The next step in the study is to test scenarios of groundwater injection flows and extractions with the basin groundwater model.

The expansion options for advanced water treatment plant (AWTP) capacity and location are driven by different system conditions. The following model scenarios have been developed to identify, with an initial high-level planning analysis, the AWTP expansion capacity and equalization tank size that would be required under the following conditions:

- Los Coyotes WRP production allocated to recycled water demands would be based on current deliveries.
- Los Coyotes WRP production allocated to demands would be increased to maximize current contracted allocations.
- Long Beach WRP inflows to the LVL AWTF expansion would be kept to the minimum described under the Recycled Water Supply for LVL AWTF contract (Agreement WD-3535).
- Long Beach WRP inflows to the LVL AWTF expansion would be increased based on availability (per historical production), limited to 9 million gallons per day (MGD) (per Agreement WD-3535).

Figure 1 shows the size of the plant and the associated equalization storage that would minimize the unit cost (dollars per acre-foot) of the water after the project has been implemented.

Figure 1 illustrates the main uncertainties in the system with the target maximum supplies available and the range of possible treatment plant size and equalization storage obtained after many simulations. The figure also shows the current uncertainty of unit cost for the final produced water.

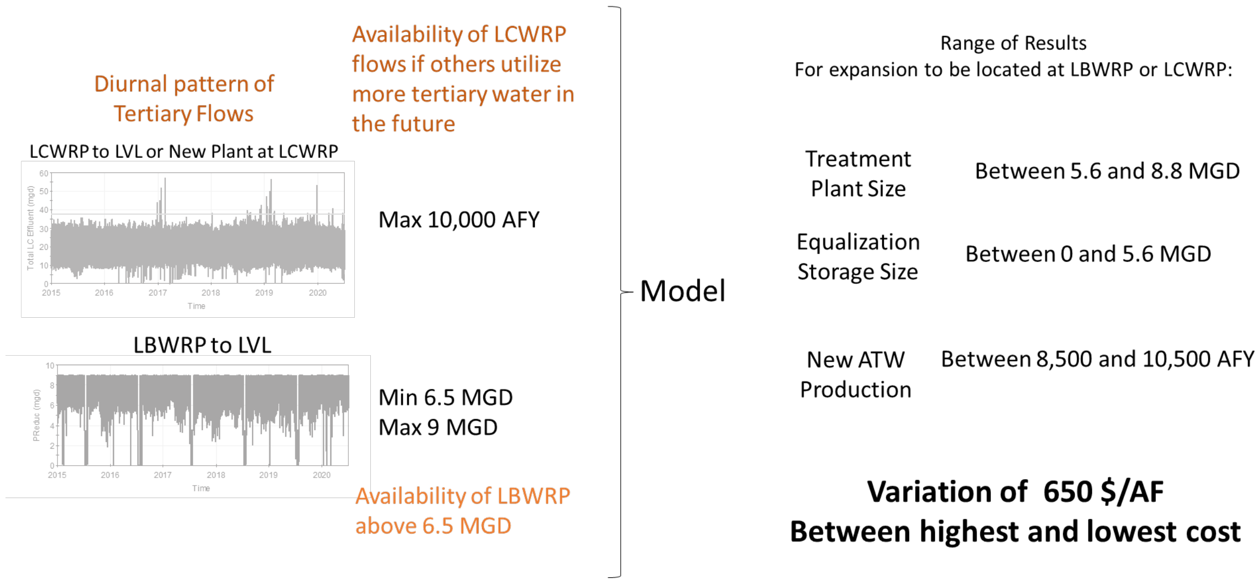


Figure 1. System Uncertainties
ATW = advanced treated water
LBWRP = Long Beach Water Reclamation Plant
LCWRP = Los Coyotes Water Reclamation Plant

2. Methodology and Assumptions

The LVL/Los Coyotes WRP Water Balance Model tool was developed to better understand a potential expansion of advanced treated water in the Central Basin. The model has been developed to evaluate multiple possible system scenarios and to better understand uncertainties related to:

- Potential source water supplies to the new AWTP
- Diurnal flow patterns in source water supplies
- Location of the expansion
- Cost of product water
- Optimal advanced treated water production
- Impact on ability of a scenario to meet demand at the Alamitos Barrier

Figure 2 shows the system schematic and illustrates the potential system configurations. The project would have two main distinct phases:

- Phase 1, Steady State Operations: During this phase, the LVL AWTF will ramp up to its maximum production capacity with supplies from the Long Beach WRP. This phase might not support the implementation of an inland wellfield, and all production could be injected at the Alamitos Barrier and the 2-MGD LVL AWTF onsite well.
- Phase 2, Augmentation: This phase includes additional advanced treated water production, either at the LVL AWTF location or at the Los Coyotes WRP. The additional advanced treated water could increase deliveries to the Alamitos Barrier or be injected at a new wellfield for extraction during the same year, in accordance with basin augmentation requirements.

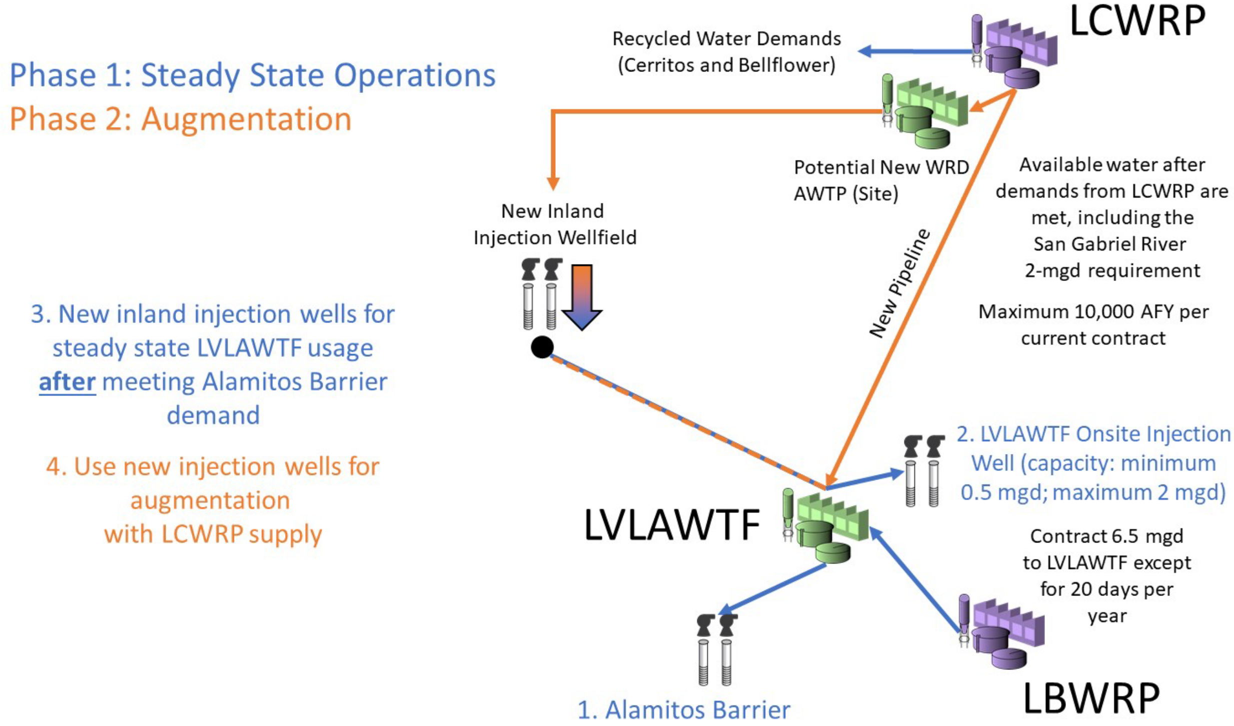


Figure 2. System Schematic Showing Main Project Components by Phase

2.1 Supplies and Demands

Two sources of supplies for advanced treated water have been considered in the model simulations:

- Los Coyotes WRP: The current contractual agreement between the Water Replenishment District of Southern California (WRD) and Sanitation Districts of Los Angeles County is for 10,000 AFY of deliveries of tertiary water from the Los Coyotes WRP to WRD.
- Long Beach WRP: The contract between WRD and Long Beach Water Department guarantees a minimum of 6.5 MGD of tertiary flow, except for 20 days of the year. The 6.5-MGD average could increase depending on diurnal production patterns, but will not exceed 9 MGD[1] (per Agreement WD-3535).

Historical production data from the Los Coyotes WRP and the Long Beach WRP were obtained for January 2015 to July 2020. The original dataset that was provided had some gaps and some periods when operation was abnormally low because of operational interruptions. Per input from the Sanitation Districts of Los Angeles County, a new dataset was created that adjusted the low production values to the more consistent production expected in the future.

It is expected that the water reclamation plants will not experience the reduction of flows that has occurred in the past, which was based on site-specific challenges and not inflow availability; therefore, the time series of historical effluent from the Los Coyotes WRP and the Long Beach WRP have been adjusted

[1] The availability of flows beyond the 6.5-MGD contractual maximum will depend on the allocation of Long Beach WRP flows to other potential recycled water uses.

based on past, normal operating flows. The adjustment to hourly flows has been based on the historical average diurnal pattern and the standard deviation of these measurements. Figure 3 and Figure 4 present the adjustment results as daily averages, which display more clearly than the corrected hourly data.

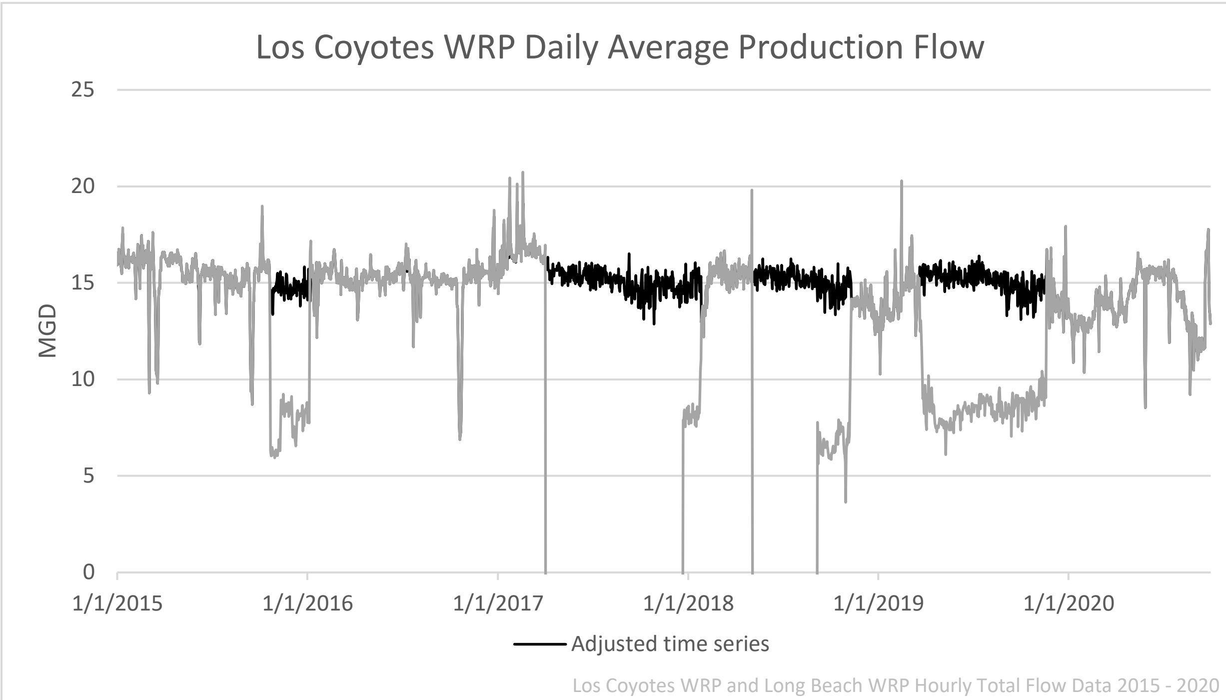


Figure 3. Original versus Adjusted Los Coyotes WRP Average Daily Production

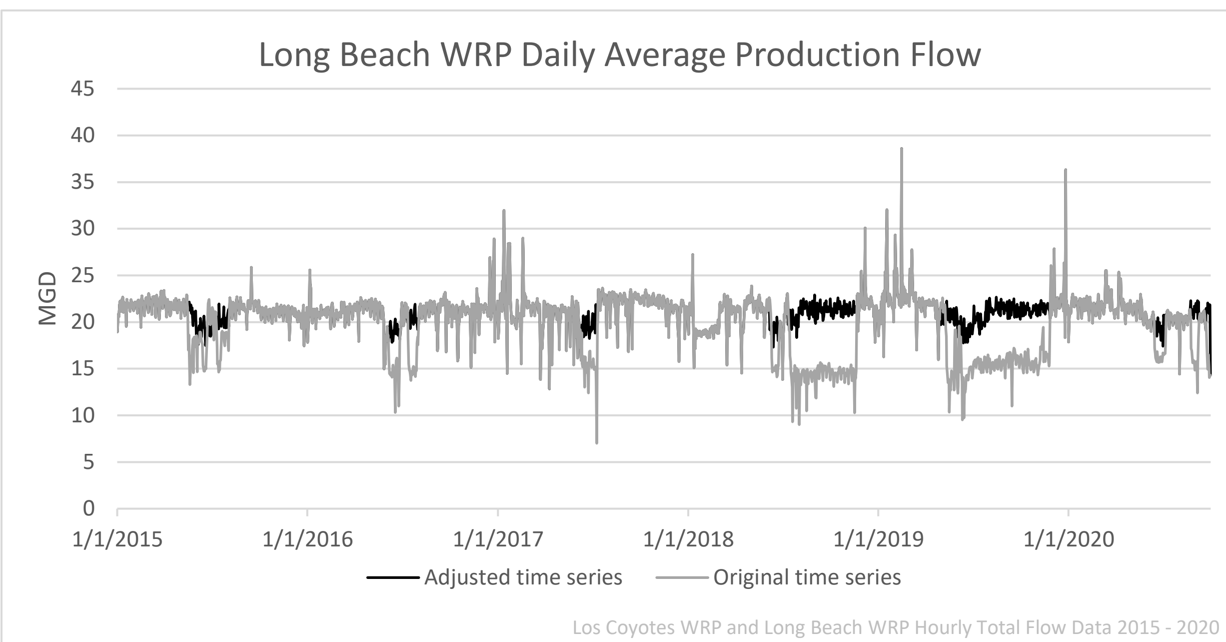


Figure 4. Original versus Adjusted Long Beach WRP Average Daily Production

Data gaps on demands have also been corrected. The same methodology applied to adjust the time series for the Long Beach WRP and the Los Coyotes WRP has been applied to the Long Beach WRP demands for tertiary water. Historical demands fulfilled by the Los Coyotes WRP (that is, to the cities of Cerritos and Bellflower) that had a gap on the hourly time step have been corrected with the daily average (available at all time steps) multiplied by the average diurnal pattern.

2.2 System Assumptions

The main assumptions driving the modeling results are related to:

- Availability of supplies
- Usage of available supplies (contractual, annual volumes)
- How future demands vary between series “a” (current recycled water demands) and series “b” (recycled water volumes equal contracted allocations)
- Size of advanced water treatment facilities

The availability of supplies is driven by the Long Beach WRP and Los Coyotes WRP production diurnal patterns. This analysis assumes that the recent historical production will remain the same for the near future, neither increasing nor decreasing tertiary effluent production. Future model scenarios could consider growth projections that could impact wastewater production and therefore change the tertiary water output.

WRD’s contracted allocation for the Los Coyotes WRP tertiary effluent is set at 10,000 AFY. The model keeps track of an annual moving average of WRD’s usage of the 10,000-AFY allocation. The inflow from the Los Coyotes WRP is capped at 8.921 MGD (10,000 AFY) whenever the 1-year moving average exceeds 10,000 AFY. In the absence of a more discrete flow limitation (for example, hourly, daily, or monthly), the 10,000-AFY limit is thus assumed to be the limit.

Figure 5 depicts the prioritization of Long Beach WRP effluent usage. Jacobs assumed that the LVL AWTF expansion will have priority for the first 6.5 MGD produced, followed by other recycled water demands from the Long Beach WRP. If there is additional Long Beach WRP effluent available after these demands have been met, it could also be sent to the LVL AWTF, as long as the total effluent from the Long Beach WRP to the LVL AWTF does not exceed 13.9 cubic feet per second (equivalent to 9 MGD) (per Agreement WD-3535).

A reduction in Long Beach WRP effluent to the LVL AWTF has been applied to the model to mimic potential effluent reductions described in the contract (Agreement WD-3535). The reduction assumes that, during the month of July (when there are higher recycled water demands), the Long Beach WRP effluent will drop to 3.5 MGD for 5 days, then to 0 MGD for 10 days, and then back to 3.5 MGD for 5 days.

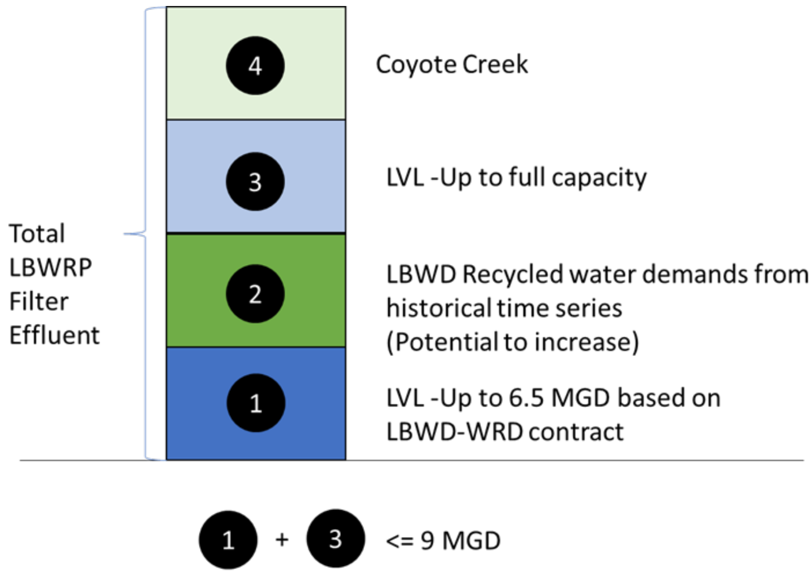


Figure 5. Long Beach WRP Order of Priority for Effluent Usage

Some model scenarios assume that Los Coyotes WRP demands could increase to their maximum contracted allocations. The maximum allocation determined by the contracted flows for the cities of Bellflower and Cerritos is 10,500 AFY. The current historical average usage of recycled water is 3,977 AFY. A factor of 2.64 (10,500/3,977) has been applied to diurnal hourly historical demands for scenarios that assume increased usage of Los Coyotes WRP allocation by current users. Figure 6 shows how the diurnal historical and modified increased demand patterns compare against the average Los Coyotes WRP production. The figure shows the average diurnal values for the entire historical dataset available. The following approach assumes that if usage of recycled water increases in the future, it will be for the same purposes as in the past; therefore, the diurnal pattern will remain the same, but will be scaled so that the maximum allocation is used. This approach does not necessarily guarantee that the maximum allocation will always be met because the allocation is always dependent on the Los Coyotes WRP production patterns. For example, there may be times when the adjusted demand (demand x 2.64) may be above the Los Coyotes WRP production at a specific hour of the day. This condition will prevent the model from reaching the maximum allocation for the agencies.

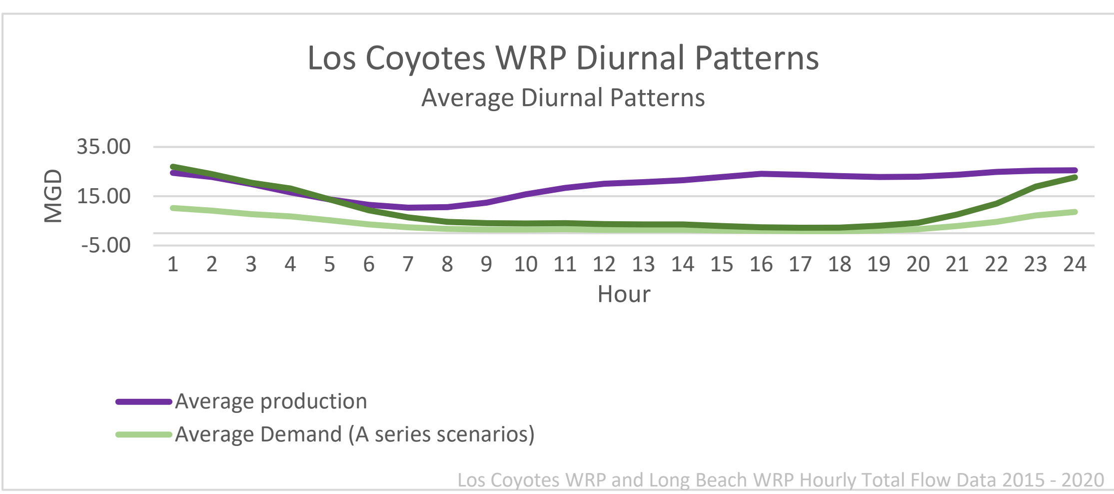


Figure 6. Los Coyotes WRP Average Adjusted Demands versus Average Production

2.3 Input Variables

The different model runs (scenarios) have been based on different sizes of AWTPs, locations of the treatment plants, sizes of equalization storage, demand adjustments, and availability of inflows from the Long Beach WRP. The input variations are as follows:

- Location of the expansion: On the Los Coyotes WRP property or adjacent to the Long Beach WRP
- Size of the expansion: Variable, the initial estimate will double the current LVL AWTF capacity of 8-MGD product water
- Equalization storage – Variable, between 0.1 to 6 million gallons (MG)

The varied uses of the advanced treated water are also included as an input variable for the model runs in which the expansion was located at the Long Beach WRP. In that case, the advanced treated water could supply the demands of the Alamitos Barrier in addition to a new wellfield. This assumption only impacts the size of the wellfield downstream of the new AWTP expansion. The Alamitos Barrier demands have priority for the AWTP production; so, a reduced volume of new advanced treated water production would go to the new wellfield to be injected as part of a water augmentation project. Figure 7 shows the Alamitos Barrier demand pattern in the model based on the historical monthly pattern applied to a 6-MGD average demand.

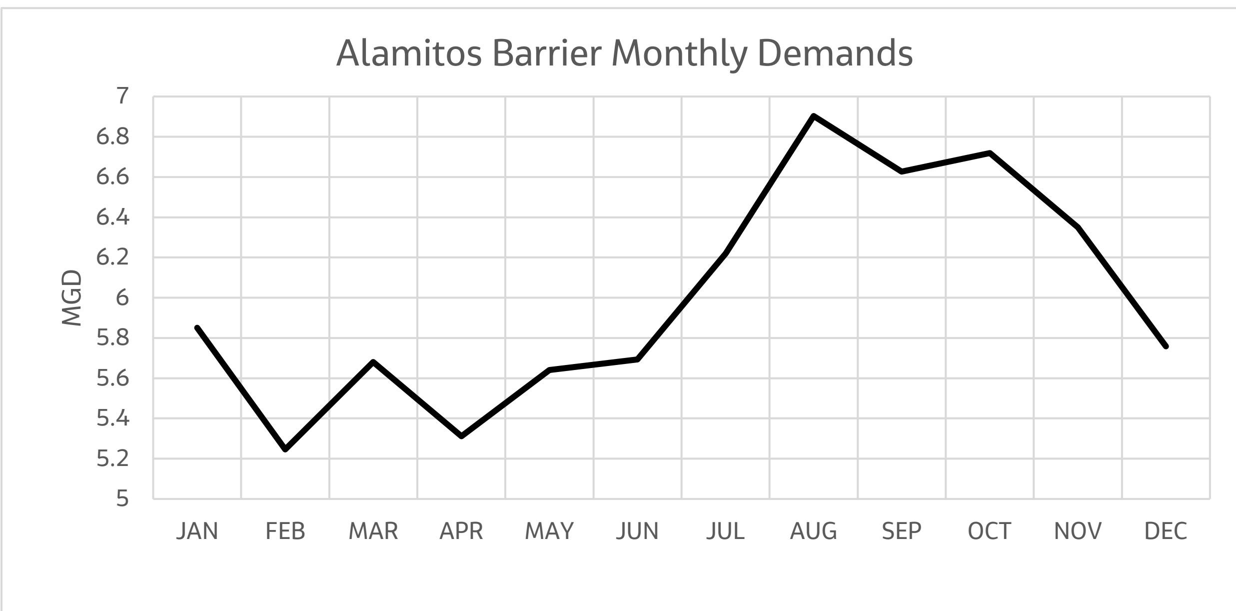


Figure 7. Estimated Future Alamitos Barrier Demands

Installation of a new 2-MGD injection well has been planned onsite at the LVL AWTF. The intent of this well is for use when the advanced treated water from the LVL AWTF cannot be sent to the Alamitos Barrier.

The initial modeling runs included the previously noted assumptions. Many model runs were performed with different combinations of plant capacities and equalization storage sizes, and the results were evaluated to identify the best combination (use of 10,000 AFY of WRD's Los Coyotes WRP contract at a low cost) of project component sizes. The LVL/Los Coyotes Water Balance Model was then updated, including the cost for the facilities (refer to Section 2.4).

2.4 Cost Assumptions for Model Optimization

Table 1 presents the cost elements that have been included in the model and considered in the optimization for the combination of facility sizes.

Table 1. Cost Assumptions Used in the Optimization of Facility Sizes

	Long Beach WRP	Los Coyotes WRP
Site adders	$6,266,667	$5,848,600
Sewer connection	$2,850,000	$3,400,000
Pipeline from the Los Coyotes WRP to the Long Beach WRP	$20,004,000	Not applicable
Plant	~ $10 million/MGD	~ $10 million/MGD
Equalization storage	~ $2.25 million/MG	~ $2.25 million/MG
Pipeline from the AWTP to the injection wellfield	$2.9 million per mile	$2.9 million per mile
Sewer surcharges	$442,500 per year	$567,000 per year
Operations	$6,800,000 per year	$6,800,000 per year

Note:
~ = approximately

The costs in Table 1 have been used in the optimization modeling runs to achieve the best combinations of treatment size and equalization storage for the different model scenarios and system configurations. The Leo J. Vander Lans Advanced Water Treatment Facility Expansion Feasibility Technical Memorandum (Appendix J) details the assumptions of the listed costs.

Under scenarios that assumed expanded advanced water treatment production at the Long Beach WRP, the assumptions for conveyance of supplies from the Los Coyotes WRP to Long Beach WRP and LVL AWTF are as follows:

- Approximately 6 miles long
- Assumed average daily flow of 8.7 MGD
- Maximum flow of 10.5 MGD
- 24 inches in diameter

The pipeline cost estimate ranged from $14,003,000 to $30,006,000, with $20,004,000 as the average cost. The model runs have used the average cost estimate.

The pipeline cost from the AWTP expansion (at Long Beach WRP and Los Coyotes WRP) to the injection wellfield has been estimated at $2.9 million per mile, based on recent estimates of pipeline costs prepared for the Joint Los Angeles Basin Replenishment and Extraction Master Plan. This pipeline cost is applied only to the pipeline conveying advanced treated water from the new AWTP expansion location to the wellfield. For these pipelines going from the AWTP to the wellfields, there is uncertainty regarding the cost per mile (model runs used $2.9 million per mile) and the length of pipes to the wellfield. Figure 8 shows potential injection well locations and the approximate distances of pipes needed. Preliminary injection locations were identified based on the average transmissivity values from the Los Angeles Coastal Plain groundwater model (LACPGM), and proximity to active production wells. Average transmissivity in square feet per day (ft^2/day) was calculated as the arithmetic average of transmissivities of all the model layers in the LACPGM. The calculated transmissivities were grouped in to three categories: high (> 10,000 ft^2/day), medium (5,000 – 10,000 ft^2/day) and low (< 5,000 ft^2/day) transmissivities for identifying the preliminary locations. Production well data were obtained from the WRD's GIS Hub, and filtered for active production wells. Figure 8 shows the preliminary injection locations near the Los Coyotes WRP and the LVL AWTF.

Each scenario has assumed minimum and maximum pipe lengths. The model results in this document assume the average of the pipeline length possible for each scenario. For example, scenarios where the expansion has been located at the Long Beach WRP, pipe lengths have been considered to be:

- 6 miles from the Los Coyotes WRP to the LVL AWTF at a cost of $20,004,000
- 2.4 miles (an average of 1.3 and 3.5 miles) from the AWTP to the injection wellfield at $2.9 million per mile

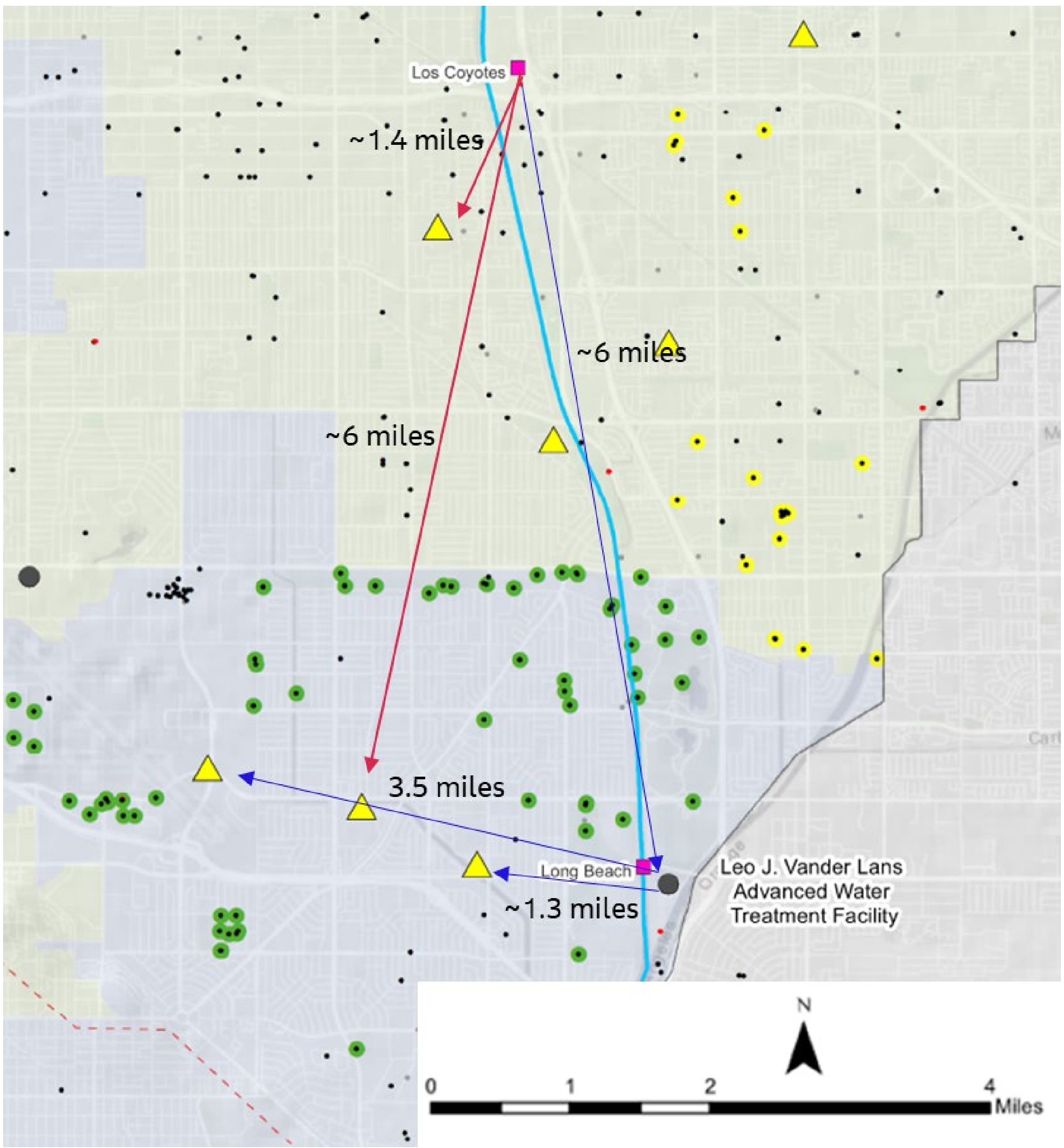


Figure 8. Approximate Pipeline Distances from Expanded Advanced Water Treatment Production to New Injection Wellfields

The costs do not include the new wellfield that would be needed for injection. Jacobs assumes that all model runs will have a similar cost for the wellfields although the size of the wellfields might vary across scenarios. In some scenarios, the size of the wellfield might be smaller than others, resulting in a potential cost difference. WRD and the stakeholders will refine wellfield cost estimates in a later phase, after injection locations have been identified and refined.

All costs in Table 1 have been added to develop the estimated total cost to implement the AWTP, with the exception of the annual sewer surcharges and annual operations costs. The cost to implement the AWTP has been converted into an annual cost based on a 30-year, 3% interest rate bond and has been added to the annual costs of sewer surcharges and plant operation to develop a total annual cost.

The final unit cost for the new advanced treated water produced has been determined by dividing the annual cost by the average annual production exceeding the 6,300 AFY (5.2 MGD) that was determined to be the current baseline production of the LVL AWTF without any expansion.

2.5 Cost Range

In addition to the costs that have been used in the model, a cost range has been developed to estimate the unit cost of new produced water for different model scenarios. The intent of the cost range is to provide an indication of the extent of the cost variation for the many items that comprise the cost of the project.

Table 2 shows the range of potential facility sizes from the many different model scenarios that have been considered for the range of costs. The sizes of the facilities in Table 2 are not necessarily associated with viable scenarios; rather, they have been modeled to develop the variation of cost for the different items of the project. For example, when an expansion is considered at the Los Coyotes WRP location, Table 2 lists a high bookend based on the costs of a project with a 9-MGD plant and 8.8- to 3.3-MG equalization storage. These costs do not correspond to one scenario that has the facilities at these sizes, but sizes that have been observed individually from many scenarios run since the beginning of this study. Although the maximum bookend will probably meet all project needs, the minimum bookend combination of sizes will not meet the requirement of utilizing the full 10,000 AFY of Long Beach WRP supplies under all potential scenarios.

Table 2. Range of Potential Costs Related to Project Implementation

		Expansion at Long Beach WRP		Expansion Los Coyotes WRP	
		Low	**High**	**Low**	**High**
Plant Size	MGD	5.6	8.1	8.2	8.8
Equalization Storage	MG	0.9	3.8	0	3.3
AWTP Capital Cost					
Construction	$	$35,759,395	$78,154,106	$52,361,972	$84,908,164
Engineering, CM, Permitting	$	$7,151,879	$15,630,821	$10,472,394	$16,981,633
Equalization Tank					
Size	$	$3,690,000	$9,119,000	$0	$8,316,000
Site Adders					
Adders	$	$6,266,667	$6,266,667	$5,848,600	$5,848,600
Sewer					
Connection Fees		$2,500,000	$3,200,000	$3,400,000	$3,400,000

Table 2. Range of Potential Costs Related to Project Implementation

		Expansion at Long Beach WRP		Expansion Los Coyotes WRP	
		Low	**High**	**Low**	**High**
Pipeline					
Los Coyotes to LVL AWTF		$14,003,000	$30,006,000	$0	$0
Production to Wellfield		$4,350,000	$11,600,000	$2,900,000	$20,300,000
Total	**$**	**$73,720,941**	**$153,976,594**	**$74,982,966**	**$139,754,397**
Assume 30-year 3% Interest Rate					
3%	$/year	$3,729,726	$7,790,058	$3,793,575	$7,070,522
Annual Costs					
Cost to Implement the AWTP	$/year	$3,729,726	$7,790,058	$3,793,575	$7,070,522
Plant Operation	$/year	$6,800,000	$6,800,000	$6,800,000	$6,800,000
Sewer	$/year	$432,000	$453,000	$567,000	$567,000
Total Annual	$/year	$10,961,726	$15,043,058	$11,160,575	$14,437,522
Assumed Production Ranges	AFY	8,900	10,500	8,500	9,900
Unit cost potential Range	**$/AF**	**$1,043.97**	**$1,690.23**	**$1,127.33**	**$1,698.53**

3. Model Runs

A matrix of assumptions was initially developed for the first model runs. Attachment 1 provides the initial matrix of assumptions with the initial scenarios. The initial scenarios were modified, and the following subsection presents the latest model scenarios.

3.1 Model Scenarios

The latest model scenarios have been determined based on the main system uncertainties related to plant inflows, options to feed the new AWTP, and options for advanced treated water usage. The combination of the different conditions related to the main system uncertainties has resulted in eight different scenarios independent of treatment capacity. Table 3 shows the eight scenarios. The three variations of the scenarios or main system uncertainties include:

- Use or no use of Long Beach WRP excess water (above 6.5 MGD) to backfill the LVL AWTF (Alternatives 1 and 2)
- Expansion at the Long Beach WRP/LVL AWTF site, or at the Los Coyotes WRP site
- Assumption that the allocation of Los Coyotes WRP production will be consistent with current use or will increase to the maximum allocation defined in existing contracts (Scenario Variations a and b)

Table 3. Latest Model Runs with Variations of Treatment Location, Use of Long Beach WRP Flows, and Los Coyotes WRP Plant Demand Variations

Alternatives	Expansion at Long Beach WRP*	Expansion at Los Coyotes WRP
Long Beach WRP excess backfills LVL AWTF	2a – Los Coyotes WRP allocation based on historical deliveries	3a – Los Coyotes WRP allocation based on historical deliveries
	2b – Los Coyotes WRP allocations to others maximized	3b – Los Coyotes WRP allocations to others maximized
Only minimum Long Beach WRP flows are used to backfill LVL AWTF	2a – Los Coyotes WRP allocation based on historical deliveries	3a – Los Coyotes WRP allocation based on historical deliveries
	2b – Los Coyotes WRP allocations to others maximized	3b – Los Coyotes WRP allocations to others maximized

* Long Beach WRP priority will use water provided by the Long Beach WRP in excess of the contract amount (~ 6.5 MGD). Approximate due to the 1 month that Long Beach WRP could provide less than 6.5 MGD.

All model scenarios are consistent with the assumptions in Section 2.2.

The latest model update has included costs for the system (Section 2.4). With the costs incorporated in the model, the selection of best expansion size and equalization storage has been based on maximum utilization of the WRD 10,000-AFY supply allocation from the Los Coyotes WRP, and a minimum unit cost of water for the project. Section 3.1 presents the optimized combinations of treatment size and equalization storage for each alternative.

The criteria used to determine acceptable combinations of treatment and equalization capacities are important to the overall results. For example, a change in available flow target usage from 10,000 AFY to an average of 9,500 AFY could result in significant changes. For that reason, the criterion should be clear and potentially improved in the future. It is not clear how the 10,000-AFY limitation will be implemented, the details of when WRD will be receiving the 10,000 AFY (months of the year), and how it will be accounted for.

The criterion that was used in the optimization is that a scenario run would not be acceptable if the combination of treatment capacity and equalization storage could not yield at least 99% of the 10,000-AFY supply usage (or 9,900 AFY). Additionally, whenever the annual moving average of supply usage would increase above 10,000 AFY, the supply of flow from the Los Coyotes WRP would be limited to maintain an annual moving average of 10,000-AFY flow or 8.921 MGD.

3.2 Model Results

Attachment 2 presents a summary of model results. Table 4 describes each of the items in Attachment 2. The daily time series of all described metrics are available directly from the model.

Table 4. Summary Table Metric Items

Item	Metric	Units	Description
1.1	Capacity (outflow) – LVL AWTF	MGD	Total advanced water production if the expansion is located at the Long Beach WRP/LVL AWTF. This includes the current LVL AWTF capacity of 8 MGD.
1.2	Capacity (outflow) - Los Coyotes WRP	MGD	Total advanced water production at the new facility to be located at the Los Coyotes WRP.

Table 4. Summary Table Metric Items

Item	Metric	Units	Description
1.3	Equalization storage - LVL AWTF	MG	Total equalization storage needed for the AWTP production at the Long Beach WRP/LVL AWTF expansion location.
1.4	Equalization storage - Los Coyotes WRP	MG	Total equalization storage needed for the AWTP production at the Los Coyotes WRP expansion location.
1.5	New wells injection capacity (at LVL AWTF)	MGD	Capacity of the single well to be located at the current LVL AWTF.
1.6	New wells injection capacity (outside LVL AWTF)	MGD	Model limitation of the new injection well facility to be built more than a mile from the AWTP production at the LVL AWTF.
1.7	New wells injection capacity (from Los Coyotes WRP)	MGD	Model limitation of the new injection well facility to be built more than a mile from the AWTP production at the Los Coyotes WRP.
2.1	Los Coyotes contract usage - WRD	AFY	Annual average of WRD usage of its 10,000-AFY allocation of Los Coyotes WRP production.
2.2	Los Coyotes contract usage - Others	AFY	Annual average of Cerritos and Bellflower usage of their 10,500-AFY allocation of the Los Coyotes WRP production.
2.3	Total advanced water treatment production	AFY	Annual average total system advanced treated water production; this includes current LVL AWTF production, future LVL AWTF expansion (if applicable), and a future Los Coyotes WRP AWTP (if applicable).
2.4	Alamitos Barrier deliveries from LVL AWTF	AFY	Total advanced treated water delivered from the LVL AWTF (current and future expanded plant) to the Alamitos Barrier.
2.5	New wells injection	AFY	Annual average of injected water that does not include Alamitos Barrier injection.
2.6	Total injection	AFY	Annual average total advanced treated water injection, including injection at the Alamitos Barrier, the LVL AWTF well, and future injection wellfields.
2.7	Discharges to San Gabriel River (above 2 MGD)	AFY	Annual average discharges to the San Gabriel River for flows that are above treatment capacity or that go over the injection wellfield capacity (if determined that the wellfield has a capacity on item 1.5).
2.8	AVG injection - One new well at the LVL AWTF site	MGD	Average flow injection in the one new well at the LVL AWTF.
2.9	AVG injection - New wells from the LVL AWTF	MGD	Average flow injection in the new wellfield designed to inject flows from new advanced water treatment at the Long Beach WRP/LVL AWTF location.
2.10	AVG injection - New wells from the Los Coyotes WRP	MGD	Average flow injection in the new wellfield designed to inject flows from new advanced water treatment at the Los Coyotes WRP location.
2.1	AVG Los Coyotes WRP-LVL AWTF pipeline	MGD	Average flow for the pipeline connecting tertiary water from the Los Coyotes WRP to the LVL AWTF.
2.1	AVG Long Beach WRP to LVL AWTF	MGD	Average flow from the Long Beach WRP to the LVL AWTF (expanded or not).
3.1	LVL AWTF plant production change	1/day	Average number of times that the LVL AWTF* will change the production capacity in a day (train changes).
3.2	Los Coyotes AWTP production change	1/day	Average number of times that the Los Coyotes AWTP will change the production capacity in a day (train changes).

Table 4. Summary Table Metric Items

Item	Metric	Units	Description
3.3	Shutdown events (LVL AWTF)	count	Total number of shutdown events at the LVL AWTF throughout the entire simulation (2008 days or 48,192 hours) due to lack of inflows.
3.4	Shutdown events (Los Coyotes AWTP)	count	Total number of shutdown events at the Los Coyotes WRP throughout the entire simulation (2008 days or 48,192 hours) due to lack of inflows.
3.5	Plant utilization (LVL AWTF)	% of maximum	LVL AWTF percentage of simulated production over hypothetical production achieved at maximum capacity all the time.
3.6	Plant utilization (Los Coyotes AWTP)	% of maximum	Los Coyotes AWTP percentage of simulated production over hypothetical production achieved at maximum capacity all the time.
3.7	Imported water to Alamitos Barrier	AFY	Annual average imported water (from Metropolitan Water District) to be injected at the Alamitos Barrier.
3.8	LVL AWTF average plant efficiency	%	Plant efficiency (outflow/inflow) is a function of active trains. This metric measures the average efficiency achieved at the LVL AWTF over the simulation.
3.9	Los Coyotes AWTP average plant efficiency	%	Plant efficiency (outflow/inflow) is a function of active trains. This metric measures the average efficiency achieved at the Los Coyotes AWTP over the simulation.
3.10	Simulation time above brine limit	%	Percentage of simulation time that brine discharges exceeded current limitations.
4.1	Unit cost of project water	$/AF	Unit cost of new advanced water treatment (in excess of the current 6,300 AFY from the LVL AWTF to the Alamitos Barrier) based on current available project costs.

Notes:

* The LVL AWTF capacity includes available capacity in the existing LVL AWTF plus expanded capacity with a new AWTP.

$/AF = dollar(s) per acre-foot
AVG = average

4. Summary

The optimization process in Section 3 has resulted in eight different model scenarios with combinations of treatment and equalization storage that would minimize the unit costs of new advanced treated water and use the 10,000-AFY allocation of supply from the Los Coyotes WRP. Combinations of treatment capacity and equalization storage have been determined for each one of the scenarios so that the unit cost for the advanced treated water would be minimum, and the WRD allocation of Los Coyotes WRP production would be used.

Table 5 shows all eight scenarios, the unit cost for the new advanced treated water, the required advanced water treatment production capacity, the required size of equalization storage, and the additional flow from the Long Beach WRP that has been used above the minimum flows determined by the contract (only for Alternative 1).

The lowest unit cost project size suggests the following:

- Advanced treated water expansion at the current Long Beach WRP/LVL AWTF location might be more cost efficient than an AWTF at Los Coyotes WRP.

- An advanced water treatment expansion size of 8.1 MGD with 3.8 MG of equalization storage could accommodate uncertainties related to future Los Coyotes WRP demands and uncertainties about additional water that could be provided by Long Beach WRP.

Table 5. Summary of Model Results Related to Facility Size and Unit Cost of Water

Alternatives where Long Beach WRP Excess Backfills LVL AWTF (Alt 1)	Units	Long Beach WRP Location		Los Coyotes WRP Location	
		2a	2b	3a	3b
New Water Cost ($/AF)	$/AF	$1,271.00	$1,327.00	$1,482.00	$1,550.00
Production Capacity (NEW treatment)	MGD	**7.3**	**8.1**	**8.8**	**8.2**
Equalization Storage	MG	0.87	3.83	0	3.27
Additional Long Beach water used (beyond 6.5 MGD)	AFY	1,457	1,457	1,233	1,233
	MGD	1.3	1.3	1.1	1.1
Alternatives where No Long Beach WRP Excess Used (Alt2)	**Units**	**Long Beach WRP Location**		**Los Coyotes WRP Location**	
		2a	**2b**	**3a**	**3b**
New Water Cost ($/AF)	$/AF	$1,408.00	$1,455.00	$1,485.00	$1,553.00
Production Capacity (NEW treatment)	MGD	**5.6**	**6.5**	**8.8**	**8.2**
Equalization Storage	MG	1.24	3.11	0	3.27
Additional Long Beach water used (beyond 6.5 MGD)	AFY	-	-	-	-
	MGD				

Note:

All scenarios assume capacity of treatment and equalization storage to use 10,000 AFY of Los Coyotes effluent.

Figure 9 shows an overall summary of the model runs after the optimization process. For each model scenario in Section 3, the left-side bar chart shows the required size of expansion (in addition to current LVL AWTF capacity) that would be needed for a successful advanced water treatment project. The advanced water treatment expansion size varies from 5.6 to 8.8 MGD. The middle bar chart on Figure 9 shows the final unit cost for each scenario. Advanced treated water expansion at the Long Beach WRP/LVL AWTF location has the lowest unit cost compared with producing advanced treated water at the Los Coyotes WRP. The right-side bar chart on Figure 9 shows the final annual average of new advanced treated water production.

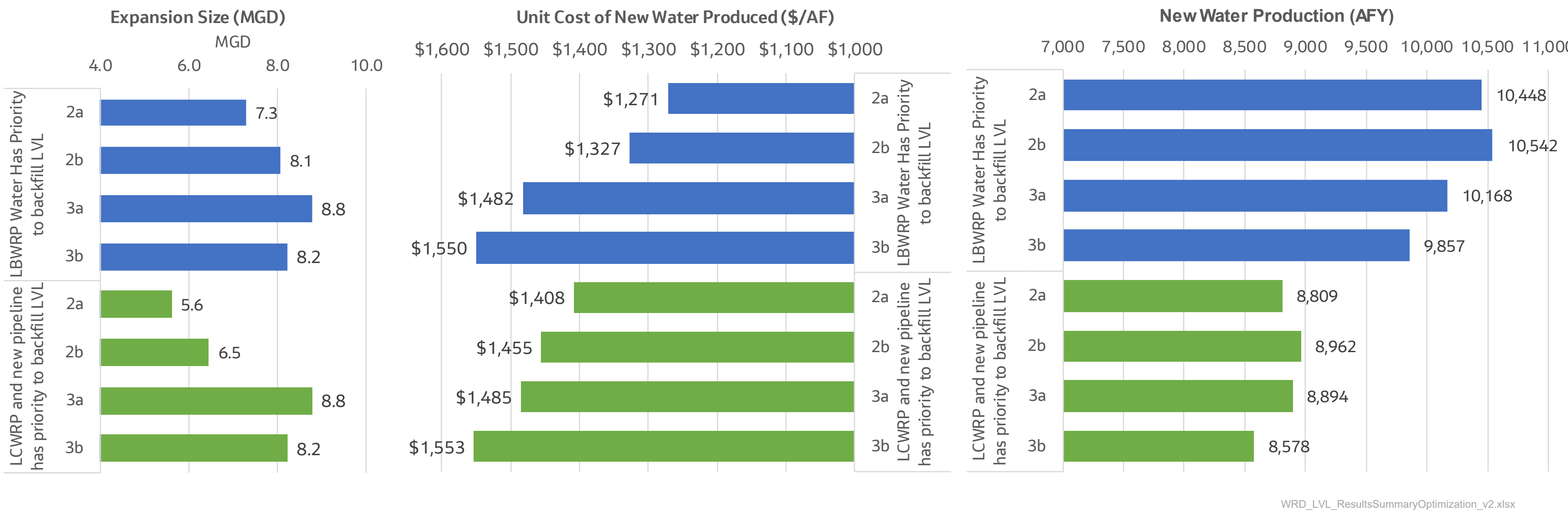


Figure 9. Summary of Optimized Modeling Scenarios

Sections 4.1 and 4.2 describe the lowest unit cost achieved for Scenarios a and b (where Scenario a maintains current Los Coyotes WRP tertiary demands and Scenario b meets more aggressive demands, up to the maximum contracted Los Coyotes WRP allocations).

4.1 Lowest Cost for Expansion Located at the Long Beach WRP/LVL AWTF Site

Scenario a: The optimization results returned an expansion of 7.3 MGD (of product water, in addition to the current 8-MGD LVL AWTF capacity) with an equalization tank of 0.87-MG capacity. The total unit cost (based on assumptions in Section 2.4) was $1,271 per acre-foot.

Scenario b: The optimization results returned an expansion of 8.1 MGD (of product water, in addition to the current 8-MGD LVL AWTF capacity) with an equalization tank of 3.83-MG capacity. The total unit cost (based on assumptions in Section 2.4) was $1,327 per acre-foot.

The scenarios where available Long Beach WRP flows (above contractual minimums) were not considered had greater costs than the alternatives where the additional flow was used to produce advanced treated water.

4.2 Lowest Cost for Expansion Located at the Los Coyotes WRP

Scenario a: The optimization results returned a new AWTP of 8.8 MGD (of product water) located at the Los Coyotes WRP with no equalization tank. The total unit cost (based on assumptions in Section 2.4) was $1,482 per acre-foot.

Scenario b: The optimization results returned a new AWTP of 8.2 MGD (of product water) located at the Los Coyotes WRP with an equalization tank of 3.27-MG capacity. The total unit cost (based on assumptions in Section 2.4) was $1,550 per acre-foot.

The scenarios where available Long Beach WRP flows were not considered (above contractual minimums), had slightly greater costs than the alternatives where the additional flow was used to produce advanced treated water.

5. Reference

Jacobs. 2021. *Geotechnical Investigation Report: Power Distribution System Modifications.* Prepared for Sanitation Districts of Los Angeles County. March 10.

Attachment 1
Initial Model Scenario Assumptions

Attachment 1. Initial Model Scenario Assumptions

		Model Assumptions											
Overall Scenario	**Model Scenario**	**LVL inflows from LBWRP**	**LC inflows**	**Alamitos Barrier injection**	**AWTF at Expanded LVL Capacity**	**LVL capacity**	**AWTF at LCWRP Capacity**	**Equalization Storage**	**LC Recycled Water Demands**	**New Wellfield**	**GW Production**	**LB Area Additional Groundwater Production**	**Scenario goals**
1-Baseline Scenarios	**Scenario1a-Current Conditions**	6.5 mgd contract	x	Historical Injections to be replaced by LVL (5.8 to 6.0 MGD) Use monthly average pattern	No expansion	current capacity max 8.0 mgd production (8.7 mgd inflow)	x	No eq storage	Historical	1 new injection well (1.2 MGD and 2.5 MGD)	Historical	Assume 1:1 ratio between new extractions and new injections balanced annually	Establishing the range of potential base case scenarios
	Scenario1b-LVL Maximized & full injection	6.5 mgd contract	Use available flows from LCWRP up to 10,000 AFY (8.9MGD) via new pipeline to LVL	Historical Injections to be replaced by LVL (5.8 to 6.0 MGD)	No expansion	current capacity max 8.0 mgd production (8.7 mgd inflow)	x	No eq storage	Historical	TBD (up to full 8 MGD capacity used)	Historical	Assume 1:1 ratio between new extractions and new injections balanced annually	Determine potential size for a new offsite injection well field (in addition to the 1 well of scenario 1a)
2-Scenario Pipeline	**Scenario2a-LVL Expansion**	6.5 mgd contract	Use available flows from LCWRP up to 10,000 AFY (8.9MGD) via new pipeline to LVL	Historical Injections to be replaced by LVL (5.8 to 6.0 MGD)	Expansion at current LVL site. Pipe connection between LCWRP and LVL	TBD	x	TBD	Historical	TBD	Historical	TBD based on Scenario 1 assumptions	1.determine potential size for a new offsite injection well field 2.determine optimal LVL capacity 3.determine equalization storage needs
	Scenario2b-LVL Expansion with LCWRP Allocations Included	6.5 mgd contract	Use available flows from LCWRP up to 10,000 AFY (8.9MGD) via new pipeline to LVL	Historical Injections to be replaced by LVL (5.8 to 6.0 MGD)	Expansion at current LVL site. Pipe connection between LCWRP and LVL	TBD	x	TBD	Incorp. other RW allocations per LASCD (Maximum allocation)	TBD	Historical	TBD based on Scenario 1 assumptions	1.determine potential size for a new offsite injection well field 2.determine optimal LVL capacity 3.determine equalization storage needs
3-Scenario AWT @ LCWRP	**Scenario3a-New AWTP at LCWRP**	6.5 mgd contract	Use available flows from LCWRP up to 10,000 AFY (8.9MGD) to new AWTF	Historical Injections to be replaced by LVL (5.8 to 6.0 MGD)	New AWTF located at LCWRP. Capacity TBD. No pipe connection between LCWRP and LVL	current capacity max 8.0 mgd production (8.7 mgd inflow)	TBD	TBD	Historical	TBD	Historical	TBD based on Scenario 1 assumptions	1.determine size for new AWTP at LCWRP 2.determine size of new injection wellfield near LCWRP 3. determine size of new offsite injection wellfield at LVL (using existing capacity)
	Scenario3b- New AWTP at LCWRP with LCWRP Allocations Included	6.5 mgd contract	Use available flows from LCWRP up to 10,000 AFY (8.9MGD) to new AWTF	Historical Injections to be replaced by LVL (5.8 to 6.0 MGD)	New AWTF located at LCWRP. Capacity TBD. No pipe connection between LCWRP and LVL	current capacity max 8.0 mgd production (8.7 mgd inflow)	TBD	TBD	Incorp. other RW allocations per LASCD (Maximum allocation)	TBD	Historical	TBD based on Scenario 1 assumptions	1.determine size for new AWTP at LCWRP 2.determine size of new injection wellfield near LCWRP 3. determine size of new offsite injection wellfield at LVL (using existing capacity)
													WRD_LVL_Scenarios_20210629a.xlsx

Attachment 2
Summary of Model Results

Attachment 2. Summary of Model Results

		Score Card		Model Scenarios									
						Alt1-Variable LVWRP				Alt2-Fixed LBWRP			
				No Expansion		Expansion @LVL		Expansion @ LC		Expansion @LVL		Expansion @ LC	
	Item#	Metric	units	1a	1b	2a	2b	3a	3b	2a	2b	3b	3b
Metrics Related to Total Infrastructure Cost	1.1	Capacity (Outflow) LVL AWTP	MGD	8.0	8.0	15.3	16.1	8.0	8.0	13.6	14.5	8.0	8.0
	1.2	Capacity (Outflow) LC AWTP	MGD	0.0	0.0	0.0	0.0	8.8	8.2	0.0	0.0	8.8	8.2
	1.3	EQ storage LVL AWTP	Mgal	0.0	0.0	0.9	3.8	0.0	0.0	1.2	3.1	0.0	0.0
	1.4	EQ storage LC AWTP	Mgal	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	3.3
	1.5	New Wells Injection Capacity (@LVL)	MGD	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	1.6	New Wells Injection Capacity (outside LVL)	MGD	0.0	9999.0	9999.0	9999.0	2.0	2.0	9999.0	9999.0	2.0	2.0
	1.7	New Wells Injection Capacity (from LC)	MGD	0.0	0.0	0.0	0.0	9999.0	9999.0	0.0	0.0	9999.0	9999.0
Metrics Related to Total	2.1	LC Contract Usage WRD	AFY	-	1,400	9,900	9,900	10,000	9,900	9,930	9,900	10,000	9,900
	2.2	LC Contract Usage Others	AFY	3,900	3,900	3,900	8,500	3,900	8,500	3,900	8,500	3,900	8,500
	2.3	Total AWT Production	AFY	7,500	8,900	16,700	16,800	16,500	16,200	15,100	15,300	15,200	14,900
	2.4	Alamitos Barrier Deliveries from LVL	AFY	6,000	6,600	6,700	6,500	5,800	5,800	6,700	6,500	5,200	5,200
	2.5	New Wells Injection	AFY	1,400	2,300	10,100	10,300	10,700	10,400	8,400	8,700	10,000	9,700
	2.6	Total Injection	AFY	7,400	8,900	16,800	16,800	16,500	16,200	15,100	15,200	15,200	14,900
	2.7	Discharges to SGR (above 2 mgd)	AFY	19,900	18,500	10,000	5,400	9,900	5,300	10,000	5,300	9,900	5,300
	2.8	AVG injection 1 New Well @ LVL site	MGD	0.7	1.0	1.5	1.4	0.6	0.6	1.5	1.4	0.0	0.0
	2.9	AVG injection New Wells from LVL	MGD	0.0	0.0	6.5	6.8	0.0	0.0	5.0	5.4	0.0	0.0
	2.10	AVG injection New Wells from LC	MGD	0.0	0.0	0.0	0.0	8.0	7.7	0.0	0.0	7.9	7.7
	2.11	AVG LC-LVL Pipeline	MGD	0.0	1.2	8.9	8.8	0.0	0.0	8.9	8.8	0.0	0.0
	2.12	AVG LBWRP to LVL	MGD	7.4	7.4	7.6	7.6	7.4	7.4	6.3	6.3	6.3	6.3
Other Quantitative	3.1	LVLAWT plant production change	1/day	7.8	0.7	2.5	3.8	7.8	8.0	0.7	4.5	0.0	0.0
	3.2	LCAWT plant production change	1/day	0.0	0.0	0.0	0.0	5.7	3.4	0.0	0.0	5.7	3.6
	3.3	Shut down events (LVL)	count	22.0	24.0	23.0	70.0	22.0	22.0	21.0	61.0	5.0	5.0
	3.4	Shut down events (LC AWT)	count	0.0	0.0	0.0	0.0	261.0	750.0	0.0	0.0	261.0	752.0
	3.5	Plant Utilization (LVL AWT)	% of maximum	85%	99%	98%	94%	85%	85%	99%	94%	72%	72%
	3.6	Plant Utilization (LC AWT)	% of maximum	0%	0%	0%	0%	74%	78%	0%	0%	63%	66%
	3.7	Imported water to Alamitos Barrier	AFY	659	42	31	181	893	891	22	163	1494	1494
	3.8	LVL Average Plant Efficiency	%	88%	92%	91%	90%	88%	88%	89%	89%	87%	87%
	3.9	LC Average Plant Efficiency	%	0%	0%	0%	0%	87%	82%	0%	0%	87%	82%
	3.10	Simulation time above Brine limit	%	0%	0%	100%	98%	0%	0%	100%	99%	0%	0%
Unit Cost	4.1	Unit cost of Project Water	$/AF	$0.00		$ 1,271	$ 1,327	$ 1,482	$ 1,550	$ 1,408	$ 1,455	$ 1,485	$ 1,553

WRD_LVL_Scenarios_20220517a.xlsx

ASSUMING HISTORICAL DEMANDS FROM LCWRP (less variability in flow volumes)					
EXPANSION AT LVL (Scenarios 2a)					
	LVL Onsite Injection Well (MGD)*		% Of Barrier Demand Supplied**	New Supply Available (MGD)*	
	Low	High		Low	High
Available Capacity at LVL Used	1.73	2.00	99.5%	5.45	8.01
Available Capacity at LVL not used	1.81	2.00	99.7%	4.30	6.35
EXPANSION AT LCWRP (Scenarios 3a)					
	LVL Onsite Injection Well (MGD)*		% Of Barrier Demand Supplied	New Supply Available (MGD)*	
	Low	High		Low	High
Available Capacity at LVL Used	0.45	1.74	86.5%	0.00	0.20
Available Capacity at LVL not used	0.34	0.50	77.7%	7.04	9.22
ASSUMING DEMAND FROM LCWRP IS MAXED TO ALLOCATIONS (more variability in flow volumes)					
EXPANSION AT LVL (Scenarios 2b)					
	LVL Onsite Injection Well (MGD)*		% Of Barrier Demand Supplied	New Supply Available (MGD)*	
	Low	High		Low	High
Available Capacity at LVL Used	1.33	2.00	97.2%	4.17	8.81
Available Capacity at LVL not used	1.34	2.00	97.5%	3.52	7.20
EXPANSION AT LCWRP (Scenarios 3b)					
	LVL Onsite Injection Well (MGD)*		% of Barrier Demand Supplied	New Supply Available (MGD)*	
	Low	High		Low	High
Available Capacity at LVL Used	0.45	1.75	86.6%	5.71	8.73
Available Capacity at LVL not used	0.34	0.50	77.7%	5.70	8.73

*Monthly average values

** Including current supply from LVL

Appendix J
TM 6.2.2-LVL AWTF Expansion Feasibility

Jacobs

Memorandum

1000 Wilshire Boulevard, Suite 1140
Los Angeles, California 90017
United States
T +1.213.538.1388
F +1.230.538.1399
www.jacobs.com

Subject	**Technical Memorandum 6.2.2 - Leo J. Vander Lans Advanced Water Treatment Facility Expansion Feasibility Technical Memorandum – Final**
Project Name	WRD and LADWP Joint Los Angeles Basin Replenishment and Extraction Master Plan
Date	August 30, 2021 (Revised)

1. Background

The Water Replenishment District of Southern California (WRD) owns and operates the Leo J. Vander Lans Advanced Water Treatment Facility (LVL AWTF) in the city of Long Beach. The LVL AWTF provides advanced treated water that is injected at the Alamitos Barrier in Long Beach, which thereby protects and replenishes the freshwater aquifers in the Central Groundwater Basin. The facility was constructed in 2003, with an initial capacity of 3 million gallons per day (MGD), and was expanded in 2014 to produce up to 8 MGD of advanced treated water. It processes Title 22 tertiary reclaimed water from the adjacent Los Angeles County Sanitation District's (LACSD's) Long Beach Water Reclamation Plant (WRP) via microfiltration (MF), reverse osmosis (RO), and ultraviolet advanced oxidation process (UVAOP). Future plans are in place for the facility to receive additional water from the Long Beach WRP and, potentially, new water from the Los Coyotes WRP, located about 6 miles north.

As more water is readily available from the Long Beach WRP and Los Coyotes WRP, the treatment capacity of the LVL AWTF must be expanded to support the additional injection, and treatment is required to comply with Title 22 regulations for groundwater injection. This technical memorandum evaluates the feasibility of providing an additional 8 MGD of AWTF treatment capacity at two locations: (1) the existing Long Beach WRP site; and (2) the Los Coyotes WRP site.

2. Approach

An AWTF layout has been developed for each site, and the treatment buildings have been sized based on the approach described here.

2.1 Capacity

A product water capacity of 8 MGD has been assumed for the expansion; however, the actual LVL AWTF capacity to be implemented may differ based on the results of the Water Balance Model, which suggests the new AWTF could range in capacity from 5.6 to 8.8 MGD due to the many possible expansion configurations and different inflow availability scenarios. As such, although the actual site layout will also vary based on the ultimate plant capacity selected, 8 MGD is near the upper end of the range of potential plant capacities and represents a conservative approach in evaluating the feasibility of siting an AWTF at each location.

2.2 Treatment Process and Footprint

Jacobs has assumed the new AWTF will match the current treatment process and recovery at the LVL AWTF. The process flow diagram has been assumed to be identical to the LVL AWTF (Figure 1). The MF system has been designed to achieve 99% recovery with backwash waste recovery through dissolved air flotation (DAF) and secondary MF treatment; however, WRD currently bypasses the DAF system and the performance has been acceptable, so DAF has been omitted in the proposed AWTF layout. Figure 2 shows the operation and testing that reflect the plant recovery at various feed rates to the RO system at the LVL AWTF. The primary second-stage RO process has been tested at maximum RO train flows (4 MGD) to achieve 85% recovery, with the third-stage RO operating at 52% recovery, resulting in an overall plant recovery of 92%. Overall, plant recovery is less when the RO trains operate at capacities below the maximum. Because the expansion AWTF matches the existing LVL AWTF in both capacity (that is, 8 MGD) and treatment process, the area requirements for the various treatment units have been sized based on the existing footprint at the LVL AWTF.

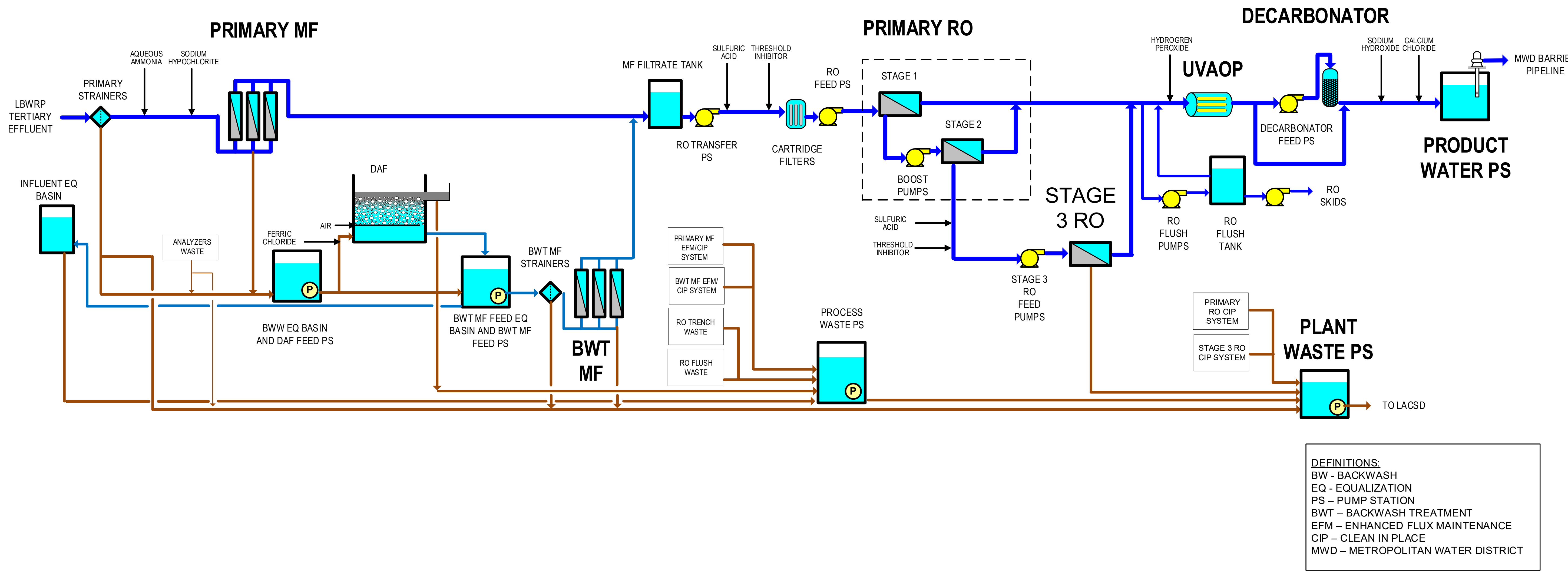


Figure 1. Process Flow Diagram of the Existing Leo J. Vander Lans Advanced Water Treatment Facility

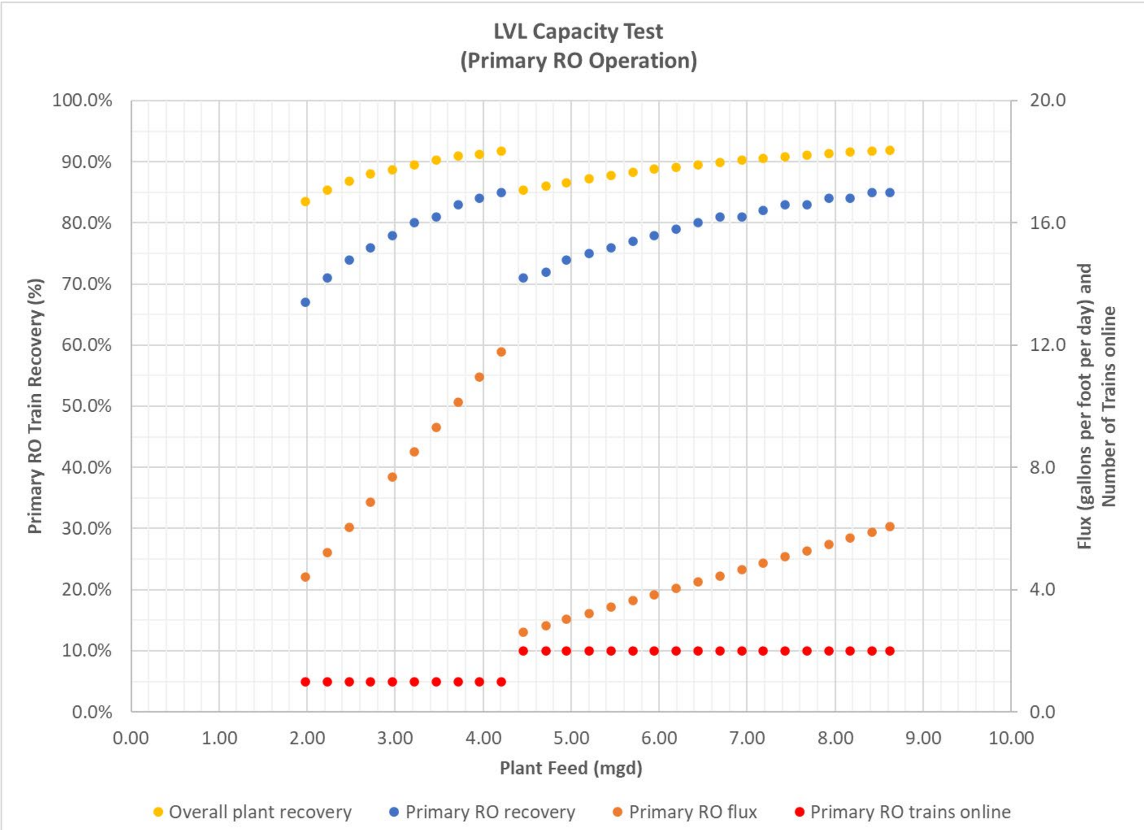


Figure 2. Operation and Testing of Plant Recovery by the Water Replenishment District of Southern California

2.3 Process Building

To minimize site area requirements, the main treatment processes (that is, MF, RO, and UVAOP) have been colocated in a single two-story building. The configuration and orientation of the treatment processes have been adjusted to best fit in a single building, and the MF and RO recoveries have been assumed to match the LVL AWTF. To optimize the RO area requirement and the overall building footprint, the number of RO pressure vessels stacked vertically has been assumed to be nine as opposed to the six-high configuration that is currently in use at LVL AWTF. A scissor lift or similar equipment will be required when loading or extracting membranes from the RO pressure vessels. Instead of using a scissor lift for the sampling of the individual pressure vessels when there is an excursion in permeate quality, it is also possible to install a sample panel on the side of the RO skid to test total dissolved solids (TDS) and conductivity for each pressure vessel.

To capture more water from the Long Beach WRP or the Los Coyotes WRP during brief high-flow periods, and to minimize flow changes at the AWTF, an equalization tank has been proposed to be located underneath the process building. A total depth of 20 feet has been assumed, with a sidewater depth of 16 feet to accommodate freeboard and overflow conditions. The footprint of the equalization tank has been sized to match the above grade process building, resulting in a storage volume of 1.7 million gallows (MG). The flow data will require further analysis as the project advances, which may result in a change in the storage requirements. Figures 3 through 5 present the process building plan layouts. Building lines have been provided with each plan for reference.

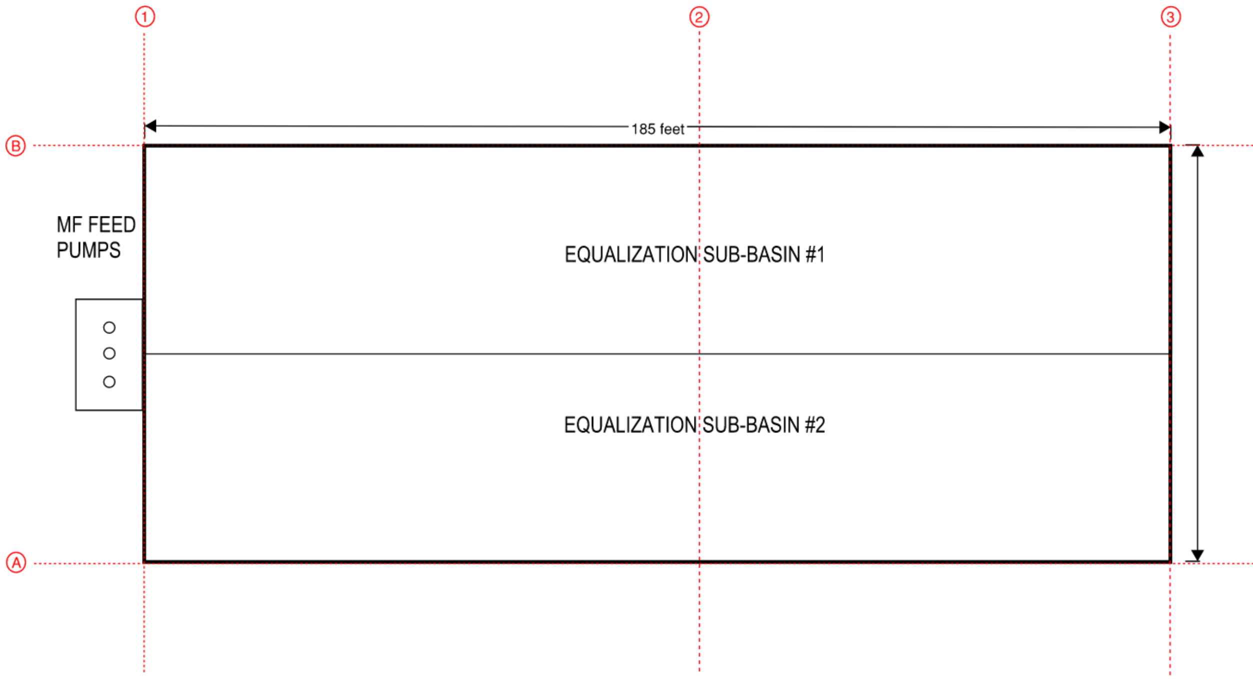


Figure 3. Plan Layout of the Below-Grade Equalization Tank

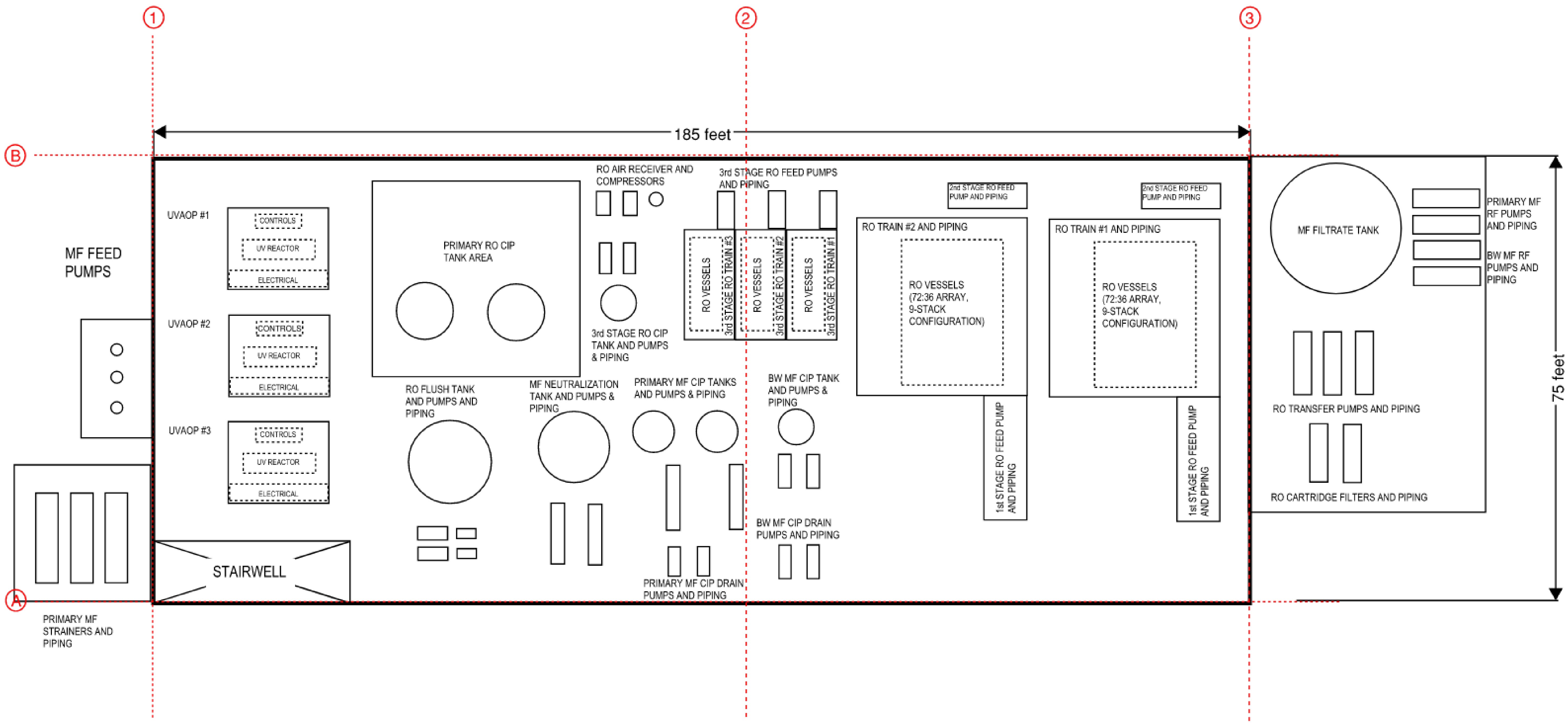


Figure 4. First-story Plan Layout of the Process Building

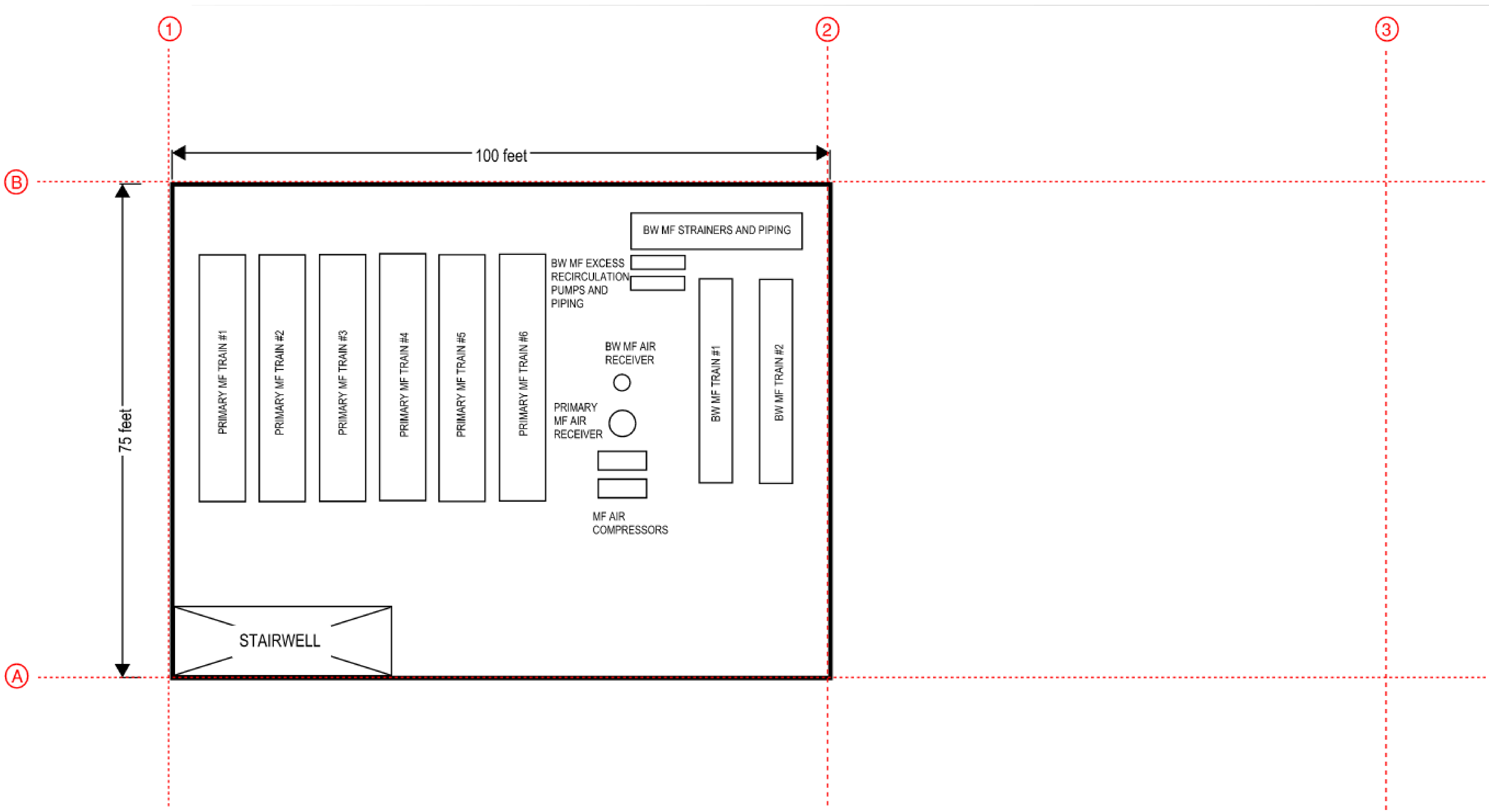


Figure 5. Second-story Plan Layout of the Process Building

2.4 Ancillary Facilities

The configurations of ancillary facilities (for example, a chemical building) and some treatment processes (for example, decarbonation and water stabilization) have been adjusted to best fit individual site constraints; however, most area requirements have been unchanged. Notably, based on input from WRD, the size of the product water pumping station has increased by 20% from 55,600 to 66,800 gallons to provide more consistent flow downstream. This is subject to change as more analysis is conducted on flow data.

Given the proximity of the existing LVL AWTF site to the Long Beach WRP site, Jacobs has assumed that the existing control and maintenance buildings at the LVL AWTF could be shared for use at the Long Beach WRP site; however, new control and maintenance buildings would be required at the Los Coyotes WRP site.

2.5 Other Considerations

Waste streams (secondary MF backwash, RO concentrate, and membrane chemical cleaning solutions) have been assumed to be discharged to the sewer.

3. Long Beach Water Reclamation Plant Site

Figure 6 shows the site at the Long Beach WRP, which is bounded by San Gabriel River to the left and Coyote Creek to the right. The existing LVL AWTF is located within a 4-acre parcel owned by WRD, and the Long Beach WRP is located within a 16.8-acre parcel to the south that is owned by LACSD. The greenspace to the north belongs to the City of Long Beach, and the land to the west contains a power line easement owned by electricity supplier Southern California Edison. Considering the constraints that surround the LVL AWTF, the only viable site for the expansion AWTF is the undeveloped parcel of land (approximately 2.7 acres) within the LACSD property, immediately south of the LVL AWTF.

Figure 6. Long Beach Water Reclamation Plant Site
Source: Americas Imagery Catalog (Jacobs.com)
Notes:
LBWRP = Long Beach Water Reclamation Plant
SCE = Southern California Edison

Figure 7 shows the layout of the expansion AWTF, which occupies 64,600 square feet (ft^2) (that is, 1.5 acres) on the identified parcel of land at the Long Beach WRP site. There is a 16-foot grade difference compared to the existing LVL AWTF grade, and the proposed site would require approximately 34,000 cubic yards (yd^3) of imported fill. Access would be provided from the LVL AWTF site by extending the road that runs north-south between the existing chemical building and the control building. The access road would loop around the site to facilitate truck movement for chemical deliveries. The layout reserves 51,800 ft^2 (that is, 1.2 acres) of land for the Long Beach WRP that is sufficient to construct a 6.2-MG primary effluent flow equalization basin,[1] assuming 16 feet of sidewater depth, and also allocates a 7,600-ft^2 strip for future injection wells.

[1] The *Clearwater Program: Master Facilities Plan* (LACSD, CH2M, and MWH 2012) recommended an equalization volume of 5 MG.

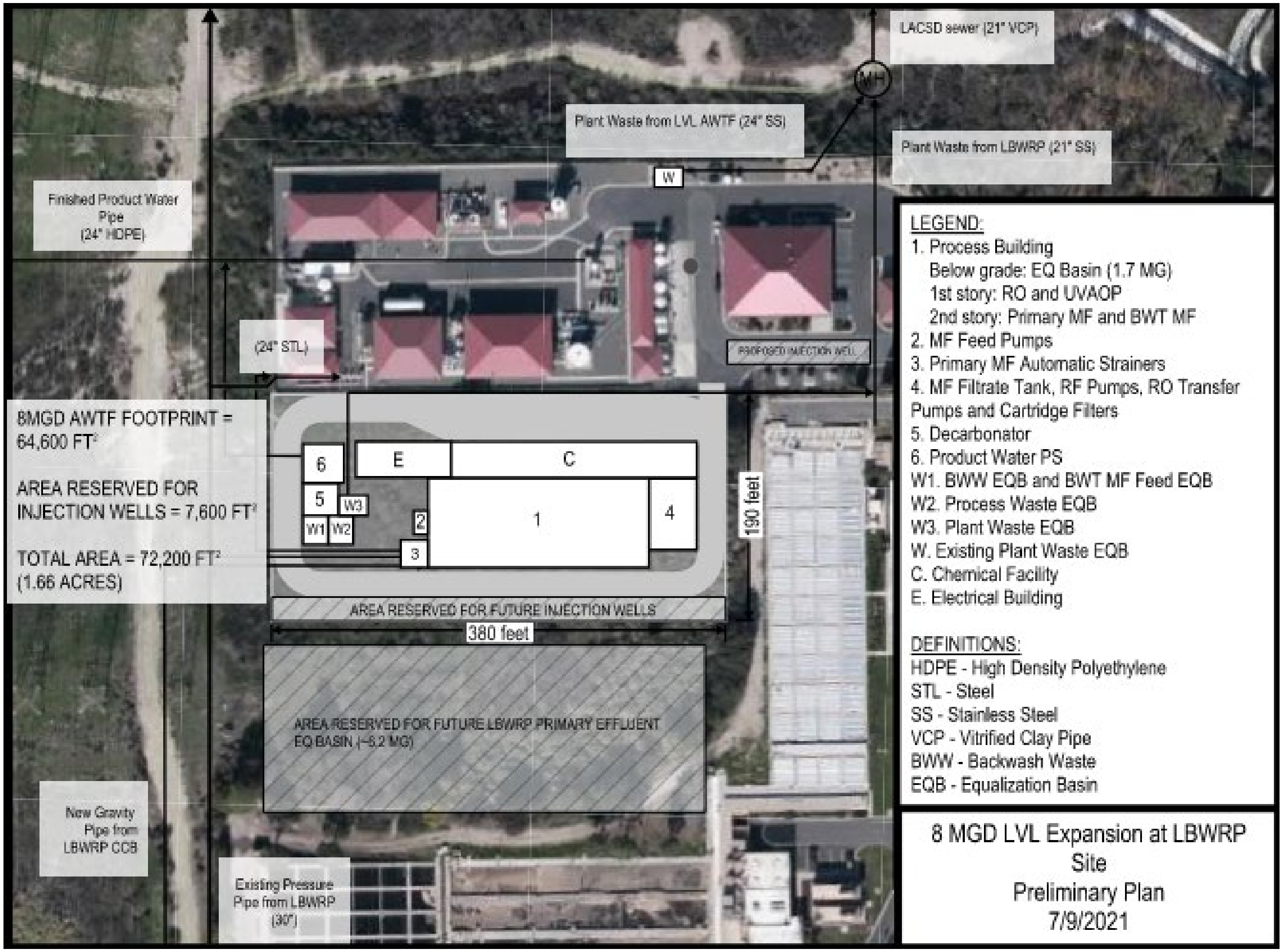


Figure 7. Expansion Advanced Water Treatment Plant Layout at the Long Beach Water Reclamation Plant Site
Source: Americas Imagery Catalog (Jacobs.com)

Jacobs has assumed that the existing common facilities at the LVL AWTF—namely, the warehouse and the control building (less the electrical room)—will be shared with the expansion plant. With respect to major piping connections, the expansion facility will receive flow at the below grade equalization tank via a new gravity pipe from the Long Beach WRP chlorine contact basins and a new pressurized pipe from the Los Coyotes WRP. A pipeline will also be provided from the proposed equalization tank to the LVL AWTF influent to allow for the transfer of Los Coyotes WRP water between the expansion facility and the existing facility. Connection to either the LVL AWTF influent pipeline or the existing LVL AWTF equalization tank (located below the existing ultraviolet facility; 0.18 MG in volume) would be made depending on hydraulic grade line differences between the two plants and specific pumping provisions provided in each equalization tank. Details of this connection would be further developed during the design process. Currently, the existing product water pump station delivers product water to an offsite blend station via a 24-inch-diameter high-density polyethylene conveyance line. The velocity in the pipeline is 7.9 feet per second at a flow rate of 16 MGD (after the expansion AWTF is built), which may result in excessive pressure at the product water pump station. Detailed analysis of the pump and pipeline system will be required as the project advances to determine the suitability of the existing pumps and pipeline to convey the higher flow or the need for a larger or additional pipeline.

Similarly, the expansion facility will tie into the existing plant waste equalization basin or discharge pipe before connecting into the LACSD sewer for treatment at the Joint Water Pollution Control Plant. Due to downstream hydraulic restrictions, the plant waste discharge from the LVL AWTF is limited to 760,000 gallons per day (gpd) as per the existing industrial discharge permit. The highest average rate at which wastewater is allowed to be discharged during any 5-minute period is 528 gallons per minute. The current total plant waste discharge from the LVL AWTF is already near the limit, at around 750,000 gpd, and the expansion of the AWTF, based on the same capacity and treatment process, will approximately double the discharge. Based on feedback from LACSD, there is minimal capacity to accept additional flow from the LVL AWTF due to a hydraulic limitation in the sewer connection between maintenance hole A277 and the Long Beach Interceptor Pumping Plant (Figure 8). LACSD has no plans in place to increase sewer capacity, and a $4.2 million project for 1.2 miles of a 24-inch-diameter relief sewer will likely be needed if WRD increases discharge at LVL AWTF.

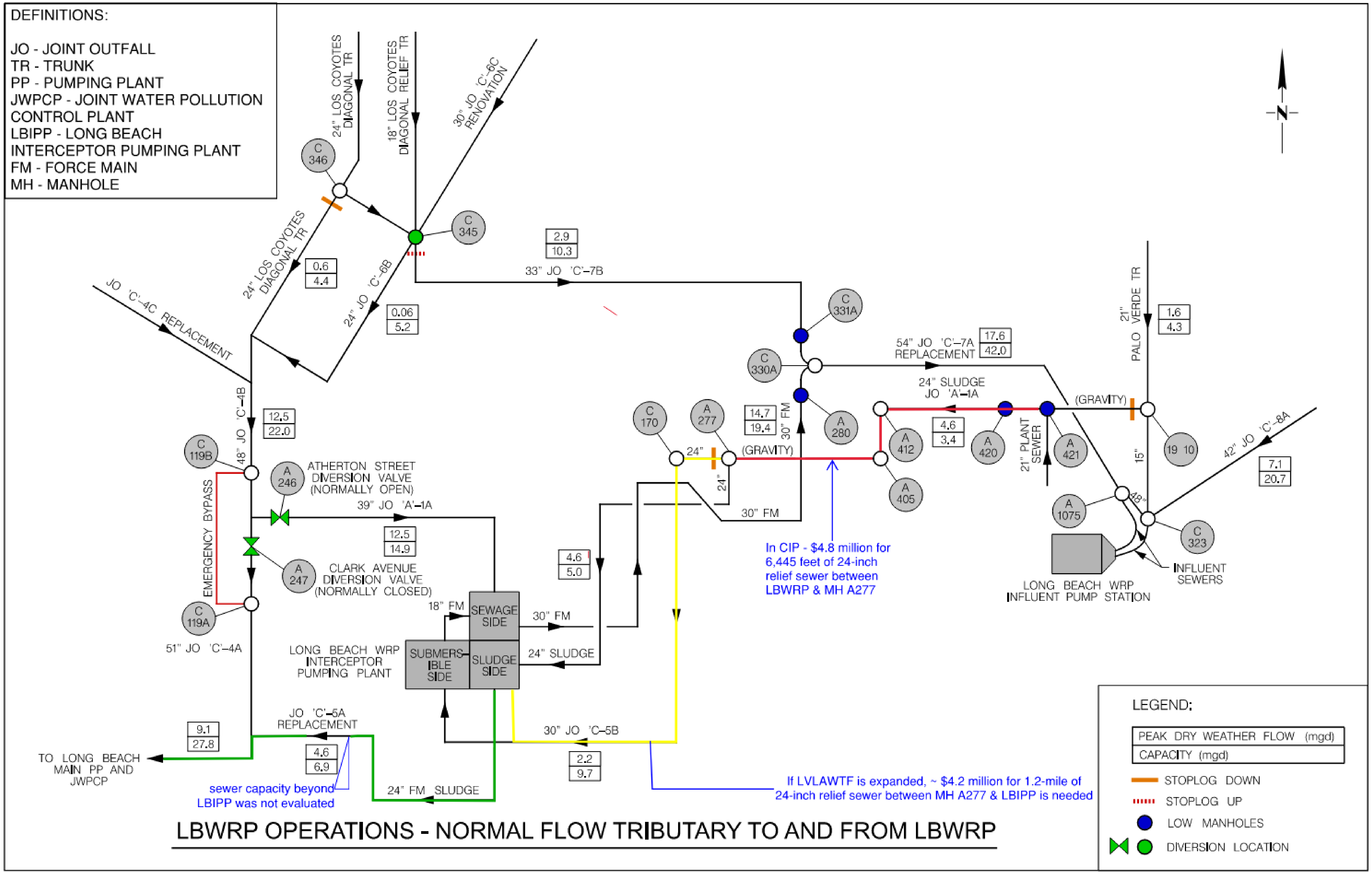


Figure 8. Hydraulic Limitation in the Los Angeles County Sanitation Districts Sewer Connection between the Long Beach Water Reclamation Plant and the Long Beach Interceptor Pumping Plant

Based on a geotechnical study at the Long Beach WRP in 2019 (Geo-Logic Associates 2019), the borings indicated high groundwater at an elevation of 7 feet. Assuming that the Long Beach WRP site will be filled to an elevation of 34 feet to match the existing LVL AWTF grade, the 20-foot-deep influent equalization tank of the expansion AWTF will be 7 feet above the groundwater level (Figure 9). However, prior to further design development, Jacobs recommends performing geotechnical borings specific to the expansion site to confirm groundwater elevations.

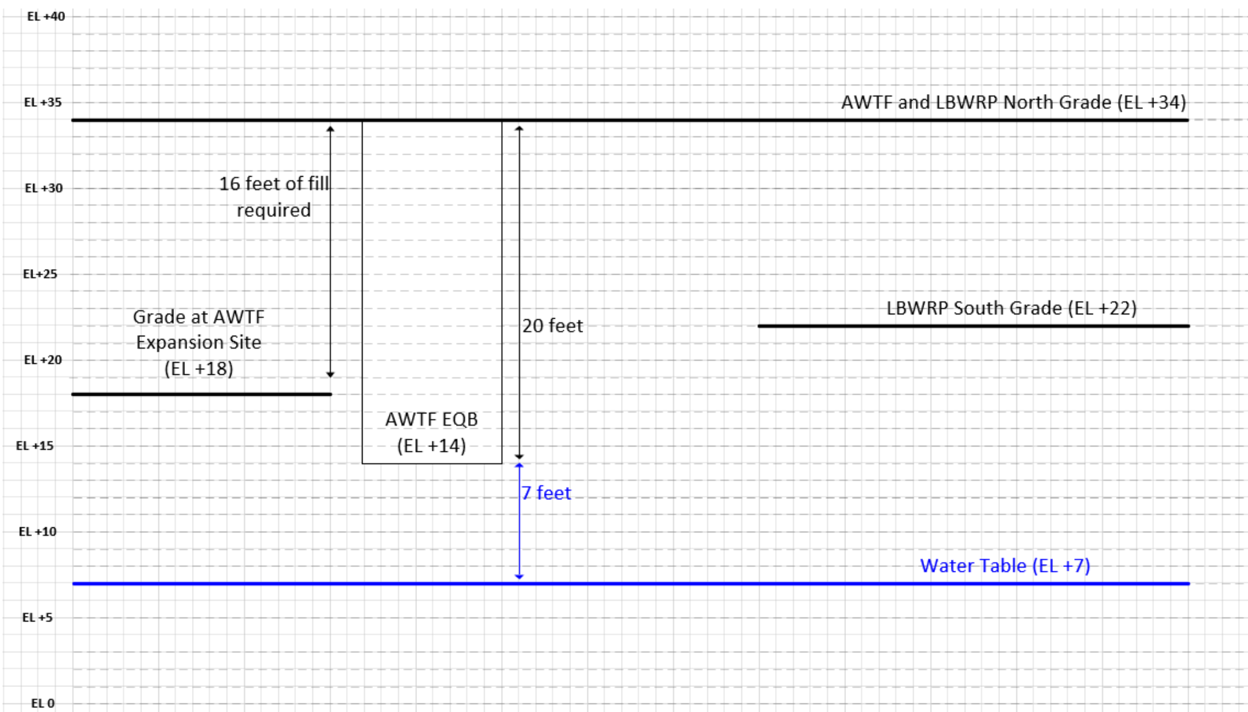


Figure 9. Groundwater Profile at the Long Beach Water Reclamation Plant Site

4. Los Coyotes Water Reclamation Plant Site

At the Los Coyotes WRP, a 1.5-acre site to the south of the plant has been identified for the new 8-MGD AWTF (Figure 10). The site is surrounded by the existing Los Coyotes WRP to the north and west, and is bounded by a ditch that runs alongside San Gabriel River Freeway on the east and Artesia Freeway on the south. The available land area is much smaller than the Long Beach WRP site, and utilities and yard piping surround the site (Figure 11).

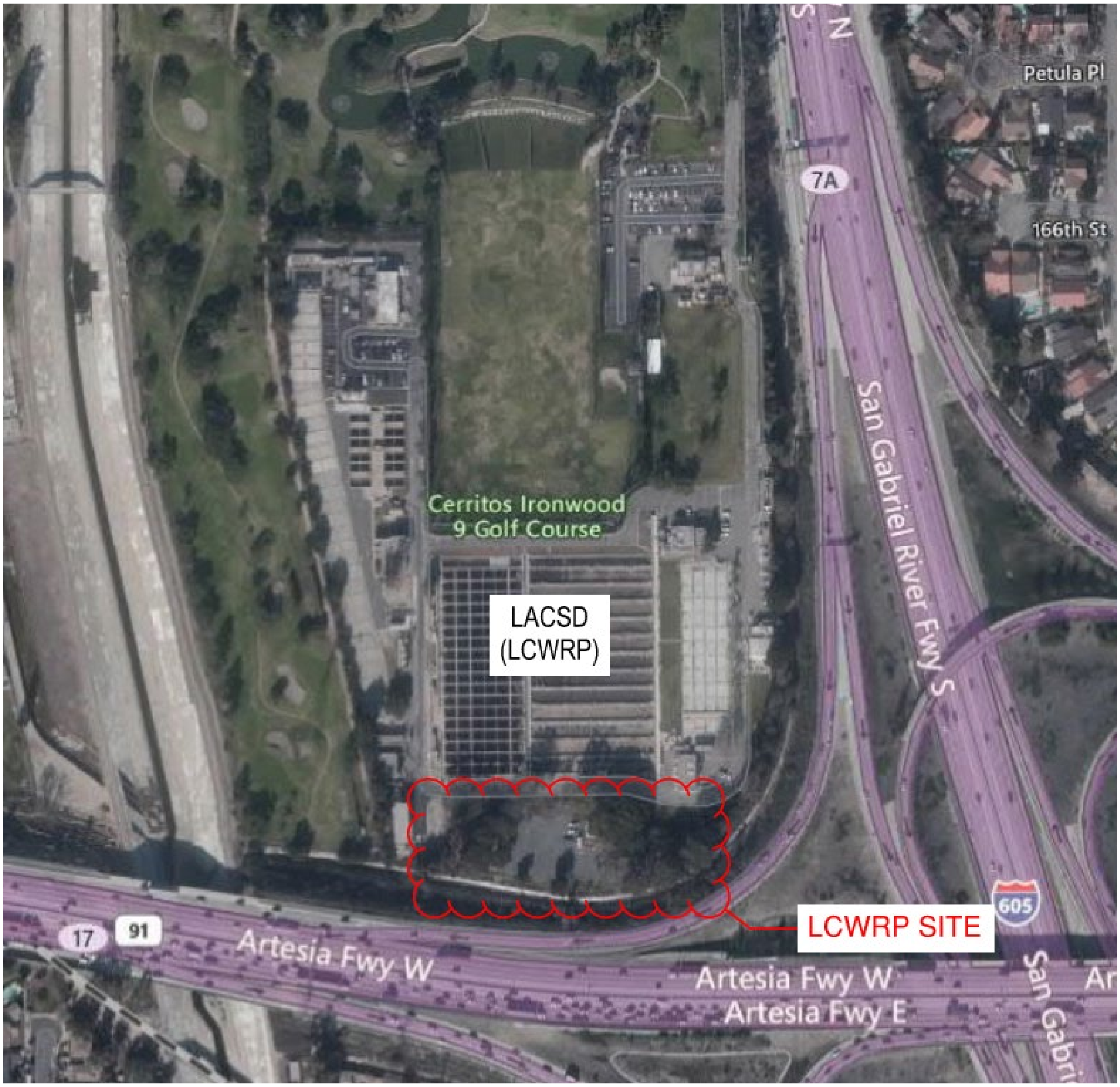


Figure 10. Los Coyotes Water Reclamation Plant Site
Source: Americas Imagery Catalog (Jacobs.com)

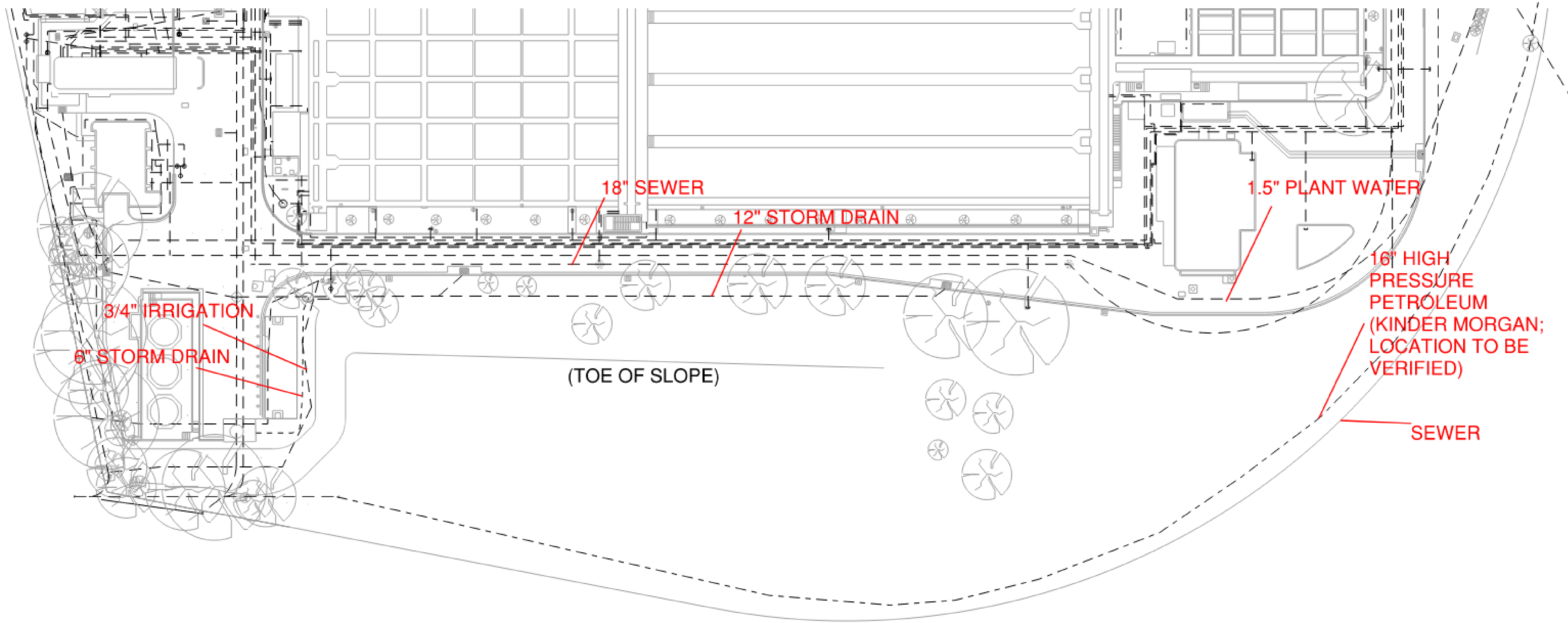


Figure 11. Yard Piping and Utilities at the Los Coyotes Water Reclamation Plant Site

Figure 12 shows the layout of the new AWTF, which occupies 55,380 ft^2 (that is, 1.3 acres) of the Los Coyotes WRP site. The proposed site would need to be raised by approximately 5 feet (with approximately 10,000 yd^3 of fill material) to match the existing Los Coyotes WRP site grade elevation of 74 feet. A soil retention system (for example, sheet piling) would need to be provided to protect existing utilities along the north side (the existing Los Coyotes WRP yard piping and yard electrical) and the south side (the high-pressure petroleum pipeline) of the site during construction of the below grade equalization tank and building foundations. This would increase construction complexity and cost, especially given the tight space.

Access will need to be provided through the existing Los Coyotes WRP, which may cause security and operational issues for the Los Coyotes WRP. The proximity of the AWTF to the Los Coyotes WRP aeration tanks is not ideal given LACSD's long-term issues with odors in that area, which might affect public perception during tours of the AWTF. LACSD's ongoing projects may reduce odors.

An internal road that would run east-west through the center of the AWTF would be provided for truck delivery to the chemical building and general access. Unlike the expansion AWTF at the Long Beach WRP site, new control and maintenance buildings would be required. Jacobs has assumed that feed to the AWTF would be routed in from the northwest location on the Los Coyotes WRP site; however, further design development would be necessary to better define its location and the location and routing of the finished water product pipeline and the waste discharge pipeline. The final routing of these pipelines may impact the proposed facility layout; for example, if the finished water pipeline is routed to the east, the decarbonator and product water pump station would likely be moved to the eastern side of the proposed site to reduce pipe length and complexity. Jacobs has assumed that the AWTF would discharge waste streams to the sewer, and LACSD has confirmed that there would be adequate capacity to receive the additional waste discharged from the 8-MGD facility.

Although no geotechnical borings have been specifically conducted at the expansion site, groundwater was encountered in a borehole in the vicinity of the expansion site in 2001 (refer to LOS-B-1 by Geo-Logic Associates on Figure 13) at an elevation of 44 to 45 feet. In 2015, another borehole (refer to B-9 by Amec Foster Wheeler on Figure 13) did not encounter groundwater at its termination depth of 26.4 feet below ground surface (that is, an approximate elevation of 46 feet).

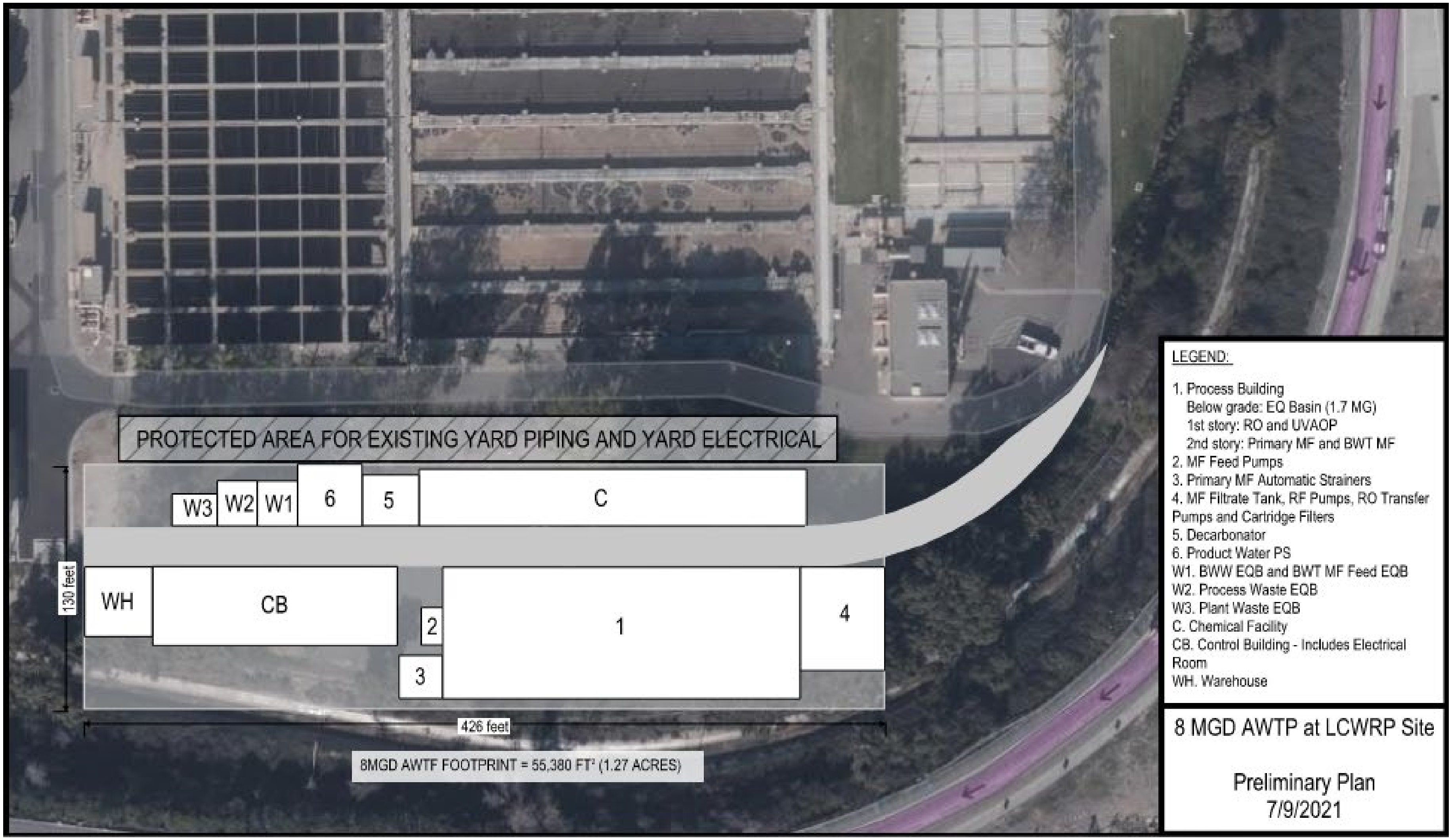


Figure 12. New Advanced Water Treatment Plant at the Los Coyotes Water Reclamation Plant Site
Source: Americas Imagery Catalog (Jacobs.com)

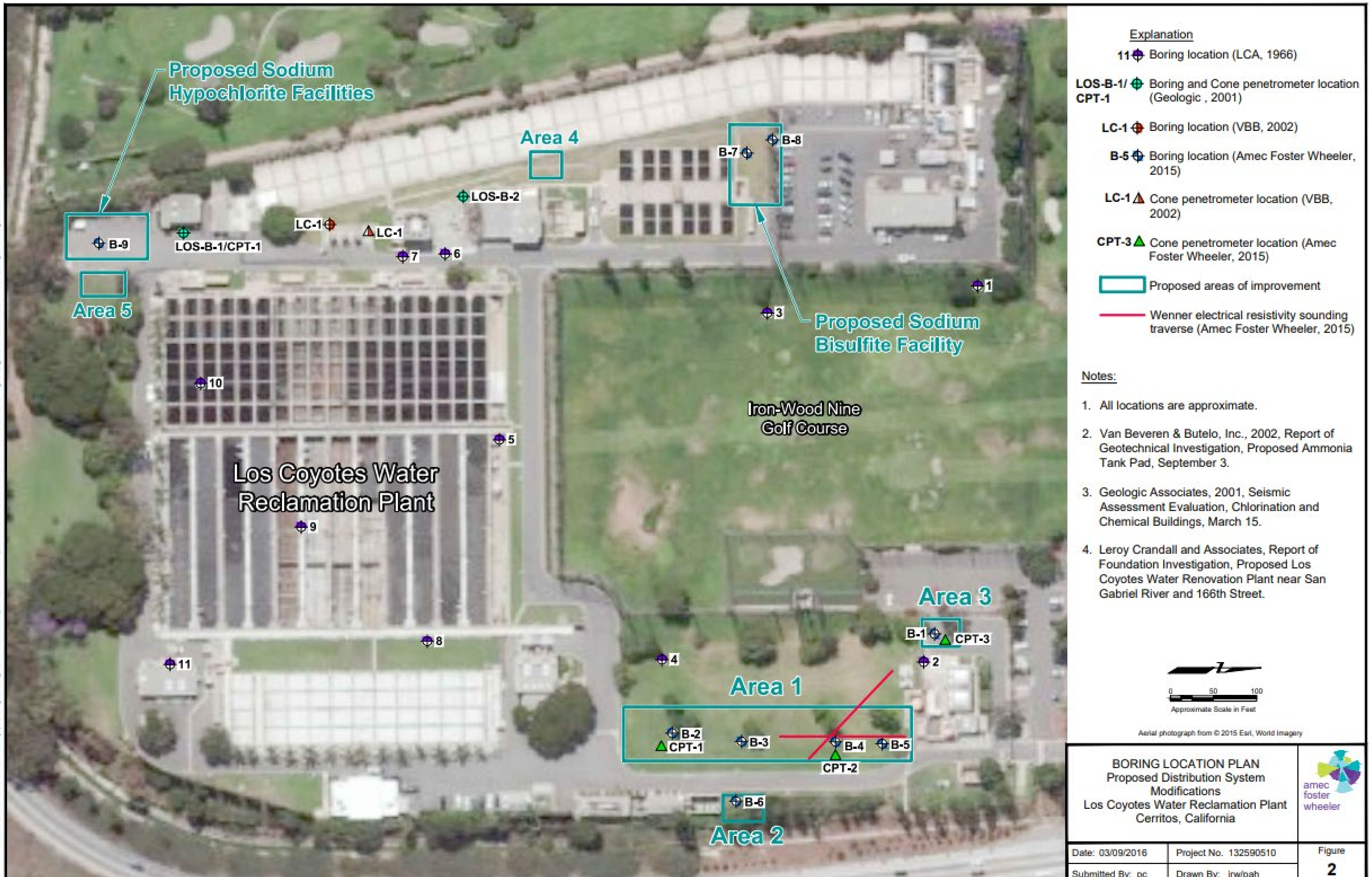


Figure 13. Borehole Locations at the Los Coyotes Water Reclamation Plant
Source: Amec Foster Wheeler 2016

Based on another geotechnical study at Los Coyotes WRP in 2016 (Amec Foster Wheeler 2016), the highest historical groundwater level was recorded at an elevation of 61.5 feet in 1941. Considering that the proposed AWTF influent equalization tank would be at an elevation of approximately 54 feet, the bottom of the tank would be 8 feet under the water table (Figure 14) and dewatering would be necessary if historical high groundwater conditions were present during construction. Specific geotechnical borings would be required at the expansion site to ascertain the groundwater level prior to construction.

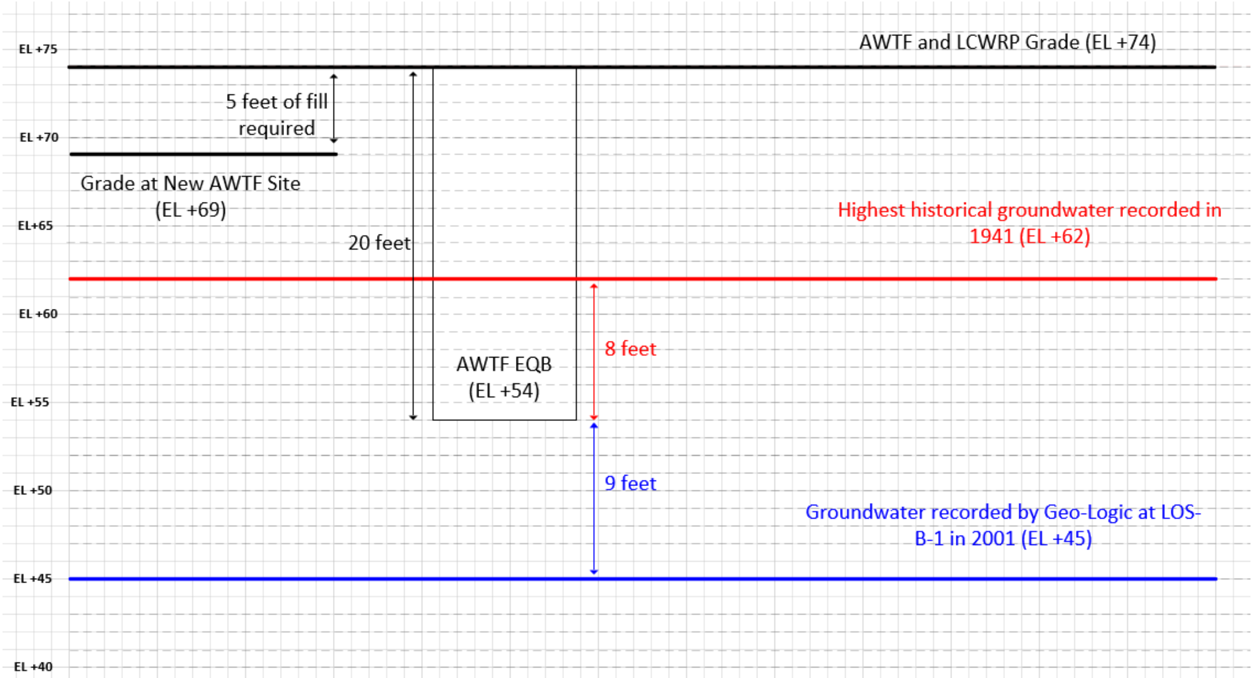


Figure 14. Groundwater Profile at the Los Coyotes Water Reclamation Plant Site

5. Site Comparison

Table 1 summarizes the major considerations for each site. The key considerations at the Long Beach WRP site are the significant fill requirement due to the 16-foot grade difference between the existing LVL AWTF grade and the proposed site and existing sewer discharge limitations that would require sewer system improvements if the LVL AWTF was to increase its discharge flow. Although there are no sewer limitations at the Los Coyotes WRP site, the limited space available at the south end of the Los Coyotes WRP and the underground utilities and yard piping nearby would present a challenge during construction. Odor from the aeration tanks at the south end of Los Coyotes WRP and the potential impact on Los Coyotes WRP operations from chemical deliveries to the AWTF would also have to be considered.

Table 1. Comparison between the Long Beach Water Reclamation Plant Site and the Los Coyotes Water Reclamation Plant Site

Considerations	Long Beach WRP Site	Los Coyotes WRP Site
Site constraints	▪ Significant fill required	▪ Tight site; difficult construction ▪ Historical high groundwater ▪ Odor from the south end of the Los Coyotes WRP ▪ Chemical deliveries to the AWTF may affect operations at the Los Coyotes WRP
Sewer discharge	▪ Sewer discharge limitations	▪ No sewer constraints
Other considerations	▪ Pipeline required from the Los Coyotes WRP to the LVL AWTF ▪ New administration and warehouse buildings not required ▪ Potential for shared O&M staff with the LVL AWTF ▪ Opportunity to share chemical deliveries and storage with the LVL AWTF ▪ Opportunity to use unused capacity at the LVL AWTF (6.5 to 8.0 MGD)	▪ Use of last available real estate for future expansion of WRP or contractor laydown area for future projects ▪ Pipeline to the LVL AWTF not required ▪ New O&M buildings required ▪ May require additional operations staff

Note:

O&M = operations and maintenance

6. Alternative Treatment and Disposal of Waste Streams

Currently, the LVL AWTF achieves a high overall plant recovery of 92% by using a secondary RO system (third-stage RO) and treating the backwash waste from the automatic strainers and primary MF through the backwash treatment MF system. This allows the plant to minimize its waste flow discharge and keep within LACSD's permitted sewer discharge limit of 0.76 MGD. An alternative approach would be to discharge the MF backwash directly to Long Beach WRP or Los Coyotes WRP without treatment to avoid higher sewer connection fees and backwash treatment requirements. Tables 2 and 3 present a cost analysis that compares the status quo (Scenario 1) and the recycling of MF backwash directly to Long Beach WRP or Los Coyotes WRP without treatment (Scenario 2) at both the Long Beach WRP site (Table 2) and the Los Coyotes WRP site (Table 3). In Scenario 3, the footprint of the AWTF has been further reduced by removing the third-stage RO; however, this also results in an increase in waste discharge and higher sewer fees. The alternative approaches could reduce the AWTF site footprint by eliminating some treatment, but would need to be further examined when the design progresses to determine if there is merit to either approach.

Table 2. 8-million gallon per day Advanced Water Treatment Plant Expansion at the Long Beach Water Reclamation Plant Site

Scenario	Description	AWTF Feed Flow (MGD)	AWTF Product Flow (MGD)	Plant Recovery	Waste Sent to Sewer				One-time Connection Fee with LVL AWTF Permitted Flow[a]	One-time Connection Fee with 2019-2020 LVL AWTF Existing Flow[a]	Annual Surcharge Fee[b]
					Flow (MGD)	COD (mg/L)	TSS (mg/L)	TDS (mg/L)			
1	New AWTF waste sent to sewer	8.75	8.00	91%	0.75	377	88.12	10,019	$3.2 million	$1.4 million	$567,000
2	No MF BW treatment, but keep third-stage RO at the new AWTF; send MF BW waste directly to the Long Beach WRP; all other flows sent to sewer	8.75	7.57	87%	0.71	378	0.41	10,126	$2.7 million	$840,000	$453,000
3	No MF BW treatment or third-stage RO at the new AWTF; send new MF BW waste directly to the Long Beach WRP; all other flows sent to sewer	8.75	6.96	80%	1.38	199	0.21	5,385	$4.6 million	$2.8 million	$760,000

[a] The connection fee at the Long Beach WRP includes a discount of $100,000 to $200,000 because it is on a "continuous" parcel to an existing, permitted facility (the LVL AWTF). The expansion must be combined with the existing facility and then compared to the existing baseline. The 2019-2020 evaluation used the existing surcharge for the existing LVL AWTF; a typical evaluation uses the existing surcharge plus the proposed surcharge. Permitted flow used the maximum that could be discharged under the current permit that would be used if the LVL AWTF was actually discharging at that rate.

[b] The annual surcharge estimate is only for the additional flow from the expansion.

Notes:

BW = backwash
COD = chemical oxygen demand
mg/L = milligram(s) per liter
TSS = total suspended solids

Table 3. New 8-million gallon per day Advanced Water Treatment Plant at the Los Coyotes Water Reclamation Plant Site

Scenario	Description	AWTF Feed Flow (MGD)	AWTF Product Flow (MGD)	Plant Recovery	Waste Sent to Sewer				One-time Connection Fee	Annual Surcharge Fee
					Flow (MGD)	COD (mg/L)	TSS (mg/L)	TDS (mg/L)		
1	New AWTF waste sent to sewer	8.75	8.00	91%	0.75	377	88.12	10,019	$3.4 million	$567,000
2	No MF BW treatment, but keep third-stage RO at the new AWTF; send MF BW waste directly to the Long Beach WRP; all other flows sent to sewer	8.75	7.57	87%	0.71	378	0.41	10,126	$3 million	$453,000
3	No MF BW treatment or third-stage RO at the new AWTF; send new MF BW waste directly to the Long Beach WRP; all other flows sent to sewer	8.75	6.96	80%	1.38	199	0.21	5,385	$5.5 million	$760,000

7. References

Amec Foster Wheeler. 2016. *Geotechnical Investigation Report: Power Distribution System Modifications.* Prepared for Los Angeles County Sanitation Districts. March 10.

Geo-Logic Associates. 2019. *Geotechnical Evaluation Report: Power Distribution System Modifications.* Prepared for Los Angeles County Sanitation Districts. August 28.

Los Angeles County Sanitation Districts (LACSD), CH2M HILL, Inc. (CH2M), and MWH Americas, Inc. (MWH). 2012. *Clearwater Program: Final Master Facilities Plan.* Prepared for Los Angeles County Sanitation Districts. November.

Appendix K
TM 6.2.4-LVL Groundwater Modeling

Jacobs

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Memorandum

1000 Wilshire Boulevard, Suite 1140
Los Angeles, California 90017
United States
T +1.213.538.1388
F +1.230.538.1399
www.jacobs.com

Subject	**Technical Memorandum 6.2.4 – Phase 2 Groundwater Modeling-LVL/Los Coyotes WRP Project – Final**
Project Name	WRD and LADWP Joint Los Angeles Basin Replenishment and Extraction Master Plan
Date	March 14, 2022 (Revised)

1. Introduction

This technical memorandum (TM) documents the groundwater modeling and associated results to assess the hydrogeologic feasibility of replenishment and augmentation Project Concepts near the Leo J. Vander Lans Advanced Water Treatment Facility (LVL AWTF) and Los Coyotes Water Reclamation Plant (WRP), as part of the Water Replenishment District (WRD) and Los Angeles Department of Water and Power (LADWP) Joint Los Angeles Basin Replenishment and Extraction Master Plan (Joint Master Plan). Groundwater modeling documented in this TM is part of the Phase 2 evaluation described in TM 6.1.1 – Phase 2 Groundwater Modeling-Hyperion WRP Project (Appendix G) , which represents a significant update from the earlier Phase 1 groundwater modeling, documented in TM 3.2.1 (Appendix D).

The Joint Master Plan document is a compilation of several TMs that were prepared through the various stages of the plan. The following are summaries of the TMs relevant to this TM:

- TM 1 – Identification of System Components
  - TM 1 (Appendix A) documented the process for identifying a comprehensive list of all potential replenishment sources, treatment locations, replenishment locations, and extraction locations. A set of defined criteria was used to identify the most feasible components to carry forward as projects to consider in the Joint Master Plan. The TM concludes with a final list of project components to be considered, a list of project components that were not recommended, the criteria used to determine projects that would not be recommended, and a matrix grouping the individual projects from the supply, treatment, replenishment, and extraction project component groups into single projects that could be evaluated.
- TM 2 – Project Concepts Development and Selection (Appendix B)
  - The system components identified in TM 1 were used to develop 30 Project Concepts and Add-on Projects. These Project Concepts were initially screened based on overall feasibility and discussion between WRD, LADWP, and Jacobs. After screening, 17 Project Concepts were selected. These Project Concepts were scored and ranked in an iterative process to collaboratively determine which projects should be selected for further development and serve as the overall recommended projects in the Joint Master Plan.
- TM 3.1 – Basis of Project Development
  - TM 3.1 (Appendix C) describes the basis of project development and key assumptions to be used in subsequent development of the Hyperion WRP Project and the Los Coyotes WRP Project that

were selected after the screening process described in TM 2. A simplified Water Balance Model was developed for the Hyperion WRP Project with the goal of running many different scenarios that required different basin operations. The Water Balance Model scenarios were created with WRD and LADWP.

- TM 3.2.1 – Phase 1 Groundwater Modeling Results
  - TM 3.2.1 (Appendix D) documents the results of the Phase 1 groundwater modeling conducted to evaluate the hydrogeologic feasibility of the injection and extraction wellfield locations. Groundwater modeling inputs were based on the Hyperion Water Balance Model scenarios developed in TM 3.1. Section 1.1 of this TM summarizes the results.
- TM 3.2.4 – Los Coyotes Water Reclamation Plant to Leo J. Vander Lans Advanced Water Treatment Facility Review
  - TM 3.2.4 (Appendix F) provides a detailed evaluation of the LVL/Los Coyotes WRP Project and a review of preliminary design documents for the pipeline and pump station between the Los Coyotes WRP and the LVL AWTF. TM 3.2.4 documents the LVL AWTF effluent flow analysis, preliminary design document review, and cost estimate update for the Los Coyotes WRP Project.
- TM 6.2.1 – LVL/Los Coyotes Water Balance Model
  - TM 6.2.1 (Appendix H) provides interim documentation of the LVL AWTF process and the scenario results. Specific scenarios were identified for hydrogeologic feasibility evaluation through groundwater modeling.

Phase 2 modeling evaluated scenarios developed with WRD and LADWP that incorporated future groundwater extraction and augmentation plans from the Long Beach Water Department (LBWD). The Jacobs LVL/Los Coyotes Water Balance Model simulated these scenarios and estimated advanced treated recycled water available for groundwater injection at the LVL AWTF and Los Coyotes WRP. The main objective of Phase 2 groundwater modeling for the LVL AWTF and Los Coyotes WRP components was to evaluate the hydrogeologic feasibility of (1) replenishment (where the entire volume of available advanced treated recycled water was injected into the subsurface) and (2) augmentation (where the available advanced treated recycled water was injected into the subsurface and an equivalent volume was extracted within the same year to meet demands) at the LVL AWTF and Los Coyotes WRP. The modeling also identified conceptual locations and depths for potential new injection and extraction wellfields (for the Augmentation Scenarios) in the vicinity of the LVL AWTF and Los Coyotes WRP.

This TM summarizes the groundwater quality data compiled for the areas close to the LVL AWTF and Los Coyotes WRP and the conceptual wellfield locations. The water quality datasets will be used to support a subsequent phase of refined modeling, Material Physical Harm (MPH) assessment, and site-selection investigations. This TM also discusses suggested next steps for incorporating water quality data to further evaluate the groundwater modeling results.

1.1 Summary of Phase 1

Groundwater modeling in Phase 1 was presented in TM 3.1 (Appendix C) and summarized in TM 6.1.1 (Appendix G). The Los Angeles Coastal Plain Groundwater Model (LACPGM), which the U.S. Geological Survey (USGS) recently developed (Paulinski 2021), was used as a predictive tool to assess the physical limitations of proposed replenishment, injection, and extraction locations and volumes. Phase 1 modeling focused primarily on the Hyperion WRP Project components in the Los Angeles Forebay and included a preliminary evaluation of injection near the LVL AWTF. The Hyperion Water Balance Model scenarios provided total volumes of injection identified for aquifer recharge and augmentation near the LVL AWTF.

The Phase 1 combined total injection volume for replenishment or augmentation near the LVL AWTF was 4,000 acre-feet per year (AFY) for all the project scenarios except the Baseline scenario (refer to TM 3.1 in Appendix C for details). For Phase 1 modeling, this 4,000 AFY of injection was a “placeholder” to be refined during Phase 2 modeling, as subsequent sections describe. For each Phase 1 project scenario, the respective volumes were applied to three new injection wells near the LVL AWTF. Modeling results for all project scenarios with injection near the LVL AWTF indicated that threshold maximum water levels, set at 50 feet below the top of the shallowest groundwater node at that location, representative of ground surface, were exceeded. The exceedance of thresholds was attributed to historically high water levels and lack of additional extraction near the new injection wells.

1.2 Approach for Phase 2

Phase 2 modeling built on the model developed during Phase 1 and added more detail and refinement to the modeling assumptions in and around the LVL AWTF and Los Coyotes WRP areas.

Groundwater modeling for the Los Coyotes WRP Project under Phase 2 commenced after the development of the LVL/Los Coyotes Water Balance Model, documented in TM 6.2.1 (Appendix I). The Phase 2 groundwater modeling for the Los Coyotes WRP Project combined the following three sources of inputs (described in the following sections):

1) LVL/Los Coyotes Water Balance Model
2) Hyperion Water Balance Model
3) LBWD’s Adaptive Management Plan

The LVL/Los Coyotes Water Balance Model evaluated options for the expansion of advanced treated water considering supplies from the Long Beach WRP or the Los Coyotes WRP. The evaluation focused on available supplies for the advanced treated water production and demand for the advanced treated water produced at the LVL AWTF. The LVL/Los Coyotes Water Balance Model had multiple scenarios for 2 main alternatives: 1) with advanced treated water produced at a new plant located at Los Coyotes WRP, and 2) with advanced treated water produced at the LVL AWTF. Following input from WRD staff, two of the eight total scenarios were evaluated using the groundwater model, similar to Phase 1 modeling. For each scenario, conceptual areas were identified for injection and extraction wellfields.

The LBWD is one of the largest pumpers in the Central Basin, with several extraction wells near the LVL AWTF. WRD staff initiated communication with LBWD to identify its future pumping demands and management plans. LBWD provided data from its Adaptive Management Plan, including projections of future pumping and augmentation. LBWD’s future plans include full use of its pumping rights. Figure 1.2.1 shows existing LBWD wells and the average pumping over the period from 1986 to 2015. LBWD’s source water for augmentation in the Central Basin will be provided by the Metropolitan Water District’s (Metropolitan’s) Regional Recycled Water Program (RRWP). The LBWD data were incorporated into a selected Hyperion WRP Project Water Balance Model scenario to develop a new No Project scenario. The No Project scenario was then modified to include the LVL/Los Coyotes Water Balance Model scenarios by adding on the injection timeseries from the LVL/Los Coyotes Water Balance Model Scenarios to create the Project Scenarios. Section 2 describes the No Project and Project Scenarios in detail.

Specific locations for future LBWD injection and extraction wellfields were not available at the time of this study. Therefore, the modeling was performed using representative locations for LBWD future facilities and sited close to LBWD’s existing distribution network. Due to the uncertainty of future LBWD facilities and the potential overlap with injection and extraction wellfields considered under this study (for the LVL AWTF project component), the proposed LVL AWTF injection and extraction wellfield locations were considered at a conceptual level. Detailed siting, parcel investigation, and MPH analysis were not undertaken at this stage and are left for subsequent modeling when LBWD future facilities are better defined.

2. Modification of Hyperion Water Balance Model Scenarios

Before input was incorporated from the LVL/Los Coyotes Water Balance Model, a representative scenario was chosen from the Hyperion Water Balance Model and modified to account for LBWD's future pumping and augmentation. The Hyperion Water Balance Model Scenario 7 was identified as representative because it simulates extraction up to the total (basin-wide) allowed pumping allocation (APA) by all pumpers in the Central Basin (Attachment 1). Groundwater modeling for the previous Hyperion Scenario 7 assumed 4,000 AFY of replenishment at the LVL AWTF from the Los Coyotes WRP (Appendix C). Because the groundwater model for the Los Coyotes WRP Project was meant to reevaluate replenishment and augmentation feasibility near the LVL AWTF and Los Coyotes WRP, the 4,000 AFY of replenishment included in the previous Hyperion Scenario 7 groundwater model was removed to allow the model to incorporate revised replenishment or augmentation volumes coming from the LVL/Los Coyotes Water Balance Model. Figures 2.1a and 2.1b show the typical rates of injection and extraction (relevant in the Augmentation Scenarios) for the LVL/Los Coyotes WRP components for a given year of the model simulation period. The adjusted Hyperion Water Balance Model Scenario 7 was subsequently modified to maximize LBWD's extractions at existing wells up to its APA. Future LBWD injection and extraction was incorporated based on information from LBWD's Adaptive Management Plan and communication or discussions with LBWD staff. The following two modifications were made to develop a new Scenario 7 incorporating LBWD's future projects:

1) Addition of 3,100 AFY of pumping from one new well in the West Coast Basin. Siting information for this new well was not available at the time of modeling. The modeled location within the West Coast Basin is conceptual and close to a park area and the LBWD distribution network. The location was made available after modeling was completed and new simulations were not run to incorporate this adjustment, but it is anticipated that the modified location of the well will not change the modeling results due to its distance from the hypothetical LVL/Los Coyotes WRP Project's injection and extraction wells.
2) Addition of 4,500 AFY of augmentation from Metropolitan's RRWP. This was accomplished by an additional extraction of 4,500 AFY at LBWD's existing pumping wells and the injection of 4,500 AFY at new injection wells. Although the use of existing aquifer storage and recovery (ASR) wells for injection was identified in an earlier study WRD and Metropolitan conducted (CH2M HILL 2016), LBWD staff confirmed that revised locations will be identified for injection-only wells rather than the ASR wells. Siting information for the future injection wells was not known, so the locations were conceptual.

The West Coast Basin well (WCB-1) was assumed to be close to the existing LBWD distribution network and was screened in the model in the most transmissive model layer. The new hypothetical LBWD injection wells included to simulate RRWP augmentation were screened in the same sequences as nearby LBWD extraction wells. The hypothetical injection wells (LB-IW-1 through LB-IW-4) were located near the LBWD existing wellfield but separated by a minimum distance of 0.5 mile from nearby extraction wells to allow for adequate Title 22 residence times between the injection wells and drinking water wells in the vicinity. Figure 2.2 shows the locations of LBWD's hypothetical injection wells and the WCB-1 extraction well incorporated into the modified Hyperion Water Balance Model scenarios to establish the No Project Scenario. The locations of future additional LBWD injection and extraction are hypothetical and will need to be revised once LBWD's future plans for groundwater facilities are finalized.

This new LVL/Los Coyotes WRP Scenario 7 is specific to the Los Coyotes WRP and LVL AWTF alternatives and is the basis for simulation of the LVL/Los Coyotes Water Balance Model scenarios subsequent sections discuss. As such, this LVL/Los Coyotes WRP Scenario 7 is considered a No Project Alternative and is the baseline against which the Los Coyotes AWTF and LVL AWTF alternatives are assessed.

3. Groundwater Modeling

The LACPGM was used as a predictive tool to assess the physical limitations of each scenario's proposed replenishment, injection, and extraction locations and volumes. TM 3.2.1 discusses modifications to the LACPGM inputs and incorporation of the Hyperion Water Balance Model scenarios (Appendix D).

Figures 3.1a and 3.1b present simulated water levels for the No Project Alternative at representative locations. Figure 3.1a is the simulated hydrograph at a location close to the LVL AWTF, and Figure 3.1b corresponds to a location close to the Los Coyotes WRP. The maximum heads at LVL-IW01 and LC-IW01 for the project simulation period are -9 feet above mean sea level (amsl) and 5 feet amsl, respectively. These hydrographs show that under the No Project Alternative, water levels in specific geologic sequences are less than 50 feet from the top of the shallowest groundwater node at the location. As Section 3.2 describes, the 50-foot space is a threshold condition used to evaluate the hydrogeologic feasibility of new injection well locations. Figures 3.2a through 3.2f show the simulated regional water level contours for a simulation period with a high injection volume in the LVL/Los Coyotes Water Balance Model from the baseline scenario.

3.1 Mapping of LVL/Los Coyotes Water Balance Model Outputs

TM 6.2.1 discusses the LVL/Los Coyotes Water Balance Model development in detail (Appendix I). Table 3.1 summarizes the scenarios developed using the LVL/Los Coyotes Water Balance Model, and this section discusses two scenarios that were identified for groundwater modeling. The scenarios and alternatives from the LVL/Los Coyotes Water Balance Model are organized as follows:

- There are two alternatives that refer to the volumes of water received from Long Beach:
  - Alternative 1 corresponds to the availability of excess water from the Long Beach WRP, above 6.5 million gallons per day (MGD)[1] to backfill the LVL AWTF
  - Alternative 2 uses only minimum Long Beach WRP flows
- There are three scenarios referring to where expansion will occur:
  - Scenario 1: No expansion
  - Scenario 2: Expansion near Long Beach/LVL AWTF
  - Scenario 3: Expansion near Los Coyotes WRP
- Each scenario also has a variant (indicated by the letter "a" or "b") indicating how the tertiary water production from Los Coyotes WRP will be allocated in the future:
  - a: Los Coyotes WRP allocation is based on historical data; this assumes that the cities of Cerritos and Bellflower will continue taking the historical recycled water flows from Los Coyotes WRP that they have been taking in the past (recent data from January 2015 to December 2019), which is below their maximum by contract.

[1] The water supply delivery protocol contained in agreement WD-3535 between WRD and LBWD for the sale of Long Beach WRP effluent as influent to the LVL AWTF is based on a constant, minimum flow rate of 6.5 MGD.

- b: Los Coyotes WRP allocations to the cities of Cerritos and Bellflower are maximized to their contract limits.

These combine to create a total of eight project scenarios in addition to Scenario 1, which represents no future expansion at either LVL AWTF or Los Coyotes WRP. The two scenarios 2a and 3a under Alternative 1 were identified as the only scenarios to be used for evaluation using the groundwater model because they represented the maximum amount of advanced treated recycled water available for recharge near the LVL AWTF and Los Coyotes WRP, respectively.

The LVL/Los Coyotes Water Balance Model provided a monthly time-series of injection volumes for a 5-year period. This 5-year period was repeated six times to evaluate the impact with the groundwater model over a 30-year period with variable hydrology. Table 3.2 provides a mapping of the relevant Water Balance Model outputs categorized by output variable name and corresponding groundwater model input representation. A 2-MGD (target capacity) injection well is slated to be constructed at the LVL AWTF in 2022. As such, this project component was included as part of the replenishment or augmentation facilities near LVL AWTF. The LVL/Los Coyotes Water Balance Model includes supply to Alamitos Barrier demand, after first supplying a minimum of 0.5 MGD at the 2-MGD LVL AWTF injection well. Any additional supply is then applied to the LVL AWTF injection well, up to its target capacity of 2 MGD. TM 6.2.1 discusses these assumptions and scenario-specific variations in supply to the Alamitos Barrier in detail (Appendix I).

For the two scenarios modeled, both replenishment and augmentation options were simulated, for a total of four simulations. Replenishment is defined as an injection-only project option with no additional extraction; augmentation is defined as injection combined with an equal volume of extraction each year.

Alternative 1, Scenario 2a considers injection wells near the LVL AWTF. The injection-only option of this scenario will be referred to as LVL Replenishment, and the injection and extraction option of this scenario will be referred to as LVL Augmentation. Analogously, Alternative 1, Scenario 3a simulations will be referred to as Los Coyotes Replenishment and Los Coyotes Augmentation.

In the augmentation simulations, annual extraction must match annual injection. The extractions should also be reflective of annual demands. As such, the timing of extractions was adjusted to reflect historical seasonal trends in pumping. The average quarterly distribution of pumping in both the Central and West Coast Basins was used to distribute the total annual volumetric flux across the quarterly stress periods. Figures 2.2a and 2.2b demonstrate the time-series of new extraction and injection for each LVL AWTF and Los Coyotes WRP scenario for a typical year.

The volumes of extraction for the LVL AWTF wells were assumed to be equal to injection at the new LVL AWTF injection wellfields combined with the 2-MGD LVL AWTF well. Similarly, the volumes of extraction for the Los Coyotes AWTF area were assumed to be equal to the new injection corresponding to Los Coyotes AWTF replenishment. Table 3.3 presents these rates.

3.2 Hydrogeologic Feasibility Evaluation – Wellfield Scale

Similar to Phase 1, the approach for evaluating hydrogeologic feasibility of a new well location was based on comparing simulated water levels against water levels thresholds. For the Phase 2 Los Coyotes WRP Project modeling, hydrogeologic feasibility assessment was focused on new injection locations and evaluating whether 100% replenishment was feasible or whether augmentation (which requires extraction within the same year) would be necessary to mitigate high water levels. At the new injection locations, high water levels were the primary concern; simulated water levels were compared with the top elevation of the shallowest groundwater model node at the injection location to evaluate potential flooding. High water levels are of concern due to surface flooding at wellheads, increased potential for liquefaction, and excessive hydraulic head buildup or mounding in and around wells.

The threshold for an injection location was considered exceeded if the highest simulated water level was less than 50 feet below the top of the shallowest groundwater node, representative of ground surface. This threshold was taken as a conservative engineering threshold based on professional judgment to avoid excessive buildup of water levels or pressure in and around injection wells. In addition, the 50-foot below ground surface (bgs) threshold was applied for the estimation of storage space (Johnson and Njuguna 2003) in the Central and West Coast Basins. The estimated storage space subsequently became the basis for the Central and West Coast Basins 2013 and 2014 Judgment Amendments that enabled use of the available storage space with augmentation projects.

3.3 Placement and Screening of Wells

Placement of new injection and extraction well screens was based on aquifer transmissivity from the LACPGM (Paulinski 2021) and additional considerations. The relevant model layers listed sequentially by increasing depth are as follows:

1) Dominguez Sequence, Model Layer 2
2) Mesa Sequence, Model Layer 3
3) Pacific A Sequence, Model Layer 4
4) Pacific Sequence, Model Layer 5
5) Harbor Sequence, Model Layer 6
6) Bent Spring Sequence, Model Layer 7
7) Upper Wilmington A Sequence, Model Layer 8
8) Upper Wilmington B Sequence, Model Layer 9

Model Layer 1 is not representative of a geologic unit and is only used in the model to receive recharge across the entire model domain. A detailed description of the age and boundaries of each sequence is available in the LACPGM model development report (Paulinski 2021).

The locations of potential injection and extraction wells were chosen in consultation with WRD. The locations of the injection wells were initially identified based on model transmissivity, proximity to existing extraction locations (although they were still 0.5 mile away to ensure adequate residence time for Title 22 compliance), site feasibility (open-space areas), and proximity to the Metropolitan recycled water Backbone conveyance system or to the LVL AWTF. The new extraction well locations were then based around the injection locations. They were located near the injection wells (although they were still 0.5 mile away to ensure adequate residence time for Title 22 compliance) so as to mitigate any mounding that may occur as a result of the injection.

Screening depths were selected based on two considerations: (1) model layers with transmissivity above 10,000 square feet per day were selected first and (2) nearby extraction wells were used to screen additional model layers to comparable depths irrespective of the model transmissivity in those layers. New potential extraction wells had the same screened sequence layers as the associated injection wells (for example, LC-IW01 had the same layers screened as LC-EW01). Figure 3.3.1 shows a map of fence sections. Figures 3.3.2a through 3.3.2c, 3.3.3a through 3.3.3c, and 3.3.4a and 3.3.4b are fence sections that show the depths and sequences screened for the hypothetical well groupings of future LBWD injection through the RRWP, LVL AWTF injection and extraction, and Los Coyotes AWTF injection and extraction, respectively, based on well layouts from Augmentation Scenarios. The hypothetical LBWD injection wells associated with the RRWP are screened approximately 250 feet bgs to 1,250 feet bgs. Hypothetical LVL

AWTF wells are screened from approximately 150 feet bgs to 1,500 feet bgs. Hypothetical Los Coyotes AWTF wells are screened from approximately 300 feet bgs to 1,800 feet bgs.

3.4 Replenishment (Injection-only) Scenarios

The Replenishment Scenarios simulate injection at the 2-MGD LVL AWTF well and additional injection wells for Scenarios 2a and 3a under Alternative 1. Similar to Phase 1, hydrogeologic feasibility for new injection wells is assessed against the 50-foot threshold requirement. The following sections present the results of the Replenishment Scenarios that simulated injection close to the LVL AWTF and Los Coyotes AWTF, respectively.

3.4.1 Alternative 1, Scenario 2a –LVL AWTF Replenishment

Figure 3.4.1 shows the well configuration for the LVL AWTF Replenishment Scenario, which includes approximately 7.0 MGD and 2.0 MGD of injection at 3 new hypothetical LVL AWTF injection wells (LVL-IW02 through LVL-IW04) and the 2-MGD LVL AWTF well (LVL-IW01). Figure 3.4.1 shows the initial layout of well locations identified for LVL AWTF replenishment, which has different positions of injection wells compared to the Augmentation Scenario. These locations were selected based on the feasibility of site availability (places with open-space areas) and convenience for conveyance. North of LVL AWTF did not have feasible locations due to potential access constraints and local extraction wells being close by. Locations to the east were also ruled out due to conveyance challenges on the east side of El Dorado Park. Figures 3.4.2a through 3.4.2d show the hydrographs at the new LVL AWTF injection wells (LVL-IW02 through LVL-IW04) as well as the planned 2-MGD LVL AWTF well (LVL-IW01). The maximum head at LVL-IW01 for the project simulation period is 2 feet amsl. The maximum head at any of the hypothetical LVL AWTF locations (LVL-IW02-04) for the project simulation period is 4 feet amsl. The minimum elevation difference between the top of the shallowest groundwater node and the simulated heads in the injected (confined) sequences ranged from 12 feet at LVL-IW01 and LVL-IW02 to 19 feet at LVL-IW04. The average elevation difference between the simulated heads in the injected sequences and the top of the shallowest groundwater node ranged from 35 feet at LVL-IW02 to 66 feet at LVL-IW04. In comparison with the No Project Alternative (Figure 3.1a), water levels at the LVL-IW01 location increased by approximately 10 feet in the Pacific Sequence, 16 feet in the Harbor Sequence, and 19 feet in the deeper Upper Wilmington A Sequence. These model results suggest excessive head buildup near injection wells as simulated heads exceed the threshold of 50 feet below the top of the shallowest groundwater node. The hydrographs show simulated head response in the injected sequences, which are all confined at the LVL AWTF injection well locations. Surface flooding or liquefaction is driven by water level increases in shallow unconfined aquifers. As such, the simulation results show excessive head buildup in and around the injection wells in the injected confined sequences. Further analysis needs to be conducted to assess risk from flooding or liquefaction in the unconfined sequences.

The LVL AWTF injection wells were simulated at locations near the Alamitos Barrier and may affect the barrier water levels. Figure 3.4.3 shows the simulated maximum water levels across the Alamitos Barrier nodes in the shallow Mesa Sequence for the historical and the LVL AWTF Replenishment Scenarios. The figure indicates the simulated Replenishment Scenario maximum water levels across the barrier can potentially exceed the respective simulated historical maximum water levels. This condition may require adjustment of the barrier operations during periods of high water levels and optimization of injection rates at specific barrier wells. Figures 3.4.4a through 3.4.4f show the simulated regional water level contours for a simulation period with a high injection volume in the LVL/Los Coyotes Water Balance Model. The simulated water level contours in the Pacific and Harbor sequences show the LVL AWTF injection wells result in a spatially extensive mound and partially mitigate the large pumping centers north of the well locations (Figures 3.4.4b and 3.4.4c, respectively).

3.4.2 Alternative 1, Scenario 3a – Los Coyotes WRP Replenishment

Figure 3.4.5 shows the well configuration for the Los Coyotes Replenishment Scenario, which includes approximately 8.4 MGD and 1.0 MGD of injection at 5 new hypothetical Los Coyotes AWTF injection wells (LC-IW01 through LC-IW05) and the planned 2-MGD LVL AWTF well (LVL-IW01), respectively. The locations for hypothetical Los Coyotes AWTF injection wells were based on potential convenience for conveyance and finding suitable potential open-space areas. This area has more conveyance challenges compared to the LVL AWTF well placement due to freeways and limited potential sites near the planned Metropolitan Backbone that are free of access constraints. Figures 3.4.6a through 3.4.6f show the hydrographs at the new Los Coyotes AWTF injection wells (LC-IW01 through LC-IW05), as well as the planned 2-MGD LVL AWTF well (LVL-IW01). The maximum head at LVL-IW01 for the project simulation period is -3 feet amsl. The maximum head at any of the hypothetical Los Coyotes AWTF locations (LC-IW01 through LC-IW05) for the project simulation period is 32 feet amsl. The minimum elevation difference between the top of the shallowest groundwater node and the simulated heads ranged from 17 feet at LVL-IW01 to 56 feet at LC-IW04. The average elevation difference between the simulated heads and the top of the shallowest groundwater node ranged from 45 feet at LC-IW03 to 74 feet at LC-IW04. In comparison with the No Project Alternative, water levels at the LC-IW01 location increased by approximately 6 feet in the Pacific A Sequence, 11 feet in the Pacific Sequence, 14 feet in the Harbor Sequence, and 11 feet in the Bent Spring Sequence. High water levels exceeded the 50 feet below the top of the shallowest groundwater node threshold continuously at the LVL-IW01 location and intermittently at the LC-IW locations. Regional water level impacts are shown in the maps of water level contours at a period with high project injection on Figures 3.4.7a through 3.4.7e. Figures 3.4.6a through 3.4.6f illustrate that the Los Coyotes WRP injection wells show intermittent exceedances of the 50 feet below the top of the shallowest groundwater node threshold at the southernmost wellfields (LC-IW01, LC-IW02, LC-IW03), with no exceedances at the northernmost wellfields (LC-IW04, LC-IW05). In general, the Los Coyotes AWTF injection well locations have less buildup of head and exceedances of the 50-foot threshold compared to the LVL AWTF wells.

3.5 Augmentation (Injection and Extraction) Scenarios

Extraction is added to each injection scenario to attempt to mitigate potential high water levels in the Replenishment Scenarios. The LVL AWTF Replenishment Scenario resulted in water levels that frequently exceeded the 50-foot threshold requirement, and the Los Coyotes Replenishment Scenario resulted in intermittent high water levels at a few wells. The following sections present the results of the Augmentation Scenarios that simulated extraction at new extraction wells close to the LVL AWTF and Los Coyotes AWTF injection wells.

3.5.1 Alternative 1, Scenario 2a – LVL AWTF Augmentation

Figure 3.5.1 shows the well configuration for the LVL AWTF Augmentation Scenario, which includes approximately 7.0 MGD and 2.0 MGD of injection at 3 new hypothetical LVL AWTF injection wells (LVL-IW02 through LVL-IW04) and the planned 2-MGD LVL AWTF well (LVL-IW01), respectively, and 9.0 MGD of extraction at 4 new hypothetical LVL AWTF extraction wells (LVL-EW01 through LVL-EW04). The LVL AWTF extraction wells were located nearby to attempt to mitigate high water levels near the injection wells while respecting the need for 6-month residence of the injected water. The effort to use the extraction wells to mitigate high water levels also motivated the decision to convert LVL-IW02 from the Replenishment Scenario to an extraction well to create a line of extraction wells between injection wells and add a new injection well to the north (LVL-IW04). Figures 3.5.2a through 3.5.2d show the hydrographs at the new LVL AWTF injection wells (LVL-IW02 through LVL-IW04) as well as the planned 2-MGD LVL AWTF well (LVL-IW01). The maximum head at LVL-IW01 for the project simulation period is -8 feet amsl.

The maximum head at any of the hypothetical LVL AWTF locations (LVL-IW02-04) for the project simulation period is also -8 feet amsl. The minimum elevation difference between the top of the shallowest groundwater node and the simulated heads in the injected (confined) sequences ranged from 22 feet at LVL-IW01 to 28 feet at LVL-IW04. The average elevation difference between the simulated heads and the top of the shallowest groundwater node ranged from 51 feet at LVL-IW01 to 70 feet at LVL-IW04. Adding extraction to the LVL AWTF scenario lowered high water levels by approximately 10 feet. Although the maximum water levels were still above the 50-foot threshold requirement, the exceedances were reduced, and average groundwater elevations were below the 50-feet threshold. Regional water level impacts are shown in the maps of water level contours at a period with high project injection on Figures 3.5.3a through 3.5.3f. The contours show that the regional water levels are 10 to 15 feet lower in the Pacific and Harbor sequences when compared to the Replenishment-only scenario.

3.5.2 Alternative 1, Scenario 3a – Los Coyotes WRP Augmentation

Figure 3.5.4 shows the well configuration for the Los Coyotes Replenishment Scenario, which includes approximately 8.4 MGD and 1.0 MGD of injection at the new hypothetical Los Coyotes AWTF injection wells (LC-IW01 through LC-IW05) and the planned 2-MGD LVL AWTF well (LVL-IW01), respectively, and 8.4 MGD of extraction at new hypothetical Los Coyotes AWTF extraction wells (LC-EW01 through LC-EW05). Figures 3.5.5a through 3.5.5f show the hydrographs at the new Los Coyotes WRP injection wells (LC-IW01 through LC-IW05) as well as the planned 2-MGD LVL AWTF well (LVL-IW01). The maximum head at LVL-IW01 for the project simulation period is -6 feet amsl. The maximum head at any of the hypothetical Los Coyotes AWTF locations (LC-IW01 through LC-IW05) for the project simulation period is 17 feet amsl. The minimum elevation difference between the top of the shallowest groundwater node and the simulated heads in the injected (confined) sequences ranged from 20 feet at LVL-IW01 to 64 feet at LC-IW04. The average elevation difference between the simulated heads and the top of the shallowest groundwater node ranged from 55 feet at LC-IW03 to 82 feet at LC-IW04. Although LVL-IW01 still experienced high water levels, all of the Los Coyotes AWTF injection wells satisfied the high water level threshold when extraction was added. Regional water level impacts are shown in the maps of water level contours at a period with high project injection on Figures 3.5.6a through 3.5.6e. The contours show that the simulated regional water levels were 10 to 15 feet lower in the Pacific, Harbor, Bent Spring, and Upper Wilmington A sequences when compared to the Replenishment-only scenario.

3.6 Title 22 – Residence Time Requirements

The State Water Resources Control Board (SWRCB) Code of Regulations, Title 22, Article 5.2, *Indirect Potable Reuse: Groundwater Replenishment – Subsurface Application* directs applicants of indirect potable reuse programs through subsurface injection to demonstrate at minimum 6 months of residence time for water injected into the subsurface before being extracted if demonstrating through a numerical model.

The particle-tracking tool MODPATH 7 (Pollock 2016) was used to simulate residence time of injected water through analysis of the USGS's MODFLOW model simulations representing project scenarios. The particles' starting locations were placed at the center of all groundwater nodes where water was injected (only layers that were screened). A porosity of 0.25 was assumed for the particle tracking simulation, which was informed by literature values and a previous model of the Los Angeles Coastal Plain (Reichard 2003). The particle-tracking simulation was started from the stress period in which project extraction and injection began and ran for the entire period of simulated project extraction and injection, which is 30 years. Particle-tracking simulations were executed for both Augmentation Scenarios. Figures 3.6.1a through 3.6.1e and Figures 3.6.2a through 3.6.2d show the complete paths of the particles' first 6 months of travel for the LVL AWTF Augmentation Scenario and the Los Coyotes WRP Augmentation Scenario, respectively. Tables 3.4 and 3.5 show the distance each particle placed at each injection well traveled in 6 months for each sequence water is injected for Augmentation Scenarios. The maximum distance traveled in 6 months in each model layer ranged from 29 to 285 feet. Particles traveled the farthest in the Pacific Sequence. Based on these results, placement of injection and extraction wells closer than 0.5 mile can be considered in subsequent siting evaluations.

4. Water Quality Data

Water quality data was compiled from readily available data from the SWRCB Groundwater Ambient Monitoring and Assessment (GAMA) centralized public water quality database and was preliminarily evaluated to assess potential water quality issues in and around the proposed facilities (California Water Boards 2022). This phase of work was primarily focused on data collection to identify potential for water quality impacts from the project facilities. A more comprehensive water quality impact evaluation, including potential for MPH with a more detailed evaluation, should be conducted at a later phase when future injection and extraction facilities for LBWD are better defined.

Water quality data collected from GAMA was filtered by analyte and depth to evaluate water quality in the Central Basin, focusing on the area near the simulated LVL AWTF and Los Coyotes WRP injection and extraction wells. The public database, also known as the Groundwater Information System, is a compilation of multiple official datasets hosted through a web map accessible through the GAMA Online Tools. The GAMA dataset includes wells from Regional Water Quality Control Board regulatory sites (GeoTracker), Department of Water Resources wells, Division of Drinking Water public supply wells, SWRCB-regulated sites monitoring wells, and domestic drinking wells sampled by the SWRCB. The GAMA data is also considered more robust because responsible parties under active regulatory oversight for the past two decades have been required to submit data electronically to the Los Angeles Regional Water Quality Control Board (Regional Board). This provided staff with easy access to numerous investigation reports, water level data for evaluating depth to contamination, and various water quality data for sites the Regional Board actively manages. However, there still remains a considerable amount of uncertainty as not all known sites are readily available or easily accessible because the Regional Board may not actively manage them.

The GAMA Groundwater Information System was queried for all available results within the West Coast Basin and Central Basin boundaries (California Water Boards 2022). The GAMA dataset was filtered by depth (where the information was available) for a preliminary evaluation of the depths of potential contamination. Figure 4.1 shows the data available from the GAMA water quality database for several depth intervals (shallower than 200 feet, between 200 to 500 feet, and deeper than 500 feet). As Figure 4.1 shows, most of the GAMA well data available are at depths less than 200 feet. The preliminary water quality data evaluation indicates that the areas close to the Los Coyotes WRP have few locations with water quality data deeper than 500 feet. Several wells with data in the GAMA database do not have depth information available. The next phase of evaluation may entail a more comprehensive data search and review to obtain depth-specific information on groundwater contamination at the GAMA sites near the proposed well locations.

Additional filtering was applied to the GAMA data to provide a preliminary assessment of several key constituents of concern (COCs) grouped by petroleum hydrocarbons (represented by benzene and methyl tertiary butyl ether), chlorinated solvents (represented by trichloroethene and tetrachloroethene), other miscible constituents (represented by perchlorate and 1,4-dioxane), and other highly mobile COCs (represented by perfluorooctanoic acid [PFOA] and perfluorooctanoic sulfonate [PFOS]). Figures 4.2 and 4.3 show the results. The filtered data on these figures represent the most currently available data for analytes above detection levels. The figures show that for the key COCs, most of the GAMA data for the analytes evaluated are at shallow depths (less than 200 feet bgs). For one site located north of the

91 freeway in the Paramount area, GAMA data indicate PFOA or PFAS detection at a depth greater than 500 feet. This evaluation simply reports the availability or detection of key COCs at different depths. Overall, the data evaluated seem to indicate fairly good water quality at depth (as assessed based on few COCs above detection levels at depths greater than 500 feet) in the area of interest. Comparison to regulatory standards (maximum contamination level, notification levels, or response levels) and potential impacts from proposed injection and extraction facilities was not undertaken at this stage and will need to be assessed in the next phase through a comprehensive groundwater quality investigation and MPH evaluation. The absence of data does not necessarily imply the absence of contamination, and site-specific data collection is recommended before any siting of project facilities.

WRD's annual regional groundwater monitoring report also provides additional data for deep, nested groundwater monitoring wells and active water supply wells to evaluate various constituents throughout the Central Basin and West Coast Basin. Based on the WRD monitoring reports, the water quality in the study area is generally good, especially within the deeper groundwater monitoring well and drinking water supply wells in and around the study area (that is, LVL AWTF and Los Coyotes WRP). The reports are available online at https://www.wrd.org/reports/regional-groundwater-monitoring-report (WRD 2022).

Groundwater quality can be spatially variable because different aquifer and aquitard zones within the groundwater basin may display different levels of contamination. Groundwater quality is also temporally variable, with plumes moving, dispersing, or diluting (or a combination) over time. Hence, the detailed evaluation of groundwater quality impacts on the proposed projects should be evaluated in a subsequent detailed modeling and field data-collection phase.

5. Recommendations and Conclusions

Phase 2 modeling for the Los Coyotes WRP Project of the Joint Master Plan was performed to identify locations and volumes for new well locations and evaluate hydrogeologic feasibility of replenishment and augmentation at the LVL AWTF and Los Coyotes WRP. The Phase 2 modeling results indicate the following:

- Replenishment of 9.0 MGD was simulated at 4 new injection wells near the LVL AWTF. Modeling results indicate that injection near the LVL AWTF in the Replenishment Scenario is constrained by high water levels in the injected (confined) sequences. This result is consistent with that from Phase 1. More data is needed from the 2-MGD LVL AWTF well to evaluate the potential for high water levels during injection.
- Augmentation of 9.0 MGD was simulated at 4 new extraction wells near the LVL AWTF. Adding new extraction wells for augmentation lowers water levels at the LVL AWTF injection wells by approximately 10 feet compared to the Replenishment Scenario. However, water levels still rise above the threshold of 50 feet below the top of the shallowest groundwater node at the injection locations.
- Replenishment of 8.4 MGD was simulated at 5 new injection wells near the Los Coyotes WRP. Compared to the LVL AWTF area, replenishment in the Los Coyotes WRP area is more feasible (less constrained by high water levels), with intermittent exceedances of the threshold in the southern wellfields. The Los Coyotes WRP area is potentially more feasible compared to the LVL AWTF area due to regional water levels sufficiently below the ground surface in the Los Coyotes WRP area.
- Augmentation of 8.4 MGD was simulated at 5 new extraction wells near the Los Coyotes WRP. Augmentation in the Los Coyotes WRP area decreases water levels at the Los Coyotes WRP injection wells by an average of approximately 10 feet. This scenario is hydrogeologically feasible with water levels at three out of five locations (LC-IW01, LC-IW02, LC-IW03) intermittently exceeding the high

water level threshold in the Los Coyotes WRP area. The average water levels at these injection wells are all below the high water level threshold.

- Particle-tracking results indicated that all the injection locations satisfy the minimum 6-month residence time required under Title 22.
- The injection locations identified in this phase were evaluated primarily for hydrogeologic feasibility and incorporated pumping projections the LBWD provided. These locations will need to be further evaluated for additional permitting and basin management criteria. Additional analyses are required to identify specific parcels for siting the wells and to integrate any updated information from LBWD's future plans and Metropolitan's RRWP.
- WRD is in the process of installing a new injection well at the LVL AWTF. Data from the field investigation during testing and installation should be used to validate the LACPGM model properties and recalibrate as necessary. The field data should also be used to validate the high water levels to evaluate potential for flooding and liquefaction.
- The model assessed hydrogeologic feasibility for replenishment and Augmentation Scenarios at LVL AWTF and Los Coyotes WRP. The final project will likely include some replenishment and augmentation components. The split between replenishment and augmentation will need to be evaluated in a future phase based on pumpers' APAs, future demands, and interest in augmenting their pumping rights through additional extractions.

6. Limitations and Uncertainty

Phase 2 groundwater modeling was conducted as a desktop study to evaluate the Los Coyotes WRP Project water balance scenarios and focused on the hydrogeologic feasibility at conceptual new injection well locations. The LACPGM is a regional model and was used as a decision-support tool to provide an assessment of the hydrogeologic feasibility of different locations and volumes of injection and extraction wells. As with any groundwater model of this scale, the LACPGM is a numerical approximation of the hydrologic variability and geologic complexity, at a scale that is appropriate for regional-scale assessments such as the one this Joint Master Plan describes.

The LACPGM has inherent limitations due to the spatial and temporal discretization along with uncertainties in model inputs and parameters (Paulinski 2021). These model hydraulic parameters were an important factor in identifying potential locations and evaluating wellfield feasibility. In particular, the LACPGM layer transmissivities and storage coefficients were estimated using model calibration (Paulinski 2021) and represent average aquifer properties at the 1/8-mile grid scale. As such, the LACPGM does not explicitly simulate any well or site-scale geologic heterogeneities that may affect flow and transport at the field scale.

An MPH investigation was not conducted as part of this evaluation; however, a cursory review was conducted to evaluate groundwater quality data compiled from GeoTracker GAMA. There is significant uncertainty in the depth and location of potential contaminants (known and unknown) because a comprehensive, readily available database is not currently available for all regulatory agencies responsible for overseeing environmentally affected sites (that is, the U.S. Environmental Protection Agency, California Department of Toxic Substances Control, and Regional Board). It is plausible there are other sites in the study area that are currently unknown and as such were not evaluated.

7. References

California Water Boards. 2022. *GAMA Groundwater Information System*. Accessed April 23, 2021. https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/.

CH2M HILL Engineers. 2016. *Central and West Coast Basins Modeling for Metropolitan Regional Recycled Water Supply Program*. Prepared for the Water Replenishment District of Southern California and the Metropolitan Water District of Southern California. Final. October 21.

Johnson, T., and W. Njuguna. 2003. *Aquifer Storage Calculations Using GIS and MODFLOW Los Angeles County, California*. ESRI Annual Users Conference. September.

Paulinski, S., ed. 2021. *Development of a groundwater-simulation model in the Los Angeles Coastal Plain, Los Angeles County, California: U.S. Geological Survey Scientific Investigations Report 2021-5088*. https://doi.org/10.3133/sir20215088.

Pollock, D.W. 2016. *User guide for MODPATH Version 7—A particle-tracking model for MODFLOW: U.S. Geological Survey Open-File Report 2016–1086*. http://dx.doi.org/10.3133/ofr20161086.

Reichard, E.G., ed. 2003. *Geohydrology, Geochemistry, and Ground-Water Simulation-Optimization of the Central and West Coast Basins, Los Angeles County, California: U.S. Geological Survey Scientific Investigations Report 2003-4065*. https://doi.org/10.3133/wri034065.

Water Replenishment District of Southern California (WRD). 2022. Regional Groundwater Monitoring Report. Accessed March 1. https://www.wrd.org/reports/regional-groundwater-monitoring-report.

Tables

Table 3.1: Water Balance Model Scenarios & Alternatives Matrix

Source Water Alternatives	**Scenario 1: No Expansion**	**Scenario 2: Expansion at LBWRP/LVLAWTF**	**Scenario 3: Expansion at LCWRP**
***Alternative 1**: LBWRP excess backfills LVLAWTF*	1a – Current conditions	2a - LCWRP Allocation based on historical deliveries	3a - LCWRP Allocation based on historical deliveries
	1b – LVL maximized and full injection	2b - LCWRP allocations to others maximized	3b - LCWRP allocations to others maximized
***Alternative 2**: Only minimum LBWRP flows are used to backfill LVL AWTF*	2a – Current conditions	2a - LCWRP Allocation based on historical deliveries	3a - LCWRP Allocation based on historical deliveries
	2b - LVL maximized and full injection	2b - LCWRP allocations to others maximized	3b - LCWRP allocations to others maximized

Table 3.2: Injection Well Categories as Received from Jacobs Water Balance Model

Water Balance Model Output	Explanation	Groundwater Model Representation (group)	Groundwater Model Injection Location(s)
Alamitos Barrier Injection	From LVLAWTF to the Alamitos Barrier. Any difference between the Alamitos Barrier demands and the Alamitos Barrier injection series, is assumed to be provided by imported water from MWD.	Injection at existing Alamitos Barrier injection wells (Alamitos Gap Barrier)	Alamitos Barrier
LVL Well Injection	From LVLAWTF to the 2 MGD well that is being tested	Injection at 2 MGD well at LVL facility (LVL Injection)	LVL-IW01
New Wellfield for Replenishment/ Augmentation near LVL Facility	Water available after sending water the Alamitos barrier and the local LVL well (2 MGD).	Injection at new potential locations near LVL/Long Beach (New LB Injection)	LVL-IW02; LVL-IW03; LVL-IW04
New Wellfield for Replenishment/ Augmentation near LC Facility	Water produced at the LCWRP for injection at a new wellfield	Injection at new potential locations near LC (New LC Injection)	LC-IW01; LC-IW02; LC-IW03; LC-IW04; LC-IW05

Table 3.3: Average Rates for each Project Component for each Scenario in Acre-feet/year (AFY)

Project Components	**LVL Baseline [AFY]**	**LVL Replenishment: Alt 1, Scenario 2a [AFY]**	**LVL Augmentation: Alt 1, Scenario 3a [AFY]**	**LC Replenishment: Alt 1, Scenario 2a [AFY]**	**LC Augmentation: Alt 1, Scenario 3a [AFY]**
Alamitos Barrier Injection	5,456	6,688	6,688	5,782	5,782
LBWD Extraction	37,192	37,192	37,192	37,192	37,192
WCB Extraction	3,100	3,100	3,100	3,100	3,100
LBWD Injection/ Extraction (RRWP)	4,500	4,500	4,500	4,500	4,500
New LC Injection	0	0	0	9,460	9,460
New LVL Injection	0	7,823	7,823	25	25
(2 MGD) LVL Well Injection	0	2,214	2,214	1,145	1,145
New LC Extraction	0	0	0	0	9,460
New LVL Extraction	0	0	10,037	0	0

Table 3.4: Distance traveled in 6 months from Injection Wells in LVL Augmentation Scenario for each Sequence Injected into

Distance Traveled by Injection Well (ft)				
Sequence	LVL-IW01	LVL-IW02	LVL-IW03	LVL-IW04
Pacific	41	136	53	285
Harbor	69	80	67	135
Bent Spring	N/A	18	23	29
Upper Wilmington A	75	112	124	145
Upper Wilmington B	N/A	40	46	40

Table 3.5: Distance traveled in 6 months from Injection Wells in LC Augmentation Scenario for each Sequence Injected into

Distance Traveled by Injection Well (ft)					
Sequence	LC-IW01	LC-IW02	LC-IW03	LC-IW04	LC-IW05
Pacific A	70	76	70	69	146
Pacific	64	64	65	82	95
Harbor	58	52	55	N/A	N/A
Bent Spring	44	75	93	71	82

Figures

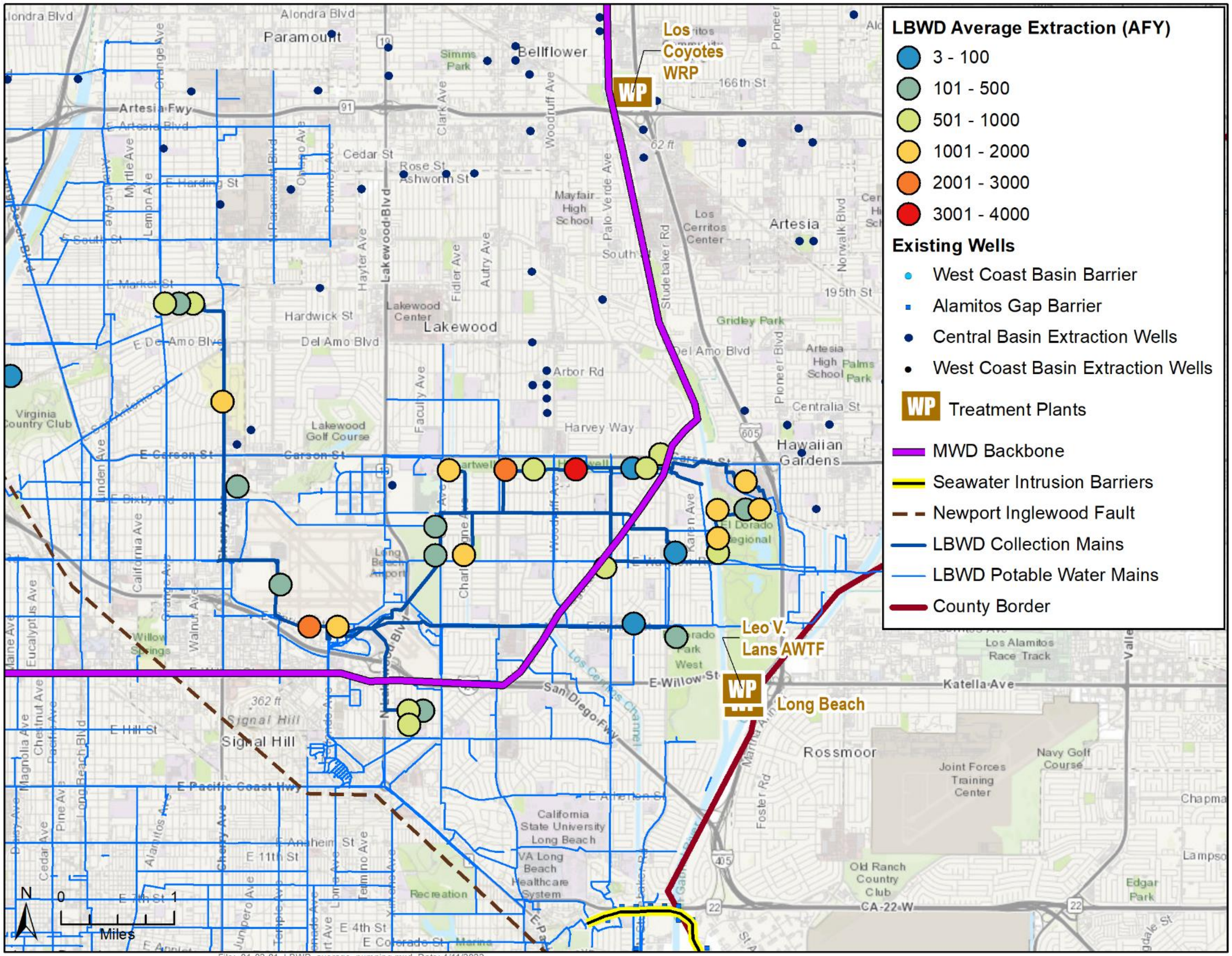
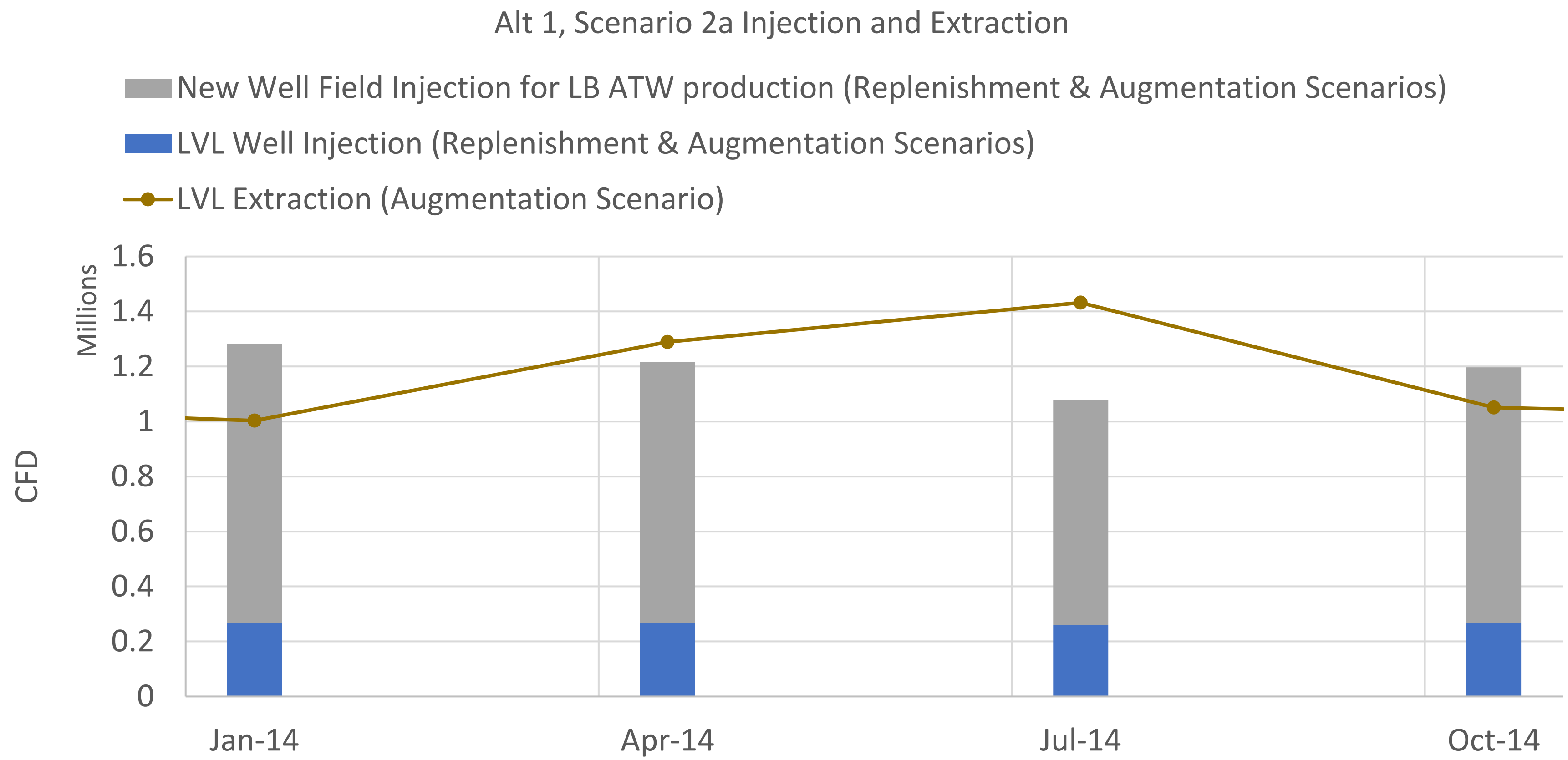


Figure 1.2.1
Average LBWD Pumping in All Scenarios from 1986-2015 of Model Simulation



INTERA

Figure 2.1a
Typical Year of Injection & Extraction Fluxes for LVL Scenarios

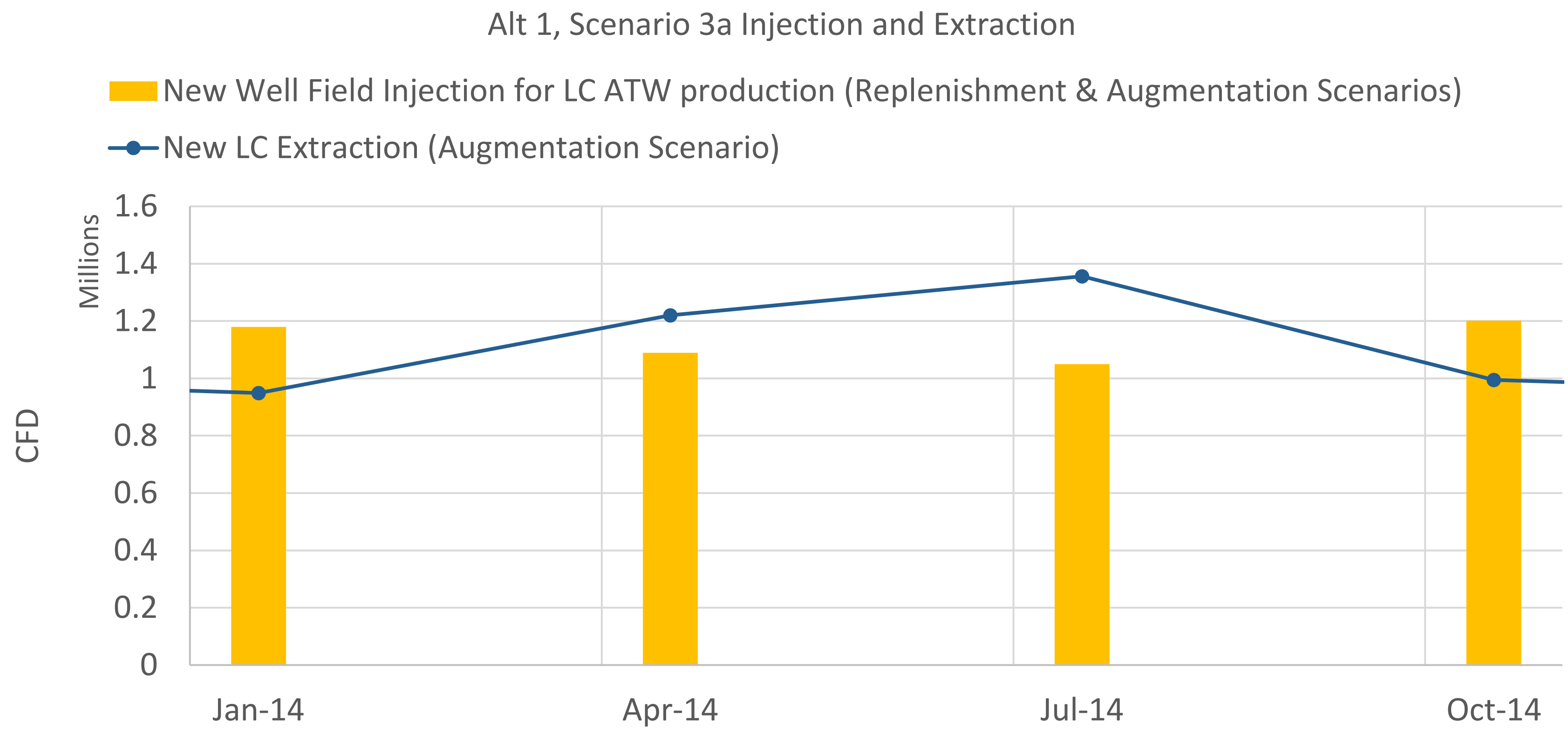
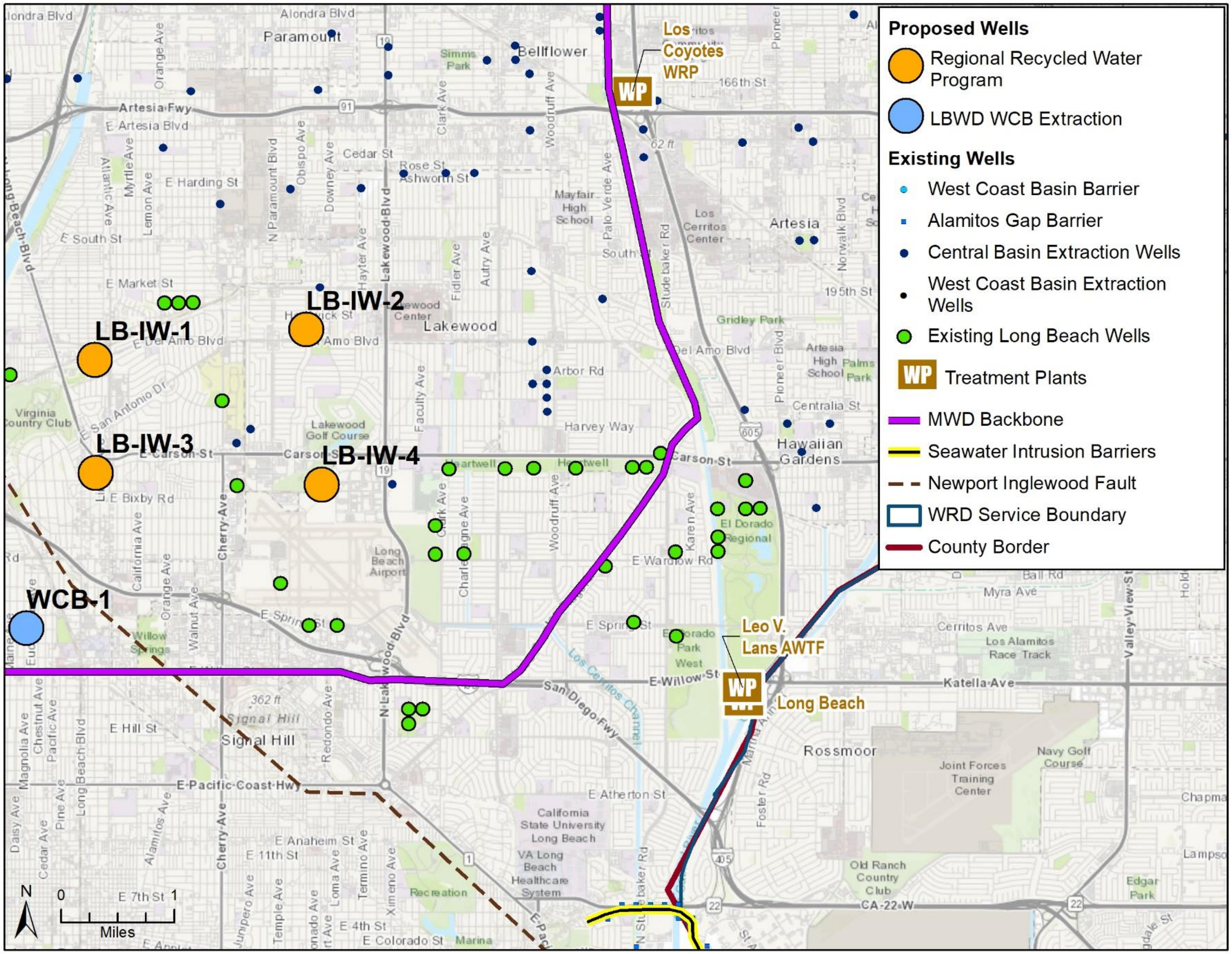


Figure 2.1b
Typical Year of Injection & Extraction Fluxes for LC Scenarios



INTERA

Figure 2.2
Map of Base Locations (LBWD future-included)

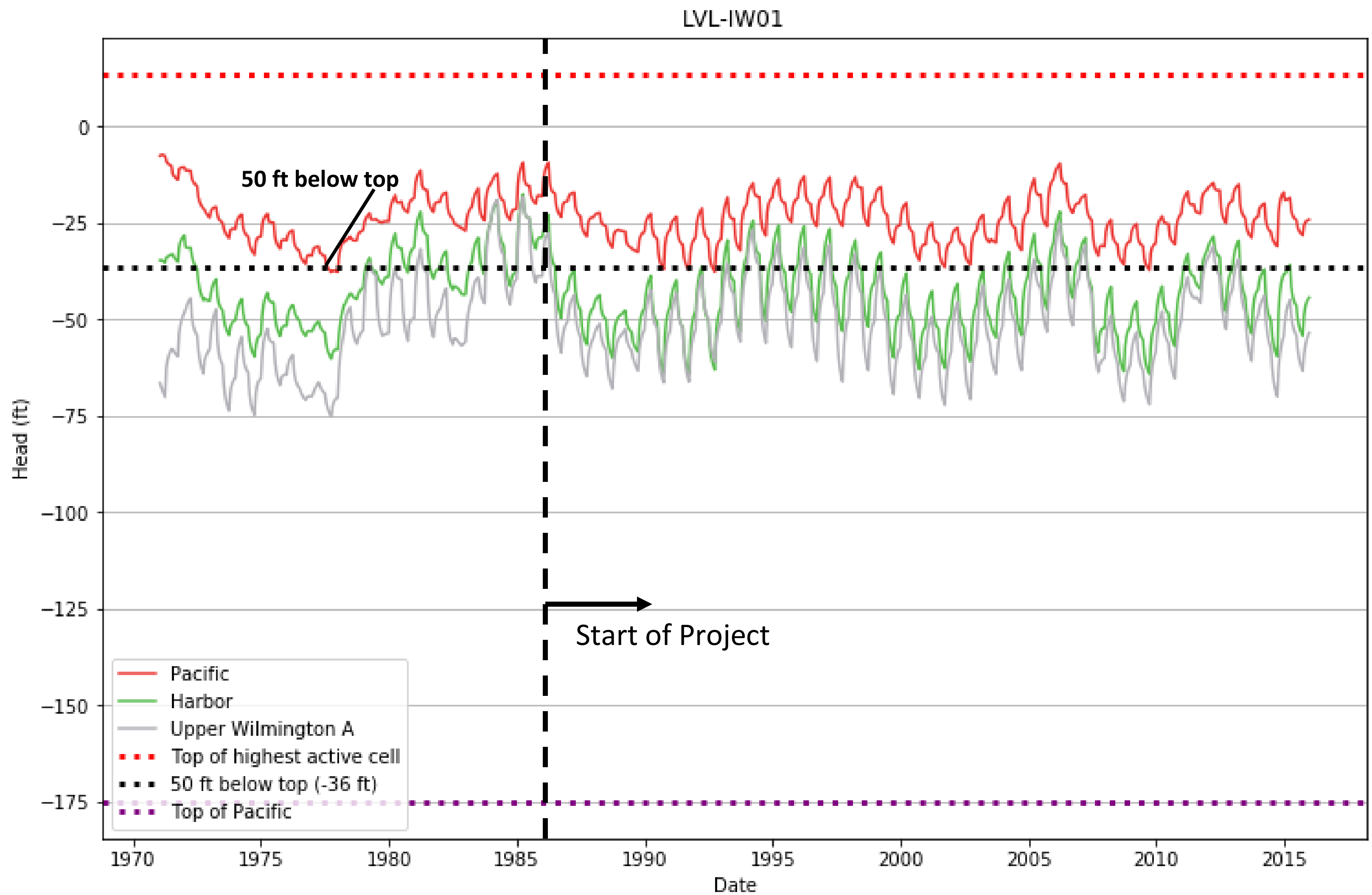
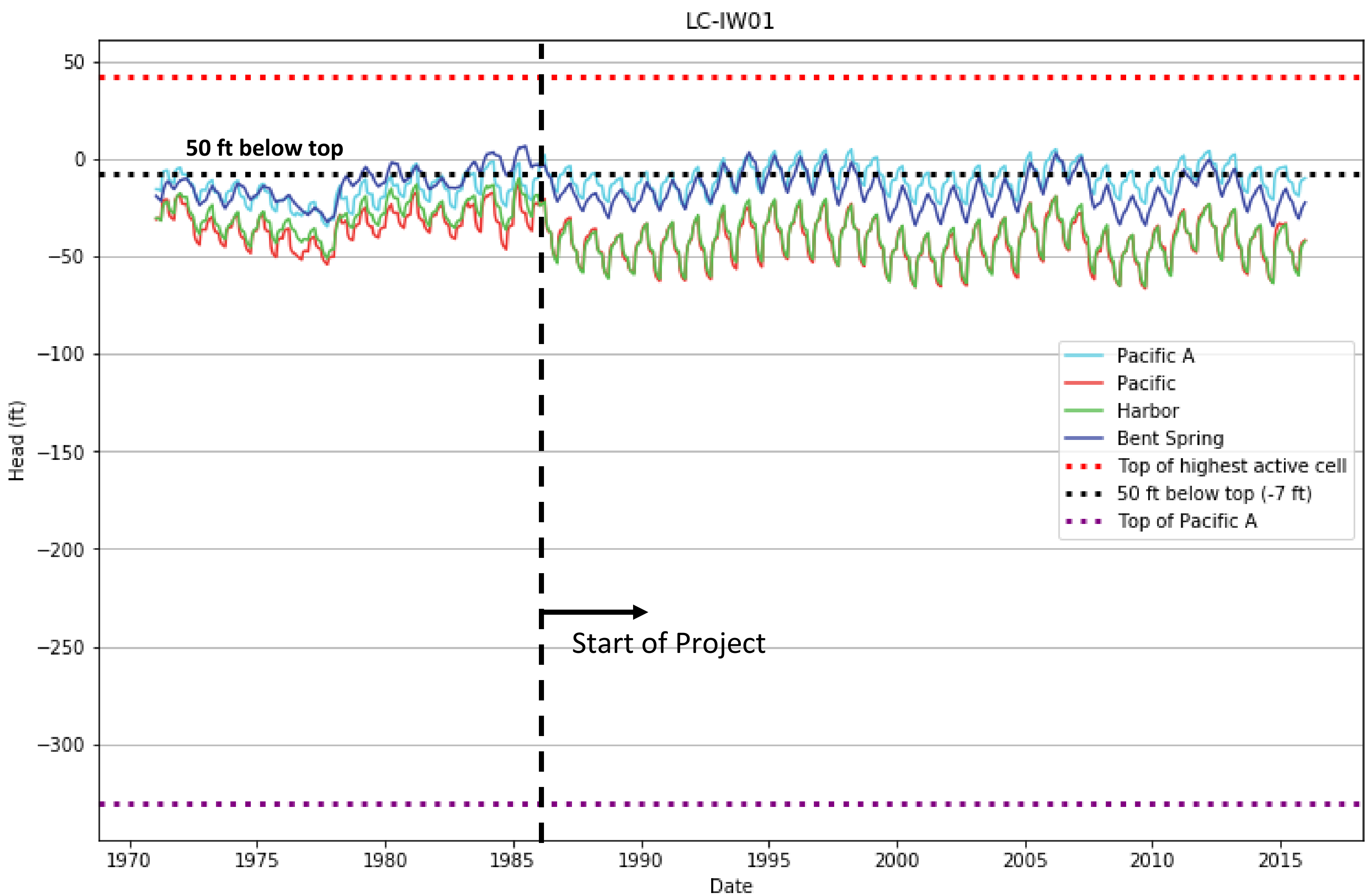
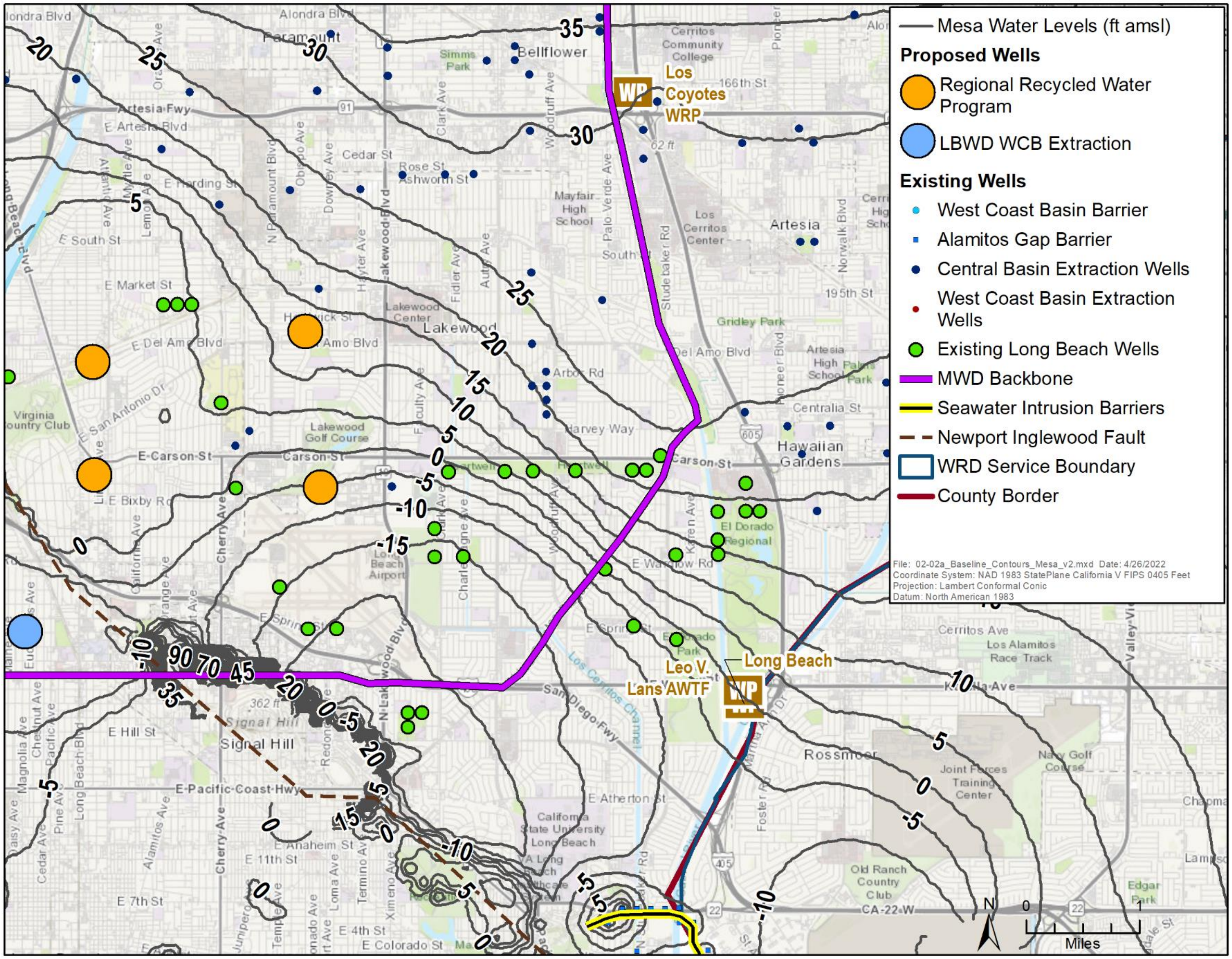


Figure 3.1a
Hydrographs at LVL -IW01 – No Project Scenario



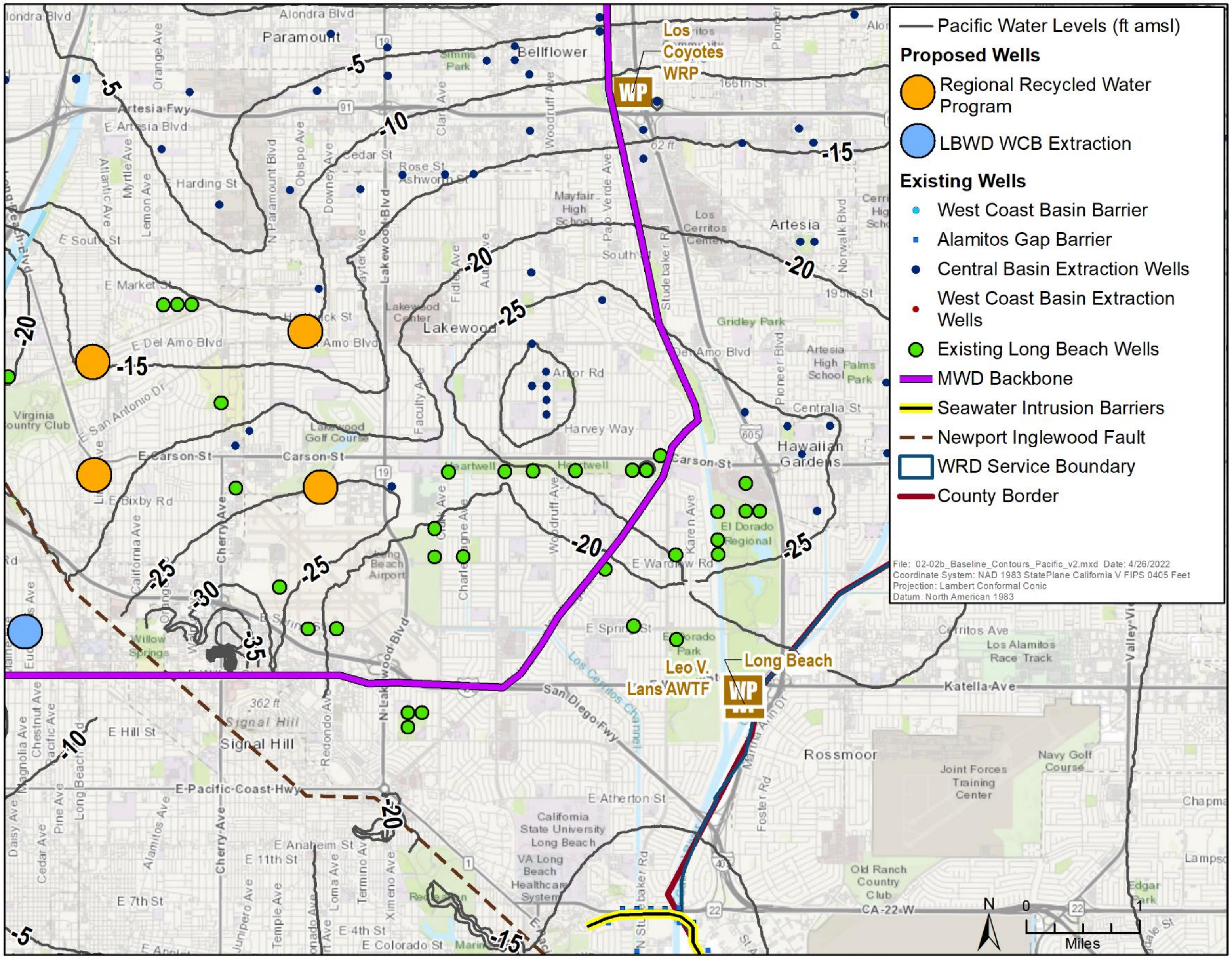
INTERA

Figure 3.1b
Hydrographs at LC-IW01 – No Project Scenario



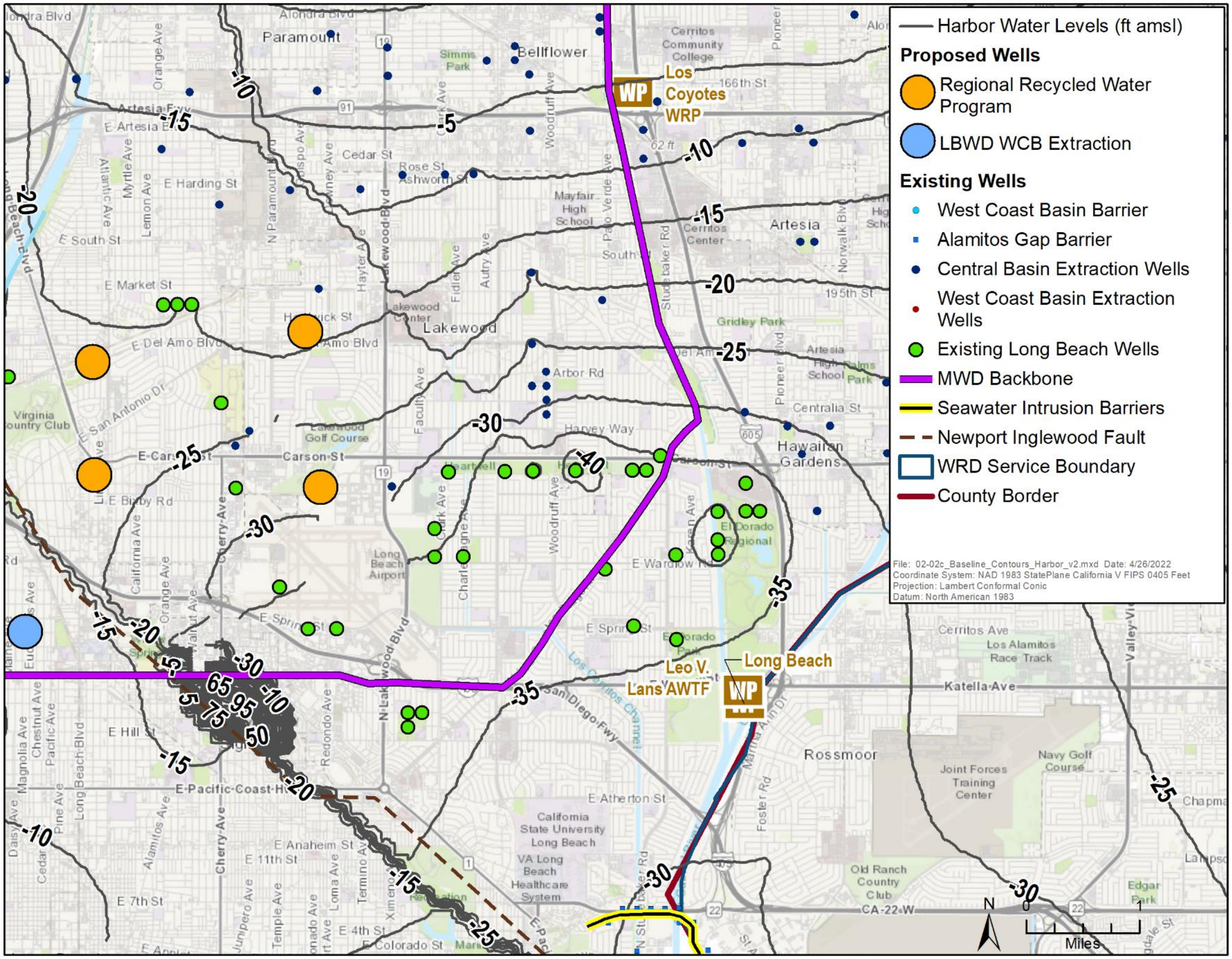
INTERA

Figure 3.2a
Contours of No Project Scenario (Mesa Sequence) - 1/1/2011



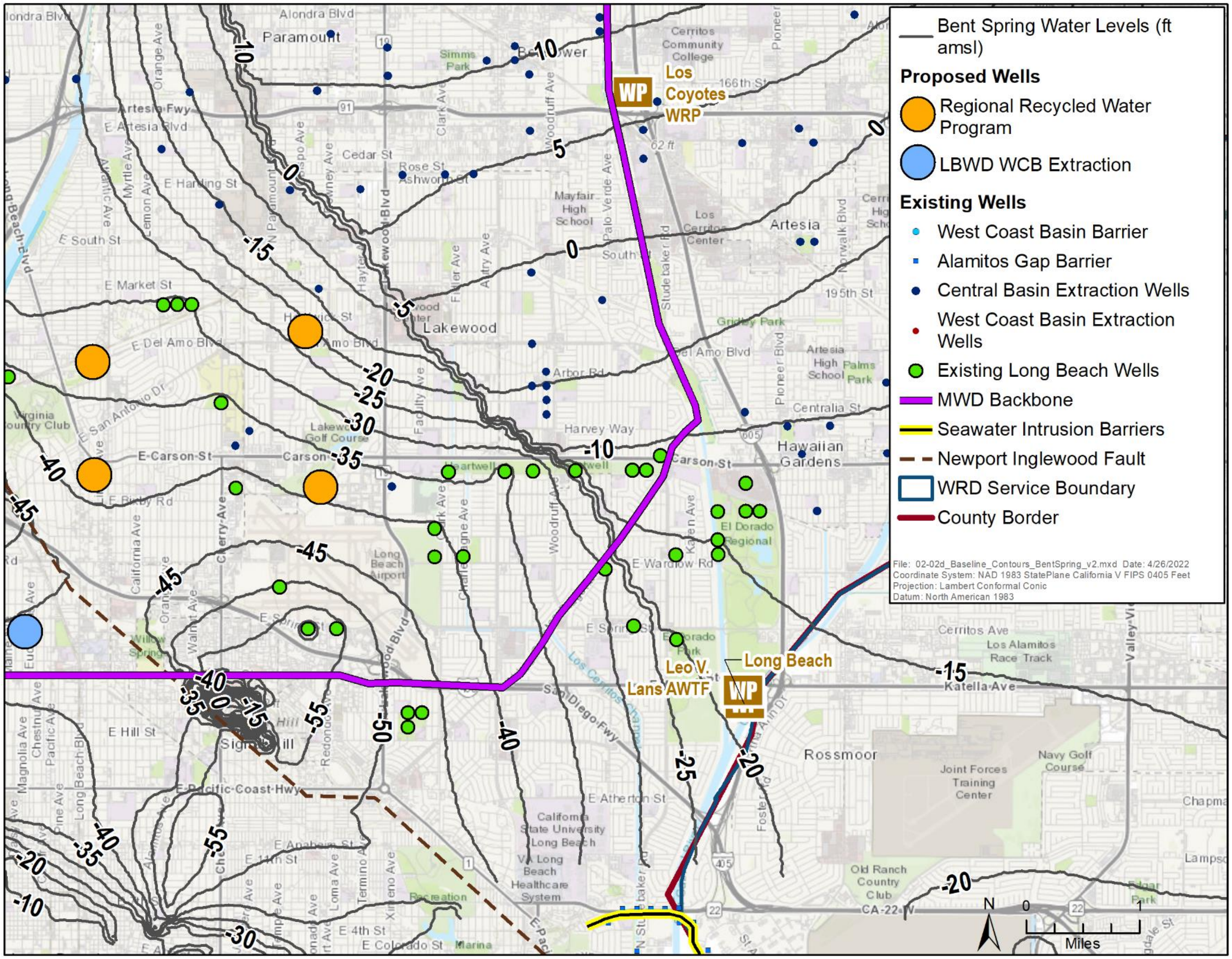
INTERA

Figure 3.2b
Contours of No Project Scenario (Pacific Sequence)- 1/1/2011



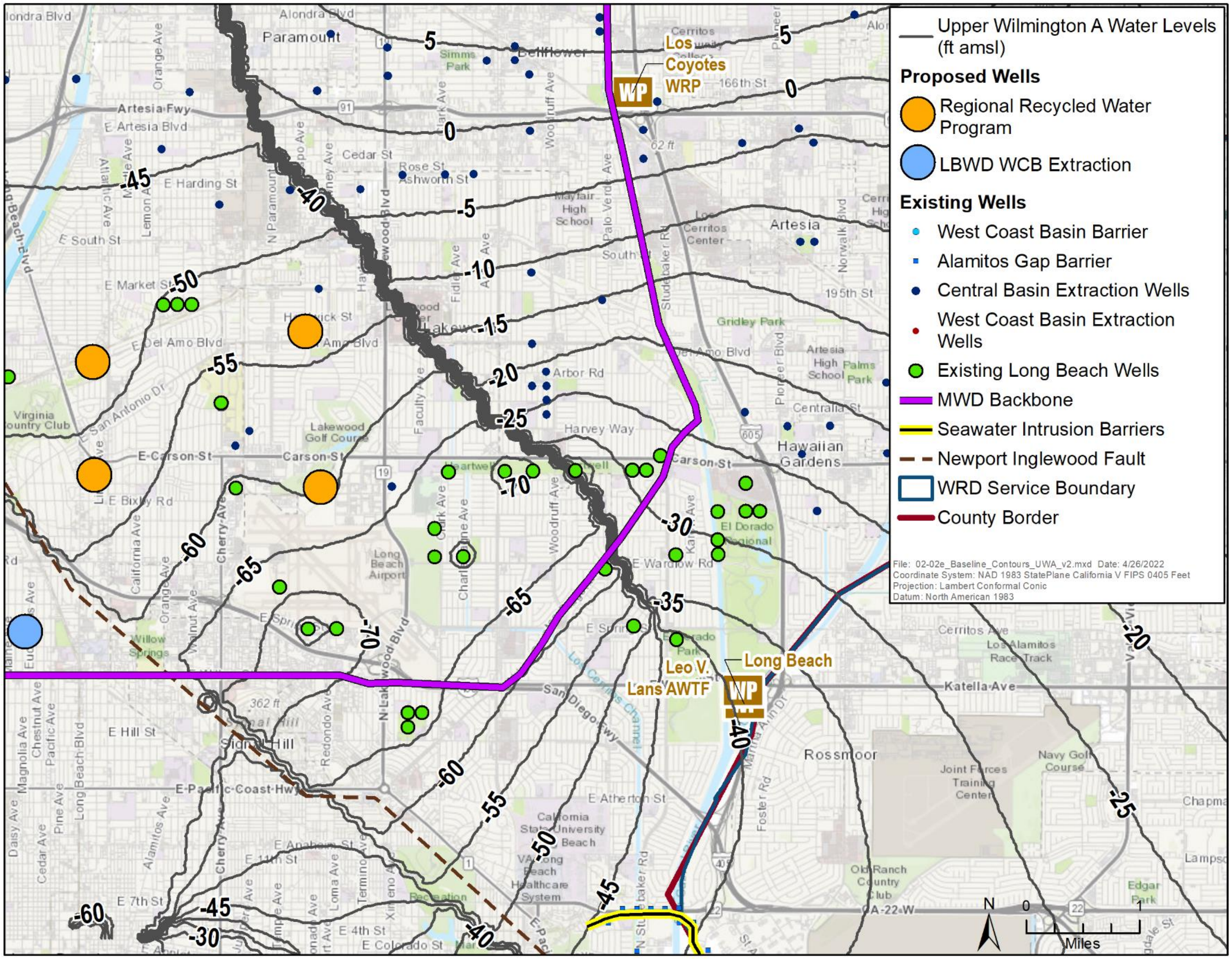
INTERA

Figure 3.2c
Contours of No Project Scenario (Harbor Sequence) - 1/1/2011



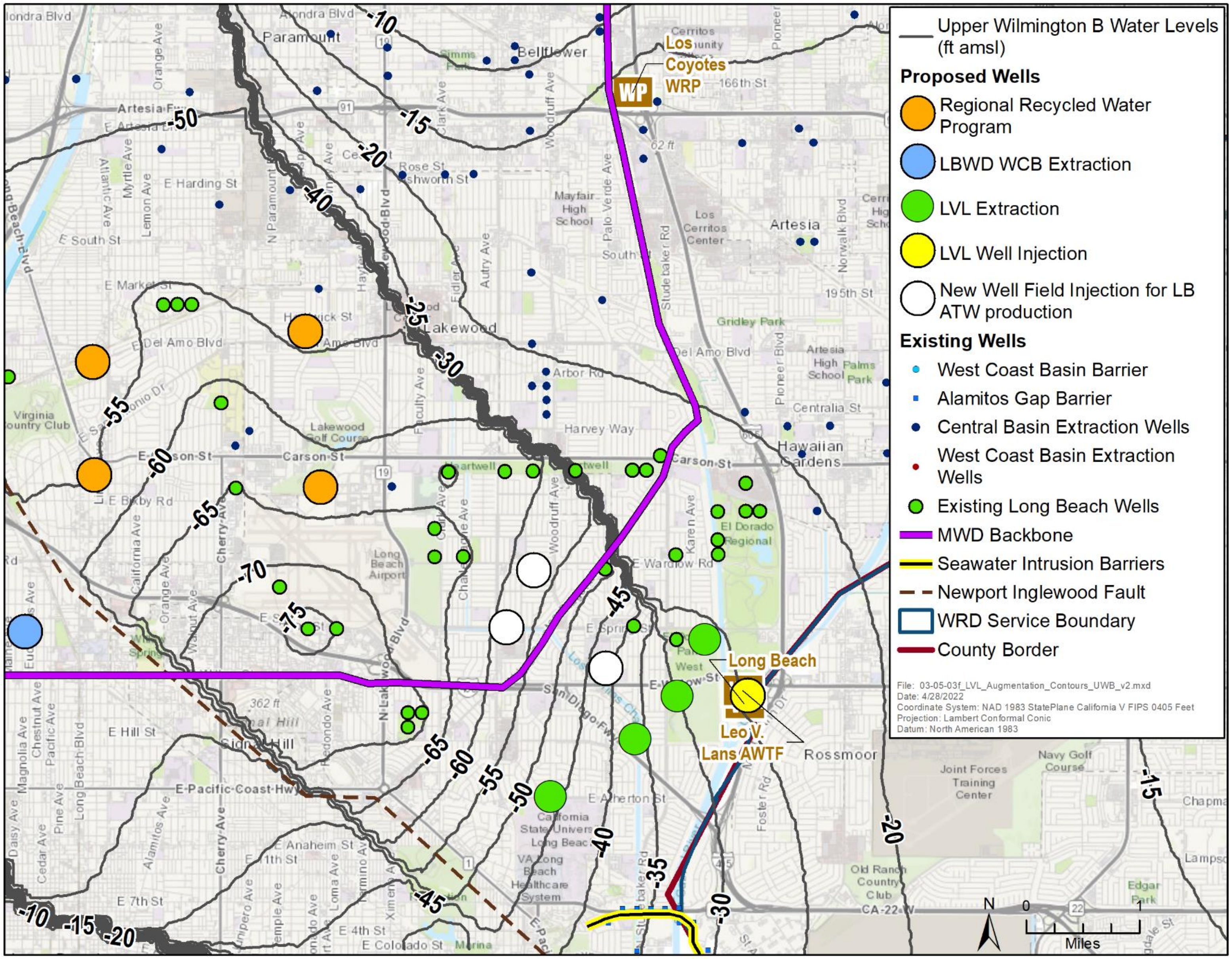
INTERA

Figure 3.2d
Contours of No Project Scenario (Bent Spring Sequence) - 1/1/2011



INTERA

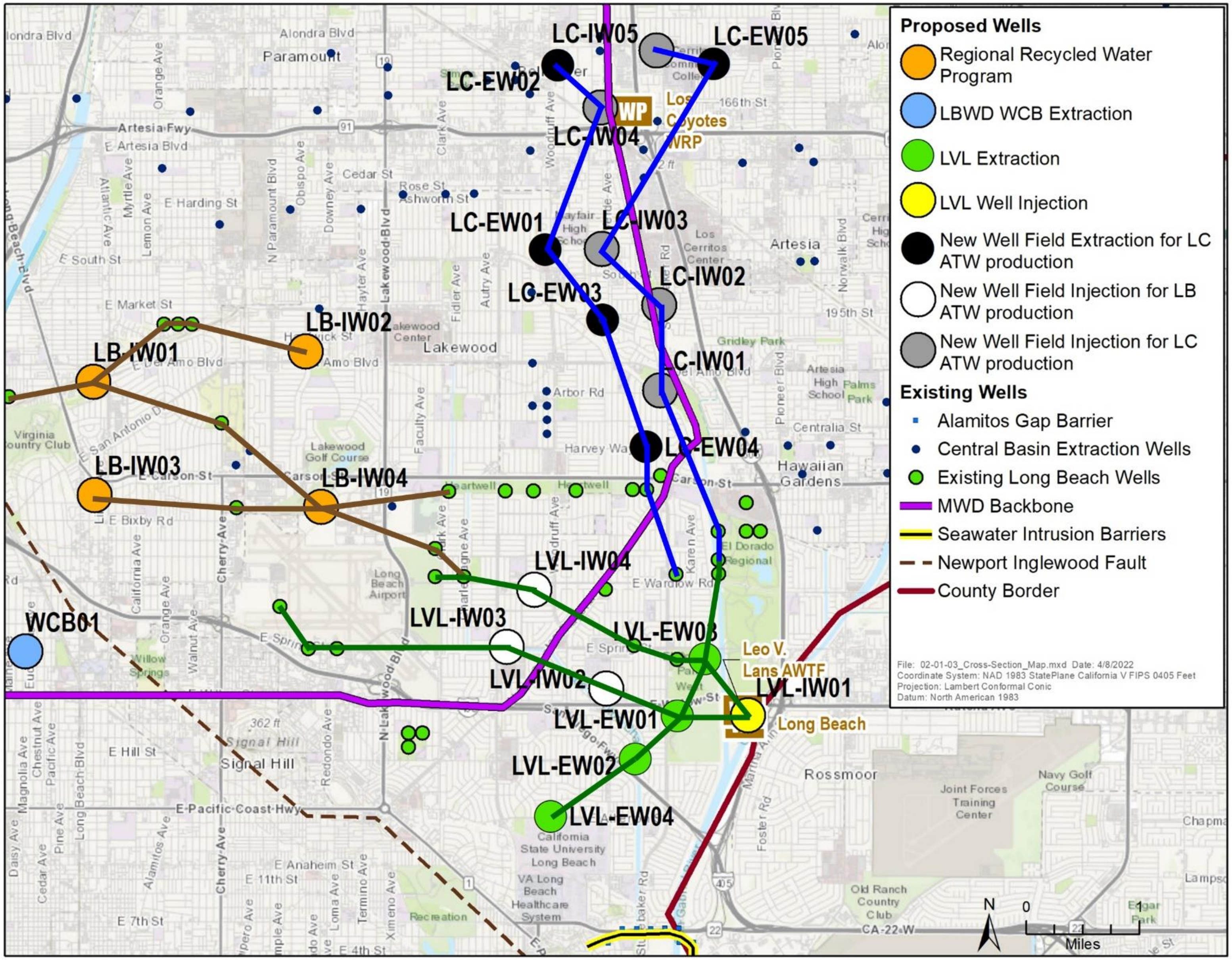
Figure 3.2e
Contours of No Project Scenario (Upper Wilmington A Sequence) - 1/1/2011



INTERA

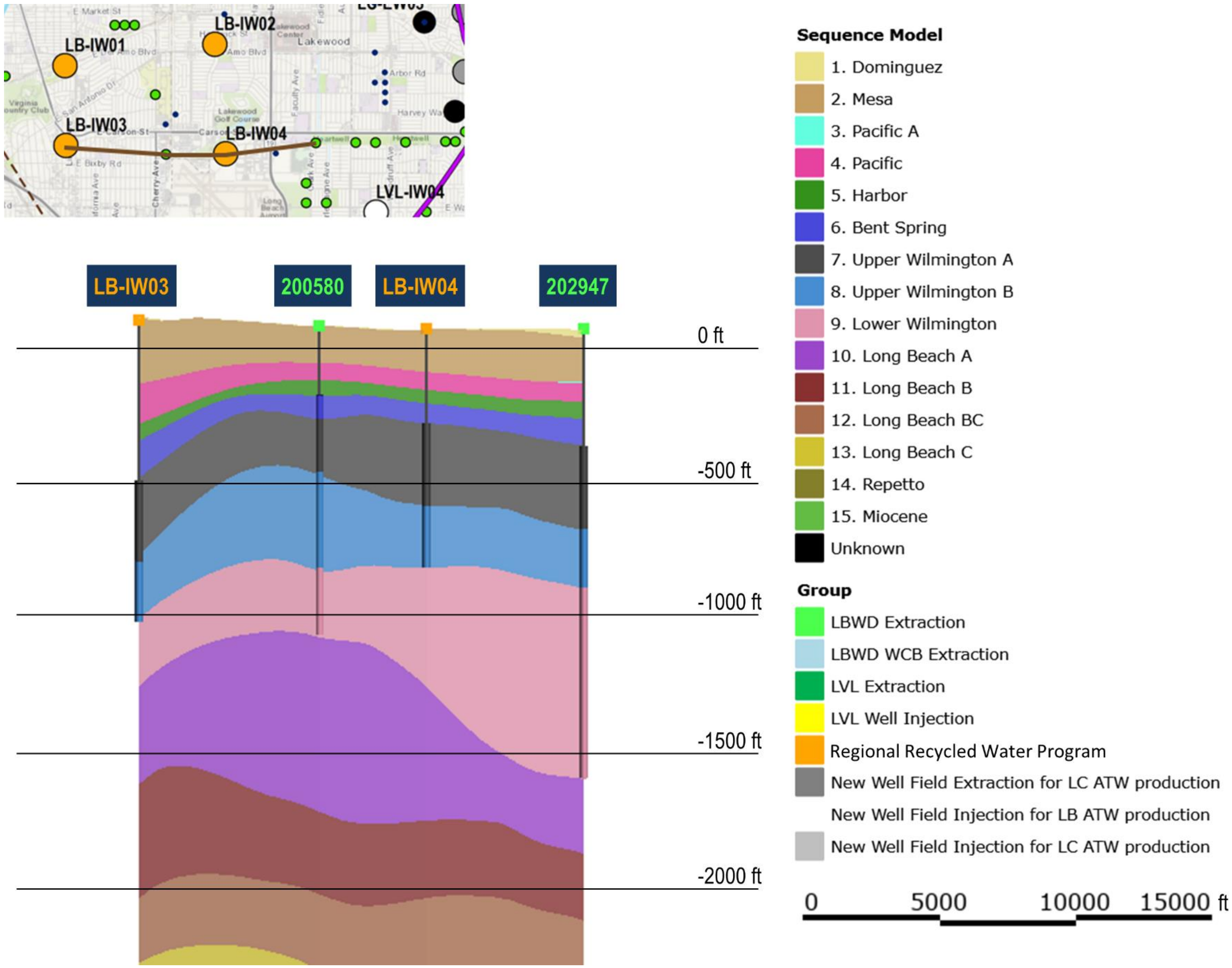
Figure 3.2f

Contours of No Project Scenario (Upper Wilmington B Sequence) - 1/1/2011



![INTERA]

Figure 3.3.1
Potential Wellfield Locations and Fence-Sections



INTERA

Figure 3.3.2a

Wellfield Fence Section – LB-IW03,LB-IW04

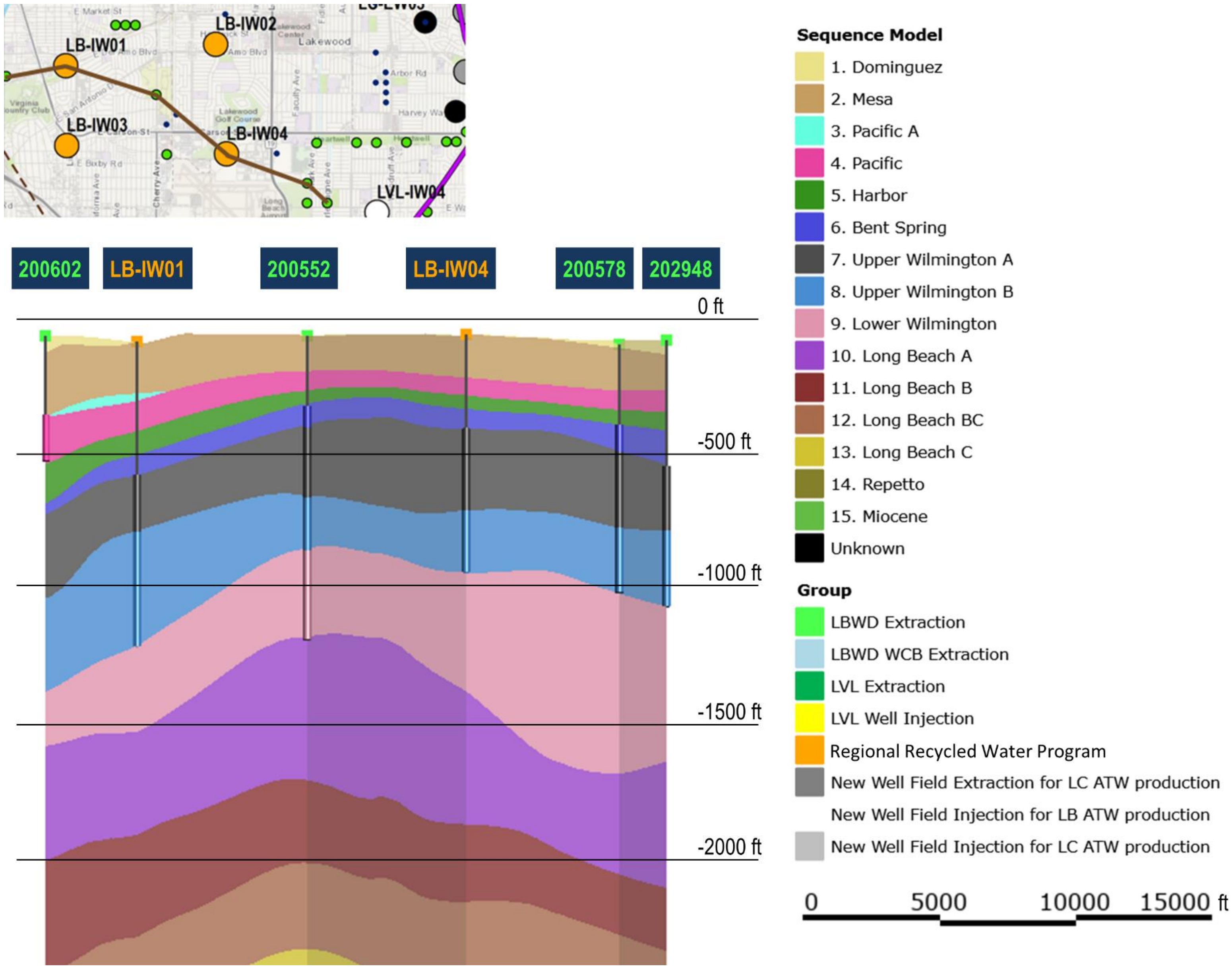
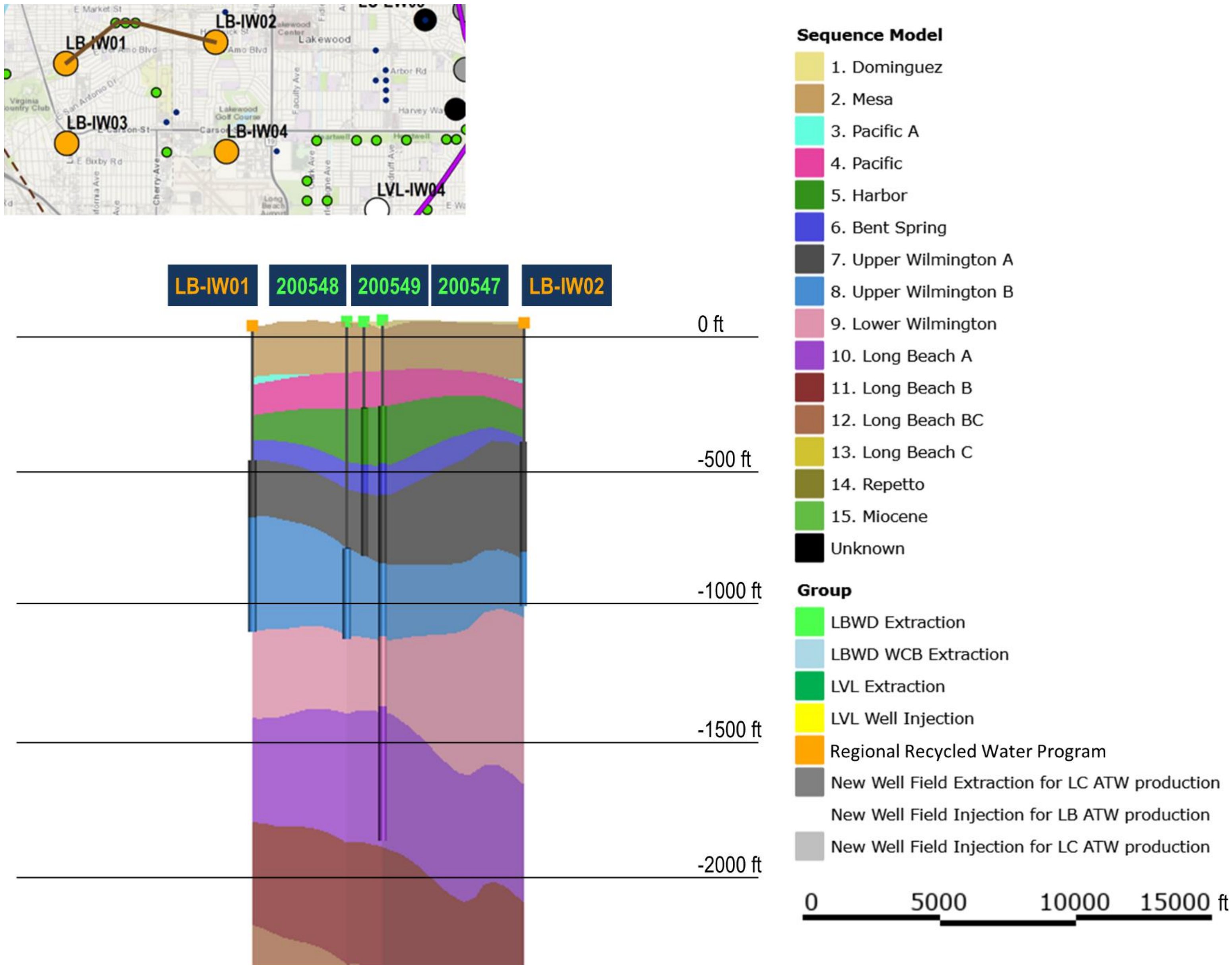
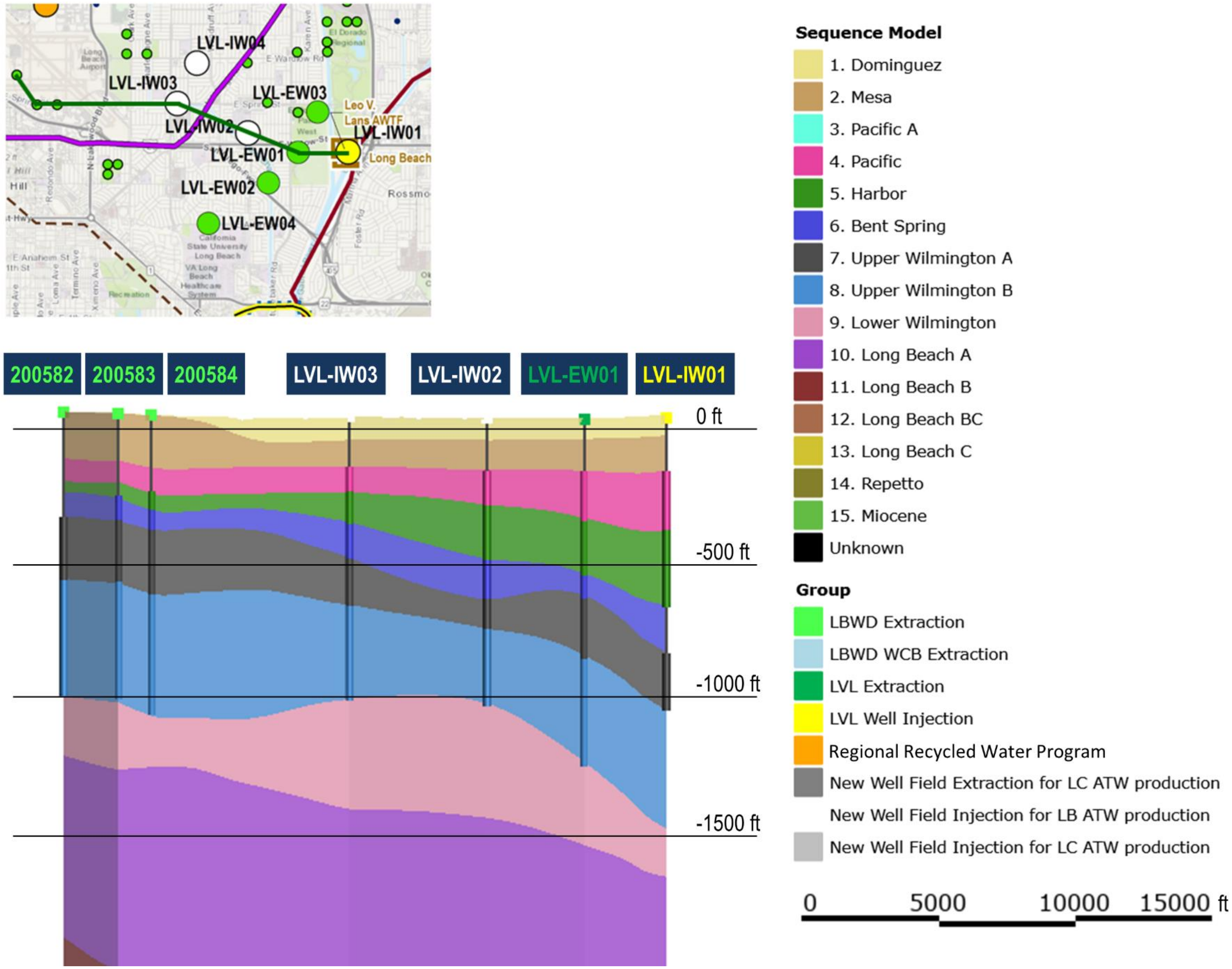


Figure 3.3.2b
Wellfield Fence Section – LB-IW01,LB-IW04



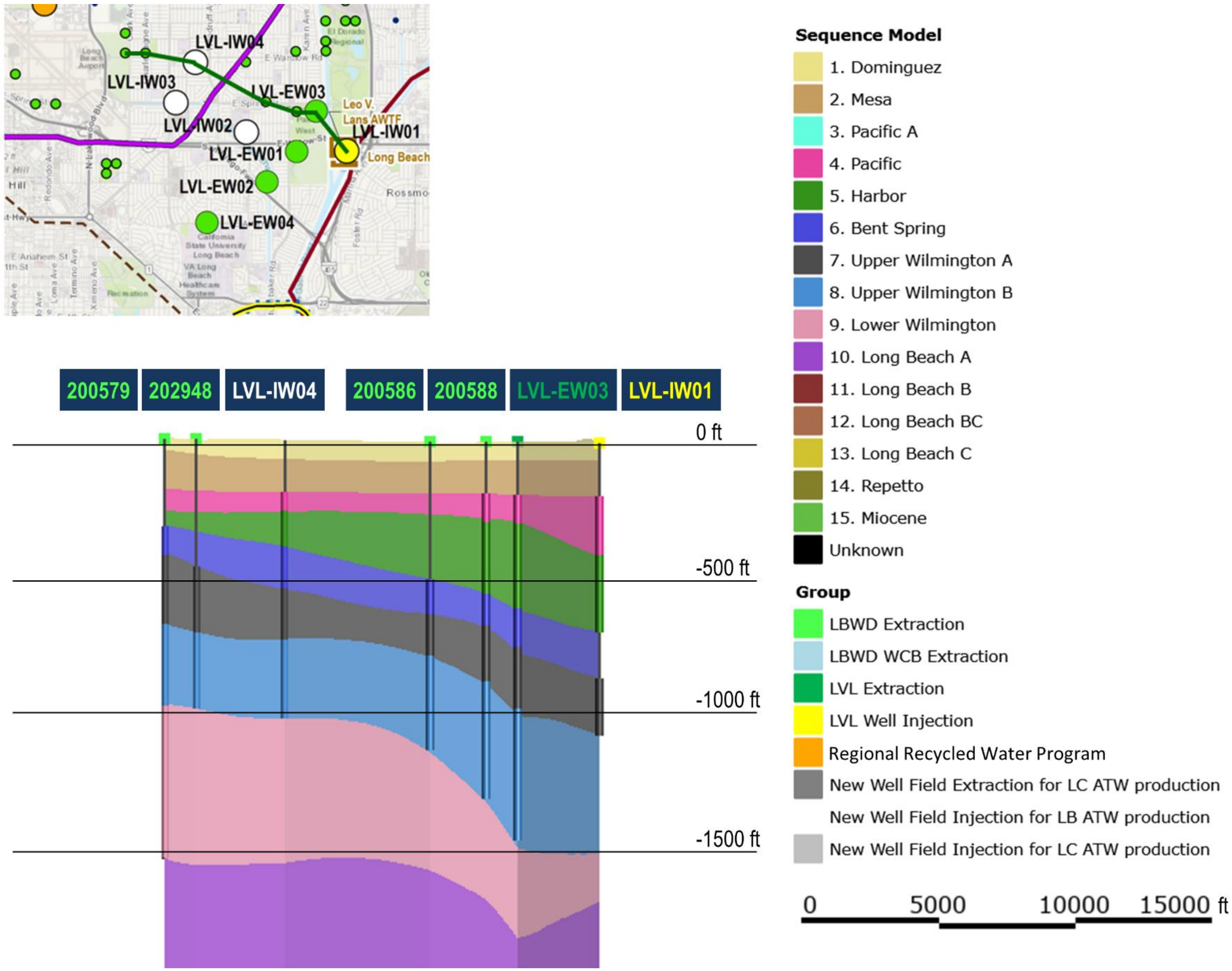
INTERA

Figure 3.3.2c
Wellfield Fence Section – LB-IW01,LB-IW02



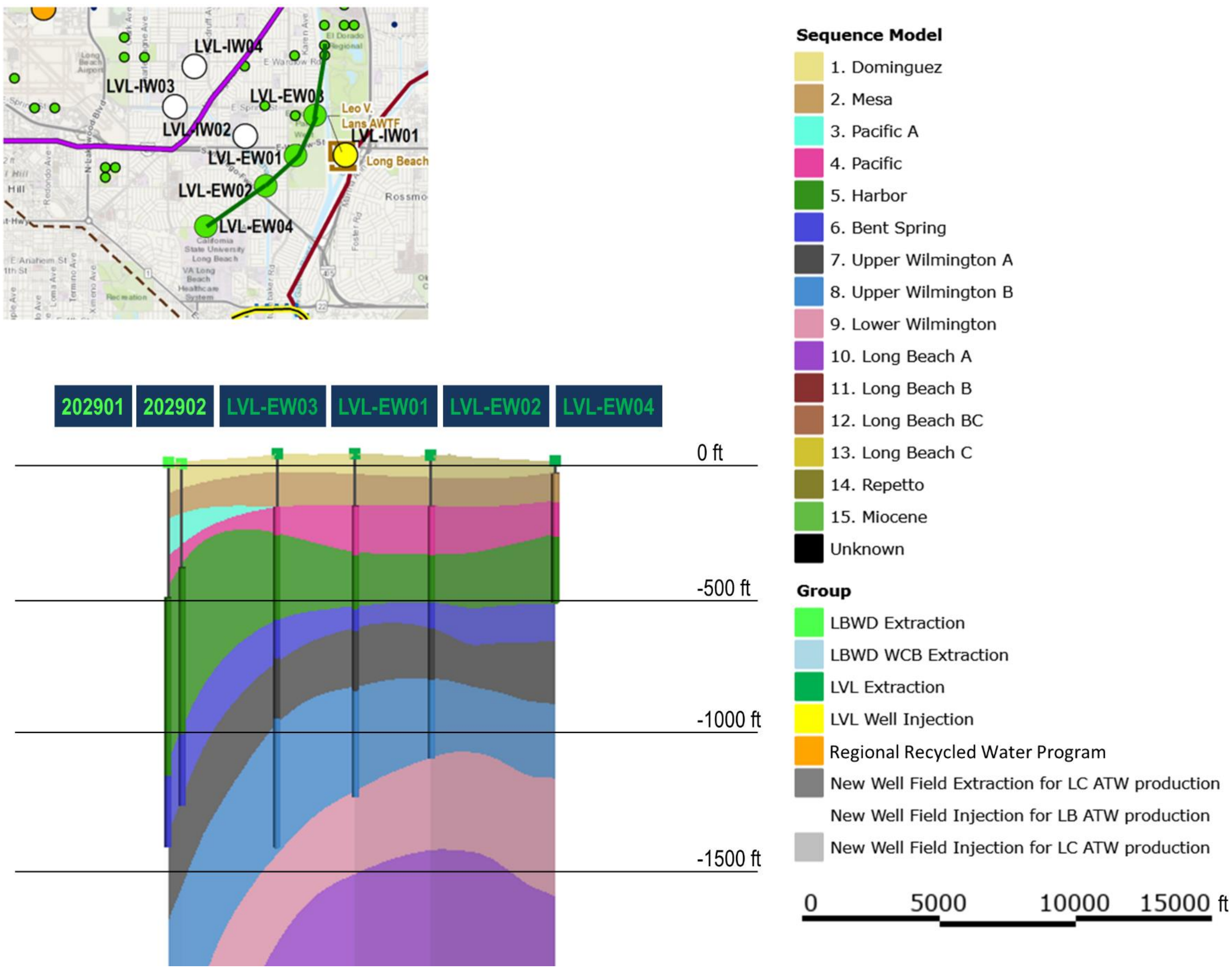
INTERA

Figure 3.3.3a
Wellfield Fence Section – LVL-IW01, LVL-IW02,LVL-IW03,LVL-IW04



INTERA

Figure 3.3.3b
Wellfield Fence Section – LVL-IW01, LVL-EW01,LVL-EW03



INTERA

Figure 3.3.3c
Wellfield Fence Section – LVL-IW02, LVL-EW02,LVL-EW03,LVL-EW04

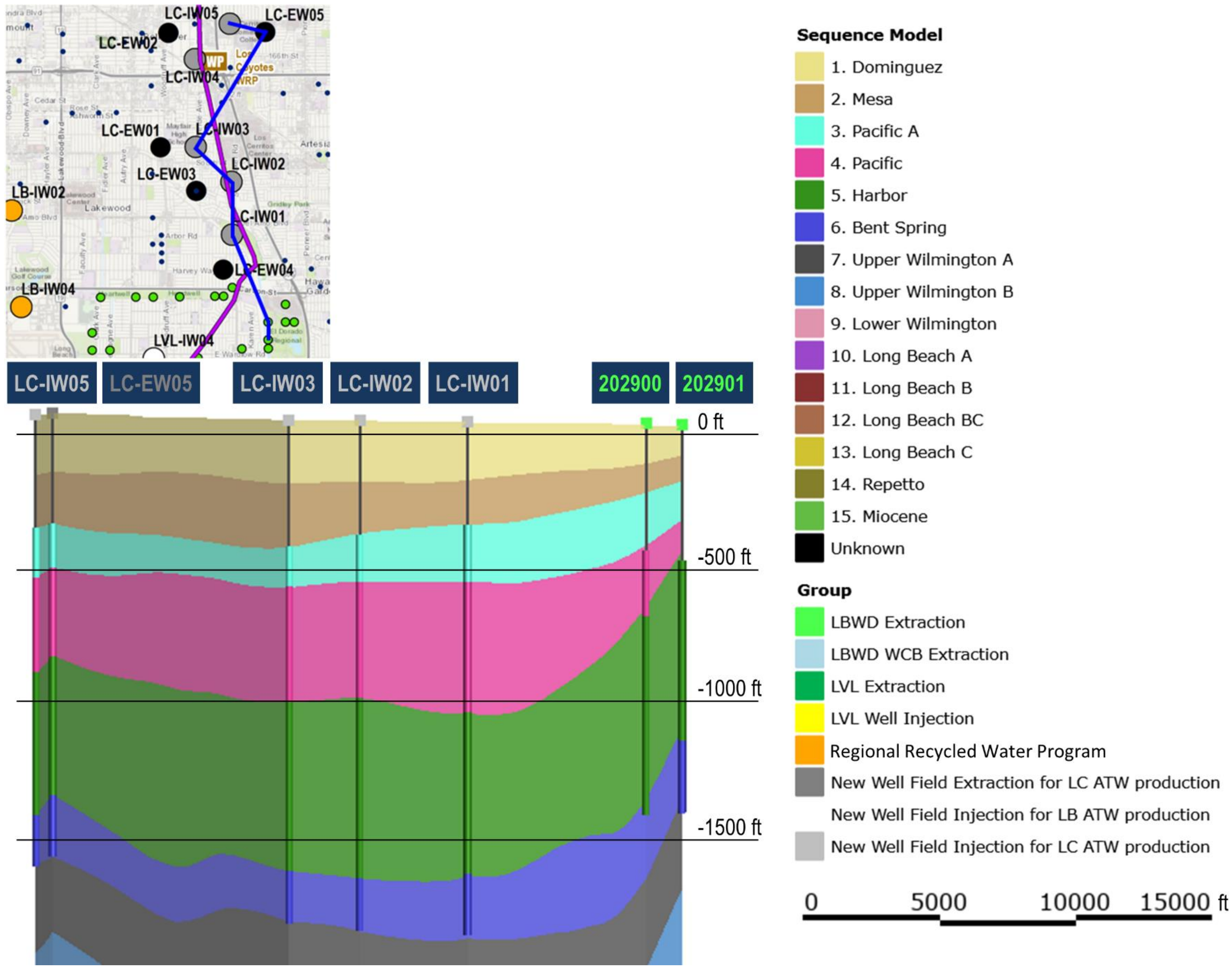
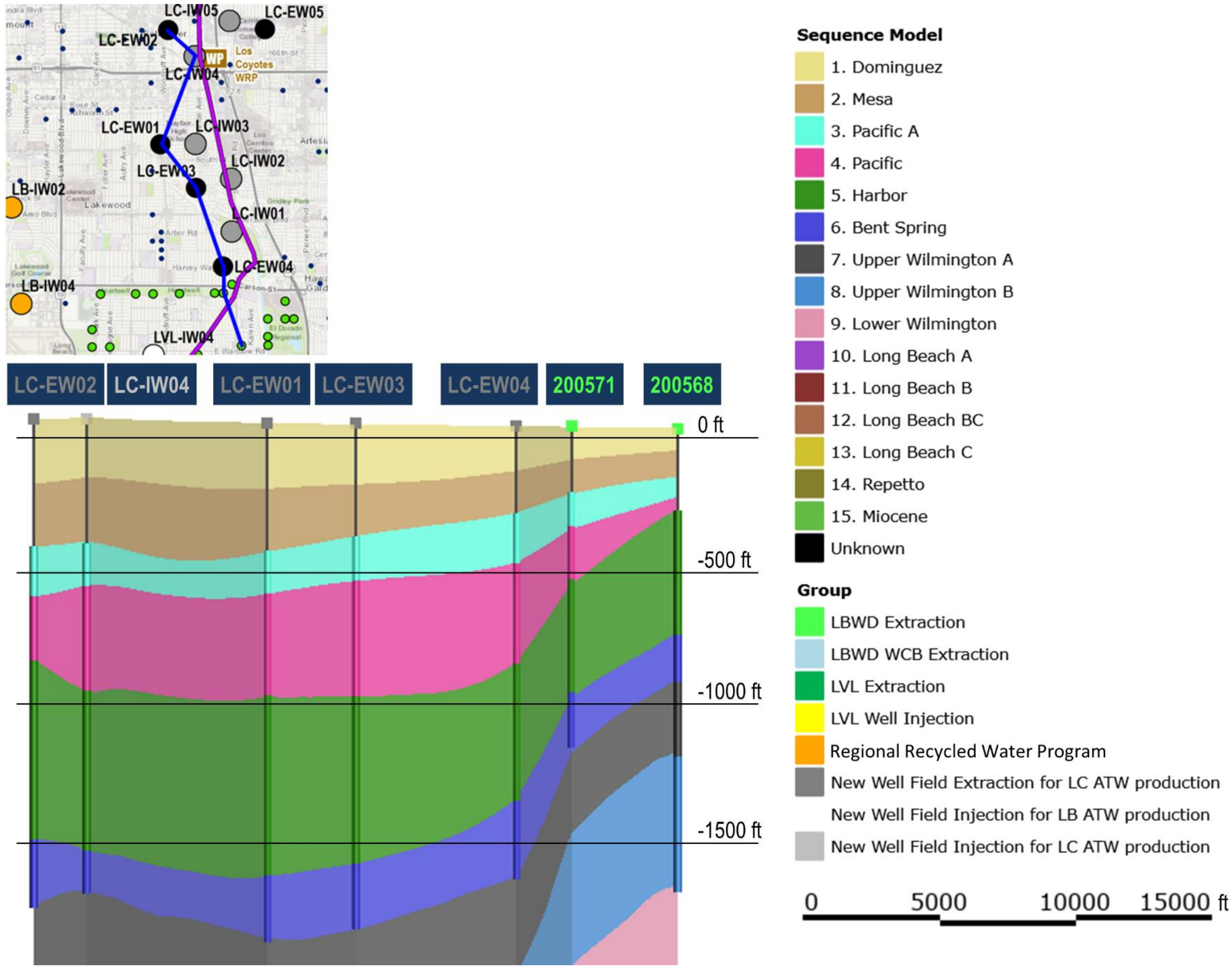


Figure 3.3.4a
Wellfield Fence Section – LC-IW01, LC-IW02,LC-IW03,LC-IW05,LC-EW05



INTERA

Figure 3.3.4b
Wellfield Fence Section – LC-EW01, LC-EW02,LC-EW03,LC-EW04,LC-IW04

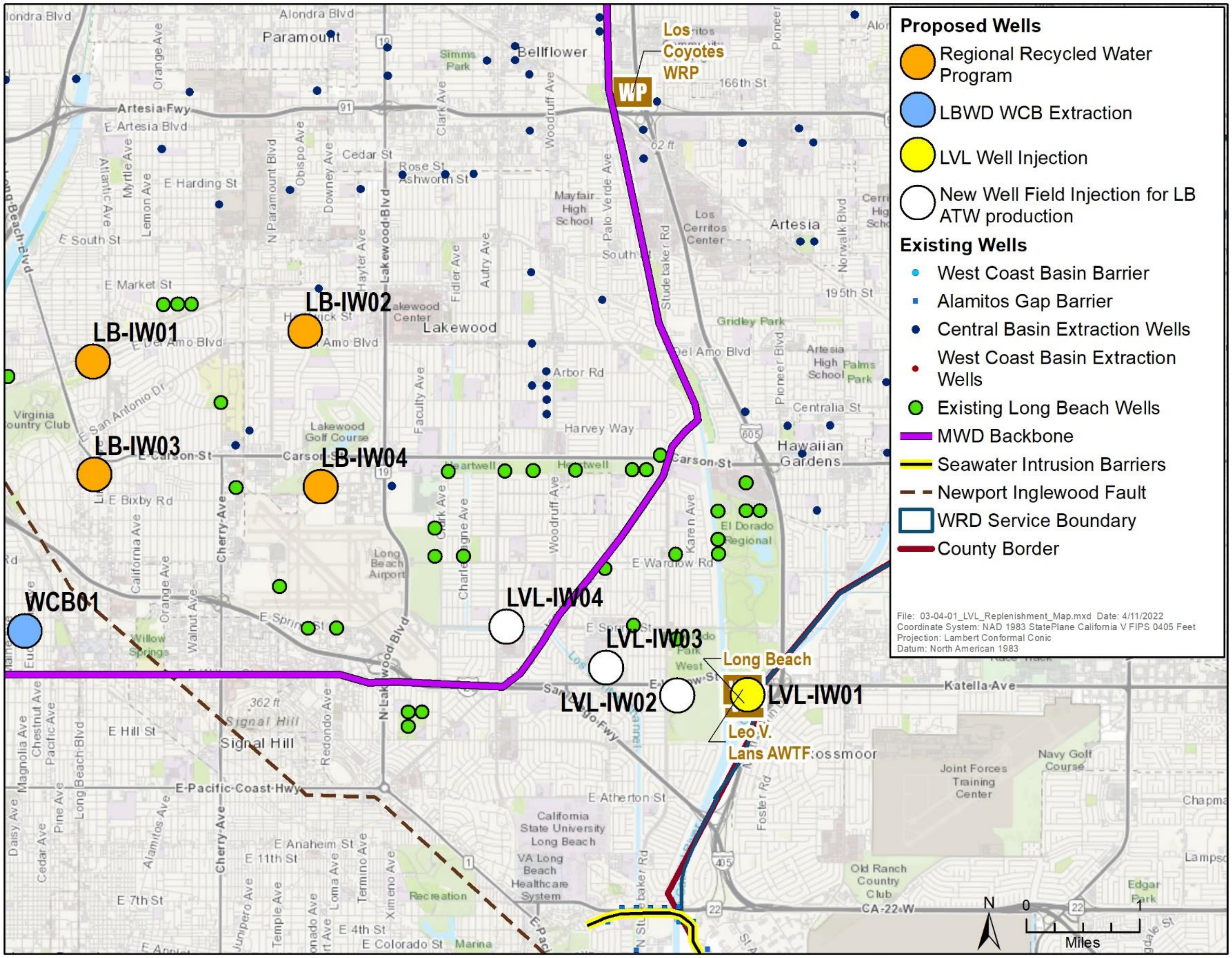
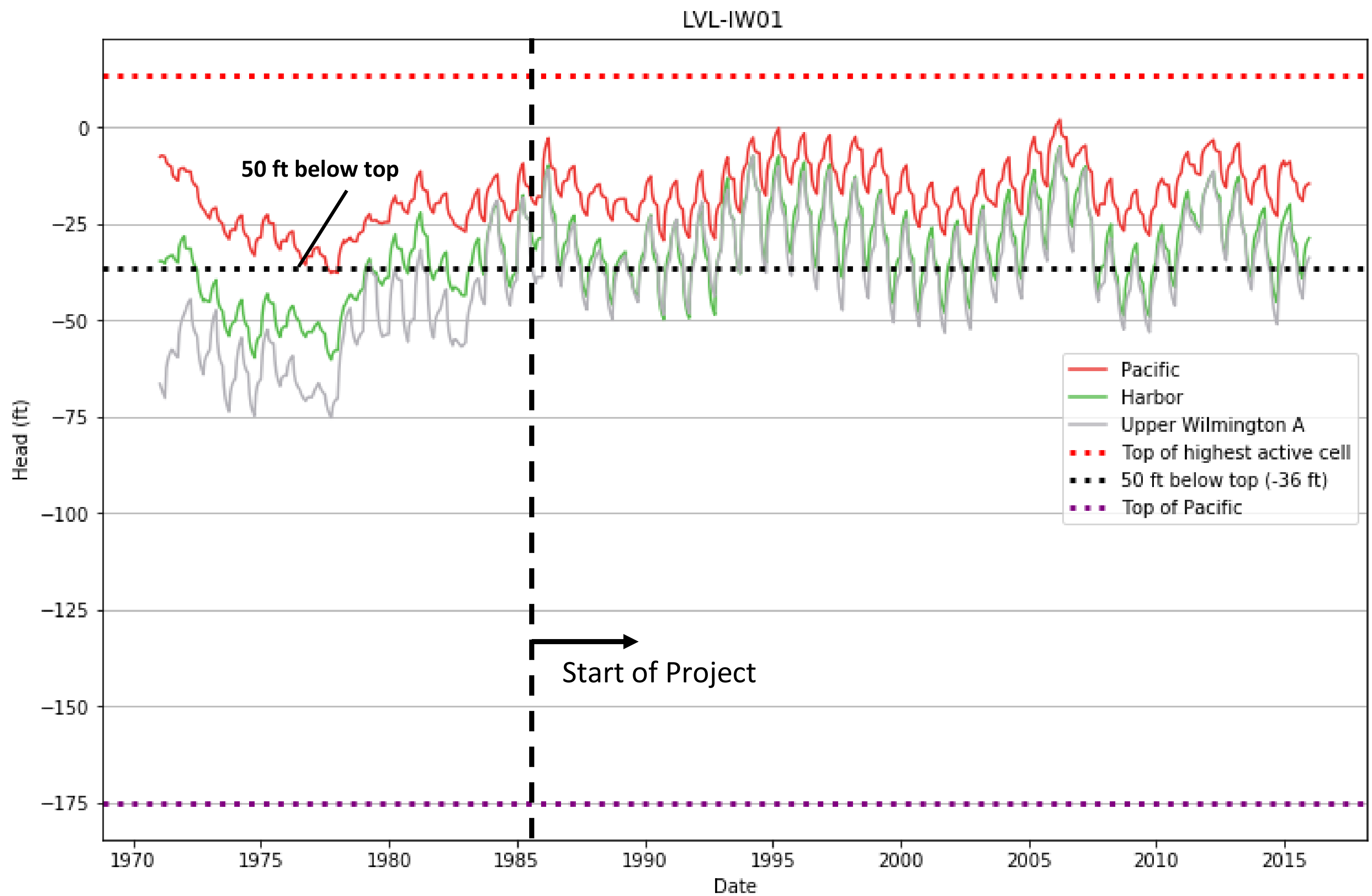
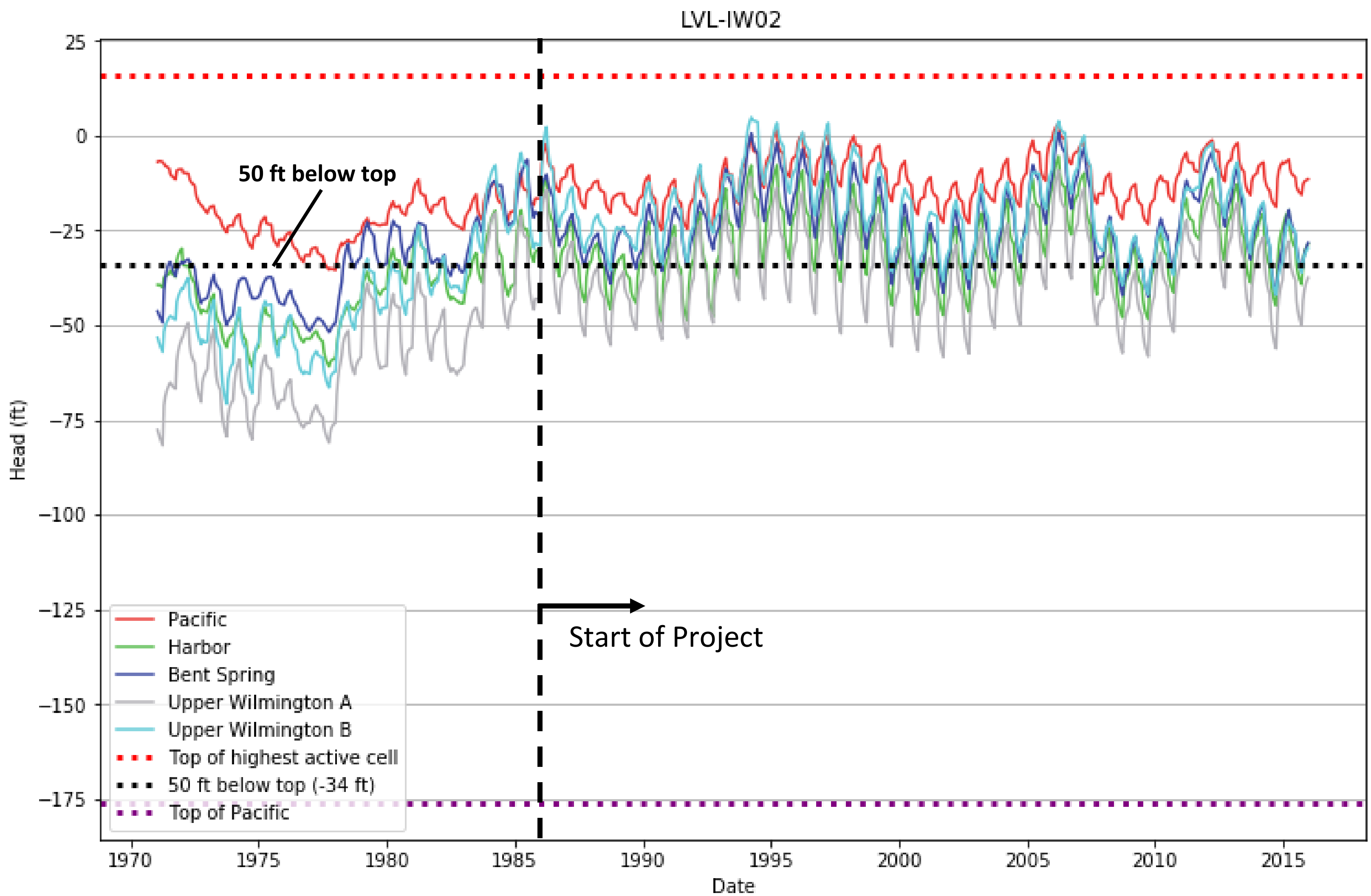


Figure 3.4.1
Map of LVL Replenishment Locations



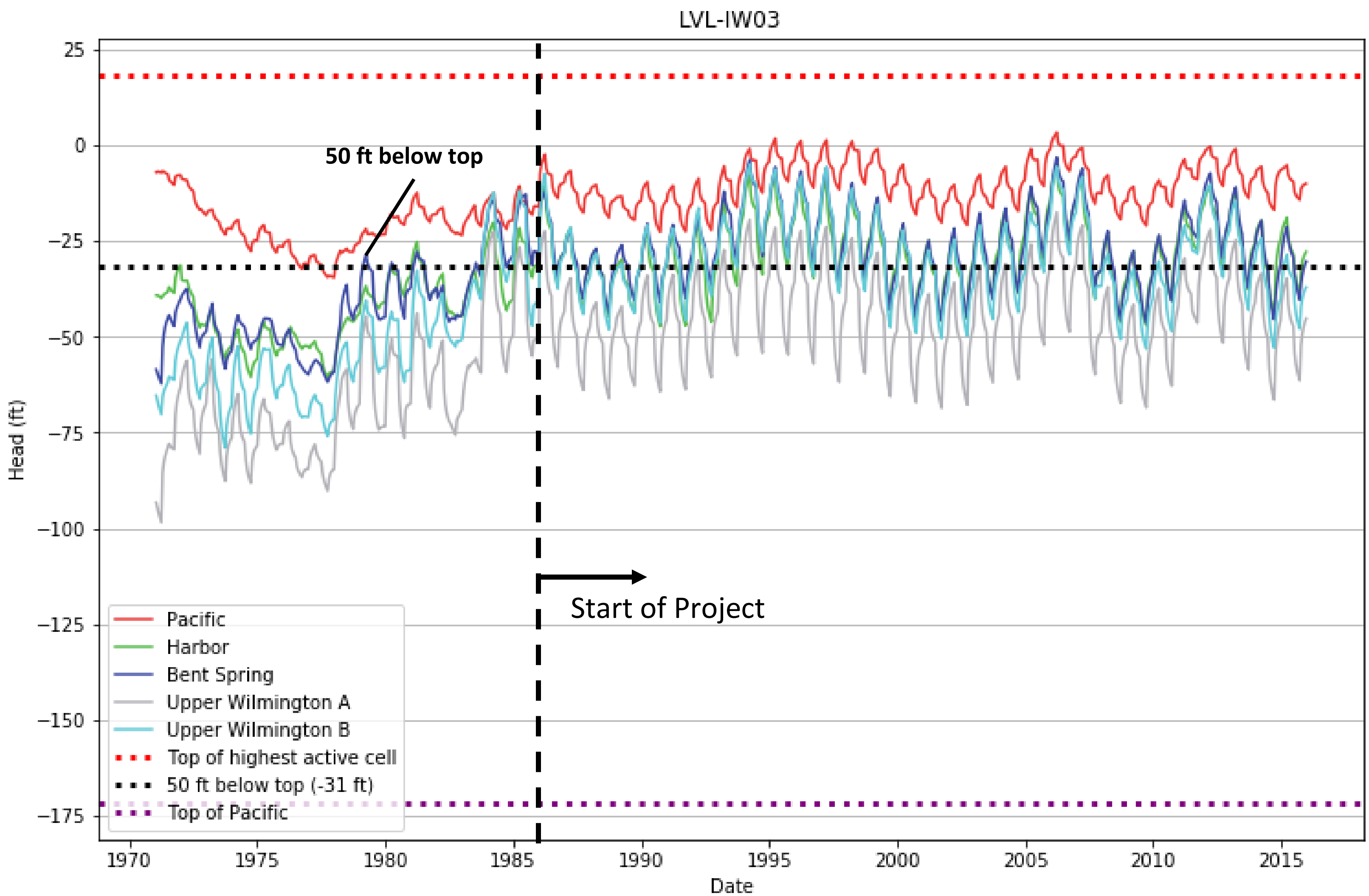
INTERA

Figure 3.4.2a
Hydrographs at LVL -IW01 - LVL
Replenishment Scenario



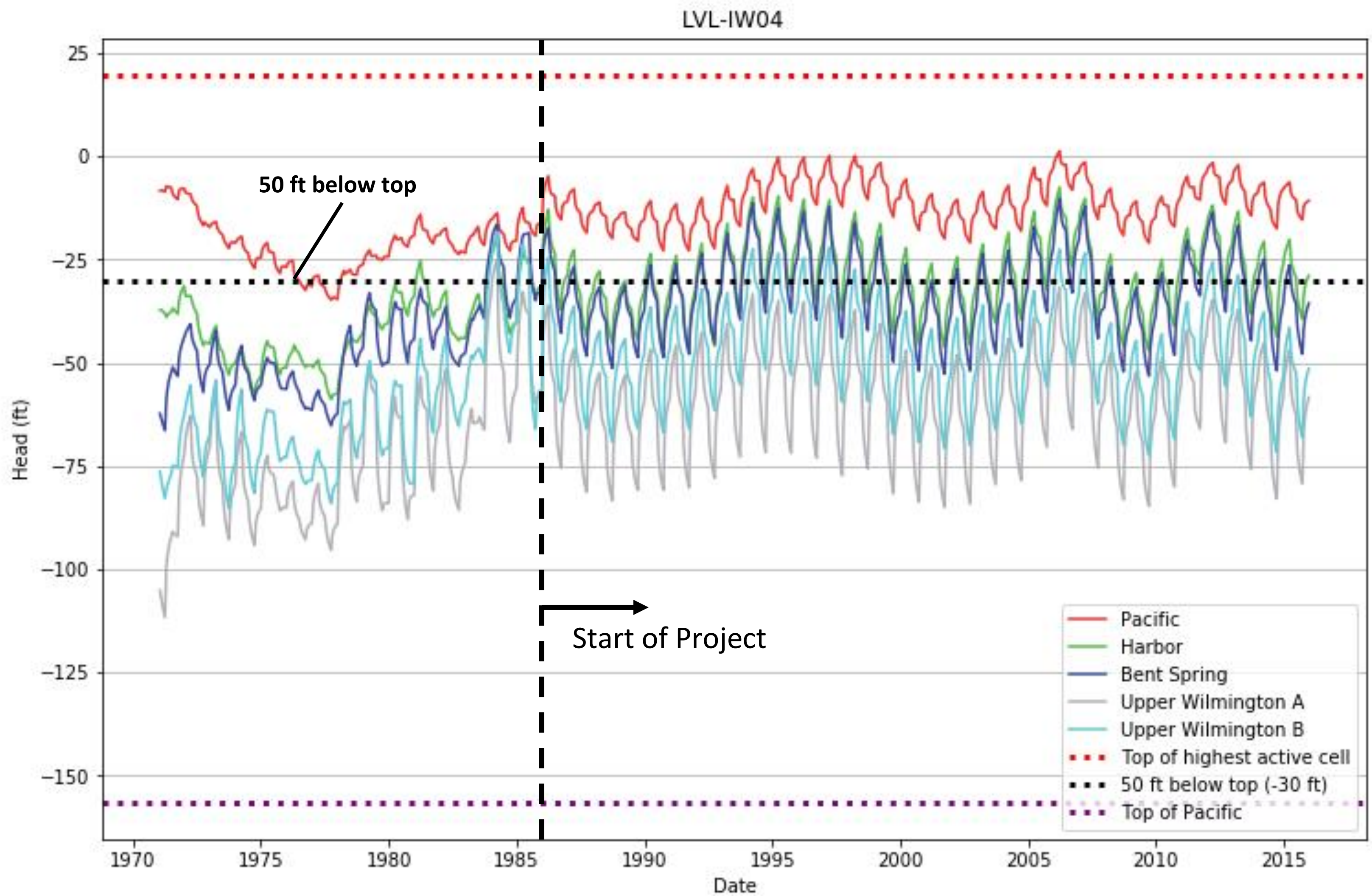
INTERA

Figure 3.4.2b
Hydrographs at LVL -IW02 - LVL
Replenishment Scenario



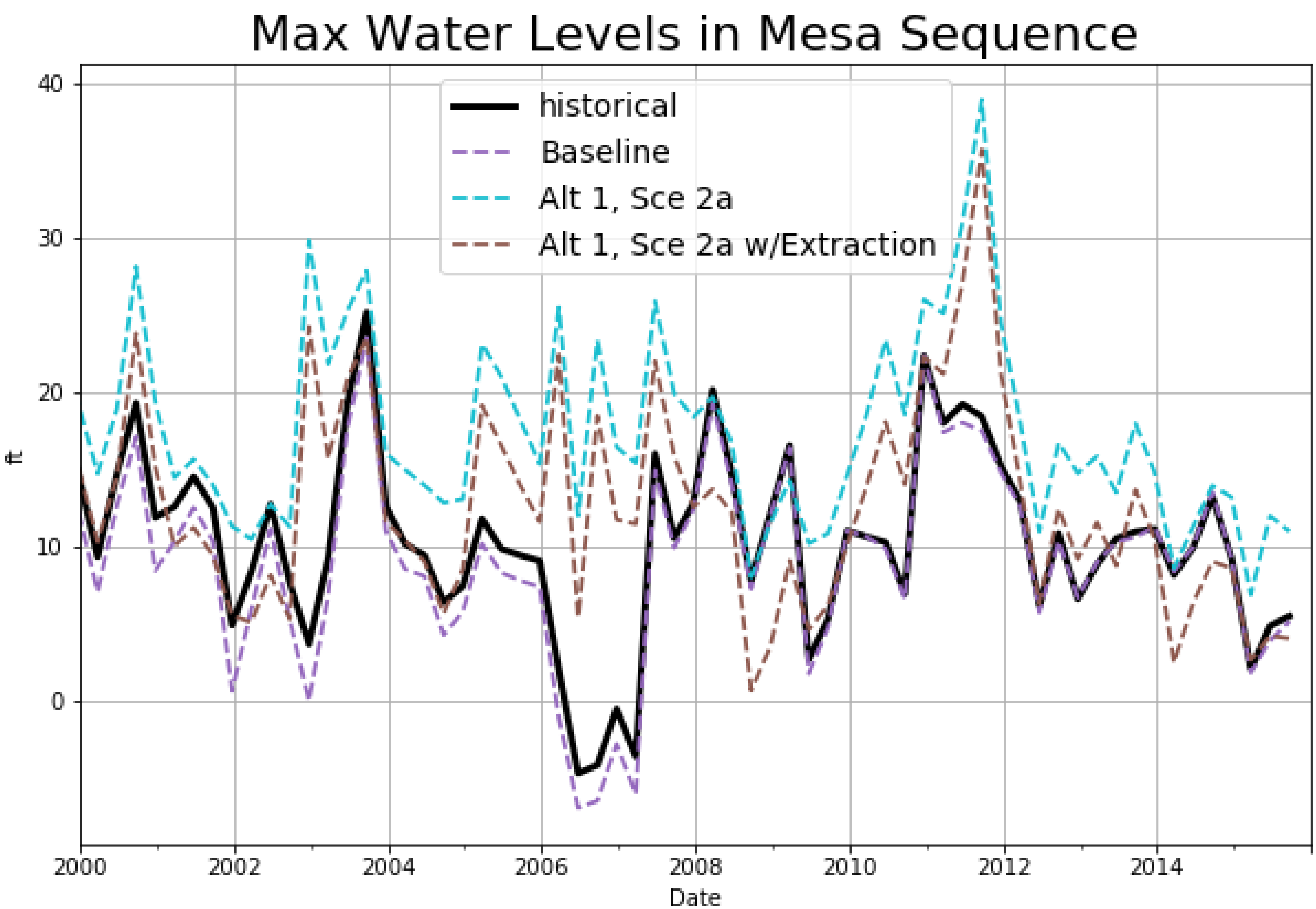
INTERA

Figure 3.4.2c
Hydrographs at LVL -IW03 - LVL
Replenishment Scenario



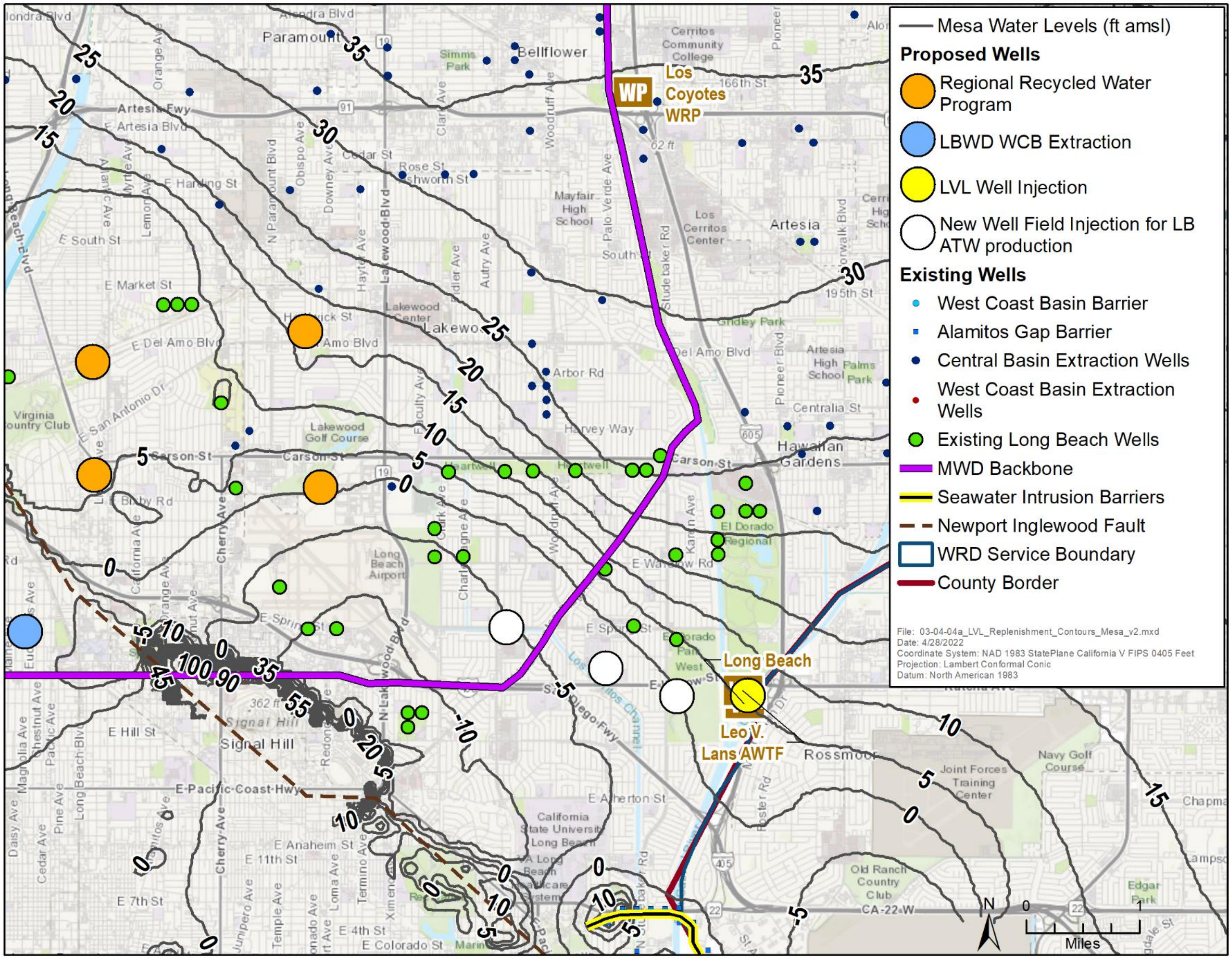
INTERA

Figure 3.4.2d
Hydrographs at LVL -IW04 - LVL Replenishment Scenario



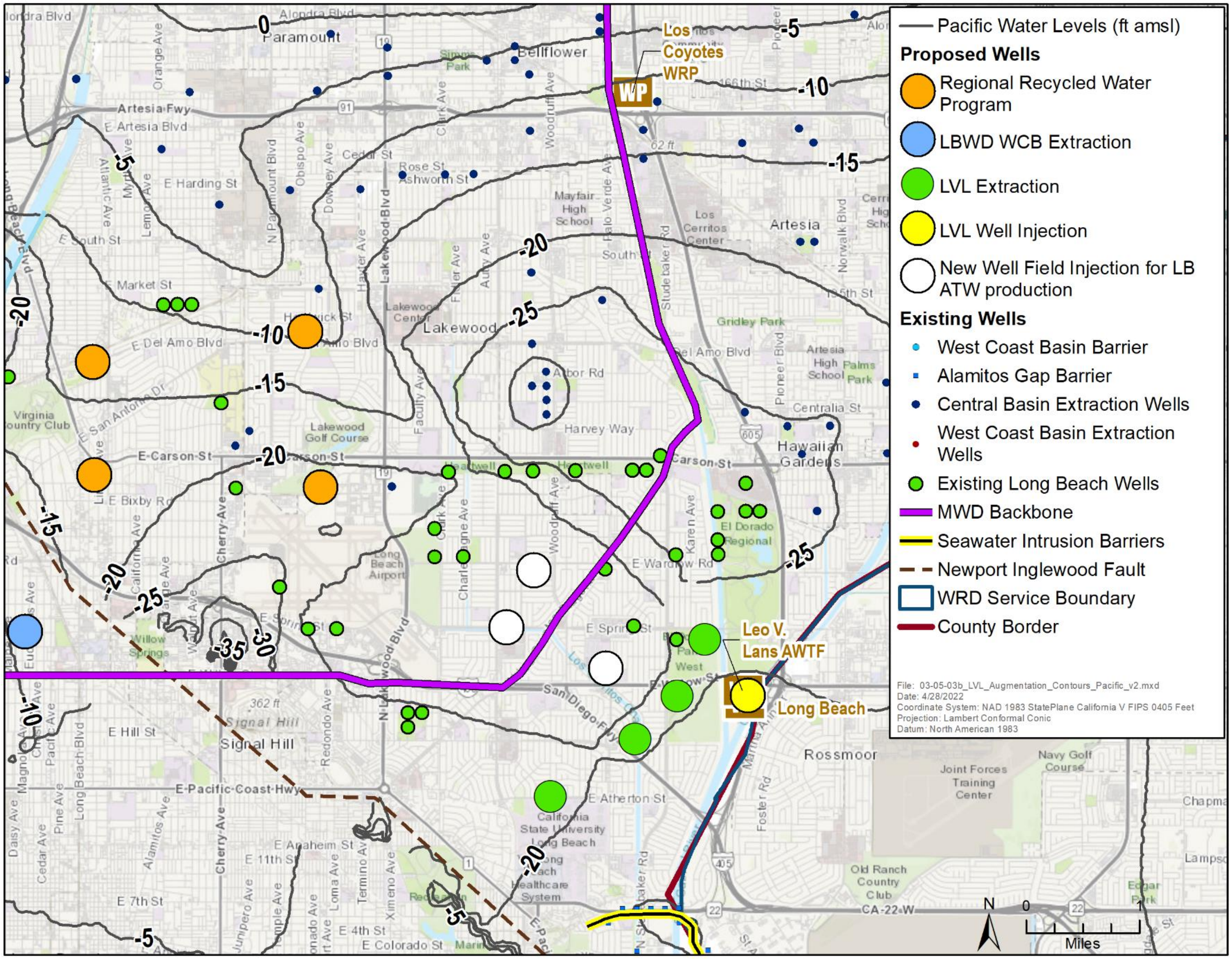
INTERA

Figure 3.4.3
Maximum Simulated Water Levels at
Alamitos Barrier in Mesa Sequence



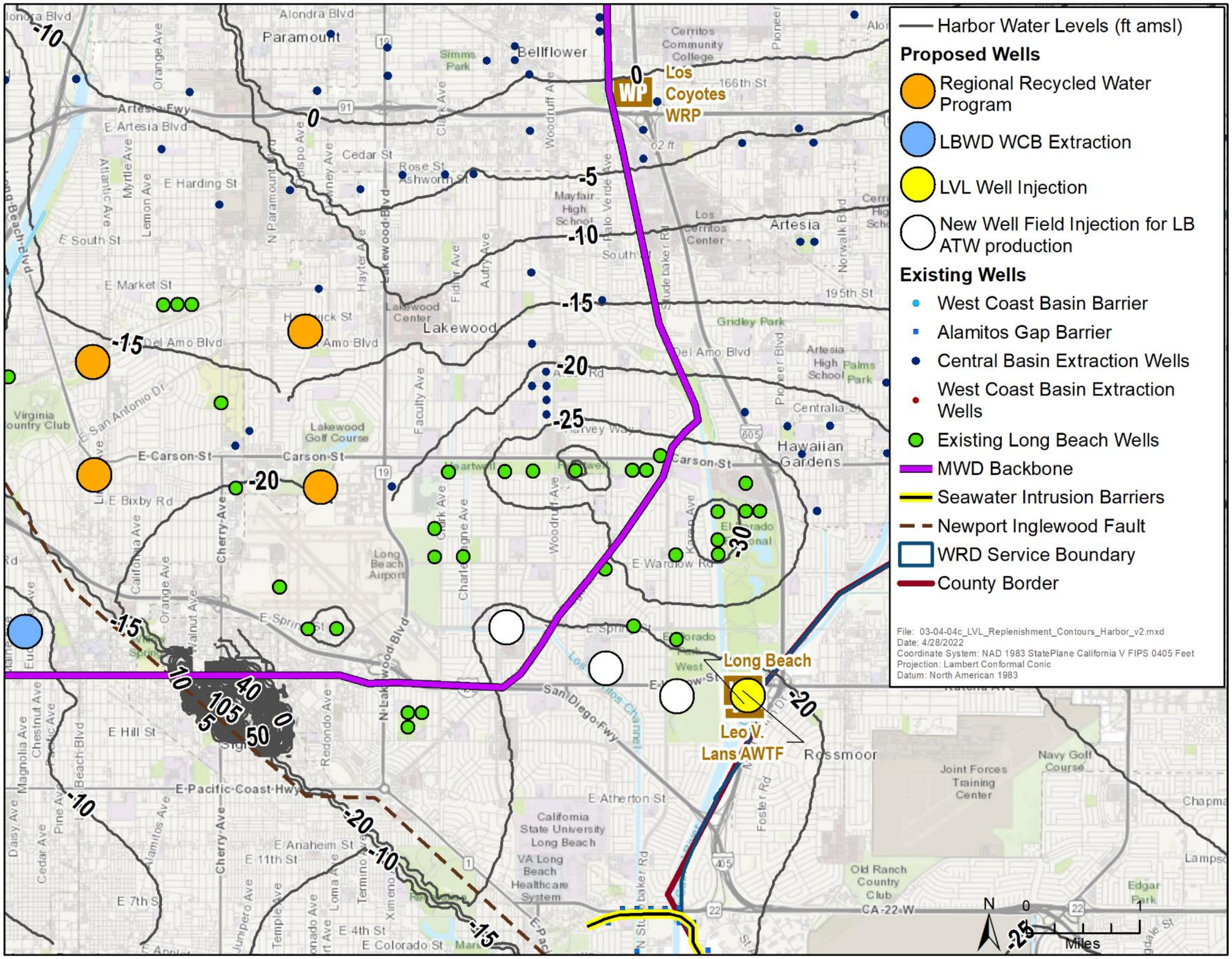
INTERA

Figure 3.4.4a
Contours of LVL Replenishment (Mesa Sequence) - 1/1/2011



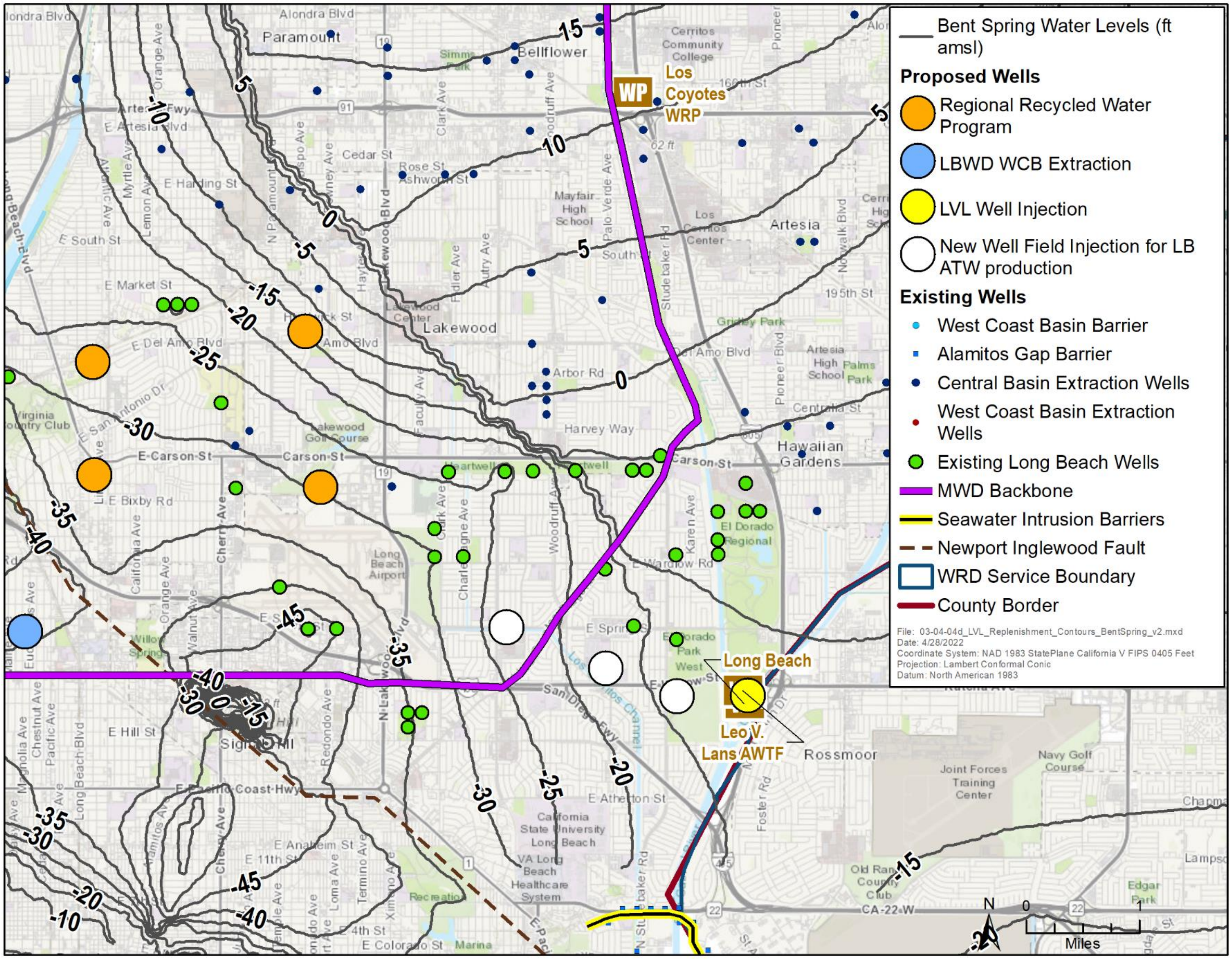
INTERA

Figure 3.4.4b
Contours of LVL Replenishment (Pacific Sequence)- 1/1/2011



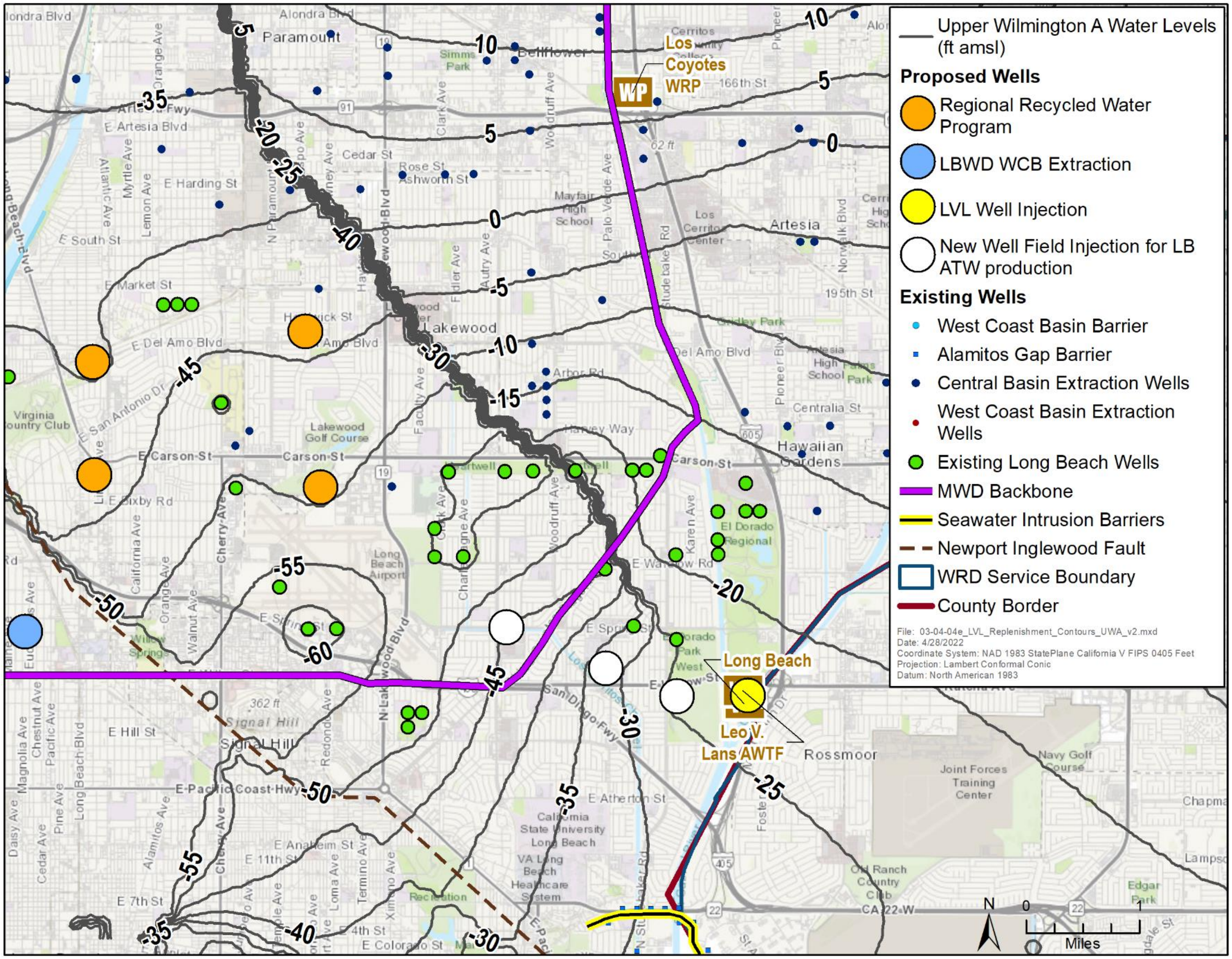
INTERA

Figure 3.4.4c
Contours of LVL Replenishment (Harbor Sequence) - 1/1/2011



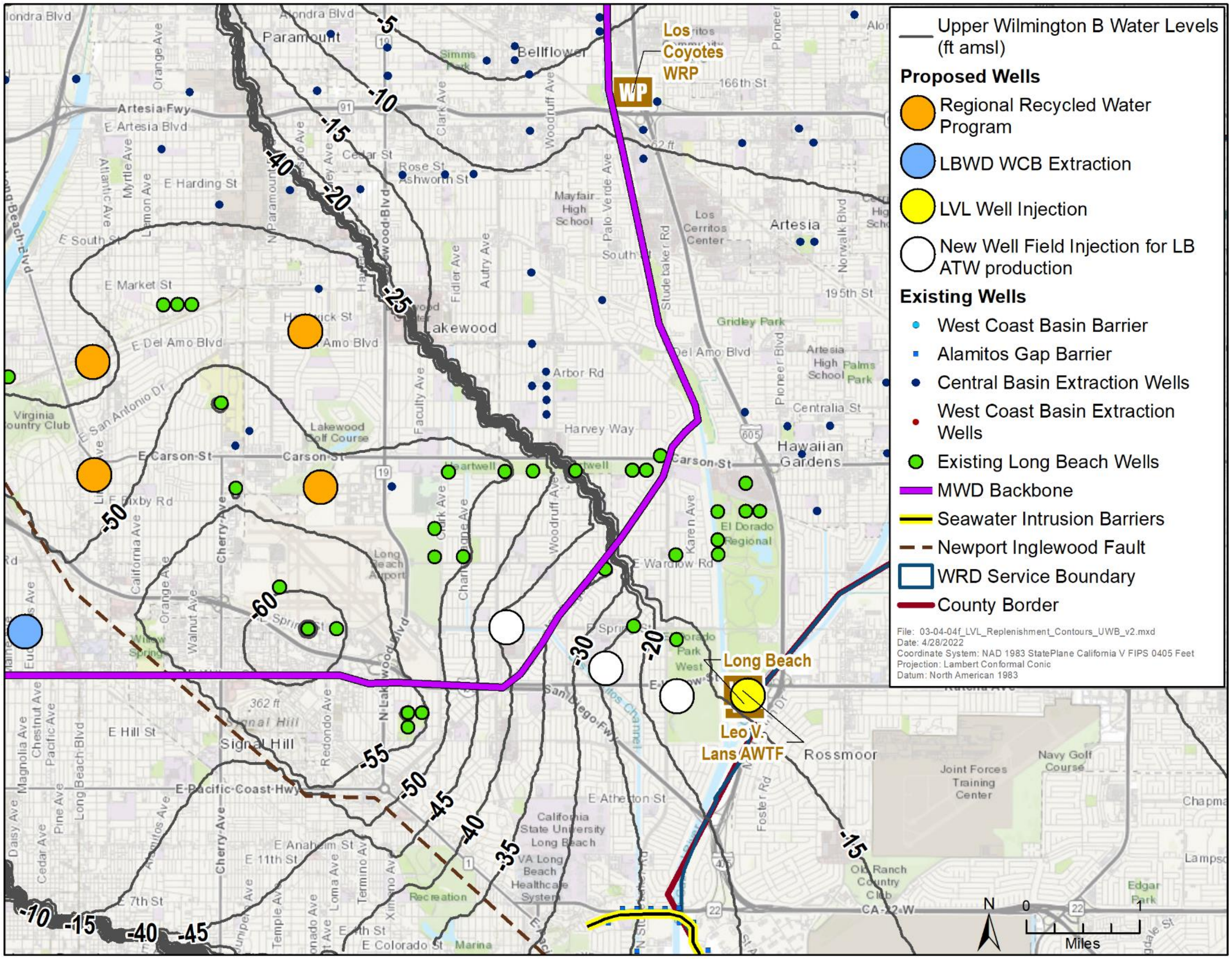
INTERA

Figure 3.4.4d
Contours of LVL Replenishment (Bent Spring Sequence) - 1/1/2011



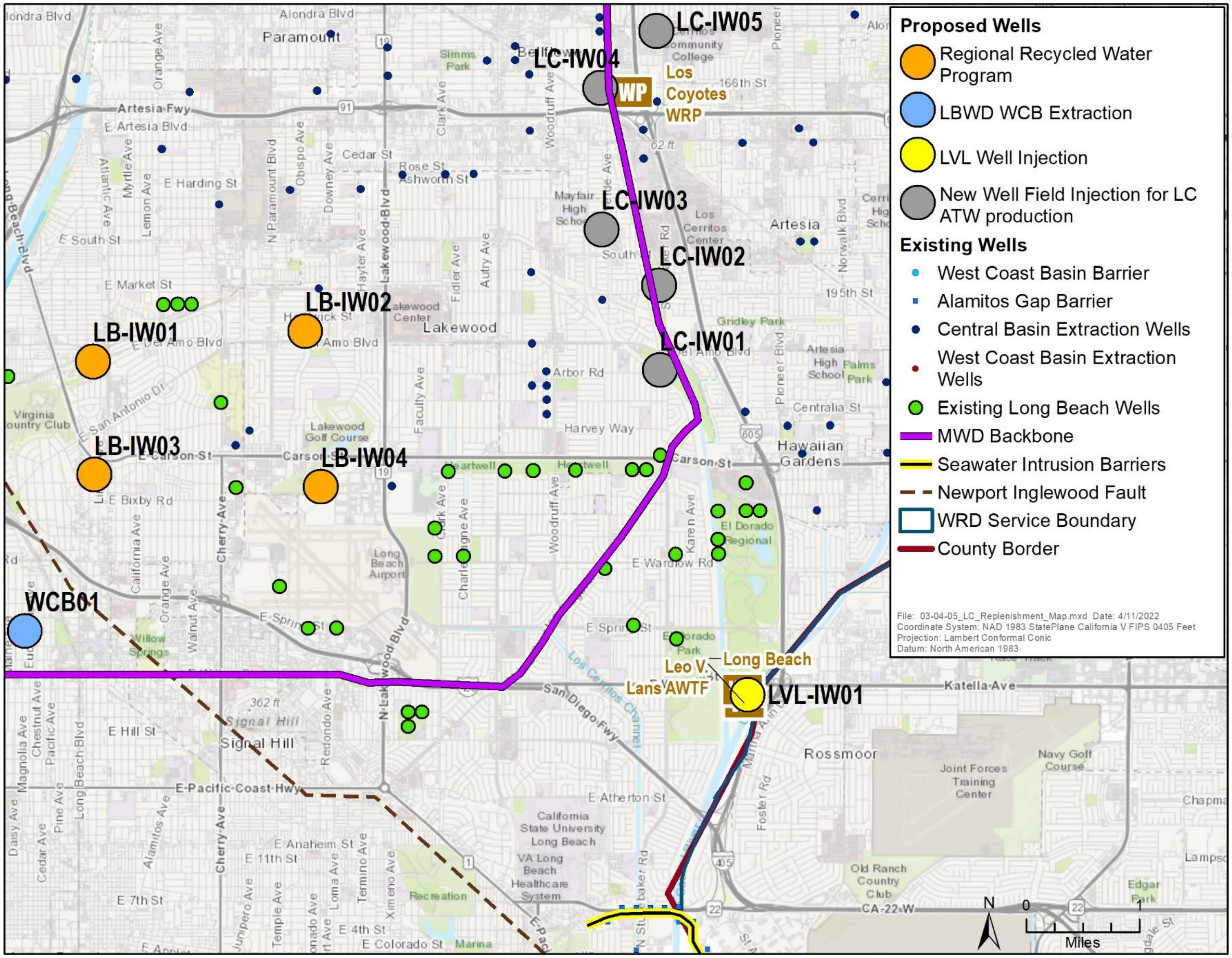
INTERA

Figure 3.4.4e
Contours of LVL Replenishment (Upper Wilmington A Sequence) - 1/1/2011



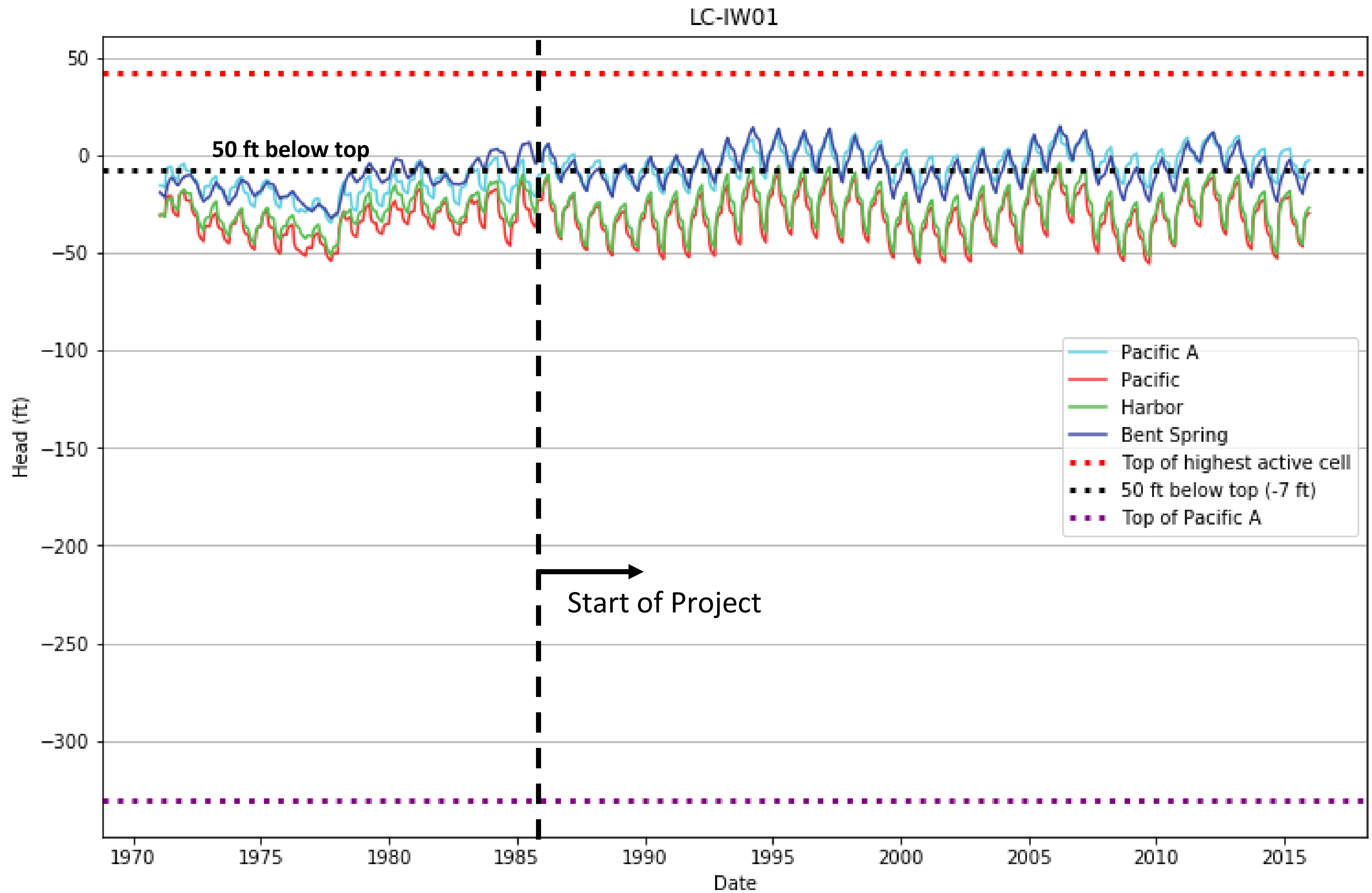
INTERA

Figure 3.4.4f
Contours of LVL Replenishment (Upper Wilmington B Sequence) - 1/1/2011



INTERA

Figure 3.4.5
Map of LC Replenishment Locations



INTERA

Figure 3.4.6a
Hydrographs at LC-IW01 - LC Replenishment Scenario

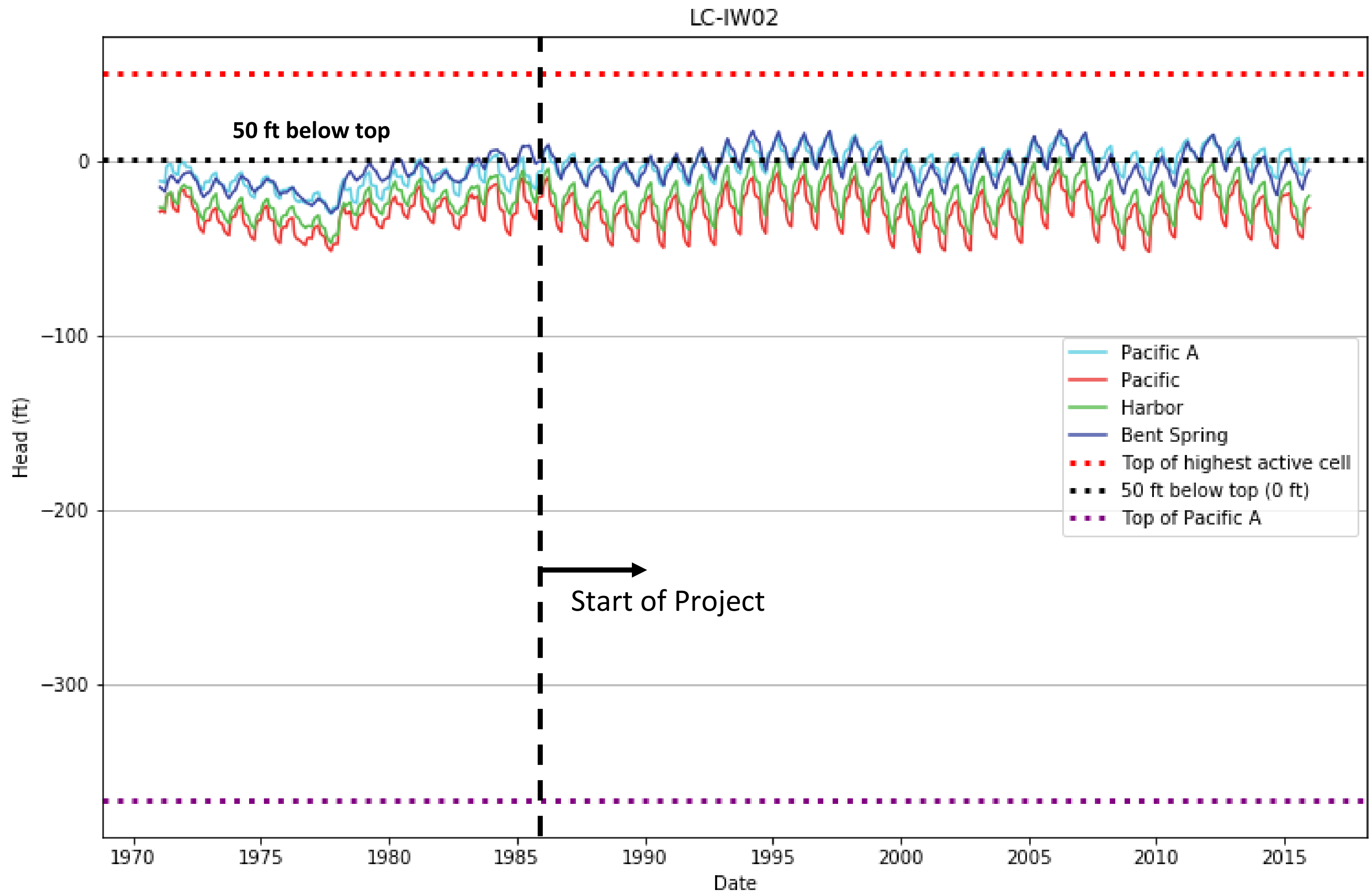
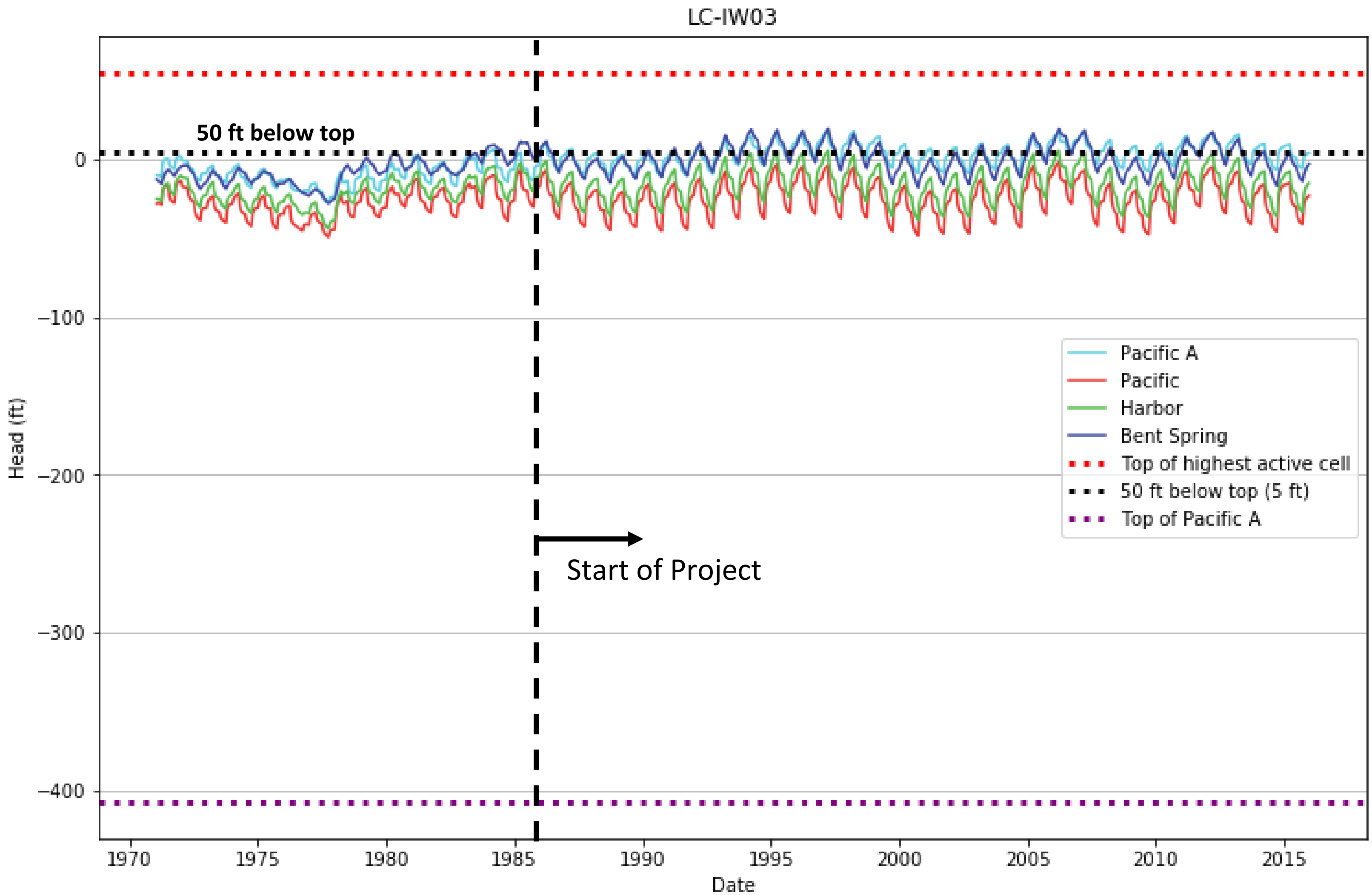
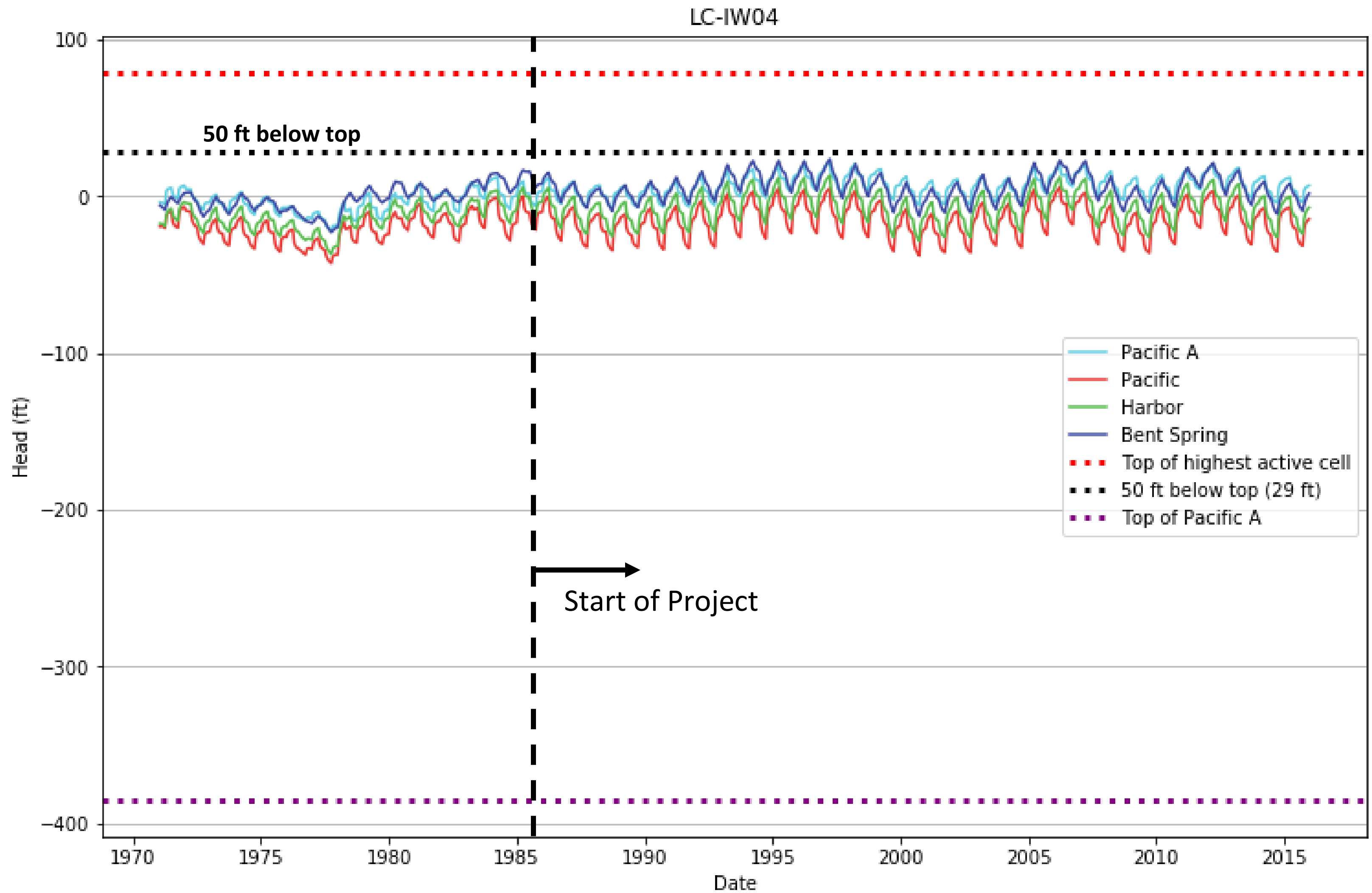


Figure 3.4.6b
Hydrographs at LC-IW02 - LC
Replenishment Scenario



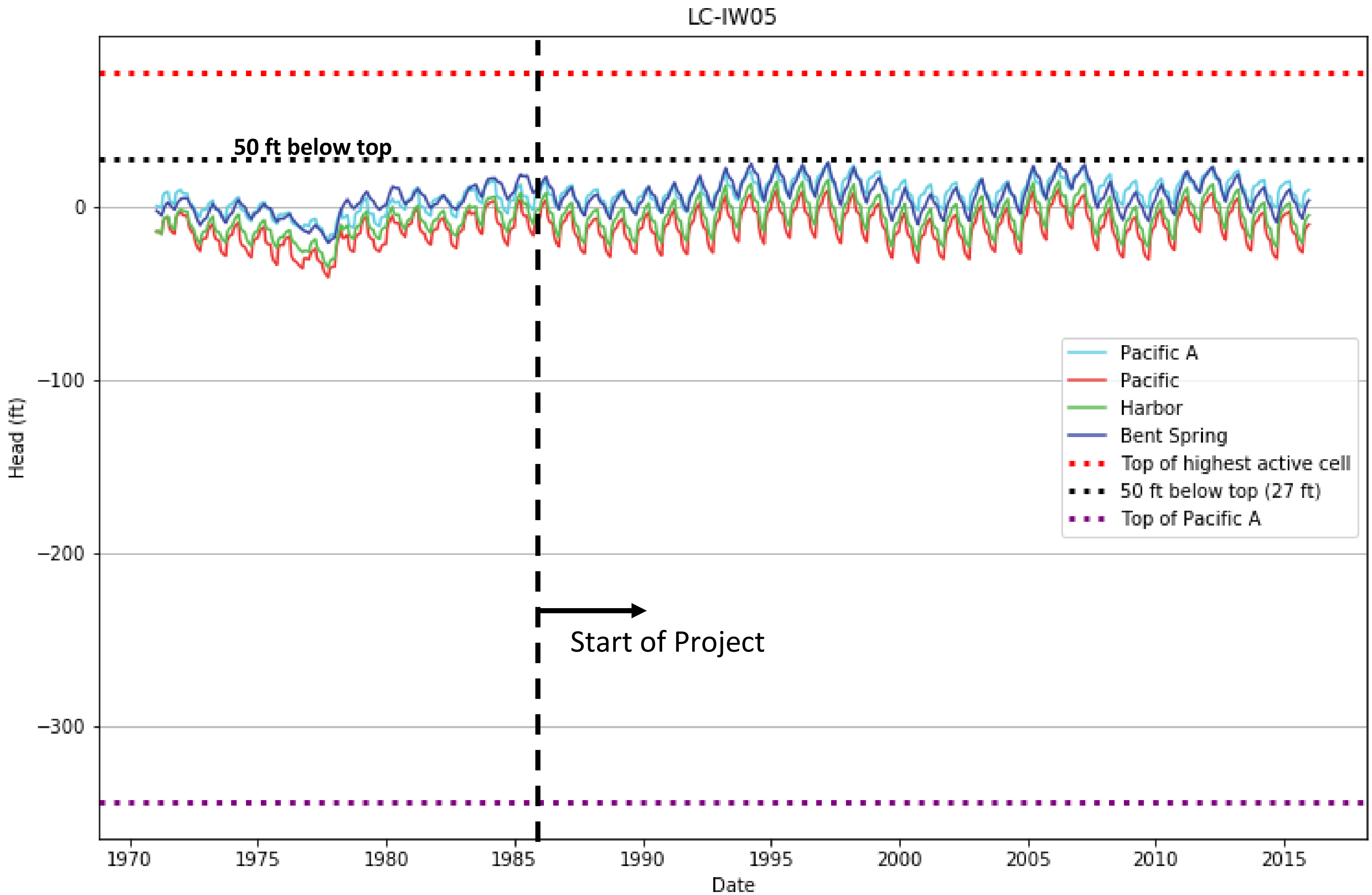
INTERA

Figure 3.4.6c
Hydrographs at LC-IW03 - LC Replenishment Scenario



INTERA

Figure 3.4.6d
Hydrographs at LC-IW04 - LC Replenishment Scenario

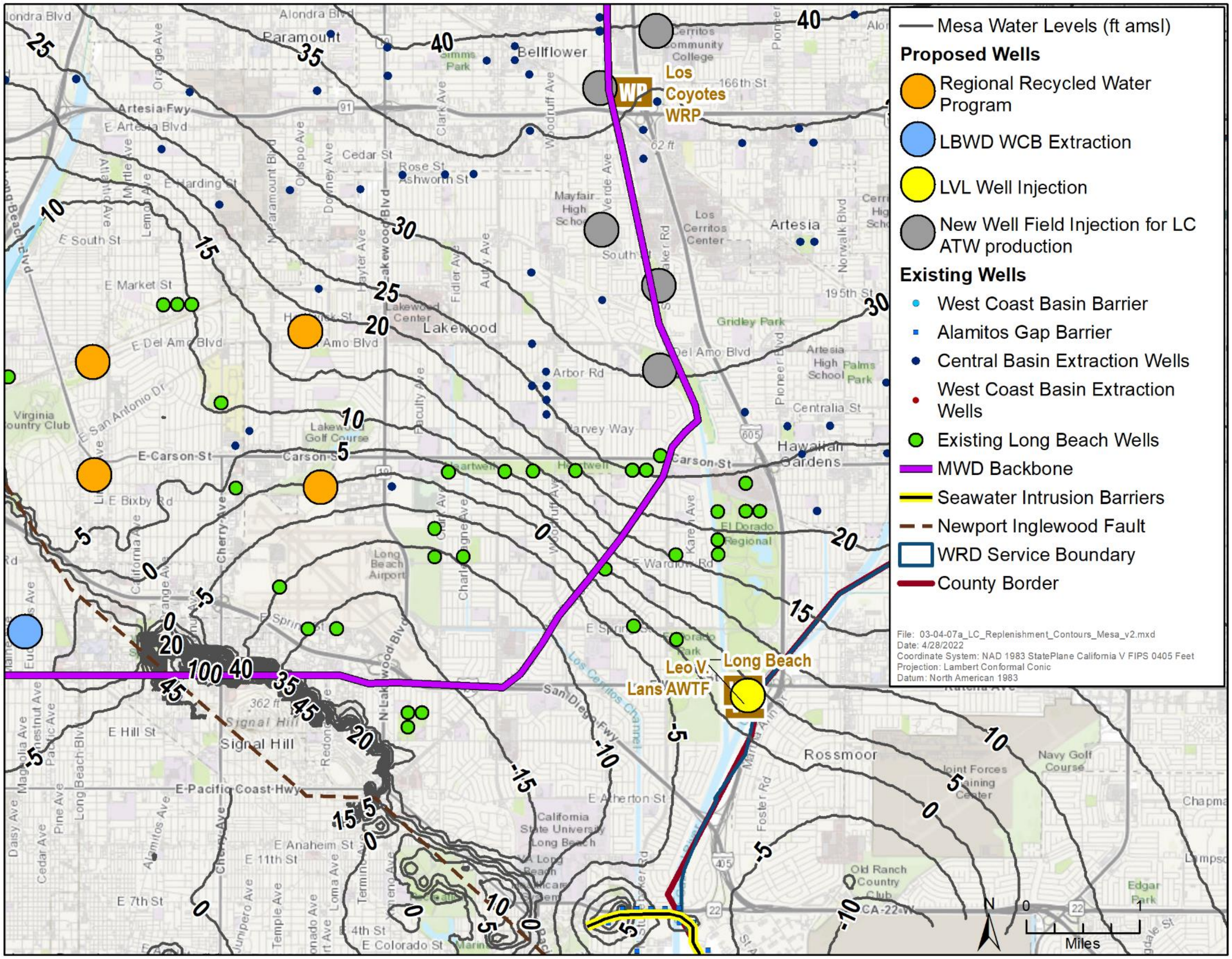


INTERA

Figure 3.4.6e
Hydrographs at LC-IW05 - LC Replenishment Scenario

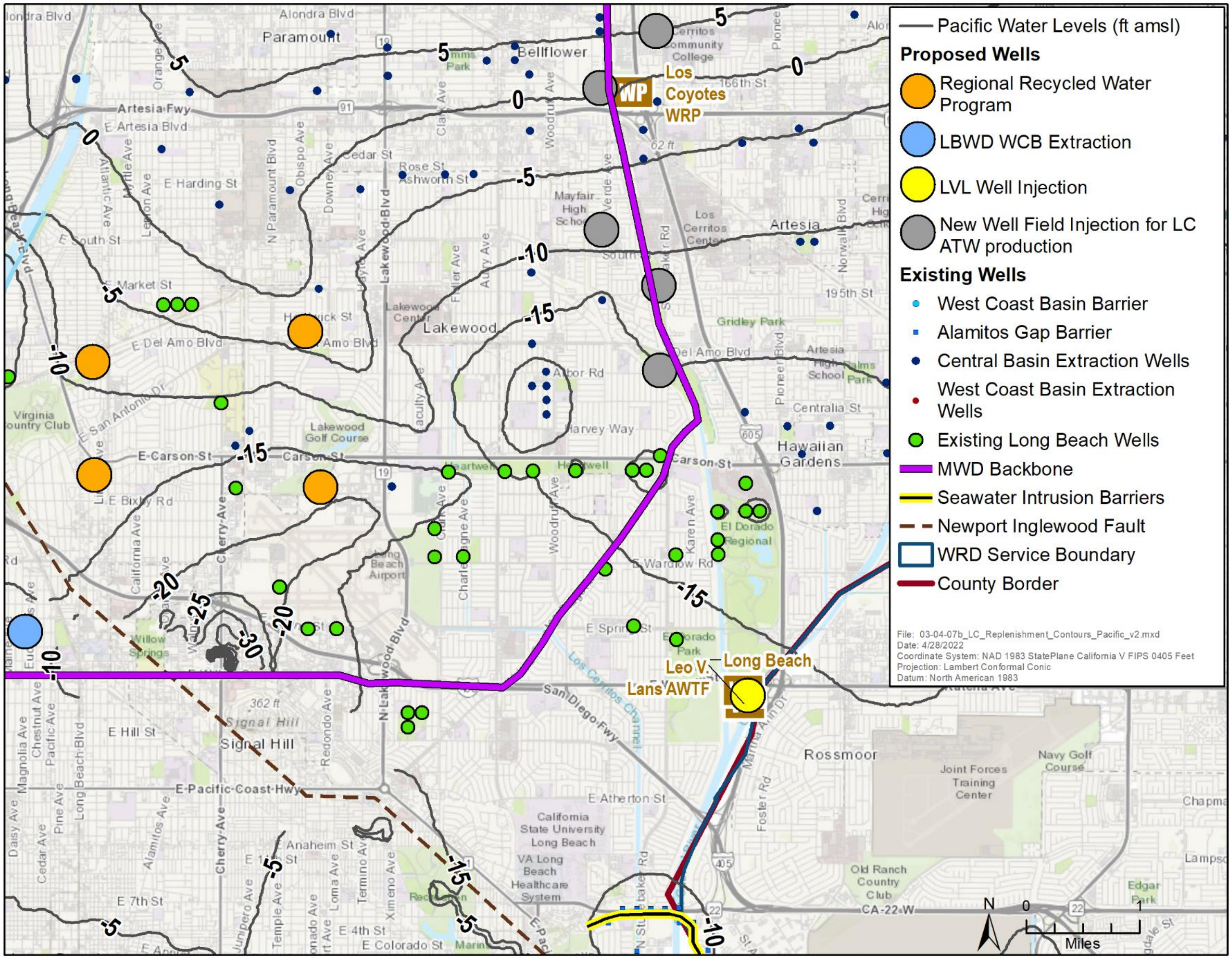
INTERA

Figure 3.4.6f
Hydrographs at LVL -IW01 - LC
Replenishment Scenario



INTERA

Figure 3.4.7a
Contours of LC Replenishment (Mesa Sequence) - 1/1/2011



INTERA

Figure 3.4.7b
Contours of LC Replenishment (Pacific Sequence) - 1/1/2011

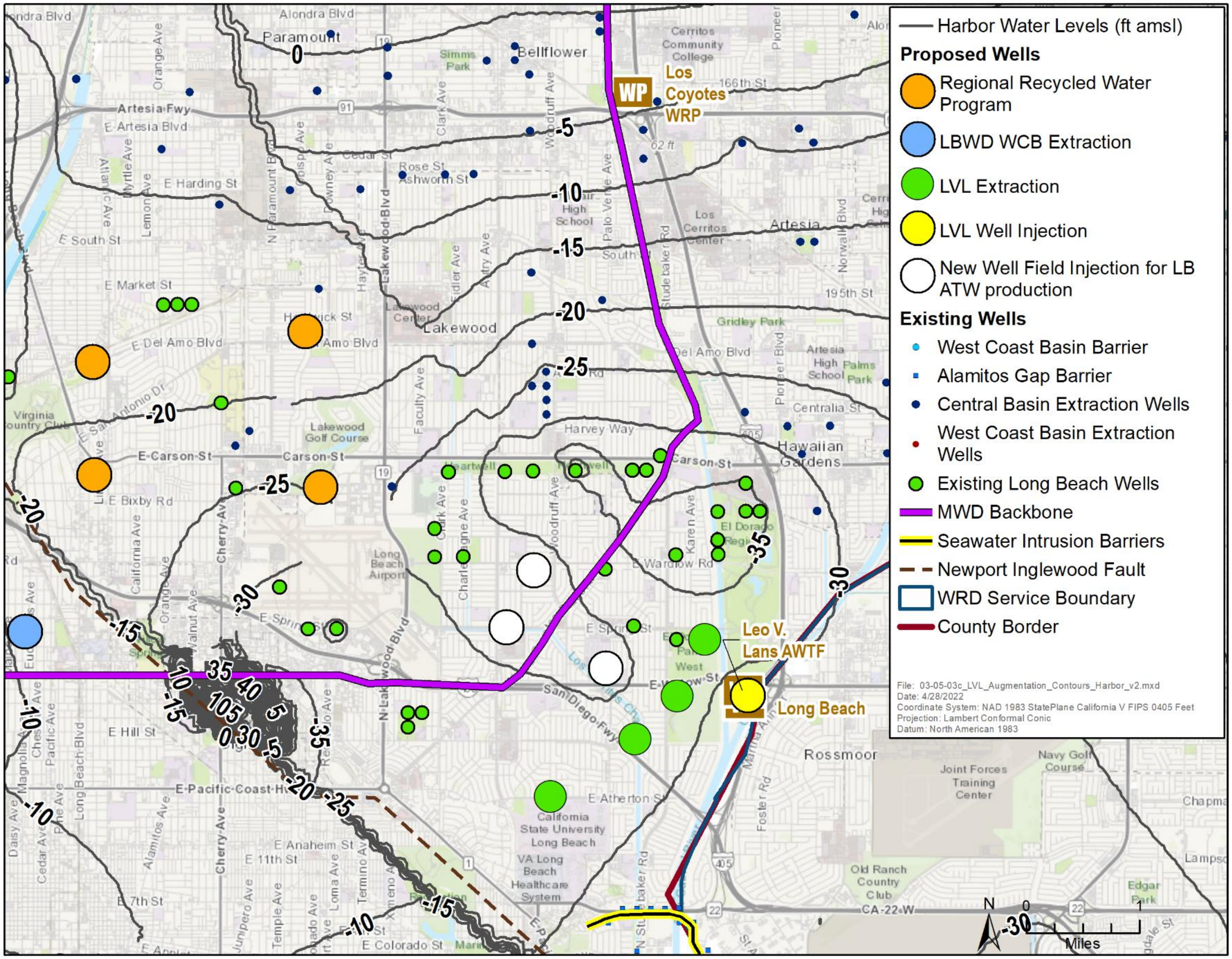
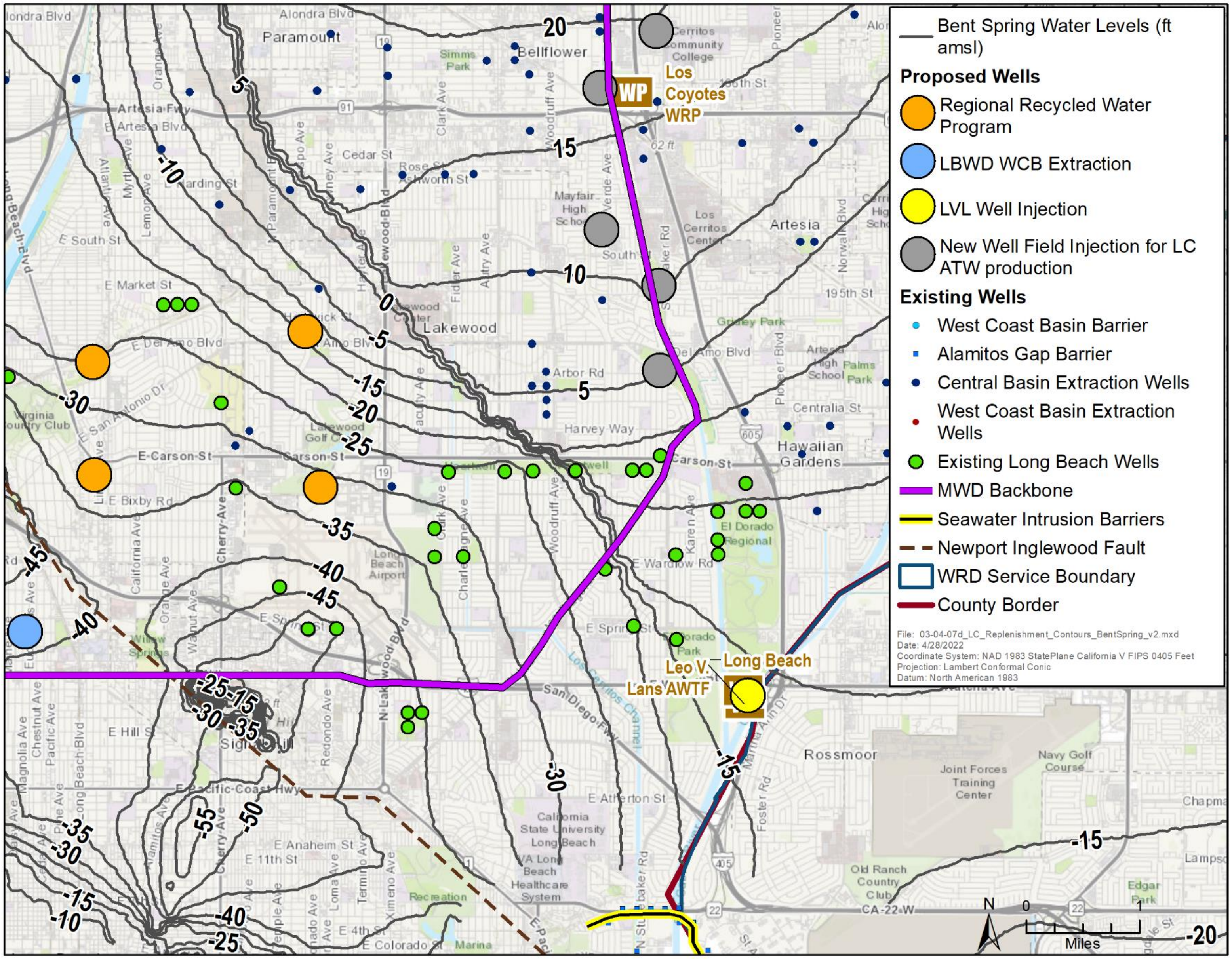
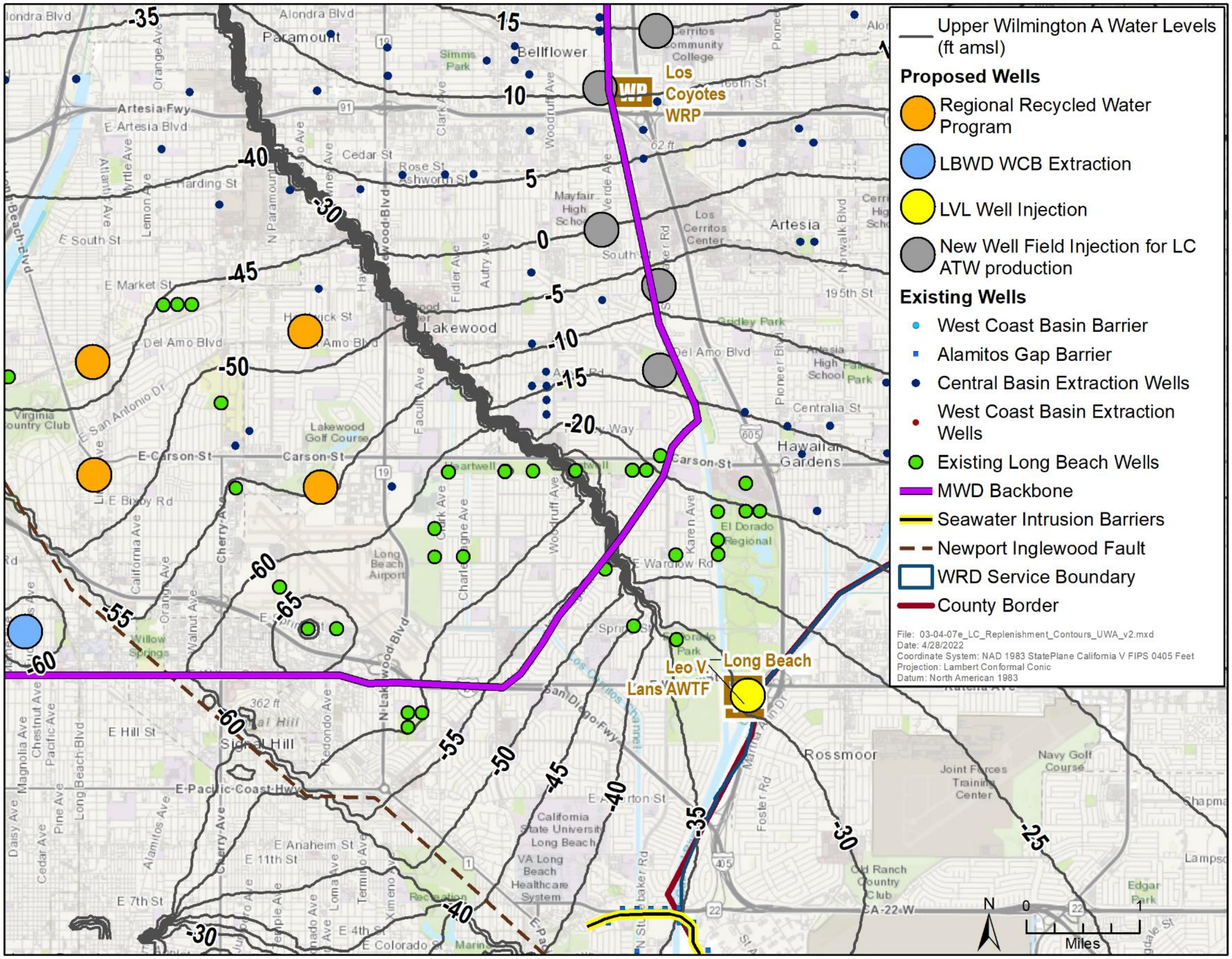


Figure 3.4.7c
Contours of LC Replenishment (Harbor Sequence) - 1/1/2011



INTERA

Figure 3.4.7d
Contours of LC Replenishment (Bent Spring Sequence) - 1/1/2011



INTERA

Figure 3.4.7e
Contours of LC Replenishment (Upper Wilmington A Sequence) - 1/1/2011

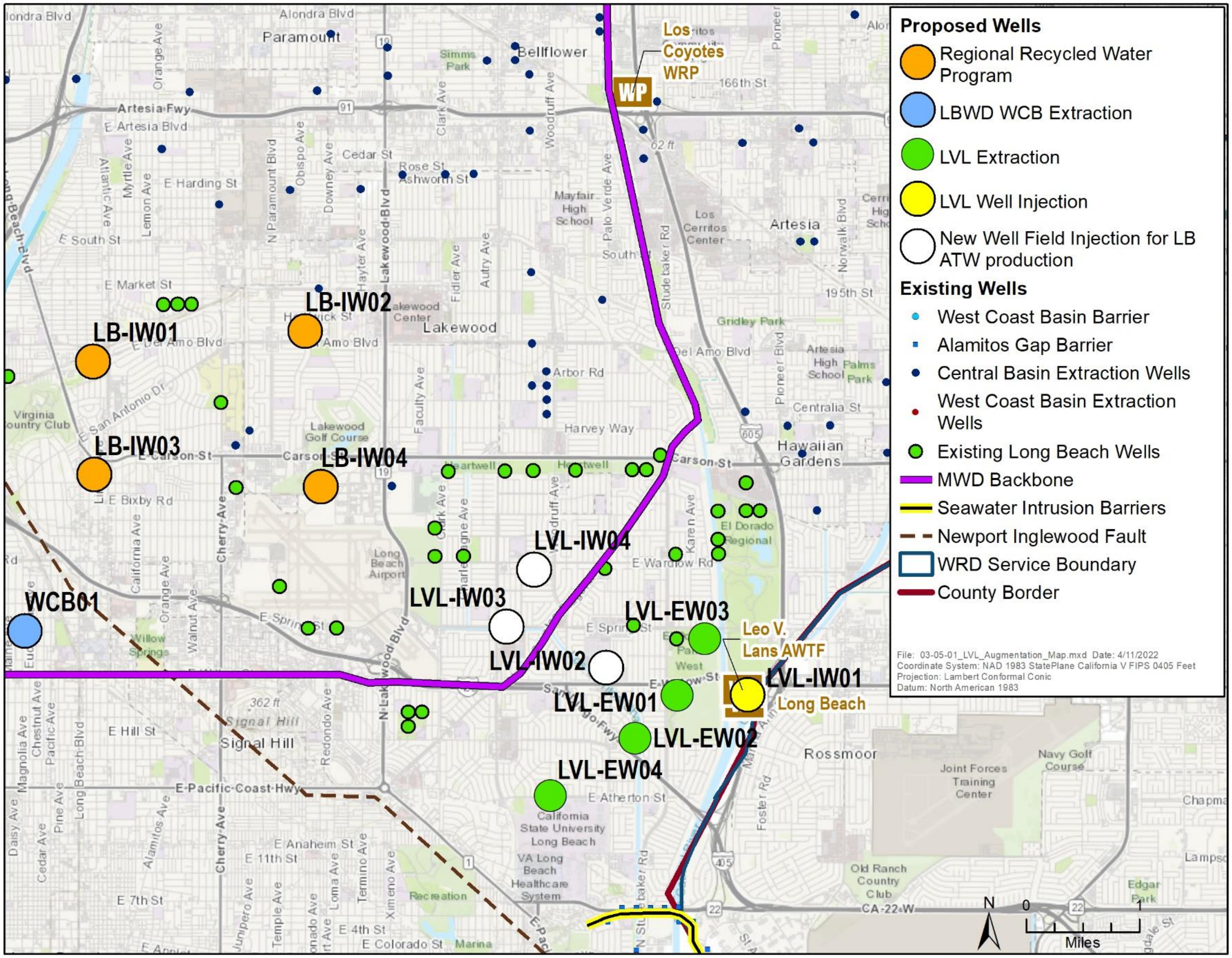


Figure 3.5.1
Map of LVL Augmentation Locations

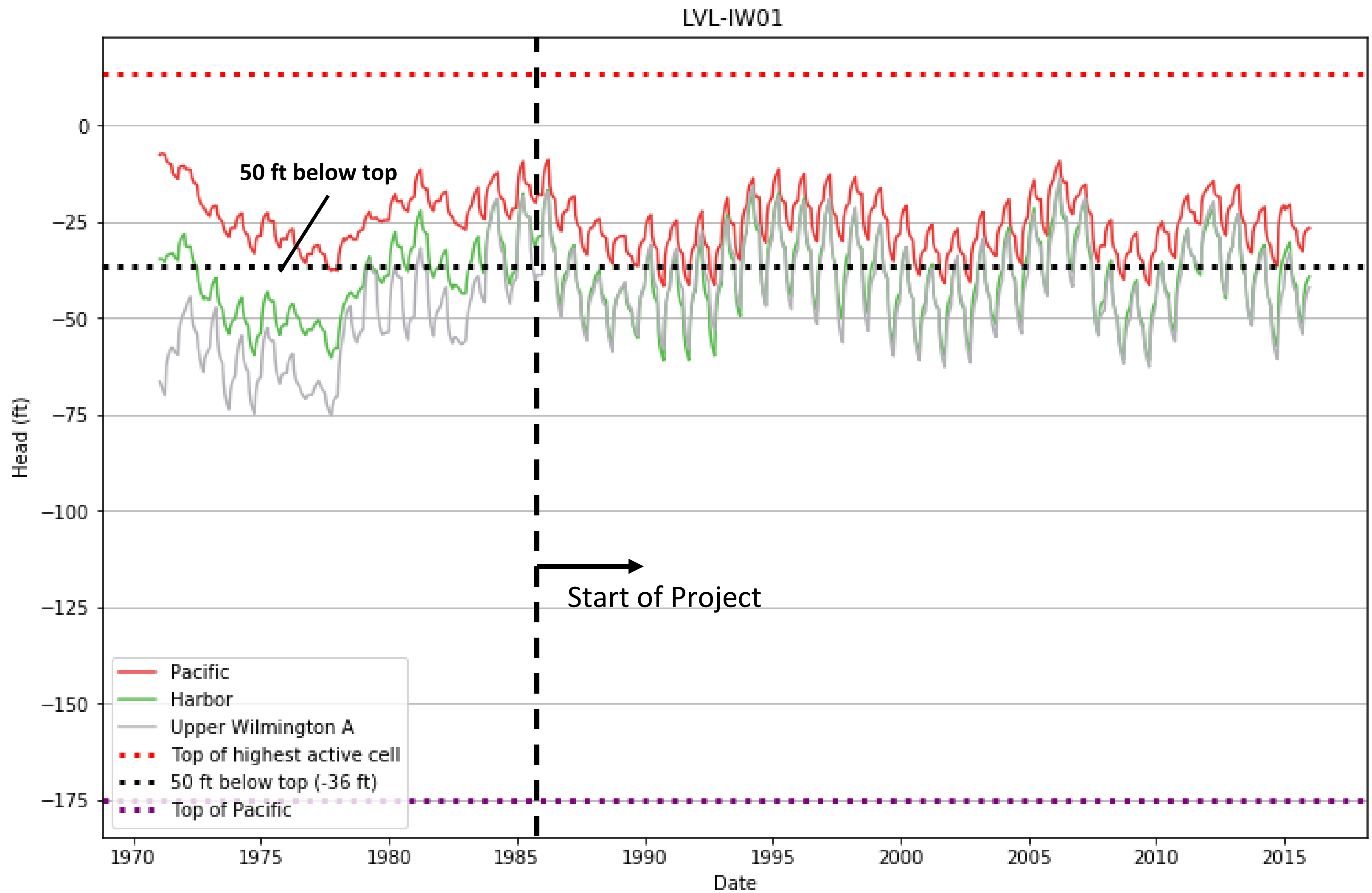
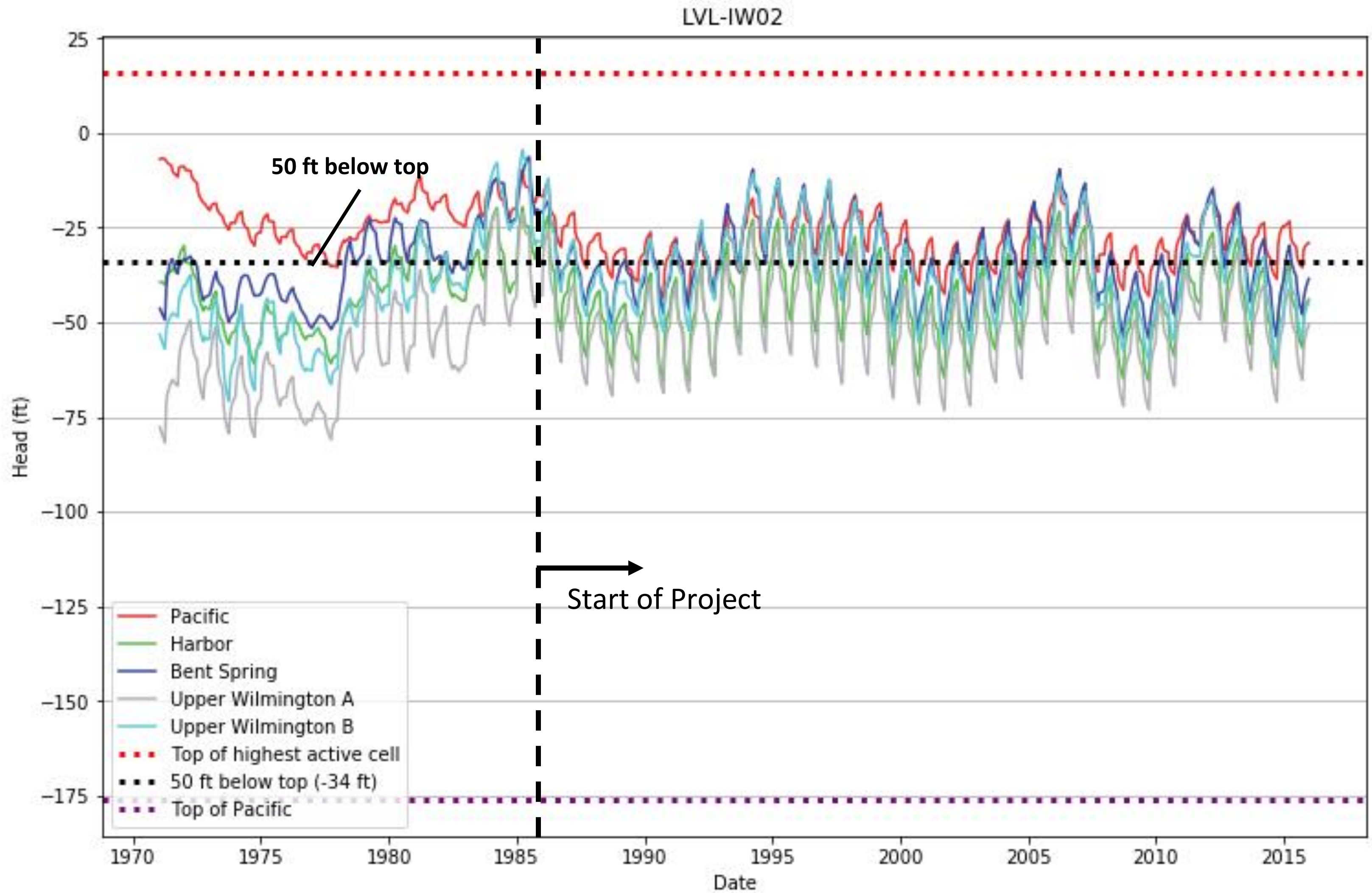


Figure 3.5.2a
Hydrographs at LVL -IW01 - LVL Augmentation Scenario



INTERA

Figure 3.5.2b
Hydrographs at LVL -IW02 - LVL Augmentation Scenario

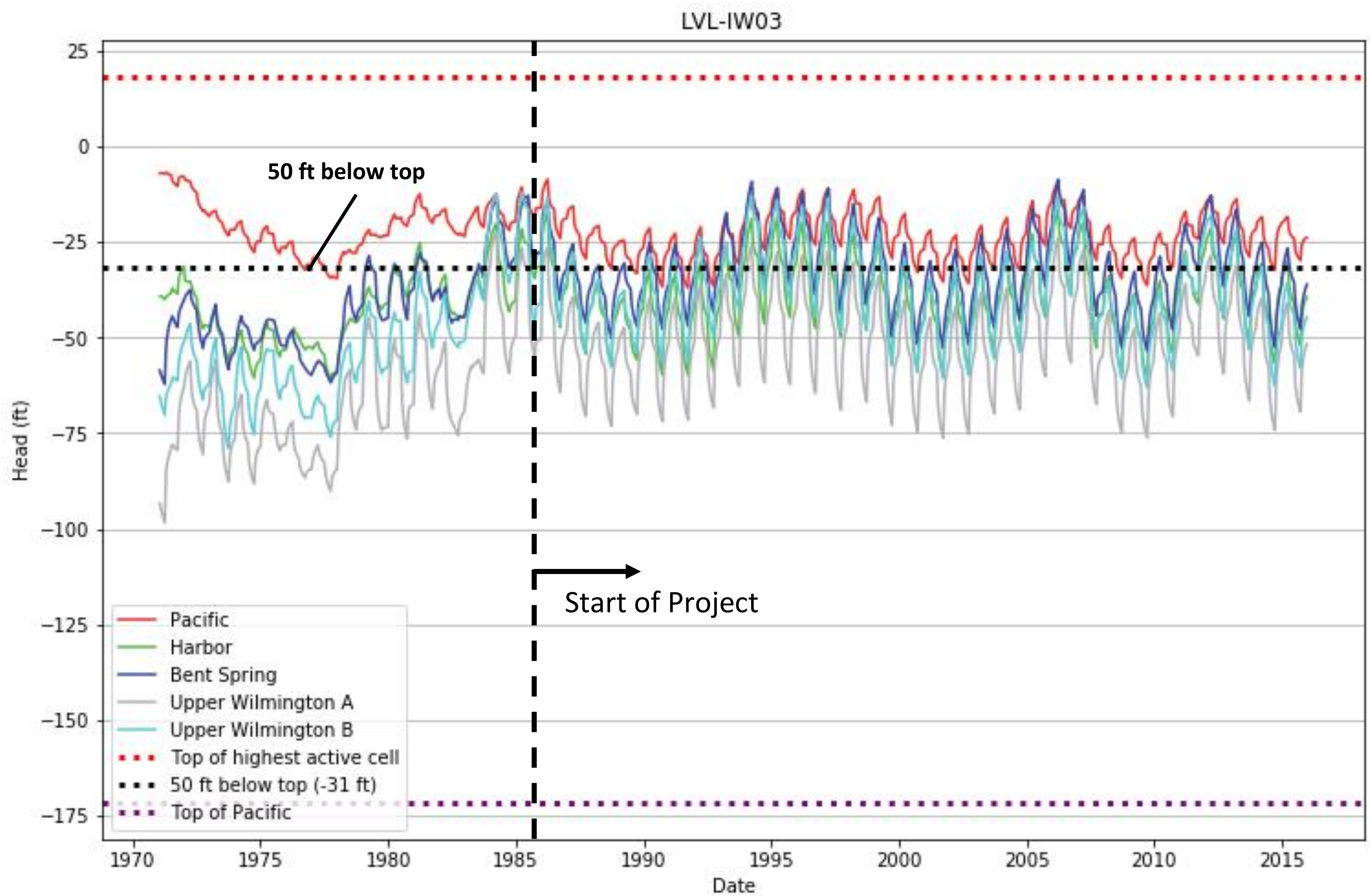
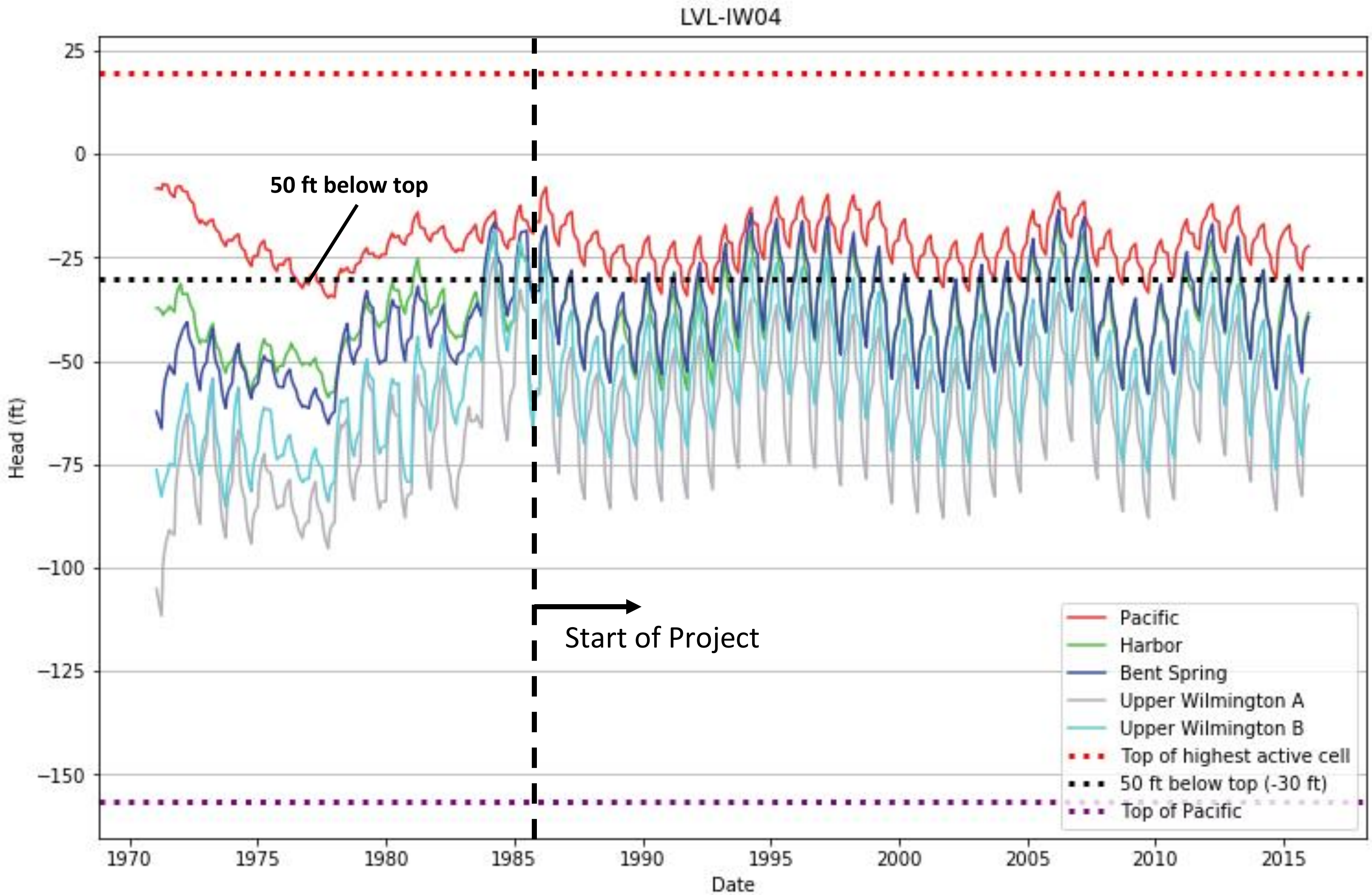
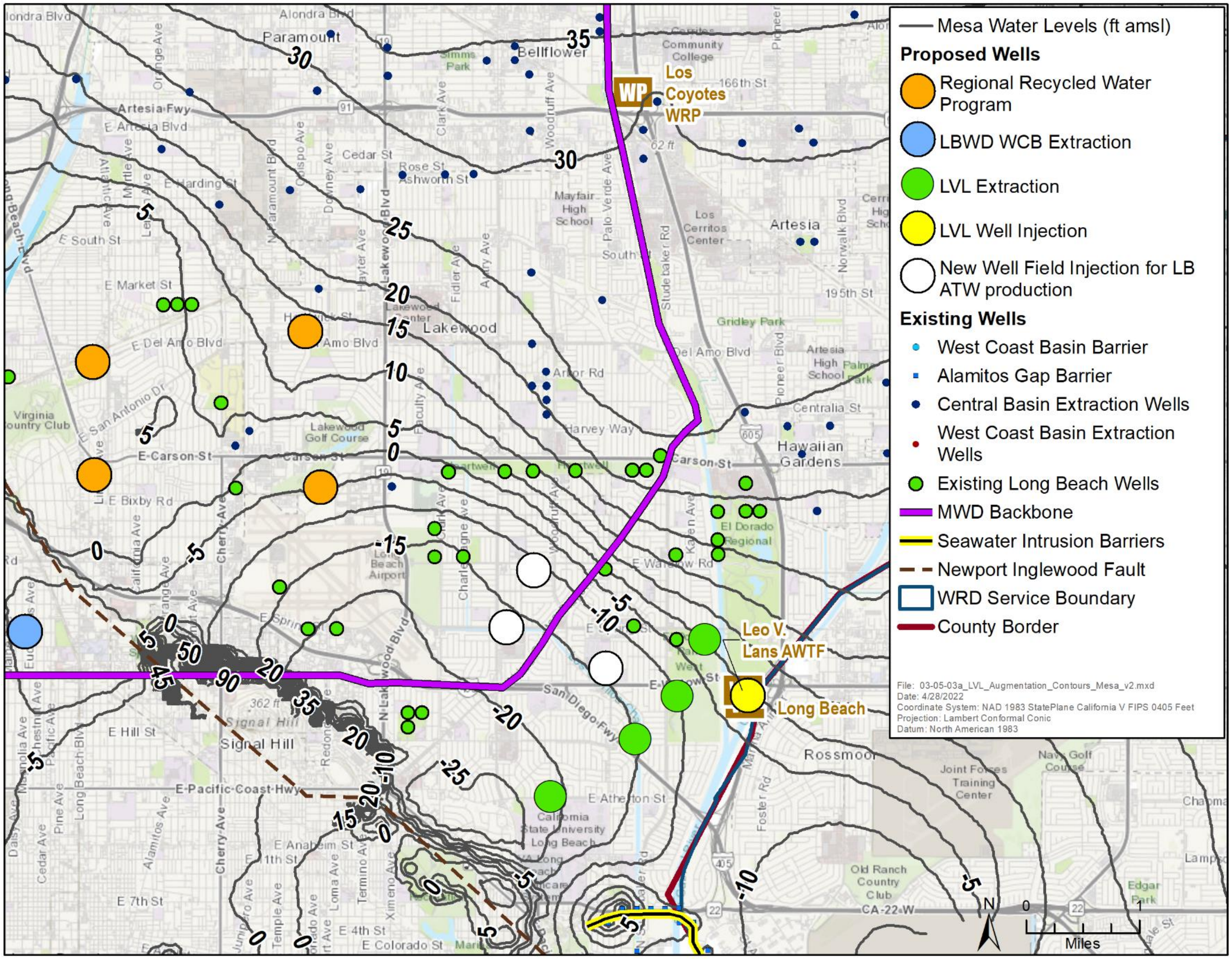


Figure 3.5.2c
Hydrographs at LVL -IW03 - LVL Augmentation Scenario



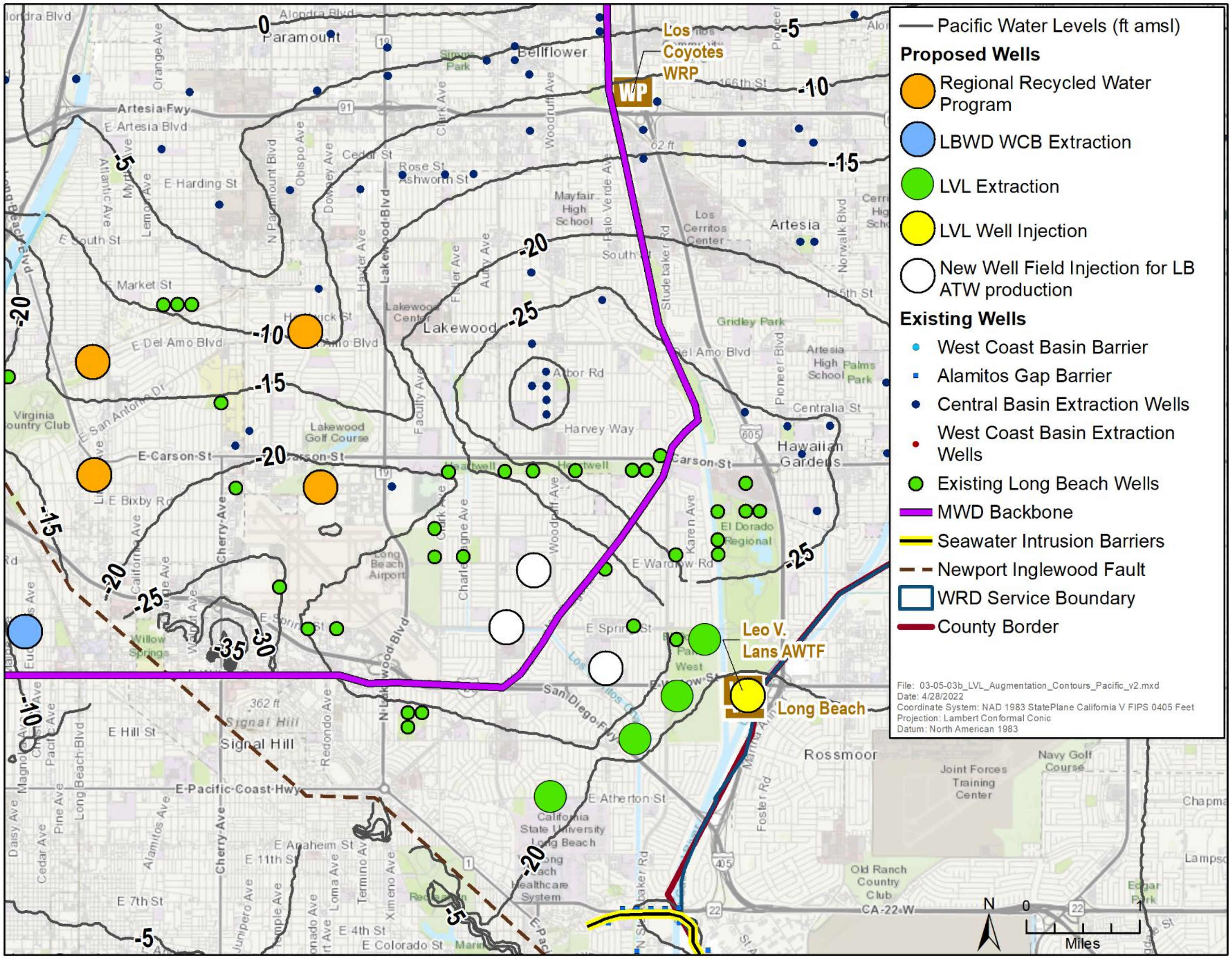
INTERA

Figure 3.5.2d
Hydrographs at LVL -IW04 - LVL Augmentation Scenario



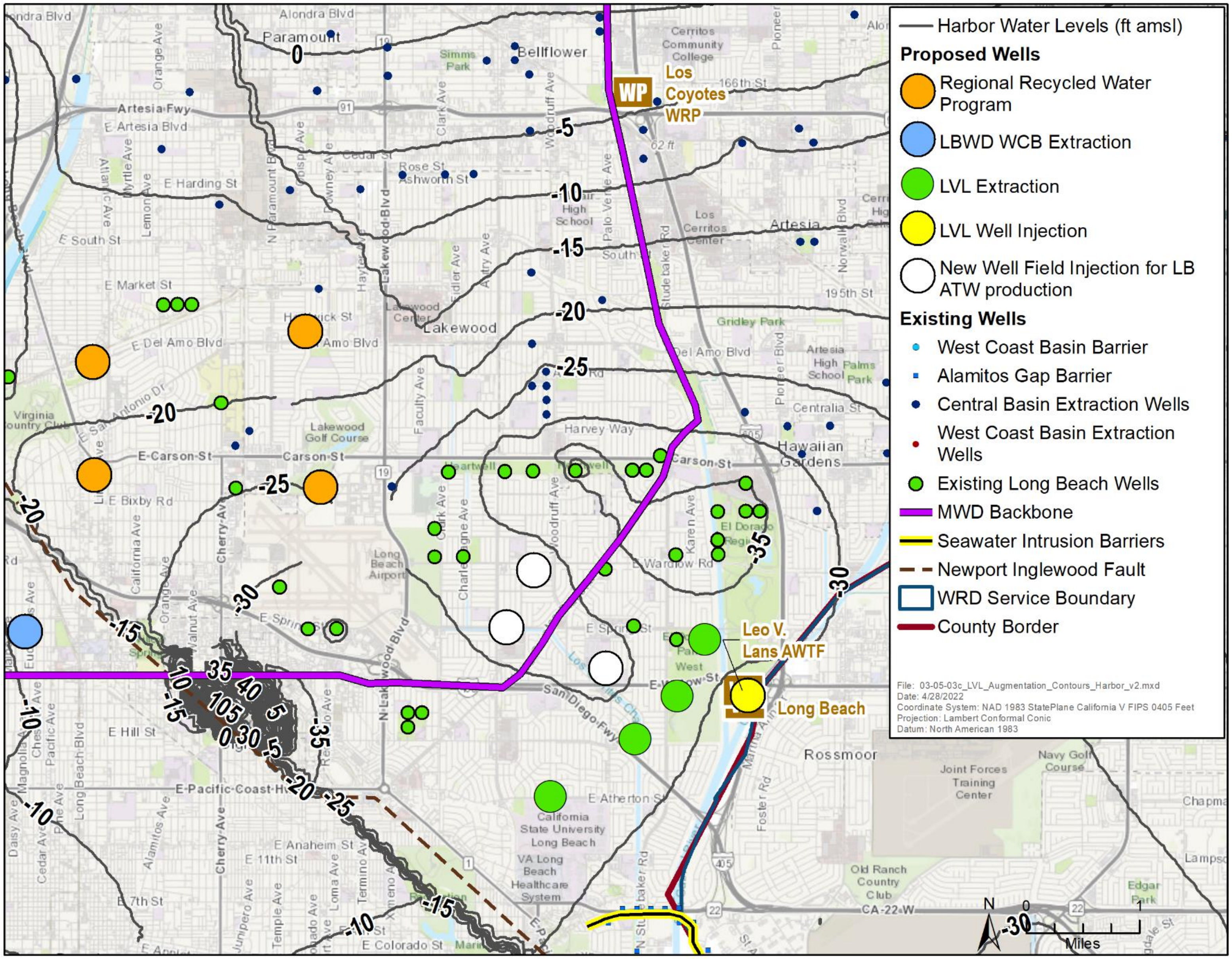
INTERA

Figure 3.5.3a
Contours of LVL Augmentation (Mesa Sequence) - 1/1/2011



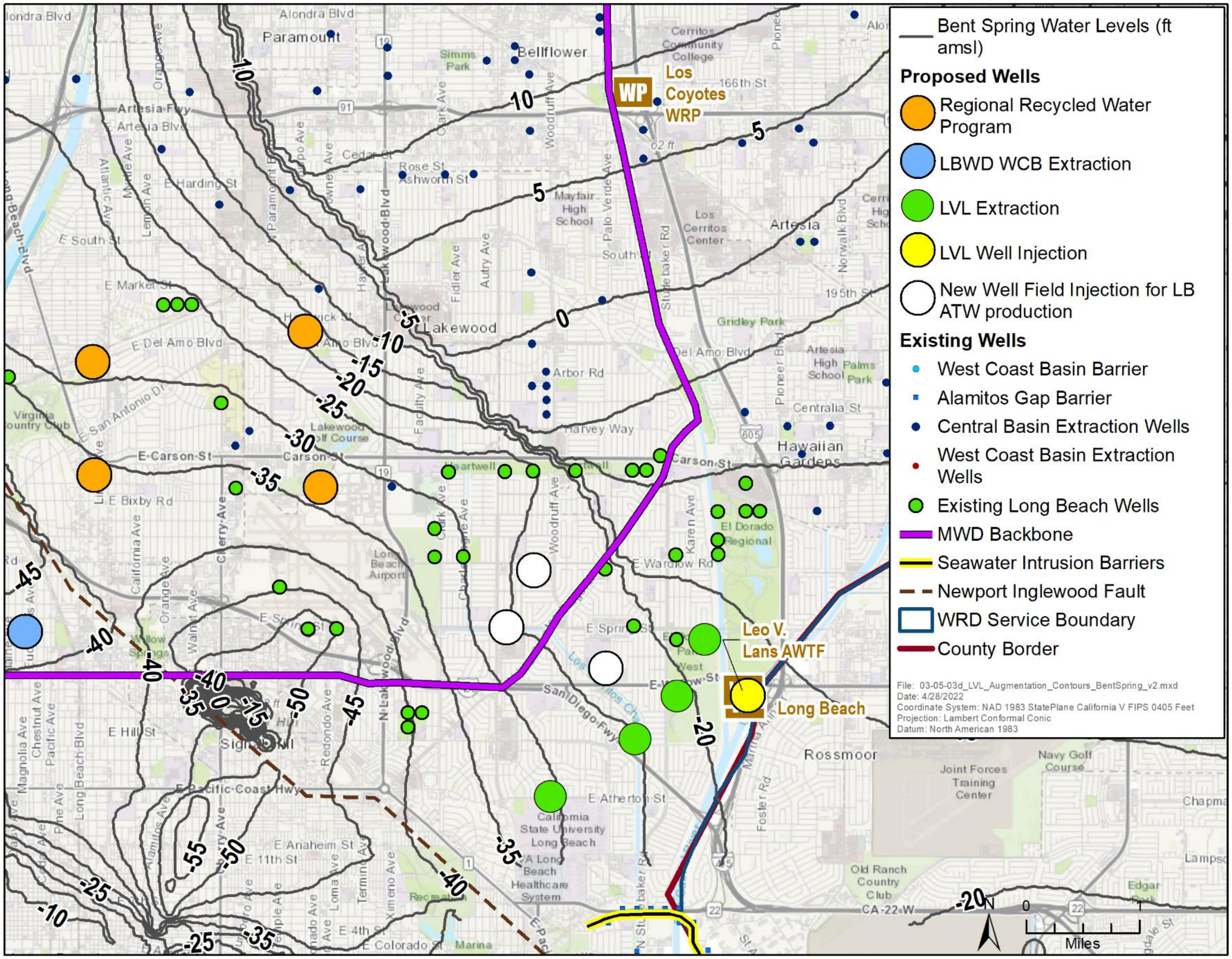
INTERA

Figure 3.5.3b
Contours of LVL Augmentation (Pacific Sequence) - 1/1/2011



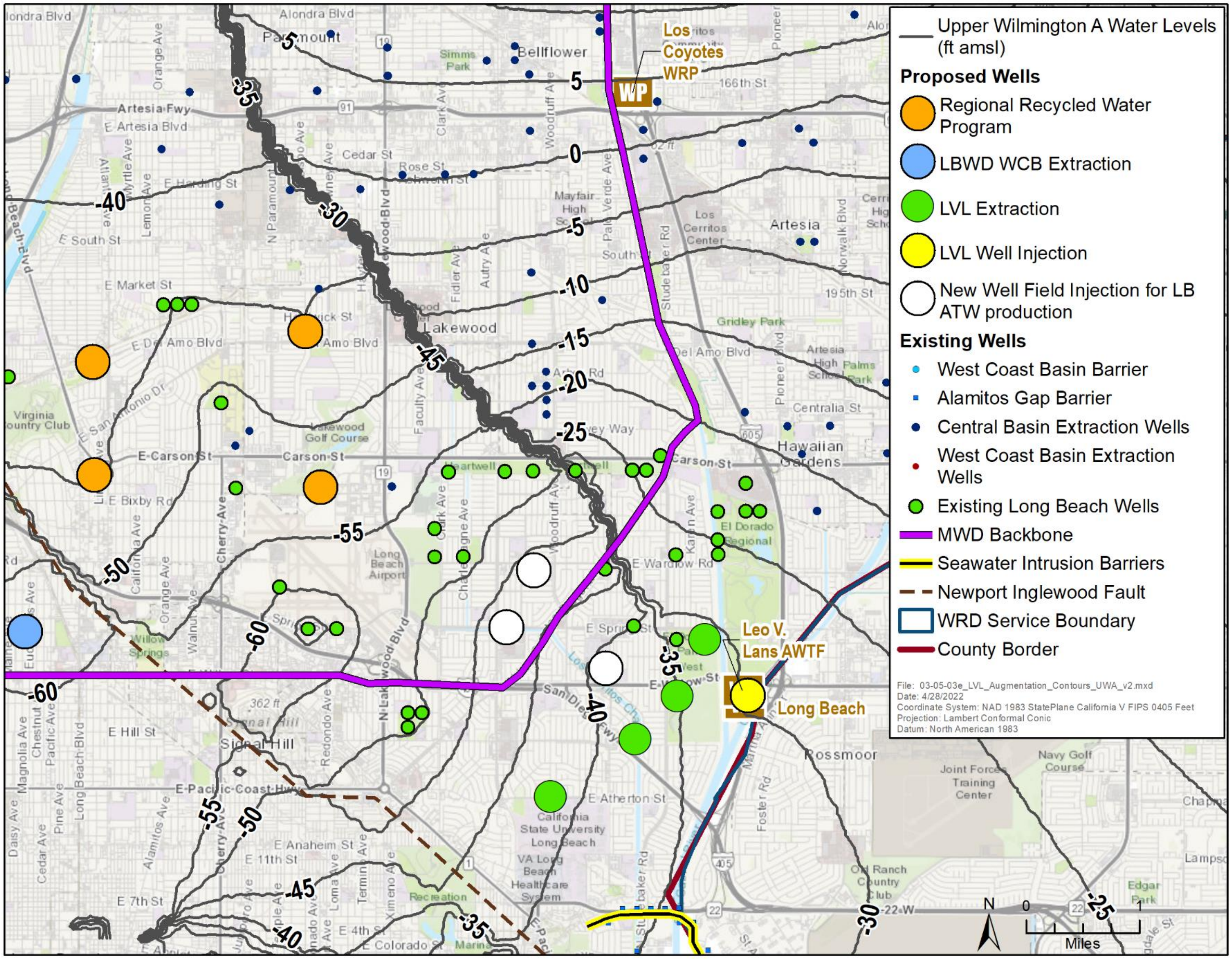
INTERA

Figure 3.5.3c
Contours of LVL Augmentation (Harbor Sequence) - 1/1/2011



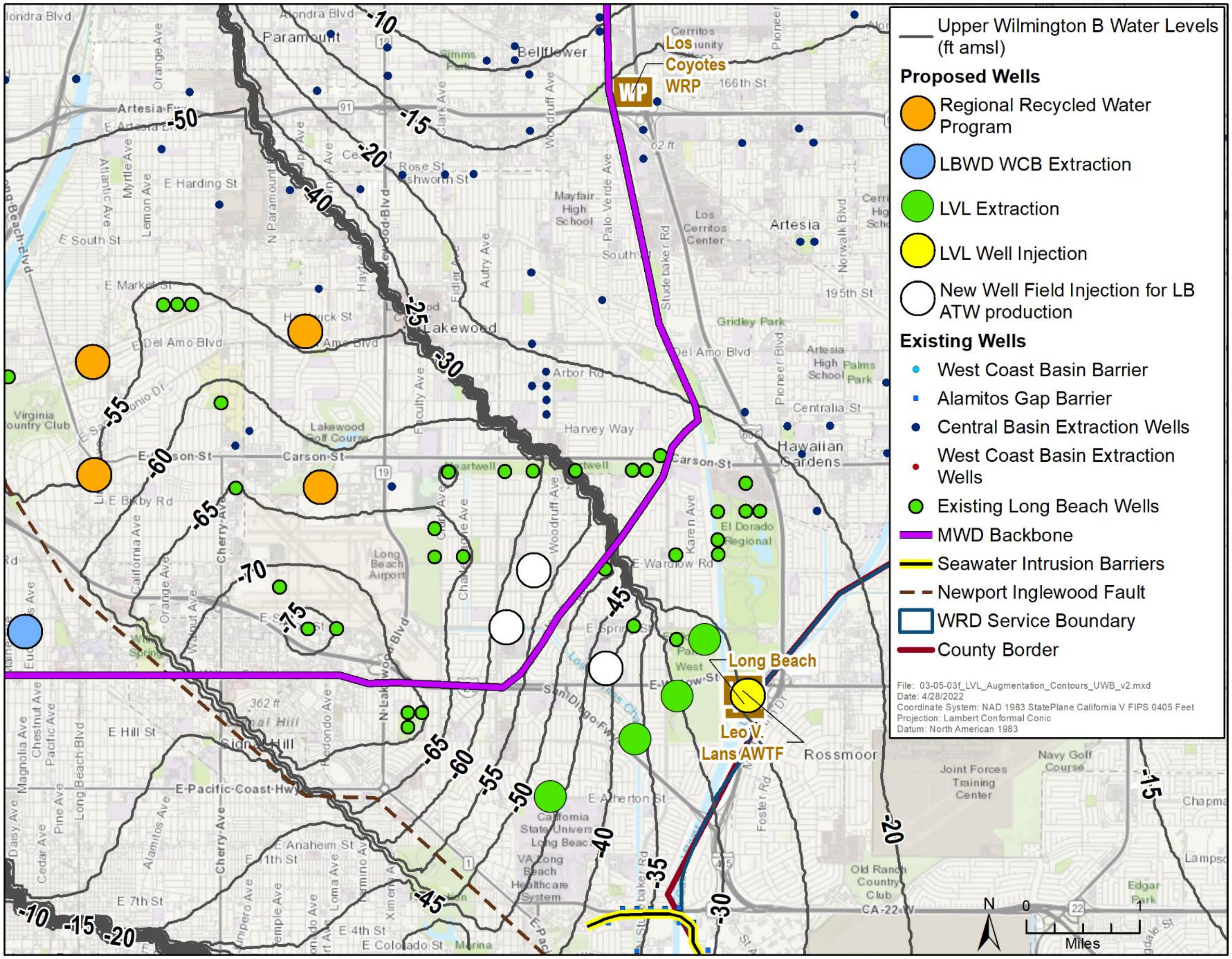
INTERA

Figure 3.5.3d
Contours of LVL Augmentation (Bent Spring Sequence) - 1/1/2011



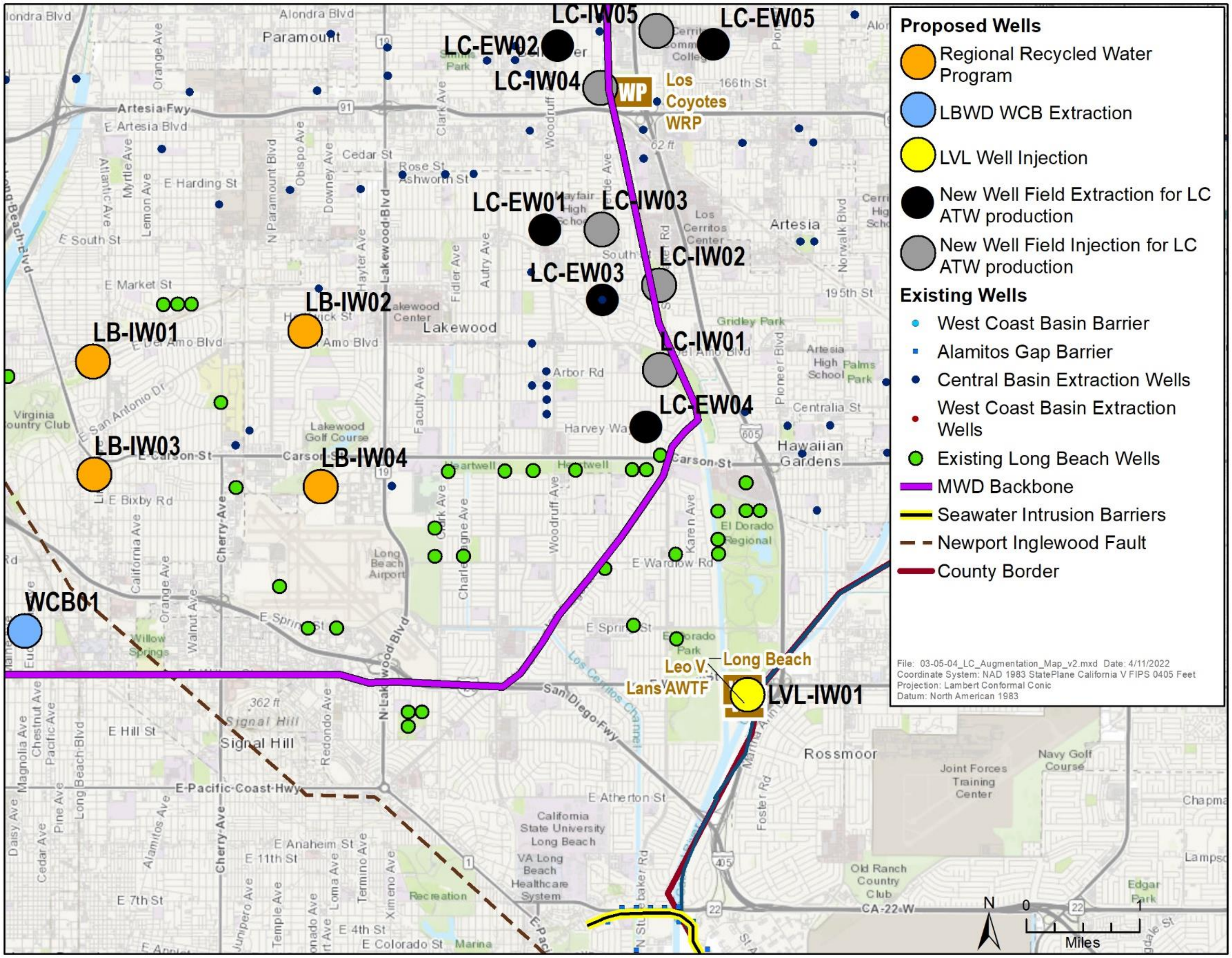
INTERA

Figure 3.5.3e
Contours of LVL Augmentation (Upper Wilmington A Sequence) - 1/1/2011



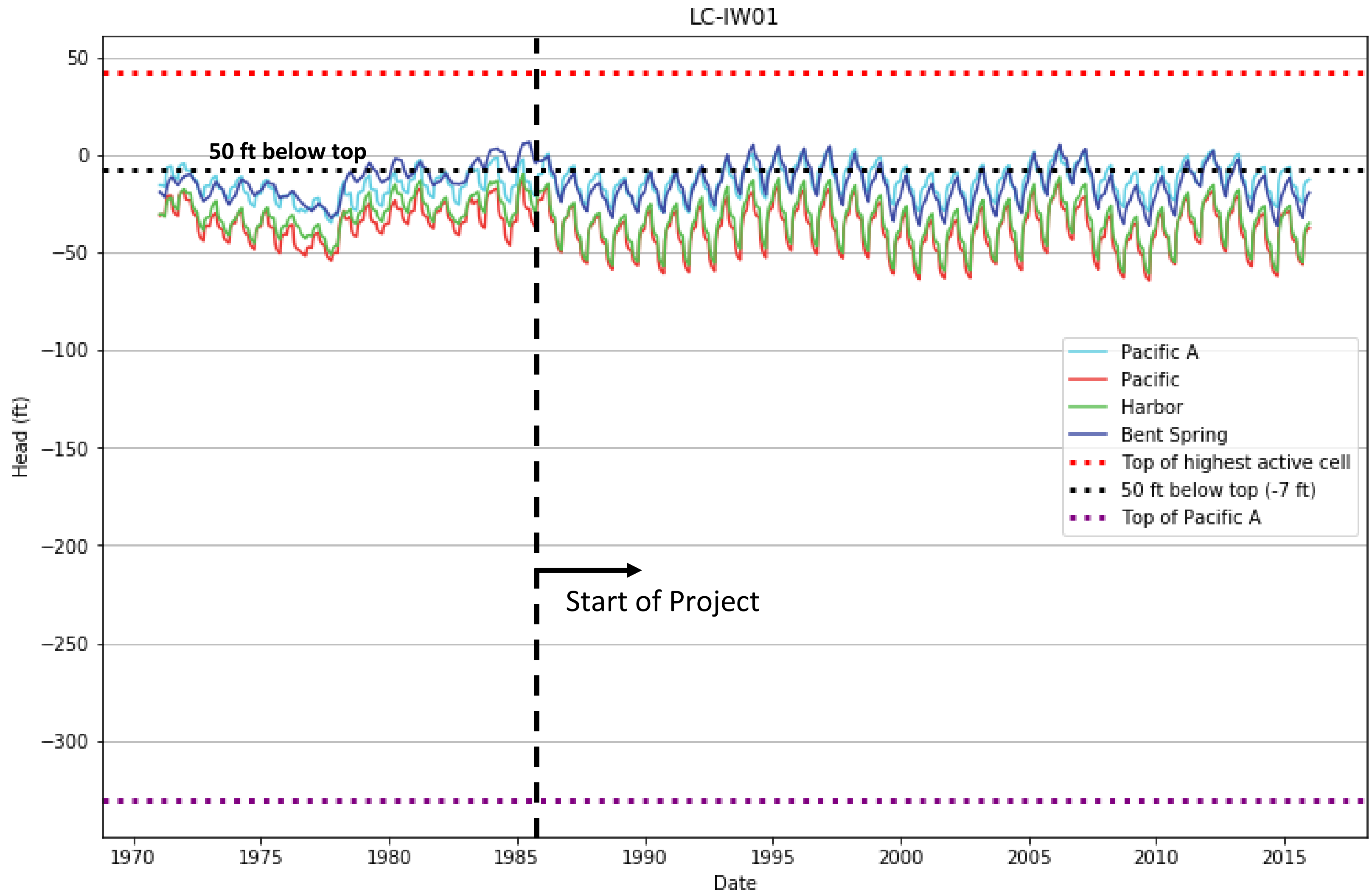
INTERA

Figure 3.5.3f
Contours of LVL Augmentation (Upper Wilmington B Sequence) - 1/1/2011



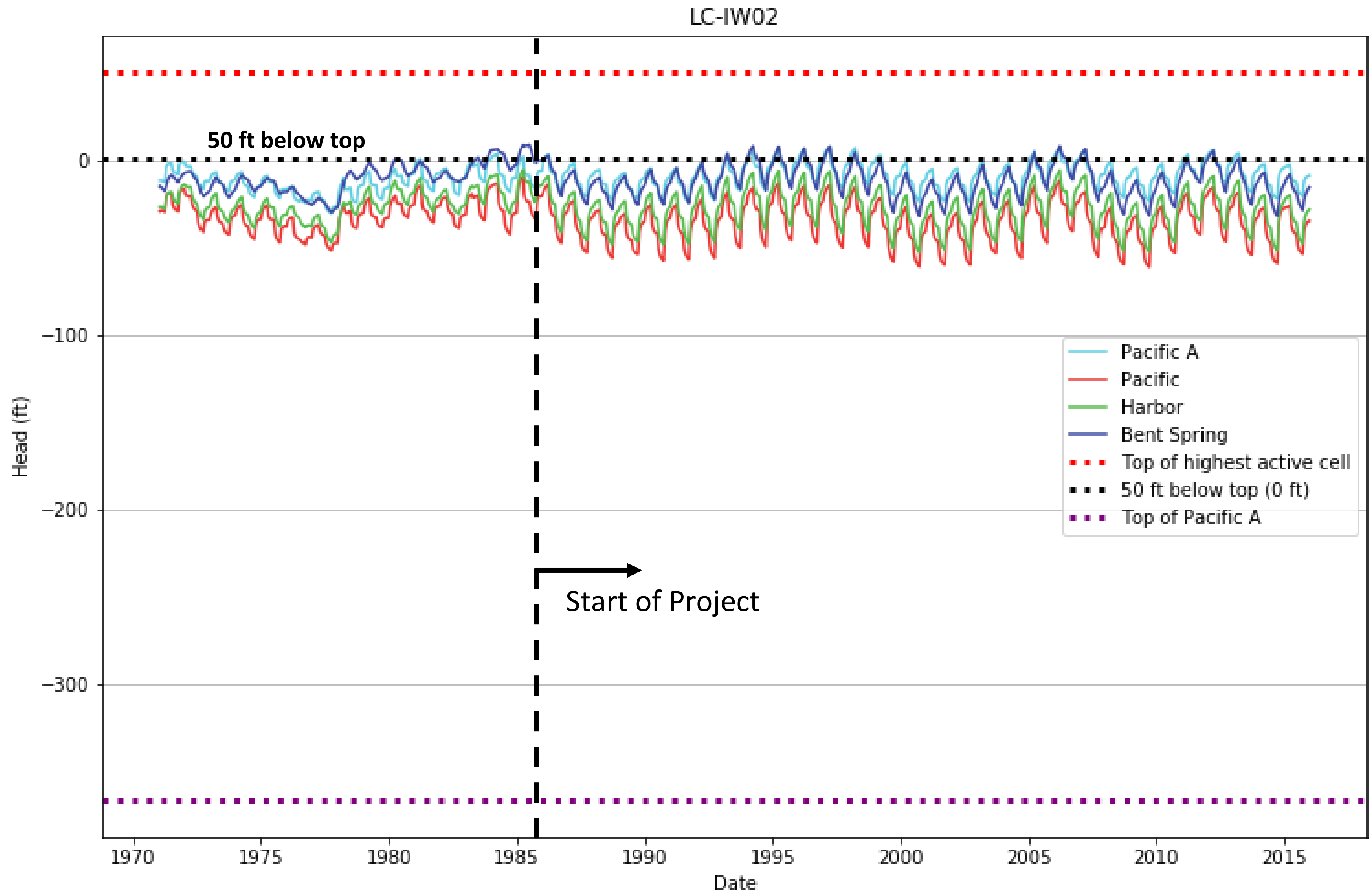
INTERA

Figure 3.5.4
Map of LC Augmentation Locations



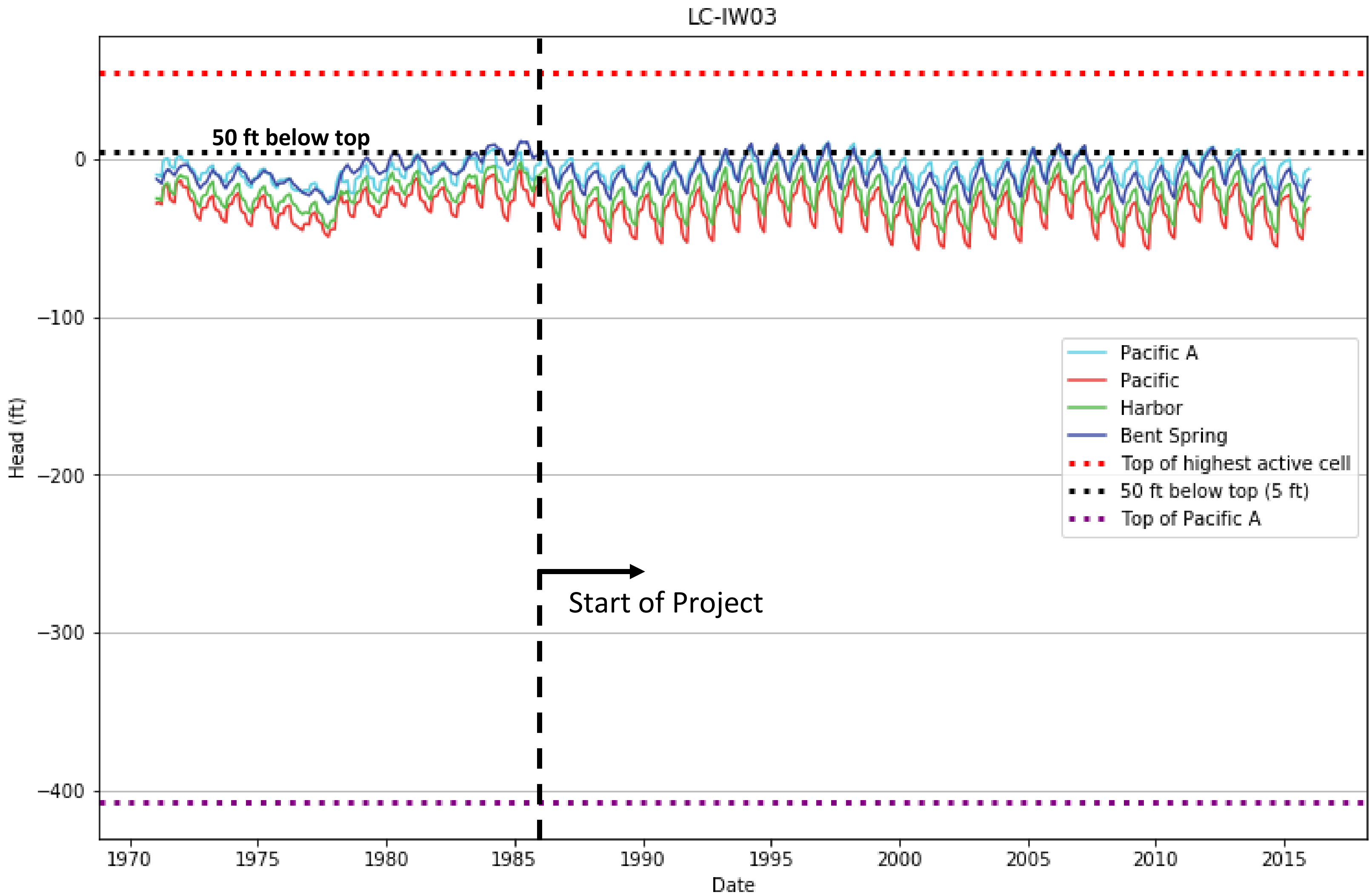
INTERA

Figure 3.5.5a
Hydrographs at LC-IW01 - LC Augmentation Scenario



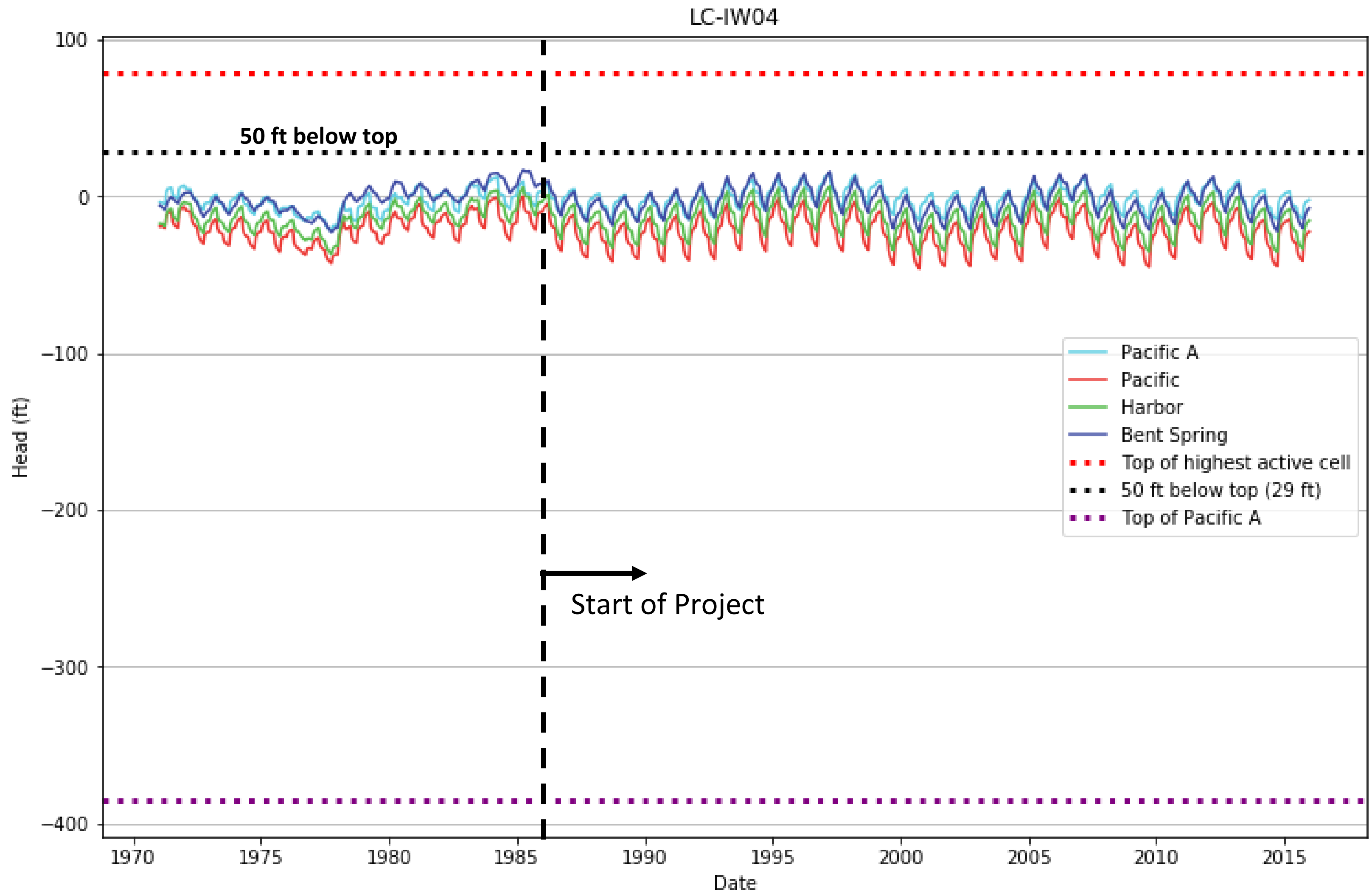
INTERA

Figure 3.5.5b
Hydrographs at LC-IW02 - LC Augmentation Scenario



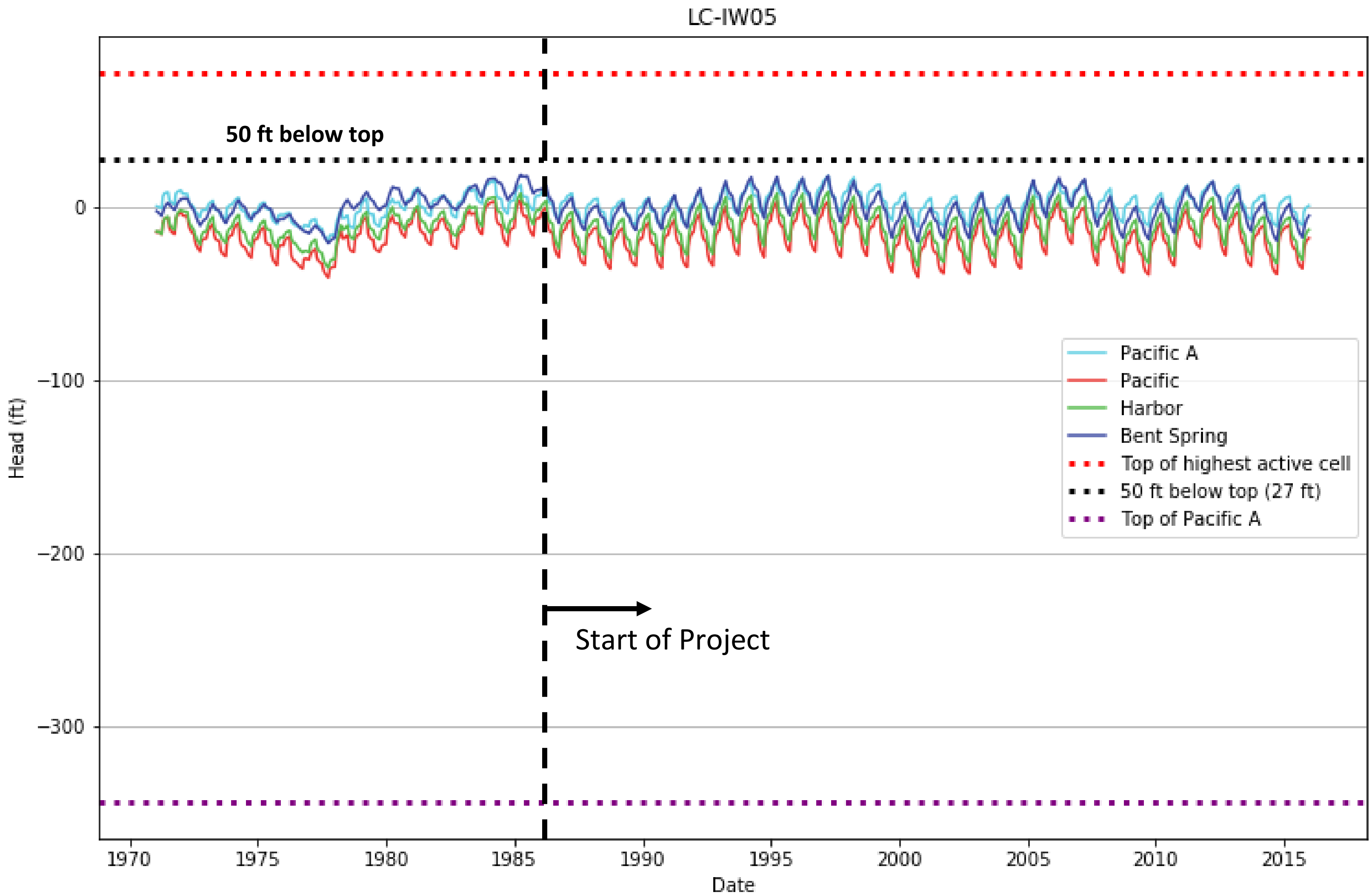
INTERA

Figure 3.5.5c
Hydrographs at LC-IW03 - LC Augmentation Scenario



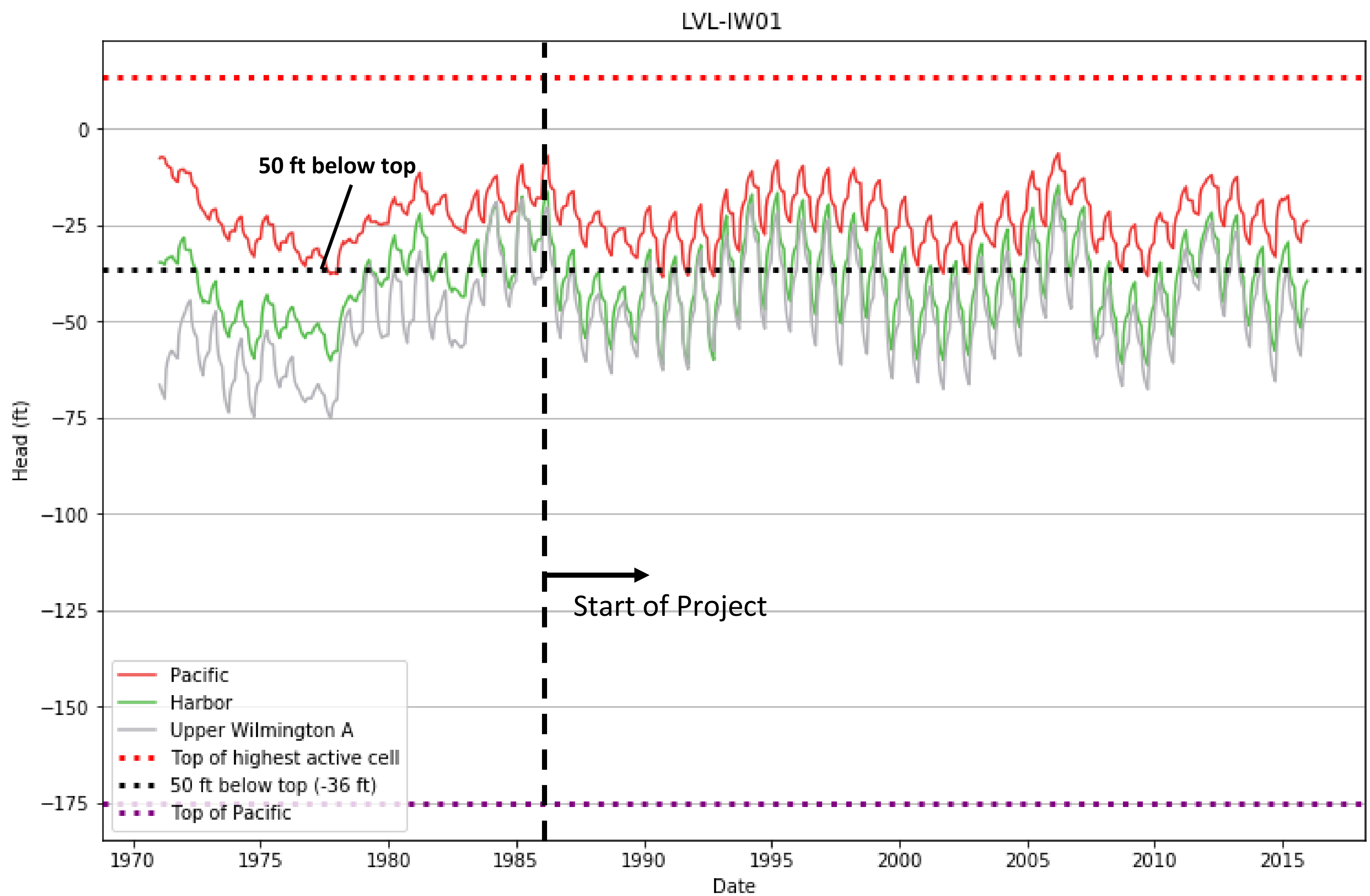
INTERA

Figure 3.5.5d
Hydrographs at LC-IW04 - LC Augmentation Scenario



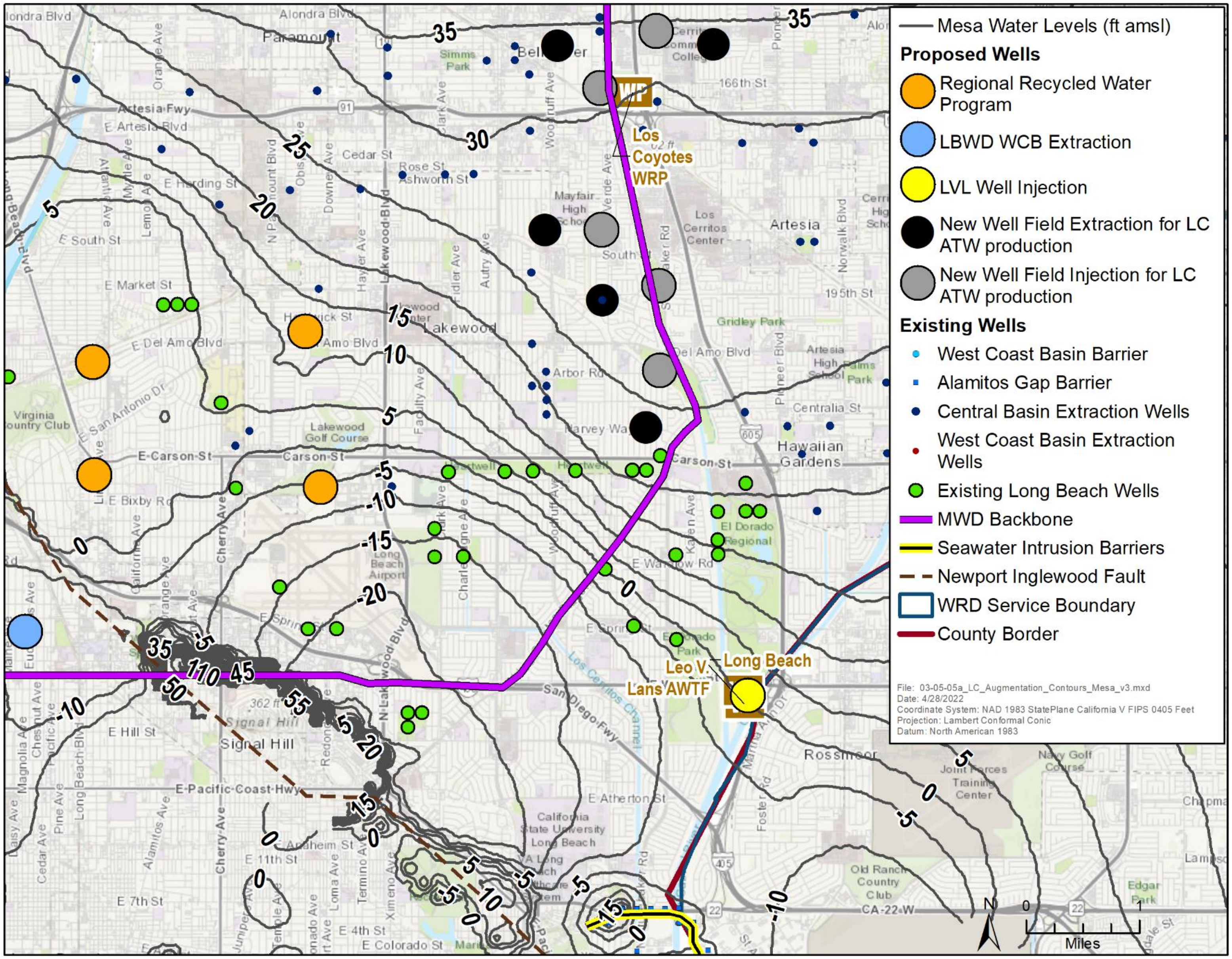
INTERA

Figure 3.5.5e
Hydrographs at LC-IW05 - LC Augmentation Scenario



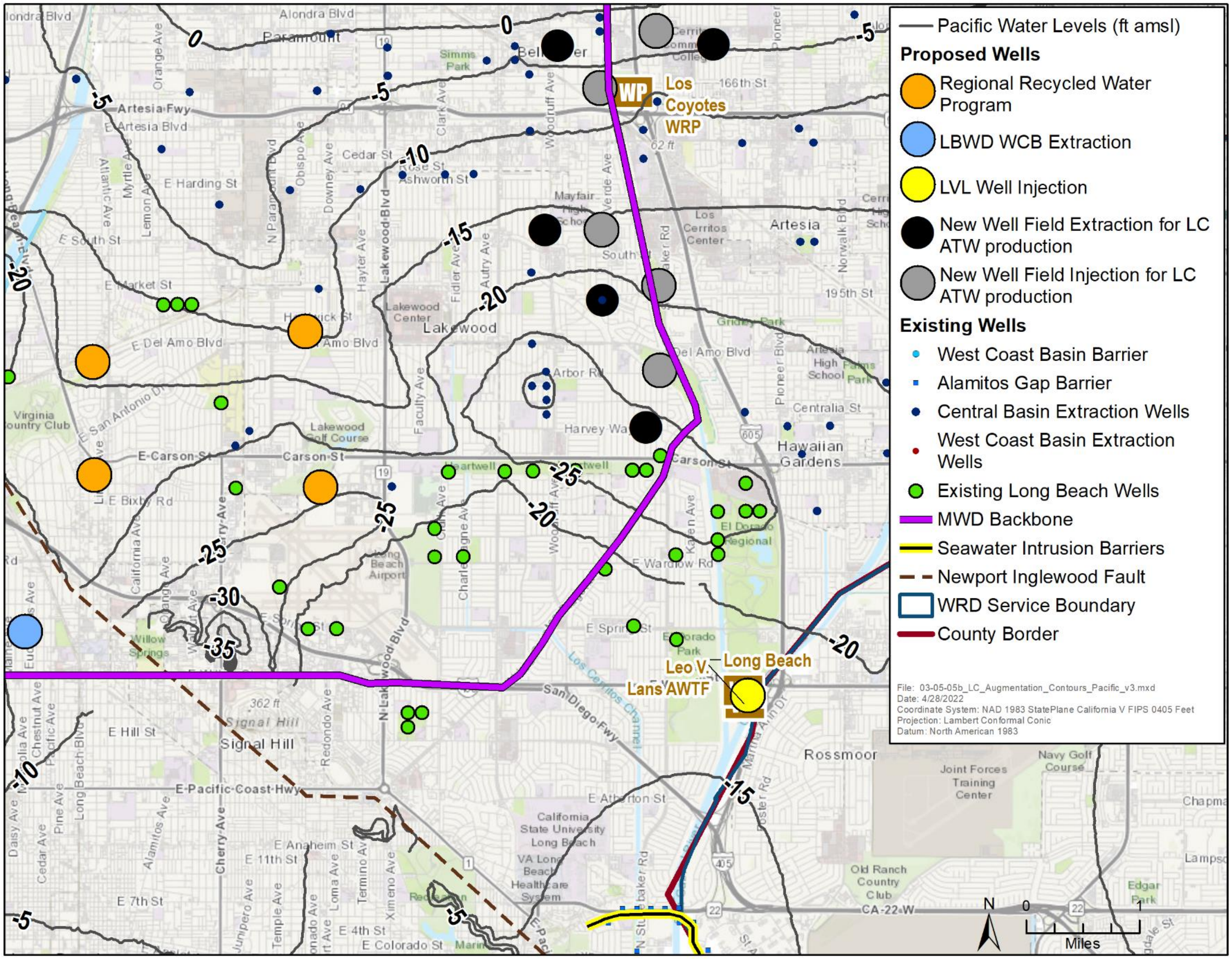
INTERA

Figure 3.5.5f
Hydrographs at LVL -IW01 - LC Augmentation Scenario



INTERA

Figure 3.5.6a
Contours of LC Augmentation (Mesa Sequence) - 1/1/2011



INTERA

Figure 3.5.6b
Contours of LC Augmentation (Pacific Sequence) - 1/1/2011

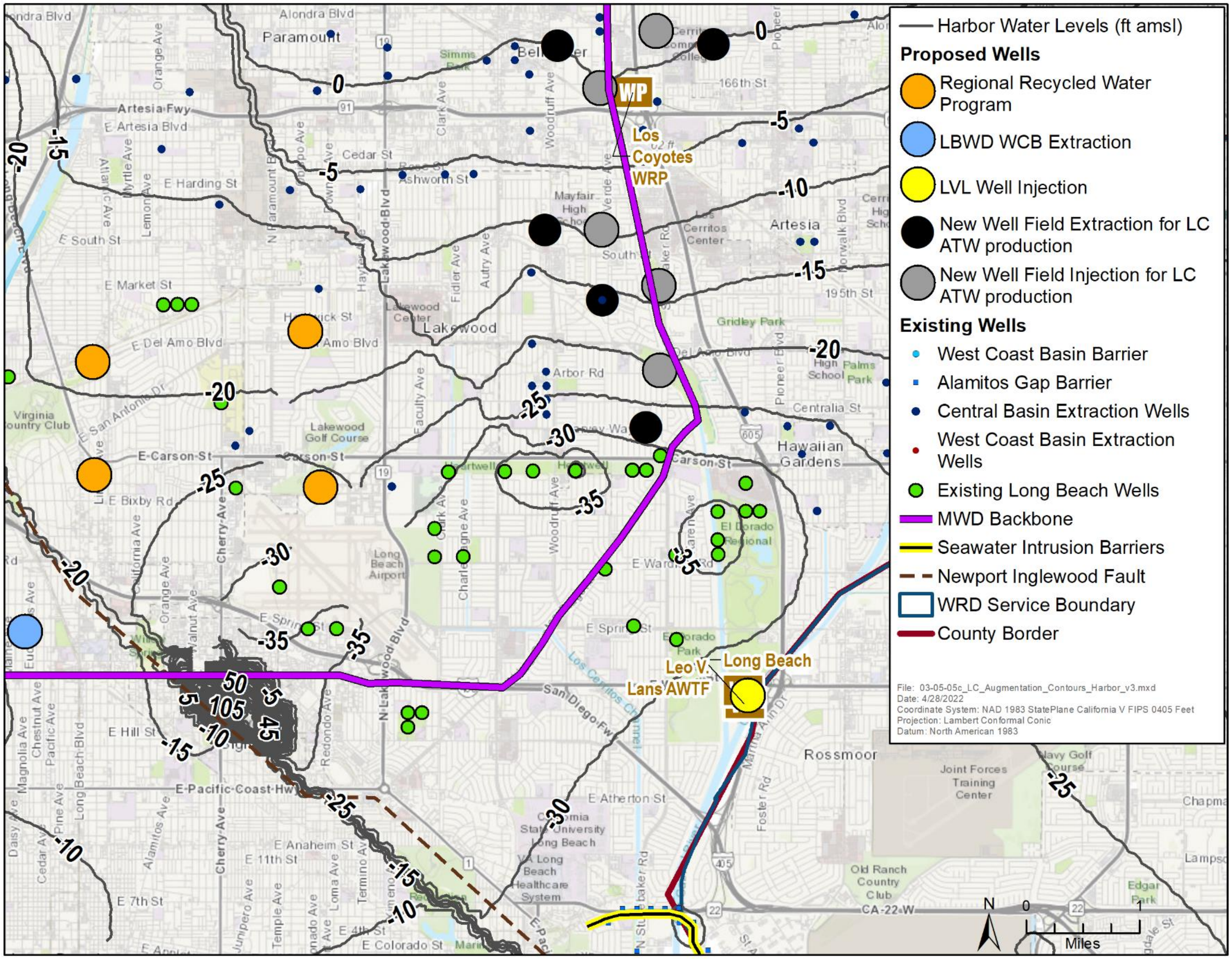
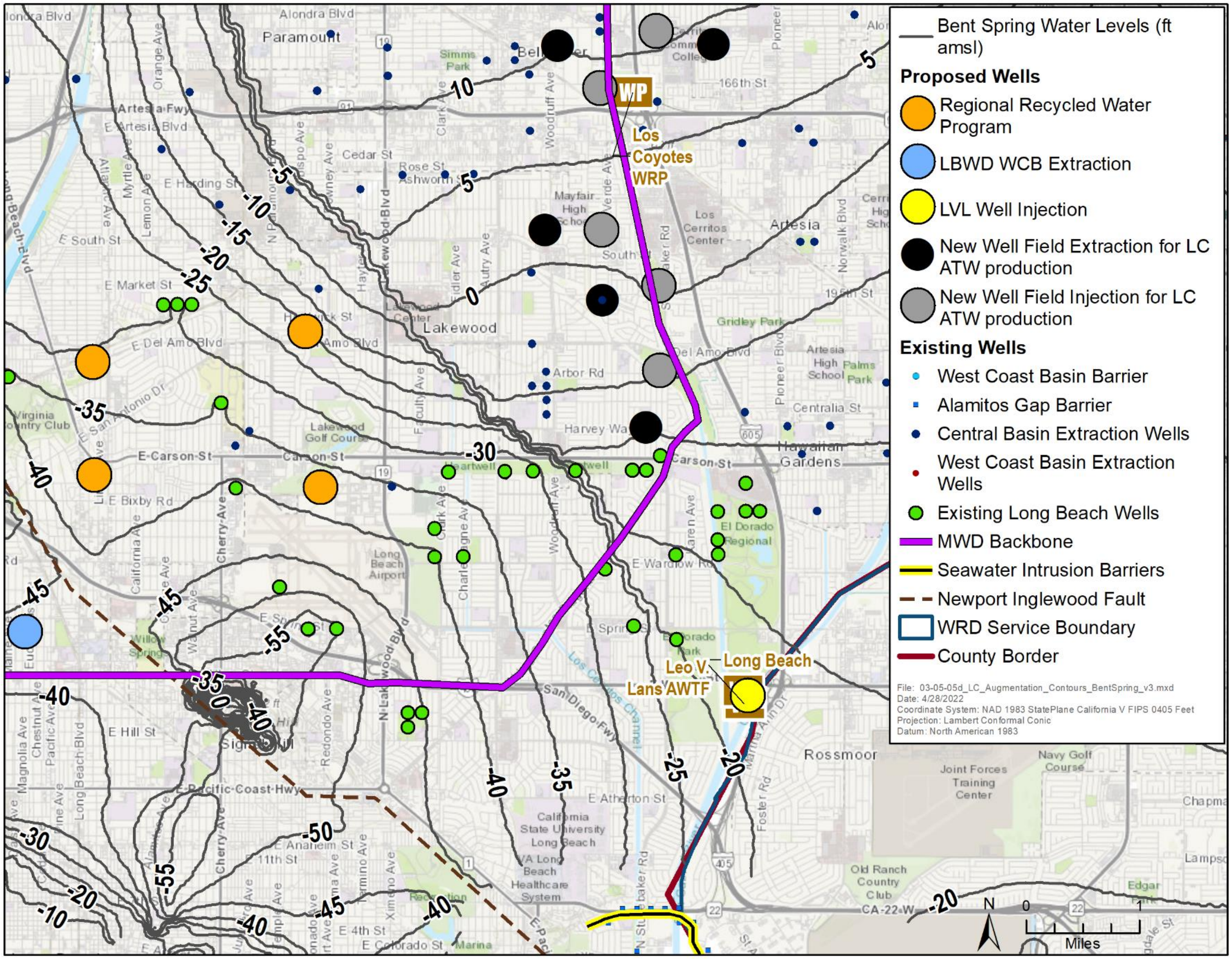
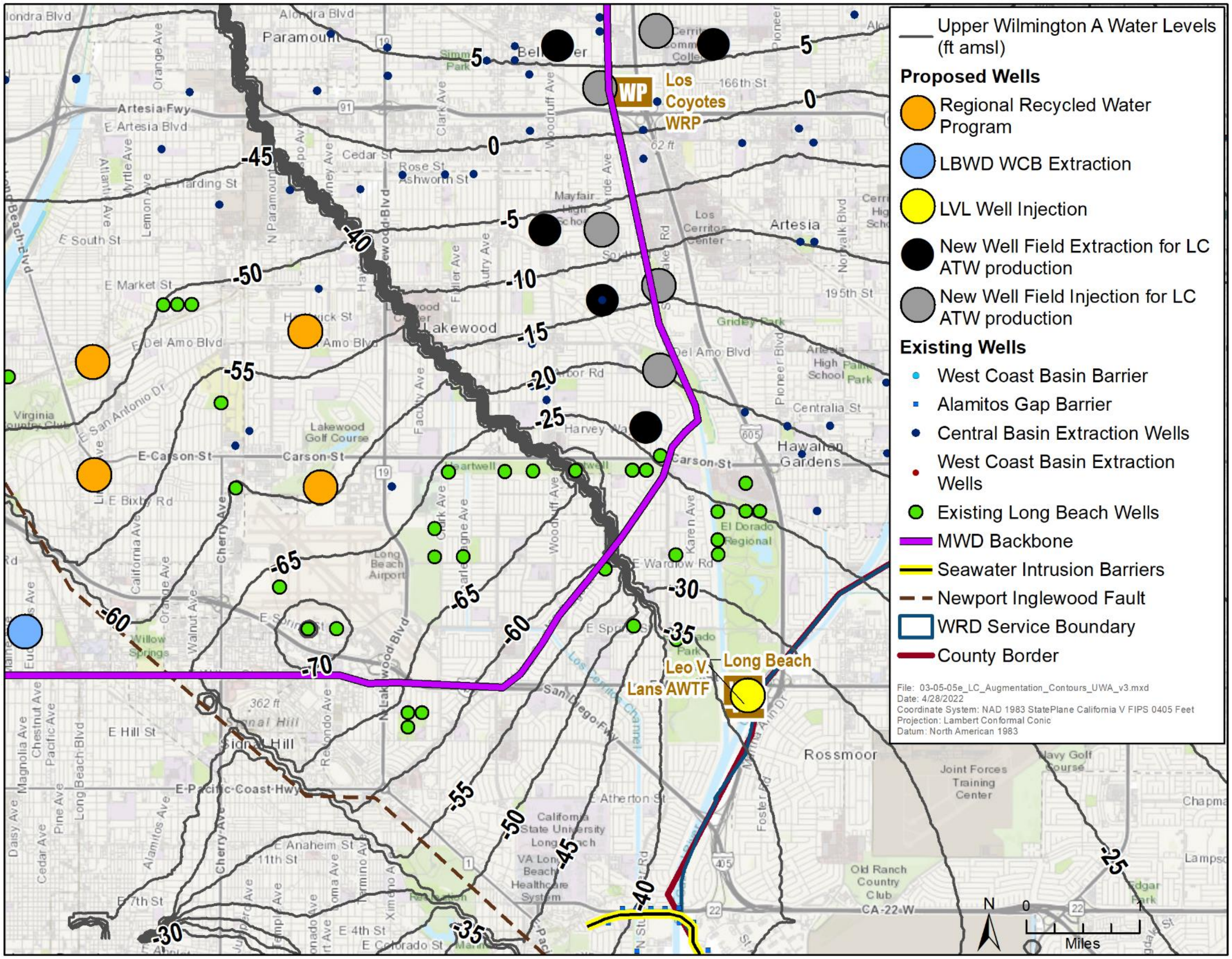


Figure 3.5.6c
Contours of LC Augmentation (Harbor Sequence) - 1/1/2011



INTERA

Figure 3.5.6d
Contours of LC Augmentation (Bent Spring Sequence) - 1/1/2011



INTERA

Figure 3.5.6e
Contours of LC Augmentation (Upper Wilmington A Sequence) - 1/1/2011

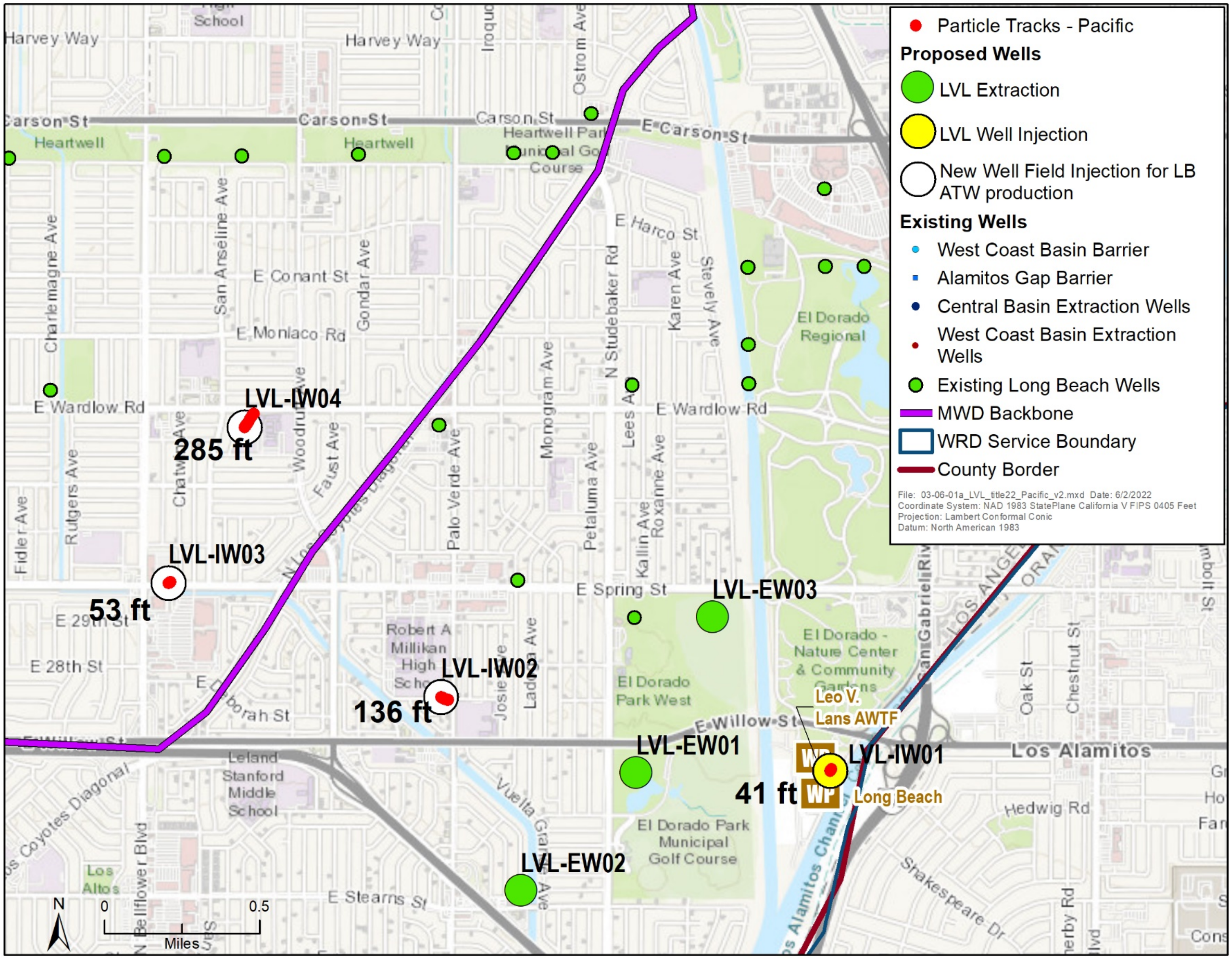
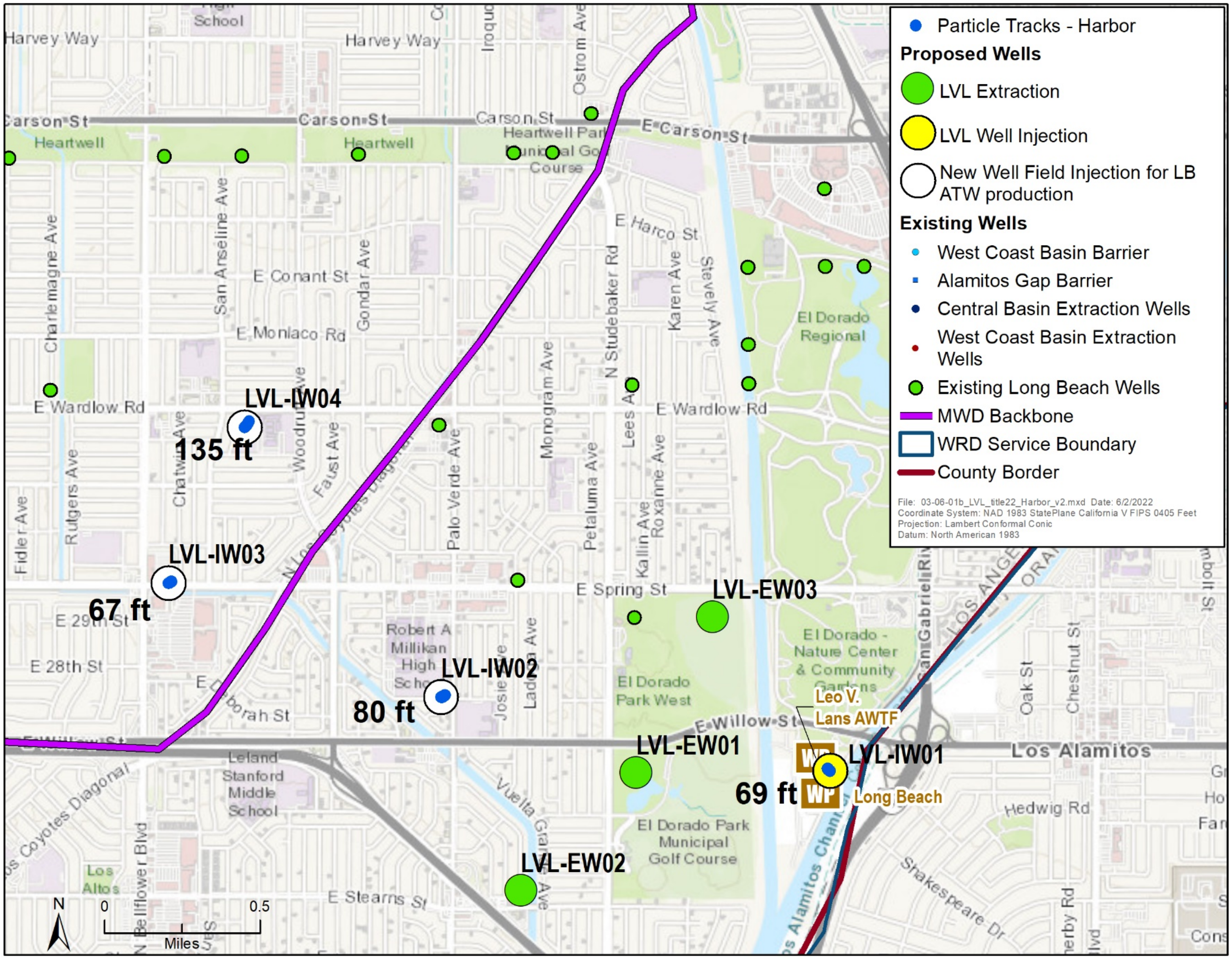


Figure 3.6.1a
LVL Augmentation Title 22 Results: Pacific Sequence



INTERA

Figure 3.6.1b
LVL Augmentation Title 22 Results: Harbor Sequence

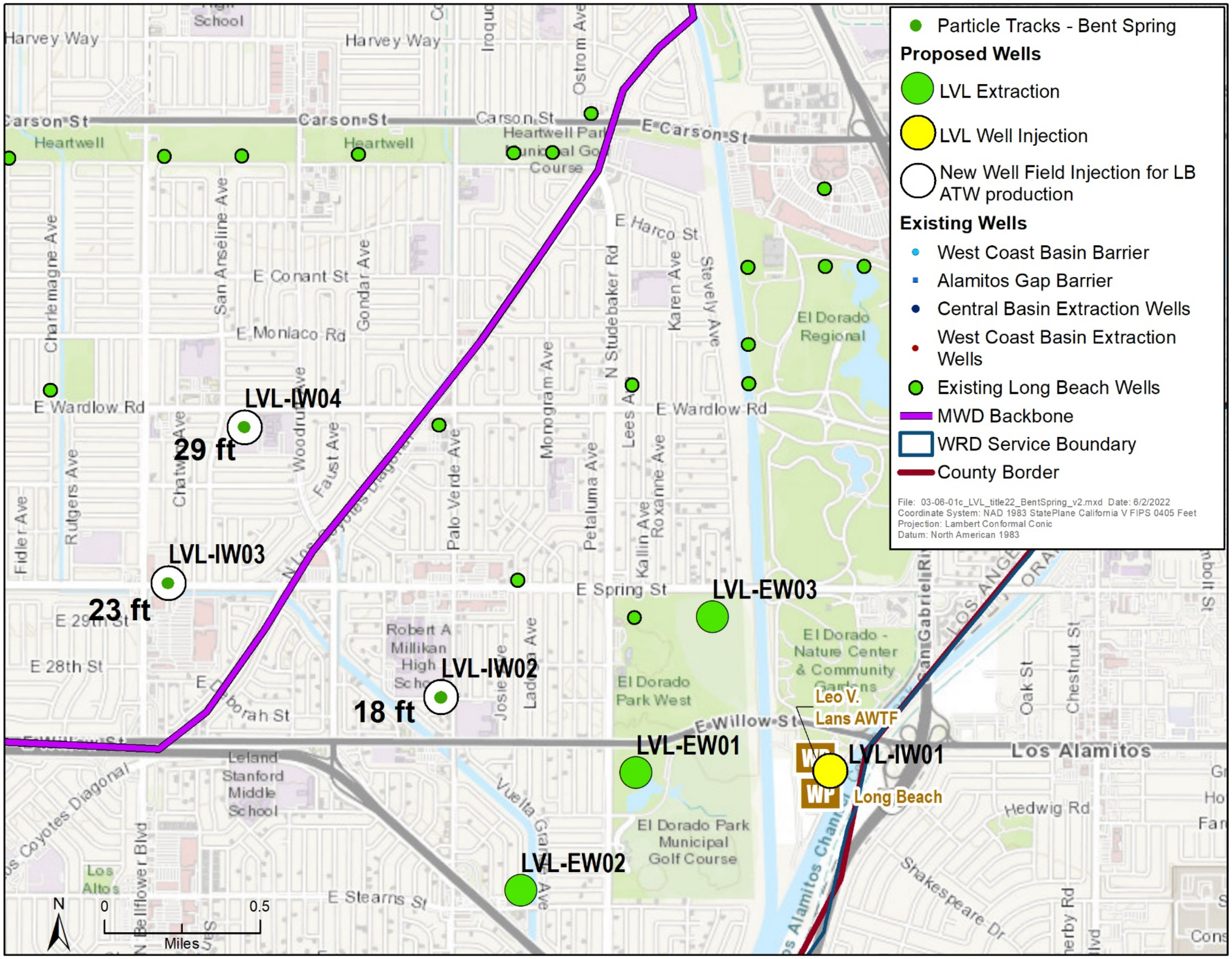
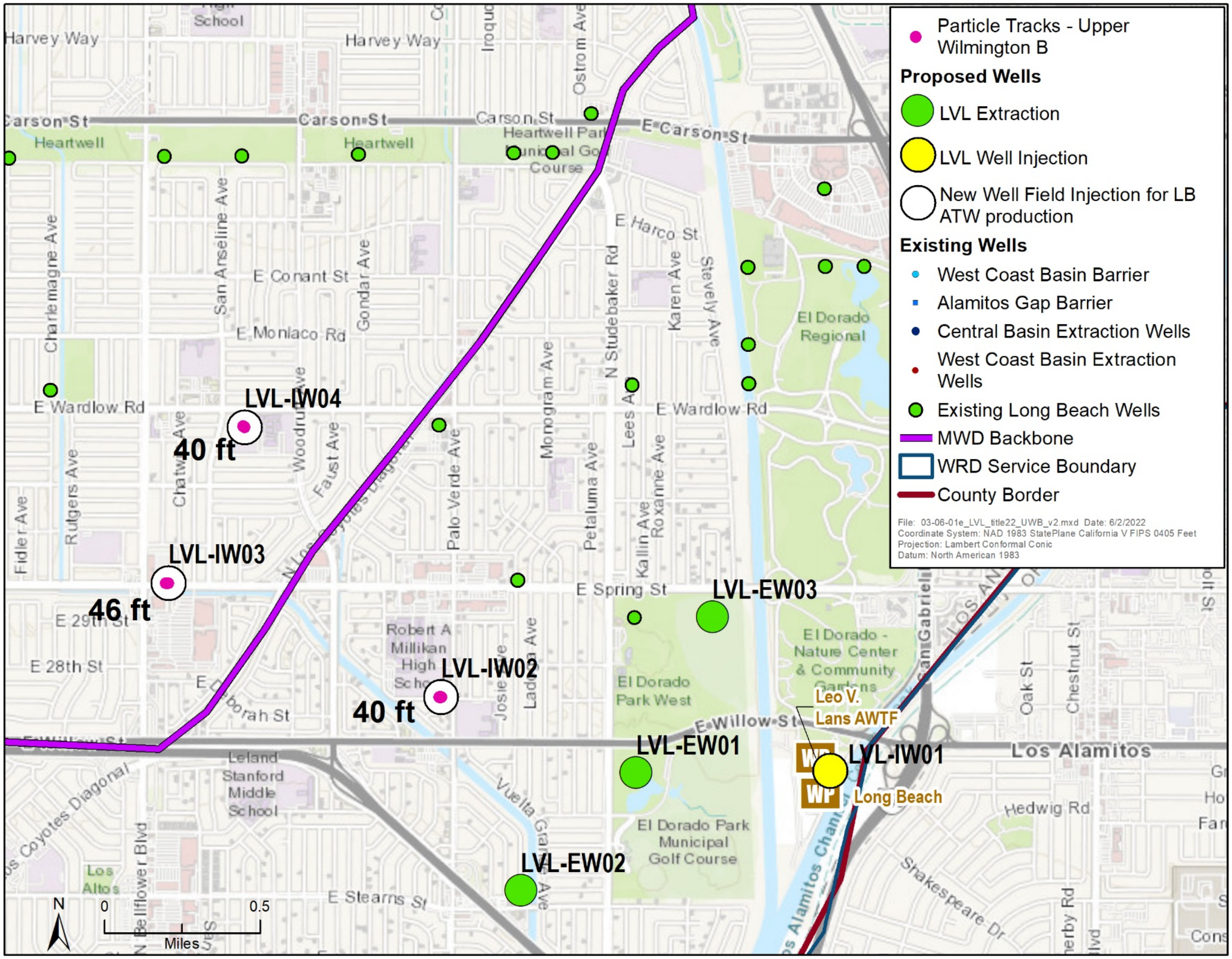


Figure 3.6.1c
LVL Augmentation Title 22 Results: Bent Spring Sequence

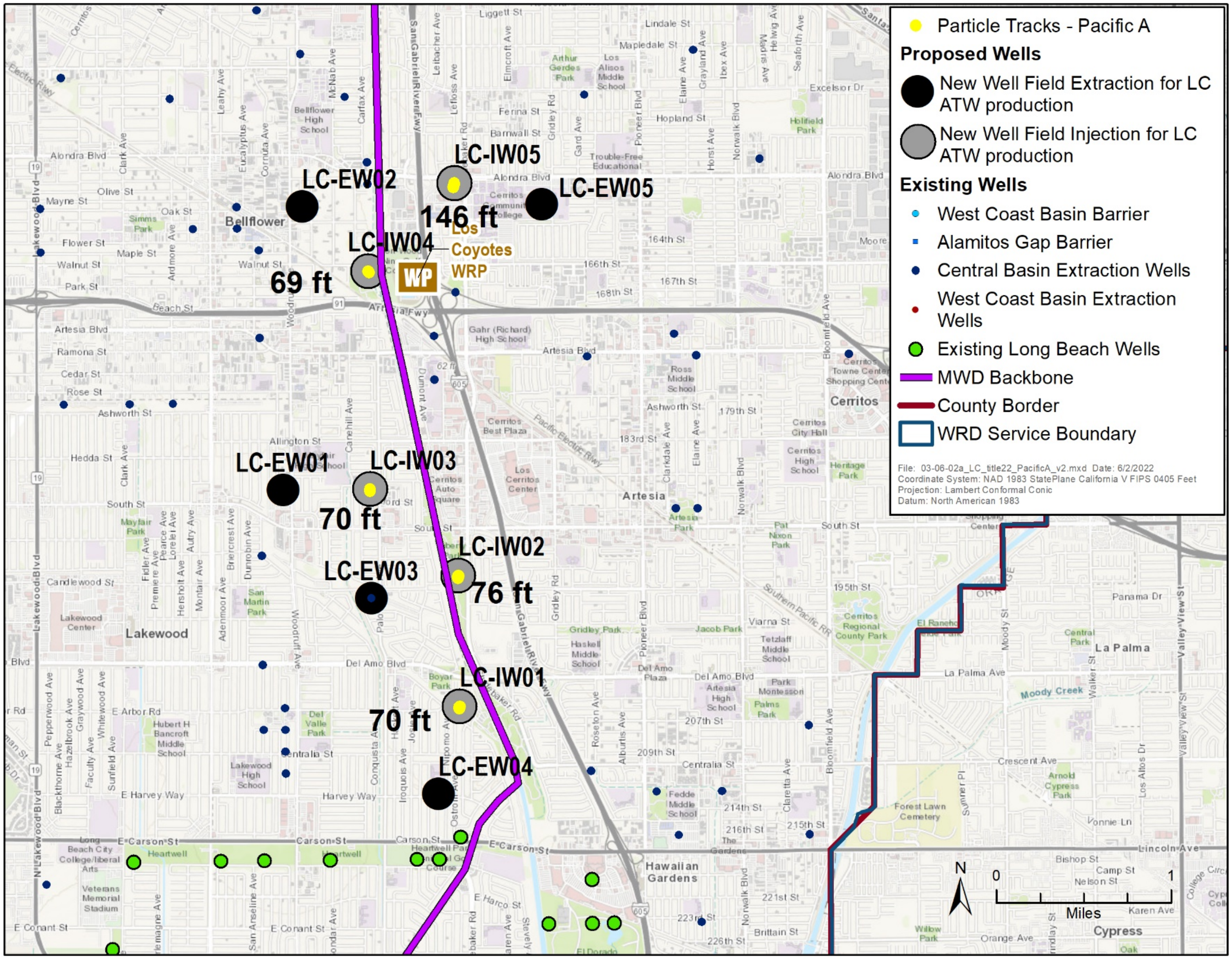
Figure 3.6.1d
LVL Augmentation Title 22 Results: Upper Wilmington A Sequence



INTERA

Figure 3.6.1e

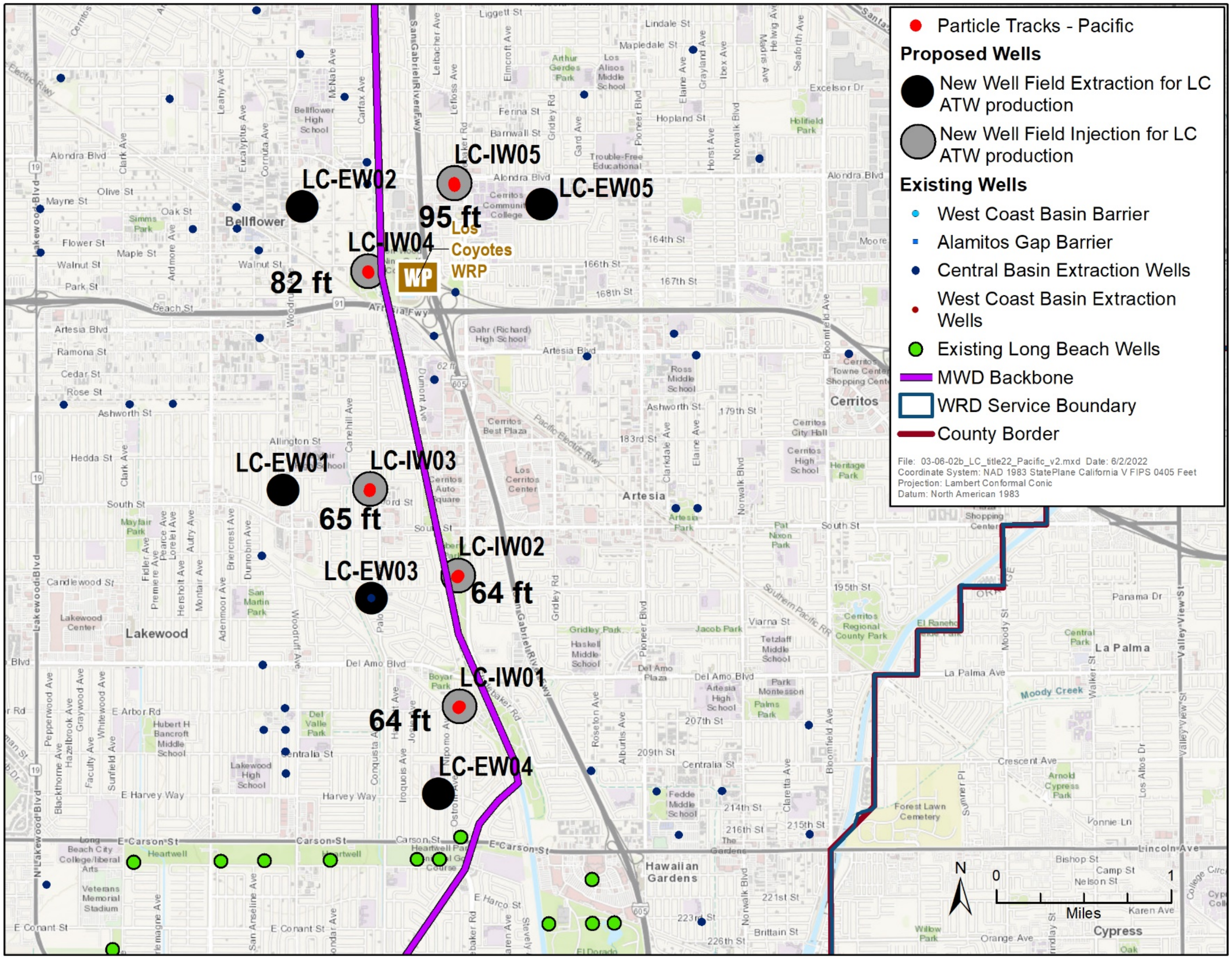
LVL Augmentation Title 22 Results: Upper Wilmington B Sequence



INTERA

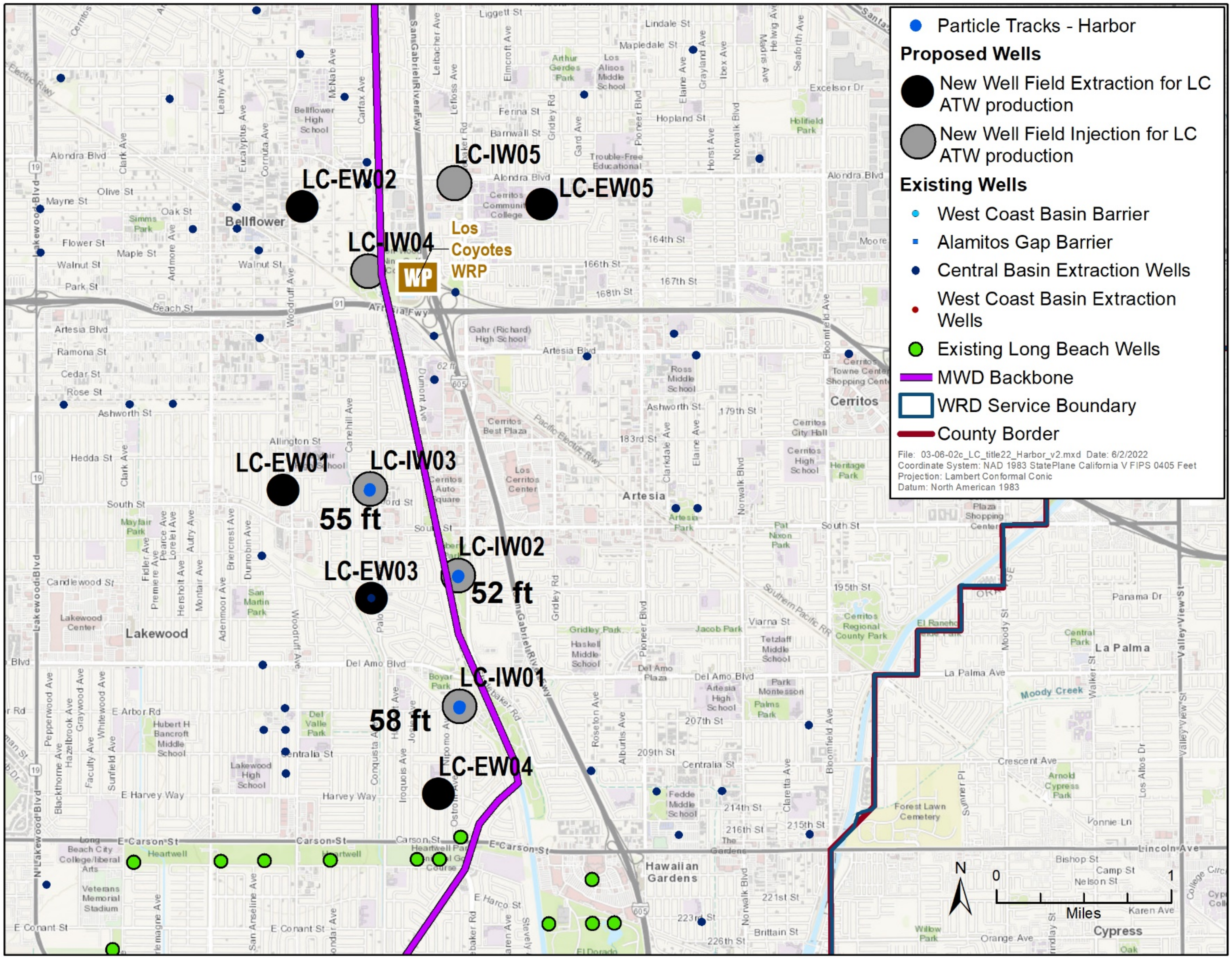
Figure 3.6.2a

LC Augmentation Title 22 Results: Pacific A Sequence



INTERA

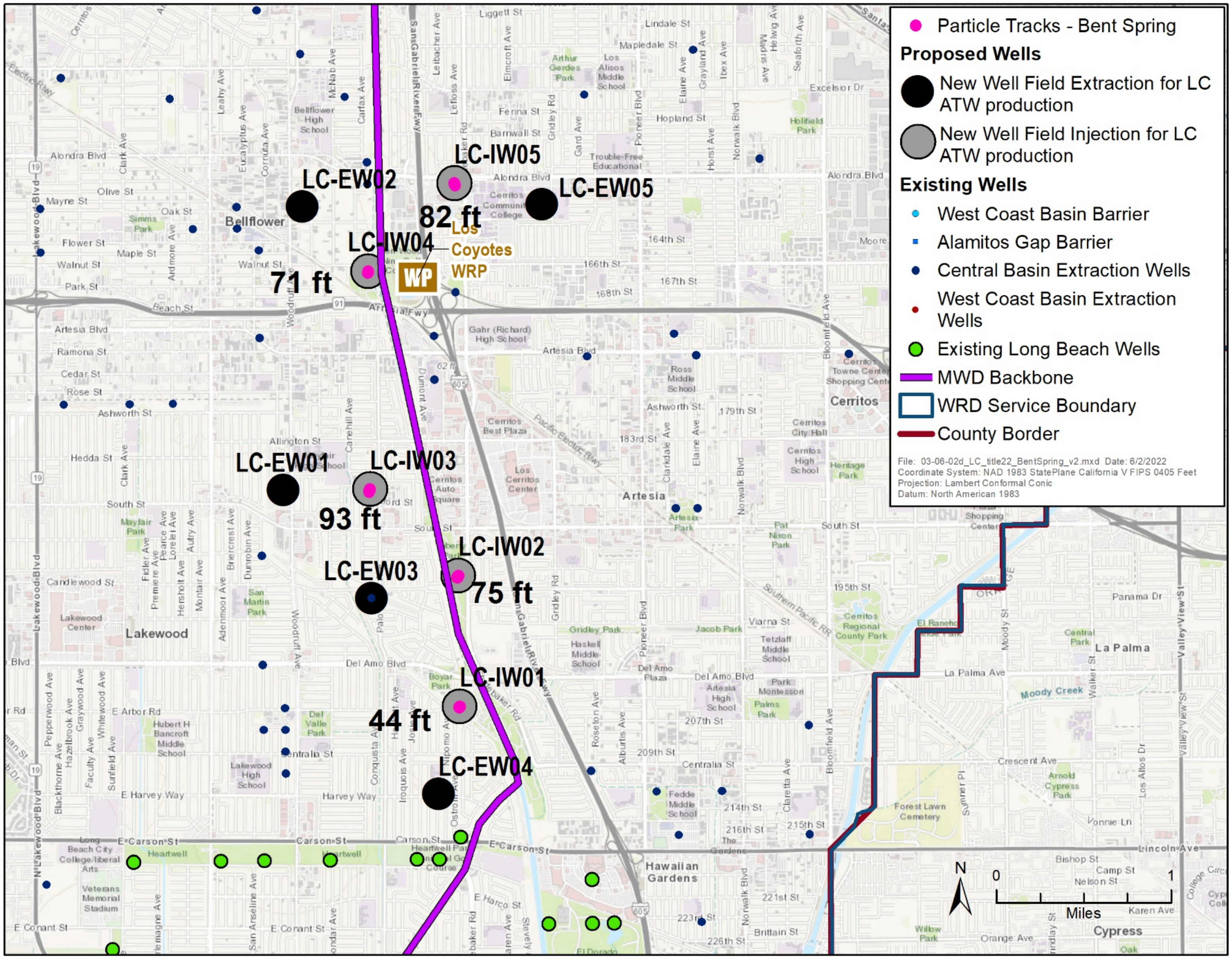
Figure 3.6.2b
LC Augmentation Title 22 Results: Pacific Sequence



INTERA

Figure 3.6.2c

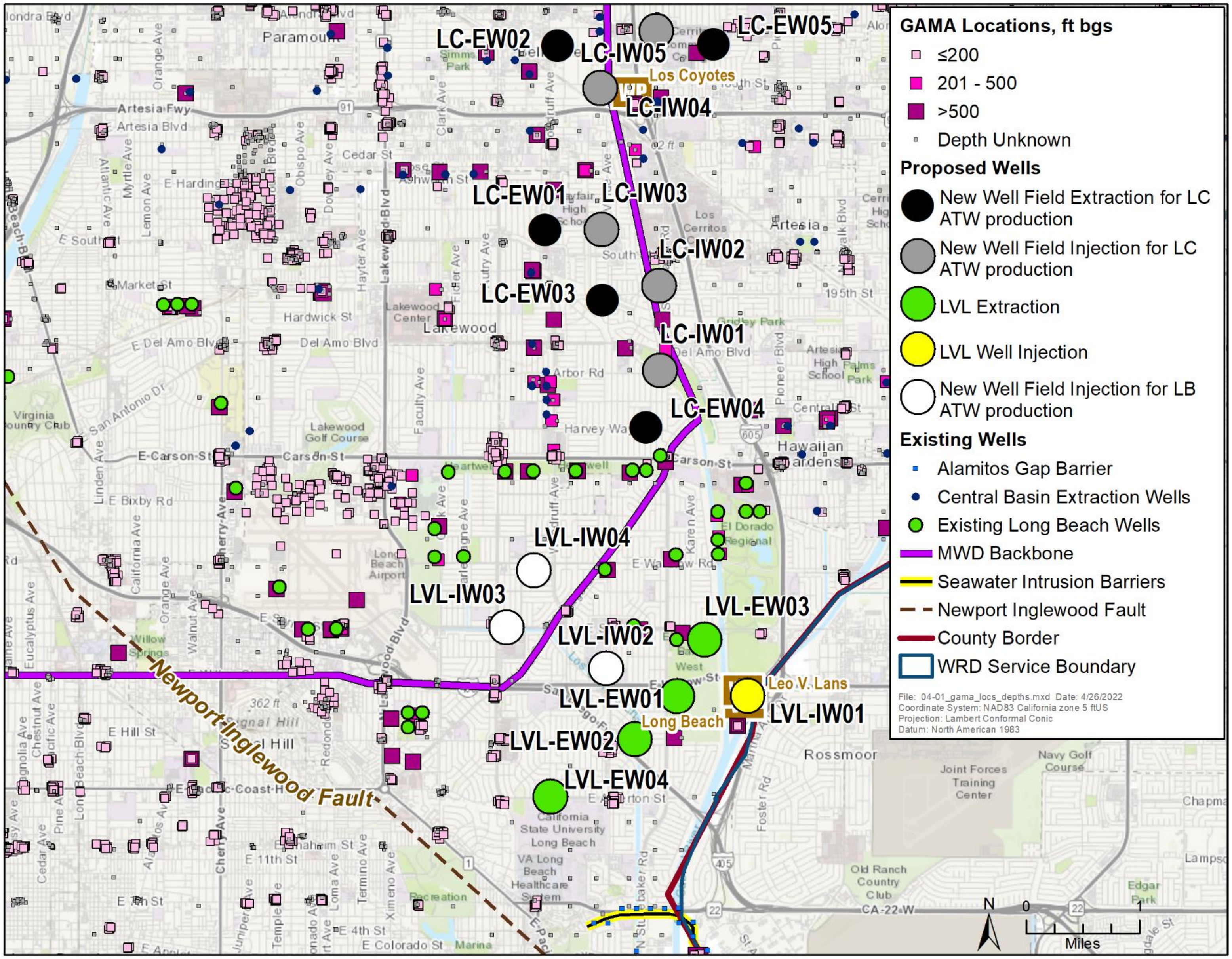
LC Augmentation Title 22 Results: Harbor Sequence



INTERA

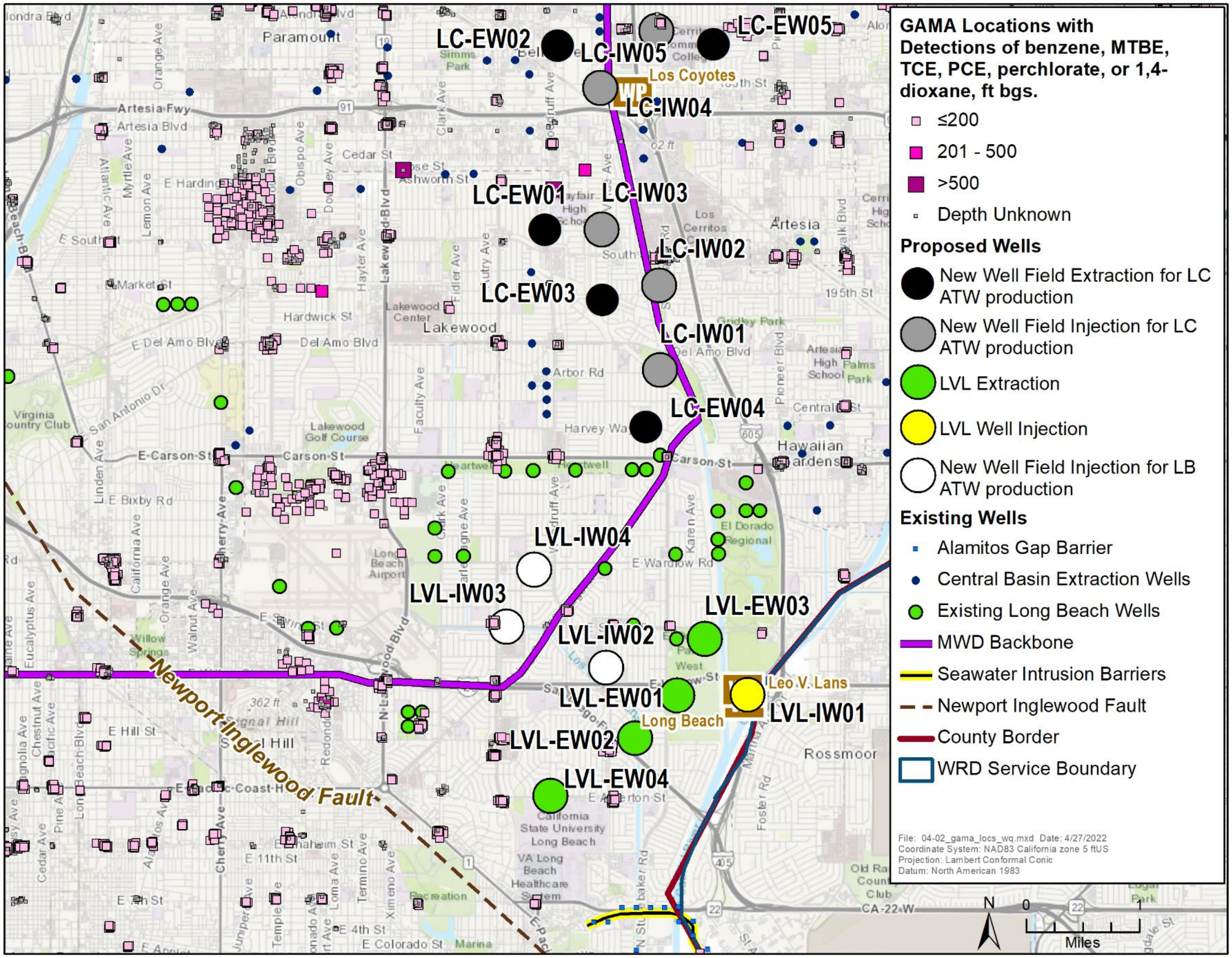
Figure 3.6.2d

LC Augmentation Title 22 Results: Bent Spring Sequence



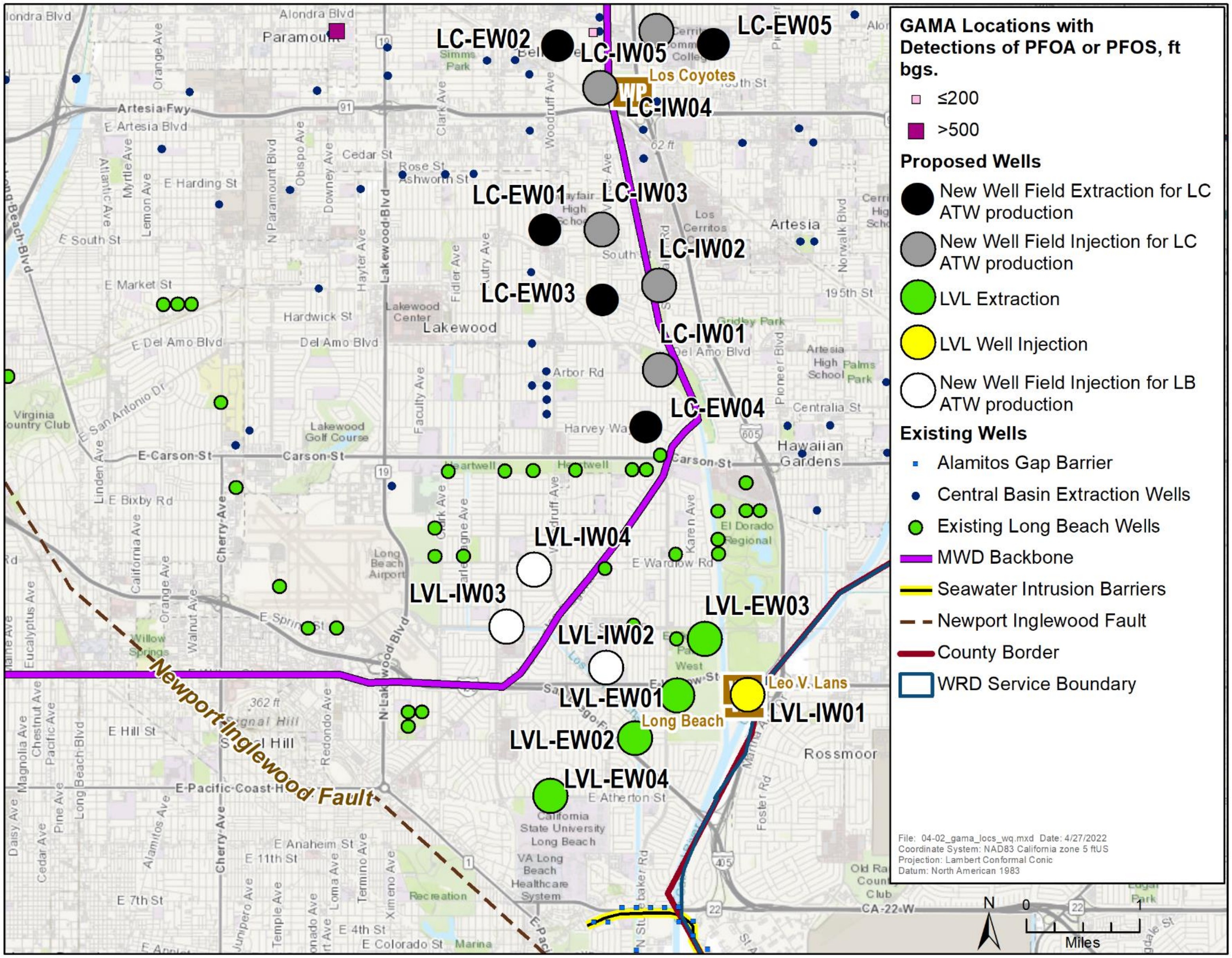
INTERA

Figure 4.1
GAMA Well Locations near LVL/LC Project Area



INTERA

Figure 4.2
GAMA Well Locations by Depth with Detections of Key Constituents of Concern



INTERA

Figure 4.3
GAMA Well Locations by Depth with Detections of PFOA or PFAS

Attachment 1
Modeling Scenarios

Hyperion Water Balance Model Scenarios
(TM 3.1 Basis of Project Development)

Modeling Scenarios

			Rights	Extraction				Replenishment					Storage	
			LADWP	Central Basin		West Coast Basin		Natural Recharge and Underflow	MAR	Hyperion	ARC	LC	Initial CB and WCB Storage	LADWP Maximum Storage Assumption
Scenario	Title	Notes (from original matrix)		LADWP	All Other Pumpers	All Pumpers	RBWRP							
Scenario 1	**Baseline - Historical plus RBWRP**	Baseline conditions	CB APA = 17,236 AFY WCB WR = 1,503 AFY Total = 18,739 AFY	Historical extraction, annual average 3,671 AFY	Historical extraction volume and monthly pattern from 1986-2015 (178,848 AFY average)	Historical extraction volume and monthly pattern from 1986-2015 (31,631 AFY average)	20,000 AFY, location and potential patterns to be provided by Jacobs (Jacobs to provide location of extraction wells - constant pumping assumed)	Historical recharge from 1986-2015 baseline hydrology	Historical recharge from 1986-2015 (MFB + Barriers + in-lieu); increase barrier recharge for RBWRP by 20,000 AFY (matching extraction rate)	Assume 50% (or 10,000 AFY) of the increased replenishment for RBWRP is from Hyperion, and the remaining 50% would be from another source	No ARC	No LC	Historical 1985 levels	CB APA =17,236 AFY maximum storage = 200% of APA (34,472 AFY) in CB
Scenario 2	**Scenario 1 + Initial WR Leasing in CB (LADWP) OR LADWP on the way to maximum target rights in CB**	LADWP begins acquiring additional rights (goal = 25,000 total) LADWP Leases 6,896 as needed	CB APA of 24,132= 17,236 (own)+6,896 (leased) WCB WR = 1,503 AFY Total = 25,635 AFY	LADWP 30-year demand monthly pattern (averaged to be 24,132 AFY); limit extraction to 140% of APA or to 40 cfs for 10 months	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1 + remaining Hyperion water to be sent to barriers and potentially to the LAAFP for flows in excess of LADWP's extractions in the CB	10,000 AFY	LC to provide up to 4,000 AFY to CB MAR	Same as Scenario1	CB APA = 24,132 AFY maximum storage = 200% of CB APA (48,264 AFY)
Scenario 3	**Scenario 1 + WCB WR Transfer to CB (LADWP) + WR Leasing (LADWP) OR LADWP at maximum target rights**	APA Transfer of 5,000 AFY to CB by LADWP LADWP now owns 25,000 rights total LADWP leases 7,500 rights	CB APA: 25,000 AFY (own) = 17,236 + 5,000 (transfer from WCB) + 2,764 (purchase) + 7,500 (lease) WCB WR = 0 (goes to zero because LADWP is buying and transferring rights from the WCB) Total = 32,500 AFY	LADWP 30-year demand monthly pattern (averaged to be 32,500 AFY); limit extraction to 140% of APA or to 90 cfs for 6 months	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	28,829 AFY (25.72 MGD) (due to LADWP increase in CB) (difference between 32,500 and 3,671 historical LADWP pumping). Any excess flow from Hyperion AWT will be sent to the LAAFP	Same as Scenario 2	Same as Scenario 2	Same as Scenario 1	CB APA = 25,000 AFY maximum storage = 200% of CB APA (50,000 AFY)
Scenario 3a	**Scenario 3 variation with change in LADWP's extraction schedule**	Same as Scenario 3	Same as Scenario 3	No extraction in December and January; 4 months at 40 cfs, and 6 months at 90 cfs	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 3	Same as Scenario 1	Same as Scenario 3
Scenario 4	**Scenario 3 + maximum APA extraction in CB (other pumpers) OR LADWP at maximum target rights plus full CB rights utilization**	Maximize APA in CB, WCB average pumping with RBWRP	Same as Scenario 3	Same as Scenario 3	Full APA extraction (189,867 AFY average)	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 3 + need additional recharge to satisfy increased CB extraction by other pumpers; LADWP's increase in extraction will be covered by Hyperion AWT, and other increases will be covered by WRD	Hyperion AWT will be used to cover LADWP's increase in extractions only; any excess flow from Hyperion AWT will be sent to the LAAFP	Same as Scenario 3	Same as Scenario 2	Same as Scenario 1	Same as Scenario 3
Scenario 5	**Scenario 4 + maximum WR extraction in WCB (other pumpers) OR LADWP at maximum target rights plus full CB and WCB rights utilization**	Replenishment calculation = [(WCB APA - 5000) + (CB APA + 5000)] - 20000	Same as Scenario 3	Same as Scenario 3	Same as Scenario 4	WCB full WRs 39,468 AFY= 64,468 AFY - 5,000 AFY (WCB-CB transfer) - 20,000 AFY (RBWRP)	Same as Scenario 1	Same as Scenario 1	Same as Scenario 4 + need additional recharge to satisfy increased WCB extraction by other pumpers	Hyperion AWT will be used to cover LADWP's increase in extractions only. Any excess flow from Hyperion AWT will be sent to the LAAFP	Same as Scenario 4	Same as Scenario 2	Same as Scenario 1	Same as Scenario 3
Scenario 6	**Scenario 5 + Ph 1 augmentation (LADWP) OR LADWP CB Augmentation Phase 1**	LADWP begins augmentation program in CB	Same as Scenario 3	LADWP 30-year demand monthly pattern (averaged to be 32,500 AFY); limit extraction to 140% of APA or to 90 cfs for 9 months + 12,500 AFY in same year as augmentation replenishment	Same as Scenario 5	Same as Scenario 5	Same as Scenario 1	Same as Scenario 1	Same as Scenario 5	Same as Scenario 3 + 12,500 AFY (11.15 MGD) as an augmentation project	Same as Scenario 5	Use up to 4,000 AFY from LC first, then Hyperion; model assumes that LC augmentation will be for WCB	Same as Scenario 1	Same as Scenario 3
Scenario 7	**Scenario 5 + Ph 2 augmentation (LADWP) OR LADWP CB Augmentation Phase 2**	LADWP begins augmentation program in CB	Same as Scenario 3	LADWP 30-year demand monthly pattern (averaged to be 32,500 AFY); limit extraction to 140% of APA or to 90 cfs for 12 months + 30,000 AFY in same year as augmentation replenishment	Same as Scenario 5	Same as Scenario 5	Same as Scenario 1	Same as Scenario 1	Same as Scenario 5	Same as Scenario 6 + 17,500 AFY (15.6 MGD) as augmentation project	Same as Scenario 6	Same as Scenario 6	Same as Scenario 1	Same as Scenario 3

Notes:

% = percent

AFY = acre-foot (feet) per year

APA = Allowed Pumping Allocation

AR = Adjudicated Right

ARC = Albert Robles Center for Water Recycling and Environmental Learning

AWT = Advanced Water Treatment

CB = Central Basin

cfs = cubic foot (feet) per second

GW = groundwater

LAAFP = Los Angeles Aqueduct Filtration Plant

LADWP = Los Angeles Department of Water and Power

LC = Los Coyotes

MAR = Managed Aquifer Recharge

MFB = Montebello Forebay

MGD = million gallons per day

Ph = phase

RBWRP = Regional Brackish Water Reclamation Program

WB = water balance

WCB = West Coast Basin

WR = Water Right

WRD = Replenishment District of Southern California