Focused Remedial Investigation/Feasibility Study Work Plan

City of Pasadena's Sunset Reservoir Site
Pasadena, California

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Prepared for:

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Acronym List

Acronym	Definition
1,2,3-TCP	1,2,3-Trichloropropane
AF	Acre-Feet
AFY	Acre-Feet per Year
ARAR	Applicable or Relevant and Appropriate Requirements
bgs	Below Ground Surface
c-1,2-DCE	Cis-1,2-dichloroethylene
Caltech	California Institute of Technology
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	Cubic Feet Per Second
COC	Contaminant of Concern
CSM	Conceptual Site Model
DTSC	Department of Toxic Substances Control
EIR	Environmental Impact Report
ESI	Expanded Site Investigation
FFA	Federal Facilities Agreement
FS	Feasibility Study
gpm	Gallons Per Minute
IRP	Integrated Resources Plan
JPL	Jet Propulsion Laboratory
LAWC	Lincoln Avenue Water Company
LGAC	Liquid-Phase Granular Activated Carbon
MCL	Maximum Contaminant Level
MG	Million Gallons
MHTS	Monk Hill Treatment System
MSL	Mean Sea Level
MWD	Metropolitan Water District of Southern California
NASA	National Aeronautics and Space Administration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ng/L	Nanograms Per Liter
NPL	National Priorities List
OU	Operational Unit
PA	Preliminary Assessment
PCE	Tetrachloroethylene

Acronym	Definition
PRG	Preliminary Remediation Goal
PWP	Pasadena Water and Power
RAO	Remedial Action Objective
RBMB	Raymond Basin Management Board
RI	Remedial Investigation
RO	Remedial Objective
ROD	Record of Decision
RWQCB	Regional Water Quality Control Board
SI	Site Investigation
SWRCB-DDW	State Water Resources Control Borad-Division of Drinking Water
TCE	Trichloroethylene
µg/L	Micrograms Per Liter
EPA	United States Environmental Protection Agency

1. Introduction

This Focused Remedial Investigation/Feasibility Study Work Plan (Focused RI/FS Work Plan) for the City of Pasadena's Sunset Reservoir site has been prepared by Roux Associates, Inc. (Roux), on behalf of the City of Pasadena/Pasadena Department of Water and Power (PWP). The purpose of the work plan is to set forth a scope of work designed to supplement the Remedial Investigation/Feasibility Study (RI/FS) previously conducted for the National Aeronautical and Space Administration (NASA) Jet Propulsion Laboratory (JPL) Superfund Site. The RI/FS for the JL Superfund Site, completed in 2000, focused on the JPL facility and nearby off-facility groundwater impacts and did not address the groundwater quality impacts found at and near the Sunset Reservoir site. Available data developed during and after the JPL RI/FS indicate that the JPL facility is a potential contributor to groundwater impacts at and near the Sunset Reservoir site.

The Focused RI/FS for the Sunset Reservoir site will include an RI component and an FS component. The RI component will include the assembling and evaluation of available information relevant to groundwater contamination in the vicinity of the JPL facility and the Sunset Reservoir site, for the purpose of determining whether and to what extent contamination arising from the JPL facility is present at and in the vicinity of the Sunset Reservoir site. The FS component will identify and evaluate remedial alternatives to mitigate the water quality impacts at and near the Sunset Reservoir site, focusing specifically on ex-situ groundwater treatment remedies which will allow more flexible use of groundwater as a potable water supply (given the current situation requiring a blending strategy and consideration of multiple water supply challenges) until aquifer restoration is completed by others.

The remainder of this Focused RI/FS Work Plan is organized as follows:

Section 2: Background;

Section 3: Preliminary Identification of RAOs, PRGs, and ARARs;

Section 4: Focused RI Work Plan;

Section 5: Focused FS Work Plan; and

Section 6: References

2. Background

General descriptions and histories are provided below for both the Sunset Reservoir site (Section 2.1.1) and the JPL facility (Section 2.1.2), and the physical setting of both are described in Section 2.2. Selected previous investigations are summarized chronologically in Section 2.3 to provide a summary of relevant aspects of the JPL Superfund Site.[1] Section 2.4 describes the groundwater supply system at the Sunset Reservoir site in greater detail and includes key operational procedures which may be relevant to the FS.

2.1 Descriptions and Histories

2.1.1 Sunset Reservoir Site

PWP-owns and operates the Sunset Reservoir site, which is located at the corner of Sunset Avenue and West Mountain Street in the northwest part of Pasadena (see Figure 1) and consists of two partially buried, aboveground reservoirs with a total capacity of 15.5 million gallons (MG),[2] two water supply wells (Bangham Well and Sunset Well), a turnout (P-01) for water imported from Metropolitan Water District of Southern California (MWD), a disinfection facility, and the Glorieta Pump Station (see Figure 2). A third water supply well (the Parke Well) is located approximately 3/4 miles southeast of the Sunset Reservoir site and is connected to the reservoir site through a series of mains. Collectively, these three wells (Bangham, Sunset and Parke) are referred to as "the Sunset wells."[3] Because nitrate, perchlorate, volatile organic compounds (VOCs), and 1,2,3-trichloropropane (1,2,3-TCP) are present in groundwater from the Sunset wells, it is blended with water imported from the MWD in Sunset Reservoir 2, and then the blended water is distributed to PWP's Sunset Pressure Zone and other areas of the PWP distribution system. Prior to 2020, blending occurred in both reservoirs (units 1 and 2), but due to the condition of unit 1, it was taken out of service in 2020. The Sunset Reservoirs were originally constructed in the late 1800s and early 1900s as earthen structures lined with concrete. In the 1930s, 4-foot-high concrete walls were added to increase capacity (Kennedy Jenks 2021; Helix 2025; PWP 2025a).

PWP is currently in the final design phase of a plan to replace the aging Sunset reservoirs with two circular, prestressed wire wrap concrete reservoirs with a capacity of 11 MG. The plan also includes a groundwater treatment facility due to the presence of contamination in the groundwater extracted by the Sunset wells. The new reservoirs, treatment and disinfection facilities, and new supporting infrastructure make up the proposed Sunset Complex Project. The system improvements will allow PWP to continue to provide reliable and clean drinking water. The location of the proposed facilities will remain generally the same as the current facilities. Proposed reservoir capacities are 4.9 MG (Reservoir #1) and 6.1 MG (Reservoir #2). Proposed treatment facilities include ion exchange (IX) and liquid-phase granular activated carbon (LGAC) for contaminant removal, and disinfection equipment. The initial phase for the treatment chain is 1,500 gallons per minute (gpm). A buildout phase will be incorporated into the design, which will add an additional 3,000 gpm (4,500 gpm total) of treatment capacity. In the construction phase of the project, supporting

[1] It is important to note that the reports referenced in Section 2.3 are not all-inclusive and were selected as key documents to provide a general history.

[2] Sunset Reservoir 1 has a capacity of 5.6 MG and Sunset Reservoir 2 has a capacity of 9.9 MG.

[3] Previously, there were five Sunset wells: the Bangham, Sunset, Garfield, Villa, and Copelin wells. The Garfield Well was deactivated in 2018 and subsequently destroyed in 2020; it was replaced by the Parke well in 2025. The Villa well, located nearby, was also deactivated in 2018 but has not been destroyed. The Copelin well, which was located on City of Pasadena property adjacent to the Sunset Reservoir site, was deactivated in 2018 and destroyed in 2020. All three former Sunset wells (Garfield, Villa, and Copelin) exhibited some form of chemical contamination prior to their deactivation. Their locations are shown in Figure 2.

infrastructure, such as the concrete foundation, buried pipeline, power conduits and wiring, etc., will be installed for future treatment capacity. Space is also provided for a future nitrate treatment system.

2.1.2 JPL Facility

The JPL facility is located on the border of northwestern Pasadena and La Cañada Flintridge (see Figure 1). It is a federally funded research and development center owned and sponsored by NASA and administered and managed by California Institute of Technology (Caltech). Rocketry research experiments began in the Arroyo Seco creek bed in 1936 led by a professor and students from Caltech as part of the Guggenheim Aeronautics Laboratory at Caltech (GALCIT). The GALCIT rocketry program evolved into the JPL facility as it came under contract with the United States Army in 1944/1945, and NASA took control of the JPL facility in 1958 (FFA 1992 and Caltech 2026). JPL (and previously Caltech) was an instrumental facility in the development of liquid and solid rocket motor technology, including the pioneering/initial testing of perchlorate solid rocket motors including the use of 1,2,3-TCP as a binder for perchlorate (Bartley 1946, Sutton 1996, Schumacher 1999).

In 1980, VOCs were detected at levels above drinking water standards in the first analyses performed for three PWP water-supply wells located approximately 1,000 ft downgradient of the JPL facility, which was suspected to be the source of the contamination (Ebasco 1988). Around the same time, VOCs were detected in the two nearby Lincoln Avenue Water Company (LAWC) supply wells (ATSDR 1999). The elevated contaminant VOC concentrations forced the temporary closure of two of the PWP wells in 1985, the two LAWC wells in 1987, and two additional PWP wells in 1989 (ATSDR 1999). In 1990, NASA funded the construction of a water treatment plant, consisting of air stripping with vapor-phase granular activated carbon, for the four closed PWP wells (collectively referred to as the Monk Hill wells) to allow the resumption of water production from those wells. The LAWC constructed a water treatment system in 1992, which allowed them to resume production from their two contaminated wells (ATSDR 1999).

In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), NASA conducted a Preliminary Assessment (PA), a Site Investigation (SI), and an Expanded Site Investigation (ESI) of the JPL facility from 1984 to 1990. Subsequently, the JPL facility was placed on the National Priorities List (NPL), on October 14,1992. A Federal Facilities Agreement (FFA) under which NASA undertook investigation and remediation activities for the JPL Superfund Site was established in December 1992; the parties to the FFA were the United States Environmental Protection Agency (EPA), Department of Toxic Substances Control (DTSC), Regional Water Quality Control Board (RWQCB) – Los Angeles Region, and NASA (FFA 1992). The 1993 RI/FS Work Plan for the JPL Superfund Site divided the Site into three Operable Units, or OUs (EBASCO 1993):

- OU1 is the on-site groundwater characterization unit;
- OU2 is the on-site contaminant source characterization unit; and,
- OU3 is the off-site groundwater characterization unit.

While the RIs for OU1 and OU3 (which were combined) were ongoing and with the advent of more sensitive laboratory analytical methods, perchlorate was detected in samples collected from wells owned and operated by PWP and LAWC. According to NASA (2014a), the PWP's Arroyo Well (one of the four Monk Hill wells) was shut down in 1997 due to elevated perchlorate levels, as were the PWP's other Monk Hill wells (Well 52, Ventura Well, and Windsor Well) and the five then-existing Sunset wells in 2002. The RI analyses were expanded to include perchlorate. More detailed information about the JPL Superfund Site is provided in Section 2.3.

2.2 Physical Setting

The Sunset Reservoir site and the JPL facility are both located in the mid-eastern portion of Los Angeles County, within the western portion of the San Gabriel Valley. The San Gabriel Valley is bounded on the north by the San Gabriel Mountains and to the south, southwest, and southeast by a series of east-west trending hills that include the Repetto, Mered, Puente, and San Jose Hills and the Raymond Fault to the south/southeast (PWP 2021). The San Gabriel Valley is underlain by more than 1,200 ft of alluvial materials (gravel, sand, silt and clay) overlying impervious bedrock below (which has lowered over time by tectonic activity). These alluvial materials constitute a major regional aquifer, which is divided into a series of basins, including the Raymond Basin in the northwest portion of the San Gabriel Valley, where both the Sunset Reservoir site and the JPL facility are located. The Raymond Basin in turn is divided into three subareas: the Pasadena Subarea, the Santa Anita Subarea, and the Monk Hill Subarea (PWP 2021). The Sunset Reservoir site is located within the Pasadena Subarea of the Raymond Basin, and the JPL facility is located in the Monk Hill Subarea of the Raymond Basin. The aquifer in the Monk Hill Subarea and the Pasadena Subarea is generally considered to be an unconfined, or water table, aquifer and can be divided into four groundwater aquifer zones separated by thin, silt-rich layers (Batelle 2004).

Within the Raymond Basin, groundwater generally flows southward from the recharge areas at the base of the San Gabiel Mountains to areas of discharge along the Raymond Fault. However, local groundwater flow regimes exist within the basin, and a confluence of two such groundwater flow regimes reportedly occurs within the Monk Hill Subarea where the JPL facility is located. At the western end of the Monk Hill Subarea (west of JPL), groundwater flow is predominantly to the southeast, while at the eastern end of the Monk Hill Subarea (east of JPL), groundwater flow is predominantly to the south (Batelle 2004).

In the vicinity of the JPL facility itself, groundwater flow directions are dynamic. In general, natural groundwater flow beneath the facility is to the southeast; however, the aquifer is affected by various natural and anthropogenic influences that include pumping from nearby municipal production wells, groundwater recharge from Arroyo Seco spreading basins, seasonal and regional groundwater recharge from precipitation (primarily at the mouth of the Arroyo Seco), and regional groundwater flow. The extraction of water from municipal production wells reportedly has the most significant effect on the natural groundwater flow (Batelle 2004).

Depth to groundwater at the JPL facility ranges from 22 to 270 feet below ground surface (bgs). This wide range of depths to groundwater has been attributed primarily to the relatively steep topography present at the JPL facility and local groundwater mounding, but also to seasonal groundwater recharge from nearby spreading grounds and the extraction of groundwater from nearby municipal production wells. Since 1996, groundwater elevations have fluctuated up to 75 ft each year beneath the JPL facility as a result of these influences (Batelle 2004).

2.3 Review of Previous Relevant Reports and Related Documents

The results of the combined OU1 and OU3 RIs were presented in the 1999 OU1/OU3 RI Report (Foster Wheeler 1999a). The results of the on-site contaminant source characterization (OU2) were presented in the 1999 OU2 RI Report (Foster Wheeler 1999b). An FS for OU2 was completed in 2000 (Foster Wheeler 2000a), and a Record of Decision was issued for OU2 in 2002 to reduce the vadose zone contaminant source using soil vapor extraction (Batelle 2002). The OU2 cleanup goals were subsequently achieved (using soil vapor extraction), as reported in the Remedial Action Report for OU2 (NASA 2007a). The FS for OU1 and

OU3 (likewise combined) was also completed in 2000, and a draft report was issued that year (Foster Wheeler 2000b). Based on this draft FS, Interim Records of Decision were issued for OU1 and OU3 in 2007 (NASA 2007b; NASA 2007c). The OU1 ROD required the expansion of the existing OU1 demonstration study groundwater extraction system, i.e., aboveground treatment and re-injection of the treated groundwater (NASA 2007b). The OU3 ROD included NASA funding the construction of a new treatment plant (the Monk Hill Treatment System [MHTS]) for removal of perchlorate and VOCs at the four PWP Monk Hill Subarea wells and continued funding of similar treatment at the two LAWC wells that had begun in 2004. The previous air stripping system was removed in December 2006. The OU3 ROD also noted that additional analytes had been added to the JPL groundwater monitoring program at the request of the California Department of Health Services to evaluate drinking water permit considerations. These additional analytes were 1,2,3-TCP, 1,4-dioxane, and nitrosodimethylamine (NASA 2007c).

NASA prepared the JPL Groundwater Modeling Report in 2003 to support the OU3 remedy (NASA 2003). Batelle, on behalf of NASA, then prepared an addendum to the RI Work Plan for OU1 and OU3, which included additional investigations for OU3 to better determine the extent of contaminants that originated from the JPL facility (Battelle 2004). The investigations included stable isotope analyses of groundwater samples based on research by Dr. Neil Sturcio, who at that time was affiliated with the University of Illinois at Chicago, and the installation of two additional monitoring wells—MW-25, installed in 2004 just north of the Sunset Reservoir site (NASA 2005a), and MW-26, installed in 2005 roughly halfway between the JPL facility and the Sunset Reservoir site (NASA 2005b). NASA also evaluated the occurrence of nitrate in groundwater from water supply wells and monitoring wells in the Monk Hill Subarea, as reported in a 2005 Technical Memorandum (NASA 2005c).

In January 2007, NASA issued a Technical Memorandum (NASA 2007d) providing results of the additional investigation, along with an evaluation of the downgradient (southern) extent of chemicals originating from the JPL facility and an evaluation of whether the occurrence of perchlorate in groundwater at the Sunset wells was associated with migration from the JPL facility. Engaged by NASA, Dr. Neil Sturchio prepared a memorandum dated May 15, 2007 with his interpretation of the stable isotope ratio measurements (Sturchio 2007).

In June 2007, under contract to PWP, GEOSCIENCE Support Services, Inc. (Geoscience) prepared comments on NASA's January 2007 Technical Memorandum(Geoscience 2007). Geoscience's comments discussed groundwater modeling, groundwater geochemistry, chemical concentration data, and perchlorate isotope data. In October 2007, EPA provided comments on NASA's January 2007 Technical Memorandum, also addressing groundwater modeling, groundwater geochemistry, chemical concentration data, and perchlorate isotope data (EPA 2007). In May 2008, DTSC provided comments on NASA's January 2007 Technical Memorandum related to NASA's interpretations on groundwater flow directions, geochemistry, and the groundwater model (DTSC 2008). NASA responded to the comments from PWP, EPA, and DTSC in December 2008 (NASA 2008).

In 2009, PWP engaged Geoscience and William McCaron, Inc. (WMI) to evaluate the fate and transport of perchlorate contamination from the JPL facility, assess the impact of JPL contamination on Sunset wells, provide a critical evaluation of the perchlorate stable isotope data presented in NASA's 2007 Technical Memorandum, and update the Raymond Basin Management Board (RBMB) Groundwater Model (Geoscience/WMI 2009). NASA responded to Geoscience/WMI's report in a 2010 memorandum (NASA 2010).

In 2010, NASA directed the Environmental Restoration Department of the Battelle Memorial Institute (Battelle) to prepare a 97-005 Technical Report in accordance with California Department of Public Health's (CDPH's) Policy Memorandum 97-005, as part of the permitting process on behalf of PWP (Batelle 2010). This effort was to support construction of treatment facilities for key impacted Monk Hill wells due to the source water meeting the criteria of "an extremely impaired source" (PWP: Arroyo Well, Well 52, Ventura Well, and Windsor Well; LAWC: Wells #3 and #5; and Las Flores Water Company Well #2). The primary contaminants of concern (COCs) listed in the 97-005 Technical Report are carbon tetrachloride; trichloroethylene (TCE); tetrachloroethylene (PCE); 1,2,3-TCP; and perchlorate. A source water assessment, full characterization of the raw water quality, identification of existing source protection programs, description of effective monitoring and treatment and risks associated with failure of the treatment system, and alternatives and associated risks were discussed in the document (Battelle 2010). The CDPH provided a project evaluation summary of the Batelle report and found that, together, the sources of supply, treatment works, and operation were capable of reliably producing a safe potable water supply (CDPH 2011).

NASA conducted the first Five-Year Review of the remedy for OU1 and OU3 (NASA 2012a) in February 2012. EPA approved NASA's Five-Year Review in a letter dated February 17, 2012 (EPA 2012). PWP issued a memorandum, *Synopsis of Technical Memorandum on the Perchlorate Contamination of the Sunset Reservoir Wells,* in May 2012 providing their opinions to EPA on the origin of perchlorate in the Sunset Reservoir area groundwater (PWP 2012). NASA prepared responses to the opinions in the May 2012 PWP Memorandum in its own memorandum which included comments from Dr. Sturchio (NASA 2012b).

EPA issued a letter dated November 19, 2013 to PWP containing EPA's opinion regarding JPL as a potential source of perchlorate to the Sunset Reservoir area groundwater and indicated that groundwater monitoring will be conducted in the Sunset Reservoir area (EPA 2013).

NASA prepared a Focused Feasibility Study for OU1 and OU3 in 2014 (NASA 2014a). NASA prepared a response to comments from EPA, DTSC and PWP on the draft version of the Focused Feasibility Study (NASA 2014b).

NASA conducted the Second Five-Year Review of the remedy for OU1 and OU3 (NASA 2017) in January 2017 and issued a final Record of Decision for OU1 and OU3 in 2018 (NASA 2018). The 2018 ROD was a final remedial decision which called for the continued implementation of the OU1 and OU3 interim remedies. At the time, detections of 1,2,3-TCP were discussed as part of the Final ROD; however, the California Maximum Contaminant Level (MCL) for 1,2,3-TCP was not established until December 2017, and reference to the new State MCL was not made in the Final ROD (NASA 2022a). EPA concurred in a letter dated August 14, 2020, that NASA has completed the remedial actions described in the 2018 Record of Decision for OU1 and OU3 (EPA 2020). EPA (2020) stated that the remedial actions for the interim ROD were previously determined to be complete and with the implementation of institutional controls, the remedial action for the final ROD was considered complete.

NASA issued a draft Third Five-Year Review in November 2021 (NASA 2021). PWP submitted comments to EPA on the draft Third Five-Year Review for OU1 and OU3 through its consultant, Roux (PWP/Roux 2021; Roux 2022). EPA submitted comments to NASA on the draft Third Five-Year Review for OU1 and OU3 in a letter dated January 14, 2022 (EPA 2022a). NASA issued the final Third Five-Year Review of the remedy for OU1 and OU3 (NASA 2022b) in April 2022, which included provisions for voluntarily preparing an SI work plan to evaluate PFAS impacts (to be conducted outside of the CERCLA program) and to conduct a low-level 1,2,3-TCP analysis in all JPL monitoring wells including preparation of a technical memorandum to document

results and conclusions. EPA generally concurred with NASA's Third Five-Year Review of the remedy for OU1 and OU3 (EPA 2022b).

Based on the preliminary description and history of the JPL Superfund Site presented above and as further described in the rest of Section 2, the main documents to be reviewed for the Focused RI/FS are those listed in Section 6, References. These documents generally cover those leading to listing the JPL facility on the NPL, the RI, the Additional Investigation (including comments and responses regarding the Additional Investigation), Feasibility Studies, Interim and Final Records of Decisions, Five-Year Reviews and associated comments and responses, Remedial Actions and Completion Reports, and routine groundwater monitoring reports.

2.4 Sunset Reservoir Challenges

As discussed earlier, PWP blends MWD water with their local well supplies. This is done to meet water quality standards, on account of the contaminants found in the local well supplies. These contaminants include perchlorate, 1,2,3-TCP, certain VOCs,[4] and nitrate (PWP 2025a).

2.4.1 Blending Plan

To maintain contaminant concentrations below their respective Maximum Contaminant Levels (MCLs) at the Sunset Reservoir, blending of groundwater and imported MWD water is conducted by PWP in accordance with their Blending Plan (PWP 2025a; PWP 2025b). The Blending Plan, developed by PWP, provides field, laboratory, and operational procedures for blending impacted groundwater to achieve potable-use standards. The blending plan has been revised over time since the initial blending plan was established in October 1996. Multiple revisions have been accepted by the appropriate regulatory agency adjusting to various contaminant concentrations, compliance standards, and the number of wells in operation. The most recent accepted plan is dated April 2025. The goal of the blending program is to assure that PWP complies with the MCLs for nitrate, perchlorate, VOCs, and 1,2,3-TCP by maintaining concentrations of these contaminants in the reservoir and distribution system at levels not to exceed 80 percent of the respective MCLs. The table below summarizes each contaminant's MCL and blending target concentration (80 percent of the MCL).

Contaminant	MCL	Blending Target Concentration
NO_3 as N	10 mg/L	≤ 8 mg/L
ClO_4	6 µg/L	≤ 4.8 µg/L
TCE	5 µg/L	≤ 4 µg/L
PCE	5 µg/L	≤ 4 µg/L
c-1,2-DCE	6 µg/L	≤ 4.8 µg/L
1,2,3-TCP	5 ng/L	≤ 4 ng/L

Imported water from MWD is blended with sources of higher concentrations (groundwater wells) in order to meet PWP's drinking water permit requirements. The table below lists the average (A) and range (R) of analytical results for each well and its recent flow (discharge). Due to an increase in concentration of 1,2,3-

[4] VOCs of concern include TCE, PCE, and cis-1,2-dichloroethylene (c-1,2-DCE).

TCP in the Bangham and Sunset wells since 2018, the maximum values for each well are used in the blending scenario projections (PWP 2025a).

Source		NO_3 as N (mg/L)	ClO_4 (µg/L)	TCE (µg/L)	PCE (µg/L)	c-1,2-DCE (µg/L)	1,2,3-TCP (ng/L)	Flow (gpm)
Bangham	R	<0.4-9.0	<4-8.8	<0.5-1.1	<0.5-8.2	<0.5-0.6	<5-14.0	1,275 (Deliberately limiting flow)
	A	7.5	6.6	0.6	3.4	<0.5	9.4	
Parke[1]		4.3	1.7	<0.5	<0.5	<0.5	2.2	1,500
Sunset	R	7.4-10.0	7.6-16.4	0.7-9.8	1.2-4.8	<0.5-2.5	<5-12.0	1,300
	A	8.8	9.5	3.2	2.9	1.2	7.0	
MWD		<0.4	<1	<0.5	<0.5	<0.5	<5	3,142

R = Range A= Average

[1] Initial testing for the Parke well began in February 2025; therefore, only a limited data set is available, and thus no range or average values are provided.

Although blending well water with more costly MWD imported water provides for drinking water, seasonal factors may hinder PWP's operational goals for use of more local groundwater. Importing MWD water for blending increases as production levels of local groundwater increases. Additionally, elevated levels of contaminant also drive the volume for MWD water. However, overall system demands decrease during cooler seasons, and therefore short-term supply may exceed instantaneous system demands. This becomes increasingly problematic between daylight versus nighttime hours due to diurnal variability in demand. During these periods, groundwater production must be reduced given imported MWD water cannot be reduced due to the purpose it serves as the blending source. Likewise when seasonal demands initially begin to increase or operational demands fluctuate due to local factors (special large events, irrigating days, emergency preparedness, etc.), turning on a well for short-term basis with blending may result in excessive wear and tear on pumping equipment or higher electrical costs due to short-term load demands. Operating multiple contaminated wells with blending as demands fluctuate up and down will also require wells to cycle on and off, which lead to early system wear and tear. Ultimately any reduction in MWD imported water due to a severe drought, catastrophic events, or planned maintenance will proportionally reduce the number of contaminated wells that may operate.

2.4.2 Water Rights/Limitations of Blending Plan and Supply & Demand Requirements

In December 1944, the Raymond Basin was adjudicated to resolve conflicts between pumping entities, with the court allocating water rights to certain parties within the Basin (PWP 2021). Water rights allocated to each party were based on the aquifer's safe yield as determined by the RBMB Report in 1943 (Langridge et al. 2016). The safe yield was later modified in 1955. On July 1, 2009, the pumpers with decreed rights in the Pasadena Subarea voluntarily reduced pumping to address declining water levels. A similar voluntary reduction occurred in 2024 for pumpers with decreed rights in the Monk Hill Subarea. The combined reduction of both subareas resulted in a water right of 9,232.7 acre-feet/year (AFY) for PWP.

PWP has rights to divert up to 25 cubic feet per second (cfs) of surface water from the Arroyo Seco and Millard Canyon and up to 8.9 cfs from the Eaton Walsh to recharge the Raymond Basin, which results in surface water spreading credits and consequently, an increase in pumping rights. On average, PWP receives

approximately 2,700 AFY of additional pumping rights from wells in the Monk Hill and Pasadena Subareas. In addition, long-term storage policies adopted in 1992 and 1993 allocated a current volume of 34,000 AF. Long-term storage is essential to PWP's water-supply resiliency (PWP 2021); the long-term storage program is currently "frozen" (RBMB 2025), and PWP works with the RBMB and other purveyors to maximize in-lieu options when possible.

PWP has worked with JPL over several decades to resolve water quality impacts. A new Monk Hill Treatment System production well (Explorer Well) is under construction that will improve the effectiveness of NASA's cleanup efforts of the groundwater contaminated by past waste management practices. Explorer well is located in the former JPL East Parking Lot and has a capacity to pump at a rate of approximately 1,100 gpm. The well will provide PWP with flexibility in operating its system and will allow increased production from the Monk Hill Subarea.

Water right constraints and optimal flexibility in the timing and location of producing groundwater from wells and/or augmenting groundwater supplies via MWD or in-lieu programs are a challenge throughout the Raymond Basin. For example, as already mentioned, recent drought conditions did result in a reduction of water rights, constraining pumping of the LAWC treatment system and the MHTS. As described in NASA's Drought Contingency Plan, the quantity of water pumped from LAWC #5 and #6 to create hydraulic control in the Monk Hill Basin is approximately 700 acre-feet more than LAWCs available water (i.e., decreed right – 24% reduction + spreading credits), therefore LAWC would need an additional 700 acre-feet of water annually via lease or other mechanism (NASA 2022c).

Water service reliability as assessed in a normal year, single dry year, and five consecutive dry years results in a consistent surplus of clean, potable water to PWP's customers. However, reliability of MWD's imported water has been less than certain in recent years due to intense droughts and environmental restrictions. According to MWD's 2015 Integrated Resources Plan (IRP) Update, future water shortages could occur up to 15 percent of the projected 20 years (PWP 2021). PWP's Sunset Reservoir blending plan is almost entirely reliant on imported water supply from MWD, thus PWP's ability to provide its customers with increased volume of local groundwater cannot be achieved without an adequate supply of imported MWD water(PWP 2021).

In 2020, a total of 29,346 acre-feet (AF) of water was utilized by PWP. This was comprised of 38 percent groundwater, 61 percent imported water from MWD, and 1 percent purchased from local water suppliers. Water demand projections from 2026 to 2040 are expected to remain largely the same. This includes mandated reductions imposed by Senate Bill 606, Assembly Bill 1668, and future State water loss reduction rules (PWP 2021). From July 1, 2024 to June 30, 2025 (latest fiscal year figure), PWP extracted 8,771.9 AF of water within the Pasadena Subarea and a total of 12,464.5 AF of water within both subareas (Pasadena and Monk Hill) (RBMB 2025).

2.4.3 Proposed Sunset Complex

As described in Section 2.1.1, PWP plans to replace the two aging reservoirs and install a new groundwater treatment plant to remove VOC and perchlorate and thus avoid the need to blend for these contaminants. The infrastructure improvements proposed in the Sunset Complex Project will provide for increased system reliability and operational flexibility. A 45-day public comment period was issued for the project on July 31, 2025 which concluded on September 15, 2025. In addition, PWP held a scoping meeting on April 7, 2022. Public comments received are addressed in the Environmental Impact Report (EIR). The EIR will be adopted

in 2026 and Kennedy Jenks is finalizing the design. Construction is estimated to begin in late 2027 and be completed in 2029.

3. Preliminary Identification of RAOs, PRGs, and ARARs

According to the 2018 JPL Superfund Site ROD, groundwater in OU1 and OU3 of the JPL Superfund Site is contaminated with VOCs and perchlorate above health-based drinking water standards. Based on the current and reasonably anticipated use of OU3 groundwater as drinking water, NASA (2018) established the following as Remedial Action Objectives (RAOs) for OU1 and OU3 groundwater:

1. Protect human health and the environment by preventing exposure to VOCs (carbon tetrachloride and TCE) and perchlorate originating from JPL facility.
2. Restore beneficial use of groundwater containing VOCs and perchlorate originating from JPL facility.
3. Prevent further migration of carbon tetrachloride, TCE and perchlorate beyond the current extent.

The 2018 ROD also established performance objectives to achieve the RAOs. They are as follows:

1. Reduction of overall VOC (carbon tetrachloride, TCE, and PCE) and perchlorate concentrations within the groundwater monitoring and extraction wells compared to baseline levels so that the treated water can be supplied as drinking water to the residents and customers of the City of Pasadena and LAWC. 40 CFR 300.430 (f)(5)(iii) states that a ROD shall indicate, as appropriate, the remediation goals the remedy is expected to achieve. Remediation goals were not specifically defined in the 2018 ROD, but it provided applicable drinking water standards as shown in the table below.

Chemical of Concern	Federal MCL (40 CFR 141.61) ug/L	California MCL (CCF Title 22, 64444) ug/L
Carbon tetrachloride	5	0.5
TCE	5	5
PCE	5	5
Perchlorate	20*	6

* Proposed

2. Asymptotic mass removal achieved after appropriate system optimization. Asymptotic conditions will have been reached when the upper portion of the cumulative mass removal curve approached zero.
3. Operate the LAWC and City of Pasadena centralized treatment systems until carbon tetrachloride, TCE, PCE and perchlorate concentrations in the extracted water are consistently reduced to levels that no longer exceed applicable drinking water standards.

The 2018 ROD identified chemical-specific and action-specific Applicable or Relevant and Appropriate Requirements (ARARs) for the selected remedy but determined that there are no location specific ARARs associated with the selected remedy. The RAOs, Preliminary Remediation Goals (PRGs) and ARARs to be identified during the Focused RI/FS may be similar to those ones listed in the 2018 OU1/OU3 ROD, but will be modified, as appropriate, for the Sunset Reservoir site.

4. Focused RI Work Plan

The RI component of the Focused RI/FS for the Sunset Reservoir site will include the assembling and evaluation of available information relevant to groundwater contamination in the vicinity of the JPL facility and the Sunset Reservoir, for the purpose of determining whether and to what extent contamination arising from the JPL facility is present in the vicinity of the Sunset Reservoir. As discussed in Section 1, the RI/FS for the JPL Superfund Site did not address groundwater quality impacts found in the Sunset wells, and available data indicate that the JPL facility may be a contributor to groundwater impacts to these wells. Moreover, certain conclusions of the RI/FS warrant reexamination in light of additional information developed since completion of the RI/FS.

The Focused RI will comprise four main elements:

- Review and evaluation of available information regarding contaminant sources;
- Review and evaluation of available information regarding contaminant migration pathways;
- Review and evaluation of available information regarding groundwater chemistry; and
- Evaluation of risk to human health associated with use of groundwater at the Sunset Reservoir site

Each of the Focused RI elements is discussed briefly below.

4.1 Review and Evaluation of Contaminant Sources

Potential sources for the water quality impacts in the Sunset wells will be identified and evaluated. The OU2 RI Report stated, “contamination appeared, in most cases, to be related to previously identified seepage pits, waste pits, and disposal areas.” (Foster Wheeler 1999b). This Focused RI Report will summarize information on other potential sources at the JPL facility that were not sufficiently evaluated during the RI/FS and/or in subsequent documents. It will also summarize and evaluate information on potential point and non-point sources beyond the JPL facility.

4.2 Review and Evaluation of Contaminant Migration Pathways

Available information regarding contaminant migration pathways to the Sunset wells will be compiled and evaluated. Much information exists regarding migration pathways in groundwater, including several particle tracking models. The Focused RI will summarize the various models developed and the conclusions drawn from them. Key assumptions, data gaps, model calibration/validation procedures, etc. for each model will be discussed. Areas of focus will include, but not be limited to, the following:

- Seasonal variability, including effects of drought and surplus recharge;
- Effect of pumping on groundwater flow direction; and
- The influence of the Arroyo Seco and Devils Gate Reservoir on groundwater flow paths

The Focused RI will also look at a migration pathway heretofore not given sufficient attention, specifically the downstream transport of JPL contaminants historically discharged to the Arroyo Seco, with subsequent infiltration into groundwater downstream from the JPL facility, where groundwater flow paths are different from those at the JPL facility.

4.3 Review and Evaluation of Groundwater Chemistry

The Focused RI will also review and evaluate available information on groundwater chemistry. This will include, but not be limited to, evaluation of the following:

- Major ion chemistry;
- Isotopic evaluation;
- JPL groundwater indicator chemicals; and
- Commingling of COCs

4.4 Evaluation of Risk to Human Health

The human health risk assessment did not evaluate risk attributable to the consumption of drinking water from other water supply wells in the area (i.e., Pasadena Subarea wells), because of the limited extent of the JPL plume defined at that time. The Focused RI Report will therefore include a risk assessment focusing on the consumption of water derived from each of the Sunset wells (i.e., unblended).

Although potential exposures to ecological receptors may also exist due to discharges from the JPL facility to the Arroyo Seco, the Focused RI Risk Assessment is concerned only with exposures associated with the use of groundwater from the Sunset wells, and so ecological receptors will not be considered.

5. Focused FS Work Plan

The Focused FS component of the Focused RI/FS for the Sunset Reservoir site will identify and evaluate remedial alternatives to mitigate the water quality impacts, focusing specifically on ex-situ groundwater treatment remedies which will allow more flexible use of groundwater as a potable water supply (given the current situation requiring a blending strategy and consideration of multiple water supply challenges) until aquifer restoration is completed by others.

5.1 Identification of ARARs, RAOs, and PRGs

To facilitate the development of remedial action alternatives for the Sunset Reservoir site, the Focused FS will identify all ARARs, including all chemical-specific, location-specific, and action-specific regulatory requirements, as well as advisories, criteria, and guidance to be considered ("TBCs") if it helps to ensure protectiveness or is otherwise appropriate for use in a specific alternative. Following the identification of all ARARs, remedial action objectives will be identified, followed by PRGs. The RAOs and PRGs will be used to streamline the development of remedial action alternatives.

5.2 Development of Remedial Alternatives

This section of the Focused FS is to identify general response actions and provide a narrative discussion of the initial screening and evaluation of technology types and process options. The technology types and process options that survived the full screening and evaluation process will be incorporated into alternatives. Technology types and process options potentially applicable will be compiled from a variety of resources developed for application at Superfund sites and from other standard engineering texts/literature. The technology types and process options that cannot be technically implemented for the Sunset Reservoir site are screened from further consideration.

5.2.1 Preliminary Screening of Remedial Technologies

The Focused FS process begins with identification of areas and/or volumes of media to be addressed. General response actions are identified which could satisfy the RAOs for each media of interest. For each, general response actions, technology types and associated process options are identified which could be implemented to potentially satisfy the RAOs. Under this section of the Focused FS, potentially relevant technologies for addressing the groundwater contamination are identified. Technology types and process options are subject to an initial screening, primarily focused on consideration of technical implementability of the technology or process option at the Site. A technology type is defined as a general category of technologies, such as chemical treatment. Process options are the unique processes within each technology type that specify how the technology is implemented. Process options and entire technology types are retained or eliminated from further consideration on the basis of technical implementability considering site-specific information such as, but not limited to, contaminant types/concentrations and subsurface hydrogeology.

5.2.2 Initial Identification and Screening of Alternatives

The technologies that are carried forward for further consideration are then evaluated with respect to effectiveness, implement ability and relative cost. Certain process options are again eliminated from further consideration and the remaining technology types and process options are carried forward for inclusion into an alternative. This section of the Focused FS assembles the technologies that survive the preliminary

screening into alternatives that will be analyzed more fully in the Detailed Analysis of Alternatives. The alternatives are screened based on short term effectiveness, long term effectiveness, implementability and relative cost.

5.3 Detailed Evaluation of Remedial Alternatives

This section of the Focused FS will present the detailed analysis of alternatives including an individual analysis of each alternative against threshold and primary balancing criteria followed by a comparative analysis of the alternatives using these same criteria.[5] As required by the National Contingency Plan (NCP), the "No Action" general response action (in this case, no blending) is required for consideration and comparison to other general response actions.

5.3.1 Overall Protection of Human Health and the Environment

Only alternatives that are protective of human health and the environment will be carried forward for a detailed analysis, except for the required No Action Alternative.

5.3.2 Compliance with ARARs

Only alternatives that are in compliance with ARARs will be carried forward for a detailed analysis, except for the required No Action Alternative. If a desirable alternative does not meet ARARs, a waiver from the ARAR(s) can be sought.

5.3.3 Long-Term Effectiveness and Permanence

Alternatives will be evaluated for long-term effectiveness and performance, which will address the results of a remedial action in terms of the risk from untreated waste or treatment residuals remaining at the conclusion of the remedial activities. The primary focus is the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes.

5.3.4 Reduction of Toxicity, Mobility or Volume

This section will address statutory preference for source-control actions that employ treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of hazardous substances. Alternatives will be evaluated for the ability to reduce the principal threats through destruction of toxic contaminants, reduction of the total mass of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of total volume of contaminated media.

5.3.5 Short-Term Effectiveness

Alternatives will be evaluated for the effects on human health and the environment during the construction and implementation phase of the alternative and the amount of time until the RAOs are met.

[5] Per EPA guidance (EPA 1988), the "modifying criteria" of State Acceptance and Community Acceptance are not evaluated at the FS stage.

5.3.6 Implementability

Ease or difficulty of implementing an alternative will be evaluated considering the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation.

5.3.7 Cost

The capital and Operation &Maintenance (O&M) costs associated with each alternative will be evaluated with an estimated accuracy of -30 percent to +50 percent and a net present value of capital and O&M costs.

5.4 Comparative Analysis of Remedial Alternatives

Each alternative will be compared based on the expanded list of seven criteria listed in Section 5.3, above.

5.5 Recommended Remedial Alternatives

The NCP criteria for the selection of the most appropriate alternative include the following:

1. Must be protective of human health and the environment (i.e., threshold criteria);
2. Must achieve ARARs or a waiver from the ARARs (i.e., threshold criteria);
3. Must be cost-effective, which is determined by comparing the overall effectiveness to cost. A remedy shall be cost-effective if its costs are proportional to its overall effectiveness. Overall effectiveness is determined by combining evaluation of long-term effectiveness and permanence, reduction of toxicity, mobility, or volume through treatment, and short-term effectiveness; and,
4. Selecting the alternative that provides the best balance of trade-offs among alternatives in terms of the five primary balancing criteria. The balancing criteria shall emphasize long-term effectiveness and reduction of toxicity, mobility, or volume through treatment and consider the preference for treatment as a principal element and the bias against off-Site land disposal of untreated waste.

While the NCP indicates a preference for the reduction of toxicity, mobility, or volume through treatment, it should be noted that this is not possible for the Sunset wells, because the source of the groundwater contamination at the Sunset Reservoir site is not from that location.

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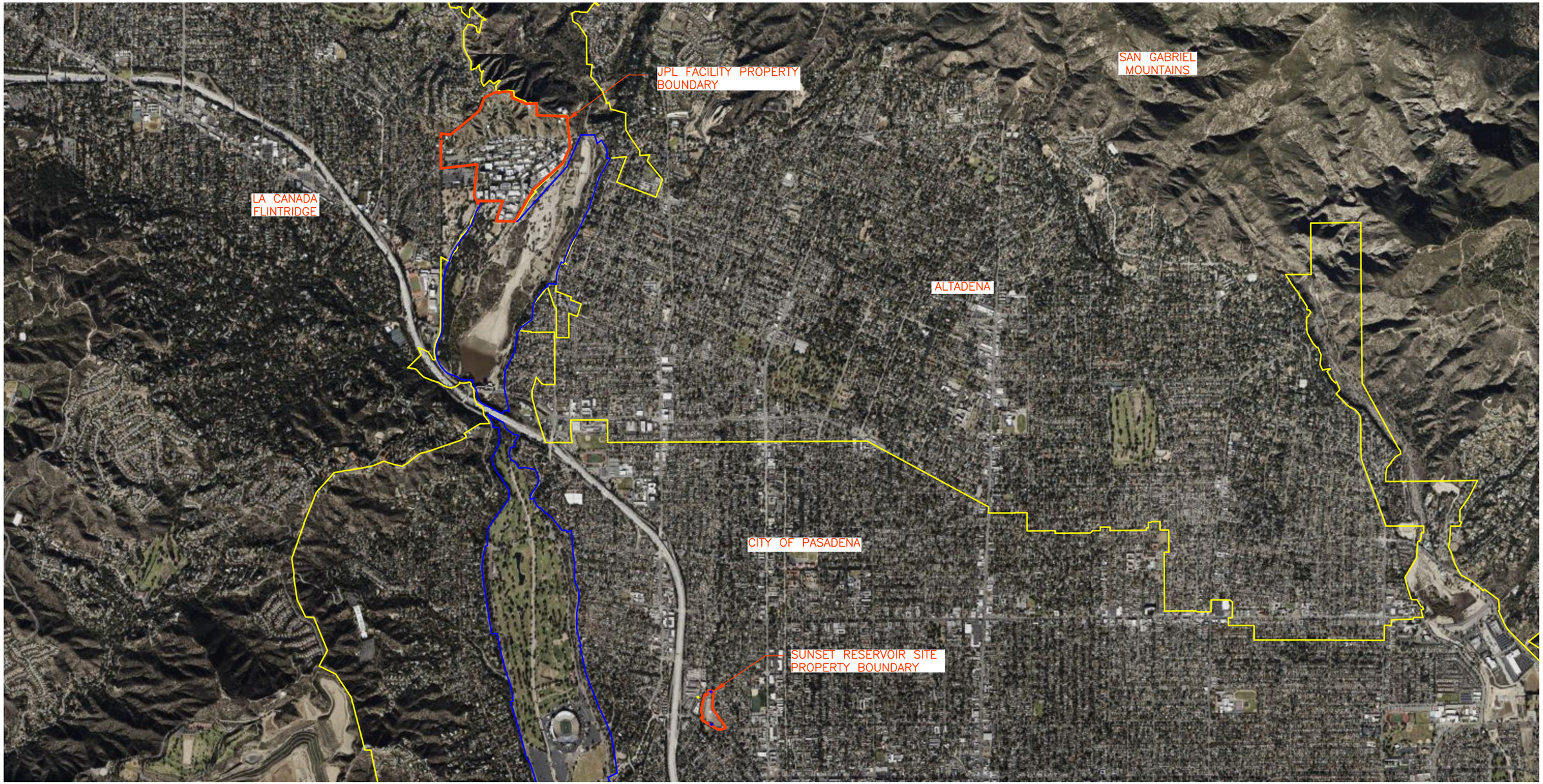
FIGURES

1. Location of Sunset Complex and JPL Facility
2. Sunset Complex Features Map



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- CITY OF PASADENA BOUNDARY

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LOCATION OF SUNSET RESERVOIR SITE AND JPL FACILITY

PASADENA, CA 91103

Prepared for:

CITY OF PASADENA

ROUX

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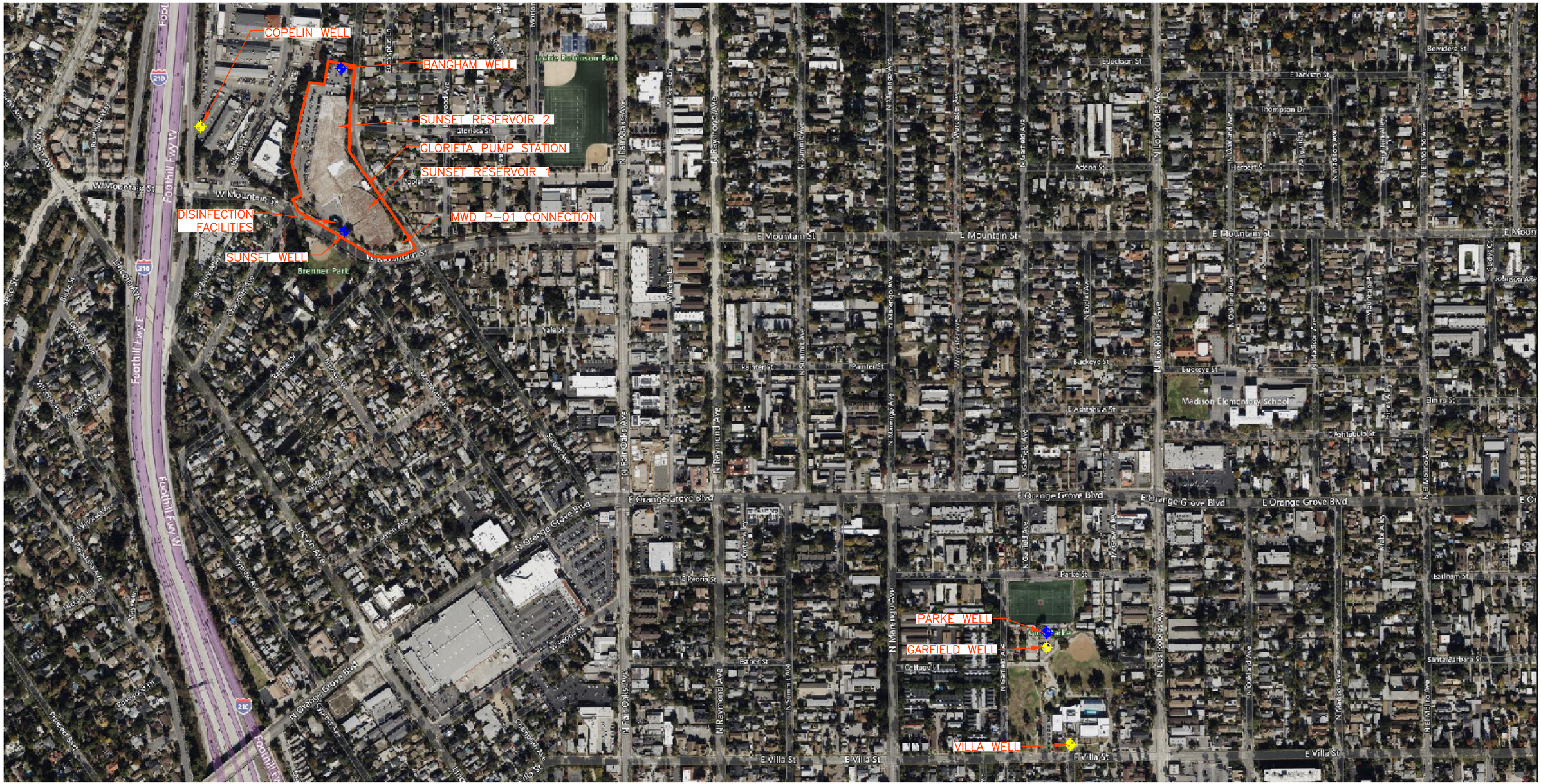

LEGEND

PROPERTY BOUNDARY

SUNSET RESERVOIR SITE MUNICIPAL WELL APPROXIMATE LOCATION

INACTIVE SUNSET RESERVOIR SITE MUNICIPAL WELL APPROXIMATE LOCATION

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Title:

SUNSET RESERVOIR SITE FEATURES MAP

PASADENA, CA 91103

Prepared for:

CITY OF PASADENA

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