Attachment 1, Appendix F

ADDITIONAL ANALYSIS – Fish Entrainment Risk Assessment Study

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ATTACHMENT 1

APPENDIX F

FISH ENTRAINMENT RISK ASSESSMENT STUDY
Additional Analysis

1.0 INTRODUCTION

The Federal Energy Regulatory Commission's (FERC) Additional Information Request (AIR) included four items (i.e., AIR-10, AIR-11, AIR-12, and AIR-13) pertaining to the Licensees' *Fish Entrainment Risk Assessment Study* (Study 4.1.17). As a summary, FERC requested the Licensees to:

- Expand the analysis to include juvenile rainbow trout (*Oncorhynchus mykiss*), all life stages of largemouth bass (*Micropterus salmoides*), and juvenile and adult life stages of hitch (*Lavinia exilicauda*) and striped bass (*Morone saxatilis*) during both stratified and non-stratified conditions in Pyramid Lake;

- Evaluate the rates and sources of mortality associated with volitional entrainment of juvenile and adult rainbow trout, all life stages of largemouth bass, juvenile and adult hitch, and juvenile and adult striped bass; and,

- Provide a detailed description of the methods used to calculate intake velocities and how velocity dissipates with distance from the trash racks of the intake structures for the Angeles Tunnel and the Pyramid Dam Low-Level Outlet Works, including detailed drawings of each intake structure showing the dimensions of each structure's trash racks.

The following analyses and discussion provide the additional information requested by FERC using the intake velocities calculated in the Licensees' Study 4.1.17.

2.0 CALCULATION OF INTAKE VELOCITIES

2.1 ANGELES TUNNEL INTAKE STRUCTURE

The velocities induced by the intake structure in Pyramid Lake for the 7.2-mile-long Angeles Tunnel (Appendix G, Figure G1) were calculated by first obtaining the specifications of the tunnel, which are as follows:

- 18,400 cubic feet per second (cfs) design discharge

- Four, 22- by 22-foot horizontal openings

- 30-foot diameter tunnel

Next, the Licensees gathered the trash rack dimensions of the Angeles Tunnel Intake to calculate the effective area through which water flows into the intake structure. Percent of blockage by trash racks was calculated based on as-built design specification drawings (provided in Appendix G). This effective intake area is equal to the total intake area multiplied by the percent of the total intake area not blocked by the trash racks (i.e., one minus the percent of total intake area blocked by the trash racks). The total intake area is 4,856 square feet. The trash rack blockage of the total intake area is approximately 15.93 percent based on as-built design specification drawings. As such, the effective intake area is 4,082 square feet for the Angeles Tunnel Intake structure.

The maximum velocity induced by the intake tunnel is equal to the maximum discharge (18,400 cfs) divided by the effective intake area. In addition to the maximum discharge, the following discharge values were analyzed.

- 10 percent exceedance discharge (1989-2015): 5,766 cfs
- 90 percent exceedance discharge (1989-2015): 310 cfs
- Median discharge (1989-2015): 2,502 cfs
- Maximum observed (1989-2015): 11,539 cfs

To relate velocity to radial distance from the intake centerline, a hemispherical velocity dissipation model (Appendix G, Figure G2) was applied to create a velocity-distance relationship for the field of influence created by the intake. The flat flow area of the intake structure is converted to an equivalent hemisphere surface area, A, given by:

$$A = 2\pi r^2$$

Radial distances up to the radius, r, of the hemisphere (blue hemisphere in Appendix G, Figure G2) are assumed to experience the maximum velocity induced by the intake. A decay in velocity occurs at distances beyond r. These velocities, V, are calculated by

$$V = Q/2\pi {r_{dist}}^2$$

where Q is discharge through the intake structure and r_{dist} is the radial distance from the centerline of the intake. The calculated velocities for the Angeles Tunnel Intake structure at the discharges of interest are presented in Figure F2-1.

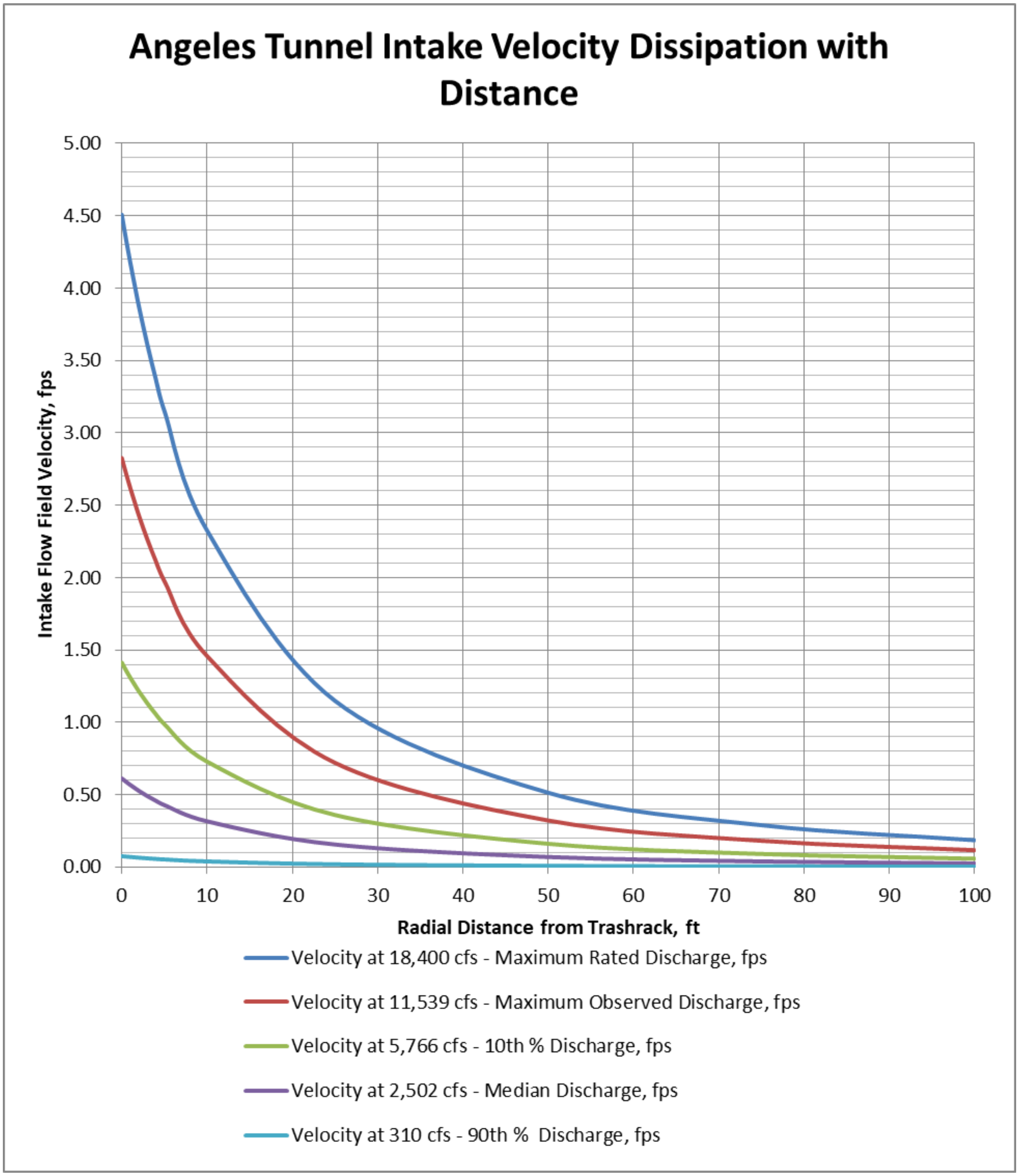


Figure F2-1. Area of Velocity Influence for the Angeles Tunnel Intake Structure at a Range of Intake Discharges

2.2 PYRAMID DAM LOW-LEVEL OUTLET WORKS STRUCTURE

The velocities induced by the Pyramid Dam Low-Level Outlet Works structure (Appendix G, Figure G3 and Figure G4) were calculated by first obtaining the specifications of the tunnel associated with this structure, which are as follows:

- 1,200 cfs design discharge (4,400 cfs maximum)
- 8-sided intake (8 vertical racks [15- by 10-foot] + 1 octagonal top rack)
- 15-foot diameter tunnel
- Stream releases are made through four valves (an 8-inch pressure reducing valve, a 16-inch fixed cone valve, and two 36-inch fixed cone valves)

Next, the Licensees gathered the trash rack dimensions to calculate the effective intake area that water flows through into the low-level outlet works structure. For each of the openings, the percent of blockage by trash racks was calculated based on as-built design specification drawings (provided in Appendix G). This effective intake area is equal to the total intake area multiplied by the percent of the total intake area not blocked by the trash racks (i.e., one minus the proportion of total intake area blocked by the trash racks). Based on as-built design specification drawings, the total intake area is 1,286 square feet, and the trash rack blockage of the total intake area is approximately 20.07 percent (257.44 square feet). Therefore, the effective flow area (i.e., area not blocked by trash racks) was calculated to be approximately 1,025.1 square feet for the Pyramid Dam Low-Level Outlet Works structure.

The maximum velocity induced by the tunnel of the Pyramid Dam Low-Level Outlet Works structure is equal to the maximum theoretical discharge (4,400 cfs) divided by the effective flow area. The maximum theoretical discharge was determined by summing the maximum rated normal discharge (1,200 cfs) through the four normally-operated cone valves of the stream release facility and the maximum discharge (3,200 cfs) through the 78-inch emergency release butterfly valve and conduit; it should be noted that the maximum theoretical discharge would only occur in emergency situations and may not be physically attainable due to hydraulic constraints as well as public safety and facility considerations. In addition to the maximum theoretical discharge, the following discharge values were analyzed:

- Maximum rated normal discharge: 1,200 cfs
- 10 percent exceedance discharge (2005-2016): 60 cfs
- 90 percent exceedance discharge (2005-2016): 2 cfs
- Median discharge (2005-2016): 9 cfs
- Maximum observed (1989-2015): 1,882 cfs

To relate velocity to distance from the intake centerline, a cylindrical velocity dissipation model was applied to create a velocity-distance relationship for the field of influence created by the Pyramid Dam Low-Level Outlet Works structure. The flow area, *A*, of the structure is converted to an equivalent cylindrical surface area given by

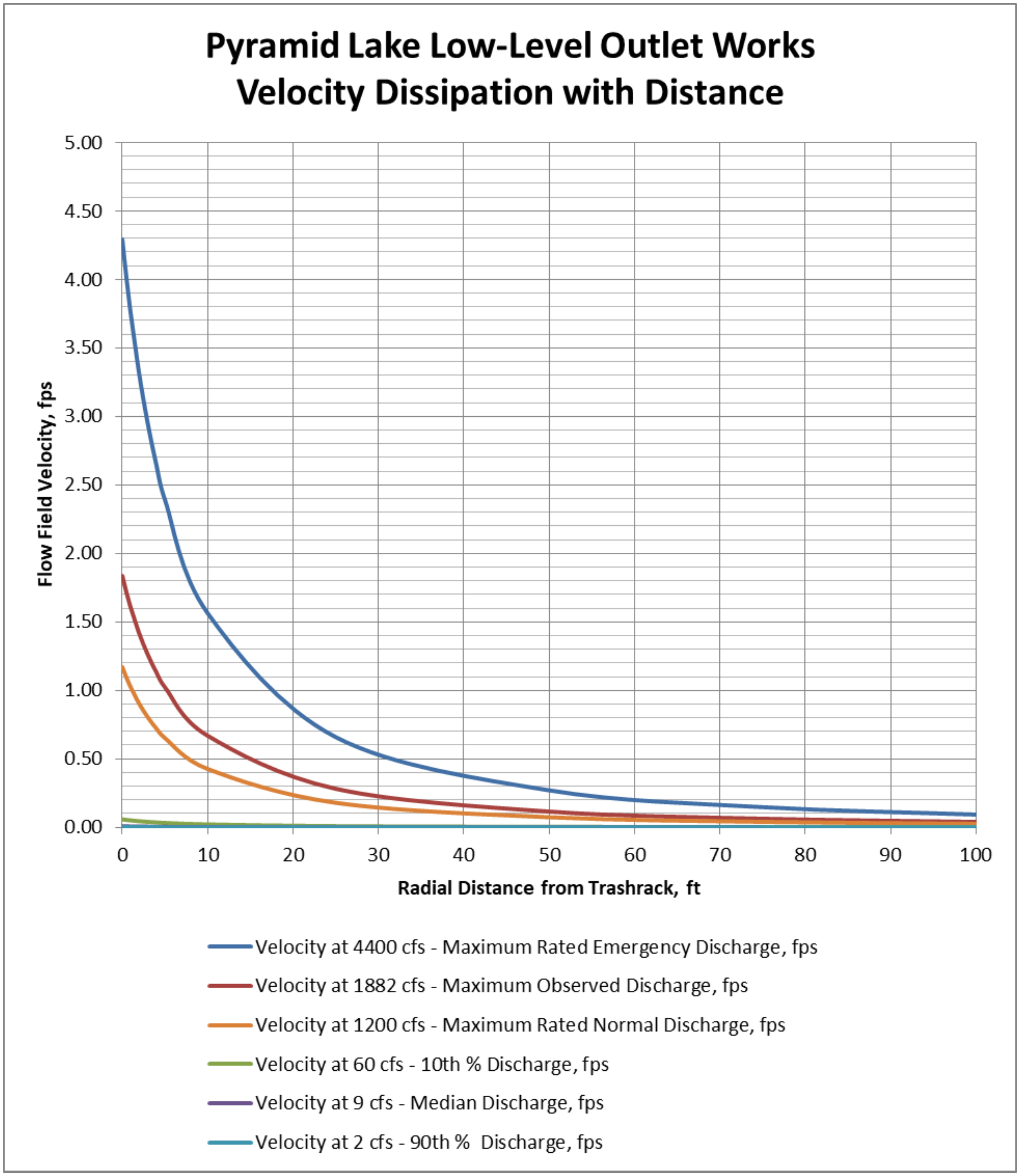
$$A = 2\pi rh + \pi r^2$$

where *h* is the height of the cylinder and *r* is the cylinder's radius. Only one end of the cylinder is accounted for in this equation, which most closely represents the condition of the Pyramid Dam Low-Level Outlet Works structure.

Distances up to the radius of the equivalent cylinder are assumed to experience the maximum velocity induced by the intake. A decay in velocity occurs for distances beyond the radius of the equivalent cylinder. These velocities, *V*, are calculated by

$$V = Q/(2\pi r_{dist}h + \pi {r_{dist}}^2)$$

where *Q* is the discharge of interest and r_{dist} is the distance from the centerline of the structure. The calculated velocities for the Pyramid Dam Low-Level Outlet Works structure at the discharges of interest are presented in Figure F2-2.



Note: Calculated velocities for the median discharge (9 cfs) and 90th % exceedance discharge (2 cfs) are essentially equal to zero across all distances from the structure, making the lines representing them appear visually non-discernible in the figure.

Figure F2-2. Area of Velocity Influence for the Pyramid Dam Low-Level Outlet Works Structure at a Range of Discharges

3.0 CHARACTERIZATION OF STRATIFICATION IN PYRAMID LAKE

The Licensees provided a summary of water temperature data for Pyramid Lake from 2015 through 2019 in Section 5.2.1 of the Licensees' Final License Application (FLA). When comparing water temperatures near the surface and near the bottom (FLA Tables 5.2-21 and 5.2-22, respectively), Pyramid Lake is typically well mixed from October through February, has a well-developed thermocline from April through August, and is typically in a transitional period during the months of March and September. During stratification, the thermocline generally occurs within the upper 100 to 150 feet of the water column (FLA Figures 5.2-9d through 5.2-9h). During mixed periods, temperature is relatively consistent throughout the water column and can range from approximately 20 degrees Celsius (°C) in October to approximately 11 °C in February (FLA Tables 5.2-21 and 5.2-22).

4.0 ECOLOGY AND BEHAVIOR OF TARGET SPECIES AND LIFE STAGES

The general ecology and behavior of a given species and life stage of fish can provide considerable context when assessing the risk of entrainment. For example, if a given fish species requires certain habitats or conditions for growth, survival, and reproduction, and those habitats or conditions do not exist in the vicinity of an entrainment point, then the species would not be expected to occur at that entrainment point and the risk of entrainment for that species would be expected to be low or nonexistent. The following sections provide details regarding the ecology, behavior, and life stages of the target species in Pyramid Lake to inform the assessment of risk of entrainment into the Pyramid Dam Low-Level Outlet Work structure and Angeles Tunnel Intake structure.

4.1 RAINBOW TROUT

Landlocked populations of rainbow trout are typically either fluvial (i.e., spawning and rearing in tributary streams and using downstream river reaches for growth and maturation) or adfluvial (i.e., lake migrant; spawning and rearing in tributary streams and using downstream lake habitats for growth and maturation), and utilize different lake or tributary stream habitats depending on life stage, time of year, and availability of habitats (Groot and Margolis 1991[1]; James and Kelso 1995[2]; Moyle 2002[3]; Quinn 2005[4]). Spawning occurs in streams during the winter or spring months, and juveniles rear in the stream for one or more years. In adfluvial populations, after rearing in the stream for one or more years, juveniles migrate downstream to lake habitats where they initially occupy littoral (i.e., near-shore) habitats and feed on invertebrates and small

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[1] Groot, C. and L. Margolis, eds. 1991. *Pacific salmon life histories*. University of British Columbia Press, Vancouver.

[2] James, G. D. and J. R. M. Kelso. 1995. Movements and habitat preference of adult rainbow trout (*Oncorhynchus mykiss*) in a New Zealand montane lake. New Zealand Journal of Marine and Freshwater Research 29(4):493-503.

[3] Moyle, P. B. 2002. *Inland fishes of California. Revised and improved*. University of California Press, Berkeley, California.

[4] Quinn, T. P. 2005. *The behavior and ecology of Pacific salmon and trout*. University of Washington Press, Seattle, Washington.

fish. Downstream migration of juveniles typically occurs from spring through summer (Moyle 2002; Quinn 2005). Habitat utilization by lake-dwelling rainbow trout varies by time of day as well as seasonally, and typically depends on prey availability (James and Kelso 1995; Moyle 2002). Typically, rainbow trout occupy relatively deeper habitats during midday, and can be found near the surface at night and during the low-light periods at dawn and dusk (Moyle 2002). During summer, rainbow trout escaping higher surface temperatures can be found in deeper water, though they rarely occur deeper than the thermocline due to reduced dissolved oxygen levels and prey availability typical of the hypolimnion (Nowak and Quinn 2002[5]; Quinn 2005). Rainbow trout prefer nearshore habitats and return in the fall and winter as temperatures in the more productive littoral zone cool (James and Kelso 1995; Moyle 2002; Nowak and Quinn 2002). Sexually mature rainbow trout congregate near lake tributary mouths in late winter and early spring while they wait for appropriate flows to initiate the spawning migration (James and Kelso 1995; Moyle 2002; Quinn 2005).

In Pyramid Lake, hatchery origin rainbow trout have been heavily stocked for years to support the recreational trout fishery. Rainbow trout are native in the Piru Creek basin, and Piru Creek upstream of Pyramid Lake is designated by the California Department of Fish and Wildlife (CDFW) as a Heritage and Wild Trout stream (CDFG 2008[6]). Some have speculated that native rainbow trout in Piru Creek above Pyramid Lake may seek to migrate downstream past Pyramid Dam. A result of this attempted downstream migration may be entrainment into the Angeles Tunnel Intake structure and the Pyramid Dam Low-Level Outlet Works structure. However, the Licensees have not come across available literature to support the idea that downstream migrating rainbow trout would swim to substantial depths to find a downstream route. To the contrary, the available literature indicates that downstream-migrating juveniles of most salmonid species seek areas of downstream current to direct and facilitate the downstream migration (Quinn 2005). Such a downstream current does not exist in the majority of large lakes or impoundments that do not make substantial releases of water through surface spill. For example, in the main-stem Columbia River, where downstream-migrating salmonids must pass a series of hydroelectric forebays and dams to reach the ocean, the results of three-dimensional acoustic tracking studies suggest that smolts generally show an aversion to migrating at depths greater than 60 to 70 feet (Cash et al. 2002[7]; Faber et al. 2011[8]).

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[5] Nowak, G. M. and T. P. Quinn. 2002. Diel and seasonal patterns of horizontal and vertical movements of telemetered cutthroat trout in Lake Washington, Washington. Transactions of the American Fisheries Society. 131(3):452-462.

[6] California Department of Fish and Game. 2008. Upper Piru Creek Summary Report: Snowy, Buck, Piru, Alamo, and Matua Creeks, June 11-13, 2008. Heritage and Wild Trout Program. Prepared by J. Weaver and S. Mehalick.

[7] Cash, K. M., N. S. Adams, T. W. Hatton, E. C. Jones, and D. W. Rondorf. 2002. Three-dimensional fish tracking to evaluate the operation of the Lower Granite Surface Bypass Collector and Behavioral Guidance Structure During 2000. Prepared for U.S. Army Corps of Engineers, Walla Walla District, by U.S. Geological Survey, Columbia River Research Laboratory, Cook, Washington.

[8] Faber, D. M., G. R. Plosky, M. A. Weiland, D. Deng, J. S. Hughes, J. Kim, T. Fu, E. S. Fischer, T. J. Monter, and J. R. Skalski. 2011. Evaluation of behavioral guidance structure on juvenile salmonid

4.2 LARGEMOUTH BASS

Largemouth bass is a common warmwater game-fish species that, while not native in California, is present in many California lakes and reservoirs, including Pyramid Lake where it was historically stocked to establish a recreational warmwater fishery. Spawning occurs in shallow (i.e., approximately 6.5 feet deep or less) littoral habitats in spring as water temperatures rise (Moyle 2002). Larval largemouth bass remain close to the nest and are guarded by the male parent for up to four weeks (Moyle 2002). Juvenile largemouth bass tend to travel in schools along the shoreline where they feed on zooplankton and small invertebrates (Moyle 2002). Adult bass tend to be associated with structure (e.g., rocky outcrops, submerged stumps or trees) at varying depths in the nearshore environment (Moyle 2002), and are rarely found in open water or at great depths (Essington and Kitchell 1999[9]; Ahrenstorff et al. 2009[10]), which suggests that the presence or absence of a thermocline would not influence the type of habitat utilized by largemouth bass. Furthermore, largemouth bass are not typically migratory and tend to occupy relatively small home ranges, the size of which are driven by the densities of littoral aquatic vegetation and prey (Essington and Kitchell 1999; Ahrenstorff et al 2009). In addition to being present in Pyramid Lake, largemouth bass was historically stocked in Piru Creek downstream of Pyramid Dam (i.e., Pyramid reach) (FERC 2004[11]) and continues to occur there.

4.3 STRIPED BASS

Striped bass, which are an anadromous predatory fish species native to the eastern seaboard of North America, have been introduced to the Central Valley of California and have become well-established. Striped bass were historically stocked in Pyramid Lake by CDFW (DWR 1975[12]; DWR 1981[13]). Striped bass are primarily estuarine or marine, and typically require large rivers for spawning and sufficient flows for egg hatching (CDFW 2020; University of California Davis 2020). However, lake spawning has been documented in some populations in large reservoirs (Gustaveson et al. 1984[14]). In rivers, spawning occurs in shallow waters, such as pool tailout or run habitats. Eggs are slightly negatively buoyant and tend to remain in the water column or settle out in shallow waters (Moyle 2002). Larvae hatch in as little as 48 hours and become free

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passage and survival at Bonneville Dam in 2009. Prepared for the U. S. Army Corps of Engineers, Portland District, by Pacific Northwest National Laboratory, Richland, Washington.

[9] Essington, T. E. and J. F. Kitchell. 1999. New perspectives in the analysis of fish distributions: a case study on the spatial distribution of largemouth bass (*Micropterus salmoides*). Canadian Journal of Fisheries and Aquatic Sciences 56(1):52-60.

[10] Ahrenstorff, T. D., G. G. Sass, and M. R. Helmus. 2009. The influence of littoral zone coarse woody habitat on home range size, spatial distribution, and feeding ecology of largemouth bass (*Micropterus salmoides*). Hydrobiologia (2009) 623:223-233.

[11] Federal Energy Regulatory Commission (FERC). 2004. Final Exhibit E. Santa Felicia Project Relicensing (Project 2153). Section 2.4 Appendix B.

[12] California Department of Water Resources (DWR). 1975. Management of the California SWP (Bulletin 132-75). Sacramento, California.

[13] DWR. 1981. Management of the California SWP (Bulletin 132-81). Sacramento, California.

[14] Gustaveson, W. A., T. D. Pettengill, J. E. Johnson, and J. R. Wahl. 1984. Evidence of in-reservoir spawning of striped bass in Lake Powell, Utah-Arizona. North American Journal of Fisheries Management 4:540-546.

swimming in as little as one week. Larval striped bass are transported downstream to estuaries by river currents, where they feed on zooplankton and require high prey densities to satisfy their high metabolic rates (Moyle 2002). As landlocked juvenile striped bass grow, they transition to pelagic habitats and become increasingly piscivorous. In a hydroacoustic study in Lake Powell (Utah and Arizona), adult striped bass were found to occur in close proximity to the thermocline during periods of stratification, and did not occur in depths greater than approximately 180 feet during periods of non-stratification (Mueller and Horn 1999[15]), even though the maximum depth of the reservoir exceeds 550 feet. In anadromous populations, adult striped bass generally move into fresh water from bays and estuaries in the fall, and return to salt water in the spring following spawning (Moyle 2002). The Licensees have not found any documentation of striped bass occurring in Pyramid reach.

4.4 HITCH

Hitch are a species of freshwater cyprinid (i.e., minnow) native to the Central Valley of California, and are a State species of concern due to declining abundance in their native range. Hitch spawn during the spring in small tributaries to either lakes or larger streams. After hatching, fry are quickly dispersed downstream by stream or river currents. In lakes, juveniles typically shoal in littoral habitats and remain closely associated with submerged aquatic vegetation and other complex cover along shores to avoid predation. Adults in lakes are mostly pelagic in the epilimnion and are rarely found in areas that are not rich in zooplankton (Moyle 2002).

Hitch are not native to the Piru Creek watershed, and have been officially documented in Pyramid Lake only on two occasions: once in 1984, and a second time in 1992 (Swift et al. 1993[16]). Other sources (e.g., CDFG 2001[17]; CDFW 2013[18]; Moyle 2002) have also reported the presence of hitch in Pyramid Lake, but either attribute the report to Swift et al. (1993) or provide no documentation. Hitch were not captured or observed during the most recent fisheries surveys in Pyramid Lake, which were conducted in 2013 (CDFW 2013). In their description of the occurrence of hitch in Pyramid Lake, Swift et al. (1993) summarized that the species “is possibly established or at least a regular immigrant from central California.” As a result of the sporadic documentation of presence and lack of recent observations for hitch in Pyramid Lake, it is likely that hitch are in extremely low abundance or are not established in Pyramid Lake. Hitch has not been documented in Pyramid reach, nor was it observed during relicensing electrofishing surveys of Quail Lake, which provides flows that can be bypassed directly into Pyramid Lake.

[15] Mueller, G. and M. J. Horn. 1999. Description of the pelagic zooplankton and fish communities of Lakes Powell and Mead. U.S. Geological Survey and U. S. Bureau of Reclamation.
[16] Swift, C. C., T. R. Haglund, M. Ruiz, and R. N. Fisher. 1993. The status and distribution of the freshwater fishes of southern California. Bulletin of the Southern California Academy of Sciences 92(3):101-167.
[17] CDFG. 2001. Trout Stocking Study, Pyramid Reservoir. Prepared by E. Tavares, Department of Fish and Game, South Coast Region. May 2001.
[18] CDFW. 2013. Pyramid Lake Fall 2013 General Fisheries Survey. Prepared by D. R. Black, Inland Fisheries Division, South Coast Region. October 2013.

5.0 SWIM SPEEDS FOR TARGET SPECIES AND LIFE STAGES

Swim speeds of fish are generally described according to three categories based on the amount of time a particular speed can be sustained before the fish experiences fatigue: sustained swimming can be maintained for more than 200 minutes, prolonged swimming can be sustained for between 20 seconds and 200 minutes, and burst (or, less-commonly, sprint) swimming speeds can be maintained for less than 20 seconds (Beamish 1978[19]). Sustained swimming typically represents routine and low-effort activities, while burst swimming is typically reserved for activities such as predator or threat avoidance, capturing prey, movement against high velocities, or leaping out of water. Common and recreationally important species, such as rainbow trout, largemouth bass, and striped bass, tend to receive more focus in terms of research and, as a result, the range of swimming capabilities of these species tend to be more thoroughly documented. On the other hand, species that are less common or recreationally unappreciated, such as hitch, tend to be less studied and, as such, may have little or no documentation regarding swimming abilities. In the table below, sustained and burst speeds are represented for rainbow trout, largemouth bass, and striped bass, while only sustained speeds are represented for hitch. The following sections describe, as available in the literature, the swim speeds of the target species and life stages, which are summarized in Table F5-1, below.

[19] Beamish, F. W. H. 1978. Swimming capacity. In *Fish Physiology, Volume VII, Locomotion*. W. S. Hoar and D. J Randall, eds. Academic Press, San Francisco, California.

Table F5-1. Swimming Speeds for Target Fish Species And Life Stages

Species	Life Stage	Approx. Length (in.)	Swim Type	Speed (fps)
Rainbow Trout (*Oncorhynchus mykiss*)	Juvenile	4	Sustained	1.05[1]
			Burst	3.38[1]
	Adult	11	Sustained	2.30[1]
			Burst	11.48[1]
Largemouth Bass (*Micropterus salmoides*)	Larval	NA	Sustained	0.13[2]
	Juvenile	5	Sustained	1.17[3]
			Burst	>2.71[4]
	Adult	8	Sustained	2.89[5]
			Burst	>4.34[4]
Striped Bass (*Morone saxatilis*)	Larval	1	Sustained	0.25[6]
	Juvenile	4	Sustained	0.97[7]
			Burst	3.33[8]
	Juvenile/Adult	10	Sustained	2.42[7]
			Burst	8.33[8]
	Juvenile/Adult	14	Sustained	3.38[7]
			Burst	11.67[8]
	Adult	19	Sustained	4.59[7]
			Burst	15.83[8]
Hitch (*Lavinia exilicauda*)	Juvenile	2	Sustained	0.25[9]
	Juvenile/Adult	7	Sustained	0.88[9]
	Adult	12	Sustained	1.5[9]

Sources: [1]Bainbridge 1968; [2]Laurence 1972; [3]Katopodis and Gervais 2016; [4]Beamish 1978; [5]Bainbridge 1958; [6]Moyle 2002; [7]Freadman 1979; [8]Casto-Santos 2005; [9]Myrick and Cech 2000
Notes: Approximate fish lengths in inches are provided if they were reported. Larval life stage do not have documented burst speeds. Swim speeds are reported for different life stages based on research and as documented in available literature. While burst and sustained swim types are listed for all, additional life stages are reported based on available information.
Key:
fps = feet per second
in. = inch
NA = not applicable

5.1 RAINBOW TROUT

Juvenile rainbow trout of 10 centimeters (cm) (approximately 4 inches) total length (TL) have been reported to be capable of maintaining sustained swimming speeds of 0.32 meters per second (mps) (approximately 1.05 fps) and burst speeds of 1.03 mps (approximately 3.38 fps) (Bainbridge 1968[20]). Adult rainbow trout of 28 cm

[20] Bainbridge, R. 1968. Speed and stamina in three fish. Journal of Experimental Biology 37(1):129-153.

(approximately 11 inches) TL have been documented to attain sustained speeds of 1.7 mps (approximately 2.3 fps) and burst speeds of 3.5 mps (approximately 11.48 fps) (Bainbridge 1968).

5.2 LARGEMOUTH BASS

Largemouth bass are typically discussed according to larval, juvenile, and adult life stages. Larval largemouth bass (length not reported) have been observed to be capable of sustained swim speeds of 0.04 mps (approximately 0.13 fps) (Laurence 1972[21]). Average sustained swim speeds of 0.356 mps (approximately 1.17 fps) have been reported for juvenile largemouth bass averaging 12.3 cm (approximately 5 inches) TL (Katopodis and Gervais 2016[22]). Moyle (2002) reports that both male and female largemouth bass can become sexually mature at approximately 20 cm TL. Bainbridge (1958)[23] reported sustained swimming speeds of 0.88 mps (approximately 2.89 fps) for largemouth bass of 21 cm (approximately 8 inches) TL. The Licensees found that direct reports of burst speed for largemouth bass of any life stage are not readily available in the literature, so a conservative general burst speed estimate of 6.5 body lengths per second (blps) (Beamish 1978) was used to determine that burst speed of a 5-inch TL largemouth bass would be expected to be greater than 2.71 fps, and greater than 4.34 fps for an 8-inch TL largemouth bass.

5.3 STRIPED BASS

Similar to largemouth bass, discussions of striped bass typically focus on the larval, juvenile, and adult life stages. Sexual maturation in striped bass typically occurs at age 2 or 3 years for males, and from ages 4 to 6 years for females. Moyle (2002) reports that striped bass can grow to an average TL of approximately 4 inches in the first year, approximately 10 inches in the second year, approximately 14 inches in the third year, and approximately 19 inches in the fourth year, with additional growth averaging 2 to 4 inches annually thereafter. Larval striped bass are relatively strong swimmers, with sustained larval swim speeds of 3 to 4 blps being reported (Moyle 2002). Freadman (1979[24]) reported maximum sustained swim speeds for striped bass to range from 2.9 to 3.3 blps, and Castro-Santos (2005[25]) documented sprint (i.e., burst) speeds in striped bass between approximately 10 to 20 blps. Assuming the conservative values of 2.9 blps for sustained swimming and 10 blps for burst swimming, the following calculated velocities are expected for:

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[21] Laurence, G. C. 1972. Comparative swimming abilities of fed and starved larval largemouth bass (*Micropterus salmoides*). Journal of Fish Biology 4(1):73-78.
[22] Katopodis, C. and R. Gervais. 2016. Fish swimming performance database and analyses. Fisheries and Oceans Canada, Canadian Science Advisory Secretariat. Ottawa, Ontario. January 2016.
[23] Bainbridge, R. 1958. The speed of swimming as related to size and to the frequency and amplitude of the tail beat. Journal of Experimental Biology 35(1):109-133.
[24] Freadman, M. A. 1979. Swimming energetics of striped bass (*Morone saxatilis*) and bluefish (*Pomatomus saltatrix*): gill ventilation and swimming metabolism. Journal of Experimental Biology 83:217-230.
[25] Castro-Santos, T. 2005. Optimal swim speeds for traversing velocity barriers: an analysis of volitional high-speed swimming behavior of migratory fishes. Journal of Experimental Biology 208:421-432.

- 4-inch TL striped bass: approximately 0.97 fps (sustained) and 3.33 fps (burst)
- 10-inch TL striped bass: approximately 2.42 fps (sustained) and 8.33 fps (burst)
- 14-inch TL striped bass: approximately 3.38 fps (sustained) and 11.67 fps (burst)
- 19-inch TL striped bass: approximately 4.59 fps (sustained) and 15.83 fps (burst)

5.4 HITCH

Moyle (2002) notes that hitch are not aggressive swimmers, and one investigation into hitch swim speed reported sustained swim speeds ranging from 1.5 to 2.4 blps (Myrick and Cech 2000[26]). In Clear Lake, California, hitch were observed to achieve lengths of approximately 2 inches within the first three months after hatching, up to approximately 7 inches by the end of the first year, and up to approximately 12 inches by the end of the second year. Males typically mature at 1 year of age, while females tend to mature in the second or third year (Moyle 2002). Assuming the conservative sustained swim speed of 1.5 blps, expected sustained swim speeds would be approximately 0.25 fps for a 2-inch TL hitch, approximately 0.88 fps for a 7-inch TL hitch, and approximately 1.5 fps for a 12-inch TL hitch.

6.0 RISK OF ENTRAINMENT

For any fish, the risk of being involuntarily entrained into a given intake structure depends primarily on whether or not the fish occurs within the area influenced by the water velocities created by operation of the intake, and secondarily on the fish's ability to evade or outswim the intake velocities. Volitional entrainment, and any risk associated with it, depends on a fish's ability and biological motivation (e.g., food, refuge, or other biological needs) to access a given intake structure. The ecological and behavioral information presented in Section 4.0, above, indicates that no larval or small juvenile life stages of any of the target species would be expected to occur at the approximate 250 feet average depth of the Angeles Tunnel Intake structure and the Pyramid Dam Low-Level Outlet Works structure because they require the food and cover provided only in shallow littoral habitats. However, those life stages have been included in the following entrainment analyses as requested by FERC and to allow evaluation of the risk of entrainment in the extremely unlikely case that they would occur in the vicinity of the intakes. The following discussion regarding the risk of entrainment for target fish species and life stages is provided according to involuntary entrainment and volitional entrainment.

6.1 INVOLUNTARY ENTRAINMENT

For the purposes of this analysis, it is assumed that a fish attempting to evade the intake velocity of intake structures would be using burst swimming. As such, when available, burst swim speeds were used to assess the risk of involuntary entrainment

[26] Myrick, C. A. and J. J. Cech, Jr. 2000. Swimming performances of four California stream fishes: temperature effects. Environmental Biology of Fishes 58:289-295.

into the intake structures. If burst speeds were not available, sustained speeds were used. Based on swim speeds alone and according to the calculated intake velocities, the risk of involuntary entrainment into the Angeles Tunnel Intake structure (Table F6-1) is similar to the risk of entrainment into the Pyramid Dam Low-Level Outlet Works structure (Table F6-2) across the target fish species and life stages. The distances from trash racks at which involuntary entrainment would be possible vary for each of the structures. As demonstrated by the data in Tables F6-1 and F6-2, the risk of involuntary entrainment for juvenile and adult rainbow trout, juvenile and adult largemouth bass, juvenile and adult striped bass, and adult hitch is essentially nonexistent at all but the highest modeled discharges for each structure based on swim speeds alone. Of the fish species and life stages examined and based on swim speeds alone, involuntary entrainment into either structure is possible across more discharges for the larval life stages of largemouth bass and striped bass, and for juvenile and small adult hitch. However, as mentioned above, it is highly unlikely that larval largemouth bass or striped bass would be in the vicinity of the intakes. Likewise, it is highly unlikely that larval, juvenile, or small adult hitch would be in the vicinity of the deep structures.

Table F6-1. Approximate Entrainment Distances for Target Fish Species and Life Stages for Angeles Tunnel Intake Structure

Species	Life Stage	Swim Speed (fps)	Discharge in Angeles Tunnel (cfs)				
			18,400	**11,539**	**5,766**	**2,502**	**310**
Rainbow trout	Juvenile	3.38[a]	*5*	--	--	--	--
	Adult	11.48[a]	--	--	--	--	--
Largemouth bass	Larval	0.13[b]	*>100*	*100*	*50*	*25*	--
	Juvenile	2.71[a]	*5*	*0.5*	--	--	--
	Adult	4.34[a]	*0.5*	--	--	--	--
Striped bass	Larval	0.25[b]	*75*	*50*	*25*	*10*	--
	Juvenile (4 in.)	3.33[a]	*5*	--	--	--	--
	Juv/Ad (10 in.)	8.33[a]	--	--	--	--	--
	Juv/Ad (14 in.)	11.67[a]	--	--	--	--	--
	Adult (19 in.)	15.83[a]	--	--	--	--	--
Hitch	Juvenile (2 in.)	0.25[b]	*75*	*50*	*25*	*10*	--
	Juv/Ad (7 in.)	0.88[b]	*30*	*20*	*5*	--	--
	Adult (12 in.)	1.5[b]	*20*	*10*	--	--	--

Notes:
Distances, in feet, in italics
[a]*Burst speed*
[b]*Sustained speed*
-- No entrainment expected at any distance from trash racks based on velocity calculations and documented swim speeds
Key:
fps = feet per second
cfs = cubic feet per second
in. = inches
Juv/Ad (# in.) = a fish of # length could be juvenile or adult depending on sex

Table F6-2. Approximate Entrainment Distances for Target Fish Species and Life Stages for Pyramid Dam Low-Level Outlet Works Structure

Species	Life Stage	Swim Speed (fps)	Discharge in Low-Level Outlet (cfs)					
			4,400	1,882	1,200	60	9	2
Rainbow trout	Juvenile	3.38[a]	*2*	--	--	--	--	--
	Adult	11.48[a]	--	--	--	--	--	--
Largemouth bass	Larval	0.13[b]	*75*	*50*	*25*	--	--	--
	Juvenile	2.71[a]	*3*	--	--	--	--	--
	Adult	4.34[a]	--	--	--	--	--	--
Striped bass	Larval	0.25[b]	*50*	*25*	*20*	--	--	--
	Juvenile (4 in.)	3.33[a]	*2*	--	--	--	--	--
	Juv/Ad (10 in.)	8.33[a]	--	--	--	--	--	--
	Juv/Ad (14 in.)	11.67[a]	--	--	--	--	--	--
	Adult (19 in.)	15.83[a]	--	--	--	--	--	--
Hitch	Juvenile (2 in.)	0.25[b]	*50*	*25*	*20*	--	--	--
	Juv/Ad (7 in.)	0.88[b]	*20*	*6*	*2*	--	--	--
	Adult (12 in.)	1.5[b]	*10*	*2*	--	--	--	--

Notes:
Distances, in feet, in italics
[a]Burst speed
[b]Sustained speed
-- No entrainment expected at any distance from trash racks based on velocity calculations and documented swim speeds
Key:
fps = feet per second
cfs = cubic feet per second
in. = inches
Juv/Ad (# in.) = a fish of # length could be juvenile or adult depending on sex

6.2 VOLITIONAL ENTRAINMENT

Volitional entrainment into an intake structure occurs when a fish enters the structure under its own will. As such, swim speed is an irrelevant metric for assessing volitional entrainment. The primary factor limiting volitional entrainment is whether a given species or life stage can access the intake structure and the likelihood to be present. From the technical drawings provided in Appendix G, the spacing between trash rack bars on both structures is approximately 6 inches, so the trash racks are not expected to physically limit access to the structures for any of the target species or life stages, except for potentially large adult striped bass. Therefore, if any of the target fish species or life stages present in Pyramid Lake, aside from large adult striped bass, could theoretically access either the Angeles Tunnel Intake structure or the Pyramid Dam Low-Level Outlet Works structure, it is assumed that volitional entrainment could occur.

For any of the target fish species and life stages, volitional entrainment into either structure could result in possible injury or mortality resulting from pressure differentials (i.e., barotrauma) that would be experienced as fish travel from the relatively high-pressure intake depths in Pyramid Lake to the relatively low-pressure environment at the tunnel discharge point. The rapid decompression that can occur in this transition may result in damaged, ruptured, or everted swim bladders or other internal organs (Algera et al. 2020[27]; Brown et al. 2014[28]). At Pyramid Dam, the stream release facility consists of four conevalves which could impinge entrained individuals larger than the valve gap, which varies with the release discharge, and results in mortality. Additionally, the Low-Level Outlet Works discharges onto rock or riprap, which could result in injury or mortality of volitionally entrained fish through abrasion or impact. Furthermore, turbines used for hydroelectric generation can exacerbate barotrauma and cause injury or mortality through blade strikes or impingement. Francis-type turbines, such as those used for power generation at Castaic Powerplant, have been found to be associated with higher rates of mortality in fish than other types of turbines (e.g., Kaplan turbines) (Algera et al. 2020). Therefore, the likely sources of injury or mortality for fish volitionally entrained into the Pyramid Dam Low-Level Outlet Works structure include barotrauma and risks associated with impingement in the valves of the stream release facility and being discharged onto rock or riprap. For planktonic larval life stages that can pass through the intakes and possibly the valves, if they are present during the large releases which are limited to timing of large inflows, the major cause of mortality would likely be shear stress and turbulence created by passage of water through the cone valves. For fish volitionally entrained into the Angeles Tunnel Intake structure, the likely sources of mortality include barotrauma and risks associated with passage through the Francis-type turbines at the Castaic Powerplant. The rate of potential mortality that would be expected for either structure is not known, but may be high or even complete (i.e., 100 percent mortality) due to the hydraulic head (approximately 250 feet on average) associated with both structures and the potential barometric pressure differential resulting from that hydraulic head (Brown et al. 2014). However, volitional entrainment into either structure is highly unlikely for the larval life stages of largemouth bass, striped bass and rainbow trout, and for juvenile and small adult hitch, which, as mentioned above, are very unlikely to be in the vicinity of the intakes.

6.3 QUAIL LAKE, PEACE VALLEY PIPELINE, AND WARNE POWERHOUSE

FERC's AIR Item No. 12 identified that the effects of fish entrainment at Warne Powerplant would be analyzed in FERC's relicensing National Environmental Policy Act document. As such, the Licensees provide the following additional information regarding the potential for involuntary or volitional entrainment of target fish species and their associated life stages from Quail Lake into the Peace Valley Pipeline, and the potential for associated mortality of entrained fishes at the Warne Powerhouse.

[27] Algera, D. K., T. Rytwinski, J. J. Taylor, J. R. Bennett, K. E. Smokorowski, P. M. Harrison, K. D. Clarke, E. C. Enders, M. Power, M. S. Bevelhimer, and S. J. Cooke. 2020. What are the relative risks of mortality and injury for fish during downstream passage at hydroelectric dams in temperate regions? A systematic review. Environmental Evidence (2020)9:3.

[28] Brown, R. S., A. H. Colotelo, B. D. Pflugrath, C. A. Boys, L. J. Baumgartner, Z. D. Deng, L. G. M. Silva, C. J. Brauner, M. Mallen-Cooper, O. Phonekhampeng, G. Thorncraft, and D. Singhanouvong. 2014. Understanding barotrauma in fish passing hydro structures: a global strategy for sustainable development of water resources. Fisheries 39(3):108-122.

The Licensees' Quail Lake Fisheries Assessment (Study 4.1.2) identified that largemouth bass and striped bass were among the most abundant fish species observed during fish sampling at Quail Lake. The smallest striped bass encountered during the Licensees' study was approximately 7.5 inches in length, indicating that striped bass of age 1 year and older are present in Quail Lake. Landlocked populations of striped bass exist in some California waters; however, they are mostly not self-reproducing as landlocked striped bass can breed only when there are rivers with sufficient length and flows to suspend eggs long enough until they hatch (CDFW 2020[29]; University of California Davis 2020[30]). Striped bass are not expected to be naturally reproductive in Quail Lake, but the presence of larval, juvenile, and adult striped bass is possible through transmission of State Water Project (SWP) water.

Largemouth bass were observed across a range of lengths during the Licensees' study, and given the presence of abundant suitable spawning habitat, it is likely that largemouth bass have become established and are naturally reproducing in Quail Lake. While hitch were listed in a DWR brochure (1997[31]) as being present in Quail Lake, that document did not provide any sources for the presence of hitch, and no hitch were observed during the Licensees' Study 4.1.2. The FLA identified that rainbow trout were historically stocked sporadically in Quail Lake by CDFW as part of the statewide trout stocking program, but CDFW ceased fish stocking at Quail Lake in 2012, and no rainbow trout were observed during the Licensees' Study 4.1.2. Therefore, the following analysis of involuntary and volitional entrainment of Quail Lake fish into the Peace Valley Pipeline focuses on all life stages of largemouth bass and striped bass.

Water released from Quail Lake through Quail Lake Outlet flows into the Lower Quail Canal, which is a 2-mile-long, concrete-lined canal that serves as a conveyance to the Peace Valley Pipeline Intake and acts as a surge pond during startup of the Warne Powerplant. The canal has a bottom width of 24 feet, northern embankment height of approximately 50 feet, and a southern embankment height of about 40 feet; a maximum flow capacity of 3,129 cfs; and normally operates between an elevation of 3,310 feet and 3,324.5 feet. The canal volume is 1,150 acre-feet at an elevation of 3,325 feet.

From the intake, water is conveyed through the Peace Valley Pipeline into the bifurcated penstocks towards the two generating units of the Warne Powerplant for power generation. The intake structure dimensions and the maximum intake flow rate are provided in the *2014 Quail Dam Supporting Technical Information Document* (Quail Dam STID). Relevant figures from the Quail Dam STID that show the technical specifications of the intake structure are included in Appendix G of this response. Maximum near-field velocities were calculated with relation to the maximum intake discharge and gross area formed by the intake structure. The dissipation of velocity with

[29] CDFW. 2020. Marine Management News. Creature feature: striped bass. Available online: https://cdfwmarine.wordpress.com/2016/01/14/creature-feature-striped-bass/. Accessed June 15, 2020.
[30] UCDavis. 2020. California Fish Website. California fish species. Striped bass. Available online: http://calfish.ucdavis.edu/species/?ds=241&uid=96. Accessed June 15, 2020.
[31] California Department of Water Resources. 1997. Quail Lake (Brochure). State Water Project. Available online: http://www.water.ca.gov/recreation/brochures/pdf/7-97-Broch-Quail.pdf. Accessed October 1, 2018.

distance was calculated with respect to increasing radial distance from the intake structure as a function of surface area.

The Peace Valley Pipeline Intake structure consists of four identical 9-foot-wide by 54-foot-high entrances which transition to two 9- by 12-foot conduits. The left conduit, which flows into the Peace Valley Pipeline, has a 9-foot 9-inch by 13-foot 2-inch bulkhead gate and a 12-foot by 12-foot emergency slide gate. The unused right conduit contains a bulkhead gate. The left conduit entrance has a total intake area of 972 square feet. The maximum velocity induced by the intake is 1.61 feet per second, and is equal to the maximum discharge (1,564 cfs) divided by the effective flow area. In addition to the maximum discharge, the following discharge values were also analyzed, as determined from daily average discharges from a period of record of 1989 to 2017.

- 20 percent exceedance discharge (1989-2017): 1,118 cfs
- 80 percent exceedance discharge (1989-2017): 171 cfs
- Median discharge (1989-2017): 704 cfs

To estimate velocity dissipation with increasing distance from the intake, a hemispherical velocity dissipation model was applied to create a velocity-distance relationship for the field of influence created by the intake. The flat flow area of the intake structure was converted into a hemisphere radius with an equivalent surface area given by the hemispherical surface area equation presented in Section 2.1 of this Appendix F. This hemispherical model provides a reasonably conservative estimate because the surface area available for flow is likely greater than a perfect hemisphere as distance from the intake increases. Velocity dissipation in Lower Quail Canal is likely to be constrained by the trapezoidal shape and physical dimensions of the canal. Therefore, the maximum flow area is a function of water elevation in the canal. Section 2.4.2 of the Quail Dam STID states that the normal maximum water depth is 38.3 feet, leaving 4 feet of lined freeboard. At this depth, the maximum flow area in the canal is 3,198 square feet. At maximum flow capacity of 1,564 cfs through the Peace Valley Pipeline Intake, this area results in a minimum velocity of 0.49 feet per second. For all modeled discharges, velocity dissipation ceased at a distance of 10.1 feet from the intake as a result of the canal dimensions, and velocities in Lower Quail Canal further than 10.1 feet upstream from the Peace Valley Pipeline Intake became constant. Calculated approach velocities for the Peace Valley Pipeline Intake are presented in Figure F7-1.

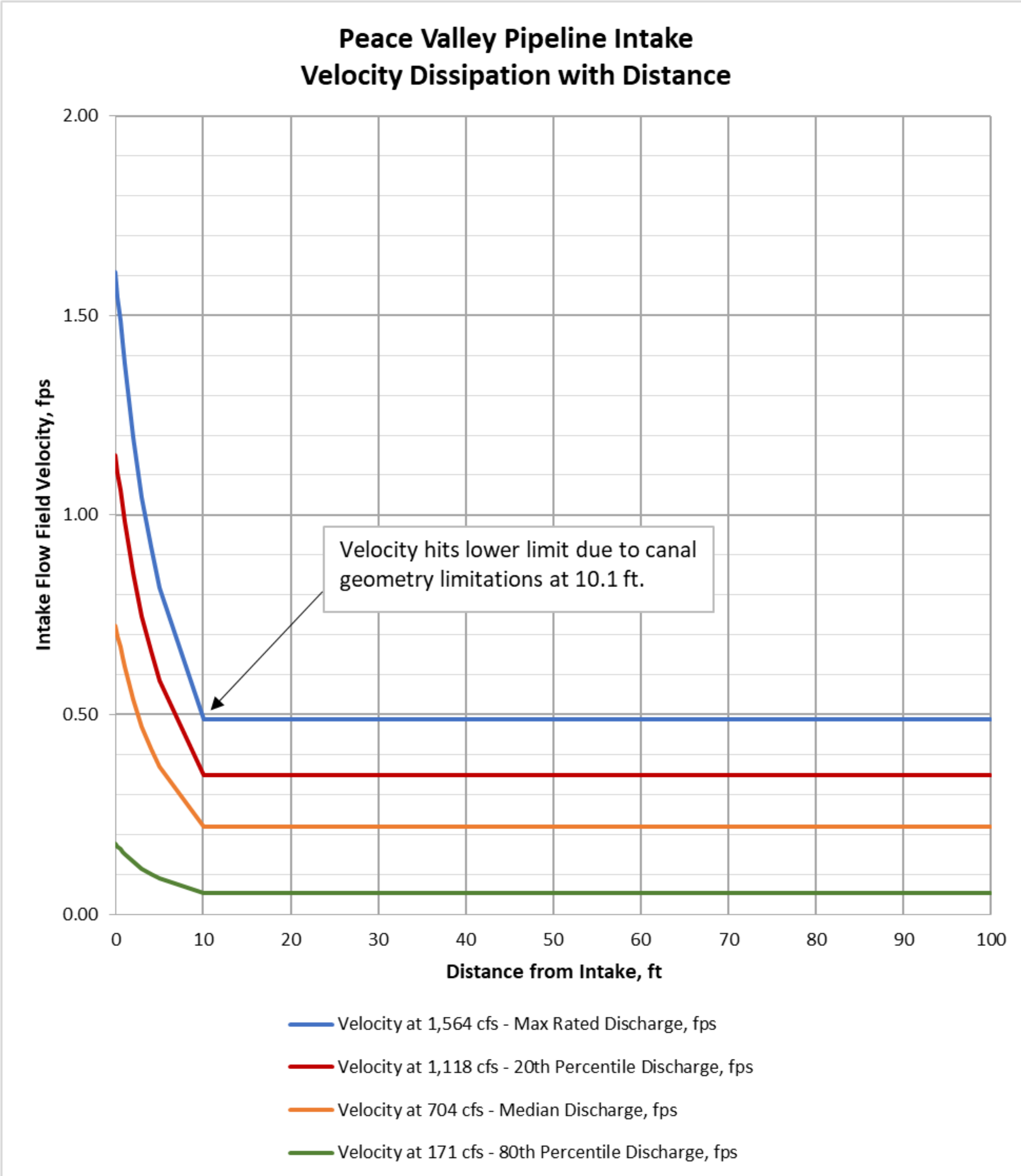

Figure F6-1. Area of Velocity Influence for the Peace Valley Pipeline Intake Structure at a Range of Intake Discharges

According to the calculated intake velocities and based on swim speeds alone, involuntary entrainment into the Peace Valley Pipeline Intake is only expected to be possible for larval life stages of largemouth bass and striped bass (Table F7-1). Larval largemouth bass are expected to remain near nests for protection; however, suitable largemouth bass spawning habitat is not present in the concrete-lined Lower Quail Canal. Larval striped bass, if present, are closely associated with high densities of their planktonic prey base, which is expected to occur in the main body of Quail Lake rather than in Lower Quail Canal. Therefore, while entrainment is possible for larval life stages of largemouth bass and striped bass from Quail Lake into the Peace Valley Pipeline, the rate of entrainment is expected to be low due to a low likelihood of occurrence for larval largemouth bass and striped bass to be in the Lower Quail Canal.

Table F6-3. Approximate Entrainment Distances for Target Fish Species and Life Stages for Peace Valley Pipeline Intake Structure

Species	Life Stage	Swim Speed (fps)	Discharge to Peace Valley Pipeline (cfs)			
			1,564	1,118	704	171
Largemouth bass	Larval	0.13[b]	*>100*	*>100*	*>100*	*2*
	Juvenile	2.71[a]	--	--	--	--
	Adult	4.34[a]	--	--	--	--
Striped bass	Larval	0.25[b]	*>100*	*>100*	*10*	--
	Juvenile (4 in.)	3.33[a]	--	--	--	--
	Juv/Ad (10 in.)	8.33[a]	--	--	--	--
	Juv/Ad (14 in.)	11.67[a]	--	--	--	--
	Adult (19 in.)	15.83[a]	--	--	--	--

Notes:
Distance (in feet) from Peace Valley Pipeline Intake in italics
[a]Burst speed
[b]Sustained speed
-- No entrainment expected at any distance from intake based on calculated velocities and documented swim speeds.
Key:
cfs = cubic feet per second
fps = feet per second
in. = inches
Juv/Ad (# in.) = a fish of # length could be juvenile or adult depending on sex

Due to the relatively shallow depth of the Peace Valley Pipeline Intake, it is expected that any life stage of largemouth bass and striped bass, if inclined to do so, could volitionally enter the Peace Valley Pipeline Intake. However, as stated above, larval life stages are not expected to occur in Lower Quail Canal due to their habitat requirements. Therefore, volitional entry of largemouth bass and striped bass is expected to be limited to the juvenile and adult life stages.

The Warne Powerplant utilizes two Pelton wheel generators for power generation. Pelton wheel turbines function through the discharge of water through constricting nozzles, which create high-velocity jets of water that are directed into the drive cups on the turbine wheel. The rate of mortality for fish entrained into the Peace Valley Pipeline Intake and discharged onto the Pelton wheels at Warne Powerplant is expected to be high or even complete (i.e., 100 percent). The source of mortality is expected to be high-velocity impact with the drive cups on the Pelton wheels, should any fish make it past the high velocity nozzles that direct water to each drive cup.

7.0 CONCLUSIONS

7.1 PYRAMID DAM LOW-LEVEL OUTLET WORKS AND ANGELES TUNNEL INTAKE STRUCTURE

From the information and analyses presented above, based on swim speeds alone, the risk of involuntary entrainment into the Angeles Tunnel Intake structure and the Pyramid Dam Low-Level Outlet Works structure is nonexistent or essentially non-existent for all but the highest modeled discharges (i.e., 18,400 cfs and 11,539 cfs for the Angeles Tunnel Intake structure; 4,400 cfs and 1,882 cfs for the Pyramid Dam Low-Level Outlet Works) for adult rainbow trout, adult and juvenile largemouth bass, striped bass age 2 years and older, and adult hitch. In addition, entrainment of larval largemouth bass and striped bass, and juvenile and small adult hitch is possible across most modeled discharges (i.e., 18,400 cfs, 11,539 cfs, 5,766 cfs, and 2,502 cfs) in the Angeles Tunnel Intake structure and across the highest three modeled discharges (i.e., 4,400 cfs, 1,822 cfs, and 1,200 cfs) in the Pyramid Dam Low-Level Outlet Works structure. Additionally, if any life stage of a target fish species were to occur in the vicinity of either structure, volitional entrainment could potentially occur and could result in injury or mortality through the mechanisms of barotrauma, impingement, abrasion, concussion by turbine impellers, or from hydraulic shear stresses and cavitation.

However, when taking into account the ecological and behavioral information for the target species and life stages presented in Section 4.0 of this appendix, the likelihood of any life stage of any target fish species occurring in Pyramid Lake at the depth of the structures is extremely low to nonexistent. As previously discussed, the larval and small juvenile life stages of all target fish species are dependent on littoral or stream habitats for growth and survival. The two structures occur at approximately 250 feet below the average operating water surface elevation of Pyramid Lake. Of the target fish species and life stages, adult rainbow trout, juvenile and adult striped bass, and adult hitch are the only groups that are not closely associated with relatively shallow depths in littoral habitats, based on the information provided in Section 4.0 above. Adult rainbow trout, juvenile and adult striped bass, and adult hitch are known to occupy pelagic habitats in open water sections of lakes (Moyle 2002; Nowack and Quinn 2002; Quinn 2005). However, during periods of stratification (i.e., April through September in Pyramid Lake), these fish are not known to venture below the depth of the thermocline most likely due to low prey availability in the hypolimnion (Moyle 2002; Nowack and Quinn 2002; Mueller and Horn 1999). Downstream-migrating juvenile anadromous salmonids have been shown to prefer relatively shallow depths and to seek downstream currents during outmigration (Cash et al. 2002; Faber et al. 2011). Juvenile rainbow trout from Piru Creek above Pyramid Lake attempting to migrate downstream through Pyramid Lake during the spring or summer would not encounter a directed downstream current in Pyramid Lake, and would have to exhibit the unlikely behavior of diving deeper than their documented preference to encounter the flow field of either intake structure.

During periods of non-stratification (i.e., October through March in Pyramid Lake), pelagic rainbow trout would be expected to be transitioning back to near shore habitats and lesser depths (James and Kelso 1995; Moyle 2002; Quinn 2005). As previously described, largemouth bass are not typically associated with pelagic habitats, tend not to be migratory, and have relatively small home ranges (Essington and Kitchell 1999; Ahrenstorff et al. 2009). As such, largemouth bass habitat utilization is not expected to be significantly influenced by the presence or absence of stratification. Striped bass that are not migrating out of lakes to spawn can remain pelagic during the non-stratified period, but have not been documented in deep lakes at depths greater than approximately 180 feet, even when maximum lake depth far exceeds that depth (Gustaveson et al. 1984; Mueller and Horn 1999). Hitch behavior in lakes during non-stratified periods is not well documented. However, regardless of life stage, hitch are generally documented to remain closely associated with their main prey base (i.e., zooplankton; Moyle 2002). During periods of mixing, vertical distributions of zooplankton in the water column may reach greater depths than during periods of stratification, but the maximum depth of zooplankton is driven by the depth of phytoplankton, which in turn is controlled by the depth to which light penetrates into the water column (Longhi and Beisner 2009[32]). In Pyramid Lake, light would not be expected to penetrate to depths of approximately 250 feet where the intake structures are located. A general rule of thumb used by limnologists to identify the maximum depth of light penetration is to multiply the maximum depth of visibility from the surface, as measured with a Secchi disk, by three. According to this approximation and using Secchi depth readings from Pyramid Lake from water quality investigations conducted by the Licensees from 2015 through 2019, an average maximum light penetration of approximately 48 feet occurs from October through December in Pyramid Lake (DWR 2015-2019 – Station PY001000). Therefore the depth of zooplankton, and adult hitch by association, in Pyramid Lake during non-stratified periods would not be expected to exceed approximately 50 feet.

For the reasons stated above including consideration on the timing of various life stages, no life stage of any target fish species would be expected to occur in the vicinity of either the Angeles Tunnel Intake structure or the Pyramid Dam Low-Level Outlet Works structure. Therefore, involuntary entrainment of target fish species and their life stages into either structure is not expected to occur. Additionally, because no life stage of any target fish species is expected to occur in the vicinity of either intake structure, volitional entrainment of any life stage of target fish species into either intake structure is not expected. Not only is it improbable that an individual of any life stage would descend to the deeper portions of Pyramid Lake where the intakes occur, but it is highly unlikely that, when in the deep portion of the reservoir, individuals would encounter the area of influence around the intakes given that the depth of the intakes corresponds to an area of approximately 100 acres (as shown in the area-capacity curve presented in Figure 4.2-12 of Appendix B of the Licensees' FLA). Furthermore, given the highly improbable occurrence that a single individual from any life stage of any target species would be involuntarily or volitionally entrained, it is even more improbable that enough individuals

[32] Longhi, M. L. and B. E. Beisner. 2009. Environmental factors controlling the vertical distribution of phytoplankton in lakes. Journal of Plankton Research 31(10):1195-1207.

of any target fish species would be entrained in sufficient numbers to affect the species' population as a whole in the reservoir, or downstream of Pyramid Dam should it survive entrainment.

7.2 PEACE VALLEY PIPELINE INTAKE AND WARNE POWERHOUSE

While involuntary entrainment is possible for larval life stages of largemouth bass and striped bass from Quail Lake into the Peace Valley Pipeline, the rate of entrainment is expected to be low due to a low likelihood of occurrence for larval largemouth bass and striped bass to be in the Lower Quail Canal. As discussed above, volitional entrainment into Peace Valley Pipeline Intake is technically possible for any life stage of largemouth bass and striped bass, but is expected to be limited to the juvenile and adult life stages for both species due to the habitat requirements and typical behavior of larval life stages of both species. High rates of mortality for any life stage of largemouth bass and striped bass associated with involuntary or volitional entrainment into Peace Valley Pipeline are expected due to the Pelton wheel-driven generators utilized at Warne Powerplant.

However, sufficiently high rates of involuntary and volitional entrainment into the Peace Valley Pipeline and associated mortality at Warne Powerplant of largemouth bass and striped bass would need to occur to result in significant harm (i.e., greater than background rates of natural mortality) to the populations of largemouth bass and striped bass in Quail Lake. As stated previously, largemouth bass and striped bass were among the most abundant fish species encountered during the Licensees' Study 4.1.2, and observed condition factors of sampled individuals indicated that the populations of both species in Quail Lake are healthy. Furthermore, Quail Lake has historically supported and continues to support a popular recreational fishery that primarily targets both striped bass and largemouth bass. Both of these pieces of information suggest that, while involuntary and volitional entrainment of largemouth bass and striped bass into Peace Valley Pipeline is possible, the rate of entrainment into the Peace Valley Pipeline and mortality at Warne Powerplant of largemouth bass and striped bass is sufficiently low to not result in adverse effects to the overall larger populations of largemouth bass and striped bass in Quail Lake, which continue to be augmented through delivery of SWP water.

Attachment 1, Appendix G

ADDITIONAL ANALYSIS – Fish Entrainment Risk Assessment Study – DRAWINGS

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ATTACHMENT 1

APPENDIX G

ADDITIONAL ANALYSIS – Fish Entrainment Risk Assessment Study – DRAWINGS

In accordance with Section (§) 5.30 and § 4.32(k) of the Federal Energy Regulatory Commission's (FERC) regulations, and in light of heightened national security concerns, the Licensees request that the Fish Entrainment Risk Assessment Study drawings included in this Appendix G of Attachment 1 be treated by FERC as Critical Energy Infrastructure Information (CEII) under § 388.112 of FERC's regulations, and not be released to the public.

The drawings satisfy the definition of CEII in § 388.112(c) of FERC's regulations because they contain design information about existing critical infrastructure that relates to details about the generation and transmission of electrical energy, and could be useful to a person planning an attack on critical infrastructure. Moreover, such information is exempt from disclosure under the freedom of Information Act 5 United States Code § 552.

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Attachment 1, Appendix H

Tricolored Blackbird Potential Habitat

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ATTACHMENT 1

APPENDIX H

Tricolored Blackbird Potential Habitat

Appendix H contains sensitive, confidential, and privileged information regarding potential habitat for the Tricolored Blackbird within the proposed Project boundary.

The Licensees request that the information included in this Appendix H of Attachment 1 be treated by the Federal Energy Regulatory Commission (FERC) as Privileged and Controlled Unclassified Information (CUI), and not be released to the public.

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Attachment 1, Appendix I

Revised Sensitive Aquatic and Terrestrial Wildlife Management Plan

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SOUTH SWP HYDROPOWER
FERC PROJECT NO. 2426-227

SENSITIVE AQUATIC AND TERRESTRIAL WILDLIFE MANAGEMENT PLAN

July 2020

State of California
California Natural Resources Agency
DEPARTMENT OF WATER RESOURCES
Hydropower License Planning and Compliance Office

LA DWP Los Angeles Department of Water & Power

Los Angeles
DEPARTMENT OF WATER AND POWER

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COMMONLY USED TERMS, ACRONYMS AND ABBREVIATIONS

ANF	Angeles National Forest
APLIC	Avian Power Line Interaction Committee
Application for New License	Licensees' Application for a New License for Major Project – Existing Dam for the South SWP Hydropower, Federal Energy Regulatory Commission Project No. 2426-227
BLM	U.S. Department of the Interior, Bureau of Land Management
CDFW	California Department of Fish and Wildlife
CESA	California Endangered Species Act
DWR	California Department of Water Resources
Emergency	Defined as an event that is reasonably out of the control of the Licensees and requires the Licensees to take immediate action, either unilaterally or under instruction of law enforcement, emergency services, grid balancing authorities including California Independent System Operator and Los Angeles Department of Water and Power, or other regulatory entity, including actions to prevent the imminent loss of human life, injury to the public or the Licensees' staff, or damage to property. An emergency may include but is not limited to: natural events such as earthquakes, landslides, storms, or wildfires; vandalism; malfunction, failure, or loss of reliability of the electric grid or Project works; or other public safety incidents.
Equipment Exclusion Zone	Areas around perennial streams, permanent bodies of water, and intermittent streams and ponds, where mobile and heavy equipment cannot be parked, driven, or used off of a Primary Project Road. The mobile and heavy equipment may be parked, driven, or used within the right-of-way of the Primary Project Road.
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
IVMP	Integrated Vegetation Management Plan
LADWP	Los Angeles Department of Water and Power
Licensees	California Department of Water Resources and Los Angeles Department of Water and Power
LPNF	Los Padres National Forest
LWM	large woody material
MOU	Memorandum of Understanding
NFS	National Forest System

O&M	operations and maintenance
Primary Project Road	A Primary Project Road is identified in the license as a Project facility, is used almost exclusively to access the Project, is within the Project boundary, and is operated and maintained exclusively by the Licensees as a Project feature. This includes roads associated with Project recreation facilities but does not include designated parking areas that are considered part of the facility or feature for which the parking area is provided. Primary Project Roads do not include "shared," "joint," or "multiple use" roads that are used and maintained by multiple parties, including the Licensees.
Project	South SWP Hydropower, Federal Energy Regulatory Commission Project No. 2426
SWP	State Water Project
USFS	U.S. Department of Agriculture, Forest Service
USFWS	U.S. Department of the Interior, Fish and Wildlife Service

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1.0 INTRODUCTION

On January 30, 2020, the California Department of Water Resources (DWR) and the Los Angeles Department of Water and Power (LADWP) (Licensees), pursuant to Title 18 of the Code of Federal Regulations, Subchapter B (Regulation under the Federal Power Act), Part 4, Subpart F (Application for License for Major Project – Existing Dam) and Part 5 (Integrated Licensing Application Process), filed with the Federal Energy Regulatory Commission (FERC) an Application for a New License for Major Project – Existing Dam (Application for New License) for the Licensees' South SWP Hydropower, FERC Project No. 2426 (Project).

The Licensees included this Sensitive Aquatic and Terrestrial Wildlife Management Plan (Plan) in their Application for New License. On July 24, 2020, DWR and LADWP updated and resubmitted this Plan in response to FERC's April 27, 2020 Additional Information Request.

All elevation data in this exhibit are in United States (U.S.) Department of Commerce, National Oceanic and Atmospheric Administration, National Geodetic Survey Vertical Datum of 1929, unless otherwise stated.

1.1 BACKGROUND

1.1.1 Brief Description of the Project

The Project is part of a larger water storage and delivery system, the State Water Project (SWP), which is the largest state-owned and operated water supply project of its kind in the United States. The SWP provides southern California with many benefits, including affordable water supply, reliable regional clean energy, opportunities to integrate green energy, accessible public recreation opportunities, and environmental benefits.

The Project is located within Los Angeles County in southern California, on the West Branch of the SWP. The Project has a FERC-authorized installed capacity of 1,349,290 kilowatts. Project facilities range in elevation from 3,325 feet to 1,130 feet, and include the Warne Power Development and Castaic Power Development. Facilities and features of the Warne Power Development include: (1) Quail Lake, Quail Lake Embankment and Quail Lake Outlet; (2) Lower Quail Canal and Quail Detention Embankment; (3) Peace Valley Pipeline Intake, Peace Valley Pipeline Intake Embankment, and Peace Valley Pipeline; (4) Gorman Bypass Channel; (5) William E. Warne Powerplant and Switchyard; (6) Primary Project Roads and Trails; (7) Quail Lake recreation facilities, and (8) streamflow and reservoir staff gages. Facilities and features of the Castaic Power Development include: (1) Pyramid Dam and Lake; (2) Angeles Tunnel and Surge Chamber; (3) Castaic Penstocks; (4) Castaic Powerplant and Switchyard; (5) Elderberry Forebay Dam, Elderberry Forebay, and Outlet; (6) Storm Bypass Channel and Check Dams; (7) Castaic Transmission Line; (8) Primary Project Roads and Trails; and (9) Pyramid Lake recreation facilities.

Facilities upstream of the Angeles Tunnel Surge Chamber are operated and managed by DWR. The remainder of the downstream facilities, including the Surge Chamber, are operated and managed by LADWP. An April 2010 amendment to the Memorandum of Understanding (MOU) between the U.S. Department of Agriculture, Forest Service (USFS) and DWR outlines the responsibilities regarding management of recreation facilities at Pyramid Lake. In accordance with Amendment No. 2 to the MOU, effective January 1, 2011, DWR assumed responsibility from USFS for routine operations and maintenance (O&M) of recreation sites located on National Forest System (NFS) lands located within the Project boundary and management of public recreation activities at these sites and on Pyramid Lake itself.

The Project is operated as a power recovery project using SWP water. For that reason, Project operations do not vary based on changes in local hydrological conditions. In essence, the Project is operated in a run-of-release mode, generating power as SWP water is provided for downstream consumptive use, with the exception that the Castaic Powerplant is a pumping–generating plant that reuses SWP water to generate electricity before it is delivered to downstream water users.

The Project boundary comprises 2,007.0 acres, of which 1,334.6 acres are managed by the Angeles National Forest (ANF), 665.9 acres are managed by the Los Padres National Forest (LPNF), and 6.5 acres are administered by the U.S. Department of the Interior, Bureau of Land Management (BLM). USFS administers the ANF and LPNF in conformance with the ANF and LPNF Land Management Plans (USFS 2005a, 2005b, 2005c). In addition, LADWP manages the Castaic Transmission Line right-of-way

Figure 1.1-1 shows the Project vicinity. Figure 1.1-2 shows the Project facilities, including land ownership.

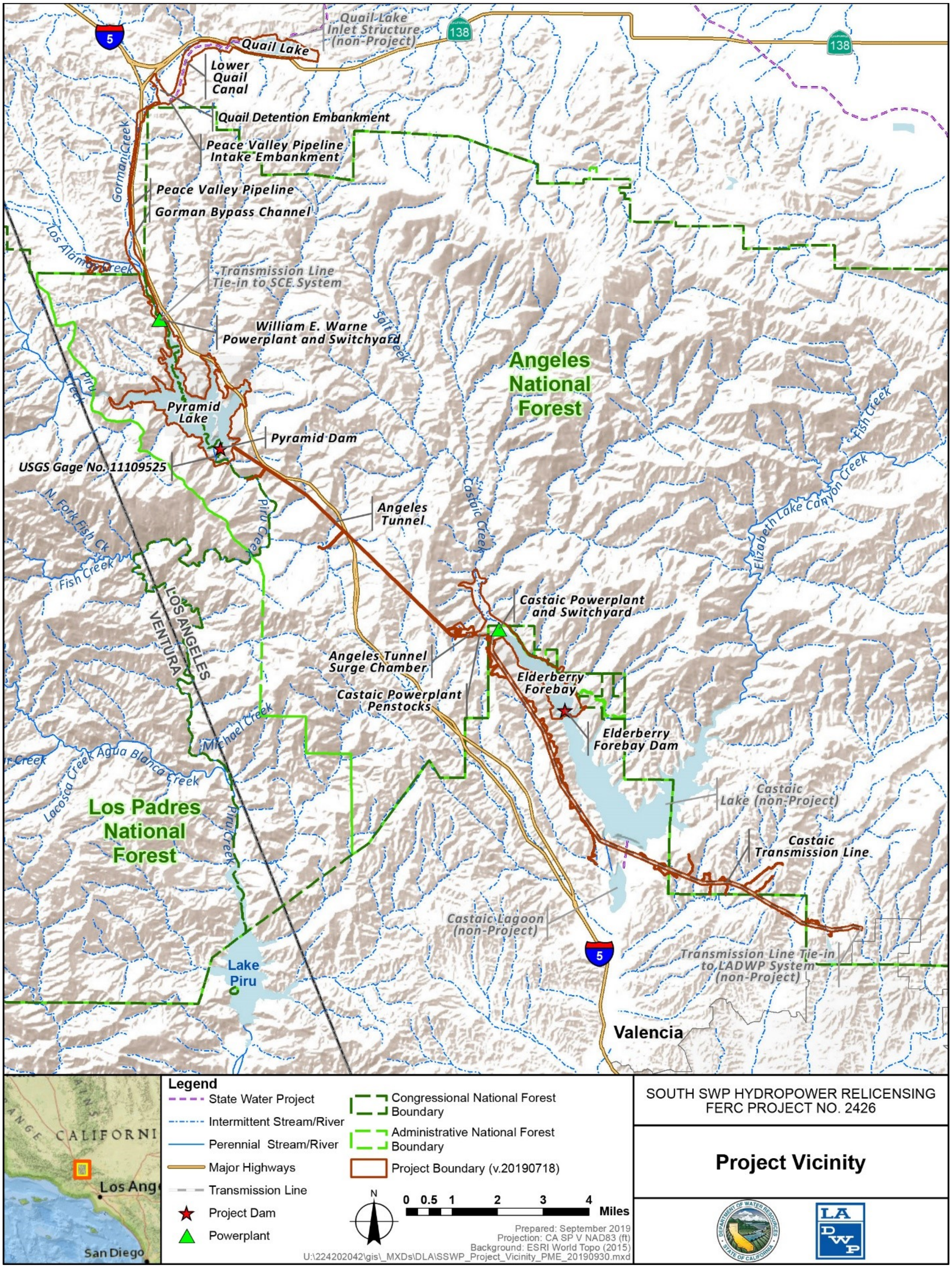

Figure 1.1-1. South SWP Hydropower Vicinity Map

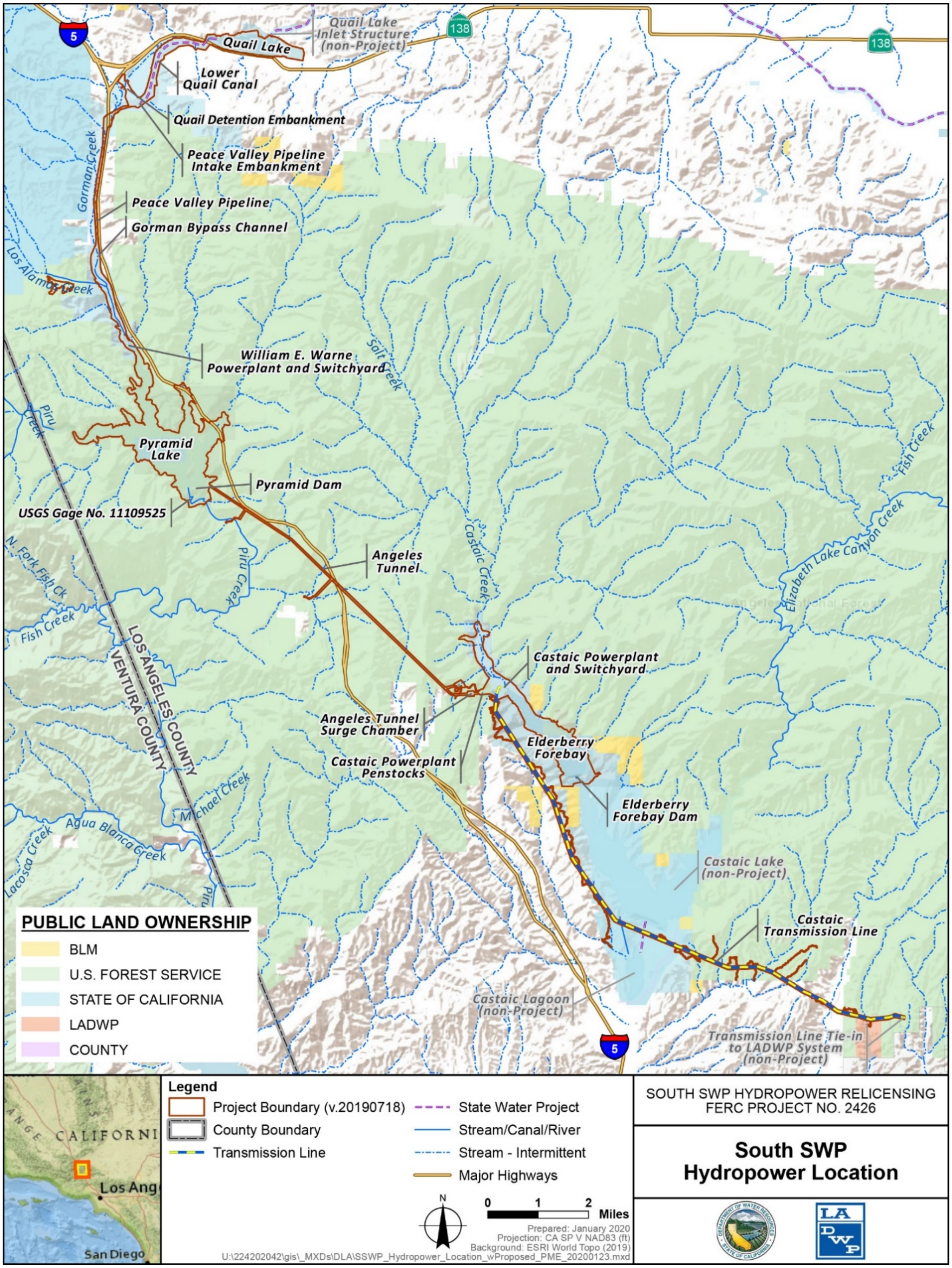

Figure 1.1-2. South SWP Hydropower Facilities and Land Ownership

1.2 PURPOSE OF THE PLAN

The purpose of this Plan is to describe measures that, when implemented, would minimize impacts from Project O&M and Project-related recreation to sensitive aquatic and terrestrial wildlife species (sensitive species) and sensitive habitats. For the purpose of this Plan, sensitive species include species listed or proposed for listing under the Endangered Species Act (ESA) or the California Endangered Special Act (CESA); listed as Fully Protected by the State; listed as Forest Service Sensitive when they occur on NFS lands; listed as Sensitive when they occur on lands administered by BLM; and/or listed as a Species of Special Concern by the California Department of Fish and Wildlife (CDFW). Further, for the purpose of this Plan, sensitive habitats include wetlands[1], riparian areas[2], waters of the United States[3] and the State[4], littoral zones[5] and vegetation communities listed as Sensitive Natural Communities[6] by CDFW. The Licensees will coordinate the efforts required under this Plan with other Project resource efforts, including implementation of other resource management plans and measures included in the new license.

1.3 GOAL AND OBJECTIVE OF THE PLAN

The primary goal of the Plan is to describe protective measures during Project O&M and Project-related recreation that would be implemented under the new license to protect sensitive species and sensitive habitats. The objective of the Plan is to provide guidelines to meet the goal of the Plan.

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[1] Wetlands are defined by federal policy as "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and which, under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (EPA 2018). Wetland areas include marshes, shallow swamps, lakeshores, wet meadows, and riparian areas, and often occur along or adjacent to perennial or intermittent water bodies. State wetlands are defined as "an area is wetland if, under normal circumstances, (1) the area has continuous or recurrent saturation of the upper substrate caused by groundwater, or shallow surface water, or both; (2) the duration of such saturation is sufficient to cause anaerobic conditions in the upper substrate; and (3) the area's vegetation is dominated by hydrophytes or the area lacks vegetation." (SWRCB 2019).

[2] Riparian areas are vegetated zones that form a transition between permanently saturated areas and upland areas, and that typically exhibit vegetation and physical characteristics associated with permanent sources of surface water or groundwater (USACE 1987).

[3] Waters of the United States is defined, as applicable to the Project, at the following link: https://www.epa.gov/sites/production/files/2020-01/documents/navigable_waters_protection_rule_prepbulication.pdf. (USACE and EPA 2020; 85 Federal Register 22250 [Final Rule April 21, 2020]).

[4] State waters, as applicable to the Project, are defined as any surface water or groundwater, including saline waters, within the boundaries of the State (SWRCB 2008). Waters of the State includes all waters of the United States (SWRCB 2019).

[5] Littoral areas are those areas with standing water of depths less than 6.6 feet. These areas typically support aquatic bed or emergent vegetation (Cowardin et al. 1979).

[6] CDFW considers natural communities, as defined by VegCAMP, Sensitive Natural Communities if they have ranks of S1 (Critically Imperiled), S2 (Imperiled) or S3 (Vulnerable) (CDFW 2020). Within the Project boundary, known Sensitive Natural Communities include Desert Riparian (51.5 acres), Joshua Tree (0.2 acres), Valley Foothill Riparian (96.3 acres), Desert Wash (2.5 acres), Fresh Emergent Wetland (55.3 acres), and Wet Meadow (20.9 acres).

1.4 CONTENTS OF THE PLAN

The Plan includes the following:

- Section 1.0. Introduction. This section includes introductory information, including a brief description of the Project, and the purpose, goal, and objective of the Plan.
- Section 2.0. General Protection Measures. This section includes protection measures that cover a variety of species and locations on the Project during both routine[7] and non-routine Project O&M activities.[8] Some measures may be applied differently based on the species, location, expected level of disturbance, and the nature O&M activity being undertaken.
- Section 3.0. Consultation and Plan Revisions. This section includes a plan for consultation with USFS and other applicable resource agencies; and identifies when the Licensees will review, update, and/or revise the Plan, in consultation with USFS and other applicable resource agencies.
- Section 4.0. References Cited. This section includes the resource documents cited in this Plan.

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[7] Routine Project O&M activities include those described in Exhibit B of the Licensees' Application for New License.

[8] Non-routine Project O&M includes activities conducted outside of day-to-day routine operations and maintenance, including: major transmission pole replacements (>5 consecutive poles in a single area), reconductoring multiple spans in a non-emergency situation, road and facility construction or repair not described in Exhibit B, ground-disturbing activities of greater than 0.5 acre not described in Exhibit B, vegetation management/removal projects outside of areas described in the Licensees' Application for New License, and other activities not described in Exhibit B of the Licensees' Application for New License.

2.0 GENERAL PROTECTION MEASURES

Sensitive species within the Project boundary will be protected through a series of measures. These measures will include protections to sensitive habitats, specific time restrictions, and the implementation of protective buffers around known sensitive resources, as described below. Some measures may be applied differently based on the species, location, expected level of disturbance, and the nature O&M activity being undertaken.

2.1 MEASURES TO PROTECT SENSITIVE HABITATS

Unless otherwise specified by existing State and federal permits and authorizations, the Licensees will implement the measures described below to protect riparian areas, wetlands, and littoral zones during Project O&M activities:

- Establish, excluding Primary Project Roads, a mobile and heavy equipment exclusion zone[9] within 100 feet of perennial streams or permanent bodies of water, and 50 feet of intermittent streams and ponds, unless otherwise coordinated with USFS on NFS lands or BLM on BLM-administered lands. Mobile and heavy equipment may be parked, driven, or used within the right-of-way of a Primary Project Road.

- In a riparian zone (except for the 100-foot protective buffer around reservoirs) outside of recreation facilities, leave large woody material (LWM) on site unless the LWM has the potential to result in a safety risk, or USFS on NFS lands or BLM on BLM-administered lands determines that the LWM poses an unacceptable fire risk.

- Except as otherwise needed for safety purposes, at dams and along Primary Project Roads, minimize native vegetation removal in wetland, riparian, or littoral zones.

- Minimize Project activities in Sensitive Natural Communities and discuss any non-routine Project O&M planned inside a Sensitive Natural Community with CDFW and the applicable land management agency during the Agency Consultation Meeting described in Section 3.1 to identify Best Management Practices.

- Avoid disturbing habitat for the San Emigdio blue butterfly (*Plebulina emigdionis*), specifically the four-winged saltbrush (*Atriplex canescens*), unless surveys of four-winged saltbrush plants that may be disturbed by Project O&M find no evidence of use by the San Emigdio blue butterfly.

[9] Mobile and heavy equipment exclusion zone is defined as areas around perennial streams, permanent bodies of water, and intermittent streams and ponds, where mobile or heavy equipment cannot be parked, driven, or used off of a Primary Project Road.

2.2 MEASURES TO PROTECT SENSITIVE SPECIES AND NESTING BIRDS

The Licensees will implement the measures described below to protect sensitive species, sensitive habitat, nesting birds and other non-bird nesting while conducting Project O&M activities. In the case of an emergency, Project activities will be exempt from the measures. For the purpose of this Plan, an emergency is defined as an event that is reasonably out of the control of the Licensees and requires the Licensees to take immediate action, either unilaterally or under instruction of law enforcement, emergency services, grid balancing authorities including the California Independent System Operator and LADWP, or other regulatory entity, including actions to prevent the imminent loss of human life, injury to the public or the Licensees' staff, or damage to property. An emergency may include but is not limited to natural events such as earthquakes, landslides, storms, or wildfires; vandalism; malfunction, failure, or loss of reliability of the electric grid or Project works; or other public safety incidents. In case of an emergency, the Licensees will notify the U.S. Department of the Interior, Fish and Wildlife Service (USFWS) and CDFW as well as USFS if the emergency occurs on NFS lands and BLM if the emergency occurs on BLM-administered lands, within approximately 48 hours of commencement of Project activities that are undertaken based on an emergency and that require suspension of the protection measures described below.

- **Non-Routine Project Activities**. For non-routine Project activities, the Licensees will conduct pre-construction surveys for sensitive habitat (including four-winged saltbrush) and sensitive species in the work area and within a 500-foot search buffer of the work area, as practicable and as safely accessible. Any sensitive habitat will be flagged for avoidance, and appropriate protective buffers will be set up around occurrences of non-bird nests (e.g., woodrat nests), burrows, and other sensitive resources. If sensitive species are observed within the work area prior to or during work, they will be allowed to move from the area of their own volition, if feasible. If a sensitive species does not move out of the area, the Licensees' biologist will be contacted for subsequent action. If any ESA-listed or CESA-listed species are located during pre-construction surveys, the Licensees will consult with the USFWS or CDFW, as appropriate based on jurisdiction, prior to starting work to identify appropriate species-specific protection measures.

  If potential bat roosting habitat could be impacted, the procedures for removing hazard trees described in the Licensees' Integrated Vegetation Management Plan (IVMP) will be followed. If impacts to sensitive species or their habitats cannot be avoided, the Licensees will consult with the agency with jurisdiction and acquire any necessary permits or approvals prior to removing the hazard tree.

- **Breeding/Nesting Birds.** To protect native breeding birds, the Licensees will generally avoid areas of breeding/nesting, and plan vegetation removal and other Project activities that could impact nesting birds outside of the general avian breeding season of February 1 through August 31. If Project activities that could disturb breeding/nesting birds cannot be avoided during this period (i.e. limited operating period), the Licensees' biologist will coordinate a focused survey for active nests within the work area, plus a reasonable search buffer around the work area, within 7 days prior to the commencement of Project activities. If no nests are located within the search area, work may proceed as planned. If an active nest is located, the following recommended protective buffers will be considered when establishing protective measures around an active nest, unless otherwise specified by the USFWS and CDFW. Activities may require smaller or larger protective buffers due to the nature of the activity, the expected level of disturbance, and distance from the location of a Project activity.

- 0.5 mile for California condor (*Gymnogyps californianus*) or other ESA-listed birds (USFWS 1996),
- 660 feet for bald (*Haliaeetus leucocephalus*) and golden eagle (*Aquila chrysaetos*) (USFWS 2007),
- 500 feet for CESA-listed or Fully Protected raptor species,
- 60 to 300 feet for tricolored blackbird (*Agelaius tricolor*), depending on the level of disturbance (CDFW 2015)
- 300 feet for other CESA-listed species, special-status bird species, and native raptors, and
- 50 feet for all other native nesting birds.

For Project O&M activities that include the use of a helicopter, blasting, or other similar loud noises above existing background noise levels, a protective buffer of 0.5-mile around special-status species nest sites will be established, unless topographical or other physical barriers effectively block noise and reduce the need for a protective buffer.

If Project O&M staff incidentally observe signs of disturbance or distress to nesting birds in response to conducting routine Project O&M activities, staff will immediately cease the activities that are causing the disturbance/distress, as long as it is safe to do so, and will notify the Licensees' authorized representative or designee. A biologist will monitor the area where the disturbed/distressed bird(s) were observed to determine if there is a nest in the area. If the bird species is a protected species under the federal ESA or CESA, the biologist will meet the prerequisites consistent with permit requirements.

If a previously undetected active nest is detected, the Licensees will establish a appropriate protective buffer around the nest, as described, and work may continue. For non-ESA or CESA-listed species, if nesting birds within an established protective buffer exhibit signs of stress during continued work activities, the protective buffer will be expanded by half its existing width for the duration of Project activities or some additional width or distance determined by the biologist. If nesting birds continue to show signs of stress and disturbance, the activities will be delayed in the area until the nestlings have fledged or the nest is no longer active as determined by the biologist. If work needs to continue in the area of the nest, the Licensees will consult with the appropriate agencies about required measures.

Refer to the Licensees' Final Application for New License, Exhibit E, Section 5.3 (Fish and Aquatic Resources), Section 5.4 (Terrestrial Resources), and Section 5.4.3 (Federal ESA, Listed and Candidate Species) for the results of the Licensees' relicensing studies relative to sensitive species and sensitive habitats.

- **Sensitive Amphibians and Reptiles.** When the Licensees need to conduct vegetation management activities within 500 feet of known breeding sites or apply pesticides within 500 feet of known locations of sensitive amphibians and reptiles, the follow actions will be taken unless already covered under an existing permit or authorization by the USFWS, CDFW, and USFS. The Licensees will coordinate with USFS on NFS lands, BLM on BLM-administered lands, and CDFW and/or USFWS based on jurisdiction. Any pesticide use that is deemed by the Licensees as necessary on NFS lands will be designed to avoid adverse effects to individuals and their habitats. If the regulatory agency with jurisdiction (e.g., USFS, BLM, CDFW, USFWS) approves the application of pesticides within 500 feet of known locations of California red-legged frog or arroyo toad, the Licensees will apply pesticides according to label instructions, with considerations for recommended protection measures provided by those agencies. This measure applies to the sensitive amphibian and reptile species listed below.

  - California red-legged frog (*Rana draytonii*),
  - arroyo toad (*Anaxyrus californicus*),
  - foothill yellow-legged frog (*Rana boylii*),
  - Western spadefoot (*Spea hammondii*),
  - two-striped gartersnake (*Thamnophis hammondii*),
  - South Coast gartersnake (i.e., occurrences of California red-sided gartersnake [*Thamnophis sirtalis infernalis*] from coastal Ventura County to San Diego County),
  - Southern Western (or western) pond turtle (*Actinemys* [=*Emys*] *pallida* [or *marmorata pallida*]),
  - yellow-blotched salamander (*Ensatina eschscholtzii croceater*),

    - Northern California legless lizard (*Anniella pulchra*),
    - Southern California legless lizard (*Anniella stebbinsi)*,
    - California glossy snake (*Arizona elegans occidentalis*),
    - coastal whiptail (*Aspidoscelis tigris stejnegeri*),
    - San Bernardino ring-necked snake (*Diadophis punctatus mode*stus),
    - California mountain kingsnake (*Lampropeltis zonata parvirubra*),
    - coastal rosy boa (*Lichanura orcutti*),
    - coast horned lizard (*Phrynosoma blainvillii*), and
    - coast patch-nosed snake (*Salvadora hexalepis virgultea*),

- **Avian Collision with Project Transmission Line.** The Castaic Transmission Line will be made compliant with Avian Power Line Interaction Committee (APLIC) guidelines as transmission line poles are replaced or repaired (APLIC 2020). New and repaired poles will be designed to meet the most updated APLIC guidelines at the time of their repair or replacement. Any known bird strikes on the Castaic Transmission Line will be reported as part of the annual meeting, as described in Section 3.1. Information to be collected by the Licensees on bird strikes include: (1) location of strike; (2) species of bird; and (3) time and date. If an ESA- or CESA-listed species is found to have struck a Project transmission line, USFWS or CDFW, as appropriate, will be notified within 24 hours of discovering the bird. If there are multiple bird electrocutions at any specific part of the transmission line, the Licensees will coordinate with CDFW and/or USFWS, as applicable, on the possible placement of bird protective features on the lines and/or poles.

- **Hazard Tree Removal**. Within the Project boundary, the Licensees will adhere to the applicable procedures described in the Licensees' IVMP for removing hazard trees for the protection of sensitive species and sensitive habitats.

- **Elderberry Forebay**. For the protection of ESA- and CESA-listed species at Elderberry Forebay, pre-construction surveys will be conducted in the footprint and a 500-foot search buffer, where practicable and safely accessible, of Project O&M activities (e.g., dredging, dam repair, pesticide application, and vegetation management) that could impact ESA- or CESA-listed species or their habitats. If ESA- or CESA-listed species are located that are not covered by the Licensees' existing permits and/or Biological Opinions and/or Assessments, the Licensees will consult with USFWS or CDFW, as applicable, prior to beginning the work. If ESA- or CESA-listed species are covered by existing regulatory approvals, the provisions of the approvals will be followed. If no ESA- or CESA-listed species are located, work may continue as planned.[10]

- **Distressed Sensitive Species**. The Licensees' Project O&M staff will report any instances of injured, notably diseased, or deceased sensitive species observed within the Project boundary to the Licensees' authorized representative or designee, who will report the information to the jurisdictional agency(ies) as appropriate.

2.3 PESTICIDE USE RESTRICTIONS

Pesticides are defined as any chemical used to treat unwanted vegetation, algae, and aquatic weed species. For the protection of sensitive species and sensitive habitat, the Licensees will adhere to the pesticide use procedures described in the IVMP and will adhere to the terms and conditions of their existing State Water Resources Control Board-issued National Pollutant Discharge Elimination System permits and the associated Aquatic Pesticide Application Plans.

[10] Where existing Biological Opinions, permits, or other binding agreements pre-date this Plan with more restrictive requirements, their respective requirements will take precedence.

3.0 CONSULTATION AND PLAN REVISIONS

3.1 AGENCY CONSULTATION MEETING

Beginning the first full calendar year of the new license and annually thereafter, the Licensees will hold a meeting with USFS and other applicable resource agencies to discuss sensitive species and sensitive habitats. As part of the meeting, the Licensees will share information regarding locations of new sensitive species occurrences, if any; management activities undertaken by the Licensees in the past calendar year to protect sensitive species and sensitive habitats; limited operating periods and protective buffers; and any emergency work undertaken by the Licensees in the prior calendar year that may have affected sensitive species and sensitive habitats. This meeting may be combined with the annual meeting between the Licensees and the USFS.

3.2 PLAN REVISIONS

The Licensees will evaluate the requirements of this Plan during the life of the new license and may modify those requirements in consultation with USFS, BLM, and other applicable resource agencies, as necessary. The Licensees will provide these agencies 60 calendar days to provide written comments and recommendations before the Licensees file the updated Plan with FERC for approval. The updated Plan will include documentation of all relevant coordination and consultation. If the Licensees do not adopt a particular recommendation by the above agencies, the filing will include the Licensees' reasons for not doing so. The Licensees will implement the Plan as approved by FERC. The Plan will not be considered revised until FERC issues its approval.

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4.0 REFERENCES CITED

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Attachment 1, Appendix J

Revised Exhibit F Drawings – F-01, F-07, AND F-08

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ATTACHMENT 1

APPENDIX J

Revised Exhibit F Drawings – F-01, F-07, AND F-08

In accordance with Section (§) 5.30 and § 4.32(k) of the Federal Energy Regulatory Commission's (FERC) regulations, and in light of heightened national security concerns, the Licensees request that the revised Exhibit F drawings included in this Appendix J of Attachment 1 be treated by FERC as Critical Energy Infrastructure Information (CEII) under § 388.112 of FERC's regulations, and not be released to the public.

The drawings satisfy the definition of CEII in § 388.112(c) of FERC's regulations because they contain design information about existing critical infrastructure that relates to details about the generation and transmission of electrical energy, and could be useful to a person planning an attack on critical infrastructure. Moreover, such information is exempt from disclosure under the freedom of Information Act 5 United States Code § 552.

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Attachment 1, Appendix K

Quail Detention Embankment – Supporting Design Information

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ATTACHMENT 1

APPENDIX K

Quail Detention Embankment – Supporting Design Information

In accordance with Section (§) 5.30 and § 4.32(k) of the Federal Energy Regulatory Commission's (FERC) regulations, and in light of heightened national security concerns, the Licensees request that the Quail Detention Embankment supporting design information included in this Appendix K of Attachment 1 be treated by FERC as Critical Energy Infrastructure Information (CEII) under § 388.112 of FERC's regulations, and not be released to the public.

The supporting design information satisfies the definition of CEII in § 388.112(c) of FERC's regulations because it contains design information about existing critical infrastructure that relates to details about the generation and transmission of electrical energy, and could be useful to a person planning an attack on critical infrastructure. Moreover, such information is exempt from disclosure under the freedom of Information Act 5 United States Code § 552.

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Attachment 1, Appendix L

Revised Exhibit G Maps

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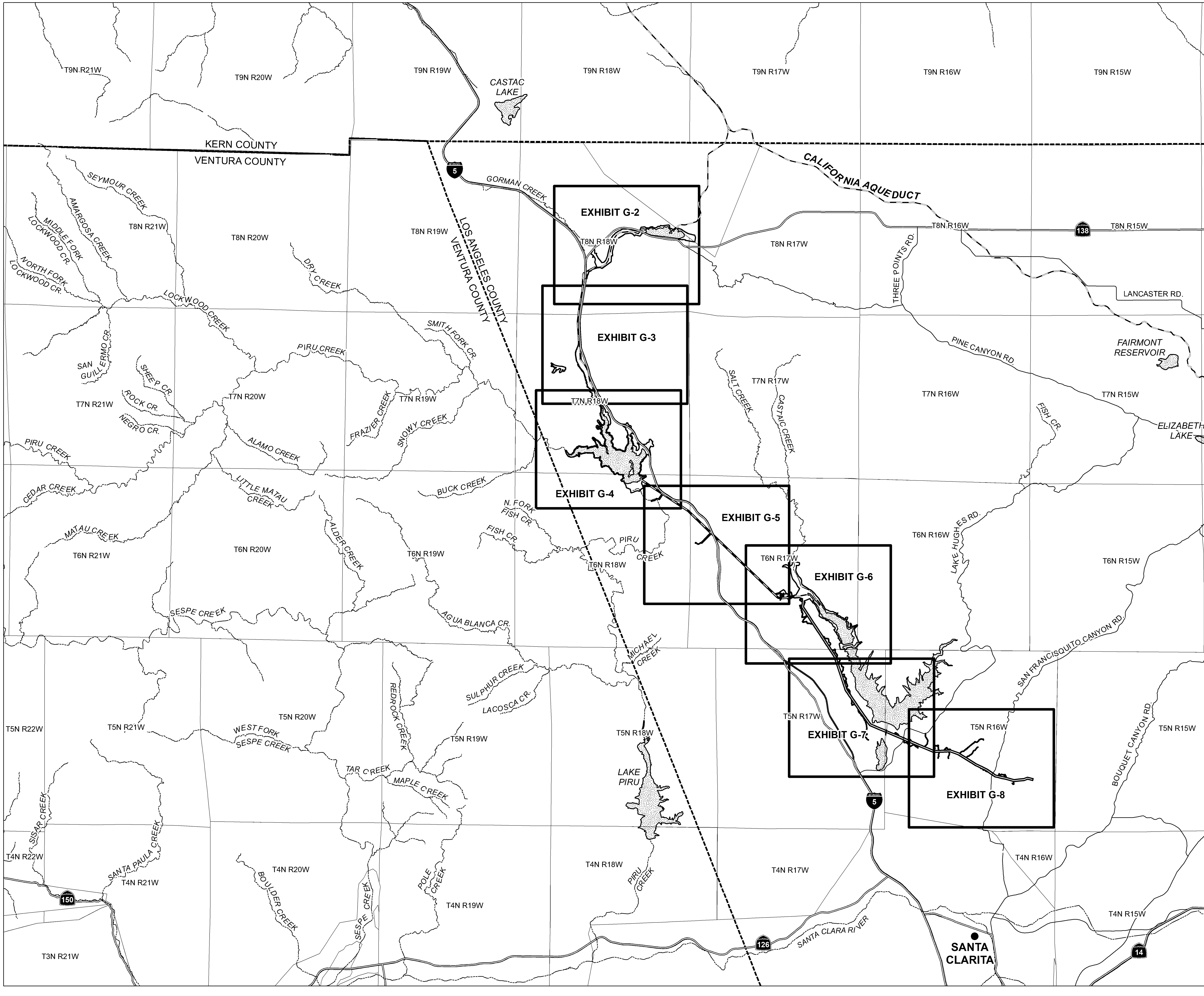


DRAWING COORDINATE SYSTEM
PROJECTION: CA. STATE PLANE
DATUM: NAD 83
ZONE: CA. 5
UNITS: U.S. SURVEY FEET

- CITY
- HWY
- INTERSTATE
- LAKE/RESERVOIR
- RIVER
- HIGHWAY
- MAJOR ROAD
- EXHIBIT G EXTENT
- PROPOSED PROJECT BOUNDARY (V.20190718)
- TOWNSHIP/RANGE BOUNDARY
- COUNTY
- CALIFORNIA AQUEDUCT

0 0.5 1 2 3 4
Miles

N

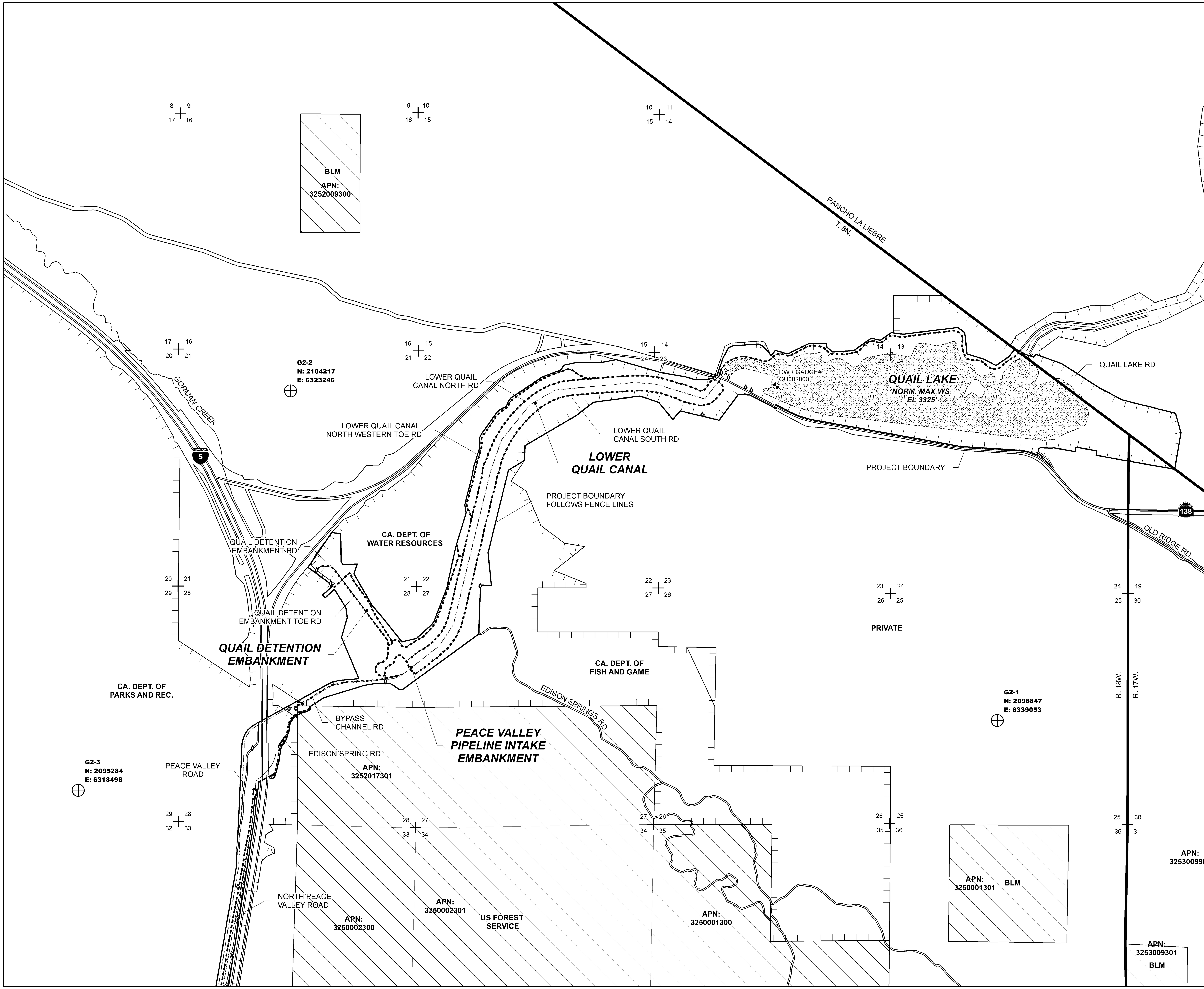
DECLINATION (12/20/2017): 12° 13' E CHANGING BY 0° 5' W PER YEAR
COMPUTED FROM NOAA'S MAGNETIC DECLINATION CALCULATOR

EXHIBIT G-1

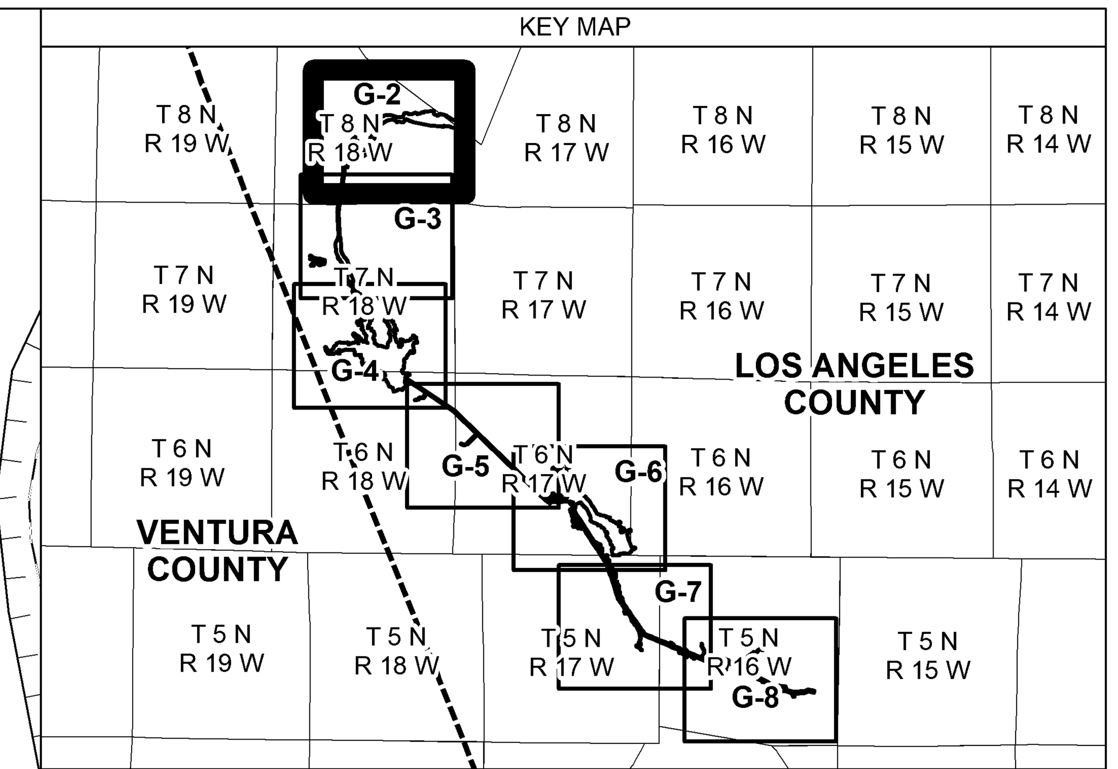
SOUTH SWP HYDROPOWER PROPOSED PROJECT BOUNDARY OVERVIEW MAP

CA. DEPT. OF WATER RESOURCES & L.A. DEPT. OF WATER & POWER
LOS ANGELES COUNTY, CALIFORNIA **FERC NO. 2426**

DATE:	SCALE:	DRAWING NUMBER:
MAY, 2020	1 INCH = 1.5 MILES @ 24"X36"	



KEY MAP



SURVEYORS STATEMENT

I HEREBY STATE THAT THE P-2426 PROJECT BOUNDARY DELINEATION FOR THE SOUTH STATE WATER PROJECT IS SHOWN ON THIS EXHIBIT "G" IS DEVELOPED WITHIN REASONABLE ACCURACIES AS REQUIRED IN 18CFR4.41 TO THE GEOGRAPHIC LOCATION BASED ON A GRAPHICAL POSITIONING IN REFERENCE TO USGS QUADRANGLE MAPPING WITHIN +/- 40 FEET. THE P-2426 DOCUMENT PROJECT BOUNDARY WAS DIGITIZED TO GRAPHICALLY BEST FIT THE FEATURES ON USGS EROS HIGH RESOLUTION ORTHO IMAGERY AND WAS NOT FIELD SURVEYED.

LS STAMP

DRAWING COORDINATE SYSTEM

PROJECTION: CA. STATE PLANE
DATUM: NAD 83
ZONE: CA. 5
UNITS: U.S. SURVEY FEET

THE LICENSE EITHER OWNS IN FEE SIMPLE, POSSESSES ADEQUATE LAND RIGHTS, OR WILL AQUIRE ADEQUATE LAND RIGHTS OVER ALL LANDS SHOWN THAT ARE INSIDE THE PROJECT BOUNDARY

SECTION CORNER
REFERENCE POINT
GATE
USGS AND CDEC GAUGE STATION
PROJECT ROAD
NAMED ROAD
TRAIL
UNVERIFIED TRAIL
CULVERT
FOREST SERVICE ROAD
TRANSMISSION LINE
STREAM / RIVER
CALIFORNIA AQUEDUCT

COUNTY
PROPOSED PROJECT BOUNDARY (V.20190718)
TOWNSHIP/RANGE LINE
LAKE/RESERVOIR

LAND OWNERSHIP

COUNTY
LADWP
FEDERAL
STATE OF CALIFORNIA
PRIVATE

0 375 750 1,500 2,250 3,000
Feet

N

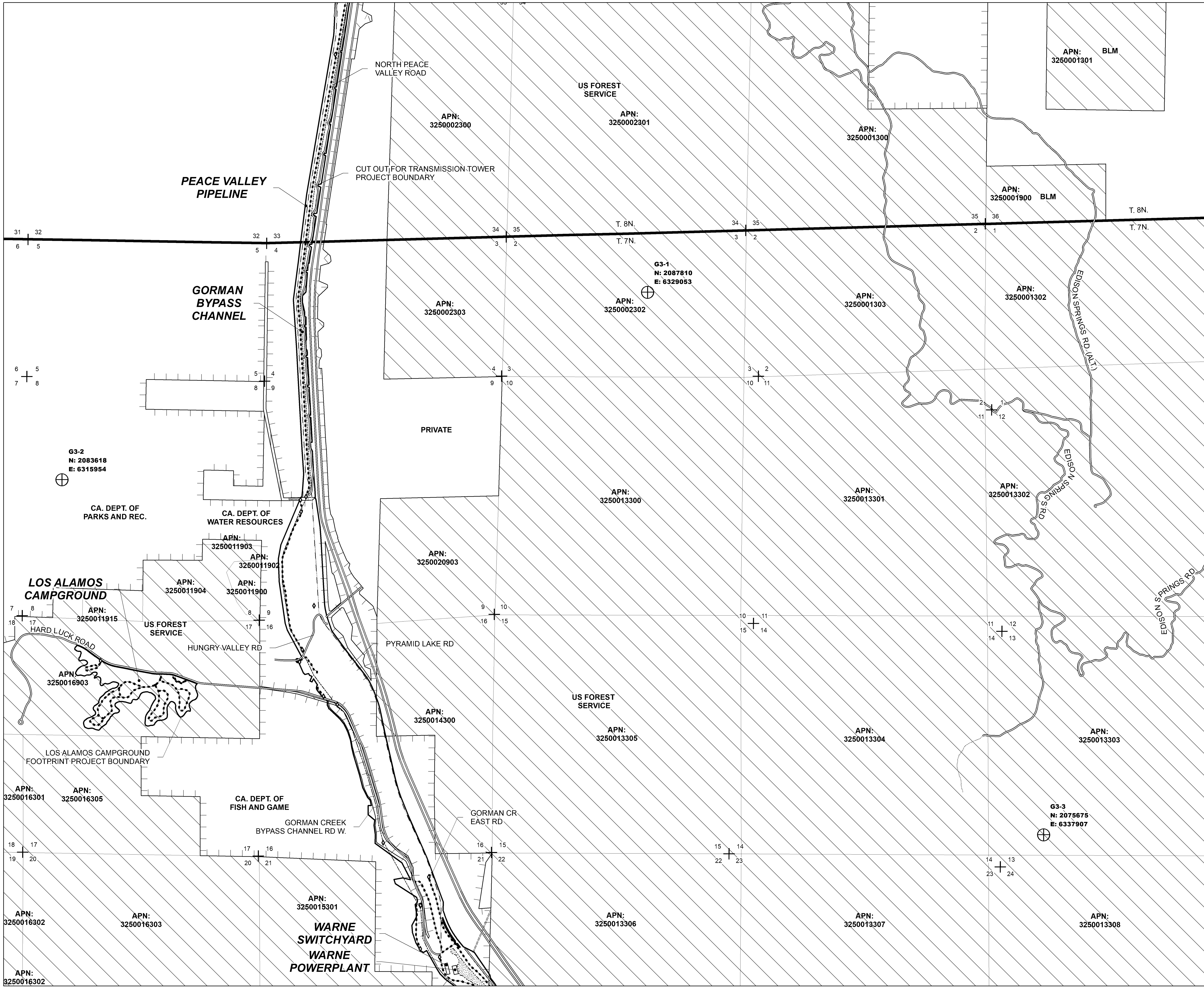
DECLINATION (12/20/2017): 12° 13' E CHANGING BY 0° 5' W PER YEAR
COMPUTED FROM NOAA'S MAGNETIC DECLINATION CALCULATOR

EXHIBIT G-2

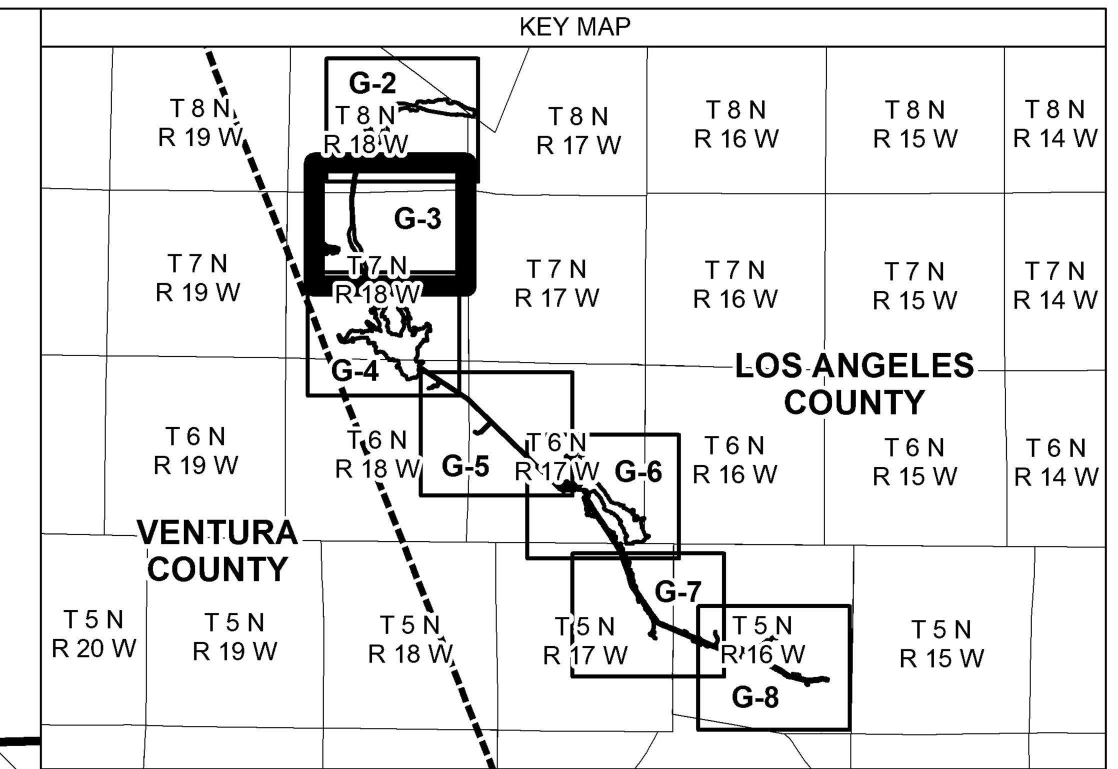
SOUTH SWP HYDROPOWER QUAIL LAKE AND LOWER QUAIL CANAL PROPOSED PROJECT BOUNDARY MAP

CA. DEPT. OF WATER RESOURCES & L.A. DEPT. OF WATER & POWER
LOS ANGELES COUNTY, CALIFORNIA **FERC NO. 2426**

DATE:	SCALE:	DRAWING NUMBER:
MAY, 2020	1 INCH = 1000 FEET @ 24"X36"	



KEY MAP



SURVEYORS STATEMENT

I HEREBY STATE THAT THE P-2426 PROJECT BOUNDARY DELINEATION FOR THE SOUTH STATE WATER PROJECT IS SHOWN ON THIS EXHIBIT "G" IS DEVELOPED WITHIN REASONABLE ACCURACIES AS REQUIRED IN 18CFR4.41 TO THE GEOGRAPHIC LOCATION BASED ON A GRAPHICAL POSITIONING IN REFERENCE TO USGS QUADRANGLE MAPPING WITHIN +/- 40 FEET. THE P-2426 DOCUMENT PROJECT BOUNDARY WAS DIGITIZED TO GRAPHICALLY BEST FIT THE FEATURES ON USGS EROS HIGH RESOLUTION ORTHO IMAGERY AND WAS NOT FIELD SURVEYED.

LS STAMP

DRAWING COORDINATE SYSTEM

PROJECTION: CA. STATE PLANE
DATUM: NAD 83
ZONE: CA. 5
UNITS: U.S. SURVEY FEET

THE LICENSE EITHER OWNS IN FEE SIMPLE, POSSESSES ADEQUATE LAND RIGHTS, OR WILL AQUIRE ADEQUATE LAND RIGHTS OVER ALL LANDS SHOWN THAT ARE INSIDE THE PROJECT BOUNDARY

- SECTION CORNER
- REFERENCE POINT
- GATE
- USGS AND CDEC GAUGE STATION
- PROJECT ROAD
- NAMED ROAD
- TRAIL
- UNVERIFIED TRAIL
- CULVERT
- FOREST SERVICE ROAD
- TRANSMISSION LINE
- STREAM / RIVER
- CALIFORNIA AQUEDUCT
- COUNTY
- PROPOSED PROJECT BOUNDARY (V.20190718)
- TOWNSHIP/RANGE LINE
- LAKE/RESERVOIR

LAND OWNERSHIP

- COUNTY
- LADWP
- FEDERAL
- STATE OF CALIFORNIA
- PRIVATE

0 375 750 1,500 2,250 3,000
Feet

N

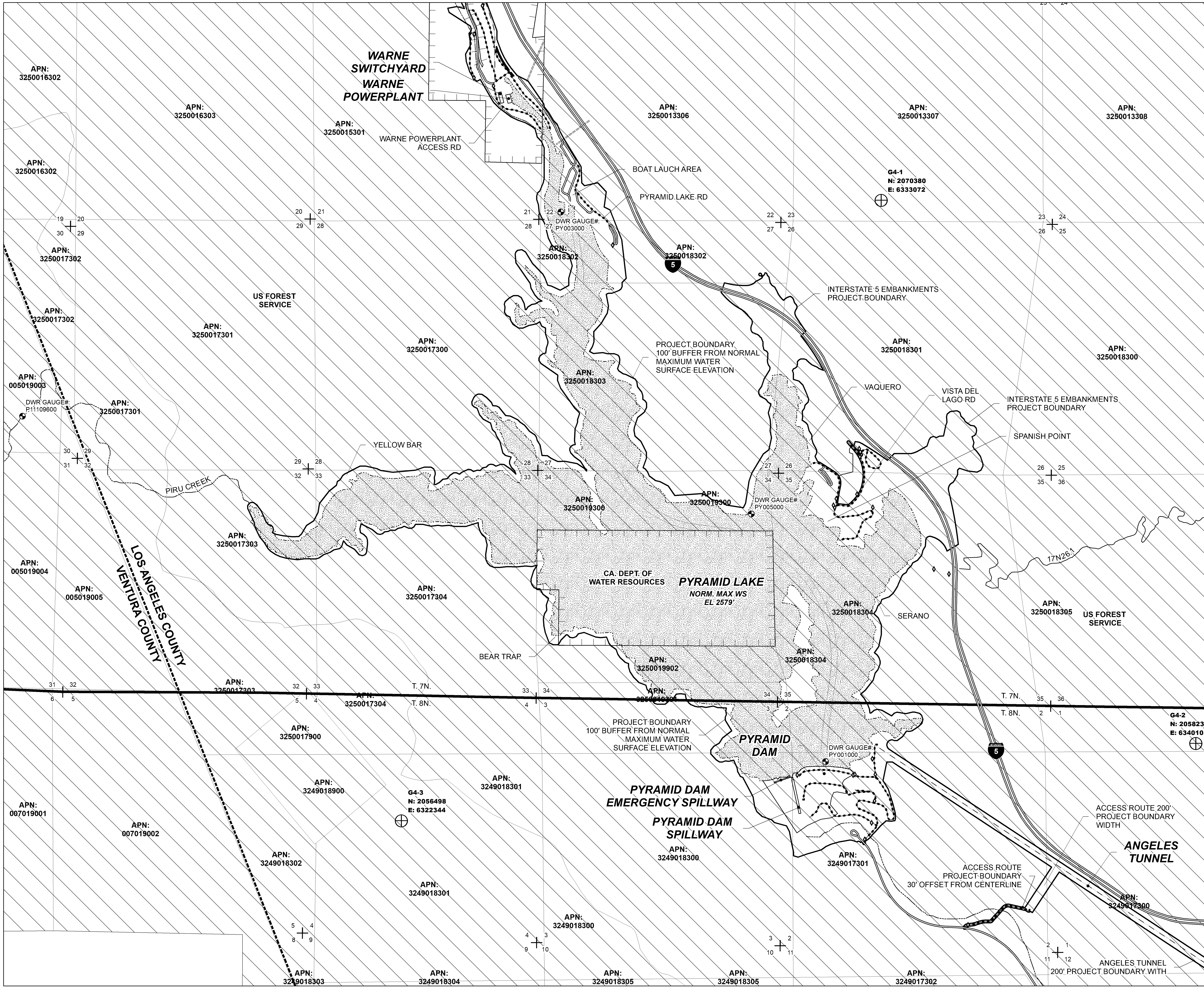
DECLINATION (12/20/2017): 12° 13' E CHANGING BY 0° 5' W PER YEAR
COMPUTED FROM NOAA'S MAGNETIC DECLINATION CALCULATOR

EXHIBIT G-3

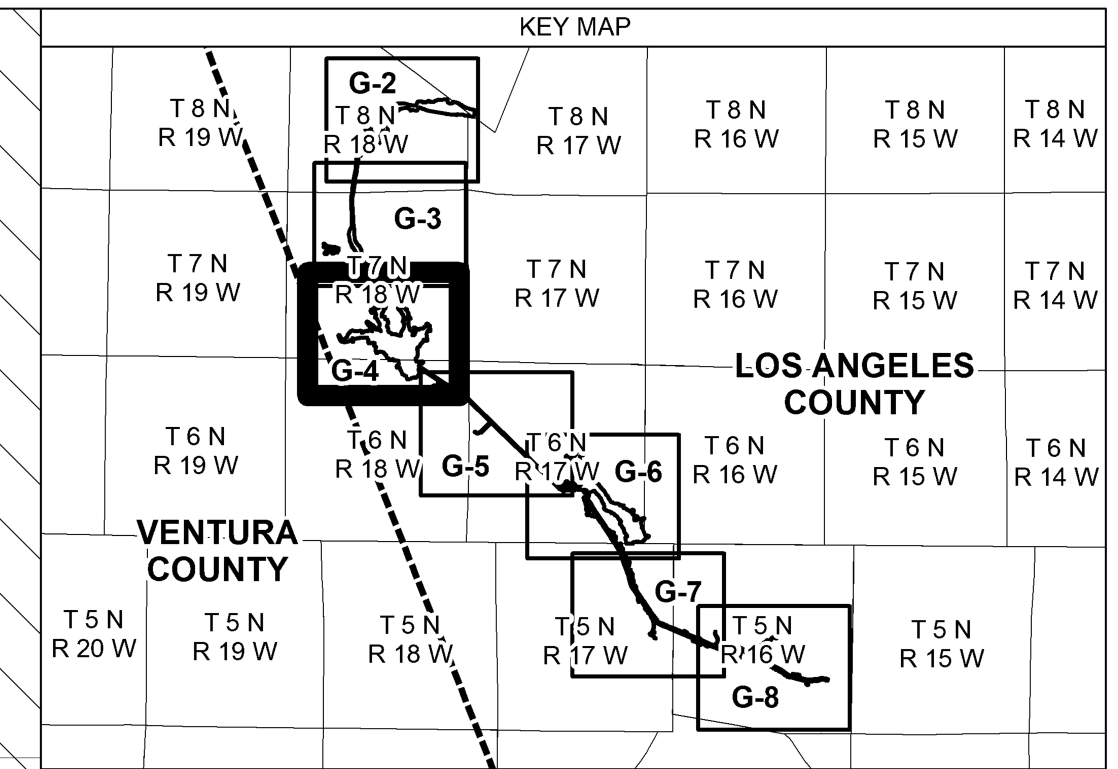
SOUTH SWP HYDROPOWER PEACE VALLEY PIPELINE AND WARNE POWERPLANT PROPOSED PROJECT BOUNDARY MAP

CA. DEPT. OF WATER RESOURCES & L.A. DEPT. OF WATER & POWER
LOS ANGELES COUNTY, CALIFORNIA FERC NO. 2426

DATE:	SCALE:	DRAWING NUMBER:
MAY, 2020	1 INCH = 1000 FEET @ 24"X36"	



KEY MAP



SURVEYORS STATEMENT

I HEREBY STATE THAT THE P-2426 PROJECT BOUNDARY DELINEATION FOR THE SOUTH STATE WATER PROJECT IS SHOWN ON THIS EXHIBIT "G" IS DEVELOPED WITHIN REASONABLE ACCURACIES AS REQUIRED IN 18CFR4.41 TO THE GEOGRAPHIC LOCATION BASED ON A GRAPHICAL POSITIONING IN REFERENCE TO USGS QUADRANGLE MAPPING WITHIN +/- 40 FEET. THE P-2426 DOCUMENT PROJECT BOUNDARY WAS DIGITIZED TO GRAPHICALLY BEST FIT THE FEATURES ON USGS EROS HIGH RESOLUTION ORTHO IMAGERY AND WAS NOT FIELD SURVEYED.

LS STAMP

DRAWING COORDINATE SYSTEM

PROJECTION: CA. STATE PLANE
DATUM: NAD 83
ZONE: CA. 5
UNITS: U.S. SURVEY FEET

THE LICENSE EITHER OWNS IN FEE SIMPLE, POSSESSES ADEQUATE LAND RIGHTS, OR WILL AQUIRE ADEQUATE LAND RIGHTS OVER ALL LANDS SHOWN THAT ARE INSIDE THE PROJECT BOUNDARY

SECTION CORNER
REFERENCE POINT
GATE
USGS AND CDEC GAUGE STATION
PROJECT ROAD
NAMED ROAD
TRAIL
UNVERIFIED TRAIL
CULVET
FOREST SERVICE ROAD
TRANSMISSION LINE
STREAM / RIVER
CALIFORNIA AQUEDUCT

COUNTY
PROPOSED PROJECT BOUNDARY (V.20190718)
TOWNSHIP/RANGE LINE
LAKE/RESERVOIR

LAND OWNERSHIP

COUNTY
LADWP
FEDERAL
STATE OF CALIFORNIA
PRIVATE

0 375 750 1,500 2,250 3,000
Feet

N

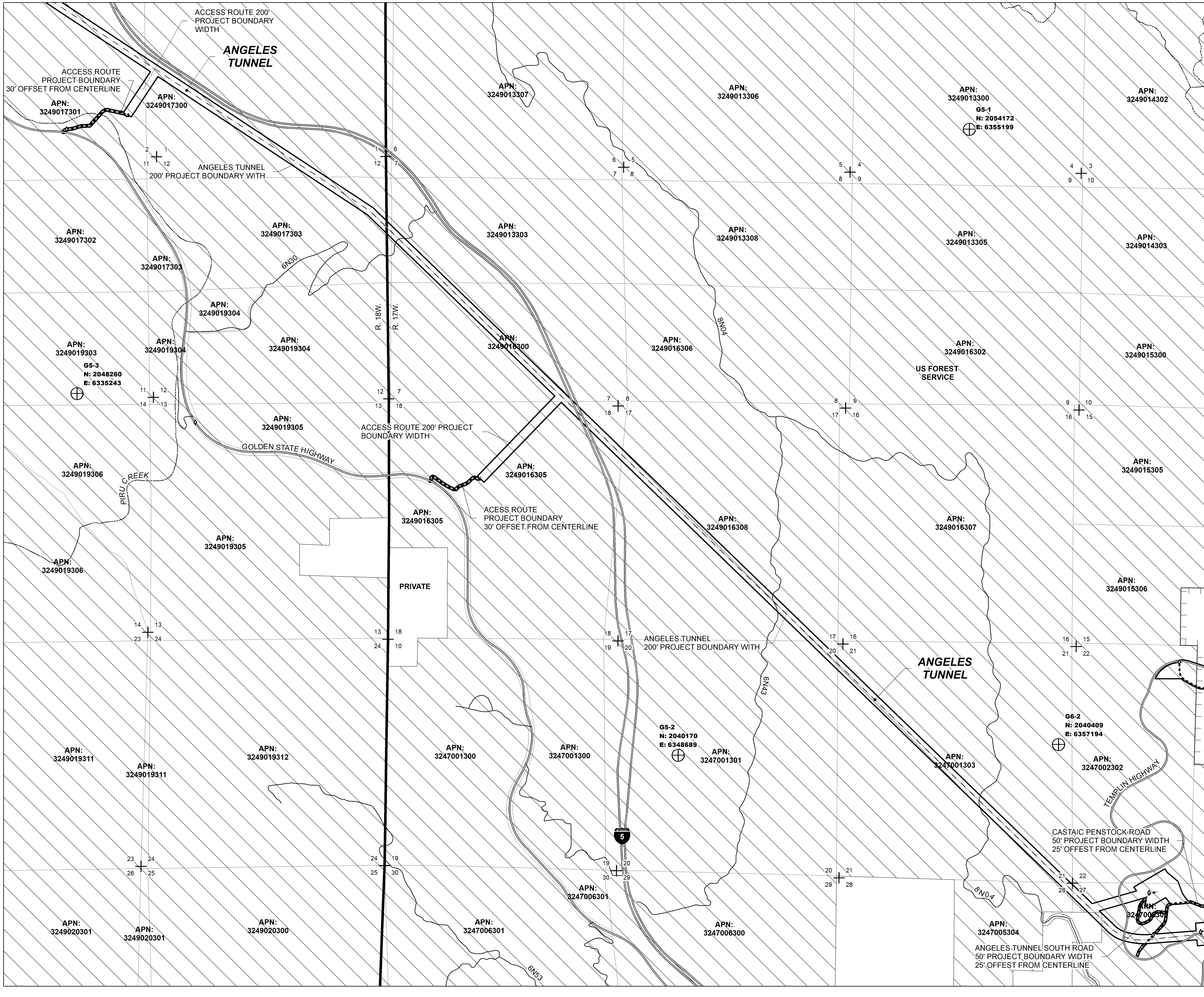
DECLINATION (12/20/2017): 12° 13' E CHANGING BY 0° 5' W PER YEAR
COMPUTED FROM NOAA'S MAGNETIC DECLINATION CALCULATOR

EXHIBIT G-4

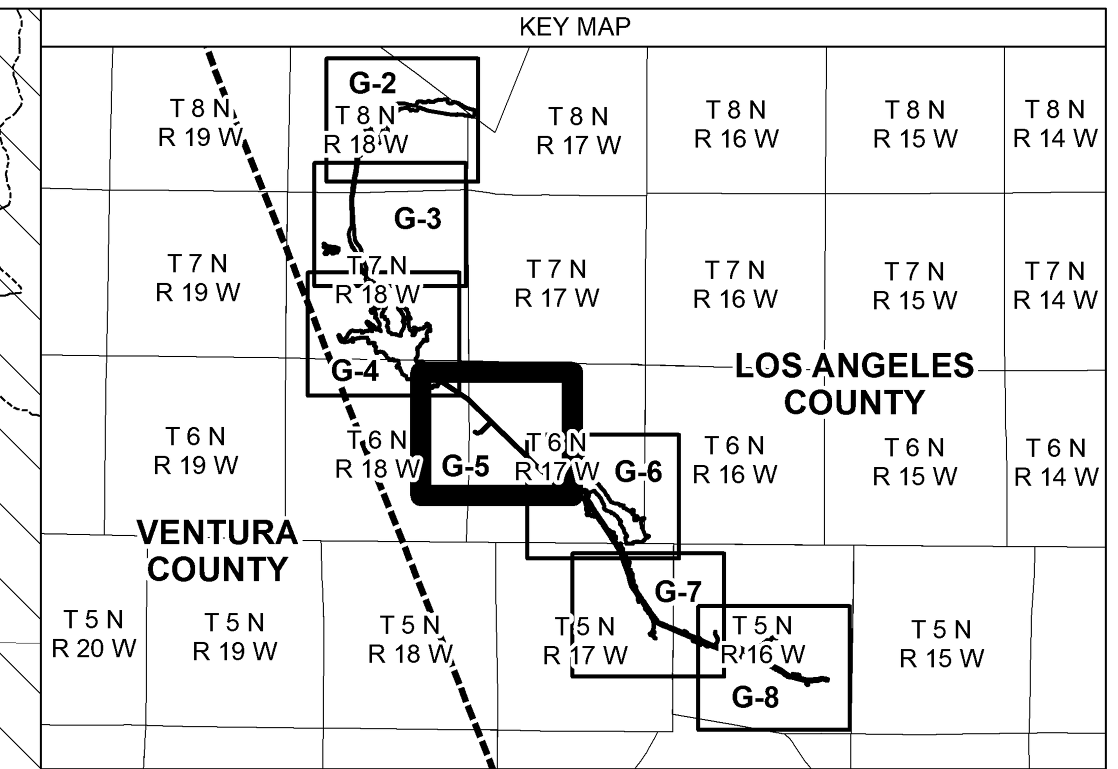
SOUTH SWP HYDROPOWER PYRAMID LAKE AND DAM PROPOSED PROJECT BOUNDARY MAP

CA. DEPT. OF WATER RESOURCES & L.A. DEPT. OF WATER & POWER
LOS ANGELES COUNTY, CALIFORNIA **FERC NO. 2426**

DATE:	SCALE:	DRAWING NUMBER:
MAY, 2020	1 INCH = 1000 FEET @ 24"X36"	



KEY MAP



SURVEYORS STATEMENT

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LS STAMP

DRAWING COORDINATE SYSTEM

PROJECTION: CA. STATE PLANE
DATUM: NAD 83
ZONE: CA. 5
UNITS: U.S. SURVEY FEET

THE LICENSE EITHER OWNS IN FEE SIMPLE, POSSESSES ADEQUATE LAND RIGHTS, OR WILL AQUIRE ADEQUATE LAND RIGHTS OVER ALL LANDS SHOWN THAT ARE INSIDE THE PROJECT BOUNDARY

SECTION CORNER
REFERENCE POINT
GATE
USGS AND CDEC GAUGE STATION
PROJECT ROAD
NAMED ROAD
TRAIL
UNVERIFIED TRAIL
CULVET
FOREST SERVICE ROAD
TRANSMISSION LINE
STREAM / RIVER
CALIFORNIA AQUEDUCT

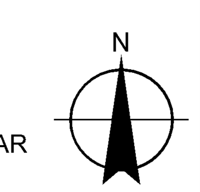
COUNTY
PROPOSED PROJECT BOUNDARY (V.20190201)
TOWNSHIP/RANGE LINE
LAKE/RESERVOIR

LAND OWNERSHIP

COUNTY
LADWP
FEDERAL
STATE OF CALIFORNIA
PRIVATE

0 375 750 1,500 2,250 3,000
Feet

N



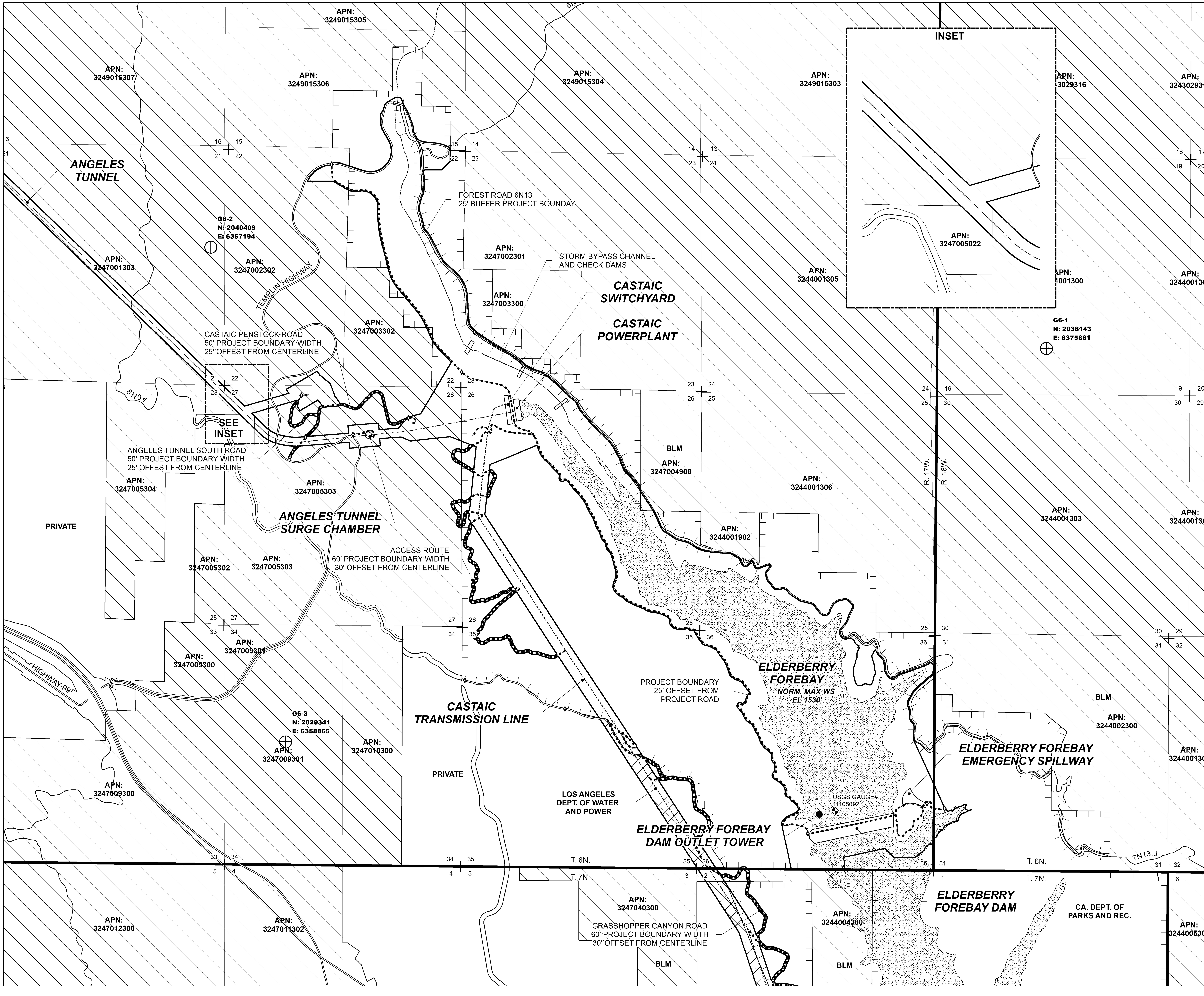
DECLINATION (12/20/2017): 12° 13' E CHANGING BY 0° 5' W PER YEAR
COMPUTED FROM NOAA'S MAGNETIC DECLINATION CALCULATOR

EXHIBIT G-5

SOUTH SWP HYDROPOWER ANGELES TUNNEL PROPOSED PROJECT BOUNDARY MAP

CA. DEPT. OF WATER RESOURCES & L.A. DEPT. OF WATER & POWER
LOS ANGELES COUNTY, CALIFORNIA FERC NO. 2426

DATE:	SCALE:	DRAWING NUMBER:
MAY, 2020	1 INCH = 1000 FEET @ 24"X36"	



KEY MAP

T 8 N R 19 W	T 8 N R 18 W (G-2)	T 8 N R 17 W	T 8 N R 16 W	T 8 N R 15 W	T 8 N R 14 W
T 7 N R 19 W	T 7 N R 18 W (G-3, G-4)	T 7 N R 17 W	T 7 N R 16 W	T 7 N R 15 W	T 7 N R 14 W
T 6 N R 19 W	T 6 N R 18 W (G-5)	T 6 N R 17 W (G-6)	T 6 N R 16 W	T 6 N R 15 W	T 6 N R 14 W
T 5 N R 20 W	T 5 N R 19 W	T 5 N R 18 W	T 5 N R 17 W (G-7)	T 5 N R 16 W (G-8)	T 5 N R 15 W

VENTURA COUNTY
LOS ANGELES COUNTY

SURVEYORS STATEMENT

I HEREBY STATE THAT THE P-2426 PROJECT BOUNDARY DELINEATION FOR THE SOUTH STATE WATER PROJECT IS SHOWN ON THIS EXHIBIT "G" IS DEVELOPED WITHIN REASONABLE ACCURACIES AS REQUIRED IN 18CFR4.41 TO THE GEOGRAPHIC LOCATION BASED ON A GRAPHICAL POSITIONING IN REFERENCE TO USGS QUADRANGLE MAPPING WITHIN +/- 40 FEET. THE P-2426 DOCUMENT PROJECT BOUNDARY WAS DIGITIZED TO GRAPHICALLY BEST FIT THE FEATURES ON USGS EROS HIGH RESOLUTION ORTHO IMAGERY AND WAS NOT FIELD SURVEYED.

LS STAMP

DRAWING COORDINATE SYSTEM

PROJECTION: CA. STATE PLANE
DATUM: NAD 83
ZONE: CA. 5
UNITS: U.S. SURVEY FEET

THE LICENSE EITHER OWNS IN FEE SIMPLE, POSSESSES ADEQUATE LAND RIGHTS, OR WILL AQUIRE ADEQUATE LAND RIGHTS OVER ALL LANDS SHOWN THAT ARE INSIDE THE PROJECT BOUNDARY

- SECTION CORNER
- REFERENCE POINT
- GATE
- USGS AND CDEC GAUGE STATION
- PROJECT ROAD
- NAMED ROAD
- TRAIL
- UNVERIFIED TRAIL
- CULVET
- FOREST SERVICE ROAD
- TRANSMISSION
- STREAM / RIVER
- CALIFORNIA AQUEDUCT
- COUNTY
- PROPOSED PROJECT BOUNDARY (V.20190718)
- TOWNSHIP/RANGE LINE
- LAKE/RESERVOIR

LAND OWNERSHIP

- COUNTY
- LADWP
- FEDERAL
- STATE OF CALIFORNIA
- PRIVATE

0 375 750 1,500 2,250 3,000
Feet

N

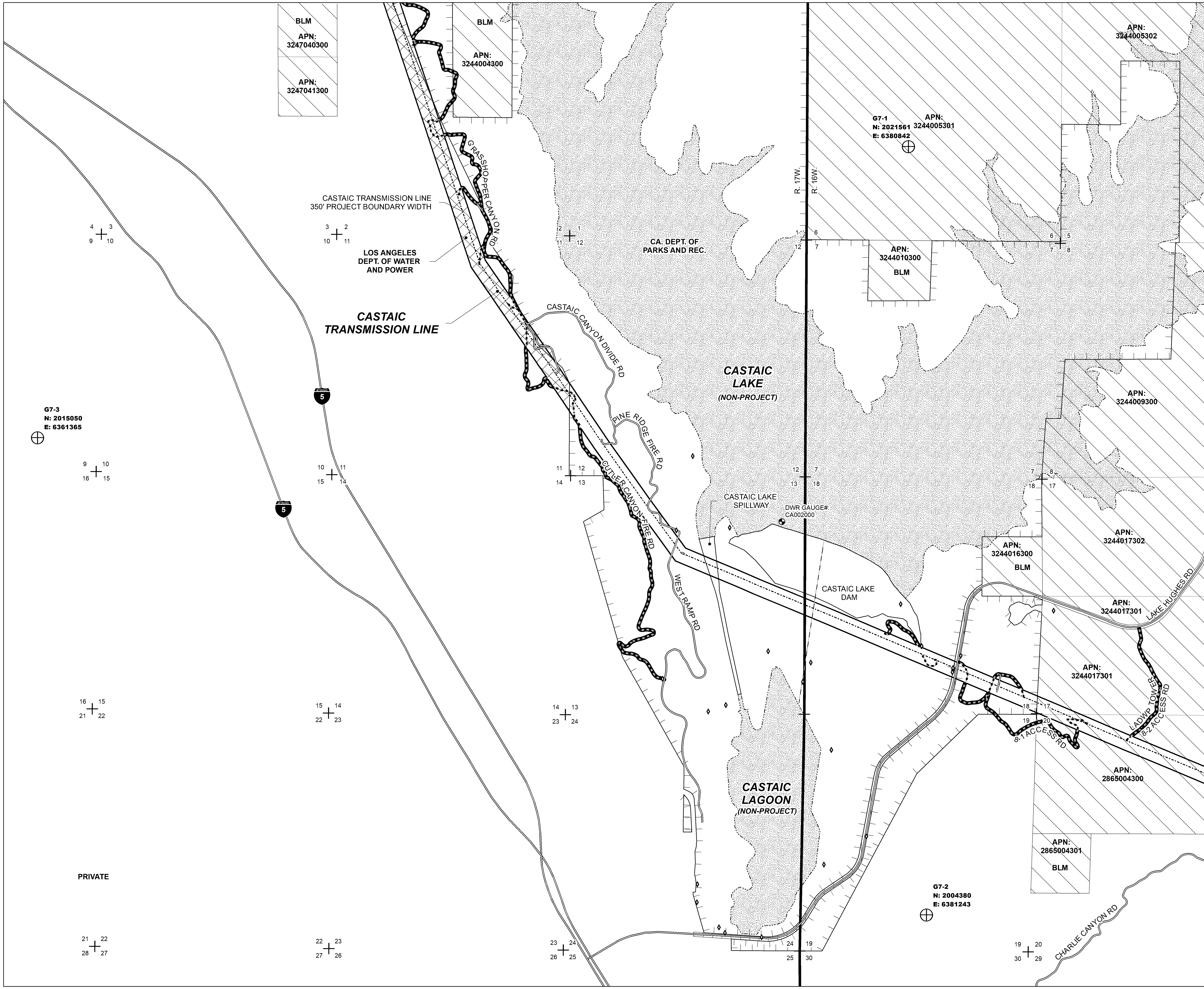
DECLINATION (12/20/2017): 12° 13' E CHANGING BY 0° 5' W PER YEAR
COMPUTED FROM NOAA'S MAGNETIC DECLINATION CALCULATOR

EXHIBIT G-6

SOUTH SWP HYDROPOWER CASTAIC POWERPLANT AND ELDERBERRY FOREBAY PROPOSED PROJECT BOUNDARY MAP

CA. DEPT. OF WATER RESOURCES & L.A. DEPT. OF WATER & POWER
LOS ANGELES COUNTY, CALIFORNIA FERC NO. 2426

DATE:	SCALE:	DRAWING NUMBER:
MAY, 2020	1 INCH = 1000 FEET @ 24"X36"	



SURVEYORS STATEMENT

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LS STAMP

DRAWING COORDINATE SYSTEM

PROJECTION: CA. STATE PLANE
DATUM: NAD 83
ZONE: CA. 5
UNITS: U.S. SURVEY FEET

THE LICENSE EITHER OWNS IN FEE SIMPLE, POSSESSES ADEQUATE LAND RIGHTS, OR WILL AQUIRE ADEQUATE LAND RIGHTS OVER ALL LANDS SHOWN THAT ARE INSIDE THE PROJECT BOUNDARY

SECTION CORNER
REFERENCE POINT
GATE
USGS AND CDEC GAUGE STATION
PROJECT ROAD
NAMED ROAD
TRAIL
UNVERIFIED TRAIL
CULVET
FOREST SERVICE ROAD
TRANSMISSION LINE
STREAM / RIVER
CALIFORNIA AQUEDUCT
COUNTY
PROPOSED PROJECT BOUNDARY (V.20190718)
TOWNSHIP/RANGE LINE
LAKE/RESERVOIR

LAND OWNERSHIP

COUNTY
LADWP
FEDERAL
STATE OF CALIFORNIA
PRIVATE

0 375 750 1,500 2,250 3,000
Feet

N

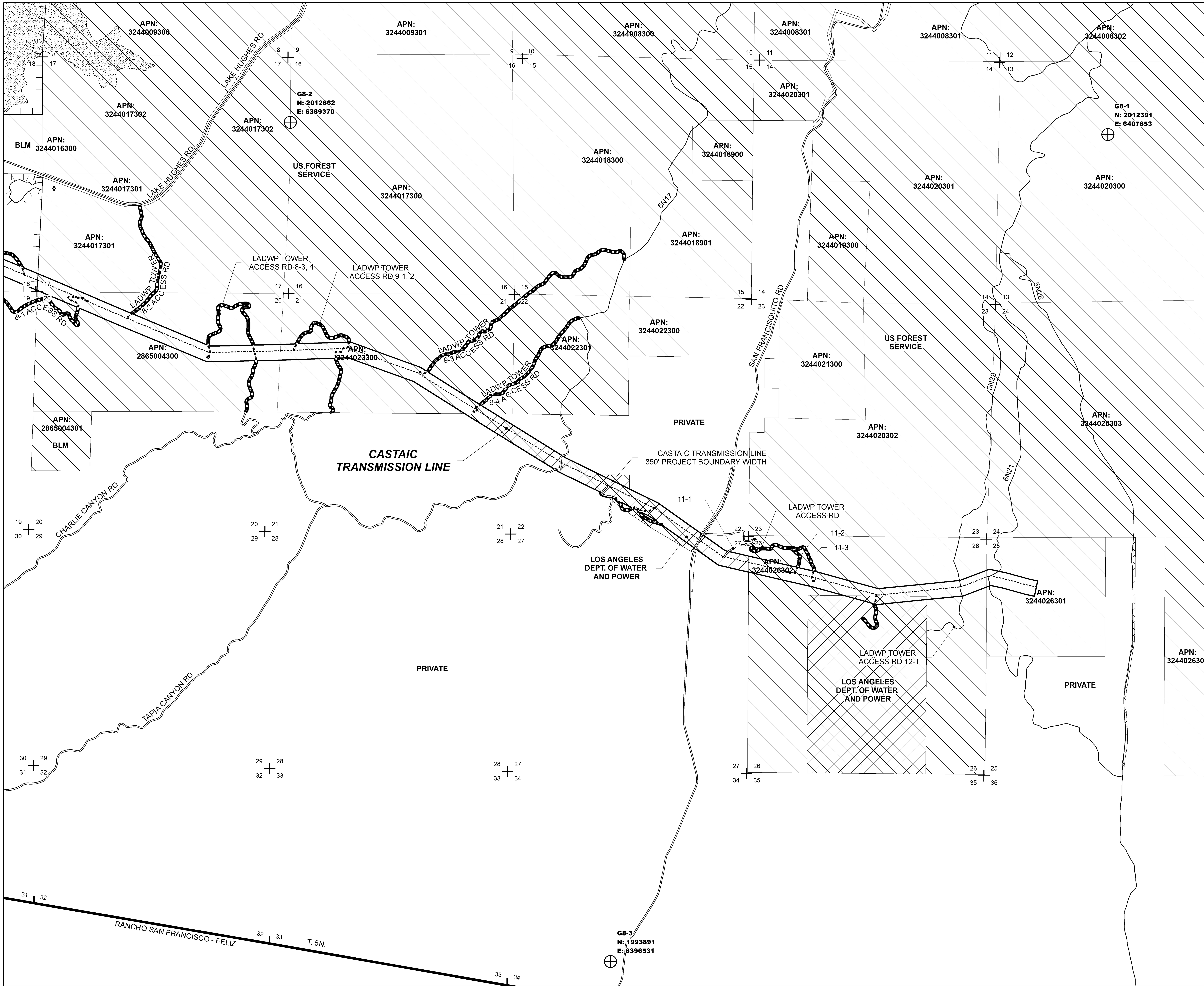
DECLINATION (12/20/2017): 12° 13' E CHANGING BY 0° 5' W PER YEAR
COMPUTED FROM NOAA'S MAGNETIC DECLINATION CALCULATOR

EXHIBIT G-7

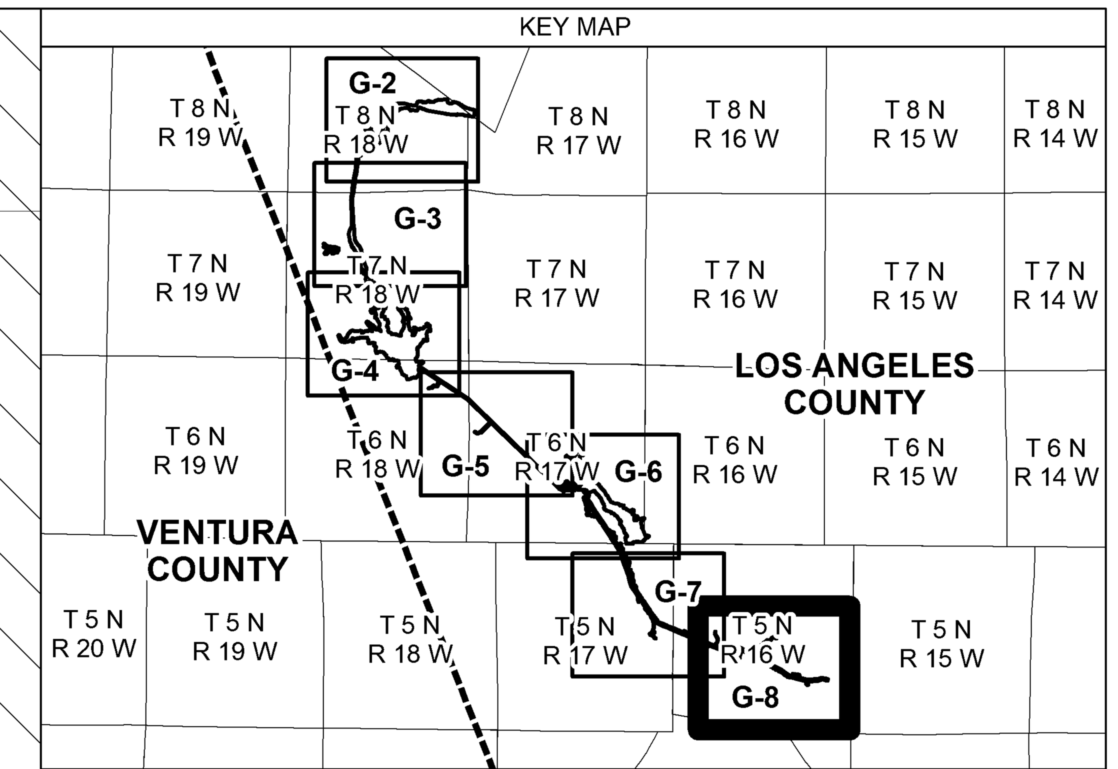
SOUTH SWP HYDROPOWER CASTAIC TRANSMISSION LINE PROPOSED PROJECT BOUNDARY MAP

CA. DEPT. OF WATER RESOURCES & L.A. DEPT. OF WATER & POWER
LOS ANGELES COUNTY, CALIFORNIA FERC NO. 2426

DATE:	SCALE:	DRAWING NUMBER:
MAY, 2020	1 INCH = 1000 FEET @ 24"X36"	



KEY MAP



SURVEYORS STATEMENT

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LS STAMP

DRAWING COORDINATE SYSTEM

PROJECTION: CA. STATE PLANE
DATUM: NAD 83
ZONE: CA. 5
UNITS: U.S. SURVEY FEET

THE LICENSE EITHER OWNS IN FEE SIMPLE, POSSESSES ADEQUATE LAND RIGHTS, OR WILL AQUIRE ADEQUATE LAND RIGHTS OVER ALL LANDS SHOWN THAT ARE INSIDE THE PROJECT BOUNDARY

SECTION CORNER
REFERENCE POINT
GATE
USGS AND CDEC GAUGE STATION
PROJECT ROAD
NAMED ROAD
TRAIL
UNVERIFIED TRAIL
CULVET
FOREST SERVICE ROAD
TRANSMISSION LINE
STREAM / RIVER
CALIFORNIA AQUEDUCT

COUNTY
PROPOSED PROJECT BOUNDARY (V.20190718)
TOWNSHIP/RANGE LINE
LAKE/RESERVOIR

LAND OWNERSHIP

COUNTY
LADWP
FEDERAL
STATE OF CALIFORNIA
PRIVATE

0 375 750 1,500 2,250 3,000
Feet

N

DECLINATION (12/20/2017): 12° 13' E CHANGING BY 0° 5' W PER YEAR
COMPUTED FROM NOAA'S MAGNETIC DECLINATION CALCULATOR

EXHIBIT G-8

SOUTH SWP HYDROPOWER CASTAIC TRANSMISSION LINE PROPOSED PROJECT BOUNDARY MAP

CA. DEPT. OF WATER RESOURCES & L.A. DEPT. OF WATER & POWER
LOS ANGELES COUNTY, CALIFORNIA **FERC NO. 2426**

DATE:	**SCALE:**	**DRAWING NUMBER:**
MAY, 2020	1 INCH = 1000 FEET @ 24"X36"	