4.5 Take of the California Tiger Salamander

Appendix 4.B *Terrestrial Impact Analysis Methods*, describes the methods and assumptions used to analyze the effects of the PP on wildlife species. Appendix 2.A *Status of the Species,* Sections 2.5.4, *Species Habitat Suitability Model* and 2.5.5, *Suitable Habitat Definition*, define suitable habitat and describe the habitat model for California tiger salamander.

Activities associated with geotechnical exploration, Clifton Court Forebay modification, power supply and grid connections, and habitat restoration may affect California tiger salamander, as described below. Figure 4.5-1 provides an overview of the locations of surface impacts relative to California tiger salamander modeled habitat and occurrences. There are 12,724 acres of modeled California tiger salamander habitat in the legal delta. An estimated 50 acres (<1% of total modeled habitat in the legal delta) of California tiger salamander modeled habitat will be lost as a result of project implementation, including 47 acres within the construction footprint and 3 acres that may be affected by activities generating vibrations. Table 4.5-1 and Table 4.5-2 summarize the total estimated habitat loss of California tiger salamander modeled habitat. Only terrestrial cover and aestivation habitat loss is expected to occur; the PP would not entail loss of any aquatic breeding habitat.

Table 4.5-1. Maximum Habitat Loss on Modeled Habitat for California Tiger Salamander by Activity Type (Acres)

California Tiger Salamander Modeled Habitat	Total Modeled Terrestrial Cover and Aestivation Habitat in the Legal Delta	Permanent Habitat Loss								Temporary Habitat Loss	
		Safe Haven Work Areas	North Delta Intakes	Tunneled Conveyance Facilities	Clifton Court Forebay Modifications	Head of Old River Gate	Reusable Tunnel Material	Power Supply and Grid Connections	Total Maximum Habitat Loss	Geotechnical Exploration	Power Supply and Grid Connections
Terrestrial Cover and Aestivation	12,724	0	0	0	49	0	0	1	50	0	6

Table 4.5-2. Maximum Direct Effects on and Conservation of Modeled Habitat for California Tiger Salamander

California Tiger Salamander Modeled Habitat	Permanent Habit Loss	Compensation Ratios		Total Compensation (Acres)	
	Total Maximum Habitat Loss (Acres)	Protection	Restoration	Protection	Restoration
Terrestrial Cover and Aestivation	50[1]	3:1		150	

Notes
[1] Includes 47 acres within the construction footprint and 3 acres within 75 feet of project activities that may generate vibrations affecting California tiger salamander.

4.5.1 Effects on California Tiger Salamander from the Proposed Project

4.5.1.1 Geotechnical Exploration

4.5.1.1.1 Habitat Loss and Fragmentation

The only permanent loss of California tiger salamander habitat resulting from geotechnical exploration will be boreholes, which will be grouted upon completion. These holes are very small (approximately 8 inches in diameter) and their filling would have no or negligible effects on the California tiger salamander.

4.5.1.1.2 Construction Related Effects

Geotechnical exploration activities will will not affect any areas that will not be permanently impacted by the construction of features related to the conveyance facility (less than one acre of temporary impact in the location that a canal will be constructed).

4.5.1.1.3 Operations and Maintenance

There will be no ongoing operations and maintenance associated with the geotechnical activities, resulting in no effect on California tiger salamander.

4.5.1.2 Safe Haven Work Areas

Safe haven work areas are not expected to occur in California tiger salamander habitat. Activities in these areas will not affect the species.

4.5.1.3 North Delta Intake Construction

The north Delta intake construction area does not overlap with California tiger salamander modeled habitat. Activities in this area will not affect the species (Figure 4.5-1).

4.5.1.4 Tunneled Conveyance Facilities

Tunneled conveyance facilities construction does not overlap with California tiger salamander modeled habitat. Activities in this area will not affect the species (Figure 4.5-1).

4.5.1.5 Clifton Court Forebay Modification

4.5.1.5.1 Habitat Loss and Fragmentation

An estimated 46 acres of California tiger salamander modeled terrestrial cover and aestivation habitat overlaps with the mapped canal modifications at Clifton Court Forebay (Figure 4.5-2), where land will be cleared for permanent facilities and temporary work areas. The activities that will result in habitat loss include canal construction that will remove terrestrial cover and aestivation habitat at the southern end of the Clifton Court Forebay. Another 3 acres of upland habitat may be affected by construction related vibrations, as described in Section 4.5.1.5.2, *Construction Related Effects.*

The loss of California tiger salamander terrestrial cover and aestivation habitat will be offset through protection at a 3:1 ratio (Table 4.5-2). As described in Section 5.3.5.2.1, *Activities with Fixed Locations*, workers will confine ground disturbance and habitat removal to the minimal area necessary to facilitate construction activities. As detailed in Section 5.4.5.2, *Siting Criteria for Compensation for Effects*, these conservation lands will be sited in locations that provide high habitat values for the species, consisting of large, contiguous blocks of habitat suitable for California tiger salamander. As detailed in Section 5.4.5.3, *Management and Enhancement*, these conservation lands will be protected and managed for the species in perpetuity.

4.5.1.5.2 Construction Related Effects

Construction activities at the canal work area south of Clifton Court Forebay include vegetation clearing, excavation, pile driving, dredging, and cofferdam and embankment construction. The duration of construction in this area will be approximately six years, although construction of the outlet canal, the only component that will affect California tiger salamander, will be approximately 18 months in duration. For complete details on construction activities and phasing, see Section 3.2.6 *Connections to Banks and Jones Pumping Plants;* for more details on schedule, see Appendix 3.D *Construction Schedule for the Proposed Project*.

Vehicles and heavy equipment used at the construction site could injure or kill California tiger salamanders if individuals are present within the construction footprint. Other effects related to construction within the construction footprint may include entanglement in erosion control materials or contamination because of toxic substances such as fuels. Effects within the construction footprint. However, this effect will be unlikely to occur because exclusion fencing will be installed no more than 14 days prior to any site clearing and these areas will be monitored to minimize the potential for California tiger salamanders to enter the work area.

DWR will implement measures to minimize effects on California tiger salamander that could result from initial ground clearing activities, as described in Section 5.3.5.2.1, *Activities with Fixed Locations*, under *Site Preparation* and *Initial Clearance/Ground Disturbance.* To minimize effects on California tiger salamander during the initial clearing, a CDFW-approved biologist will conduct preconstruction surveys within the construction footprint (after installing amphibian exclusion fencing along the perimeter) and will relocate any California tiger salamanders found in accordance with a CDFW-approved relocation plan. The initial ground disturbance and clearing within suitable California tiger salamander habitat will be then be confined to the dry season, and all such activities will be limited to periods of no or low rainfall. Ground disturbing activities in suitable California tiger salamander terrestrial cover and aestivation habitat will cease on days with a 40% or greater forecast of rain from the closest National Weather Service (NWS) weather station, however, ground disturbing work may continue if a CDFW-approved biologist surveys the worksite before construction begins each day rain is forecast and is present during ground disturbing work. Ground disturbing activities may continue after the rain ceases and the work areas is surveyed by the CDFW-approved biologist. If rain exceeds 0.5 inches during a 24-hour period, work will cease until the NWS forecasts no further rain. Modifications to this timing may be approved by CDFW based on site conditions and expected risks to California tiger salamanders as described in Section 5.3.5.2, *Take Minimization Measures*. With these measures in place, the potential for injury or mortality of California tiger salamander will be minimized but there will still be potential for mortality of any individuals not detected during preconstruction surveys within the 46 acres of habitat in the construction footprint. There is also the potential for California tiger salamanders found within the construction footprint to be harassed through the relocation process. Potential for injury, mortality, or harassment is low because the likelihood of California tiger salamander occurrence in this area is low.

During initial site clearing and ongoing construction, DWR will implement measures to prevent injury, mortality, or harassment of individuals that could otherwise result from degradation of adjacent habitat from run-off and siltation. This will include implementation of a Stormwater Pollution Prevention Plan (AMM3) and an Erosion and Sediment Control Plan (AMM4), described in Appendix 3.F *General Avoidance and Minimization Measures*. With implementation of these measures, take associated with run-off or siltation will be avoided.

During initial site clearing and ongoing construction, DWR will implement measures to prevent injury or mortality of individuals that could otherwise result from erosion control materials. To prevent California tiger salamander from becoming entangled, trapped, or injured by erosion control structures, erosion control measures that use plastic or synthetic monofilament netting will not be used within areas designated to have suitable California tiger salamander habitat and the perimeter of construction sites will be fenced with amphibian exclusion fencing. With this measure in place, take associated with erosion control measures will be avoided.

During initial site clearing and ongoing construction, DWR will implement measures to prevent injury or mortality of individuals that could otherwise result from toxic substances such as fuels. With implementation of AMM5, *Spill Prevention, Containment, and Countermeasure Plan*, described in Appendix 3.F *General Avoidance and Minimization Measures*, take associated with toxic substances will be avoided.

Because dusk and dawn are often the times when the California tiger salamander is most actively moving and foraging, to the greatest extent practicable, earthmoving and construction activities will cease no less than 30 minutes before sunset and will not begin again prior to 30 minutes after sunrise within suitable California tiger salamander habitat. Except when necessary for driver or pedestrian safety, to the greatest extent practicable, artificial lighting at a worksite will be prohibited during the hours of darkness within California tiger salamander aquatic habitat or as determined in coordination with the US Fish and Wildlife Service. If night working and lighting is necessary, all lighting will be directed away and shielded from California tiger salamander habitat outside the construction area to minimize light spillover to the greatest extent possible. If light spillover into adjacent California tiger salamander habitat occurs, a CDFW-approved biologist will be present during night work to survey for burrows and emerging California tiger salamanders in areas illuminated by construction lighting. If California tiger salamander is found above-ground the CDFW-approved biologist has the authority to terminate the project activities until the light is directed away from the burrows, the California tiger salamander moves out of the illuminated area, or the California tiger salamander is relocated out of the illuminated area by the CDFW-approved biologist.

Although measures will be applied to minimize the risk of harassing or displacing California tiger salamanders outside the construction footprint during construction, some individuals may be harassed or displaced from habitat with these measures in place, as described below.

California tiger salamander could be impacted by construction disturbance outside the project footprint if they occur in the vicinity. The potential concern is from sound-induced vibration through the soil, which could cause the species to emerge from upland burrows during a non-rain event. One research paper and one known incident provide background information regarding induced emergence.

Dimmit and Ruibal (1980) found that spadefoot toads relied primarily on vibration from rain falling on the ground at their burrows, rather than increased moisture in the soil from rain, as the signal to emerge from burrows. They were able to induce emergence by setting an off-balance test tube spinner within 1 meter of the burrow, which vibrated the soil in close proximity to the animals, and observed almost 100% emergence. The researchers noted that sound-induced vibration from violent, rainless thunder storms, would also produce the emergence response. Spadefoot toads also emerge from their burrows without any inducement to feed. This research has been assumed relevant to California tiger salamander, although no similar study has been applied to those species.

More specific to California tiger salamander was an incident at a SMUD project site in South Sacramento County in the 2000s. The subject project site was determined to not support California tiger salamander, but when a water truck began spraying heavy amounts of water for dust control, California tiger salamanders began to emerge from their burrows. Using Dimmit and Ruibal (1980) as the bases for emergence, it seems reasonable that the water falling on the burrows provided the appropriate vibration to cause emergence.

Given the evidence described above, it is reasonable to assume that mechanical construction activities such as tracked bulldozers moving from point to point, and excavators digging, could cause vibration that California tiger salamanders could confuse for rainfall, and induce emergence. Three factors need to be considered in evaluating the level and area of impact to the species: the extent that mechanical vibration mimics rainfall vibration *at distance*, the reaction of the species to vibration that does not mimic rainfall, and the effect on the two species of "accidental" emergence. The extent of the vibration is determined based on the likely ground-disturbing machinery used at the construction site: bulldozers, excavators, and scrapers; the likely closest machine to the edge of the footprint, and thus producing vibration at the greatest distance outside the footprint, would be a tracked machine like a bulldozer; the primary cause of ground vibration would be from its tracks hitting the ground. A bulldozer produces perceivable vibration to 135 feet [Caltrans 2013, Table 17]. It is also based on the attenuation coefficient for competent soils: most sands, sandy clays, silty clays, gravel, silts, weathered rock.

It is unlikely that California tiger salamanders would emerge from burrows from all perceivable vibration. Dimmit and Ruibal (1980) created a significant ground-vibration directly over the burrowing animal, and rainfall on the ground above the animal would produce significant immediate-area vibration. Most California tiger salamanders occur in grasslands grazed by cattle. Cattle moving over a California tiger salamander burrow would produce vibration. But California tiger salamanders have been known to thrive in uplands grazed by cattle, so either all vibrations are not perceived by the species the same way, or accidental emergence is not detrimental, e.g. once at the opening to the burrow, the species recognizes that the vibration was not caused by rain, and they retreat back into the lower areas of the hole. Additionally, California tiger salamanders occur and thrive in areas with wind generators of various sizes, which also produce significant sound and vibration.

Potential continual emergence caused by ongoing construction may be detrimental to the species. Based on data regarding the distance vibration travels for the project-related activities, it is assumed that vibrations will affect areas within 75 feet of activities related to Clifton Court Forebay modifications (Dave Buehler pers comm). Therefore, 3 acres of California tiger salamander upland habitat could be affected by vibrations.

4.5.1.5.3 Operations and Maintenance

The operational components of the modified Clifton Court Forebay include the pumping plant, control structures, and siphons. These features will not be operated in or near California tiger salamander habitat and are not expected to affect the species.

The forebay and canals will need control of vegetation and rodents, and perhaps embankment repairs. Maintenance of control structures could include removal or installation of roller gates, radial gates, and stop logs. Maintenance requirements for the spillway will include the removal and disposal of any debris blocking the outlet culverts. After construction, however, these areas will no longer consist of suitable California tiger salamander habitat, therefore this species is not expected to be affected by these activities.

4.5.1.6 Power Supply and Grid Connections

4.5.1.6.1 Habitat Loss and Fragmentation

To conservatively assess impacts from transmission line placement, a 50-foot wide permanent disturbance area along the transmission line corridor was assumed (see Appendix 4.B, *Terrestrial Effects Analysis Methods* for additional details about the impact assessment method). Based on this method, an estimated 6 acres of California tiger salamander aestivation and cover habitat along the east side of the Delta-Mendota canal may be temporarily lost as a result of the construction of temporary transmission lines (Table 4.5-1). Temporary impacts are incurred from activities that will not last more than one year and include access routes (vehicles driving over ground to access the site), temporary staging areas for poles or placement, and reconductoring areas. Ongoing vegetation management around the poles and under the lines will be limited to small scale mechanical mowing, if any, in California tiger salamander habitat because aquatic and grassland areas typically do not need to be cleared to maintain transmission line corridors. Up to one acre may be permanently removed as result of placement of power poles.

Because transmission line effects are primarily short-term and temporary, specific compensation for the 6 acres of California tiger salamander habitat disturbance will be offset by returning these areas to pre-project conditions. The acre to be permanently lost will be offset at a 3:1 ratio.

4.5.1.6.2 Construction Related Effects

New temporary power lines to power construction activities will be built prior to construction of permanent transmission lines to power conveyance facilities. These lines will extend existing power infrastructure (lines and substations) to construction areas, generally providing electrical capacity of 12 kV at work sites.

Construction of new transmission lines will require site preparation, tower or pole construction, and line stringing. For 12 kV and 69 kV lines, cranes will be used during the line-stringing phase; for stringing transmission lines between 230 kV towers, cranes and helicopters will be used. Construction-related activities will be largely concentrated in a 100- by 50-foot area around pole or tower placement areas, and, in the case of conductor pulling locations, in a 350-foot corridor (measured from the base of the tower or pole); conductor pulling locations will occur at any turns greater than 15 degrees and/or every 2 miles of line. Construction will also require vehicular access to each tower or pole location. Vehicular access routes will use existing routes to the greatest extent practicable, but some overland travel will likely be necessary. The duration of transmission line construction activities will not be more than one year at any one location. See Section 3.2.7.2, *Construction*, for a full description of the construction activities.

The operation of equipment during construction of the transmission lines could injure or kill California tiger salamander within the 7 acres (6 acres temporary and 1 acre permanent) of habitat if individuals are present. The construction related effects and measures to minimize them are similar to those described above for construction at the canal work area near Clifton Court Forebay in Section 4.5.1.5.2, *Construction Related Effects*, with the exception that activities will be restricted to the daytime so that no artificial lighting is necessary. Additionally, because noise and vibrations from the transmission line activities are not expected to reach the levels they would under Clifton Court Forebay construction, harassment or displacement of individuals beyond the 7-acre disturbance footprint is not anticipated.

4.5.1.6.3 Operations and Maintenance

Ongoing vegetation management around the poles and under the lines will be limited to small scale mowing, if any, in California tiger salamander habitat because aquatic and grassland areas seldom if ever need to be cleared to maintain transmission line corridors. Effects on California tiger salamander from transmission line operations and maintenance, if any, are expected to be negligible, and are not expected to result in take of California tiger salamander.

4.5.1.7 Head of Old River Gate

The HOR gate construction area does not overlap with California tiger salamander modeled habitat (Figure 4.5-1). Activities in this area will not affect the species.

4.5.1.8 Reusable Tunnel Material

The RTM sites do not overlap with California tiger salamander modeled habitat (Figure 4.5-1). Activities in this area will not affect the species.

4.5.1.9 Restoration

4.5.1.9.1 Habitat Loss and Fragmentation

Restoration activities will avoid effects on California tiger salamander and its habitat with the exception of vernal pool complex restoration, which may result in loss of 11 acres of California tiger salamander terrestrial cover and aestivation habitat. While the exact location of vernal pool restoration is not known, it is likely that it will be in the region directly west, north, or south of CCF where California tiger salamander modeled habitat exists. Although vernal pool restoration in grasslands will result in some loss of California tiger salamander habitat, protection and management of surrounding grasslands associated with the vernal pools is expected to benefit California tiger salamander.

4.5.1.9.2 Construction Related Effects

Vernal pool restoration will involve use of heavy equipment to excavate areas within grasslands to create topographic depressions. California tiger salamanders could be injured or killed by heavy equipment or struck by vehicles associated with vernal pool construction. The types of effects and measures to minimize these effects are as described in Section 4.5.1.5.2, *Construction Related Effects*. Although measures will be applied to minimize the risk of injuring or California tiger salamander during construction, and to minimize the risk of disrupting behavior through noise or lighting, some potential remains for these effects to occur with all the minimization measures in effect.

4.5.1.9.3 Operations and Maintenance

A variety of management actions to be implemented within restored vernal pool complex may result in localized ground disturbances within California tiger salamander habitat. Ground-disturbing activities such as removal of nonnative vegetation and road and other infrastructure maintenance activities are expected to have minor effects on available California tiger salamander. Management activities could result in the injury or mortality of California tiger salamanders if individuals are present in work sites or if dens occur near habitat management work sites. Noise and visual disturbances could also affect California tiger salamanders use of the surrounding habitat. These effects are expected to be minor, and will be minimized with implementation of the worker awareness training, monitoring, and best management practices described in Section 5.3.5.2 *Take Minimization Measures*. Furthermore, the management and enhancement of vernal pool complexes are expected to benefit the species.

4.5.2 Take Analysis

The PP may result in mortality to California tiger salamanders inhabiting or utilizing the up to 104 acres of California tiger salamander terrestrial cover and aestivation habitat expected to be lost. The risk of mortality will be minimized through the mitigation measures described in Section 5.3.3.2.1 *Project Activities with Known Locations*.

4.5.3 Analysis of Impacts in the Project Area

There are 1,003 CNDDB California tiger salamander occurrences throughout California, none of which are in the project area. There are at least eleven (<1% of range-wide) in the legal delta, just west of Clifton Court Forebay, but no known occurrences within the project construction footprint. None of the aquatic habitat associated with these occurrences will be affected by the PP.

There are approximately 12,724 acres of modeled terrestrial cover and aestivation habitat for California tiger salamander in the legal delta. Covered activities are projected to permanently affect a total of 50 acres (<1%) of modeled terrestrial cover and aestivation habitat in the legal delta.

Shaffer and Trenham (2005) suggest that 50% of the subadult and adult California tiger salamander population occurs within 150 meters (approximately 500 feet) of breeding habitat, and that 90% occurs within 490 meters (approximately 1,600 feet) and 95% occurs within 630 meters (approximately 2,065 feet). Also, construction, restoration, and enhancement activities in areas with higher population densities (such as breeding habitat and uplands within 1,600 feet of breeding habitat) have greater potential to encounter individuals (i.e., 90% of the population). Based on dispersal distances, the probability of killing individuals dispersing or using uplands drops substantially the farther away the project activity is from the breeding habitat because individuals are less likely to be present at greater distances. Except for the intakes, the proposed water conveyance and transmission construction activities occur more than 600 meters from modeled California tiger salamander breeding habitat and more than 700 meters from the nearest extant record for the species (which is near CCF). For the intakes, there is no modeled habitat within the project construction footprint, and no known California tiger salamander occurrences in the nearby modeled habitat, in Stone Lakes. Based on this information, no mortality is expected for salamander eggs or metamorphs found in aquatic breeding habitat. Furthermore, the likelihood of take of adults or juveniles from water conveyance and transmission line construction is low due to the distance these impacts will be from occupied breeding sites and low likelihood of individuals being present where construction activities will occur. However, a few individuals might occur in upland areas that will be cleared during project activities. In addition, the species model may be missing aquatic habitat within 600 meters of project activities, with the potential for take of adults or juveniles in these areas.

Covered activities will minimize take of California tiger salamander to the maximum extent practicable; however, mortality may occur as a result of construction and activities occurring as a result of enhancement and management actions on preservation lands. Mortality will be minimized and fully mitigated through the measures described in Section 5.3.5.2 T*ake Minimization Measures*.

Overall the impacts on California tiger salamander will not be substantial when considering the relative amount of habitat affected in the legal delta, which will be <1% (50 acres) of the terrestrial cover and aestivation habitat, and when considering the take minimization measures that are presented in Section 5.3.5.2.1 *Activities with Fixed Locations*, which will minimize take to the maximum extent practicable. Furthermore, the proposed mitigation presented Section 5.4.5 *California Tiger Salamander*, which includes the protection, enhancement, and management of up to 150 acres of terrestrial cover and aestivation habitat with suitable aquatic habitat, will fully mitigate the loss of habitat if all potential impacts on modeled habitat occur. Mitigation will be implemented prior to or concurrent with the impact.

4.5.4 Analysis of Potential for Jeopardy

4.5.4.1 Cumulative Effects

The projects and programs that have been considered as part of the cumulative analysis have been drawn primarily from Draft EIR/EIS Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions* (California Department of Water Resources, U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, and National Marine Fisheries Service 2013). Those projects and programs that could impact terrestrial resources in the legal delta are presented in Appendix 4.B, *Terrestrial Methods*. The list of past, present and reasonably foreseeable future projects and programs has been evaluated to determine which of these activities may have effects on California tiger salamander. Most of the local, state and federal land use and land management programs that are affecting or will affect the legal delta are designed to preserve open space and agricultural lands, and to manage the resources of the area for multiple uses, including agriculture, recreation, fish and wildlife habitat, flood protection and water management. Most of these projects and programs have a conservation or restoration component and thus could ultimately be beneficial to California tiger salamander. These programs include the Yolo Natural Heritage Program Plan, Yolo Bypass Wildlife Area Land Management Plan, Solano County Multispecies Habitat Conservation Plan, Stone Lakes National Wildlife Refuge Comprehensive Conservation Plan, South Sacramento Habitat Conservation Plan, San Joaquin County Multi-Species Habitat Conservation and Open Space Plan, and California EcoRestore.

The PP’s impacts on California tiger salamander habitat will be minor, affecting <1% of the modeled habitat in the legal delta. The take minimization and mitigation measures will ensure that the loss of habitat will be fully mitigated and that take will be minimized. The project activities’ effect on California tiger salamander will not be cumulatively considerable.

4.5.4.2 Potential to Jeopardize the Existence of the Species

The issuance of the ITP is not expected to jeopardize the continued existence of California tiger salamander for the following reasons.

Level of Take – The overall potential for take is low. Covered activities have a low likelihood of resulting in mortality of individuals. The covered activities will result in permanent impacts on up to 50 acres of terrestrial cover and aestivation habitat (<1% of modeled habitat in the legal delta). These habitat losses are small and are not expected to have a population level effect.

Take Minimization Measures – The proposed TMMs described in Section 5.3.5.2.1, *Activities with Known Locations*, greatly reduce the potential for mortality of individuals, which makes it unlikely that activities will affect reproductive rates of the population or survivorship of individuals.

Mitigation – Mitigation is expected to fully offset habitat loss and any loss of individuals because higher-quality, intact habitat will be acquired, enhanced, and managed in perpetuity.

While existing California tiger salamander populations appear to be in decline (California Department of Fish and Game 2010), the project's activities will not exacerbate this decline and are not expected to result in significant losses of individuals of the species or its habitat. The applicant's take minimization measures will ensure impacts on habitat and individuals are minimized, and the mitigation will ensure occupied habitat is protected.

For the California tiger salamander, the primary threats to its survival include habitat loss, conversion, and fragmentation, as well as species hybridization. The proposed project will not threaten the survival of the California tiger salamander because the covered activities will not result in significant losses of individuals of the species or habitat. The covered activities will also not substantially contribute to the fragmentation of remaining habitat because most of the covered activities will be outside of the species' habitat and will not create barriers to movement. Also, covered activities will not contribute to the impact of hybridization because covered activities will not result in the translocation of hybrids or introduction of non-native tiger salamanders.

Considering the low potential for take relative to these factors, the take minimization measures in Section 5.3.5.2.1, *Activities with Known Locations*, and that the loss of habitat will be fully mitigated, the PP will not adversely affect the reproduction and survival of the California tiger salamander, and the issuance of the ITP will not jeopardize the continued existence of the species.

4.5.5 References

California Department of Fish and Game. 2010. Report to the Fish and Game Commission: A status review of the California Tiger Salamander (Ambystoma californiense). Wildlife Branch Nongame Wildlife Program Report 2010-4.California Department of Water Resources, U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, and National Marine Fisheries Service. 2013. *Draft Environmental Impact Report/Environmental Impact Statement for the Bay Delta Conservation Plan.* Prepared by ICF International. Sacramento, CA.

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4.6 Take of the Giant Garter Snake

Appendix 4.B *Terrestrial Impact Analysis Methods*, describes the methods and assumptions used to analyze the effects of the PP on terrestrial species. Section 2.6.4 *Species Habitat Suitability Model* describes the habitat model for giant garter snake, and Section 2.6.5 *Suitable Habitat Definition* defines suitable habitat for this species.

Activities associated with geotechnical exploration, safe haven work areas, NDD construction, tunneled conveyance facilities, Clifton Court Forebay modifications, power supply and grid connections, the HOR Gate, reusable tunnel material, and habitat restoration have the potential to affect giant garter snakes, as described below. Figure 4.6-1 provides an overview of the locations of surface impacts relative to giant garter snake modeled habitat and occurrences. There are 88,947 acres (26,328 acres of aquatic habitat and 62,619 acres of upland habitat) of modeled giant garter snake habitat in the Delta. An estimated 775 acres (<1% of total modeled habitat in the Delta) of modeled giant garter snake habitat will be lost as a result of project implementation. This includes 205 acres of modeled aquatic habitat (<1% of modeled aquatic habitat in the Delta) and 570 acres of modeled upland habitat (<1% of modeled upland habitat in the Delta). Effects from these activities are detailed below. Table 4.6-1 and Table 4.6-2 summarize the total estimated loss of giant garter snake modeled habitat.

Table 4.6-1. Maximum Loss of Giant Garter Snake Modeled Habitat by Activity Type (Acres)

Giant Garter Snake Modeled Habitat	Total Modeled Habitat in the Delta	Permanent Habitat Loss								Temporary Habitat Loss	
		Safe Haven Work Areas	North Delta Intakes	Tunneled Conveyance Facilities	Clifton Court Forebay Modifications	Head of Old River Gate	Reusable Tunnel Material	Power Supply and Grid Connections	Total Maximum Habitat Loss	Geotechnical Exploration	Power Supply and Grid Connections
Aquatic	26,328	0	12	93	16	1	83	0	205	0[1]	0[1]
Upland	62,619	0	62	127	219	2	159	1	570	98	67
Total	**88,947**	**0**	**74**	**220**	**235**	**3**	**242**	**1**	**775**	**98**	**67**

[1] Geotechnical exploration and power supply and grid connections will avoid suitable aquatic giant garter snake habitat; see Section 5.3.6, *Giant Garter Snake*.

Table 4.6-2. Maximum Direct Effects on and Conservation of Modeled Habitat for Giant Garter Snake

	Permanent Habitat Loss	Compensation Ratios		Total Compensation	
	Total Maximum Habitat Loss (Acres)	Protection	Restoration	Protection[2]	Restoration[2]
Aquatic Total	205	3:1 or 2:1[1]		615 or 410	
Upland Total	570			1,710 or 1,140	
TOTAL	**775**			**2,325 or 1,550**	

[1] The 3:1 mitigation ratio will be applied when "in-kind" mitigation is used. In-kind mitigation is mitigation that replaces a habitat of similar quality, character, and location as that which was lost within the known range of the giant garter snake as described in Section 2.6.4 *Species Habitat Suitability Model*. DWR will mitigate at a rate of 2:1 for each acre of lost aquatic and upland habitat if the mitigation is created/protected in a high-priority conservation location for giant garter snake agreed upon by CDFW5, such as the eastern protection area between Caldoni Marsh and Stone Lakes

[2] Compensation can be achieved through restoration or protection. The protection component of habitat compensation will be limited to up to 1/3 of the total compensation.

4.6.1 Effects on Giant Garter Snake from the Proposed Project

4.6.1.1 Geotechnical Exploration

4.6.1.1.1 Habitat Loss and Fragmentation

The only permanent loss of giant garter snake habitat resulting from geotechnical exploration will be boreholes, which will be grouted upon completion. These holes are very small (approximately 8 inches diameter) and this permanent loss is not expected to result in incidental take of giant garter snake. Temporary habitat disturbance that is expected to occur during the exploration is described below in Section 4.6.1.1.2 *Construction Related Effects.*

4.6.1.1.2 Construction Related Effects

Geotechnical exploration will avoid effects on giant garter snake aquatic habitat but may temporarily affect up to 98 acres of upland habitat during geotechnical exploration (see Appendix 4.B, *Terrestrial Impact Analysis Methods* for a description of the methods applied to develop this estimate). Except for the habitat loss associated with boreholes described above, this temporary effect will consist of driving overland to access the boring sites, and storing equipment for short time periods (a few hours to 12 days). The operation of equipment during construction could result in injury or mortality of giant garter snakes associated with the 98 acres of upland habitat, if any are present. The potential for this effect will be minimized by confining activities within giant garter upland habitat to the active season, confining movement of heavy equipment to existing access roads or to locations outside giant garter snake upland habitat, and requiring that all construction personnel receive worker awareness training, as described in Section 5.3.6.2.2 *Activities with Flexible Locations*.

4.6.1.1.3 Operations and Maintenance

There will be no ongoing operations or maintenance associated with geotechnical exploration, therefore no potential for incidental take of giant garter snake.

4.6.1.2 Safe Haven Work Areas

As described in Section 5.3.6.2.2 *Activities with Flexible Locations*, safe haven work areas will avoid giant garter snake habitat. Therefore, construction and operation of safe haven work areas will not cause incidental take of giant garter snake.

4.6.1.3 North Delta Diversion Construction

4.6.1.3.1 Habitat Loss and Fragmentation

An estimated 74 acres of giant garter snake modeled habitat overlaps with the NDD footprint (Figures 4.6-2, 4.6-3, and 4.6-4), where land will be cleared for permanent facilities and temporary work areas. The 74 acres of modeled habitat includes 12 acres of aquatic habitat and 62 acres of upland habitat. Of the estimated 74 acres of modeled habitat to be removed, 47 acres (3 acres of aquatic and 44 acres of upland) will result from construction of permanent facilities such as the NDDs and associated electrical buildings and facilities, and permanent access roads. The remaining 27 acres (9 acres of aquatic and 18 acres of upland) of loss will result from use of the work areas, which will last for approximately five years at each NDD site: because the duration of this effect is greater than one year, this effect will be compensated as if it were a permanent effect.

As shown on Figures 4.6-2, 4.6-3, and 4.6-4, the modeled habitat to be lost as a result of NDD construction is modeled upland habitat along the Sacramento River. Per the Draft 2015 *Recovery Plan for Giant Garter Snake*, the Sacramento River at the NDD sites does not meet the definition of either aquatic habitat or a corridor (U.S. Fish and Wildlife Service 2015). Therefore, neither the NDDs nor their construction are likely to obstruct giant garter snake movement in the Sacramento River. Table 4.6-2 shows the compensation acreage to offset the total loss of giant garter snake habitat.

4.6.1.3.2 Construction Related Effects

Construction activities at each NDD site that may affect giant garter snake include ground clearing and grading, construction of the NDDs and associated facilities, vehicular use including transport of construction equipment and materials, in-water construction of crib walls, and in-water pile driving. It is unlikely that the in-water activity will affect giant garter snakes because the activities will occur in the Sacramento River, where the species is very unlikely to be present, based on the definitions of aquatic and corridor habitat presented in the Draft 2015 *Recovery Plan for Giant Garter Snake* (U.S. Fish and Wildlife Service 2015).

The duration of construction at each NDD site will be approximately 5 years. Implementation of intake construction at each location will be staggered by approximately 6 months. Construction for Intake 3, the middle intake, will begin first; approximately 6 months later, construction will begin at intake 5, the southernmost intake. Construction at intake 2, the northernmost intake, will begin approximately 1 year after having begun at intake 5. The result is that construction will overlap at all three sites for approximately 4 years.

Vehicles and heavy equipment used to clear the construction sites and transport equipment and material could injure or kill giant garter snakes if individuals are present within the construction footprint. This effect would be most likely to occur during site clearing (up to several days at each location) because thereafter, exclusion fencing will be installed, and these areas will be monitored to minimize the potential for giant garter snakes to enter the work area. To avoid crushing giant garter snakes in their burrows during brumation (cold-weather hibernation), site clearing within suitable giant garter snake habitat will occur during the active season, and the site will be fenced with exclusionary fencing to prevent snakes from entering the work area. A biological monitor will inspect the construction area prior to and during construction, and if a giant garter snake is encountered during surveys or construction, activities that may kill the snake will cease until appropriate corrective measures have been completed, it has been determined that the giant garter snake will not be harmed, or the giant garter snake has left the work area (or actively relocated if needed, consistent with provisions in Section 5.3.6.2.1, *Activities with Fixed Locations*). Additional measures to minimize this effect include limiting vehicle speed to 10 miles per hour within and in the vicinity of giant garter snake habitat where practical and safe to do so, visually checking for giant garter snakes under vehicles and equipment prior to moving them, and checking crevices or cavities in the work area including stockpiles which have been left for more than 24 hours where cracks or crevices may have formed. Equipment will be stored in designated staging areas, and these staging areas will have exclusion fencing where giant garter snakes have potential to occur. These measures are described in detail in Section 5.3.6.2.1 *Activities with Fixed Locations*. With these measures in place, there is still potential for giant garter snakes to be injured or killed within the 62 acres of upland habitat if, for example, vehicles are unable to avoid giant garter snakes or if a snake is able to get through the exclusion fencing and is undetected by the biological monitor.

Giant garter snakes could potentially become entangled, trapped, or injured as a result of erosion control measures that use plastic or synthetic monofilament netting in construction areas within the construction footprint. This effect is not likely given that the construction area will be fenced and monitored after the biological monitor has relocated any giant garter snakes found in the construction area. This effect will be further avoided as described in Appendix 3.F *General Avoidance and Minimization Measures*, AMM2 *Construction Best Management Practices and Monitoring* by prohibiting use of these materials and limiting erosion control materials silt fencing. Giant garter snakes might also be trapped in pipes or other structures used for construction. To minimize this risk, as described in Section 5.3.6.2.1 *Activities with Fixed Locations*, workers will inspect any conduits or other features where giant garter snakes may be trapped, and workers will properly contain and remove all trash and waste items generated during construction.

Giant garter snakes might be injured or killed, or their habitat may be contaminated, as a result of the use of toxic materials during construction. To minimize this risk, all construction equipment will be maintained to prevent leaks of fuel, lubricant, or other fluids, and workers will exercise extreme caution when handling or storing materials. Workers will keep appropriate materials on site to contain and clean up any spills as described in Appendix 3.F *General Avoidance and Minimization Measures*, AMM5 *Spill Prevention, Containment, and Countermeasure Plan.*

Construction related effects on aquatic habitat outside the development footprint include decreased water quality during construction activities due to runoff, dewatering, and minor ground disturbance. The risk of construction-related water quality effects will be minimized through standard water quality protection measures as described in Appendix 3.F *General*

Avoidance and Minimization Measures, AMM3 *Stormwater Pollution Prevention Plan* and AMM4 *Erosion and Sediment Control Plan*.

Construction related light is not expected to affect giant garter snakes because they are diurnal and spent nighttime hours in burrows. Additionally, all lighting within construction areas will be screened and directed away from habitat areas.

Noise and vibrations in and near habitat could result in harm and/or harassment of giant garter snakes by interfering with normal activities such as feeding, sheltering, movement between refugia and foraging grounds, and other essential behaviors. Little is known regarding the effects noise and vibrations on giant garter snakes. Giant garter snakes might avoid otherwise suitable habitat close to construction sites where intense vibrations were being created, but are unlikely to be affected by noise alone. Snake ear anatomy only allows them to detect vibrations from the ground, requiring noise that creates ground vibration. Typical construction activities that would occur close to the edge of the construction footprint and create enough vibration for snakes to perceive would be dozing and grading of staging areas and access roads and use of trucks to transfer construction materials to and from the construction sites. These construction activities are unlikely to transmit vibration at an intensity perceptible to giant garter snakes at distances greater than 50 feet, though it is unknown if the species would avoid suitable habitat because of vibration. In addition, the level of potential disturbance at the edge of the construction footprint will vary by construction activity, from period to period, from no disturbance to the estimated maximum. Construction-related vibration, if it caused giant garter snake avoidance of suitable habitat, would be a temporary habitat loss, typically episodic for periods of hours, days or weeks, followed by periods of no disturbance. Noise effects will be minimized as described in Appendix 3.F *General Avoidance and Minimization Measures*, AMM13 *Noise Abatement.* However, since these measures will only be implemented where practicable, some residual effects resulting from noise and vibrations are anticipated near giant garter snake habitat. Due to the long-term nature of the activities, giant garter snakes may habituate to these disturbances. DWR will monitor giant garter snake habitat immediately adjacent to the construction footprint prior to and during construction activities that could produce significant vibration outside the project footprint to determine if giant garter snakes are present and if they appear to be affected and report those findings to CDFW.

4.6.1.3.3 Operations and Maintenance

4.6.1.3.3.1 Maintenance

Ongoing maintenance activities at the NDDs include intake dewatering, sediment removal, debris removal, and biofouling and corrosion removal. These activities will occur from water-based equipment approximately annually. These activities are not expected to affect giant garter snake or its habitat because, as stated above, giant garter snakes are not likely to be present in the open water portion of the Sacramento River.

4.6.1.3.3.2 Operations

4.6.1.3.3.2.1 Microcystis

NDD operation has potential to affect streamflows, temperature, and residence times, all of which may affect the occurrence of *Microcystis* blooms. *Microcystis* is a toxic blue-green alga shown to have negative effects on the aquatic foodweb of the Delta (Brooks et al. 2012), with blooms generally occurring from between June to October, when water temperature is 19°C or more. The sensitivity to microcystins, the toxins produced by *Microcystis*, varies by species and life stage (Butler et al. 2009; Schmidt et al. 2013). During *Microcystis* blooms, microcystins may accumulate in tissues of small planktivorous (plankton-eating) fish through the consumption of *Microcystis* or through foodweb transfer, i.e., consumption of prey that have consumed *Microcystis* (Schmidt et al. 2013); to a lesser extent, microcystins may be absorbed directly from the water (Butler et al. 2009). Microcystins are actively absorbed into the tissues and organs of vertebrates, particularly the liver, where they disrupt cellular activity (Butler at al. 2009; Schmidt et al. 2013). Although microcystins have been found in various aquatic organisms, including phytoplankton, zooplankton, crayfish, shrimp, mussel, snail, fish, and frogs, and are known to accumulate in several fish species (Schmidt et al. 2013; Smith and Haney 2006), some research indicates that the toxins may be excreted by the kidneys or metabolized into less toxic forms (Gupta and Guha 2006; Schmidt et al. 2013; Smith and Haney 2006). A study on sunfish found microcystin concentrations decreased after exposure, however, some persisted in organs.

The potential operational effects of the PP on *Microcystis* were assessed using two approaches. First, the frequency of flow conditions conducive to *Microcystis* occurrence (as defined by Lehman et al. 2013) was assessed in the San Joaquin River past Jersey Point (QWEST) and in the Sacramento River at Rio Vista (QRIO), based on DSM2-HYDRO modeling. Second, DSM2-QUAL water temperature modeling and DSM2-PTM for estimates of residence time (BA Appendix 6.A, *Quantitative Methods for Biological Assessment of Delta Smelt*, Section 6.A.4.3 Microcystis *(DSM2-PTM Residence Time)* [Reclamation 2016]) were used to inform the potential for *Microcystis* occurrence, given the importance of water temperature and the probable importance of residence time (although there are no published relationships between *Microcystis* occurrence and residence time in the Delta). Note that more weight is placed on the analysis based on the published flow conditions at which *Microcystis* occurs (Lehman et al. 2013), because there are no published analyses of the relationship between *Microcystis* occurrence and residence time. Both sets of quantitative analyses (i.e., the flow analysis and the residence time/temperature analysis) focused on the summer/fall (July–November) period because it is during this time of the year that *Microcystis* blooms are likely to occur. Note that other environmental factors, such as nutrients, also affect the abundance of *Microcystis* (Lehman et al. 2014), but these factors are not readily predictable for comparison of the NAA and PP scenarios. This introduces some uncertainty to results based only on flow or residence time/temperature.

The first analysis examined the frequency of years during July–November in which mean monthly flows were within the range at which *Microcystis* has been shown to occur, per Lehman et al. (2013: 155): -240 to 50 m^3/s (approx. -8,500 to 1,800 cfs) for QWEST, and 100-450 m^3/s (approx. 3,500 to 15,900 cfs) for QRIO[1]. This analysis suggested that flow conditions conducive to *Microcystis* bloom occurrence would tend to occur less frequently under the PP than NAA in the San Joaquin River, based on QWEST. For NAA, the percentage of years with QWEST within the range for *Microcystis* occurrence ranged from 89% in October to 98% in August, whereas for PP, the range was from 9% of years in October to 99% of years in August (Table 4.6-3). Neither the NAA nor the PP yielded mean monthly flows below the range noted for *Microcystis* occurrence, whereas for the PP there were substantially more years above the range

[1] The DSM2-HYDRO output locations used for estimating QWEST were RSAN018 + SLTRM004 + SLDUT007; and for QRIO was RSAC101.

than for NAA. The results reflected greater mean QWEST flows under the NAA compared to PP, with monthly means under the PP ranging from just under 0 m^3/s (-100 cfs) in August (compared to -168 m^3/s or -5,900 cfs under NAA) to 245 m^3/s (8,600 cfs) in October (compared to 16 m^3/s or 570 cfs under NAA). These results are attributable to less south Delta export pumping under the PP than under the NAA.

Table 4.6-3. Percentage of Modeled Years (1922-2003) in Which Mean Monthly Flow in the San Joaquin River Past Jersey Point (QWEST) Was Below, Within, and Above the Range for *Microcystis* Occurrence (Lehman et al. 2013).

	NAA				Proposed Project			
	Below Range (< -240 m^3/s)	Within Range (-240 to 50 m^3/s)	Above Range (> 50 m^3/s)	Mean Flow, m^3/s (cfs)	Below Range (< -240 m^3/s)	Within Range (-240 to 50 m^3/s)	Above Range (> 50 m^3/s)	Mean Flow, m^3/s (cfs)
July	0%	95%	5%	-162 (-5,714)	0%	78%	22%	68 (2,384)
August	0%	98%	2%	-168 (-5,931)	0%	99%	1%	-3 (-103)
September	0%	96%	4%	-128 (-4,531)	0%	52%	48%	191 (6,729)
October	0%	89%	11%	16 (568)	0%	9%	91%	245 (8,637)
November	0%	91%	9%	-39 (-1,391)	0%	53%	47%	178 (6,281)

Implementation of north Delta export pumping under the PP would result in reduced Sacramento River flow compared to the NAA, as reflected in the examination of QRIO (Table 4.6-3). The percentage of years within the range at which *Microcystis* has been noted to occur ranged from 59% in September to 89% in August under NAA, compared to a range from 48% in September to 96% in July for PP (Table 4.6-4). Given that Lehman et al.'s (2013) suggested mechanism for the importance of flow was lower flows leading to sufficiently long residence time to allow *Microcystis* colonies to accumulate into blooms, flows below the range noted for *Microcystis* occurrence by Lehman et al. (100–450 m^3/s) could also be favorable for bloom occurrence, whereas flows above the range may reduce residence time sufficiently to limit bloom formation. The percentage of years in which mean monthly flow was above the range that Lehman et al. (2013) found for *Microcystis* occurrence was less under PP than NAA in July (0%, compared to 10% under NAA), September (0%, compared to 29% under NAA), and November (10%, compared to 16% under NAA). On the basis of differences in QRIO flow, therefore, there could be greater potential for *Microcystis* occurrence in the lower Sacramento River under the PP than NAA. However, this is currently not an area of intense *Microcystis* blooms and if it remains turbid in the future, it is expected that current conditions will continue.

Table 4.6-4. Percentage of Modeled Years (1922-2003) in Which Mean Monthly Flow in the Sacramento River at Rio Vista Was Below, Within, and Above the Range for *Microcystis* Occurrence (Lehman et al. 2013).

	NAA				Proposed Project			
	Below Range (< -100 m^3/s)	**Within Range (-100 to 450 m^3/s)**	**Above Range (> 450 m^3/s)**	**Mean Flow, m^3/s (cfs)**	**Below Range (< -100 m^3/s)**	**Within Range (-100 to 450 m^3/s)**	**Above Range (> 450 m^3/s)**	**Mean Flow, m^3/s (cfs)**
July	5%	85%	10%	702 (24,793)	4%	96%	0%	396 (13,984)
August	11%	89%	0%	462 (16,331)	11%	89%	0%	282 (9,942)
September	12%	59%	29%	754 (26,612)	52%	48%	0%	457 (16,136)
October	15%	84%	1%	420 (14,839)	15%	84%	1%	291 (10,275)
November	7%	77%	16%	769 (27,162)	0%	90%	10%	541 (19,097)

The results of the DSM2-PTM-based residence time analysis presented here focus only on the particle insertion locations upstream (east) of Suisun Bay and Suisun Marsh, because this is where effects of the PP on hydraulic residence time are highest. The effects of the PP on residence time varied by subregion of the Delta. As previously described, there has been no published analysis of the relationship between *Microcystis* occurrence and residence time, so there is uncertainty as to what the differences described here may mean in terms of potential for *Microcystis* occurrence. In the riverine portions of the Sacramento River, residence time is short under both scenarios and so there is little potential for the PP to influence the growth potential of *Microcystis* (Table 4.6-5 and Table 4.6-6). During summer and fall, residence time in the Sacramento Ship Channel subregion is usually strongly tidally driven, with a relatively minor component of riverine flow, so there is little difference in residence time between the no action alterative (NAA) and PP (Table 4.6-7). Residence time generally was estimated to be 1–4 days longer under PP than under NAA in the Cache Slough and Liberty Island subregion during July to November (Table 4.6-8); this generally was also true for Rio Vista and the lower Sacramento River in July and August, whereas the residence time in September to November in these subregions generally was similar or slightly lower under PP than under NAA (Table 4.6-9 and Table 4.6-10). As noted in the analysis of QRIO based on Lehman et al. (2013), this is currently not an area of intense *Microcystis* blooms and if it remains turbid in the future, it is expected that current conditions will continue.

In the Lower San Joaquin River and Twitchell Island subregions, residence time generally was greater under the PP than under NAA in July and August, but was similar or less under the PP than under NAA in September to November (Table 4.6-11 and Table 4.6-12). This is in general agreement with the analysis of QWEST that was previously presented: in July and August, QWEST mean values below -5,000 cfs (Table 4.6-3) under NAA reflects high south Delta export pumping that would cause particles to leave the area rapidly (towards the south Delta export facilities) compared to PP. Residence time in the eastern portion of the Delta (San Joaquin River at Prisoners Point and near Stockton, Mokelumne River, and Disappointment Slough) generally was estimated to be greater under the PP (Table 4.6-13, Table 4.6-14, Table 4.6-15, Table 4.6-16), in some cases 4–12 days longer, e.g., Disappointment Slough in July. Substantially greater residence times under the PP also were estimated for Mildred Island, e.g., over 10 days at the 25%–75% percentiles (Table 4.6-17). Increases in residence time were apparent over much of the central/south Delta subregions examined, including Holland Cut (Table 4.6-18), Franks Tract (Table 4.6-19), and Rock Slough and Discovery Bay (Table 4.6-20). Low residence times in Old River and Middle River reflect the relatively short duration before particles are entrained, but lower south Delta export pumping under the PP leads to longer residence times even in these channels, particularly in September–November (Table 4.6-21 and Table 4.6-22). Additional factors increasing residence time in these months under the PP include no export pumping and HOR gate closure during and prior to the fall pulse flow period (Section 3.3.2, *Operational Criteria*, BA Appendix 5.A *CALSIM Methods and Results,* Section 5.A.5.2 [Reclamation 2016]). Considerably increased residence times in Victoria Canal under the PP (compared to NAA) in some months likely reflects the modeled operations of Contra Costa Water District diversions; particles that are entrained relatively quickly by the diversion under the NAA are not moved as quickly in the PP because the Rock Slough diversion is used preferentially, in response to higher EC (Table 4.6-23). Relatively long residence times in the Grant Line Canal and Old River subregion reflect the influence of the south Delta temporary barriers, with similar or longer residence times under the PP in July–August (Table 4.6-24); shorter residence times under the

PP in October/November are a result of differing assumptions regarding the fall operations of the HOR gate under the PP compared to the rock barrier under the NAA. In general, there were relatively small differences in residence time for the Upper San Joaquin River subregion (Table 4.6-25).

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Table 4.6-5. Summary Statistics of Residence Time (Days) in the Upper Sacramento River Subregion from DSM2-PTM.

Percentile	July			August			September			October			November		
	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA
5%	0.4	0.7	0.3 (65%)	0.6	1.2	0.6 (107%)	0.5	0.7	0.3 (57%)	0.5	1.1	0.7 (148%)	0.4	0.8	0.4 (99%)
25%	0.5	1.1	0.7 (135%)	0.6	1.5	0.8 (126%)	0.5	1.0	0.5 (83%)	0.8	1.4	0.7 (87%)	0.6	1.1	0.4 (69%)
50% (median)	0.5	1.2	0.7 (124%)	0.7	1.8	1.1 (164%)	1.2	2.2	1.0 (89%)	1.0	1.7	0.6 (63%)	1.0	1.4	0.4 (45%)
75%	0.8	1.4	0.6 (76%)	1.8	2.0	0.2 (14%)	2.4	2.7	0.4 (15%)	1.6	1.9	0.2 (13%)	1.8	1.7	0.0 (-2%)
95%	2.4	2.7	0.2 (9%)	3.2	3.1	0.0 (-1%)	20.1	11.5	-8.7 (-43%)	2.3	2.3	0.0 (0%)	16.2	10.6	-5.5 (-34%)

Table 4.6-6. Summary Statistics of Residence Time (Days) in the Sacramento River Near Ryde Subregion from DSM2-PTM.

Percentile	July			August			September			October			November		
	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA
5%	0.3	0.4	0.1 (33%)	0.5	0.9	0.4 (69%)	0.5	0.6	0.1 (29%)	0.3	0.6	0.3 (76%)	0.4	0.7	0.3 (85%)
25%	0.5	0.8	0.4 (80%)	0.6	1.1	0.5 (89%)	0.5	0.7	0.2 (33%)	0.6	1.2	0.5 (83%)	0.5	0.9	0.4 (78%)
50% (median)	0.5	1.0	0.5 (89%)	0.7	1.3	0.6 (89%)	0.7	1.5	0.8 (113%)	0.9	1.5	0.6 (65%)	0.8	1.3	0.6 (72%)
75%	0.7	1.2	0.5 (65%)	1.3	1.8	0.5 (40%)	1.7	2.1	0.5 (29%)	1.4	1.7	0.2 (16%)	1.1	1.5	0.4 (32%)
95%	1.8	1.7	-0.1 (-6%)	2.4	2.7	0.2 (10%)	2.5	2.5	0.0 (0%)	2.1	2.3	0.2 (12%)	1.9	1.9	0.0 (-1%)

Table 4.6-7. Summary Statistics of Residence Time (Days) in the Sacramento River Ship Channel Subregion from DSM2-PTM.

Percentile	July			August			September			October			November		
	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA
5%	43.3	43.4	0.1 (0%)	43.2	43.1	0.0 (0%)	43.2	43.2	0.0 (0%)	42.5	42.5	0.0 (0%)	39.8	39.7	-0.1 (0%)
25%	43.4	43.5	0.0 (0%)	43.3	43.4	0.1 (0%)	43.3	43.3	0.0 (0%)	43.4	43.3	0.0 (0%)	42.3	42.2	0.0 (0%)
50% (median)	43.6	43.6	0.0 (0%)	43.7	43.8	0.1 (0%)	43.7	43.7	0.1 (0%)	43.7	43.6	0.0 (0%)	43.1	43.1	0.0 (0%)
75%	44.0	44.1	0.0 (0%)	44.0	44.1	0.0 (0%)	43.9	44.0	0.0 (0%)	43.9	43.9	0.0 (0%)	44.1	44.0	0.0 (0%)
95%	44.3	44.3	0.0 (0%)	44.2	44.2	0.0 (0%)	44.3	44.3	0.1 (0%)	44.4	44.4	0.0 (0%)	44.3	44.3	0.0 (0%)

Table 4.6-8. Summary Statistics of Residence Time (Days) in the Cache Slough and Liberty Island Subregion from DSM2-PTM.

Percentile	July			August			September			October			November		
	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA
5%	20.4	22.5	2.1 (10%)	16.5	19.5	3.0 (18%)	13.1	14.2	1.1 (8%)	11.4	13.8	2.4 (21%)	8.3	9.6	1.3 (15%)
25%	21.3	23.3	2.0 (9%)	17.2	20.8	3.6 (21%)	14.7	17.5	2.7 (18%)	14.7	17.1	2.4 (17%)	11.5	13.1	1.6 (14%)
50% (median)	22.0	23.8	1.8 (8%)	18.3	21.1	2.8 (15%)	16.1	18.7	2.7 (16%)	15.9	18.2	2.2 (14%)	13.4	14.5	1.2 (9%)
75%	22.7	25.1	2.4 (11%)	20.6	22.1	1.5 (7%)	18.2	21.1	2.9 (16%)	17.6	18.6	1.0 (6%)	14.9	15.6	0.7 (5%)
95%	25.8	27.0	1.2 (5%)	22.3	23.7	1.4 (6%)	22.5	22.3	-0.2 (-1%)	19.0	19.5	0.5 (3%)	16.7	16.4	-0.3 (-2%)

Table 4.6-9. Summary Statistics of Residence Time (Days) in the Sacramento River Near Rio Vista Subregion from DSM2-PTM.

Percentile	July			August			September			October			November		
	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA
5%	1.4	2.0	0.7 (48%)	5.8	7.4	1.6 (27%)	3.2	1.8	-1.4 (-43%)	3.8	2.7	-1.1 (-29%)	3.6	3.9	0.3 (9%)
25%	4.7	7.7	1.2 (17%)	9.2	9.2	0.0 (0%)	5.0	2.7	-2.3 (-46%)	5.6	5.3	-0.3 (-5%)	5.0	5.3	0.3 (5%)
50% (median)	7.4	11.9	4.5 (60%)	10.4	13.6	3.2 (31%)	7.8	9.0	1.2 (16%)	9.2	8.1	-1.1 (-12%)	6.2	4.7	0.5 (7%)
75%	13.7	14.9	1.1 (8%)	14.7	17.0	2.3 (16%)	15.5	14.7	-0.8 (-5%)	11.9	10.2	-1.7 (-14%)	8.0	9.9	1.9 (24%)
95%	17.3	17.1	-0.2 (-1%)	17.9	19.6	1.7 (10%)	18.9	17.9	-1.0 (-5%)	15.9	14.7	-1.1 (-7%)	12.3	12.1	-0.2 (-2%)

Table 4.6-10. Summary Statistics of Residence Time (Days) in the Lower Sacramento River Subregion from DSM2-PTM.

Percentile	July			August			September			October			November		
	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA
5%	3.2	4.7	1.6 (49%)	10.1	12.2	2.1 (21%)	4.7	3.5	-1.3 (-26%)	6.7	6.7	0.0 (0%)	6.1	6.0	-0.1 (-2%)
25%	9.1	12.3	3.2 (35%)	13.5	13.6	0.1 (1%)	7.0	4.4	-2.6 (-37%)	8.8	8.4	-0.4 (-5%)	7.5	7.4	-0.1 (-1%)
50% (median)	12.9	15.0	2.1 (17%)	17.4	18.7	1.3 (8%)	13.4	12.5	-0.9 (-7%)	13.4	12.9	-0.5 (-4%)	10.2	10.8	0.6 (6%)
75%	20.9	21.0	0.2 (1%)	21.7	23.4	1.7 (8%)	22.6	21.2	-1.5 (-6%)	18.4	16.9	-1.5 (-8%)	13.2	14.7	1.4 (11%)
95%	22.4	22.2	-0.2 (-1%)	23.5	24.4	0.9 (4%)	24.3	23.4	-0.9 (-4%)	20.9	20.5	-0.4 (-2%)	18.7	18.4	-0.3 (-1%)

Table 4.6-11. Summary Statistics of Residence Time (Days) in the Lower San Joaquin River Subregion from DSM2-PTM.

Percentile	July			August			September			October			November		
	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA
5%	3.1	4.7	1.4 (45%)	12.0	12.7	0.7 (6%)	5.5	3.7	-1.8 (-32%)	7.5	6.8	-0.7 (-9%)	7.1	5.2	-2.0 (-27%)
25%	11.3	13.0	1.7 (15%)	15.4	14.2	-1.2 (-8%)	10.4	4.3	-6.1 (-58%)	9.8	7.8	-2.0 (-21%)	9.6	8.1	-1.5 (-15%)
50% (median)	14.1	16.0	2.0 (14%)	17.8	18.3	0.5 (3%)	14.5	11.9	-2.6 (-18%)	13.4	11.5	-1.9 (-14%)	12.2	10.9	-1.3 (-11%)
75%	20.4	21.5	1.1 (5%)	22.4	23.3	1.0 (4%)	22.9	20.7	-2.2 (-10%)	19.9	16.7	-3.2 (-16%)	14.5	15.7	1.2 (8%)
95%	22.7	23.4	0.7 (3%)	24.7	25.2	0.4 (2%)	25.5	24.3	-1.1 (-4%)	22.3	21.0	-1.3 (-6%)	19.3	20.1	0.8 (4%)

Table 4.6-12. Summary Statistics of Residence Time (Days) in the San Joaquin River at Twitchell Island Subregion from DSM2-PTM.

Percentile	July			August			September			October			November		
	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA
5%	2.7	3.1	0.4 (14%)	9.5	12.1	2.6 (27%)	8.1	4.3	-3.8 (-47%)	8.4	5.3	-3.2 (-38%)	7.6	6.0	-1.6 (-21%)
25%	10.2	13.5	3.3 (32%)	10.8	13.6	2.8 (26%)	10.3	5.9	-4.3 (-42%)	12.4	8.0	-4.3 (-35%)	10.6	9.6	-1.0 (-9%)
50% (median)	12.0	16.1	4.1 (35%)	12.6	17.0	4.5 (36%)	11.6	13.3	1.6 (14%)	14.5	11.8	-2.7 (-18%)	12.6	11.8	-0.8 (-6%)
75%	13.6	18.1	4.5 (33%)	19.4	20.4	1.1 (6%)	19.0	20.0	1.0 (5%)	18.2	16.9	-1.4 (-8%)	15.3	15.9	0.6 (4%)
95%	21.0	21.1	0.1 (0%)	23.4	22.2	-1.2 (-5%)	23.0	22.6	-0.4 (-2%)	20.8	20.2	-0.6 (-3%)	18.9	19.7	0.8 (4%)

Table 4.6-13. Summary Statistics of Residence Time (Days) in the San Joaquin River at Prisoners Point from DSM2-PTM.

Percentile	July			August			September			October			November		
	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA
5%	2.7	3.0	0.3 (10%)	4.3	8.4	4.1 (95%)	4.4	5.3	0.9 (20%)	7.5	6.5	-1.0 (-14%)	3.9	4.7	2.7 (68%)
25%	4.9	9.7	4.7 (96%)	5.0	10.5	5.5 (109%)	5.4	7.7	2.3 (43%)	9.8	8.3	-1.5 (-15%)	7.4	8.4	1.0 (14%)
50% (median)	6.0	10.7	4.7 (79%)	6.3	11.0	4.7 (74%)	7.4	11.0	3.7 (50%)	10.7	11.0	0.3 (3%)	8.6	10.6	2.0 (24%)
75%	7.3	12.2	4.9 (66%)	12.5	13.3	0.9 (7%)	10.9	15.0	4.1 (38%)	14.1	14.7	0.7 (5%)	11.1	12.4	1.3 (11%)
95%	13.6	14.7	1.2 (9%)	18.7	16.2	-2.5 (-13%)	16.8	16.7	-0.1 (-1%)	16.5	17.2	0.7 (4%)	14.7	15.0	0.4 (3%)

Table 4.6-14. Summary Statistics of Residence Time (Days) in the North and South Forks Mokelumne River Subregion from DSM2-PTM.

Percentile	July			August			September			October			November		
	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA
5%	4.9	8.7	3.8 (79%)	3.0	6.7	3.7 (126%)	3.9	5.8	1.9 (50%)	6.3	7.5	1.2 (18%)	5.6	5.3	-0.2 (-4%)
25%	12.6	15.6	3.0 (24%)	4.2	8.9	4.7 (112%)	6.7	8.7	2.0 (30%)	9.4	8.7	-0.7 (-7%)	7.1	9.7	2.6 (36%)
50% (median)	20.8	20.8	0.0 (0%)	8.3	11.9	3.6 (44%)	11.4	12.4	1.0 (9%)	10.0	10.7	0.7 (7%)	8.9	10.3	1.4 (16%)
75%	26.1	24.7	-1.5 (-6%)	17.2	17.9	0.7 (4%)	17.0	17.7	0.7 (4%)	13.6	14.0	0.4 (3%)	11.1	12.5	1.3 (12%)
95%	34.2	31.5	-2.7 (-8%)	27.2	20.1	-7.1 (-26%)	24.7	22.2	-2.5 (-10%)	21.5	14.7	-4.9 (-23%)	16.5	14.2	-2.3 (-14%)

Table 4.6-15. Summary Statistics of Residence Time (Days) in the Disappointment Slough Subregion from DSM2-PTM.

Percentile	July			August			September			October			November		
	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA
5%	12.1	15.5	3.4 (29%)	10.9	18.2	7.2 (66%)	10.8	15.2	4.4 (40%)	13.2	9.5	-3.7 (-28%)	14.7	15.1	0.3 (2%)
25%	17.9	26.7	8.9 (50%)	20.8	20.9	0.1 (1%)	16.8	18.4	1.6 (9%)	15.8	17.8	2.0 (13%)	18.6	17.9	-0.6 (-3%)
50% (median)	25.0	36.9	11.8 (47%)	25.7	29.9	4.2 (16%)	20.6	23.0	2.4 (12%)	19.6	22.9	3.3 (17%)	24.7	21.0	-3.8 (-15%)
75%	34.0	39.4	5.5 (16%)	29.3	33.0	3.8 (13%)	23.3	25.1	1.8 (8%)	23.7	28.7	5.0 (21%)	29.0	29.6	0.7 (2%)
95%	38.2	41.9	3.7 (10%)	34.2	35.6	1.4 (4%)	27.5	29.3	1.8 (7%)	27.5	30.8	3.3 (12%)	34.9	33.2	-1.7 (-5%)

Table 4.6-16. Summary Statistics of Residence Time (Days) in the San Joaquin River Near Stockton Subregion from DSM2-PTM.

Percentile	July			August			September			October			November		
	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA
5%	1.3	1.5	0.2 (12%)	3.2	3.9	0.7 (22%)	4.1	4.3	0.1 (4%)	3.0	3.5	0.5 (17%)	2.8	3.1	0.4 (13%)
25%	5.8	7.8	2.0 (35%)	6.5	8.0	1.5 (23%)	5.9	6.8	0.9 (16%)	4.1	5.1	1.0 (25%)	4.4	5.0	0.6 (14%)
50% (median)	13.9	11.7	-2.3 (-16%)	9.7	9.8	0.1 (1%)	6.7	8.6	1.9 (29%)	5.2	6.2	1.1 (21%)	5.7	6.8	1.1 (19%)
75%	18.1	13.0	-5.0 (-28%)	12.1	10.9	-1.1 (-9%)	8.7	9.8	1.1 (13%)	6.4	7.4	1.1 (17%)	7.5	7.6	0.2 (2%)
95%	29.2	23.0	-6.2 (-21%)	15.1	14.4	-0.7 (-5%)	10.0	11.0	1.1 (11%)	8.3	9.0	0.7 (8%)	8.7	9.3	0.6 (7%)

Table 4.6-17. Summary Statistics of Residence Time (Days) in the Mildred Island Subregion from DSM2-PTM.

Percentile	July			August			September			October			November		
	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA
5%	3.0	7.1	4.1 (138%)	1.8	5.0	3.3 (183%)	2.0	7.4	5.4 (270%)	2.9	8.9	6.0 (205%)	2.1	4.1	2.0 (93%)
25%	4.4	15.5	11.1 (255%)	2.2	8.1	5.8 (262%)	3.2	9.2	6.0 (188%)	3.7	11.6	7.9 (215%)	3.0	6.1	3.1 (106%)
50% (median)	6.9	23.4	16.5 (238%)	3.7	9.5	5.9 (160%)	4.7	10.7	6.0 (127%)	5.2	13.0	7.8 (150%)	4.7	13.9	9.3 (205%)
75%	11.1	27.1	16.0 (144%)	13.6	11.9	-1.7 (-12%)	6.9	14.9	8.0 (115%)	9.5	16.5	7.0 (73%)	15.9	15.7	-0.2 (-1%)
95%	25.1	30.0	4.9 (20%)	19.3	19.6	0.3 (2%)	15.4	16.8	1.4 (9%)	21.6	22.6	1.0 (4%)	21.1	21.5	0.4 (2%)

Table 4.6-18. Summary Statistics of Residence Time (Days) in the Holland Cut Subregion from DSM2-PTM.

Percentile	July			August			September			October			November		
	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA
5%	1.4	3.8	2.4 (169%)	1.2	3.7	2.4 (198%)	1.5	4.7	3.3 (225%)	2.5	6.5	3.9 (156%)	1.8	3.3	1.5 (81%)
25%	2.0	4.2	2.2 (114%)	1.6	5.1	3.5 (226%)	1.8	5.5	3.7 (208%)	3.4	8.0	4.7 (134%)	2.6	4.0	1.4 (52%)
50% (median)	2.5	4.7	2.3 (95%)	2.4	5.7	3.3 (139%)	3.0	7.5	4.5 (154%)	3.9	8.6	4.7 (123%)	3.3	5.8	2.5 (75%)
75%	3.5	6.0	2.5 (73%)	5.4	4.7	1.1 (21%)	5.7	8.8	3.1 (55%)	5.8	9.1	3.3 (57%)	4.9	8.5	3.7 (76%)
95%	5.6	6.8	1.2 (22%)	9.8	7.8	-2.0 (-21%)	9.7	9.7	-0.1 (-1%)	7.5	9.8	2.3 (31%)	6.9	9.6	2.8 (41%)

Table 4.6-19. Summary Statistics of Residence Time (Days) in the Franks Tract Subregion from DSM2-PTM.

Percentile	July			August			September			October			November		
	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA
5%	9.4	10.7	1.2 (13%)	10.0	11.1	1.1 (11%)	9.0	8.2	-0.8 (-9%)	9.1	8.6	-0.5 (-5%)	8.1	8.0	-0.1 (-1%)
25%	10.9	12.2	1.3 (12%)	10.9	13.2	2.4 (22%)	10.3	9.4	-0.8 (-8%)	11.1	9.7	-1.5 (-13%)	11.2	10.3	-0.9 (-8%)
50% (median)	11.6	14.4	2.8 (24%)	11.9	16.1	4.3 (36%)	11.8	14.1	2.3 (20%)	13.9	12.5	-1.4 (-10%)	12.3	12.0	-0.3 (-3%)
75%	12.8	14.7	3.8 (30%)	17.0	17.8	0.8 (5%)	16.2	17.4	1.1 (7%)	15.4	13.8	-1.6 (-10%)	14.4	15.1	0.7 (5%)
95%	16.9	17.5	0.6 (3%)	18.0	19.9	1.9 (10%)	18.7	18.5	-0.2 (-1%)	18.6	17.0	-1.7 (-9%)	18.1	18.0	-0.1 (-1%)

Table 4.6-20. Summary Statistics of Residence Time (Days) in the Rock Slough and Discovery Bay Subregion from DSM2-PTM.

Percentile	July			August			September			October			November		
	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA
5%	4.7	7.4	2.6 (54%)	3.9	8.5	4.7 (119%)	4.7	11.0	6.3 (135%)	5.4	8.4	3.0 (55%)	5.0	6.9	1.9 (37%)
25%	5.6	8.8	3.3 (59%)	5.3	9.7	4.4 (84%)	5.6	14.7	8.9 (159%)	7.3	10.0	2.8 (38%)	5.9	8.2	2.3 (39%)
50% (median)	6.4	10.0	3.7 (57%)	5.7	11.9	6.2 (109%)	6.8	17.5	10.7 (158%)	8.8	15.2	6.4 (72%)	7.5	9.8	2.2 (29%)
75%	7.3	11.4	4.1 (56%)	10.1	15.9	5.9 (58%)	14.7	19.3	2.7 (17%)	12.1	17.1	5.0 (42%)	10.8	12.1	1.3 (12%)
95%	10.7	13.9	3.1 (29%)	19.2	22.3	3.1 (16%)	19.8	25.2	5.4 (27%)	20.6	19.2	-1.4 (-7%)	12.2	13.6	1.5 (12%)

Table 4.6-21. Summary Statistics of Residence Time (Days) in the Old River Subregion from DSM2-PTM.

Percentile	July			August			September			October			November		
	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA
5%	0.5	1.5	1.0 (212%)	0.4	1.4	1.0 (275%)	0.6	1.7	1.1 (199%)	0.6	2.5	1.9 (304%)	0.7	1.3	0.6 (82%)
25%	0.7	1.8	1.1 (164%)	0.6	1.6	1.1 (189%)	0.8	2.5	1.7 (208%)	1.0	3.4	2.3 (228%)	0.9	1.7	0.8 (89%)
50% (median)	1.0	2.3	1.3 (131%)	1.0	2.0	1.0 (102%)	1.1	3.5	2.5 (231%)	1.3	5.9	4.7 (363%)	1.1	1.9	0.7 (64%)
75%	1.4	2.8	1.4 (101%)	2.0	2.5	0.5 (23%)	1.9	6.4	4.5 (243%)	1.7	8.0	6.4 (382%)	1.8	7.2	5.4 (299%)
95%	4.2	3.8	-0.3 (-8%)	4.1	4.7	0.7 (17%)	2.7	12.0	9.3 (347%)	2.4	12.0	9.6 (393%)	2.8	8.6	5.8 (205%)

Table 4.6-22. Summary Statistics of Residence Time (Days) in the Middle River Subregion from DSM2-PTM.

Percentile	July			August			September			October			November		
	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA
5%	0.5	0.8	0.3 (62%)	0.4	0.7	0.3 (78%)	0.4	1.1	0.7 (180%)	0.5	1.5	1.0 (196%)	0.4	0.7	0.3 (58%)
25%	0.6	1.1	0.6 (101%)	0.4	0.9	0.5 (114%)	0.4	1.2	0.7 (177%)	0.6	2.0	1.4 (228%)	0.6	0.9	0.3 (51%)
50% (median)	0.7	1.3	0.6 (93%)	0.5	1.0	0.5 (99%)	0.5	1.4	0.8 (155%)	0.7	2.8	2.1 (292%)	0.7	1.1	0.4 (63%)
75%	0.8	1.6	0.8 (100%)	0.9	1.1	0.3 (29%)	0.8	1.6	0.8 (95%)	1.0	7.9	7.0 (727%)	0.8	10.9	10.1 (1,218%)
95%	2.4	4.5	2.1 (88%)	1.9	1.7	-0.2 (-13%)	1.3	2.4	1.1 (84%)	1.2	18.0	16.8 (1351%)	1.1	11.8	10.7 (979%)

Table 4.6-23. Summary Statistics of Residence Time (Days) in the Victoria Canal Subregion from DSM2-PTM.

Percentile	July			August			September			October			November		
	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA
5%	0.3	2.5	2.2 (713%)	0.2	0.5	0.3 (116%)	0.3	0.7	0.4 (170%)	0.3	3.7	3.4 (1082%)	0.3	0.5	0.2 (51%)
25%	0.3	7.4	7.0 (2074%)	0.3	2.2	2.0 (731%)	0.3	4.1	3.8 (1339%)	0.4	5.4	5.1 (1353%)	0.4	0.6	0.2 (57%)
50% (median)	1.3	13.0	11.7 (939%)	4.7	7.6	3.0 (64%)	1.2	7.2	5.9 (480%)	0.6	10.5	9.9 (1734%)	0.6	7.1	6.5 (1052%)
75%	10.0	19.9	9.9 (99%)	14.5	14.2	-0.3 (-2%)	10.6	11.6	1.0 (10%)	3.9	14.7	10.8 (278%)	4.9	11.1	6.2 (126%)
95%	16.8	25.4	8.7 (52%)	26.4	21.1	-5.3 (-20%)	20.4	19.9	-0.5 (-3%)	15.7	17.8	2.1 (13%)	12.3	14.1	1.8 (15%)

Table 4.6-24. Summary Statistics of Residence Time (Days) in the Grant Line Canal and Old River Subregion from DSM2-PTM.

Percentile	July			August			September			October			November		
	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA
5%	2.2	3.0	0.8 (35%)	9.3	9.3	-0.1 (-1%)	2.7	6.2	3.4 (125%)	3.6	3.1	-0.5 (-14%)	4.4	5.4	1.0 (23%)
25%	29.3	29.6	0.3 (1%)	20.2	23.5	3.2 (16%)	8.5	10.0	1.5 (18%)	6.7	4.3	-2.4 (-36%)	8.2	8.1	-0.1 (-1%)
50% (median)	38.7	40.0	1.4 (4%)	27.3	29.1	1.8 (6%)	16.9	23.3	6.4 (38%)	13.6	10.1	-3.4 (-25%)	11.8	9.2	-2.7 (-22%)
75%	40.4	41.0	0.6 (1%)	36.2	35.5	-0.7 (-2%)	32.9	35.8	3.0 (9%)	19.5	14.7	-4.7 (-24%)	14.4	11.2	-3.3 (-23%)
95%	42.8	42.0	-0.9 (-2%)	40.8	37.0	-3.8 (-9%)	38.1	38.0	-0.1 (0%)	24.2	24.7	0.6 (3%)	21.2	13.1	-8.0 (-38%)

Table 4.6-25. Summary Statistics of Residence Time (Days) in the Upper San Joaquin River Subregion from DSM2-PTM.

Percentile	July			August			September			October			November		
	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA	NAA	PP	PP vs. NAA
5%	0.2	0.2	0.0 (0%)	0.2	0.2	0.0 (-1%)	0.4	0.4	0.0 (-2%)	0.3	0.3	0.0 (16%)	0.3	0.3	0.0 (-8%)
25%	0.8	0.7	-0.1 (-11%)	0.9	0.8	-0.1 (-16%)	0.7	0.7	-0.1 (-10%)	0.5	0.6	0.1 (23%)	0.4	0.3	0.0 (-6%)
50% (median)	2.0	1.4	-0.7 (-33%)	1.5	1.2	-0.3 (-18%)	1.0	0.8	-0.1 (-13%)	0.6	0.7	0.1 (25%)	0.5	0.5	0.0 (-8%)
75%	3.3	1.8	-1.5 (-46%)	1.9	1.6	-0.3 (-15%)	1.2	1.1	-0.2 (-14%)	0.7	0.8	0.2 (27%)	0.6	0.6	0.0 (-7%)
95%	13.5	6.7	-6.8 (-50%)	2.8	2.4	-0.4 (-15%)	1.5	1.3	-0.2 (-16%)	0.8	0.9	0.1 (18%)	0.6	0.6	0.0 (-1%)

The extent to which giant garter snakes occur within the Delta is unknown, though population concentrations are known to occur along the periphery of the Delta in the Yolo Basin-Willow Slough, Yolo Basin Liberty Farms, and Caldoni Marsh-White Slough regions (U.S. Fish and Wildlife Service 1999). The giant garter snake diet consists primarily of frogs (chiefly American bullfrog [*Rana catesbeiana]*) and western chorus frog [*Pseudacris triseriata*]) and fish, with preference given to frogs (Halsted and Ersan pers. comm). American bullfrog tadpoles eat algae, aquatic plant matter, and some insects. Adult bullfrogs are opportunistic predators, consuming a wide-range of terrestrial and aquatic prey including invertebrates, mammals, birds, fish, reptiles, and amphibians, including other bullfrogs. The western chorus frog has a primarily land-sourced diet of slugs, spiders, isopods, centipedes, earthworms, and insects (Morey 2008), and thus has low potential exposure to microcystin. Bullfrogs forage within the terrestrial and aquatic foodwebs, and may ingest microcystins through the consumption of fish and other aquatic organisms, or through consumption of other bullfrogs.

The streamflow and temperature modeling results suggest there is potential for increased frequency of *Microcystis* blooms during the summer and fall months where giant garter snakes occur in portions of the Sacramento River system in the Delta. *Microcystis* toxicity has been shown to cause deleterious effects on fish and bird species (Butler et al. 2009), but sensitivity to microcystins varies by species and life stage (Table 4.6-3; Butler et al. 2009). The effects of *Microcystis* blooms on giant garter snakes or the prey of giant garter snakes are unknown. Small fish and bullfrogs consumed by giant garter snakes during or after *Microcystis* blooms could be sources of microcystins for giant garter snakes. In the northern portion of the Delta, *Microcystis* blooms are currently not common; if water in this region remains turbid in the future, current conditions are expected to continue.

In the south and central portions of the Delta, residence time would be increase under the PP relative to the NAA, which would increase the potential of giant garter snakes exposure to microcystin through the consumption of fish and bullfrogs. This would give greater potential for adverse effects of *Microcystis* under the PP relative to the NAA; however, under the NAA, lower residence time would reflect zooplankton and other food web materials being more susceptible to entrainment because of greater south Delta export pumping, so the overall effect is uncertain; and, as stated previously, the potential effect of *Microcystis* blooms on giant garter snakes is unknown, especially given their preference for American bullfrogs and western chorus frogs.

There is potential for increased occurrence of *Microcystis* blooms in the Sacramento and San Joaquin Delta and therefore increased potential for giant garter snake exposure to microcystins. However, because giant garter snakes preferentially prey upon frogs, which forage in both the terrestrial and aquatic foodweb, and because the effects of current *Microcystis* blooms on giant garter snake are not well understood, the effects of potential increased occurrence of *Microcystis* blooms on giant garter snakes is also unknown.

4.6.1.3.3.2.2 Selenium

4.6.1.3.3.2.2.1 Baseline Exposure

A current mass balance of selenium, as a function of source and conveyance, is not available for the San Francisco Estuary (Presser and Luoma 2010). Annual and seasonal variations of selenium concentrations in the Delta and estuary are influenced by discharges in rivers and anthropogenic sources (Presser and Luoma 2006). Water inflow to the Delta comes primarily from the Sacramento and San Joaquin rivers of which the Sacramento River provides the largest water volume contribution and dilution of selenium inputs from other sources. Factors affecting selenium contribution and dilution include the total river inflow, water diversions and/or exports, the proportion of the San Joaquin River that is diverted south before entering the Estuary, and total outflow of the Estuary to the Pacific Ocean (Presser and Luoma 2010).

Selenium contamination in soils and water of the Sacramento Valley is not high and thus not considered a threat in this part of the giant garter snake's range (Seiler *et al.* 2003). In the San Joaquin River basin implementation of both regulatory controls and the Grassland Bypass Project, which manages agricultural drainage south and west of the Grassland Ecological Area, have significantly improved water quality in the San Joaquin River and adjacent channels. However, irrigation drainage into Mud Slough and the San Joaquin River results in non-compliance with the selenium water quality objective. Achieving water quality compliance for this segment of the river is not anticipated until 2019 or later. Continued inputs from precipitation runoff from selenium-laden soils, irrigation drainage, and existing riverbed loads still provide inputs of selenium to the Delta where giant garter snakes are potentially exposed to selenium through their diet consisting principally of amphibians and small fish.

Modification of Delta inflow via construction of the North Delta diversions and water operations changes for the SWP and CVP may interact with selenium fate and transport. Conceptually, exports of San Joaquin River selenium-laden water out of the Delta and into Delta Mendota Canal and California Aquaduct will be reduced under the PP. In addition, less Sacramento River water will be available for dilution of San Joaquin River. Meseck and Cutter (2006) developed a biogeochemical modeling of the estuary to simulate salinity, total suspended material, phytoplankton biomass, and dissolved and particulate selenium concentrations. They modeled an increase in discharge from the San Joaquin River and varying sources of refinery inputs to investigate how it would affect the dissolved and particulate selenium in the San Francisco Bay. They found that when river flow was low (i.e., November, 70-day residence time) total particulate selenium (the bioavailable form) concentrations could increase. These results suggest that bioavailable selenium and associated food web accumulation could increase because of increased San Joaquin River flow and reduced south Delta exports (Meseck and Cutter 2006).

4.6.1.3.3.2.2.2 Known Effects of Selenium on Snakes and Reptiles

Dietary uptake is the principal route of toxic exposure to selenium in wildlife, including giant garter snake (Beckon et al. 2003). Our current understanding is that selenium does not biomagnify and the majority of food web enrichment occurs at the lowest trophic levels. Scaled reptiles, such as giant garter snake generally do not secrete an albumin layer, as do birds, crocodilians, and turtles (Unrine *et al.* 2006). As a result, selenium may be transported through serum to the egg from the liver as vitellogenin, whereas in birds, crocodilians, and turtles, additional oviductal contributions of selenium occur post-ovulation (Unrine *et al.* 2006, Janz *et al.* 2010). Therefore, a dietary selenium toxicity threshold, rather than an egg concentration threshold, appears appropriate for assessing selenium effects to giant garter snake.

Elevated selenium through diet or maternal transfer to offspring can affect vertebrates when selenium is substituted for sulfur during protein synthesis. Improperly folded proteins and dysfunctional enzymes can result, with consequences including oxidative stress and embryo toxicity. Toxicity thresholds are established by identifying concentrations of selenium that result in an observable effect on an organism (e.g., altered metabolism, mortality, deformity, reproductive failure). No information is available on the toxicity thresholds or indirect effects of selenium for giant garter snake or other snakes. However, information on the risk of selenium exposure on other species may be useful in predicting general effects on giant garter snakes. Laboratory and field study on giant garter snake and terrestrial snakes have documented selenium bioaccumulation from through prey consumption.

A single laboratory study dosed female terrestrial brown house snakes (*Lamprophis falginosus*) with selenium, as selanomethonine, injected into their food items at ~1 (control), 10, and 20 µg/g (dry weight) doses. The investigators selected these dosages because they represented the range of exposures used in prior avian and mammalian studies. No significant effects on survival or reproduction were observed at any dose (Hopkins *et al.* 2004). However, in the two treatment groups selenium was transferred to eggs in concentrations that exceeded all suggested reproduction thresholds for birds and fish (24.25 ±0.49 µg/g dry weight in the 20 µg/g treatment group) (Hopkins *et al.* 2004). No information was available on the consequences of the egg selenium burdens for post-hatch survival.

Wylie et al. (2009) measured selenium and other trace elements in 23 dead giant garter snakes collected from 1995 to 2004 at sites in Colusa National Wildlife Refuge, the Natomas Basin, and other sites in northern California. Giant garter snake liver selenium concentrations ranged from 1.24 to 6.98 µg/g (dry weight) with a geometric mean of 3.06 µg/g. Current science does not provide information about the consequences of these selenium body burdens to the health or survival of individuals or populations of giant garter snake.

4.6.1.3.3.2.2.3 Effects of the Proposed Project

There are currently no predictive modeling tools, nor is there an understanding of effects thresholds, that would enable predicting direct effects of dietary selenium exposure on giant garter snakes. However, inferences about the effects of selenium exposure are possible using Delta Smelt as a surrogate for giant garter snakes' prey.

In the Delta Smelt effects analysis (Section 4.1, *Effects on Delta Smelt*) DSM2 volumetric fingerprinting was used to estimate the source water contribution of the Delta water sources including the San Joaquin River that are the primary source of selenium loading to the Delta. Aqueous and Delta Smelt selenium tissue concentrations were modeled at five sites: San Joaquin River at Prisoners Point, Cache Slough at Ryer Island, Sacramento River at Emmaton, San Joaquin River at Antioch, and Suisun Bay at Mallard Island. Modeling results indicated that, of these five sites, the highest proportion of San Joaquin River water and its selenium load (and thus resulting fish tissue selenium) occurred at Prisoners Point. Thus, of the Delta sites modeled for Delta Smelt, Prisoners Point represents the worst-case scenario for selenium exposure.

Results for the PP selenium bioaccumulation modeling for Delta Smelt at Prisoners Point showed increases of as much as twice the modeled tissue concentration, in Delta Smelt foraging at that location. Despite the predicted increases, all but 0.7% of modeled tissue concentrations were below the effects threshold for fish deformities. Based on these modeling results, the PP is unlikely to increase tissue concentrations significantly enough to result in detrimental effects to Delta Smelt. The PP would be expected to have similar effects on fishes with diets and habitat preferences similar to Delta Smelt (e.g., silversides). However, this assumption would not apply to young sunfishes or Sacramento Splittail whose parental diet may include other fish or bivalves that bioaccumulate selenium at substantially higher rate than crustaceans. Our surrogate Delta Smelt tissue modeling also does not represent the risk to giant garter snake foraging in locations upstream of Prisoners Point that have higher San Joaquin River water and selenium contributions.

Residence times could provide an additional line of evidence in evaluating the risk of selenium effects from the PP. A significant factor in the bioavailability of selenium is water residence time. Biogeochemical modeling suggests that increasing the San Joaquin River discharge could result in increased bioavailable selenium during “low flow” conditions (Meseck and Cutter 2006). Low flow conditions modeled were 70-day residence times.

For the PP, residence times were estimated using DSM2-PTM to evaluate the effects of water operations on water quality. Residence time changes under for the PP varied greatly by model site. The highest residence times for the both the NAA and the PP occurred at Grant Line Canal and Old River sites. The modeling predicted for the PP a 95% percentile, July water residence time of 42.8 days, a reduction of 0.8 days compared to the NAA. Residence time estimates did not meet or exceed the 70-day residence times used in the Meseck and Cutter (2006) biogeochemical modeling that predicted increased selenium bioavailability. This would suggest that the PP and would not result in the same increase of bioavailable, particulate selenium predicted by their hydrologic conditions modeling of Meseck and Cutter (2006).

4.6.1.3.3.2.2.4 All Life Stages

4.6.1.3.3.2.2.4.1 Individual-Level

Two modeling efforts suggest the potential for increases in San Joaquin River water and its associated selenium load to the Delta. We lack information about effects thresholds or exposure risk directly to giant garter snake. Using Delta Smelt as a surrogate for giant garter snake fish prey, selenium bioaccumulation modeling suggests that reductions in fish prey for fish feeding at the same tropic level as Delta Smelt are unlikely to result from the PP. Prey fishes that feed on bivalves or at a higher trophic level may represent an increased risk. Project effects on giant garter snake, either directly to the snake via increased dietary selenium, indirectly through reduced fish prey availability are currently unquantifiable. If risk were increased because of the PP, it would most likely occur for giant garter snakes residing and feeding in the South Delta and the San Joaquin River upstream from Prisoners Point to Vernalis or from snakes that consumed Sacramento splittail or piscivorous fish species.

4.6.1.3.3.2.2.4.2 Population-Level

There is inadequate information available to assess the risk to giant garter snake individuals or populations from selenium. If giant garter snakes were affected by a selenium increase caused by the PP it would be most likely to occur in the South Delta and the San Joaquin River upstream from Prisoners Point to Vernalis. Giant garter snakes reside in areas of the Delta and lower San Joaquin River (Kesterson and Grasslands Bypass) where selenium has been historically elevated. Population effects were not documented as a result of those historic exposures.

4.6.1.3.3.2.3 Methylmercury

The PP could potentially expose giant garter snake to methylmercury by the following mechanisms:

- Changes in the ambient water column concentrations of methylmercury attributable to operations of the proposed conveyance facilities.
- Exposure of ambient methylmercury in sediments during in-water construction or maintenance work.
- Biogenic production of methylmercury within restoration wetlands.

4.6.1.3.3.2.3.1 Changes in the ambient water column concentrations of methylmercury attributable to operations of the proposed conveyance facilities

As described in the FEIR/FEIS for WQ Impact 13, operational modeling does not show any meaningful changes in mercury as a result of operations. To quote from that analysis:

> The effects of Alternative 4A on waterborne concentrations of mercury (Appendix 8I, Mercury, Table I-17) and methylmercury (Appendix 8I, Table I-18), and fish tissue mercury concentrations for largemouth bass fillet (Appendix 8I, Tables I-20a and I-20b) were evaluated for nine Delta locations.
>
> Increases in long-term average mercury concentrations relative to Existing Conditions and the No Action Alternative (ELT) would be very small, 0.3 ng/L or less. Also, use of assimilative capacity for mercury relative to the 25 ng/L ecological threshold under Alternative 4A, relative to Existing Conditions and the No Action Alternative (ELT), would be very low, about 2% or less, as a long-term average, for all Delta locations (Appendix 8I, Mercury, Table I-23). These concentration changes and small changes in assimilative capacity for mercury are not expected to result in adverse (or positive) effects to beneficial uses.
>
> Changes in methylmercury concentrations in water also are expected to be very small. The greatest annual average methylmercury concentration under Alternative 4A would be 0.166 ng/L for the San Joaquin River at Buckley Cove, for the drought period modeled, which would be slightly higher than Existing Conditions (0.161 ng/L) and slightly lower than the No Action Alternative (ELT) (0.168 ng/L) (Appendix 8I, Mercury, Table I-18). All methylmercury concentrations in water were estimated to exceed the TMDL guidance objective of 0.06 ng/L under Existing Conditions and, therefore, no assimilative capacity exists.
>
> Fish tissue estimates for largemouth bass fillet show small or no increases in mercury concentrations under Alternative 4A relative to Existing Conditions and the No Action Alternative (ELT) based on long-term annual average concentrations for mercury at the Delta locations (Appendix 8I, Mercury, Tables I-20a and I-20b). Concentrations expected for Alternative 4A with Equation 1 show increases of 6% or less relative to Existing Conditions and the No Action

Alternative (ELT) (Appendix 8I, Table I-20a). Concentrations expected for Alternative 4A with Equation 2 show increases of 8% or less relative to Existing Conditions and the No Action Alternative (ELT) (Appendix 8I, Table I-20b). Concentrations expected for Alternative 4A with Equation 1 show decreases of 1% relative to Existing Conditions at the North Bay Aqueduct at Barker Slough Pumping Plant in all years and 1% relative to the No Action Alternative at San Joaquin River at Buckley Cove in all years and the drought period (Appendix 8I, Mercury, Table I-20a). Concentrations expected for Alternative 4A with Equation 2 show decreases in the North Bay Aqueduct at Barker Slough relative to Existing Conditions in all years of 1%, and a decrease of 2% relative to the No Action Alternative (ELT) in all years and the drought period (Appendix 8I, Table I-20b).

Because the increases are relatively small, and it is not evident that substantive increases are expected at numerous locations throughout the Delta, these changes are expected to be within the uncertainty inherent in the modeling approach, and would likely not be measurable in the environment. See Appendix 8I, Mercury, for a complete discussion of the uncertainty associated with the fish tissue estimates. Briefly, the bioaccumulation models contain multiple sources of uncertainty associated with their development. These are related to analytical variability; temporal and/or seasonal variability in Delta source water concentrations of methylmercury; interconversion of mercury species (i.e., the non-conservative nature of methylmercury as a modeled constituent); and limited sample size (both in number of fish and time span over which the measurements were made), among others. Although there is considerable uncertainty in the models used, the results serve as reasonable approximations of a very complex process. Considering the uncertainty, small (i.e., < 20–25%) increases or decreases in modeled fish tissue mercury concentrations at a few Delta locations (i.e., 2–3) should be interpreted to be within the uncertainty of the overall approach, and not predictive of actual adverse effects. Larger increases, or increases evident throughout the Delta, can be interpreted as more reliable indicators of potential adverse effects.

In the LLT, the Delta source water fractions may be different from those occurring in the ELT due to changes in upstream hydrology and Delta hydrodynamics from additional climate change and sea level rise. These effects would occur independent of the alternative and, thus, the alternative-specific effects on mercury in the LLT are expected to be similar to those described above.

4.6.1.3.3.2.3.2 Exposure of ambient methylmercury in sediments during in-water construction or maintenance work

It is possible that methylmercury could be exposed in sediments during in-water work (primarily, dredging) during conveyance facility construction or maintenance (note, however, that the 2081 application does not seek authorization for take occurring as a result of in-water maintenance). As detailed in the effects analysis for each fish species, this risk will be minimized by implementing TMM6 *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*. In particular, TMM6 requires preparing a sampling and analysis plan (SAP) prior to dredging in order to ascertain the risk of encountering toxics (methylmercury among them), and then requires a variety of best management practices such as use of silt curtains, adherence to approved in-water work windows, etc. to minimize the risk of those toxics affecting aquatic life, including giant garter snake.

4.6.1.3.3.2.3.3 Biogenic production of methylmercury within restoration wetlands

It is possible that methylmercury could be created by natural biogenic processes in mitigation wetlands constructed pursuant to the PP (note, however, that the PP does not seek take authorization for construction of such wetlands). The potential for methylmercury generation in mitigation wetlands would be minimized by implementation of TMM10 *Methylmercury Management*, which prescribes wetland siting, design, and construction measures intended to minimize the risks of methylmercury generation in mitigation wetlands.

4.6.1.3.3.2.3.4 Conclusion

In view of these results, and in consideration of the proposed minimization measures, there is an insignificant risk of incidental take of giant garter snake as a result of the PP via any mechanism involving exposure to or generation of methylmercury.

4.6.1.4 Tunneled Conveyance Facilities

The water conveyance facilities that overlap with giant garter snake habitat include a tunnel work area, the intermediate forebay and spillway, two road interchanges, barge unloading facilities, a concrete batch plant on Bouldin Island, a retrieval shaft on Bason Island, and access roads.

4.6.1.4.1 Habitat Loss and Fragmentation

The mapped water conveyance facilities overlap with 220 acres of giant garter snake modeled habitat, including 127 acres of upland habitat and 93 acres of aquatic habitat.

The 220 acres of giant garter snake habitat to be removed because of conveyance facility construction consist of multiple small areas spread out across the Delta, and this loss is not expected to appreciably fragment or isolate patches of giant garter snake habitat in the Delta.

Table 4.6-2 provides the compensation acreage to offset giant garter snake habitat loss resulting from water conveyance facility construction. As described in Section 5.3.6.2.1 *Activities with Fixed Locations*, workers will confine ground disturbance and habitat removal to the minimal area necessary to facilitate construction activities.

4.6.1.4.2 Construction Related Effects

Construction activities associated with the conveyance facilities will include short-term segment storage, fan line storage, crane use, dry houses, settling ponds, daily spoils piles, use of power supplies, air, and water treatment. These activities will occur within the permanent construction footprint for the project. There will also be slurry wall construction at some sites, and associated slurry ponds. RTM handling and permanent spoils disposal will be necessary, as discussed in Section 3.2.10.6 *Dispose Spoils*. Access routes and new permanent access roads will be constructed for each shaft site. Twin Cities Road provides access to the intermediate forebay and their associated shafts, but for all other shafts, access roads will be constructed (within the existing impact footprint). To minimize effects, DWR will install exclusion fencing around the work area before the beginning of any construction activity and maintain that fencing for the duration of the project activities, even if there is a significant gap between the time of site clearing and initiation of major construction activity.

Construction of the intermediate forebay first entails excavating the embankment areas down to suitable material, then constructing the embankment, and then building the inlet and outlet shafts (which also serve as TBM launch shafts). Then the interior basin is excavated to design depth (-20 feet), and the spillway is constructed.

To allow time for soil consolidation and pad curing at the tunnel work areas and the intermediate forebay, fill pad construction significantly precedes other work at the shaft site; at the intermediate forebay, for instance, earthwork begins 2.5 years prior to ground improvement, and is then followed by a 9-month period of ground improvement, before the site is ready for construction. The result is that the entire footprint will be cleared very early in the construction schedule. The duration of active tunnel construction is expected to be approximately eight years. The duration of construction activity at the intermediate forebay is expected to be approximately five years. See Section 3.2.3 *Tunnel Conveyance* and Appendix 3.D, *Construction Schedule for the Proposed Project* for complete construction activity and timing details.

The construction related effects and measures to minimize them are similar to those described above for construction at the NDD sites under Section 4.6.1.3.2 *Construction Related Effects.*

4.6.1.4.3 Operations and Maintenance

Permanent water conveyance facilities, including the pumping plant and the intermediate forebay, will require operation and maintenance. Routine maintenance of the tunnel facility will likely include some weed control around the structure which may result in injury or mortality of giant garter snakes. There is also a potential for giant garter snakes to be injured or killed if, for example, vehicles traveling to or from the facilities must travel greater than 10 miles per hour and are unable to avoid giant garter snakes. These effects will be minimized by restricting vegetation control to the active season and confining the use of heavy equipment to outside suitable garter snake habitat unless it is needed for travel to the site as described in Section 5.3.6.2.2 *Activities with Flexible Locations*. With these measures in place, operations and maintenance activities are expected to avoid take of giant garter snake.

4.6.1.5 Clifton Court Forebay Modification

4.6.1.5.1 Habitat Loss and Fragmentation

An estimated 235 acres of giant garter snake modeled habitat overlaps with the mapped Clifton Court Forebay modifications (Figures 4.6-26 through 4.6-29), where land will be cleared for permanent facilities and temporary work areas. The 235 acres of modeled habitat includes 16 acres of aquatic habitat and 219 acres of upland habitat. Construction of the shelf on the east and south side of Clifton Court Forebay expansion area were included in the analysis, which determined no impacts to giant garter snake habitat in this area.

As shown on Figures 4.6-26 through 4.6-29, construction related activities near Clifton Court Forebay will remove upland and aquatic habitat for giant garter snake. These activities include construction of a barge unloading facility, fuel station, a concrete batch plant, a new forebay overflow structure and work area, and shaft location, which will result in loss of natural wetlands providing aquatic habitat and adjacent upland habitat at the northern end of Clifton Court Forebay. Also, construction of the tunnel conveyor facility will remove upland habitat in this area, and construction of the new forebay will remove upland habitat at the southern end of the Clifton Court Forebay. Construction of access roads, a control structure with associated work area, forebay embankment, and canal work areas will result in loss of aquatic and upland habitat on the west side of Clifton Court Forebay.

As shown on Figure 4.6-26, the forebay dredging area and construction of the new forebay, forebay embankment area, and control structure work area will remove upland habitat around Clifton Court Forebay, Old River, and Delta-Mendota Canal.

Table 4.6-2 provides the compensation acreage to offset giant garter snake habitat loss resulting from Clifton Court Forebay modifications. As described in Section 5.3.6.2.1 *Activities with Fixed Locations*, workers will confine ground disturbance and habitat removal to the minimal area necessary to facilitate construction activities.

4.6.1.5.2 Construction Related Effects

Construction activities at Clifton Court Forebay include vegetation clearing, pile driving, excavation, dredging, and coffer dam and embankment construction. Construction at Clifton Court Forebay will be phased by location and the duration of construction will be approximately six years. For complete details on construction activities and phasing, see Section 3.2.5 *Clifton Court Forebay*, for more details on schedule, see Appendix 3.D, *Construction Schedule for the Proposed Project*.

The construction related effects and measures to minimize them are the same as described above for construction at the NDD sites under Section 4.6.1.3.2 *Construction Related Effects.*

4.6.1.5.3 Operations and Maintenance

The operational components of the modified Clifton Court Forebay include the pumping plant, control structures, and siphons. The features will are not located in giant garter snake habitat and are not expected to affect the species.

All maintenance of new facilities will be contained within the defined project construction footprint. The forebay and the canals will require erosion control. Giant garter snake could potentially become entangled, trapped, or injured as a result of erosion control measures that use plastic or synthetic monofilament netting in construction areas. These activities will occur in areas already included in the permanent impact footprint for the project. This effect will be avoided as described in Appendix 3.F *General Avoidance and Minimization Measures*, AMM2 *Construction Best Management Practices and Monitoring*, by requiring the use of silt fencing.

The forebay and canals will also require control of vegetation and rodents, and embankment repairs. These activities will occur in areas already included in the permanent impact footprint for the project. Maintenance of control structures could include removal or installation of roller gates, radial gates, and stop logs. Maintenance requirements for the spillway will include the removal and disposal of any debris blocking the outlet culverts. Use of heavy equipment for maintenance may injure or kill giant garter snakes: these effects and associated minimization measures are as described in Section 4.6.1.3.2 *Construction Related Effects.* Additionally, removal of vegetation, embankment repairs, and rodent control measures may result in injury or mortality of giant garter snakes, or may degrade habitat by removing cover. These effects will be minimized by restricting vegetation control to the active season, avoiding the use of poison bait, and confining the use of heavy equipment to outside 200 feet of the banks of potential garter snake habitat as described in Section 5.3.6.2.2 *Activities with Flexible Locations.*

Maintenance dredging is not expected to be necessary to remove sediments in the forebays.

4.6.1.6 Power Supply and Grid Connections

4.6.1.6.1 Habitat Loss and Fragmentation

To conservatively asses temporary impacts from transmission line placement due to the flexibility of the final alignment, a 50-foot wide permanent disturbance area along the transmission line corridor was assumed (see Appendix 4.B *Terrestrial Impact Analysis Methods* for additional details about the impact assessment method). Based on this method, an estimated 85 acres of giant garter snake habitat may be temporarily impacted, including 18 acres of aquatic and 68 acres of upland habitat, as a result of the construction of both temporary and permanent transmission lines (Table 4.6-1). Relocation of transmission lines for construction of the shelf on the east and south side of Clifton Court Forebay expansion area were included in the analysis, which determined no impacts to giant garter snake habitat in this area.

Temporary impacts are incurred from activities that will not last more than one year and include access routes (vehicles driving over ground to access the site), temporary staging areas for poles or placement, and reconductoring areas. Temporary disturbances will be restored to pre-project conditions using suitable vegetation agreed upon in writing by CDFW as described in section 5.3.6.2.2 *Activities with Flexible Locations*.

Permanent habitat loss consists only of the footprints of pole and towers, but this permanent loss is very small (upland habitat only, and less than one acre for all land cover types in the Project Area). Ongoing vegetation management around the poles and under the lines will be minimal in giant garter snake habitat because aquatic and grassland areas typically do not need to be cleared to maintain transmission line corridors.

Because this disturbance is primarily from short-term, temporary effects, specific compensation for the 67 acres of giant garter snake habitat disturbance will be offset by returning these areas to pre-project conditions. Also, the placement of poles will be sufficiently flexible to avoid sensitive wetlands, including giant garter snake aquatic habitat such as canals and irrigation ditches. It may be impractical to place poles or towers in waters or wetlands because of the need to build large, costly pads to accommodate these locations. The permanent loss of up to 1 acre of upland habitat will be compensated at a 2:1 or 3:1 ratio (Table 4.6-2). As detailed in Section

5.4.0.1 *Restoration and Protection Site Management Plans*, these conservation lands will be protected and managed for the species.

4.6.1.6.2 Construction Related Effects

New temporary power lines to power construction activities will be built prior to construction of permanent transmission lines to power conveyance facilities. These lines will extend existing power infrastructure (lines and substations) to construction areas, generally providing electrical capacity of 12 kV at work sites. Main shafts for the construction of deep tunnel segments will require the construction of 69 kV temporary power lines. An existing 500kV line, which crosses the area proposed for expansion of the Clifton Court Forebay, will be relocated to the southern end of the expanded forebay in order to avoid disruption of existing power facilities. No interconnection to this existing line is proposed.

Temporary substations will be constructed at each of the NDD sites, at the IF, and at each of the launch shaft locations. To serve permanent pumping loads, a permanent substation will be constructed adjacent to the pumping plants at CCF, where electrical power will be transformed from 230 kV to appropriate voltages for the pumps and other facilities at the pumping plant site. For operation of the NDDs, existing distribution lines will be used to power gate operations, lighting, and auxiliary equipment at these facilities.

Construction of new transmission lines will require site preparation, tower or pole construction, and line stringing. For 12 kV and 69 kV lines, cranes will be used during the line-stringing phase; for stringing transmission lines between 230 kV towers, cranes and helicopters will be used. Construction-related activities will be largely concentrated in a 100- by 50-foot area around pole or tower placement areas, and, in the case of conductor pulling locations, in a 350-foot corridor (measured from the base of the tower or pole); conductor pulling locations will occur at any turns greater than 15 degrees and/or every 2 miles of line. Construction will also require vehicular access to each tower or pole location. Vehicular access routes will use existing routes to the greatest extent practicable, but some overland travel will likely be necessary. The duration of transmission line construction activities will not be more than one year at any one location.

The construction related effects and measures to minimize them are the same as described above for construction at the NDD sites under Section 4.6.1.3.2 *Construction Related Effects.*

4.6.1.6.3 Operations and Maintenance

The temporary transmission lines will be in place for the duration of conveyance facility construction (approximately ten years); the permanent transmission lines will remain to supply power to the pumping plant. Maintenance activities at the transmission lines will include vegetation management and overland travel for some emergency repairs. Vegetation control along the transmission line alignment is not expected to adversely affect the giant garter snake because this species typically occurs in open upland areas such as grasslands, and grassland removal is not typically done for transmission line maintenance. Maintenance vehicles could injure or kill giant garter snakes as they travel to and from maintenance sites.

4.6.1.7 Head of Old River Gate

4.6.1.7.1 Habitat Loss and Fragmentation

Construction of the HOR gate will result in loss of an estimated 3 acres of giant garter snake habitat, including 1 acre of aquatic habitat and 2 acres of associated uplands (Figure 4.6-33). Table 4.6-2 provides the compensation acreage to offset giant garter snake habitat loss resulting from construction of HOR gate. eAs described in Section 5.3.6.2.1 *Activities with Fixed Locations*, workers will confine ground disturbance and habitat removal to the minimal area necessary to facilitate construction activities.

4.6.1.7.2 Construction Related Effects

HOR gate construction has two major components: dredging and construction. Dredging to prepare the channel for gate construction will occur along 500 feet of channel, from 150 feet upstream to 350 feet downstream from the proposed barrier. Dredging will occur at a time between August 1 and November 30, lasting approximately 15 days, and will otherwise occur as described in Section 3.2.10.8 *Dredging and Riprap Placement*. Dredging equipment will be operated from a barge in the channel. Giant garter snakes could be injured or killed by dredging equipment during this activity. As described in Section 5.3.6.2.2 *Activities with Fixed Locations* and Appendix 3.F *General Avoidance and Minimization Measures,*, this effect will be minimized by dewatering of habitat prior to construction to encourage giant garter snakes to move out of aquatic habitat, and by installation of construction fencing and monitoring to exclude giant garter snakes from the work area. There is still a chance that giant garter snakes occur in the work areas and be missed by monitors, therefore the potential remains for injury or killing of giant garter snakes in this area.

During HOR gate construction, a cofferdam will be erected to create a dewatered construction area for ease of access and egress. Construction will occur in two phases. The first phase will include construction of half of the operable barrier, masonry control building, operator’s building, and boat lock. The second phase will include construction of the second half of the operable barrier, the equipment storage area, and the remaining fixtures, including the communications antenna and fish passage structure. The construction duration is estimated to be up to 32 months. Site access roads and staging areas used in the past for rock barrier installation and removal will be used for construction, staging, and other construction support facilities for the proposed barrier. The construction of the cofferdam and the foundation for the HOR gate will require in-water pile driving, performed as described in Section 3.2.10.11 *Pile Driving*. Sheet piles will be installed starting with a vibratory hammer, then switching to an impact hammer if refusal is encountered before target depths. Installing the foundation for the operable barrier will require 100 14-inch steel pipe or H-piles to be set with 1 pile driver on site. Approximately 15 piles will be set per day with up to 1,050 strikes per pile over an estimated 7-day period.

The operable barrier construction site has for many years been used for seasonal construction and removal of a temporary rock barrier, and this disturbance at the site renders it less likely that giant garter snakes occur in the area to be affected. If giant garter snakes are present during construction, however, they may potentially be killed or injured by construction equipment or vehicles. These effects and measures to minimize them are as described in Section 4.6.1.3.2

Construction Related Effects. With these measures in place, there is still potential for giant garter snakes to be injured or killed if, for example, if vehicles must travel greater than 10 miles per hour and are unable to avoid giant garter snakes or if a snake is able to get through the construction fencing and is undetected by the biological monitor.

Giant garter snakes may potentially be affected by vibrations from the pile drivers. This could cause giant garter snakes to move out of suitable habitat near construction.

4.6.1.7.3 Operations and Maintenance

Maintenance of the motors, compressors, and control systems will occur annually and require a service truck. Maintenance dredging around the gate will be necessary to clear out sediment deposits. Dredging around the gates will be conducted using a sealed clamshell dredge. Depending on the rate of sedimentation, maintenance will occur every 3 to 5 years, removing no more than 25% of the original dredged amount. This dredging will have similar effects and be subject to the same minimization measures as those described for dredging in Section 4.6.1.3.2 *Construction Related Effects.*

4.6.1.8 Reusable Tunnel Material

4.6.1.8.1 Habitat Loss and Fragmentation

An estimated 242 acres of giant garter snake modeled habitat overlaps with the mapped RTM sites, where reusable tunnel material will be placed. The 242 acres of modeled habitat includes 83 acres of aquatic habitat and 159 acres of upland habitat.

The habitat to be removed at several RTM sites, and the extent to which RTM placement at each site may fragment the remaining habitat, is described below.

4.6.1.8.1.1 RTM Site near Intake 2

The RTM site near Intake 2 overlaps with a strip of giant garter snake upland habitat along Morrison Creek that consists of riparian vegetation. Giant garter snakes tend to use open areas rather than shaded riparian areas for upland habitat. It is therefore unlikely that giant garter snakes use this area frequently if at all. The RTM site will only remove a sliver of the upland habitat in this area and the remaining upland and aquatic habitat along Morrison Creek will remain intact, therefore the RTM placement and storage will not result in fragmentation or isolation of giant garter snake habitat.

4.6.1.8.1.2 RTM Site South of Lambert Road

The RTM site just south of Lambert Road overlaps with two narrow stretches of drainage ditch providing aquatic giant garter snake habitat, however they are bordered by cultivated lands that are regularly disked and therefore do not provide upland habitat for giant garter snake. The RTM site is south of a large, contiguous block of habitat in the Stone Lakes area and does not fragment this habitat or isolate it from contiguous habitat to the east and south of the RTM site. It may, however, contribute to fragmentation by diminishing the existing string of small habitat patches between the larger Mokelumne and the Stone Lakes habitat blocks. Additionally, loss of a small amount of aquatic habitat at the south end of the RTM site could diminish connectivity between Snodgrass Slough and the agricultural ditch east of the slough. Aquatic connectivity between the ditch and Snodgrass Slough will not be severed, however, as the access road to the RTM will bridge over the ditch and the drainage ditches that surround the RTM will remain.

4.6.1.8.1.3 RTM Site on Zacharias Island

The RTM site on Zacharias Island overlaps with giant garter snake modeled upland habitat along the western edge and southern end of the island, adjacent to Snodgrass Slough. The aquatic/wetland habitat located at the southern tip of Zacharias Island on the inside portion of the levees, which could serve as suitable habitat for giant garter snake, will be fully avoided by project-related construction activity, as described in Section 5.3.6.2.1 *Activities with Fixed Locations*.

The RTM site is located between giant garter snake habitat along Snodgrass Slough, to the west, and giant garter snake habitat along a tributary to Snodgrass Slough, to the east. Placement of the RTM may impede overland travel of giant garter snakes between these two tributaries, although during the period of active use of the RTM site, the impediment would not be greater than that imposed by cultivated land, which is not classified as dispersal habitat under the Draft 2015 *Recovery Plan for Giant Garter Snake* (U.S. Fish and Wildlife Service 2015). The RTM site currently consists of cultivated lands that are regularly disked, with a patch of riparian habitat at the southern tip: giant garter snakes are not likely to be traveling overland through these land cover types for dispersal. Connectivity will remain via agricultural ditches to the north and where the drainage ditch to the east of Zacharias Island meets Snodgrass Slough, south of Zacharias Island.

4.6.1.8.1.4 Northernmost Triangular RTM Site

This RTM site overlaps with giant garter snake modeled aquatic habitat and adjacent upland habitat. The aquatic habitat consists of an open borrow pit and the surrounding uplands are sparsely vegetated with riparian species. Removal of this habitat will remove an isolated habitat block in this area. The remaining habitat within this block will consist of narrow drainage ditches and associated uplands. The RTM placement will not create any barriers to movement from the remaining habitat, as there is no habitat present immediately to the east of the RTM site. It may, however, contribute to fragmentation by diminishing the existing string of small habitat patches between the larger Mokelumne and the Stone Lakes habitat blocks.

4.6.1.8.1.5 RTM Site, Second Triangular RTM Site from the North

This RTM site overlaps with giant garter snake modeled aquatic habitat and associated modeled upland habitat. The aquatic habitat consists of an open borrow pit and the surrounding uplands are open and sparsely vegetated. Removal of this habitat may contribute to fragmentation by diminishing the existing string of small habitat blocks between the larger Mokelumne and the Stone Lakes habitat blocks.

4.6.1.8.1.6 RTM Site North and South of Twin Cities Road

This RTM site and conveyor overlaps with giant garter snake modeled aquatic habitat and associated modeled upland habitat. The aquatic habitat consists of two open borrow pits (one north and one south of Twin Cities Road) and the surrounding uplands are open and sparsely vegetated. As described above, the RTM placement may contribute to fragmentation by diminishing the existing string of small habitat patches between the larger Mokelumne and the Stone Lakes habitat blocks.

4.6.1.8.1.7 RTM Site on Bouldin Island

This RTM site overlaps with giant garter snake modeled aquatic habitat consisting of shallow ponded areas surrounded by regularly disked cultivated lands. The RTM placement will remove several patches of giant garter snake habitat, including aquatic habitat associated with regularly disked lands that do not provide suitable upland habitat. As shown on The RTM placement will also remove high quality aquatic and upland habitat along Potato Slough and Little Potato Slough. The RTM placement in this location will diminish connectivity between the sloughs and the agricultural ditches in the southeast portion of Bouldin Island, and connectivity between habitat where giant garter snakes have been found in the Bouldin Island area and the Caldoni Marsh/White Slough area. However, agricultural ditches that remain on the island will continue to provide east-west and north-south connectivity on the island. Furthermore, the RTM is not expected to significantly alter the ability for giant garter snakes to move across the island once the material is in place.

4.6.1.8.1.8 RTM West of Clifton Court Forebay

This RTM site will result in the removal of a small amount of upland habitat associated with a small, isolated aquatic feature west of Clifton Court Forebay. Most of the upland habitat associated with this aquatic feature will remain. The RTM site will result in removal of aquatic and upland habitat west of Clifton Court Forebay, and aquatic and upland habitat near the northwest corner of Clifton County Forebay. Additionally, the RTM site and access road will impact moderate quality aquatic and high quality upland habitat west of Clifton Court Forebay.

4.6.1.8.1.9 Summary of Habitat Loss Resulting from RTM Storage

RTM storage will result in the loss of an estimated 159 acres of upland habitat and 83 acres of aquatic habitat for giant garter snake. Table 4.6-2 provides the compensation acreage to offset giant garter snake habitat loss resulting from RTM placement. As described in Section 5.3.6.2.1 *Activities with Fixed Locations*, workers will confine ground disturbance and habitat removal to the minimal area necessary to facilitate construction activities but will not extend beyond the project footprint.

4.6.1.8.2 Construction Related Effects

RTM areas will be constructed, as needed, depending on location. The RTM storage site at Clifton Court Forebay will be the first to be constructed and filled (Appendix 3.D, *Assumed Construction Schedule for the Proposed Project*) with all other RTM storage sites beginning construction within two years. The RTM storage site at Bouldin Island will be the last to begin construction. RTM storage area construction and placement will occur almost continuously during tunnel excavation, approximately 10 years.

Construction activities at each RTM site will include the use of heavy equipment for ground clearing and grading and soil tilling and rotation. Material will be moved to the site using a conveyor belt and on-site, long-term storage is assumed. The movement of the material to another site is not an activity covered in the assessment. For more details about the activities associated with RTM placement see Section 3.2.10.6 *Dispose Soils*.

Vehicles and heavy equipment used to clear the RTM sites and transport equipment and material could injure or kill giant garter snakes if individuals are present within the RTM footprint. This effect would be most likely to occur during site clearing (up to several days at each location) because thereafter, exclusion fencing will be installed, and these areas will be monitored to minimize the potential for giant garter snake to enter the work area. Other effects related to placement of RTM may include entanglement in erosion control materials, contamination as a result of toxic substances such as fuels, degradation of aquatic habitat from run-off and siltation, and behavioral changes as a result of noise, lighting, or vibration. These effects and measures to minimize them are similar to those described above for construction at the NDD sites under Section 4.6.1.3.2 *Construction-Related Effects.*

4.6.1.8.3 Operations and Maintenance

There are no operations and maintenance activities associated with the RTM sites and therefore no effects to giant garter snake. While reuse of the RTM is possible, future uses for the material have not yet been identified. It is likely that the material will remain in designated storage areas for a period of years before a suitable use is identified, and any such use or disturbance of the site that could result in take of giant garter snake will be subject to environmental evaluation and permitting independent of the PP. Therefore disposition of RTM is assumed to be permanent and future reuse of this material is not part of the PP.

4.6.2 Habitat Restoration/Mitigation

Habitat restoration to mitigate effects of the PA could affect giant garter snake, as described below. However, take of giant garter snake resulting from habitat restoration will not be authorized through this 2081, and will require separate permitting. Therefore, these acreages are not included in Tables 4.6-1 or 4.6-2.

4.6.2.1 Habitat Conversion

Tidal, nontidal, and riparian restoration and channel margin enhancement to offset the effects on species habitat and wetlands will result in conversion of giant garter snake habitat to other habitat types. All restoration sites will be selected by DWR, subject to approval by the jurisdictional fish and wildlife agencies (CDFW, NMFS, USFWS). The acres to be lost as a result of restoration were estimated as described in Appendix 4.B *Terrestrial Impact Analysis Methods*.

4.6.2.1.1.1 Tidal Restoration

DWR will restore 305 acres of tidal wetlands to benefit Delta Smelt and other aquatic species to meet habitat restoration requirements. Tidal wetland restoration will include restoration for the loss of wetland types such as emergent wetland and tidal channels. This tidal restoration is likely to occur in the east, north, or west Delta. Potential locations of tidal and wetland restoration include Grizzly Slough, Lower Yolo Ranch, Zacharias Island, and Sherman Island. In the Delta, wetland and riparian habitats are typically restored by the conversion of currently leveed, cultivated land. Such wetland restoration typically involves grading and contouring of the previously cultivated land within the levees, and breaching of the levees in one or more places.

Permanent effects on giant garter snake aquatic habitat are likely to occur when agricultural ditches are modified and flooded as part of the restoration process. The conversion of rice to tidal habitat would be a permanent loss, however, rice is not common the portions of north slough, Cache Slough, or Sherman Island where tidal restoration would likely be placed. Other aquatic features that have potential to occur on cultivated lands converted to wetlands include natural channels and topographic depressions. Tidal aquatic edge habitat where open water meets the levee edge will also be permanently lost in those reaches where the levee is breached. Temporary effects on aquatic edge habitat are also likely to occur during the time of construction, though these effects would not be expected to last more than 2 years. Permanent effects on upland habitat will primarily occur where upland basking habitat (levees) are removed to create tidal connectivity. If small, interior levees exist on the property, these features could be graded to achieve topographical or elevational design requirements, though in many cases, these features are allowed to persist as they foster the formation of mixed plant communities and high-tide refugial habitat for wetland species.

Tidal restoration will result in the loss of an estimated 154 acres of giant garter snake habitat, including an estimated 118 acres of upland habitat and 36 acres of aquatic habitat. See Appendix 4.B, *Terrestrial Impact Analysis Methods*, for details about the method used to calculate the effects of tidal restoration to giant garter snake.

4.6.2.1.1.2 Nontidal Restoration

DWR will restore 625 acres of nontidal wetlands to benefit giant garter snake and other species that rely upon nontidal wetlands (e.g., greater sandhill crane). Nontidal restoration for these species may also contribute to mitigation required as compliance with Section 404 of the Clean Water Act. Of the 625 acres that will be restored, 521 acres will be restored to benefit giant garter snake. The remaining 104 acres of nontidal restoration will benefit the greater and lesser sandhill crane. Nontidal wetland restoration projects for giant garter snake, when constructed, will increase the available, high quality, aquatic and upland habitat for giant garter snake. Habitat loss associated with nontidal wetland restoration projects for giant garter snake is assumed to be temporary and result in a net benefit to the species. Temporary effects will be related to the use and staging of construction equipment on the tops of levees where giant garter snakes are known to bask. There is also potential for canal and ditch aquatic habitat for giant garter snake will be converted to nontidal wetland.

4.6.2.1.1.3 Riparian Restoration

DWR will restore 79 acres of riparian natural community to benefit the valley elderberry longhorn beetle and Swainson’s hawk. Riparian restoration is likely to occur in the north Delta, Cache Slough, Cosumnes-Mokelumne, or along the Sacramento River. Riparian restoration in this region will likely be accomplished in one of two ways. One way is to reconnect subsided, cultivated lands to flood flows and allow the upland areas (often around the edges of levees) within the parcel to recruit riparian vegetation types, riparian planting will also likely be used to enhance recruitment. Grading could be used in this scenario to increase the amount of area that is at the proper elevations for riparian habitats. Riparian restoration could also be accomplished through levee setbacks. This kind of restoration will require building a new levee behind the existing levee, grading and contouring the existing levee to create the desired habitat types which will likely be a mix of wetland, vegetated edge, and riparian. This kind of riparian restoration will likely occur in a matrix of channel margin enhancement and/or floodplain restoration.

Riparian restoration projects will likely occur on lands that are currently in cultivation. Giant garter snake aquatic habitat in the cultivated regions of Cache Slough, north Delta, Cosumnes-Mokelumne, or the Sacramento River is primarily vegetated edge of tidal habitat or irrigation canals or ditches. Upland habitat in these regions is primarily the tops of levees. For riparian projects where parcels of land are flooded, the primary giant garter snake habitat type that will be lost is the aquatic habitat provided by irrigation canals and ditches. Vegetated tidal edge will be permanently lost wherever levee sections are removed. Canals and ditches will be flooded, at least during some times of the year, and may be graded to increase topographic diversity. Additional vegetated edge could be created on the internal sides of the levees however, these are the regions where riparian restoration will be targeted. Riparian restoration through levee setback may have greater potential to benefit giant garter snake because these types of projects will likely also include channel margin enhancement components that could benefit giant garter snake by restoring sections of vegetated edge habitat.

4.6.2.1.1.4 Channel Margin Enhancement

DWR will enhance approximately 5 miles of channel margins between open water and upland areas to provide improved habitat for migrating salmonids. Channel margin enhancement activities are likely to occur near the NDD sites on the mainstem of the Sacramento River or on one of the nearby connected tidal sloughs (e.g., Steamboat Slough, Elk Slough, or Snodgrass Slough). Channel margin enhancement has the potential to be combined with riparian restoration to meet multiple goals on one restoration site.

Channel margin enhancement will target degraded aquatic edge habitat to improve habitat conditions for migrating salmon and other aquatic species such as Delta Smelt. Enhanced channel margin sections will seek to replace “hardened”, riprap edge habitat with more emergent wetland and riparian habitat. This can be achieved by creating a “bench” of sediment (or other material) at the aquatic edge onto which vegetation can be planted or naturally recruited. This approach to channel margin enhancement is likely to be used to create emergent wetland habitat. More complex channel margin enhancement, where riparian restoration is likely to be a component, will be achieved using levee setbacks.

4.6.2.2 Construction Related Effects

The construction related effects and measures to minimize them are the same as described above for construction at the NDD sites under Section 4.6.1.3.2 *Construction Related Effects*.

4.6.2.3 Operations and Maintenance

Management activities in restored giant garter snake habitat may affect the species. Management activities may include invasive species control or hydrologic modifications. These management activities are not expected to result in take of giant garter snake with the implementation of measures defined in Section 5.3.6.2.1 *Activities with Fixed Locations*, which would avoid and minimize effects on the species.

4.6.3 Take Analysis

The PP may result in mortality of individuals as a result of construction activities within habitat affected by covered activities. Mortality will be avoided and minimized through the measures described Section 5.3.6.2 *Take Minimization Measures*.

4.6.4 Analysis of Impacts in the Project Area

There are 268 extant California Natural Diversity Database (CNDDB) occurrences of the giant garter snake range-wide, of which 24 are in the Delta (California Department of Fish and Wildlife 2015). There are also 13 non-CNDDB extant occurrences for this species in the Delta. The Delta includes two of the 13 giant garter snake subpopulations identified in the draft recovery plan for this species: the two subpopulations are in the Yolo Basin/Willow Slough and Coldani Marsh-White Slough areas. Recent sightings of giant garter snakes in the Central Delta on Webb and Empire Tracts (Eric Hansen pers. comm.) suggest giant garter snakes are using portions of the Central Delta previously thought to be unoccupied. The Delta is therefore important for the long-term survival and conservation of the giant garter snake.

Based on modeled habitat for the giant garter snake, the Delta supports approximately 26,328 acres of aquatic and 62,619 acres of upland modeled habitat for the giant garter snake. Covered activities are projected to permanently affect up to 205 acres of modeled aquatic habitat (<1% of modeled aquatic habitat in the Delta) and up to 570 acres of modeled upland habitat (<1% of modeled upland habitat in the Delta). In addition, up to 67 acres of upland habitat will be temporarily affected.

Without take minimization measures, the operation of construction equipment could result in mortality of giant garter snakes. The risk of mortality will be minimized through planning and preconstruction surveys and the installation of exclusion fencing between the work area and suitable habitat, as described in Section 5.3.6.2 *Take Minimization Measures*.

Overall the impacts on giant garter snake will not be substantial when considering the relative amount of habitat affected in the Delta, and when considering the take minimization measures that are presented in Section 5.3.6.2 *Take Minimization Measures*, which will avoid take to the maximum extent practicable. Furthermore, the proposed mitigation presented above in Table 4.6-2, which includes the protection of restoration of 410 to 615 acres of aquatic habitat (some of which may be achieved through protection) and the protection of 1,140 to 1,710 acres of upland habitat, would fully mitigate the impact. Mitigation will be implemented prior to or concurrent with the impact. If habitat is protected after the impact occurs, to offset the temporal loss of habitat the mitigation amount will be increased by 5% for every year protection is delayed (e.g., if protection occurs two years after the impact occurs, mitigation will be 10% greater than required if protection occurs prior to or concurrent with the impact).

4.6.5 Analysis of Potential for Jeopardy

Giant garter snake's capability to survive and reproduce is based on the availability of suitable aquatic habitat and adjacent upland refugia. Information on population trends and known threats to the species are presented in Section 2.6 *Giant Garter Snake*, and the cumulative effects and jeopardy analyses in light of these factors are provided below.

4.6.5.1 Climate Change

Climate change threatens to modify annual weather patterns, which may result in reduction of giant garter snake aquatic habitat. Climate change may result in a loss of giant garter snake and/or prey, and/or increased numbers of their predators, parasites, and disease.

4.6.5.2 Cumulative Effects

The projects and programs that have been considered as part of the cumulative analysis have been drawn primarily from Appendix 4.C *Information to Support Cumulative Effects Analysis*. Those projects and programs that could impact terrestrial resources in the Delta are presented in Appendix 4.B *Terrestrial Impact Analysis Methods*. The list of past, present and reasonably foreseeable future projects and programs has been evaluated to determine which of these activities may affect giant garter snakes. Most of the local, state and federal land use and land management programs that are affecting or will affect the Delta are designed to preserve open space and agricultural lands, and to manage the resources of the area for multiple uses, including agriculture, recreation, fish and wildlife habitat, flood protection and water management. This list includes several programs that will be beneficial to giant garter snake, which includes the Yolo Natural Community Conservation Plan/Habitat Conservation Plan, Yolo Bypass Wildlife Area Land Management Plan, Solano County Multispecies Habitat Conservation Plan, Stone Lakes National Wildlife Refuge Comprehensive Conservation Plan, South Sacramento Habitat Conservation Plan, San Joaquin County Multi-Species Habitat Conservation and Open Space Plan, and California EcoRestore. On the upland fringes of the Delta, plans exist for small expansions of urban development that would remove primarily agricultural land uses.

The PP's take minimization and mitigation measures will ensure that the loss of habitat will be fully mitigated and that take will be minimized. The effect of the PP and other closely related actions on giant garter snake will not be cumulatively considerable.

4.6.5.3 Potential to Jeopardize the Existence of the Species

The issuance of the ITP is not expected to jeopardize the continued existence of giant garter snake for the following reasons.

Level of Take – The overall potential for take is low. Covered activities have a low likelihood of resulting in mortality of individuals. The covered activities will result in permanent impacts on up to 205 acres of aquatic habitat and up to 570 acres of upland habitat. These habitat losses are relatively small and are not expected to have a population level effect.

Take Minimization Measures – The proposed TMM take minimization measures described in Section 5.3.6.2 *Take Minimization Measures* greatly reduce the potential for mortality of individuals, which makes it unlikely that covered activities will affect reproductive rates of the population or survivorship of individuals.

Mitigation – Mitigation is expected to fully offset habitat loss and any loss of individuals because high-quality, larger-scale, habitat will be restored, protected, managed, and enhanced for the benefit of giant garter snake.

Giant garter snake populations are still in a state of decline relative to historic abundance and available habitat (Wood et al. 2015). The Yolo and Delta Basin (Badger Creek and White Slough) clusters are represented by only a few populations and ensuring the continued existence of these populations may be critical for maintaining overall genetic diversity within the species (Wood et al. 2015). The primary threats to survival of the giant garter snake include habitat loss, conversion, and fragmentation, as well as flood control activities, changes in agricultural and land management practices, and water pollution. The PP will not threaten the survival of the giant garter snake because it will not result in significant losses of individuals of the species or habitat. The covered activities will also not substantially contribute to the fragmentation of remaining habitat because most of the covered activities will be outside of areas of high quality habitat and will not create barriers to movement.

Considering the low potential for take relative to these factors, the protection afforded by the take minimization measures in Section 5.3.6.2 *Take Minimization Measures*, and that the loss of habitat will be fully mitigated, the covered activities will not adversely affect the reproduction and survival of the giant garter snake, and the issuance of the ITP will not jeopardize the continued existence of the species.

4.6.6 References

4.6.6.1 Written References

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4.7 Take of the Swainson's Hawk

Appendix 4.B, *Terrestrial Effects Analysis Methods*, describes the methods and assumptions used to analyze the effects of the PP on wildlife species. Section 2.7.4 *Species Habitat Suitability Model* provides a description of the habitat model for Swainson's hawk.

Activities associated with geotechnical exploration, safe haven work areas, North Delta intake construction, tunneled conveyance facility construction, Clifton Court Forebay modifications, power supply and grid connections, Head of Old River (HOR) gate, and reusable tunnel material (RTM) storage areas may affect Swainson's hawk, as described below. Figure 4.7-1 provides an overview of the locations of surface impacts relative to Swainson's hawk modeled habitat. There are 443,059 acres of modeled Swainson's hawk habitat in the Delta, including 433,972 acres of foraging habitat and 9,087 acres of nesting habitat. An estimated 3,791 acres (<1% of total modeled habitat in the Delta) of Swainson's hawk modeled habitat, including 3,769 acres of foraging habitat and 22 acres of nesting habitat, will be permanently lost as a result of the PP. Table 4.7-1 summarizes the total estimated loss of Swainson's hawk modeled habitat.

The Swainson's hawk effects analysis uses the terms defined below in reference to nesting habitat.

- Suitable nesting habitat. Suitable nesting habitat is defined in Section 2.7.5, *Suitable Habitat Definition*. Suitable nesting habitat will be delineated through site-level surveys during implementation by an Approved Biologist[2] to quantify and track impacts.

- Modeled nesting habitat. Modeled nesting habitat is based on existing vegetation data that primarily identifies patches of existing forests that include tree types that are known to be used by Swainson's hawk for nesting. The nesting model does not include individual trees that are known to be used to Swainson's hawk for nesting. However, the model is considered to be adequately conservative to provide an estimate of total acres of nesting habitat loss. Modeled Swainson's hawk nesting habitat is described in Section 2.7.4, *Species Habitat Suitability Model*. Effects to modeled nesting habitat were determined by intersecting the model and the construction footprint in GIS. Modeled habitat is used to conservatively estimate maximum habitat loss to set the incidental take permit take limit; suitable habitat will be delineated by the Approved Biologist to quantify actual habitat loss during implementation as described above.

- Affected nest site. An affected nest site is a 125-acre area where more than 50% of the suitable nest trees (20 feet or taller) will be removed; the method and associated assumptions used to derive this definition are described in Appendix 4.B, in Section 4.B.4.1.4, *Swainson's Hawk Analysis of Affected Nest Sites*. Figure 4.7-39 illustrates how such 125-acre areas are distributed across the project area.

[2] The qualifications for an *Approved Biologist* include direct or contractual employment by DWR, and approval of suitability for work on the PP as stated in writing by representatives of CDFW and USFWS.

- Active nest/active nest tree. An active nest is a nest that was used for Swainson's hawk nesting during one or more of the last five years (California Department of Fish and Game 1994). An active nest tree is a tree supporting an active nest.

- Occupied nest/occupied nest tree. An occupied nest is a nest being used by a Swainson's hawk during the breeding season, and thus requiring avoidance and minimization measures during the breeding season to avoid Swainson's hawk injury or mortality. An occupied nest tree is a tree supporting an occupied nest. The Approved Biologist, in coordination with CDFW, will make determinations regarding the occupancy of Swainson's hawk nests.

Table 4.7-1. Maximum Habitat Loss on Modeled Habitat for Swainson's Hawk by Activity Type (Acres)

Swainson's Hawk Modeled Habitat	Total Modeled Habitat in the Delta	Permanent Habitat Loss								Temporary Habitat Loss		
		Safe Haven Work Areas (Atmospheric)	North Delta Intakes	Tunneled Conveyance Facilities	Clifton Court Forebay Modifications	Power Supply and Connection	Head of Old River Gate	RTM Storage Area	Total Permanent Habitat Loss	Geotechnical Exploration	Power Supply and Connection	Safe Haven Work Areas (Pressurized)
Foraging	433,972	66	280	445	778	0	1	2,199	3,769	710	270	134
Nesting	9,087	0	8	2	0	2	0	10	22	0[b]	0	0
Total	**443,059**	**66**	**288**	**447**	**778**	**2**	**1**	**2,209**	**3,791**	**710**	**270**	**134**

[a] Permanent restoration effects have been estimated conservatively to inform the jeopardy analysis. Restoration activities will be addressed under a separate incidental take permit.

[b] Although the GIS analysis indicates 6 acres of nesting habitat loss from geotechnical exploration, the take minimization measures require that geotechnical exploration activities avoid removal of Swainson's hawk nesting habitat.

Table 4.7-2. Maximum Direct Effects on and Conservation of Modeled Habitat for Swainson's Hawk

Swainson's Hawk Modeled Habitat	Permanent Habit Loss	Compensation Ratios		Total Compensation (Acres)	
	Total Maximum Habitat Loss (Acres)[a]	Protection	Restoration	Protection	Restoration
Foraging	3,769[a]	1:1	0	3,769	0
Nesting	22	1:1	1:1[b]	22	22
Total	**3,791**			**3,791**	**22**

a. Total maximum habitat loss does not include the permanent effects estimated from restoration activities. Those effects will be addressed under a separate incidental take permit.
b. In addition to the 1:1 restoration, mature trees will be transplanted in associated with additional sapling plantings as described in Sections 5.4.7.2 and 5.4.7.3.

4.7.1 Effects on Swainson's Hawk from the Proposed Project

4.7.1.1 Geotechnical Exploration

4.7.1.1.1 Habitat Loss and Fragmentation

Geotechnical exploration activities will result in the temporary loss of up to 710 acres of Swainson's hawk foraging habitat. Geotechnical exploration will fully avoid Swainson's hawk nesting habitat as described in Section 5.3.7.2.2 *Activities with Flexible Locations*. The temporary impact will consist of driving overland to access the geotechnical exploration sites, and storing equipment at the sites for short time periods (2 to 21 days). The only permanent loss of foraging habitat will be from the bore holes, which will be grouted upon completion. Bore holes are very small (approximately 8 inches in diameter) and will have no or negligible effects on Swainson's hawk foraging habitat. Temporarily disturbed areas where vegetation is removed will be restored to pre-project conditions using suitable vegetation, determined in consultation with CDFW, as described in section 5.3.7.2.2 *Activities with Flexible Locations.* This will likely not be necessary for most of the temporarily disturbed areas, however, as the disturbance primarily consists of driving over agricultural areas or grassland for 2 to 21 days.

4.7.1.1.2 Construction Related Effects

Geotechnical exploration that occurs when Swainson's hawks are absent from the project area (from September 15 to March 1) will have no effects on the species. Without the take minimization measures, activity during the breeding season (March 1 to September 15) near occupied nests could disturb breeding Swainson's hawks. The take minimization measures described in Section 5.3.7.2, *Take Minimization Measures*, including preconstruction surveys, establishment of no-disturbance buffers, and biological monitoring, will be used to minimize disturbance of nesting Swainson's hawks. These measures include establishing a 650-foot-radius no-disturbance buffer around each occupied Swainson's hawk nest tree. No construction activity will be allowed in the buffer while a nest is occupied by Swainson's hawk during the breeding season, unless otherwise approved in writing by CDFW and addition avoidance measures are implemented as stipulated in Section 5.3.7.2 *Take Minimization Measures*. With these measures, mortality will be avoided.

4.7.1.1.3 Operations and Maintenance

There will be no operations and maintenance associated with geotechnical activities.

4.7.1.2 Safe Haven Work Areas

4.7.1.2.1 Habitat Loss and Fragmentation

Construction of atmospheric (emergency access) safe haven shafts will result in the permanent loss of an estimated 66 acres of foraging habitat, based on 22 atmospheric access shafts at three acres each. Emergency access shafts will avoid nesting habitat. Habitat loss from emergency shafts is considered permanent because they will likely be used longer than one year.

Construction of pressurized safe haven shafts will result in the temporary disturbance of an estimated 134 acres, based on 134 safe haven shafts at one acre each. Habitat disturbance from pressurized safe haven shafts is considered temporary because they will be used for less than a year, and disturbed areas will be returned to pre-project conditions within a year of disturbance.

Once surface drilling and treatment operations are completed (8 weeks to 24 months), all equipment will be removed and the surface features reestablished. Construction of safe haven work areas will fully avoid Swainson's hawk occupied nests during the breeding season and take of individuals as described in Section 5.3.7.2.2 *Activities with Flexible Locations*.

4.7.1.2.2 Construction Related Effects

The surface drilling and treatment operation will take from 8 weeks to 24 months. Construction related actions are not expected to injure or kill Swainson's hawk individuals. Foraging Swainson's hawks are highly mobile and would avoid direct injury or mortality from construction equipment. Furthermore, Swainson's hawks frequently forage in the vicinity of operating farm equipment, therefore the presence of construction equipment and its associated noise is not expected to disrupt Swainson's hawk foraging behavior. In the absence of take minimization measures, construction of safe haven work areas in the vicinity of Swainson's hawk nests could cause hawks to abandon nests, resulting in mortality of eggs or chicks. The take minimization measures described in Section 5.3.7.2 *Take Minimization Measures*, including preconstruction surveys, establishment of no-disturbance buffers, and biological monitoring, will be used to minimize disturbance of nesting Swainson's hawks. These measures include establishing a 650-foot-radius no-disturbance buffer around each occupied Swainson's hawk nest tree. No construction activity will be allowed in the buffer while a nest is occupied by Swainson's hawk during the breeding season, unless otherwise approved in writing by CDFW and additional avoidance measures are implemented as stipulated in Section 5.3.7.2 *Take Minimization Measures*. With these measures, mortality will be avoided.

4.7.1.2.3 Operations and Maintenance

There will be no operations and maintenance associated with safe haven work areas.

4.7.1.3 North Delta Diversion Construction

4.7.1.3.1 Habitat Loss and Fragmentation

NDD construction will result in permanent loss of 280 acres of Swainson's hawk foraging habitat and 8 acres of Swainson's hawk nesting habitat. In addition, up to six affected nest sites could be lost as the result of NDD construction (Figure 4.7-2). The removal of active nest trees will be minimized, and the removal of occupied nest trees will be avoided, as described in Section 5.3.7.2.1, *Activities with Known Locations.* For the methods and assumptions used to estimate the loss of nest sites, see Appendix 4.B, Section 4.B.4.1.4, *Swainson's Hawk Analysis of Affected Nest Trees*[3]. Loss of nest sites will be offset through transplanting of mature trees as

[3] Based on the analysis, there is potential for four affected nest sites as a result of NDD construction. The take estimate was increased by two nest sites to provide a conservative estimate of potentially affected nest sites. The actual number of affected nest sites will be determined during project implementation.

described in Section 5.4.7.2 *Transplant Mature Trees*, and additional saplings will be planted in association with these trees as described in Section 5.4.7.3 *Plant Tree Saplings*.

4.7.1.3.2 Construction Related Effects

Construction activities at each intake that may affect Swainson's hawk include grading, construction of the intakes and associated facilities, vehicular use including transport of construction equipment and materials, in-water construction of crib walls, and in-water pile driving.

The duration of construction at each intake facility will be approximately five years. Implementation of intake construction at each location will be staggered by approximately six months. Construction for intake 3, the middle intake, will begin first; approximately six months later, construction will begin at intake 5, the southernmost intake. Construction at intake 2, the northernmost intake, will begin approximately one year after having begun at intake 5. The result is that construction will overlap at all three sites for approximately four years.

Construction related actions are not expected to injure or kill Swainson's hawk individuals. Foraging Swainson's hawks are highly mobile and would avoid direct injury or mortality from construction equipment. Furthermore, Swainson's hawks frequently forage in the vicinity of operating farm equipment, therefore the presence of construction equipment and its associated noise is not expected to disrupt Swainson's hawk foraging behavior. In the absence of take minimization measures, construction in the vicinity of Swainson's hawk nests could cause hawks to abandon nests, resulting in mortality of eggs or chicks. The take minimization measures described in Section 5.3.7.2 *Take Minimization Measures*, including preconstruction surveys, establishment of no-disturbance buffers, and biological monitoring, will be used to minimize disturbance of breeding Swainson's hawks. The removal of active nest trees will be minimized, and the removal of occupied nest trees will be avoided during the breeding season, as described in Section 5.3.7.2.1 *Activities with Known Locations*. These measures include establishing a 650-foot-radius no-disturbance buffer around each occupied Swainson's hawk nest tree. No construction activity will be allowed in the buffer while a nest is occupied by Swainson's hawk during the breeding season, unless otherwise approved in writing by CDFW and addition avoidance measures are implemented as stipulated in Section 5.3.7.2 *Take Minimization Measures*. With these measures, mortality will be avoided.

4.7.1.3.3 Operations and Maintenance

Ongoing NDD maintenance activities include intake dewatering, sediment removal, debris removal, and biofouling and corrosion removal. These activities will occur from water-based equipment approximately annually. These activities are not expected to affect Swainson's hawk or its habitat because they will only affect the open water portion of the Sacramento River and areas within the facility.

4.7.1.4 Tunneled Conveyance Facilities

4.7.1.4.1 Habitat Loss and Fragmentation

Tunneled conveyance facility activities include construction of the intermediate forebay (IF) and overflow area, barge unloading areas, shaft locations, and the pumping plant. These activities will result in permanent removal of up to 447 acres of modeled Swainson's hawk habitat in the north and central Delta and in the area around Clifton Court Forebay (CCF). This total consists of a loss of up to 445 acres of foraging habitat and 2 acres of nesting habitat for Swainson's hawk. Effects on foraging habitat will occur primarily on cultivated land, in an area with numerous Swainson's hawk occurrences in the vicinity. The removal of active nest trees will be minimized, and the removal of occupied nest trees will be avoided during the breeding season, as described in Section 5.3.7.2.1 *Activities with Known Locations.*

4.7.1.4.2 Construction Related Effects

The duration of active tunnel construction areas is expected to be approximately eight years. See Section 3.2.3 *Tunneled Conveyance* and Appendix 3.D *Construction Schedule for the Proposed Project*, for complete construction activity and timing details.

Construction noise up to 60 dBA (the standard noise threshold for avian species; Dooling and Popper 2007) will occur within 1,200 feet of the footprints for tunnel work areas, tunnel conveyors, and vent shafts. Construction and pile driving noise up to 60 dBA will occur up to 2,000 feet from the edge of the barge unloading facilities. Light associated with nighttime activities is also possible.

Construction related actions are not expected to injure or kill Swainson's hawk individuals. These effects are as described above in Section 4.7.1.3.2 *Construction Related Effects*.

4.7.1.4.3 Operations and Maintenance

Maintenance of the above-ground water conveyance facilities could result in ongoing but infrequent, periodic post-construction noise and visual disturbances that could affect Swainson's hawk use of surrounding habitat. These effects may include vehicle use along the conveyance corridor, and inspection and maintenance of above-ground facilities. These potential effects will be minimized with implementation of the take minimization measures in Section 5.3.7.2 *Take Minimization Measures*, which include establishment of no-disturbance buffers around occupied nests, and biological monitoring. With these measures, ongoing operation and maintenance activities are not expected to result in take of Swainson's hawk.

4.7.1.5 Clifton Court Forebay Modification

4.7.1.5.1 Habitat Loss and Fragmentation

CCF modification includes dredging, the expansion of the forebay through the creation of a new embankment, and the creation of two new canals and siphon, roads, an overflow structure, conveyor belt, control structures, and work areas. These activities will result in the permanent loss of 778 acres of Swainson's hawk foraging habitat. The removal of active nest trees will be minimized, and the removal of occupied nest trees will be avoided during the breeding season, as described in Section 5.3.7.2.1 *Activities with Known Locations.*

4.7.1.5.2 Construction Related Effects

Construction activities at Clifton Court Forebay include pile driving, excavation, dredging, and cofferdam and embankment construction. Construction at Clifton Court Forebay will be phased by location, and the duration of construction will be approximately six years. The duration of dredging is expected to be approximately four years. Noise produced by the combined use of the six loudest pieces of construction equipment and pile driving will be no more than 60 dBA at 2,000 feet from the edge of CCF. For complete details on construction activities and phasing, see Section 3.2.5 *Clifton Court Forebay*; for more details on schedule, see Appendix 3.D *Construction Schedule for the Proposed Project*.

Construction related actions are not expected to injure or kill Swainson's hawk individuals. These effects are as described above in Section 4.7.1.3.2 *Construction Related Effects*.

4.7.1.5.3 Operations and Maintenance

The operational components of the modified Clifton Court Forebay include the control structures and the siphons. The forebay and the canals will require erosion control, and control of vegetation and rodents. Maintenance of control structures could include roller gates, radial gates, and stop logs. Maintenance requirements for the spillway will include the removal and disposal of any debris blocking the outlet culverts. Operations and maintenance related actions are not expected to injure or kill Swaison's hawk individuals with implementation of the take minimization measures, for the same reasons described under Section 4.7.1.3.2 *Construction Related Effects*.

4.7.1.6 Power Supply and Grid Connections

4.7.1.6.1 Habitat Loss and Fragmentation

Assuming a 50-foot wide disturbance area along the transmission line corridor for pole and tower placement, access roads, and ongoing operations and maintenance, up to 270 acres of Swainson's hawk foraging habitat will be temporarily disturbed and up to 2 acres of nesting habitat will be permanently affected. Most of the disturbance will consist of construction-related work areas and overland travel and will be limited to the duration of construction, which is not expected to be longer than one year in any one location. The loss of foraging habitat is therefore considered to be temporary. Temporarily disturbed areas will be restored to pre-project conditions using suitable vegetation, selected in consultation with CDFW, as described in Section 5.3.7.2.2 *Activities with Flexible Locations*.

The loss of 2 acres of modeled nesting habitat is considered permanent because of the time it will take for replaced nest trees to reach a size that is suitable for Swainson's hawk nesting. There will also be permanent loss of foraging habitat where poles and towers are placed, but this permanent loss is very small (less than one acre for all land cover types) and will be subsumed within the total foraging habitat acreage loss estimated for the incidental take permit. See Table 4.B-1 in Appendix 4.B *Terrestrial Methods*, for a description of the disturbance acres associated with transmission line construction. The permanent loss of nesting habitat will be offset through protection and restoration of riparian habitat (Table 4.7-2).

The removal of active nest trees will be minimized, and the removal of occupied nest trees will be avoided during the breeding season, as described in Section 5.3.7.2.2 *Activities with Flexible Locations*.

4.7.1.6.2 Construction Related Effects

New temporary power lines to power construction activities will be built prior to construction of permanent transmission lines to power conveyance facilities. These lines will extend existing power infrastructure (lines and substations) to construction areas, generally providing electrical capacity of 12 kV at work sites. Main shafts for the construction of deep tunnel segments will require the construction of 69 kV temporary power lines. An existing 500kV line, which crosses the area proposed for expansion of the CCF, will be relocated to the south of the expanded forebay in order to avoid disruption of existing power facilities. No interconnection to this existing line is proposed.

Temporary substations will be constructed at each intake, at the IF, and at each of the launch shaft locations. To serve permanent pumping loads, a permanent substation will be constructed adjacent to the pumping plants at CCF, where electrical power will be transformed from 230 kV to appropriate voltages for the pumps and other facilities at the site. For operation of the NDDs, existing distribution lines will be used to power gate operations, lighting, and auxiliary equipment.

Construction of new transmission lines will require site preparation, tower or pole construction, and line stringing. For 12 kV and 69 kV lines, cranes will be used during the line-stringing phase; for stringing transmission lines between 230 kV towers, cranes and helicopters will be used. Construction-related activities will be largely concentrated in a 100- by 50-foot area around each pole or tower placement site, and, in the case of conductor pulling locations, in a 350-foot corridor (measured along the alignment from the base of the tower or pole); conductor pulling locations will occur at any turns greater than 15 degrees and/or every 2 miles of line. Construction will also require vehicular access to each tower or pole location. Vehicular access routes will use existing routes to the greatest extent practicable, but some overland travel will likely be necessary. The duration of transmission line construction activities will not be more than one year at any one location. See Section 3.2.7.2 *Construction* for a full description of the construction activities.

Construction activities are not expected to injure or kill Swainson's hawk individuals. These effects are as described above in Section 4.7.1.3.2 *Construction Related Effects*.

4.7.1.6.3 Operations and Maintenance

The temporary transmission lines will be in place for the duration of conveyance facility construction (approximately ten years); the permanent transmission lines will remain to supply power to the pumping plant (Figures 4.7-31 through 4.7-37). Maintenance activities at the transmission lines will include vegetation management and overland travel for some emergency repairs. Ongoing vegetation management around the poles and under the lines is expected to be minimal in Swainson's hawk habitat because grassland and/or cropland areas seldom if ever need to be cleared to maintain transmission line corridors. Therefore, maintenance activities for transmission lines will not affect Swainson's hawk foraging habitat.

New transmission lines will increase the risk for bird strikes on transmission lines. Swainson's hawk is expected to be at low risk of bird strike. The Swainson's hawk has long, narrow, tapered wings; a body size that allows for efficient soaring flight; highly developed aerial maneuverability; highly developed eyesight; and fair-weather flight behavior. These factors result in a low relative risk for transmission line collision mortality. The existing network of 8,472 miles of transmission and distribution lines in the Delta poses a small risk for Swainson's hawk. The addition of up to approximately 9.3 miles of permanent and temporary transmission lines in the project area is expected to incrementally increase this low risk of collision and mortality. To minimize this incremental increase in risk, bird strike diverters will be placed on all new temporary and permanent transmission lines as described in Section 5.3.7.2.2 *Activities with Flexible Locations*. Bird strike diverters are devices attached to power lines and are designed to make the lines more visible to birds as they fly. Enhancing the visibility of lines involves marking the lines with one or more of the diverters to minimize the potential for a bird strike. To mitigate for this effect, bird strike diverters will also be placed on existing transmission lines as described in Section 5.4.7.4 *Install Bird Strike Diverters on Existing Transmission and Distribution Lines.* Any mortality associated with transmission line collision, if it occurs at all, is not anticipated to affect the population of Swainson's hawks in the Delta; the placement of bird diverters on new and existing transmission lines will further minimize and fully mitigate the potential for bird strike.

4.7.1.7 Head of Old River Gate

4.7.1.7.1 Habitat Loss and Fragmentation

Head of Old River gate (HOR gate) construction will result in the loss of one acre of foraging habitat (Figure 4.7-38). No Swainson's hawk nesting habitat will be removed as a result of HOR gate construction.

4.7.1.7.2 Construction Related Effects

HOR gate construction will include dredging along 500 feet of channel to prepare it for gate construction, which will last approximately 15 days (Section 3.2.10.8 *Dredging and Riprap Placement*). Dredging equipment will be operated from a barge in the channel. It will also include construction of a cofferdam and foundation for the HOR gate, which will require in-water pile driving and will last up to 32 months (Section 3.2.10.11 *Pile Driving*). The installation of the cofferdam will require up to 700 strikes per pile over an estimated 40-day period. The installment of the foundation for the operable barrier will require 15 piles to be set per day with up to 1,050 strikes per pile over an estimated 7-day period. Noise produced by this activity, including the combined use of the six loudest pieces of construction equipment along with pile driving, will not exceed 60 dBA at 2,000 feet from the edge of the project footprint. Noise, light, or vibration effects on Swainson's hawk foraging habitat in the vicinity of the HOR gate construction footprint are expected to be insignificant. Construction related actions are not expected to injure or kill Swainson's hawk individuals. These effects are as described above in Section 4.7.1.3.2 *Construction Related Effects*.

4.7.1.7.3 Operations and Maintenance

The new HOR gate will replace the temporary rock barrier that is typically installed at the same location. Because the HOR gate is replacing an existing temporary barrier, no adverse effects to nesting habitat are expected.

Periodic maintenance of the HOR gates would occur every 5 to 10 years. Maintenance dredging around the gate would be necessary to clear out sediment deposits. Noise generated by the service truck and the dredging machinery will not exceed 60 dBA (standard threshold for avian species; Dooley and Popper 2007) at 1,200 feet from the activity (See Section 3.3 *Operations and Maintenance of New and Existing Facilities* for further detail). These operations and maintenance related actions are not expected to injure or kill Swainson's hawk individuals.

4.7.1.8 Reusable Tunnel Material

4.7.1.8.1 Habitat Loss and Fragmentation

The mapped construction footprints for the RTM sites overlap with 2,199 acres of Swainson's hawk modeled foraging habitat and 10 acres of Swainson's hawk modeled nesting habitat (Figures 4.7-2, 4.7-6, 4.7-16, 4.7-17, 4.7-18, 4.7-22, 4.7-23, 4.7-24, 4.7-32, 4.7-34, 4.7-35). In addition, up to three Swainson's hawk nest sites could be lost as the result of RTM placement. For the methods and assumptions used to estimate the loss of nest trees, see Table 4.B-2 in Section 4.B.4.4 *Summarizing Effects on Wildlife and Plants*. The loss of an occupied nest tree will be avoided as described in Section 5.3.7.2.1 *Activities with Known Locations*. Removal of an active nest tree outside the breeding season (i.e., prior to egg laying and after post-hatching) will be minimized to the extent possible as described in Section 5.3.7.2.1 *Activities with Known Locations*.

4.7.1.8.2 Construction Related Effects

Each RTM storage area will be operational for five to eight years. RTM storage areas will be constructed as needed, depending on location. RTM storage area construction and placement will occur almost continuously through tunnel excavation, for approximately 10 years. Construction activities at each RTM site will include the use of heavy equipment for ground clearing and grading and soil tilling and rotation. Material will be moved to the site using a conveyor belt and on-site, permanent storage is assumed. Any subsequent movement of the material to another site is not part of the PP and would require separate environmental evaluation and permitting. For more details about the activities associated with RTM placement see Section 3.2.10.6 *Dispose Soils*.

Activities associate with construction and filling of RTM storage areas are not expected to injure or kill Swainson's hawk individuals. Effects will be as described above in Section 4.7.1.3.2 *Construction Related Effects*.

4.7.1.8.3 Operations and Maintenance

There are no operations and maintenance activities associated with the RTM storage areas and therefore no effects on Swainson's hawk.

4.7.1.9 Restoration

4.7.1.9.1 Habitat Loss and Fragmentation

Tidal and nontidal wetland restoration will result in the permanent loss of up to an estimated 305 acres of suitable Swainson's hawk foraging habitat[4]. The tidal and nontidal wetland restoration has not yet been sited; however, the tidal restoration will likely be sited in the Cache Slough, North Delta, east Delta, or west Delta region. Mortality of Swainson's hawk will be avoided during tidal restoration as described in Section 5.3.7.2 *Take Minimization Measures*. Take minimization measures include preconstruction surveys, establishment of no-disturbance buffers, no removal of occupied nest trees during the breeding season, and biological monitoring.

Riparian natural community restoration will result in the permanent removal or conversion of up to 102 acres of Swainson's hawk foraging habitat. Mortality of Swainson's hawks will be avoided or minimized during riparian restoration, as described in Section 5.3.7.2 *Take Minimization Measures*. Take minimization measures include preconstruction surveys, establishment of no-disturbance buffers, removal of active nest trees outside of the breeding season, and biological monitoring.

Take of Swainson's hawk as a result of restoration activity, and mitigation for the take, will be addressed through a future 2081 application with CDFW.

4.7.1.9.2 Construction Related Effects

The construction related effects of habitat restoration, and measures to minimize them, are the same as described above under Section 4.7.1.3.2 *Construction Related Effects*.

4.7.1.9.3 Operations and Maintenance

Management activities in restored riparian (nesting) habitat may affect the species. Management activities may include invasive species control. This management would have minimal effect on the species due to the implementation of measures prescribed in Section 5.3.7.2.1 *Activities with Fixed Locations* to minimize effects on the species and avoid nesting birds.

4.7.2 Take Analysis

In the absence of the proposed take minimization measures, the operation of construction equipment could result in mortality of Swainson's hawk eggs or nestlings, which are susceptible to vegetation-clearing activities, parent nest abandonment, or increased exposure to the elements

[4] Tidal restoration of 305 acres will provide mitigation for effects to covered fish. To conservatively estimate effects, it is assumed that all 305 acres of tidal restoration will occur on cultivated lands that have habitat value to Swainson's hawk.

or to predators. Mortality of adults is not expected to occur because they are mobile and are able to avoid construction equipment. Noise and visual disturbances associated with construction could temporarily displace Swainson's hawks, or temporarily reduce the use of suitable habitat adjacent to construction areas. With implementation of the measures described in Section 5.3.7.2 *Take Minimization Measures*, these activities are not expected to result in abandonment of an active nest, and otherwise to avoid mortality of individuals.

4.7.3 Analysis of Impacts in the Project Area

The Swainson's hawk population in the Delta is large and widely distributed, with over 400 reported breeding records (California Department of Fish and Wildlife 2013). At least 300 of these are considered independent breeding territories that are potentially active in any given year, representing about 14% of the statewide population (California Department of Fish and Wildlife 2013). Therefore, the Delta constitutes an important portion of the species' California range. The Project Area overlaps with at least 27 of the documented breeding records from the Delta (California Department of Fish and Wildlife 2013).

The Delta supports 443,059 acres of modeled habitat for the Swainson's hawk, including 9,087 acres of nesting habitat and 433,972 acres of foraging habitat. Sustainability of the Swainson's hawk population in the Delta depends on providing and maintaining suitable breeding sites interspersed in sufficient acreage of compatible agricultural and grassland landscapes that support abundant, accessible prey. The PP will permanently affect an estimated 3,738 acres (0.9% of habitat in the Delta) of foraging habitat and an estimated 23 acres (0.2% of habitat in the Delta) of nesting habitat. There will also be up to 9 affected nest sites resulting from the PP. In addition, an estimated 980 acres of foraging habitat will be temporarily lost.

Without the take minimization measures, the operation of construction equipment could result in mortality of Swainson's hawk eggs or nestlings, which are susceptible to site clearing, parent nest abandonment, or increased exposure to the elements or to predators. Mortality of adults and fledged juveniles who are no longer dependent on the adults is not expected because they are mobile and are able to evade construction equipment. Mortality will be minimized and largely avoided through planning and preconstruction surveys and the establishment of a no-disturbance buffer around each active Swainson's hawk nest site, as described in Section 5.3.7.2 *Take Minimization Measures*, although there is still potential for some mortality to occur with full implementation of these measures.

Construction activities within 0.25 mile of occupied Swainson's hawk nests could disturb breeding Swainson's hawks and potentially cause them to be abandon a nest, in the absence of take minimization measures. Construction activities with known and uncertain locations will minimize or avoid effects from noise within ¼ mile of an occupied nest by identifying occupied nests through preconstruction surveys, establishing a non-disturbance buffer, and monitoring occupied nests for evidence of disturbance as described in Section 5.3.7.2 *Take Minimization Measures.*

Take in the form of mortality as a result of enhancement and management actions on preservation lands will be avoided through the measures described in Section 5.3.7 *Swainson's Hawk.*

Overall the impacts of the PP on Swainson's hawk will not be substantial when considering the relative amount of habitat affected in the Delta, which will be 0.9% of the modeled foraging habitat and 0.2% of the modeled nesting habitat, and when considering the take minimization measures (Section 5.3.7.2 *Take Minimization Measures*), which will minimize take and largely avoid injury or mortality.

4.7.4 Analysis of Potential for Jeopardy

Swainson's hawk's ability to survive and reproduce is based on the availability of nesting habitat and its proximity to high quality foraging habitat. Information on population trends and known threats to Swainson's hawk in the Delta are presented in Section 2.7 *Swainson's Hawk*. Cumulative effects and jeopardy analyses in light of these factors are provided below.

4.7.4.1 Cumulative Effects

The projects and programs that have been considered as part of the cumulative effects analysis have been drawn primarily from Appendix 4.C, *Information to Support Cumulative Effects Analysis*. The list of past, present and reasonably foreseeable future projects and programs has been evaluated to determine which of these activities may affect Swainson's hawk. Most of the local, state and federal land use and land management programs that are affecting or will affect the Delta are designed to preserve open space and agricultural lands, and to manage the resources of the area for multiple uses, including agriculture, recreation, fish and wildlife habitat, flood protection and water management. This list includes several programs that will be beneficial to Swainson's hawk, which include the Yolo Natural Heritage Program Plan, Yolo Bypass Wildlife Area Land Management Plan, Solano County Multispecies Habitat Conservation Plan, Stone Lakes National Wildlife Refuge Comprehensive Conservation Plan, South Sacramento Habitat Conservation Plan, San Joaquin County Multi-Species Habitat Conservation and Open Space Plan, and California EcoRestore. On the upland fringes of the Delta, plans exist for small expansions of urban development that would remove primarily agricultural land uses. These cumulative programs and projects will generally result in beneficial outcomes for Swainson's hawks.

The PP will affect foraging and nesting habitat for Swainson's hawk; however, these habitats represent only 1% and 0.4% of available modeled habitat in the Delta, respectively. Take minimization and mitigation measures will ensure that the loss of habitat will be minimized and fully mitigated, and that injury or death of individuals will be largely avoided. Thus, the PP will not have a cumulatively considerable effect on Swainson's hawk.

4.7.4.2 Climate Change

Changes in precipitation patterns and hydrology of drainages could reduce the amount of Swainson's hawk nesting habitat in the Delta. Changes in water availability could result in changing cropping patterns, which may diminish alfalfa, the Swainson's hawk's primary foraging habitat in the Delta. Changing precipitation may also result in a reduction of rodent prey for Swainson's hawk. Sea level rise may diminish Swainson's hawk foraging habitat through inundation. Audubon's climate model predicts a 43% decrease in the breeding range for Swainson's hawk throughout its United States range by 2080.

4.7.4.3 Potential to Jeopardize the Existence of Species

The issuance of the ITP is not expected to jeopardize the continued existence of Swainson's hawk for the following reasons.

4.7.4.3.1 Level of Take

Injury or mortality of Swainson's hawks will be largely avoided. The PP will result in permanent loss of up to 3,738 acres of modeled foraging habitat and 23 acres of breeding modeled habitat, representing a total impact of up to 3,761 acres, or 0.8% of total modeled habitat in the Delta.

4.7.4.3.2 Take Minimization Measures

The proposed take minimization measures in Section 5.3.7.2 *Take Minimization Measures*, largely avoid the potential for mortality of individuals and minimize effects on the species, which makes it unlikely that the PP will affect reproductive rates of the population or survivorship of individuals.

4.7.4.3.3 Mitigation

Mitigation is expected to fully offset habitat loss because high value foraging habitat and suitable breeding habitat will be managed in perpetuity. Nesting habitat will be restored at a 1:1 ratio and protected at a 1:1 ratio. In addition, to mitigate the temporal loss of up to 9 affected nest sites, mature trees will be transplanted and additional saplings will be planted in association with the transplanted trees. Additionally, trees for nesting will be planted on protected cultivated lands as needed to provide nest trees at a rate of one tree per 10 acres of protected cultivated lands. The establishment and sustainability of Swainson's hawk prey populations will be supported by establishing 20- to 30-foot-wide hedgerows along field borders and roadsides at a minimum rate of 400 linear feet per 100 acres of protected cultivated lands. Removal of occupied nests will be avoided through the implementation of measures described in Section 5.3.7.2 *Take Minimization Measures*, which include preconstruction surveys, establishment of no-disturbance buffers, no removal of occupied nest trees during the breeding season, and biological monitoring.

4.7.4.3.4 Conclusion

The primary threats to the continued survival of Swainson's hawk include habitat loss, conversion, and fragmentation. Agricultural cover types in the Delta that are suitable for Swainson's hawk are increasingly being converted to cover types unsuitable for the species. The proposed mitigation will increase the extent of protected suitable foraging habitats and these protected habitats will be managed and enhanced to maximize their value for Swainson's hawk.

Considering the potential for injury or mortality will be largely avoided and the loss of habitat will be minimized and fully mitigated, the PP will not adversely affect the reproduction and survival of Swainson's hawk, and the issuance of the ITP will not jeopardize the continued existence of the species.

4.7.5 References

California Department of Fish and Game. 1994. Staff report regarding mitigation for impacts to Swainson's hawks (*Buteo swainsoni*) in the Central Valley of California. Sacramento, CA.

California Department of Fish and Wildlife. 2013. California Natural Diversity Database.

California Department of Water Resources, U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, and National Marine Fisheries Service 2013. Draft Bay-Delta Conservation Plan. December.

4.8 Take of the Tricolored Blackbird

Appendix 4.B, *Terrestrial Effects Analysis Methods*, describes the methods and assumptions used to analyze the effects of the PP on wildlife species. Section 2.8.4 *Species Habitat Suitability Model*, provides a description of the suitable habitat model for tricolored blackbird. Section 2.8.5 *Suitable Habitat Definition*, provides a definition of suitable tricolored blackbird habitat.

Activities associated with geotechnical exploration, safe haven work areas, North Delta intake construction, tunneled conveyance facility construction, Clifton Court Forebay modifications, power supply and grid connections, the HOR gate, and RTM storage areas may affect tricolored blackbird, as described below. Figure 4.8-1 provides an overview of the locations of surface impacts relative to tricolored blackbird modeled habitat. An estimated 3,873 acres (less than 1 percent of total modeled habitat in the Delta) of tricolored blackbird modeled habitat will be permanently lost as a result of the PP, including both breeding and nonbreeding habitat. Table 4.8-1 and Table 4.8-2 summarize the total estimated loss of tricolored blackbird modeled habitat.

Table 4.8-1. Maximum Habitat Loss on Modeled Habitat for Tricolored Blackbird by Activity Type (Acres)

Tricolored Blackbird Modeled Habitat	Total Modeled Habitat in the Delta	Permanent Habitat Loss								Temporary Habitat Loss		
		Safe Haven Work Areas (Atmospheric)	North Delta Intakes	Tunneled Conveyance Facilities	Clifton Court Forebay Modifications	Head of Old River Gate	RTM Storage Area	Power Supply and Connection	Total Maximum Habitat Loss	Geotechnical Exploration	Power Supply and Connection	Safe Haven Work Areas (Pressurized)
Foraging Habitat - Breeding	163,012	66	76	267	780	3	870	1	2,063	18	147	134
Foraging Habitat-Nonbreeding	231,026	0	164	173	1	0	1,435	1	1,774	229	148	0
Nesting	1,935	0	0	14	2	0	0	0	16	0	0	0
Roosting	28,096	0	8	4	0	0	8	0	20	0	0	0
Total	**424,069**	**66**	**249**	**458**	**782**	**3**	**2,313**	**2**	**3,873**	**247**	**307**	**134**

Table 4.8-2. Maximum Direct Effects on and Conservation of Modeled Habitat for Tricolored Blackbird

Tricolored Blackbird Modeled Habitat	Permanent Habit Loss	Compensation Ratios		Total Compensation (Acres)	
	Total Maximum Habitat Loss (Acres)	Protection	Restoration	Protection	Restoration
Breeding Habitat – Foraging	2,063	1:1	0	2,063	
Breeding Habitat - Nesting	16	3:1		48	
Nonbreeding Habitat –Foraging	1,774	1:1		1,774	
Nonbreeding Habitat - Roosting	20	2:1		40	
Total	**3,873**			**3,925**	

4.8.1 Effects on the Tricolored Blackbird from the Proposed Project

4.8.1.1 Geotechnical Exploration

4.8.1.1.1 Habitat Loss or Disturbance and Fragmentation

Geotechnical exploration activities will result in the temporary disturbance of up to 247 acres of tricolored blackbird habitat (<0.1 percent of modeled habitat in the Delta), including up to 18 acres of breeding season foraging habitat and 159 acres of non-breeding season foraging habitat. Geotechnical activities will avoid nesting and roosting habitat. The only permanent effects will be the bore holes, which will be grouted upon completion. Bore holes are very small (approximately 8 inches in diameter) and will have no or negligible effects on tricolored blackbird modeled foraging habitat. Most of the temporary impact will consist of driving overland to access the boring sites, and storing equipment at the boring sites for short time periods (2 to 21 days). Temporary disturbances where vegetation is removed will be restored to pre-project conditions using suitable vegetation as needed agreed upon in writing by CDFW as described in Section 5.3.8.2.2 *Activities with Flexible Locations,* although vegetation removal is not expected to occur as a result of overland travel on grasslands or agricultural areas.

4.8.1.1.2 Construction Related Effects

Without the avoidance and minimization measures, operation of geotechnical exploration equipment during the breeding season could result in mortality of tricolored blackbird eggs or nestlings, which are susceptible to land-clearing activities, parent nest abandonment, or increased exposure to the elements or to predators. Geotechnical exploration, however, will avoid nesting and roosting habitat, as described in Section 5.3.8.2.2 *Activities with Flexible Locations.* Furthermore, the take minimization measures described in Section 5.3.8 *Tricolored Blackbird,* including preconstruction surveys, establishment of no-disturbance buffers, and biological monitoring, will be used to avoid disturbance of breeding tricolored blackbirds, if present in the vicinity of geotechnical activities. Due to the relatively small extent of individual borings and short duration of the activity, and the implementation of take minimization measures, effects on tricolored blackbirds from geotechnical exploration will be minimal. With implementation of the measures described in Section 5.3.8.2 *Take Minimization Measures*, geotechnical boring activities are not expected result in take of tricolored blackbird.

4.8.1.1.3 Operations and Maintenance

There will be no operations and maintenance associated with geotechnical activities.

4.8.1.2 Safe Haven Work Areas

4.8.1.2.1 Habitat Loss and Fragmentation

Construction of atmospheric (emergency access) safe haven shafts will result in the permanent loss of an estimated 66 acres of foraging habitat, based on 22 atmospheric access shafts at three acres each. Emergency access shafts will avoid nesting habitat. Habitat loss from emergency shafts is considered permanent because they will likely be used longer than one year.

Construction of pressurized safe haven shafts will result in the temporary disturbance of an estimated 134 acres, based on 134 safe haven shafts at one acre each. Habitat disturbance from pressurized safe haven shafts is considered temporary because they will be used for less than a year, and disturbed areas will be returned to pre-project conditions within a year of disturbance.

Once surface drilling and treatment operations are completed at each safe haven work area (8 weeks to 24 months), all equipment will be removed and the surface features reestablished.

4.8.1.2.2 Construction Related Effects

The surface drilling and treatment operation will take from 8 weeks to 24 months. Construction related actions are not expected to injure or kill tricolored blackbird individuals with the implementation of Section 5.3.8.2 *Take Minimization Measures,* which requires that no activity take place within 300 to 1,300 feet of an active nesting colony during the breeding season. With implementation of these measures, construction activities are not expected result in take of tricolored blackbird.

4.8.1.2.3 Operations and Maintenance

There will be no operations and maintenance associated with safe haven work areas.

4.8.1.3 North Delta Diversion Construction

4.8.1.3.1 Habitat Loss and Fragmentation

NDD construction will result in the permanent loss of an estimated 249 acres of tricolored blackbird habitat (<0.1 percent of modeled habitat in the Delta), including 76 acres of breeding season foraging habitat, 164 acres of nonbreeding season foraging habitat, and eight acres of roosting habitat. No nesting habitat will be affected by NDD construction. Figures 4.8-2, 4.8-3, and 4.8-4 show where habitat will be lost as a result of NDD construction.

4.8.1.3.2 Construction Related Effects

Construction activities at each intake will include ground clearing and grading, in-water construction of sheet pile walls, in-water pile driving, excavation, and drilling. These activities will require the use of loud, heavy equipment within the construction site as well as along the access roads to the site. Pile driving will create noise and vibration effects. The duration of the effect will be approximately five years as each intake will take approximately five years to construct. Intake 3, the middle intake, will begin construction first; approximately six months later, construction will begin at intake 5, the southernmost intake. Construction at intake 2, the northernmost intake, will begin approximately one year after having begun at intake 5. Construction will overlap at all three sites for approximately four years.

Noise is the construction-related effect with potential to reach furthest from the project footprint. The standard noise disturbance threshold for avian species is 60 dBA (Dooling and Popper 2007). The combined use of the six loudest pieces of construction equipment with concurrent pile driving will be no louder than 60 dBA at 2,000 feet from the edge of the project footprint. Construction related effects on tricolored blackbird will be avoided by establishing 300 to 1,300-foot setbacks between intake construction and nesting tricolored blackbird colonies during the breeding season, if colonies are present at the time of site clearing for construction. Although some residual noise may exist within 2,000 feet of the construction equipment, these are not expected to result in take. These buffers will be consistent with CDFW standards, as described in Section 5.3.8 *Tricolored Blackbird.* There are, however, no records of tricolored blackbird colonies in the vicinity of the proposed north Delta intake sites other than a historic record at Stone Lakes National Wildlife Refuge (CNDDB occurrence #480; this historic 1989 record is not shown on Figure 4.8-1). With implementation of the measures described in Section 5.3.8.2 *Take Minimization Measures*, construction activities are not expected result in take of tricolored blackbird.

4.8.1.3.3 Operations and Maintenance

Periodic maintenance activities at the intakes include intake dewatering, sediment removal, debris removal, and biofouling and corrosion removal. These activities will be performed using water-based equipment approximately annually. Noise and lighting effects from maintenance activities and permanent facility lighting are not expected to adversely affect tricolored blackbird if they use habitat in the vicinity, with the establishment of setbacks from active colonies during the breeding season as described in Section 5.3.8.2 *Take Minimization Measures.* As stated above, no records of tricolored blackbird colonies in the vicinity of the NDD sites.

4.8.1.4 Tunneled Conveyance Facilities

4.8.1.4.1 Habitat Loss and Fragmentation

Water conveyance facility construction will result in the permanent removal of 458 acres of tricolored blackbird modeled habitat (<0.1 percent of modeled habitat within the Delta), including 267 acres of breeding season foraging habitat, 167 acres of nonbreeding season foraging habitat, 4 acres of roosting habitat, and 14 acres of nesting habitat (Tables 4.8-1 and 4.8-2).

4.8.1.4.2 Construction Related Effects

Operation of construction equipment could result in injury or mortality of tricolored blackbirds. Without avoidance measures, risk would be greatest to eggs and nestlings susceptible to land clearing activities, nest abandonment, or increased exposure to the elements or to predators. Injury to adults and fledged juveniles is less likely as these individuals are mobile and have the ability to avoid contact with construction equipment. Injury or mortality will be avoided through planning and preconstruction surveys, and avoidance of active nesting colonies during the breeding season as described in Section 5.3.8.2 *Take Minimization Measures*. With implementation of these measures, construction activities are not expected result in take of tricolored blackbird.

4.8.1.4.3 Operations and Maintenance

Operations and maintenance of the conveyance facilities, such as ground disturbance to control nonnative vegetation, could result in local adverse habitat effects, injury or mortality of tricolored blackbird, and temporary noise and disturbance effects, if habitat or individuals are present in work sites during the activity. These effects will be avoided with implementation of the measures described in Section 5.3.8.2 *Take Minimization Measures*.

4.8.1.5 Clifton Court Forebay Modification

4.8.1.5.1 Habitat Loss and Fragmentation

Clifton Court Forebay (CCF) Modification includes dredging, the expansion of the forebay through the creation of a new embankment, and the creation of a new canal and siphon. These changes will result in the permanent loss of 782 acres of tricolored blackbird habitat (<0.1 percent of modeled habitat within the Delta), including 780 acres of breeding season foraging habitat, 1 acre of nonbreeding season foraging habitat, and 2 acres of nesting habitat (Figures 4.8-28 and 4.8-29). There are no records of a nesting colony at the location where the two acres of nesting habitat will be removed: the nearest recorded breeding occurrence is approximately 2.5 miles.

4.8.1.5.2 Construction Related Effects

Construction activities at Clifton Court Forebay include pile driving, excavation, dredging, and cofferdam and embankment construction. Construction at Clifton Court Forebay will be phased by location and the duration of construction will be approximately six years. The duration of dredging is expected to be approximately four years. For complete details on construction activities and phasing, see Section 3.2.5 *Clifton Court Forebay*; for more details on schedule, see Appendix 3.D *Construction Schedule for the Proposed Project*.

Construction activities are not expected to injure or kill tricolored blackbirds. If a bird were to forage in a region where construction, dredging, or drilling activities were occurring, the bird would be expected to avoid the equipment. Injury or mortality of eggs, nestlings, or fledglings will be avoided through planning and preconstruction surveys, and avoidance of active nesting colonies during the breeding season as described in Section 5.3.8.2 *Take Minimization Measures*. Noise generated by the combined use of the six loudest pieces of construction equipment and pile driving will be no more than 60 dBA at 2,000 feet from the edge of CCF: a 300 to 1,300-foot buffer will be established between these activities and active colonies during the breeding season, as described in Section 5.3.8 *Tricolored Blackbird*. With implementation of these measures, construction activities are not expected result in take of tricolored blackbird.

4.8.1.5.3 Operations and Maintenance

The operational components of the modified Clifton Court Forebay include the control structures and the siphons. Maintenance activities at forebay and the canals will include erosion control, control of vegetation and rodents, embankment repairs, and monitoring of seepage flows. Maintenance at control structures will include repair or replacement of roller gates, radial gates, and stop logs. Maintenance at the spillway will include removal and disposal of any debris blocking the outlet culverts. Dredging is not expected to be needed, since the forebay is designed to hold 50 years of sediment.

Operations and maintenance are not expected to injure or kill tricolored blackbirds with implementation of the measures described in Section 5.3.8.2 *Take Minimization Measures.* Because these activities generate small levels of noise, any potential effect on tricolored blackbird would be insignificant and undetectable. Therefore, no noise related effects on tricolored blackbird are anticipated from the operations and maintenance associated with Clifton Court Forebay.

4.8.1.6 Power Supply and Grid Connections

4.8.1.6.1 Habitat Loss or Disturbance and Fragmentation

Assuming a 50-foot wide disturbance area along the transmission line corridor for pole and tower placement, access roads, and ongoing operations and maintenance, up to 295 acres of modeled tricolored blackbird habitat (>0.01 percent of modeled tricolored blackbird habitat in the project area) will be temporarily disturbed for the power supply and grid connections. This includes 147 acres of breeding season foraging habitat and 148 acres of nonbreeding season habitat. Roosting and nesting habitat will be avoided as described in Section 5.3.8.2.2 *Activities with Flexible Locations.* Most of the disturbance will consist of construction-related work areas and will be limited to the duration of construction, which is not expected to be longer than one year in any one location. Temporary disturbances will be restored to pre-project conditions using suitable vegetation agreed upon in writing by CDFW as described in Section 5.3.8.2.2 *Activities with Flexible Locations.* Ongoing vegetation management around the poles and under the lines is not expected to affect tricolored blackbird foraging habitat because grassland and/or cropland areas seldom if ever need to be cleared to maintain transmission line corridors. Up to one acre of breeding season foraging habitat and one acre of nonbreeding season foraging habitat loss may result from access road construction and pole and tower placement. The actual amount of impacted habitat will be determined during preconstruction surveys as detailed in the take minimization measures for tricolored blackbird in Section 5.3.8.1 *Suitable Habitat Definition.*

4.8.1.6.2 Construction Related Effects

Construction related actions are not expected to injure or kill tricolored blackbirds. If a bird were to forage in a region where transmission line construction was occurring, the bird would be expected to avoid the equipment and the construction area. Injury or mortality of eggs, nestlings, or fledglings, as well as disturbance resulting from noise or lighting, will be avoided through surveys and setbacks from active nests as described in Section 5.3.8.2 *Take Minimization Measures*. With implementation of these measures, construction activities are not expected result in take of tricolored blackbird.

4.8.1.6.3 Operations and Maintenance

The temporary transmission lines will be in place for the duration of conveyance facility construction (approximately ten years); the permanent transmission lines will remain to supply power to the pumping plant. Maintenance activities at the transmission lines will include vegetation management and overland travel for some emergency repairs. Maintenance of vegetation is not expected to affect foraging habitat because clearing is seldom if ever required in grasslands and agricultural lands. Therefore, operations and maintenance activities for transmission lines will not result in any additional adverse effects on the species.

4.8.1.7 Head of Old River Gate

4.8.1.7.1 Habitat Loss and Fragmentation

The construction of the HOR gate will result in the permanent loss of 3 acres (<0.1 percent of modeled breeding season foraging habitat in the Delta) of modeled tricolored blackbird breeding season foraging habitat (Figure 4.8-33).

4.8.1.7.2 Construction Related Effects

HOR gate construction will include approximately 15 days of dredging along 500 feet of channel to prepare it for gate construction (Section 3.2.10.8 *Dredging and Riprap Placement*). Dredging equipment will be operated from a barge in the channel. Construction of a cofferdam and foundation for the HOR gate will require in-water pile driving and will last up to 32 months (Section 3.2.10.11 *Pile Driving*). The installation of the cofferdam will require up to 700 strikes per pile over an estimated 40-day period. The installment of the foundation for the operable barrier will require 15 piles to be set per day with up to 1,050 strikes per pile over an estimated 7-day period.

Construction is not expected to injure or kill tricolored blackbirds with implementation of the measures described in Section 5.3.8.2 *Take Minimization Measures.* Noise is the construction-related effect with potential to reach furthest from the project footprint. The standard noise disturbance threshold for avian species is 60 dBA (Dooling and Popper 2007). The combined use of the six loudest pieces of construction equipment and pile driving will be no louder than 60 dBA at 2,000 feet from the edge of the project footprint. With implementation of the measures described in Section 5.3.8.2 *Take Minimization Measures*, construction activities are not expected result in take of tricolored blackbird.

4.8.1.7.3 Operations and Maintenance

The HOR gate will replace the temporary rock barrier that is typically installed at the same location. Because the HOR gate is replacing an existing temporary barrier, no adverse effects to potentially suitable habitat from hydrological changes are expected.

Maintenance dredging around the HOR gate will occur to clear out sediment deposits. Depending on the rate of sedimentation, maintenance will occur every 3 to 5 years. Noise generated by this activity will not exceed 60 dBA (standard noise disturbance threshold for avian species; Dooley and Popper 2007) at 1,200 feet (See Section 3.3 *Operations and Maintenance of New and Existing Facilities* for further detail).

Operations and maintenance related actions are not expected to injure or kill tricolored blackbird individuals with implementation of the measures described in Section 5.3.8.2 *Take Minimization Measures*. Noise, light, or vibration effects on tricolored blackbird modeled habitat in the vicinity of the HOR gate construction footprint, if any, are expected to be insignificant because the species is very unlikely to occur at this location: the nearest known nesting colony is approximately two miles from the site. With implementation of the measures described in Section 5.3.8.2 *Take Minimization Measures*, operations and maintenance activities are not expected to result in take of tricolored blackbird.

4.8.1.8 Reusable Tunnel Material

4.8.1.8.1 Habitat Loss and Fragmentation

RTM placement will result in loss of an estimated 2,313 acres of modeled tricolored blackbird habitat (<0.1 percent of modeled habitat in the Delta), including 870 acres of breeding season foraging habitat, 1,435 acres of nonbreeding season foraging habitat, and eight acres of roosting habitat.

4.8.1.8.2 Construction Related Effects

Each RTM storage area will take five to eight years to construct and fill. RTM storage area construction and placement will occur almost continuously through tunnel excavation, approximately 10 years. Construction activities at each RTM storage area will include the use of heavy equipment for ground clearing and grading and soil tilling and rotation. Material will be moved to the site using a conveyor belt and on-site, long-term storage is assumed. The movement of the material to another site is not an activity covered in the assessment. For more details about the activities associated with RTM placement see Section 3.2.10.6 *Dispose Soils*.

Operation of equipment during the breeding season could result in mortality of tricolored blackbird eggs or nestlings, which are susceptible to land-clearing activities, parent nest abandonment, or increased exposure to the elements or to predators. RTM placement will avoid active tricolored blackbird nesting colonies and associated habitat during the breeding season (generally March 15–July 31). The take minimization measures described in Section 5.3.8.2 *Take Minimization Measures,* including preconstruction surveys, establishment of no-disturbance buffers, and biological monitoring, will be used to avoid disturbance of breeding or roosting tricolored blackbirds, if present. With implementation of the measures described in Section

5.3.8.2 *Take Minimization Measures*, construction activities are not expected result in take of tricolored blackbird.

4.8.1.8.3 Operations and Maintenance

There are no operations and maintenance activities associated with the RTM storage areas and therefore no effects on tricolored blackbird.

4.8.2 Take Analysis

The operation of construction equipment could result in mortality of tricolored blackbird eggs or nestlings, which are susceptible to vegetation-clearing activities, parent nest abandonment, or increased exposure to the elements or to predators. Mortality of adults is not expected to occur because they are mobile and are able to flee from construction equipment. Noise and visual disturbances associated with construction could temporarily displace tricolored blackbird, temporarily reduce the use of suitable habitat adjacent to construction areas, and/or result in abandonment of an active nest. These outcomes will be avoided through the measures described in Section 5.3.8.2 *Take Minimization Measures*.

4.8.3 Analysis of Impact in the Project Area

Tricolored blackbird is a colonial nesting passerine that is largely restricted to California. More than 95 percent of the California breeding population of tricolored blackbirds occurs in the Central Valley (Kyle and Kelsey 2011), many of which are breeding in milo and grain fields. Breeding also occurs in the foothills of the Sierra Nevada south to Kern County, the coastal slopes from Sonoma County to the Mexican border, and sporadically in the Modoc Plateau. A relatively small portion of the species' total range falls within the Delta. While the overall range of the tricolored blackbird is largely unchanged since the 1930s (Neff 1937; DeHaven et al. 1975; Beedy et al. 1991; Hamilton 1998), large gaps now exist in the species' former range. Surveys during the 1990s (Hamilton et al. 1995; Beedy and Hamilton 1997; Hamilton 2000) indicated a significant declining trend in California populations since the 1930s. Recent surveys suggest the rate of decline in the number of tricolor blackbirds increased through the 2000s. From 2008 to 2011 the number of tricolors dropped by 34 percent, from 395,000 to 258,000 birds (Kyle and Kelsey 2011); from 2011 to 2014 the number of tricolors dropped by 44 percent, from 258,000 to 145,000 birds (Meese 2014). Although there are few reported historical nesting records of tricolored blackbirds nesting in the vicinity of the project (Neff 1937; Beedy et al. 1991; California Department of Fish and Wildlife 2013), more recent surveys have documented occasional nesting colonies along the fringe of Suisun Marsh, in the Yolo Bypass, and along the southwestern perimeter of the project area, (Meese 2014.). While breeding colonies are uncommon, the Delta is recognized as a major wintering area for the species (Hamilton 2004, Beedy 2008).

The Delta supports 424,069 acres of modeled habitat for the tricolored blackbird. The PP will permanently affect an estimated 3,813 acres (<0.1 percent of total modeled habitat in Delta) of tricolored blackbird modeled habitat, including 3,777 acres of foraging habitat (>.01 percent of foraging habitat in the Delta), 20 acres of roosting habitat (>.01 percent of roosting habitat in the Delta, and 16 acres of nesting habitat (>.01 percent of nesting habitat in the Delta). Some habitat may also be lost as a result of habitat restoration, but take for this activity will not be authorized under this 2081. There are no recorded occurrence of tricolored blackbird nesting colonies in or near the nesting habitat that will be removed.

Without avoidance measures, the operation of construction equipment could result in mortality of tricolored blackbird eggs or nestlings, which are susceptible to site clearing, parent nest abandonment, or increased exposure to the elements or to predators. Mortality of adults and fledged juveniles is not expected because they are mobile and are able to evade construction equipment. The risk of mortality will be minimized through planning and preconstruction surveys and construction activities under the proposed project will be avoided within 300 to 1,300 feet of an active nesting colony as described in Section 5.3.8.2 *Take Minimization Measures*.

Overall the impacts of the Proposed Project on tricolored blackbird will not be substantial when considering the relative amount of habitat affected in the Delta, and when considering the take minimization measures presented in Section 5.3.8.2 *Take Minimization Measures*, which will avoid injury or mortality and minimize disturbances to the species. Furthermore, the proposed mitigation presented Section 5.4.8.1 *Compensation for Effects*, which includes the protection of up to 2,004 acres of breeding season foraging habitat and another 1,773 acres of non-breeding season foraging habitat, plus protection of 20 to 40 acres of roosting habitat (depending on whether the habitat is occupied) and protection or restoration of 48 acres of nesting habitat, will fully mitigate the loss of modeled habitat. Mitigation will be implemented prior to or concurrent with the impact.

4.8.4 Analysis of Potential for Jeopardy

4.8.4.1 Cumulative Effects

The projects and programs that have been considered as part of the cumulative effects analysis have been drawn primarily from Appendix 4.C *Information to Support Cumulative Effects Analysis.* The list of past, present and reasonably foreseeable future projects and programs has been evaluated to determine which of these activities may affect tricolored blackbird. Most of the local, state and federal land use and land management programs that are affecting or will affect the Delta are designed to preserve open space and agricultural lands, and to manage the resources of the area for multiple uses, including agriculture, recreation, fish and wildlife habitat, flood protection and water management. This list includes several programs that will be beneficial to tricolored blackbird, which include the Yolo Natural Heritage Program Plan, Yolo Bypass Wildlife Area Land Management Plan, Solano County Multispecies Habitat Conservation Plan, Stone Lakes National Wildlife Refuge Comprehensive Conservation Plan, South Sacramento Habitat Conservation Plan, San Joaquin County Multi-Species Habitat Conservation and Open Space Plan, and California EcoRestore. On the upland fringes of the Delta, plans exist for small expansions of urban development that would remove primarily agricultural land uses. In the main, however, these cumulative programs and projects will result in beneficial outcomes for tricolored blackbirds.

The covered activities' impacts on tricolored blackbird habitat will affect suitable breeding and non-breeding habitat; however, these habitats comprise less than 0.1 percent of the available modeled habitat in the Delta. Take minimization and mitigation measures will ensure that the loss of habitat will be minimized and fully mitigated. Thus, the covered activities' cumulative effect on tricolored blackbird will not be cumulatively considerable.

4.8.4.2 Potential to Jeopardize the Existence of the Species

The issuance of the ITP is not expected to jeopardize the continued existence of tricolored blackbird for the following reasons.

Level of Take – The overall potential for take of individuals is low in consideration of the take minimization measures that will be implemented. Covered activities will result in permanent impacts on up to 2,004 acres of breeding season foraging habitat, 1,773 acres of nonbreeding season foraging habitat, 20 acres of roosting habitat, and 16 acres of nesting habitat. This represents a very small proportion of the habitat in the Delta, and the Delta is a small proportion of the species' statewide range.

Take Minimization Measures – The proposed take minimization measures in Section 5.3.8.2 *Take Minimization Measures*, greatly reduce the potential for mortality of individuals, which makes it unlikely that covered activities will affect reproductive rates of the population or survivorship of individuals.

Mitigation – Mitigation is expected to fully offset habitat loss and any loss of individuals because high value foraging habitat and suitable breeding habitat will be managed in perpetuity within the project area. Foraging habitat will be protected at a 1:1 ratio, nesting habitat will be restored and protected at a ratio of 3:1, and roosting habitat will be protected or restored at a 1:1 to 2:1 ratio (depending on whether it is occupied). Take of active nest colonies will be avoided through the implementation of measures described in Section 5.3.8.2 *Take Minimization Measures*, which include preconstruction surveys and establishment of no-disturbance buffers.

The primary threats to the continued survival of tricolored blackbird include habitat loss, conversion, and fragmentation. The proposed mitigation will increase the extent of protected suitable breeding and non-breeding habitats and these protected habitats will be managed and enhanced to maximize their value for tricolored blackbird.

Considering the potential for take will be avoided and minimized and that the loss of habitat will be fully mitigated, the covered activities will not adversely affect the reproduction and survival of tricolored blackbird, and the issuance of the ITP will not jeopardize the continued existence of the species.

4.8.5 References

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4.9 Take of Mason's Lilaeopsis

Appendix 4.B *Terrestrial Effects Analysis Methods* describes the methods and assumptions used to analyze the effects of the covered activity on plant and wildlife species. Section 2.9.5 *Suitable Habitat Definition* provides a definition of suitable Mason's lilaeopsis habitat.

Activities associated with tunneled conveyance facility construction may affect Mason's lilaeopsis as described below. Figure 4.9-1 provides an overview of the locations of surface impacts relative to Mason's lilaeopsis habitat, and Figures 4.9-2 through 4.9-10 show the locations of areas surveyed and suitable habitat within the project area. An estimated 800 linear feet of Mason's lilaeopsis habitat will be permanently lost as a result of the covered activities. Table 4.9-2 summarizes the total estimated loss of Mason's lilaeopsis habitat.

Table 4.9-1. Loss of Suitable Habitat for Mason's Lilaeopsis by Activity Type (Linear Feet)

Mason's Lilaeopsis Modeled Habitat	Permanent Habitat Loss (Linear Feet)								Temporary Habitat Loss	
	Safe Haven Work Areas	North Delta Intakes	Tunneled Conveyance Facilities	Clifton Court Forebay Modifications	Head of Old River Gate	Reusable Tunnel Material	Restoration	Total Maximum Habitat Loss	Geotechnical Exploration	Power Supply and Connection
Mason's Lilaeopsis Habitat	0	0	800[a]	0	0	0	0	800	0	0

[a]Up to 10 of these 800 feet may be occupied (although this species was not present during project surveys, small numbers of the plant could potentially establish in the impact area prior to the impact.

Table 4.9-2. Direct Effects on and Conservation of Mason's Lilaeopsis Suitable Habitat and Occurrences

Mason's Lilaeopsis Modeled Habitat	Permanent Habit Loss	Compensation Ratios	Total Compensation (Linear Feet)
	Total Maximum Habitat Loss (Linear Feet)	Restoration	Restoration
Mason's lilaeopsis habitat	800	1:1	800
Mason's lilaeopsis occurrences	1 occurrence (or portions of several occurrences, not to exceed 10 linear feet, all occurring within the 800 linear feet of habitat impact.	3:1	30 linear feet, all occurring within the 800 linear feet of habitat compensation

4.9.1 Effect on Mason's Lilaeopsis from the Proposed Project

4.9.1.1 Geotechnical Exploration

Geotechnical exploration is not expected to be needed in Mason's lilaeopsis suitable habitat, therefore this activity is not expected to affect Mason's lilaeopsis.

4.9.1.2 Safe Haven Work Areas

Safe haven work area are not expected to be needed in Mason's lilaeopsis suitable habitat, therefore this activity is not expected to affect Mason's lilaeopsis.

4.9.1.3 North Delta Diversion Construction

NDD construction is not expected to affect any Mason's lilaeopsis suitable habitat, therefore this activity is not expected to affect Mason's lilaeopsis

4.9.1.4 Tunneled Conveyance Facilities

4.9.1.4.1 Habitat Loss and Fragmentation

Water conveyance facility construction has potential to cause the permanent loss of 300 feet of suitable habitat for Mason's lilaeopsis at the barge landing site at Bacon Island and 500 feet of suitable habitat at the barge landing site at Victoria Island. There are no known, extant occurrences of Mason's lilaeopsis that overlap with the conveyance facility construction footprint.

4.9.1.4.2 Construction Related Effects

Erosion and sedimentation due to ground disturbing activities during construction may potentially affect Mason's lilaeopsis suitable habitat. AMM4, *Erosion and Sedimentation Plan*, will minimize impacts on sensitive terrestrial and aquatic habitats due to construction related effects. Also, when possible, construction activities will be conducted on the landside of the levee away from Mason's lilaeopsis habitat.

Ground disturbances could also introduce propagules of nonnative invasive plant species or cause existing populations of nonnative invasive plant species to expand, potentially reducing habitat suitability for Mason's lilaeopsis. Adverse effects caused by nonnative plant introduction will be minimized with implementation of take minimization measures in Section 5.3.9 *Mason's Lilaeopsis*, which include identifying areas of invasive plants prior to ground disturbance adjacent to suitable habitat and targeting those areas for invasive species control or eradication. .

4.9.1.4.3 Operations and Maintenance

Effects to Mason's lilaeopsis suitable habitat impacted by construction of the facility described above are considered permanent and no additional effects are expected due to operations and maintenance activities that occur at these sites. Therefore operation and maintenance activities are not expected to have additional effects on Mason's lilaeopsis.

4.9.1.5 Clifton Court Forebay Modification

Clifton Court forebay modification is not expected to be needed in Mason's lilaeopsis suitable habitat, therefore this activity is not expected to affect Mason's lilaeopsis.

4.9.1.6 Power Supply and Grid Connections

Assuming a 50-foot-wide permanent disturbance area along the transmission line corridor for pole and tower placement, access roads, and ongoing operations and maintenance, it is expected that no occurrences of Mason's lilaeopsis will be affected because transmission lines will likely span tidal wetland areas, with no on-ground facilities sited in such areas. However, the potential to affect occurrences will be determined during preconstruction surveys. AMM 30 *Transmission Line Design and Alignment Guidelines* (Appendix 3.F *General Avoidance and Minimization Measures*), will minimize impacts on sensitive terrestrial and aquatic habitats when siting poles and towers. Additionally, as described in Section 5.3.9.2 *Project Activities with Uncertain Locations*, transmission line construction will fully avoid Mason's lilaeopsis habitat. Therefore this activity is not expected to affect Mason's lilaeopsis.

4.9.1.7 Head of Old River Gate

Head of Old River gate activities are not expected in any areas of Mason's lilaeopsis suitable habitat, therefore this activity is not expected to affect Mason's lilaeopsis.

4.9.1.8 Reusable Tunnel Material

Reusable tunnel material is not expected to be placed in Mason's lilaeopsis suitable habitat, therefore this activity is not expected to affect Mason's lilaeopsis.

4.9.2 Take Analysis

The operation of construction equipment could result in take of Mason's lilaeopsis plants by crushing individuals or disturbing the soil near occurrences. Construction activities could also result in growth inhibition, life cycle changes, and loss of Mason's lilaeopsis plants from sedimentation or erosion. A total of 800 feet of suitable habitat is expected to be impacted. Take will be minimized through the mitigation measures described in Section 5.3.9 *Mason's Lilaeopsis*, which include conducting preconstruction surveys, installation of silt fences between work areas and plants, and implementing measures to avoid and minimize the introduction of invasive species.

4.9.3 Analysis of Impacts in the Project Area

Mason's lilaeopsis is endemic to California, with all range-wide occurrences entirely within the state. Currently, there are 197 presumed extant occurrences of Mason's lilaeopsis (California Department of Fish and Wildlife 2013; Delta Habitat Conservation and Conveyance Program 2011). Of these occurrences, 160 (81 percent) are located in the legal Delta. Fifty-three occurrences in the legal Delta (29 percent) are located partly or entirely on existing conservation lands.

A total of 800 linear feet of suitable habitat loss will occur, with a loss of no more than one occurrence occupying up to 10 linear feet of habitat. Preconstruction surveys, construction monitoring, and other measures will be implemented to minimize loss of this plant during construction, as described in Section 5.3.9 *Mason's Lilaeopsis*.

Overall the impacts on Mason's lilaeopsis will not be substantial when considering the small amount of habitat affected in the project area and the lack of known occurrences affected (although the take analysis assumes one occurrence occupying up to ten linear feet may be affected, if plants become established in the project area), and when considering the take minimization measures that are presented in Section 5.3.9 *Mason's Lilaeopsis*. Furthermore, the proposed mitigation presented in Section 5.4.0.3.1 *Tidal Wetland Restoration*, which includes the restoration of 800 linear feet of habitat as a component of the tidal restoration, will fully mitigate the loss of habitat. An additional 30 linear feet of habitat will be restored to mitigate for loss of up to 10 linear feet of occupied habitat, and DWR will attempt to transplant plants from the impact area into the restored habitat. Mitigation will be implemented prior to or concurrent with the impact.

4.9.4 Analysis of Potential for Jeopardy

Mason's lilaeopsis' ability to survive and reproduce is based on the availability of suitable tidal emergent wetland and mudflat habitat. Information on population trends and known threats are presented in Chapter 2, and cumulative effects and jeopardy analyses in light of these factors are provided below.

4.9.4.1 Cumulative Effects

The projects and programs that have been considered as part of the cumulative analysis have been drawn primarily from Appendix 4.C, *Information to Support Cumulative Effects Analysis.* Those projects and programs that could impact terrestrial resources in the project area are presented in Appendix 4.B *Terrestrial Methods*. The list of past, present and reasonably foreseeable future projects and programs has been evaluated to determine which of these activities may have effects on Mason lilaeopsis. Most of the local, state and federal land use and land management programs that are affecting or will affect the Delta are designed to preserve open space and agricultural lands, and to manage the resources of the area for multiple uses, including agriculture, recreation, fish and wildlife habitat, flood protection and water management. This list includes several programs that will be beneficial to Mason's lilaeopsis, which includes the Yolo Natural Heritage Program Plan, Yolo Bypass Wildlife Area Land Management Plan, Solano County Multispecies Habitat Conservation Plan, Stone Lakes National Wildlife Refuge Comprehensive Conservation Plan, South Sacramento Habitat Conservation Plan, San Joaquin County Multi-Species Habitat Conservation and Open Space Plan, and California EcoRestore.

The project activities' impacts on Mason's lilaeopsis will be relatively minimal and the take minimization and mitigation measures will ensure that the loss of habitat and effects on the species are fully mitigated. The project activities' cumulative effect on Mason's lilaeopsis will not be cumulatively considerable.

4.9.4.2 Potential to Jeopardize the Existence of the Species

The issuance of a rare plant permit is not expected to jeopardize the continued existence of Mason's lilaeopsis for the following reasons.

Level of Take – The overall take of Mason's lilaeopsis is minimal when considering that no more than one occurrence will be affected in the project area, if any. Covered activities will potentially result in permanent impacts on up to 800 linear feet of suitable habitat.

Take Minimization Measures – The proposed take minimization measures in Section 5.3.9 *Mason's Lilaeopsis* greatly reduce the potential for mortality of individuals, which makes it unlikely that activities will affect populations or survivorship of individuals.

Mitigation – Mitigation is expected to fully offset habitat loss and any loss of individuals. Restoration will occur at 1:1 for loss of suitable habitat and an additional 3:1 for loss of up to ten linear feet of occupied habitat. DWR will attempt to transplant Mason's lilaeopsis plants from the impact area to the restored habitat. Restoration will be based on the amount of linear feet of suitable or occupied habitat impacted, which will be determined in preconstruction surveys conducted as one of the measures identified in Section 5.3.9 *Mason's Lilaeopsis.* The current estimate is 800 linear feet of habitat affected. Restored habitat is expected to be of very high value primarily because of the topographic improvements that will be made in restored areas and the proximity of restored habitat to existing occurrences that will be necessary to provide vegetative propagules and seed for colonization. All restored Mason's lilaeopsis habitat is expected to provide for the expansion of existing occurrences as well as the colonization of new ones. Restored habitat will be monitored annually to determine whether or not occurrences naturally colonize and establish.

Mason's lilaeopsis populations are considered to be stable to declining. The Proposed Project will not alter this status and is not expected to result in significant losses of individuals of the species or its habitat. The take minimization measures will ensure impacts on habitat and individuals are minimized, and the mitigation will help ensure occupied habitat is protected.

The primary threats to survival of the Mason's lilaeopsis include habitat loss, conversion, and fragmentation, as well as the introduction of nonnative species. The covered activities will not threaten the survival of the Mason's lilaeopsis because the activities will not result in significant losses of individuals of the species or habitat. Take minimization measures will also reduce the threat of the introduction of nonnative species.

Considering the level of take in light of the proposed take minimization and mitigation measures, the implementation of the take minimization measures, and that the loss of habitat will be fully mitigated, the covered activities will not adversely affect the reproduction and survival of Mason's lilaeopsis, and the issuance of a rare plant permit will not jeopardize the continued existence of the species.

4.9.1 References

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