Appendix C – Construction Equipment List

This page intentionally left blank

NVRRWP Construction Phasing and Equipment List for Air Quality Modeling

Alternative 1 (Combined) - Preliminary - Facilities Planning

July 7, 2014

Construction of Weir Structure

Phase	Working Days[1]	Equipment Type	Quantity of Equipment	Hours per Day
Site Prep	20	Graders	1	8
		Tractors/Loaders/Backhoes	1	8
Excavation	40	Concrete/Industrial Saws	1	8
		Rubber Tired Dozers	1	1
		Tractors/Loaders/Backhoes	2	6
		Excavators	1	2
		Bore/Drill Rigs	1	6
Construction	50	Cranes	1	4
		Forklifts	2	6
		Tractors/Loaders/Backhoes	2	8
		Air Compressor	1	1
		Pumps	1	2
Paving	10	Cement and Mortar Mixers	4	6
		Pavers	1	7
		Rollers	1	7
		Tractors/Loaders/Backhoes	1	7
	Daily Mileage	**Trips per Day[2]**		
Hauling Trips (see Material Movement-Weir Tab)	30	1		
Daily Worker Trips (1 crew trucks for PM, 1 inspection/testing trucks, 2 crew trucks for construction)	20	8		

1. Assumes the structure takes 6 months to finish
2. Hauling trips assumes phased soil import and export. If not phased, see soil movement tab for total round trips.

Construction of Pipeline - Trenched East and West of River

Phase	Working Days[1]	Equipment Type	Quantity of Equipment	Hours per Day
Site Prep	19	Rubber Tired Dozers	1	8
		Scrapers	1	8
		Signal Boards	5	8
Trenching	73	Excavators	1	8
		Graders	1	8
		Rubber Tired Dozers	1	8
		Scapers	2	8
		Signal Boards	5	8
		Tractors/Loaders/Backhoes	2	8
Pipeline	48	Graders	1	8
		Scrapers	2	8
		Signal Boards	5	8
		Trenchers	1	8
		Tractors/Loaders/Backhoes	2	8
Backfill and Paving	28	Rollers	1	8
		Signal Boards	5	8
		Cement Truck	1	8
		Asphalt Truck	1	8
		Tractors/Loaders/Backhoes	2	8
	Daily Mileage	**Round Trips per day[2]**		
Hauling Trips (See Soil Movement-Pipeline Tab)	30	83		
Worker Trips (2 crew trucks for PM, 4 inspection/testing trucks, 8 crew trucks for construction)	20	28		

1. Working days are counted as 20 days within a calendar month. The trenched pipeline takes 168 days to finish assuming maximum rate of construction at 400 LF/day
The average construction speed according to the proposed schedule is actually 200 LF/day per construction team. This estimates a more conservative approach using two construction teams, totaling 400LF/day.
2. Hauling trips assumes phased soil import and export. If not phased, see soil movement tab for total round trips.

Construction of Pump Station – Modesto

Phase	Working Days[1]	Equipment Type	Quantity of Equipment	Hours per Day
Construction	60	Excavator	1	8
	60	Bulldozer	1	8
	60	Cranes	1	4
	60	Front end Loader	1	8
	60	Sheepfoot Compactor	1	8
	30	Semi-Truck – Delivery (One delivery per day)	1	NA
	270	Water Truck	1	4
Equipment Installation	60	Cranes	1	4
	30	Front end Loader	1	4
	180	Water Truck	1	4
	Daily Mileage	**Trips per Day[2]**		
Hauling Trips (Retrofitting existing pump station; no major soil movement)	30	0		
Daily Worker Trips (2 crew trucks for PM, 2 crew trucks for construction, 2 crew trucks for equipment install)	20	12		

1. Assumes the structure takes 10 months to finish (Project schedule proposed 12 months and we're more conservative in case the schedule will be updated)
2. Hauling Trips only apply to Excavation and construction phase, assuming minimum grading required (above ground PS)

San Joaquin River Crossing @ Modesto

Phase	Working Days[1]	Equipment Type	Quantity of Equipment	Hours per Day
Construction	120	Excavators	2	8
	45	Tunneling Machine	1	8
	60	Pile Driver (The pile driver will likely only operate the first 2 months of the construction duration.)	1	8
	240	Crane	1	4
	60	Front End Loader	1	8
	120	Water Truck	1	4
	15	Semi-truck – delivery (Two deliveries per day)	2	NA
	15	Concrete Delivery Truck	2	8
	60	Bulldozer	1	8
	60	Sheep Foot Compactor	1	8
	Daily Mileage	**Trips per Day[2]**		
Hauling Trips (See Soil Movement-Pipeline Tab)	30	2		
Daily Worker Trips (3 crew trucks for PM, 4 crew trucks for construction, 1 inspection/testing truck)	20	16		

1. Assumes the crossing takes 300 days to finish
2. Hauling trips assumes phased soil import and export. If not phased, see soil movement tab for total round trips.

NVRRWP Construction Phasing and Equipment List for Air Quality Modeling

Alternative 2 (Separate) - Preliminary - Facilities Planning

July 7, 2014

Construction of Weir Structure – Modesto

Phase	Working Days[1]	Equipment Type	Quantity of Equipment	Hours per Day
Site Prep	20	Graders	1	8
		Tractors/Loaders/Backhoes	1	8
Excavation	40	Concrete/Industrial Saws	1	8
		Rubber Tired Dozers	1	1
		Tractors/Loaders/Backhoes	2	6
		Excavators	1	2
		Bore/Drill Rigs	1	6
Construction	50	Cranes	1	4
		Forklifts	2	6
		Tractors/Loaders/Backhoes	2	8
		Air Compressor	1	1
		Pumps	1	2
Paving	10	Cement and Mortar Mixers	4	6
		Pavers	1	7
		Rollers	1	7
		Tractors/Loaders/Backhoes	1	7
	Daily Mileage	**Trips per Day[2]**		
Hauling Trips (See Material Movement-Weir Tab)	30	1		
Daily Worker Trips (1 crew trucks for PM, 1 inspection/testing trucks, 2 crew trucks for construction)	20	8		

1. Assumes the structure takes 6 months to finish
2. Hauling Trips only apply to excavation and construction phase, assumes phased soil import and export. If soil movement is not phased then round trips per day should be 2.

Construction of Weir Structure – Turlock

Phase	Working Days[1]	Equipment Type	Quantity of Equipment	Hours per Day
Site Prep	20	Graders	1	8
		Tractors/Loaders/Backhoes	1	8
Excavation	40	Concrete/Industrial Saws	1	8
		Rubber Tired Dozers	1	1
		Tractors/Loaders/Backhoes	2	6
		Excavators	1	2
		Bore/Drill Rigs	1	6
Construction	50	Cranes	1	4
		Forklifts	2	6
		Tractors/Loaders/Backhoes	2	8
		Air Compressor	1	1
		Pumps	1	2
Paving	10	Cement and Mortar Mixers	4	6
		Pavers	1	7
		Rollers	1	7
		Tractors/Loaders/Backhoes	1	7
	Daily Mileage	**Trips per Day[2]**		
Hauling Trips 9See Material Movement-Weir Tab)	30	1		
Daily Worker Trips (1 crew trucks for PM, 1 inspection/testing trucks, 2 crew trucks for construction)	20	8		

1. Assumes the structure takes 6 months to finish
2. Hauling Trips only apply to excavation and construction phase, assumes phased soil import and export. If soil movement is not phased then round trips per day should be 2.

Construction of Pipeline - Trenched East and West of River

Phase	Working Days[1]	Equipment Type	Quantity of Equipment	Hours per Day
Site Prep	19	Rubber Tired Dozers	2	8
		Scrapers	2	8
		Signal Boards	10	8
Trenching	86	Excavators	2	8
		Graders	2	8
		Rubber Tired Dozers	2	8
		Scapers	4	8
		Signal Boards	10	8
		Tractors/Loaders/Backhoes	4	8
Pipeline	57	Graders	2	8
		Scrapers	4	8
		Signal Boards	10	8
		Trenchers	2	8
		Tractors/Loaders/Backhoes	4	8
Backfill and Paving	28	Rollers	2	8
		Signal Boards	10	8
		Cement Truck	2	8
		Asphalt Truck	2	8
		Tractors/Loaders/Backhoes	4	8
	Daily Mileage	**Round Trips per day[2]**		
Hauling Trips (See Soil Movment-Pipeline Tab)	30	71		
Worker Trips (2 crew trucks for PM, 4 inspection/testing trucks, 8 crew trucks for construction)	20	28		

1. Working days are counted as 20 days within a calendar month. The trenched pipeline takes 144 days to finish assuming maximum rate of construction at 400 LF/day
The average construction speed according to the proposed schedule is actually 200 LF/day per construction team. This estimates a more conservative approach using two construction teams, totaling 400LF/day.
2. Hauling trips assumes phased soil import and export. If not phased, see soil movement tab for total round trips.

Construction of Pump Station – Modesto

Phase	Working Days[1]	Equipment Type	Quantity of Equipment	Hours per Day
Construction	60	Excavator	1	8
	60	Bulldozer	1	8
	60	Cranes	1	4
	60	Front end Loader	1	8
	60	Sheepfoot Compactor	1	8
	30	Semi-Truck – Delivery (one delivery day)	1	NA
	270	Water Truck	1	4
Equipment Installation	60	Cranes	1	4
	30	Front end Loader	1	4
	180	Water Truck	1	4
	Daily Mileage	**Trips per Day[2]**		
Hauling Trips (Retrofitting existing pump station; no major soil movement)	30	0		
Daily Worker Trips (2 crew trucks for PM, 2 crew trucks for construction, 2 crew trucks for equipment install)	20	12		

1. Assumes the structure takes 10 months to finish (Project schedule proposed 12 months and we're more conservative in case the schedule will be updated)
2. Hauling Trips only apply to Excavation and construction phase, assuming minimum grading required (above ground PS)

Construction of Pump Station – Turlock

Phase	Working Days[1]	Equipment Type	Quantity of Equipment	Hours per Day
Construction	90	Excavator	2	8
	30	Bulldozer	1	8
	90	Cranes	1	4
	90	Front end Loader	1	8
	90	Sheepfoot Compactor	1	8
	30	Concrete Delivery	4	8
	30	Semi-Truck – Delivery (2 deliveries per day)	2	NA
	270	Water Truck	1	4
Equipment Installation	60	Cranes	1	4
	30	Front end Loader (See Material Movement-Weir Tab)	1	4
	180	Water Truck	1	4
	Daily Mileage	**Trips per Day[2]**		
Hauling Trips (See Material Movement-Pump Station Tab)	30	1		
Daily Worker Trips (2 crew trucks for PM, 3 crew trucks for construction, 2 crew trucks for equipment install)	20	14		

1. Assumes the structure takes 10 months to finish (Project schedule proposed 12 months and we're more conservative in case the schedule will be updated)
2. Hauling Trips only apply to Excavation and construction phase, assuming minimum grading required (above ground PS)

San Joaquin River Crossing @ Modesto

Phase	Working Days[1]	Equipment Type	Quantity of Equipment	Hours per Day
Construction	120	Excavators	2	8
	45	Tunneling Machine	1	8
	60	Pile Driver (The pile driver will likely only operate the first 2 months of the construction duration.)	1	8
	240	Crane	1	4
	60	Front End Loader	1	8
	120	Water Truck	1	4
	15	Semi-truck – delivery (two deliveries per day)	2	NA
	15	Concrete Delivery Truck	2	8
	60	Bulldozer	1	8
	60	Sheep Foot Compactor	1	8
	Daily Mileage	**Trips per Day[2]**		
Hauling Trips (See Soil Movement - Pipeline Tab)	30	2		
Daily Worker Trips (3 crew trucks for PM, 4 crew trucks for construction, 1 inspection/testing truck)	20	16		

1. Assumes the crossing takes 300 days to finish
2. Hauling Trips only apply to Excavation and construction phase, assuming minimum grading required (above ground PS)

San Joaquin River Crossing @ Turlock

Phase	Working Days[1]	Equipment Type	Quantity of Equipment	Hours per Day
Construction	120	Excavators	2	8
	45	Tunneling Machine	1	8
	60	Pile Driver (The pile driver will likely only operate the first 2 months of the construction duration.)	1	8
	240	Crane	1	4
	60	Front End Loader	1	8
	120	Water Truck	1	4
	15	Semi-truck – delivery (two deliveries per day)	2	NA
	15	Concrete Delivery Truck	2	8
	60	Bulldozer	1	8
	60	Sheep Foot Compactor	1	8
	Daily Mileage	**Trips per Day[2]**		
Hauling Trips (See Soil Movement - Pipeline Tab)	30	2		
Daily Worker Trips (3 crew trucks for PM, 4 crew trucks for construction, 1 inspection/testing truck)	20	16		

1. Assumes the crossing takes 300 days to finish
2. Hauling Trips only apply to Excavation and construction phase, assuming minimum grading required (above ground PS)

Pipeline Component Assumptions – Alternative 1

Project Working Day Schedule	Days	Month
Assuming 5 days/week	168	8.4

Average Speed	200	LF/day	
Max Speed for Pipe Construction	400	LF/day	Assumes 2 crews
Max Speed for Material Import/Export	400	LF/day	
Disturbed Area	45	ft	

Truck Capacity												
Assuming project alignment is constructed linearly with no overlapping component												
	Pipeline Description					**Disturbed Acreage**			**Import/Export Soil**			
Parameters	**RW Pipe Length**		**Trench Width**	**Bedding and Filling Depth**	**Pipe Diameter**	**Disturb Total**	**Disturb Max. Daily**		**Import Max. Daily**	**Export Max. Daily**	**Total Import**	**Total Export**
Unites	**miles**	**feet**	**feet**	**feet**	**in**	**acres**	**acres**		**CY**	**CY**	**CY**	**CY**
East	7.2	**37,800**	6	8	**42**	39.0	0.41	38.38	568.6	711.1	53,730.4	67,200.0
West	5.6	**29,500**	8	8	**54**	30.5	0.41	48.10	712.5	948.1	52,549.0	69,925.9
Total	12.7	67,300	-	-	-	39.0	0.41		**1,281.1**	**1,659.3**	53,730.4	67,200.0
Daily Average	-	**400.00**	-	-	-	**0.23**	-		-	-	**319.3**	**399.4**
Hauling Truck trips									64	83		
Hauling Truck Mileage									30	30		
									If Phased	83		
									If Not Pha	147		

River Crossing at Modesto

Length	3000	ft
Diameter	54	inch
With Casing	66	inch
Soil from Crossing	2639.81	yards
Entry and Pullback Pit		
Width	50	ft
Length	100	ft
Depth	5	ft
Soil Excavation	1851.85	yards
Total Soil Excavation from River Crossing	4491.66	yards
	224.583	# of trucks total
	1.87153	# of trucks/day

Pump Station – Modesto

Construction Schedule

Phases	Week
Site Preparation	4
Grading	4
Building Construction	12
Architectural Coating	0
Paving	2
Total	22

Construction Details

General Description		
Pump Station Size	500	hp
Disturbed Acreage	0.10	Acre
Pump Station Building Width	80	ft
Pump Station Building Length	50	ft
Height	16	ft
Footprint	0.09	Acre
Footprint from DPR map	-	Acre

Material Export		
Grading Excavation (Export)	0	Cubic Yard
Foundation Width	4	ft
Foundation Depth	2	ft
Foundation Excavation (Export)	72	Cubic Yard
Total Export Volume	72	Cubic Yard

Material Import		
Foundation Material (Import)	72	Cubic Yard
Building Wall Thickness	0.7	ft
Building Floor Thickness	1.0	ft
Building Material (Import)	250	Cubic Yard
Total Import Volume	322	Cubic Yard

Operation Details

Operation		
Power	500	hp
Annual Energy Consumption	3440423.725	kWh/Yr
Backup Generator	0	kW

Weir

Total Soil Import Export

500	CY import (estimated based on existing drawing)
500	CY export
25	# of 20 Yard Trucks
30	# of days of import/export
0.833333	# of truck trips per day

Pipeline Component Assumptions – Alternative 2

Project Working Day Schedule	Days	Month
Assuming 5 days/week	144	7.2

Average Speed	200	LF/day
Max Speed for Pipe Construction	400	LF/day
Max Speed for Material Import/Export	400	LF/day
Disturbed Area	40	ft

Truck Capacity

Assuming project alignment is constructed linearly with no overlapping component

	Pipeline Description					Disturbed Acreage			Import/Export Soil			
Parameters	**RW Pipe Length**		**Trench Width**	**Bedding and Filling Depth**	**Pipe Diameter**	**Disturb Total**	**Disturb Max. Daily**		**Import Max. Daily**	**Export Max. Daily**	**Total Import**	**Total Export**
Unites	**miles**	**feet**	**feet**	**feet**	**in**	**acres**	**acres**		**CY**	**CY**	**CY**	**CY**
Phase1 - Modesto	5.6	**29,500**	6	8	**42**	27.1	0.37	38.38	568.6	711.1	41,932.5	52,444.4
Phase 2 - Turlock	5.3	28,000	6	8	**42**	25.7	0.37	38.38	**568.6**	**711.1**	39,800.3	49,777.8
Total	10.9	57,500	-	-	-	27.1	0.37		**1,137.2**	**1,422.2**	81,732.8	102,222.2
Daily Average	-	**400.00**	-	-	-	**0.19**	-		-	-	**568.6**	**711.1**
Hauling Truck trips									57	71		
Hauling Truck Mileage									30	30		
									If Phased	71		
									If Not Phased	128		

River Crossing at Modesto

Length	3000	ft
Diameter	42	inch
With Casing	54	inch
Soil from Crossing	1767.1459	yards
Entry and Pullback Pit		
Width	50	ft
Length	100	ft
Depth	5	ft
Soil Excavation	1851.8519	yards
Total Soil Excavation from River Crossing	3618.9977	yards
	180.94989	# of trucks total
	1.5079157	# of trucks/day

River Crossing at Turlock

Length	3000	ft
Diameter	42	inch
With Casing	54	inch

Soil from Crossing	1767.1459	yards
Entry and Pullback Pit		
Width	50	ft
Length	100	ft
Depth	5	ft
Soil Excavation	1851.8519	yards
Total Soil Excavation from River Crossing	3618.9977	yards
	180.94989	# of trucks total
	1.5079157	# of trucks/day

Conversion Factors:
1 mile = 5,280 feet
1 acre = 43,560 sq. feet
1 CY = 27 CF

Pump Station – PS @ Harding Drain Bypass

Construction Schedule

Phases	Week
Site Preparation	4
Grading	4
Building Construction	12
Architectural Coating	0
Paving	2
Total	22

Construction Details

General Description		
Pump Station Size	250	hp
Disturbed Acreage	0.10	Acre
Pump Station Building Width (size of the PS structure is estimated based on number of pumps)	40	ft
Pump Station Building Length	50	ft
Height	15	ft
Footprint	0.05	Acre
	-	Acre

Material Export		
Grading Excavation (Export) (15'x30'x15' wet well below grade, 40'x50' building above grade but not centered over wet well)	250	Cubic Yard
Foundation Depth	2	ft
Foundation Excavation (Export)	148	Cubic Yard
Total Export Volume	398	Cubic Yard

Material Import		
Foundation Material (Import)	148	Cubic Yard
Building Wall Thickness	0.7	ft
Building Floor Thickness	1.0	ft
Building Material (Import)	140	Cubic Yard
Total Import Volume	288	Cubic Yard

Operation Details

Operation		
Power	250	hp
Annual Energy Consumption	1720211.863	kWh/Yr
Backup Generator	0	kW

	Total	Per Day
If phased	19.90741	0.66358
If not phased	34.30247	1.143416

Weir (per weir installation)

Total soil import export	
500	CY import
500	CY export
25	# of 20 Yard Trucks
30	# of days of import/export
0.833333	# of truck trips per day

This page intentionally left blank

Appendix D – Supporting Documentation Related to Biological Resources

Appendix D – Supporting Documentation Related to Biological Resources

This appendix provides supporting documentation for biological resources. Background information on special-status plant and wildlife species with potential to occur in the Study Area was compiled from numerous sources including, but not limited to, the following:

- U.S. Fish and Wildlife Service (USFWS) List of Federal Endangered and Threatened Species that Occur in or May Be Affected by Projects in Stanislaus County as well as in the USGS 7.5 minute quadrangles for the Study Area, including Patterson, Westley, Brush Lake, Crow's Landing (USFWS 2014);
- California Natural Diversity Database (CNDDB and CNPS Inventory of Rare and Endangered Plants of California queries for the USGS 7.5 minute quadrangles within the Project Area and the quadrangles immediately adjacent to them, which are: Patterson, Westley, Brush Lake, Crow's Landing, Copper Mountain, Solyo, Vernalis, Ripon, Salida, Riverbank, Ceres, Hatch, Gustine, Newman, Orestimba Peak and Wilcox Ridge;
- eBird.org records for the Modesto Wastewater Treatment Plant and spray fields; and
- Horizon's field notes and reports from pre-construction surveys and construction monitoring for the Harding Drain Bypass Project (Horizon 2014a).

Chapter 1 Plants

1.1 Alkali milkvetch (*Astragalus tener* var. *tener*) – Rare Plant Rank 1B.2

This plant is an annual herb that is part of the pea family (Fabaceae). It occurs in a range of habitat conditions including vernal pools and playas, edges of salt marshes, alkali meadows, and moist grassy flats (USFWS 2014). Currently, it is most frequently found in the Solano-Colusa vernal pool region. Extant occurrences in the Central Valley include populations in Yolo and Merced counties (LSA 2012). A population of Alkali milkvetch was reported 5 miles east of the Project Area along West Main Avenue, however this population has not been relocated and is thought to be extirpated (CCH 2014a). No *Astragalus* species were observed within the potential suitable habitat within the Project Area (Horizon 2014a).

1.2 Heartscale (*Atriplex cordulata*) – Rare Plant Rank 1B.2

Heartscale is a small, herbaceous, annual species in the goosefoot family (Chenopodiaceae). It occurs on alkaline soils in the southern Sacramento and San Joaquin Valleys. It typically occurs in chenopod scrub and is known to occur in "trampled soils" (BLM 2014), which are present within the alkali scrub adjacent to the Project Area along West Main Avenue.

1.3 Brittlescale (*Atriplex depressa*) – Rare Plant Rank 1B.2

Brittlescale is a small, herbaceous, annual species in the goosefoot family (Chenopodiaceae). It typically occurs on alkaline clay soils in chenopod scrub, grasslands, and meadows. Potentially suitable habitat occurs in alkali flat/scrub habitat adjacent to the Project Area along West Main Avenue.

1.4 Lesser saltscale (*Atriplex minuscula*) – Rare Plant Rank 1B.1

This species is associated with many of the same halophytes as heartscale and San Joaquin spearscale. The life history of lesser saltscale is poorly known, except that it is an annual and flowers from May to October (Skinner and Pavlik 1994; USFWS 1998a). Potentially suitable habitat occurs in alkali flat/scrub habitat adjacent to the Project Area along West Main Avenue. A population of lesser saltscale was recorded approximately 5 miles west of the Project Area just north of West Main Avenue. This record is from 1936 and it has not been relocated suggesting the site has been extirpated (CCH 2014b).

1.5 Vernal pool smallscale (*Atriplex persistens*) – Rare Plant Rank 1B.2

This small, herbaceous plant is endemic to California and was first recognized as a unique species in 1993 (Stutz and Chu 1993). In the San Joaquin Valley, it is known to occur in only a few locations. There is a record for vernal pool smallscale along Carpenter Road from 1965. The location of the occurrence was mapped as a "best guess" in the California Natural Diversity Database (CNDDB) (CDFW 2014a). This occurrence is considered "possibly extirpated." Potentially suitable habitat for this species occurs within the alkali pool adjacent to the Project Area along West Main Avenue.

1.6 Hispid bird's beak (*Chloropyron molle* ssp. *hispidum*) – Rare Plant Rank 1B.2

Hispid bird's beak often occurs with inland saltgrass and alkali sea heath, both of which are present adjacent to the Project Area along West Main Avenue. The nearest known location of this species is 20 miles to the south of the Project area within the Kesterson National Wildlife Refuge. Potentially suitable habitat for this species occurs within the alkali flats adjacent to the Project Area along West Main Avenue.

1.7 San Joaquin spearscale (*Extriplex joaquiniana*) – Rare Plant Rank 1B.2

San Joaquin spearscale occurs in chenopod scrub and seasonally wet areas including meadows and seeps. The Project Area is within the known range of San Joaquin spearscale. Potentially suitable habitat occurs in alkali scrub habitat adjacent to the Project Area along West Main Avenue. The nearest known populations of these species are approximately 20 miles to the south of the Project Area (Jepson Flora Project 2014).

1.8 Slough thistle (*Cirsium crassicaule*) – Rare Plant Rank 1B.1

Slough thistle annual to biennial herbaceous member of the sunflower family (Asteraceae) that may occur within chenopod scrub, riparian scrub and freshwater marshes primarily along sloughs, riverbanks and other marshy areas (CNPS 2014). Habitat for this species might be present within the San Joaquin River crossings, along the river bank and backwater areas. The nearest reported location of this species is over 35 miles to the north of the Project Area near Manteca (Calflora 2014).

1.9 Delta button celery (*Eryngium racemosum*) – Rare Plant Rank 1B.1

Potential habitat for this species might be present within the San Joaquin River crossings, however the hard clay soils and open alkali habitat required for these species was not observed during the preliminary survey conducted in May 2014. The nearest location of Delta button celery is 5 miles to the south of the Project Area within the floodplain of the San Joaquin River (Jepson Flora Project 2014).

1.10 Prostrate vernal pool navarretia (*Navarretia prostrata*) – Rare Plant Rank 1B.1

This is a small annual plant that occurs in vernal pools and alkali flats. This species is more commonly found in vernal pools of southern California. The nearest reported occurrence of prostrate vernal pool navarretia is approximately 20 miles to the south of the Project Area in the Great Valley Grasslands State Park. Potentially suitable habitat for this species occurs within the alkali habitats adjacent to the Project Area along West Main Avenue.

1.11 Sanford's arrowhead (*Sagittaria sanfordii*) – Rare Plant Rank 1B.2

This species occurs in standing or slow-moving freshwater ponds, marshes, and ditches. It flowers May to October. Freshwater marshes within the San Joaquin River crossings provide potentially suitable habitat.

Chapter 2 Invertebrates

2.1 Conservancy Fairy Shrimp (*Branchinecta conservatio*) - Federally Endangered, State Endangered

Conservancy fairy shrimp have delicate elongate bodies, large stalked compound eyes, no carapaces (hard shell), and 11 pairs of swimming legs. Males range from 0.6 to 1.1 inches long, with females measuring slightly smaller, between 0.6 and 0.9 inches (USFWS 2012a), making them the largest of the endemic Central Valley fairy shrimp. They glide gracefully upside down, swimming by beating their legs in a complex, wavelike movement that passes from front to back. Conservancy fairy shrimp, like many other branchiopods, feed on algae, bacteria, protozoa, rotifers, and bits of detritus.

Conservancy fairy shrimp occur in vernal pools found on several different landforms, geologic formations, and soil types. The majority of sites inhabited by this species of fairy shrimp are relatively large and turbid pools (USFWS 2012a), with a mean size of 6.89 acres (Eriksen and Belk 1999). Populations within the Central Valley have been located in northern hardpan pools in swales of old braided alluvium (Eriksen and Belk 1999). This species has a relatively long maturation and reproductive period, and is typically found with other branchiopod species with long maturation and reproductive periods, such as the vernal pool tadpole shrimp and vernal pool fairy shrimp (Helm and Vollmar 2002).

The historical distribution of Conservancy fairy shrimp is not known, but it is likely Conservancy fairy shrimp once occupied suitable vernal pool habitats throughout a large portion of the Central Valley and southern coastal regions of California (USFWS 2012a). The alkaline pool adjacent to the Project Area provides marginally suitable habitat for Conservancy fairy shrimp, although this alkaline pool is considerably smaller (0.30 acres) than the pools in which this species is typically found (mean 6.89 acres) (Helm 1998).

2.2 Longhorn Fairy Shrimp (*Branchinecta longiantenna*) - Federally Endangered

The longhorn fairy shrimp ranges in size from 0.5 to 0.8 inch long. Its morphology is similar to the Conservancy fairy shrimp. Longhorn fairy shrimp are distinguished from other fairy shrimp by the male's extremely long second antennae (USFWS 2012b).

Longhorn fairy shrimp are found in sandstone or basalt-flow depression basins to small swale and earth slump, with a grassy or, occasionally, muddy bottoms in grassland habitats (Eriksen and Belk 1999). Despite occurring in clear, neutral pools with low total dissolved solids in portions of their range, longhorn fairy shrimp have also been observed in turbid, alkaline pools in the Carrizo Plain vernal pool region and at the proposed Alkali Sink Conservation Bank east of Mendota in Fresno County.

Known populations of longhorn fairy shrimp include: (1) areas within and adjacent to the Carrizo Plain National Monument, San Luis Obispo County; (2) areas within the San Luis National Wildlife Refuge Complex, Merced County; (3) areas within the Brushy Peak Preserve, Alameda County; (4) areas within the Vasco Caves Preserve, near the town of Byron in Contra Costa County; and, (5) areas within the proposed Alkali Sink Conservation Bank east of Mendota in Fresno County (USFWS 2012b). Potentially suitable habitat for this species occurs in the alkaline pool and swale adjacent to the Project Area.

2.3 Vernal Pool Tadpole Shrimp (*Lepidurus packardi*) – Federally Endangered

Vernal pool tadpole shrimp are small crustaceans (0.6 to 3.3 inches long) found primarily in vernal pools of California's Central Valley. Vernal pool tadpole shrimp reach sexual maturity in as little as 3 and 4 weeks. Consequently females can deposit as many as 6 clutches in a single wet season (USFWS 2007a).

Populations of vernal pool tadpole shrimp occur in a variety of ephemeral wetland habitats including vernal pools, vernal swales, ponded clay flats, alkaline pools, ephemeral stock ponds, and roadside ditches. This species inhabits clear to highly turbid water, with water temperatures ranging from 50 to 84°F (USFWS 2007a). The species is adaptable to soil and water conditions, but over 50% of known occurrences have been associated with High Terrace landforms and Redding and Corning soils (USFWS 2007a).

The vernal pool tadpole shrimp has a patchy distribution across the Central Valley of California, from Shasta County southward to northwestern Tulare County, with isolated occurrences in Alameda and Contra Costa Counties (USFWS 2007b). Potential habitat for this species occurs in alkaline pools/swales adjacent to the Project Area.

2.4 Vernal Pool Fairy Shrimp (*Branchinecta lynchi*) – Federally Threatened

The vernal pool fairy shrimp was listed as threatened on September 19, 1994 (59 FR 48136). Critical habitat was originally designated on August 6, 2003 (68 FR 46683), then revised on August 11, 2005 (70 FR 46923). A 5-year review was completed in September 2007; no change in status was recommended (USFWS 2007c).

The vernal pool fairy shrimp is a small crustaceans ranging in size from approximately 0.12 to 1.5 inches in length. The vernal pool fairy shrimp can be distinguished from other *Branchinecta* species by the morphology of the male's second antenna and the female's third thoracic segment (on the middle part of its body) (USFWS 2007c). This species is endemic to California and southern Oregon.

Vernal pool fairy shrimp may occur in various seasonally ponded habitats, from small, clear, sandstone rock pools to large, turbid, alkaline, grassland valley floor pools. It tends to occur in smaller pools measuring less than 0.05 acre. These are most commonly in grass or mud bottomed swales, or basalt flow depression pools in unplowed grasslands (USFWS 2007c). The species has the ability to inhabit disturbed/constructed sites (e.g., road-side ditches) that are often not suitable for branchiopod species. Potential habitat for this species occurs in alkaline pools/swales adjacent to the Project Area along West Main Avenue.

2.5 Valley Elderberry Longhorn Beetle (VELB) (*Desmocerus californicus dimorphus*) – Federally Threatened

The VELB is a medium-sized, stout-bodied beetle with long antennae. Body lengths of males range from about 0.5 to nearly 1 inch, with antennae about as long as their bodies. Females are slightly more robust than males with somewhat shorter antennae. Adult males have red-orange elytra (wing covers) with four elongate spots. Adult females have dark colored elytra (USFWS 2006a).

VELB are strictly associated with elderberry plants (*Sambucus* spp.) in the Central Valley during its entire life cycle. Adults emerge in the spring from pupation inside the wood of elderberry plants as they begin to bloom. The exit holes used by the emerging adults are small oval openings. The adults eat the elderberry foliage until about June when they mate. Females lay their eggs on crevices on the bark. Upon hatching, the larvae tunnel into the tree where they spend 1-2 years eating the interior wood, their sole source of food (Barr 1991).

A blue elderberry shrub was observed in near the outlet of the Harding Drain at the San Joaquin River during a reconnaissance survey in 2014 (Horizon 2014a). Blue elderberry plants are potentially present in riparian habitat along the San Joaquin River and along other drainage features. Therefore, VELB may occur in the Project Area.

Chapter 3 Fish

3.1 North American green sturgeon [Southern DPS] (*Acipenser mediostris*) – Federally Threatened, State Species of Concern

The southern distinct population segment (DPS) of the Green Sturgeon includes the spawning populations of green sturgeon south of the Eel River (exclusive), principally the Sacramento River green sturgeon spawning population. Green sturgeon use both freshwater and saltwater habitat. As adults, green sturgeon live most of their lives in nearshore oceanic waters, bays, and estuaries. Juveniles and adults are benthic feeders, and juveniles have been reported to eat mysid shrimp and amphipods in the Sacramento–San Joaquin River Delta (Delta) (Radtke 1966 in Moyle 2002); adults may eat small fish and macroinvertebrates (Moyle 2002).

Mature adult green sturgeon move into large, turbulent freshwater rivers to spawn (Moyle et al. 1992a in Moyle, 2002). Spawning occurs once the fish are more than 15 years old and is then believed to occur every 2 to 5 years (Moyle 2002). Green sturgeon migrate to fresh water in late

February and spawn from March to July, with peak spawning occurring from April to June (Moyle et al. 1995). Each female produces 60,000 to 140,000 eggs (Moyle 2002). Specific spawning habitat preferences are unclear, but eggs likely are broadcast over bedrock or sand to cobble substrates (Moyle et al. 1995). Juvenile green sturgeon live in fresh and estuarine waters for 1 to 3 years before out-migrating to saltwater (Nakamoto et al. 1995; Moyle 2002). It is currently believed that green sturgeon spawn in the Klamath River and Sacramento River basins in California and in the Rogue River in Oregon (NMFS 2009a).

The main factor believed to be responsible for the decline of the southern DPS green sturgeon is the reduction in spawning habitat in the Sacramento River. There are numerous other threats, including insufficient freshwater flow rates at spawning areas, contaminants, entrainment, impassable barriers, influence of exotic species, small population size, elevated water temperatures, and by-catch of green sturgeon in fisheries, that could potentially affect the status of the southern DPS green sturgeon (71 FR 17757).

There have been anecdotal accounts of green sturgeon in the vicinity of the Project Area (Jackson and Van Eenennaam 2013), but this species is not expected to be present (Pers. Comm. Gutierrez, 2014).

3.2 Steelhead, California Central Valley DPS (*Oncorhynchus mykiss*) – Federally Threatened

The Central Valley Distinct Population Segment (DPS) of steelhead includes all naturally spawned anadromous steelhead below natural and manmade impassable barriers in the Sacramento River and SJR and their tributaries, excluding steelhead from San Francisco and San Pablo Bays and their tributaries, but including two artificial propagation programs: the Coleman National Fish Hatchery, and the Feather River Fish Hatchery.

Steelhead are the anadromous form of rainbow trout. Steelhead can reach up to 55 pounds in weight and 45 inches in length, though average size is much smaller. They are usually dark-olive in color, shading to silvery-white on the underside with a heavily speckled body and a pink to red stripe running along their sides.

For steelhead, water quality is a critical factor during the freshwater residence time with cool, clear, and well oxygenated water needed for maximum survival (Moyle 2002). Juvenile steelhead (ages 1+ and 2+) occupy deeper water than fry and show a stronger preference for pool habitats with ample cover, as well as for rapids and cascade habitats (Dambacher 1991). Juveniles generally occupy habitat with large structures such as boulders, undercut banks, and large woody debris that provide feeding opportunities, segregation of territories, refuge from high water velocities, and cover from fish and bird predators (Moyle et al. 2008).

Central Valley steelhead are opportunistic predators of aquatic and terrestrial insects, small fish, frogs, and mice, but their primary diet consists of benthic aquatic insect larvae, particularly caddisflies (*Trichoptera*), midges (*Chironomidae*), and mayflies (*Ephemeroptera*) (Merz, 2002). Depending on season and steelhead size, they also may eat salmon eggs, juvenile salmon, sculpins, and suckers (Merz 2002).

Central Valley steelhead exhibit flexible reproductive strategies that allow for persistence in spite of variable flow conditions (McEwan 2001). Adult Central Valley steelhead typically migrate upstream in October through February, though earlier or later migration may occur. Spawning occurs in December through March; incubation and fry emergence occurs between January and May (NMFS 2009a). Juveniles typically rear in freshwater for a longer period (1 to 3 years) than other salmonids, with both juveniles and adults spending varying amounts of time in fresh and salt water (McEwan 2001). Most sub-adults/adults reside in the ocean for 1 to 3 years before returning to their natal streams in the Central Valley to spawn (Moyle 2002). Steelhead require cool fresh waters with sufficient dissolved oxygen and minimal turbidity for successful incubation and rearing. Juvenile steelhead require habitat with consistently cool temperatures as emigration is unlikely for juveniles prior to spending at least one full summer within their natal stream.

Estimates of historical and recent mean run abundance are 1–2 million and approximately 3,600, respectively (NMFS 2009a). The primary limiting factor for Central Valley steelhead is the inaccessibility of more than 95% of its historic spawning and rearing habitat due to major dams (NMFS 2009a). Other limiting factors include small passage barriers, water development and land use activities, levees and bank protection, dredging and sediment disposal, mining, contaminants, fisheries management practices, hatcheries, inadequately screened water diversions, and predation by nonnative species (McEwan 2001; Moyle et al. 2008; NMFS 2009a).

The Merced River, which is upstream of the Project Area, supports a small run of steelhead. The SJR in the Project Area functions as migration habitat for steelhead. Juvenile rearing habitat is not present.

3.3 Chinook Salmon, Central Valley Spring-Run ESU (*Oncorhynchus tshawytscha*) – Federally Threatened or Nonessential Experimental Population, State Threatened

The Central Valley Evolutionarily Significant Unit (ESU) of spring-run Chinook salmon includes all naturally spawned populations in the Sacramento River and its tributaries in California, including the Feather River, and one artificial propagation program: the Feather River Fish Hatchery spring-run Chinook salmon program. There are only three remaining “stable” populations: Mill, Deer, and Butte Creeks, which are in close geographic proximity to each other (CDFW 2004). Naturally spawning populations have been extirpated from the SJR basin (Lindley et al. 2004).

Returning Central Valley spring-run Chinook migrate upstream as sexually immature fish in spring, hold through the summer in deep pools, spawn in early fall, and migrate downstream as juveniles after either a few months or a year in fresh water (Moyle et al. 2008). Spawning migration extends from February to early July with peaks in mid-April in Butte Creek and in mid-May in Deer and Mill Creeks (Williams 2006). Central Valley spring-run Chinook attain maturity at ages of 2 to 4 years. They generally migrate higher into watersheds than other runs in order to find deep pools where cooler temperatures allow over-summering (Moyle et al. 2008). Spawning often occurs in the tail waters of their final holding pool (Moyle 2002). Incubation lasts 40–60 days and is extremely sensitive to temperature, with high egg mortality at temperatures above 57 to 61°F. Fry emerge in another 4-6 weeks (Williams 2006).

Migration can begin within hours of emergence, after a few months of natal rearing, or after over-summering in the natal stream (Hill and Webber 1999; Moyle et al. 2008; Stillwater Sciences 2006). As Central Valley spring-run Chinook travel downstream, they may rear in the lower reaches of non-natal tributaries and along mainstem margin habitats, particularly for smaller fish that need to grow larger before ocean entry (Moyle et al. 2008). Juveniles feed mainly on zooplankton, benthic invertebrates, terrestrial drift, and larvae of other fishes, especially suckers (Moyle 2002; Moyle et al. 2008).

Estimates of historic abundance indicate about 700,000 spawners, which has declined to a current level of and 500 to 4,500 spawners (NMFS 2009b). Three primary limiting factors to Central

Valley spring-run Chinook have been identified: loss of most historic spawning habitat due to impassable dams; degradation of remaining habitat; and, genetic threats from the Feather River Dish Hatchery spring-run Chinook salmon program (NMFS 2009b). Other limiting factors include water diversions, unscreened or inadequately screened water diversions, excessively high water temperatures, predation by nonnative species, urbanization and rural development, logging, grazing, agriculture, mining, estuarine alteration, fisheries management, and "natural" factors (Moyle et al. 2008; NMFS 2009b).

Central Valley spring-run Chinook salmon ESU have recently been reintroduced to this portion of the SJR (SJRRP 2014). Spring-run Chinook salmon are the focus of salmonid restoration efforts under the San Joaquin River Restoration Program. Effective August 11, 2014, spring-run Chinook salmon including those that have been released or propagated, naturally or artificially, within the experimental population area [defined as the San Joaquin River from Friant Dam downstream to its confluence with the Merced River (exclusive)] are designated a non-essential experimental population (78 CFR 79622).

3.4 Hardhead (*Mylopharodon conocephalus*) – State Species of Concern

Hardhead are distributed widely in low- to mid-elevation streams in the main Sacramento–San Joaquin River drainage, as well as in the Russian River drainage. Their range extends from the Kern River to the Pit River. In the SJR drainage, populations are scattered in the tributary streams. In the Sacramento River drainage, hardhead are present in most of the larger tributary streams, as well as in the Sacramento River.

Hardhead range in size from 11.5 to 23.5 inches. Adults have a brown or dusky bronze back with silvery sides and underside, although juveniles may lack the brown coloration altogether. Breeding males may develop white tubercles laterally along the body and snout. Hardhead typically are found with Sacramento pike minnow (*Ptychocheilus grandis*) and Sacramento suckers (*Catostomus occidentalis*).

Hardhead become sexually mature in their third year (Moyle 2002). Spawning may begin as early as April and extend as late as August, depending on location (Moyle et al. 1995; Moyle 2002; Wang 1986 in Moyle et al. 1995). Spawning is presumed to occur in gravel riffles (Moyle 2002). The incubation period is unknown. Hardhead are bottom feeders, and their diets are size-dependent. Small fish (less than 7.8 inches) feed on mayfly larvae, caddisfly larvae, and small snails (Reeves 1964 in Moyle et al. 1995), and larger fish feed on aquatic plants, crayfish and other large invertebrates (Moyle et al. 1995).

A primary factor affecting hardhead populations is the introduction of predator fish—in particular, the smallmouth bass (Brown and Moyle 1993 in Moyle et al. 1995; Gard 1994 in Moyle et al. 1995; Moyle et al. 1995). Another factor is habitat loss due to dams and diversions, which create unsuitable temperatures and flow regimes.

Hardhead have recently been observed in SJR near the confluence with the Stanislaus River (Merz 2014). Therefore, this species may possibly be within the Project Area.

3.5 Sacramento Splittail (*Pogonichthys macrolepidotus*) – State Species of Concern

Sacramento splittail are confined mostly to the Delta, Suisun Bay, and the lower Petaluma and Napa rivers. They are typically found in slow moving sections of rivers and sloughs (Moyle 2002). Sacramento splittail reach maturity in approximately 2 years. Onset of spawning is believed to be correlated to rising water levels, increased temperatures and increased day length (Moyle 2002). Spawning usually peaks in March or April, when water levels are typically high, providing access to flooded vegetation. Eggs hatch in roughly a week and the larvae's swim bladder usually inflates a week after that (Moyle 2002). Larvae start feeding on small invertebrates, switching to benthic invertebrates such as clams as they grow larger. Sacramento splittail can live up to 8 years (Moyle 2002).

Threats to Sacramento splittail are many. Sacramento splittail's historical range has been lessened through damming and levees along the rivers, which prevent inundation of the floodplain needed for spawning as well as larval development. Since larval development typically takes place in the Delta, splittail are subjected to a multitude of pesticides and pollutants, and while their effect is not known, it's not likely to be positive. Splittail are also competing heavily with invasive species.

Sacramento splittail distribution within the SJR fluctuates. During wet years, Sacramento splittail have been observed upstream of the Project Area. During dry years, the species is not common upstream of the Tuolumne River confluence (Moyle 2002). Due to the variability of the species distribution based upon flow volumes, Sacramento splittail is considered potentially present in the Project Area.

3.6 Pacific Lamprey (*Lampetra tridentata*) – Federal Species of Concern

Pacific lamprey are found in stream along the Pacific coast. In California they occur in rivers and streams north of Malibu Creek in Los Angeles County (Moyle 2002). Pacific Lamprey can still be found in nearly all of their original spawning grounds, though it is thought that runs are smaller now than they were historically.

Like all lampreys, the Pacific lamprey is eel-like in form, have sucker-like, jawless mouths (oral disk), no scales, and breathing holes instead of gills. Adult Pacific lampreys can be distinguished by three large, sharp teeth and posterior teeth on the oral disc (Moyle 2002). The two dorsal fins are slightly separated, while the second dorsal fin is continuous with the caudal fin.

Juvenile lamprey (ammocoetes) prefer soft sand or mud substrate in rivers, where they can filter feed on the surface of the substrate. They do not remain in any given area long. The ammocoete stage is thought to last 5-7 years, or until the ammocoete reaches 5.5-6.3 inches (Moyle 2002). At this point they metamorphose, gaining the ability to tolerate salt water and developing a sucking disc. They also change color from brown to blue with silver sides. Once the metamorphosis is complete they outmigrate in winter and spring during the high flows. Once in saltwater they are predatory, feeding on fish such as salmon, as well as flatfish (Moyle 2002).

Adults reach sexual maturity when they are between 11.5 and 30 inches, and make their way back into spawning streams. Both sexes assist in constructing the nest, which consists of gravel with stones on the downstream end (Moyle 2002). Adults mate several times, covering the eggs with silt and sediment after each time. After mating both sexes usually die, however some adults have been found to repeat spawn (Moyle 2002).

Threats to Pacific lamprey include damming and diverting rivers and streams, and pollution (Moyle 2002). Pacific lamprey has been observed in the SJR upstream and downstream of the Project Area (Hanni et al. 2006). Various lifestages may be present year-round, although spawning habitat is not present. Therefore, this species may possibly be in the Project Area.

3.7 Kern Brook Lamprey (*Entospherus hubbsi*) – State Species of Concern

Kern Brook lamprey are endemic to the east side of the San Joaquin Valley; Friant-Kern Canal, east of Delano, in Kern County, California, which provides ammocoete habitat but not spawning habitat; and the lower reaches of the Merced River, Kaweah River, Kings River, and SJR (Moyle et al. 1989; Moyle 2002). Kern brook lampreys may also occur in the upper SJR between Millerton Reservoir and Kerckhoff Dam, as well as in the Kings River above Oine Flat Dam (Fresno County) (Moyle et al. 1989; Moyle 2002). The abundance of Kern Brook Lamprey is hard to determine because of the similarity between the lamprey species.

Adult Kern Brook lamprey are typically 7 inches or less in total length (Moyle 2002). Adults have small, poorly developed oral disc with two rounded, nonfunctional teeth. Adults are dark on the back and sides and yellow to white on the underside. Ammocoetes can occasionally be distinguished by a dark tail and pigmentation of the head above the breathing holes (Moyle 2002).

Kern Brook lamprey prefer silty backwaters of large rivers in the foothills region. They require slight flow; therefore, reservoirs probably are poor habitats. Ammocoetes are usually found in shallow pools and along the edges of runs where flow is slight, at depths of 11.5–43 inches, and summer water temperatures rarely exceed 77°F (Moyle et al. 1989). Commonly associated with sand, gravel, and rubble substrates, ammocoetes bury themselves in sand/mud substrate (Moyle et al. 1989). They probably require gravel-rubble substrate for spawning (Moyle et al. 1989).

Threats to Kern Brook lamprey include dams and other flow alterations that reduce silt-laden backwaters required by ammocoetes (Moyle et al. 1989). Diversions have fragmented the population. The Kern Brook lamprey has been observed in SJR in the vicinity of the Project Area (Moyle et al. 2009). Various lifestages may be present in the Project Area year-round, although spawning habitat is not present.

3.8 River Lamprey (*Lampetra ayresii*) – State Species of Concern

River lamprey is thought to occur throughout Pacific coast streams, but its occurrence in California includes tributaries of San Francisco Bay, such as the Napa River, Sonoma Creek, and Alameda Creek, as well as the Sacramento, San Joaquin, and Russian Rivers (Moyle et al. 1995; Moyle 2002). Although river lamprey are believed to be in decline, the exact status of this species is uncertain. Currently, very little information describing the abundance and distribution of river lamprey is available, perhaps largely in part because the species is often overlooked and seldom studied (Moyle 2002).

Adult river lamprey have two teeth and no posterior teeth on the oral disc (Wydoski and Whitney 2003), and grow to an average total length between 7 and 12 inches. Adults are dark on the back and sides with silvery yellow on the belly and dark pigmentation on the tail (Moyle 2002). Except for the last six to twelve months of life, Kern Brook lamprey and river lamprey are indistinguishable from each other (Kostow 2002).

Limited information is available regarding the life history of this species in California. Current accounts are based largely on information from Canadian populations (Moyle 2002). River lamprey is a semelparous (i.e., individuals spawn once and then die) anadromous fish with long freshwater rearing periods. Adults return to fresh water to spawn in fall and winter, but spawning usually occurs from February through March in gravely riffles in small tributary streams (Moyle 2002). Ammocoetes remain in silty backwater habitats, where they filter feed on various microorganisms for approximately 3–5 years before migrating to the ocean during late spring periods (Moyle et al. 1995; Moyle 2002). Adult lamprey prey on other fish and may reach 6.7 inches in total length (Moyle et al. 1995).

Potential threats to river lamprey include habitat alteration and degradation due to dams, diversions, pollution, channelization/dredging, urbanization, and other factors (Moyle et al. 1995). The river lamprey has been observed in SJR in the vicinity of the Project Area (Moyle et al. 2009). Various lifestages may be present year-round, although spawning habitat is not present.

3.9 San Joaquin Roach (*Lavinia symmetricus*) – State Species of Concern

San Joaquin roach are generally found in small, warm intermittent streams, and isolated pools (Moyle 1976; Moyle et al.1982), although are most abundant in the Sierra foothills (Moyle 1976). San Joaquin roach are a robust species that have been found in relatively high temperatures (86-95° F) and low oxygen levels (1-2 ppm) (Taylor et al. 1982), in cold, well aerated clear streams (Taylor et al. 1982), in human-modified habitats (Moyle 1976; Moyle and Daniels 1982), and in the main channels of rivers. Stream width and depth seem to have little effect on population abundance.

San Joaquin roach are a small, bulky fish with a large head and small, downturned mouth. Adults grow to a total length of 3.9 to 4.7 inches. Adult San Joaquin roach are grey to blue on top with a silvery underside. Spawning adults may develop orange and red colorations on the chin and paired fins. San Joaquin roach are bottom feeders that primarily consume filamentous algae, but may also feed on crustaceans and aquatic insects (Moyle 1976).

San Joaquin roach are threatened mainly due to restricted habitat from dams, diversions, and artificial barriers. Introduced predators, such as largemouth bass and green sunfish, are further decreasing isolated populations. The SJR provides potentially suitable habitat for the San Joaquin roach. Therefore, the species may occur in the Project Area.

Chapter 4 Amphibians and Reptiles

4.1 Western Pond Turtle (*Actinemys marmorata*) – State Species of Concern

The western pond turtle occurs along the Pacific Coast of North America from Baja California and into Washington and British Columbia. In California, western pond turtles inhabit up to 90% of its historic range but in the Central Valley and west of the Sierra Nevada, but in dramatically reduced numbers (Jennings and Hayes 1994).

Western pond turtles are small to medium in size, with adults averaging 4.5-8.25 inches in shell length. From a distance, this species looks uniformly dark green or brown from head to tail. Upon closer inspection, the head and neck are flecked with khaki and brown markings.

Slow moving or slack water habitats, including ponds, lakes, rivers, streams, creeks, and marshes, are typical habitat for this species. Large amounts of vegetation, partially submerged logs, rocks, or open mud banks for basking are also a necessity. The diet of the western pond turtle is omnivorous ranging from aquatic plants, invertebrates, worms, amphibian eggs, crayfish, and fish.

Nests are located upland, generally within 500 feet of the water. Western pond turtle nesting season spans from late May to early July.

Suitable habitat for western pond turtle in the Project Area includes the SJR, natural drainages, and some drainage ditches. Therefore, this species may occur in the Project Area.

4.2 San Joaquin Whipsnake (*Masticophis flagellum ruddocki*) – State Species of Concern

Although whipsnakes can be found throughout most of the southern United States and most of Mexico, the San Joaquin subspecies is endemic to California, ranging from Arbuckle in the Sacramento Valley, southward to Kern County in the San Joaquin Valley, and westward into the inner South Coast Ranges. The San Joaquin whipsnake has been designated a species of concern by the state of California due to agriculture and urban land use changes resulting in habitat loss.

The San Joaquin whipsnake is slender with smooth scales, a think neck, and a large head and large eyes protected by supraocular scales. Adults range in color from tan, olive, brown, or yellowish brown, but lack the very dark head and neckband of other subspecies.

The San Joaquin whipsnake prefers habitats consisting of dry, open or nearly treeless areas, such as grassland or saltbush scrub, often taking refuge in rodent burrows, under shaded vegetation, or under debris. The species diet consists of large insects, bats, birds, bird eggs, amphibians, lizards, carrion, and other snakes.

Saltbush scrub on the inboard side of SJR levee near Station 1335 is potentially suitable habitat. This species was not observed in this location during surveys conducted for the Harding Drain Bypass Project (Horizon 2014b).

4.3 Giant Garter Snake (*Thamnophis gigas*) – Federally Threatened, State Threatened

The giant garter snake is endemic to the valley floor wetlands of the Sacramento and San Joaquin Valleys, occurring in a variety of emergent and agricultural wetlands. San Joaquin Valley subpopulations have suffered severe declines and possible extirpation in many areas, but populations are still supported in the northern and central San Joaquin Basin, and within the northern and southern Grassland National Wildlife Refuge (Miller and Hornaday 1999). The primary threats to the giant garter snake are habitat fragmentation, loss, and degradation.

The giant garter snake is one of the larger species of garter snakes reaching a total length up to 65 inches. The adults are dull brown with a dull yellow, mid-dorsal stripe. Giant garter snakes within the San Joaquin Valley tend to have indistinctive or no lateral stripes resulting in a checkered pattern. The underside is light brown or grayish. Giant garter snakes are highly aquatic and feed on small fish, tadpoles, and frogs (Miller and Hornaday 1999).

Giant garter snakes reach sexual maturity on average in 3 years for males and 5 years for females (58 FR 54053). The species breed in March and April, giving birth to live young in late July through early September (Hansen and Hansen 1990).

Habitat consists of (1) adequate water during the snake’s active season, (2) emergent herbaceous wetland vegetation for escape and foraging habitat, (3) grassy banks and openings in waterside vegetation for basking, and (4) higher elevation upland habitat for cover and refuge from flooding. Giant garter snakes feed on small fishes, tadpoles, and frogs (Hansen and Hansen 1990).

The natural drainage on the east side of the SJR and freshwater wetlands within SJR provide marginal to potentially suitable habitat. The Harding Drain and other large ditches with emergent vegetation provide marginal habitat. This species was not observed during surveys conducted for the Harding Drain Bypass Project (Horizon 2014b).

Chapter 5 Birds

5.1 Tricolored Blackbird (*Agelaius tricolor*) – State Species of Concern

Although isolated colonies of tricolored blackbirds can be found in Oregon, Washington, Nevada, and coastal Baja California, greater than 99% of the total population of the species live in California, with 90% residing in the Central Valley most years (Shuford and Gardali 2008). Four years of censuses of all known California colony sites pointed to alarming declines in species numbers, from 369,359 in 1994 down to 162,508 in 2000 (Shuford and Gardali 2008). Habitat loss and degradation appear to be the greatest threat to tricolored blackbird numbers (Beedy and Hamilton 1999).

Tricolored blackbirds form the largest breeding colonies of any North American landbird (Cook and Toft 2005), historically selecting freshwater marshes dominated by cattails. Habitat loss and land use changes encouraged colony development within nettles, thistles, willows, Himalayan blackberry, and grain fields. The preferred breeding habitat is cattails and brushes near open water. Prior to breeding, tricolored blackbirds eat primarily grains. During the breeding season this species feeds on grasshoppers, beetles, weevils and many other insects.

There are several documented occurrences of tricolored blackbird in the vicinity of the Project Area; most these occurrences are concentrated in the lower Tuolumne River near its confluence with the SJR. In 2014, breeding was documented in a natural channel in the Modesto Regional Water Treatment Plant spray fields (UC Davis 2014). Therefore, this species may be present in the Project Area.

5.2 Burrowing Owl (*Athene cunicularia*) – State Species of Concern

Burrowing owls historic range stretched throughout most of California, with the exception of the coastal counties north of Marin and mountainous regions (Grinnell and Miller 1944). The present day range remains largely unchanged but local declines and extirpations have dramatically impacted species population.

The preferred breeding habitat for the burrowing owl is dry open rolling hills, grasslands, fallow fields, as well as disturbed lands such as golf courses, airports, road embankments, and agricultural areas (Trulio 1997; Gervais et al. 2003; Rosenberg and Haley 2004). Nests are composed of sandy soil with minimal vegetation around, and are dug out by other small animals. This species feeds on arthropods, small rodents, amphibians, reptile species, birds and carrion.

Suitable habitat is present within the Project Area. Evidence of burrowing owls was not observed during reconnaissance surveys (Horizon 2014a). The most recent sighting in the vicinity of the Project Area is from 2003 (CDFW 2014a; ebird.org 2014).

5.3 Golden Eagle (*Aquila chrysaetos*) – State Fully Protected

Golden eagles are one of the largest birds of North America, with adults weighing up to 15 pounds, reaching a length of about 3 feet, and a wingspan of up to 7 feet. Adults are brown with tawny on the back of the head and neck.

Golden eagles occur in a variety of habitats including forests, canyons, scrub lands, desert, grasslands, and oak woodlands. Large platform nests, often 10 feet across and 3 feet high, are constructed on steep cliffs or in large trees. Golden eagles feed primarily on rabbits, hares, rodents, birds, and reptiles, but will consume carrion as well.

Golden eagles are commonly observed in the canyons and foothills to the west of the Project Area (ebird.org 2014). Foraging and nesting habitat in the Project Area is marginal, however, flyover is possible.

5.4 Swainson's Hawk (*Buteo swainsoni*) – State Threatened

The Swainson's hawk is a large raptor that breeds throughout much of the western U.S., Canada, and northern Mexico. Swainson's hawk typically winter in South America (Woodbridge 1998), but there are reports of the species wintering in the Delta (Herzog 1998). In California, 95 percent of Swainson's hawks are in the Central Valley (CDFW 2007) and about 85% of Swainson's hawks nests in the Central Valley are within riparian forest or remnant riparian trees (Woodbridge 1998).

The Swainson's hawk was listed as a threatened species in the state of California following a statewide survey conducted in 1979, estimating a 90% reduction in historic numbers (Bloom 1980). The dramatic decline in population was attributed to loss of nesting habitat, pesticide use in wintering areas, and loss or adverse modifications of foraging habitat.

This species feeds on ground squirrels, voles, and other small mammal prey during the breeding season. At other times of the year insects such as grasshopper and crickets are the primary prey. Swainson's hawks prefer riparian habitats due to the availability and distribution of large nesting trees near foraging areas of open grasslands or croplands.

Swainson's hawks nesting habitat is present in the SJR corridor and the natural drainage to the west of the river. Adjacent fields provide high quality foraging habitat. This species has been observed nesting and foraging in the Project Area (Horizon 2014b).

5.5 Northern Harrier (*Circus cyaneus*) – State Species of Concern

The northern harrier is a raptor reaching a total length of 16-24 inches, with 42 inch wingspan. Northern harriers have a long tail and white underside. Adult males differ slightly in appearance with a gray back, head, and breast and black wingtips while females are brown above and streaked below.

Historic ranges in California stretched from Oregon south to the Mexican border, occupying most wetland habitats under 8,000 feet. By the 1940s, "relatively small numbers" remained in the state through the summer to breed, mainly due to substantial loss of wetland habitats (Grinnell and Miller 1944). The present day range is similar, although overall numbers have been reduced and some local populations have been extirpated (Shuford and Gardali 2008).

Northern Harriers prefer open habitats with adequate vegetative cover, such as grasslands, a wide variety of freshwater wetlands, pastures, and croplands. Northern harriers nest on the ground within dense vegetative cover (MacWhirter and Bildstein 1996). Rodents and small birds are the main source of food.

Northern harriers have been observed in the Modesto WTP spray fields (ebird.org 2014). Additionally, flood irrigated pastures provide potential nesting habitat in the Project Area.

5.6 White-Tailed Kite (*Elanus leucurus*) – State Fully Protected

The White-tailed kite is a raptor reaching a total length of 15-17 inches and a wingspan of 42 inches. Adults are a pale gray with white head, underside, and tail. The species feeds mostly on small rodents, but will occasionally consume birds, large insects, reptiles, and amphibians.

White-tailed kites prefer habitat near agricultural areas, shrubland, grasslands, meadows, or emergent wetlands. Nests are placed 20-100 feet above the ground near the top of dense oak, willow, or other tree stand (Thompson 1975). Habitat loss is the leading cause for decreasing white-tailed kite numbers.

White-tailed kites have been observed in the Modesto WTP spray fields (ebird.org 2014). Additionally, riparian areas in the SJR provide potential nesting habitat.

5.7 Bald Eagle (*Haliaeetus luecocephalus*) – Federally Delisted, State Endangered, State Fully Protected

Adult Bald eagles grow to a total length of 30-37 inches with a wingspan of 72-90 inches and a bodyweight of 10-14 pounds. Bald eagles build platform nests in large trees 50-200 feet above ground, usually near a permanent water source (Ziener 1990). Females are slightly larger than males. Bald eagles are opportunistic foragers and consume a variety of prey including fish, waterfowl, small animals, and carrion.

Although no historical population data exists, bald eagles were widespread and abundant in California. Following World War II, the use of DDT resulted in shell thinning of bald eagle eggs and devastated populations nationwide to near extinction levels. Habitat loss also negatively impacted numbers. By the 1970s, less than 30 resident, breeding pairs remained within California, all within the northern portion of the state (CDFW 2014b). Conservation efforts have helped the species rebound nationwide. In 2010, there were 323 known resident, breeding pairs in California (CDFW 2014b). In addition to the resident population, hundreds of migratory bald eagles winter at lakes, reservoirs, riparian corridors and some rangelands and coastal wetlands throughout California.

Bald eagles have been observed in the canyons and foothills to the west of the Project Area and at the Modesto WTP (ebird.org 2014). The SJR provides suitable foraging and winter roosting habitat; nesting is unlikely.

5.8 Loggerhead Shrike (*Lanius ludovicianus*) – State Species of Concern

The loggerhead shrike is widely found in lower elevations throughout the U.S. except in portions of the Northwest and Northeast. Historically, loggerhead shrikes were classified as “common” to “abundant” throughout most of California (Grinnell and Miller 1944; Grinnell and Wythe 1927; Willett 1933). Although recent and historic breeding ranges remain similar, habitat loss and degradation has led to a downward trend in population and resulted in local extirpation throughout California (Sauer et al. 1996; Sauer et al. 2005). California loggerhead shrike populations are highest in areas of the Central Valley, Coast Ranges, and the southern deserts (Saucer et al. 2005), and in winter throughout the San Joaquin Valley, the south central coast, and the south-eastern deserts (Saucer et al. 1996).

Adult loggerhead shrikes can be identified by their grey head and back, black eye mask, and black wings and tail over a white body. Adults grow to a total length of 8-10 inches. In California, loggerhead shrikes prefer shrublands or open woodlands, requiring tall shrubs or trees for perching with a mix or grass cover and bare ground for hunting. The species feeds primarily on large insects, reptiles, amphibians, small rodents, and small birds (Craig 1978; Yosef 1996). Loggerhead shrikes lack talons associated with many other birds of prey, instead impaling its prey on sharp, thorny, multistemmed plants and barbed-wire fences (Yousef 1996; Pruitt 2000).

Suitable nesting habitat for loggerhead shrikes is present in SJR riparian areas (Horizon 2014a). Therefore, this species may occur in the Project Area.

5.9 Least Bell's vireo (*Vireo bellii pusillus*) – Federally Endangered, State Endangered

The least Bell's vireo (LBV) is one of four subspecies of Bell's vireo. All subspecies are similar in appearance (Kus 2002). LBV are small birds, measuring only about 4.5 to 5.0 inches long. They have short rounded wings and short, straight bills. They are recognized in breeding areas by their distinctive call (USFWS 2006b).

The LBV is an obligate riparian species in the breeding season. The species winters in southern Baja California, Mexico (USFWS 1998b). The species typically arrives in California breeding territories in mid-March to early April. Early to mid-successional riparian habitat is typically used for nesting (Kus 2002).

Historically, the Central Valley was considered the center of LBV's breeding range (USFWS 2006b), but prior to 2005 no LBV nests had been confirmed in the Central Valley for over 50 years. There is an historic record of LBV from the late 1920s in Del Puerto Canyon, which is west of the Project Area. In June 2005, a LBV nest was founded in a riparian restoration site at the San Joaquin River National Wildlife Refuge, which is approximately 10 mile north of the Project Area. Riparian scrub in the vicinity of Stations 320+00 to 333+00 (Figure 3.4-1, Sheet 6) provides potentially suitable breeding habitat for LBV, though vegetation cover may not be quite as dense the species' preferred breeding habitat.

Chapter 6 Mammals

6.1 Western Red Bat (*Lasiurus blossevillii*) – State Species of Concern

The western red bat is a medium-sized bat with adults weighing 0.2-0.5 ounces. Adults are reddish in color and have short, broad, and rounded ears with a short, plain nose. While in flight, a relatively long tail extends straight out giving the western red bat a distinctive silhouette against the sky as compared to other species (Barbour and Davis 1969).

In California, the western red bat occurs from Shasta County to the Mexican border, west of the Sierra Nevada. Western red bats prefer to roost in forests and woodlands from sea level up through mixed conifer forests (Zeiner et al. 1990), roosting anywhere from 2-40 feet in trees near riparian corridors fields, or urban areas. Adults feed on a variety of insects, specifically moths, crickets, beetles, and cicadas, foraging over a variety of habitats, including grasslands, shrublands, open woodlands and forests, and croplands

Western red bats make a relatively short migration from the summer ranges to the coastal lowlands south of San Francisco Bay during the winter months. Potential western red bat roosting habitat is present in the SJR corridor.

6.2 American Badger (*Taxidea taxus*) – State Species of Concern

The American badger a large member of the mustelid family, with a shaggy silver, gray coat and darker colored, white striped head. Characterized by stocky, powerful legs and 1.0-1.5 inch claws, the American badger is adept at digging. Adults can weigh between 12 and 24 pounds, with males larger than females.

Found throughout most of California except in the northern North Coast area, American badgers are most abundant in drier open stages of shrub, forest, and herbaceous habitats (Zeiner et al. 1990). American badgers burrow into loose soils, frequently reusing old burrows, but may also dig a new den each night (Zeiner et al. 1990).

American badgers main food source is fossorial rodents, but will also consume reptiles, insects, eggs, birds, and carrion, depending on the season and availability of food. Drier portions of the SJR floodplain provide foraging and dispersal habitat for American badgers. Therefore, this species may possibly be in the Project Area.

6.3 San Joaquin kit fox (*Vulpes macrotis mutica*) – Federally Endangered, State Threatened

The San Joaquin kit fox (SJKF) has a small, slim body with an average weight of 5 lbs. and stands about 12 inches tall. It has long legs, large ears, and a long bushy tail that tapers at the tip. The ears are conspicuously large and densely covered on the inside with stiff, white hairs. The summer coat is light buff to buff-gray on the back and white on the belly; its winter coat is grizzled gray on the back, rust to buff on the sides, and white beneath. The tail is distinguished by a prominent black tip (USFWS 2010).

The SJKF inhabits arid valley and foothill grasslands, sparsely vegetated scrub/shrub habitats (USFWS 1998a), and some agricultural and urban areas (Jensen 1972). San Joaquin kit fox use complex dens for shelter, protection, and rearing of young (USFWS 1998a). Dens may be used year round. Most dens are located in flat terrain or the lower slopes of hills, and are commonly found in washes, drainages, and roadside berms. San Joaquin kit fox are reputed to be poor diggers and are usually found in areas with loose-textured, friable soils (USFWS 1998a).

Minimal habitat for SJKF is present in the Project Area. Lands to the west of the Project Area provide linkages for populations to the south and north (USFWS 2010). Kit fox presence in the northern range may be dependent on occasional dispersing animals from populations to the south of Santa Nella (Constable et al. 2009).

Chapter 7 References

Barr, C. B. 1991. The distribution, habitat, and status of the valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*). U.S. Fish and Wildlife Service; Sacramento, California.

Barbour, R. W., and W. H. Davis. 1969. Bats of America. University of Kentucky Press, Lexington, 285 pp.

Beedy, E. C., and Hamilton, W. J., III. 1999. Tricolored Blackbird (*Agelaius tricolor*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 423. Birds N. Am., Philadelphia.

Bloom, P.H. 1980. The status of Swainson's Hawk in California, 1979. Federal Aid in Wildlife Restoration, Project W-54-R-12, Non-Game Wildlife Investigations. Job Final Report 11-8.0. 42 pp.

Bureau of Land Management (BLM). 2014. Description of Heartleafed saltbrush, Bakersfield Office. Available: http://www.blm.gov/ca/st/en/prog/ssp/plants/atriplex_cordulata.print.html

Calflora. 2014. Calflora Plant Search [web application]. Berkeley, California. Available at: http://www.calflora.org/ , accessed: May 30, 2014

California Department of Fish and Wildlife (CDFW). 2004. Sacramento River Spring-Run Chinook Salmon. 2002-2003 Biennial Report. Prepared by CDFW Habitat Conservation Division, Native Anadromous Fish and Watershed Branch. June. Available: http://www.dfg.ca.gov/fish/Resources/Chinook/.

_____. 2007. California Swainson's Hawk Inventory: 2005-2006. UC Davis Wildlife Health Center. 2007 Final Report. P0485902. May 31. Available: file:///C:/Users/Jacob/Downloads/RAP-final-report-form-2007.pdf.

_____. 2014a. California Natural Diversity Database (CNDDB). Biogeographic Data Branch. Sacramento, California. October 2014 update.

_____. 2014b. Bald Eagles in California. Available: http://www.dfg.ca.gov/wildlife/nongame/t_e_spp/bald_eagle/index.html.

California Native Plant Society (CNPS). 2014. Inventory of Rare and Endangered Plants (online edition, v8-02). California Native Plant Society, Sacramento, CA. Website. Available at: http://www.rareplants.cnps.org, accessed May 30 2014

Consortium of California Herbaria (CCH). 2014a. Accession results for Astragalus tener var. tener UC764740. Accessed at: ucjeps.berkeley.edu/consortium/; Mon Jun 2 16:20:04 2014

Consortium of California Herbaria (CCH). 2014b. Accession results for Atriplex minuscula UC1010740. Available at: ucjeps.berkeley.edu/consortium/. Accessed on June 2, 2014

Constable, Julie L., B.L. Cypher, S.E. Phillips, P.A. Kelly. 2009. Conservation Of San Joaquin Kit Foxes In Western Merced County, California. Prepared for the U.S. Bureau of Reclamation.

Cook, L. F., Toft, C. A. 2005. Dynamics of extinction: population decline in the colonially nesting Tricolored Blackbird *Agelaius tricolor*. Bird Conservation International 15: 73-88.

Craig, R. B. 1978. An analysis of the predatory behavior of the Loggerhead Shrike. Auk 95:221–234.

Dambacher, J. M. 1991. Distribution, abundance, and emigration of juvenile steelhead (*Oncorhynchus mykiss*), and analysis of stream habitat in the Steamboat Creek Basin, Oregon. M.S. Thesis. Fisheries Science, Oregon State University. 129 pp.

Dixon, J. B. 1937. The golden eagle in San Diego County, California. Condor 39:49-56.

ebird.org. 2014. Observations for Modesto Wastewater Treatment Plant and Modesto Wastewater Treatment Plant Agricultural Fields. Available: http://ebird.org/ebird/hotspot/L246766 and http://ebird.org/ebird/hotspot/L109389. Accessed July 14, 2014.

Eriksen, C. and D. Belk. 1999. Fairy Shrimps of California's Puddles, Pools, and Playas. 1999. Mad River Press, Eureka, California.

Gervais, J. A., Rosenberg, D. K., and Anthony, R. G. 2003. Space use and pesticide exposure risk of male Burrowing Owls in an agricultural landscape. J. Wildlife Mgmt. 67:156–165.

Grinnell, J., and Wythe, M. 1927. Directory to the bird-life of the San Francisco Bay region. Pac. Coast Avifauna no. 18.

Grinnell, J., and Miller, A. H. 1944. The distribution of the birds of California. Pac. Coast Avifauna no. 27.

Gutierrez, Monica. 2014. Fisheries Biologist, National Marine Fisheries Serv. Personal communication with Jennifer Lewis of U.S. Bureau of Reclamation regarding presence of green sturgeon in the Project Area.

Hanni, J., Poytress, B., Blaylock-Herod, H. 2006. Spatial and Temporal Distribution Patterns of Pacific and River Lamprey in the Sacramento and San Joaquin Rivers and Delta. Poster for American Fisheries Society, 40th annual meeting of the American Fisheries Society California-Nevada Chapter. Available: http://www.fws.gov/stockton/jfmp/datareports.asp.

Hansen, R.W. and G.E. Hansen. 1990. *Thamnophis gigas*. Reproduction. Herpetological Review 21(4):93-94.

Helm, B. 1998. The biogeography of eight large branchiopods endemic to California. Pp. 124-139 In C.W. Witham, E. Bauder, D. Belk, W. Ferren, and R. Ornduff (eds.). Ecology, Conservation, and Management of Vernal Pool Ecosystems – Proceedings from a 1996 Conference. California Native Plant Society, Sacramento, California

Helm, B.P. and J.E. Vollmar. 2002. Large Branchiopods. In: Vollmar, J.E. (Ed.). 2002. Wildlife and Rare Plant Ecology of Eastern Merced County's Vernal Pool Grasslands. Vollmar Consulting, Berkeley, CA.

Hill, K. A., and Webber, J. D. 1999. Butte Creek springrun Chinook salmon, *Oncorhynchus tshawytscha*, juvenile outmigration and life history 1995–1998. Inland Fisheries Administrative Report no. 99-5. California Department of Fish and Game, Sacramento Valley and Central Sierra Region. Rancho Cordova, CA.

Horizon Water and Environment (Horizon). 2014a. North Valley Regional Recycled Water Program: Biological Resources Report. Prepared for RMC Water and Environment.

Horizon Water and Environment (Horizon). 2014b. Construction Completion Report for the Harding Drain Bypass Project. Prepared for the City of Turlock. May.

Howell, C.A., J. Wood, M.D. Dettling, K. Griggs, C. Otte, L. Lina, and T. Gardali. 2010. Least Bell's Vireo breeding records in the Central Valley following decades of extirpation. Western North American Naturalist 70(1):105-11

Jackson, Z. J., and J. P. Van Eenennaam. 2013. 2012 San Joaquin River sturgeon spawning survey. Stockton Fish and Wildlife Office, Anadromous Fish Restoration Program, U.S. Fish and Wildlife Service, Lodi, California.

Jennings, M.R. and M.P. Hayes. 1994. Amphibian and Reptile Species of Concern in California. Final Report to the California Department of Fish and Game Inland Fisheries Division.

Jepson Flora Project. 2013. Jepson eFlora. Available at: http://ucjeps.berkeley.edu/IJM.html, accessed on May 30 2014

King, F., and Behler, J. 1979. The Audubon Society Field Guide to North America Reptiles and Amphibians. New York: Alfred A. Knopf, Inc.

Kostow, K. 2002. Oregon lampreys: natural history, status, and analysis of management issues. Oregon Department of Fish and Wildlife, Portland, Oregon.

Kus, B. 2002. Least Bell's Vireo (*Vireo bellii pusillus*). In The Riparian Bird Conservation Plan: a strategy for reversing the decline of riparian-associated birds in California. California Partners in Flight. http://www.prbo.org/calpif/htmldocs/riparian_v-2.html

Lindley S.T., R. Schick, B.P. May, J.J. Anderson, S.S. Greene, C.C. Hanson, A. Low, D. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2004. Population Structure of Threatened and Endangered Chinook Salmon ESUs in California's Central Valley Basin. NOAA Technical Memorandum NOAA TM NMFS SWFSC 360. April.

LSA Associates. 2012. Solano County HCP, Public Draft. Species account for Alkali Milk-Vetch. Prepared for Solano County Water Agency. Available: http://www.scwa2.com/Documents/hcp/Pre-public%20draft/Appendices/Appendix%20B/VFGandVP/Plants/H-6.Alkali%20Milk%20Vetch.pdf.

MacWhirter, R.B., and Bildstein, K.L. 1996. Northern Harrier (*Circus cyaneus*), in the Brids of North America (A. Poole and F. Gill, eds.), no. 210. Acad. Nat. Sci., Philadelphia.

McEwan, D. 2001. Central Valley Steelhead. Pages 620 in R. L. Brown (editor), Contributions to the Biology of Central Valley Salmonids, Vol. 1, Fish Bulletin 179. Sacramento, CA: California Department of Fish and Wildlife.

Merz, J. E. 2002. Seasonal feeding habits, growth, and movement of steelhead trout in the lower Mokelumne River, California. California Department Fish and Wildlife 88:95–111.

Merz, Joe, Restoration Ecologist, Cramer Fish Sciences. July 10, 2014. Personal communication with Kevin Fisher of Horizon regarding presence of fish species observed in the San Joaquin River.

Miller, Karen J. and Hornaday, Kelly. 1999. DRAFT Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*). U.S. Fish and Wildlife Service and the Giant Garter Snake Recovery Team.

Moyle, P. B., and Nichols, R. D. 1973. Ecology of some native and introduced fishes of the Sierra Nevada foothills in central California. Copeia 1973:478–490.

Moyle, P.B. 1976. Inland fishes of California. University of California Press. Berkeley, California.

Moyle, P. B., and Daniels, R. A. 1982. Fishes of the Pit River system, and Surprise Valley region. Zoology 115:1–82.

Moyle, P. B., and Baltz, D. M. 1985. Microhabitat use by an assemblage of California stream fishes: developing criteria for instream flow recommendations. Transactions of the American Fisheries Society 114:695–704.

Moyle, P. B., Williams, J. E., and Wikramanayake, E. D. 1989. Fish species of special concern of California. Final report submitted to State of California Resources Agency.

Moyle, P. B., Yoshiyama, R. M., Williams, J. E., and Wikramanayake, E. D. 1995. Fish Species of Special Concern in California: Second Edition. Prepared for California Fish and Game by the University of California, Davis, Department of Wildlife and Fisheries Biology. 272 pp.

Moyle, Peter B. 2002. Inland Fishes of California. University of California Press. Berkeley, California.

Moyle, P. B., Israel, J. A., and Purdy, S. E. 2008. Salmon, steelhead and trout in California: Status of an emblematic fauna. Prepared for California Trout by University of California, Davis, Center for Watershed Science. 316 pp.

Moyle, P. B., Brown, L. R., Chase, S. D., and Quinones, R. M. 2009. Status and conservation of lampreys in California. American Fisheries Society Symposium 72:000-000.

Nakamoto, R. J., Kisanuki, T. T., and Goldsmith, G. H. 1995. Age and growth of Klamath River green sturgeon (*Acipenser medirostris*). U.S. Fish and Wildlife Service, Klamath River Fishery Resource Office, Project No. 93-FP-13. 20 pp.

National Marine Fisheries Service (NMFS). 2009a. Biological opinion and conference opinion on the long-term operations of the Central Valley Project and the State Water Project. NMFS, Southwest Region, Long Beach, California. http://cdm16658.contentdm.oclc.org/cdm/ref/collection/p267501ccp2/id/1701.

_____. 2009b. Species of Concern profile: Chinook Salmon (*Oncorhynchus tshawytscha*). Available: http://www.nmfs.noaa.gov/pr/pdfs/species/Chinooksalmon_detailed.pdf

Pacific Flyway Council (PFC). 1999. Pacific Flyway management plan for the cackling Canada goose. Cackling Canada Goose Subcomm. Pacific Flyway Study Comm. [c/o USFWS], Portland, OR. Unpubl. Rept. 36 pp.

Pruitt, L. 2000. Loggerhead Shrike status assessment. U.S. Fish and Wildlife Service. Bloomington, IN

Rosenberg, D. K., and Haley, K. L. 2004. The ecology of Burrowing Owls in the agroecosystem of the Imperial Valley, California. Studies Avian Biol. 27:120–135.

San Joaquin River Restoration Program (SJRRP). 2014. U.S. Fish and Wildlife Service and Reclamation Release Spring-run Chinook Salmon into the San Joaquin River for Study. News bulletin released by the Bureau of Reclamation and U.S. Fish and Wildlife Service, 17 April 2014.

Sauer, J. R., Schwartz, S., and Hoover, B. 1996. The Christmas Bird Count Home Page, version 95.1. Patuxent Wildlife Rescue Center, Laurel, MD. Available: http://birds.audubon.org/christmas-bird-count.

Sauer, J. R., Hines, J. E., and Fallon, J. 2005. The North American Breeding Bird Survey, results and analysis 1966–2004, version 2005.2. USGS Patuxent Wildl. Res. Ctr. Available: https://www.pwrc.usgs.gov/bbs/.

Shuford, W. D., and Gardali, T., editors. 2008. California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Studies of Western Birds. Western Field Ornithologists and California Department of Fish and Wildlife.

Skinner, M. and B. Pavlik, 1994. Inventory of rare and endangered vascular plants of California. CA Native Plant Society Sacramento, 338 pp.

Smith, D. G., and J. R. Murphy. 1973. Breeding ecology of raptors in the eastern Great Basin of Utah. Brigham Young Univ., Provo. Sci. Bull. Biol. Ser. 18, No. 3. 76pp.

Stillwater Sciences. 2011. Tuolumne River 2010 Oncorhynchus mykiss Monitoring Summary Report. Prepared for the Turlock Irrigation District and Modesto Irrigation District. Berkeley, California.

Stutz, H.C., and G. L. Chu. 1993. *Atriplex persistens* (Chenopodiaceae), a new species from California. Madrono 40:209-213

Taylor, T.L., P.B. Moyle, and D.G. Price. 1982. Fishes of the Clear Lake Basin. University of California Publ. Zool. 115:171-224.

Thompson, B. C. 1975. A new prey-pursuit behavior by white-tailed hawks. Auk 92:395.

Trulio, L. 1997. Burrowing owl demography and habitat use at two urban sites in Santa Clara County, California. Raptor Res. Rep. 9:84-89.

University of California, Davis (UC Davis). 2014. Tricolored Blackbird Portal. 2014 Breeding Colony Location Maps. Available: http://tricolor.ice.ucdavis.edu/content/breeding-colony-location-maps

U.S. Fish and Wildlife Service (USFWS). 1998a. Recovery Plan for Upland Species of the San Joaquin Valley. Fish and Wildlife Service, Portland, Oregon. Available at: http://ecos.fws.gov/docs/recovery_plan/980930a.pdf

_____. 1998b. Draft Recovery Plan for the Least Bell's Vireo. Fish and Wildlife Service, Portland, Oregon. Available at: http://ecos.fws.gov/docs/recovery_plan/980506.pdf

_____. 1999a. Draft Recovery Plan for the Giant Garter Snake. U.S. Fish and Wildlife Service, Region 1. Available at: http://ecos.fws.gov/docs/recovery_plan/990702b.pdf

_____. 1999b. Conservation Guidelines for Valley Elderberry Longhorn Beetle. U.S. Fish and Wildlife Service, Sacramento, California. 9 July 1999. Available at: http://www.fws.gov/sacramento/es/Survey-Protocols-Guidelines/Documents/velb_conservation.pdf.

_____. 2006a. Valley Elderberry Longhorn Beetle 5-Year Review. U.S. Fish and Wildlife Service Sacramento Fish and Wildlife Office, Sacramento, California. September 2006. Available at: http://www.fws.gov/cno/es/VELB%205-year%20review.FINAL.pdf

_____. 2006b. Least Bell's Vireo 5-Year Review, Summary and Evaluation. U.S. Fish and Wildlife Service Carlsbad Fish and Wildlife Office, Carlsbad, California. September. http://ecos.fws.gov/docs/five_year_review/doc781.pdf

_____. 2007a. Species Account Vernal Pool Tadpole Shrimp. Available: http://www.fws.gov/sacramento/ES/Five-Year-Reviews/es_five-year.htm.

_____. 2007b. Vernal Pool Tadpole Shrimp 5-Year Review. U.S. Fish and Wildlife Service Sacramento Fish and Wildlife Office, Sacramento, California. September. Available: http://ecos.fws.gov/docs/five_year_review/doc1160.pdf.

_____. 2007c. Species Account Vernal Pool Fairy Shrimp. Sacramento Fish and Wildlife Office. December. Available: http://ecos.fws.gov/docs/five_year_review/doc1150.pdf.

_____. 2010. San Joaquin Kit Fox 5-Year Review. Sacramento Fish and Wildlife Office. February. Available: http://ecos.fws.gov/docs/five_year_review/doc3222.pdf

_____. 2012a. Conservancy Fairy Shrimp (*Branchinecta conservatio*) 5-Year Review (2012). Sacramento Fish and Wildlife Office. June. Available: http://ecos.fws.gov/docs/five_year_review/doc4012.pdf

_____. 2012b. Longhorn Fairy Shrimp (*Branchinecta longiantenna*) 5-Year Review (2012). Sacramento Fish and Wildlife Office. June. Available: http://ecos.fws.gov/docs/five_year_review/doc4011.pdf

_____. 2012c. Giant Garter Snake (*Thamnophis gigas*), Five-year Review: Summary and Evaluation. June. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office. Available at: http://ecos.fws.gov/docs/five_year_review/doc4009.pdf

_____. 2014. Species Account for Alkali Milk-Vetch. Available: http://www.fws.gov/sacramento/es/Recovery-Planning/Vernal-Pool/Documents/alkali_milk-vetch.pdf.

Warren, Kelly. 2006. Identification Field Guide to the Geese of the Willamette Valley and Lower Columbia River, 2nd edition. Wild Spirit Resources LLC.

Willett, G. 1933. A revised list of the birds of southwest-ern California. Pac. Coast Avifauna 21.

Williams, J.G. 2006. Central Valley salmon: a perspective on Chinook and steelhead in the Central Valley of California. San Francisco Estuary and Watershed Science. Available: http://repositories.cdlib.org/jmie/sfews/vol4/iss3/art2

Woodbridge, B. 1998. Swainson's Hawk (*Buteo swainsoni*). The Riparian Bird Conservation Plan. California Partners in Flight: a strategy for reversing the decline of desert-associated birds in California. Available: http://www.prbo.org/calpif/htmldocs/species/riparian/swainsons_hawk.htm

Wydoski, R. S., and Whitney, R. R. 1979. Inland fishes of Washington. University of Washington Press, Seattle, WA.

Yosef, R. 1996. Loggerhead Shrike (*Lanius ludovicianus*) in The Birds of North America, No. 231 (A. Poole Ed.) Cornell Lab of Ornithology, Ithaca, New York.

Zeiner, D.C., Laudenslayer Jr., W.F., Mayer, K.E., and White, M. eds. 1988-1990. California's Wildlife. Vol. I-III. California Department of Fish and Game, Sacramento, California.

Appendix E – Assessment of Potential Effects on Fishery Habitat

This page intentionally left blank

Assessment of Potential Effects of the North Valley Regional Recycled Water Program (NVRRWP) Reductions in Freshwater Discharges into the

San Joaquin River on Fishery Habitat and Juvenile Salmon Survival

Hanson Environmental, Inc.
446 green view court
walnut creek, ca
August 2013

Chapter 1 Introduction

The San Joaquin River provides habitat for a diverse assemblage of fish and aquatic macroinvertebrates. The river also serves as a migration corridor and juvenile rearing habitat for Chinook salmon. Results of previous studies have shown positive relationships between the flow in the San Joaquin River during the spring (e.g., March-May) and the survival of juvenile salmon as well as adult salmon escapement 2.5 years later. Currently the Modesto and Turlock waste water treatment plants (WWTP) discharge treated waste water into the San Joaquin River where it augments existing flows and therefore provides potential biological benefits to improved habitat conditions for salmon and other fishery resources. As shown in Table 1, the Modesto and Turlock WWTPs release an average of 25 cfs into the San Joaquin River with a range of average monthly flows of 12.9 – 51.4 cfs. The North Valley Regional Recycled Water Program (NVRRWP) is proposing that rather than discharging the treated and processed waste water into the San Joaquin River as is currently being done, the Modesto and Turlock treatment plants would recycle the waste water for other inland uses such as irrigation of farmland. The curtailment in WWTP discharges from these two plants into the river would result in an incremental reduction in river flows as shown in Table 1. For comparison, the average flow in the San Joaquin River during the spring months (March – May) of dry water years typically ranges from approximately 1,500 to 2,000 cfs while average flows in a normal water year typically range from approximately 3,000 to 4,000 cfs. Spring flows in a wet year typically range from approximately 8,000 to 14,000 cfs. The actual flow in the San Joaquin River varies substantially within and among years.

Table 1: Average monthly WWTP discharges to San Joaquin River in cfs from 2000-2012

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Modesto	31.4	38.2	35.2	10.1	7.0	0.0	0.0	0.0	0.0	0.1	5.1	17.7
Turlock	13.1	13.2	12.9	13.0	12.7	12.9	12.9	13.4	13.3	13.8	13.3	13.4
Total	**44.5**	**51.4**	**48.1**	**23.1**	**19.7**	**12.9**	**12.9**	**13.4**	**13.3**	**13.9**	**18.4**	**31.1**

Although the amount of spring discharges is relatively small compared to total river flows (e.g., for example the April average WWTP discharge is 23.2 cfs and the San Joaquin River mean April flow at Vernalis is 3,095 cfs), the removal of these discharges into the San Joaquin River would contribute to an incremental reduction in the water levels and flows in the river downstream of the discharge location. This reduction in river flow could potentially adversely affect habitat conditions in the river for fish and the survival of juvenile salmon during their spring migration from the river to coastal marine waters. The objective of this analysis is to evaluate the potential for adverse effects of a reduction in freshwater discharges to the San Joaquin River as a result of the proposed NVRRWP water recycling project on instream flows, fishery habitat and juvenile Chinook salmon survival and abundance.

Chapter 2 Approach/Methods

To assess the potential effects of reducing San Joaquin River flows as a result of implementing the water recycle program and curtailing the discharge of treated waste water to the river, Chinook salmon were selected as the indicator species for use in these analyses. Quantitative data on the relationships between San Joaquin River flows and habitat quality and availability, survival, and abundance are not available for other fish species inhabiting the river and therefore the potential effects of the proposed recycle project could not be quantified for these other fish species. Fall-run Chinook salmon are a species sensitive to changes in instream flows and other environmental factors such as exposure to seasonally elevated water temperature when compared to the greater tolerance of many of the resident and other migratory fish and therefore are considered to be a good indicator species for use in this assessment.

Fall-run Chinook salmon use the San Joaquin River tributaries for spawning and juvenile rearing. The juvenile salmon then migrate downstream through the lower river during the late winter and spring months. The greatest migration by juvenile salmon smolts occurs during March-May. The survival of juvenile salmon has also been shown to vary in response to changes in river flow during the spring migration period (SJRGA 2007). To assess the potential effects of changes in river flow four independent analyses were considered including (1) the predicted change in juvenile salmon survival as a function of river flow, (2) the predicted change in adult salmon escapement as a function of river flow during the spring outmigration period 2.5 years earlier, (3) changes in river habitat based on stage-discharge relationships developed for the river by the U.S. Geological Survey (USGS) and the location of the estuarine low salinity zone during biologically sensitive spring months, and (4) predicted changes in salmon abundance based on use of the California Department of Fish and Wildlife (CDFW) San Joaquin River fall-run salmon lifecycle simulation model (SalSim). By comparing historic flows to those flows without the addition of WWTP discharges we are able to simulate the potential effect that the removal of WWTP discharges will have on salmon from a variety of metrics.

2.1 Base Vs Adjusted Flow Conditions

To simulate the potential effects that the removal of WWTP discharge from the San Joaquin river system would have on potential salmon survival and abundance, it was first necessary to establish baseflow conditions in the river with the existing WWTP discharges and simulated river flow conditions without the contribution of the WWTP discharges. For purposes of these biological analyses, river flow at the USGS Vernalis gage was selected to represent baseflow conditions. Although the WWTP discharge occurs further upstream on the San Joaquin River, the flows at Vernalis were selected since the existing biological relationships between river flow and juvenile salmon survival, river flow and subsequent adult escapement, and Vernalis flows are a key driver in the SalSim lifecycle model. Average daily flows were compiled for the Vernalis gage from the USGS website for March, April and May, 1923-2012. In order to account for yearly variation, 5, 25, 50(mean) and 75 percentile flow data was used to represent “critical”, “dry”, “normal” and “wet” flow conditions. The daily average flow was used to create a monthly average. These average months are used to represent the “base” flow conditions in the lower San Joaquin River under existing conditions with the WWTP discharges in operation.

WWTP discharge levels were calculated using the average monthly discharge from the Modesto and Turlock plants for March, April and May for 2000-2012 (Table 1). These average monthly discharge rates were then subtracted from the corresponding average monthly river flow at the Vernalis gage to create the “adjusted” flow. The values for the base and adjusted flows were then entered into various survival models described below in order to predict how these changes in flow conditions may effect salmon survival and abundance.

Percent differences were calculated as:

$$\% = (1 – (\text{Adjusted flow}/\text{Base flow}))*100$$

2.2 Juvenile salmon survival-flow relationships

The San Joaquin River Agreement (SJRA) and Vernalis Adaptive Management Plan (VAMP) conducted a long-term scientific experiment to determine how juvenile salmon survival rates change in response to alterations in San Joaquin River flows and State Water Project (SWP)/Central Valley Project (CVP) exports with the installation of the Head of Old River Barrier (HORB). The survival studies were based on a mark-recapture experimental design in which juvenile fall-run Chinook salmon produced in the Merced River fish hatchery were coded wire tagged (CWT) and released into the San Joaquin River at Mossdale and Durham Ferry and subsequently recaptured downstream at Antioch and Chipps Island (SJRGA 2007). Additional CWT salmon were released at Jersey Point to act as a control. The ratio of CWT salmon recaptured from the upstream and downstream release sites was then used to calculate an estimate of juvenile salmon survival. The resulting survival estimates were then correlated with river flows measured at the Vernalis gage during the period of juvenile migration when the HORB was installed and when it was not installed. The relationship between survival estimates for juvenile salmon based on recaptures at Antioch and Chipps Island were significantly related to corresponding estimates of survival based on adult salmon from the ocean fishery (SJRGA 2007), which improves the confidence in the use of the juvenile survival-flow relationship as the basis for this analysis. Regression analysis from these data was used as a predictive model to assess the potential change in juvenile salmon survival as a function of reducing river flow in response to the curtailment of the WWTP discharges. The flow-survival relationships with and without the HORB are shown in Figure 1. The regression equations used to predict the change in juvenile survival as a function of river flow during the spring migration period are:

With HORB

Survival estimate = 0.0001(cfs)-0.2851

$R^2 = 0.73$

Without HORB

Survival estimate = 5e-6(cfs) + 0.1403

$R^2 = 0.04$

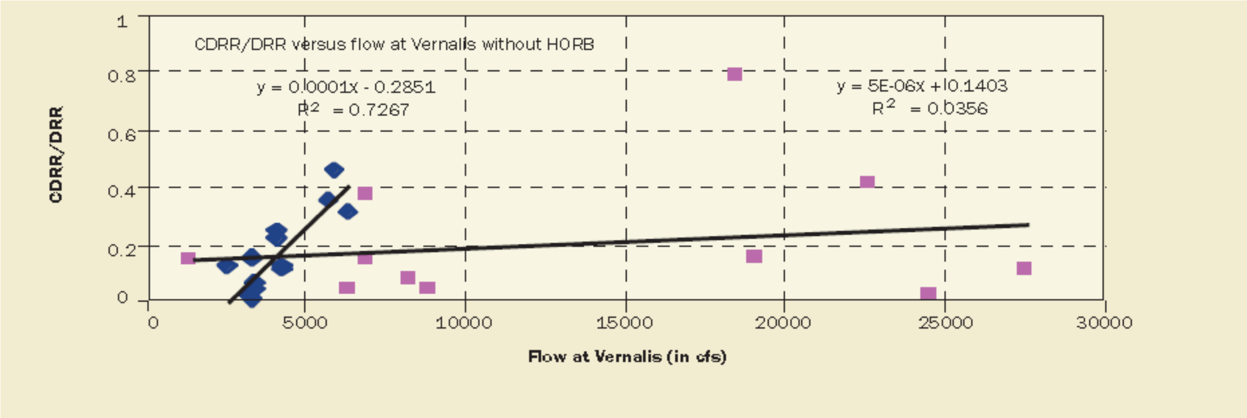


Figure 1: Relationships between juvenile salmon survival and flow in the San Joaquin River at Vernalis with and without the Head of Old River Barrier (HORB). The blue dots reflect flow-survival estimates when the HORB was installed and the red dots reflect flow-survival estimates when the HORB was not installed based on juvenile fall-run Chinook salmon mark-recapture experiments with tagged salmon released at Mossdale and Durham Ferry and recaptured at Chipps Island. Source: SJRGA 2007.

2.2.1 Escapement

Adult fall-run Chinook salmon return (escape) from the ocean and migrate through the San Joaquin River to spawn in upstream tributaries. Surveys have routinely been conducted by CDFW within the tributaries during the fall spawning period to quantify the number of spawning adults each year. Salmon escapement estimates are available for the period from 1952 through 2010 from the CDFW GranTab Chinook salmon escapement summaries. For these analyses, annual adult escapement to the Stanislaus, Tuolumne, and Merced rivers were combined to generate an annual estimate of fall-run Chinook salmon escapement to the San Joaquin River basin. No salmon currently spawn in the San Joaquin River between the confluence with the Merced River and Friant Dam, although restoration of salmon populations in this reach of the river is underway. Although there are many factors effecting adult escapement and survival rates, studies have correlated San Joaquin River flows when juvenile salmon are migrating downstream in the spring with subsequent adult escapement in the fall 2.5 years later. For the analysis of changes in river flow presented in this assessment the average March-May flow in the San Joaquin River at the Vernalis gage from the USGS and DWR DAYFLOW data summaries were compiled each year. Regression analyses were used to establish a relationship between average spring river flow and subsequent adult salmon escapement 2.5 years later.

Regression analysis was used to predict escapement under the baseflow and adjusted flow conditions based on the following equation:

$$\text{Escapement} = 1.5879\ (\text{cfs}) + 11{,}458$$
$$R^2 = 0.32$$

2.2.2 River and Delta habitat

As flow through a channel increases the channel depth and/or wetted width increases, which may affect the area of usable habitat for juvenile salmon and other migrant and resident fish. As part of maintaining streamflow gages USGS periodically measures the stage-discharge relationship for each monitoring location. The shape of the stage-discharge curve is determined by the shape of the channel at the gage location. As the geomorphology of riverbeds change over time, regular stage-discharge surveys are necessary to insure accurate flow measurements at each gage. The most current stage-discharge relationship from the USGS gage at Vernalis (Figure 2) was used to simulate channel depths as an indicator of habitat conditions within the river with and without the WWTP discharges. Percent changes in the base versus adjusted flow conditions indicate predicted percent changes in salmon habitat with the removal of the WWTP discharge.

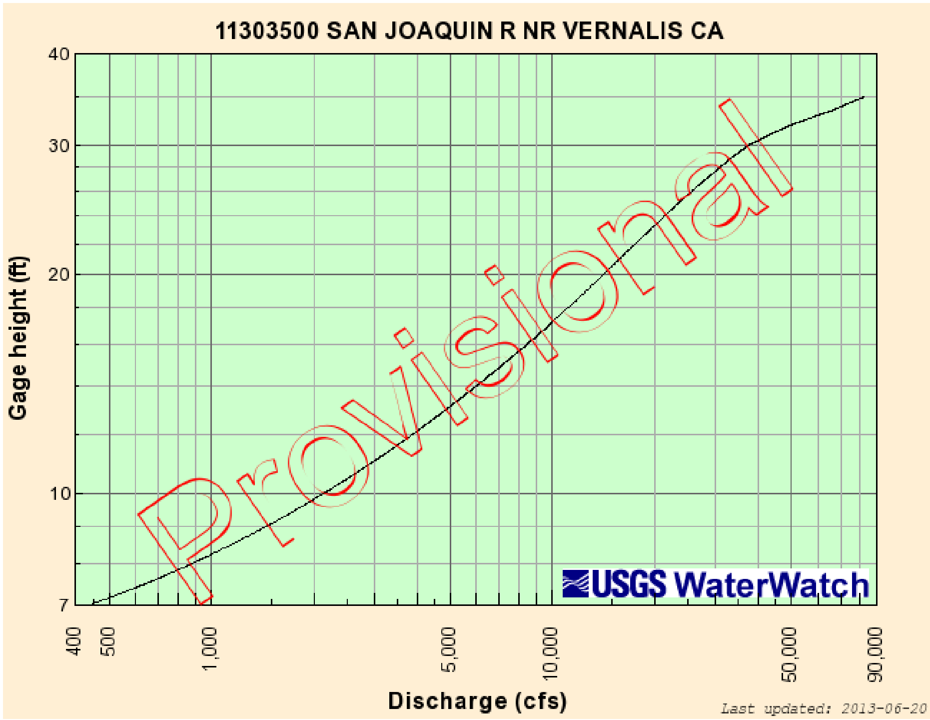


Figure 2: USGS stage-discharge relationship for the San Joaquin gage at Vernalis.

Habitat conditions for fish and other aquatic resources inhabiting the Delta and estuarine regions of the system have frequently been linked to the location of the low salinity zone. One indicator of the low salinity zone is the location, in kilometers upstream from the Golden Gate Bridge, where bottom salinity is 2 psu (referred to as X2 location). The location of the low salinity zone in the estuary is a function of the tides moving saltwater upstream from the ocean and bays and the magnitude of freshwater moving downstream from the Sacramento, San Joaquin, and other Central Valley rivers (referred to as Delta outflow). The relationship between Delta outflow and X2 location was used to assess the potential magnitude in changes of X2 location with and without the WWTP discharges. The analysis focused on X2 location during the biologically sensitive spring months of March-May. The change in X2 location was based on the following equation:

$$X2(t) = 10.16+0.945*X2(t-1)-1.487\log(Qout)(t)$$

where t=current day Delta outflow and t-1 is the X2 location on the previous day.

The analysis was run over Delta outflows ranging from approximately 3,500 to 23,000 cfs and assuming the total monthly WWTP discharge during March-May shown in Table 1.

2.2.3 SalSim

The CDFW has developed a lifecycle simulation model for fall-run Chinook salmon produced in San Joaquin River tributaries. The SalSim model (http://www.salsim.com/) is based on a series of relationships between river flows, reservoir storage, water temperature, and a combination of other factors affecting survival and abundance in the upstream tributaries, within the lower San Joaquin River and Delta, and within the ocean. The SalSim model uses a variety of historic hydrological and biological data to simulate hypothetical flow conditions and the response of the Chinook salmon population. Although SalSim was not designed to be used as a "forecast model", altering the historic flows by known amounts generates alternative scenarios in which “what if” models can be used to simulate alternative salmon production through changes in historic water operations.

For this study, we simulated eight different flow conditions: critical, dry, normal and wet hydrologic conditions assuming baseline flows and adjusted flows at Vernalis without the WWTP discharges. The baseline conditions were generated by running the simulation without any changes to the flow conditions. The WWTP discharge reduction scenario (Adjusted) was simulated in the SalSim model by reflecting the percent change in river flow based on the WWTP discharge rates presented in Table 1. Because the simulation was run year round, rather than just during the spring, the WWTP discharge reduction calculations were calculated for an entire year. Total monthly WWTP discharges (Table 1) were subtracted from the monthly river flow at the USGS Vernalis gage under “Critical” (5 percentile), “Dry” (25 percentile), “Normal” (50 percentile or mean) and “Wet” (75 percentile) hydrologic conditions in the model. From these values, a percent change from the baseline flow was calculated.

SalSim was then used to simulate the changes in hydrologic conditions that would occur in the river with and without the WWTP discharges. SalSim produces a number of salmon population metrics for use in the analysis including ocean escapement, total spawners for all tributary spawning destinations, total spawning and egg production within the tributaries, total egg mortality, total juvenile salmon mortality and an estimate of the total number of juvenile salmon produced in the San Joaquin River tributaries entering the ocean assuming river flows with and without the WWTP discharges. The potential effect of changes in river flow on fall-run Chinook salmon population dynamics was assessed based on consideration of both the change in the abundance of various lifestages as well as the percentage change to account for variation in salmon abundance among years.

Results of the SalSim modeling produced a number of biological metrics for various lifestages of fall-run Chinook salmon under the baseline and proposed project hydrologic conditions. The model, however, does not allow changes to be made to instream flows in the San Joaquin River, but rather only allows flow changes in the model to occur in the upstream tributaries. By reducing flow in one of the tributaries to try to simulate the predicted flow reduction associated with the proposed project the model also changed upstream reservoir storage and associated seasonal water temperature conditions within the tributary that also affected the survival estimates for Chinook salmon (e.g., incubating eggs and juvenile rearing) within the tributary. Under these simulated conditions, results of the model became unstable and in some cases inconsistent with the general population dynamics of fall-run Chinook salmon. The initial results of the simulation model comparisons were not realistic or reliable. To help try to resolve these initial simulation model inconsistencies we met with Dale Stanton, an engineer with CDFW who is actively involved in development and evaluation of the SalSim model, to discuss how the model could be configured to simulate changes in San Joaquin River flows associated with the proposed project, while not altering upstream reservoir operations and other aspects of the model. Mr. Stanton reported that the SalSim model was not developed to address changes in San Joaquin River flows such as those that would occur under the proposed project operations, and therefore, the model could not be used to reliably predict changes in San Joaquin River fall-run Chinook salmon abundance or population dynamics as an assessment tool for the proposed project evaluation. Based on these initial model results and consultation with CDFW the SalSim model was not subsequently used in these analyses.

Chapter 3 Results

3.1 Flow differences with and without WWTP discharges

Predicted changes to San Joaquin River flow when the WWTP discharge is removed (Adjusted flow) is on average less than 1% (ranges from 0.16 – 2.46%) of the total San Joaquin River flow (base flow) between March and May. Throughout the spring juvenile salmon migration season, the rate of WWTP discharges is reduced from an average 48.2 cfs in March to an average 19.8 cfs in May (Table 1). Dry, normal and wet years, as modeled by analyzing the 25th, 50th (mean) and 75th flow percentages from the

Vernalis gage, showed that in dry and normal years, the net flow did not widely vary. Wet years, however show a steep increase in river flow during the March-May period. As a result, the net change in river flow at Vernalis is reduced in proportion to the change in baseflows within the river (Table 2). Results of these flow analyses were used in the comparative assessment of predicted changes to salmon survival and abundance with and without the WWTP discharges.

Table 2: Spring flow rates (cfs) for dry, normal and wet years, the average WWTP discharge rate (cfs) for their associated months and the percentage difference with and without the WWTP discharges.

	March			April			May		
	25th %	Mean	75th %	25th %	Mean	75th %	25th %	Mean	75th %
Base Flow (cfs)	1,957	3,481	9,178	1,600	3,095	10,392	1,739	3,470	12,126
WWTP Discharges (cfs)	48.2	48.2	48.2	23.2	23.2	23.2	19.8	19.8	19.8
Adjusted Flow (cfs)	1,909	3,433	9,130	1,577	3,072	10,369	1,719	3,450	12,106
% Change	**2.46%**	**1.38%**	**0.53%**	**1.45%**	**0.75%**	**0.22%**	**1.14%**	**0.57%**	**0.16%**

3.2 Juvenile Chinook salmon survival

Previous studies of juvenile salmon survival in the San Joaquin River clearly show that the presence of the HORB, used to keep juvenile salmon from migrating into Old River, greatly increases the likelihood of survival (Figure 1). As expected based on the regressions shown in Figure 1, the survival of juvenile salmon was extremely sensitive to increasing or decreasing river flows when the HORB was installed and survival rates were not sensitive to river flow when the HORB was not installed. When the base and adjusted flow conditions were compared based on the juvenile salmon survival-flow regression models (Figure 1), the decrease in predicted survival with and without the WWTP discharges ranged from 0.000 to 0.005 for conditions with the HORB in place and were all 0.000 without the HORB (Table 3). Although changes in survival between the baseflow and adjusted flow conditions can be calculated using the regression models, the magnitude of these differences is so small that it could not be measured in field studies. The model predicts a moderately strong correlation between increased flow and increased survival ($R^2 = 0.73$) when the HORB is in place. Although there is still a positive relationship between survival and flow for conditions without the HORB, the statistical correlation is weak ($R^2 = 0.04$) and not statistically significant. The relatively high variability in the relationship between salmon survival and river flow, especially when the HORB is not installed, suggests that the predicted small change in survival shown in Table 3 is well within the observed variability in survival rates and would not be detectable in the river.

Table 3: Estimated change in juvenile Chinook salmon survival as a function of San Joaquin River flow with and without the Head of River Barrier (HORB).

	March			April			May		
	25th %	Mean	75th %	25th %	Mean	75th %	25th %	Mean	75th %
With HORB									
Baseflow survival	0.000	0.063	0.633	0.000	0.024	0.754	0.000	0.062	0.928
Adjusted flow survival	0.000	0.0.58	0.628	0.000	0.022	0.752	0.000	0.060	0.926
Net change	0.000	0.005	0.005	0.000	0.002	0.002	0.000	0.002	0.002
Without HORB									
Baseflow survival	0.150	0.158	0.186	0.148	0.156	0.192	0.149	0.158	0.201
Adjusted flow survival	0.150	0.157	0.186	0.148	0.156	0.192	0.149	0.158	0.201
Net change	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

3.3 Adult Chinook salmon escapement

The correlation between the springtime flow measured at the USGS Vernalis gage and returning adult Chinook escapement 2.5 years later show a positive trend and predict that a reduction in river flow will contribute to a reduction in the number of adult salmon returning into the San Joaquin River tributaries to spawn. The predicted change in adult salmon escapement, as calculated by the regression for river flow conditions during the March-May juvenile outmigration period, was a reduction in average escapement of 0.52% assuming the WWTP discharge to the river is no longer occurring (Table 4). The regression model predicts a reduction in salmon returns of 77, 37 and 31 individuals for March, April and May respectively, assuming no WWTP discharges. The total predicted reduction in escapement from a reduction in river flow over the March-May juvenile migration period is 145 fish out of predicted escapement estimates ranging from approximately 14,000 to 31,000 adults (less than 1%). The actual adult salmon escapement to the San Joaquin River basin varies substantially among years. The high variation in the escapement-flow relationship (R^2 = 0.32) suggests that the predicted small change in escapement is well within the observed variability in the relationship and would not be detectable in the river.

Table 4: Predicted change in adult salmon escapement with and without the WWTP discharges.

	March			April			May		
	25th %	Mean	75th %	25th %	Mean	75th %	25th %	Mean	75th %
Base Flow Escapement	14,566	16,986	26,032	13,999	16,373	27,959	14,219	16,968	30,713
Adjusted Escapement	14,489	16,909	25,955	13,962	16,336	27,923	14,188	16,936	30,681
Difference	77	77	77	37	37	37	31	31	31
% Change	**0.53%**	**0.45%**	**0.29%**	**0.26%**	**0.22%**	**0.13%**	**0.22%**	**0.19%**	**0.10%**

3.4 Habitat in the river and Delta

Changes in water depth as a function of river flow were used as an indicator of potential changes in habitat conditions and availability for juvenile salmon and other resident and migratory fish species. As flow increased through the San Joaquin River the stage height, and associated useable habitat, increased as well. The ranges of changes in stage height for base and adjusted flow remained fairly consistent for each seasonal condition. The reduction in river stage height (a reflection of water depth in the river) associated with curtailment of the WWTP discharges was estimated to range from 0.02 to 0.08 feet (Table 5). Differences between base and adjusted flow river stages varied consistently by less than 0.8% (Table 5) which is consistent with results of previous analyses. Much of the San Joaquin River channel has been incised or contained by levees. Under these conditions the predicted change in river stage would not be expected to result in biologically meaningful reductions in the quantity or quality (e.g., wetted channel width) of habitat for fish within the river.

Table 5: Changes in stage height (feet) as a function of river flow.

	March			April			May		
	25th %	Mean	75th %	25th %	Mean	75th %	25th %	Mean	75th %
Base Stage Height (ft)	9.75	11.60	16.56	9.23	11.17	17.44	9.44	11.59	18.59
Adjusted Stage Height (ft)	9.67	11.55	16.53	9.20	11.14	17.40	9.41	11.57	18.57
Change in Stage (ft)	0.08	0.05	0.02	0.03	0.03	0.04	0.03	0.02	0.02
% Change	**0.82%**	**0.43%**	**0.18%**	**0.33%**	**0.27%**	**0.23%**	**0.32%**	**0.17%**	**0.11%**

The predicted change in X2 location, a reflection of the low salinity zone habitat for estuarine fish and other organisms, moved upstream on average 0.06 km in March, an average of 0.03 km in April, and an average of 0.02 km in May. The magnitude of these changes would not be detectable in the field given the natural variation in X2 location based on variation in tidal conditions. In other environmental analyses an upstream movement of X2 location by less than 0.25 km (and in some cases less than 0.5 km) has been found to be less than significant. The magnitude of upstream movement of X2 in this assessment is expected to have no effect on habitat quality or availability in the estuarine low salinity zone or on the aquatic species that inhabit the low salinity zone.

Chapter 4 Summary and Conclusions

The two primary conclusions from this assessment are:

- Curtailment of treated waste water discharges from the Modesto and Turlock WWTPs into the San Joaquin River will result in an incremental reduction in river flow from the point of the existing discharge downstream. The reduction in San Joaquin River flow would contribute, based on the best scientific information available, to an incremental reduction in juvenile Chinook salmon survival during spring outmigration, a reduction in adult salmon escapement to the San Joaquin River tributaries, and an incremental reduction in habitat quality and availability in the lower river and estuary.
- The magnitude of predicted changes in juvenile salmon survival, adult escapement, and habitat conditions in the lower river and estuary was small (typically less than 1% when compared to current baseline conditions) and is well within the natural observed variation in the regression relationships used in these analyses. The magnitude of predicted changes in juvenile salmon survival and adult escapement, habitat quality and availability in the lower San Joaquin River, and the location of the estuarine low salinity zone (X2 location) would not be detectable in field studies and is considered to be less than significant.

Based on results of this study, curtailment of the discharge of treated waste water from the WWTPs at Modesto and Turlock into the San Joaquin River would not be expected to result in a measureable effect on the population dynamics of Chinook salmon. Since Chinook salmon are among the most sensitive fish species to changes in instream flows and other associated environmental factors (e.g., exposure to seasonally elevated water temperatures) the potential effects of the proposed curtailment of WWTP discharges to the river would be expected to be less for other resident and migratory fish inhabiting the San Joaquin River.

Chapter 5 Literature Cited

San Joaquin River Group Authority (SJRGA) 2007. San Joaquin River Agreement 2006 annual technical report. Prepared by San Joaquin River Group Authority. Prepared for State Water Resources Control Board. January 2007.

Appendix F – Draft Frac-Out Contingency Plan for Horizontal Directional Drilling

This page intentionally left blank

Appendix F – Sample Frac-Out Prevention Plan for Horizontal Directional Drilling

Introduction

Horizontal Directional Drilling (HDD) methods are often employed to avoid direct effects to sensitive resources such as stream crossings and archeological sites. However, indirect effects to sensitive resources may occur as a result of the inadvertent release of drilling fluids. This document provides a brief summary of HDD procedures, including an explanation of the role of drilling fluids. (Forkert Engineering & Surveying, Inc., and Chambers Group, Inc. 2008)

The NVRRWP EIR/EIS evaluates two alternatives that may use HDD. The Combined Alignment Alternative has one crossing of the San Joaquin River near the existing discharge location for Modesto's Jennings Wastewater Treatment Plant, hereafter referred to as the "Modesto Crossing". The Separate Alignment Alternative has two crossings of the river, the Modesto Crossing, and a second crossing further south near the end of Turlock's Harding Drain Bypass Pipeline, hereafter referred to as the "Turlock Crossing". Both crossings would be constructed using some form of trenchless technology, which could either be HDD or microtunneling. Because HDD uses a pressurized slurry for the drilling process this technique presents the risk of an uncontrolled release of drilling fluid to the ground surface, known as "frac-out. Microtunneling uses a boring machine, and thus does not have the potential for frac-out. Because of the potential use of HDD for construction of a crossing of the San Joaquin River, this example frac-out plan is presented to describe potential measures to prevent frac-out or other environmental impacts associated with HDD procedures. If HDD is selected as the preferred trenchless construction method, this draft plan would be modified as appropriate for the crossing, as designed, and finalized by the selected contractor.

HDD Procedures

Conventional HDD operations have three main steps: the pilot bore, reaming and the pulling of conduit and/or casing. The pilot bore involves drilling the length of the bore with a small-diameter drill head to establish an accurate bore path. Once the entire bore path has been pilot-bored, a reamer is placed on the drill head. The reamer is then pulled back through the borehole to widen the hole (back-reaming). The final step entails attaching the conduit or casing to the drill head and pulling it back through the entire length of the borehole.

HDD operations for the Proposed Project are expected to range from 2,500 to 3,500 feet in length for the Modesto and Turlock crossings, respectively. The depth of the bore shall be at least 30 feet below the lower extent of the San Joaquin River. This depth shall increase as determined by site-specific conditions. The bores are required to maintain a minimum depth below the ground. Cobbles or rocky strata may cause the bore to go deeper to find an easier path.

General commitments to be enforced:

- Depth of bore below the riverbed shall be at least 30 feet;
- Drilling fluid materials and their respective Material Safety Data Sheets (MSDS) shall be disclosed; and
- Drilling fluids shall be monitored to assure pH values remain near neutral (between 6.5 and 8.0).

The contractor shall study the site-specific conditions for the river crossing. Based on this information, the contractor shall highlight potential problem areas, prepare an appropriate site specific plan and commit to employing all measures necessary to maximize the success of the HDD operation. For example, these measures may include substituting drill bits or reamers, altering the viscosity of the drilling fluid, and introduce drilling fluid additives as indicated by soil types and varying substrates found throughout the bore profile. The contractor is required to evaluate the following information:

- Geotechnical report;
- Design plans showing the location of the river crossing;
- Summary of sensitive resources present or potentially present;
- Existing conditions of bed and bank (from field visit);
- Photos showing the existing setting; and
- Survey of bore site, including equipment staging areas, approximate location of drilling entry and exit (subject to minor change at time of construction due to soil conditions encountered during bore process), approximate location of access roads in relation to surrounding area.

Drilling Fluids

Typically, the drilling fluid is composed of two basic elements: water and clay particulates. The clay particulate component typically consists of bentonite. Bentonite is composed essentially of montmorillonite clay, which has a relatively high shrink-swell capacity. The structure of bentonite resembles a sandwiched deck of cards. When mixed in water, these cards or clay platelets rearrange for increased surface area exposure. Bentonite attracts water to its negative face and magnetically bonds to water molecules. Because of this unique characteristic, bentonite is capable of absorbing seven to ten times its own weight in water, and swelling up to eighteen times its dry volume. Together, the bentonite and water mixture acts to lubricate and cool the drill head, seal and fill the pore spaces surrounding the drill hole, prevent the bore hole walls from collapsing inward, and suspend cuttings (native soil removed during the boring process) within the drill hole.

In some cases, inert and non-toxic Loss Circulation Materials (LCMs) are added to the mixture. These materials include, but are not limited to, cotton dust, cotton seed hulls, wood fiber, M-1 mica and cedar fiber.

During typical HDD operations, some drilling fluids are absorbed by the lateral and subterranean fractures within the formation. This is a fairly normal occurrence during HDD operations that does not necessarily mean the drilling fluid is rising to the surface or migrating great distances from the borehole. However, it is possible that drilling fluids may reach the surface by following a vertical fracture in the formation. This event is commonly referred to as a hydro-geologic fracture (frac-out). The released drilling fluids may contain a lower concentration of bentonite when they surface because they can be filtered as they pass through certain types of ground material such as sandy soils. Materials used to control a frac-out may include straw bale, straw waddle, silt fence, and gravel bag. These materials would be kept at the boring site in quantities sufficient to contain a 40-foot perimeter around a frac-out.

Potential Impacts to Aquatic Biological Resources

The release of drilling fluid from fractures in the earth's surface may be terrestrial or aquatic in nature and varies in quantity. Terrestrial frac-outs occurring in upland areas are typically easy to contain and therefore result in relatively minor effects to the surrounding environment. Frac-outs occurring in aquatic environments are more difficult to contain primarily because bentonite readily disperses in flowing water and quickly settles in standing water. Bentonite is non-toxic, but there are two specific indirect effects of bentonite on aquatic life. Initially, the suspended bentonite may inhibit respiration of fishes, although this is typically short-lived. Once the bentonite settles, secondary long-term effects can result. For example, egg masses of fish could be covered by a layer of bentonite inhibiting the flow of dissolved oxygen to the egg masses. Secondly, benthonic invertebrates and/or the larval stages of pelagic organisms may be covered and suffocate due to fouled gills and/or lack of oxygen (Forkert Engineering & Surveying, Inc., and Chambers Group, Inc. 2008). Because of the potential for impacts to aquatic species, this appendix provides a sample contingency plan to prevent frac-out and minimize effects if one should occur.

On-Site Monitoring

During pilot bore drilling operations, visual inspection along the bore path of the alignment shall take place at all times. Additionally, monitors shall be stationed approximately 50 feet upstream and downstream of the crossing point. On-site training shall be provided for all monitors, and names and phone numbers of the monitors shall be provided to the on-site agency representatives.

The contractor shall supply the following information to the monitoring team throughout the duration of the HDD operation at specific time intervals (e.g. upon completion of each drill rod):

- Position of the drilling head relative to the drilling point of entry;
- Estimated total volume of drilling fluid that has been pumped during the drilling operation;
- Comparison of the current total volume of drilling fluid used and the estimated current total volume of returns;
- Equipment breakdowns and repairs;
- Any abnormal drilling fluid pressure at the time of occurrence; and
- Any change of drilling fluid contents (e.g. new bentonite mixture or introduction of LCMs).

Field Response Plan

During the drilling process, the contractor shall adjust the thickness of the bentonite mixture to match the substrate conditions and ensure continuous flow. Subsequently, the contractor shall closely monitor drilling pressures and penetration rates so use of fluid pressure shall be optimal to penetrate the formation.

Some loss of returns may be inevitable as drilling fluids are absorbed by the lateral and subterranean fractures within the formation. In case of a gradual loss of approximately fifty- percent of expected returns, not including surface frac-outs, the contractor shall act to restore returns, including:

- Modifying drilling fluid properties (viscosity and gel strength);
- Modifying pressure and volume;
- Advance or retreat pilot stem and/or wash over pipe (i.e. swab the borehole); and
- Introduce LCMs according to manufacturer's instructions.

A complete and sudden loss of returns serves as a signal to both the contractor and the monitor that something more significant may be occurring and to watch closely for a possible surface release. This draft plan uses the loss of returns or pressure, the use of a tracing dye and visual indications, to trigger response and mitigation actions.

In the event of a sudden loss of approximately 75 percent of expected returns, or in the event that a surface release of drilling fluid or dye are detected, the contractor shall temporarily cease operations to determine what actions need to be taken. In areas containing sensitive resources, agency notifications shall be made and the decision to resume operations shall be determined in consultation with the appropriate agencies' representatives (see Item 7 of this plan). Any release to the surface shall be addressed in accordance with the release response plan (see below).

All equipment required to contain and clean up a frac-out release would be available at the work site. Equipment includes the following:

- Heavy weight plastic clean gravel filled sand bags (at least 20 bags);
- Geotek filter bags 10-by-12-foot size or equivalent (at least 3 bags);

- Several hard plastic (5-gallon) buckets;
- One wide heavy-duty push broom;
- Three flat blade shovels;
- Silt fence (appropriate coverage up to 40-foot perimeter);
- Certified weed-free hay bales (appropriate coverage up to 40-foot perimeter);
- Two bundles of absorbent pads to use with plastic sheeting for placement beneath motorized equipment while in operation in the vicinity of the riparian/stream zone;
- Straw logs (wattles or fiber rolls)(at least two 10-foot rolls);
- Portable pumps;
- A minimum of 100 feet of hose; and
- Vacuum truck (minimum 800-gallon).

All containment equipment would be kept on site at each bore location. General responses to frac-out releases are as follows:

- Directional boring would stop immediately;
- The bore stem would be pulled back to relieve pressure on frac-out;
- The Environmental Inspector would be notified to ensure adequate response actions are taken and notifications are made;
- Terrestrial releases would be cleaned up using on-site equipment;
- A dike/berm may be constructed around the frac-out (terrestrial only) to entrap released drilling fluid;
- Response equipment (e.g., portable pumps and fully equipped 800-gallon vacuum trucks) would be mobilized to recover larger releases of drilling fluid;
- Access to the frac-out release area would be via existing roads and temporary work easements. Additional access needed to perform cleanup activities would be coordinated with and require the approval of all regulating entities;
- All equipment or vehicles driven or operated adjacent to a water body or wetland would be checked and maintained daily to prevent leaks of hazardous materials.

The directional bore activities would be designed to avoid and otherwise minimize the potential for affects to sensitive biological and cultural resources. Additionally, the crew, with the guidance of on-site monitors and the Environmental Inspector (where the Environmental Inspector may also act as an on-site monitor), would construct barriers (i.e. straw bales or silt fences) around the perimeter of all sensitive resources (e.g. stream bank, riparian vegetation) prior to the commencement of work. This technique is aimed to prevent released material from reaching the sensitive resources.

In addition to the aforementioned procedures, the following containment procedures and commitments shall be implemented for all frac-out releases located within a water body:

- Measures to avoid in-stream disturbance (e.g., pulling the drill stem back and going deeper) and to prevent further frac-out would be implemented first.
- A standing pipe (such as a 55-gallon drum with the top and bottom removed, heavy PVC pipe or CMP or culvert type material) shall be placed around the frac-out to contain the drilling mud;
- Sand bags would be used (if necessary) to seal the base of the standing pipe;
- Any existing berms, barriers, or silt fence established to protect sensitive resources would be strengthened, as necessary, to contain drilling fluids and prevent their encroachment on

sensitive biological and cultural resources and divert drilling fluid from entering jurisdictional waters;

- Secondary containment (plastic sheeting) for the pump unit would be used;
- A trailer mounted vacuum or vacuum truck shall be deployed to vacuum out contained drilling fluids;
- Vacuumed drilling fluids shall be disposed in accordance with local, state and federal regulations;
- No refueling would occur within 100 feet of the stream zone, wetlands, and other sensitive habitats;
- All other response activities would take place within the authorized ROW unless otherwise approved in writing.
- The Environmental Inspector would notify the appropriate agencies.

Pre-construction surveys shall be conducted in accordance with Mitigation Measures defined in this EIR/EIS by qualified biologists to identify all species potentially affected by drilling operations;

Notification and Documentation

If a frac-out occurs or any degree of dye were detected within the water column of the stream, the Environmental Inspector shall immediately notify the appropriate resource agencies, and additional follow-up response actions would be developed in coordination with agency representatives. The following entities shall be contacted by phone with a written report to follow:

- California Department of Fish and Wildlife (CDFW)
- Regional Water Quality Control Board (RWQCB)
- California State Lands Commission
- United States Fish and Wildlife Service (USFWS)
- National Marine Fisheries Service (NMFS)
- United States Army Corps of Engineers

Documentation of environmental compliance would include written reports of observations, documentation of events and follow-up, and project tracking. The following forms of documentation shall be submitted to the noted agencies on a timely manner:

- Pre-construction geotechnical evaluations at major bore sites would be provided to CDFW and RWQCB prior to construction.
- Monthly Monitoring Reports would summarize construction activity and daily monitoring logs for the previous month of construction, and would be provided to the resource agencies as required by applicable permits.
- Post-Construction Summary Report would summarize the construction activity and monitoring results for the Project, and would be submitted to the resource agencies.

Training of Project Personnel

Prior to the commencement of construction, the contractor's personnel shall attend a training session on-site. The training session shall cover the following topics:

- Details of the information found within the contractor's project-specific frac-out plan;
- Specific permitting conditions and requirements;
- Requirement to retain copies of all appropriate permits on the site during all operations;
- Sensitive resources located at or near the site;

- Requirement to monitoring during all operations;
- Situations that invoke a halt of operation;
- Proper lines of communication;
- Proper lines of authority and responsibility;
- Information the contractor shall provide to the monitoring personnel and project owner's site representative;
- Contact names and phone numbers of the appropriate individuals and agencies; and,
- Types of events that the contractor is required to report and to whom.

The contractor shall provide an overview of the drilling operation in their work plan. The training session shall ensure that contractor personnel recognize the authority of the on-site monitors to stop drilling.

The focus on environmental orientation would be to both educate and motivate all project personnel to minimize disturbance to the surrounding environment and to take actions to protect sensitive resources. Knowledgeable environmental compliance team members would be available to answer questions and provide relevant information as requested. The worker orientation program would inform project workers of their responsibilities in regards to sensitive biological resources. The Environmental Inspector would serve as a contact for issues that may arise concerning implementation of protection measures, and to document and report on adherence to these measures.

References

Forkert Engineering & Surveying, Inc., and Chambers Group, Inc. July 2008. Horizontal directional drilling: contingency and resource protection plan for construction of the AT&T Fiber Optic Cable Installation Project, Clark County, Nevada and San Bernardino County, California. Prepared for AT&T

Appendix G – Evaluation of NVRRWP Impact on Groundwater

This page intentionally left blank

DRAFT Technical Memorandum (TM)

NVRRWP - Groundwater Impact

Subject:	**Evaluation of NVRRWP Impact on Groundwater**
Prepared For:	Del Puerto Water District, City of Modesto and City of Turlock
Prepared by:	Reza Namvar
Reviewed by:	Ali Taghavi
Date:	July 23, 2014
Reference:	0453-003 NVRRWP Phase 3

1 Introduction

The proposed North Valley Regional Recycled Water Program (NVRRWP) is being developed as a regional solution to address water supply shortages and reliability concerns by utilizing recycled water for beneficial use[1]. The proposed NVRRWP would deliver recycled water produced by the Cities of Modesto and Turlock to the Del Puerto Water District (DPWD).

Currently, wastewater generated by the City of Turlock is being treated and discharged to the San Joaquin River. The City of Modesto treats and discharges to the San Joaquin River during winter months, with no discharge during the summer months. With the proposed NVRRWP, this recycled water will be discharged to the Delta-Mendota Canal (DMC) and delivered to DPWD via the DMC.

1.1 Objective

This Technical Memorandum presents the approach and results of analysis of NVRRWP impacts on groundwater in the vicinity of the San Joaquin River from the project area to the Vernalis station, located approximately 25 miles downstream from the Turlock recycled water discharge location.

1.2 Approach

The NVRRWP would result in reduction of stream flows in the San Joaquin River as no more recycled water from Cities of Modesto and Turlock would be discharged to the San Joaquin River under the project conditions. The impact of reductions in the San Joaquin River streamflows on groundwater under the NVRRWP conditions was analyzed using the California Department of Water Resources (DWR) California Central Valley Groundwater-Surface Water Simulation Model (C2VSim). The existing conditions baseline (EC Baseline) version of C2VSim was used for this analysis. The EC Baseline model was configured to run with and without discharges of recycled water by the Cities of Modesto and Turlock to the San Joaquin River. The changes in groundwater elevations and storage under the two EC Baseline model runs reflects the impact of the NVRRWP on groundwater.

2 C2VSim Model

DWR has developed the C2VSim model as a tool to aid in water resources management planning. C2VSim simulates water movement through the interconnected land surface, surface water and groundwater flow systems in the 20,000 mi^2 of the alluvial Central Valley aquifer. C2VSim dynamically calculates groundwater conditions based on urban and crop water demands; long-term hydrologic and meteorlogic records, land use, cropping patterns, and other inputs.

[1] http://www.nvr-recycledwater.org/

C2VSim has two versions based on resolution of the model grid. C2VSim coarse grid (C2VSim-CG) has a coarser grid with an average element area of approximately 14 mi^2 (9,200 acres) (Brush et al., 2013). C2VSim fine grid (C2VSim-FG) has a significantly finer grid with an average element area of approximately 410 acres (0.64 mi^2) (RMC, 2011). C2VSim-FG is refined around the streams as well as San Joaquin River with an average of 0.5 mile node spacing. The node spacing increases gradually away from the streams to an average of 1.5 miles. C2VSIM-FG has been used for analysis of many Central Valley wide or regional projects, including interaction of surface water and groundwater resources (RMC, 2014) C2VSim-FG was used for the analysis of NVRRWP groundwater impact. Figure 1 illustrates the C2VSim-FG grid in the vicinity of the NVRRWP. C2VSIM-FG model area is divided into 21 subregions to facilitate data entry and reporting of model results. The model output can be summarized to produce water budgets for each of 21 model subregions or the entire model area. Figure 2 illustrate the C2VSIM-FG subregions and DWR's Bulletin 118 groundwater basins in the project area.

2.1 Historical Simulation

C2VSim-FG uses a detailed database of monthly precipitation, land use, crop acreage, river inflow and surface water diversion information from October 1921 through September 2009 to calculate historical water use, groundwater pumping and changes in aquifer storage. This long hydrologic period incorporates the significant historical variations (dry, multiple dry, wet, and multiple wet years) in the Central Valley.

2.2 Existing Conditions Simulation

The EC Baseline version of C2VSim-FG was used for the analysis of NVRRWP groundwater impact. The simulation period for this version of C2VSim-FG is 88 years incorporating historical hydrology from 1922 to 2009. It applies current level of land use and water use to this hydrology. The EC Baseline model was configured for the following runs:

- EC Baseline with recycled water discharge to San Joaquin River
- EC Baseline without recycled water discharge to San Joaquin River

The changes in groundwater elevations and storage under the two model runs reflect the impact of the NVRRWP on groundwater.

3 Recycled Water Discharges

The City of Turlock discharges approximately an average of 8.5 million gallons per day (MGD) of recycled water to the San Joaquin River. This rate remains the same through the year. However, the City of Modesto only discharges recycled water to San Joaquin River from November to May with an average of 7.8 MGD with discharges ranging from zero MGD during June to October to a maximum of approximately 25 MGD in February. Figure 3 illustrates the monthly combined recycled water discharge rates from Cities of Modesto and Turlock.

4 Results

The two model runs based on EC Baseline version of C2VSim-FG were compared to evaluate the impact of NVRRWP on streamflows at Vernalis and groundwater storage and elevations.

4.1 Streamflows at Vernalis

The removal of recycled water discharges to the San Joaquin River by the Cities of Modesto and Turlock would result in reduced streamflows downstream from the discharge points. Comparison of the two model runs showed that the average monthly streamflows at Vernalis station would reduce by approximately 2,900 acre-feet (AF)/month in March to approximately 750 AF/month from June to October (Figure 4). The average annual streamflows at Vernalis station would be reduced by approximately 18,000 AF/year. The average discharge of the San Joaquin River between 1924 and 2011 was 3.3 million AF/year. The reduction is San Joaquin River streamflows at Vernalis due to NVRRWP is approximately 0.5% of the average annual flows.

4.2 Groundwater Storage and Elevations

The reduction in San Joaquin River streamflows would result in changes in stream-aquifer interaction. Reduction of streamflows would increase stream gains from the aquifer when the stream is a gaining stream (i.e. groundwater levels are higher than stream levels). In contrast, reduction of streamflows would reduce stream losses to the aquifer when the stream is a losing stream (i.e. groundwater levels are lower than stream levels). The average monthly change in groundwater storage for C2VSim subregions 8 to 12 in the vicinity of the NVRRWP is presented in Figure 5. Groundwater storage is reduced from September to March; however, groundwater storage is increased from April to August. The average annual reduction in groundwater storage is approximately 27 AF/year (Table 1).

The annual changes in groundwater storage for C2VSim subregions 8 to 12 through the 88 years of simulation and under various hydrologic conditions are presented in Figure 6. The change in groundwater storage varies from approximately -280 AF/year to approximately 150 AF/year. The cumulative change in groundwater storage is also shown in Figure 6. Over the 88-year simulation period, NVRRWP would result in approximately 2,420 AF of less groundwater in storage in the project area (Figure 6 and Table 1). This is equivalent to 27 AF/year average loss of contribution to groundwater storage. This change in groundwater storage is less than significant and is considered negligible and well within the potential range of accuracy of C2VSim.

5 Conclusions

Based on the analysis performed using the C2VSim, the groundwater storage loss is approximately 28 AF/year which is not significant in the context of hydrology of the basin. The results indicate that the groundwater impact of NVRRWP in the area from the recycled water discharge points to the Vernalis station is minimal and not significant.

6 References

Brush, C.F., E.C. Dogrul, and T.N. Kadir, 2013. Development and Calibration of the California Central Valley Groundwater-Surface Water Simulation Model (C2VSim), Version 3.02-CG. DWR Technical Memorandum.

RMC, 2011. Refinement of spatial resolution of the C2VSIM. Technical Memorandum submitted to DWR.

RMC, 2014. Assessment of surface water and groundwater conditions and interaction in California’s Central Valley – Insights to inform sustainable water management. Report prepared for The Nature Conservancy.

Table 1: Change in Groundwater Storage for C2VSim-FG Subregions in the NVRRWP Area

C2VSim	B118 Groundwater Basin	Change in Groundwater Storage	
		Average Annual (AF/yr)	Cumulative (AF)
8	Eastern San Joaquin, Cosumnes, South American	-7	-630
9	Tracy, Solano, Eastern San Joaquin, South American	-10	-900
10	Delta-Mendota	-5	-450
11	Modesto, Eastern San Joaquin	-3	-230
12	Turlock	-2	-210
13	Merced, Chowchilla, Madera	0	0
Total		-27	-2,420

Figure 2: C2VSim Grid in the NVRRWP Area

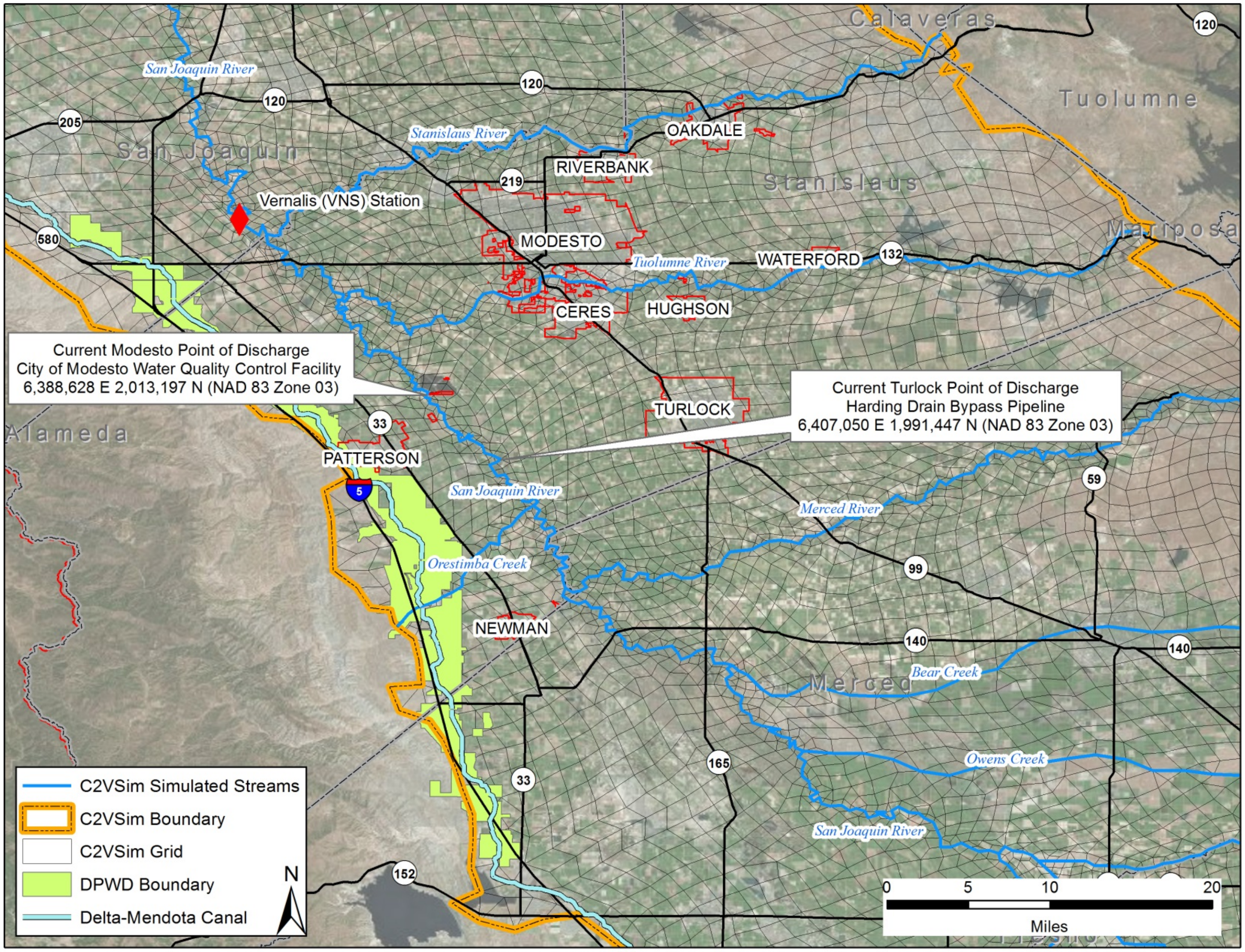


Figure 2: C2VSim Subregions and DWR Bulletin 118 Groundwater Basins in the NVRRWP Area

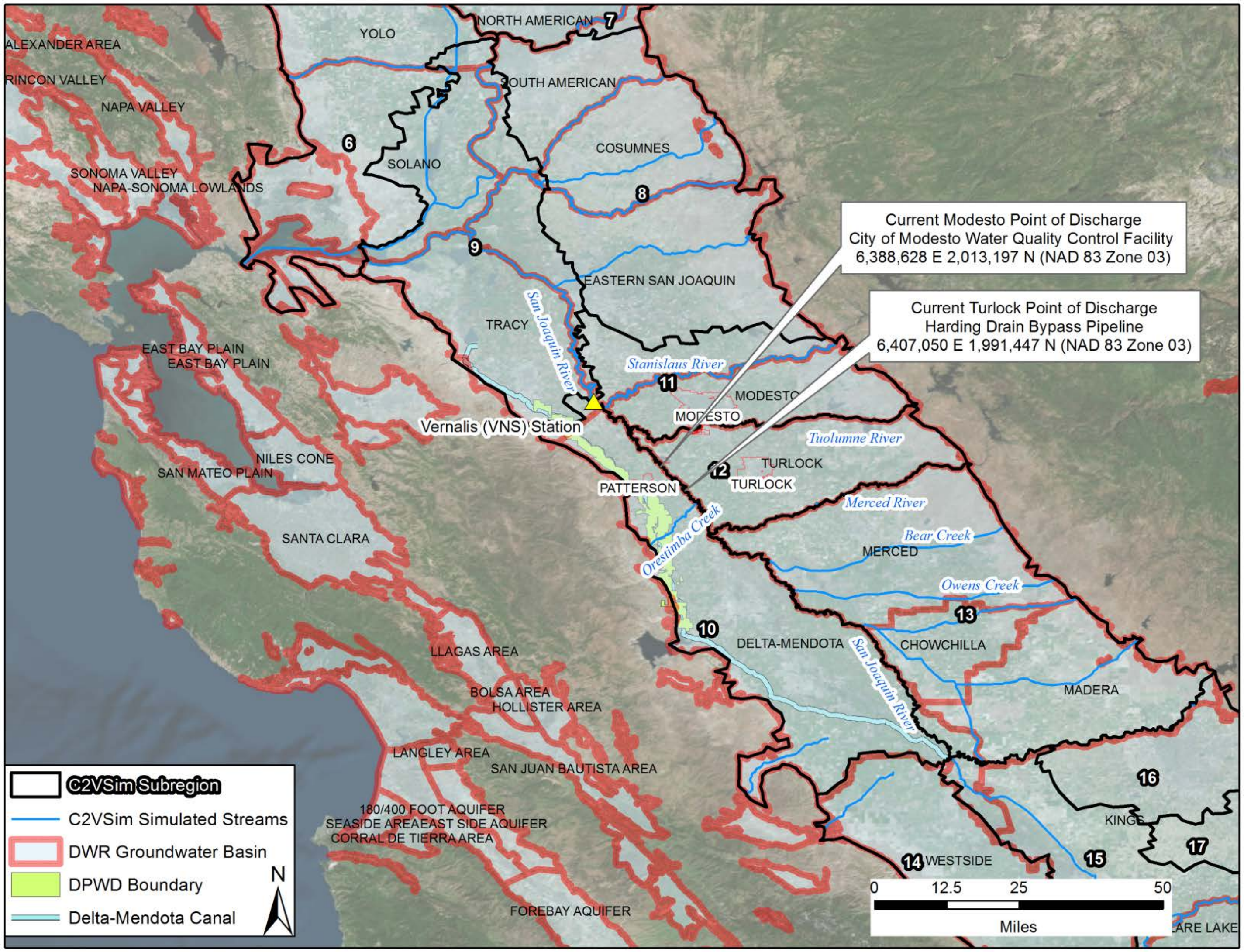


Figure 3: Cities of Modesto and Turlock average monthly recycled water discharges to San Joaquin River

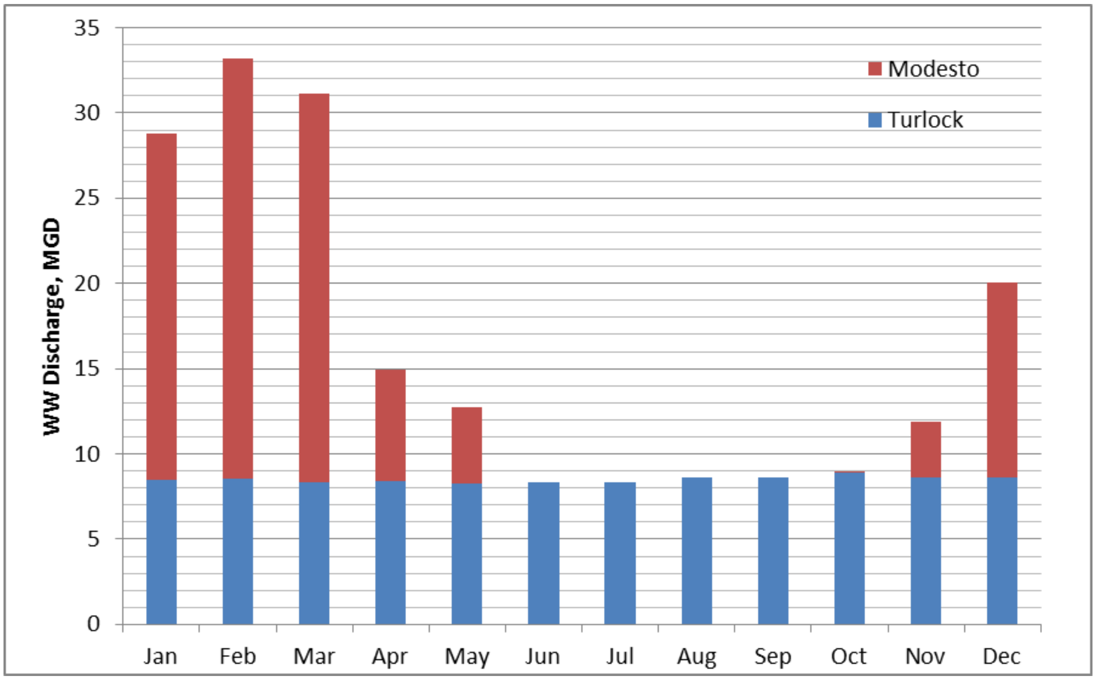


Figure 4: Average monthly reduction of San Joaquin River streamflows at Vernalis

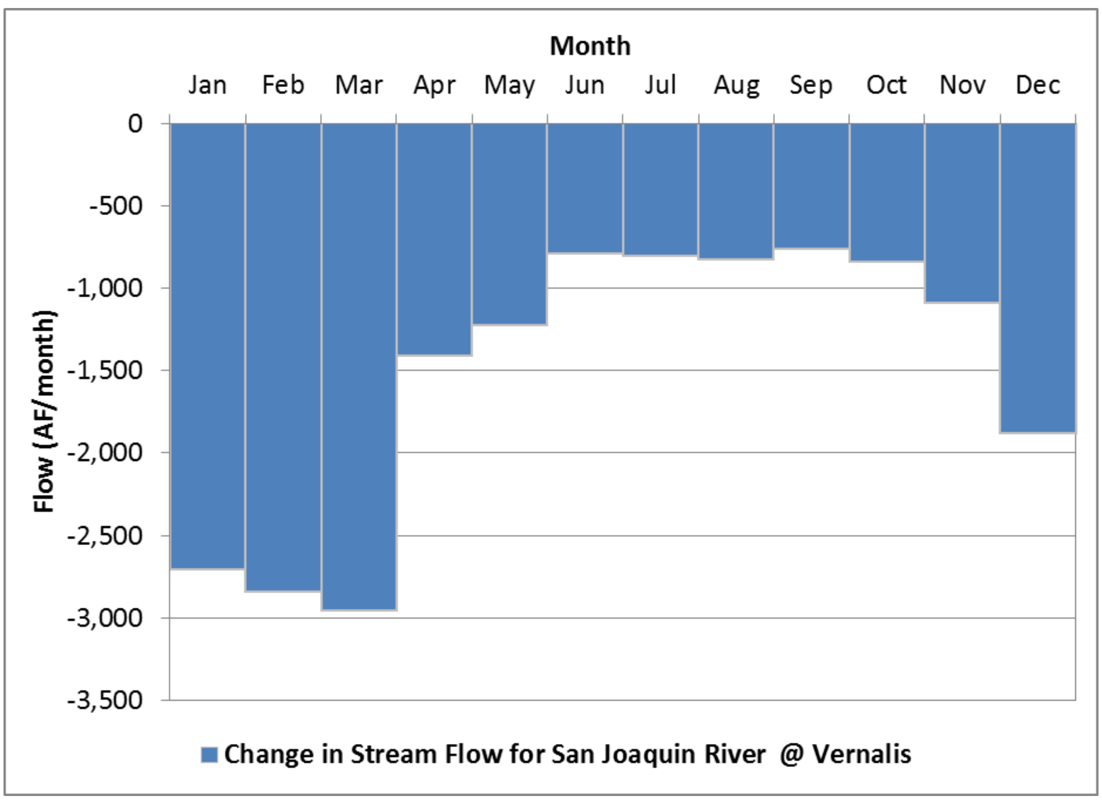


Figure 5: Average monthly change in groundwater storage for C2VSim subregions 8 to 12

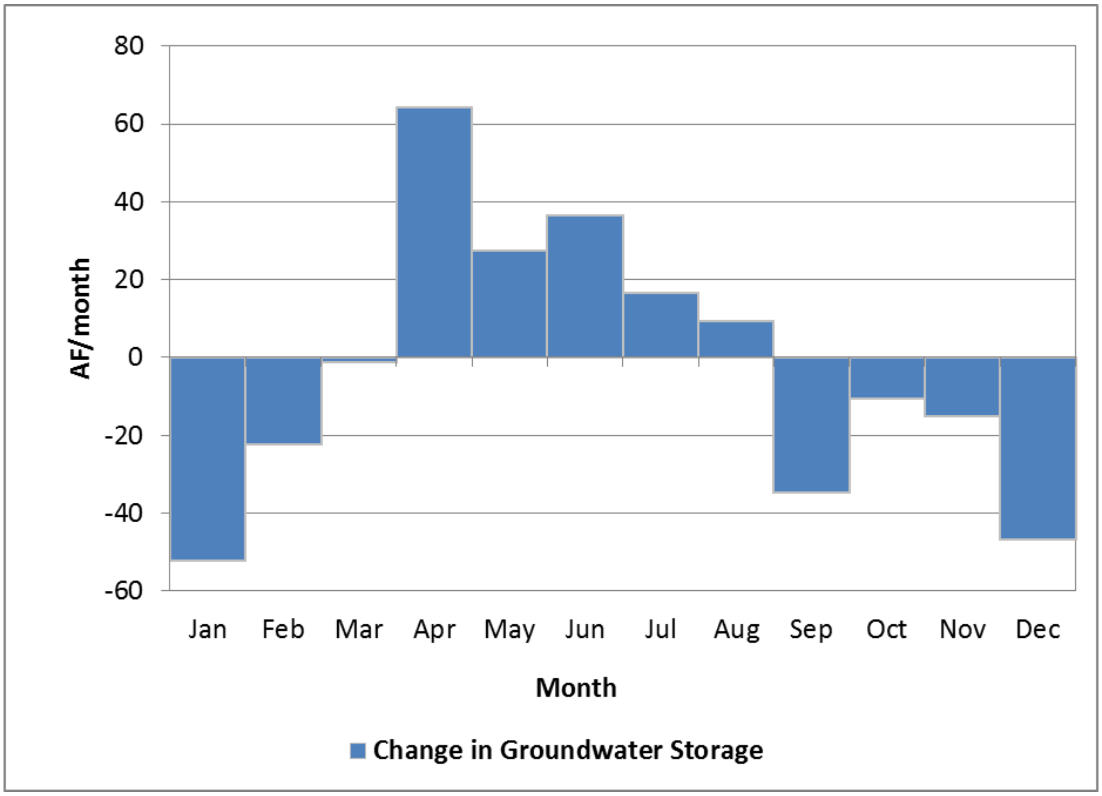
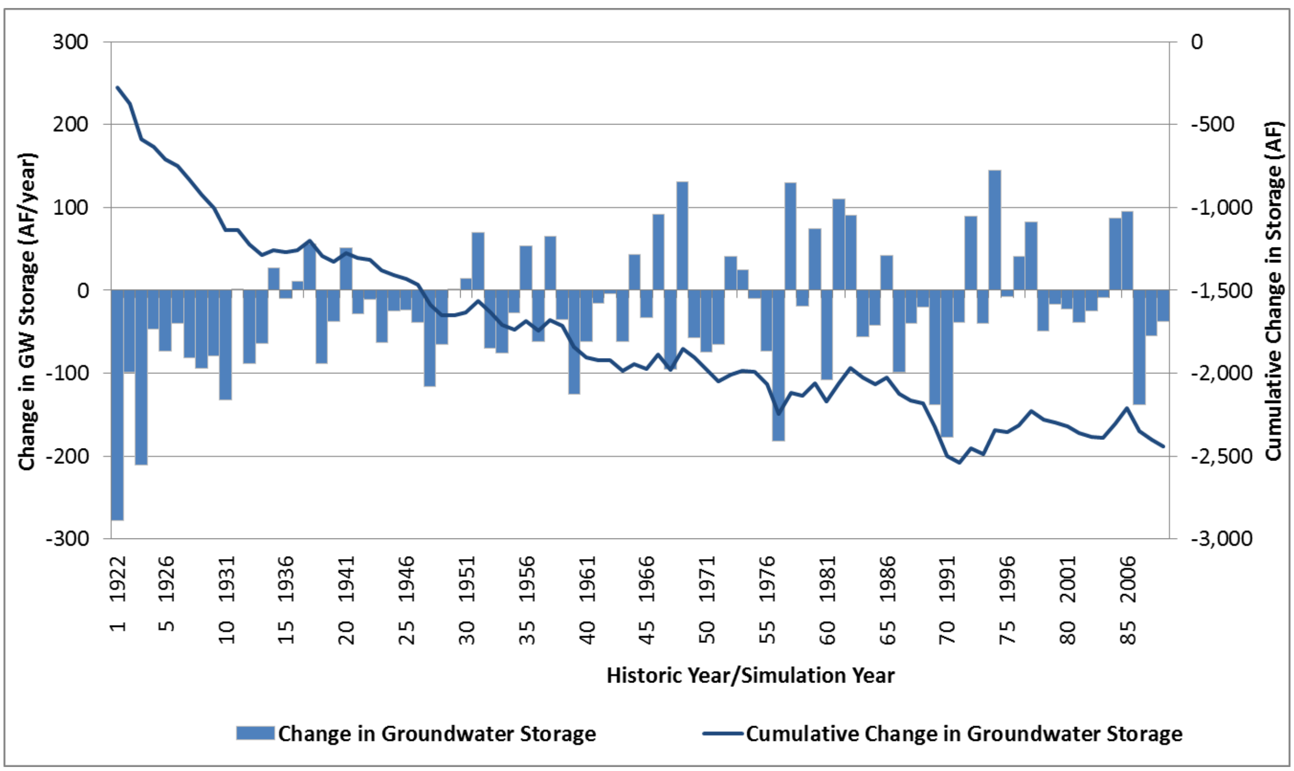


Figure 6: Cumulative change in groundwater storage for C2VSim subregions 8 to 12



Appendix H – Distribution List

This page intentionally left blank

Appendix H Distribution List

Public circulation of the North Valley Regional Recycled Water Program (NVRRWP) EIR/EIS makes use of electronic media to ensure cost-effective access is made available to the public and interested parties. The Draft EIR/EIS is available online at the NVRRWP project website: http://www.nvr-recycledwater.org/documents.asp. The Draft EIR/EIS is also available for review at the locations listed below.

Persons, agencies and organizations listed in this chapter will be informed of the availability of the Draft EIR/EIS and locations where the document will be available for review, as well as the timing of the 60-day review period.

Document Availability

The Draft EIR/EIS is available for review at the Partner Agencies' main offices and at the Reclamation office in Fresno:

City of Modesto, Utilities Department
1010 Tenth Street, 4th Floor
Modesto, CA 95354

City of Turlock
156 S. Broadway
Turlock, CA 95380

Del Puerto Water District
17840 Ward Ave
Patterson, CA 95363

U.S. Bureau of Reclamation
1243 "N" Street
Fresno, CA 93721

Agencies and organizations receiving Notice of Availability of the Draft EIR/EIS are listed below. A notice of availability of the Draft EIR/EIS will also be sent to individuals and interested parties.

Federal and State Agencies

California Department of Fish and Wildlife, Region 3

California Department of Fish and Wildlife, Region 4

California Department of Planning and Research

California Department of Transportation (Caltrans) District 10

California Regional Water Quality Control Board, Central Valley

California Office of Historic Preservation

California State Lands Commission

California State Water Resources Control Board, Division of Financial Assistance

California State Water Resources Control Board, Division of Water Rights

NOAA National Marine Fisheries Service

U.S. Army Corp of Engineers, Sacramento District

U.S. Environmental Protection Agency, Region 9

U.S. Fish and Wildlife Service

Regional/Local Agencies

Central California Irrigation District

Central Valley Flood Protection Board

City of Ceres

City of Modesto

City of Modesto (East Stanislaus IRWM)

City of Patterson

City of Turlock

Kern County Water Agency

Merced County

Metropolitan Water District of Southern California

Modesto Irrigation District

Patterson Irrigation District

San Joaquin County

San Joaquin Valley Air Pollution Control District

San Luis & Delta-Mendota Water Authority

San Luis Water District

Santa Clara Valley Water District

Stanislaus County

Turlock Irrigation District

West Stanislaus Irrigation District

Westlands Water District

Other Interested Parties

Organizations

Ducks Unlimited

Griffith & Masuda

Stanislaus Farm Bureau

Stewart and Jasper

The Nature Conservancy

Robert Gioletti & Sons Dairy

West Yost Associates

Individuals

Ryon Sellmon

Mark Serpa

Amber Madden

Michael George