Appendix A Site Descriptions

Contents

Appendix A Site Descriptions

Calaveras River Downstream of Confluence with the Stockton Diverting Canal

Interstate 5 Bridges

The Interstate 5 bridges, northbound and southbound, are identical. The bridges cross perpendicular to the Calaveras River near river mile 2. The bridges are west of downtown Stockton (Photo A-1). Each bridge has two lanes for vehicles and a bicycle and pedestrian lane. The Interstate 5 bridges are in the area of tidal influence so that water inundates this section of river throughout the year.

Each Interstate 5 Bridge spans 532 feet. Each bridge has 8 rows of 10 piers, and each row is about 48 feet apart. The active channel encompasses 3 rows of piers and is about 150 feet wide. The northbound and southbound bridges are about 20 feet apart (Photo A-2).

Upstream of the bridges, the river channel is well defined, slightly meandering, and wide. The water moves slowly (Photo A-3). The upstream banks are steep until near the top of the levee where the slope becomes more gradual. The banks are well vegetated with weeds (lots of blackberry), bushes, and grasses. Upstream, there are a few visible riparian trees; they would provide little shade to the river channel. We were unable to determine the composition of the channel bottom because of the steep banks and depth of the water.

Downstream of the bridges, the river channel is well-defined, straight, and wide. The current is slow (Photo A-4). The downstream banks are steep until near the tops of the levee where the slope becomes more gradual. Compared to the upstream banks, the banks downstream have less vegetation. The banks are still vegetated with grasses and weeds, especially blackberry. Downstream are a few riparian trees. They probably would not provide shade to the river channel. We were unable to determine the composition of the channel bottom because of steep banks and deep water. Farther downstream, along the left bank, there are a few scattered boat docks, presumably associated with neighboring homes.

The presence of water is constant, and we were unable to determine channel bottom characteristics. The Interstate 5 bridges have no visible water surface difference between one side of the structure and the other and do not appear to be barriers to fish migration. We will confirm this by modeling fish passage at the McAllen Road Bridge.

Photo A-1. Looking upstream at Interstate 5 bridges on the Calaveras River

Photo A-2. Looking between the northbound and southbound Interstate 5 bridges on the Calaveras River

Photo A-3. Looking upstream from Interstate 5 bridges on the Calaveras River

Photo A-4. Looking downstream near Interstate 5 bridges on the Calaveras

Pershing Avenue Bridge

The Pershing Avenue Bridge crosses perpendicular to the Calaveras River near river mile 3.2, downstream of the confluence of the Stockton Diverting Canal and the Calaveras River (Photo A-5). The Pershing Avenue Bridge crosses the Calaveras River on the west side of the University of the Pacific campus.

The Pershing Avenue Bridge spans 413 feet. The concrete bridge has 102 piers configured in 17 roughly parallel rows of six. The distance between the rows of piers is about 22 feet. The active channel encompasses 8 rows of piers and is about 167 feet wide. The bridge has four lanes. There is no apron under the bridge; however, there are extensive riprap and concrete slabs in the channel extending onto the banks. Both the north and south banks have concrete paths for biking, running, and walking.

Upstream of the bridge, the river channel is well-defined, relatively straight, and dissects the University of the Pacific campus (Photo A-6). Tidal influence keeps water in this section of the river. The upstream banks are flat until you reach the river channel where they are steeply incised. The banks are well vegetated with weeds and grasses. Scattered riparian trees provide minimal shade to the river channel. The invasive giant reed or *Arundo donax* inundates an island immediately upstream of the bridge. The river bottom directly under and upstream of the bridge is composed of riprap and concrete slabs. Deeper water upstream prevented us from determining what makes up the bottom.

Immediately downstream of the bridge the river channel is composed of riprap and concrete slabs. Farther downstream the channel bottom is bare with scattered rocks. Just downstream, the invasive giant reed or *Arundo donax* covers an island (Photo A-7). The banks downstream are flat until you reach the active channel where they become steeply incised. The banks are well vegetated with weeds and grasses. Scattered riparian trees provide minimal shade to the river channel. There is a slight left to right meander when looking downstream from Pershing Avenue Bridge.

Because of a constant presence of water, we were unable to determine channel bottom characteristics. Pershing Avenue Bridge has no visible water surface difference between one side of the structure and the other so it does not appear to be a barrier to fish migration. We will be confirming this by modeling fish passage at the McAllen Road Bridge.

Photo A-5. Looking downstream at Pershing Avenue bridge

Photo A-6: Upstream Calaveras River channel from Pershing Avenue bridge

Photo A-7. Below Pershing Avenue bridge looking downstream. Also looking at island inundated with giant reed or *Arundo donax.*

Pacific Avenue Bridge, Northbound

The Pacific Avenue bridges, northbound and southbound, are not the same. The bridges cross perpendicular to the Calaveras River at river mile 3.7. The northbound bridge is on the eastern edge of the University of the Pacific campus in downtown Stockton (Photo A-8). The northbound bridge has two traffic lanes and a lane for pedestrians and bicycles. The Pacific Avenue bridges are both in the area of the river that is under tidal influence; therefore, the channel has water all year.

Pacific Avenue Bridge, northbound, spans about 275 feet. The bridge has 11 rows of 6 piers. The distance between each row is about 20 feet. The active channel encompasses six to seven rows of piers. There is no apron under the bridge. The north bank of the river channel has a paved bicycle and pedestrian trail.

Upstream of the bridge, the river is a well defined, slightly meandering, and slow current (Photo A-9). The upstream banks are relatively flat until you reach the active channel where the banks are steep and incised. The banks are well vegetated with weeds and grasses. Upstream, along the banks and on islands in the river channel, are extensive stands of giant reed, or *Arundo donax*, and other invasive plant species. Upstream, a few riparian trees provide little shade to the river channel. Because of deep water and vegetation, it is hard to determine the composition of the river bottom upstream.

Immediately downstream of the bridge, the river channel is choked completely with invasive water hyacinth (Photo A-12, from the Pacific Avenue southbound bridge). Downstream of the bridge the river channel is well defined, straight, and with tidally influenced, slow current. The downstream banks are relatively flat until you reach the active channel where the banks become steeper. The banks are well vegetated with weeds, bushes, and grasses. Downstream, a few riparian trees provide little, if any, shade to the river channel. There are extensive growths of giant reed or *Arundo donax*, on both banks downstream. Immediately downstream of the Pacific Avenue bridges, there is a remnant concrete structure (Photo A-12, from the Pacific Avenue southbound lanes).

Because the structure has no apron or riprap scour protection and there is no visible water surface difference between one side of the structure and the other, it is not a barrier to fish migration. We will be confirming this by modeling fish passage at the McAllen Road Bridge.

Photo A-8. Looking downstream at Pacific Avenue Bridge, northbound on the Calaveras

Photo A-9. Looking upstream from Pacific Avenue Bridge, northbound

Pacific Avenue Bridge, Southbound

The Pacific Avenue bridges, northbound and southbound, are not the same. The bridges cross perpendicular to the Calaveras River at river mile 3.7. The southbound bridge is on the eastern edge of the University of the Pacific Campus in downtown Stockton (Photo A-10). The southbound bridge has two lanes and a pedestrian and bicycle lane. The Pacific Avenue bridges are both in the area of the river that is under tidal influence; therefore, the channel contains water throughout the year.

Pacific Avenue Bridge, southbound, spans about 275 feet. The bridge contains arch pier structures divided into three smaller piers that connect with the substrate (Photo A-10). The bridge has six rows of three piers. The distance between each row is 40 feet. The active channel encompasses two of the main pier structures, and the active channel is about 66 feet wide. The Pacific Avenue Bridge, southbound, is in an area influenced by tides so that there is water all year. That makes it hard to tell if there is an apron under the bridge. The north bank of the river channel has a paved bicycle and pedestrian trail.

Upstream of the bridge, the river channel is well defined and straight; the current is slow (Photo A-11). The upstream banks are relatively flat until you reach the active channel where the banks become steeper. The banks are well vegetated with weeds, bushes, and grasses. Upstream, a few riparian trees provide little shade, if any, to the river channel. There are extensive growths of giant reed or *Arundo donax,* on both banks upstream. Immediately upstream of the Pacific Avenue bridges is a remnant concrete structure that once served as a base for a flashboard dam (Photo A-13).

Downstream of the bridge, the river is well defined, slightly meandering with a slow current (Photo A-12). The downstream banks are relatively flat until you reach the active channel where the banks are steep and incised. The banks are well vegetated with weeds and grasses. Immediately downstream of the bridge, the river channel is choked with invasive water hyacinth (Photo A-12). Farther downstream, along the banks and on islands in the river channel, are extensive stands of giant reed, or *Arundo donax,* and other invasive plants. Downstream, a few riparian trees provide little shade, if any, to the river channel. Because of deep water and vegetation, it is hard to determine the composition of the river bottom downstream.

Because the structure has no apron or riprap scour protection and there is no visible water surface difference between one side of the structure and the other, it is not a barrier to fish migration. We will be confirming this by modeling fish passage at the McAllen Road Bridge.

Photo A-10 Looking upstream at Pacific Avenue Bridge, southbound

Photo A-11. Looking upstream from Pacific Avenue bridges on the Calaveras

Photo A-12. Looking downstream from Pacific Avenue Bridge, southbound

Concrete Remnant Structure Upstream Of Pacific Avenue Bridge

The concrete remnant structure upstream of Pacific Avenue Bridge, near river mile 3.9, appears to have been the foundation and abutments of a flashboard dam. The opening between abutments is 8 feet wide, and the bankfull width is 60 feet. The structure has been washed away near the left bank and is no longer in use. Because the structure is no longer in use, it should be removed.

Photo A-13. Upstream face of concrete remnant structure

El Dorado Street Bridge

The El Dorado Street Bridge crosses perpendicular to the Calaveras River near river mile 4.5, downstream of the confluence of the Stockton Diverting Canal and the Calaveras River (Photo A-14). The El Dorado Street Bridge carries four lanes.

The El Dorado Street Bridge spans 379 feet. The concrete bridge contains 84 piers configured in 14 roughly parallel rows of 6. The distance between the rows of piers is about 22 feet. The active channel encompasses 3 rows of piers and is 58 feet wide. There is no apron under the bridge, but there is some scattered rubble. The north side of the channel has a paved path, and the bank on the south side of the channel has a dirt road.

Upstream of the bridge, the river is well defined and slightly meandering, and the current is slow (Photo A-15). The upstream banks are flat until you reach the channel where the bank becomes steep and incised. The left bank is well vegetated with bushes, weedy vegetation, and grasses; the right bank contains primarily grasses and weedy vegetation. Upstream, there are no riparian trees on the levees. The river bottom upstream of the bridge is composed of bare earth with scattered pieces of rubble.

Downstream of the bridge, the river channel meanders slightly, and its bottom is bare earth with some scattered rubble (Photo A-16). The downstream banks are flat until you reach the channel where the bank becomes steep and incised. The banks are well vegetated with weeds and grasses. There are no riparian trees downstream of the bridge. On the right bank, immediately downstream of the bridge, are four drainage pipes (Photo A-17).

The structure has no apron or riprap scour protection, and there is no visible water surface difference between one side of the structure and the other. Despite the presence of scattered rubble, it is not a barrier to fish migration. We will be confirming this by modeling fish passage at the McAllen Road Bridge.

Photo A-14. Looking downstream at El Dorado Street Bridge

Photo A-15. Looking upstream of El Dorado Street Bridge

Photo A-16. Downstream of El Dorado Street Bridge

Photo A-17. Drainpipes downstream of El Dorado Street Bridge

Railroad Crossing No. 2

Railroad Crossing No. 2 crosses perpendicular to the Calaveras River at river mile 5.2, downstream of the West Lane Bridge and railroad crossing No. 1 (Photo A-18). Railroad crossing No. 2 is an active crossing with one set of tracks.

Railroad Crossing No. 2 spans 270 feet. The railroad deck is concrete, and the piers are steel. The crossing has 10 piers that are 27 feet apart. The active channel spans 42 feet and encompasses one pier. There is no apron under the crossing, but there is some scattered rubble under the bridge. Additionally, there is a lot of trash in the river below the trestle (Photo A-19). The north side of the channel contains a bicycle path. Upstream of the crossing on the north bank are some storm drain outlets (Photo A-20).

Upstream of the bridge, the river is a well defined and slightly meandering channel (Photo A-21). The upstream banks are relatively flat until you reach the river channel, which is steeply incised. The left and right banks are well vegetated with weedy vegetation and grasses. Upstream, there are no riparian trees on the levees. The river bottom upstream of the bridge is bare earth with scattered pieces of rubble.

Downstream of the crossing, the river channel is relatively straight and the channel bottom is composed of bare earth with some scattered rubble (Photo A-22). The downstream banks are relatively flat until you reach the river channel, which is steeply incised. The banks are well vegetated with weeds and grasses. There are few riparian trees downstream of Railroad Crossing No. 1 that provide limited shade to the river channel. Modeling results from Mormon Slough Railroad Crossing will be used to assess fish passage at Railroad Crossing No. 2.

Photo A-18. Looking downstream at Railroad Crossing No. 2

Photo A-19. Trash under Railroad Crossing No. 2

Photo A-20. Drain outlets upstream of Railroad Crossing No. 2

Photo A-21. Looking upstream from Railroad Crossing No. 2

Photo A-22. Looking downstream of Railroad Crossing No. 2

West Lane Bridge

The West Lane Bridge crosses perpendicular to the Calaveras River near river mile 5.5, downstream of the confluence of the Stockton Diverting Canal and the Calaveras River (Photo A-23). There are actually two separate bridges that are the same, one for southbound traffic and one for northbound traffic (Photo A-24). The West Lane Bridge crosses the Calaveras River between railroad crossings No. 1 and No. 2.

The West Lane Bridge spans 286 feet. Each concrete bridge has 60 piers configured in 10 roughly parallel rows of 6. The distance between the rows of piers is 26 feet. The active channel is 105 feet wide and encompasses 4 rows of piers. Each bridge contains two traffic lanes. There is no apron under the bridge, but there is scattered rubble under the bridge extending to the banks. The north side of the channel has a paved path, and the bank on the south side has a dirt road.

Upstream of the bridge, the river channel is well defined and slightly meandering (Photo A-25). The upstream banks are relatively flat until you reach the levee where the bank becomes steeper. The banks are well vegetated with weeds and grasses. A few scattered riparian trees are near the top of the levees. Based on the location of the trees relative to the active channel, it is likely that they would provide no shade to the river channel. The river bottom upstream of the bridges is composed of bare earth with a few scattered pieces of rubble.

Downstream of the bridge, the river channel is relatively straight. The bottom is composed of bare earth with some scattered rubble. The downstream banks are relatively flat until you reach the levee where the bank becomes steeper. The banks are well vegetated with weeds and grasses. The few scattered riparian trees near the top of the levees are likely to provide no shade to the river channel.

Because the structure has no apron or riprap scour protection and there is no visible water surface difference between one side of the structure and the other, it is not a barrier to fish migration. We will be confirming this by modeling fish passage at the McAllen Road Bridge.

Photo A-23. Looking downstream at West Lane Bridge

Photo A-24. Looking between the two West Lane Bridges

Photo A-25. Looking upstream of West Lane Bridge

Photo A-26. Looking downstream of West Lane Bridge

Pedestrian Bridge Downstream of Railroad Crossing No. 1

The Pedestrian Bridge crosses perpendicular to the Calaveras River near river mile 5.6, just downstream of the railroad crossing No. 1 and upstream of West Lane Bridge (Photo A-27). The Pedestrian Bridge is wide enough to provide for two-way bicycle or pedestrian traffic from the south and north sides of the Calaveras River.

The Pedestrian Bridge spans about 315 feet. The bridge uses four piers that are not evenly spaced. Going from south to north, distance between the piers is 62, 79, and 30 feet. The active channel does not appear to regularly encompass any of the four piers. There is no apron under the bridge, but the ground surrounding each pier is covered in a roughly circular pattern of riprap that extends about 15 feet (Photo A-28).

Upstream of the bridge, the river is a well defined and slightly meandering channel (Photo A-29). The upstream banks are relatively flat until you reach the levee where the bank becomes steeper. The left bank is steeper as you approach the active river channel. The banks are well vegetated with weeds and grasses, with some bushes on the left bank. Upstream, there are no riparian trees. The river bottom upstream of the bridge(s) is composed of bare earth with a few scattered pieces of rubble.

Downstream of the bridge, the river channel slightly meanders and is composed of bare earth with some scattered rubble. The downstream banks are relatively flat until you reach the active channel where the banks become steeper. The banks are well vegetated with weeds and grasses. Downstream, there are no riparian trees on the levees.

Because the structure has no apron or riprap scour protection and there is no visible water surface difference between one side of the structure and the other, it is not a barrier to fish migration. We will be confirming this by modeling fish passage at the McAllen Road Bridge.

Photo A-27. Looking upstream at Pedestrian Bridge, Railroad Crossing No. 1 in the distance

Photo A-28. Looking at riprap around piers at Pedestrian Bridge

Photo A-29. Looking upstream from Pedestrian Bridge toward Railroad Crossing No. 1

Photo A-30. From Pedestrian Bridge looking downstream, towards West Lane Bridges

Railroad Crossing No. 1

The Railroad Crossing No. 1 crosses perpendicular to the Calaveras River at river mile 5.7, just downstream of the confluence between the Stockton Diverting Canal and the Calaveras River (Photo A-31). Railroad crossing No. 1 is an active bridge with one set of tracks.

The Railroad Crossing No. 1 spans about 275 feet. The concrete crossing contains 9 piers that are 25 feet apart. The active channel encompasses 2 piers with a width of 60 feet. There is no apron under the bridge, but there is some scattered rubble under the bridge. There is a bike path on the south side of the channel. Structural repairs were made to the crossing in 2004 (Photo A-32).

Upstream of the bridge, the river is a well-defined and slightly meandering channel (Photo A-33). The upstream banks are relatively flat until you reach the levee. The left and right banks are well vegetated with bushes, weedy vegetation, and grasses. Upstream, there are no riparian trees on the levees. The river bottom upstream of the bridge is composed of bare earth with a few scattered pieces of rubble.

Downstream of the bridge, the river channel slightly meanders, and the bottom is composed of bare earth with some scattered rubble (Photo A-34). The downstream banks are relatively flat until you reach the levee. The banks are well vegetated with weeds and grasses. Downstream, there are few riparian trees that provide limited shade to the river channel. A short distance downstream are two more bridges, a pedestrian bridge and the West Lane Bridge. Fish passage at Railroad Crossing No. 1 will be assessed using modeling results from Mormon Slough railroad crossing.

Photo A-31. Looking upstream at Railroad Crossing No. 1

Photo A-32. Construction on Railroad Crossing No. 1 in late 2004

Photo A-33. Looking upstream from Railroad Crossing No. 1

Photo A-34. Downstream of Railroad Crossing No. 1 looking downstream toward Pedestrian Bridge and West Lane Bridge

Calaveras River between the Calaveras Headworks and the Confluence with the Stockton Diverting Canal

Old Wooden Bridge

The Old Wooden Bridge is an abandoned wooden bridge on the Calaveras River channel downstream of the Calaveras Headworks near river mile 6. The structure is oriented perpendicular to the flow path and spans approximately 65 feet across the channel. Two sets of wooden support piers made of treated lumber are in the bankfull channel. Most of the small diameter, unfinished logs that rest on the piers spanning the channel remain in place. A few are broken partway or are completely missing. Only a few of the planks that make up the bridge deck still exist at the right bank side (Photo A-35).

The bridge piers are spaced approximately 20 feet apart; the footings are protected by a full-span concrete apron (Photo A-36). The apron is the width of the bridge at approximately 16 feet. The apron appears to be in fair condition and has a rough concrete pour at the downstream end to attempt to reduce scour (Photo A-37).

Upstream of the bridge, the channel is straight and well defined with a rounded trapezoidal shape. The banks are completely covered with thick, grassy vegetation. A single tree stands on the left bank (Photo A-38). The bottom of the upstream pool is approximately one foot below the top of the concrete apron.

The downstream channel is also well defined and a rounded trapezoidal shape. The dense, grassy vegetation on the banks extends into the stream channel starting approximately 20 feet downstream from the structure (Photo A-39). The distance from the top of the apron to the bottom of the downstream pool is approximately 1.75 feet.

The structure appears to be creating some localized downstream scour at the right bank (Photo A-40). This scour is likely due to velocity increased by constriction of flow between the bridge piers and by the concrete apron that is smoother than the natural channel bottom. Because the structure is no longer in use and the bridge is unsafe, the bridge should be removed. Removal of the structure should eliminate future scour problems and unsafe conditions.

Photo A-35. View from downstream of Old Wooden Bridge

Photo A-36. Footings and apron of Old Wooden Bridge

Photo A-37. Rough concrete pour at downstream edge of apron at Old Wooden Bridge

Photo A-38. Concrete apron and upstream channel of Old Wooden Bridge

Photo A-39. Channel downstream of Old Wooden Bridge

Photo A-40. Scour hole at right bank downstream of Old Wooden Bridge

Gotelli Low-flow Road Crossing (River Mile 6.2)

The Gotelli Crossing is a culvert that provides vehicular access across the Calaveras River (Photo A-41). The structure is on the Calaveras River at river mile 6.2, downstream of the Calaveras Headworks. The crossing consists of a circular corrugated metal culvert overlain by an earthen fill road prism situated perpendicular to the channel alignment. The road crossing is unpaved and about 17 feet wide and 40 feet long. The culvert has a diameter of 3.5 feet and a length of 20 feet and is laid on a 2% slope. The inlet and outlet inverts of the culvert are flush with the channel thalweg. The pipe is in poor condition.

The upstream channel is relatively straight, narrow, and trapezoidal (Photo A-42). The channel bottom was fairly clean, and the banks were overgrown with grassy vegetation. The channel bed substrate and banks appeared to be predominantly silty clay.

The downstream channel has properties similar to the upstream channel (Photo A-43). The channel bottom is lined with broken concrete and various household refuse items within 16 feet of the outlet. Further downstream, the bottom of the channel was relatively clean, and the banks were overgrown with grassy vegetation. An old road crossing downstream of the site was causing a backwater condition during the site visit.

Photo A- 41. Gotelli Low-flow Road Crossing (River Mile 6.2), view of outlet

Photo A- 42. Calaveras River upstream of Gotelli Low-flow Road Crossing (River Mile 6.2)

Photo A- 43. Calaveras downstream of Gotelli Low-flow Road Crossing (River Mile 6.2)

McAllen Road Bridge

The McAllen Road Bridge crosses perpendicular to the Calaveras River at river mile 6.9. The bridge is immediately downstream of McAllen flashboard dam (Photo A-44). The bridge has a two-lane road.

The McAllen Road Bridge spans 113 feet. The bridge has two rows of four piers. The rows are 31 feet apart. The active channel below the bridge is 28 feet wide. There is extensive riprap in the channel below, immediately upstream and downstream from the bridge (Photo A-45).

Upstream from the bridge the river channel is a well-defined rounded trapezoid and slightly meandering (Photo A-46). The upstream banks slope moderately until you near the tops of the levee where it becomes more gradual. The banks are well vegetated with weeds, bushes, and grasses. Upstream, riparian trees provide some shade to the river channel. Immediately upstream from the bridge is McAllen flashboard dam. Riprap covers the upstream channel (Photo A-47). Upstream on the right bank are four drainpipe outlets (Photo A-48). Farther upstream, the river channel is bare with scattered rubble.

Downstream of McAllen Road Bridge the river channel narrows and is well defined (Photo A-49). The downstream banks are steep until you reach the top of the levee where the slope becomes more gradual. The banks are heavily vegetated with grasses, bushes, and weedy vegetation (especially blackberry). Downstream riparian trees (especially left bank) provide shade to the river channel. Immediately downstream from the bridge, the channel is composed of riprap that gives way to a bare substrate.

This structure was modeled to evaluate depth and velocity at the bridge against fish passage criteria. The modeling results are in this report. The model results from this structure also represent fish passage at other bridges on the Calaveras River listed in Table 5-3 of the main report.

Photo A-44. Looking downstream at McAllen Road Bridge

Photo A-45. Riprap below McAllen Road Bridge

Photo A-46. Looking upstream from McAllen Road Bridge

Photo A-47. McAllen Flashboard Dam upstream of McAllen Road Bridge

Photo A-48. Drainpipes upstream of McAllen Road Bridge

Photo A-49. From McAllen Road Bridge looking downstream

McAllen Flashboard Dam

McAllen Flashboard Dam base is near river mile 6.9, immediately upstream of McAllen Road Bridge (Photo A-50). Flashboards are used during irrigation season. When the flashboards are removed, the channel typically receives minimal flows.

The dam base span is about 36 feet. The distance between terminal points of the concrete on the banks is about 43 feet. The bankfull channel is about 80 feet wide. The bottom of the dam base is 5 feet wide and creates a 1.3-foot sloping drop to the channel bed. Riprap and boulders line the channel bottom. Additionally, significant amounts of trashy debris are in the river channel near this site. We saw many dead or trapped carp, catfish, and crayfish in the pools around the structure (Photo A-51). Four water outfall pipes are on the right bank upstream from the dam (Photo A-52). The structure is a concrete base across the channel bottom and extends partly up the sides of the channel. There is no notch in the flashboard dam base.

The upstream channel about 50 feet from the structure is covered with riprap (Photo A-53). Upstream, the river channel is a well-defined rounded trapezoid and slightly meandering (Photo A-54). Upstream beyond the riprap, the substrate in the river channel is silty clay with some scattered riprap. The upstream banks are moderate in slope until you near the tops of the levee where the slope becomes more gradual. The banks are well vegetated with weeds, bushes, and grasses. Upstream, riparian trees provide some shade to the river channel.

Immediately downstream from the dam base the channel bed and lower banks are covered with riprap. The riprap continues until downstream of McAllen Road Bridge where the channel substrate gives way to silty clay with some scattered riprap. Downstream, the channel narrows visibly and is well-defined. The downstream banks are steep until you reach the area near the tops of the levee where the slope becomes more gradual. The banks are heavily vegetated with grasses, bushes, and weedy vegetation, especially blackberry. Downstream, riparian trees (especially left bank) shade the river channel.

With the flashboards in, McAllen Flashboard Dam is 5.3 feet high and spans 36 feet across the river (Photo A-55). During irrigation season, the typical water surface difference between the dam crest and the plunge pool is 2.9 feet. The deepest part of the plunge pool is 2.4 feet deep and about 4 feet away from the dam face.

The minimum plunge pool depth of 2 feet for juvenile salmonids is met at McAllen Flashboard Dam. This structure was modeled to evaluate depth and velocity at the dam against fish passage criteria. The modeling results are in this report. The model results from this structure also represent fish passage at other flashboard dam bases on the Calaveras River listed in Table 5-11 of the main report.

Photo A-50. The McAllen Flashboard Dam base

Photo A-51. Stranded fish and crayfish at McAllen Flashboard Dam base

Photo A-52. Outfall pipes upstream of McAllen Flashboard Dam base

Photo A-53. Upstream from McAllen Flashboard Dam base

Photo A-54. Upstream from McAllen Flashboard Dam base

Photo A-55. Downstream from McAllen Flashboard Dam

Highway 99 Pedestrian Bridge

The Highway 99 Pedestrian Bridge crosses perpendicular to the Calaveras River at river mile 7.4. This bridge is just downstream from the Highway 99 Bridge, southbound. The bridge is wide enough for cyclists and walkers simultaneously.

The Highway 99 Pedestrian Bridge spans 126 feet. The bridge uses four wooden piers grouped into two rows of two. Each row is 33 feet apart. The 15-foot-wide active channel runs between the two rows of piers. Under the bridge, the channel is bare earth.

Immediately upstream from the pedestrian bridge are the Highway 99 bridges, southbound and northbound (Photo A-57). The river channel upstream from the bridge has a bare earth substrate with some scattered riprap. Farther upstream, the river channel converts into the concrete that is associated with the apron from Highway 99 Bridge, northbound. As the river channel approaches the apron, the channel becomes wider. Upstream from the bridge, both banks go from being covered with grasses to bare earth (when under Highway 99 bridge, southbound), to riprap, weedy grasses, and bushes (between Highway 99 bridges), and finally to concrete (associated with Highway 99 Bridge, northbound). The upstream banks are moderately sloped near the river channel, becoming less steep as you approach the road.

Downstream from the pedestrian bridge, the channel is bare earth with some scattered riprap. Here the river channel narrows and has a slight meander (Photo A-58). Downstream from the bridge, both banks are covered with blackberry and grasses. The downstream banks are steep near the river, but less steep as you approach the tops of the levees. A few riparian trees provide minimal shade to the river channel.

Because the structure has no apron or riprap scour protection and there is no visible water surface difference between one side of the structure and the other, it is not a barrier to fish migration. We will be confirming this by modeling fish passage at the McAllen Road Bridge.

Photo A-56. Highway 99 Pedestrian Bridge

Photo A-57. Between Highway 99 Pedestrian Bridge and Highway 99 Bridge, southbound

Photo A-58. Downstream of Highway 99 Pedestrian Bridge

Highway 99 Bridge, Northbound

The Highway 99 bridges, northbound and southbound, are not the same. The bridges cross perpendicular to the Calaveras River at river mile 7.5. There is also a pedestrian bridge on the west side of the southbound bridge. The northbound bridge provides two lanes for vehicle traffic.

Highway 99 Bridge, northbound, spans 126 feet. The bridge has 22 piers that are grouped into 2 rows of 11 each. Each row of piers is 54 feet apart. The 35-foot-wide active channel runs between the 2 rows of piers. An apron extends upstream and downstream from the bridge. The concrete associated with the apron fully covers the banks and extends the length of the bridge. Both upstream and downstream, the level of the apron is flush with the river channel bottom.

Directly under the bridge and extending about 40 feet upstream, the substrate is a thin layer of silt and rock that covers the apron. Farther upstream past the apron, the channel is bare and contains some scattered riprap. At this point the river channel narrows and has a slight meander (Photo A-59). Upstream from the bridge, both banks are covered with concrete from the apron. The upstream banks are moderately sloped near the river channel, becoming less steep as you approach the road. Upstream from the apron, the right bank has some riprap and outlets from two storm runoff pipes (Photo A-60). Both banks are vegetated with weedy bushes and grasses. A few riparian trees provide little shade to the river channel.

Directly under the bridge and extending about 25 feet downstream, the substrate is a thin layer of silt and rock that covers the apron. Farther downstream past the apron, the channel is bare with some scattered riprap. At this point the river channel narrows and approaches the Highway 99 Bridge, southbound (Photo A-61). Downstream from the bridge, both banks are covered with concrete from the apron. The downstream banks are moderately sloped near the river channel, becoming less steep as you approach the road height where you will encounter a concrete wall. Downstream from the apron the left bank has riprap and an outlet from a storm runoff pipe. The right bank is vegetated with weedy bushes and grasses.

Because the structure has an apron, sufficient water is needed to allow for passage. We will be confirming this by modeling fish passage at another bridge with similar conditions.

Photo A-59. Downstream at Highway 99 Bridge, northbound

Photo A-60. Upstream of Highway 99 Bridge, northbound

Photo A-61. Upstream of Highway 99 Bridge, northbound, at the drain outlets

Photo A-62. Downstream of Highway 99 Bridge, northbound

Highway 99 Bridge, Southbound

The Highway 99 bridges, northbound and southbound, are not the same. The bridges cross perpendicular to the river at river mile 7.4. There is also a pedestrian bridge on the west side of the southbound bridge. The southbound bridge provides two traffic lanes.

Highway 99 Bridge, southbound, spans 126 feet. The bridge has eight piers that are grouped into two rows of four each. Additionally, each row has an adjacent pier, bringing the total to 10 piers (Photo A-63). Each row of piers is 33 feet apart. The 15-foot-wide active channel runs between the two rows of piers.

Directly under the bridge the substrate is bare earth with a few scattered rocks. Upstream from the bridge, the river channel widens and runs over the apron associated with the Highway 99 Bridge, northbound. The upstream banks are moderately sloped near the river channel, becoming less steep as you approach the road. The left bank has riprap and an outlet from a storm runoff pipe. The right bank is vegetated with weedy bushes and grasses. Farther upstream the banks give way to concrete associated with the Highway 99 Bridge, northbound.

Immediately downstream from the Highway 99 Bridge, southbound, is a pedestrian walkway (Photo A-64). Downstream from the Highway 99 Bridge, southbound, the river narrows and has a slight meander (Photo A-65). The downstream banks are steep to the crest of the levees. The banks are well vegetated with weeds and grasses. Downstream, a few riparian trees provide little shade, if any, to the river channel.

Because the structure has no apron or riprap scour protection and there is no visible water surface difference between one side of the structure and the other, it is not a barrier to fish migration. We will be confirming this by modeling fish passage at the McAllen Road Bridge.

Photo A-63. Upstream looking at Highway 99 Bridge, southbound

Photo A-64. Looking at piers under Highway 99 Bridge, southbound

Photo A-65. Looking between Highway 99 Bridge, southbound, and the pedestrian bridge

Photo A-66. Looking downstream of Highway 99 Bridge, southbound, at the Calaveras River

Cherryland Flashboard Dam

Cherryland Flashboard Dam is at river mile 7.9, downstream from the Calaveras Headworks (Photo A-67). The structure supports flashboards during irrigation season. Flashboards are removed during non-irrigation season, and the Calaveras River receives only minimal flows that are released from the Calaveras Headworks.

The dam base span is about 32 feet with a bankfull channel width of 46 feet. The length of the dam base along the channel centerline is 25 feet. There is a drop of 3.5 feet from the base of the dam to the downstream river channel bottom. However, in the area where the dam base drops to the river channel, the channel is choked with riprap and woody debris (Photo A-68). The dam base extends from the channel bottom up part of the banks (Photo A-69). The dam base span is only about 8 feet across the channel bottom and narrows the river channel. There is not a notch in the dam base. When water flow is present, typically there are swift currents over the dam base.

The river channel immediately downstream from the dam base is cluttered with riprap and debris. After about 50 feet, the riprap gives way to a bare substrate made up of silty clay with some small stones. The downstream bank is heavily vegetated with small bushes and grasses. The downstream river channel has little or no meander with a well-defined rounded trapezoidal cross section (Photo A-70).

The river channel immediately upstream from the dam base is backwatered by the dam base, and the water surface is wide and flat compared to downstream (Photo A-71). On each side of the bank upstream, there are drainage canal outlets (Photo A-72). The river channel narrows upstream from the drainage canals outlet, has little or no meander, and has a rounded trapezoidal cross section. Compared to the downstream bank, the upstream bank is less vegetated. There are few bushes, and the lower portion of the left bank is bare. Scattered willows and cottonwoods would provide limited shade in the river channel (Photo A-73).

Cherryland Flashboard Dam is an 8.1-foot-high flashboard dam that spans about 25 feet (Photo A-74). The flashboards, guide posts, and supports are set into slots in a concrete lined section of the channel. During the irrigation season the dam creates a 3.5-foot water surface difference between the upstream and downstream pools. The plunge pool immediately downstream from the dam is about a foot deep and 5.7 feet away from the dam face.

The minimum plunge pool depth of 2 feet for juvenile salmonids is not met at Cherryland Dam. This structure was modeled to evaluate depth and velocity at the dam against fish passage criteria. The modeling results are in this report.

Photo A-67. Cherryland Flashboard Dam base

Photo A-68. The drop from dam base to river channel with no flow

Photo A-69. Downstream end of Cherryland Flashboard Dam base

Photo A-70. Downstream from Cherryland Flashboard Dam

Photo A-71. Upstream end of Cherryland Flashboard Dam

Photo A-72. The outlet of drainage canal upstream of Cherryland Flashboard Dam

Photo A-73. Upstream from Cherryland Flashboard Dam

Photo A-74. Downstream looking upstream at Cherryland Flashboard Dam

Railroad Crossing Near Leonardini Road

The Railroad Crossing near Leonardini Road crosses perpendicular to the Calaveras River at river mile 8.6, downstream of the Calaveras Headworks (Photo A-75). The Railroad Crossing near Leonardini is upstream of Cherryland Flashboard Dam.

The Railroad Crossing near Leonardini Road spans 85 feet. The crossing is a wooden bridge supporting a single set of tracks. The active channel is 30 feet wide. The active channel widens under the crossing and encompasses four piers. The crossing contains four wooden piers that are subdivided into six supporting wooden beams. There are many pieces of broken concrete under the crossing (Photo A-76). There is no apron under the bridge.

The river channel upstream is bare earth composed of silty-clay soil with some scattered concrete debris (Photo A-77). The channel is trapezoidal, wide, and has slight meander to the right. The upstream banks are sloped moderately. The right and left banks are heavily vegetated with bushy weeds and grasses. Some riparian trees on the left bank and orchard trees encroach on both right and left banks. These trees would provide little shade to the river channel.

Immediately downstream of the crossing are scattered pieces of concrete pipe. Downstream of the concrete rubble, the river channel is bare earth composed of silty-clay soil. The channel is trapezoidal, narrows some compared to under the crossing and upstream, and has a slight meander. The downstream banks are sloped moderately. The right and left banks are heavily vegetated with bushy weeds and grasses. The riparian trees would provide little shade to the river channel. Modeling results from Mormon Slough railroad crossing will be used to assess fish passage at the railroad crossing near Leonardini Road.

Photo A-75. Railroad Crossing near Leonardini Road on the Calaveras River

Photo A-76. Concrete debris under Railroad Crossing near Leonardini Road on the Calaveras River

Photo A-77. Looking upstream from Railroad Crossing near Leonardini Road at the Calaveras River channel

Old DWR Gage Weir

Old DWR Gage Weir is an abandoned flow gage system on the Calaveras River downstream of Calaveras Headworks at river mile 9.5. The system consists of a concrete weir downstream of Solari Ranch Road bridge and an encased gage apparatus affixed to the bridge at the right bank.

The concrete weir spans 16 feet across the channel bottom in an arced chevron shape pointing in the downstream direction. The weir has an ogee shape; a rounded crest that slopes down then flattens, and is about 4 feet from upstream crest to downstream lip and 2.5 feet tall from centerline crest to toe (Photo A-78). Under low-flow conditions, there is a drop from the downstream edge of the weir to plunge pool surface.

The typical channel near the structure has a rounded trapezoidal shape and is straight and well defined. The channel upstream from the weir is silty and flat. The banks are vegetated with vines and trees, with dense, overhanging vegetation on the left bank. Upstream from the weir is the abandoned DWR stream gage apparatus and bridge for Solari Ranch Road. About 15 feet upstream from the bridge are concrete lined banks and the concrete base for Solari flashboard dam.

Downstream from the weir, the silty bottom has riprap and scattered concrete rubble. Dense blackberry vines and trees overhang the channel on the left bank. The right bank has sparser blackberry cover and shows signs of bank erosion (Photo A-79). Trash and debris litter the channel bottom both up and downstream from the weir.

The structure is a potential barrier to upstream fish migration. Until flows are high enough to backwater or submerge the weir, fish leaping onto the flat portion of the weir do not have sufficient water depth to proceed and leap over the rounded crest. Water velocity over the smooth concrete may also cause a fish to fall back after leaping onto the lower weir. Because the weir and gage are no longer in use, the structure should be removed.

Photo A-78. Looking upstream at the Old DWR Gage Weir

Photo A-79. Looking downstream from the Old DWR Gage Weir crest

Solari Ranch Road Bridge

The Solari Ranch Road Bridge crosses perpendicular to the Calaveras River at river mile 9.5, downstream from the Calaveras Headworks (Photo A-80). The bridge is immediately downstream of Solari Ranch flashboard dam and immediately upstream from the old DWR stream gage.

The Solari Ranch Road Bridge spans 75 feet. The concrete bridge has 10 piers configured in two parallel rows of five. The distance between the rows of piers is 26 feet. The active channel runs between the two rows of piers. The bridge carries a two-lane road. No apron is under the bridge, but a weir structure associated with the stream gage is immediately downstream (Photo A-81). There is a lot of trash in the area under, upstream, and downstream from the bridge (Photo A-82).

About 15 feet upstream from the bridge are concrete lined banks and the concrete base for Solari Flashboard Dam. (The concrete base for Solari Flashboard Dam extends 52 feet.) The river channel immediately upstream of Solari Ranch Road Bridge and Solari Ranch Flashboard Dam is comprised of bare earth with some scattered rubble. The channel is trapezoid in shape and has little meander (Photo A-83). The upstream banks are moderate in slope until you near the tops of the levee where the slope becomes more gradual. Both banks are well vegetated with weeds, bushes, and grasses. Upstream, there are riparian trees, and they provide some shade to the river channel.

Immediately downstream from the bridge are the stream gage and the weir (Photo A-81). The concrete weir spans 16 feet across the channel bottom in an arced chevron shape pointing in the downstream direction. The weir has a 2.5-foot drop from crest to channel bottom. Farther downstream, where there is no rubble, debris, or trash, the channel substrate is comprised of silty-clay soil (Photo A-84). Compared to the upstream banks, the downstream banks are steeper. Both banks are well vegetated with weeds, bushes, and grasses (except for under the bridge). Dense blackberry vines and trees overhang the channel on the left bank. Downstream, there are riparian trees, and they provide some shade to the river channel.

The structure has no apron or riprap scour protection and there is no visible water surface difference between one side of the structure and the other. With appropriate water present, it is not a barrier to fish migration. We will be confirming this by modeling fish passage at the McAllen Road Bridge.

Photo A-80. Looking downstream at Solari Ranch Road Bridge

Photo A-81. Stream gage weir downstream of Solari Ranch Road Bridge

Photo A-82. Trash below Solari Ranch Road Bridge

Photo A-83. From Solari Ranch Road bridge looking upstream at the Calaveras River

Photo A-84. From Solari Ranch Road Bridge looking downstream

Solari Ranch Flashboard Dam

Solari Ranch Flashboard Dam base is near river mile 10.1, immediately upstream of Solari Ranch Road Bridge and the old DWR stream gage (Photo A-85). The structure provides support for flashboards during irrigation season. When the flashboards are removed, the channel typically receives minimal flows.

The base of Solari Dam is concrete lining that creates a trapezoidal channel. The structure span comprises the distance between terminal points of the concrete on the banks, about 51 feet. The bankfull channel width is about 51 feet. The concrete lining extends about 52 feet along the channel, is about 13 feet wide, and ends flush with the channel bottom. There are significant amounts of trashy debris in the river channel near this site. There is no dam base notch present. When water flow is present, typically high water velocities exist over the dam base.

The river channel immediately upstream from the dam base is bare with some scattered rubble. The channel is trapezoid in shape and has little meander (Photo A-86). The upstream banks are moderate in slope until you near the top of the levee where the slope is more gradual. Both banks are well vegetated with weeds, bushes, and grasses. Upstream, there are riparian trees, and they provide some shade to the river channel.

Immediately downstream from the dam base there is a narrow band of riprap that crosses the whole channel. Downstream of this row of riprap there is scattered rubble, and excessive trash and debris (Photo A-87). This continues downstream past the old DWR stream gage. Where there is not rubble, debris, or trash the channel substrate is comprised of silty-clay soil. Compared to the upstream banks, the downstream banks are steeper. Both banks are well vegetated with weeds, bushes, and grasses (except for under the bridge). Downstream, there are riparian trees, and they provide some shade to the river channel. Fish passage at Solari Ranch flashboard dam is represented by the modeling results from Murphy Dam.

Photo A-85. Solari Ranch Flashboard Dam base

Photo A-86. Upstream from Solari Ranch Flashboard Dam

Photo A-87. Downstream from Solari Ranch Flashboard Dam base

Ashley Lane Bridge

The Ashley Lane Bridge crosses perpendicular to the Calaveras River near river mile 10, downstream from the Calaveras Headworks (Photo A-88).

The Ashley Lane Bridge spans about 58.5 feet. The concrete bridge has five piers configured into one row in the center of the bridge. The active channel is about 13 feet but widens under the bridge and runs on either side of the row of piers. Under the bridge, concrete abutments form the edge of the active river channel (Photo A-89). There is a two-lane road on the bridge. There is no apron under the bridge.

The river channel upstream is bare comprised of silty-clay soil with some scattered rubble. The channel is trapezoid and has little meander. The upstream banks are steep to moderate (with the right bank being steeper) until you near the tops of the levee where the slope becomes more gradual. The right bank is heavily vegetated with bushy weeds that constrict the river channel. Weeds, bushes, and grasses cover the left bank. Riparian trees provide little shade to the river channel (Photo A-90). Downstream conditions are the same (Photo A-91).

Because the structure has no apron or riprap scour protection and there is no visible water surface difference between one side of the structure and the other, it is not a barrier to fish migration. We will be confirming this by modeling fish passage at the McAllen Road Bridge.

Photo A-88. Ashley Lane Bridge

Photo A-89. Concrete abutments under Ashley Lane Bridge

Photo A-90. Upstream from Ashley Lane Bridge

Photo A-91. Downstream from Ashley Lane Bridge

Alpine Road Bridge

The Alpine Road Bridge crosses perpendicular to the river near river mile 11.1, downstream from the Calaveras Headworks (Photo A-92).

The Alpine Road Bridge spans about 72 feet. The concrete bridge has eight piers configured in two parallel rows of four. The rows are about 28 feet apart. The active channel is about 8 feet but widens under the bridge and runs between the two rows of piers. The bridge carries a two-lane road. There is no apron under the bridge.

The river channel upstream is bare comprised of silty-clay soil with some scattered rubble. The channel is trapezoid in shape and has little meander (Photo A-93). The upstream banks are steep until you near the tops of the levee where the slope becomes more gradual. Weeds, bushes, and grasses (including blackberry and giant reed) completely cover both banks. In places, vegetation completely covers the river channel. Upstream, a few riparian trees provide some shade to the river channel.

Downstream the channel substrate is bare comprised of silty-clay soil. The channel is trapezoid in shape and has little meander. The downstream banks are steep until you near the tops of the levee where the slope becomes more gradual. The downstream channel is similar in vegetative composition as compared to the upstream channel (Photo A-94). Downstream, there are riparian trees, and they provide some shade to the river channel.

Because the structure has no apron or riprap scour protection and there is no visible water surface difference between one side of the structure and the other, it is not a barrier to fish migration. We will be confirming this by modeling fish passage at the McAllen Road Bridge.

Photo A-92. Alpine Road Bridge

Photo A-93. Upstream from Alpine Road Bridge

Photo A-94. Downstream from Alpine Road Bridge

Pezzi Flashboard Dam

Pezzi Flashboard Dam is near river mile 12, downstream from the Calaveras Headworks. The structure is a concrete box culvert with two bays oriented perpendicular to the river (Photo A-95). The structure supports flashboards during the irrigation season and is topped with a 20-foot-wide bridge.

The culvert has two bays that are 12 feet wide, 17 feet high and 20 feet long. A half-height buttress wall is centered in each bay to support the flashboards. Each bay and buttress has metal guide slots to install flashboards across the inlet of the structure to allow upstream water diversions during the irrigation season (Photo A-96).

Due to the large amount of accumulated sediment upstream from the inlet, three rows of flashboards (total height 3.6 feet) were still in place as of November 2002. The bottom slab of the culvert was buried below sediment.

The channel upstream from the culvert is gradually meandering and well defined with a rounded trapezoidal cross section. The channel bottom and lower banks are bare; made up of silty-clay with some small stones. The mid- and upper-side slopes are well vegetated with shrubs and trees (Photo A-97). Both sideslopes have concrete protection that extends about 20 feet upstream from the structure. The right bank (looking downstream) also has a water-diversion pump. Significant sediment accumulation has occurred due to the seasonal flashboard dam. The sediment occurs during the irrigation season when the flashboards are in place and irrigation flows are routed through the channel. During the non-irrigation season, when the flashboards are removed, the channel typically receives minimal flows.

The downstream reach narrows and curves to the left (looking downstream) as it moves away from the structure. Concrete lines the right slope from the top of the bank to mid-channel and extends 95 feet downstream from the structure. Dense blackberry bushes and shrubs cover the left slope. Downstream from the concrete lining, both banks are heavily overgrown (Photo A-98). Both the channel bottom and banks are made up of sandy clay with some small stones. A lot of sediment has been deposited downstream. A sandy bar has formed on the right immediately downstream from the culvert outlet; up to 1.5 feet of sandy material covers the concrete lining in the channel.

The low flow control point is 40 feet downstream from the structure where the channel narrows. Upstream from the control point, a pool is backed up inside the culvert. Downstream from the control point, the channel has the characteristic of a glide.

Pezzi Flashboard Dam has half-height buttress walls centered in each bay to provide support for the flashboards. Each bay and buttress has metal guide slots for installation of flashboards across the inlet of the structure to accommodate upstream water diversions during the irrigation season. The culvert bays are blocked with flashboards 7.3 feet high during the irrigation season (Photo A-99). The flashboards create a 7.2-foot water surface difference. The plunge pool downstream from the dam is about 4 feet from the dam face and greater than 5 feet deep.

Photo A-95. Looking upstream at Pezzi Flashboard Dam

Photo A-96. View looking upstream from top of Pezzi Flashboard Dam with flashboards installed

Photo A-97. Upstream view of Pezzi Flashboard Dam. Note sediment accumulation at inlet

Photo A-98. Channel downstream of Pezzi Flashboard Dam

Photo A-99. Looking upstream at Pezzi Flashboard Dam

Pezzi Road Bridge

The Pezzi Road Bridge crosses perpendicular to the river at river mile 11.9, downstream from the Calaveras Headworks (Photo A-100). Pezzi Road Bridge is downstream of Pezzi Flashboard Dam.

The Pezzi Road Bridge spans 63 feet. The concrete bridge has four piers configured in two parallel rows of two. The distance between the rows of piers is 25 feet. The active channel width is 20 feet but widens under the bridge and runs between the two rows of piers. The bridge carries a two-lane road. There is no apron under the bridge. Some trash and other debris are under the bridge (Photo A-101).

The river channel upstream is bare silty-clay soil with some scattered rubble. The channel is trapezoid and has little meander. The upstream banks are moderate until you near the tops of the levee where the slope becomes more gradual. Weeds, bushes, and grasses (especially blackberry) completely cover both banks. Upstream, a few riparian trees provide some shade to the river channel.

Downstream the channel substrate is bare silty-clay soil. The channel is trapezoid and has little meander. The downstream banks are steep until you near the tops of the levee where the slope becomes more gradual. The downstream channel has similar vegetation to the upstream channel (Photo A-102). Downstream, there are a few riparian trees, and they provide some shade to the river channel.

Because the structure has no apron or riprap scour protection and there is no visible water surface difference between one side of the structure and the other, it is not a barrier to fish migration. We will be confirming this by modeling fish passage at the McAllen Road Bridge.

Photo A-100. Pezzi Road Bridge on the Calaveras River

Photo A-101. Trash under Pezzi Road Bridge

Photo A-102. Looking downstream from under Pezzi Road Bridge

Murphy Flashboard Dam

Murphy Flashboard Dam crosses perpendicular to the river at river mile 12.5, downstream from the Calaveras Headworks. The model results for this structure are included in the main body of the report.

The culvert abutments are 23 feet long in the direction of flow and extend into the channel 18 feet from the banks. The culvert has four narrow bays that are 5 feet wide and 15 feet high. The walls dividing the bays are a foot thick and sloped on the downstream side, extending farther downstream at the base (18 feet) than at the top (6 feet) (Photo A-103). The culvert floor is 19 feet long in the direction of flow. Each bay has metal guide slots for installation of flashboards across the inlet of the structure to accommodate upstream water diversions during the irrigation season (Photo A-104). The total span between the abutments is 23 feet. The flashboards of Murphy Flashboard Dam block the entire opening of the culverts during irrigation season (Photo A-105). The boards are placed 10.5 feet high and create a 3.5 feet water surface difference. The downstream plunge pool is at least 7.4 feet deep and 5.3 feet from the dam face. The minimum plunge pool depth of 2 feet for juvenile salmonids is met at Murphy Dam.

One row of flashboards (1.2 feet high) remained in place as of November 2002, and a large amount of sediment has accumulated upstream of the inlet. The bottom slab of the culvert was embedded below deposited sediment, but this area was still lower in elevation than the channel upstream or downstream.

The channel upstream of the culvert is gradually meandering, wide and well defined with a rounded trapezoidal cross section. Immediately upstream of the structure, both side slopes have concrete protection that extends about 13 feet upstream. A diversion pump is on each bank. Beyond the concrete lining, the channel bottom and lower banks are bare; made up of silty-clay with some small stones. The upper side slopes are well vegetated with grasses, shrubs and a few trees (Photo A-106). The sediment accumulation occurs during the irrigation season when the flashboards are in place and irrigation flows are routed through the channel. During the non-irrigation season, when the flashboards are removed, the channel typically receives minimal flows.

Downstream of the culvert, the channel continues its gradual meander, and has a wide, rounded trapezoidal shape. Concrete lines both banks for about 24 feet downstream of the structure’s abutments. Beyond the concrete lining, the silty-clay lower banks and channel are free of debris and vegetation (Photo A-107). The upper side slopes are well vegetated with shrubs and trees (Photo A-108). Although there is a scour pool inside the culvert due to water flow over the flashboards, the scour is localized. Once outside the culvert, the channel thalweg rapidly returns nearly to that of the upstream elevation (Photo A-103).

Photo A-103. View from downstream side of Murphy Flashboard Dam

Photo A-104. View from upstream side of Murphy Flashboard Dam

Photo A-105. View of Murphy Flashboard Dam with flashboards installed

Photo A-106. Upstream view from top of Murphy Flashboard Dam with flashboards installed

Photo A-107. Calaveras River channel downstream of Murphy Flashboard Dam

Photo A-108. Downstream view from top of Murphy Flashboard Dam with flashboards installed

Highway 88 Bridge

The Highway 88 Bridge crosses perpendicular to the Calaveras River near river mile 13, downstream from the Calaveras Headworks (Photo A-109). Highway 88 bridge is upstream of Murphy Flashboard Dam.

The Highway 88 Bridge spans 71 feet. It is a single-span steel bridge. The active channel is 36 feet. The bridge has a two-lane road. There is no apron under the bridge.

The river channel upstream is bare, comprised of silty-clay. The channel cross section is a trapezoid, wide, and has a slight meander to the right. The upstream banks are moderate in slope. The right and left banks are heavily vegetated with bushy weeds (especially blackberry), and grasses. Riparian trees on the right bank provide little shade to the river channel (Photo A-110).

The river channel downstream is bare comprised of silty-clay. The channel is trapezoid in shape, wide, and has a slight meander. The downstream banks are moderate in slope. The right and left banks are heavily vegetated with bushy weeds (especially blackberry), and grasses. Riparian trees on the left bank provide little shade to the river channel (Photo A-111).

Because the structure has no apron or riprap scour protection and there is no visible water surface difference between one side of the structure and the other, it is not a barrier to fish migration. We will be confirming this by modeling fish passage at the McAllen Road Bridge.

Photo A-109. Highway 88 Bridge

Photo A-110. From under Highway 88 Bridge looking upstream

Photo A-111. From under Highway 88 Bridge looking downstream

Eight Mile Road Bridge

The Eight Mile Road Bridge crosses perpendicular to the Calaveras River near river mile 15, downstream from the Calaveras Headworks (Photo A-112). The bridge is downstream of Eight Mile Dam.

The Eight Mile Road Bridge is 106 feet long and 40 feet wide. The concrete bridge has eight piers configured in two parallel rows of four. The rows are 27 feet apart. The active channel runs between the two rows of piers. There is a two-lane road on the bridge. There is no apron under it.

The river channel upstream is bare with some scattered rubble. The channel is shaped like a trapezoid and has little meander (Photo A-113). The upstream banks are steep until you near the tops of the levee where the slope becomes more gradual. Weeds, bushes, and grasses (especially blackberry) cover both banks. Upstream, a few riparian trees provide some shade to the river channel.

Downstream, under the rubble, the channel substrate is silty-clay. The channel is trapezoid in shape and has little meander. The downstream banks are steep until you near the tops of the levee where the slope becomes more gradual. Both banks are well vegetated with weeds, bushes, and grasses. Dense blackberry vines and trees overhang and constrict the channel. In places, the vegetation is so thick that it blocks the channel (Photo A-114). Downstream, there are riparian trees, which provide some shade to the river channel.

Because the structure has no apron or riprap scour protection and there is no visible water surface difference between one side of the structure and the other, it is not a barrier to fish migration. We will be confirming this by modeling fish passage at the McAllen Road Bridge.

Photo A-112. Looking downstream at Eight Mile Road Bridge

Photo A-113. Looking upstream from under Eight Mile Road Bridge

Photo A-114. Looking downstream from under Eight Mile Road Bridge

Eight Mile Flashboard Dam

Eight Mile Flashboard Dam base is on the Calaveras River near river mile 15, upstream of Eight Mile Road Bridge (Photo A-115). The structure provides support for flashboards during irrigation season. When the flashboards are removed, the channel typically receives minimal flows.

The dam base span is about 68.5 feet. The structure is a trapezoid that forms a complete concrete lining on the river channel and on the banks. The active channel is about 10 feet wide. Due to silt buildup in the river channel, there is no drop from the dam base to the channel bed. The bottom portion of the dam is covered with a thin layer of silt and algae. There is no dam base notch present.

Upstream of Eight Mile Flashboard Dam base there are some sandbags on the right bank. Farther upstream on the right bank and on the left bank, the banks are comprised of bare earth. Farther up the banks the vegetation becomes thick with weedy bushes (especially blackberry) (Photo A-116). Upstream, the river channel is a well-defined rounded trapezoid, slightly meandering, and is bare. The upstream banks are moderate in slope. Upstream, there are riparian trees that provide shade to the river channel.

Immediately downstream from the dam base the channel is inundated with vegetation (Photo A-117). The vegetation creates a constriction of the river channel and continues that way downstream of Eight Mile Flashboard Dam beyond Eight Mile Road Bridge. The vegetation is a mixture of weedy grasses, weedy bushes, and riparian trees. Downstream from the dam base the river channel substrate gives way to silty clay with some woody debris and scattered rubble. The downstream banks are steep and heavily vegetated. Downstream, riparian trees provide shade to the river channel.

Eight Mile Flashboard Dam is an 8.8-foot-tall flashboard dam, spanning 23.6 feet at the channel bottom and 70.2 feet at the top with a wooden catwalk (Photo A-118). During the irrigation season, the flashboard dam creates a 6.9-foot water surface difference. The 2.2-foot-deep plunge pool is 12.2 feet downstream from the dam face.

The minimum plunge pool depth of 2 feet for juvenile salmonids is met at Eight Mile Flashboard Dam. The modeling results from McAllen Dam will be used to assess fish passage at Eight Mile flashboard Dam.

Photo A-115. Eight Mile Flashboard Dam base

Photo A-116. Looking upstream from Eight Mile Flashboard Dam base

Photo A-117. Downstream from Eight Mile Flashboard Dam base

Photo A-118. Looking upstream at Eight Mile Flashboard Dam

Jack Tone Road Bridge

The Jack Tone Road Bridge crosses perpendicular to the Calaveras River at river mile 15.8, downstream from the Calaveras Headworks (Photo A-119). The Jack Tone footbridge is immediately downstream of Jack Tone Road Bridge.

The Jack Tone Road Bridge spans 145 feet. The bridge contains eight concrete piers that are comprised in two parallel rows of four. Each row of piers is 30 feet apart. The active channel is 30 feet and runs roughly between the 2 rows of piers. There is no apron under the bridge, but there is some scattered rubble and trash.

The river channel upstream is bare silty-clay. The channel is trapezoidal and has a slight meander. The upstream banks are steep. Above the bare portion of the river channel, the right and left banks are heavily vegetated with bushy weeds (especially blackberry) and grasses. Some riparian trees on both banks provide some shade to the river channel (Photo A-120).

Downstream from the bridge, the river channel is bare earth composed of silty-clay soil. The channel is trapezoidal and has a slight meander. The downstream banks are steep. The right and left banks are heavily vegetated with bushy weeds and grasses until you reach the edge of the active channel where the banks go bare. Riparian trees provide shade to the river channel. The Jack Tone Footbridge is downstream (Photo A-121).

Because the structure has no apron or riprap scour protection and there is no visible water surface difference between one side of the structure and the other, it is not a barrier to fish migration. We will be confirming this by modeling fish passage at the McAllen Road Bridge.

Photo A-119. Looking downstream at the Jack Tone Road Bridge

Photo A-120. Looking upstream from Jack Tone Road Bridge

Photo A-121. Downstream from Jack Tone Road Bridge toward Jack Tone Footbridge

Jack Tone Footbridge

The Jack Tone Footbridge crosses perpendicular to the Calaveras River near river mile 15.8, downstream of the Calaveras Headworks (Photo A-122). The Jack Tone Footbridge is immediately downstream of Jack Tone Road Bridge.

The Jack Tone Footbridge spans approximately 140 feet. The footbridge contains 2 steel piers that are 30 feet apart. The active channel is 35 feet and encompasses both piers. There is no apron under the bridge.

The river channel upstream is bare earth composed of silty-clay soil. The channel is trapezoidal and has a slight meander. The upstream banks are steep. The right and left banks are heavily vegetated with bushy weeds (especially blackberry) and grasses until you reach the edge of the active channel where the banks give way to bare earth. Some visible riparian trees on both banks provide some shade to the river channel (Photo A-123). Upstream of the Jack Tone Footbridge is the Jack Tone Road Bridge. Under this bridge are some scattered rubble and trashy debris.

Downstream of the footbridge the river channel is bare earth composed of silty-clay soil. The channel is trapezoidal and has a slight meander. The downstream banks are steep. The right and left banks are heavily vegetated with bushy weeds and grasses until you reach the edge of the active channel where the banks give way to bare earth. Visible riparian trees provide shade to the river channel. Further downstream is a logjam across the river channel (Photo A-124).

Photo A-122: Jack Tone Footbridge on the Calaveras River

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Photo A-123: Looking upstream from under Jack Tone Footbridge on the Calaveras River

Photo A-124: Looking downstream from Jack Tone Footbridge on the Calaveras River

Tully Road Bridge

The Tully Road Bridge crosses perpendicular to the Calaveras River at river mile 17.8, downstream from the Calaveras Headworks (Photo A-125). The bridge is downstream of Tully Flashboard Dam.

The Tully Road Bridge spans 105 feet, with a width of 31 feet. The concrete bridge has eight piers configured in two parallel rows of four. The distance between the rows of piers is 28 feet. The active channel runs between the two rows of piers. The bridge functions as a standard road crossing with a lane of traffic in each direction. There is no apron under the bridge.

The river channel upstream is bare with some scattered rubble. The channel is shaped like a trapezoid and has little meander (Photo A-126). The upstream banks are steep until you near the top of the levee where the slope becomes more gradual. Both banks are covered with weeds, bushes, and grasses (especially blackberry). In places, thick vegetation blocks the flow. Upstream, a few riparian trees provide some shade to the river channel.

Downstream the channel substrate is bare silty-clay. The channel is trapezoidal and has little meander. The downstream banks are steep until you near the top of the levee where the slope becomes more gradual. Both banks are well vegetated with weeds, bushes, and grasses. Compared to the upstream channel, the downstream channel is more open (Photo A-127). Downstream, riparian trees provide some shade to the river channel.

Because the structure has no apron or riprap scour protection and there is no visible water surface difference between one side of the structure and the other, it is not a barrier to fish migration. We will be confirming this by modeling fish passage at the McAllen Road Bridge. However, the thick vegetation under this structure may present some passage issues under certain flows.

Photo A-125. Tully Road Bridge

Photo A-126. Looking upstream from under Tully Road Bridge

Photo A-127. Downstream from Tully Road Bridge

Tully Flashboard Dam

Tully Flashboard Dam is at river mile 17.9, immediately upstream of Tully Road Bridge. The base of the structure (Photo A-128) provides support for flashboards during irrigation season. When the flashboards are removed, the channel typically receives minimal flows.

The dam base span is 65 feet. The distance between terminal points of the concrete on the banks is 68 feet, also representing the bankfull channel. The structure, shaped like a trapezoid, forms a complete concrete lining on the river channel and on the banks. The bottom of the dam base is 4 feet wide, and there is no drop from the dam base to the channel bed. The bottom portion of the dam is covered with a thin layer of silt and algae. There is no dam base notch.

Immediately upstream of Tully Flashboard Dam there is some scattered rubble on the left bank. Farther upstream on the left and right banks, the channel is mostly bare with some grass. Farther up the banks, the vegetation becomes thick with weedy bushes (especially blackberry) (Photo A-129). Upstream, the river channel is a well-defined rounded trapezoid, slightly meandering, and bare. The upstream banks are moderate in slope, and a few riparian trees provide minimal shade to the river channel.

Immediately downstream of Tully Flashboard Dam, the channel is inundated with vegetation (Photo A-130). This vegetation constricts the river channel. The vegetation is a mixture of weedy grasses, weedy bushes, and riparian trees, and continues along the river channel downstream of Tully flashboard dam beyond Tully Road Bridge. Downstream from the dam, the river channel substrate gives way to silty clay with some woody debris. The downstream banks are steep and heavily vegetated. Downstream, riparian trees provide shade to the river channel.

Tully Flashboard Dam is 10 feet high and spans 67 feet across the river (Photo A-131). During the irrigation season, the dam creates a 7.2-foot water surface difference. Modeling results from McAllen Dam will be used to assess fish passage at Tully Flashboard Dam.

Photo A-128. Looking at the base of Tully Flashboard Dam

Photo A-129. Looking upstream from Tully Flashboard Dam

Photo A-130. Downstream from Tully Flashboard Dam

Photo A-131. Looking at Tully Flashboard Dam

Rosa Bridge

The Rosa Bridge crosses perpendicular to the Calaveras River at river mile 18.6, downstream from the Calaveras Headworks (Photo A-132). The bridge is made of wood with concrete piers and is used as part of an orchard and farm.

The Rosa Bridge spans 61.5 feet. The Rosa Bridge contains two cement piers. Each pier is subdivided into four parts as the piers reach the roadway portion of the bridge. The active channel width is 18 feet, with water flowing around the base of one of the piers. There is no apron under the bridge.

Upstream of the bridge, the river channel is trapezoidal with little meander and is partially inundated with Himalayan blackberry (Photo A-133). The right bank upstream has a gentle slope and is characterized by riparian vegetation, including oaks. The left bank upstream has a gentle slope that is chocked by Himalayan blackberry. At the top of both banks are orchard groves. The riparian vegetation upstream provides moderate shade to the river channel.

Downstream of the bridge the river channel is characterized by the presence of riparian trees and Himalayan blackberry (Photo A-134). Both the left and right banks downstream have steep slopes. The riparian vegetation provides shade to the river channel. Orchards are present along both banks beyond the riparian vegetation. Downstream is a pumping structure located on top of the right bank.

Photo A-132. Rosa Bridge

Photo A-133. From Rosa Bridge looking upstream

Photo A-134. From Rosa Bridge looking downstream

Duncan Road Bridge (private)

The Duncan Road Bridge (private) crosses perpendicular to the Calaveras River at river mile 19.6, downstream from the Calaveras Headworks (Photo A-135). The bridge is made primarily of steel with a concrete road on top and is used as a private driveway.

The Duncan Road Bridge spans 73 feet. The Duncan Road Bridge (private) is a span bridge absent of piers. The active channel width is 25 feet. There is no apron under the bridge.

Immediately upstream of the bridge on the right bank is a house and garage. Upstream of the bridge, the river channel is trapezoidal with little meander (Photo A-136). The right bank upstream has a gentle slope and is characterized by planted riparian vegetation, especially maples. The left bank upstream has a steep slope and is inundated with Himalayan blackberry. At the top of both banks are orchard groves. The riparian vegetation upstream provides minimal shade to the river channel.

Immediately downstream of the bridge, riparian trees characterize the river channel (Photo A-137). Both the left and right banks downstream have steep slopes. The riparian vegetation provides ample shade to the river channel. An orchard is present along the right bank beyond the riparian vegetation. On top of the left bank downstream is a barn structure.

Photo A-135. Duncan Road Bridge (private)

Photo A-136. From Duncan Road Bridge (private) looking upstream

Photo A-137. From Duncan Road Bridge (private) looking downstream

Messick Road Bridge

The Messick Road Bridge crosses perpendicular to the Calaveras River at river mile 20.1, downstream from the Calaveras Headworks (Photo A-138). The bridge appears to be in good condition with few signs of age.

The Messick Road Bridge spans 89 feet. The concrete bridge has eight piers configured in two parallel rows of four. The rows of piers are 25 feet apart. The active channel runs between the two rows of piers. The bridge is a standard road crossing. There is no apron under the bridge.

Upstream from the bridge, the river flows in a well-defined, slow-flowing channel. It is less than 3 feet deep and configured in a rounded trapezoid (Photo A-139). The upstream banks are well vegetated and contain riparian and orchard trees that provide shade to the river. The river bottom directly under and upstream from the bridge has scattered rubble that leads to bare river bed farther upstream. Immediately downstream from the bridge, the river channel is covered with heavy vegetation (Photo A-140). This narrows the river channel and increases flows. The downstream channel is bare. The river banks downstream from the bridge are steep, and the banks upstream have a more gradual slope. There are gradual meanders in the river upstream and downstream from the bridge.

Because the structure has no apron or riprap scour protection and there is no visible water surface difference between one side of the structure and the other, it is not a barrier to fish migration. We will be confirming this by modeling fish passage at the McAllen Road Bridge.

Photo A-138. Upstream at Messick Road Bridge

Photo A-139. Upstream from Messick Road Bridge

Photo A-140. Downstream from Messick Road Bridge

Guernsey Road Bridge

The Guernsey Road Bridge crosses perpendicular to the Calaveras River at river mile 20.6, downstream of the Calaveras Headworks (Photo A-141).

The Guernsey Road Bridge spans 34 feet. The bridge does not have any piers. The bridge has concrete abutments at both ends for support. The active channel is 21 feet. There is no apron under the bridge. There is scattered riprap under the bridge. The riprap encompasses the entire active channel and extends approximately 20 feet upstream and downstream.

Upstream, past the riprap, the river channel is bare earth composed of silty-clay soil. The channel is trapezoidal and has a slight meander. The left bank upstream is steep and heavily vegetated with weedy bushes and grasses and some riparian vegetation. The left bank is less steep and less vegetated. Some grasses and riparian vegetation are associated with the left bank (Photo A-142).

Downstream of the bridge, past the riprap, the river channel is bare earth composed of silty-clay soil. The channel is trapezoidal and has a slight meander. The right bank is heavily vegetated with bushy weeds, and the left bank is dominated by grasses. Visible riparian trees provide shade to the river channel (Photo A-143). The upstream and downstream areas surrounding the river are dominated by orchards.

Photo A-141. Guernsey Road Bridge on the Calaveras River

Photo A-142. Looking upstream from Guernsey Road Bridge

Photo A-143. Looking downstream from Guernsey Road Bridge at the log jam

Clements Road Flashboard Dam and Bridge

Clements Road Flashboard Dam and Bridge was one of the eight structures modeled in 2004.

The Clements Road Dam Crossing is on the Calaveras River near river mile 21.5, downstream of the Calaveras Headworks. The structure is a box culvert with two bays oriented perpendicular to the river (Photo A-144). The structure functions as a road crossing and a temporary dam. Clements Road runs across the top of the structure. The structure has guide slots for installing flashboards across the inlet to divert water during the irrigation season.

The culvert has 2 identical bays that are 7.5 feet wide, 6 feet high, and 30 feet long. The culvert bottom is not embedded. The structure appears to be in good condition. Both the upstream and downstream ends of the box culvert are flush with the vertical concrete headwalls. Guidewalls bracket the inlet bays and extend 2 feet upstream, perpendicular to the headwall, to support the flashboards. The culvert inlet is relatively flush with the channel thalweg, and has a concrete apron that has irregularly shaped rough edges. The left bank at the inlet has a concrete over-pour feature extending a few feet upstream to armor the structure. The outlet apron is a continuation of the box culvert bottom. The apron is flat, made of concrete, spans the full width of the channel, and extends four feet downstream from the culvert outlet. A 3-foot drop exists from the top of the outlet apron to the riprap below.

The channel upstream of the culvert is somewhat meandering and well defined with a rounded trapezoidal cross section. Both the channel bed and lower banks are bare; grasses cover the mid- and upper side slopes (Photo A-145). There are many trees and bushes on top of the channel banks. The thalweg has an adverse slope leading up to the culverts.

The downstream channel is similar to the upstream, except for the area immediately downstream from the outlet apron (Photo A-146 and Photo A-147). From the edge of the apron, a 3-foot drop onto a steep cascade over concrete rubble, debris, and riprap extends 36 feet downstream (Photo A-148 and Photo A-149). Concrete rubble also lines the channel banks near the culvert outlet and along the left side of the river (facing downstream).

Photo A-144. Downstream at Clements Road Dam

Photo A-145. Channel upstream from Clements Road Dam

Photo A-146. Downstream channel from Clements Road Dam Outlet

Photo A-147. Channel downstream of Clements Road Dam during irrigation season

Photo A-148. Downstream of Clements Road Dam looking upstream

Photo A-149. Downstream of Clements Road Dam looking upstream with flashboards installed

Botsford Bridge #1

The Botsford Bridge #1 crosses perpendicular to the Calaveras River at river mile 21.7, downstream from the Calaveras Headworks (Photo A-150). The wooden bridge is adjacent to a home and a garage, workshop area.

Botsford Bridge #1 spans 60 feet. The bridge contains six wooden piers that are comprised in two parallel rows of three. Each row of piers is 17 feet apart. The active channel width is 41.5 feet and runs around each row of piers. Under the bridge, the river channel deepens, and there is no apron. Here the river flow is slow. Areas contain algal growth.

Upstream of the bridge, the river channel gradually narrows and has a slight meander (Photo A-151). Both banks contain a mixture of oaks, Himalayan blackberry, bushes, and grasses. An orchard is on the right bank upstream. The right and left banks upstream have a gentle slope. The riparian vegetation provides shade to the river channel.

Downstream of the bridge, the river channel gradually narrows and has a slight meander (Photo A-152). The left bank is dominated by weedy species, especially Himalayan blackberry. The right bank contains a mixture of oaks, Himalayan blackberry, bushes, and grasses. An orchard is on the right bank downstream. Housing structures are downstream on the left bank. The right and left banks downstream have a gentle slope. The riparian vegetation provides shade to the river channel.

Photo A-150. Botsford Bridge #1

Photo A-151. From Botsford Bridge #1 looking upstream

Photo A-152. From Botsford Bridge #1 looking downstream

Botsford Bridge #2

Botsford Bridge #2 crosses perpendicular to the Calaveras River at river mile 21.7, downstream from the Calaveras Headworks (Photo A-153). The bridge is constructed with concrete abutments with a wooden road surface.

Botsford Bridge #2 spans 34 feet. The bridge does not contain piers, but has two concrete abutments at each bridge terminus. These abutments slightly constrict the active river channel. The active channel width is 32 feet and runs between the abutments. Under the bridge, the river channel deepens, and there is no apron. Here the river flow is slow, and areas contain algal growth.

Upstream of the bridge, the river channel becomes slightly wider and has a slight meander (Photo A-154). Both banks have a gentle slope and are lined with low lying grasses with a few intermixed riparian trees. Orchards are on both river banks upstream. The riparian vegetation provides minimal shade to the river channel.

Downstream of the bridge, the river channel slightly narrows and has a meander in the northerly direction (Photo A-155). Both banks have a gentle slope and are lined with low-lying grasses with intermixed riparian trees. An orchard is on the right bank downstream, and housing structures are on the left bank downstream. The riparian vegetation provides shade to the river channel.

Photo A-153. Botsford Bridge #25 Photo

Photo A-154. From Botsford Bridge #2 looking upstream

Photo A-155. From Botsford Bridge #2 looking downstream

Houston Bridge

The Houston Bridge crosses perpendicular to the Calaveras River at river mile 22.1, downstream from the Calaveras Headworks (Photo A-156). The bridge is made primarily of steel with a wood road on top and is used on a privately owned orchard.

The Houston Bridge spans 73 feet. The Houston Bridge is a span bridge absent of piers. The active channel width is 42 feet. There is no apron under the bridge.

Upstream of the bridge, the river channel is trapezoidal with little meander (Photo A-157). Both right and left banks are steep and characterized by weedy bushes (*Arundo*, Himalayan blackberry), grasses, and scattered riparian trees. Orchard groves are at the top of both banks, upstream and downstream of the bridge.

The left bank downstream of the bridge contains scattered riparian trees. The right bank contains weedy bushes (*Arundo*, Himalayan blackberry), grasses, and scattered riparian trees (Photo A-158). Both the left and right banks downstream have moderate slopes. The channel upstream and downstream is composed of clay material with scattered rock.

Photo A-156. Houston Bridge

Photo A-157. From Houston Bridge looking upstream

Photo A-158. From Houston Bridge looking downstream

DeMartini Lane Bridge

The DeMartini Lane Bridge crosses perpendicular to the Calaveras River at river mile 22.8, downstream of the Calaveras Headworks (Photo A-159). The DeMartini Lane Bridge is immediately downstream of DeMartini Wood Bridge.

The DeMartini Lane Bridge spans 62 feet. The bridge contains 2 rows of 2 piers that are 22 feet apart. The active channel is 22 feet. One set of piers is within the active channel. No apron is under the bridge.

The river channel upstream is bare earth composed of silty-clay soil. The channel is trapezoidal and has a slight meander. The upstream banks are steep. The right bank is heavily vegetated with bushy weeds (especially blackberry) until you reach the edge of the levee. Some riparian trees on both banks provide some shade to the river channel (Photo A-160).

Downstream of the bridge, the river channel is bare earth composed of silty-clay soil. The channel is trapezoidal and has a slight meander. The downstream banks are steep. The right and left banks are heavily vegetated with bushy weeds. Riparian trees provide shade to the river channel. Downstream, a logjam crosses the river channel (Photo A-161). Orchards dominate the upstream and downstream areas surrounding the river.

Photo A-159. DeMartini Lane Bridge on the Calaveras River

Photo A-160. Looking upstream from DeMartini Lane Bridge

Photo A-161. Looking downstream from DeMartini Lane Bridge at the logjam

DeMartini Wood Bridge

The DeMartini Wood Bridge crosses perpendicular to the Calaveras River at river mile 23.1, downstream of the Calaveras Headworks (Photo A-162). The DeMartini Wood Bridge is immediately upstream of DeMartini Lane Bridge.

The DeMartini Wood Bridge spans 54 feet. The bridge contains 2 piers that are 19 feet apart. Wood and concrete reinforce each pier. The active channel is 22 feet and runs between the 2 piers. No apron is under the bridge.

The river channel upstream is bare earth composed of silty-clay soil. The channel is trapezoidal and has a slight meander. The upstream banks are steep. The right and left banks are heavily vegetated with bushy weeds (especially blackberry) and grasses until you reach the edge of the levee. There are no visible riparian trees on either bank (Photo A-163).

Downstream of the bridge, the river channel is bare earth composed of silty-clay soil. The channel is trapezoidal and has a slight meander. The downstream banks are steep. The right and left banks are heavily vegetated with bushy weeds and grasses. There are no visible riparian trees on either bank (Photo A-164). Orchards dominate the upstream and downstream areas surrounding the river.

Photo A-162. DeMartini Wood Bridge on the Calaveras River

Photo A-163. Looking upstream from DeMartini Wood Bridge

Photo A-164. Looking downstream from DeMartini Wood Bridge

Chestnut Hill Road Bridge

The Chestnut Hill Road Bridge crosses perpendicular to the Calaveras River at river mile 23.6, downstream of the Calaveras Headworks (Photo A-165). The bridge contains two concrete piers. The active channel runs between the concrete piers. There is no apron under the bridge. Both upstream and downstream banks are vegetated with weedy bushes, grasses, and scattered riparian vegetation. Orchards dominate the area in both the upstream and downstream direction.

Photo A-165. Chestnut Hill Road Bridge on the Calaveras River

Podesta Bridge

The Podesta Bridge crosses perpendicular to the Calaveras River at river mile 24.2, downstream from the Calaveras Headworks (Photo A-166). The bridge is made of concrete primarily and actively used by many types of vehicles, including trucks, automobiles, and farm equipment.

The Podesta Bridge spans 87 feet. The bridge contains four concrete piers comprised in two parallel rows of two. Each row of piers is 35 feet apart. The active channel width is 29 feet and runs between the two rows of piers. There is no apron under the bridge.

Upstream of the bridge, the river channel meanders in a southerly direction (Photo A-167). The right bank upstream is steep and characterized by the presence of Himalayan blackberry, a few oaks, and grasses. The left bank upstream has a gentle slope and is characterized by low-lying bushes, grasses, and few oaks. At the top of both banks are orchard groves. The riparian vegetation upstream provides minimal shade to the river channel.

Immediately downstream of the bridge, the river channel widens and becomes shallower (Photo A-168). Both the left and right banks downstream have gentle slopes and contain riparian vegetation, predominantly oaks and willows with intermixed bushes and grasses. The riparian vegetation provides shade to the river channel. Orchards are present along both banks beyond the riparian vegetation.

Photo A-166. Podesta Bridge

Photo A-167. From Podesta Bridge looking upstream

Photo A-168. From Podesta Bridge looking downstream

Pelota Bridge

The Pelota Bridge crosses perpendicular to the Calaveras River at river mile 24.8, downstream from the Calaveras Headworks (Photo A-169). The bridge is made of concrete primarily and is actively used by many types of vehicles, including trucks, automobiles, and farm equipment.

The Pelota Bridge spans 79 feet. The bridge contains six concrete piers comprised in two parallel rows of three. Each row of piers is 31 feet apart. The active channel width is 31 feet and runs roughly between the 2 rows of piers. There is no apron under the bridge.

Immediately upstream of the bridge, the river channel widens and becomes shallower (Photo A-170). The right bank upstream has a gentle slope and is characterized by the presence of Himalayan blackberry, and a few oaks. A ponded area is on the right bank. The left bank upstream also is thick with Himalayan blackberry, but has more riparian trees and a steeper slope compared to the right bank. The channel is trapezoidal and has a slight meander. The riparian vegetation provides some shade to the river channel.

Immediately downstream of the bridge on the left bank is a large farm building used primarily for storing produce and equipment. The river channel is characterized by steep banks heavily vegetated with bushy weeds (especially Himalayan blackberry), oaks, and other riparian trees (Photo A-171). The channel is trapezoidal and has a slight meander. The riparian vegetation provides shade to the river channel.

Photo A-169. Pelota Bridge

Photo A-170. Upstream from Pelota Bridge

Photo A-171. Downstream from Pelota Bridge

Gotelli #1 Flashboard Dam

The Gotelli #1 Flashboard Dam is on the Calaveras River at river mile 25.4, immediately downstream of Gotelli #1 Bridge (Photos A-172 and A-173).

The Gotelli #1 Flashboard Dam spans 32 feet. The dam contains two cement abutments at either end and has three intermediate posts within the water column that are constructed of wood and metal. The concrete dam base is minimal, with an estimated width of one foot. The active channel is the same as the dam span, at 32 feet. The dam functions to provide head for the intake pipes under Gotelli #1 Bridge.

The river channel upstream has a silty substrate, intermixed with small to larger gravels. The channel is trapezoidal and has little meander. The upstream banks are steep. The right and left banks have little riparian vegetation. There are a few oaks and some scattered bushes. The riparian vegetation upstream of Gotelli #1 Flashboard Dam provides little shade to the river. Orchards are immediately beyond the levees on both banks.

The river channel downstream has a silty substrate, intermixed with small to larger gravels. The channel is trapezoidal and has little meander (Photo A-173). The downstream banks are steep. The right and left banks are characterized by low-lying weedy bushes and grasses, with a few oak trees. The riparian vegetation downstream of Gotelli #1 Flashboard Dam provides minimal shade to the river. Orchards are immediately beyond the levees on both banks.

Photo A-172. Looking downstream from Gotelli #1 Bridge at Gotelli #1 Flashboard Dam

Photo A-173. Gotelli #1 Flashboard Dam

Gotelli #1 Bridge

The Gotelli #1 Bridge crosses perpendicular to the Calaveras River at river mile 25.4, downstream from the Calaveras Headworks (Photo A-174).

The Gotelli #1 Bridge spans 80 feet. The wooden bridge has 12 piers, arranged in 3 rows of 4. The distance between the rows of piers is around 15 feet. The active channel is 31.5 feet. The bridge functions as a single-lane crossing within an orchard area. There is no apron under the bridge. Three additional metal pipes originate from the top of the bridge and terminate within the water column.

The river channel upstream has a silty substrate, intermixed with small to larger gravels. The channel is shaped like a trapezoid and has little meander (Photo A-175). The upstream banks are steep. The right and left banks have little riparian vegetation. There are a few oaks and some scattered bushes. The riparian vegetation upstream of Gotelli #1 Bridge provides little shade to the river. Orchards are immediately beyond the levees on both banks.

The river channel downstream has a silty substrate, intermixed with small to larger gravels. The channel is shaped like a trapezoid and has little meander (Photo A-176). The downstream banks are steep. The right and left banks are characterized by low lying bushes and grasses, with a few oak trees. The riparian vegetation downstream of Gotelli #1 Bridge provides minimal shade to the river. Orchards are found immediately beyond the levees on both banks. Immediately downstream of Gotelli #1 Bridge is the Gotelli #1 Flashboard Dam.

Photo A-174. Gotelli #1 Bridge

Photo A-175. Looking upstream from Gotelli #1 Bridge

Photo A-176. Looking downstream from Gotelli #1 Bridge

Gotelli #2 Bridge

The Gotelli #2 Bridge crosses perpendicular to the Calaveras River at river mile 25.6, downstream from the Calaveras Headworks (Photo A-177).

The Gotelli #2 Bridge spans 84 feet. The wooden bridge has 12 piers, arranged in 3 rows of 4. The distance between the rows of piers is around 15 feet. The active channel is 30.5 feet wide, inundating one of the rows of piers. The bridge functions as a single-lane crossing within an orchard area. There is no apron under the bridge.

The river channel upstream has a silty substrate intermixed with small to larger gravels. The channel is shaped like a trapezoid and has little meander (Photo A-178). The upstream banks are steep. Both banks contain moderate riparian vegetation, including some oaks and bushes. The riparian vegetation upstream of Gotelli #2 bridge provides some shade to the river. Orchards are immediately beyond the levees on both banks.

The river channel downstream has a silty substrate, intermixed with small to larger gravels. Approximately 0.2 miles downstream is Gotelli #1 Bridge. The channel is trapezoidal and has little meander (Photo A-179). Downstream banks are steep. Compared to the upstream channel, both banks downstream contain less riparian vegetation. There are few oaks, and most of the riparian vegetation is dominated by low-lying bushes and grasses. The riparian vegetation downstream of Gotelli #2 Bridge provides some shade to the river. Orchards are immediately beyond the levees on both banks.

Photo A-177. Gotelli #2 Bridge

Photo A-178. From Gotelli #2 Bridge looking upstream

Photo A-179. From Gotelli #2 Bridge looking downstream

Highway 26 Bridge

The Highway 26 Bridge crosses perpendicular to the Calaveras River at river mile 25.8, immediately downstream from the Calaveras Headworks (Photo A-180).

The Highway 26 Bridge spans 101 feet. The bridge contains 12 concrete piers comprised in 2 parallel rows of 6. Each row of piers is 26 feet apart. The active channel width is 23 feet and runs roughly between the 2 rows of piers. There is no apron under the bridge.

The river channel upstream becomes constricted and has steep slopes as it approaches the Calaveras Headworks. The channel is trapezoidal and has a slight meander. The right and left banks are heavily vegetated with bushy weeds (especially blackberry), grasses, oaks, and other riparian trees (Photo A-181). The riparian vegetation provides shades to the river channel.

Downstream from the bridge, the river channel is characterized by steep banks heavily vegetated with bushy weeds (especially blackberry), oaks, and other riparian trees (Photo A-182). The channel is trapezoidal and has a slight meander. The riparian vegetation provides shade to the river channel.

Photo A-180. Highway 26 Bridge

Photo A-181. Upstream from Highway 26 Bridge

Photo A-182. Downstream from Highway 26 Bridge

Calaveras Headworks

Calaveras Headworks is on the Calaveras River at about river mile 26 and near Bellota Weir. The Headworks, in combination with Bellota Weir, provide flow bifurcation control between Mormon Slough and the Calaveras River. The structure is at the head of the old Calaveras channel, perpendicular to the direction of flow, and includes an earthen berm, four culverts with control gates, a trashrack, and concrete slope lining (Photo A-183).

The Headworks berm is made of earth with a crest length of 68 feet and width of 10 feet. Four square, concrete culverts about 4 feet wide penetrate the berm and control the water flow into the Old Calaveras Channel. A 21-foot-wide trashrack on the upstream side of the berm protects the culvert inlets that have concrete head wall and wing walls. Culvert outlets have a 24-foot-wide, 7-foot-tall concrete head wall and 2-foot-long side walls. Gate valves on the upstream side control flow through the culverts. Two culverts have manual gate controls, and two have electronic control boxes. Access to the gate controls is from the top of the berm, where concrete stairs lead to a metal frame and wood plank catwalk and control deck (Photo A-184). Concrete steps on the upstream banks provide maintenance access to the trashrack and culvert gates. From the head wall to about 15 feet upstream, the sideslopes and top of banks have a rough concrete lining (Photo A-185). A concrete pad with 10-foot-long sides is at the top of the left bank immediately upstream from the edge of the rough, concrete lining.

The Headworks structure creates deep ponded water in the upstream channel. During irrigation season, upstream water depth is about 10 feet. About 300 feet upstream from the Headworks is the split in the channel that goes to Bellota Weir and Mormon Slough. The upstream channel is straight and well defined. Banks are well vegetated with grasses and shrubs, with trees near the top of the banks (Photo A-186). A pump intake is on the right riverbank about 20 feet upstream from the Headworks.

During irrigation season, water depth downstream from the structure is about 5 feet deep. Water sent downstream flows fast out of culverts (Photo A-187). The flow regime appears to be subcritical, characteristic of a glide. Downstream from the Headworks is a straight, well-defined channel. Steep banks are heavily vegetated with grasses and shrubs, with trees near the top of the banks (Photo A-188).

The Calaveras Headworks is a total barrier to upstream adult fish migration and likely a major impediment to downstream juvenile migration. The Headworks is operated to block most downstream flows from entering the Old Calaveras channel in the winter season, when adult salmon and steelhead are migrating. When the culvert gates are closed, the downstream channel is dry and impassible to fish. Winter flows in the system are directed into Mormon Slough, which is a constructed flood-control channel. During the mid-April to mid-October irrigation season, the Calaveras Headworks culvert gates are adjusted to deliver water downstream for irrigation uses. Juvenile downstream migrants may find their way through the gate openings and into the Old Calaveras Channel. Because juveniles prefer to stay in the upper to middle part of the water column, the location of the culverts near the bottom of the channel is not favorable for outmigration. If the Old Calaveras channel is to be used as a migration corridor, the Calaveras Headworks will require complete redesign, and the entire system operation will require modification. An assessment of fish passage at Calaveras Headworks is represented by the modeling results from Clements Bridge and flashboard dam.

Photo A-183. View from upstream of Calaveras Headworks

Photo A-184. Upstream from top of Calaveras Headworks berm

Photo A-185. View across Calaveras Headworks

Photo A-186. Upstream of Calaveras Headworks

Photo A-187. Downstream culvert outlet at Calaveras Headworks

Photo A-188. Downstream from top of Calaveras Headworks berm

Upstream of Calaveras Headworks to New Hogan Dam on Calaveras River

McGurk Earth Dam

The McGurk Earth Dam is on a side channel just off the main Calaveras River channel at river mile 26.3, upstream of Calaveras Headworks (Photo A-189). McGurk Earth Dam usually washes out during the winter season and is reconstructed each spring (after the rains). Bulldozers push earth and gravels from the surrounding area to create the dam. The purpose of the dam is to ensure that adequate water quality exists in the main Calaveras River channel for irrigation purposes.

McGurk Earth Dam is 140 feet in length, with a drop of 10 to 12 feet from the crest to the toe of the dam. Because the dam washes away during the rainy season, it is not an adult fish passage issue; however, the dam may trap outmigrating juvenile salmonids upstream of the dam. These juveniles would suffer threats from predation and water temperature issues.

Upstream of the dam, riparian forest surrounds the river channel (Photo A-190). There is no passage from the upstream side of the dam to the downstream side. Some water passes through the structure via hyporheic flow, but a majority of the water becomes trapped, forming a pond.

The downstream slope of the dam is gentle compared to the upstream slope. Downstream of the dam, the river channel contains little water. Areas that do have water are shallow, stagnant, and covered with algae (Photo A-191). Both banks surrounding the downstream channel have mature riparian growth. Farther downstream, this side channel reconnects with the main stem of the Calaveras River, although flows here are minimal.

Photo A-189. McGurk Earth Dam

Photo A-190. From McGurk Earth Dam looking upstream

Photo A-191. From McGurk Earth Dam looking downstream

McGurk Low-flow Road Crossing

The McGurk Low-flow Road Crossing (LFC) is on the main Calaveras River channel at river mile 27.1, upstream of Calaveras Headworks (Photo A-192). The McGurk LFC contains one concrete box culvert. The culvert is 12 feet in length, 7.5 feet in height, and 18.5 feet wide. The McGurk LFC is approximately 20 feet long and constructed of cement.

Upstream of the LFC, riparian forest surrounds both banks of the river channel (Photo A-193). This section of the river is well shaded and contains a good amount of woody debris. The active channel is 62 feet. The entire flow of the main channel is funneled through the 18.5-foot wide culvert. This creates acceleration in water velocity that may be detrimental to salmonid fish passage.

Downstream of the LFC, riparian forest surrounds both banks of the river channel (Photo A-194). The downstream end of the culvert contains an apron (Photo A-195). There is at least a 2-foot drop from the apron to the channel, further complicating salmonid fish passage. Downstream of the drop from the apron, the river water circulates in an eddy pattern, before continuing downstream. This could be an especially dangerous situation for juvenile fish.

Photo A-192. McGurk Low-flow Road Crossing

Photo A-193. From McGurk Low-flow Road Crossing looking upstream

Photo A-194. From McGurk Low-flow Road Crossing looking downstream

Photo A-195. From McGurk Low-flow Road Crossing looking at culvert apron

Wilsons Low-flow Road Crossing

The Wilsons LFC crosses perpendicular to the Calaveras River at river mile 28, upstream of the Calaveras Headworks (Photo A-196). The LFC is concrete, contains six culverts and provides cross-river traffic for vehicles including trucks, automobiles, and farm equipment.

Wilsons LFC is around 350 feet in length. The LFC contains 6 circular, metal culverts that have similar dimensions of 30 feet in length and a 3-foot diameter (Photo A-197). The river channel upstream and downstream of Wilsons LFC is wide, exceeding 350 feet.

Upstream of the LFC, mature riparian forest surrounds the river channel (Photo A-198). Due to the width of the river channel upstream of the LFC, the water velocities in this area are low. The entire 350-plus-foot width of the river upstream of the LFC passes through 6 culverts clustered in the same location. This may result in high water velocities passing through each culvert. These conditions may create issues with migrating juvenile salmonids.

Downstream of the LFC, mature riparian forest surrounds the river channel (Photo A-199). The downstream side has similar characteristics and fish passage issues compared to the upstream side. Migrating adult salmonids may have difficulties locating the culverts and dealing with the water velocities passing through the culverts.

Photo A-196. Wilsons Low Flow Road Crossing

Photo A-197. Culverts in Wilsons Low Flow Road Crossing

Photo A-198. Upstream from Wilsons Low-flow Road Crossing

Photo A-199. Upstream from Wilsons Low-flow Road Crossing

Old Dog Ranch Low-flow Road Crossing

The Old Dog Ranch LFC crosses perpendicular to the Calaveras River at river mile 29, upstream from the Calaveras Headworks (Photo A-200). The LFC contains two circular steel culverts.

The Old Dog Ranch LFC spans 103 feet with a width of 23 feet. The active channel width is 103 feet.

Upstream of the LFC, the river channel widens and is lined with riparian habitat. In this section of the river, the water is slow moving and contains areas covered with algae. Farther upstream, the river channel narrows and meanders in a southerly direction (Photo A-201).

Downstream of the bridge, the river channel narrows and is characterized by riffles and meanders (Photo A-202). Both downstream banks have gentle slopes and contain riparian trees, bushes, and alien species (especially Himalayan blackberry). The riparian vegetation provides shade to the river channel. Orchards are present along both banks beyond the riparian vegetation.

Both culverts within the LFC have similar dimensions. However, the upstream end of one of the culverts is almost completely blocked by woody debris and has minimal flow. With one culvert blocked, the other passes a majority of the flow, creating high water velocities (Photo A-203).

Photo A-200. Old Dog Ranch Low-flow Road Crossing

Photo A-201. From Old Dog Ranch Low-flow Road Crossing looking upstream

Photo A-202. From Old Dog Ranch Low-flow Road Crossing looking downstream

Photo A-203. Downstream end of culvert within Old Dog Ranch Low-flow Road Crossing

Old Dog Ranch Bridge

The Old Dog Ranch Bridge crosses the Calaveras River at river mile 29, upstream from the Calaveras Headworks (Photo A-204). The bridge is adjacent to the Old Dog Ranch Low-flow Road Crossing. The Old Dog Ranch Bridge spans 155 feet. The active channel width is 150 feet. The bridge contains two rows of three piers, for a total of six, with 51 feet between each row. The bridge has no apron.

Upstream of the bridge, the river channel widens and is lined with riparian habitat. In this section of the river, the water is slow moving and meandering. The river splits with some of the flow going under the bridge and some going toward the Old Dog Ranch LFC. Farther upstream, the river channel narrows and meanders in a southerly direction (Photo A-205).

Immediately downstream of the bridge the river channel narrows and turns sharply to the north (Photo A-206). Both downstream banks have gentle slopes and contain riparian trees, bushes, and non-native exotic species. The riparian vegetation provides shade to the river channel. Orchards are present along both banks beyond the riparian vegetation.

Photo A-204. Old Dog Ranch Bridge

Photo A-205. From Old Dog Ranch Bridge looking upstream

Photo A-206. From Old Dog Ranch Bridge looking downstream

Shelton Road Bridge

The Shelton Road Bridge crosses perpendicular to the Calaveras River near river mile 31, upstream of the Calaveras Headworks (Photo A-207).

The Shelton Road Bridge spans 217 feet. The concrete bridge has two large cement piers. The distance between the piers is 69 feet. The active channel is of similar width and runs between the two rows of piers. The bridge functions as a standard road crossing with a lane of traffic in each direction. There is no apron under the bridge.

The river channel upstream contains riffles, pools, gravels, larger streambed materials, and woody debris. The channel is shaped like a trapezoid and has meander (Photo A-208). The upstream banks are steep to gentle. Both banks are covered with riparian vegetation, including oaks, and willows. The riparian vegetation near Shelton Road Bridge provides good shade to the river and adequate cover for salmonids.

The river channel downstream contains riffles, pools, gravels, larger streambed materials, and woody debris (Photo A-209). The channel is trapezoid in shape and has meander. Downstream, the right bank is gentle; the left bank is steeper. Both banks, especially right bank, contain riparian vegetation; including oaks, and willows.

Photo A-207. Shelton Road Bridge

Photo A-208. Looking upstream from Shelton Road Bridge

Photo A-209. Downstream from Shelton Road Bridge

Deteriorated Low-flow Road Crossing

The Deteriorated Low-flow Road Crossing provides vehicular access across the Calaveras River (Photo A-210). The structure is in disrepair and is on the Calaveras River at river mile 34.9, upstream of the Calaveras Headworks. The road crossing has a drop on the downstream end that varies with the river flow. During low flows, this may hinder fish passage. Scattered rubble associated with the crossing is in the river channel.

The upstream channel has riparian vegetation providing shade to the river. The substrate contains gravels with associated larger rocks. The downstream channel has properties similar to that of the upstream, but contains scattered rubble from the deterioration of the low-flow road crossing.

Photo A-210. Deteriorated Low-flow Road Crossing

Gotelli Low-flow Road Crossing (River Mile 35.3)

The Gotelli crossing is a culvert that provides for vehicular access across the Calaveras River (Photo A-211). The structure is on the Calaveras River at river mile 35.3, upstream of the Calaveras Headworks. The crossing consists of at least one circular corrugated metal culvert. The road crossing is paved and is 14 feet wide by 142 feet long. The bankfull channel width is 90 feet. There is a 3.2-foot drop from the crest of the road crossing to the channel bed. In certain flow conditions, this creates fish passage issues. There is some scattered rubble downstream of the crossing.

Immediately upstream of the crossing, the channel bottom is a gravely substrate. Banks are well vegetated, and trees provide shade to the reach. Upstream, the river contains woody debris, riffles, and pools (Photo A-212).

The channel near the crossing is lined with rubble. Farther downstream, the channel is composed of a gravely substrate. The other downstream channel properties are similar to that of the upstream channel (Photo A-213).

Photo A-211. Gotelli Low-flow Road Crossing (River Mile 35.3)

Photo A-212. Calaveras River upstream of Gotelli Low-flow Road Crossing (River Mile 35.3)

Photo A-213. Calaveras downstream of Gotelli Low-flow Road Crossing (River Mile 35.3)

Rubble Dam upstream of Bellota Weir

The Rubble Dam upstream of Bellota Weir is in the Calaveras River at river mile 35.5, upstream of the Calaveras Headworks (Photo A-214). The rubble dam at the time of the photo was almost completely submerged by the river. Depending on the river flows, the rubble dam may be an impediment to upstream and downstream fish passage. A drop associated with the dam may hinder passage. The scattered rubble under low flow conditions may also create passage issues.

The upstream channel has riparian vegetation providing shade to the river. The substrate contains gravels with associated larger rocks. The downstream channel has properties similar to those upstream.

Photo A-214. Rubble Dam upstream of Bellota Weir in Calaveras River channel

New Hogan Dam Road Bridge

The bridge at New Hogan Dam Road crosses perpendicular to the Calaveras River near river mile 43. Approximately 125 feet long and 26 feet wide, the concrete bridge has 2 piers supporting the span that are approximately 2 feet wide by 26 feet long (Photo A-215). The piers divide the river into three channels of equal width. Concrete wing walls on both the upstream and downstream side of the bridge protect the end abutments. A concrete weir is beneath the bridge perpendicular to the flow at about the midpoint of the piers (Photo A-216). The weir is part of the gaging system at the bridge.

Immediately upstream of the bridge, the water is swift flowing and greater than 5 feet deep. The stream bottom is a gravelly substrate. Banks are well vegetated, and trees provide shade to the reach. Upstream, the river widens, and a large island is formed in the middle of the channel about 50 feet from the bridge (Photo A-217and Photo A-218). The island causes the river flows to split around it. The upstream flow regime appears to be subcritical, characteristic of a glide, with the weir acting as the dominant controlling feature for the upstream pool.

Because of the gaging weir and the channel constriction at the bridge, water flow is swift downstream of the structure (Photo A-219). The plunge pool below the weir is greater than 5 feet deep. The channel depth decreases to approximately 0.5 feet deep and flows over cobble substrate about 100 feet downstream of structure. The vegetation on the banks is the same as the upstream reach (Photo A-220).

Photo A-215. View across New Hogan Dam Road Bridge from upstream

Photo A-216. Concrete weir under New Hogan Dam Road Bridge span

Photo A-217. View of river right split of channel upstream from New Hogan Dam Road Bridge. Metal structure in left foreground is gage housing.

Photo A-218. Panoramic view of New Hogan Dam Road Bridge upstream channel

Photo A-219. View across New Hogan Dam Road Bridge from downstream

Photo A-220. Channel downstream from New Hogan Dam Road Bridge

Stockton Diverting Canal and Mormon Slough

Wooden Bridge West of Wilson Way

The wood bridge west of Wilson Way (Photo A-221) is 215 feet long and 23 feet high. It crosses the Stockton Diverting Canal west of Wilson Way and near Sanguinetti Lane. Ten piers spaced 20 feet apart support the bridge, each made up of 3 cross-braced columns. The active channel is 20 feet wide. The channel bottom is sandy with some coarse gravel, rocks, and debris, such as lumber and shopping carts, and weeds and brush cover the banks. Because there is no apron or riprap scour protection under the bridge and no visible water surface difference, it is not a barrier. We will confirm this by modeling fish passage at the Fine Road Bridge.

Photo A-221. Wooden Bridge West of Wilson Way

Wilson Way Bridge

Wilson Way Bridge is concrete, 282 feet long and 22 feet high supported by seven rows of 11 columns each with 33 feet between rows. The bridge is a quarter of a mile downstream of river mile 1 on the Stockton Diverting Canal. The three center columns of each row are the original bridge piers and are square with concrete footings. Widening the road required four more round columns set into the ground on each side of the original piers (Photos A-222, A-223). The active channel is 22 feet wide; the banks under the bridge are bare earth, but are grassy upstream and downstream of the bridge. A bike path runs along the left bank. Because the bridge has no apron or riprap scour protection and there is no visible water surface difference, it is not a barrier to fish migration. We will confirm this by modeling fish passage at the Fine Road Bridge.

Photo A-222. Wilson Way Bridge

Photo A-223. Wilson Way Bridge in the dry. Note developing willows (Salix sp.) along the bank in the foreground

Central California Traction Railroad Bridge (CCTRR)

The Central California Traction Railroad Bridge was one of the eight structures modeled in 2004. Central California Traction is an active railroad line that crosses the Stockton Diverting Canal near river mile 1. The structure is oriented perpendicular to the flow path, and the bridge piers are aligned parallel to the direction of flow. The bridge spans 245 feet across the flood diversion channel with an active channel width of 165 feet (Photo A-224).

Between the left and right bank bridge abutments, the CCTRR has 14 piers spaced 15 feet apart. A roughened concrete apron was built connecting the bridge piers in an attempt to stabilize the channel bed near the bridge. Its surface is pitted and scoured and has two large perforations extending to the channel bed. During low flows, the apron functions as a weir. A concrete box flume for concentrating low-flows cuts through the concrete apron. The apron extends 15 feet upstream of the trestle on both sides of the flume and is about 3 feet above the upstream channel thalweg. Downstream of the bridge on the right side of the flume, the concrete apron is 100 feet wide and 65 feet long. Thirty feet of concrete rubble and rooted waterweeds extend downstream from the apron on the right. On the left side of the flume, the concrete apron is 75 feet wide and only extends 15 feet downstream of the bridge. Downstream of the apron on the left lies 50 feet of concrete rubble. There is an almost 4-foot drop to the downstream channel thalweg.

The concrete box flume is 57 feet long, 6 feet wide, and 3 feet deep with the top of the flume flush with the surface of the concrete apron. The concrete of the flume is finished smooth and the flume has a mild slope of about 0.3%. There is a rough concrete apron about 10 feet long at the inlet to the flume. The flume entrance also has rough concrete wing walls to direct flow into the flume.

Upstream of the structure, the channel is straight and well defined, with a manmade trapezoidal cross section (Photo A-225). The channel bank slope is very gradual on the left bank and slightly steeper on the right. Aquatic vegetation clogs the upstream channel and grasses are the dominant vegetation on the uplands. The channel bed is silty clay with some gravelly-sands, and the banks are vegetated with low brush and weeds. The vegetation, made up of water grasses and sedges, is denser closer to the water level, transitions to weedy annual grasses and thins out toward the top of the levee (Photo A-226). The upstream flow regime appears to be subcritical for a fair distance upstream, characteristic of a glide. The flume and weir structure is the dominant controlling feature for the upstream pool.

Downstream of the structure, the low-flow path meanders mildly within the confines of the straight, well-defined flood control channel (Photo A-227). The channel bed is similar to that of the bed upstream. A transitional shelf, immediately downstream of the structure, is littered with chunks of concrete riprap and vegetated with large clumps of grasses and reeds that clog the downstream channel (Photos A-228, A-229). Grasses and the occasional small tree grow on the low- to mid-levee banks thin out toward the top of the levee and provide little in the way of riparian habitat. Debris and vegetation clutter the active channel so water splits into multiple flow paths downstream of the flume.

Photo A-224. Downstream face of CCTRR

Photo A-225. Side view of CCTRR, apron, and flume from the left downstream bank

Photo A-226. View of CCTRR flume from the upstream side

Photo A-227. Channel upstream of CCTRR showing the flume inlet

Photo A-228. View of the 'wet' downstream channel from the CCTRR flume outlet

Photo A-229. View of the 'dry' downstream channel from the CCTRR flume outlet

Cherokee Road Bridge

Cherokee Road Bridge (Photo A-230) is a 17–foot-high concrete bridge that spans the 212 feet of the Stockton Diverting Canal. The site is three-tenths of a mile upstream of river mile 1.0. Nine piers, each made up of four columns, support the bridge. The piers are 24 feet apart except for the 9-foot gap between the center piers. Water primrose grows along the water edge and into the channel, while grasses grow on the channel banks. The active channel is 110 feet wide. Because the bridge has no apron or riprap scour protection and there is no visible water surface difference, it is not a barrier to fish migration. We will confirm this by modeling fish passage at the Fine Road Bridge.

Photo A-230. Cherokee Road Bridge from the left bank looking downstream

Waterloo Road Bridge

Waterloo Road Bridge (Photo A-231) is an 18-foot-high concrete bridge that spans the 257 feet of the Stockton Diverting Canal. The bridge is three-tenths of a mile downstream of river mile 2.0. Seven piers, each made up of nine columns, support the bridge. The active channel is about 110 feet wide. Because the bridge has no apron or riprap scour protection and there is no visible water surface difference, it is not a barrier to fish migration. We will confirm this by modeling fish passage at the Fine Road Bridge.

Photo A-231. Waterloo Road Bridge looking upstream

Highway 99 Northbound and Southbound Bridges (Stockton Diverting Canal)

Highway 99 crosses the Stockton Diverting Canal on 2 bridge decks, each about 280 feet long and 18 feet high. Seven rows of piers that are 40 feet apart support each bridge deck. The northbound piers have 7 columns each (Photo A-232), and the southbound piers have 11 columns (Photo A-233).

The active channel is 29 feet wide with a silty bottom. Grass and weeds grow on the channel banks. Because the bridge has no apron or riprap scour protection and there is no visible water surface difference, it is not a barrier to fish migration (Photo A-234). We will confirm this by modeling fish passage at the Fine Road bridge.

Photo A-232. Highway 99 Southbound Bridge deck with low flow channel full

Photo A-233. Highway 99 Southbound Bridge deck with low flow channel full

Photo A-234. Highway 99 Northbound Bridge deck with low-flow channel dry

Budiselich Dam

Budiselich Dam was one of the eight structures modeled in 2004 (see main body of report). The Budiselich Flashboard Dam is in the Stockton Diverting Canal near river mile 2. The Stockton Diverting Canal joins flows of Mormon Slough and the old Calaveras River in the City of Stockton. The maximum design flow of the main channel is 12,500 cfs. The flashboards are installed during the irrigation season. The flashboards are removed during months when irrigation water is not needed, usually between October and March (Photo A-235).

The structure is composed of 8-foot high rectangular concrete wing wall abutments and a 12-foot wide flat concrete slab sill spanning the 98 feet between abutments (Photo A-235 and Photo A-236).

The concrete sill is oriented perpendicular to the flow path and is elevated above the downstream channel grade. Although the sill is about 12 feet wide, two notches 3 feet wide and 7 feet long are cut into the sill and extend through the riprap on the downstream side near the center of the span (Photo A-235 and Photo A-237). The downstream face of the dam is protected from scour by a large pile of broken concrete rubble and rock riprap extending about 50 feet downstream of the structure and extending 80 feet across the channel from the right bank (Photo A-238 and Photo A-239).

The upstream reach of the channel is wide and straight, with a manmade trapezoidal shape. The flow regime appears to be tranquil at low flows with ponding upstream of the structure because of the dam sill. The bankfull channel width is 180 feet. The channel bottom is silty-clay, with a few pieces of riprap immediately upstream of the structure. The banks are vegetated with grasses and waterweeds, which are denser at the water line (Photo A-240).

The downstream channel continues the wide, straight, trapezoidal geometry. Downstream from the riprap cascade a narrower, low-flow channel about 23 feet wide has developed in the bottom of the canal (Photo A-241). The channel bottom is silty-clay with dense grass and weed growth near the water’s edge.

Because the dam has not been used for diversions for several years, the midchannel flashboard supports were removed from the dam sill. The structure sill and abutments are being preserved in place for potential future use by SEWD.

In fall of 2001, modifications were performed to provide temporary improvements to fish passage conditions at Budiselich Dam. Sandbags were placed along the edge of the concrete perpendicular to the direction of flow to increase the depth over the sill (Photo A-242). A portion of the riprap was relocated, and sandbags were placed to create a flow path for migrating salmonids and improve water depth through the riprap cascade (Photo A-243, Photo A-244, and Photo A-245).

Photo A-235. Budiselich Dam, overview of upstream from the downstream left bank

Photo A-236. Downstream from Budiselich Dam concrete sill

Photo A-237. Typical notch in Budiselich Dam sill

Photo A-238. Riprap cascade at the downstream side of Budiselich Dam

Photo A-239. Plan view of riprap cascade downstream of Budiselich Dam

Photo A-240. Channel upstream from Budiselich Dam

Photo A-241 Channel downstream from Budiselich Dam riprap cascade

Photo A-242. At-grade view of riprap cascade downstream of Budiselich Dam

Photo A-243. Temporary modification of the channel downstream from Budiselich Dam

Photo A-244. View upstream and over Budiselich Dam and temporary channel modifications

Photo A-245. Chinook salmon carcass near top of cascade at Budiselich Dam

Stockton Terminal and Eastern Railroad Bridge

The Stockton Terminal and Eastern Railroad Short Line cross the Stockton Diverting Canal on a 305-foot-long, 18-foot-high concrete bridge. The bridge is one-tenth of a mile downstream of river mile 2. Nine rows of piers each with 4 columns 30 feet apart support the bridge (Photo A-246).

Riprap slope protection lines the otherwise weed-covered banks for about 20 feet upstream of the bridge (Photo A-247 and Photo A-248). When water is flowing, water primrose grows along the channel at the waterline. A 60-foot-wide, low-flow channel runs down the centerline of the canal. Because the bridge has no apron or riprap scour protection and there is no visible water surface difference, it is not a barrier to fish migration (Photo A-247 and Photo A-248). We will confirm this in modeling and assessing fish passage at Mormon Slough railroad crossing.

Photo A-246. The Stockton Terminal and Eastern Railroad Bridge from upstream left bank looking downstream

Photo A-247. Looking south at the Stockton Terminal Eastern Railroad Bridge on the Stockton Diverting Canal. Riprap protects the abutments above the low-flow channel

Photo A-248. Looking at the channel bed below the Stockton Terminal Eastern Railroad Bridge

Highway 26 Bridge (Stockton Diverting Canal)

Highway 26 crosses the Stockton Diverting Canal at river mile 3. The bridge is a concrete span 305 feet long and 25 feet high. The crest length is 200 feet. Nine piers supporting the bridge, each with 10 columns, are 29 feet apart. Water primrose grows over most of the water surface during the summer. The active channel widens to 90 feet at the bridge (Photo A-249). The upstream channel is a long, flat, and trapezoidal. Waterweeds choke the channel in places (Photo A-250). Because the bridge has no apron or riprap scour protection and there is no visible water surface difference, it is not a barrier to fish migration. We will confirm this by modeling fish passage at the Fine Road Bridge.

Photo A-249. Highway 26 Bridge looking south

Photo A-250. Taken from the Highway 26 Bridge looking south to north

Southern Pacific Railroad Bridge

The Southern Pacific railroad bridge spans the Stockton Diverting Canal exactly between river mile 3 and river mile 4 (Photo A-251). The bridge spans 246 feet and is 20 feet high. Sixteen piers each with four posts span the channel. The distance between the piers varies between 9 feet and 15 feet. The apron measures 109 feet long and about 200 feet wide. We could not measure downstream drop to the apron because rubble filled the channel. The upstream rise to the top of the apron is 2 feet. There is a 7-foot notch in the middle of the channel.

The banks support weeds and grasses. Tires, metal, and plastic litter the channel. There is an abandoned car on the upstream left bank. Rocks placed across the bottom resemble a weir. Water flow is funneled toward the right bank. Fish passage is likely an issue here because of the apron, concrete debris, and large pieces of trash and rubble that litter the channel. We will use modeling results from Mormon Slough Railroad crossing to assess fish passage at Southern Pacific Crossing.

Photo A-251. The Southern Pacific Railroad Crossing. Downstream is to the right.

Main Street Flashboard Dam

Main Street Flashboard Dam is on Mormon Slough, upstream of the Stockton Diverting Canal at river mile 4.9 (Photo A-252). The base provides support for flashboards during irrigation season. The flashboards usually are removed between October and March when Mormon Slough is a flood control channel (Photo A-253, Photo A-254).

The Main Street Flashboard Dam spans 70 feet between two 10-foot abutments. The width of the abutments and pads is 10 feet. There is a 35-foot notch. In the notch, there are supports for flashboards. The notch has formed a low-flow channel and low benches at the toe of the channel banks upstream and downstream. The benches along this stretch of the channel are scoured next to the low-flow channel, and grass and weeds cover benches above the scour line. The upper banks have almost no riparian cover (Photo A-255).

There is no riprap protection at Main Street Dam. The channel bottom is a bare made up of silty-clay and some rock. The channel is a well-defined trapezoidal cross section, and there is no meander in the channel upstream or downstream.

Under high flows, the channel is full and Main Street Dam is under water. At low flows, woody and trashy debris can be seen from the banks near the dam.

During irrigation season, 8-foot-high flashboards create a water surface difference between the dam crest and the plunge pool of 5.8 feet and an upstream wetted width of 86 feet (Photo A-256). The pool immediately downstream of the dam is 1.2 feet deep which does not meet the 2-foot minimum depth for juvenile salmonids. Budiselich dam model represents an assessment of fish passage at Main Street Dam.

Photo A-252. Main Street Flashboard Dam looking upstream

Photo A-253. Main Street Dam under water during high flows

Photo A-254. Upstream of Main Street Dam at high flows

Photo A-255. Upstream from Main Street Dam at low flow

Photo A-256. Flashboards in place at Main Street Dam

Panella Flashboard Dam

Panella flashboard Dam is on Mormon Slough at river mile 6.6 (Photo A-257). The dam base supports flashboards during irrigation season. The flashboards are removed usually between October and March when Mormon Slough is a flood control channel.

Panella Flashboard Dam's base spans 41 feet between the concrete abutments and is 9 feet wide, with a total span including abutments of 60 feet across Mormon Slough (Photo A-258). There is no notch in the base of the dam. Riprap and debris line the channel bottom for 39 feet downstream of the dam. Riprap also extends 12 feet upstream of the dam base for a width of 60 feet across Mormon Slough. Several mature riparian trees grow on the lower left bank upstream of the dam and provide cover and shade. A few less-mature trees grow on the left bank downstream of the dam, and provide slight cover and shade to the channel (Photo A-259).

Downstream of the riprap, rocks are scattered along the channel bed. Both upstream and downstream of the dam, the banks slope steeply, and weeds and brush grow on the banks above the scour line. The channel is straight with well-defined rounded trapezoidal cross-section.

During irrigation season with 5-foot-high flashboards, the water surface difference between the dam crest and the plunge pool is 4.3 feet and the upstream wetted width is 62 feet (Photo A-260). The concrete dam base extends 8 feet downstream of the flashboards and is flush with the channel grade. Water spills over the flashboards into a shallow pool that is just over 6 inches deep at the base of the apron. A second pool 9 feet downstream is about 1.5-foot-deep. The 6-inch downstream plunge pool depth does not meet the minimum 2-foot requirement for juvenile salmonids. We will use modeling results from Lavaggi flashboard dam to assess fish passage at Panella flashboard dam.

Photo A-257. Panella Flashboard Dam

Photo A-258. Panella Flashboard Dam upstream from downstream right bank

Photo A-259. Downstream of Panella Flashboard Dam

Photo A-260. Flashboards in at Panella Flashboard Dam

Bridge Upstream of Panella Flashboard Dam

The bridge upstream of Panella Flashboard Dam crosses Mormon Slough at river mile 6.8. The bridge span is 152 feet long, and it is 19.3 feet high. Four sets of 2 piers each, with each pair 30 feet apart, support the bridge (Photo A-261). Riprap on the right bank from the water surface to the road crown extends 600 feet upstream and 50 feet downstream. There is also some riprap scattered in the channel under the bridge (Photo A-262). There is scattered riprap around the bridge piers on the right bank and around the pair of piers next to the Mormon Slough on the left bank.

We saw no channel barriers or difference in water surface elevation at the bridge. Because the bridge has no apron or riprap scour protection and there is no visible water surface difference, it is not a barrier to fish migration. We will confirm this by modeling fish passage at the Fine Road Bridge.

Photo A-261. The bridge near Panella Dam

Photo A-262. Channel as seen under the bridge near Panella Dam

Caprini Low-flow Road Crossing

Caprini Low-flow Road Crossing was one of the eight structures modeled in 2004. The Caprini LFC is on Mormon Slough near river mile 8. The crossing is situated in the active channel perpendicular to the flow path (Photo A-263) and rises about 4 feet above the apron. The LFC is 45 feet in length and 10 feet in width. The structure is composed of a rectangular concrete road prism of unknown thickness overlaying three corrugated metal pipe (CMP) culverts.

All three culverts have similar geometric properties – corrugated metal pipe, 36 inch diameter, about 10 feet long, and set at about a 3% slope. The culvert inlets and outlets are flush with the road prism, which acts as a head wall. The road surface is composed of smooth concrete and is 10 feet wide. The structure is in fair condition with no evident structural defects. The condition of the culverts is good, though they are exhibiting signs of corrosion.

The structure has a concrete apron attached to the upstream and downstream faces of the crossing. The upstream apron extends about 15 feet upstream of the structure, spans the active channel width of 80 feet, and is flush with the culvert inlet inverts (Photo A-264). The downstream apron is also 15 feet in length and flush with the culvert outlet inverts. The portion of the apron that spans the channel bottom is flat and rough (Photo A-265). There appear to be remnant portions of the apron underneath the piles of rocky debris and riprap armor lining the side slopes. The riprap consists of large, irregularly shaped boulders and concrete slabs. A riprap cascade extends about 55 feet downstream from the outlet apron (Photo A-265).

The upstream channel consists of a gravelly-sand bottom with alluvial deposits of silt, silty-clay brush lined banks, and grass-covered levees. There is a rocky, weir-like feature immediately upstream of the crossing (Photo A-266). The upstream flow regime appears to be subcritical for a fair distance upstream, characteristic of a glide. Caprini LFC is the dominant controlling feature for the upstream pool.

Immediately downstream of the concrete apron at the culvert outlets, a rock cascade forms a series of two major step pools from the outlet apron sill to a pool below (Photo A-267). The pool below is a significant plunge pool about 120 feet long and 4 feet deep under minimal flow conditions.

The downstream channel is highly degraded (Photo A-268). A typical downstream cross section is composed of a muddy clay bottom and earthen levee banks with sparse vegetation. The active channel exhibits signs of scour at the toe of the levee with bare clay side slopes where riprap has scoured away resulting in a channel littered with rocky debris. The debris was likely placed to inhibit down-cutting and probably has been redistributed by high flows. The levee banks are heavily armored with rock slope protection. The downstream flow regime appears to be subcritical for a fair distance downstream, characteristic of a glide (Photo A-268).

On December 4, 2001, representatives from DWR observed a live female adult Chinook salmon about 30 inches long in the downstream plunge pool (Photo A-269). The fish was observed for about 30 minutes making repeated, unsuccessful attempts to ascend the rock cascade. The primary hindrance appeared to be the lack of a clear migration route over the haphazard placement of rock compounded by the lack of incremental jump pools. Preliminary field measurements at the time showed water depths of about 3 inches with a velocity of 5 feet per second across the outlet apron corresponding to a flow reading of about 15 cfs at the Mormon Slough at Bellota Gage. The actual flow at Caprini LFC was probably higher because of ungaged inflows from storm runoff to Mormon Slough between the gage and the site, particularly from Potter Creek. A dead adult salmon was found at Caprini LFC (Photo A-270).

On December 19, 2002, representatives from DWR found a relatively fresh carcass of an adult male salmon at the site (Photo A-270). The carcass was on the right side of the outlet apron wedged under a large boulder. Flows were probably high enough for the fish to ascend the rock cascade and get onto the outlet apron but unable to pass through the culverts.

Photo A-263. Upstream at Caprini LFC

Photo A-264. Concrete apron on upstream side of Caprini LFC

Photo A-265. Caprini LFC showing downstream apron

Photo A-266 View of upstream channel from Caprini LFC

Photo A-267. Plan view of rock cascade downstream of Caprini LFC

Photo A-268. Channel downstream of Caprini LFC during receding storm flows

Photo A-269. Chinook salmon attempting upstream migration past Caprini LFC

Photo A-270. Dead adult salmon at Caprini LFC

Lavaggi Flashboard Dam

Lavaggi Flashboard Dam is on Mormon Slough at river mile 7.5. The dam base supports flashboards during irrigation season. When the flashboards are removed, Mormon Slough becomes a flood control channel.

Lavaggi Flashboard Dam spans 45 feet across Mormon Slough between two 18-foot concrete abutments (Photo A-271). The dam base is 11 feet wide and drops about 2 feet to the downstream riprap. The riprap is 42 feet wide and extends 32 feet downstream of the dam base. There is also riprap on the banks immediately around the base. The channel bottom is silty-clay. In general, grass, shrubs, and weeds cover the steep banks above the scour line. Willows are beginning to take hold on the upstream left bank and immediately downstream of the left bank abutment. They provide some surface shade to the channel. The channel has little or no meander with a well-defined rounded trapezoidal cross section (Photos A-272, A-273).

During irrigation season, a 7-foot-high flashboard dam creates a 6.5-foot water surface difference and 63-foot upstream wetted width (Photo A-274). Water spilling over the dam creates a 6-inch-deep sheet flow over the downstream concrete apron, which is 7.5 feet long. Downstream of the apron, shallow water flows over and through a stretch of riprap (Photo A-275). The minimum plunge pool depth of 2 feet for juvenile salmonids is not met at Lavaggi Flashboard Dam.

This structure was modeled to evaluate depth and velocity at the dam against fish passage criteria. The modeling results are in this report.

Photo A-271. Lavaggi Flashboard Dam

Photo A-272. Upstream of Lavaggi Flashboard Dam

Photo A-273. Downstream of Lavaggi Flashboard Dam

Photo A-274. Flashboards in at Lavaggi Flashboard Dam

Photo A-275. Lavaggi Dam with boards shows shallow flow over loose riprap ending in a riprap cascade

Jack Tone Road Bridge (Mormon Slough)

Jack Tone Bridge crosses Mormon Slough just downstream of river mile 8. Four sets of piers of four columns each support the 145-foot-long bridge (Photo A-276). The column sets are 30 feet apart. Rocks line the steep left bank under the bridge. Three field drainage pipes, one upstream from the bridge and two downstream, protrude from the upper right bank and have concrete blocks below to dissipate the energy. Two outfall pipes, one each on the upstream and downstream sides of the bridge, protrude from the upper left bank. Near the bridge, the active channel is 84 feet wide with a narrower low-flow channel.

Downstream of the bridge, inside the low-flow channel there is a concrete and rock weir with riprap on the upstream side. Large boulders are on the left side of the rock weir and just below the rock weir on the right bank (Photo A-277). There is also a pile of rocks on the dry terrace on the left side of the bridge. This may prevent fish passage during times of low flow.

Because the bridge has no apron or riprap scour protection and there is no water surface difference between one side and the other, it is not a barrier to fish migration. We will confirm this by modeling fish passage at the Fine Road Bridge.

Photo A-276. Jack Tone Bridge from downstream looking upstream. Notice field drainage pipes on left bank

Photo A-277. Concrete and rock weir downstream of Jack Tone Bridge

Hogan Low-flow Road Crossing

Hogan Low-flow Crossing was one of the eight structures modeled in 2004. The Hogan LFC is on Mormon Slough near river mile 8.4. The crossing is in the active channel perpendicular to the flow path (Photo A-278). The structure is made of an irregular rectangular concrete road prism of unknown thickness poured over three not uniformly placed reinforced concrete pipe (RCP) culverts.

Culvert No. 1 (numbered from left to right with respect to Photo A-279) is a 57–foot-long, 48-inch diameter RCP. The slope of the pipe is 0.35% and the outlet is about 1.2 feet above the riprap downstream of the structure. Culverts No. 2 and No. 3 are both 64-foot-long, 30-inch diameter RCPs. The slope of culvert No. 2 is 1.9% and the drop from the outlet of the pipe to the downstream riprap is about 0.3 feet. Culvert No. 3 has an adverse slope of -1.1%. The drop from the outlet of culvert No. 3 to the downstream riprap is about 1.2 feet. The culvert inlets and outlets are projecting from the road prism.

The road surface is made of rough concrete overlay and is 50 feet wide. The structure is in poor condition exhibiting scour damage and signs of numerous repairs. Several concrete surface overlays and a crude concrete over-pour across the upstream and downstream faces of the structure are evident. Each of the culverts appears to have been retrofit with extensions (Photos A-280 and A-281).

The bed of the upstream channel (Photo A-282) has degraded leaving the inlets of the culverts perched above the bed. A typical cross section is composed of a gravelly-clay bottom with some alluvial deposits of gravelly-silt at the culvert inlets. Weeds, grass, and occasional shrubs line muddy clay banks. Some riprap is present along the lower banks and bed leading up to structure particularly on the left bank adjacent to the structure. The upstream flow regime appears to be subcritical for a fair distance upstream, characteristic of a glide. The structure is the dominant controlling feature for the upstream pool.

Downstream of the culverts riprap appears to have been scoured away. Although there are concrete pieces immediately downstream around the culverts, the rubble extends only sporadically for 100 feet. Riprap is spread intermittently across the 45 feet of channel width and along 50 feet of the right bank. Where the riprap has been scoured away, the downstream channel is also degraded. A typical cross section is composed of a muddy clay bottom and earthen levee banks with sparse vegetation. The active channel exhibits signs of scour with bare clay side slopes. Riprap covers the right bank (Photo A-283). Some of the riprap was likely placed to inhibit down cutting and has probably been redistributed by high flows. The top of the levee banks also are heavily armored with riprap. The downstream left bank is undercut where the roadway meets the left bank. The downstream flow regime appears to transition from a pool near the structure to a riffle a few hundred feet downstream.

Photo A-284 shows Hogan Crossing during the adult migration season.

Photo A-278. Hogan Low-flow Road Crossing from levee looking downstream

Photo A-279. At-grade view downstream of Hogan Low-flow Road Crossing culvert outlets

Photo A-280. Cross-view of Hogan Low-flow Road Crossing culvert inlets

Photo A-281. Hogan Low-flow Road Crossing irregular road prism, concrete over-pour, and culvert extension as seen from downstream

Photo A-282. Hogan Low-flow Road Crossing 'dry' upstream channel

Photo A-283. Hogan Low-flow Road Crossing 'dry' downstream channel

Photo A-284. Typical culvert outlet condition at Hogan Low-flow Road Crossing during adult migration season

McClean Flashboard Dam

McClean Flashboard Dam is on Mormon Slough near river mile 11 (Photo A-285). The dam base supports flashboards during irrigation season. The flashboards usually are removed between October and March when Mormon Slough is a flood control channel.

The concrete base of McClean Flashboard Dam spans 45 feet across Mormon Slough between two 16-foot concrete abutments. The concrete base is 12 feet wide and flush with the riprap scour protection upstream and downstream. Riprap extends 15 feet upstream of the dam base.

About 60 feet upstream, there is a rock and concrete rubble weir to reduce erosion upstream of the dam during high flows (Photo A-286). The right bank is steep and poorly vegetated with annual weeds and grasses (Photo A-287). There are no riparian woody plants. The banks in the active channel are eroded exposing silty clay. Two gravel bars, one next to the rubble weir, have been deposited upstream at the left bank toe. A grated pump intake pipe extends from the right bank. The channel upstream of dam is straight; however, there is a slight meander in the channel downstream. The channel has a well-defined trapezoidal cross-section.

A riprap apron extends 23 feet downstream of the dam base and extends intermittently for another 209 feet (Photo A-288). The downstream channel is narrow and incised where riprap has been scoured away. It is trapezoidal in shape with a vegetated bench next to the right and left banks. Exotic grasses and weeds cover the channel and banks. Where there is vegetation on the upper banks, it is mostly annual weedy grasses. Grass and weeds also cover the channel banks around the dam although some cattails (*Typha* sp.) and willows (*Salix* sp.) are taking hold near the toes of the downstream banks.

During irrigation season when the flashboards are in place, the crest to pool height is about 6 feet and the upstream wetted channel is 72 feet (Photo A-289). The bankfull channel is 90 feet wide and the flashboard crest length is 45 feet. Also, the flashboards are 7 feet high; water flowing over the dam creates a plunge pool of about a foot. The minimum plunge pool depth of 2 feet for juvenile salmonids is not met at McClean Flashboard Dam. We will use modeling results from Piazza flashboard dam to assess fish passage at McClean Flashboard Dam.

Photo A-285. McClean Flashboard Dam

Photo A-286. McClean Flashboard Dam with rock weir 60 feet upstream

Photo A-287. Looking upstream of McClean Flashboard Dam

Photo A-288. Looking downstream from the McClean Flashboard Dam base

Photo A-289. McClean Flashboard Dam with flashboards installed

Fujinaka Low-flow Road Crossing

The Fujinaka Low-flow Road Crossing is on Mormon Slough near river mile 10.0. The crossing is in the active channel perpendicular to the flow path (Photo A-290) and is 6 feet above the average channel bottom. The structure, which is 110 feet long, is composed of a rectangular concrete road prism of unknown thickness penetrated by three circular concrete culverts.

The road surface is made of rough concrete overlay and is 25 feet wide. The structure is in poor condition with scour damage and many signs of repair work.

The geometric properties of each culvert are different from each other. Their respective parameters are listed in Table A-1. The culverts are numbered left to right with respect to Photo A-290.

The inlet of culvert No. 1 protrudes from the crossing. The inlets of culverts No. 2 and No. 3 are flush with the crossing creating a headwall situation. The outlet of culvert No. 1 has been retrofitted with a fiberglass sleeve. None of the culvert outlets were perched under the survey conditions, and their diameters and invert elevations are staggered. During a Nov. 18, 2004, site visit, the inlet of culvert No. 1 was blocked. During storm flows, debris probably can be caught on the upstream face of the structure.

The upstream channel typically consists of grass-covered levees with rock riprap armoring along the toe and an earthen bottom with some alluvial deposits of cobble (Photo A-291). There is a point bar immediately upstream of the crossing. The upstream flow regime appears to be subcritical for a fair distance upstream, characteristic of a glide. The structure is the controlling feature for the upstream pool.

The downstream channel is similar to the upstream channel except the riprap extends partially across the channel and alluvial deposits are sparse. Between site visits, the riprap on the lower banks and toe sections immediately downstream of the structure had been scoured away (Photo A-292). The tail water control appears to be a small deposition zone. It is creating a riffle crest about 300 feet downstream from the structure where the flow of the downstream pool transitions from subcritical to supercritical flow. The riffle was composed of small cobbles and gravels. For a short distance, they seemed embedded before yielding to a dominant muddy clay substrate. Riprap scour protection lines the channel below the culverts and levee toes upstream and downstream of the low-flow crossing.

Fujinaka Low-flow Crossing has four paths for flow to pass the structure. The three culverts allow water to pass through the structure, and during high flows, water can pass over the top of the road. Under optimal hydraulic conditions, each flow path can allow fish passage.

This structure was modeled to evaluate depth and velocity at the crossing against fish passage criteria. The modeling results are in the this report.

Table A-1. Summary of Fujinaka Low-flow Crossing culvert properties.

Culvert number	Diameter (inches)	Length (feet)
1	30	27
2	40	25
3	44	23

Photo A-290. Upstream at Fujinaka Low-flow Crossing

Photo A-291. Typical upstream channel as viewed from Fujinaka Low-flow Crossing

Photo A-292. View across downstream side of Fujinaka Low-flow Crossing

Copperopolis Road Bridge

Copperopolis Road Bridge is a 190-foot concrete bridge crossing Mormon Slough at river mile 10 (Photo A-293). Two concrete piers stand 62 feet apart and are just outside the 50-foot-wide active channel. The banks are steep under the bridge. Dense *Arundo* and willow grow on the left bank. The right bank slope is more gradual upstream of the bridge where the channel also widens. The narrow low-flow channel runs over a rocky substrate. Downstream of the bridge, two rock weirs cross the channel. The first is 250 feet downstream (right side of Photo A-293); the second, another 75 feet farther. The rock weirs should be examined during low flows.

Although not visible on this photo, the upstream bank supports riparian vegetation and Himalayan blackberries line the toe a good distance upstream. A covered drain, with two culverts embedded in a concrete base that discharge into the channel, is on the upper right bank just upstream of the bridge.

Because the bridge has no apron or riprap scour protection and there is no visible water surface difference between one side of the bridge and the other, it is not a barrier to fish migration. We will confirm this by modeling fish passage at the Fine Road Bridge.

Photo A-293. Copperopolis Road Bridge from downstream looking upstream

Prato Flashboard Dam

Prato flashboard Dam is on Mormon Slough at river mile 10.4 (Photo A-294). The dam supports flashboards during irrigation season. The flashboards are removed usually between October and March when Mormon Slough is a flood control channel.

The concrete base of Prato Flashboard Dam spans 46 feet across the bottom of Mormon Slough and is 11 feet wide. Including the two concrete abutments, the dam spans 70 feet. A 5-foot section of the concrete base has been removed, creating a low-flow notch. The concrete base is flush with the riprap around the dam. Riprap in the channel bottom extends 18 feet upstream of the dam and is 70 feet wide. Riprap also extends 65 feet downstream of the dam and is 65 feet wide. The downstream riprap forms two steps and a cascade area. The first step is 20 feet from the dam base, and the second is 21 feet farther downstream. The cascade is 13 feet beyond the second step. The low-flow channel narrows downstream of the dam base.

Downstream of the dam, the banks are steep and covered mostly with weeds and gravel (Photo A-295). Weedy grasses have invaded the instream riprap, which also lines the right bank near the dam. Willows encroach into the channel and can provide some shaded riverine habitat. The channel meanders to the left and is a well-defined rounded trapezoidal cross-section. Upstream the banks are steep, covered with gravel and weeds on the left bank, and bare soil with occasional grass on the right bank (Photo A-296). One tree on the right bank that may provide some cover to the channel in the summer. The channel is a well-defined trapezoidal cross-section.

With flashboards up during irrigation season, the upstream wetted channel width is 77 feet and flashboards span 46 feet across Mormon Slough (Photo A-297). The flashboards are about 7 feet high and the water surface difference between the dam crest and the plunge pool is about 6 feet. The plunge pool is a foot deep, which does not meet the 2-foot minimum depth for juvenile salmonids. We will use modeling results from Piazza Flashboard Dam to assess fish passage at Prato Flashboard Dam.

Photo A-294. Prato Flashboard Dam

Photo A-295. Downstream of Prato Flashboard Dam

Photo A-296. Upstream of Prato Flashboard Dam

Photo A-297. Flashboards in place at Prato Flashboard Dam

Mormon Slough Railroad Bridge

The Mormon Slough Railroad Bridge (MSRR) is where the old Southern Pacific line crosses Mormon Slough near river mile 13. The structure spans about 240 feet across the bankfull channel (Photo A-298) on a skewed alignment. The structure is supported by two end abutments and four elongated hexagonal concrete piers with conical spread footings in the active channel. The structure appears abandoned because the tracks have been removed and ends barricaded. However, the structure is being preserved for potential future use by SEWD.

The four Mormon Slough Railroad Crossing Piers are 50 feet apart (Photo A-299). The piers' footings are incorporated into a concrete apron extending continuously across the channel between the abutments and 15 feet downstream and upstream of the bridge. The apron has a total width of 50 feet and there is a 9-foot drop from the apron to the channel (Photo A-300). Overall, the structure appears to be in fair condition. The structure itself is at a steep angle to the flow path. The piers project a large area with unequal flow pressures causing different flow profiles between individual piers.

The upstream channel approaches at an oblique angle (Photo A-301). The typical upstream channel cross section is a well-defined, engineered trapezoid composed of a sandy-clay substrate with alluvial deposits of gravel and cobble. Riprap extends 50 feet upstream from the upstream edge of the apron. The left bank levee toe is armored with riprap for several hundred feet more upstream (Photo A-302). The channel banks are lined with small brush and some grasses.

The upstream flow regime appears to be subcritical for a fair distance upstream, characteristic of a glide, but transitions to supercritical immediately upstream of the apron. The structure is the dominant controlling feature for the upstream pool.

The downstream channel makes a gradual sweeping right bend (Photo A-304). The typical downstream channel cross section is similar to that of the upstream except the substrate appears to be a little sandier. Riprap lines the channel bottom for 130 feet downstream of the apron. The left bank levee toe is likewise armored around the bend and downstream.

Potter Creek flows into Mormon Slough immediately downstream of the structure (Photo A-303). Potter Creek has riprap on the banks and bed upstream of the confluence with Mormon Slough. Closer to the confluence larger pieces of riprap armor the bed. Some riprap remains on the left bank as it curves around to become the Mormon Slough bank.

The downstream flow regime is subcritical, characteristic of a pool, immediately downstream of the structure and transitions to supercritical about 120 feet downstream (Photo A-305). The flow regime beyond that is not apparent.

This structure was modeled to evaluate depth and velocity at the bridge against fish passage criteria. The modeling results are in this report.

Photo A-298. View across downstream side of MSRRX

Photo A-299. MSRRX bridge piers and apron, typical

Photo A-300. Transverse view of MSRRX bridge piers and apron. Note Potter Creek in background

Photo A-301. MSRRX 'dry' upstream channel

Photo A-302. MSRRX 'wet' upstream channel

Photo A-303. Confluence of Mormon Slough and Potter Creek at MSRRX. Potter Creek on right side of photo, flowing parallel with MSRRX

Photo A-304. MSRRX 'dry' downstream channel

Photo A-305. MSRRX downstream channel

Duncan Road Bridge

Duncan Road Bridge is concrete and steel 175 feet long and 22 feet high from thalweg to the underside of the bridge (Photo A-306). It crosses Mormon Slough at two-tenths of a mile upstream of river mile 11. Two concrete piers stand 72 feet apart and are just above the active channel that is about 80 feet wide. The channel bottom is flat and silty and covered by fine gravel. The downstream channel is straight and the substrate continues to be fine gravel with no large rocks or debris. The upstream channel banks are steep and the channel itself has a natural looking meander with consolidated clay banks. Because the bridge has no apron or riprap scour protection and there is no visible water surface difference, it is not a barrier to fish migration. We will confirm this by modeling fish passage at the Fine Road Bridge.

Photo A-306. Looking upstream toward Duncan Road Bridge

Piazza Flashboard Dam

Piazza Flashboard Dam is on Mormon Slough at river mile 12.0. The structure supports flashboards during irrigation season. When they are removed, Mormon Slough becomes a flood-control channel.

The concrete base of Piazza Flashboard Dam base spans 53 feet across Mormon Slough between two 17-foot abutments (Photo A-307). The dam base is 11.5 feet wide and drops 6 inches to the downstream riprap. The riprap is 43 feet wide and extends 26 feet downstream. There is no notch in the dam base. Grass and weeds grow on the banks near the dam, but there is no riparian cover.

Upstream of the dam, there is an irrigation pump on the right bank (Photos A-308, A-309). There is riprap on the banks on the upstream side, and the channel is made up of silty-clay. There is riprap just downstream of the dam. Beyond that, rocks are scattered along the channel bed. Both upstream and downstream of the dam, the banks are steep, and weeds and brush line the banks above the scour line (Photo A-310). There is little riparian vegetation. The channel is straight with a well-defined rounded trapezoidal cross-section.

During irrigation season when flashboards are installed, the upstream wetted channel is 137 feet wide. The flashboards are 7 feet high and the water surface difference between the crest and the plunge pool is about 6 feet. Water flowing over the dam creates a plunge pool depth of a foot, which does not meet the 2-foot minimum plunge pool depth requirement for juvenile salmonids. The flashboards span 50.4 feet across Mormon Slough (Photo A-311). The concrete apron downstream of the flashboards is 8.7 feet long.

Photo A-307. Piazza Flashboard Dam base

Photo A-308. Upstream of Piazza Flashboard Dam

Photo A-309. Upstream of Piazza Flashboard Dam

Photo A-310. Downstream of Piazza Flashboard Dam

Photo A-311. Flashboards in place at Piazza Flashboard Dam

Milton Road Bridge

Milton Road Bridge is concrete and steel 207 feet long and 24 feet high from thalweg to the underside of the bridge. It crosses Mormon Slough at two-tenths of a mile below river mile 12. Two concrete piers stand 86 feet apart in the 94-foot-wide active channel. When flows recede, you can see scoured clay banks and an incised channel (Photo A-312). The channel near the bridge is straight with grassy banks. The right bank has a shallow slope and the left bank is steep. Two pump intakes are visible on the right bank upstream from the bridge. Because the bridge has no apron or riprap scour protection and there is no visible water surface difference, it is not a barrier to fish migration. We will confirm this by modeling fish passage at the Fine Road Bridge.

Photo A-312. Looking upstream toward Milton Road Bridge

Bonomo Flashboard Dam

Bonomo Flashboard Dam is on Mormon Slough at river mile 12.2. The dam provides support for flashboards during irrigation season. The flashboards usually are removed between October and March when Mormon Slough is a flood control channel.

Bonomo Flashboard Dam base spans 42 feet between concrete abutments and is 11 feet wide (Photo A-313). The concrete base has a 6-inch drop to the downstream riprap, which extends 53 feet downstream (Photo A-314). Three pump-intakes are visible upstream of the dam, two on the right bank and one on the left (Photos A-315, and A-316). Upstream, the banks are steep and heavily eroded. A walnut orchard grows close to the top of the bank crown upstream. The banks are bare or covered in weeds and grasses. There is little riparian vegetation. The middle of the channel is incised and closer to the toe; consolidated muddy benches slope into the channel.

Riprap litters the river channel immediately downstream of the dam base. Downstream of the riprap, there continues to be rocky debris on the right bank, but much of the channel has a bare substrate made up of silty-clay. Grass and weeds above the scour line cover the steep banks. There is little riparian vegetation. The downstream river channel has some meander and has a well-defined rounded trapezoidal cross-section.

During irrigation season with flashboards, the upstream wetted channel is 74 feet wide (Photo A-317). The flashboard dam is 42 feet wide. The water surface difference between the crest and plunge pool is about 5 feet and the plunge pool is 6 inches deep. The dam does not meet the minimum plunge pool depth of 2 feet for juvenile salmonids. We will use modeling results from Piazza Flashboard Dam to assess fish passage at Bonomo Flashboard Dam.

Photo A-313. Bonomo Flashboard Dam

Photo A-314. Downstream of Bonomo Flashboard Dam

Photo A-315. Upstream of Bonomo Flashboard Dam

Photo A-316. Upstream of Bonomo Flashboard Dam, left bank

Photo A-317. Flashboards in place at Bonomo Flashboard Dam

Concrete Slabs (Remnant Structure)

There are concrete slabs on the channel bottom on Mormon Slough near river mile 12.7. We suspect they are remnants of an old bridge (Photo A-318). We did not measure or survey the site. The pieces of concrete might be a barrier to fish migration and should be removed.

Photo A-318. Concrete slabs of remnant structure

Hosie Low-flow Road Crossing

The Hosie LFC (Photo A-319) is on Mormon Slough near river mile 13.2. The crossing is situated in the active channel slightly skewed to the flow path and is elevated 1.5 feet above the downstream channel bottom (Photo A-320). The structure is made of a rectangular reinforced concrete pad of unknown thickness, about 160 feet long and 13 feet wide. The concrete pad is in poor condition showing signs of scour and exposed reinforcement wire (Photo A-321).

The typical upstream channel is trapezoidal. The right upstream bank is composed of brush, weeds, and grassy vegetation on a gentle slope. The left bank is covered with riprap armoring upstream and downstream (Photo A-322). The channel bottom immediately upstream of the structure has aggraded to match grade with the structure. The upstream flow regime appears to be subcritical for a fair distance upstream, characteristic of a glide. The structure is the dominant controlling feature for the upstream pool.

The downstream channel is typically similar to the upstream except the brush is absent on the left bank (Photo A-323). The downstream face of the structure and the channel bottom 45 feet downstream are littered with rocky debris likely placed to inhibit degradation. A field visit on January 19, 2005, found riprap covering the entire 155-foot width of the downstream channel. The rocky debris consisted of large boulders and concrete chunks covered with a tough bamboo-like grass. The grass covered riprap formed three elongated islands parallel to the flow (Photo A-324). Pieces of concrete riprap lined the downstream left bank from toe to the top of the bank.

A tail water control was not found during the field survey on January 14, 2004. The downstream flow regime appears to be subcritical characteristic of a glide (Photo A-325). As the water spreads across the structure, the rocks and vegetation tend to create a braided channel under some conditions as the flow leaves the structure.

Some temporary solutions to improve fish passage conditions were done at this site in fall 2001. A series of shallow step pools leading to the structure from the downstream pool were built from small boulders and large cobble on-site and a sandbag dike was placed along the downstream sill of the structure (Photo A-326). The goal of this retrofit was to aid better fish passage by improving the migration path to the structure, consolidate the braided low-flow water to two concentrated flow paths, and increase the water depth on the road. The modifications from 2001 should be checked and any necessary maintenance or sandbag replacement made to continue providing temporary fish passage improvement.

Photo A-319. View of Hosie Low-flow Road Crossing from top of levee

Photo A-320. View across Hosie Low-flow Road Crossing

Photo A-321. Road deterioration and exposed wire mesh of Hosie Low-flow Road Crossing road surface

Photo A-322. View upstream across Hosie Low-flow Road Crossing. Sandbags installed to provide temporary fish passage improvement.

Photo A-323. Hosie Low-flow Road Crossing downstream channel. Sandbags installed to provide temporary fish passage improvement.

Photo A-324. Hosie Low-flow Road Crossing downstream channel

Photo A-325. Vegetation in active channel downstream of Hosie Low-flow Road Crossing

Photo A-326. Temporary site retrofit at Hosie Low-flow Road Crossing (2001)

Hosie Flashboard Dam

The Hosie Flashboard Dam is on Mormon Slough at river mile 13.4 (Photo A-327). The Hosie Flashboard Dam base spans 77 feet between abutments and is 11 feet wide. Riprap extends 77 feet across the channel and 49 feet downstream. There is no drop between the dam base and the downstream riprap. Upstream riprap scour protection is flush with the dam base. The dam base is in poor condition with the concrete eroding from the downstream side.

The typical upstream channel is trapezoidal (Photo A-328). The channel upstream has a slight meandering. The right upstream bank supports brush, weeds, and grassy vegetation on a gentle slope. Rock riprap covers the left bank armoring it upstream and downstream. Perennial grasses and water weeds are established in the channel. Willows are growing on depositional bars. The channel bed immediately upstream of the dam has aggraded to match the structure grade. The few riparian trees provide little shade to the slough. The dam is the dominant controlling feature for the upstream pool.

The downstream channel is similar to the upstream (Photo A-329). There is riprap downstream of the dam for 49 feet. There are no trees to shade the channel downstream of the structure.

With all the flashboards in place, the crest length is 78 feet. Upstream wetted width is 105 feet (Photo A-330). The crest to pool height is 4 feet and the plunge pool depth is 6 inches, which does not meet the minimum plunge pool depth of 2 feet for juvenile salmonids. We will use modeling results from Lavaggi Flashboard Dam to assess fish passage at Hosie Flashboard Dam.

Photo A-327. Hosie Flashboard Dam from right bank

Photo A-328. Looking upstream from Hosie Flashboard Dam

Photo A-329. Looking downstream of Hosie Flashboard Dam

Photo A-330. Hosie Flashboard Dam with all but two flashboards

Flood Road Bridge

Flood Road Bridge is concrete and steel 190 feet long (Photo A-331). It crosses Mormon Slough two-tenths of a mile upstream of river mile 14. Two concrete piers 77 feet apart support it. The piers stand at the edges of the active channel that is 70 feet wide. The channel near the bridge is straight with grassy banks. Because the bridge has no apron or riprap scour protection and there is no visible water surface difference, it is not a barrier to fish migration. We will confirm this by modeling fish passage at the Fine Road Bridge.

Photo A-331. Looking downstream toward Flood Road Bridge from the upstream left bank

Avansino Street Flashboard Dam

Avansino Street Flashboard Dam is on Mormon Slough, downstream of Bellota Weir, at river mile 14.4 (Photo A-332). The dam supports flashboards during irrigation season. The flashboards usually are removed between October and March when Mormon Slough is a flood control channel.

The Avansino Street Flashboard Dam base spans 61 feet between the concrete abutments and is 11 feet wide. There is no notch in the foundation. The base drops 6 inches to the downstream riprap. Riprap lines the entire width of the channel bottom for 33 feet downstream of the dam base. Riprap protection also lines the upstream (Photo A-333) face of the dam base and extends up the banks around the abutments. The lower banks along this stretch of the channel are scoured next to the low-flow channel and grass and shrubs cover them above the scour line (Photo A-334). The upper banks have little riparian cover.

The channel cross-section is trapezoidal, and there is no meander near the dam base. Beyond the riprap upstream and downstream of the dam base, the channel bottom is a bare, silty-clay. During high flows the dam base is under water (Photo A-335).

During the irrigation season, a 7.5-foot-high flashboard dam impounds water for irrigation deliveries through two pumps (Photo A-336). The flashboards span 61 feet across the channel between two 15-foot concrete abutments and create a 6.3-foot water surface difference. Water spilling over the dam crest falls into a 1.4-foot-deep plunge pool over a 7.7-foot-long concrete apron. The dam's minimum plunge pool depth of 2 feet for juvenile salmonids is not met. We will use modeling results from Lavaggi Flashboard Dam to assess fish passage at Avansino Flashboard Dam.

Photo A-332. Avansino Street Flashboard Dam base

Photo A-333. Upstream of Avansino Street Flashboard Dam

Photo A-334. Downstream of Avansino Street Flashboard Dam

Photo A-335. Avansino Street Flashboard Dam during high flows

Photo A-336. Flashboards in place at Avansino Street Flashboard Dam

Fine Road Bridge

Fine Road Bridge is a concrete and steel structure 206 feet long across Mormon Slough four-tenths of a mile upstream of river mile 15 (Photo A-337). The structure is supported by two concrete piers 65 feet apart. The piers stand at the edges of the active channel. Although the active channel measures 65 feet wide below the bridge, it narrows to 49 feet away from the bridge. The channel upstream and downstream of the bridge is straight. The banks are steep, and for the most part, covered with grass. The channel has a silty bottom.

Photo A-337. Fine Road Bridge

Fine Road Flashboard Dam

Fine Road Flashboard Dam is on Mormon Slough about river mile 16 (Photo A-338). It is a seasonal dam, with flashboards in during the irrigation season. The flashboards usually are removed between October and March when Mormon Slough is a flood control channel.

The Fine Road Flashboard Dam is perpendicular to the flow path. The base extends 81 feet across the channel and is 10 feet long. When boards are up, the upstream wetted channel is 97 feet. A riprap apron, flush with the base of the dam on both the upstream and downstream faces extends 35 feet downstream and across the channel and up the sides of the downstream abutments. There is a 5-foot section of riprap that has been lowered both upstream and down to direct flows through the center of the dam (Photo A-339). Mormon Slough here is wide and straight.

The upstream channel is trapezoidal. The left bank is steep, poorly vegetated and there is sporadic riprap (Photo A-342). The substrate is sandy and eroded. The right bank, although also steep upstream, has a gentler slope and covered with annual weedy grasses. There are no riparian trees but there are scattered bunches of reed grass (*Arundo donax*).

The downstream channel is terraced. The upper and lower terraces of the right bank are flat and covered by annual grasses. A few riparian trees are taking hold. The left downstream bank has a narrow, steep and poorly vegetated upper terrace and a wide, flat lower terrace. This lower terrace supports larger annual herbaceous weeds and a developing stand of riparian trees and shrubs (Photos A-340, A-343). The downstream channel banks and bed are sandy and deeply undercut.

Some weedy aquatic plants are growing on portions of the downstream riprap (Photo A-341). With the flashboards up, the upstream wetted channel is 97 feet wide. The dam span is 81 feet and the drop from the dam crest to the downstream pool is 6 feet. The bank full channel width is 215 feet. Winter weedy grasses grow on the upper right bank. The left bank has no vegetation and is most likely managed for pest control next to the orchards. We will use modeling results from Lavaggi Flashboard Dam to assess fish passage at Fine Road Flashboard Dam.

Photo A-338. Fine Road Flashboard Dam base from the right bank

Photo A-339. Fine Road Flashboard Dam looking upstream at the notch in the riprap apron

Photo A-340. Looking downstream of the Fine Road Flashboard Dam at the severe erosion in the low-flow channel and the terrace above it

Photo A-341. Looking upstream toward Fine Road Flashboard Dam with flashboards in showing development of riparian habitat

Photo A-342. Looking upstream from downstream of the Fine Road Flashboard Dam at bank full channel

Photo A-343. Upstream of Fine Road Flashboard Dam looking downstream

Highway 26 Flashboard Dam

Highway 26 Flashboard Dam is on Mormon Slough near river mile 17. The flashboards usually are removed between October and March when Mormon Slough is a flood control channel.

The Highway 26 Flashboard Dam base is 65 feet long between abutments and 11 feet wide. When the boards are in place the bank full channel width is 80 feet while the upstream wetted channel width is 72 feet. The drop from the dam crest to the downstream pool is just over 2 feet while the plunge pool depth is a tenth of an inch under a foot (Photo A-344).

The upstream channel is wide, trapezoidal and has two bends before reaching the dam (Photo A-345). The upstream banks are steep and vegetated with annual weedy species. There are a few trees near the first upstream bend (Photo A-345). When we took the photograph, however, they were too small to provide instream benefit. There is a lot of riprap on the left bank upstream and next to the abutment.

The channel downstream of the flashboard dam is straighter than the upstream channel and there are annual weeds and grasses (Photo A-346). Another similarity is the woody vegetation established and growing where the channel bends. The vegetation is hanging over the toe and providing some instream benefits.

The drop from the dam base to the riprap apron in the channel is 10 inches. The in-channel riprap spans the width of the channel for 80 feet and down the channel for 19 feet. The upstream riprap apron is 65 feet wide. We will use modeling results from Piazza Flashboard Dam to assess fish passage at Highway 26 Flashboard Dam.

Photo A-344. Highway 26 Flashboard Dam taken from the downstream left bank

Photo A-345. Hwy 26 Flashboard Dam as seen from downstream

Photo A-346. Highway 26 Flashboard Dam looking downstream

Watkins Low-flow Road Crossing

Watkins Low-flow Road Crossing was one of the eight structures modeled in 2004. The Watkins LFC (Photos A-347 and A-348) is on Mormon Slough near river mile 19. The crossing is situated in the active channel slightly skewed to the flow path. The drop from the structure crest to the channel bed has ranged from 1 foot to 2.2 feet from 2003 to 2005. The structure is made of a rectangular reinforced concrete pad of unknown thickness, about 142 feet long and 13 feet wide. A culvert of unknown dimensions exists under the road (Photo A-349).

The culvert has not been maintained. We suspect it has been abandoned. The upstream end is buried, and the downstream end is almost buried and severely deteriorated (Photo A-350). Channel debris plugged the culvert, and no daylight can be seen through it. Some water does appear to flow through the culvert which is likely the result of percolation through the porous material plugging the barrel. The jagged edges of the culvert outlet have since been removed.

The typical upstream channel is trapezoidal composed of brush-lined banks with grass and weed-covered levees and patches of rock riprap armoring (Photo A-351). The bankfull channel width is about 200 feet. The riprap on the upstream side of the structure is 192 feet wide and 9 feet long. The channel bottom immediately upstream of the structure has aggraded to match grade with the structure. The upstream flow regime appears to be subcritical for a fair distance upstream, characteristic of a glide. The structure is the dominant controlling feature for the upstream pool.

The downstream channel is dimensionally similar to the upstream with higher density of rock riprap armoring along the toe of the right channel bank (Photo A-352). The water crosses the structure and is directed toward the right bank where flows are faster and deeper. This indicates the structure has a slight slope to the right side of the channel. Riprap extends 192 feet across the channel and 25 feet downstream. The downstream flow regime appears to be subcritical characteristic of a glide.

Some temporary solutions to improve fish passage were done at this site in fall of 2001. The rock pile along the downstream face of the structure (Photo A-353) was rearranged to provide a concentrated low-flow path over a rock cascade that loosely mimics a series of step pools (Photo A-355). A sandbag dike was also placed along the downstream sill of the structure (Photo A-354). The goal was better fish passage by improving the migration path to the structure, consolidate the widespread low-flow water to a single concentrated flow path, and increase the water depth on the road. The modifications from 2001 should be checked and any necessary maintenance or sandbag replacement made to continue providing temporary fish passage improvement.

Photo A-347. Watkins LFC, overview

Photo A-348. View across Watkins LFC

Photo A-349. View upstream to Watkins LFC

Photo A-350. Deteriorated, abandoned culvert at Watkins LFC

Photo A-351. Channel upstream of Watkins LFC

Photo A-352. Channel downstream of Watkins LFC

Photo A-353. Watkins LFC 'dry' downstream channel

Photo A-354. Watkins LFC 'wet' downstream channel

Photo A-355. Rock cascade approaching Watkins LFC

Escalon Bellota Bridge

Escalon Bellota Road Bridge is a 222-foot-long concrete structure that crosses Mormon Slough about a quarter mile downstream from Bellota Weir at river mile 18 (Photo A-356). Eight rows of piers with five columns each support the bridge. Each set of piers is 26 feet apart. Weeds and brush cover the steep slopes. Vegetation also grows on the bars within the channel. The channel has a meander both upstream and downstream of the bridge. Several of the point bars support large, dense stands of *Arundo*. Because the bridge has no apron or riprap scour protection and there is no visible water surface difference, it is not a barrier to fish migration. We will confirm this by modeling fish passage at the Fine Road Bridge.

Photo A-356. Escalon Bellota Bridge

Bellota Weir

Bellota Weir is on the Calaveras River near river mile 25 (Photo A-357). We included information on Bellota Weir to provide a complete inventory of structures. However, CH2MHill is developing permanent passage solutions at Bellota Weir that are presented in *Calaveras River Anadromous Fish Protection Project* (CH2MHill 2005). The report provides a passage analysis of the weir. The weir, in combination with the Calaveras Headworks, splits flow between Mormon Slough and the Calaveras River. The weir also controls the water-surface elevation for the Stockton East Water District water diversion intake. The weir is at the upstream end of Mormon Slough, perpendicular to the channel. It has a concrete crest, removable steel channel guides to support flashboards, and a concrete apron.

The weir spans the entire channel width, 150 feet, and the 20-foot-long notch rises about 6 feet above the bottom of the upstream pool. On each side of the weir are five steps to the weir crest elevation. The bottom of the notch is about 6 feet above the thalweg of the upstream pool. Each step on the right side that make up the notch is about 20 feet wide. The bottom of the notch is 74 feet wide and the steps on the left side, facing downstream, are about 10 feet wide. The steps and notch are about 8 feet long and the steps are 1.5 feet tall. Removable steel supports and 5 foot long timber flashboards are in place to an elevation of up to10 feet above the weir crest during the irrigation season. The concrete apron lines the channel and up the banks on both sides of the weir, and extends 75 feet downstream. The concrete weir is in good condition with no structural defects. There are two pools below the flashboards. The drop to the pool just downstream of the flashboards is 13 feet. The drop from that pool to the next pool is 3 feet, which just meets the 2-foot minimum plunge pool depth for juvenile salmonids. The farthest downstream pool has a plunge pool depth of 20 feet, which is more than enough for juvenile passage.

Bellota Weir diverts water from the upper Calaveras River into Mormon Slough. The split from the Calaveras River occurs about 350 feet upstream of Bellota Weir. The upstream channel from Bellota Weir to the split is well defined and has a trapezoidal cross section with an irregular bottom (Photos A-359, A-360). The channel is flat and clean, with some grass and brush on the middle banks. There are trees on the upper banks. When we visited, the lower banks and channel bottom near the weir were under water, so we do not know the condition and substrate. About 50 feet upstream of the weir on left side of the river is the SEWD water diversion. Between the weir and the diversion, riprap slope protection covers the channel banks. The upstream flow regime is subcritical for a fair distance upstream, characteristic of a small reservoir. The weir is the dominant controlling feature for the upstream pool.

Downstream of the concrete apron, the channel bottom drops into a wide scour pool (Photos A-358, A-362). The lower banks of the channel are weedy and lined with concrete rubble for about 100 feet downstream. About 200 feet downstream of the concrete apron the pool becomes shallower and narrower, finally forming a distinct channel along right side of the river. The downstream flow regime is subcritical for the scour pool reach, and then becomes critical at the pool tailwater control.

Approaching the weir from downstream, there is a plunge pool about 75 feet from the weir crest at the end of the concrete apron. The pool is about 6 feet deep under minimal flow conditions. The apron slopes for the first 50 feet downstream, then is flat for the remaining 25 feet. At the end of the apron water drops about 9 feet to the bottom of the plunge pool. The elevation difference between the apron sill and the tailwater control is about 4 feet. The concrete apron has an average grade of 8 percent and forms an area of shallow, fast moving water.

Fish Ladder Optimal and Actual Operating Conditions

Two Denil fish ladders are used at Bellota Weir (Photos A-361). An upper ladder, provided by DFG, was first installed in fall of 1999. In the fall of 2001, the Fishery Foundation lent a second lower Denil ladder. This section describes the application of the ladders according to Bell (1991) and today's application.

According to Bell (1991), a Denil fishway must be engineered for width and depth to provide the low velocity needed in its design. It must be kept free of debris so flow characteristics of the baffles are not altered. The usual slope in a Denil fishway is one to six, and the maximum length of a section of ladder is 30 feet. Resting pools between sections of ladder are required. In addition, according to George Heise, DFG hydraulic engineer, the bottom end of a Denil ladder should be submerged so fish are not forced to jump up to get inside the ladder. Denil ladders work best under a narrow range of flows compared with other types of ladders. Desirable water depth in a Denil ladder is one foot.

Denil Application at Bellota Weir

George Heise, DFG, and Trevor Kennedy, Fishery Foundation, noted the following conditions at the Denil ladders at Bellota Weir. The upper ladder is longer than 30 feet, although its slope is within the 1 to 6 ratio. The lower ladder that extends from the downstream pool to the top of the weir apron is less than 30 feet long (Photos A-363, A-364). However, it is set at a slope of one to three, steeper than the recommended slope. In addition, water from the weir apron was not flowing down the ladder, but around the sides of the ladder. Thus, water delivery into the lower ladder is not adequate, resulting in just a couple of inches of water in the ladder itself. In addition, flow of water cascading from the weir apron along the side of the ladder may confuse fish looking for the lower ladder entrance. George Heise recommended a new temporary ladder configuration at Bellota Weir that would work in the range of 30 to 40 cubic feet per second down to 3 to 5 cubic feet per second. In addition, he recommended equalizing the length of the two ladders to two 30-foot sections with a turning pool in between on the weir apron. In December 2002, The Fishery Foundation said the lower ladder did not work at 25 to 30 cubic feet per second because water depth at the inlet was too shallow. Without flashboards on the 15-foot section of the weir north of the ladder, only 1 to 3 cubic feet per second was flowing through the ladder and the rest of the flow poured over the weir apron to the north creating false attraction flows (T. Kennedy e-mail 25 December 2002).

In January 2005, Domenichelli and Associates produced a Bellota Weir Fish Ladder Evaluation Report that gave background, evaluation criteria, hydraulic analysis, conclusions, and recommendations to improve ladder operations. We contacted George Heise. He said he agrees with the report's findings and recommendations.

A solution for fish passage improvements are detailed in CH2MHill's April 2005 report and preliminary design drawings. Darryl Hayes with CH2MHill is the project engineer to contact for copies of this preliminary design package.

Photo A-357. Bellota Weir with flashboards installed looking toward right bank

Photo A-358. Downstream of apron and weir

Photo A-359. SEWD diversion immediately upstream of Bellota Weir

Photo A-360. Upstream channel, looking upstream

Photo A-361. Upstream toward Bellota Weir at the left channel bank (fish ladders installed)

Photo A-362. Downstream channel, looking downstream

Photo A-363. Bellota Weir with fish ladders in place and temporary sandbag dike

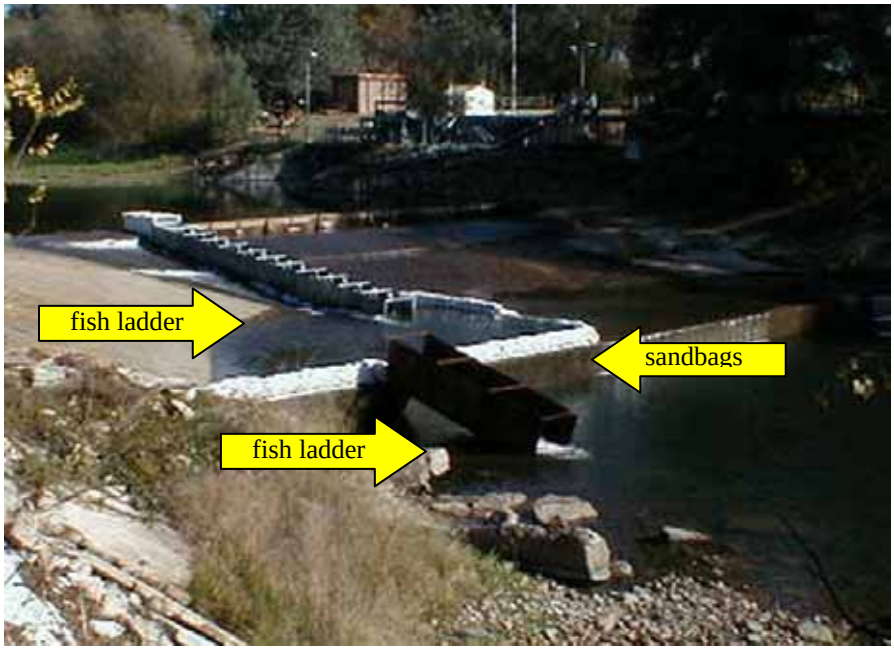

Photo A-364. Fish ladders with temporary weirs to increase depth over apron