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STATE OF CALIFORNIA
CALIFORNIA NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF SAFETY OF DAMS

INSPECTION OF DAM AND RESERVOIR IN CERTIFIED STATUS

Name of Dam: Oroville | Dam No. 1-48 | County: Butte
Type of Dam: earthfill | Type of Spillway: Gated concrete weir and ungated conc. weir
Water is 122.2 feet below spillway crest and 143.2 feet below dam crest.
WS 778.8 ft
Weather Conditions: Sunny and warm
Contacts Made: Primary contacts – Paul Dunlap, Ryan Cooper, Vanesa Morones O&M HQ; Joe Eades, Scott Turnquist OFD
Reason for Inspection: Semi-annual inspection

Important Observations, Recommendations or Actions Taken

- A plan for long-term phreatic surface monitoring within the downstream shell remains outstanding. O&M is working with DSOD on a course of action.
- Adequate and reliable reservoir drawdown capacity is important for dam safety. O&M continues to study this issue in coordination with DSOD.
- The long standing seepage area at mid-slope on the left side of the dam has dried up due to the prolonged drought.
- Wave erosion along the upper slope appears to be disturbing the rock and causing it to move down slope in some areas. Visual monitoring should continue.
- The crest road paving project remains on hold.
- The original low level outlet valves and new baffle ring have been tested satisfactorily to 4000 cfs combined flow. No significant issues were noted during a follow up inspection.
- Manufacturing defects have delayed installation of replacement discharge valves.
- Two new drill holes were recently completed at Oroville Dam; one to measure V_{s30} on the upper left abutment, and one to measure V_{s30} just downstream from the emergency spillway weir, as shown on photographs 26 and 27.

Conclusions

Based upon my inspection and information review, the dam, reservoir, and appurtenant facilities are safe for interim operation pending completion of outstanding DSOD and FERC Part12/DSRB recommendations, implementation of a phreatic surface monitoring program, and the installation and testing of new low level outlet valves.

Observations and Comments

Dam	The crest road asphalt repairs have been delayed due to higher priority work. However, the roadway is satisfactory for use in the interim. The shoulder repairs remain in satisfactory condition, as well. The embankment, groins and abutments were viewed from the dam crest, the House T access bench, and the gallery access parking areas. See photographs 1 through 4. No evidence of embankment instability or other signs of excessive stress were observed. Vegetation and rodent control remain satisfactory. The rock along the upstream slope remains sound, except in a few areas where breakdown is occurring. No action is needed at this time. The surficial rock displacement along portions of the upstream slope appears to be related to wave wash. These areas should be monitored for excessive movement. The long standing damp area at mid-level on the left side of the dam has dried out due to the extended drought, photograph 3.

Photos taken? Yes x No
cc for Owner/Book

Inspected by WPennington, Eric Holland, Austin Roundtree
Date of Inspection 8/22/16
Date of Report 9/27/16

Name of Dam Oroville Dam No. 1-48

Date of Inspection 8/22/16

Observations and Comments

The inspection team walked the right and left foundation galleries, the bypass tunnel, the S-block access, and the Emergency Exit Tunnel. We exited by way of the power house. No new concrete cracks, or any other unusual conditions were observed within the galleries. Mineral buildup at existing cracks and joints continues. An extreme example of buildup is at joint 12-13 in the bypass gallery, photograph 5. Conditions at the abandoned S-Block instrument terminal were normal. Conditions in the emergency exit tunnel appeared to be unchanged, except for ongoing repairs to the drainage collection system.

Saddle dams

Parish Camp Saddle Dam: The reservoir level was well below the embankment. The graveled crest was clear and in good condition. The slopes appeared to be stable, and the rock remains in good condition, photographs 6 and 7. The rock placed along the downstream groins to control erosion is working well. Rodent and vegetation control were good.

Bidwell Canyon Saddle Dam: The reservoir level was well below the embankment. The graveled crest was clear and in good condition. The slopes of both embankments appeared to be stable, and the rock remains in good condition, photographs 8 through 11. The horse trails along the slope of the west embankment have been backfilled. Rodent control was good. Vegetation control along the downstream slope of the south embankment is improving, and was sufficient to evaluate the slope.

Spillway

The approach channel was fully exposed and clear, and the security barrier was beached. The concrete approach walls remain stable appearing and in good condition. The Flood Control Outlet (FCO) structure appeared to be in satisfactory condition.

The spillway bridge appeared to be stable and in satisfactory condition, as well, photographs 12 and13. No new spalling was observed along the bridge bents, photograph 14, for example. The long standing diagonal crack on the left pier for gate 8 appears to have extended to the concrete chamfer below the old telltale paint mark, as evidenced by the length of the recently applied red telltale paint, photograph 14. An extension beyond the chamfer would warrant an investigation into the cause.

The FCO discharge chute was inspected from the top of the outlet structure, the trunnion deck, and the road across the river channel. Conditions appeared to be normal. The chute walls were well aligned and appeared to be stable, photographs 15 and 16. The long standing construction joint offsets at the upstream end of both chute walls remain stable, photograph 17. The energy dissipation blocks at the flip bucket appeared to be in satisfactory condition, as viewed from across the river. None of the drains along the chute were flowing.

Conditions along the emergency spillway weir were unchanged from recent inspections. The structure was stable appearing, and the concrete remains sound, photograph 18.

The gate hoist equipment appeared to be well maintained, photograph 19. The radial gates were inspected from the hoist deck and the trunnion deck. The visible components of the radial gates and trunnion systems appeared to be in satisfactory condition, photograph 20, for example. The usual detritus and bird droppings were observed along the gate members. Regular removal of debris is performed to keep these areas free of corrosion.

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Date of Inspection 8/22/16

Observations and Comments

The radial gate anchor tendons are about 50-years old and may be reaching the end of their useful life. Tendon testing was recently completed using dispersive wave techniques. Follow up research and results are expected in the next 12 months.

While on the upper deck of the Flood Control Outlet, Paul Dunlap pointed out a crack at the top of the center pier, photographs 21 and 22. This feature is adjacent to the transverse construction joint that separates the two halves of the Flood Control Outlet. The speculation is that the crack resulted from the 1975 Oroville Earthquake. Possible related concrete damage was found on the hoist deck floor, where the construction joint crosses a walk through opening at the back of the center pier, photograph 23. Broken concrete adjacent to the construction joint is also visible from the trunnion deck when looking up at the landing for the hoist deck above, photograph 24. Another indication of movement is discernable as a slight vertical bow on the top of the hoist deck hand rail above the construction joint. None of the observed concrete damage poses a dam safety concern, and may not be linked to a single event. This information is being provided for the record.

A number of Category 2 recommendations were made as a follow up to recent radial gate inspection by the HDR. Inc. Resolution of the recommendations with DSOD review is ongoing.

A seismic analysis by the Division of Engineering indicates that some of the gate members are overstressed under certain loading conditions. DSOD is reviewing the analysis and discussing the issue with O&M.

Outlet

The new low level outlet baffle ring has been installed and tested using the original valves. The combined release was 4000 cfs. Testing delays were caused by electro-mechanical issues. Manufacturing defects have delayed installation of replacement valves. The schedule to install the new valves is uncertain.

Adequate and reliable reservoir drawdown capacity is important for dam safety. O&M continues to study this issue in coordination with DSOD.

Seepage

Oroville Dam: Flow at the toe weir was normal for the summer months, about 10 gpm. The seepage flow in the galleries remains within historical trends for this time of year. Measurement weirs located along the galleries can be used to the check the flow over a specific reach. Seepage within the emergency exit tunnel appeared to be normal. Repairs to the collection system in the exit tunnel are in progress, as requested.

The traditional wet area at mid-slope on the left end of the dam was dry due to the drought conditions.

Bidwell Canyon Saddle Dam: The usual reverse foundation seepage from Miners Ranch Reservoir appeared to be normal.

Parish Camp Saddle Dam: None.

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Observations and Comments

Instr.

The latest monitoring data on file is the December 2015 DSSMR, which covers the period from 10/1/14 through 9/30/15.

Oroville Dam embankment: The three active piezometers, P-37(upstream transition), P-38(core), and P-9(core) are read at House T. The usefulness of the data for monitoring the health of the dam is limited.

The plotted AB Joint pressure readings in the core block have not been changing much in recent years, although they varied by 5 to 10 psi in years past. Field staff made an attempt to clean the pipes, with little success. The need for reading these instruments should be evaluated, and if needed, they should be restored.

The crack meters and extensometers in the core block are reading within historical limits.

An incomplete FERC Part 12/DSRB recommendation states that "....a plan for long-term monitoring of the phreatic surface within the dam embankment needs to be developed and implemented." O&M is working with DSOD to develop a course of action.

Survey monuments are located on the upstream and downstream slopes and along the crest of the dam. Crest settlement remains minimal. The maximum movement being about 9-inches at station 53+00 since 1969. Settlement and displacement along the upstream and downstream slopes remains normal and appears to be stabilizing.

A typical, clearly marked crest survey monument is shown in photograph 25. The monuments along the benches are equally well marked.

Bidwell Canyon Saddle Dam: Settlements and deflections remain small and normal.

Parish Camp Saddle Dam: Settlements and deflections remain small and normal.

The monitoring program for Oroville Dam and the saddle dams is satisfactory on an interim basis, pending development of a system to monitor the downstream phreatic surface at Oroville Dam.

Other

Two exploratory drill holes were recently completed; one is located on the upper left abutment, photograph 26, and the other is located just downstream of the emergency spillway weir, photograph 27. These holes were completed to obtain V_{s30} data for seismic stability analysis. The holes have been completed with piezometers.

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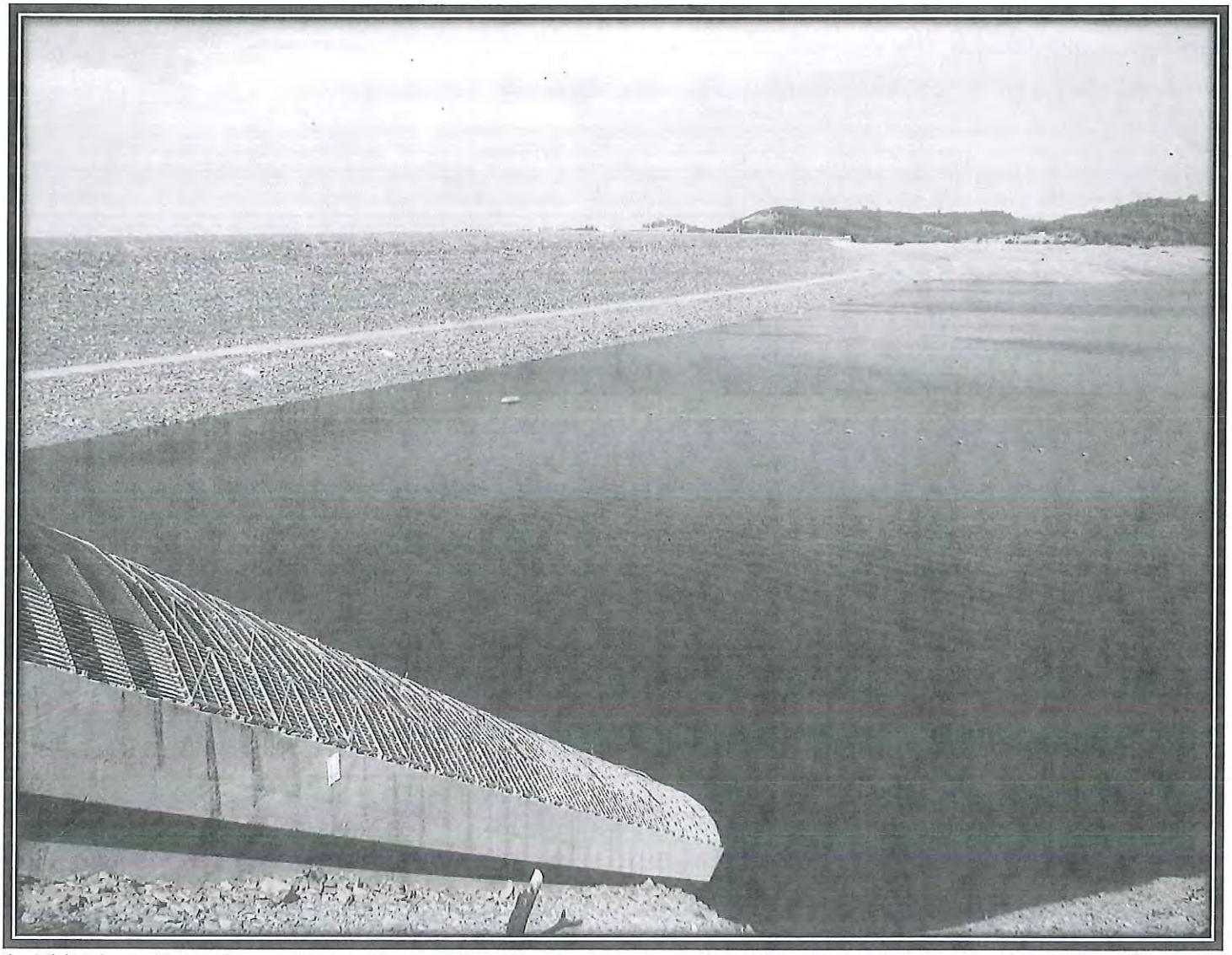
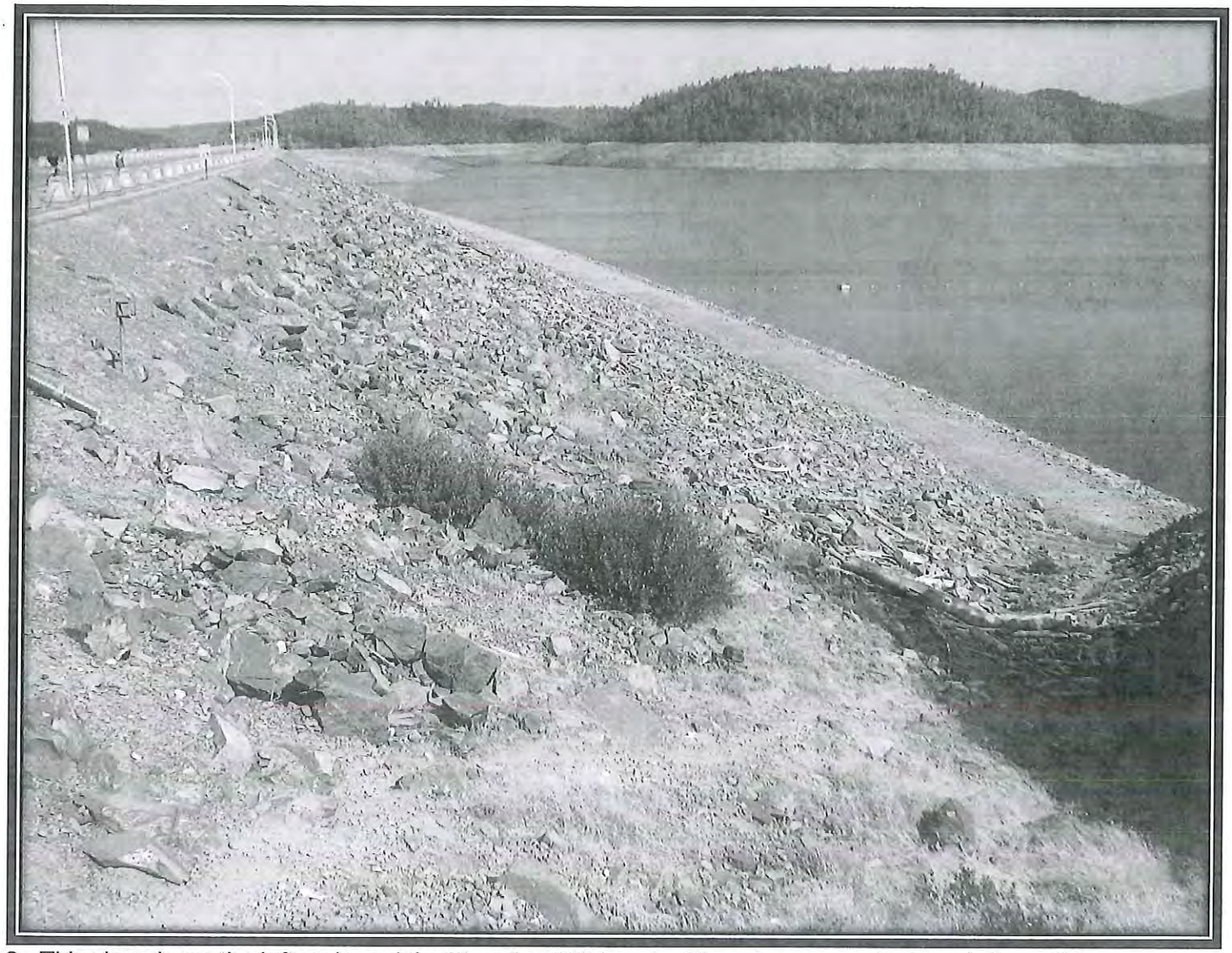


1. This view shows the upstream slope of Oroville Dam, as seen from the sloping intake structure. Conditions appeared to be satisfactory.



2. This view shows the left groin and the Elevation 815 bench. The minor amount of vegetation will be removed during routine maintenance. Conditions appeared to be normal.

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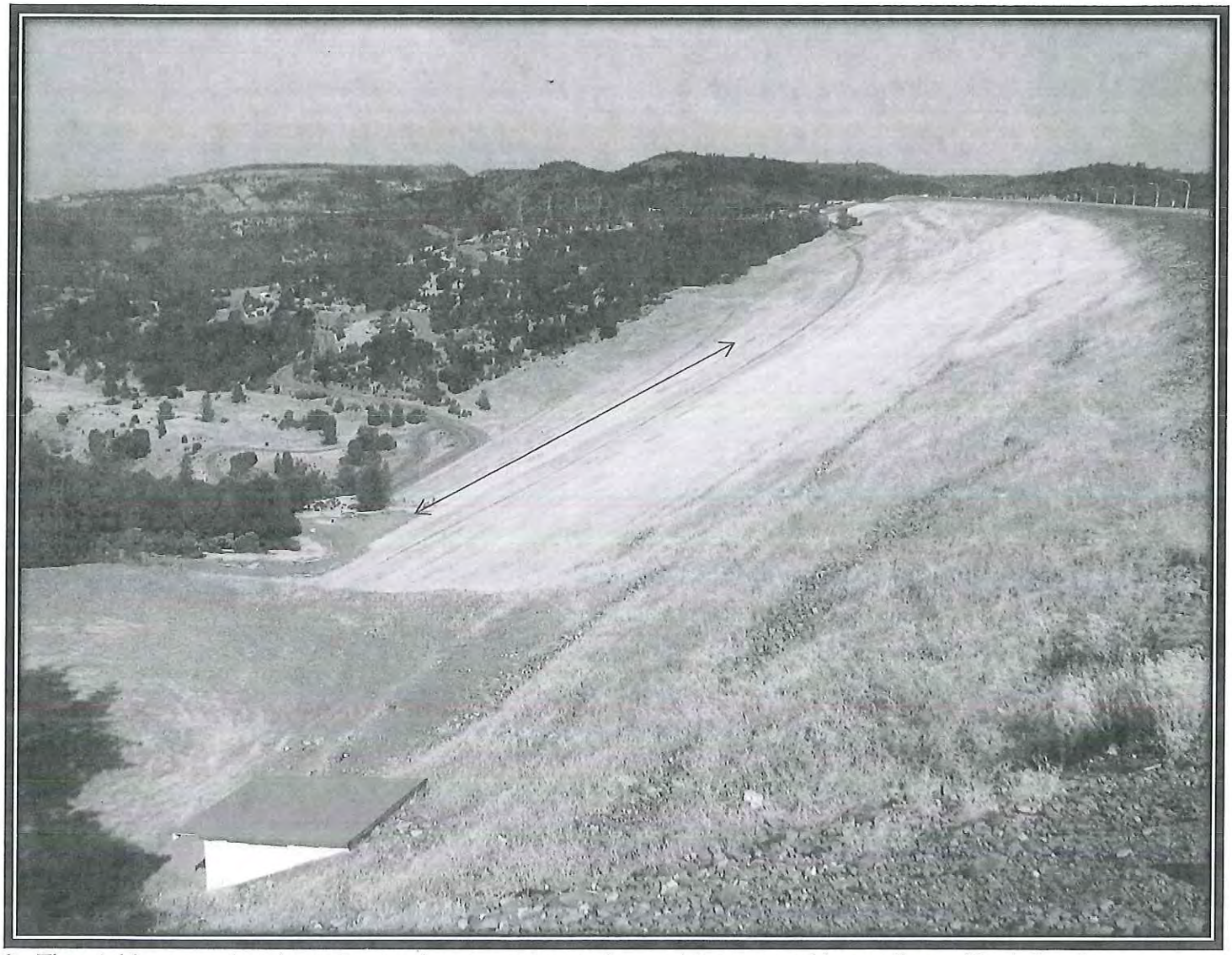
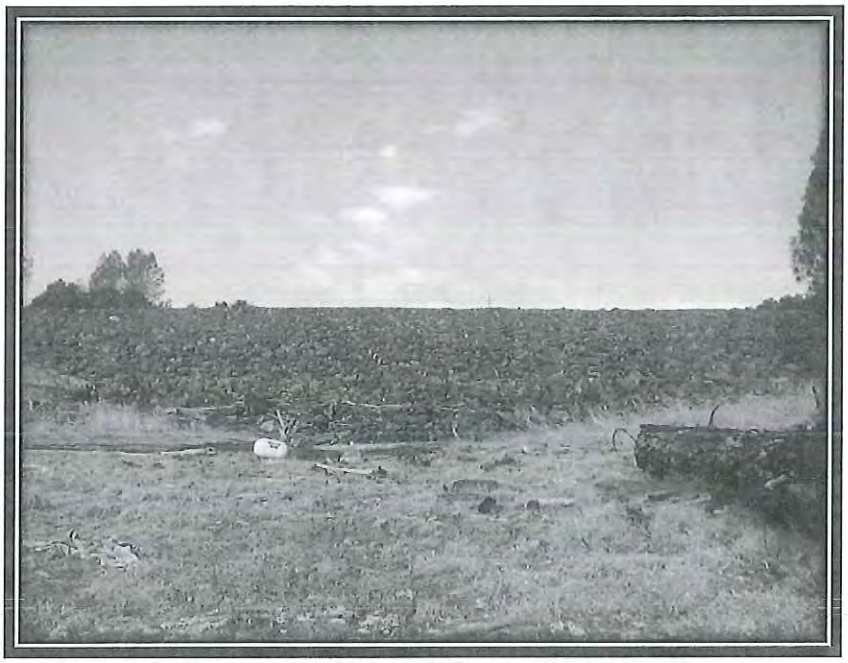


3. The stable appearing downstream slope remains unchanged from recent inspections. The left gallery access is at left. The traditional seepage area along the left side of the dam was dried out due to the extended period of drought, double arrow.

4. This view from the right groin shows a typical survey monument path and conditions along the right groin. The nature of the dirty cobble fill in the outer shell is evident.

5. An extreme example of the mineral buildup and seepage at joint 12-13 in the bypass gallery. Conditions appeared to be similar to recent inspections.



6. The upstream slope of Parish Camp Saddle Dam remains in good condition, as seen in this view looking downstream.

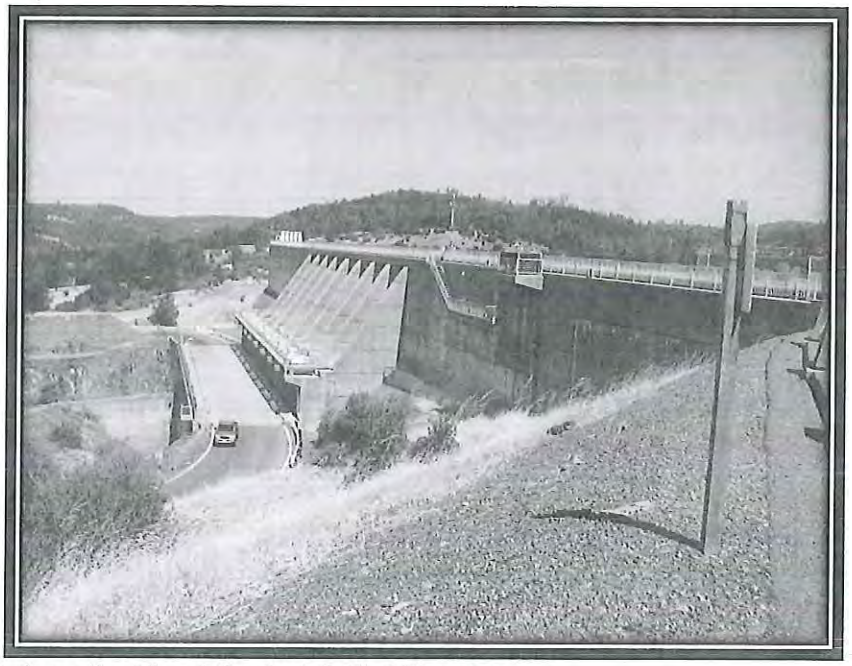
7. The well protected downstream slope of Parish Camp Saddle Dam is shown. Conditions along the crest road were good.

8. The crest road and downstream slope of the west embankment at Bidwell Canyon Saddle Dam remain in good condition.

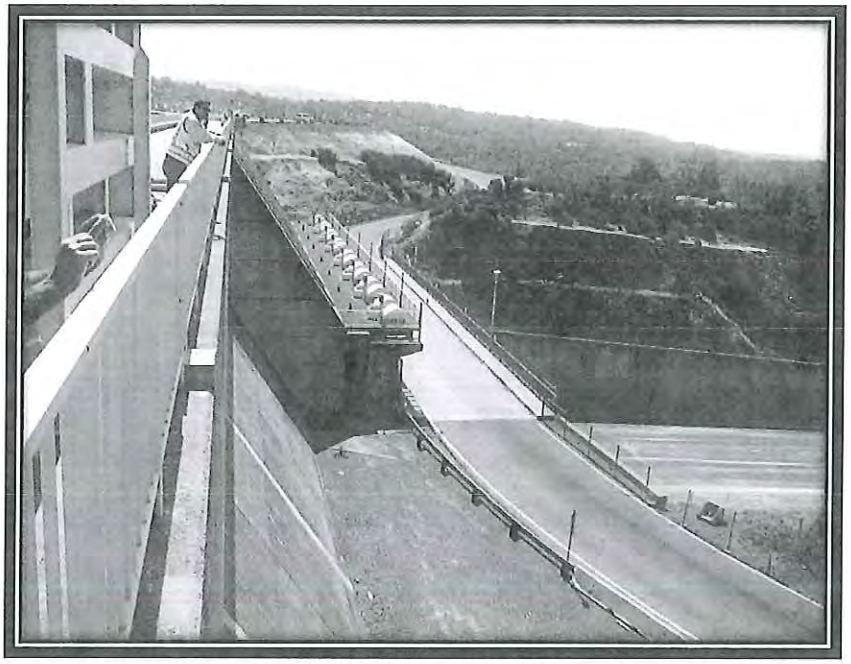
9. View looking north along the upstream side of the west embankment at Bidwell Canyon Saddle Dam.

10. View looking towards the left abutment along the south embankment of Bidwell Canyon Saddle Dam.

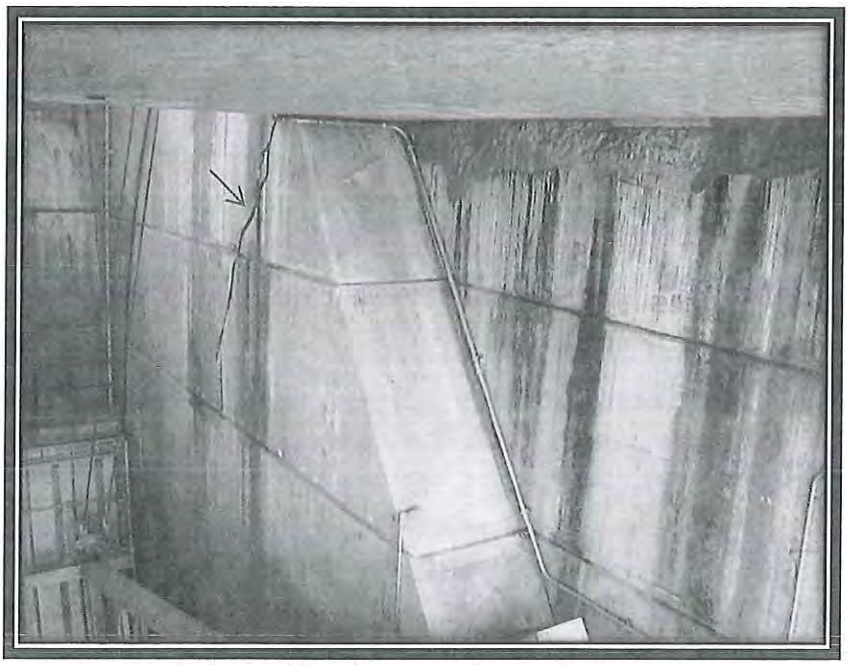
11. View looking towards the right abutment along the south embankment of Bidwell Bar Saddle Dam.



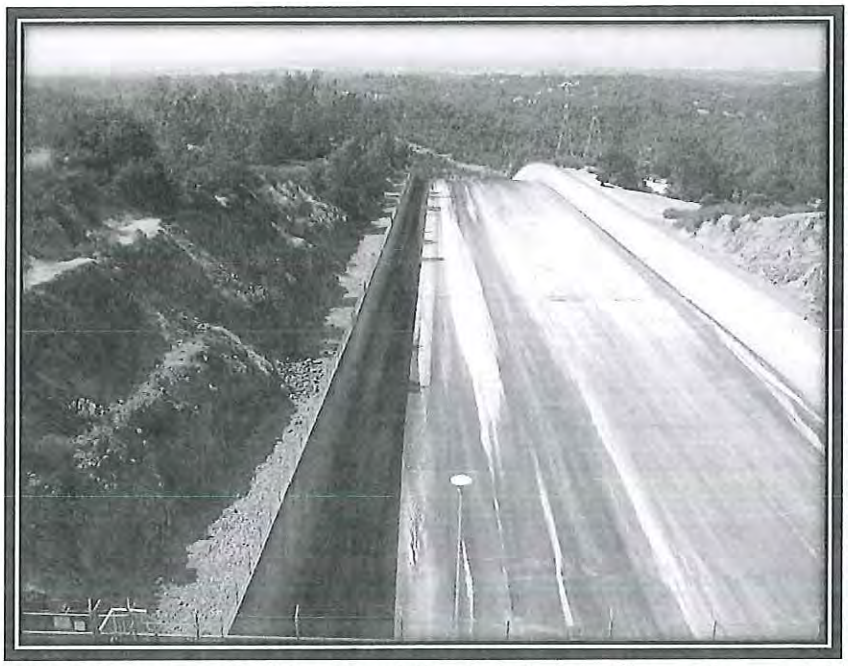
12. View looking right along the Flood Control Outlet Structure.



13. View looking left along the Flood Control Outlet Structure. The spillway is at right.

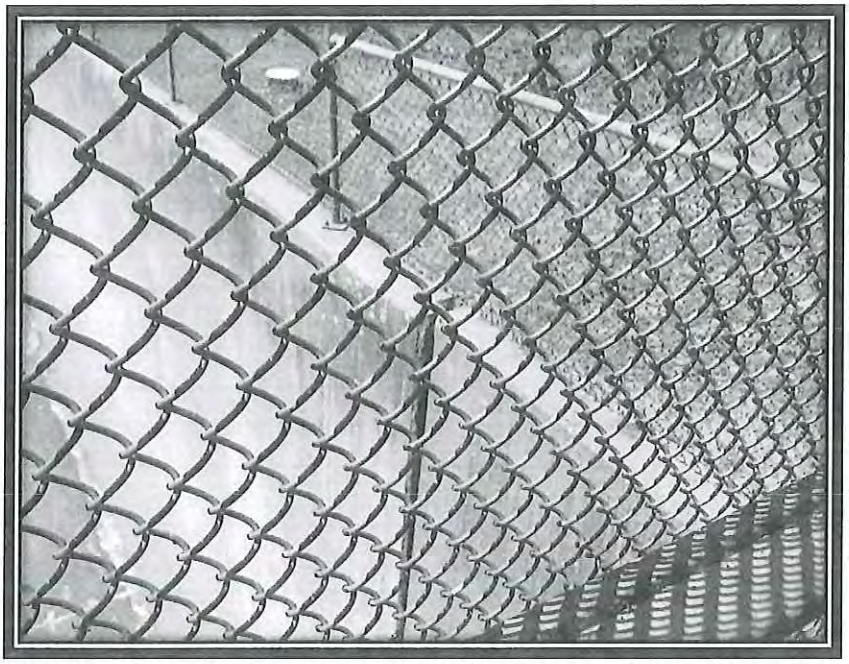


14. This view is looking upstream within the Flood Control Outlet Structure. Gate 8 is at left. Spalling at the left bridge bent remains dormant, as evidenced by the unbroken paint at the far right. The same is true of the opposite abutment. The marked crack, arrow, has extended downward to the lift line over a long period of time. It will likely stop at this location. If not, the conditions should be evaluated.

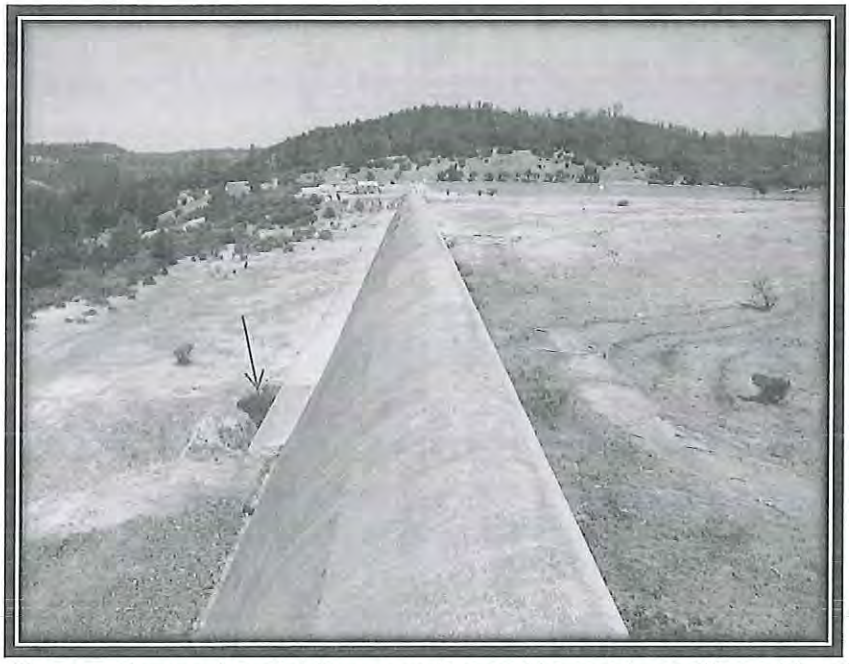


15. View looking along the left chute wall of the Flood Control Outlet. The wall was stable appearing and well aligned. Vegetation has been removed from behind the wall.

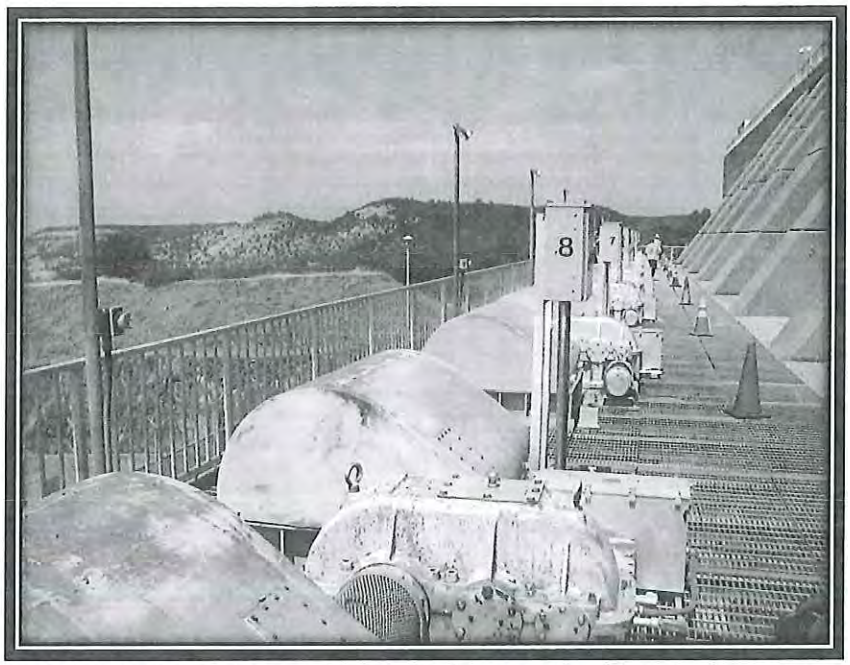
16. View looking along the right chute wall of the Flood Control Outlet. The wall was stable appearing and well aligned. Long standing, stable, joint offsets occur at the upstream end of both walls, at the construction joint between the chute wall and the outlet structure, photograph 17, for example.



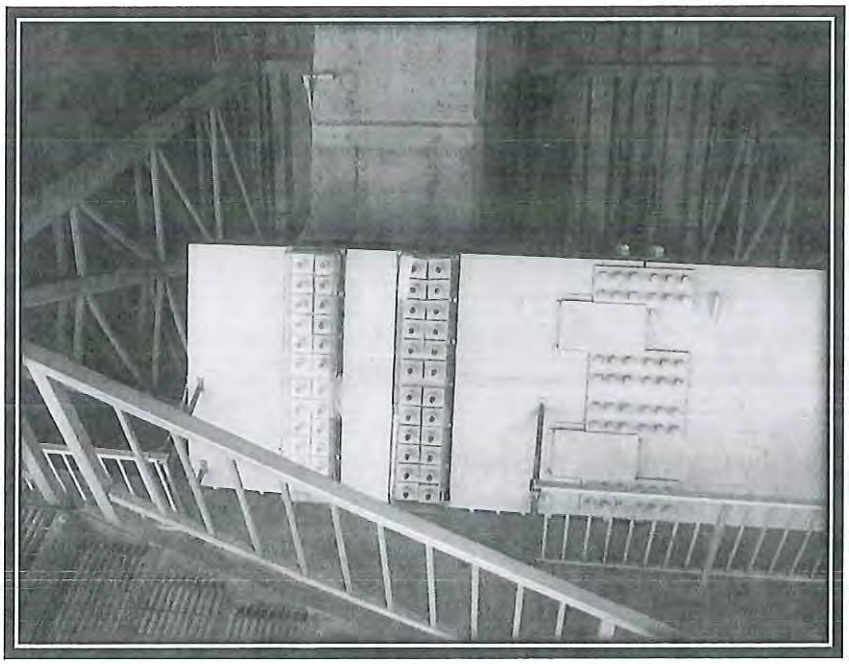
17. A stable, inward joint offset remains unchanged at the first construction joint past the Flood Control Outlet on both sides of the discharge chute. The initiation of this long standing feature is unknown.



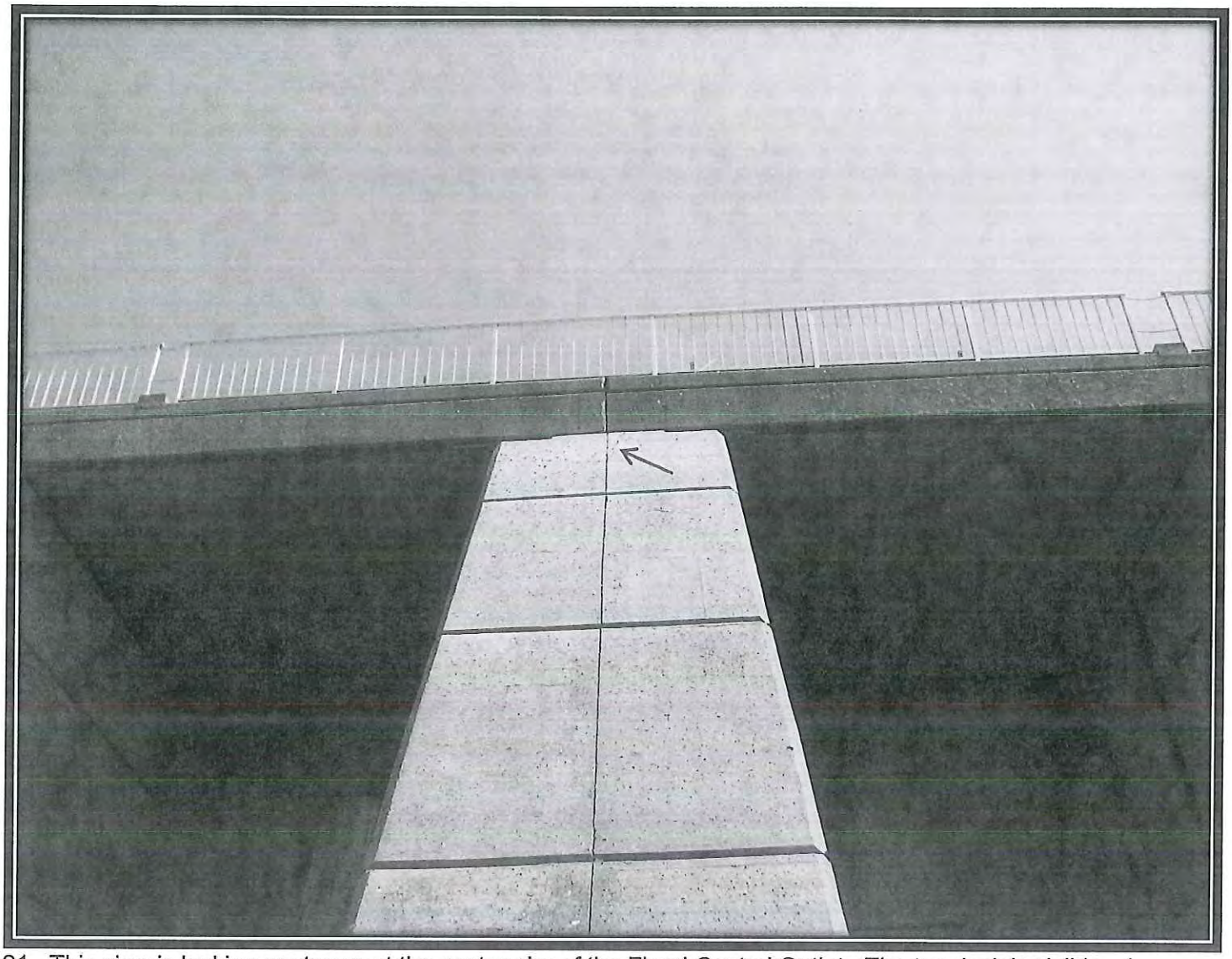
18. The emergency spillway weir remains stable appearing and in good condition. The fig tree at the arrow will be removed.



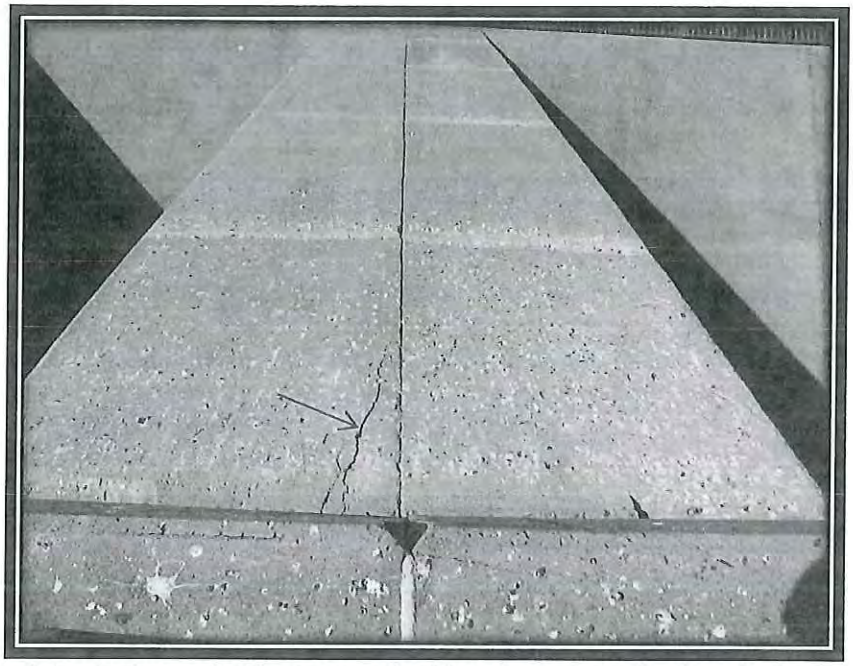
19. This view of the Flood Control Outlet hoist deck is looking north. The equipment appeared to be in satisfactory condition. A 12-inch travel test of the radial gates will be performed during the first week of October 2016.



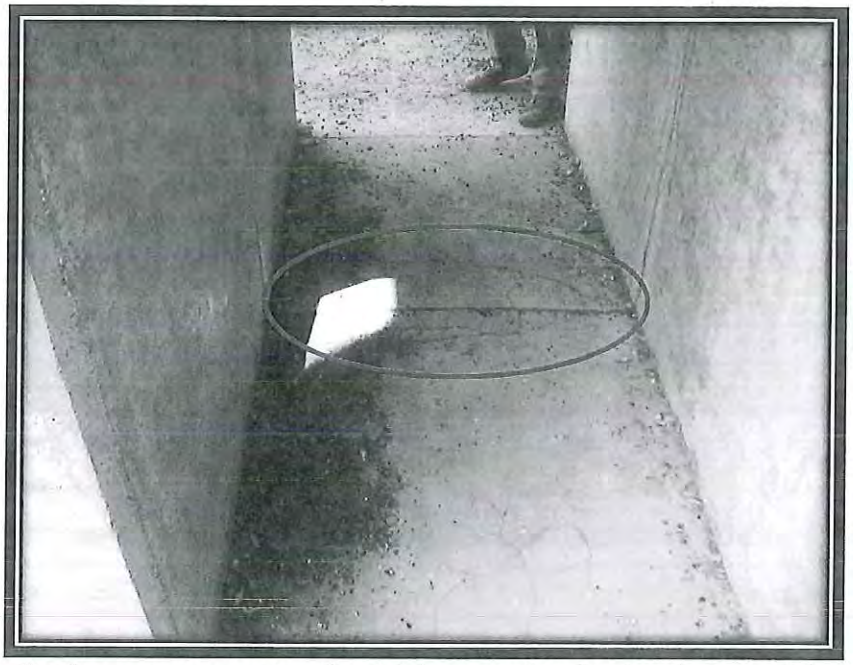
20. Gate 7, left, and Gate 8, right, at the Flood Control Outlet. The dark areas on the radial arms are bird droppings and other detritus that are removed from time to time. The exposed anchor tendons are protected by plastic covers. The ends of the tendons are greased and covered by a plastic cap.



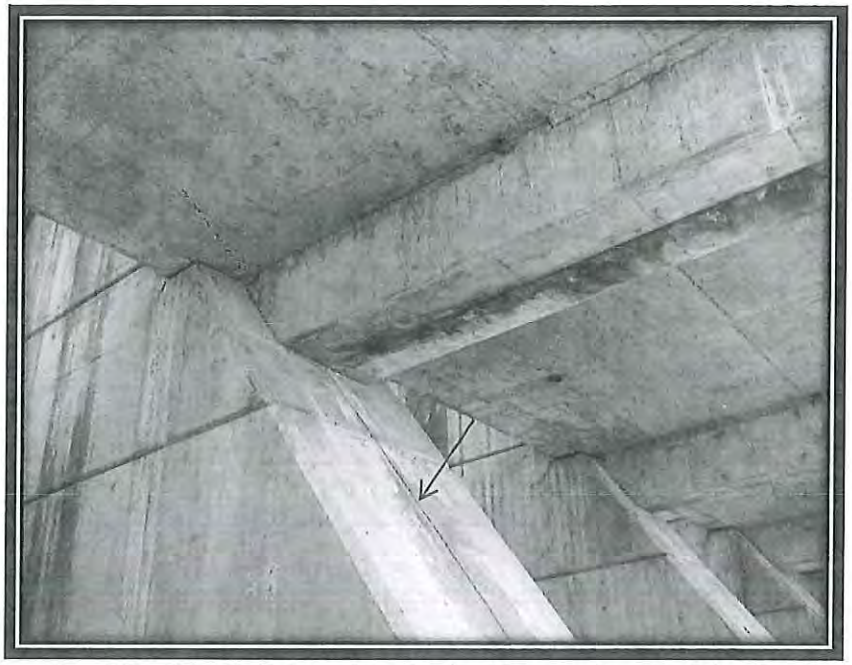
21. This view is looking upstream at the center pier of the Flood Control Outlet. The top deck is visible. A crack was recently noted at the location shown, and is also shown in photograph 22.



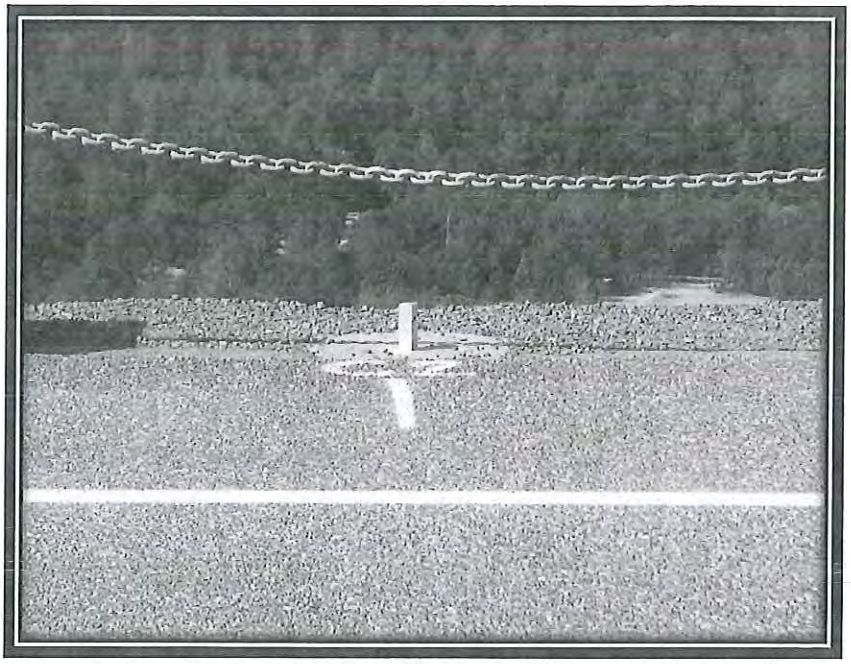
22. Close up of the crack in photograph 21, as seen looking down from the top deck of the Flood Control outlet.



23. This picture shows the transverse construction joint separating the two halves of the Flood Control Outlet where it crosses the walk through opening at the upstream side of the center pier. Buckled concrete is visible within the oval.



24. This view shows the Flood Control Outlet center pier looking upstream at the landing for the hoist deck. The solid arrow shows the construction joint. The dashed arrow is pointing at spalled concrete that may be associated with the concrete damage in photographs 21, 22 and 23.



25. Typical survey monument along the crest of Oroville Dam. Monuments along the slopes are equally well marked and maintained.

26. This view is looking down slope along the left groin of the dam. V_{s30} measurements were taken at a new drill hole indicated by the arrow.

27. This view is looking generally downstream from the Flood Control Outlet deck. V_{s30} measurements were taken at a new drill hole indicated by the arrow. A portion of the emergency spillway weir is at the lower right.