III - HISTORY OF PROJECT

3-01 **Authorization**. Authorization for Seven Oaks Dam construction is contained in the Water Resources Development Act of 1986, 99th Congress, 2nd Session, P.L. 99-662. The authorization of the overall Santa Ana River Mainstem flood control project is contained in the report of the Chief of Engineers for the Santa Ana River Mainstem, including Santiago Creek, California, dated January 15, 1982. Except for the Mentone Dam feature of the project, the Secretary was authorized to plan, design and construct a flood control storage dam on the upper Santa Ana River. The authorization language in the PL 99-662 is as follows:

> *"The project for flood control, Santa Ana River Mainstem, including Santiago Creek, California: Report of the Chief of Engineers, dated January 15, 1982, at a total cost of $1,090,000,000, with an estimated first Federal cost of $809,000,000 and an estimated first non-Federal cost of $281,000,000, except that in lieu of the Mentone Dam feature of section 903(b) of this Act, the Secretary is authorized to plan, design, and construct a flood control storage dam on the upper Santa Ana River."*

3-02 **Planning and Design**. The Santa Ana River Phase I GDM submitted to Congress in September 1980 recommended in addition to other flood control features, the construction of a flood control dam (Mentone Dam), on the Santa Ana River. Mentone Dam was to be located just northwest of the City of Mentone and north of the City of Redlands, California. The estimated cost for Mentone Dam was $530,032,000 (October 1985 price levels). Due to considerable opposition to the dam based on project effects to existing water recharge facilities in the region, and esthetic considerations, the Assistant Secretary of the Army (Civil Works) recommended the authorization of the Santa Ana River Mainstem Project with the exception of Mentone Dam.

Congress directed the Corps to study alternatives to the previously proposed Mentone Dam under Section 1304 of the 1984 Supplemental Appropriations Bill. In accordance with further directives, the study was focused on upstream flood storage alternatives. Local interests also favored a study of upstream flood storage alternatives.

The Upper Santa Ana River Flood Storage Alternative Study, Supplement to Phase I GDM on the Santa Ana River Mainstem including Santiago Creek was completed in December 1985. The Upper Santa Ana River Dam, which was later renamed to Seven Oaks Dam, became the recommended alternative to Mentone Dam and was subsequently authorized. The recommended plan consisted of a dam in the Santa Ana River Canyon about 4 miles upstream from the previously proposed Mentone damsite and about 8 miles northeast of the City of Redlands.

The proposed design of the dam consisted of an earth-and-rock-fill structure with a height of about 550 feet above the existing streambed, crest width of 40 feet, crest length of about 3,000 feet, and the crest elevation at 2,610 feet, NGVD. The proposed upstream and downstream slopes were 1V on 2H. Based on the document entitled "Phase II GDM on the Santa Ana River Mainstem including Santiago Creek, Volume 7, Hydrology", dated August 1988, the storage allocations for the reservoir behind Seven Oaks Dam below spillway crest are as follows: 1) a flood control storage of 113,600 acre-feet and 2) a 100-year sediment storage of 32,000 acre-feet. A detached spillway was proposed, to be located about 1,700 feet east of the dam, with a trapezoidal cross section, a base width of 500 feet and side slopes averaging 1V on 1H. The spillway would be unlined except for a concrete control sill across the invert at the crest.

The Seven Oaks Dam flood control project was designed to help control flooding on the Lower Santa Ana River below Prado Dam by reducing peak inflows into Prado Reservoir during large flood events. In addition, the project was designed to provide flood control protection on the Santa Ana River between Seven Oaks Dam and Prado Dam.

3-03 **Construction**. Construction of Seven Oaks Dam began in 1989. The embankment, outlet works and appurtenant structures were constructed under seven different construction contracts. The first three construction contracts involved site explorations, investigations and test fills of the foundation of the dam and at Government Canyon Ridge. The work from these contracts began in 1989 and completed in 1991. In 1992, the first substantial construction of permanent features began with the excavation and construction of the concrete lining for the outlet works tunnel and gate chamber. This work completed in July 1994. The embankment construction started in May 1994, and the dam topped out in June 1999. The overall embankment and outlet works construction were completed in November 1999. The last contract to construct the Minimum Discharge Line Extension was completed in March 2002. The project was turned over to the Local Sponsors for operation and maintenance in October 2002.

3-04 **Related Projects**. Two major flood control dams are located in the Santa Ana River Basin, downstream of Seven Oaks Dam. These structures are Prado Dam and San Antonio Dam, both of which were built and are operated by the Corps of Engineers. Other existing flood control improvements, including those on Cucamonga, Deer, Lytle, and Cajon Creeks, have been constructed by the Corps of Engineers and local interests. These improvements include channelization, debris basins, storm drains, levees, stone and wire-mesh fencing, and stone walls along the banks of stream channels. The principal existing water conservation improvements within the Santa Ana River Basin are spreading grounds and reservoirs. The more than 100 water conservation and recreation reservoirs within the basin have storage capacities ranging in volume from less than 4 to about 182,000 acre-feet in the case of Lake Mathews. Although most of the existing water-conservation improvements affect the regimen of the lesser floodflows, major floodflows are not appreciably affected. Lake Elsinore, the terminus for the San Jacinto River, has considerable potential influence on flood runoff, especially if its water surface elevation is low at the beginning of a storm. Lake Elsinore has a dead storage capacity of about 130,000 acre-feet. When full, Lake Elsinore overflows into Temescal Wash, which joins the

Santa Ana River just upstream of Prado Dam. Plate 2-01 shows location of all related projects.

a. Spreading Facilities Downstream of Seven Oaks Dam. Currently, San Bernardino Valley Water Conservation District (SBVWCD) operates groundwater recharge facilities, downstream of Seven Oaks Dam. The existing recharge basins and additional basins currently under construction are located at a borrow pit formerly used for Seven oaks Dam construction located west of Greenspot Road and north of the Santa Ana River. Some of the outflows from the Seven Oaks Dam outlet works are diverted at the SBVWCD diversion structure, located just downstream of the *USGS Santa Ana River near Mentone* stream gage (see Photos 3-1 and 3-2). From the diversion structure, the water flows through an underground box culvert, which is 10 feet wide by 9 feet high. The underground box culvert connects to a rectangular concrete channel, called a "sandbox," 400 feet downstream of the diversion structure. The purpose of the "sandbox" is to filter out excess sand carried in with streamflow. From the "sandbox", the water then continues to an unlined trapezoidal canal, flowing 2,300 feet to the west, crossing under Greenspot Road. The Parshall Flume, which is located at Greenspot Road, measures the flow as it continues west before finally entering the recharge basins at the borrow pit. At the present time, the Conservation District has 15 existing surface recharge basins, and additional recharge basins are now being constructed within the borrow pit. The SBVWCD groundwater recharge basins are shown on Plate 3-01.

Photo 3-1. Upstream View of SBVWCD Diversion Structure

Photo 3-2. Downstream View of SBVWCD Diversion Structure

3-05 Future Projects. Prado Dam, another major Corps' flood control dam on the Santa Ana River Basin is scheduled to be modified in the near future. This modification project, which is intended to increase the dam's storage and outlet capacity, is scheduled for completion within three years after the start of construction. The existing Prado Dam will undergo five construction stages, consisting of the following: 1) excavation/backfill for the installation of the new outlet conduit; 2) construction of the new intake structure; 3) partial excavation and restoration of the dam's embankment back to the current top of dam elevation of 566 feet, NGVD; 4) and the final raising of the embankment to the new height of 594.4 feet, NGVD. During the fifth stage, the existing spillway will also be raised from the current elevation of 543 feet, NGVD to 563 feet, NGVD. Detailed information concerning the Prado Dam modification features can be found in Design Memorandum No. 1, entitled Phase II GDM on the Santa Ana River Mainstem including Santiago Creek, Volume 2 - Prado Dam, dated August 1988.

3-06 Modifications to Regulations. The original design operation plan for Seven Oaks Dam is contained a document entitled Phase II GDM – Santa Ana River Mainstem, including Santiago Creek, Volume 7- Hydrology, dated August 1988. However, the inclusion of a new species on the Federal endangered species list, namely, the San Bernardino Kangaroo Rat, in addition to the already listed Slender Horned Spine Flower and the Santa Ana Woolly Star, required the Corps of Engineers to enter into a Section 7 Consultation with the U.S. Fish and Wildlife Service. Because these endangered species co-exist in the floodplain of the Santa Ana River downstream of Seven Oaks Dam, the design document plan was evaluated for impacts. It was concluded during the Section 7 consultation that the water control plan specified in the design document could be implemented with provisions added to allow flexibility to make releases in order to support environmental mitigation and enhancement activities in the downstream channel. The flood control operations include operation in coordination with Prado Dam, which is located downstream of Seven Oaks Dam; Seven Oaks Dam, dam safety considerations; mitigating for project impacts to downstream water users; as well as, environmental mitigation.

3-07 Principal Regulation Problems. Since the completion and the initial operation of Seven Oaks Dam, several operational problems have been identified. Most of these problems are mechanical in nature and involve slight design modifications. Repair work to correct these mechanical problems have been completed. Other problems are minor and do not require physical modifications. However, since they pose minor operational constraints, procedures have been developed to circumvent them. These constraints and the developed procedures are described in Chapter 7 of this manual. All the observed problems are discussed in detail in the following paragraphs:

a. Improper Seating of the Outlet Gates. A storm on February 12, 2000 required the building of a debris pool for the first time since the completion of Seven Oaks Dam. Since significant inflow was anticipated prior to the actual storm event, the sluice gate was opened after the low flow and RO gates were closed. This was done in order to fill the main tunnel, thus making the dam ready for larger releases if necessary. As inflow filled the approach channel and began spilling over the stop logs into both conduits, the 8-inch and 14-inch valves were both closed in order stop all releases and build the debris pool. As the main wet well began to fill, the dam tenders reported severe leakage from the sides of RO gate Number 2, (the service gate on the right side looking downstream). Later on during the same event, the dam tenders reported hearing a loud bang. After this sound was heard, the leakage diminished considerably.

An investigation into this incident found that the gate had slid on the invert babbitt seal and sheared off a thin skin of the babbitt metal which was lodged between the gate and gate frame slot. The inspection concluded that the gates were not fully seated onto the gate frame during initial watering up of the upstream tunnel. As water enters the tunnel, the lack of seating causes leakage on the sides of the gates, as observed by the dam tender during this incident. The gates will initially resist the pressure acting on them with the static friction forces between the gate lips and the invert babbit seal resulting from their own weight and the pressure of the hydraulic cylinders. Eventually the increasing hydrostatic pressure on the gates overcame the friction forces, causing the gates to slam against the downstream gate slot, thus causing the loud bang and the shearing of the babbit seal metal. This inspection resulted in a recommendation that during watering up of the upstream tunnel, the control gates should be raised slightly to allow the pressure upstream of the gate to seat the gate onto the gate frame seal.

b. <u>Outlet Gate Latches</u>. As a mechanical safety feature, each hydraulic slide gate at Seven Oaks Dam was designed with a latch mechanism to hold them while they are in a fully open position without drifting downward. The latch mechanism consists of a latch pin, latch arms, and a long bolt (main RO gates only) that supports the weight of the gate when it is fully open, and prevents it from drifting downward due to its own weight when the hydraulic pressure bleeds off. For the main RO gates, the latch arms are closed to hold the pin that is connected to the gate stem by a long bolt. The bolt is the weakest link for the main RO gates. As the gate rises to fully open, the pin also rises through the latch arms. The latch arms are open when the gate is moving and closes when the gate is stopped. The end of the pin has a mushroom-shaped head, which prevents the pin from slipping back through the latch arms when they are closed.

When the gate is initially fully open, the head of the pin remains above the closed latch arms and does not rest on them; therefore, when closing the gate by pushing the “LOWER” button at the control panel, the latch arms would open and the head of the pin lowers with the gate. However, if the gate were kept fully open for a long period of time, the hydraulic pressure would bleed out, which would cause the head of the pin to fully rest on the closed latch arms, and in turn, fully support the weight of the gate. Pushing the “LOWER” button under this condition would not allow the latch arms to readily open due to the weight of the gate, and the hydraulic pressure would still force the gate to lower, causing the latch arms to fail.

The design problem stated above was initially discussed by the contractor in December 1999, after a broken bolt for the latch pin had been repaired following a testing of the gates. In February 2001, retrofit work was initiated to equip each gate with a proximity switch sensor to indicate when the latch arm is open or closed. The hydraulic controls were redesigned to include an automatic two-second delay from the time the "LOWER" button is pushed to activation of hydraulic pressure to move the gate. This feature would allow time for the latch arms to open. In addition, the electrical controls were redesigned to prevent the gate from lowering if the proximity switch sensor does not indicate the latch arms are open. The gate controls were also redesigned to automatically make the gate go up for a few seconds when the "LOWER" button is pushed before allowing the gates to go down from the full open position. This feature would further prevent any possibility of damaging the latch mechanism from lowering the gate. The latch control system was redesigned, and the retrofit completed in 2002. Testing of the completed modifications was conducted on 24 June 2002. Minor problems were observed with the synchronization of the indicator light illumination when the "LOWER" button was pushed. The problems were corrected and the system retested and officially accepted on 25 June 2002. The updated as-builts and equipment operation and maintenance manuals were submitted in September 2002.

c. <u>No Gate Indicator for the Hydraulic Sluice Gate</u>. The sluice gate will be operated either fully open or fully closed under a balanced head or to a 2.5 feet maximum head differential using a portable hydraulic operator. The design did not include a gate position indicator due to susceptibility to damage from weather or potential vandalism. Visual inspection of the gate position is not possible during real-time operation. Therefore, actual position of the sluice gate is not readily available to the dam tenders. Although dam tenders are required to record and report the position of the sluice gate during each gate change, the possibility of moving the sluice gate without recording it, especially during maintenance, exists. In addition, during construction, the contractor had reported that during its initial operation, the sluice had gate drifted down when left in an open position for an extended period of time; however, this condition has not recurred to date. Currently, the only available means of verifying the position of the sluice gate is through actual operation of the gate.

d. <u>Limited Release Capability at Elevations below the Stoplogs.</u> Over the design life of the project, stoplogs are placed, as necessary, along the upstream face of the multilevel withdrawal system (MWS) wetwell of the intake structure in order to minimize the amount of sediment entering the outlet works. The elevation range between the current reservoir invert and the crest of the stoplogs is defined as the sediment pool in the water control plan. Currently, the first two rows of ports have been stoplogged, and the invert elevation, which is the invert for the next row of ports, is at 2120.24 feet, NGVD. Within this elevation range, the dam is operated mainly to minimize impacts to downstream water users. However, since the dam is not equipped with any other release mechanism when the water level is within this range, releases within the sediment pool will be limited to the amount of leakage through the stoplogs.

e. Cavitation within the 12-inch RO Recharge Line (Filling Line). During the 8-10 November 2002 storm operation, the Seven Oaks Dam project operators noticed excessive noise, indicative of cavitation, coming from the 12-inch diameter filling line while the flow was being diverted to the RO tunnel from the MDL. The noise was described as sounding like pebbles bouncing rapidly within the pipe, and the intensity of the noise increased as the butterfly valve opening increased. The noise was first detected at elevation 2130 feet, NGVD, and as the water surface elevation rose, so did the noise levels. At elevation 2160, the noise became unbearable. It is suspected that the noise might be due to the trapped air pockets downstream of the valve due to lack of an air release valve. Currently, a permanent fix for cavitation is under development, but in the mean time, operational procedures, as provided in Section 7-06.b., have been developed to address this problem.