STANDING INSTRUCTIONS TO THE PROJECT OPERATOR FOR WATER CONTROL LYTLE CREEK INTAKE STRUCTURE

I. BACKGROUND AND REPONSIBILITIES

A. GENERAL INFORMATION.

1. PURPOSE OF DOCUMENT

This document is prepared in accordance with instructions contained in Engineering Manual (EM) 1110-2-3600, Management of Water Control Systems, Nov. 1987, paragraph 9-2, (Standing Instructions to Project Operator for Water Control), and Engineering Regulation (ER) 1110-2-240, Water Control Management, Oct. 1982, and pertains to duties and responsibilities of project operators associated with the operation of Lytle Creek Intake Structure.

Definitions used are those in the U.S. Army Corps of Engineers 1950 Operations and maintenance manual for Lytle and Cajon Creeks and are updated to relate to definitions cited in EM 1110-2-3600. "As used hereinafter, the term "Superintendent" shall be defined to mean the person appointed by local interests to be directly in charge of an organization which will be fully responsible for the continuous inspections, operation, and maintenance of the project works; the term "District Engineer" shall be defined to mean the District Engineer of the Los Angeles District, Corps of Engineers, U.S. Army, or his authorized representative. The term "flood" shall mean any river stage which reaches elevation of 1134.0 ft. on the staff gauge at the intake of the outlet works. The term "right bank" or "left bank" shall be defined to mean the right or left bank or side, respectively, of a stream or channel facing downstream"; San Bernardino County Flood Control District is the designated representative of local interests for the Lytle-Cajon Creek Flood Control Improvements. For purposes of Standing Instructions to the Project Operator for Water Control, the "Superintendent" shall be the "Project Operator", and the Los Angeles District, Corps of Engineers, U.S. Army, Reservoir Regulation Section shall be the "Water Control Manager".

Operational instructions to project operators are outlined with specific emphasis on flood emergencies when communication between the dam tender and the San Bernardino County Flood Control District Operation Center have been disrupted. This document is designed to be used as an operational guide for the project operator in implementing the Lytle Creek Intake Structure Regulation Schedule (Exhibit A). Associated plates are referenced and are located in the back of this document.

The project operator is advised to have available at the Intake Structure this water control document, and the current version of other manuals that complement theses Standing Instructions including: Operations and Maintenance Manual for Lytle and Cajon Creeks (Plate 1, Ref.10); San Bernardino County Flood Control District Storm Operations Guide Manual, Oct. 1989.

Any deviation from Standing Instructions will require approval of the Reservoir Operations Center (ROC).

2. PURPOSE OF PROJECT

The purpose of the project is to protect San Bernardino, Colton, Rialto, and Fontana from a Standard project Flood (SPF) of 88,000 cubic feet per second (c.f.s.) at Foothill Boulevard. The contributing natural alluvial channels carry 35,000 c.f.s. on Lytle Creek, 26,000 c.f.s. on Cajon Creek and 17,000 c.f.s. from Devil Creek Diversion upstream of Foothill Boulevard. From the Foothill Boulevard intake, the concrete channel along the West Branch of Lytle Creek carries a design flood discharge of 30,000 c.f.s. controlled by a tainter gate which diverts flood waters above 30,000 c.f.s. into the 58,000 c.f.s. capacity concrete-lined East Branch of Lytle Creek Channel. (Figure 2) The project is an integral part of the comprehensive flood-control plan for the Santa Ana River drainage area, and prevents all but minor damage from a flood of SPF magnitude to the highly improved areas of San Bernardino and Colton near the channel, to the yards and shops of several railroads, and to the transcontinental railroads, highways, and utilities which cross the area. (See Plate 9)

3. CHAIN OF COMMAND IN FLOOD EMERGENCIES

Applicable regulations governing responsibilities of representatives of local interests and the Federal Government are found in Part 208.1, Title 33, of the Code of Federal Regulations - Navigation and Navigable Waters, Chapter II, Corps of Engineers, Department of the Army - Flood Control Regulations, Maintenance and Operation of Flood Control Works, approved by the Secretary of the Army, 9 August 1944, and published in Federal Register, 17 August 1944. Applicable sections indicating chain of command in flood emergencies contained in Par 208.10 are quoted as follows in conjunction with provisions as provided in the 1950 United States Army Corps of Engineers (USACOE) Operations and Maintenance manual for Lytle Creek Improvements:

> " The State, political subdivision thereof, or other responsible local agency, which furnished assurance that it will maintain and operate flood control works in accordance with regulations prescribed by the Secretary of War, as required by law, shall appoint a permanent committee consisting of or headed by an official hereinafter called the 'Superintendent', who shall be responsible for the development and maintenance of, and directly in charge of an organization responsible for the efficient operation and maintenance of all of the structures and facilities during flood periods and for continuous inspection and maintenance of the project works during periods of low water, all without cost to the Untied States."

> " The Superintendent will, during periods of flood flow, coordinate the functions and activities of all agencies, both public and private, that are connected with the protective works. Arrangements shall be made with the Local law enforcement agencies, street departments, and railroad and utility companies for developing a coordinated flood-fighting program, and an outline of this program filed with the District Engineers."

" Appropriate measure shall be taken by local authorities to insure that the activities of all local organizations operating public or private facilities connected with the protective works are coordinated with those of the Superintendent's organization during flood periods."

" The District Engineer will assist the Superintendent as may be practicable, in his duties of ascertaining storm developments having flood-producing potentialities, assembling flood-fighting forces and materials, and initiating and carrying out flood-fighting operations."

" The District Engineer or his authorized representatives shall have access at all times to all portions of the protective works."

4. LOCATION

Located in San Bernardino County, Lytle Creek and its principal tributary, Cajon Creek, together drain an area of 164 square miles to the Santa Ana River. Headwaters originate from the east slopes of the San Gabriel Mountains and the southwest slopes of the San Bernardino Mountains in the upper Santa Ana River Basin, varying in elevation from more than 10,000 feet at Mount San Antonio (Mount Baldy) to about 2,000 feet at the mouths of Lytle and Cajon Canyons. Upon emerging from the mountains, Lytle and Cajon Creeks flow over a large common alluvial cone and converge 3 miles northwest of the city of San Bernardino, California. From the confluence, Lytle Creek continues southeastward to the western part of the city, where it divides into two channels, the west branch following a southerly course through the city of Colton to Warm Creek and then to the Santa Ana River, and the east branch flowing southeasterly through the cit of San Bernardino to Warm Creek, a tributary of Santa Ana River. Lytle Creek Intake Structure is at the intersection of Foothill Boulevard (5th Street) and Rancho Avenue in San Bernardino at Latitude 34°07', Longitude 117°20'. The length of Lytle Creek is about 30 miles and its average slope is about 290 feet per mile. The project location is shown on Plate 2.

Lytle Creek Water Control Structures consist of: Lytle Creek (West Branch) and Cajon Creek Improvements (1944), a series of grouted-quarry-stone collecting levees (Upper and Lower Devore, Muscoy, and Island) and groins, (four Muscoy and five Riverside Avenue groins), a gated intake structure, and 15,340 feet of concrete rectangular channel from Foothill Boulevard to Warm Creek; Devil, East Twin and Warm, and Lytle Creek Improvements (1950) consisted of the following: Lytle Creek levee consists of 6,130 linear feet of grouted stone levee. Al later contract for the restoration work along the Creek's levee consisted of construction of 1,000 feet of gabions. Devil Creek Diversion which diverts flows from Devil, Badger, and Cable Creeks into Lytle Creek upstream from Highland Avenue, consists of 6,800 feet of grouted stone levee and 10,890 feet of concrete lined channel, of which 5,200 feet is rectangular and 5,690 feet is trapezoidal; Lytle Creek (East Branch) and Warm Creek Improvements (1976) (See Plate 9) added 17,610 feet of rectangular reinforced concrete channel on the East Branch of Lytle Creek from the intake structure to the confluence with Warm Creek. The existing bypass weir at the

Foothill Boulevard Intake Structure was modified to provide an inlet for the East Branch Channel. The Lytle-Cajon water control structures are shown on Plate 3A & 3B in Figures 1 through 26.

4. HISTORY

a. Construction Legislation

(1) Lytle Creek (West Branch) and Cajon Creek Improvements. (The project was constructed under Public Law 534, Seventy-eight Congress, 22 December 1944.)
" This act, in addition to previous authorizations, authorized to be appropriated the sum of $10,000,000 for prosecution of the projects approved in the Act of 22 June 1936, as modified by the Act of 28 June 1939 for the Santa Ana River Basin, including the projects on Lytle and Cajon Creeks for local flood protection at San Bernardino and Colton, California, in accordance with recommendations contained in the report of the Chief of Engineers dated 11 February 1944." (Plate 1, Ref.10)

(2) Devil, East Twin, Warm and Lytle Creek Channel Improvements. (Public Law 516, Eight-first Congress, 17 May 1950.)
" The purpose of the project is to continue the improvement of the Santa Ana River Basin by providing another important unit under the general comprehensive plan for flood control. Construction of the Devil Creek diversion would protect the city of San Bernardino and adjacent suburban areas against floods on Badger, Devil and Cable Creeks." (Plate 1, Ref.13)

(3) Lytle Creek (East Branch) and Warm Creek Improvements. (Public Law 298, 89th Congress, Flood Control Act of 27 October 1965.)
" The purpose of the project is to continue the improvement of the Santa Ana River Basin by providing another important unit under the approved general comprehensive plan for flood control in San Bernardino County, California. The project will provide protection against floods to developed areas consisting of valuable residential, commercial and industrial property, important power facilities, arterial and interstate highways and all transcontinental railroad lines serving this area." (Plate 1; Ref. 17)

b. Description of Water Control Structures at Intake Structure

Lytle Creek West Branch Channel was constructed in 1946 from Foothill Boulevard along the west branch of Lytle Creek to Warm Creek. The Lytle Creek concrete channel extends from the upstream end of the outlet structure to the downstream end of the intake transition channel, a distance of 14,741 feet. The channel is reinforced concrete and is rectangular in section, with a width of 40 feet, wall heights varying between 20 feet and 25 feet, and a design capacity of 30,000 c.f.s. (Plate 1, Ref.10; Plate 4)

The intake-transition-drop structure at the upstream end of the 40-foot-wide concrete channel is 475 feet long and was constructed din 1946. The invert is at elevation 1130 MSL. This structure consists of a converging drop inlet 120 feet long varying in width from 213 feet at the upstream end of the structure to 60 feet at the gate (Figures 4-8). The gate, a 60-foot wide by 25-foot high tainter gate of 35-foot radius, was installed in 1949 (Plate 5). Walls in the upstream section range in height from 30 feet at the upstream and, to 40 feet at the gate. Below the gate, a vertical walled transition 355 feet in length connects the 60-foot gate section to the 40-foot wide downstream channel. Walls in this section are 25 feet high except for locally increased height necessary to retain the levee fill adjacent to the gate structure. The transition section has an adverse slope between the 60-foot gate section and the 40-foot channel which increases gradually. (Plate 4)

The original bypass structure consists of a wing levee 1,000 feet long to the west of the gate section and a broad-crested overflow section 1,000 feet long to the east. The overflow section, which served to bypass excess stream flow to the natural east branch of Lytle Creek was completed in 1946. (Plate 1, Ref.4; Plate 4)

The 3.36 mile long East Branch of Lytle Creek channel improvements were completed in 1976. Other options such as flood control dams on both Lytle and Cajon Creeks were studied, but were not implemented due to the possibility of altering existing water right distributions. The improved channel of the East Branch of Lytle Creek was designed to control 58,000 c.f.s., which combined with 30,000 c.f.s. diverted into the West Branch Channel, would control a total SPF of 88,000 c.f.s at the Intake Structure. (Plate 1, Ref. 16; Plate 6).

The East Branch channel Inlet, as constructed, was modified so that the original bypass spillway was lowered to elevation 1142.5 feet MSL for a distance of 410 feet at the section in line with the 577 foot spillway levee wall addition. Side walls of the inlet were raised to elevation 1160.0 feet MSL, and 577 feet of concrete spillway levee wall was added to the top remaining bypass levee to raise it to elevation 1160.0 feet MSL. The design discharge of 58,000 c.f.s. is maintained on the East Branch Channel with the difference being that the intake walls on the East Branch Channel were angled outward so that the entrance is 417 feet wide and the crest is 400 feet wide.

For the East Branch improvements, the channel alignment and cross sections were selected on the basis of economic studies. The width of the control section at the bypass spillway was based on the common head that would be required to discharge 30,000 c.f.s. through the existing West Branch inlet and 58,000 c.f.s. through the East Branch inlet. Spillway flow was based on control at the spillway crest. The existing bypass spillway was to be modified by lowering the middle 300 feet from elevation 1,151.5 to elevation 1,141.5 and raising the end sections to the height of the existing embankment (elevation 1160). (Figures 17 & 18). The channel width was to be reduced from 300 feet at the inlet to 100 feet over a length of 1,000 feet. The 100-foot width is maintained for a distance of 2,270 feet, before transitioning to an 80-foot width. Design flow depth of ranges from 14 to 19 feet; a minimum of 2 feet is provided for freeboard. The channel is superelevated in curved reaches. The velocity of the design flow in the concrete channel ranges from 37 to 51 feet per second. The downstream terminus at the Warm Creek channel consists of a stone-lined transitions with revetted levees. The transition dissipates the energy and changes the flow to the subcritical regime within the transition.

The backwater from the natural section downstream would be sufficient to maintain the hydraulic jump in the transition (Plate 1, Ref. 16)

The levees and groins on Lytle and Cajon Creeks primarily were designed to have adequate strength and stability against high-velocity, debris-laden flows and against undercutting or overtopping rather than for the usual freeboard allowance above a computed water surface. The dimensions of channel cross sections on the debris cone change during every flood, and not accurate estimate of flow capacity can be made. Either scour or aggradations may occur along the levees and both may occur in succession at any point during a single flood. The location and severity of such action during future floods cannot be determined in advance by hydraulic computations, and consequently every point must be considered subject to that action. As designed, the levees and groins are believed adequate to contain and withstand a flood with a peak discharge of 26,000 c.f.s. in Cajon Creek at its mouth, 35,000 c.f.s. in Lytle Creek at the canyon mouth, and 60,000 c.f.s. in Lytle Creek above Foothill Boulevard. (Plate 1, Ref. 2 1945)

The Lytle Creek Levee, built in 1956 as an addition to the Lytle-Cajon Flood Control Improvements, is a revetted earth-filled levee, about 6,100 feet long and 10 feet high. It controls a flood of 60,000 c.f.s. with minimum freeboard allowance of 5 feet and would not be overtopped by a maximum flood of 96,000 c.f.s. The cross-section of the embankment is similar to the cross-sections used for the Muscoy Groin No. 4 on the opposite side of the channel; the River side Avenue Groins, upstream from the Levee; and the Island Levee, downstream. The top of Lytle Creek Levee is 18 feet wide and about 10 feet above average ground line. Both sides of the levee have slopes of 1 vertical on 2 horizontal. The channelward side of the levee is covered with a grouted-stone blanket, which extends from the top of the levee to a point 8 feet below the lowest existing channel of the adjoining stream bed to protect the slope from scour. A V-shaped, loose-stone apron, 8 feet deep, is placed at the toe of the revetted slope to retard undercutting. Streambed material is backfilled on top of the apron to the average ground line, and graded to a slope of 1 on 40 away from the levee to direct low flows away from the levee face. The channelward side of the levee extends from 10 feet above the top of the graded backfill to depths ranging from 9 to 12 feet below the top of that backfill. (Plate 1; Ref. 15)

The design of the Lytle Creek Levee System upstream of Foothill Boulevard to control the SPF was reviewed during the 1964 Corps of Engineers study and it was concluded that the existing levees would satisfactorily convey the SPF at Foothill Boulevard. (Plate 1, Ref.16)

6. HYDROLOGY

Hydrologic data and statistics for historical rainfall and runoff for the Lytle-Cajon Creek watershed are presented in Exhibit B. Plate 7 shows a hydrologic map of the watershed with instrument locations. The hydrographs on Plate 8 show floods that could occur if the January 1943 storm, the largest regional storm of record, were to center over the drainage area at a time when ground conditions were conducive to a high rate of runoff. The resultant flood is about twice as large as any known flood of record. The SPF peak inflow for future conditions at the Lytle Creek Intake Structure is computed to be 88,000 c.f.s. at Foothill Boulevard (Plate 9). Exhibit B presents documentation of determination of the SPF and discusses the possibility of larger floods at Lytle Creek Intake Structure.

7. GEOLOGY AND GROUDNWATER

a. GEOLOGY

The project area is located in the eastern part of the broad alluvial plain of the upper Santa Ana River Valley, about 7 to 8 miles south of the San Gabriel-San Bernardino Mountains, which are a portion of the eastwest trending Transverse Ranges. Underlying the valley is an oblong structural basin, composed of valley alluvium overlying the basement complex. The alluvium is derived mainly from the granite and metamorphic rocks that form the basement complex of the San Gabriel and San Bernardino Mountains to the north. These deposits are of late Quaternary age and include Holocene and Pleistocene alluvium. The total thickness of the later Quaternary alluvium in the vicinity of San Bernardino exceeds 1,000 feet.

The San Andreas and San Jacinto faults are the major active fault zones in the project area. The San Andreas Fault zone crosses through the Transverse Ranges diagonally in a northwest-southeast direction about 6 1/2 miles north of the project. The San Jacinto fault zone branches off from the San Andreas fault on the north side of the Transverse Ranges and crosses through the mountains, near parallel to the San Andreas fault zone, entering the valley along Lytle Creek. The Cucamonga fault zone parallels the south face of the San Gabriel Mountains, extending from Lytle Creek westward to Monrovia. Plate 10 shows the location of major faults relative to Lytle Creek Intake Structure and plots seismic epicenters by magnitude of the event.

b. GROUNDWATER

The downstream part of the East Branch of Lytle Creek is inside the southwest part of the Bunker Hill groundwater basin in contrast to the West Branch of Lytle Creek, which was built west of the San Jacinto fault, known also as the "Bunker Hill dike" because of its effect as a groundwater barrier. The Bunker Hill groundwater has been studied in detail by various agencies because of its economic importance to San Bernardino County. Water is absorbed by alluvium at the upstream end of the basin and is partly confined as it travels to the downstream end, where it discharges as subsurface and surface flow through the Colton Narrows of the Santa Ana River. The resultant total outflow from the basin can sometimes result in a value less than inflow during wet periods and greatly exceeding inflow during dry periods. There is natural adjustment of groundwater storage in the confined area as the water table responds to differences between inflow and outflow. The downstream part of the East Branch of Lytle Creek is within the area of perennial outflow from the Bunker Hill groundwater basin, and the water table is expected to be continuously above the channel-invert elevation downstream from station 60+00. The rest of the channel is in an area where the water table would fluctuate from below the invert elevation to substantially above that elevation.

8. PROBLEMS ENCOUTERED

a. EROSION

After the floods of January and February 1969, the COE inspected damages to levees and groins of the Lytle Creek Improvements. For the second time (the first repairs to the project occurred in 1967 subsequent to the floods of 1965 and 1966) it had been necessary to repair damage to groins, which had previously been repaired at federal expense. The cause, as presented in a letter of explanation to the San Bernardino County Supervisor, was in large measure attributed directly to the creation of large pits in the channel downstream of the groins. Ill-considered gravel extraction was considered to have started the cycle of bedload movement due to "head-cutting" into the pits and running long distances upstream to undermine important structures such as highways and flood-control works. The Corps suggested that San Bernardino County review the need to form a comprehensive policy on gravel extraction in the County which would protect public works against being undermined by head-cutting erosion.

b. SEDIMENTATION

Post-construction sedimentation problems have become evident in the lower reaches of the Warm Creek channel and Santa Ana River confluence which are partially contributed to by the Lytle-Cajon Creek watershed. Steep mountains that rise abruptly from the valley floor and have a minimum of vegetative cover are subject to major brush fires that can increase erosion potential significantly. The sediment deposition problem is aggravated at channel grade changes designed to transition with the concrete-lined channel. These conditions, combined with energy dissipators installed at the downstream end of the concrete-lined channel, resulted in an increased deposition, thereby decreasing the channel capacity.

Sediment deposits were anticipated by the LAD's initial studies, but the magnitude of these problems was not predictable from data existing at the time of the study. Following construction in 1977, the major storms of 1978 deposited approximately 1,280,000 cubic yards of sediment in the Santa Ana River improvement area and the lower improved reaches of Warm Creek. The maximum discharge during these storms recorded at E Street by the Untied States Geological Survey (USGS), was approximately 13,700 c.f.s., which was approximately equivalent to a 10-year exceedance interval. The USGS gauge Lytle Creek at Colton registered a maximum discharge of 17,500 c.f.s. on March 4, 1978. Deposits in the lower Warm Creek reach were approximately 200,000 cubic yards.

The sediment was removed at a cost of $2.7 million in 1979, but the floods of 13-21 February 1980 carried large sediment loads and deposited approximately the same amount of sediment in the same area. The maximum discharge during the period was 14,500 c.f.s. recorded at E Street by the USGS. The USGS Lytle Creek gauge at Colton registered a maximum discharge of 8,070 c.f.s. on February 16, 1980. The volume of flood in the 8-day period was 81,000 acre-feet. The 14,500 c.f.s. discharge was approximately equal to a 10-year exceedance interval.

9. CONSIDEATIONS IN THE PHYSICAL OPERATION OF WATER CONTROL STRUCTURE

a. OFFICIAL STAFF GAUGE

The official staff gauge used for determining stages listed on the rating curves and for determining the 1134.0 elevation defined officially as a "flood" is located on the left abutment of the intake of the West Branch Channel as facing downstream. It can also be referenced as the staff gauge directly north of the control house on the left intake abutment, or as the staff gauge on the east abutment of the intake to the West Branch Channel. This official staff gauge must always remain visible as an accurate indicator of water level at the Lytle Creek Intake Structure. (Figure 11)

b. RATING CURVES

Original rating curves were developed from a physical model of the Intake Structure, the original bypass structure and the west Lytle Creek Channel as studied in 1946 (Plate 1, Ref.4). The current discharge rating curve (Plate 11) accounts for the Lytle-Creek East Branch Improvements of 1976. Observations from the physical modeling indicated that for all discharges, a certain amount of movement of the bed in front of the intake structure was involved, and therefore, the discharge rating curve for the tainter gate indicates only the general trend of the relationship between pool elevation and discharge. The free-flow rating curves generated are only indicative of the relationship that existed for one condition of the channel configuration on the ground surface directly upstream from the gate intake and should not be considered as representative of all conditions, because the ground pattern, and hence the control varied with flow conditions.

For example, it was found that at high discharges, a large volume of detritus was deposited in front of the intake. This deposit affected considerably the discharge through the intake by changing the character of the control. At low flows the tendency for the water to channelize in its approach to the intake and its absence of pooling resulted in scouring of the existing bed, or of the detritus deposit in the event higher flows had preceded. Therefore, staff gauge water surface elevation-inflow discharge relationships are accurate, but the outflow rating curve relationship is not completely reliable.

The rating curves on Plate 11 indicates flow amounts n both East and West Lytle Creek Channels as read on the staff gauge on the left intake abutment of the west branch inlet.

c. UPPER DEVORE LEVEE

The Upper Devore Levee (Plate 3B, Figure 21) is a key structure for the entire project. Unexpected depositions of sediment could result in floodflows overriding the levee. Therefore, the Upper Devore Levee and Santa Fe Railway Bridge shall be continuously patrolled and emergency personnel should be prepared to raise the levee on short notice. It shall be the duty of the Superintendent to maintain a periodic patrol of the project works during all periods of flood flow in excess of a reading of 1134.0 on the staff gauge at the Intake Structure. (Plate 1, Ref.10, Figure 11)

d. TRASH BUILDUP

The intake outlet works must be monitored at all times for trash buildup of any significant amount and appropriate measures taken to remove blockages should they occur.

10. LYTLE-CAJON FLOODWAY IMPROVEMENTS

The Lytle-Cajon floodway improvements are a local protection project. All improvements have been turned over to the San Bernardino County Flood Control District, San Bernardino, California, who by resolution dated 1 May 1945, gave assurances that it would comply with all requirements of local cooperation under Part 208.10, Title 33, of the Code of Federal Regulations - Navigation and Navigable Waters, and Chapter II, Corps of Engineers, Department of the Army - Flood Control Regulations, Maintenance and Operation of Flood control Works, approved by the Secretary of the Army, 9 August 1944, and published in the Federal Register, 17 August 1944. San Bernardino County Flood Control District was granted the responsibility of representing local interests for further improvement transactions because it has already demonstrated its ability to comply with Government requirements. Under federal regulations cited, operation and maintenance is done by San Bernardino County Flood Control District.

B. ROLE OF THE PROJECT OPEATOR

1. NORMAL CONDITIONS

a. The Project Operator is responsible for water control actions during normal hydrometeorological conditions (non-flood, non-drought) without daily instruction. However, the water control manager should be contacted any time conditions are such that consultation or additional instruction regarding water control procedures are needed.

b. The Superintendent is responsible to make periodic inspections of all water control structures to insure that all levees and groins are in proper condition. Such inspections shall be made immediately prior to the beginning of the flood season; immediately following each major high water period, and otherwise at intervals not exceeding 90 days. For the sake of uniformity and to the extent practicable, the dates of inspection shall be as follows: 1

January, 1 April, 1 July, and 1 October, and immediately following each flood flow in excess of a reading of 1134.0 on the staff gauge at the Intake Structure.

c. Responsibilities of the Superintendent in line with the provisions of the Flood Control Regulations include under general duties:

(1) Training of Key Personnel. Key personnel shall be trained in order that regular maintenance work may be performed efficiently and to insure that unexpected problems related to flood control may be handled in an expeditious and orderly manner. The Superintendent should have available the names addresses, and telephone numbers of all of his key personnel and a reasonable number of substitutes. Theses key people should, in turn, have similar data on all of the personnel that will be necessary for assistance in the discharge of their duties. The organization of key personnel should include the following:

(a) Assistant to act in the place of the Superintendent in case of his absence or indisposition.

(b) Sector foremen in sufficient number to lead maintenance patrol work of the entire levee and groin systems during flood fights. High qualities of leadership and responsibility are necessary for these positions.

(2) To keep a reserve supply of materials needed during a flood emergency on hand at all times.

2. EMERGENCY CONDITIONS (FLOOD OR DROUGHT)

a. Superintendent Responsibility During Flood Conditions

(1) The Superintendent is responsible to see that all gate operations performed at Lytle Creek Intake Structure are performed in accordance with the Regulation Schedule of Exhibit A.

(2) Pertinent requirements of the Code of Federal Flood Control Regulations. Flood Control Regulations, paragraph 208.10 (b) (2) are quoted in part as follows:

" During flood periods the levee shall be patrolled continuously to locate unusual wetness of the landward slope and to be certain that:

(a) There are no indications of slides or sloughs developing;

(b) Wave wash or souring action is not occurring;

(c) No low reaches of levee exist which may be overtopped;

(d) No other conditions exist which might endanger the structure;

(e) Appropriate advance measures will be taken to insure the availability of adequate labor and materials to meet all contingencies. Immediate steps will be taken to control any condition which endangers the levee and to repair the damaged section."

(3) It shall be the duty of the Superintendent to maintain a periodic patrol of the project works during all periods of flood flow in excess of a reading of 1134.0 on the staff gauge at the intake structure, and to maintain a store of supplies and equipment available for emergency flood-fighting operations and emergency repairs.

(4) The Upper Devore Levee is a key structure for the entire project and unexpected depositions of sediment that might be caused by changes in direction of current or debris accumulations at the Santa Fe Railway bridge, could result in flood flows overriding the levee. The Superintendent shall, therefore, cause a continuous patrol to be made on the Upper Devore Levee and the Santa Fe railway bridge and be prepared to raise the levee on short notice, either by sandbags or other suitable means.

(5) The Superintendent shall dispatch a message by radio in the control house, or by telephone or telegraph, to the LAD ROC whenever the water surface in the channel reaches the reading of 1134.0 on the staff gauge on the east abutment of the intake to the West Branch Channel. The Superintendent shall provide additional staff gauge readings to the LAD Reservoir Operation Center as may requested during the storm and flood event.

(6) The Superintendent shall also ensure readings are taken of the staff gauge at intervals of one two hours during the time when the water surface is above the flood flow stage 1134.0 feet, noting the time of the observation, the staff gauge reading and the tainter gate setting. These readings shall be entered in the log of flood observations, one copy of which shall be forwarded to the District Engineer immediately following the recession of the flood, and one copy transmitted as an enclosure to the semi-annual report.

b. Drought Conditions

Drought management at Lytle Creek Intake Structure is not an issue because Lytle Creek outflows are normally captured upstream by local water companies. The Lytle Creek intake Structure is never used to impound water except for flood control. Originally, a bypass diversion for water claimed by prior water rights was included in construction at the Lytle Creek intake Structure, but has become obsolete by construction of the Lytle Creek East Branch Channel.

II. DATA COLLECTION AND REPORTING

A. NORMAL CONDITIONS

The Superintendent shall transmit to the LAD Reservoir Regulation Section once each month the original charts from the rain gauge installed at the intake works, to reach the District Office by the 7th day of the following month. In case of a major storm, the chart for that storm should be transmitted to the District Engineer immediately on removal from the gauge. The Superintendent shall maintain a file of the charts from the water level recorders and gate position recorder, such file to be available for inspection by the LAD ROC.

The Los Angeles District Corps of Engineers maintains a telemetered rain gauge record at the Lytle Creek Intake Structure for which punch tapes are collected by COE personnel at 2 month intervals. Telemetered rainfall information is available using the COE Los Angels Telemetry System (LATS), which gives instantaneous readings of precipitation as sensed in amounts of 0.04 inch of rain. Call letters for Lytle Creek Intake Structure within the TELEM data system are LYDB.

The stream gauge most accurately measuring inflows at Lytle Creek Intake Structure is the USGS gauge No. 11065000, Lytle Creek at Colton.

B. FLOOD CONDITIONS

The Superintendent shall dispatch a message by radio in the control house, or by telephone or facsimile (FAX), to the LAD ROC, at telephone number 213/452-3527 or FAX 213/452-3545, whenever the water surface in the channel reaches the staff gauge reading of 1134.0.

The Superintendent shall also ensure readings are taken of the staff gauge at intervals of one or two hours during the time when the water surface is above the flood flow stage 1134.0, nothing the time of the observation, the staff reading and the gate setting. These readings shall be entered in the log of flood observations, one copy of which shall be forwarded to the LAD immediately following the recession of the flood, and one copy transmitted as an enclosure to the semi-annual report.

C. REGIONAL HYDROMETEOROLOGICAL CONDITIONS

The Water Control Manager will inform the Project Manager by radio in the control house, or by telephone or by FAX of regional hydrometeorological conditions that may impact the intake structure.

III. WATER CONTROL ACTION AND REPORTING

A. NORMAL CONDITIONS

Under normal conditions there is no water control action to be taken at Lytle Creek Intake Structure due to the intermittent nature of Lytle-Cajon Creeks and the open standby setting of the tainter gate. Runoff occurs only at times of high intensity rainfall events. The tainter gate and backup generator are tested on a monthly basis.

B. FLOOD CONDITIONS

It shall be the duty of the Superintendent to maintain a periodic patrol of the Project Works during all periods of flood flow in excess of a reading of 1134.0 on the staff gauge at the intake structure, and to maintain a store of supplies and equipment available for emergency flood-fighting operations and emergency repairs.

A dam tender must be at the Intake Structure to record flood stage readings and to monitor floodwaters for debris buildup. The dam tender must keep the Superintendent advised of any conditions that need correcting at the Intake Structure. The dam tender is to follow the operation schedule presented below and in Exhibit A. The tainter gate operation retards flood inflows to a maximum of 30,000 c.f.s. along the West Branch Lytle Creek Channel. The spillway to the East Branch Channel will begin to spill when the discharge at the West Branch Channel is 22,800 c.f.s. The tainter gate is initially set at an opening of 20.4 feet and is reduced as the water surface rises to keep West Branch channel flow below 30,000 c.f.s. Rating curves for outflow through the West Branch tainter gate and over the East Branch spillway are shown on Plate 11.

Water Surface Elevations Feet	Gate Opening Feet	West Branch Discharge c.f.s.	East Branch Discharge c.f.s.	Combined Discharge c.f.s.
1130.0	20.4	0.0	0.0	0.0
1134.0	20.4	3,000.0	0.0	3,000.0
1135.0	20.4	5,400.0	0.0	5,400.0
1140.0	20.4	19,000.0	0.0	19,000.0
1143.0	20.4	22,800.0	0.0	23,000.0
1144.0	20.4	24,000.0	1,200.0	25,000.0
1145.0	20.4	24,400.0	3,500.0	28,000.0
1150.0	20.4	29,000.0	23,000.0	52,000.0
1150.5*	20.0	30,000.0	25,000.0	55,000.0
1151.0	19.4	30,000.0	28,000.0	58,000.0
1152.0	18.8	30,000.0	33,000.0	63,000.0
1153.0	18.5	30,000.0	39,000.0	69,000.0
1154.0	18.2	30,000.0	45,000.0	75,000.0
1155.0	18.0	30,000.0	51,000.0	81,000.0
1156.0	17.8	30,000.0	58,000.0	88,000.0
1156.1**	16.4	27,000.0	58,000.0	85,000.0
1160.0	16.4	30,000.0	87.000.0	117,000.0

* Dam tender commences gate operation
** Dam tender makes final gate change

The design for the project is the standard flood with a peak inflow of 88,000 c.f.s. The West Branch Channel passes 30,000 c.f.s. through the tainter gate and the remaining 58,000 c.f.s. is passed over the spillway to the East Branch Channel at a design pool elevation of 1156.05 ft.

If a rainfall-runoff event that exceeded the design inflow were to occur, the tainter gate would be lowered as the pool elevation rises, to limit the flow in the West Branch Channel to 30,000 c.f.s. Flow in the East Branch Channel is uncontrolled over the spillway. Flows in excess of the project design are passed downs the East Branch Channel. After the channel freeboard is surpassed, overflows would occur along portions of the East Branch Channel.

Top of the dam elevation is 1160.0 ft but the Lytle Creek Intake Structure and downstream channels are designed to pass 88,000 c.f.s. at a pool elevation of 1156.05 ft. The operation schedule provides gate settings up to the top of dam. For runoff events that produce a water surface elevation above 1156.05 ft., the dam tender will make a final setting that limits flow down the West Branch Channel to 30,000 c.f.s. (at the top of dam elevation) before the Superintendent considers evacuation of the project. At a water surface elevation matching the top of the dam, the Intake Structure can pass 116,600 c.f.s, which is 33 percent larger than the design flood. The actual inflow that makes it downs to the Intake Structure depends upon the system of upstream levees and their capability of preventing breakout flows before reaching the project.

C. INQUIRIES

The LAD Reservoir Regulation Section should be notified of all significant inquiries received by the Project Operator or Superintendent from citizens, constituents or interest groups regarding water control procedures or actions.

D. WATER CONTROL PROBLEMS

The water control manager must be contacted immediately by the most rapid means available in the event that an operational malfunction, erosion, or other incident occurs that could impact project integrity in general or water control capability in particular.

E. COMMUNICATION NETWORK IN FLOOD SITUATIONS

San Bernardino County Flood Control District	714/387-2800
San Bernardino County Communication Center 24 hr.	714/387-6076
LAD Corps of Engineers Reservoir Operation Center	213/452-3623
Control House at Lytle Creek Intake Structure	714/386-5141

F. COMMUNICATION OUTAGE

Coordination of flood control operation is under the direction of the San Bernardino County Flood Control District. During flood periods, close contact will be maintained between Operating personnel at Lytle Creek Intake Structure, the San Bernardino County Superintendent, and the Corps of Engineers Reservoir Regulation Section in Los Angeles. If communication is broken between the dam tender and the Superintendent, continue to monitor flood stage data and record, using flood lights at night if necessary, to monitor reading of staff gauge on left wall of Lytle Creek West Channel Intake.

Follow the operation schedule under Exhibit A. Operate the tainter gate (Gate and backup generator instructions, Exhibit C) if stage readings approach elevation 1150.0 feet as listed on the regulation schedule in Exhibit A.

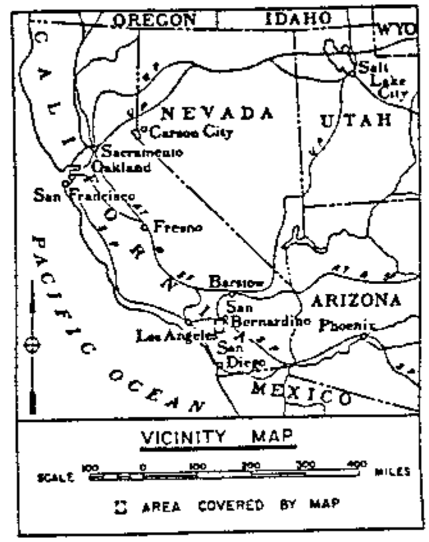
In the event of communication outage, the Los Angeles District Corps of Engineers Reservoir Regulation Section can be reached via radio call sign WUK4ROC. Also refer to the Superintendents' survey of phone located in the immediate area of Lytle Creek Intake Structure. Continued attempts should be made to re-establish communications.

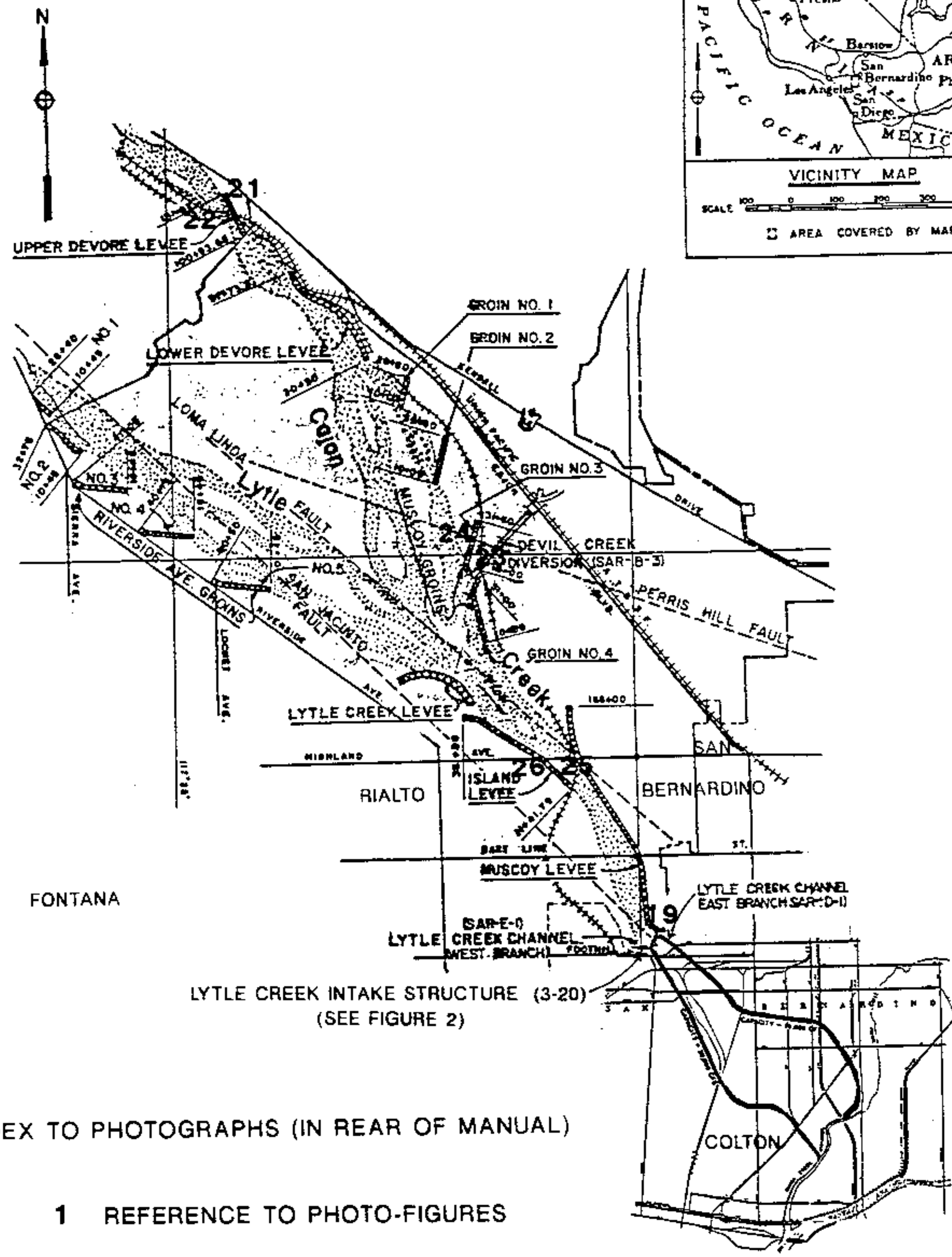
Emergency notifications are normally made by the Superintendent, however if the dam tender loses communication with the San Bernardino County Flood Control District, and an emergency notification situation arises, such as an imminent dam failure or uncontrolled flow, the dam tender should make the necessary notifications as listed in the San Bernardino County Flood Control District Storm Operations Guide Manual.

Notifications should include: (a) description of the type and extent of existing or impending emergency; (b) advisement for evacuation from the flood plain; (c) information on the time of initial release of hazardous amounts of water; (d) the depth of water behind the Intake Structure; and (e) the dam tender's name and telephone number.

Upon completing the above notifications, an attempt will be made to try to re-establish communications with the Superintendent. All notifications and lack of notifications, should be documented. The dam tender should not leave the Intake Structure unless his safety is in jeopardy. For runoff events which produce a water surface elevation above 1156.05, the dam tender should make a final gate change before following evacuation instructions of the Superintendent.

LYTLE-CAJON FLOOD CONTROL STRUCTURES

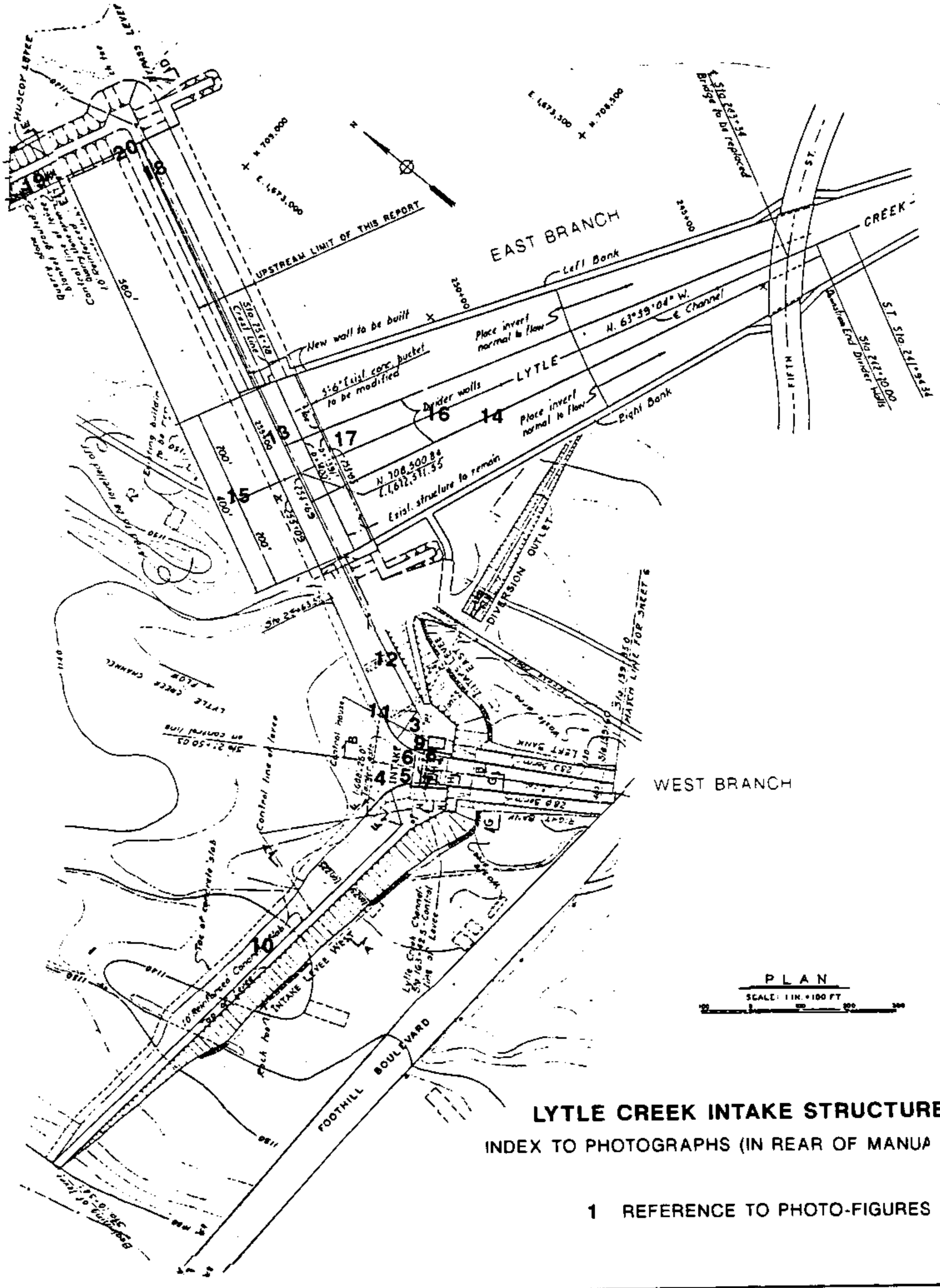




INDEX TO PHOTOGRAPHS (IN REAR OF MANUAL)

1 REFERENCE TO PHOTO-FIGURES

FIGURE 1



LYTLE CREEK INTAKE STRUCTURE

INDEX TO PHOTOGRAPHS (IN REAR OF MANUA

1 REFERENCE TO PHOTO-FIGURES

FIGURE 2

FIGURES

(PHOTOGRAPHS)

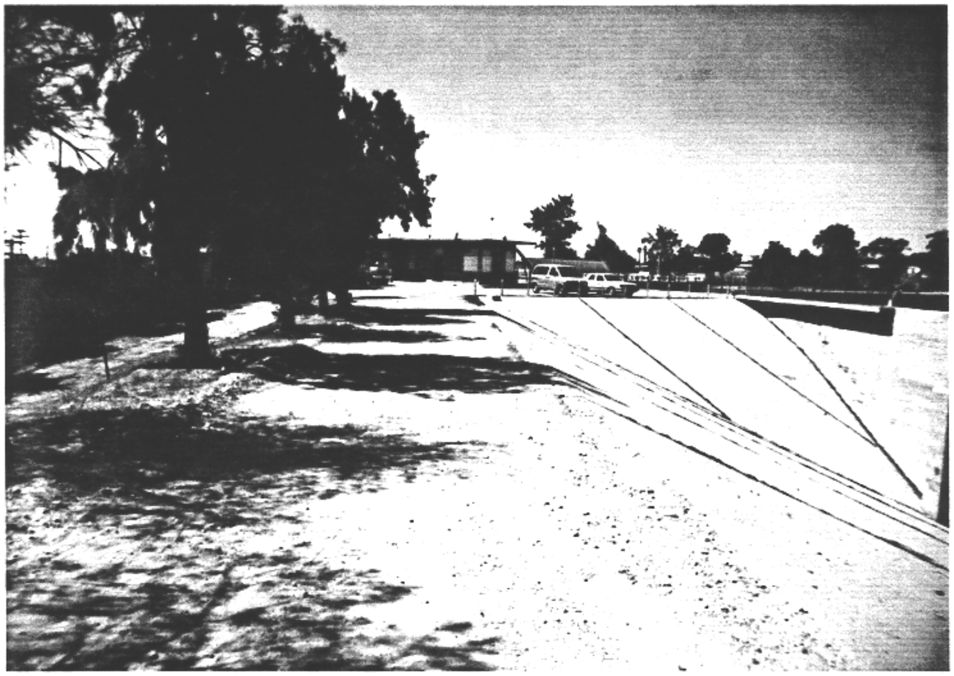


Figure 3. Lytle Creek Intake Structure Looking SW At Control House At West Branch Intake. East Wing Levee In Background.

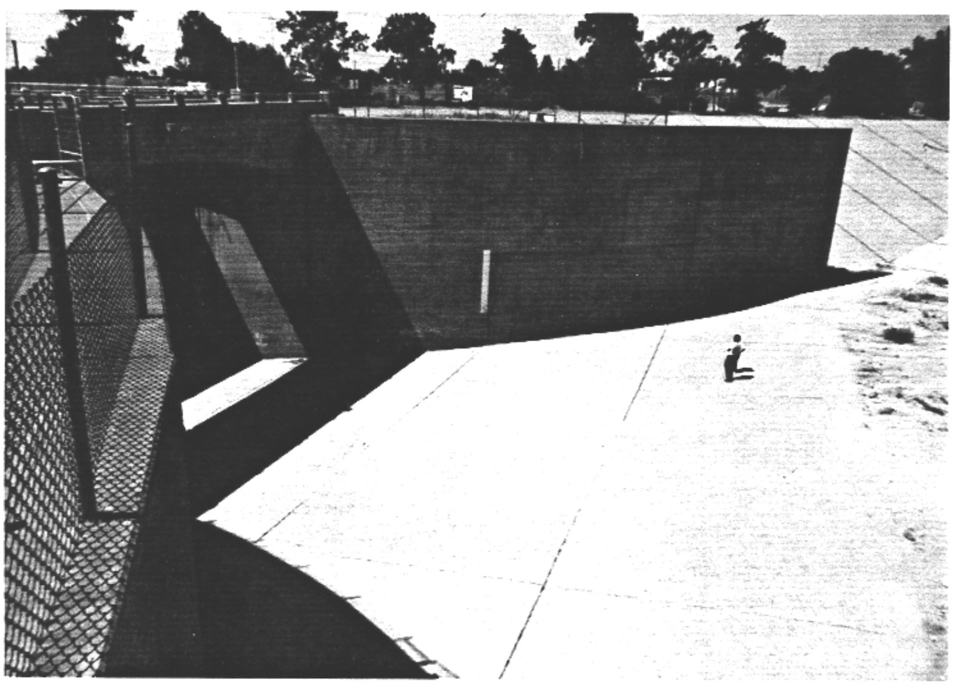


Figure 4. Lytle Creek Intake Structure. West Branch Intake With Tainter Gate Housing. Looking SW With West Wing Levee Beyond Intake.

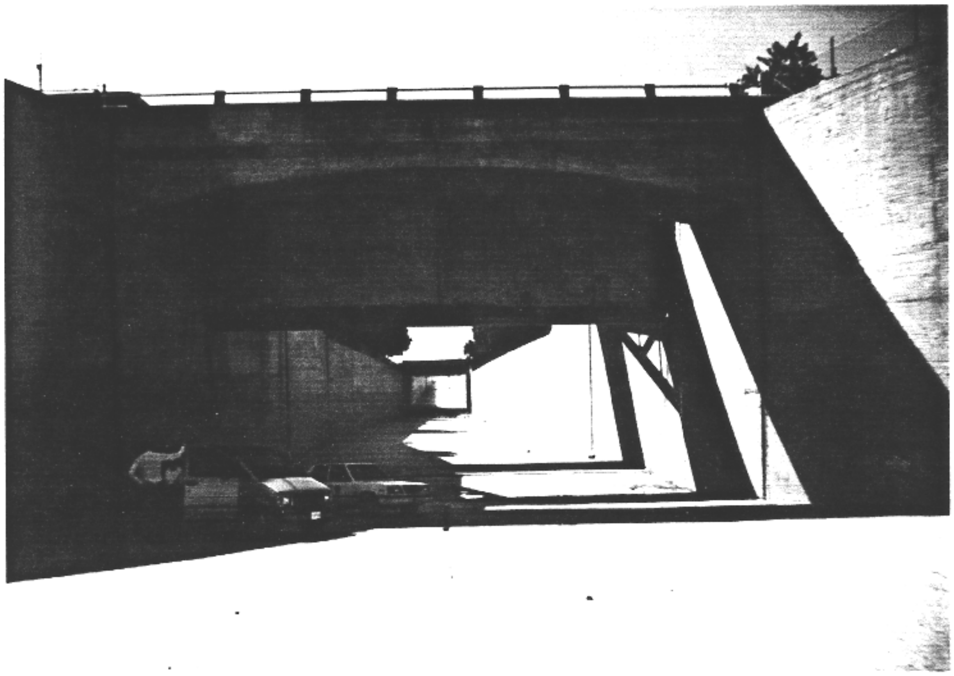


Figure 5. West Branch Lytle Creek Intake Channel With 60'x25' Tainter Gate. Looking South.

Figure 6. West Branch Lytle Creek Channel Looking SW At Tainter Gate During Gate Test. Unused Bypass To East Branch Of Lytle Creek In Foreground; No Longer Used After Construction Of The East Branch Lytle Creek Channel.

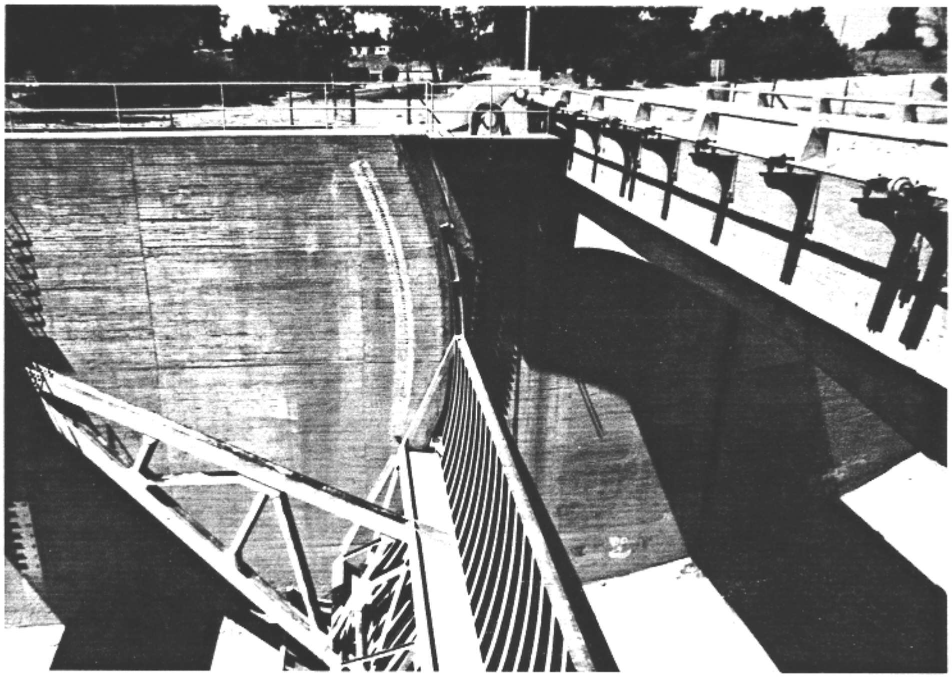


Figure 7. 60' x 25' Tainter Gate In Lytle Creek West Branch Channel Looking West During Gate Test. Lytle Creek Intake Structure.

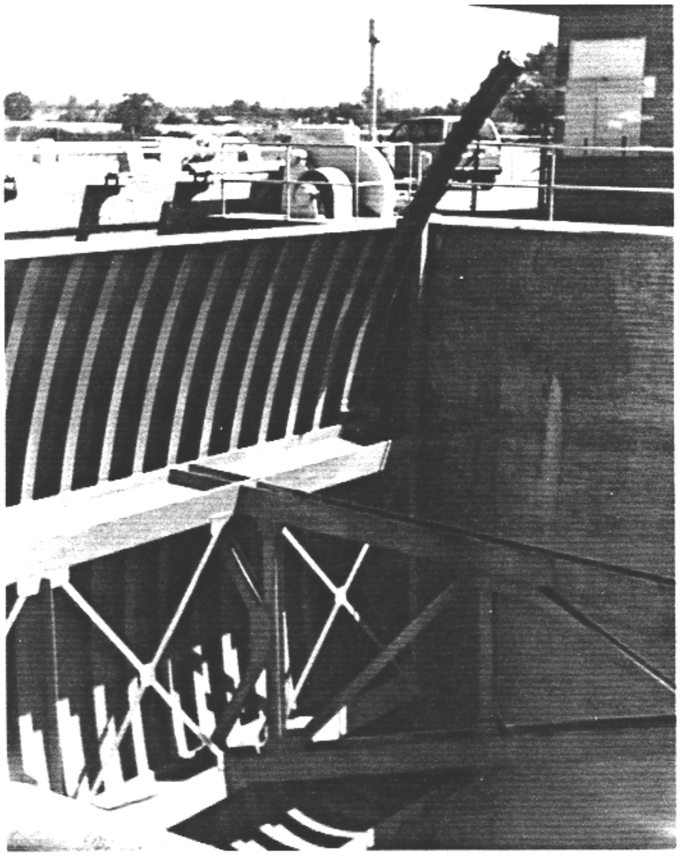


Figure 8. Lytle Creek Intake Structure And Control House. Looking NE Showing 60' x 25' Tainter Gate During Gate Test.

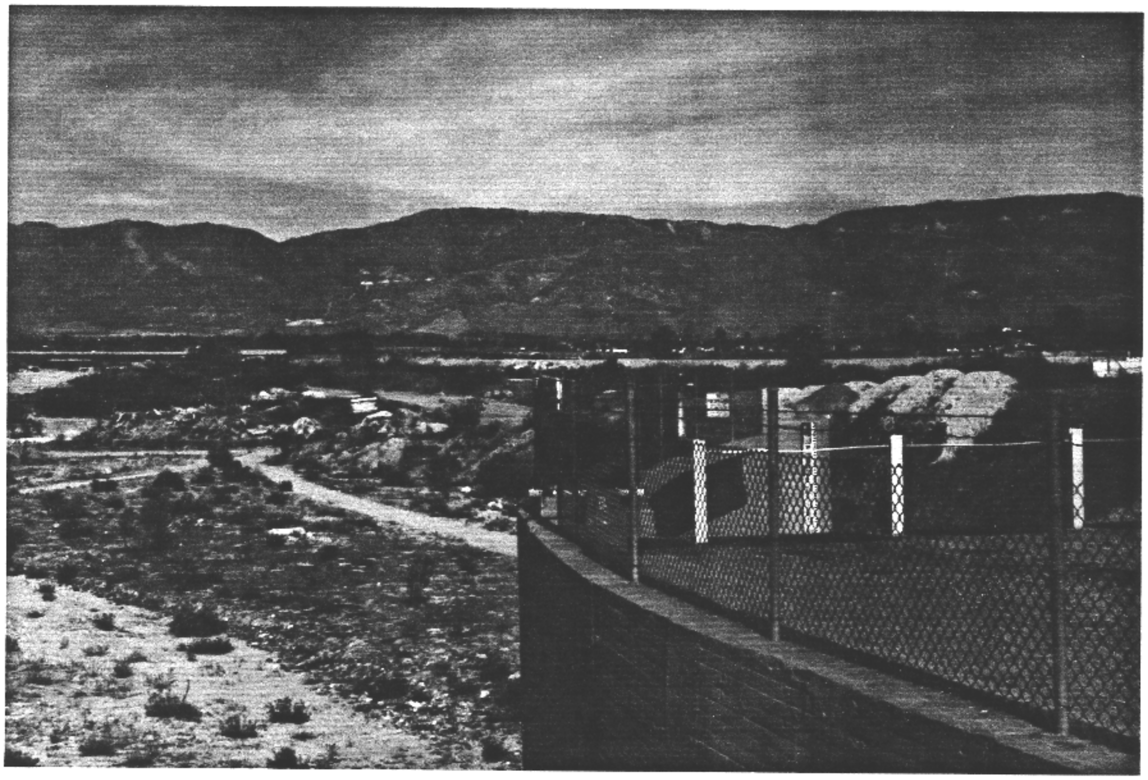


Figure 9. Lytle Creek Inlet Structure At West Branch Intake Looking NE At Lytle Creek Channel With Muscoy Levee In Background.

Figure 10. Lytle Creek Intake Structure Looking SW From Intake To West Branch Channel At The West Wing Levee, 1,000 Ft. Long.

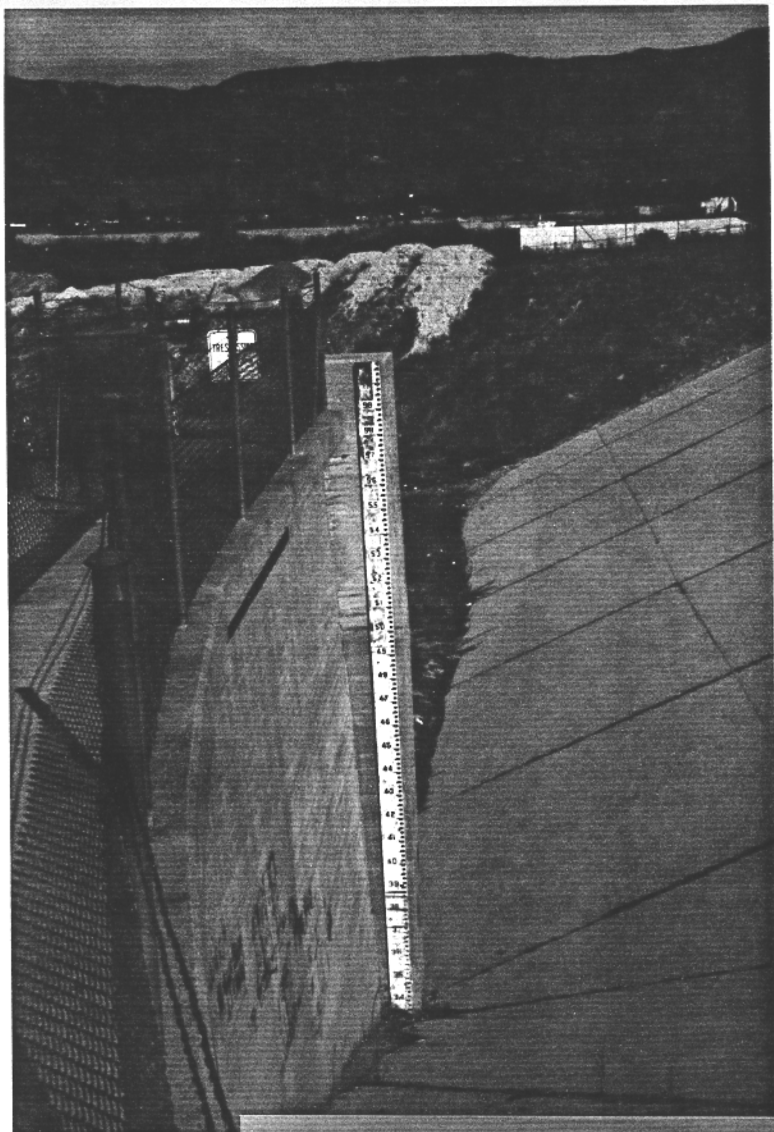
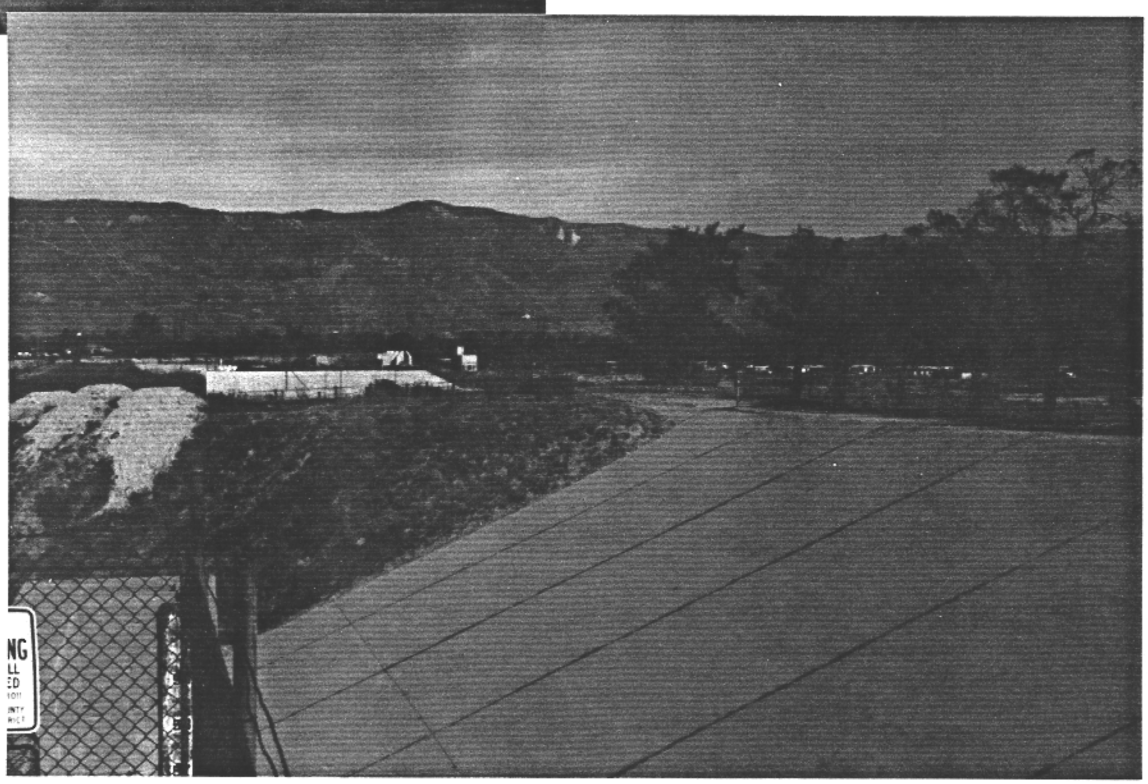


Figure 11. (Left)

Official Staff Gauge At Lytle Creek Intake Structure, Located On East Wall Of West Branch Inlet Just North Of Control House Looking NE.

Figure 12. (Below)

Lytle Creek Intake Structure Looking East Along Wing Levee Toward East Branch Channel Inlet. Haul Road For Gravel Works Crosses Over Inlet Structure Before East Branch Inlet.



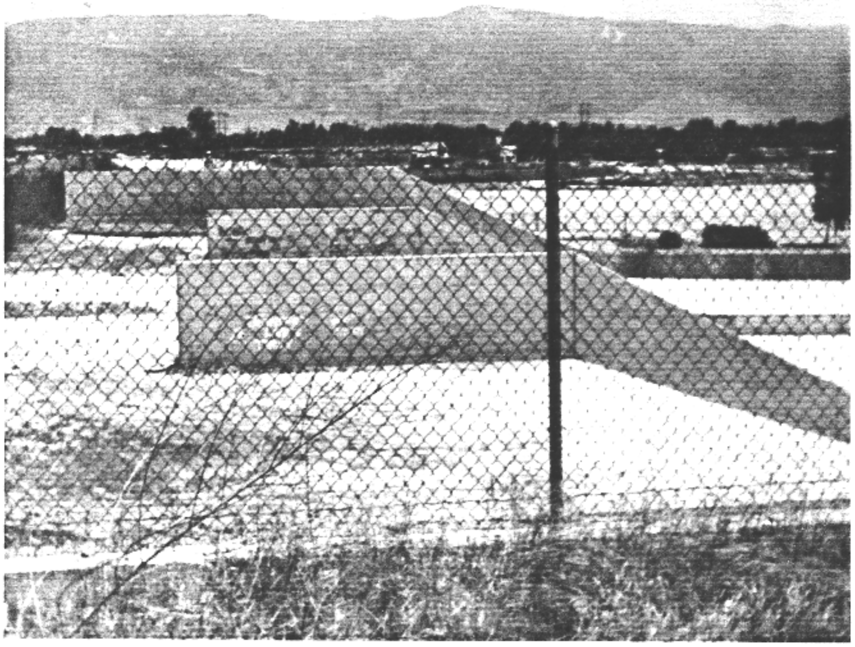


Figure 13. Invert To Lytle Creek East Branch Channel. Elev. 1143.0 looking East.

Figure 14. East Branch Lytle Creek Channel Looking SE. The 58,000 c.f.s. Capacity Channel Is 400 Feet Wide With Training Walls At 132 Foot Intervals.

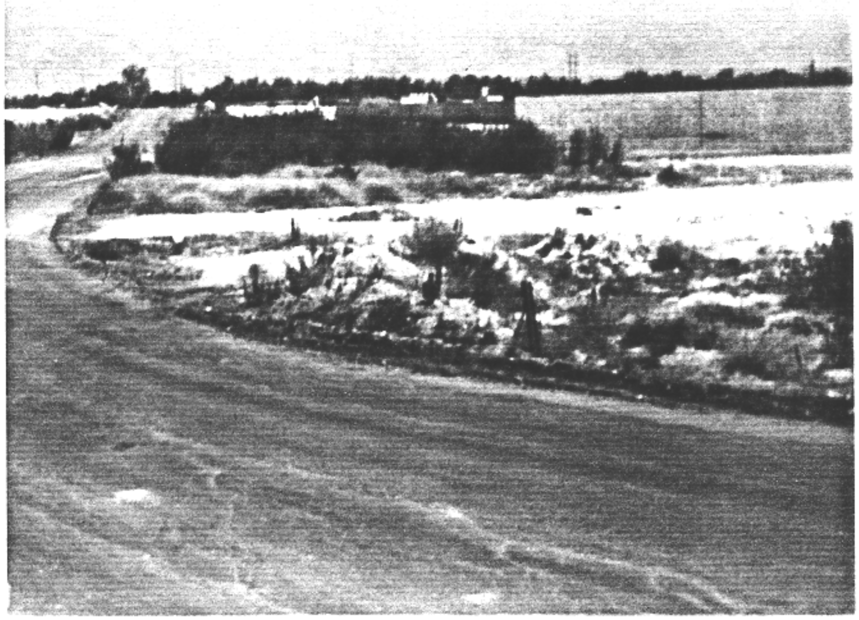


Figure 15. Invert of Lytle Creek East Branch Channel,Elev. 1143.0, With Haul Road Crossing Toward Muscoy Levee. Looking East. A Portion Of Lytle Creek Inlet Structure.

Figure 16. Looking SE Along Lytle Creek East Branch Channel. Flows Above 22,800 c.f.s. Will Begin To Flow Around The Left Wing Levee And A Portion Will Begin To Flow Down The East Branch Channel.

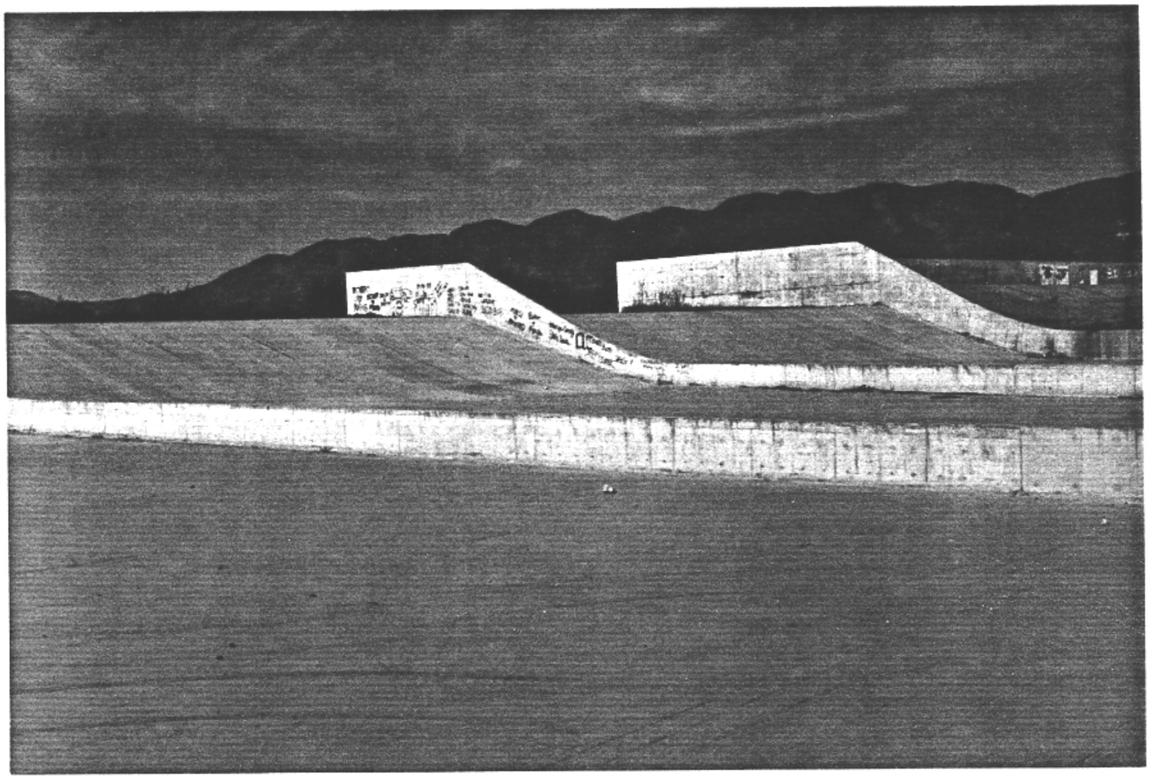


Figure 17. Lytle Creek East Branch Inlet Looking NE. On Right Is The Spillway Levee At Elev. 1160 Ft. Added Onto The Original Bypass Spillway When The East Branch Channel Was Modified. Top Of Levee Wall Is At Elevation 1160 Feet.

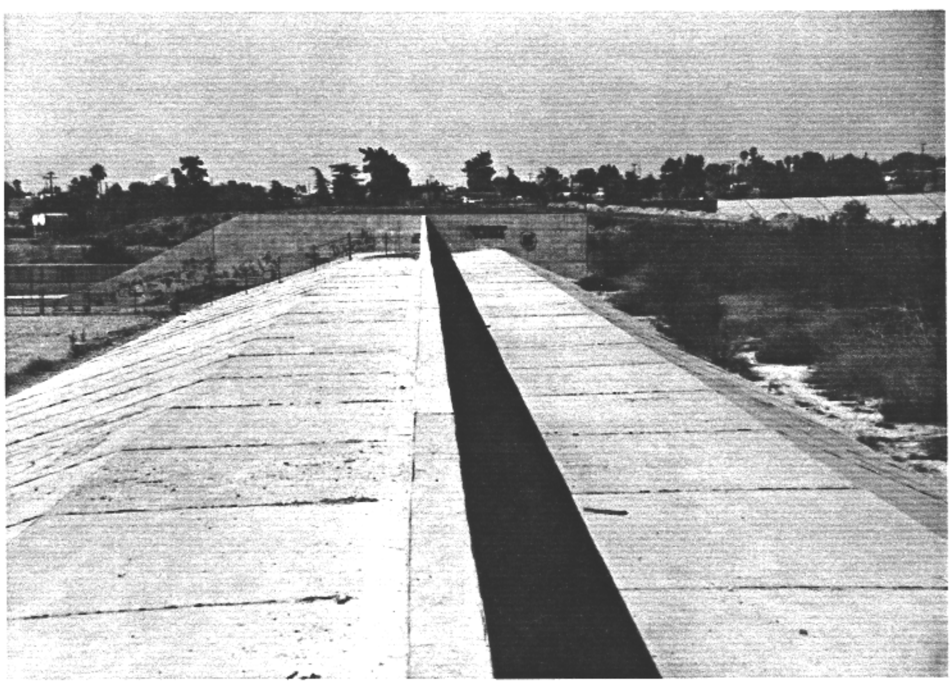


Figure 18. Looking SW Along Spillway Levee Wall Modification To Original Bypass Spillway Toward Inlet To Lytle Creek East Branch Channel And Control House At Lytle Creek West Branch Channel.

Figure 19. Looking NW Along Grouted Quarry Stone Of Muscoy Levee Near The Junction Of East Side Of Lytle Creek Intake Structure With Muscoy Levee.

Figure 20. East Junction Of Lytle Creek Intake Structure With Muscoy Levee At Edge Of Original Bypass Spillway. Looking NW, Showing Original Stage Recorder For Spillway. Gauge Is No Longer Used.

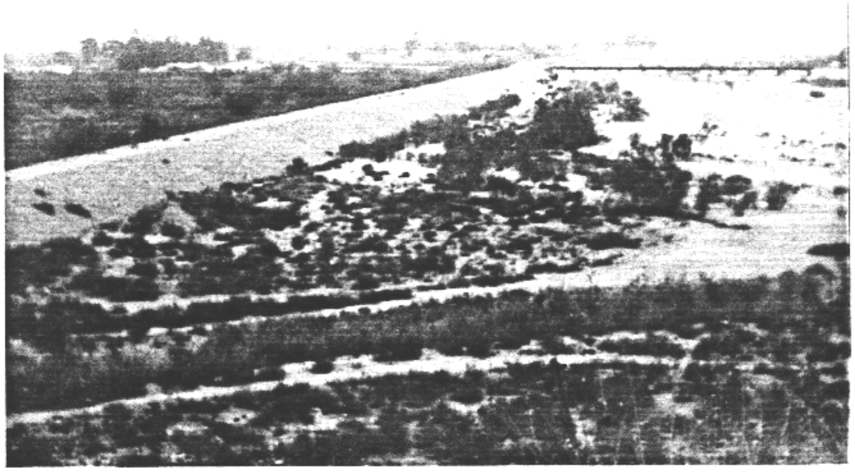


Figure 21. Upper Devore Levee On Cajon Creek Looking South. Showing One Of Two Transcontinental Railroad Bridges At Location.

Figure 22. Upper Devore Levee Looking SE Showing Two Transcontinental Railroad Tracks Crossing Cajon Creek.

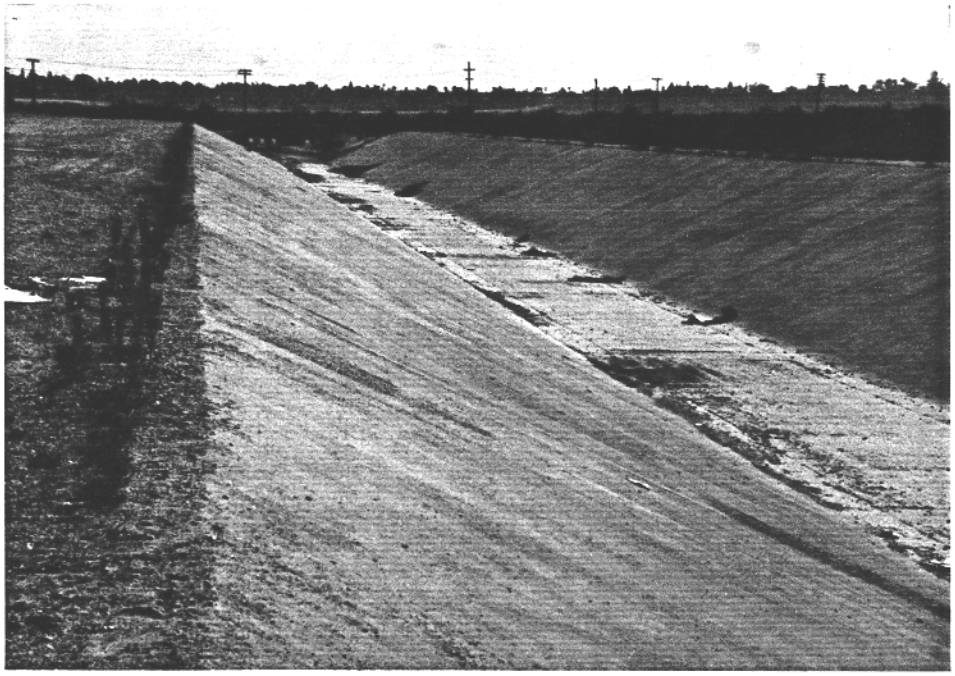


Figure 23. Devil Creek Diversion Structure Looking Downstream (SW) From 3RD Avenue Extension.

Figure 24. Levee Road On Muscoy Groin No.3 Looking South (Downstream) At Grouted Quarry Stone With Cajon Creek Channel On Right.

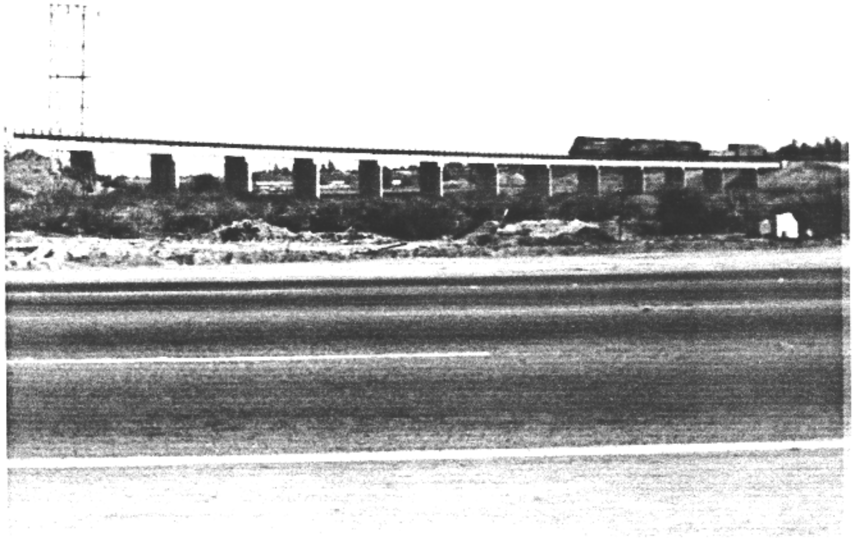


Figure 25. Railroad Crossing Lytle-Cajon Drainage At Highland Avenue Looking South With Island Levee At Right Embankment.

Figure 26. Grouted Quarry Stone Of Island Levee At Highland Avenue Looking South On Lytle-Cajon Drainage, San Bernardino County, California.