State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES
Division of Design and Construction

State Water Project
Future Supply Program

Alternative Offstream Storage Sites South of the Delta

Memorandum Report

November 1983

State of California | The Resources Agency

Memorandum

To : Arthur C. Gooch

Date : DEC 9 1983

File No.:

Subject: Alternative Offstream Storage Sites South of the Delta

From : John H. Lawder
Department of Water Resources

Attached is our Memorandum Report, "Alternative Offstream Storage Sites South of the Delta."

The attached report discusses various offstream storage sites between Clifton Court Forebay and the Coastal Branch, a distance of approximately 170 miles. A total of sixteen damsites were studied and their storage potential evaluated. Two of the lower sites at Ortigalita Creek would be used as forebays to the main dam. Little Panoche Detention site was rejected because of limited usable storage potential. Little Salado and Crow Creeks sites were combined to form one usable reservoir. Because of large embankment and foundation stripping requirements and of the potential agricultural use of the lower reservoir area, the Lower Orestimba site was not evaluated. These changes reduced the total of sixteen damsites studied to eleven reservoir sites for which embankment and area-capacity curves were prepared.

As shown in Table 1, this report summarizes the embankment volumes and reservoir capacities of the eleven alternate reservoir sites south of the Delta for future storage development. In addition, four reservoir sites, which were previously studied and are located at Kellogg and Marsh Creeks at the Delta, were also included for comparison purposes. For most sites, as time permitted, more than one water surface elevation was studied.

In summary, this report is confined to embankment volumes, stripping quantities, site evaluation, and storage potential. Further work will be required to arrive at a cursory level project estimate.

Attachment

SURNAME DWR 155 (REV. 4-62)	12-6-83 12/6/83	12/7 12/7	12/8	12-9-83

D—001832

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

DIVISION OF DESIGN AND CONSTRUCTION

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State of California
The Resources Agency
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ENGINEERING CERTIFICATION

This report has been prepared under my direction as the professional engineer in direct responsible charge of the work in accordance with the provisions of the Professional Engineer's Act of the State of California.

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D-001834

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CONVERSION FACTORS

Quantity	To Convert From Customary Unit	To Metric Unit	Multiply Customary Unit By	To Convert to Customary Unit Multiply Metric Unit By
Length	inches (in)	millimetres (mm)	25.4	0.03937
	inches (in)	centimetres (cm) for snow depth	2.54	0.3937
	feet (ft)	metres (m)	0.3048	3.2808
	miles (mi)	kilometres (km)	1.6093	0.62139
Area	square inches (in^2)	square millimetres (mm^2)	645.16	0.00155
	square feet (ft^2)	square metres (m^2)	0.092903	10.764
	acres (ac)	hectares (ha)	0.40469	2.4710
	square miles (mi^2)	square kilometres (km^2)	2.590	0.3861
Volume	gallons (gal)	litres (L)	3.7854	0.26417
	million gallons (10^6gal)	megalitres (ML)	3.7854	0.26417
	cubic feet (ft^3)	cubic metres (m^3)	0.028317	35.315
	cubic yards (yd^3)	cubic metres (m^3)	0.76455	1.308
	acre-feet (ac-ft)	cubic dekametres (dam^3)	1.2335	0.8107
Flow	cubic feet per second (ft^3/s)	cubic metres per second (m^3/s)	0.028317	35.315
	gallons per minute (gal/min)	litres per minute (L/min)	3.7854	0.26417
	gallons per day (gal/day)	litres per day (L/day)	3.7854	0.26417
	million gallons per day (mgd)	megalitres per day (ML/day)	3.7854	0.26417
	acre-feet per day (ac-ft/day)	cubic dekametres per day (dam^3/day)	1.2335	0.8107
Mass	pounds (lb)	kilograms (kg)	0.45359	2.2046
	tons (short, 2,000 lb)	megagrams (Mg)	0.90718	1.1023
Velocity	feet per second (ft/s)	metres per second (m/s)	0.3048	3.2808
Power	horsepower (hp)	kilowatts (kW)	0.746	1.3405
Pressure	pounds per square inch (psi)	kilopascals (kPa)	6.8948	0.14505
	feet head of water	kilopscals (kPa)	2.989	0.33456
Specific Capacity	gallons per minute per foot drawdown	litres per minute per metre drawdown	12.419	0.08052
Concentration	parts per million (ppm)	milligrams per litre (mg/L)	1.0	1.0
Electrical Conductivity	micromhos per centimetre	microsiemens per centimetre (uS/cm)	1.0	1.0
Temperature	degrees Fahrenheit (°F)	degrees Celsius (°C)	(°F-32)/1.8	(1.8 x °C)+32

1.0 Synopsis

This report contains a preliminary appraisal of the volume of dam earthwork required and reservoir storage available at various locations along the Governor Edmund G. Brown California Aqueduct south of the Delta. The reservoir sites are shown in Figure 1.

2.0 Summary and Conclusions

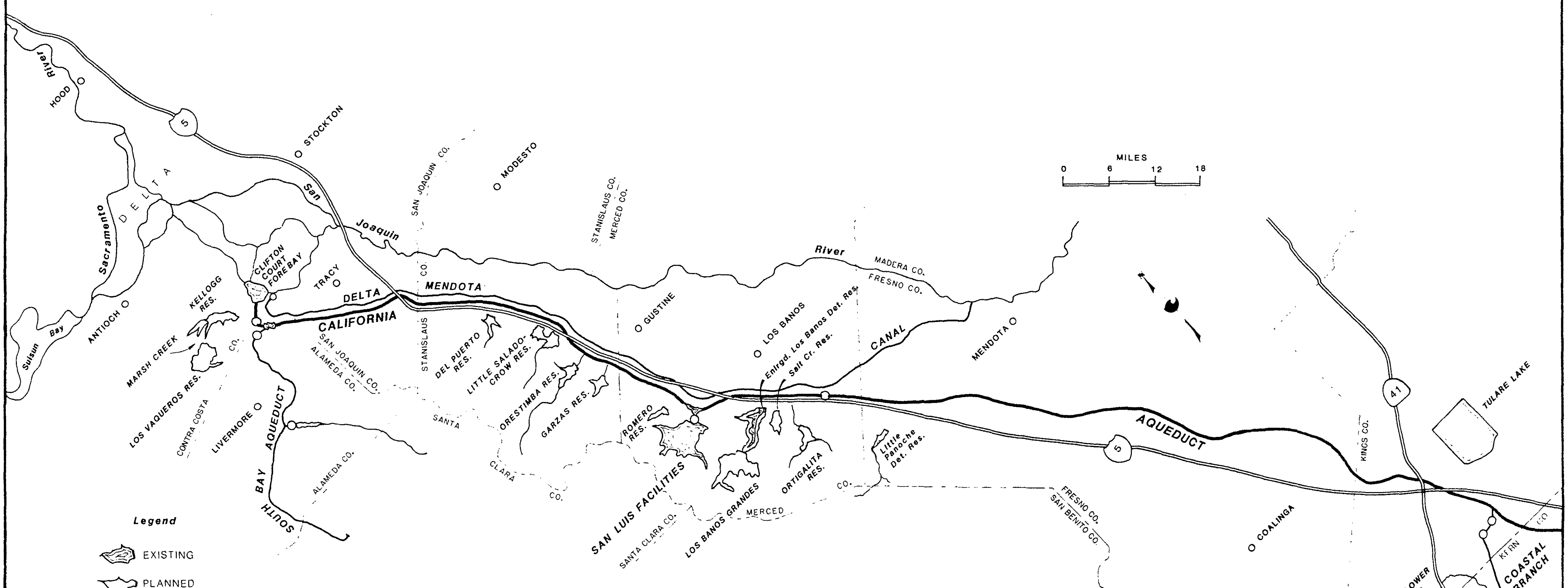
From a quantitative standpoint, the Los Banos Grandes site is clearly superior to all others in this report. Los Banos Grandes has by far the best ratio of storage per unit volume of embankment of any site studied. Stripping is minimal, and construction materials are found locally or within short distances of the site in sufficient quantity and quality. The only evident geological problem of the site is seismicity and fault proximity, which can be allowed for in design, and which is a problem with all sites in the study.

Romero is probably the worst site in the study, with Little Salado and Crow and Ortigalita very close behind. These sites have a very low ratio of storage per unit volume of embankment.

Enlargement of the existing Los Banos Detention Dam presents several difficult technical problems; namely, - the evaluation of the condition and enlargement of the existing outlet works, and the interface of the new dam core and existing dam blanket drain.

Sunflower is considerably further south than any of the other sites, is south of Dos Amigos Pumping Plant, requires seven saddle dams, and has an active oil field in the reservoir. The proposed normal pool at Sunflower site was reduced from 750 feet to 700 feet for this study because it is more engineeringly feasible.

The present capacity of 750 second-feet in the Coastal Branch Aqueduct which is only two miles from the site is inadequate for water conveyance from the Governor Edmund G. Brown California Aqueduct to Sunflower. A new canal and



ALTERNATIVE OFFSTREAM STORAGE RESERVOIR SITES - SOUTH OF DELTA

FIGURE I

pumping plants must be constructed to convey the larger flow from the Governor Edmund G. Brown California Aqueduct to the site, a distance of about 10 miles.

3.0 Quality of Studies

The sites studied in this report and listed on Table 1 range from large, relatively well studied sites such as Los Vaqueros and Los Banos Grandes to sixteen valley sites on which only recent preliminary appraisals were conducted.

4.0 Purpose

The purpose of this report is to document the site characteristics, storage availability, preliminary geological appraisal, and embankment required for potential off-stream storage sites at and south of the Delta.

5.0 Scope of the Work

This work is limited to cursory appraisal of dam sites and calculation of earthwork volumes. Pertinent site aspects not considered include hydrology, outlet works, spillways, conveyance facilities, pump-generating features, energy costs or even material availability.

The embankment volumes and storage capacities are summarized in Table 1 and plotted in Figures 2 and 3. The volumes calculated are total embankment and do not distinguish between core and shell materials.

Maximum embankment sections and embankment curves are included in Appendix II.

6.0 Basic Data

6.1 Topography

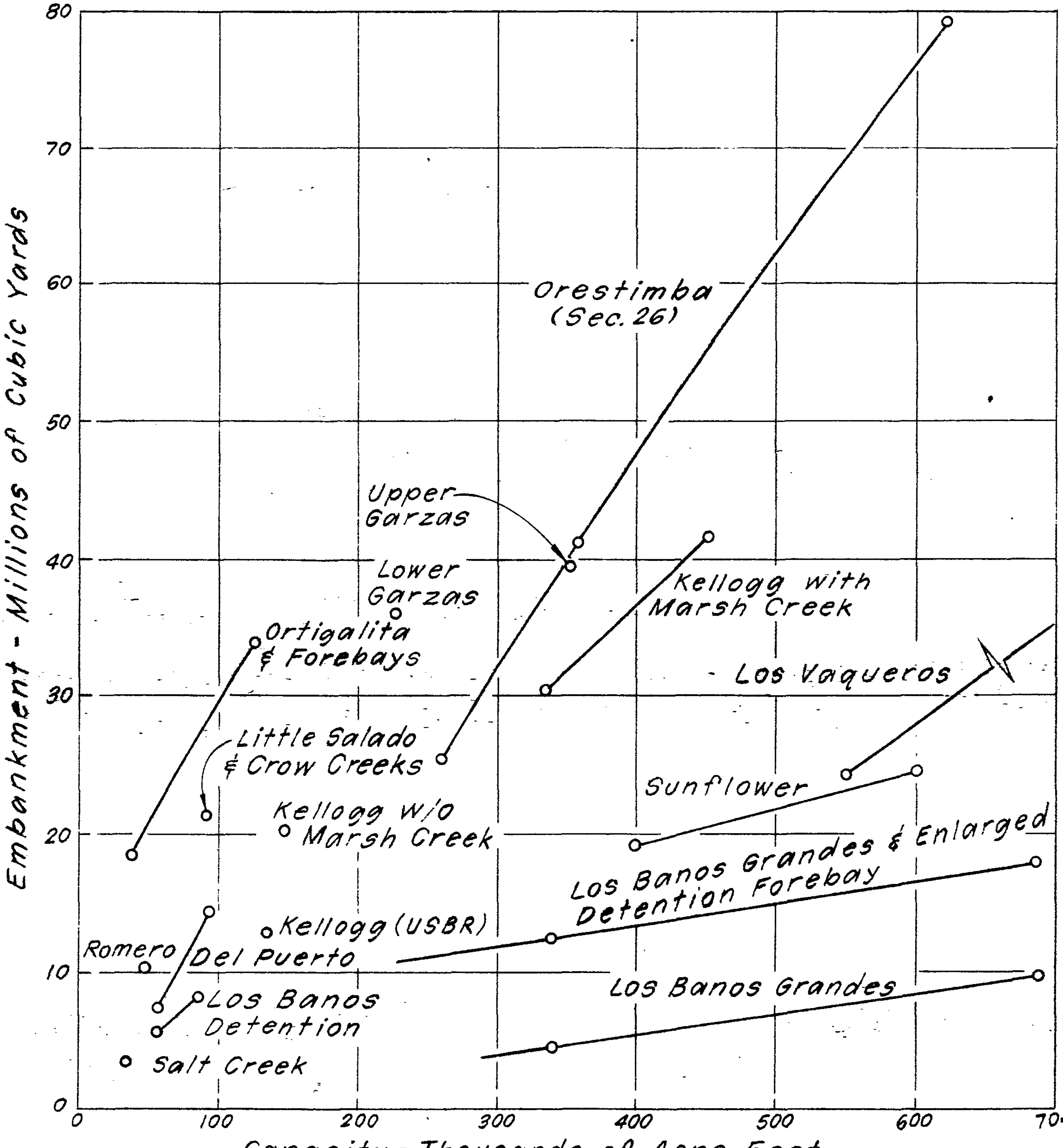
Reservoir volumes were obtained from U.S.G.S. 7.5-minute quadrangles at a scale of 1 inch equals 2,000 feet and contour intervals ranging from 20 to 40 feet. Embankment and stripping were estimated from these quadrangle

TABLE 1

EMBANKMENT VOLUMES AND RESERVOIR CAPACITIES

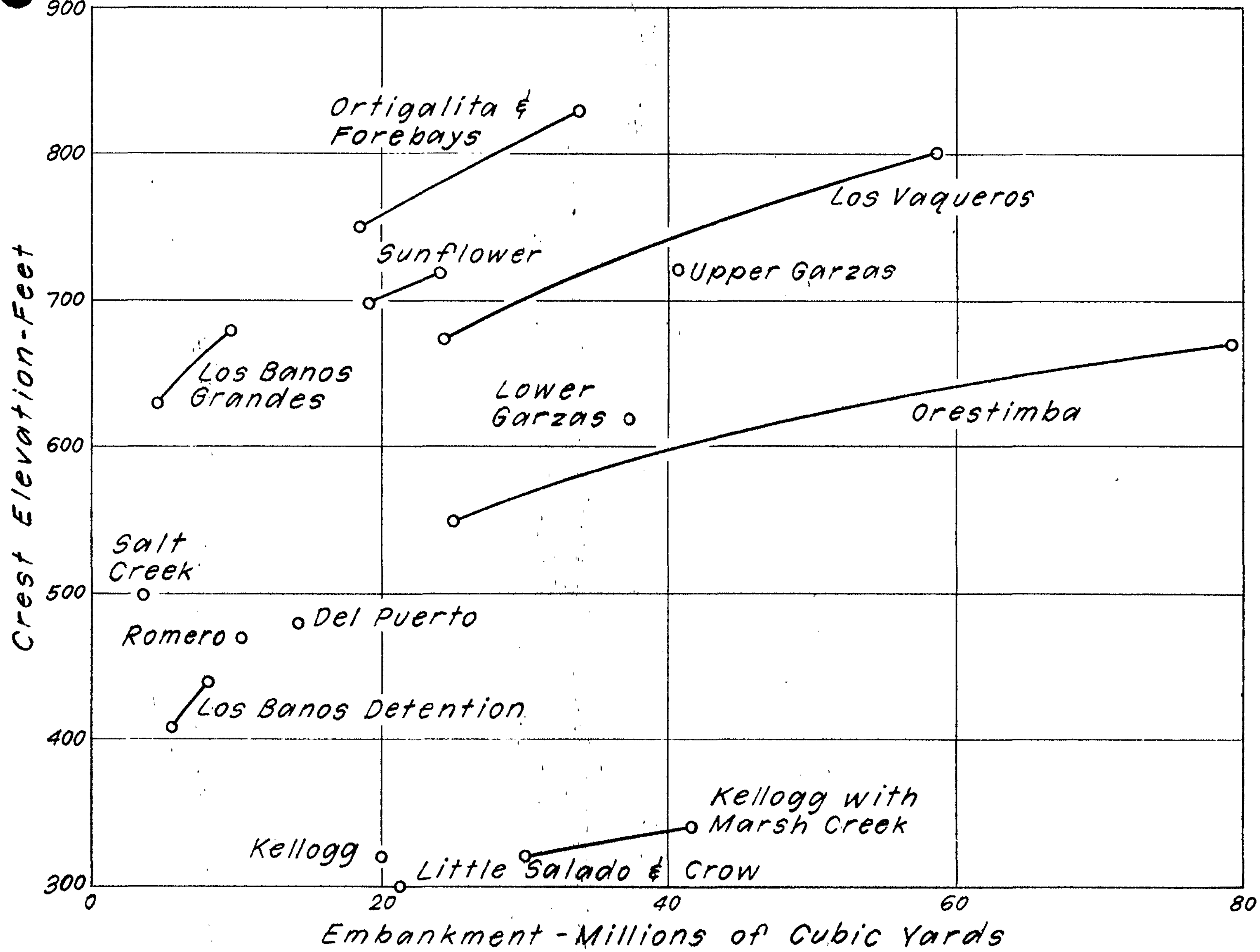
Reservoir	W.S. Elev. Feet	Capacity 1,000 A.F.	Embankment - Millions C.Y. W.O.	With Stripping
Los Vaqueros**	780*	1065		58.8
	656	553	20.4	24.1
Kellogg W/O Marsh Cr.**	300	150	15.8	20.1
Kellogg and Marsh Cr.**	320*	452		43.0
	300	334		30.1
Kellogg (USBR)**	300*	135		13.0
Del Puerto	460*	97	11.8	14.4
	405	56	5.9	7.6
Little Salado and Crow Creeks	380*	95	12.6	21.5
Orestimba - Upper	660	620	71.7	79.4
	580	360	36.7	41.0
	540	260	22.8	25.1
Garzas - Upper	700*	340	37.1	39.9
Garzas - Lower	600*	228	32.8	36.3
Romero	450*	49	8.2	10.2
Los Banos Grandes	660	680	8.6	9.9
	610	340	3.9	4.6
Enlarged Los Banos Detention	415*	86	7.3	8.1
	385	57	5.0	5.7
Salt Creek	480*	35	2.7	3.7
Ortigalita	810	125	26.7***	34.0***
	730	36	13.2***	18.6***
Sunflower	700	600	15.0	24.6
	680	400	10.7	19.2

*Recommended maximum water surface elevation
**Reservoir sites previously studied
***Includes forebay volumes



OFFSTREAM STORAGE SITES
SOUTH OF THE DELTA
EMBANKMENT VOLUME VS. STORAGE CAPACITY

Figure 2



OFFSTREAM STORAGE SITES
SOUTH OF THE DELTA
EMBANKMENT VOLUME VS. CREST ELEVATION

Figure 3

sheets except for Los Banos Grandes, Los Vaqueros, and Kellogg which have been mapped at appropriate scales by DWR.

6.2 Geology

The results of the preliminary appraisal by Project Geology are included in Appendix III to this report. The geologic reconnaissance consisted of brief field inspections of the sites (sometimes from a distance), a review of previous exploration and mapping by the Department, U.S.B.R., and others, and a search of published literature and regional geological mapping.

6.3 Area-Capacity Curves

Area-capacity curves for preliminary appraisal sites were based on U.S.G.S. quandrangles having scales and contour intervals as listed in Section 6.1. There are exceptions, however. Los Vaqueros, Kellogg and Los Banos Grandes sites are based on detailed topography prepared during higher level investigations. The scales and contour intervals are as follows:

	Damsite		Reservoir	
	Scale	CI	Scale	CI
Los Vaqueros	1 cm =25m	2m	1 cm = 50m	5m
Kellogg (Main Dam)	1 in.=240 ft.	5 ft.	1 in.=2,000 ft.	20 ft.
Los Banos Grandes	1 in.=200 ft.	10 ft.	1 in.=2,000 ft.	40 ft.

The area-capacity curves are shown in Appendix I and were prepared by the Planning staff.

7.0 Discussion of Design

7.1 Maximum Embankment Section

The maximum embankment section was estimated to be a modified homogeneous type with an impervious central core, a semi-pervious upstream shell, pervious downstream filters and chimney and blanket drains, and an essentially random downstream shell. Slopes were assumed to be 3.5 to 1 upstream and 3 to 1 downstream. This basic section was modified (upstream and downstream slopes usually flattened) where staff had special concerns about the foundation, site geography or seismic risk.

The actual embankment section used to calculate quantities for each site is included in Appendix II on the embankment volume vs. elevation figure for that site.

7.2 Los Vaqueros

The embankment and storage volumes at Los Vaqueros shown in this report were taken from previous work and reports. No new work was done for this study. The largest reservoir considered feasible at the Los Vaqueros Dam site would have a capacity of 1,065,000 acre-feet at water surface Elevation 780 feet.

Previous studies at Los Vaqueros also included reservoirs at Elevations 740, 700, and 656 feet (200 metres). Storages were 894,000, 700,000, and 553,000 acre-feet, respectively. Required embankment volumes can be found in Table 1 or in the Design and Construction Memorandum Reports, "Engineering Feasibility of Los Vaqueros Project", dated January 1981, and "Engineering Feasibility of Los Vaqueros Offstream Storage Unit With 680,000 Cubic Dekametres Capacity", dated September 1982.

7.3 Kellogg

(a) With Marsh Creek

The Kellogg Reservoir with Marsh Creek Dam and Saddle Dams is shown in Figure 4. The embankment and storage volumes for this reservoir were taken from the Design and Construction Memorandum Report, "Reconnaissance Study and Cost Estimate for Kellogg Offstream Storage Unit", dated September 1982. Three 200-to 300-foot-high dams (Kellogg, Marsh Creek, and Brushy Creek) and ten smaller dikes are required to contain the reservoir. Two water surfaces were studied; normal water surface Elevation 300 feet, with 334,000 acre-feet storage requiring 30.1 million cubic yards of embankment, and N.W.S. 320 feet with 452,000 acre-feet of storage from 43.0 million cubic yards of embankment. Side slopes on the major dams were 3.5:1 upstream and 3.25:1 downstream. Side slopes on the smaller dikes were 3:1 and 2.5:1.

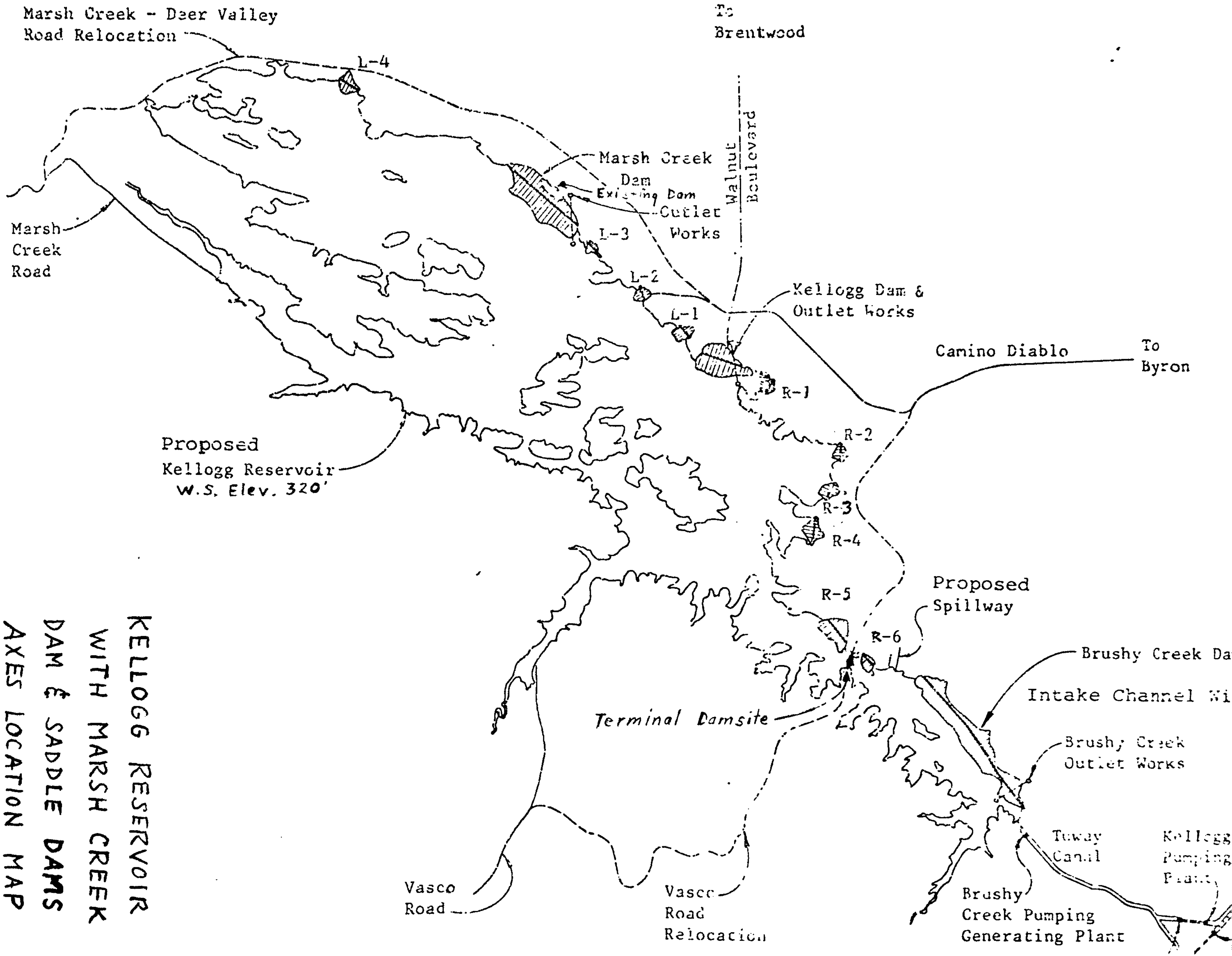
The main damsite is nearly the same as that explored by the U. S. Bureau of Reclamation in 1961. A few of the dike sites have been drilled by either DWR or USBR. No geologic exploration has been done at Brushy Creek site. Preconstruction exploration for the existing Marsh Creek Detention Dam was reviewed. Only reconnaissance level studies were made for the remaining dike sites. Results of the geologic investigations are given in a report entitled "Kellogg Offstream Storage Unit Reconnaissance Level Geologic Investigation" prepared by Project Geology and included in the Central District Memorandum Report "Reconnaissance Level Study of Kellogg Offstream Storage Unit", dated March 1983.

(b) <u>Without Marsh Creek</u>

Kellogg without Marsh Creek was created by eliminating Marsh Creek and Briones Valley from the big Kellogg Reservoir. The Marsh Creek Dam and three "L" saddle dams were eliminated and two new saddle dams added (see Figures 4 and 5). Stripping was assumed as for the "L" saddle dams. Embankment quantities were estimated using slopes similar to those in (a) above.

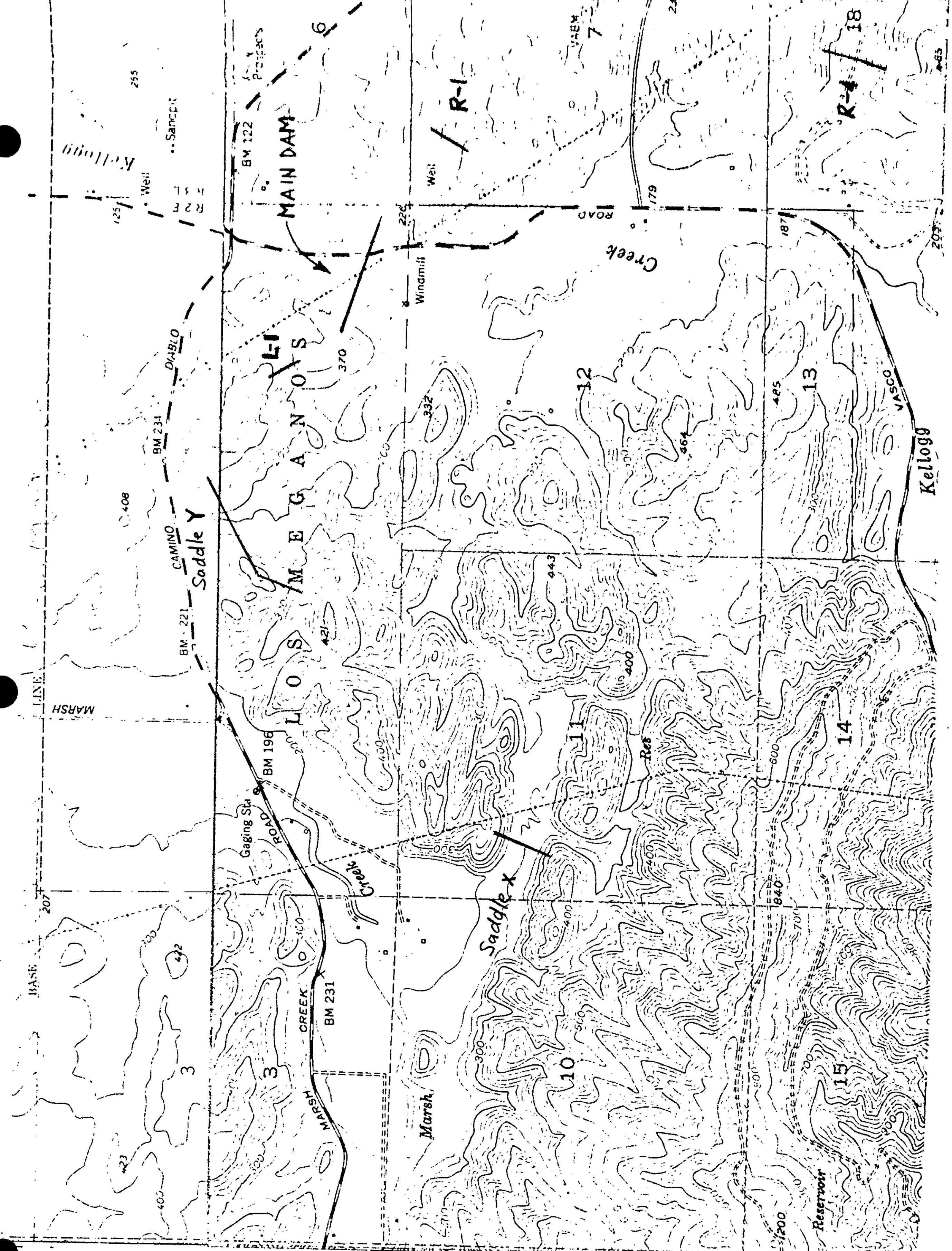
(c) <u>Without Marsh Creek or Brushy Creek</u>

Brushy Creek is included in the above Kellogg plans to add storage. If extra storage is not essential, a substantial savings can be made by eliminating the Brushy Creek Dam and B-6 saddle dam and adding a small terminal dam and 9,000 feet of canal, producing a reservoir of 135,000 acre-feet at NWS Elevation 300 from 13,000,000 cubic yards of embankment. Essentially this



KELLOGG RESERVOIR WITH MARSH CREEK DAM & SADDLE DAMS AXES LOCATION MAP

FIGURE 4



KELLOGG RESERVOIR WITHOUT MARSH CREEK DAM & SADDLE DAMS - AXES LOCATION MAP

FIGURE 5

would amount to a trade of 15,000± acre-feet of storage and 7,100,000 cubic yards of embankment for 2 miles of small concrete lined canal, at a savings of about 30 million dollars.

Without Brushy Creek Dam the pumping-generating plant serving to lift water from the aqueduct level (±243 feet) to the new reservoir would have to be moved to the terminal dam location as shown in Figure 4.

7.4 Del Puerto

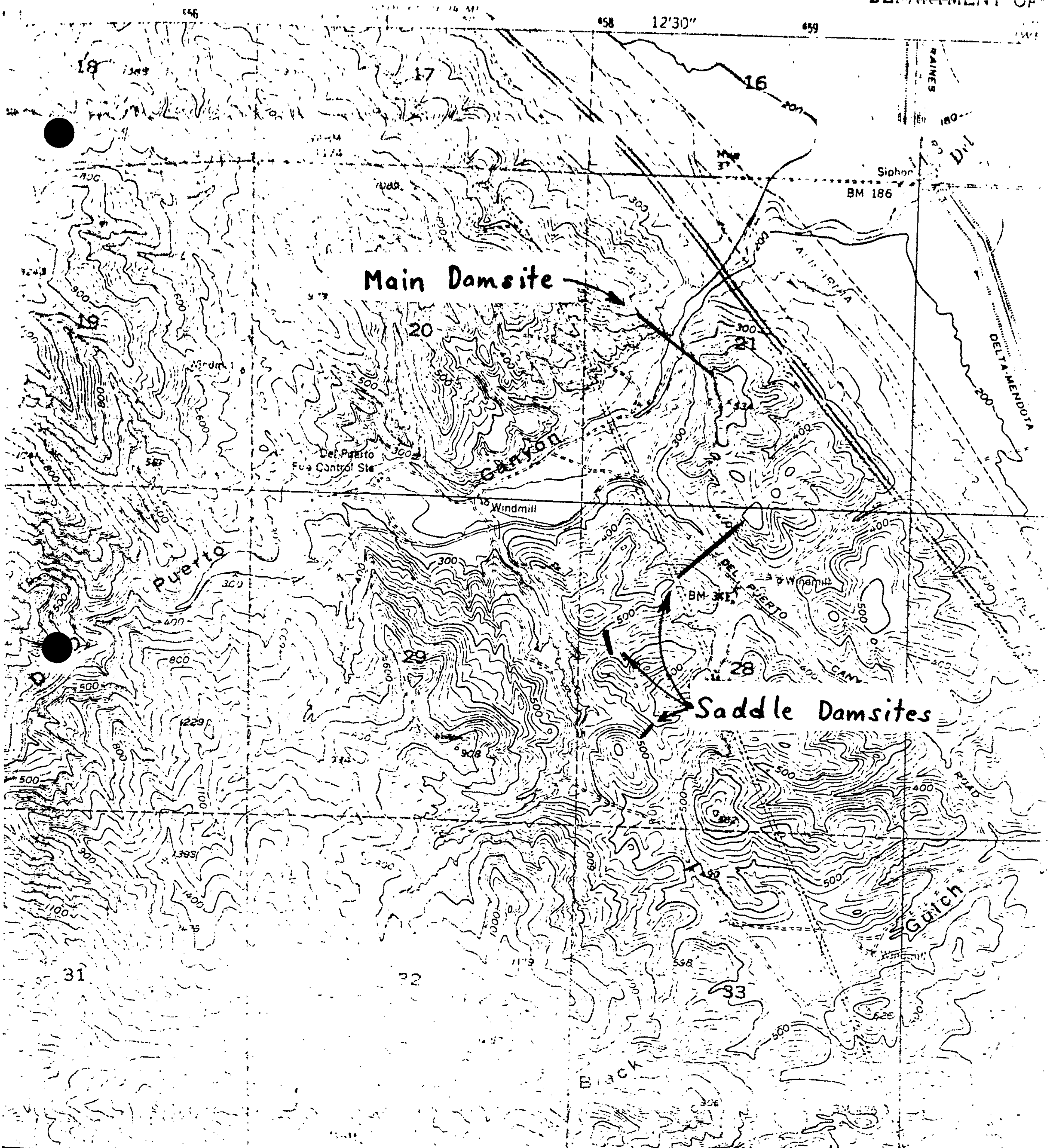
Embankment volumes versus crest elevation curves from a previously unpublished study done in 1977 were utilized at the Del Puerto site even though the 20-foot stripping depth exceeds the 8 to 12 feet estimated by Project Geology for this study. Although greater heights were considered previously, current reasoning is to limit the water surface elevation to about Elevation 460 feet so as to minimize the number of saddle dams. The largest of three would have a height of 160 feet. Side slopes of 3.5:1 were assumed both upstream and downstream. The main and saddle damsites are shown in Figure 6.

7.5 Little Salado and Crow Creek

Little Salado and Crow Creek would have a combined capacity of slightly less than 100,000 acre feet as shown in Figure 21. This is due to the presence of a low ridge at the Salado site with overlying terrace materials that appear to be pervious. Both dams would require considerable (45 feet) depths of stripping in their wide (3,000 feet) stream channels. A 4:1 upstream slope and 3.5:1 downstream were chosen due to the scarcity of pervious borrow materials. Axis locations are shown on Figures 7 and 8.

7.6 Orestimba

The Orestimba site is located about three miles west of the Governor Edmund G. Brown California Aqueduct. Although heights in excess of 300 feet were studied, lower dams are feasible. Due to the availability of



DEL PUERTO DAM AND SADDLE DAMS - AXES LOCATION MAP

FIGURE 6

LITTLE SALADO DAM
AXIS LOCATION MAP

QUADRANGLE LOCATION

FIGURE 7

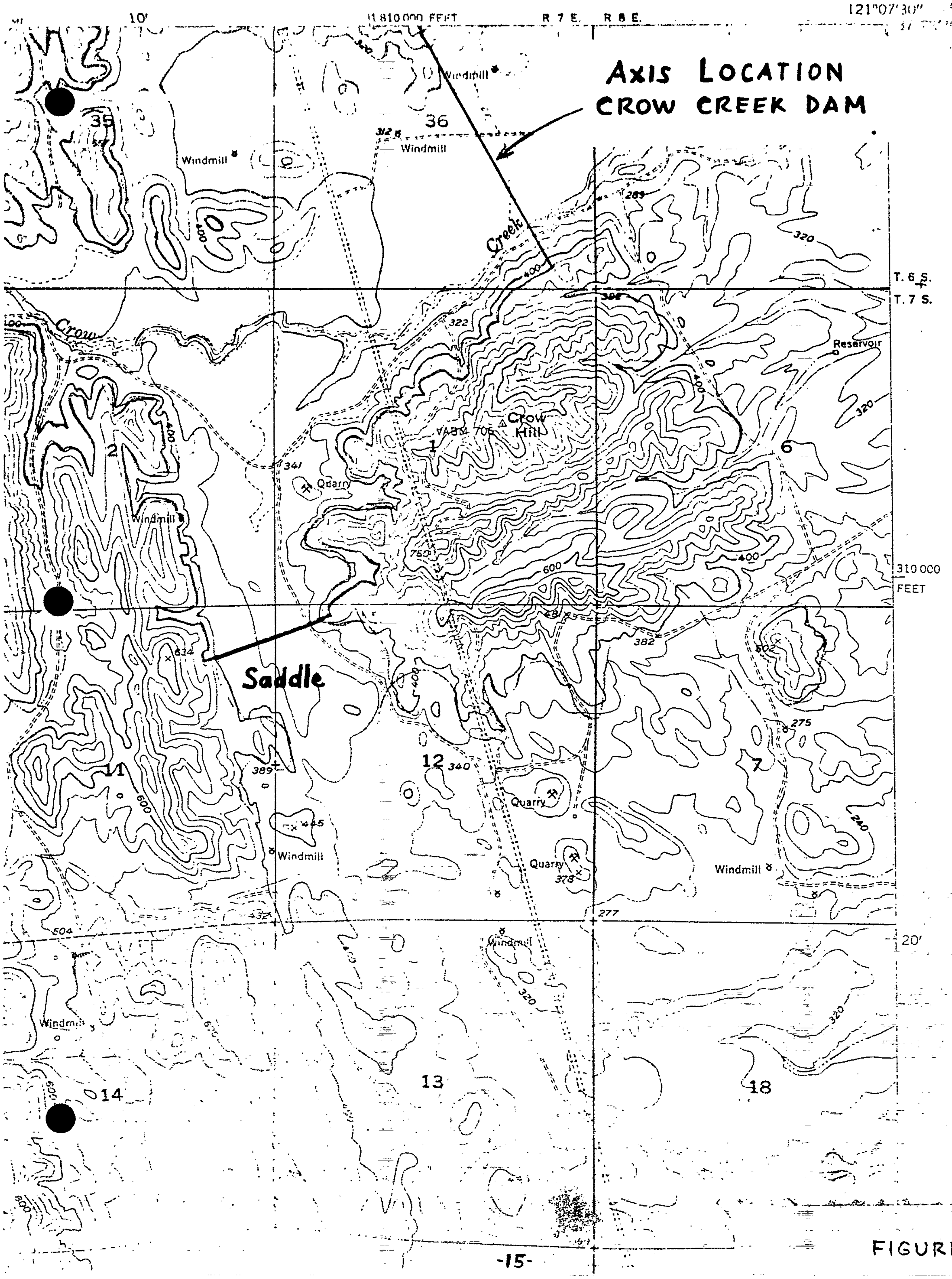


FIGURE 8

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pervious materials, slopes of 3:1 downstream and 3.5:1 upstream were assumed. This site is shown on Figure 9 and is identified in the geology appendix as the upper Orestimba Creek Damsite.

7.7 Garzas

Two sites were evaluated at Garzas Creek as shown in Figure 10.

Topography of the left abutment limits the water surface at the Lower Garzas site to about Elevation 600 feet. The upper site is limited to about Elevation 700 feet by the thinness of the abutments. The embankment slopes were the same as those chosen for Orestimba site and for similar reasons. Storage capacities of 290,000 to 340,000 acre-feet are feasible at the lower and upper sites respectively.

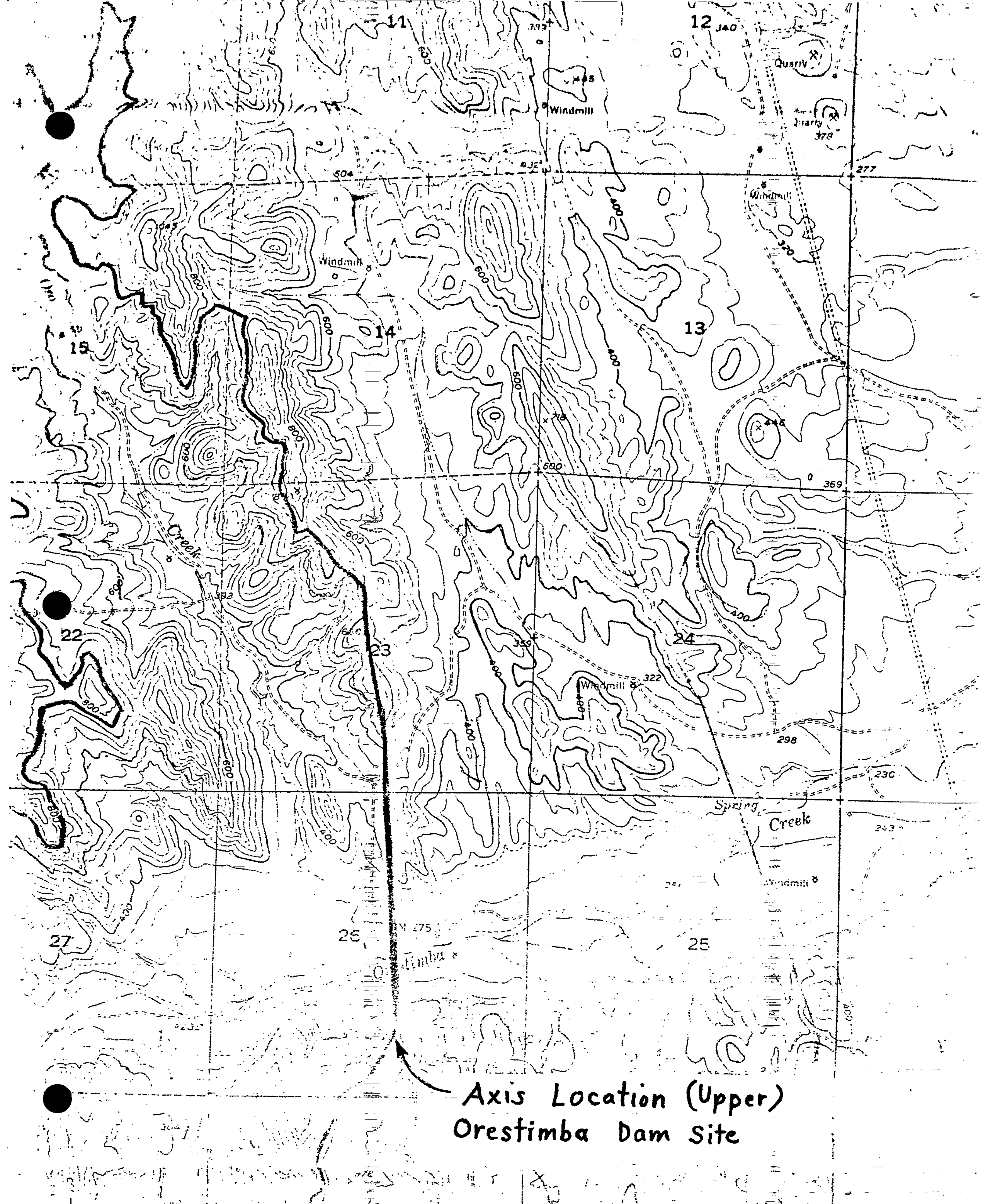
7.8 Romero

Shown in Figure 11 is the Romero site. Topography limits the amount of potential storage capacity.

No more than about 49,000 acre feet can be developed at the Romero site without having to construct numerous dikes along the left abutment ridge. Due to the moderately deep (25 feet) alluvium in the channel and assumed lack of pervious materials, a conservative upstream slope of 4:1 was selected.

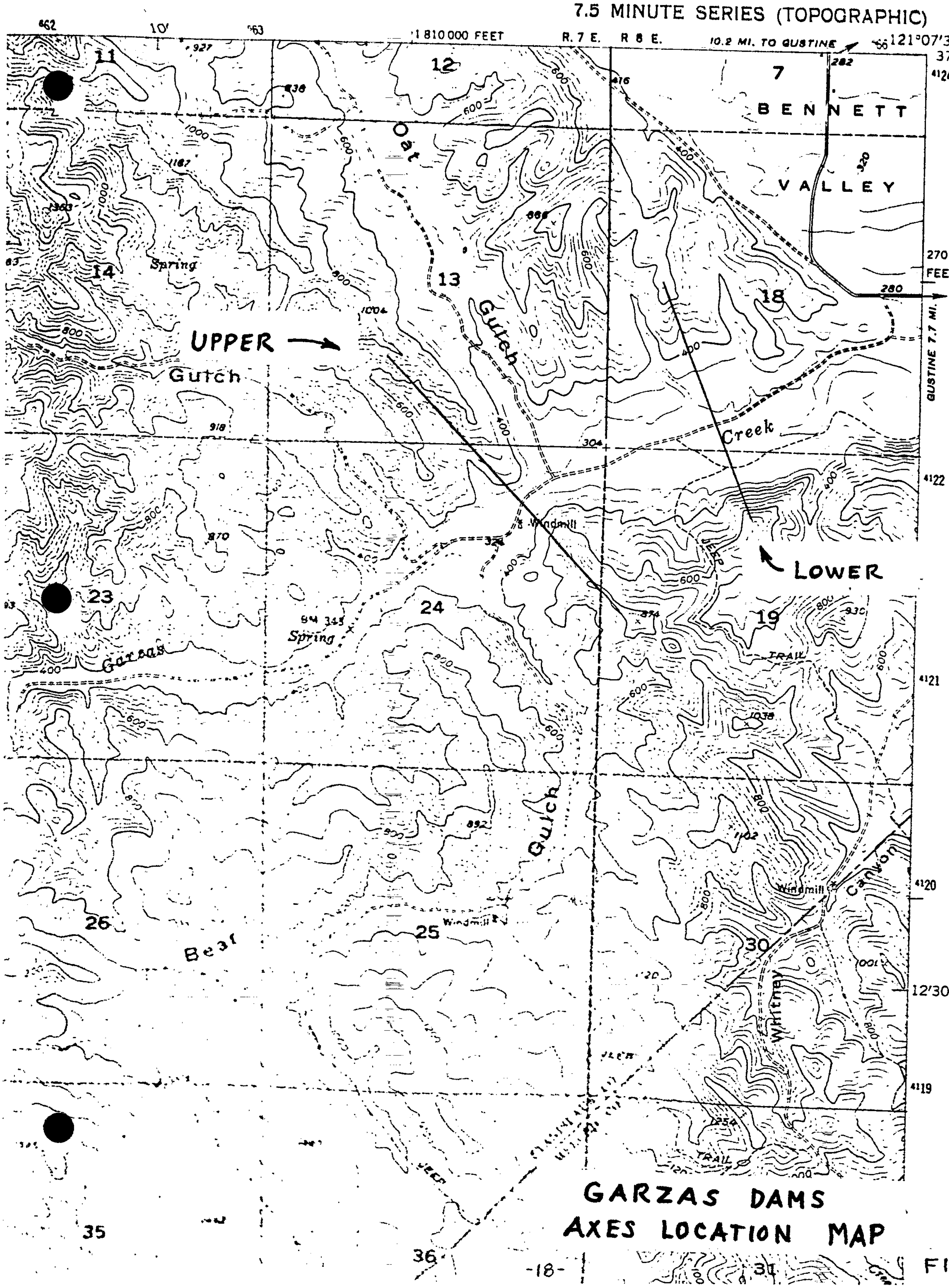
7.9 Los Banos Grandes

A storage capacity of 250,000 acre-feet can be developed with a dam at the Los Banos Grandes site and a freeboard dam on the saddle toward the Salt Creek drainage (Gaston Bide Saddle). Two larger sizes of reservoir, which included Salt Creek, were investigated during the course of this study.An auxiliary damsite approximately one mile east of "Gaston Bide Saddle" was considered for the current estimates. It appears that the volumes of embankment above ground and foundation excavation are less at this lower site on Salt Creek.


11
12
Quarry
Windmill
14
13
15
Creek
22
23
24
Spring Creek
27
26
25
Axis Location (Upper)
Orestimba Dam Site

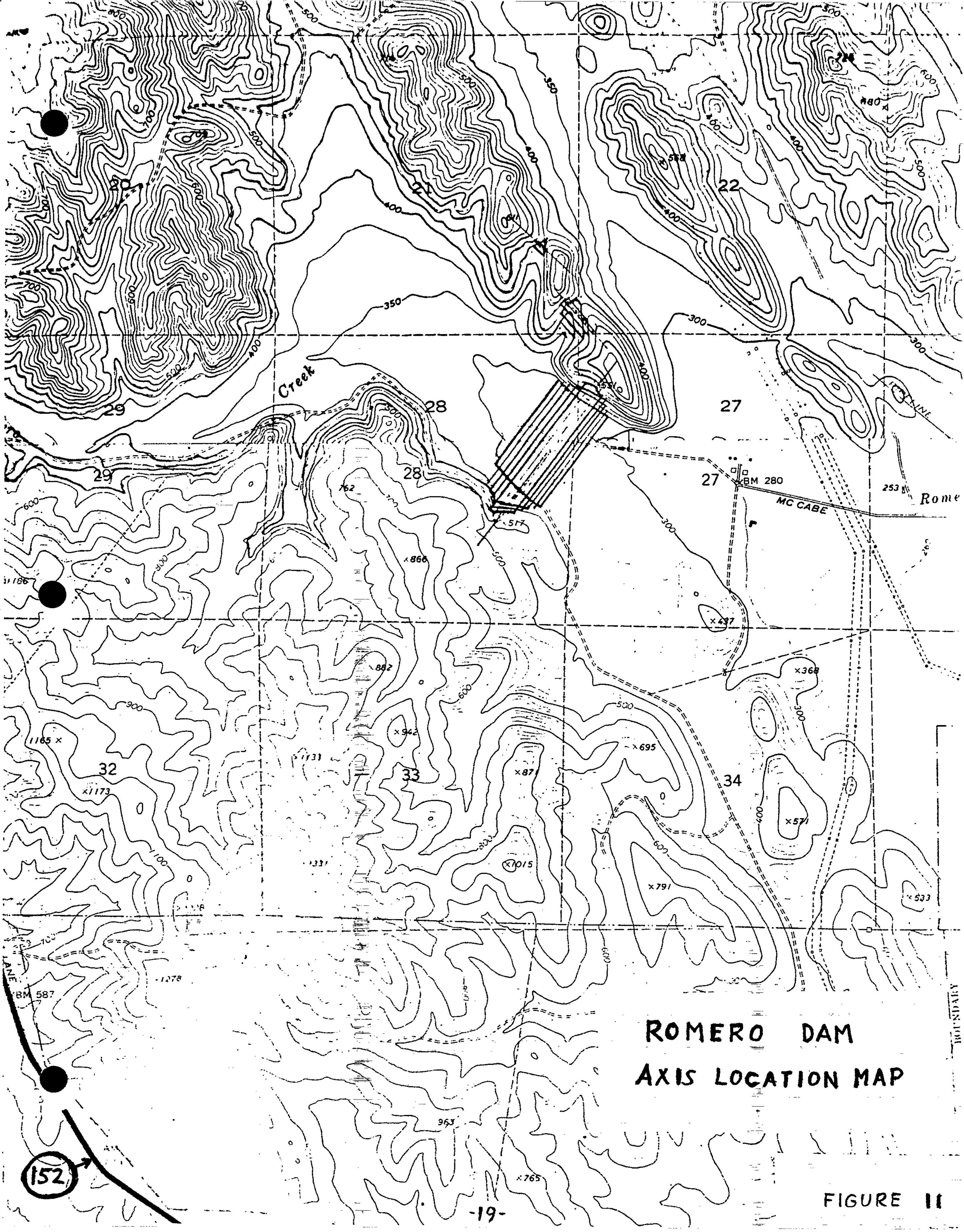
FIGURE

CREVISON PEAK QUADRANGLE
CALIFORNIA
7.5 MINUTE SERIES (TOPOGRAPHIC)



GARZAS DAMS
AXES LOCATION MAP

FIGURE 1



ROMERO DAM
AXIS LOCATION MAP

FIGURE II

The locations of these damsites are shown in Figures 12 and 13.

It has been reported that both impervious and semi-pervious borrow materials are available in the reservoir area. This is based upon exploration and testing programs conducted by the San Joaquin District between 1964 and 1967. Thus, zoned embankments with side slopes of 3.5:1 and 3:1 were utilized for estimating the volumes at the main dam and auxiliary damsites.

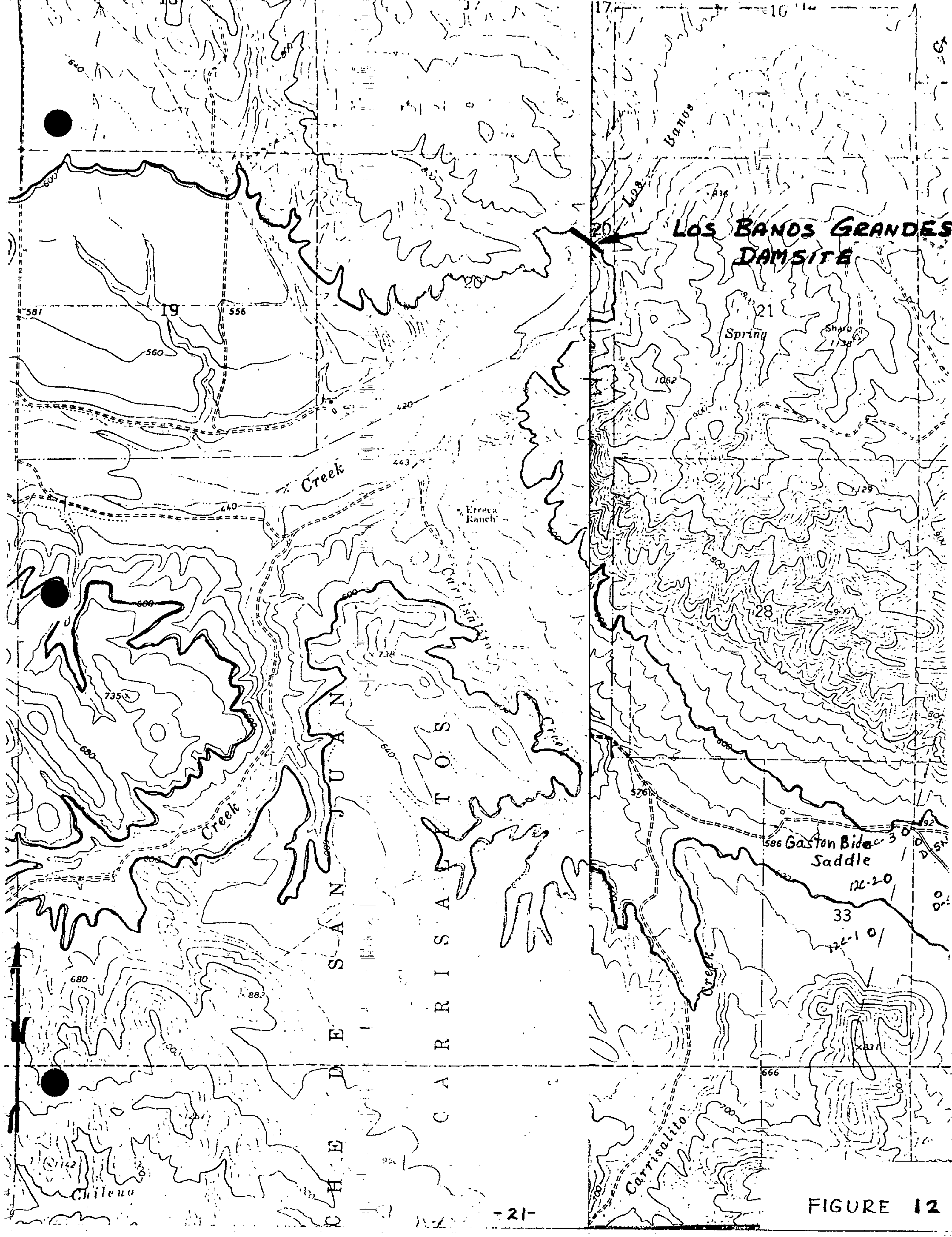
In past studies the Los Banos Grandes site was sized up to 2,300,000 acre-feet.

7.10 Enlarged Los Banos Detention Dam

The existing Los Banos Detention Dam would be enlarged to transport water to the toe of the proposed Los Banos Grandes Dam. Figure 14 shows the axis location. Two sizes were studied, normal water surface Elevation 385 feet with a storage of about 57,000 acre feet, and NWS Elevation 415 feet with 86,000 acre-feet of storage. These levels would provide about 25 and 55 feet of water respectively at the downstream toe of Los Banos Grandes Dam for tailwater at the proposed project pump/generating plants. Los Banos Grandes Dam, if in place, would slightly reduce the Detention Reservoir capacities.

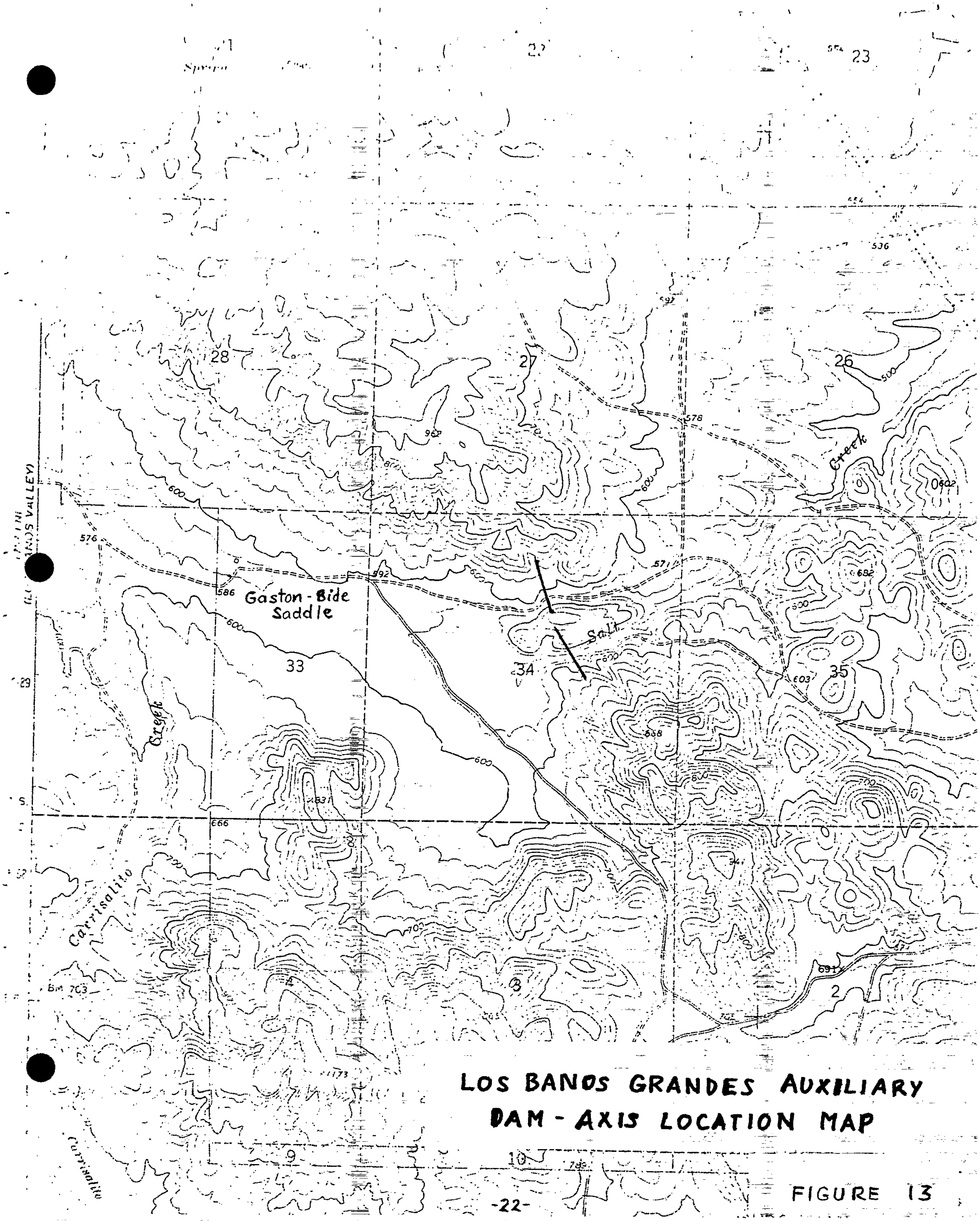
The existing Detention Dam is about 160 feet high with relatively steep slopes, narrow crest, and 30 feet of freeboard. The new dam would have a wider crest, flatter slopes, and 25 feet of freeboard. Height of the new dam, and therefore the reservoir, is limited by the presence of gravel terraces on both abutments above Elevation 415 feet.

The existing Detention Dam is incorporated into the upstream toe of the enlarged dam and would be used as a cofferdam during construction (see Figure 36). The existing blanket drain will have to be sealed with provisions for pumping at the start of construction.



LOS BANOS GRANDES DAMSITE
Los Banos
Creek
Erreca Ranch
Creek
SAN JUAN
CARRISALITOS
Gaston Bide Saddle
Spring
Carrisalito
Creek
Chileno

FIGURE 12



LOS BANOS GRANDES AUXILIARY DAM - AXIS LOCATION MAP

FIGURE 13

Stripping was assumed to average 10 feet in the channel and 5 feet on the abutments up to Elevation 415 feet and 25 feet above this. An additional 10 feet of stripping was assumed under the core as a cutoff.

A completely new spillway will be necessary with either size of enlarged dam. The outlet works would have to be extended before placement of any new embankment.

Total embankment quantities are 5,700,000 cubic yards at NWS Elevation 385 (Crest Elev. 410) and 8,100,000 cubic yards at NWS 415 (Crest Elev. 440). This latter volume was added to those for either sizes of Los Banos Grandes Dam as shown in Figure 2 due to the complexity of the enlargement.

To enlarge the existing Los Banos Detention Dam for storage potential appears limited and would require large embankment volume and cost. A more viable scheme would utilize the existing detention dam only as a forebay and would provide the storage capacity upstream at proposed Los Banos Grandes Dam and Reservoir. A small diversion channel, located at the base of the proposed Los Banos Grandes Dam, would be needed. In comparison, the construction costs for an intake channel would be much lower, however.

7.11 Salt Creek

Only 35,000 acre-feet of storage appears available at the Salt Creek site as shown in Figure 28. This is due to the presence of pervious terrace materials above Elevation 480 feet on the right abutment ridge. Conservative embankment slopes of 5:1 and 4:1 were assumed because of the proximity of a fault that may be active. The dam axis location is shown on Figure 14.

7.12 Ortigalita

Two forebays were assumed necessary for transportation of water into Ortigalita Reservoir and their fill volumes included with the main dam. They are located approximately two and four miles respectively from the aqueduct.

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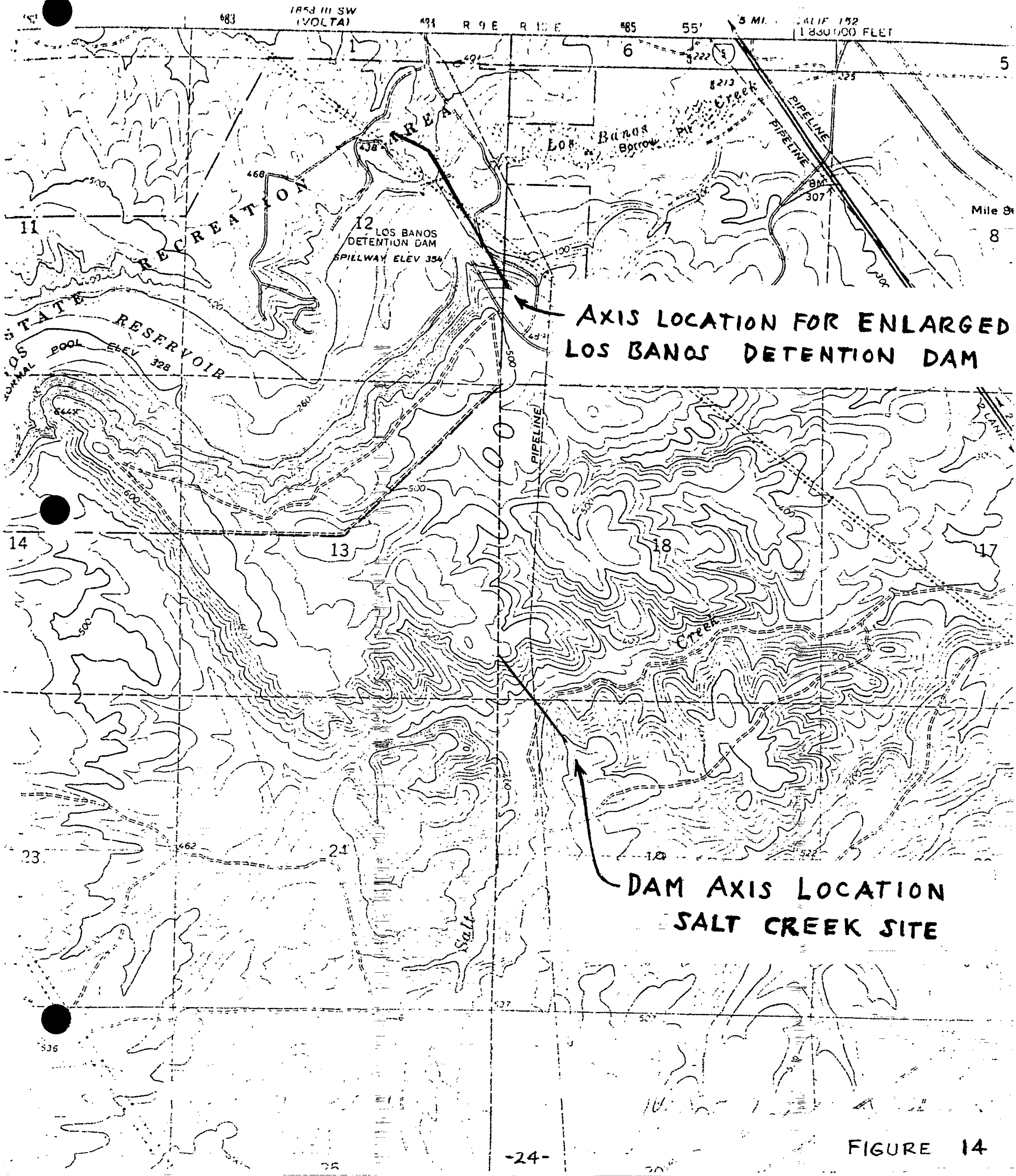

FIGURE 14

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Due to the presence of a potentially active fault near these sites, embankment slopes of 5:1 and 4:1 were used for all three embankment volume estimates.

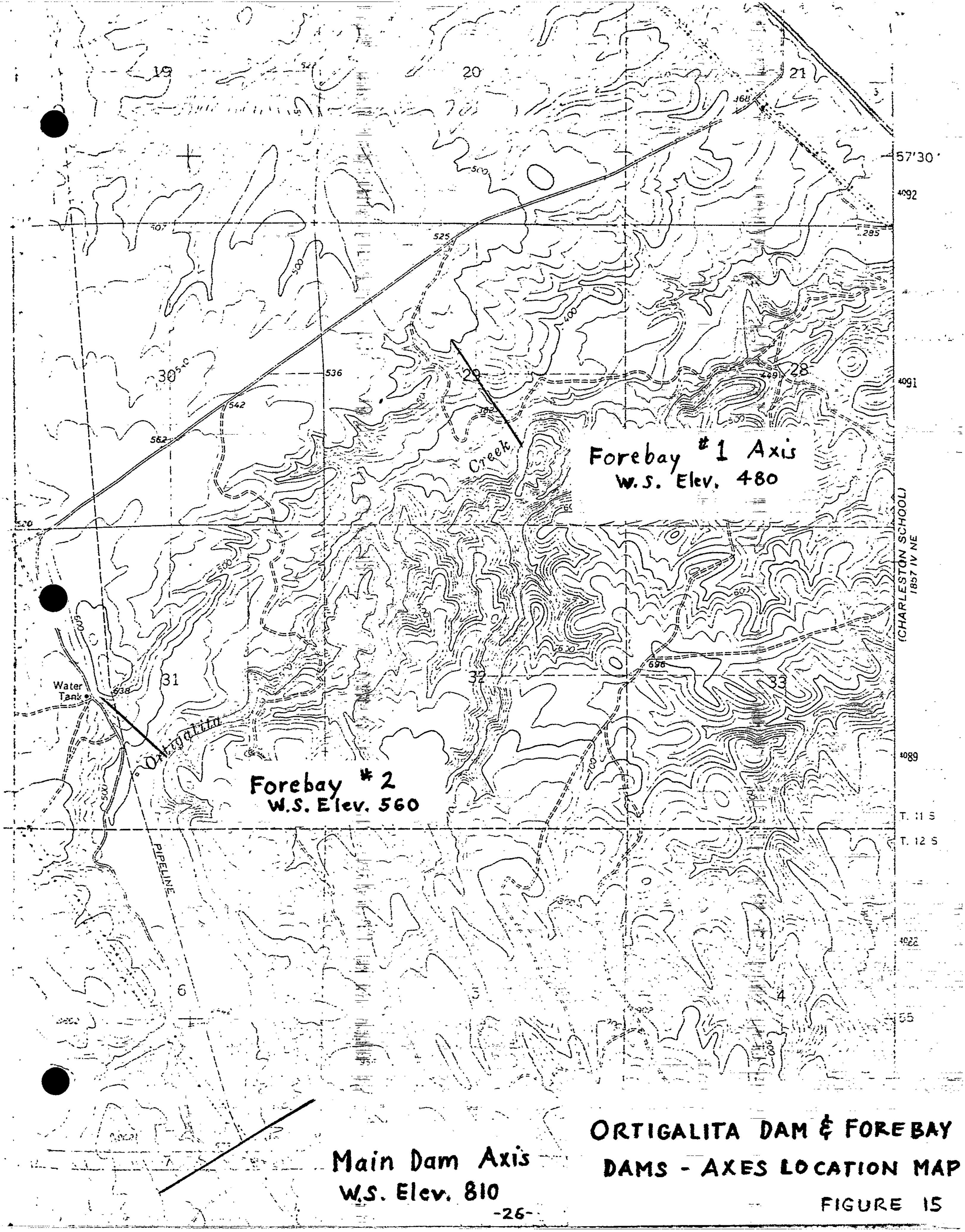
All three sites are shown in Figure 15. Storage capacities considered at the main site are 125,000 and 36,000 acre-feet at normal pool elevation of 810 and 730 feet, respectively.

7.13 Sunflower

A storage capacity of up to 500,000 acre-feet at normal pool elevation of 700 feet can be developed at the Sunflower Reservoir site. Higher water levels would require the construction of more than seven dikes in saddles on the eastern edge of the reservoir. The damsite is located about 10 miles from the Governor Edmund G. Brown California Aqueduct, two miles from the Coastal Aqueduct and less than one-half mile from the Pyramid Hills Thrust Fault. The damsite is shown in Figure 16.

Although the dam would be less than 150 feet in height, its crest length is nearly one mile. Six exploration holes were drilled along the axis by the San Joaquin District in 1967. Since these disclosed about 30 feet of weak clay alluvium overlying about 15 feet of pervious channel deposits, it was assumed that both of these zones would be stripped from the entire dam foundation. An additional 10 feet of excavation would be required beneath the impervious core to reach sound rock.

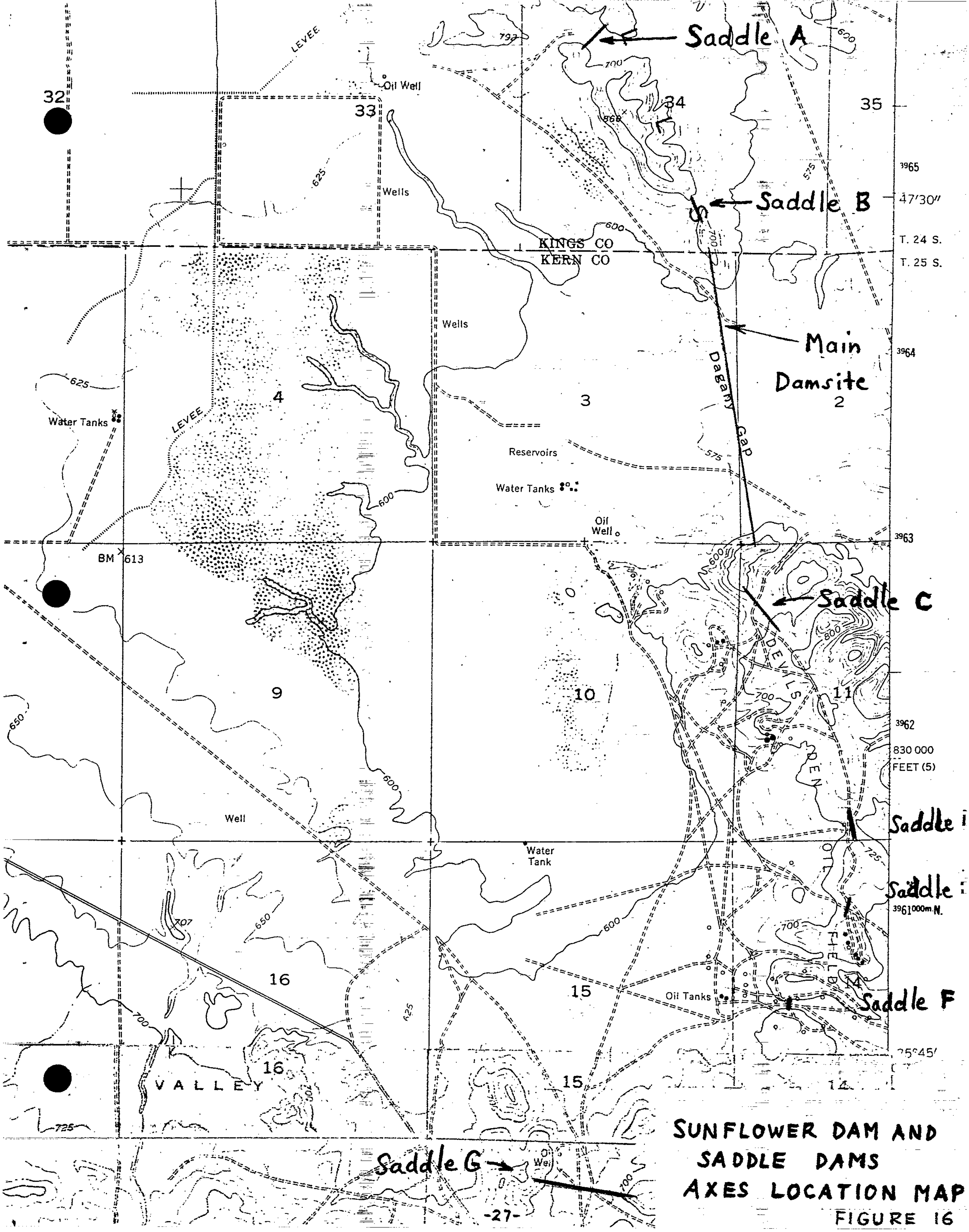
Slopes of 4:1 and 3:1 were selected for the portion of the embankment above Elevation 600 feet. Below this, slopes of 8:1 and 6:1 were provided to give additional stability since the damsite is about 12 miles from the San Andreas Fault. Less conservative slopes of 3:1 and 2.5:1 formed the basis for the saddle dam estimates.



ORTIGALITA DAM & FOREBAY DAMS - AXES LOCATION MAP

FIGURE 15

D-001865



SUNFLOWER DAM AND SADDLE DAMS AXES LOCATION MAP

FIGURE 16

7.14 Little Panoche Detention

Enlargement of existing Little Panoche Detention Dam was evaluated for this study. The site is shown in Figure 1 and was rejected because of thick (up to 100 feet) sand and gravel terraces on both abutments. These terraces start at Elevation 620 feet on the left and 640 on the right. Since the existing detention dam crest is at Elevation 676 feet, it was judged impossible to adequately strip, cutoff, or blanket the abutments to prevent excessive leakage through a storage reservoir's abutments and the site was rejected.

APPENDIX I

Area-Capacity Curves

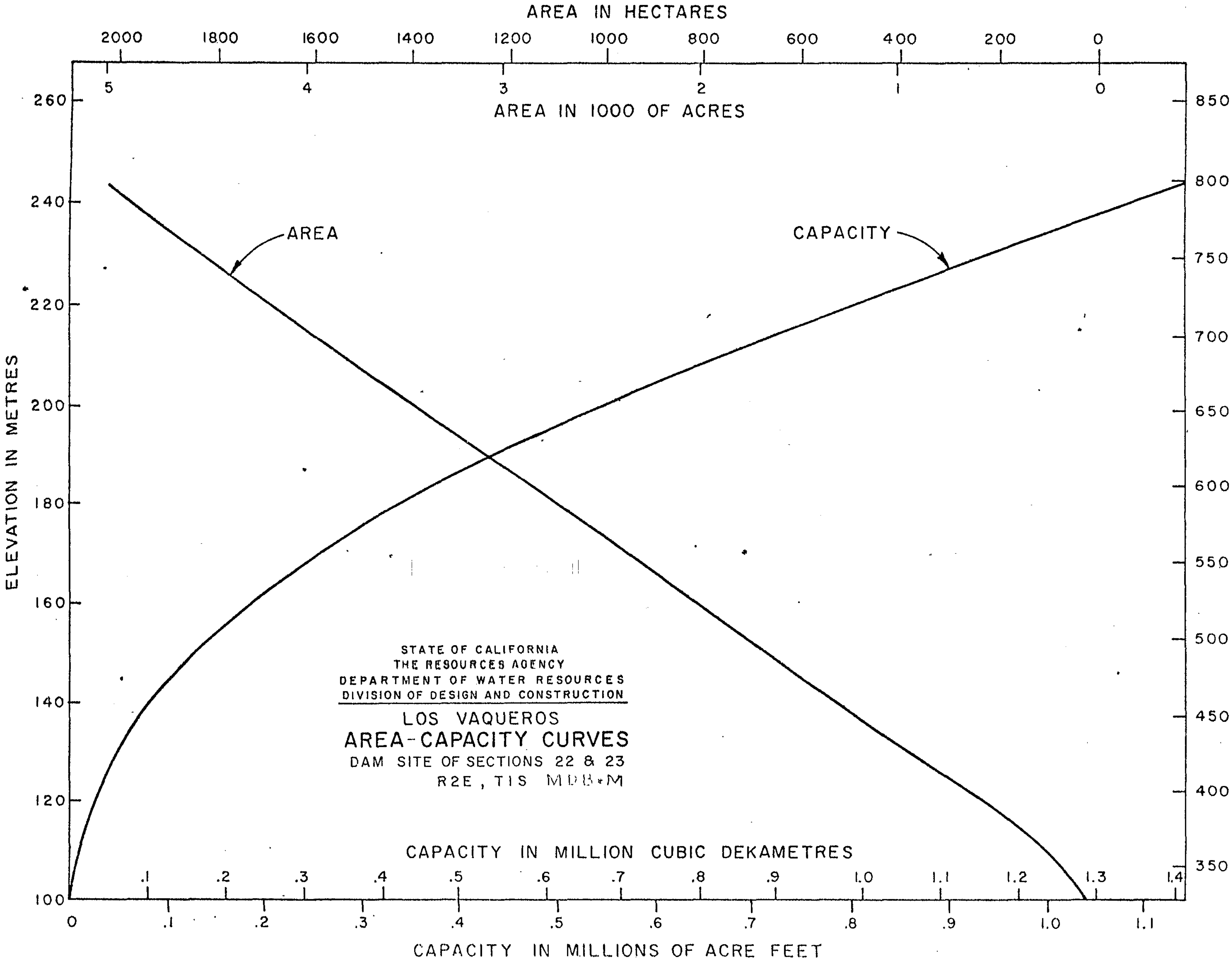
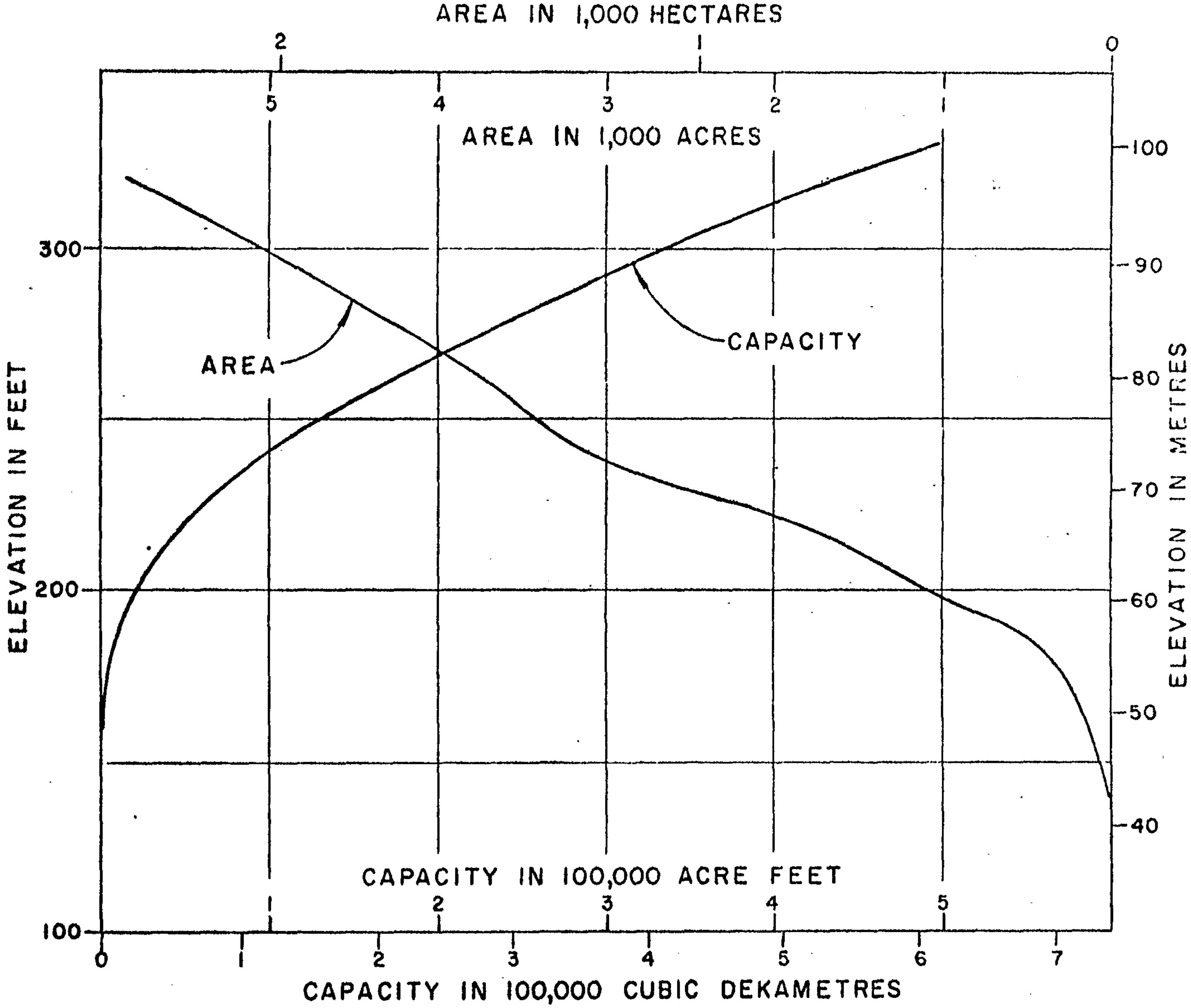


FIGURE 17

-30-

D-001869

D-001869

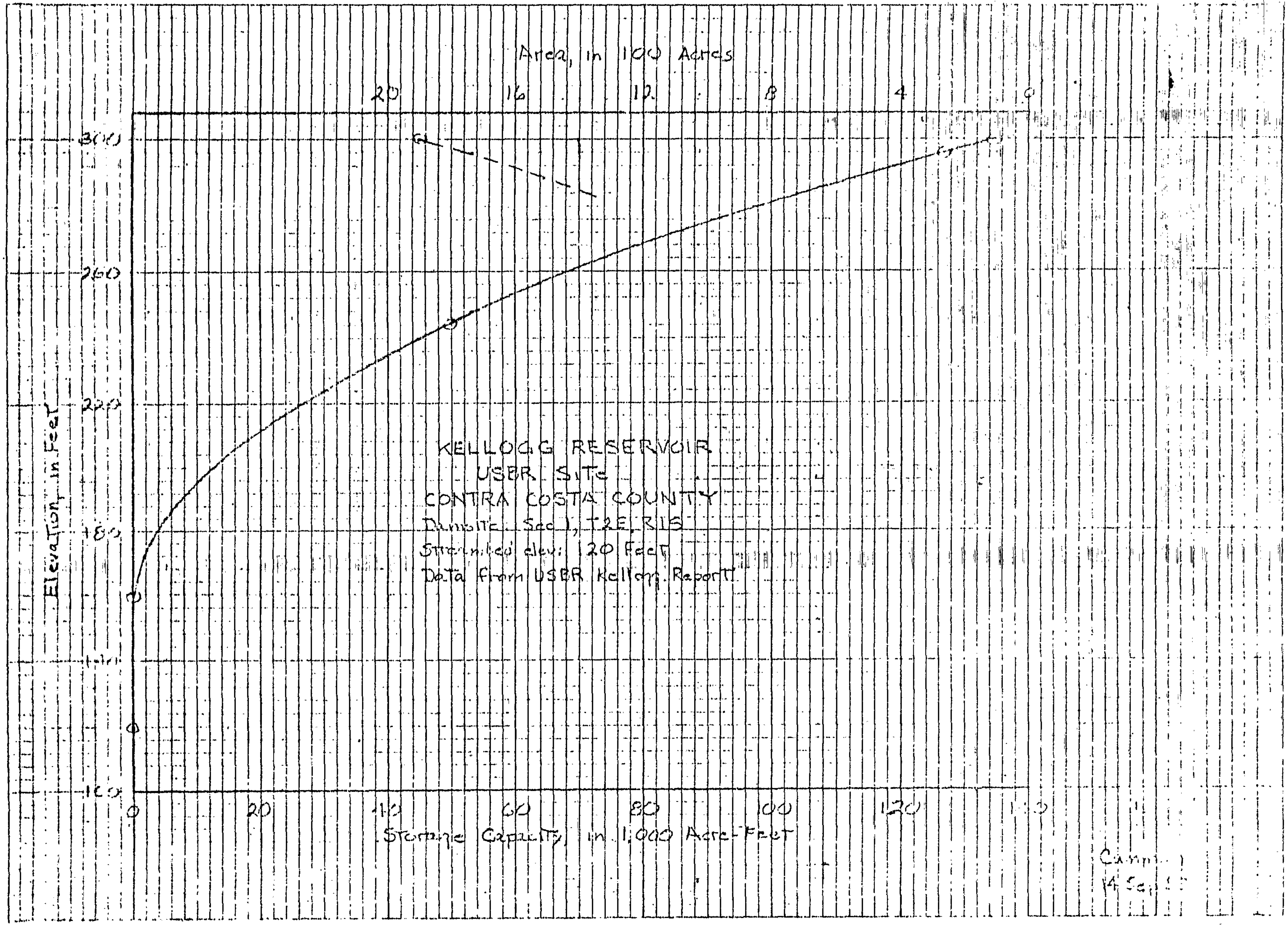


STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF DESIGN AND CONSTRUCTION

KELLOGG RESERVOIR
AREA - CAPACITY CURVES
(INCLUDES MARSH CREEK)
MAY 1982

FIGURE 18

D—001870



Area, in 100 Acres
20
16
12
8
4
0
300
260
220
180
Elevation, in Feet
0
20
40
60
80
100
120
Storage Capacity in 1,000 Acre-Feet
KELLOGG RESERVOIR
USBR Site
CONTRA COSTA COUNTY
Damsite Sec 1, T2E, R1S
Streambed elev: 120 Feet
Data from USBR Kellogg Report

FIGURE 19

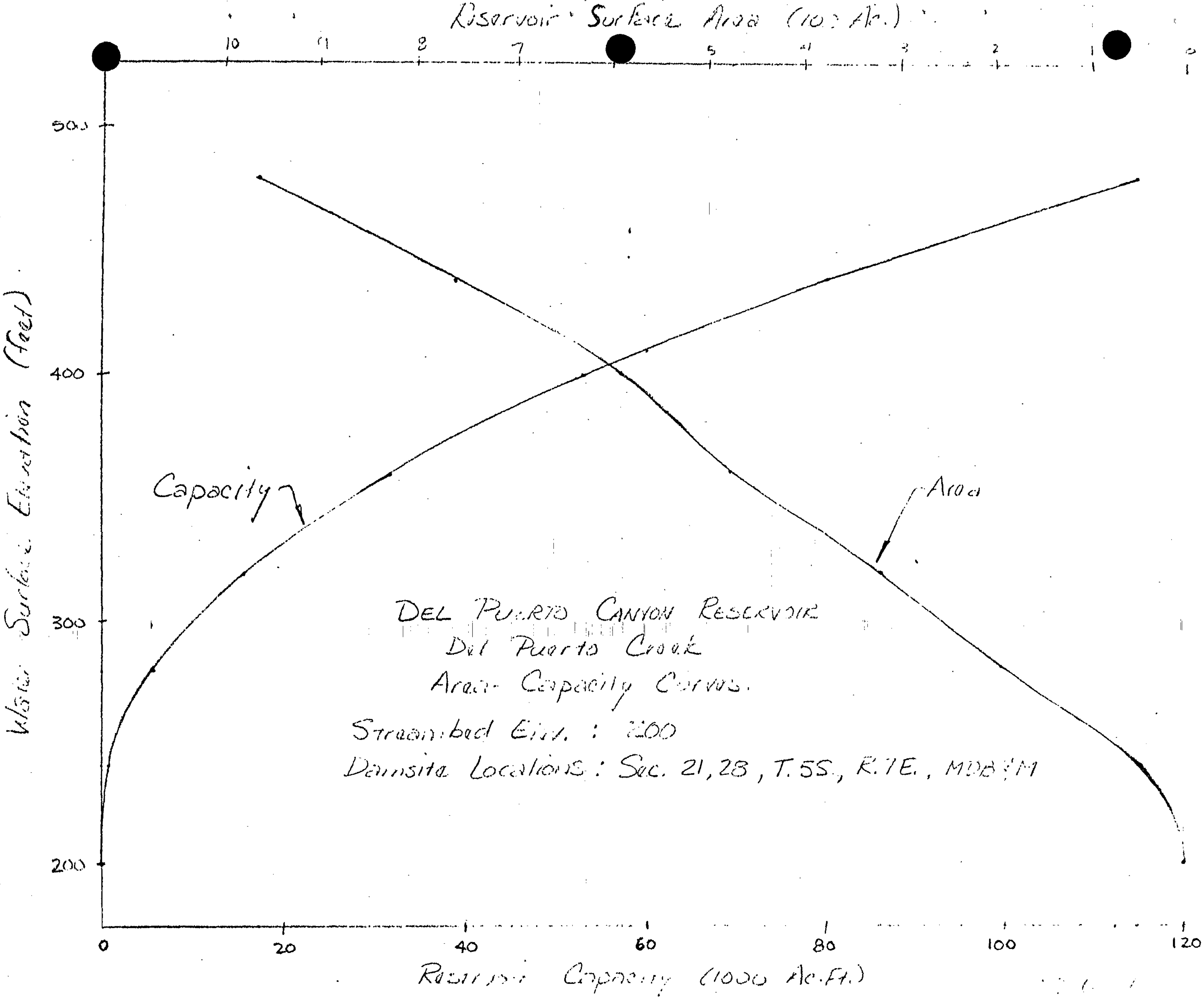


FIGURE 20

D—001872

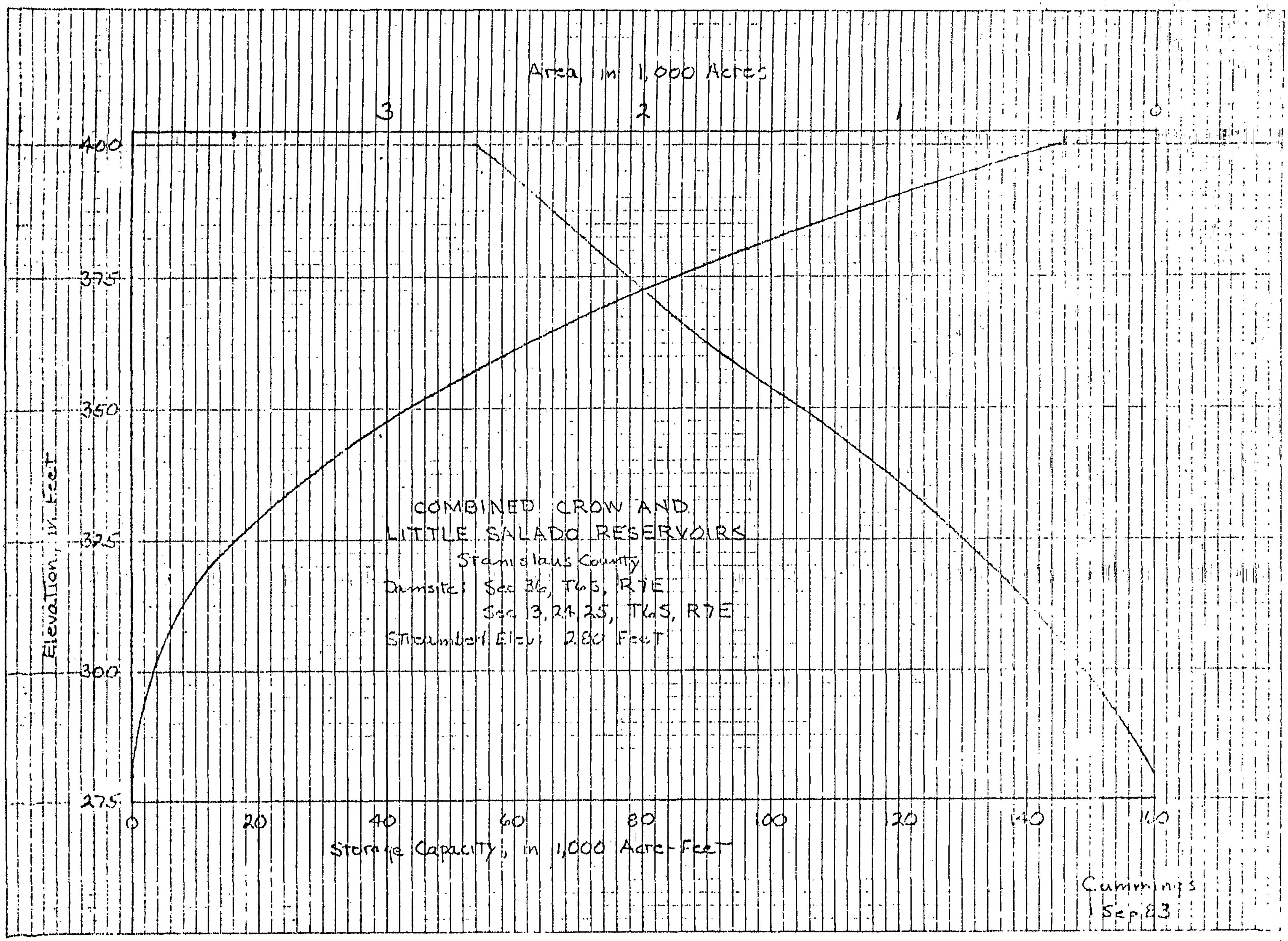

Area, in 1,000 Acres
3
2
1
0
Elevation, in Feet
400
375
350
325
300
275
COMBINED CROW AND
LITTLE SALADO RESERVOIRS
Stanislaus County
Damsite: Sec 36, T6S, R7E
Sec 13, 24, 25, T6S, R7E
Streambed Elev: 280 Feet
0
20
40
60
80
100
120
140
160
Storage Capacity, in 1,000 Acre-Feet
Cummings
Sep 83

FIGURE 2

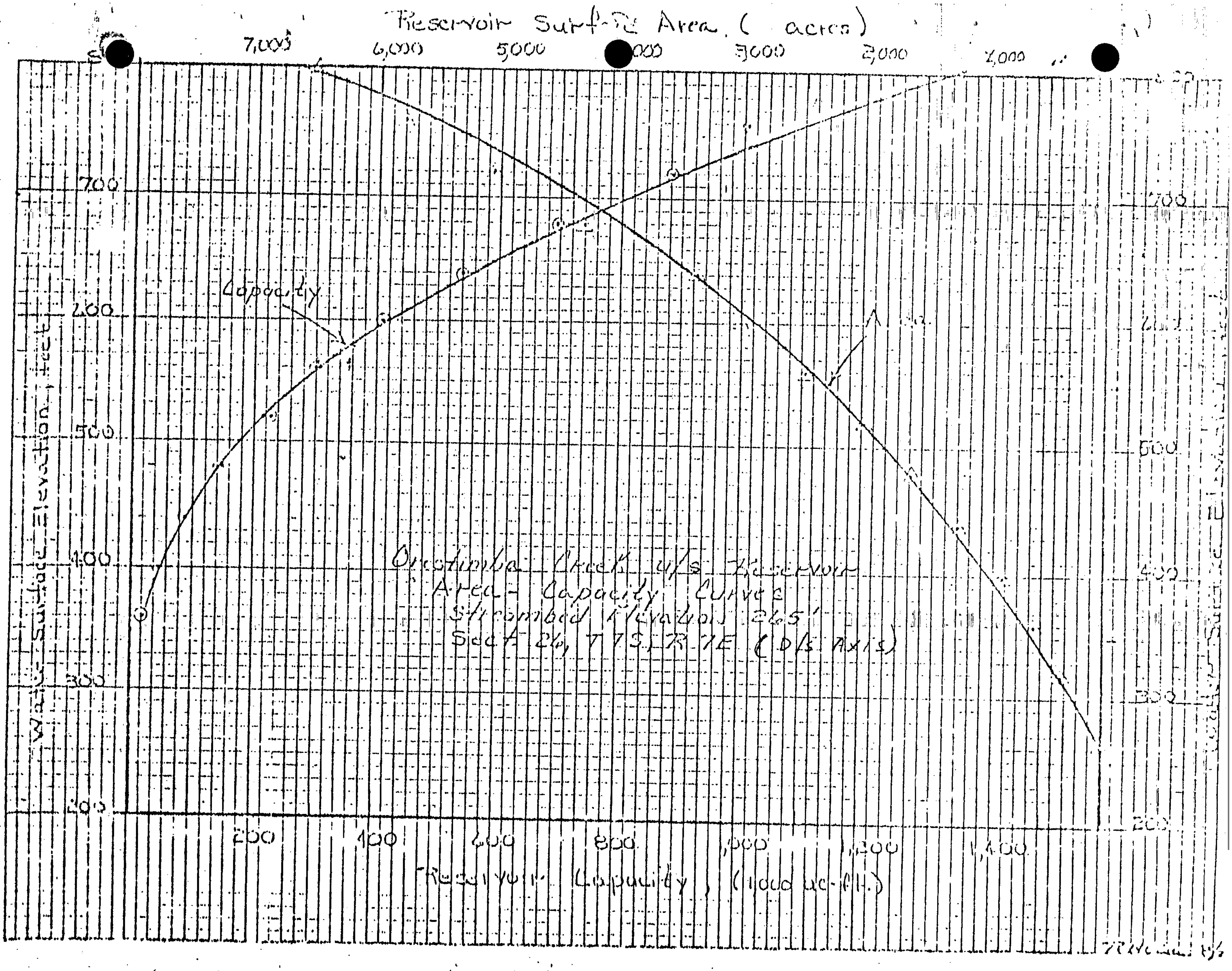

Reservoir Surface Area (acres)
7,000
6,000
5,000
3000
2,000
Water Surface Elevation, feet
700
500
400
300
200
Capacity
Area - Capacity Curves
Sect 26, T7S, R7E (D/S Axis)
200
400
600
800
1,000
1,200
1,400
Reservoir Capacity, (1000 ac-ft.)

FIGURE 22

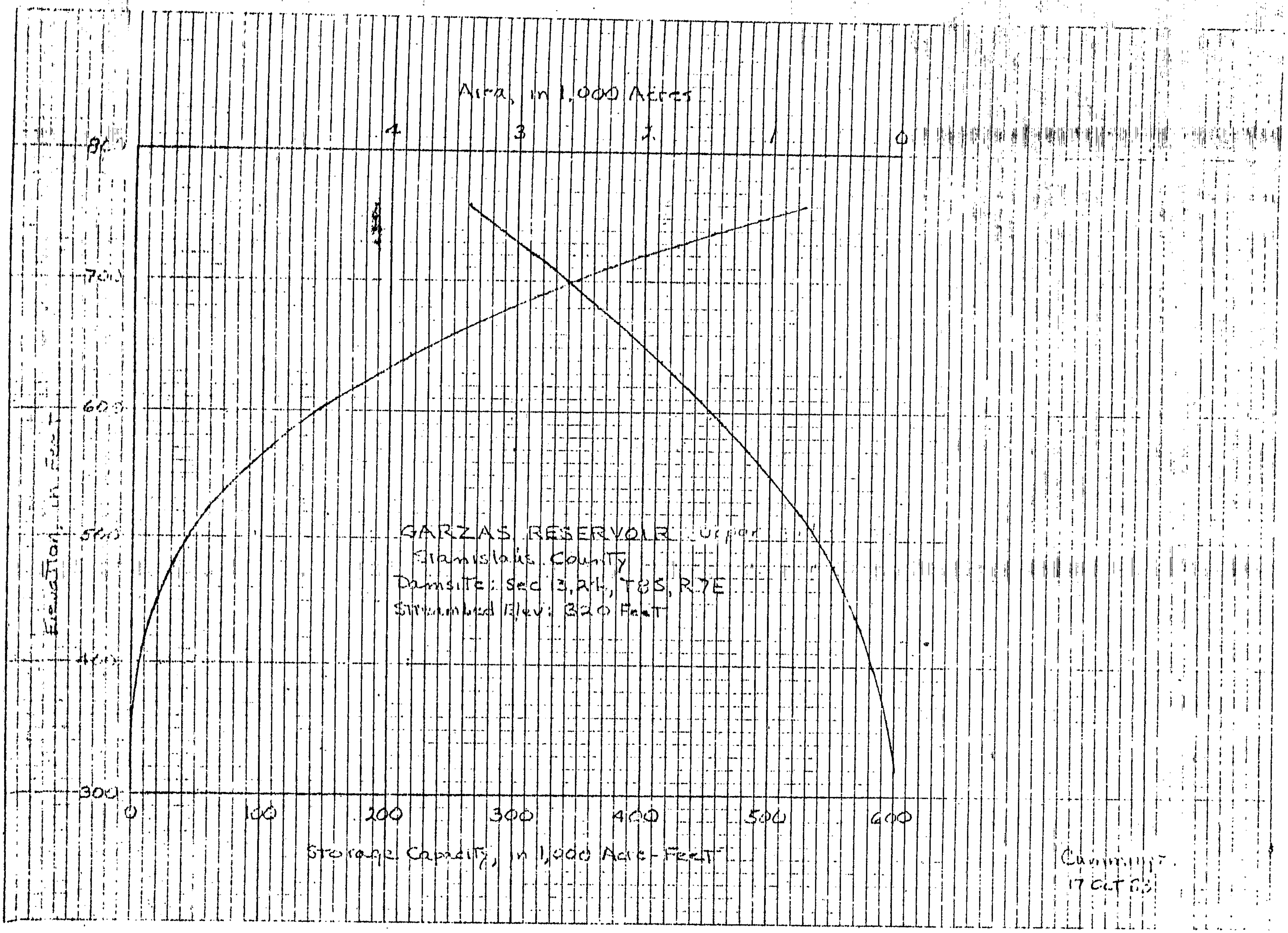
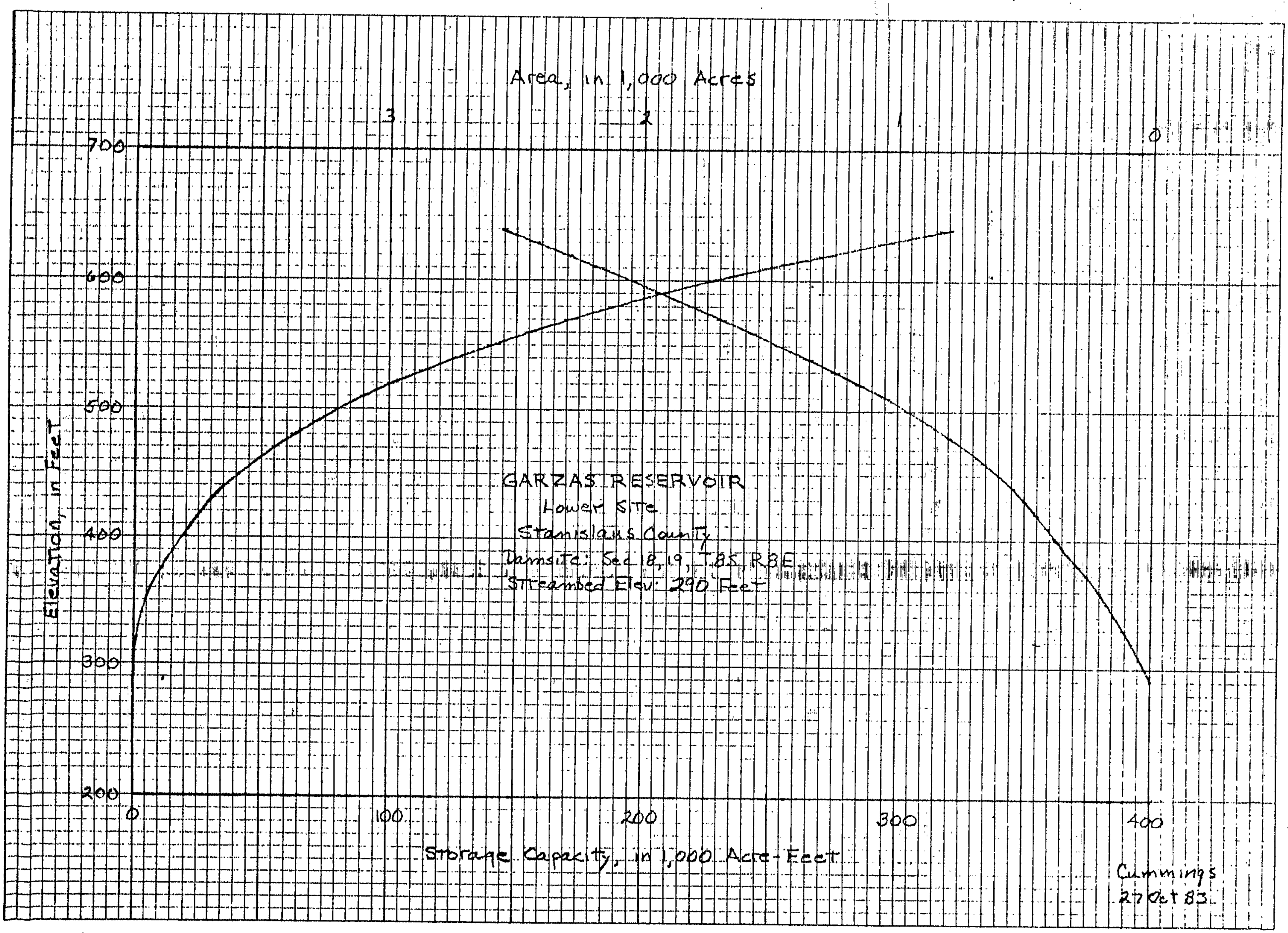


FIGURE 23

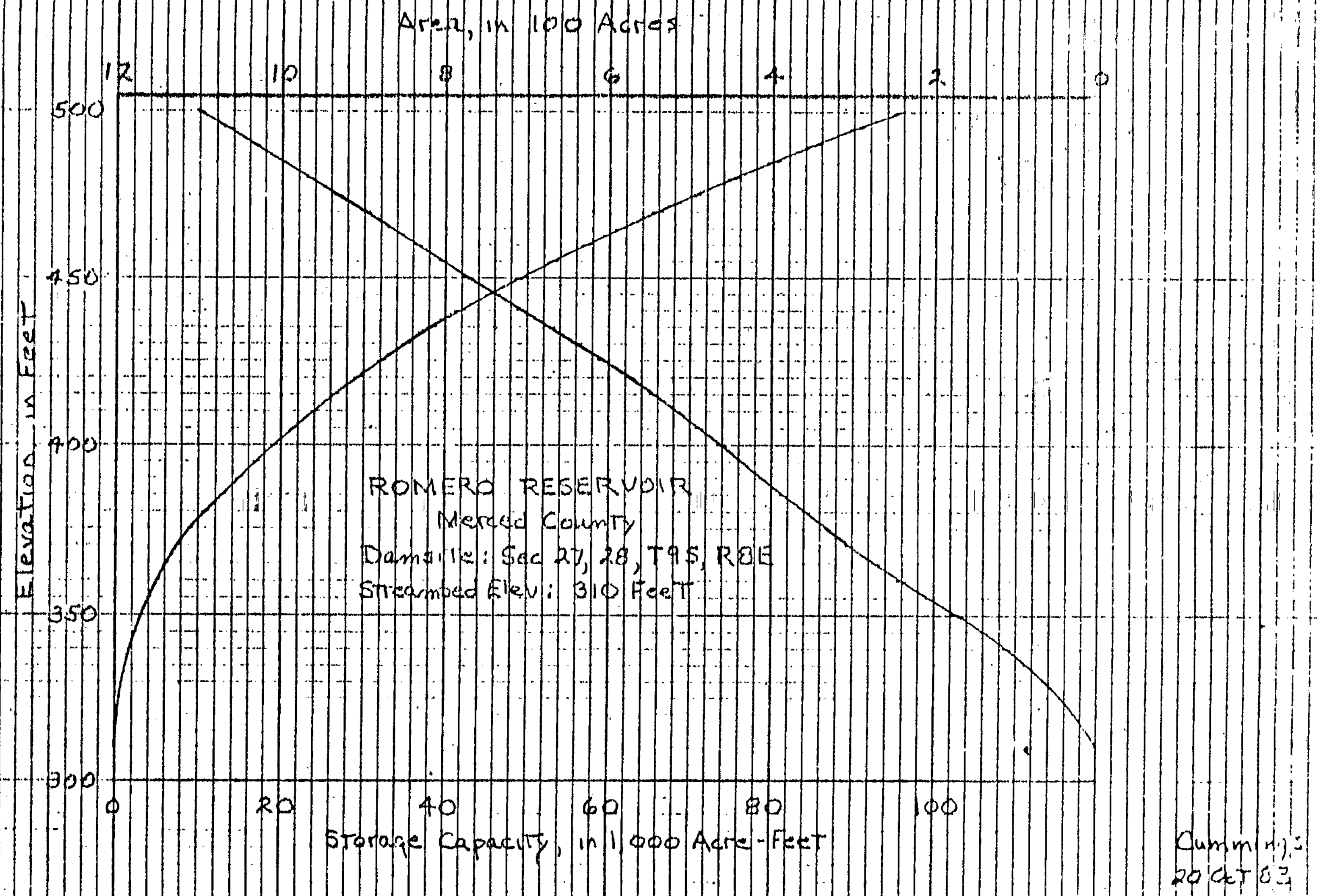
D-001875



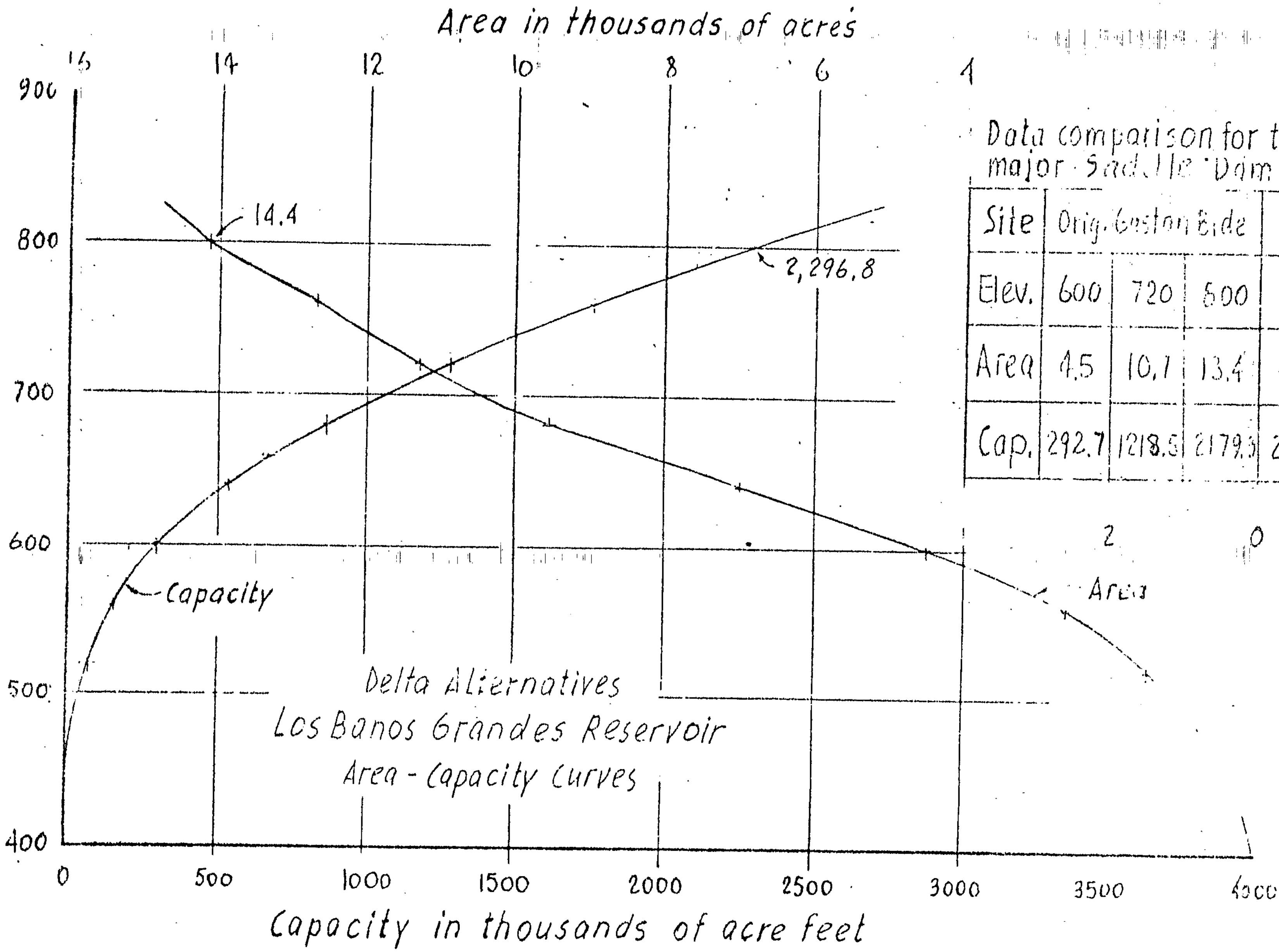
Area, in 1,000 Acres
3
2
1
0
700
600
500
400
300
200
Elevation, in Feet
GARZAS RESERVOIR
Lower Site
Stanislaus County
Damsite: Sec 18, 19, T8S R8E
Streambed Elev. 290 Feet
0
100
200
300
400
Storage Capacity, in 1,000 Acre-Feet
Cummings
27 Oct 83

FIGURE 24

FIGURE 25


Area, in 100 Acres
12
10
8
6
4
2
0
Elevation, in Feet
500
450
400
350
300
ROMERO RESERVOIR
Merced County
Damsite: Sec 27, 28, T9S, R8E
Streambed Elev: 310 Feet
0
20
40
60
80
100
Storage Capacity, in 1,000 Acre-Feet
Cummings
20 Oct 63

Note: The data are based on 7½ min quadrangle maps USGS 1969, for dam locations appropriate for the 800 ft contour line as W.S. elevation. See plan of reservoir.



Data comparison for two alternative major Saddle Dam locations

Site	Orig. Boston Bide			Alt. site [illegible]		
Elev.	600	720	800	600	720	800
Area	4.5	10.7	13.4	4.7	11.2	[illegible]
Cap.	292.7	1218.5	2179.3	296.6	1279.3	[illegible]

DWR — San Joaquin District July 7? J.S.

D-001878

-39-

FIGURE 26

D-001878

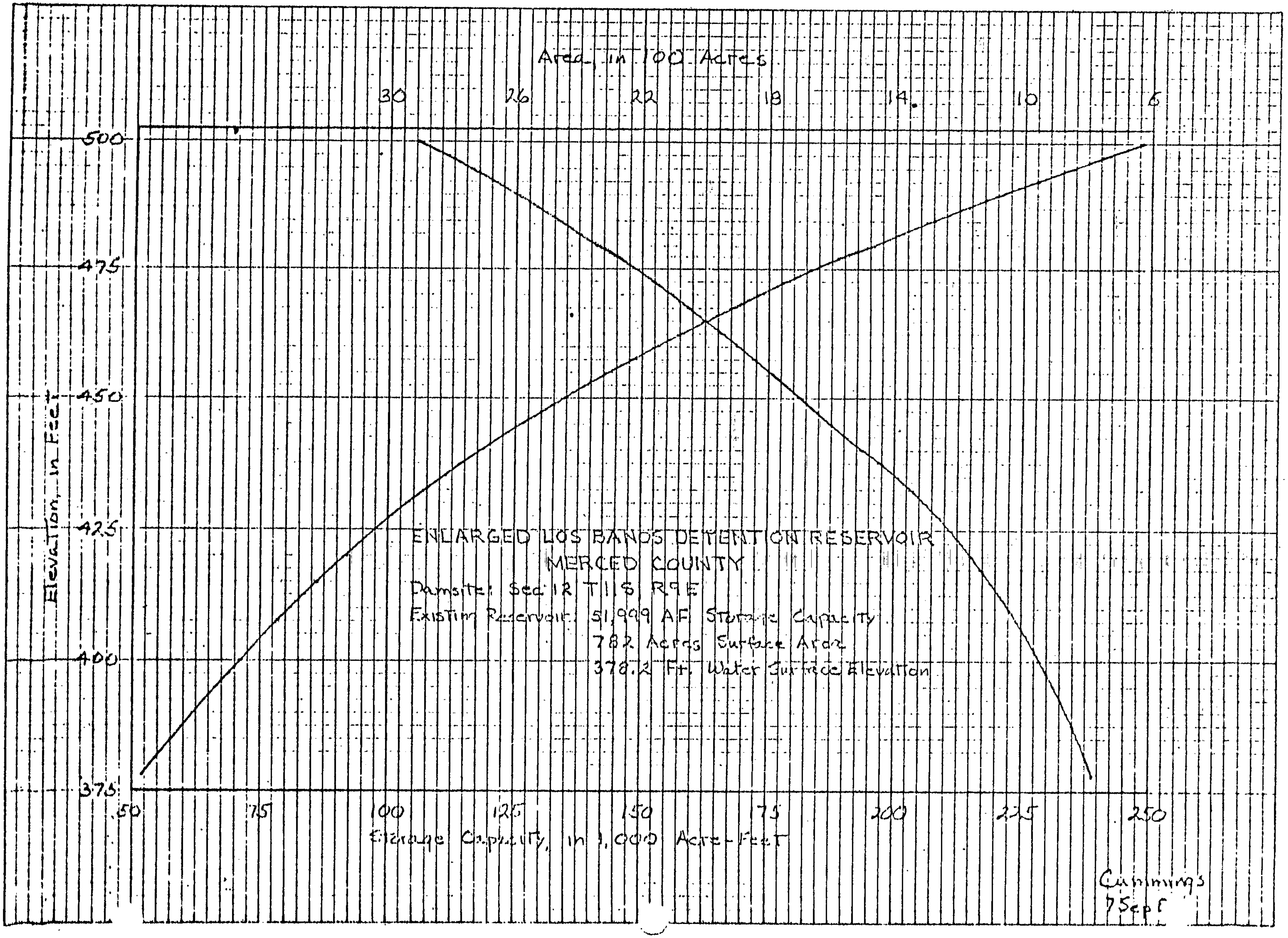


FIGURE 27

D-001879

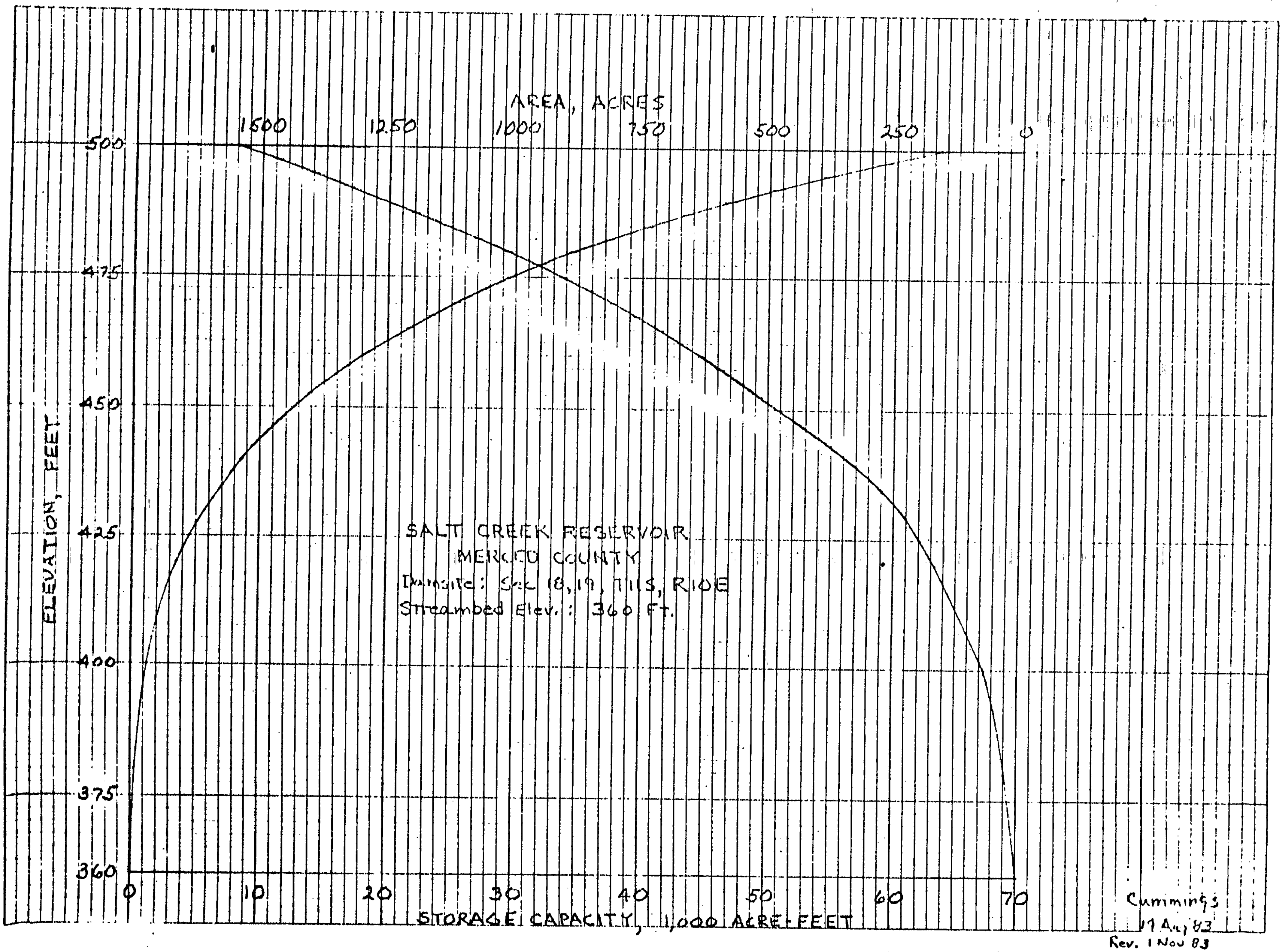

AREA, ACRES
1500
1250
1000
750
500
250
0
ELEVATION, FEET
500
475
450
425
400
375
360
SALT CREEK RESERVOIR
MERCED COUNTY
Damsite: Sec 18, 19, T11S, R10E
Streambed Elev.: 360 Ft.
0
10
20
30
40
50
60
70
STORAGE CAPACITY, 1,000 ACRE-FEET
Cummings
11 Aug 83
Rev. 1 Nov 83
K+E 10 X 10 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 0703

FIGURE 28

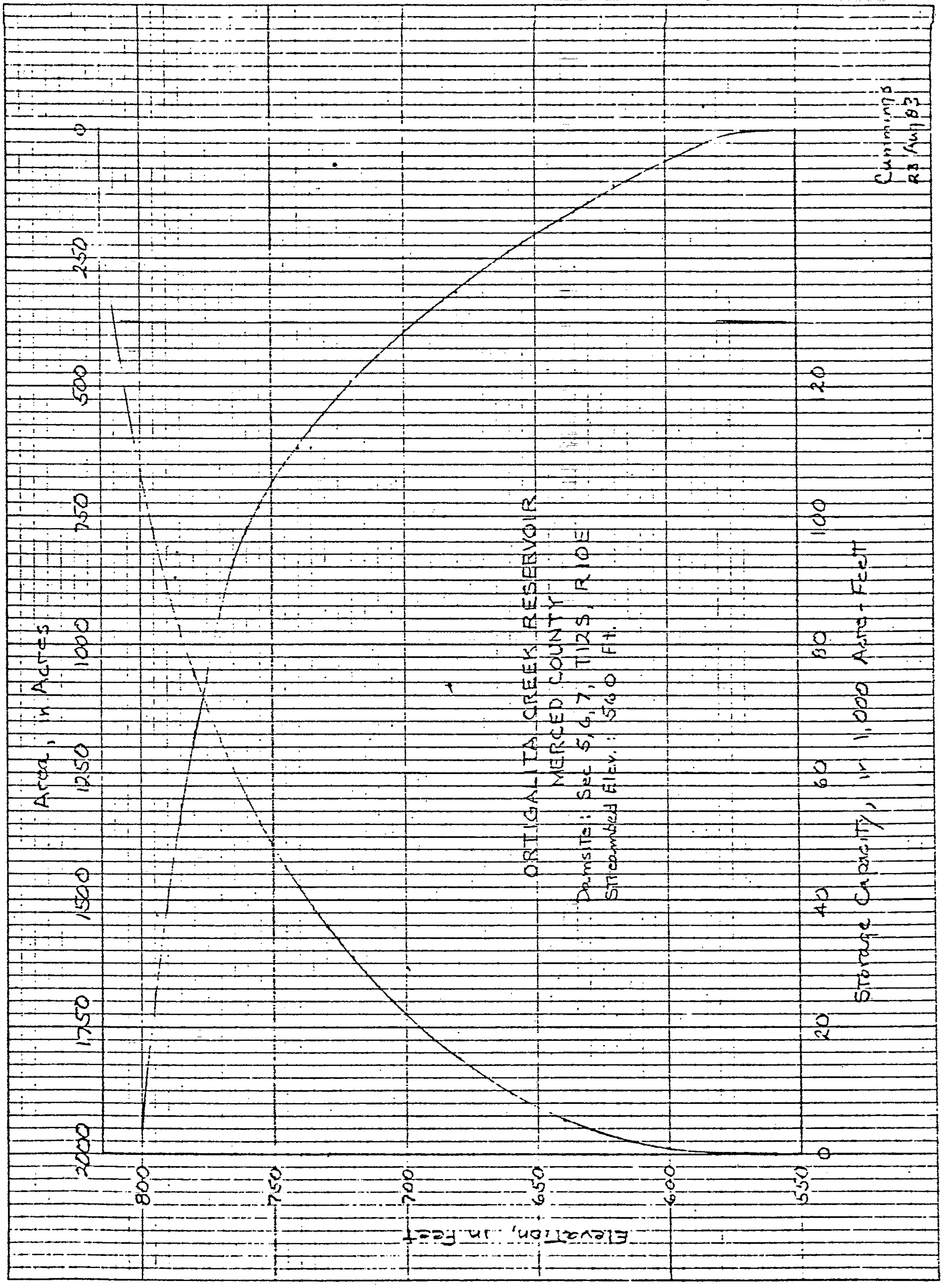

Area, in Acres
2000
1750
1500
1250
1000
750
500
250
0
ORTIGALITA CREEK RESERVOIR
MERCED COUNTY
Damsite: Sec 5, 6, 7, T12S, R10E
Streambed Elev.: 560 Ft.
Elevation, in Feet
800
750
700
650
600
550
Storage Capacity, in 1,000 Acre-Feet
0
20
40
60
80
100
120
Cummings
R3 Aug 83

FIGURE 29

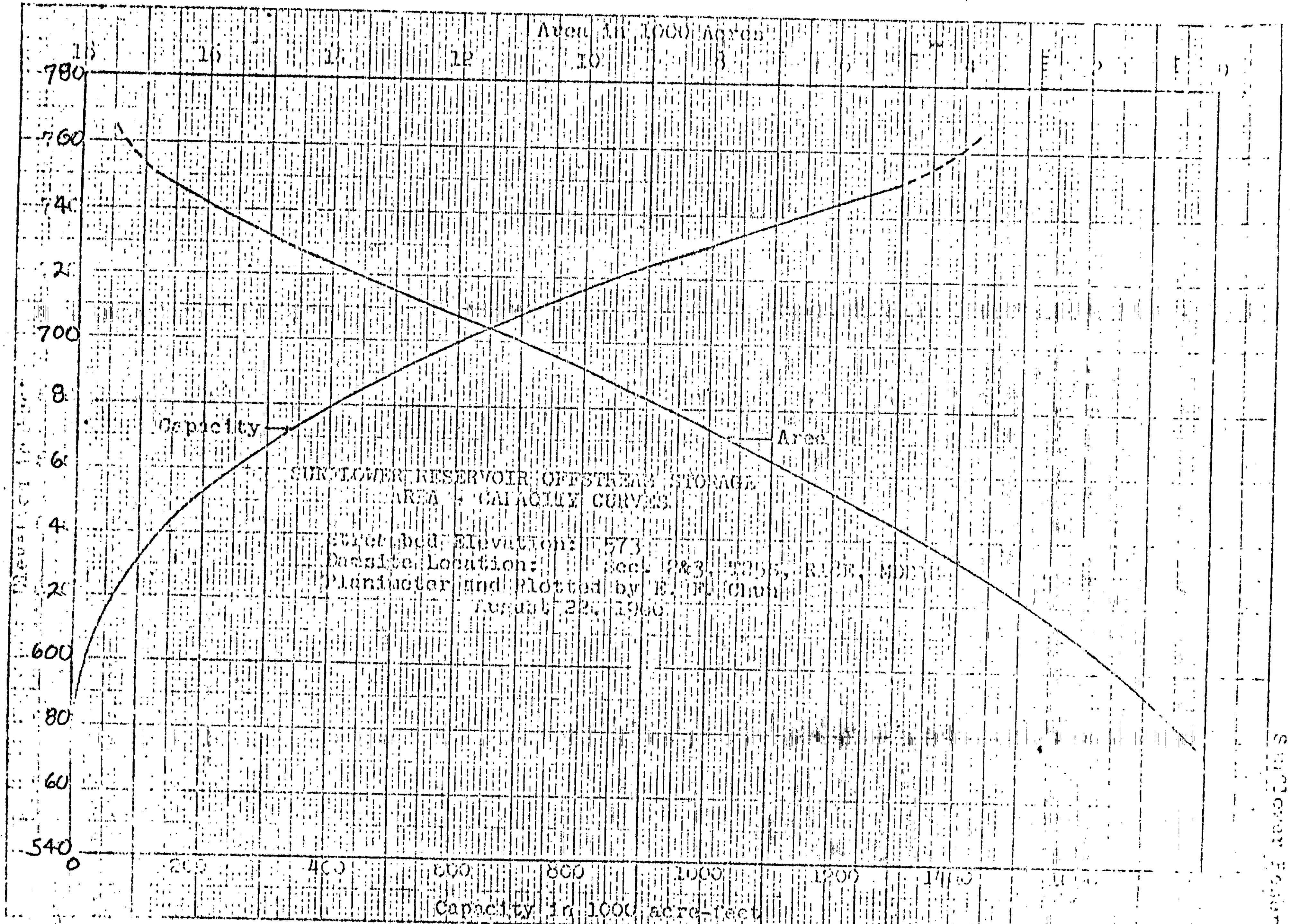
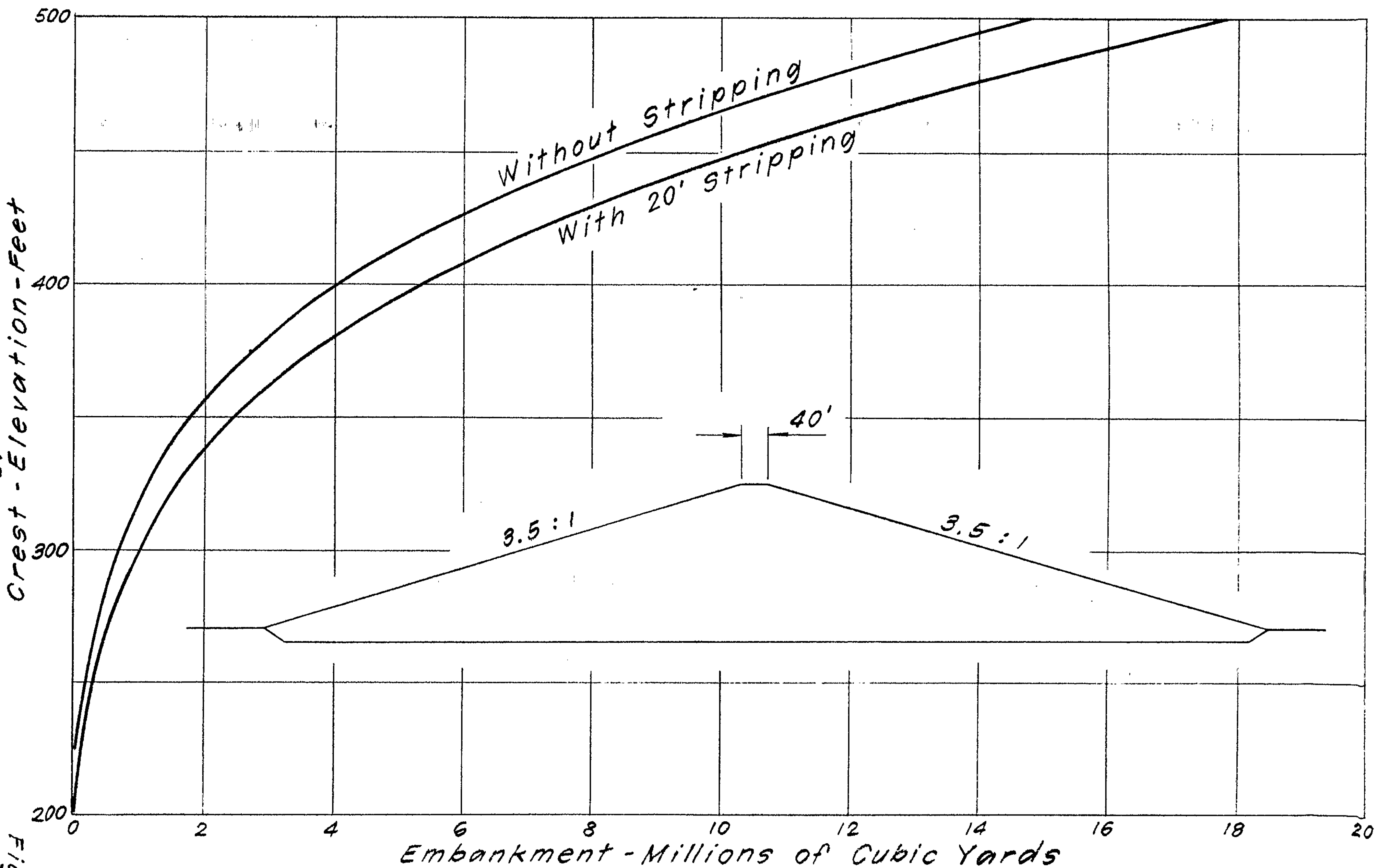

Area in 1000 Acres
16
14
12
10
8
780
760
740
700
600
540
0
200
400
600
800
1000
1200
1400
Capacity
Area
SUNFLOWER RESERVOIR OFFSTREAM STORAGE
AREA - CAPACITY CURVES
Streambed Elevation: 573
Damsite Location:
Planimeter and Plotted by E. F. Chun
August 22, 1960
Capacity in 1000 acre-feet

FIGURE 30

APPENDIX II

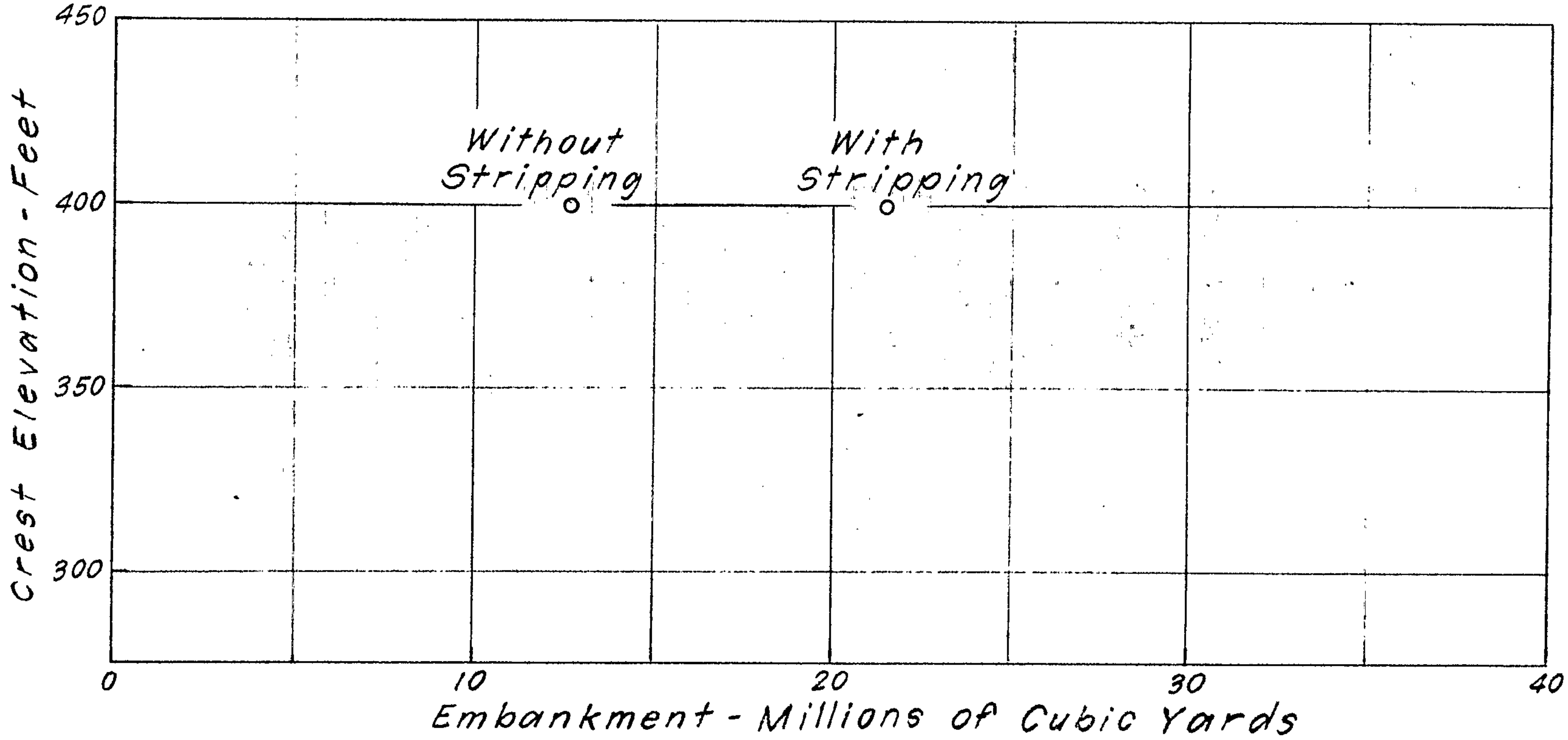
Maximum Sections and Embankment Curves

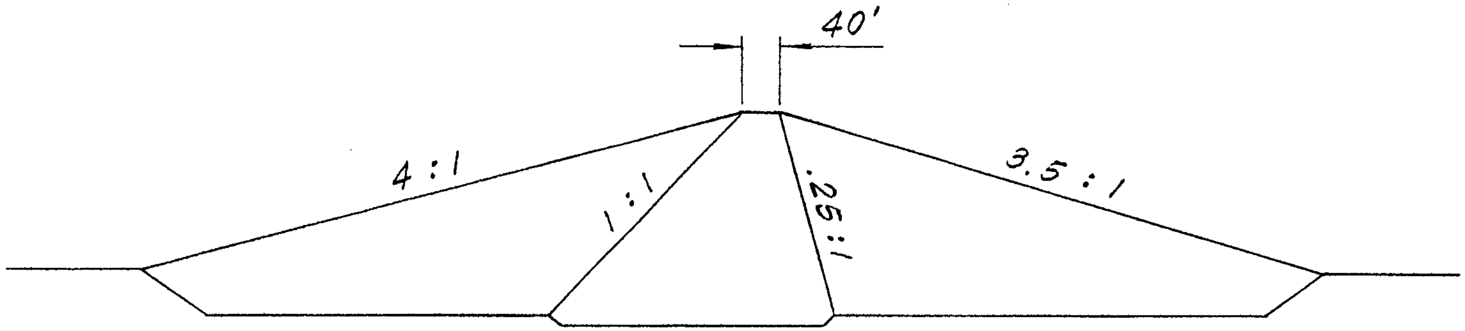
D-001883



DEL PUERTO DAM SITE

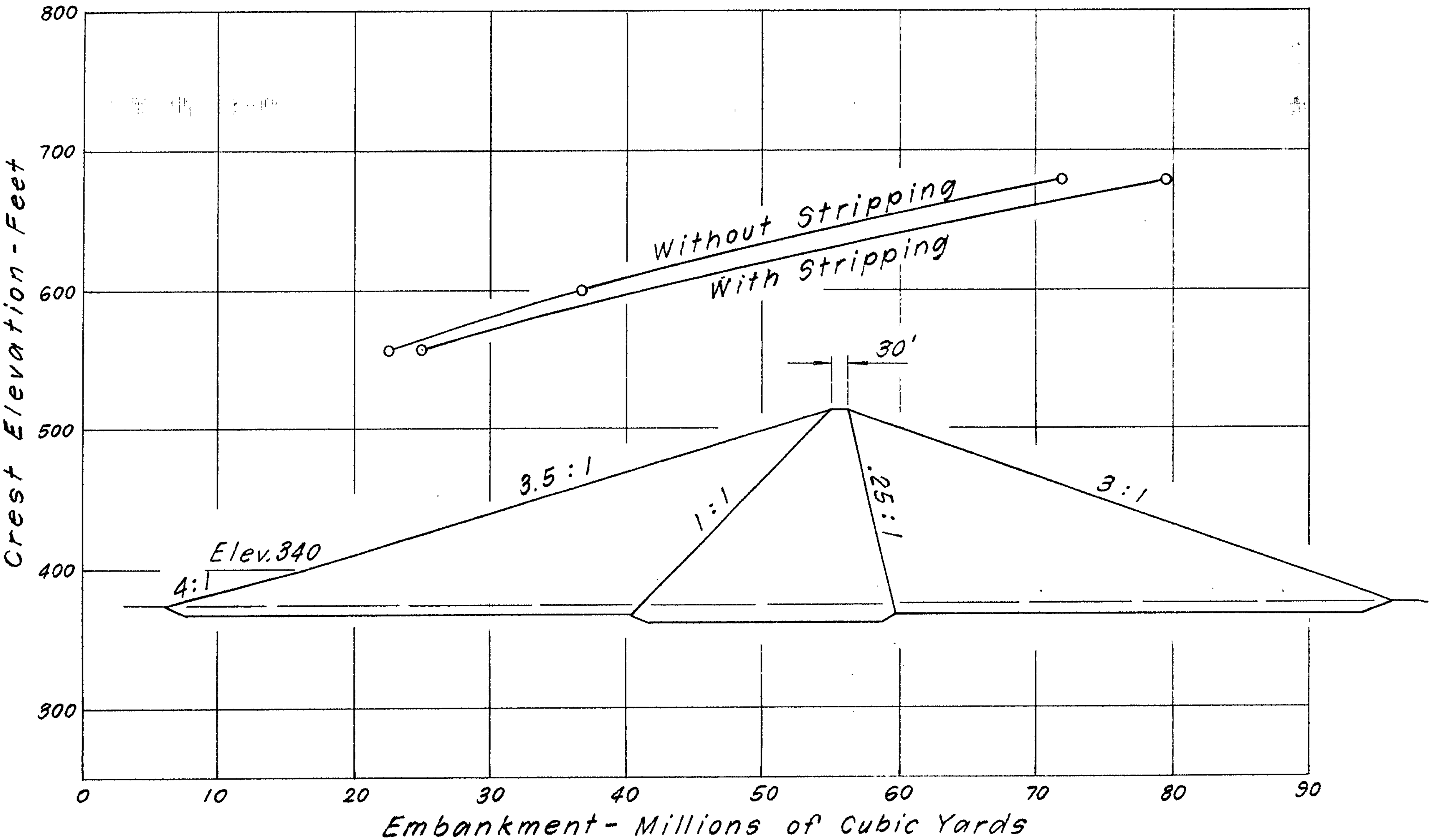
Figure 31





LITTLE SALADO AND CROW DAMS

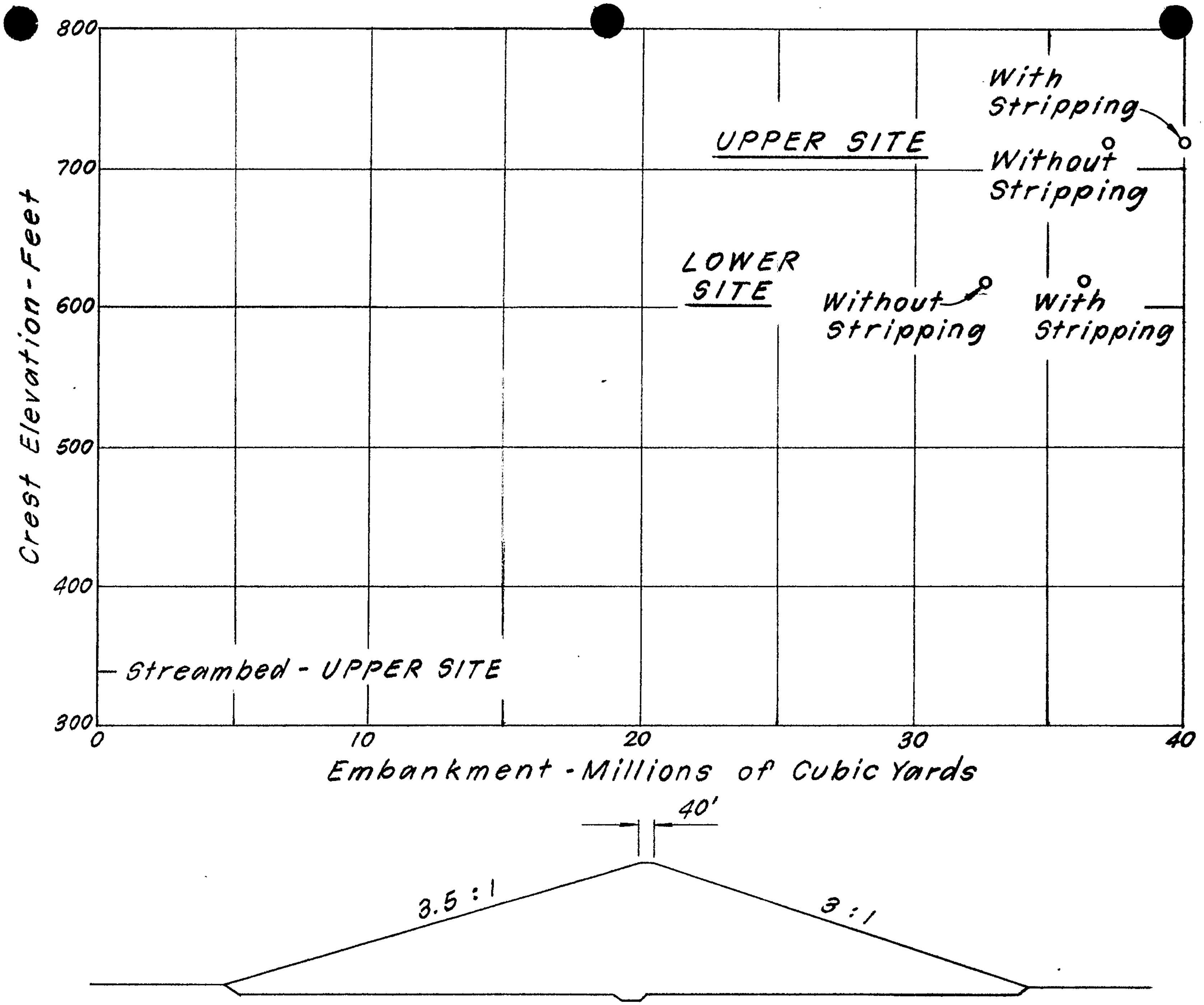
Figure 32



ORESTIMBA DAM SITE
FILL vs. ELEVATION

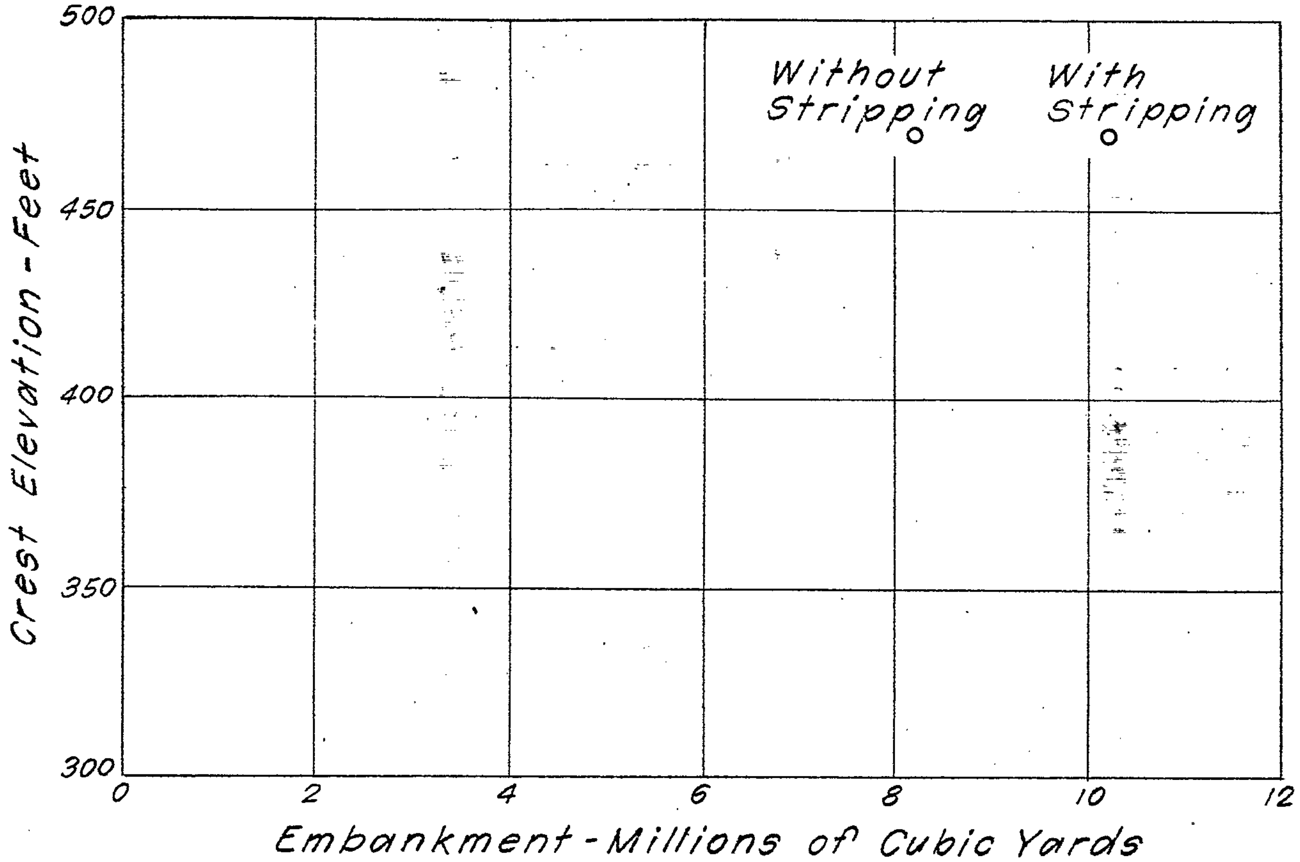
Figure 33

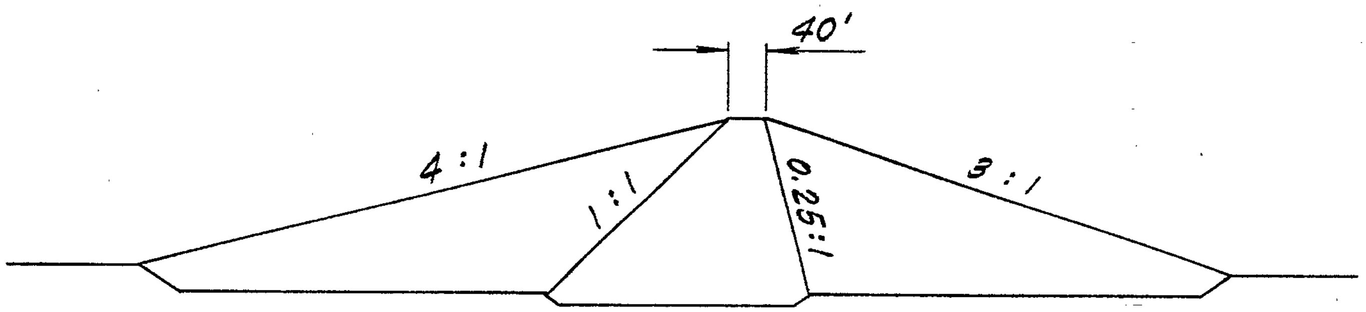
D-001886



GARZAS DAM SITE

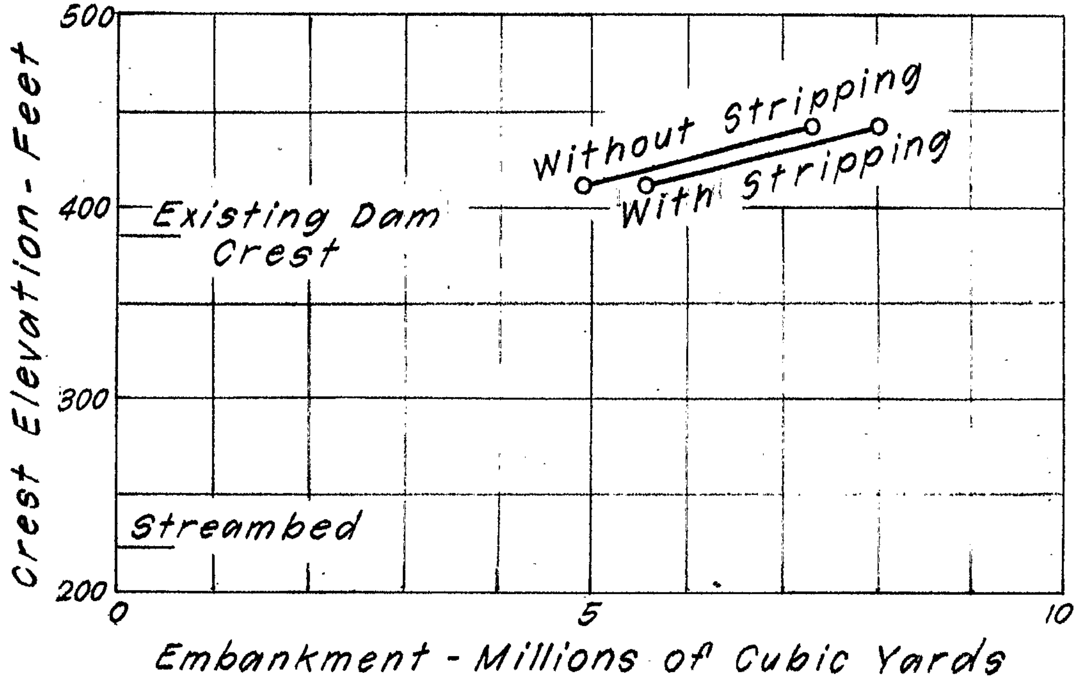
Figure 34

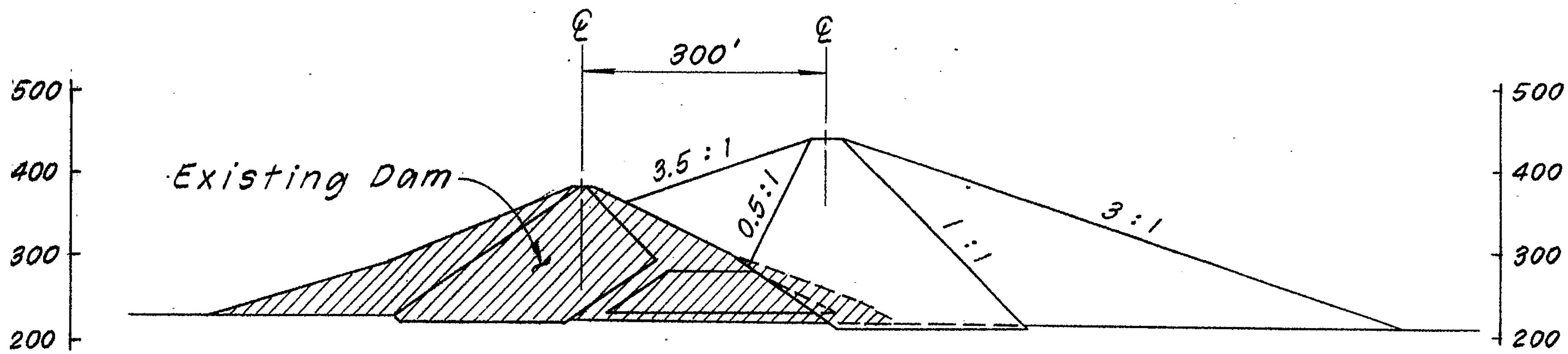




ROMERO DAM

Figure 35

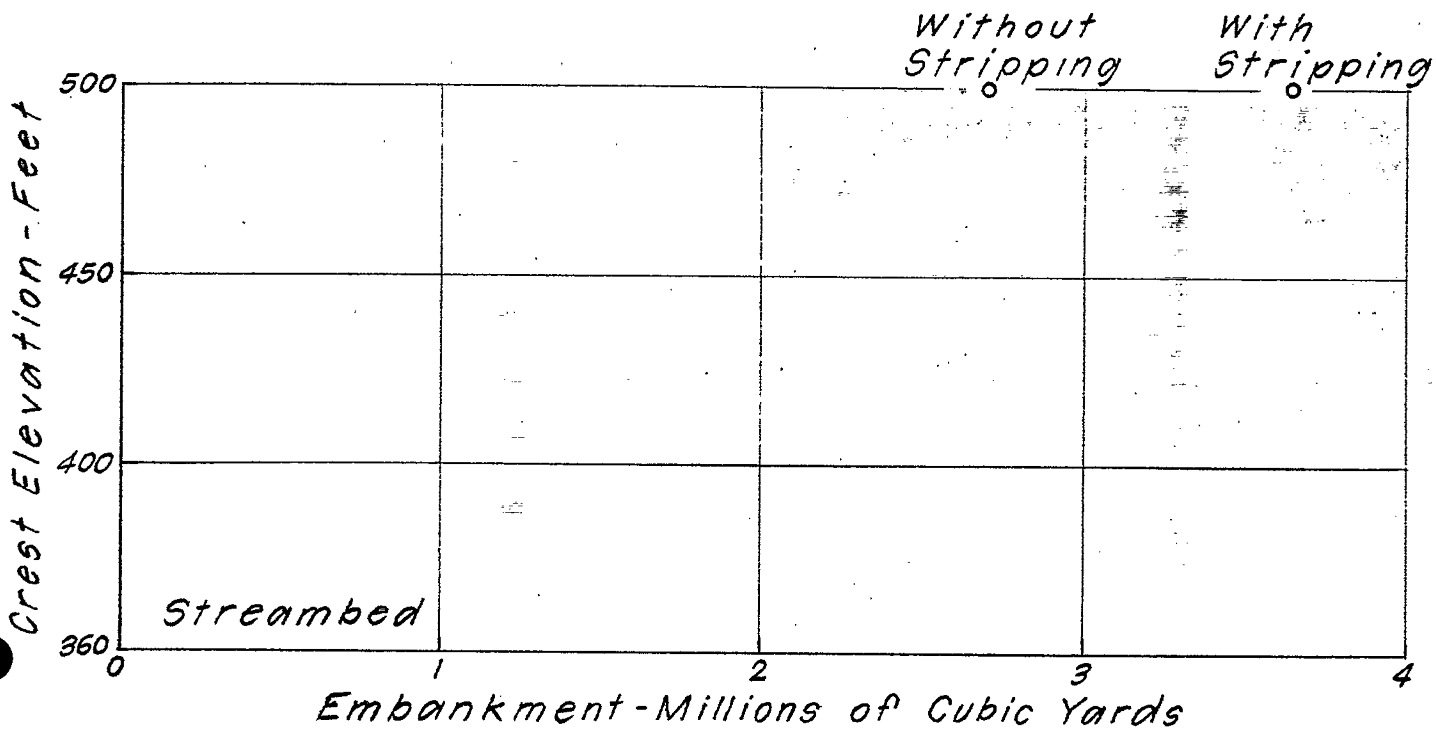


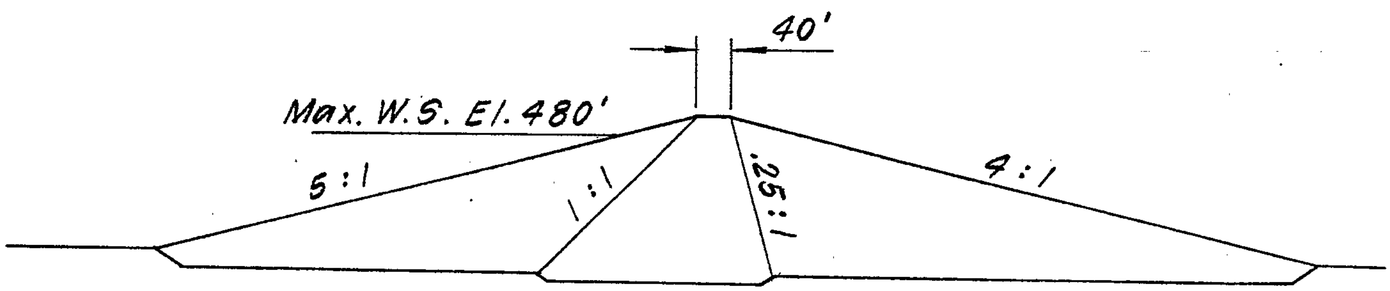


LOS BANOS DETENTION DAM ENLARGEMENT

Figure 36

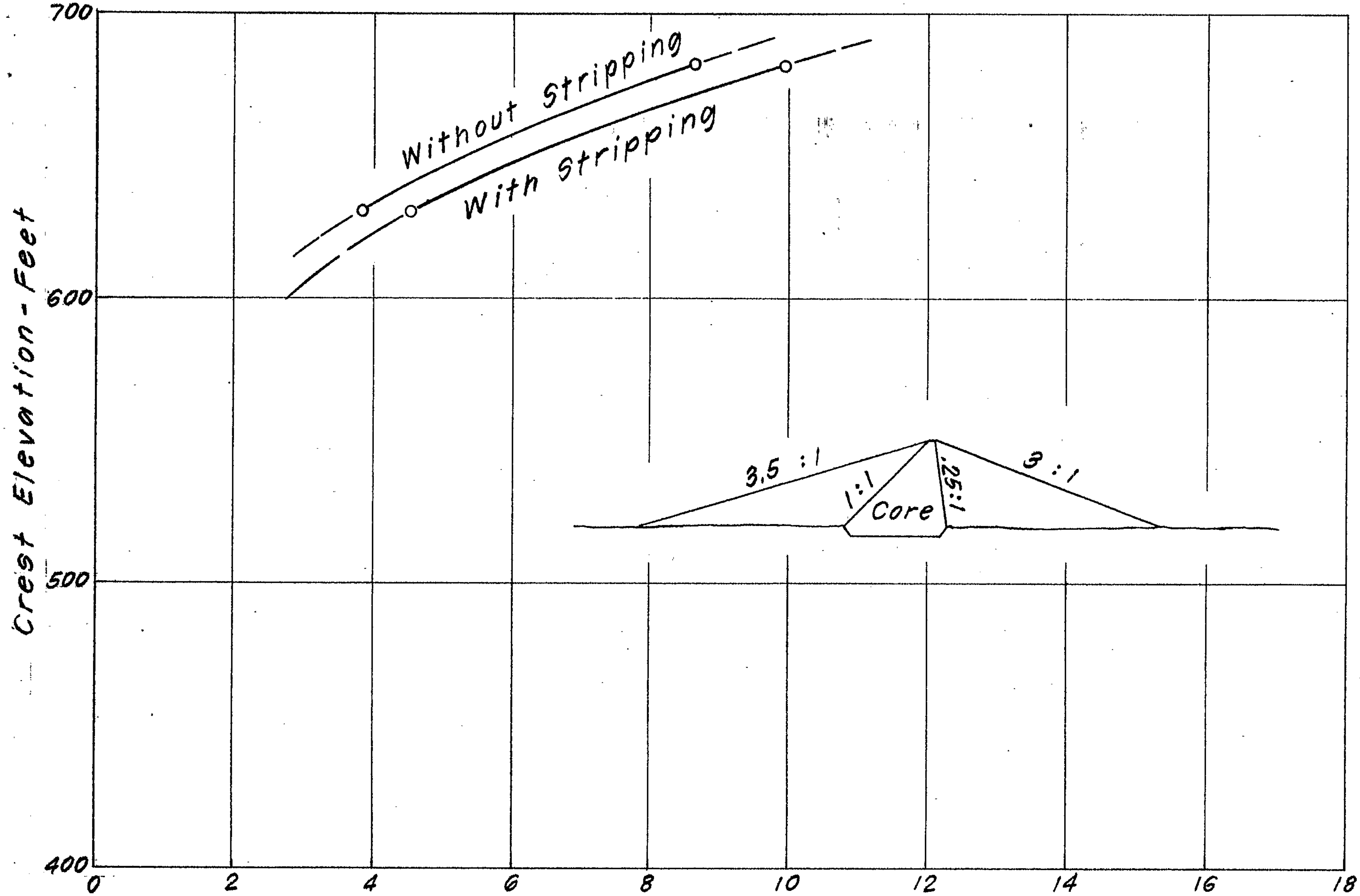
D-001889





SALT CREEK DAM

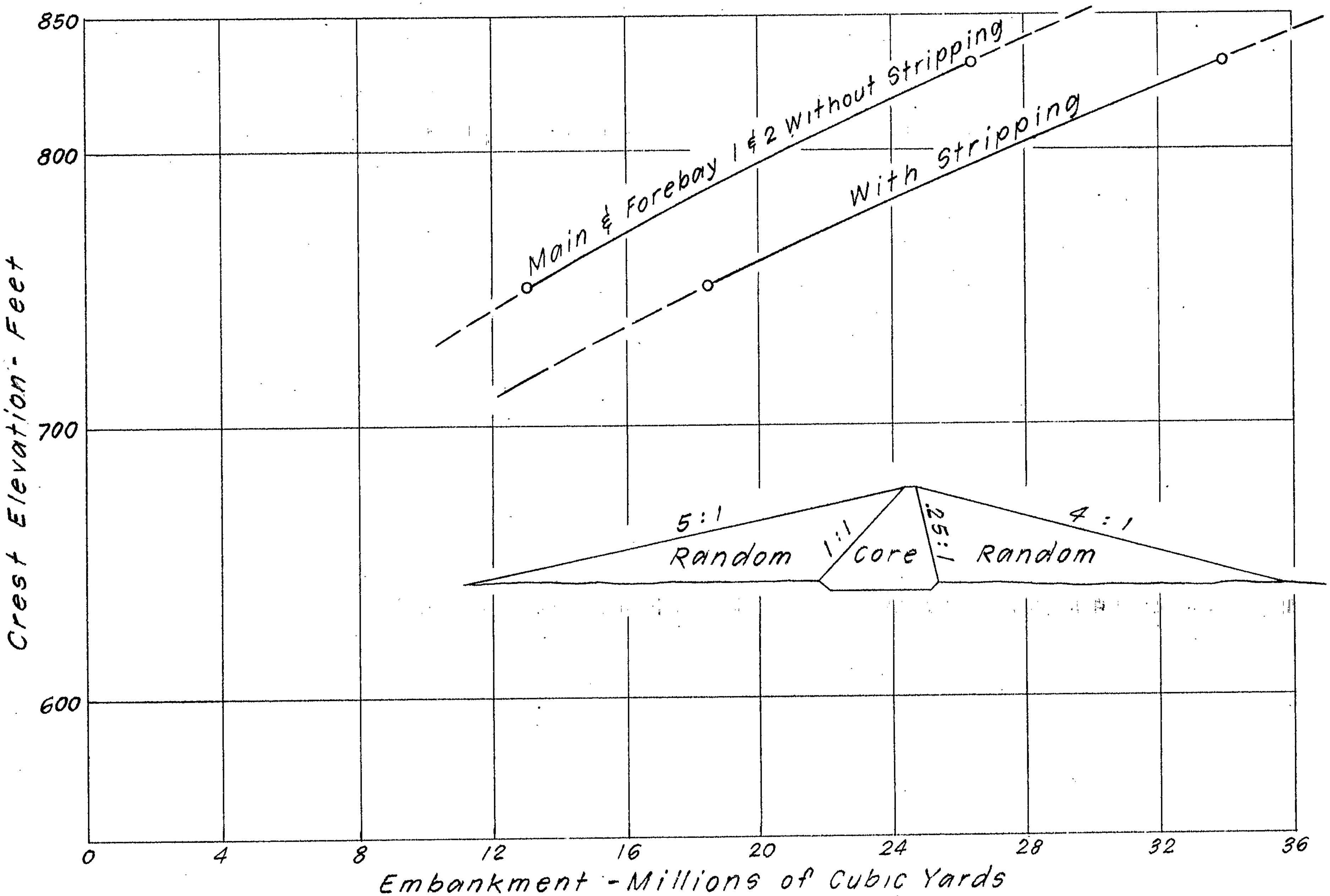
Figure 37



Embankment - Millions of Cubic Yards

LOS BANOS GRANDES

Figure 38

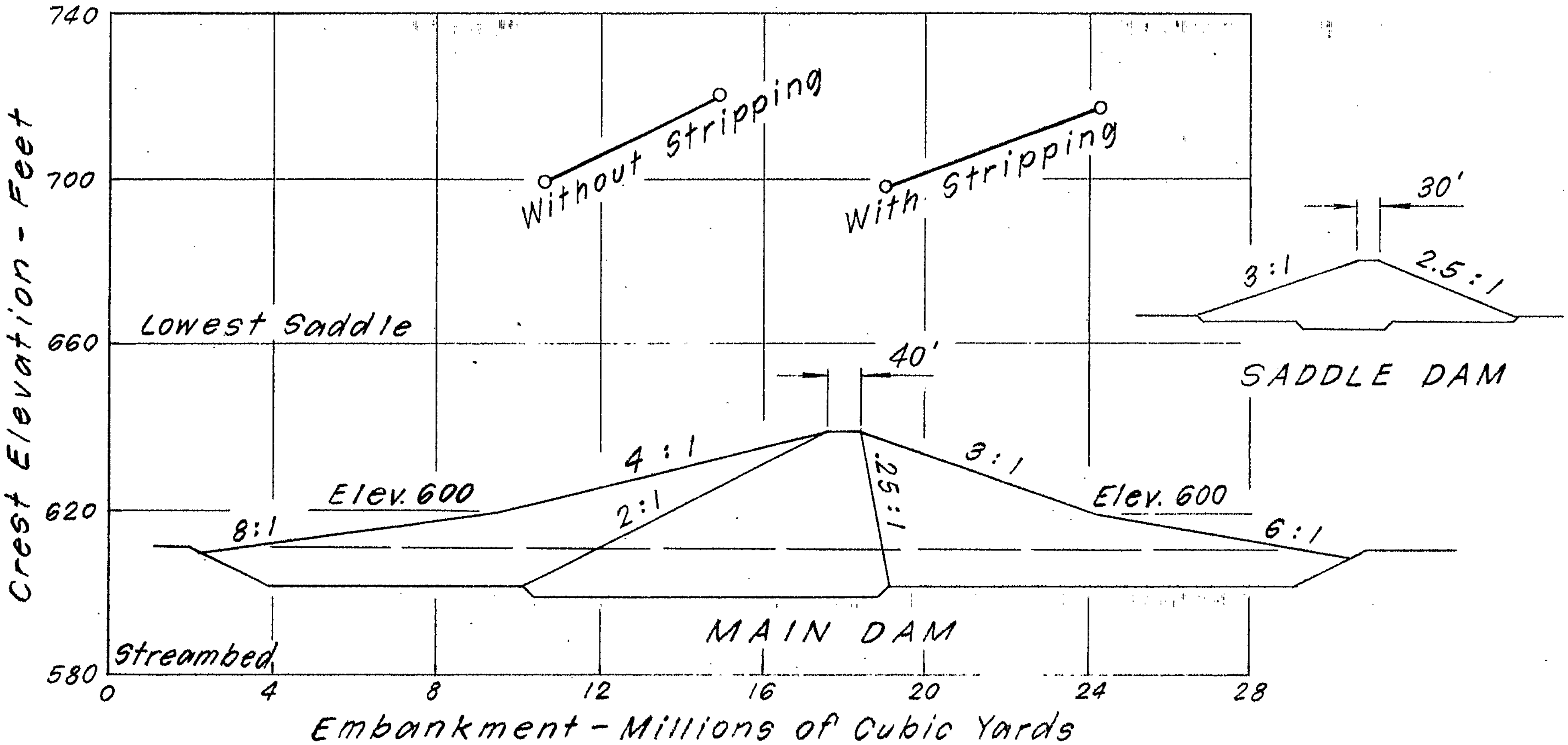


ORTIGALITA AND FOREBAY DAMS

Figure 39

D—001892

D-001892



SUNFLOWER DAM & SADDLE DAM
EMBANKMENT VOLUMES & SECTIONS.

Figure 40

APPENDIX III

SITE GEOLOGY

D-001894

State of California

The Resources Agency

→ Stafford
S. Chan

Memorandum

To : ~~Donald Steinwert~~ [handwritten initials] 10/28

Attention: Stephen Chan

Date : October 26, 1983

File No.:

Subject: Offstream Storage South Of The Delta - Cursory Geological Investigations

Mark McQuilkin

From : **Department of Water Resources**

Cursory level geological investigations were performed on 16 damsites south of the Delta, all within relatively short distances of the California Aqueduct. Investigations for seven of the sites were requested by Steve Chan, in a memorandum dated July 28, 1983. The additional sites were added later through informal discussions between H. Allsup and Steve Chan. Generally, the investigations included a brief site inspection, a literature review, and in some cases, a seismic refraction survey. The damsites are listed as follows:

1. Del Puerto Creek
2. Little Salado Creek
3. Crow Creek
4. Lower Orestimba Creek
5. Upper Orestimba Creek
6. Lower Garzas Creek
7. Upper Garzas Creek
8. Romero Creek
9. Enlarged Los Banos Detention Dam
10. Los Banos Grande
11. Salt Creek
12. Lower Ortigalita Creek
13. Middle Ortigalita Creek
14. Upper Ortigalita Creek
15. Enlarged Little Panoche Detention Dam
16. Sunflower Valley

Attached are the results of the cursory investigations with accompanying index maps, site maps, and photographs.

Attachments

SURNAME DWR 155 (REV. 4-62)	Allsup 10/26	McQuilkin		

D—001895

OFFSTREAM STORAGE
SOUTH OF THE DELTA

Cursory Geological Investigations
October 1983

1. Del Puerto Canyon

The damsite is situated across Del Puerto Creek about 2000 feet upstream from the California Aqueduct. Access to the reservoir area is by a county road but the damsite can be reached only by private roads. The inspection included a "window" survey from the county road and inspecting available geologic reports of the area. Early investigations contemplated a dam approximately 300 feet high with a maximum water surface at elevation 480. This would require the construction of one large saddle dam and two smaller ones. By lowering the water surface an additional 20 feet, to elevation 360, the smaller saddle dams practically would be eliminated.

The main damsite is a rather narrow v-shaped canyon with steep abutment slopes. Bedrock is the Oro Loma Formation, a series of interbedded conglomerates, sands, and clays. Well-cemented conglomerates form the narrow outlet for Del Puerto Canyon Creek and make up most of the foundation materials. Cementation is caused by a tuffaceous and calcareous clay matrix. The beds strike across the canyon and dip 43-58^{o} downstream. Upstream of the axis, the channel section contains terrace materials on both sides of the creek. Part of the upstream shell may rest on the Neroly Formation which is comprised mostly of tuffaceous claystones and sandstones in this area.

Foundation for the high saddle dam (180 feet high) would consist of the Neroly and Tesla Formations. The latter is comprised mostly of white, poorly-cemented sandstone with lesser amounts of shale. The beds from both formations strike perpendicular to the dam's axis and dip steeply into the left abutment.

For preliminary cost estimating, depths of stripping are estimated at 8 feet for the abutments and 12 feet for the channel. Pervious materials, such as drain rock and transition material, and riprap are not found locally and may require long haul distances. The Tesla sandstone, however, probably could be used for making soil cement in lieu of riprap. Core material and random borrow can be obtained from within the reservoir area. There are no known geologic hazards in the immediate area and the foundations should be capable of supporting the planned structures.

2. Little Salado Creek

The proposed damsite lies in a broad alluvial valley about one mile west of the California Aqueduct. Access to the site is by Fink Road, a county road that is accessible to Interstate Highway 5. Because we had no right of way onto private lands, the site inspection was limited to the county road which ran near the right abutment, and a seismic refraction survey along the side of the road. Most of the data regarding the local geology come from earlier geologic mapping by the Department.The main dam would be about 140 feet high, 6500 feet long, and have a spillway elevation of 400 feet. A freeboard-type wing dam would extend about one-half mile southward from the main dam. In addition, a saddle dam approximately 2000 feet long and 50 feet high would be required at the southern end of the reservoir if Crow Creek Dam is not constructed at the same time.

The right abutment is moderately steep (30°), grass-covered, and apparently has few outcrops. Geologic mapping indicates the lower right abutment is underlain by the Neroly Formation, an assemblage of clayey sandstone, claystone, and ash beds. The beds strike across the channel and dip gently downstream. Terrace materials largely composed of pervious sand and gravel with lesser amounts of clay and silt, overlie the Neroly and blanket most of the hills in this area. Stripping to competent bedrock would require an average of 10 feet where the bedrock is the Neroly but would be impractical in the terrace materials. The latter would require extensive blanketing to prevent seepage.

The channel section is about 3500 feet in length and lies within a walnut orchard. About 2200 feet of the channel section is underlain by alluvium. Total depth of the alluvium is not known but the seismic data indicate it is in excess of 45 feet. The remainder of the channel section is underlain partly by terrace materials that probably in turn rest on alluvium. Assuming a positive cutoff to bedrock, an overall stripping depth average of 45 feet is estimated.

The left abutment has gentle, rolling, grass-covered slopes. The abutment will rest largely on the Tesla Formation which consists of soft to moderately hard sandstone alternating with claystone and dark carbonaceous shale. Stripping to firm Tesla should average about 10 feet in depth. In the middle of the abutment area is a relatively flat, low channel that is underlain by terrace materials. Stripping in this area is expected to average at least 20 feet in depth.

The initial impression of the Little Salado Creek site is that it is a poor site. Topography on both the right and left abutments are being pushed to the maximum and leakage would be likely through the thin abutment ridges. From the topography and the way the abutments appear in the field, it appears a more reasonable elevation for the dam would be around elevation 380 rather than 400. Even so, the right abutment would require extensive blanketing to prevent seepage and piping. On the positive side, most of the materials needed for construction of the embankment are available locally. Riprap would have to be hauled in but there is sufficient sand locally for making soil cement instead.

3. <u>Crow Creek</u>

A site inspection and a seismic refraction survey in the channel section was done at this damsite. The site area can be reached only by private roads and is about 1.5 miles west of the California Aqueduct.

Crow Creek Dam is situated across Crow Creek which is a broad alluvial valley much like Little Salado Creek. The main damsite would be about 140 feet high, 4600 feet long, and have a spillway elevation of 400 feet. A 2000-foot long dike would have to be constructed in the south rim with an additional dike in the north rim if Crow Creek Dam is constructed alone.

The right abutment is gently sloping (20°), grass-covered, and apparently is made up entirely of terrace materials. These deposits are similar to those that cap the right abutment of the Little Salado Creek damsite. Stripping to firm bedrock would be impractical here and the right abutment ridge would require extensive blanketing to prevent high seepage losses and piping. For preliminary cost estimates, an average stripping depth of 20 feet is estimated for the right abutment.

The channel section is flat (currently being cultivated), about 3000 feet in length, and is completely covered by alluvium. Seismic data indicate the total thickness of the alluvium exceeds 45 feet. Assuming a positive cutoff to bedrock, the overall stripping depth is estimated to be 45 feet.

The left abutment has gentle, undulating, grass-covered slopes. Bedrock here is the Neroly or the Poverty Flat Formation. The areal extent of the formations is not known because they appear covered by a rather thin veneer of terrace material. The Neroly here is comprised mostly of tuffaceous sandstones and mudstones and the Poverty Flat is a well-compacted, uncemented sandstone. The soil cover seems relatively thin in the left side so stripping to firm foundation should require an average depth of 8 feet.

Most of the comments applied to the Little Salado Creek site apply also to Crow Creek. However, at Crow Creek the topography is not as critical so a spillway elevation of 400 feet seems practical. The right abutment though, will require more extensive blanketing than needed at Little Salado Creek. Even so, there may be no practical way of preventing excessive abutment leakage and possibly piping in the right abutment ridge.

Orestimba Creek

Two damsites were looked at on Orestimba Creek; one site with a spillway elevation of 440 feet and the other a mile farther upstream with a spillway elevation of 550 feet. Both would provide storage capacities of about 250,000 acre-feet. The sites are reached by private roads and are about 1.5 and 2.7 miles, respectively, west of the California Aqueduct. The investigation included a cursory inspection of each damsite and a seismic refraction survey in the stream channel at each site.

4. Lower Orestimba Creek

Bedrock for the downstream site and its four saddle dams consists of Tesla Formation sandstone. The sandstone exposed in outcrops along the stream channel bank is gray to gray-brown, massive, and fine grained. The sandstone is well compacted but lacks cementation. Strike of bedding is parallel with the axis of the main dam and dips downstream 18-20°.

The right abutment slopes evenly for the most part at 25°, then flattens considerably near crest elevation. No rock outcroppings are visible on the slopes and the soil and colluvium cover seem to be relatively thick. To reach suitable foundation, an estimated stripping average of ten feet will be required.

The channel section is approximately 4000 feet in length. On the right site of Orestimba Creek, the channel section is a relatively flat, stepped bench with the steps ranging from 3 to 10 feet in height. The alluvium exposed in these banks consists of gravelly sands to sandy gravels with a maximum size of about 6 inches (averaging 3 inches). Seismic data indicate the alluvium on the higher bench to be 31 feet deep. Left of the stream channel the topography is rolling rather than flat. Bedrock seems to be shallow and generally is covered with a gravelly terrace material. Sandstone is exposed occasionally along the north (left) bank of the stream channel. Exposures vary up to almost 20 feet in height and are usually capped by 5 to 10 feet of terrace gravels. Stripping to bedrock on the right side of the channel is expected to range from about 20 to 31 feet and on the left side from 6 to 15 feet, overall averaging roughly 20 feet for the entire channel section.

The left abutment slope is flatter than the right abutment and scattered patches of Tesla sandstone can be seen from a distance through the grass cover. The reservoir rim is quite thin just beyond the left end of the dam. Bedrock should be shallow but a stripping depth of 10 feet is estimated to reach firm undisturbed rock.

Saddle Dams - These damsites were not inspected. Geologic mapping indicates their foundations are the Tesla sandstone and should be similar to the left abutment of the main dam. An estimated 10-foot depth of stripping should be sufficient.

5. Upper Orestimba Creek

Bedrock for the upstream site is a gray-brown, fairly massive sandstone. The rock is very highly compacted and, though weakly cemented, is friable. Early geology mapping (U. C. masters thesis studies) indicated the sandstone to be Cretaceous Moreno Formation sandstone. In the lower abutment slopes and beneath much of the channel section, the bedrock was mapped as Moreno shale. More recent mapping has indicated the sandstone belongs to the Tesla Formation and the lower shale beds are Moreno. In either case, the rocks should provide the embankment with a suitable foundation. The beds strike across the canyon nearly parallel with the dam's axis and dip downstream 30 to 40°.

The right abutment rises abruptly above the stream channel at a 45-50 degree slope. Outcrops of massive, fine-grained sandstone occur frequently along the slope. Stripping should require no more than 5 feet to reach firm bedrock.

The channel section is approximately 2000 feet wide and contains alluvium underlain by sandstone and shale. On the right side of the channel, seismic data indicated the alluvium to be about 10 feet deep. Outcrops of sandstone occur in the left bank. Above the outcroppings are terrace materials which, based on seismic data, range up to at least 22 feet in thickness. Stripping will require removal of the stream bed alluvium and terrace materials to bedrock. This should require an average stripping depth of 15 feet for the entire channel section area.

The left abutment slope is flatter than the right abutment and is cut by a rather deep notch about two thirds of the way up the abutment. The reservoir rim is somewhat thin beyond the left end of the dam. Sandstone beds are exposed in the upper slopes of the abutment but on the lower slopes the soil and colluvium cover seems quite thick. Stripping would require the removal of about 5 feet of material in the upper abutment slopes and up to 15 feet in the lower slopes, with an overall average depth of 10 feet.

Both of the Orestimba Creek sites appear to be good damsites although the lower site seems to be pushing the topography to the limit. A more reasonable spillway elevation for the lower site would be around elevation 400. The upper site, I believe, is the best site even though it is farther from the California Aqueduct. All of the materials necessary for constructing the embankments are available locally. There are probably enough streambed sands and gravels to construct an upstream shell as well as to use for drain material. Nearby Tesla sands can be used to make soil cement instead of importing riprap. No local faulting or other geologic hazards are known to exist that might prevent the construction of an embankment of the size and type contemplated at either site.

Garzas Creek

Two sites were studied on Garzas Creek; both with spillway elevations at 600 feet. Storage capacities have not been calculated yet but the lower site should have nearly 250,000 acre-feet and the upstream site somewhat less. The embankment at the downstream site would be about 330 feet high and the upstream embankment about 310 feet high. The sites can be reached by a private road and are about 2.1 and 2.7 miles west of the California Aqueduct. The investigation included a cursory inspection of each damsite and a seismic refraction survey at the downstream site.

6. Lower Garzas Creek

No rock outcrops were found at this site during the investigation. From a distance there appear to be a few outcrops along the top of the ridge that forms the right abutment but there was insufficient time for a close-up look. Geologic mapping indicates the bedrock here to be the Upper Cretaceous Moreno Formation composed of sandstone and shale. Either rock type should provide the embankment with a suitable foundation. The beds apparently strike across the canyon and dip downstream.

The right abutment has a fairly uniform, steep (35°) slope. The reservoir rim is somewhat thin for a short distance beyond the left end of the dam. Judging by the steepness of the abutment only a shallow soil and colluvium cover over the bedrock would be expected. Depth of this cover should be no more than 10 feet.

The channel section is about 2300 feet wide and is divided into a flat, low, flood plain on the right half and a gently sloping (6-12%) terrace on the left half. Seismic data indicate the alluvium in the flood plain is only 9 feet deep and 19 feet of terrace materials occur in the lower part of the terrace. The terrace materials probably thicken towards the left abutment. The overall stripping depth (to bedrock) for the channel section should average about 15 feet.

The left abutment slopes gently at about 15° and appears to have a deeper soil and colluvium cover than the right abutment. A topographic saddle in the reservoir rim, a short distance from the right end of the dam, may require a freeboard-type embankment. Depth of stripping should average about 15 feet to bedrock .

7. Upper Garzas Creek

Bedrock at this damsite is mostly sandstone with some interbedded shale. Rock outcrops are well-exposed on both abutments. The beds strike across the canyon parallel with the dam's axis and dip about 85° downstream.

The right abutment slopes steeply, about 40°, over most of the abutment but near the base it flattens to about 25°. Soil cover ranges in thickness from about 12 feet at the base to 0 feet in the steep abutment slopes where the rock crops out. Overall, the stripping depth should average about 5 feet.

The channel section is somewhat less than 500 feet wide. Outcrops of sandstone occur in the lower portion of the 12- to 15-foot high bank on the left side of the stream channel, but none could be seen along the right bank, which is 6 to 8 feet high. The soil cover overlying the sandstone on the left side is about 5 feet thick. Though rock outcrops are absent on the right side of the channel, bedrock is expected at a relative shallow depth. An estimated overall stripping depth for the channel section should average about 12 feet.

The left abutment has gentle slopes (10°) and rolling topography. The reservoir rim is somewhat thin at the left end of the dam. Outcrops of cemented and nodular sandstone occur randomly at some localities and at others the outcrops appear to be fairly continuous. The soil cover here is deeper than on the right side so the average stripping depth should be about 10 feet.

Both sites at Garzas Creek appear to be good sites without any apparent significant defects. The lower site, topographically, is at its maximum with the spillway elevation at 600 feet whereas the upper site can be pushed to about 700 feet or more. Topographically also, the upper site seems better because it would require a smaller embankment, but on the short side, it would have less storage capacity than the lower site. Most necessary construction materials can be obtained locally and there are no known apparent geologic hazards.

8. <u>Romero Creek</u>

The Romero Creek site was proposed by Boyle Engineering for Wolfsen Enterprises. The L-shaped main dam would be about 320 feet high with the maximum water surface at elevation 600. In addition, two saddle dams would be constructed in the left reservoir rim. The site crosses Romero Creek about 1.7 miles west of the California Aqueduct. No field investigation was made at the site; only a review of the topographic maps and published geologic maps was done.

Bedrock for the embankment would be the Panoche Formation. The right abutment is moderately steep so bedrock should not be very deep. The left abutment is a series of northwest-trending, gently sloping knolls so the soil and colluvium cover there should be deeper than that at the right side. The channel section is covered by alluvium and could be as deep as 25-35 feet. Estimated stripping depths at the site is 10 feet for the right abutment, 30 feet for the channel section, and an average of 20 feet for the left side.

For the topography, at a 600-foot water surface elevation, the site has been pushed far beyond the maximum. Elevation 400 should be considered the maximum water elevation here. It appears that an enormous volume of embankment material would be needed for the main dam and accompanying saddle dams if the 600-foot elevation layout is used. The contemplated project seems to be an impractical effort for the volume of storage acquired.

9. Enlarged Los Banos Detention Dam

The investigation for this site consisted of a site inspection and reviewing a brief report by the U.S.B.R. that covered the existing dam's design and construction. An inspection of the bedrock that crops out in both abutments and in the reservoir rim, and reviewing the data from the report provided a fairly clear picture of the site's geotechnical conditions. The site is in the Los Banos State Recreational Area and can be reached by paved public roads.

Los Banos Dam is situated across Los Banos Creek about 1.3 miles from the California Aqueduct. The dam embankment is 167 feet high with its crest at elevation 384 feet. Enlargement of the dam to elevation 500 feet would raise the embankment height approximately 136 feet and require roughly an additional 5300-foot length of embankment as wing dams or dikes.

Bedrock at the site consists of sandstone, shale, and conglomerate of the marine Panoche Formation. The beds strike roughly parallel with the existing dam's axis and dip downstream 30° to 45°. Overlying the Panoche beds in the abutment slopes above the crest, are terrace deposits of mostly sandy gravel and gravelly sand. The base of the terrace deposits is at about elevation 415 at the abutments and the base apparently slopes upward in the westerly direction roughly following the topography. It was encountered in a drill hole, about 1200 feet west of the left abutment, at a depth of 20 feet (elevation 452). Thus, it seems there are at least 20 feet of pervious terrace deposits covering the Panoche sediments at the abutments and reservoir rim areas.

The Bureau's design and construction report indicates the existing dam foundation consists of alluvial sands, silts, and gravels and Panoche bedrock. Apparently the alluvium was left in place beneath the zone 2 (shell) embankment in the stream bed but was removed beneath the zone 1 (impervious) embankment. The abutments were stripped to expose bedrock. Stripping was reported to average 10 feet in depth in the stream channel and 2 to 4 feet at the abutments.

It seems the upper height limit to this site is at about elevation 415, which is the base of the terrace deposits. A dam this high would back water to the Los Banos Grande Dam site thus fulfilling the purpose of the enlargement. The sources of materials used to construct the existing dam still should be available and they should contain sufficient materials for the embankment enlargement.

10. Los Banos Grande

Reconnaissance-level studies have been completed already for this damsite and the results are covered in a memorandum report dated June 1968. No on-site inspection was made this time because of the lack of right-of-way. The previous geologic investigations included foundation drilling at the structure sites, borrow exploration drilling, and seismic refraction surveys.

The project covered by the report included a 560-foot high earthfill dam, a spillway at elevation 890 feet, and 12 saddle dams. The storage capacity for the reservoir would be 3,600,000 acre-feet. The dam presently being contemplated is 275 feet high with a spillway elevation at 605 feet, and would have a storage capacity of about 300,000 acre feet. Only one wing and saddle dam (at Salt Creek) would be needed.

The damsite is located across Los Banos Creek at the upper end of a narrow gorge that opens out to Los Banos Valley. Bedrock at the site consists of conglomerate and sandstone and lessor amounts of interbedded shale, all of the Panoche Formation. The strike of bedding is quite variable but generally, the beds strike across the gorge and dip 15° to 20° downstream. The canyon is roughly U-shaped with bedrock exposed on the slopes and in the stream channel. Only a minimal amount of stream bed sands and gravels occur. An overall stripping depth for the entire embankment area was estimated at 9 feet in the reconnaissance report but for our estimate, an average stripping depth of 10 feet should suffice.

The Salt Creek wing and saddle dam site consists of two embankments separated by a low knob. One embankment crosses the Salt Creek channel at about elevation 550 feet and the other crosses a saddle (to the north) that has a minimum elevation of about 590 feet.

A geologic reconnaisance was made at this site and the results are covered in a report dated December 1956. Bedrock at the site consists of sandstone and shale of the Panoche Formation. Exposures of bedrock occur in the abutments and channel section of the Salt Creek site but were absent in the adjacent saddle dam site. Overall stripping depths for the entire embankment area are estimated at 10 feet for the wing dam across Salt Creek and 15 feet for the saddle dam.

Topographically, Los Banos Grande is one of the best damsites on the west side of the San Joaquin Valley. Construction materials are found locally or within short distances from the site both in sufficient quantity and quality. Geologically, the only significant problem for this site,recognized at this stage, is its seismicity. The Los Banos Valley branch of the active Ortigalita Fault is only 2.5 miles west of the damsite. In addition, several lineaments suspected of being Quaternary faults occur close by; the nearest crosses Los Banos Creek about 3/4-mile upstream of the site. None of these lineaments, however, have been found to displace Holocene alluvium.

11. Salt Creek

The Salt Creek Dam site is about one mile south of the existing Los Banos Reservoir. It is located in Sections 18 and 19 about 2.3 miles west of the California Aqueduct. The embankment would be approximately 140 feet high with the spillway elevation at 480 feet. Because there was no right-of-entry, the site investigation consisted of viewing the site from a distance of about one-half mile. Geologic data was obtained from published geologic mapping.

The damsite has fairly gentle (15°) grass-covered slopes and a relatively narrow (300 feet ±) channel section. Just above the crest elevation, the slopes flatten to form a broad, undulating bench.

Geologic maps indicate the bedrock is the Panoche Formation; probably alternating sandstone and shale beds. Some outcrops could be seen in the canyon slopes (including the left abutment) from our vantage point. The soil and colluvium cover seems to be fairly thick, especially in the uppermost part of the slopes which, over much of the bench area, are covered with terrace materials. The canyon floor seems to be relatively flat and no outcrops were visible. From a distance, the creek bed appeared incised in the alluvium by as much as 10 feet. Based on these observations, the estimated depth of stripping is 20 feet in the channel section and 10 feet at both abutments.

Topographically, the damsite appears to be a good site. Impervious materials and downstream shell material probably can be obtained locally but the rest of the construction materials will have to be imported. Seismic conditions similar to the upper Los Banos site occur here also and one of the Quaternary faults (?) would cross the reservoir about 3/4-mile upstream of the damsite. Basically, the primary concern wiith this site is it appears to have a low storage capacity . Elevation 480 probably is the upper height limit for this site..

Ortigalita Creek

Three damsites were inspected briefly on Ortigalita Creek. The two lower sites would be used as forebays for pumping the water from the California Aqueduct to the upper reservoir. The investigation included an inspection of each site and a seismic refraction survey at the upper or main damsite. Access to the sites was by private roads.

12. Lower Ortigalita Creek

The lower damsite is in Section 29, T11S, R10E, two miles west of the California Aqueduct. The embankment would be approximately 160 feet high with a spillway elevation at 480 feet. The dam would back water upstream to the middle damsite.

Bedrock for the damsite belongs to the Panoche Formation. Outcrops of sandstone and large sandstone nodules occur on the moderately steep (35°) right abutment. A topographic saddle in the reservoir rim, a short distance beyond the right end of the dam, is narrow and might require a freeboard-type embankment. Outcrops of sandstone can be seen also in the left bank of the channel and in the lower slopes of the left abutment. The beds strike across the canyon and dip about 30° downstream. In contrast to the right side, the left abutment slopes gently upwards to about elevation 480 and then flattens to a narrow, slightly sloping bench. Terrace materials occur on higher ground above this bench and may also occur on the bench. Soil and colluvim cover seems quite variable, ranging from zero at outcropping, to possibly 20 feet on the upper bench.

Stripping depths for the left abutment will vary considerably but the overall average should be about 15 feet. Stripping also should average 15 feet for the channel section and only about 5 feet for the right abutment where rock exposures are fairly common.

13. Middle Ortigalita Creek

The middle damsite is in Section 31, 1.7 miles upstream from the lower site. The embankment will be 110 feet high with the spillway elevation at 560 feet. Water would be backed up by the dam to the toe of the main dam.

The embankment would be founded on Panoche sandstone and shale. Outcrops of sandstone can be seen from about midheight to nearly the top of the right abutment ridge. The lower slope appears covered with colluvium. No outcrops could be found in the channel section and the alluvium-filled section has been encised at least 20 feet by the creek. The left abutment is basically a gently sloping (7-8%) bench. Outcrops are sporadic and are seen mostly on the hillside above the crest elevation. Stripping to bedrock should average about 8 feet for the right abutment, 30 feet in the channel section, and 12 feet for the left abutment.

14. Upper (Main) Ortigalita Creek

The main damsite is in a rather broad linear valley about 5.1 miles upstream on Ortigalita Creek from the aqueduct. The damsite is in Sections 6 and 7, T125, R10E. Height of the embankment would be 265 feet with the spillway elevation at 800 feet. The investigation consisted of a site inspection and a seismic refraction survey in the channel section.

Bedrock at the site consists of Panoche sandstone and shale. The beds strike perpendicular to the dam's axis and dip into the right abutment about 35°.

The right abutment is relatively steep, about 33°, to about midheight and then flattens to 15 to 20°. Outcrops of thinly-bedded sandstone occur over much of the lower abutment slope but appear rather sparse on the gentler slope indicating a deeper soil cover. Stripping is expected to be about 5 feet in the lower slope then increasing to 10 feet or more above, overall averaging 8 feet deep.

The channel section, about 1000 feet wide, slopes gently from the left to the right side where the stream channel is encised about 8 feet into the alluvium. The seismic survey indicated the alluvium is deeper than 50 feet. Downstream one-half mile, an exposure of the alluvium in a 30-foot high stream channel cut bank indicates the alluvium contains basically cohesive materials suitable for core material. The depth of alluvium at the damsite is expected to average at least 40 feet for the entire channel width.

The left abutment is basically a dip slope, averaging about 30°. No outcrops were seen in the slope so the soil and colluvium cover should be fairly thick. An average stripping depth of approximately 15 feet is estimated for this abutment.

The main damsite lies astride a prominent lineament that some geologists consider to be a Quaternary fault. The upstream half of the middle damsite also would rest on this feature. In addition, the active Ortigalita Fault is but 4.3 miles west of the main damsite. Most construction materials can be obtained locally for the three structures but riprap and drain rock would have to be imported.

15. Enlarged Little Panoche Detention Dam

The investigation at this site included a site inspection and the review of a U.S.B.R. design and construction report for the existing dam. Bedrock was not readily discernible but was reported to be exposed only in the lower portions of the abutments. Terrace deposits that overlie the bedrock, however, are well exposed in road cuts and in the right abutment ridge. The site can be reached by the Little Panoche county Road.

The existing dam is a zoned earthfill structure 151 feet in height with its crest at elevation 676 feet. The dam lies across Little Panoche Creek approximately five miles from the California Aqueduct. Topographically it appears the dam can be raised up to a crest elevation of 800 feet (N.W.S. 780). This would require raising the existing embankment 124 feet and adding roughly 3800 feet of new embankment as wing dams or dikes.

Bedrock at the site consists of sandstone, siltstone, and shale of the Panoche Formation. The beds strike roughly parallel with the dam's axis and dip downstream. Overlying the Panoche sediments at the abutments and along the reservoir rim are flat-lying terrace deposits of sand and gravel. During construction of the dam, the base of the terrace deposits was encountered at elevation 620 on the left side and elevation 645 on the right side. Total thickness of the deposits is undeterminable with the available data but a visual inspection of the slope indicates the deposits may be as thick as 100 feet or more at the abutments.

Foundation for the existing dam consists of Panoche bedrock, terrace deposits, and streambed sands and gravels. A cutoff trench beneath the impervious zone was excavated to bedrock (except in the abutment slopes). Stripping apparently was minimal for the remainder of the foundation because "fine-grained overburden material" was left inplace and later was water treated, leveled, and rolled before placing fill. Sand and gravel also was reported left in the channel section upstream and downstream of the cutoff trench.

A storage-type embankment at this site should be limited to a spillway elevation of about elevation 620 where the base of the pervious terrace deposits are first encountered. The amount of storage then would be so small that it would make this site impractical. Embankments with higher spillway elevations would incur much greater costs for foundation stripping, cutoffs, and blanketing and even then, leakage through the abutment rims probably would be excessive.

16. Sunflower Valley

Because considerable geologic work has been done already on the Sunflower Valley project, a site inspection did not seem warranted. Previous work includes a reconnaissance geologic report, an exploration drilling program, and a seismic survey across the channel section of the damsite.

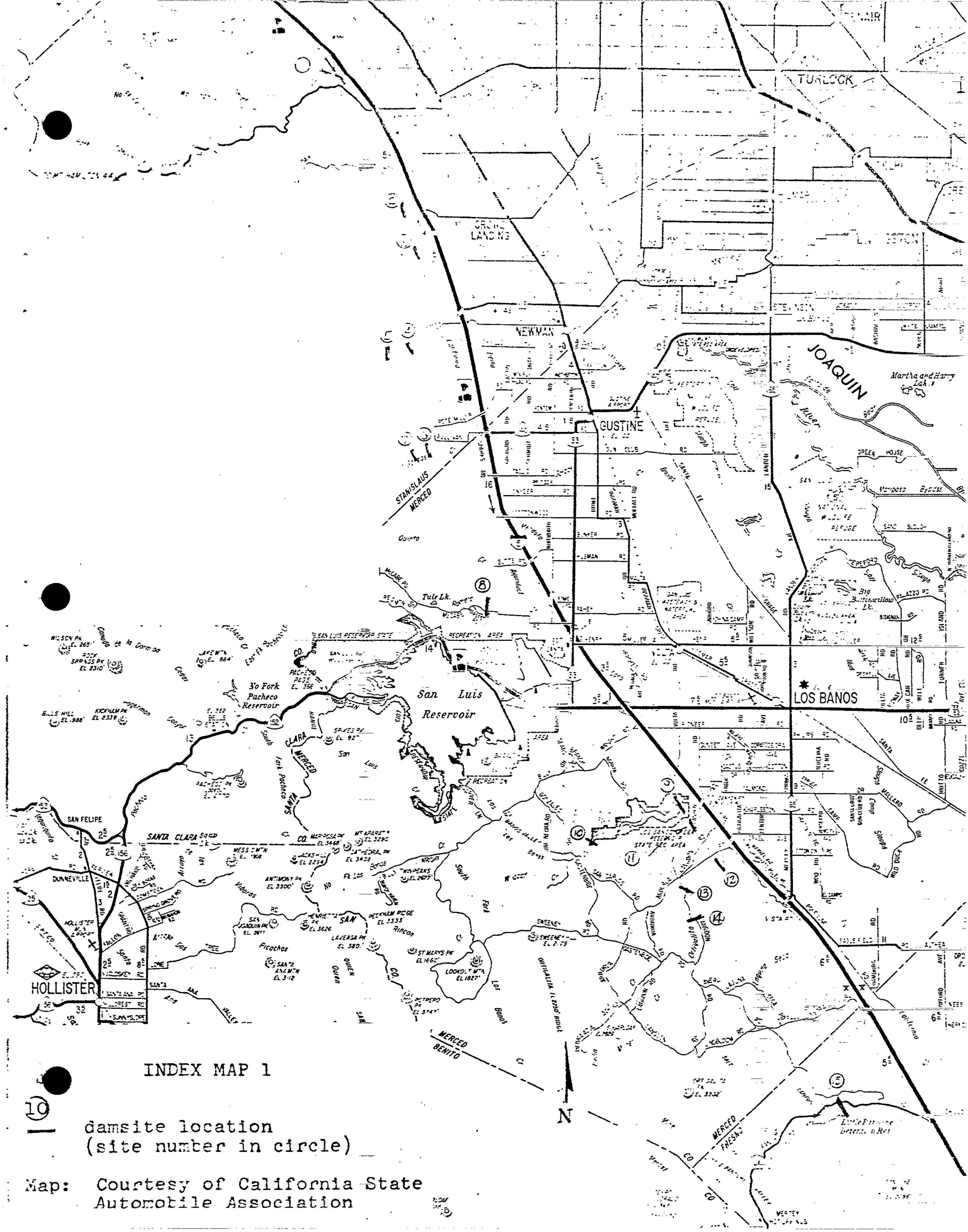
Sunflower Valley damsite lies astride a wide gap, called Dagany Gap, in the Pyramid Hills. The gap, which drains Sunflower Valley, is about two miles west of the Coastal Aqueduct. The proposed dam would be a homogeneous earthfill dam 185 feet high with 19 earthfill saddle dams of lesser height. The spillway would be at elevation 750 feet.

Bedrock for the main dam and all 19 saddle dams is the McClure shale member of the Monterey Formation. The member is made up mostly of siliceous shales that strike parallel with the dam's axis and the abutment ridges and dip downstream. The shale is described in the preliminary report as low density, brittle, and highly fractured at the surface. Surface fractures generally are filled with gypsum. Fresh shale is moderately hard, generally thinly-bedded, and lightly to moderately fractured.

Drilling disclosed the 4400-foot long channel section is underlain by up to 53 feet of alluvium resting on the McClure shale. Basically, the alluvium consists of clay deposits (with some sand interbeds) overlying a 6 to 20-foot thick bed of pervious sand and gravel deposits. The alluvium averages about 40 feet in thickness.

A rather limited amount of soils testing was done on the clay alluvium and none was done on the sand and gravel deposits. The tests indicated the clays have low shear strengths: one point, U. U. test values of less than 1 ton per square foot. Other than knowing the sand and gravel deposits are highly permeable, nothing is known of their strengths. The report covering the subsurface exploration recommended a cutoff trench be excavated to bedrock. However, in the light of today's more stringent seismicity requirements, for preliminary cost estimates the alluvium and roughly the top 5 feet of weathered shale should be completely removed from the embankment foundation. The average depth of stripping in the channel section then should be approximately 45 feet. Stripping for the abutments should average about 5 feet with an additional 10 feet of depth for a cutoff trench.

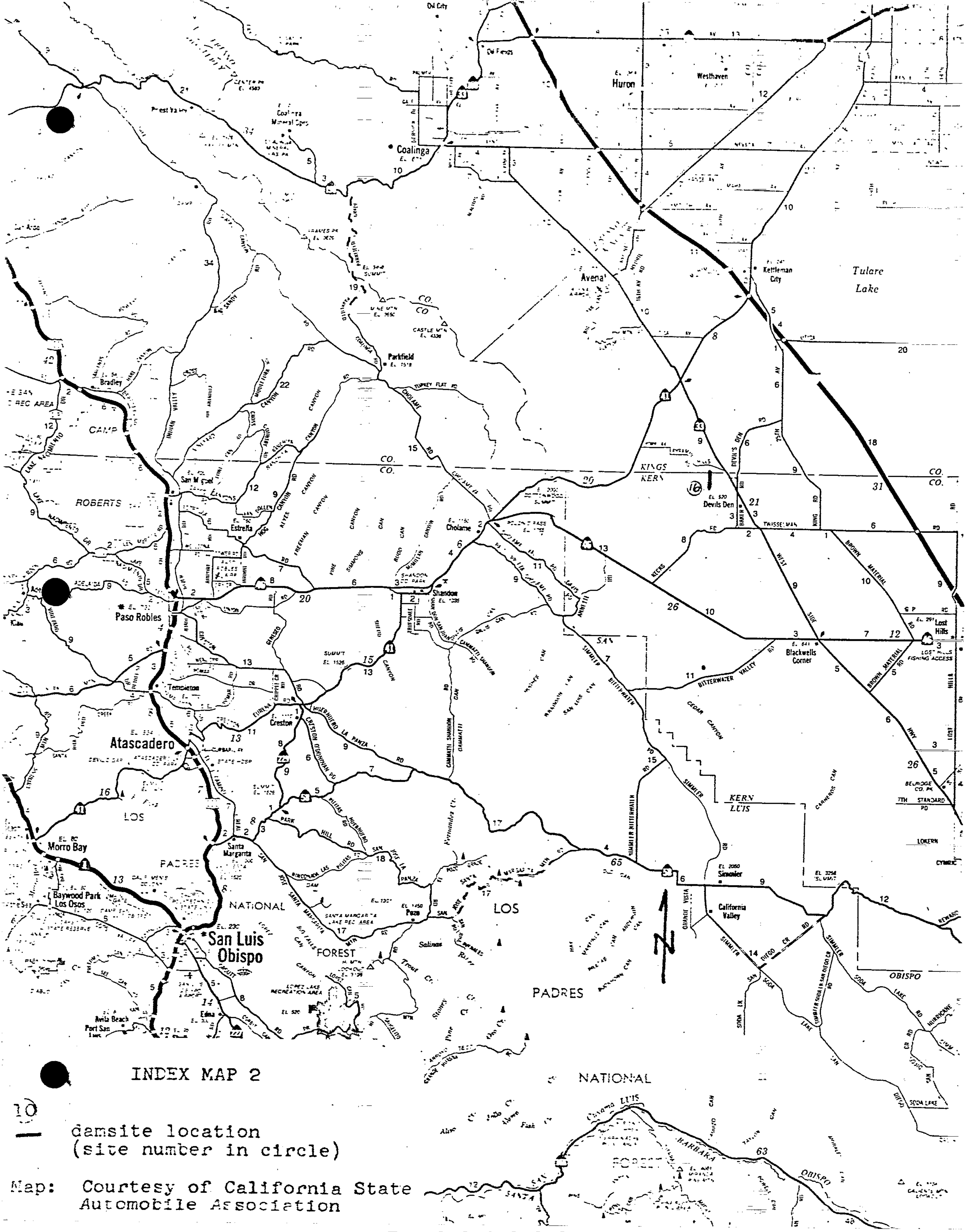
The exploration report expressed concern (but contained no assessment) for the stability of the narrow reservoir rim and for the possibility of reservoir leakage. Both are viable concerns and need to be studied. However, the topography has been pushed to the maximum for both abutment ridges by having the spillway elevation at 750 feet. By lowering the water surface at least to elevation 700 feet, most of the 19 saddle dams could be eliminated or would require no more than a freeboard type structure. Lowering the water surface also would increase the stability of the reservoir rim and reduce the possibility or the amount of leakage. Devils Den oil field occupies much of the reservoir rim south of the damsite and some oil wells are in the reservoir area.



INDEX MAP 1

⑩ damsite location
(site number in circle)

Map: Courtesy of California State Automobile Association



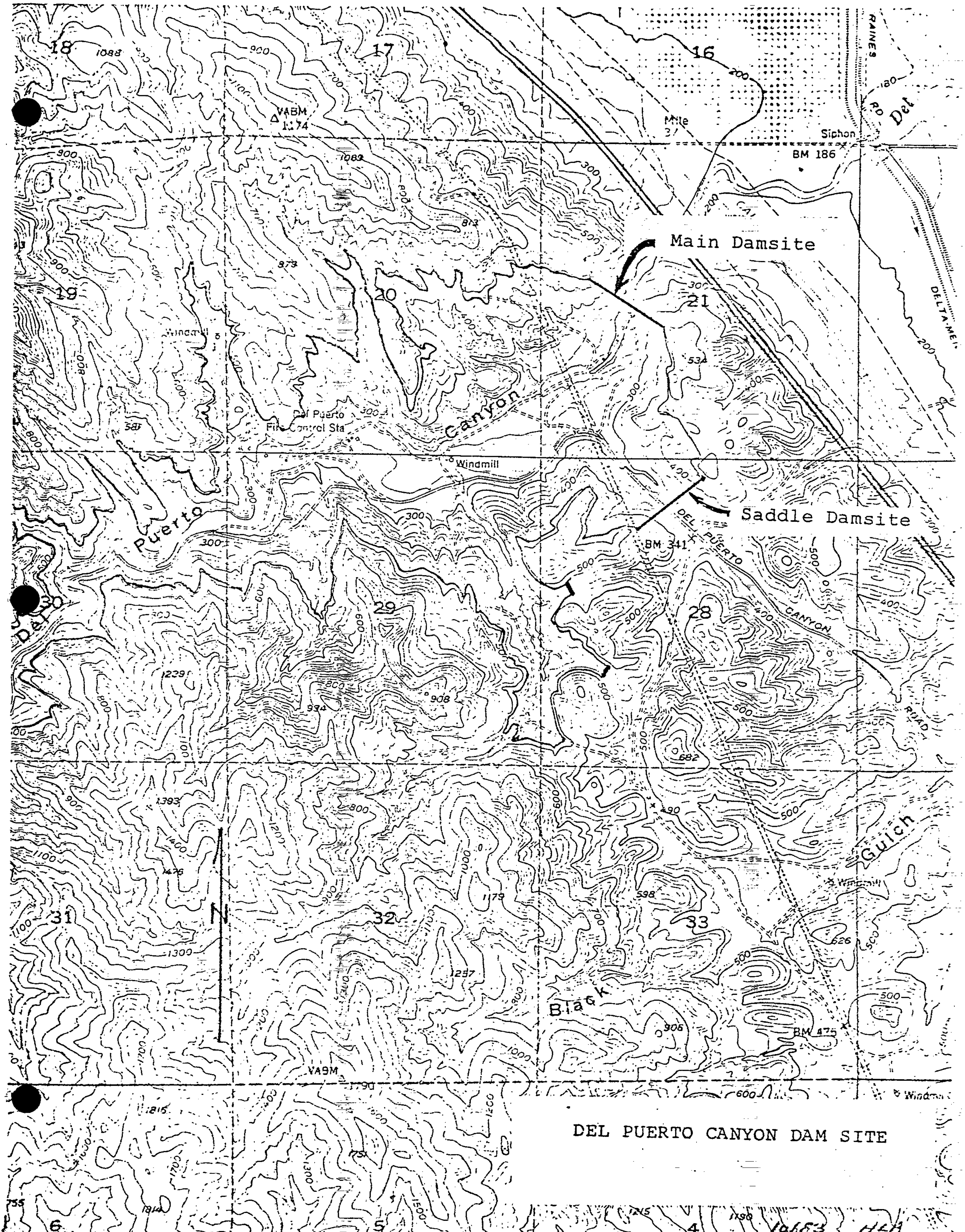
INDEX MAP 2

10 — damsite location (site number in circle)

Map: Courtesy of California State Automobile Association

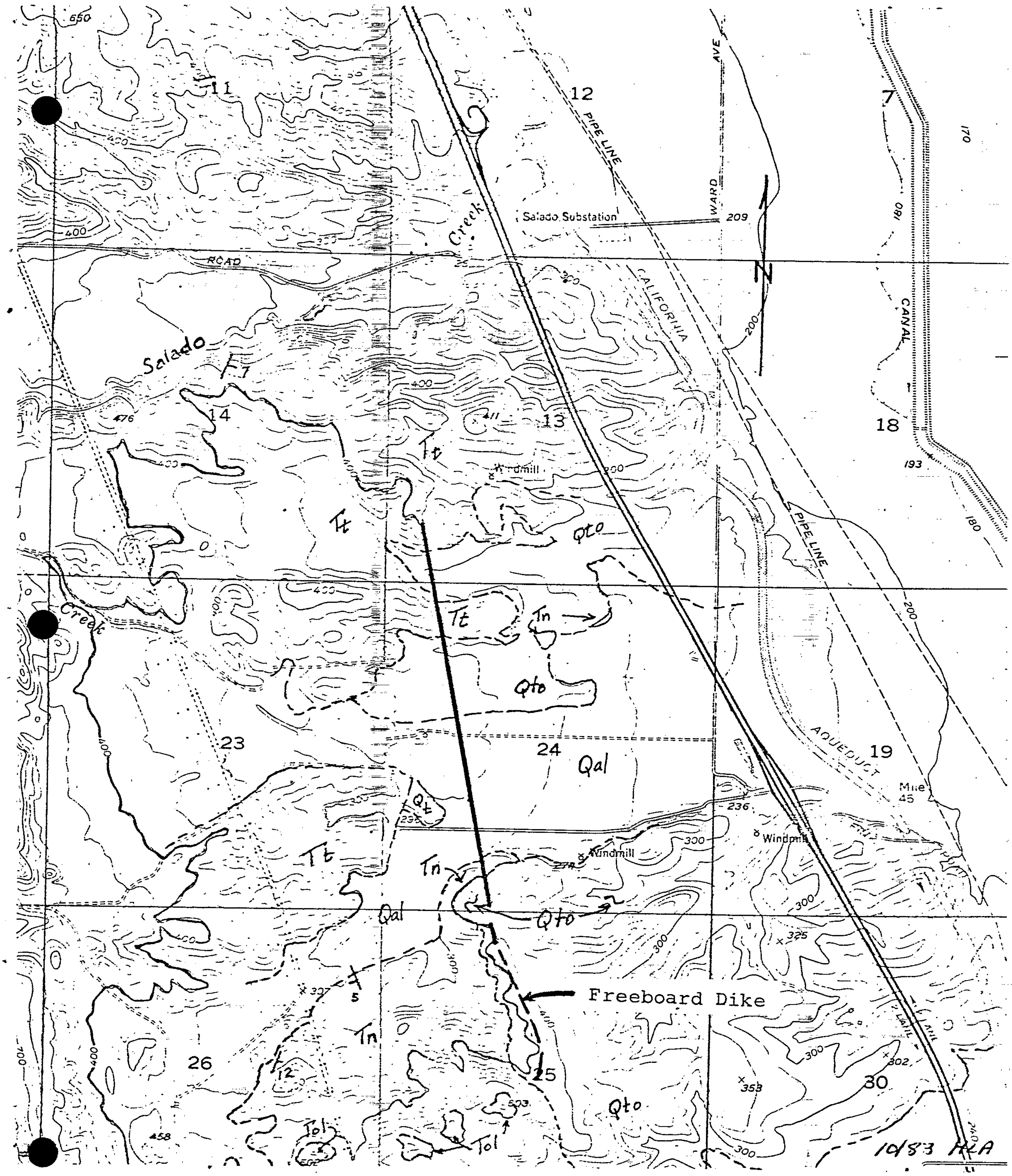
D—001909

D-001909



DEL PUERTO CANYON DAM SITE

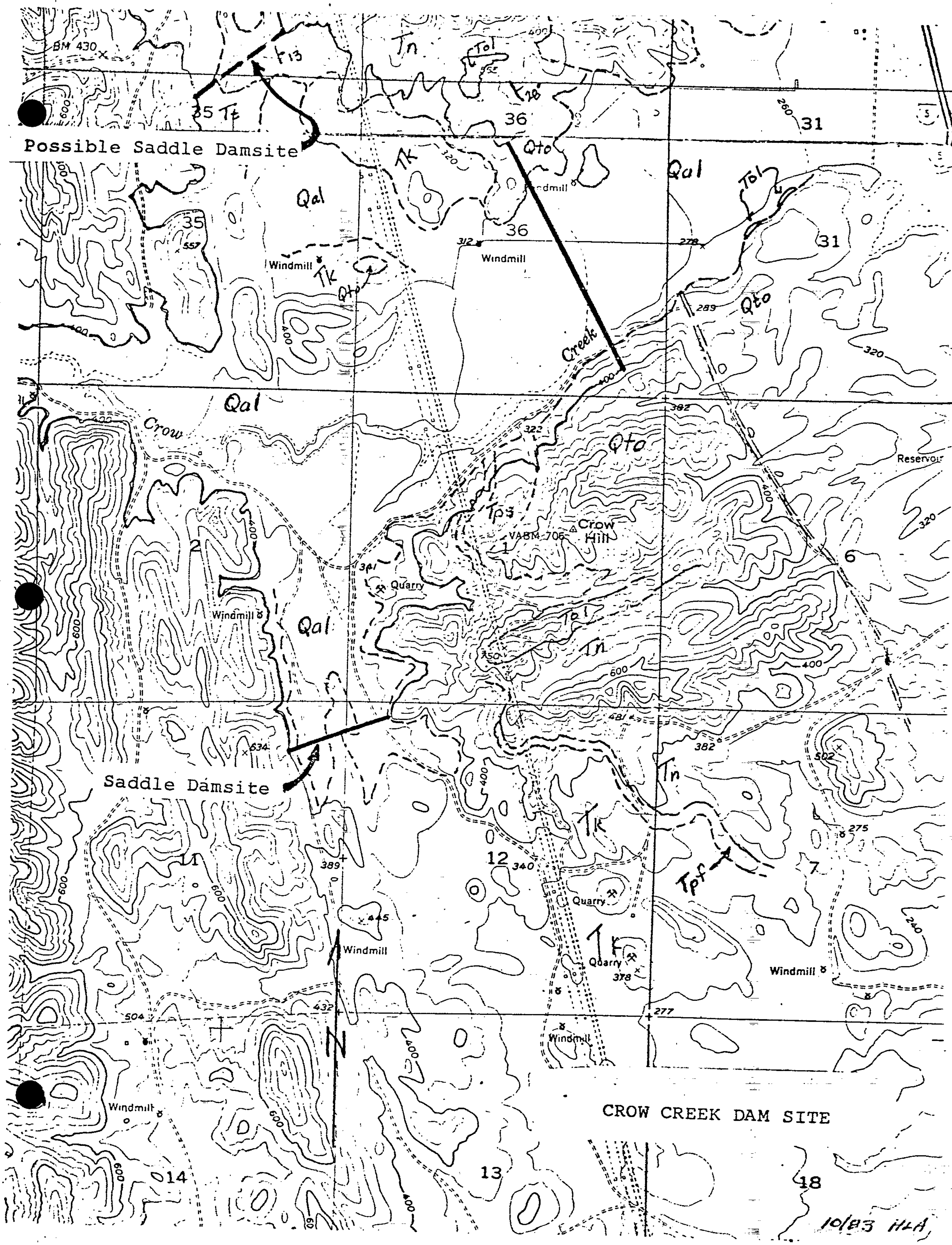
D-001910



LITTLE SALADO CREEK DAM SITE

D—001911

D-001911



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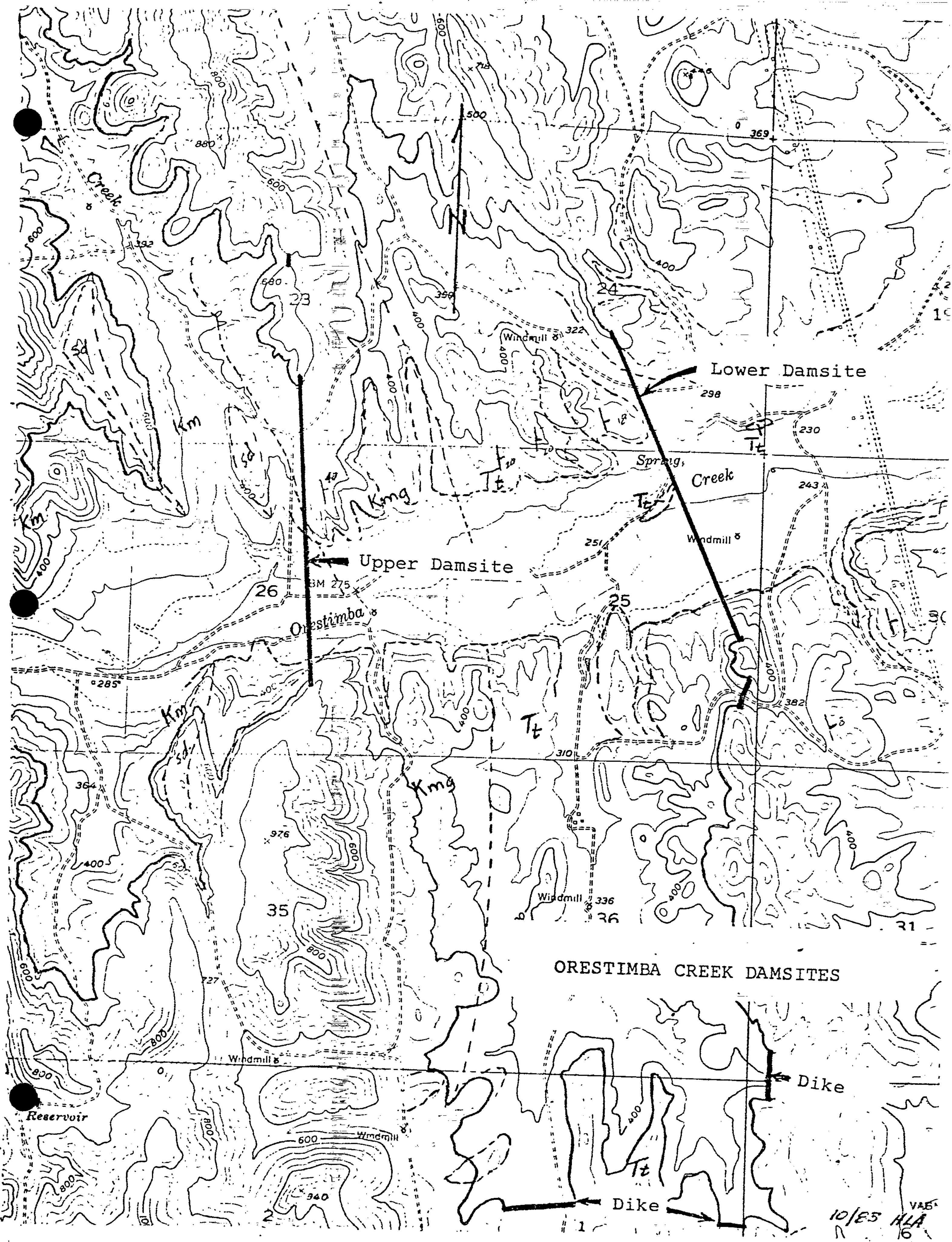
D-001912


ORESTIMBA CREEK DAMSITES
Upper Damsite
Lower Damsite
Dike
Dike
Orestimba
Spring Creek
Creek
Reservoir
Windmill
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Kmg
Tt
sd
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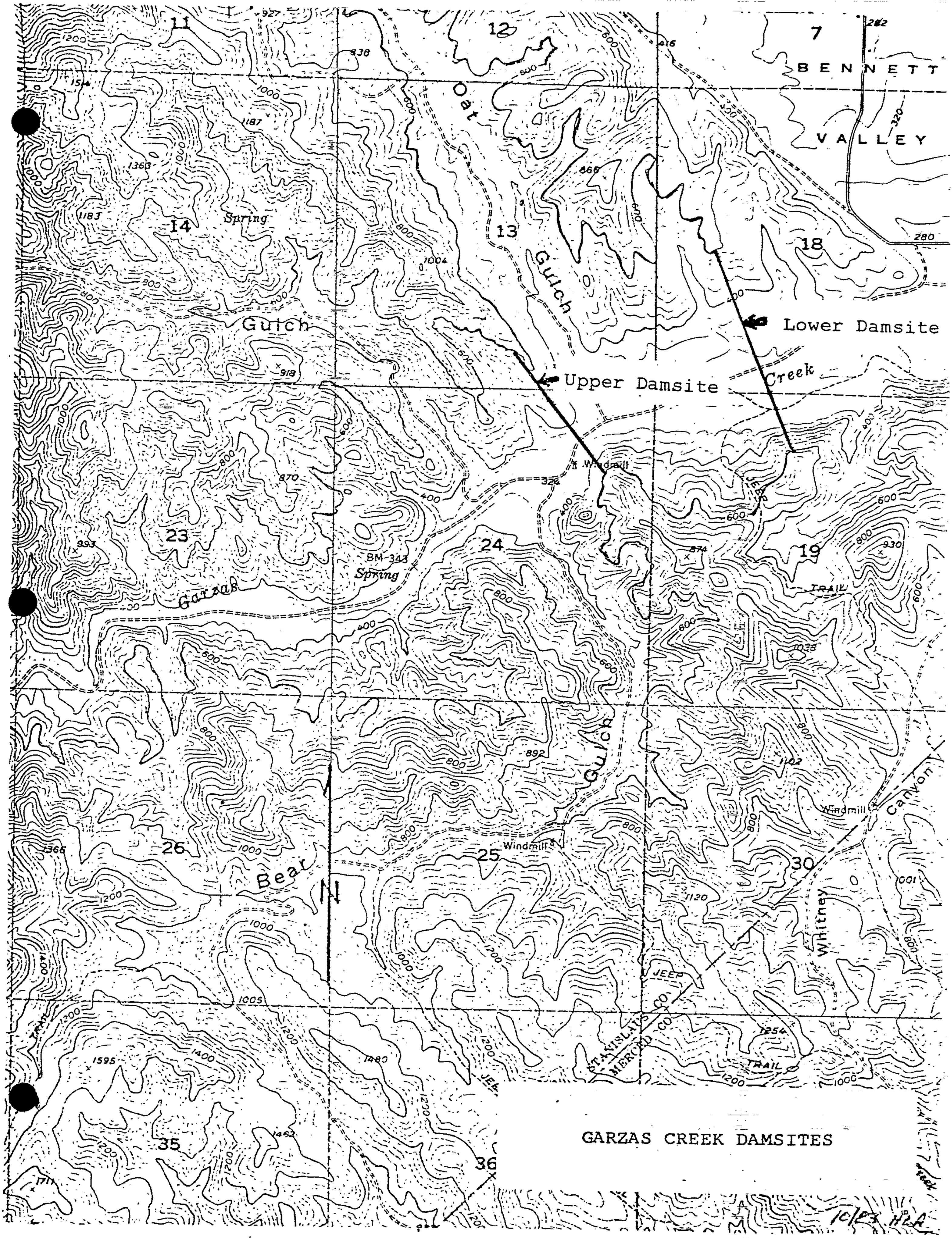
1
2
10/85 HLA
6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Lower Damsite
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Gulch
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Bear
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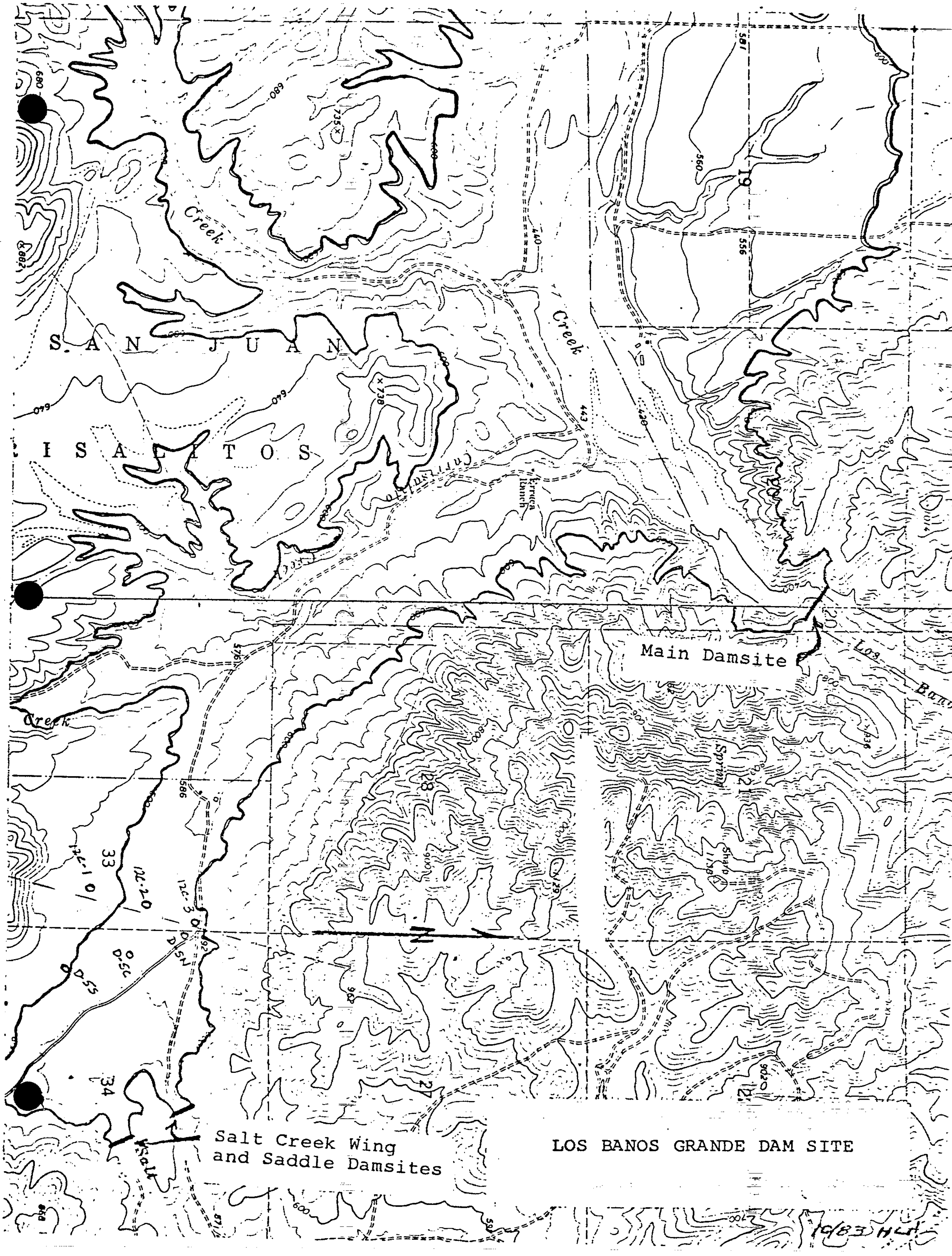
JEEP
TRAIL
BM-343



LOS BANOS GRANDE DAM SITE

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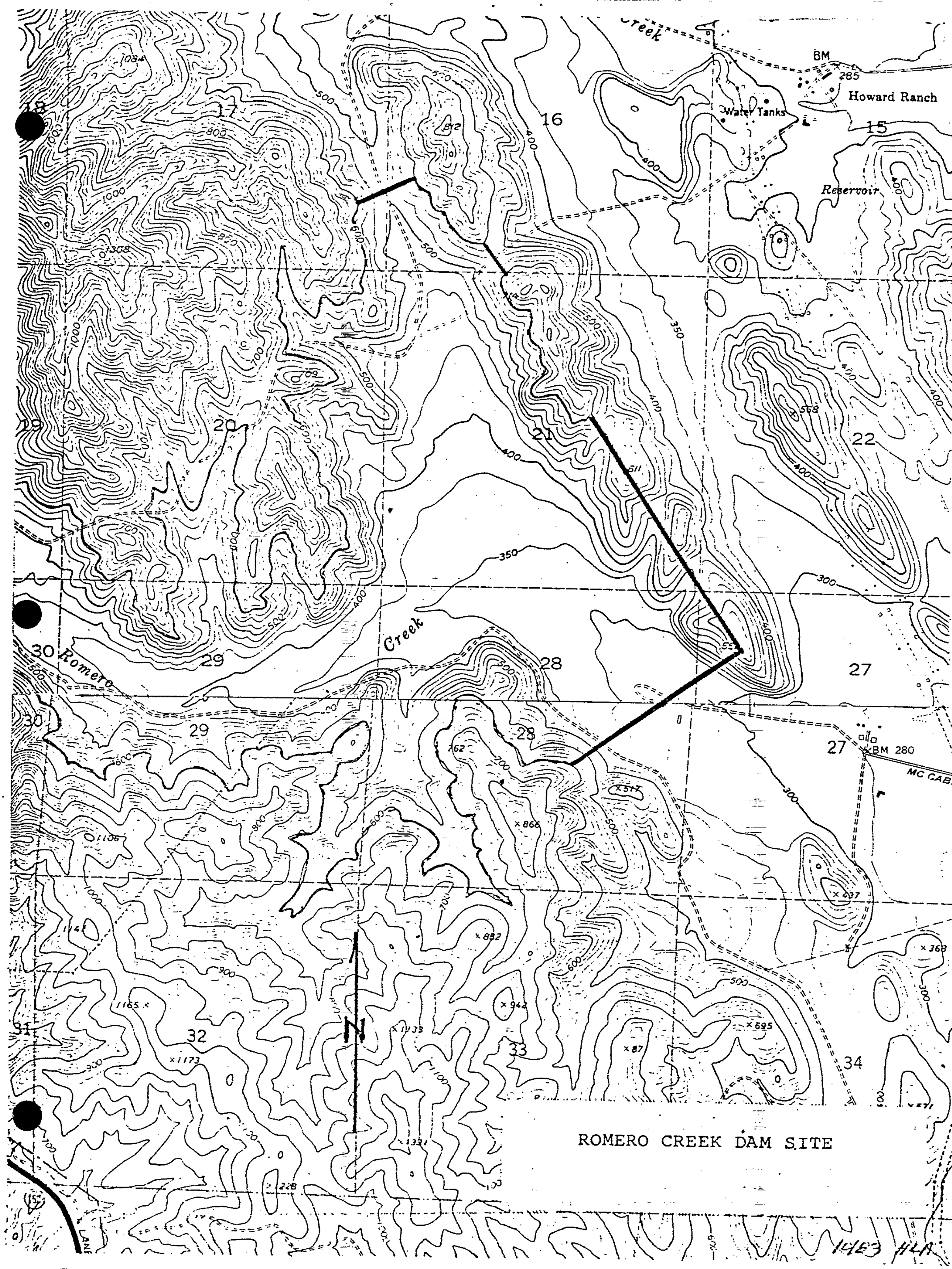

ROMERO CREEK DAM SITE
Howard Ranch
Water Tanks
Reservoir
BM 285
BM 280
Romero
Creek
MC CABE
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16
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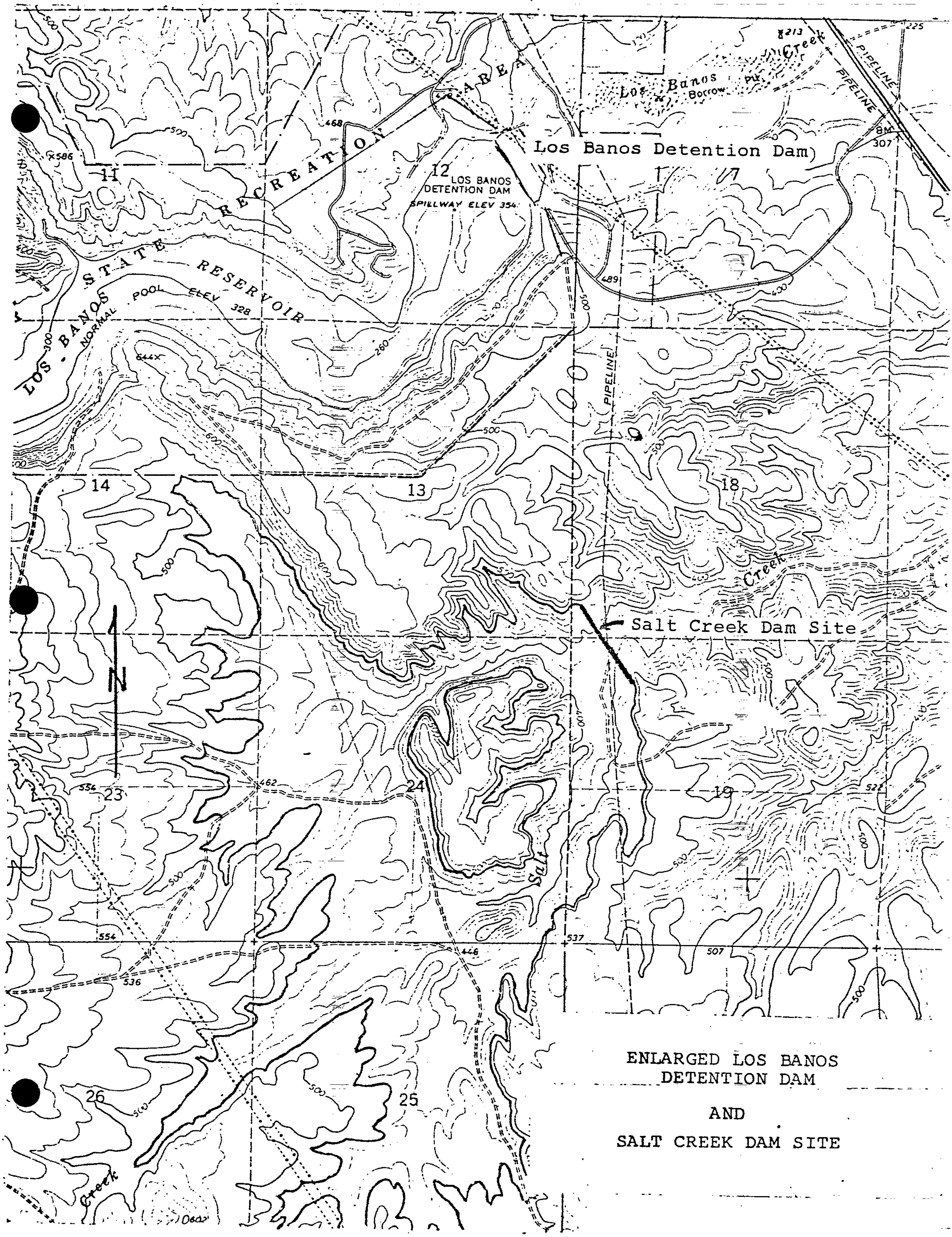
D-001916



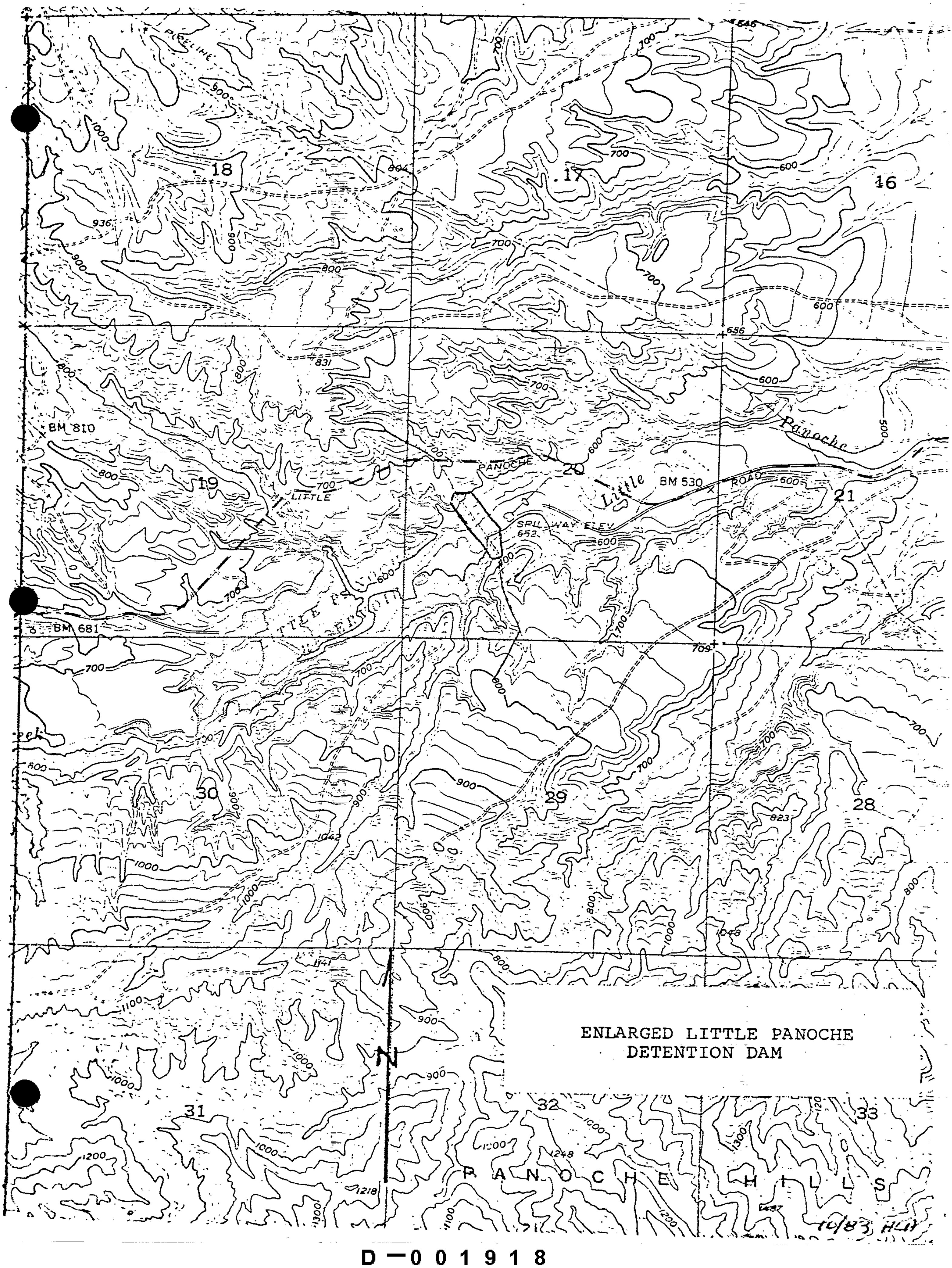
ENLARGED LOS BANOS
DETENTION DAM

AND

SALT CREEK DAM SITE

D—001917

D-001917


ENLARGED LITTLE PANOCHE
DETENTION DAM
PIPELINE
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17
16
19
20
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30
29
28
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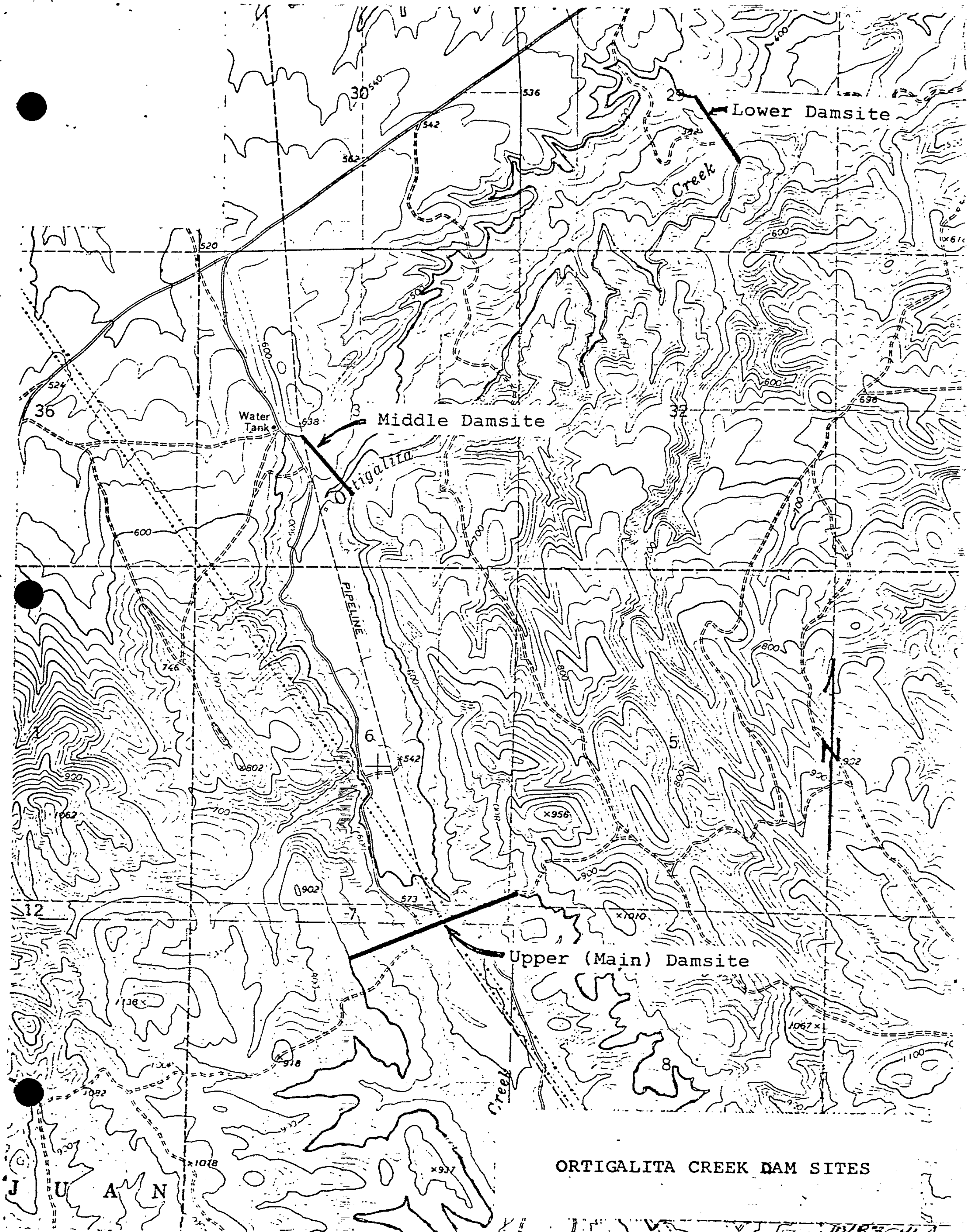
32
33
BM 810
BM 681
BM 530
LITTLE
PANOCHE
Little
Panoche
ROAD
SPILLWAY ELEV
652
RESERVOIR
P A N O C H E H I L L S
N
10/83


Lower Damsite
Creek
Middle Damsite
Water Tank
Ortigalita
PIPELINE
Upper (Main) Damsite
Creek
ORTIGALITA CREEK DAM SITES
J U A N
N
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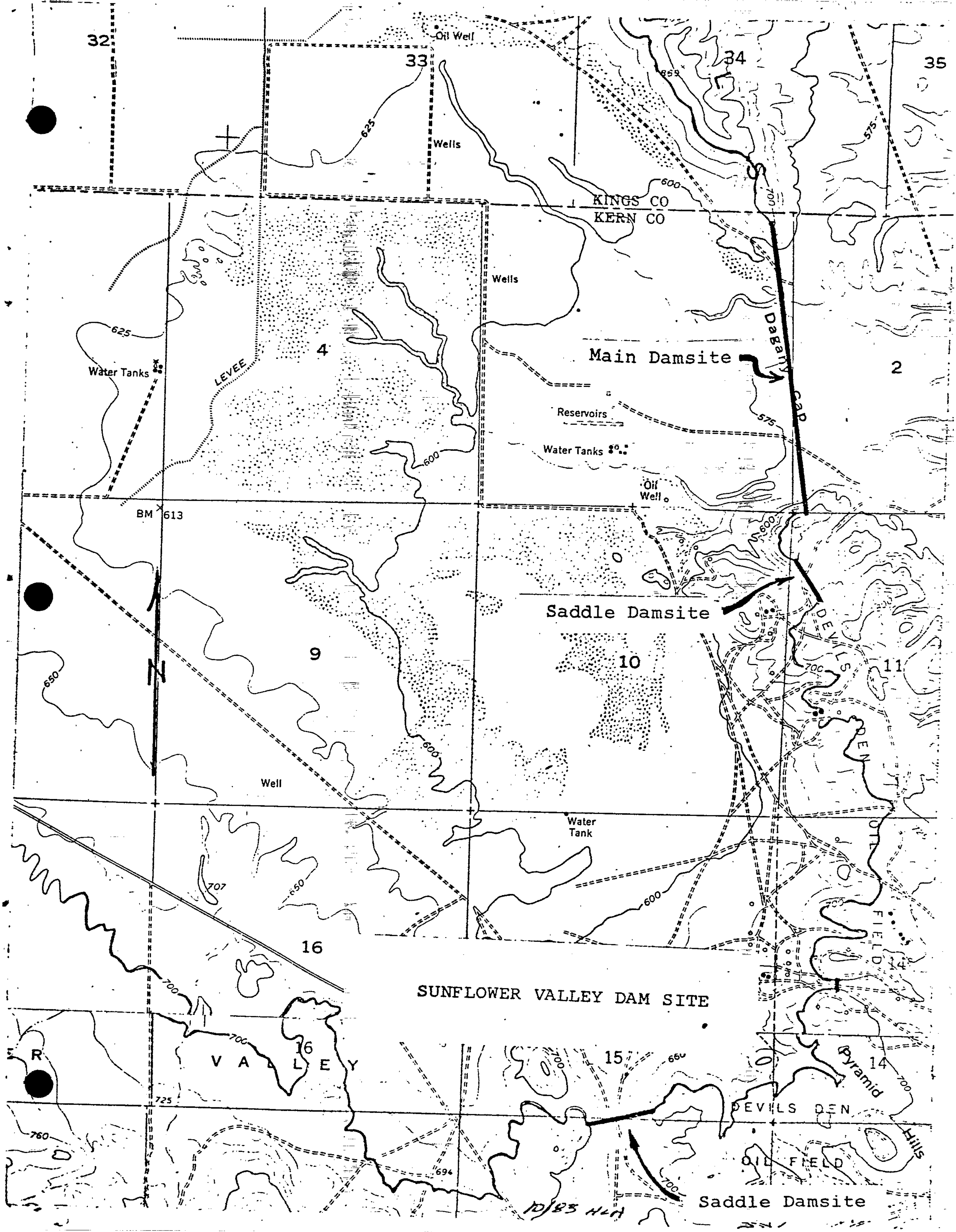
32
33
34
35
Oil Well
Wells
625
859
575
600
700
KINGS CO
KERN CO
Wells
625
Water Tanks
LEVEE
4
Main Damsite
Dagany Gap
2
Reservoirs
575
Water Tanks
600
Oil Well
BM 613
600
N
Saddle Damsite
DEVILS
9
650
10
11
700
DEN
600
Well
Water Tank
707
650
600
700
FIELD
16
SUNFLOWER VALLEY DAM SITE
14
700
16
VALLEY
15
660
Pyramid
14
700
R
725
DEVILS DEN
Hills
760
OIL FIELD
694
700
Saddle Damsite
10/83 HLH

Date Due	Date Due	Date Due
~~9/01/87~~		
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7/14/98		