2010

FLOOD HAZARD STUDY
CITY OF LAS ANIMAS, COLORADO

Prepared for

Bent County Land Use Administrator
Everett M. Myers

City of Las Animas
Alfred Putnam, Mayor

This study was funded by a supplemental planning grant from the Colorado Department of Local Affairs under provisions of House Bill 1041 (1974).

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INTRODUCTION

Las Animas is the county seat and largest community of Bent County. The city is located on the south bank of the Arkansas River, about 2½ miles upstream from the confluence of the Purgatoire River. John Martin Reservoir is located downstream from the Purgatoire. The City of Las Animas had a population of 3,402 in 1960 and 3,187 in 1972.

Purpose and Scope

In 1974, the Federal Insurance Administration of the Department of Housing and Urban Development issued a Flood-Hazard Boundary Map for the City of Las Animas which indicated that the portion of the City north of Fifth Street was located within the flood plain of the 100-year frequency flood of the Arkansas River. The map was the result of a flood-prone area map prepared by the U.S. Geological Survey. This map constituted the first step to enable the City of Las Animas to participate in the federal Flood Insurance program.

This flood-hazard map with a seemingly arbitary flood-boundary line on it caused considerable concern among the City officials as to the accuracy of the determination. This concern resulted in discussions with the Bent County Land Use Administrator about the inclusion of the flood plain determination under the supplemental-funding program of H.B. 1041. This resulted in a contract with Hydro Engineering in March, 1975 to make this study of flooding at Las Animas.

The scope of this study included an elevation survey of street intersections in north Las Animas, a survey of the Highway 50 bridge north of Las Animas, determination of channel slope, analysis of gaging station records and flood reports, and research into local newspaper accounts of past floods. The study was

concentrated on flooding by the Arkansas River, since the Corps of Engineers and the Geological Survey have indicated that the Purgatoire River does not pose a flood-hazard to Las Animas.

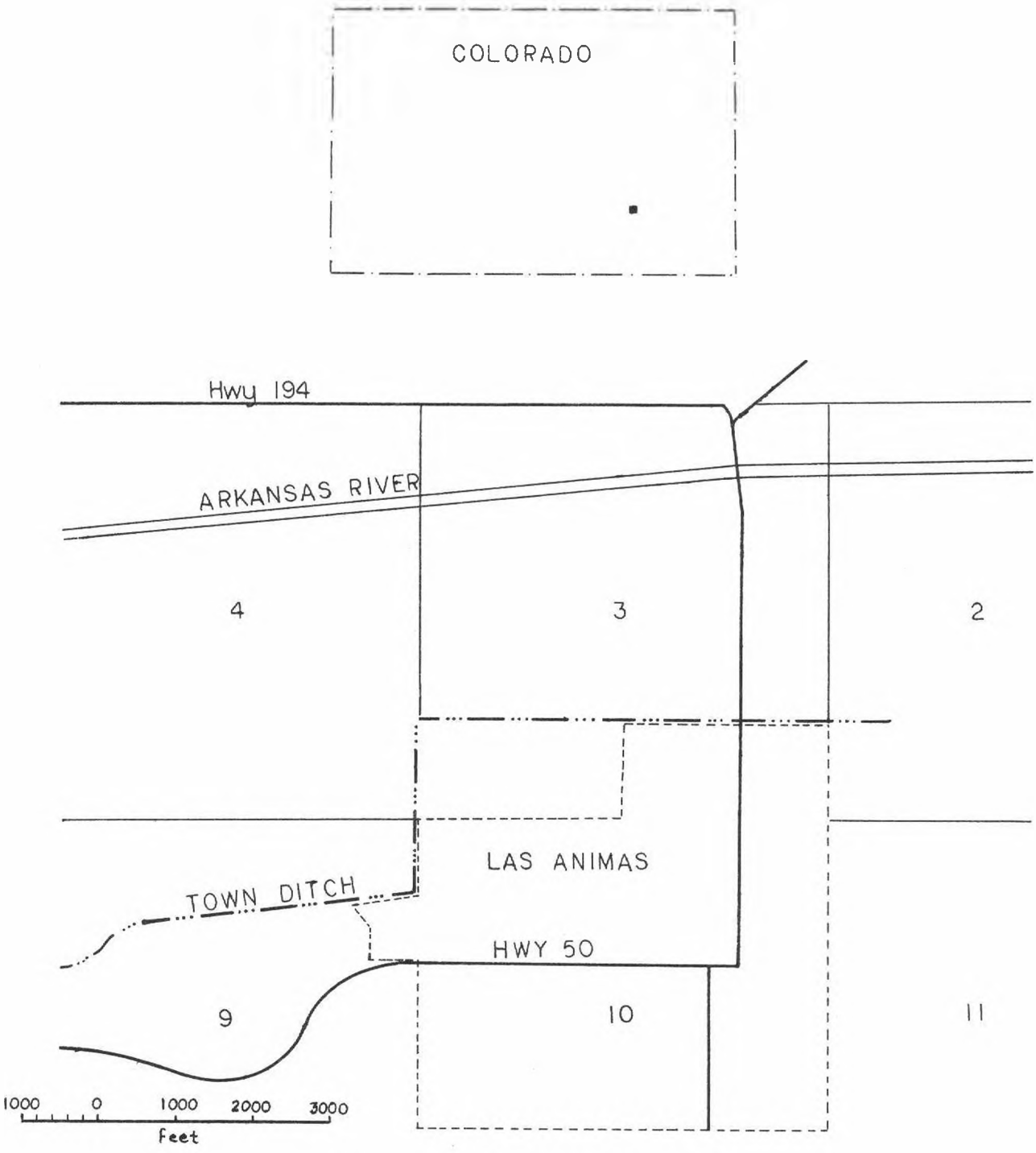


Figure 1. Location Map

ARKANSAS RIVER FLOODS

The Arkansas River originates in the Rocky Mountains of central Colorado near Leadville. The river flows south and then eastward through the Royal Gorge and emerges onto the high plains at Canon City. The river continues eastward through Pueblo, La Junta, Las Animas, Lamar, and into Kansas. A list of the major tributaries above Las Animas is included in table 1 and a basin map is included in figure 2.

The Arkansas River valley east of Canon City is an area of intensive irrigated agriculture. The majority of the river flows are derived from snowmelt in the mountains and are diverted from the river by about 12 major irrigation canals. These canals have sufficient capacity to divert virtually all of the normal river flows above Las Animas. The diversions from the river occur in both summer and winter, resulting in normal flows at Las Animas of less than 15 cfs.

Floods on the Arkansas below Canon City are the result of intense early summer rainstorms on the high plains. When these rainstorms are produced by the proper combination of meteorlogical factors, the resulting rainfall amounts can be as much as 12 inches in a 24-hour period. This intensity of rainfall on the sparsely vegetated prairie produces very high-yield flooding with over 2,000 cfs. per square mile on some drainages.

These floods boil down the normally dry tributary channels and dump into the Arkansas River valley. In the wide river valley, the peak flows from the tributaries are usually rapidly attenuated by the dense riparian vegetation along the wide, flat flood plain. Occasionally however, the peaks from several tributaries will coincide on the Arkansas with the result of extensive floods.

There are two major dams on the Arkansas in Colorado which provide flood control protection. These are Pueblo Dam, located six miles west of Pueblo, and John Martin Dam, located 14 miles east of Las Animas. Pueblo Dam was built by the Bureau of Reclamation in 1974 as a part of the Fryingpan-Arkansas Project. The dam has a capacity of 357,000 acre feet and provides multi-purpose

TABLE 1. — Drainage Area Data, Arkansas River and Tributaries
from Corps of Engineers

Main Stem Location	Arkansas River Mile Above Mouth	Intervening Area (sq. mi.)	Major Tributary Area (sq. mi.)	Area Above Location (sq. mi.)
Source (source of East Fork)	1,459.2			0
		1,218		
Salida, Colo.	1,385.4			1,218
		1,899		
Cañon City, Colo.	1,331.2			3,117
		1,553		
Pueblo Dam	1,293.7			4,670
		16		
Pueblo, Colo.	1,289.8			4,686
		104		
Fountain Creek	1,283.2		927	5,717
		105		
St. Charles River	1,273.8		482	6,304
		89		
Chico Creek	1,265.5		865	7,258
		51		
Huerfano River	1,256.2		1,876	9,185
		160		
Nepesta, Colo.	1,243.5			9,345
		423		
Apishapa River	1,228.7		1,133	10,901
		630		
Timpas Creek	1,204.9		481	12,012
		198		
La Junta, Colo.	1,198.1			12,210
		134		
Horse Creek	1,183.2		1,371	13,715
		1		
Adobe Creek	1,182.5		642	14,358
		59		
Las Animas, Colo.	1,176.6			14,417
		11		
Purgatoire River	1,172.9		3,511	17,939
		976		
John Martin Dam	1,158.7			18,915
		865		
Lamar, Colo.	1,137.3			19,780
		487		
Big Sandy Creek	1,127.5		3,426	23,693
		1,716		
Colo.-Kans. State line	1,101.0			25,409

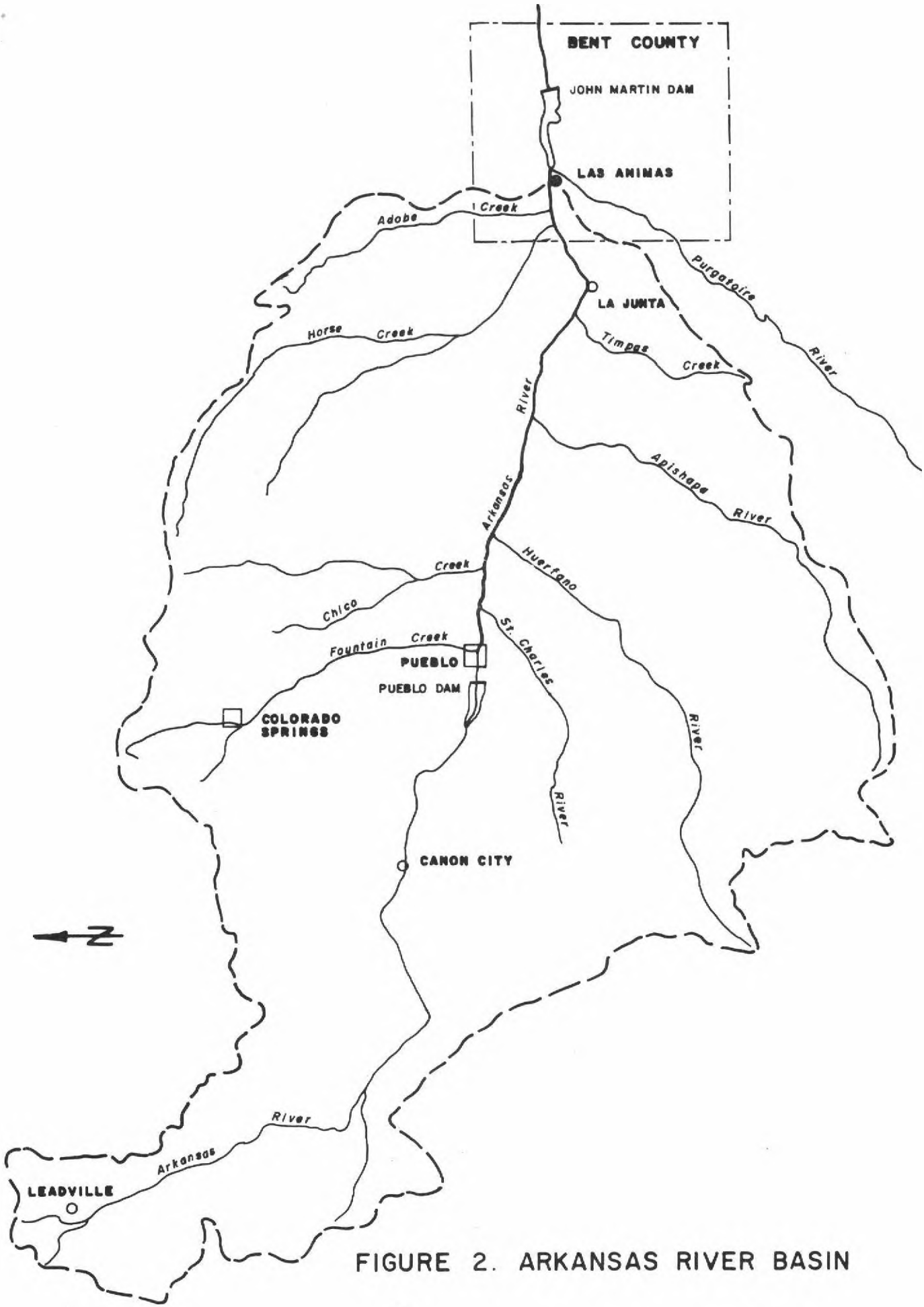


FIGURE 2. ARKANSAS RIVER BASIN

storage, including flood control. John Martin Dam was built by the Corps of Engineers in 1942 to provide flood control for the Arkansas River valley below the Purgatoire River. It has a present capacity of 637,000 acre feet.

One smaller dam, Adobe Creek Reservoir, is located on the first tributary above Las Animas. It is an irrigation reservoir with a capacity of 62,000 acre feet which provides flood control on Adobe Creek.

Flood History

Flooding has long been noted in the Arkansas valley and there are many reports of flood events by the early settlers. Prior to 1900 however, there are very few well-documented reports as to flood elevations, discharge, or inundated areas. Several of the early events which have been summarized by the Corps of Engineers and the Geological Survey include 1826, 1864, 1867, and 1884. The first documented flood occurred on May 31, 1894. This flood caused considerable damage above Pueblo, but much less damage further downstream. The U.S. Geological Survey reports a flow of 30,000 cfs at La Junta. At Las Animas, the flow was probably about 25,000 cfs and was reported to have an elevation of 4 feet less than the 1921 flood. The flood waters reached the intersection of First and Bent, an elevation of 3892.6 feet. The reports did not indicate any damage within the city.

The greatest recorded flood in the Arkansas River valley above John Martin Dam occurred on June 4, 1921. The flood was caused by intense rainfall between Pueblo and Canon City. This storm has subsequently been used by the Corps of Engineers to determine the standard project flood in the Upper Arkansas basin. The peak flows were 103,000 cfs at Pueblo, 200,000 cfs at La Junta and 187,000 cfs at Las Animas. This flood was undoubtedly a very rare event on the Arkansas River in Colorado.

In Las Animas, the flood reached an elevation of 3896 feet and water inundated the north-central and eastern portions of the city to the intersection of Sixth and Carson. The flood destroyed the highway bridge north of the city and destroyed

many houses on the south bank near the river. The estimated damage was over $600,000.

On August 23, 1923, a flood caused by the failure of the Apishapa Dam on the Apishapa River produced a peak of 60,000 cfs at La Junta. At Las Animas, there was minimal damage to houses north of the city. This indicates an elevation of less than 3892 feet and a probable discharge of less than 25,000 cfs.

Another flood on August 8, 1936 produced a peak at La Junta of 33,000 cfs and caused damage to houses north of Las Animas. An emergency levee was constructed and no damage was caused in Las Animas. The probable flow was less than 30,000 cfs.

On April 25, 1942, a minor flood occurred on the Arkansas along with a major flood on the Purgatoire River. The discharge of the Arkansas at Las Animas was 23,600 cfs with no damage to the city.

On May 20, 1955, the second largest reported flood of the Arkansas at Las Animas occurred as a result of heavy rainstorms northwest and southwest of Pueblo. The peak discharge at Las Animas was 44,000 cfs which reached an elevation of 3893.6 feet at the highway bridge, north of the city. The flood would have inundated the north-central portion of the city south to Fourth and Bent, but a group of volunteers constructed an emergency levee on the west side of the south approach to the highway bridge. The levee has an elevation of 3895 feet and extends westward to connect with an irrigation dike. This combination successfully prevented the flood waters from reaching the city.

A minor flood occurred on May 17, 1957 with a peak discharge of 21,480 cfs. This flood caused no damage to Las Animas, primarily due to the levee constructed in 1955 and to channel modifications made by the Corps of Engineers in 1956.

The most recent flood on the Arkansas River at Las Animas occurred on June 18 and 19, 1965. There were two peaks, the first was 19,800 cfs from rainstorms south of La Junta and the second was 22,100 cfs from rainstorms south of Colorado Springs. These peaks caused no damage to the City of Las Animas, due to the 1955 levee. The elevation of this flood was 3894 feet at the

highway bridge, 0.4 feet higher than the 1955 flood with only one half the amount of water. This higher elevation is due to the progressive aggradation of the river channel north of Las Animas.

This aggradation has been occurring since the 1921 flood and the spread of the salt cedar in the floodplain. However, since the 1955 flood, the channel has filled between four and eight feet at the highway bridge.

Flood Control Measures

Several measures have been taken or proposed to reduce the Arkansas River flood hazard to the City of Las Animas. The Corps of Engineers and the City of Las Animas have periodically made improvements to the channel upstream and downstream of the Highway 50 bridge. The major improvement was the straightening of the channel for about five miles above the bridge and cutting a 200-foot wide pilot channel. In addition, the Colorado Highway Department has increased the height of the highway bridge and the A.T.& S.F. railroad has removed the railroad bridge located 0.7 miles downstream.

One important measure is the completion of construction on Pueblo Dam. The flood-control protection provided will be almost complete for the Arkansas River through Pueblo to Fountain Creek. Downstream from there, the protection will be diminished as the distance increases. The list of drainage areas in table 1 shows that 4,670 square miles of the Arkansas Basin are controlled by Pueblo Dam. This leaves 9,700 square miles of uncontrolled drainage above Las Animas. The flood peak graphs on Figure 3 indicate that the majority of flood flows since 1942 have originated below Pueblo Dam. In the 1921 flood however, Pueblo Dam would have significantly reduced the downstream floods.

The Bureau of Reclamation has an operating agreement with the Corps of Engineers to govern releases from Pueblo Dam during flood conditions. The regulation of flows at Pueblo Dam is intended to keep the downstream flow below the 5,000 cfs capacity of the Arkansas channel. This regulation should allow for a greater attenuation of tributary flood peaks.

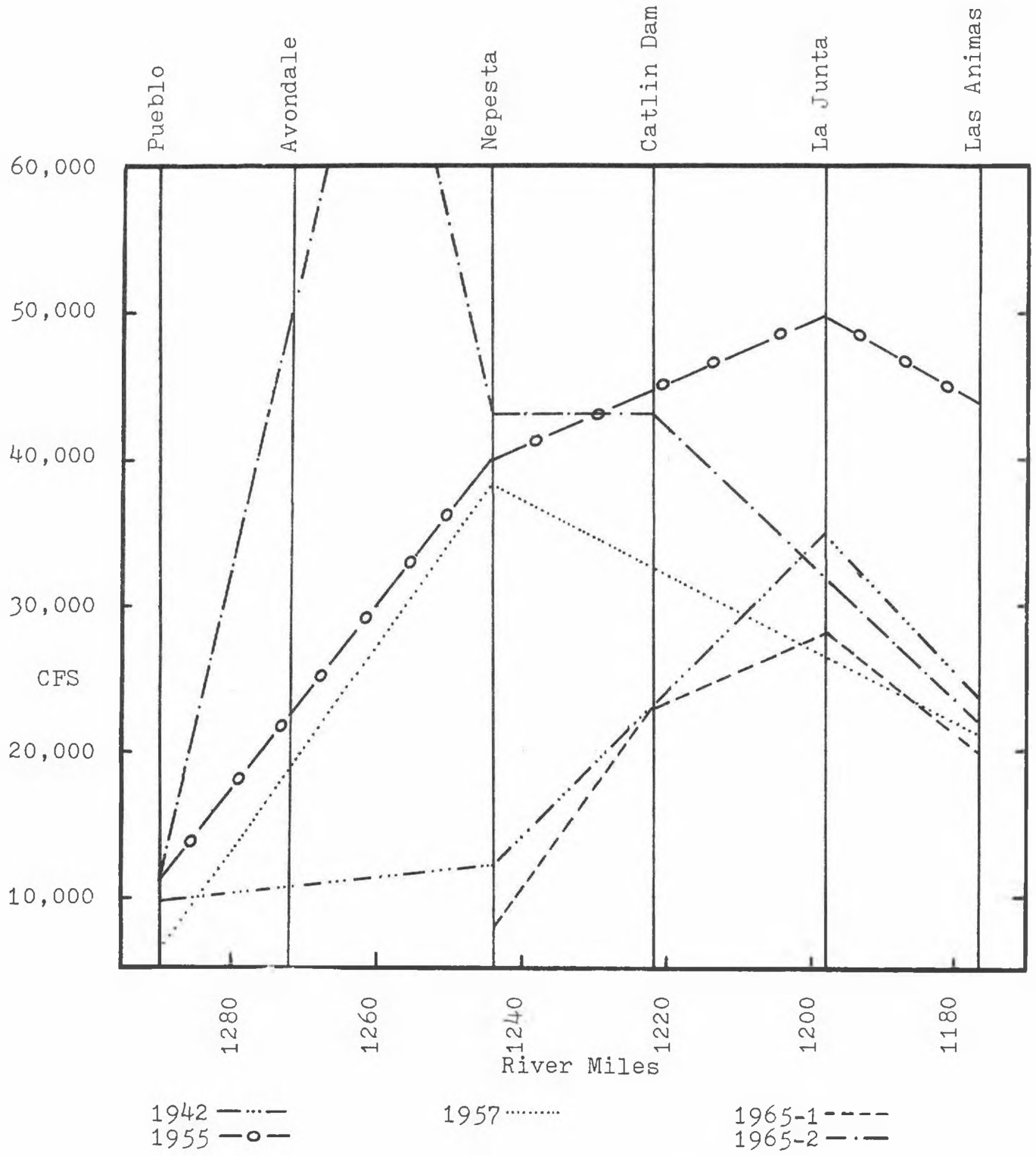


Figure 3. Downstream Changes in Flood Peaks

Commission and the Board of County Commissioners for the evaluation of the effects of the proposed use upon flood flows and other factors necessary to render a decision on the suitability of the proposed use.

1. A typical valley cross-sectional areas to be occupied by the proposed development, and high water information.
2. Plan (surface view) showing elevation or contours of the grounds; pertinent structure, fill or storage elevations of street, water supply, sanitary facilities, photographs showing existing land use and vegetation upstream and downstream, soil types, and other pertinent information.
3. Profile showing the slope of the bottom of channel or flow line of stream.

3. The applicant shall submit data identifying the above mentioned factors in four copies to the Flood Plain Administrator. The administrator should forward if applicable a copy to the Urban Drainage and Flood Control District before scheduling a hearing before the Board of County Commissioners.

4. Violations of the provisions of the Flood Plain Zone District will be treated the same as any other zoning violation.

5. If said Special Permit use is approved, the Bent County Planning Committee and Board of County Commissioners shall give written notice to the applicant of the following:

   (a) The fact that the proposed structure will be located in a flood prone area and if the variance is granted the structure will be built at the applicant's risk and applicant shall assume full liability for damages incurred.

   (b) The number of feet that the lowest floor of the proposed structure will be below the elevation of the Intermediate Regional Flood level.

   (c) The fact that flood insurance rates will be increased commensurate with the distance below the Intermediate Regional Flood level. Said notice shall be attached and made a part of the building permit received by the applicant.

SECTION VI: ADMENDMENTS TO FLOOD PLAIN ZONE BOUNDARIES

A. As evidence and data become available, the Board of County Commissioners may amend the adopted Flood Plain Zone maps

to conform with such evidence. The following procedures shall be used in processing such amendments.

1. The following described documentation and procedures shall be included in an application made to the Planning Department.

    (a) Calculations: A text containing all the calculations required in preparing these documents including the derivation of the one hundred (100) year peak flow as determined by the procedure outlined in the Denver Regional Council of Governments Drainage Manual or the Soil Conservation Service Procedure where applicable. The one hundred year peak flow will be based on a fully developed land use in the basin as indicated by the Comprehensive Future Land Use Plan.

2. Cross Section of Federal Aid Sheets, Plate 3, showing:

    (a) Adequate field cross sections of the one hundred year flood plain, at one (1) inch equals five (5) feet vertical and horizontal scale, or as required by the Engineering Department.

    (b) The one hundred (100) year high water line.

3. Map: The map of the subject area should depict the following:

    (a) Location of the cross section relative

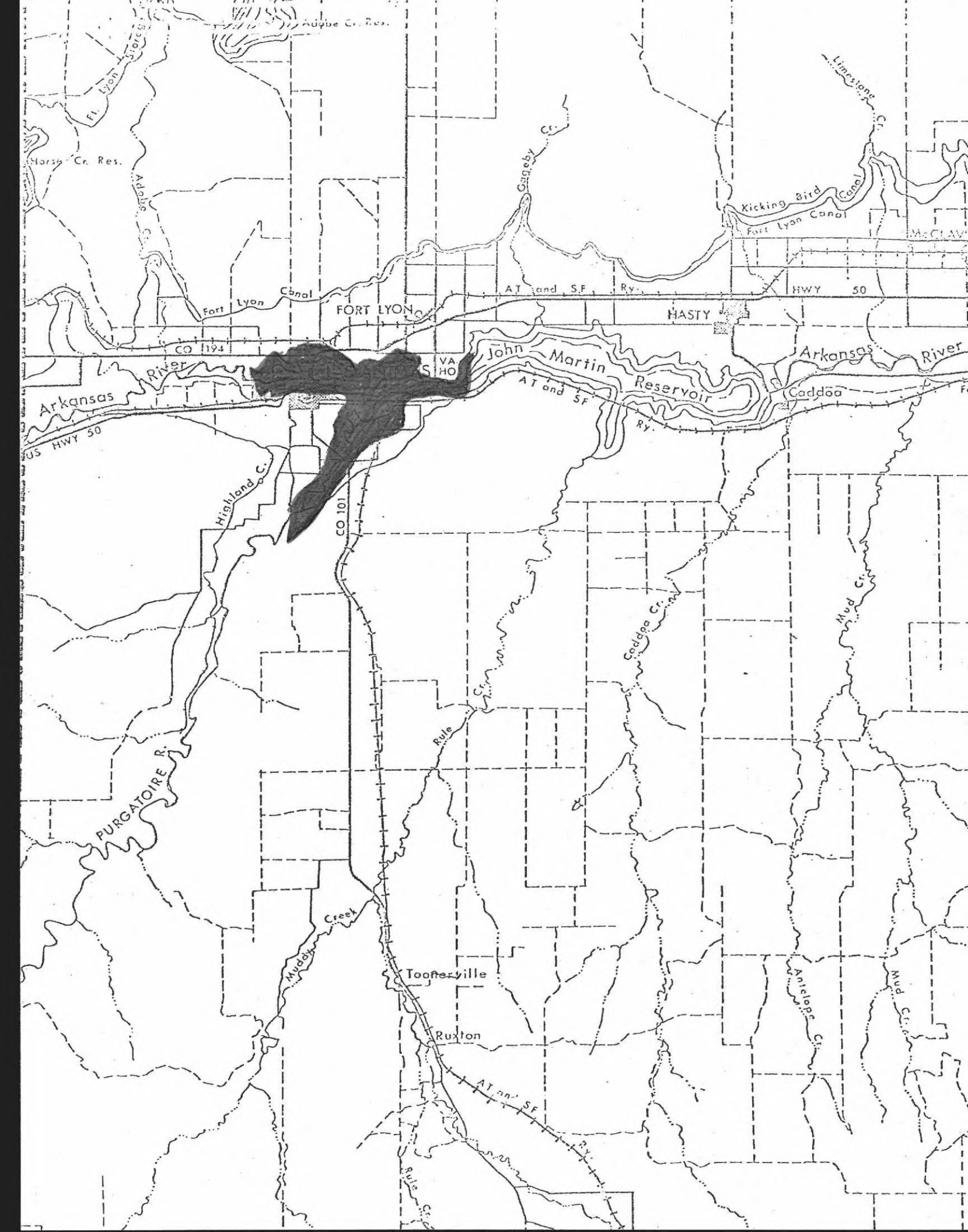
to land ownerships.

(b) Elevation and description of an established reasonably permanent bench mark.

4. All documentation submitted shall be signed and sealed by a registered professional engineer in the State of Colorado.

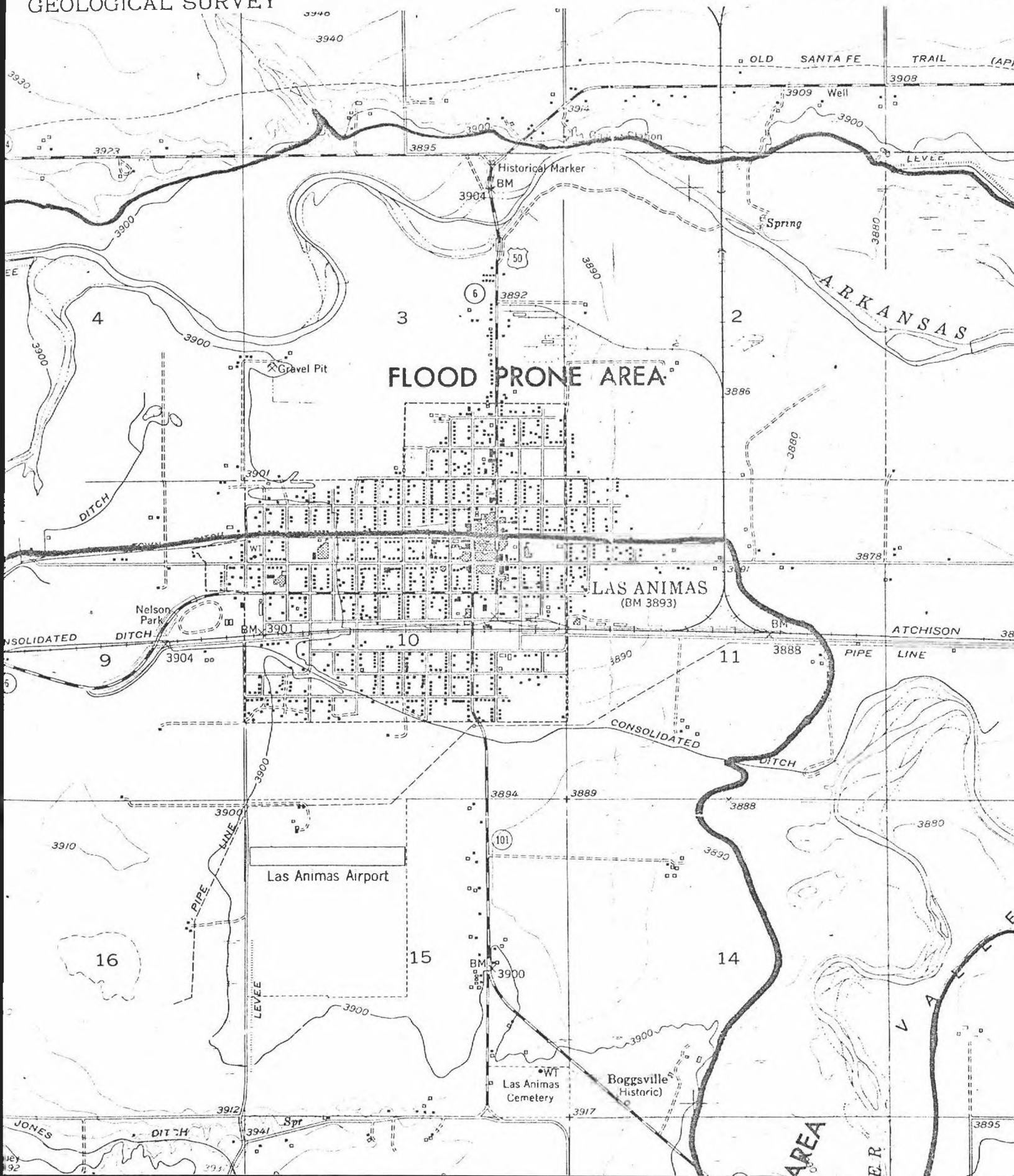
B. Upon receipt of the required documentation, the Planning Department shall forward such documentation to the Colorado Water Conservation Board. If this Department shall fail to respond within twenty four (24) days from the time of referral, the Colorado Water Conservation Board shall be deemed to have approved said proposed amendment.

C. Upon receipt of all required documentation, regular rezoning procedures may be initiated.

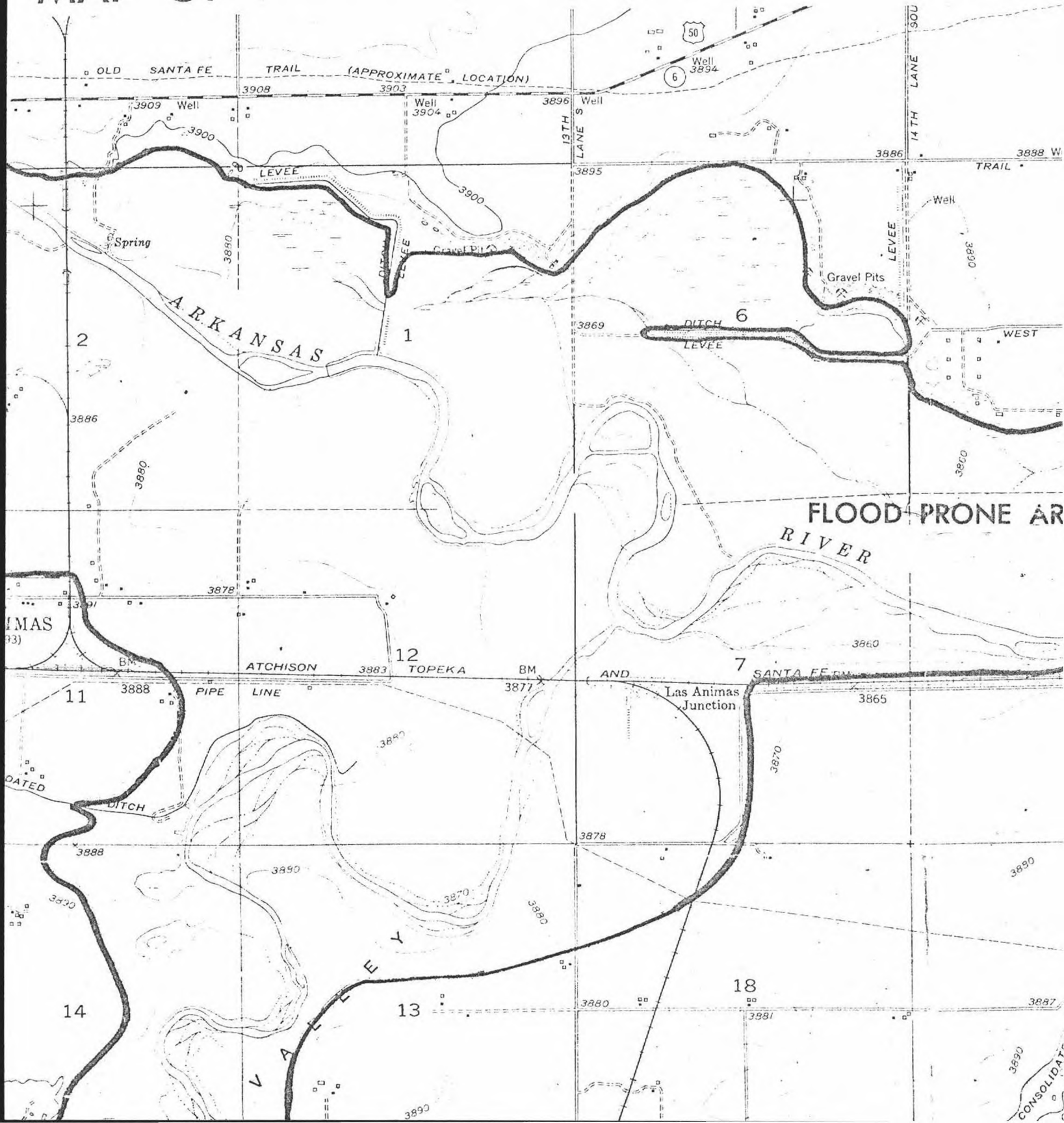

Adobe Cr. Res.
Ft. Lyon Storage
Horse Cr. Res.
Adobe Cr.
Limestone Cr.
Coogby Cr.
Kicking Bird Canal
Fort Lyon Canal
McCLAVE
AT and SF Ry.
HWY 50
Fort Lyon Canal
FORT LYON
HASTY
CO 194
John Martin Reservoir
Arkansas River
Arkansas River
AT and SF Ry.
Caddoa
US HWY 50
Highland Cr.
CO 101
Caddoa Cr.
Mud Cr.
Rule Cr.
PURGATOIRE R.
Muddy Creek
Toonerville
Ruxton
AT and SF Ry.
Antelope Cr.
Mud Cr.
Rule Cr.

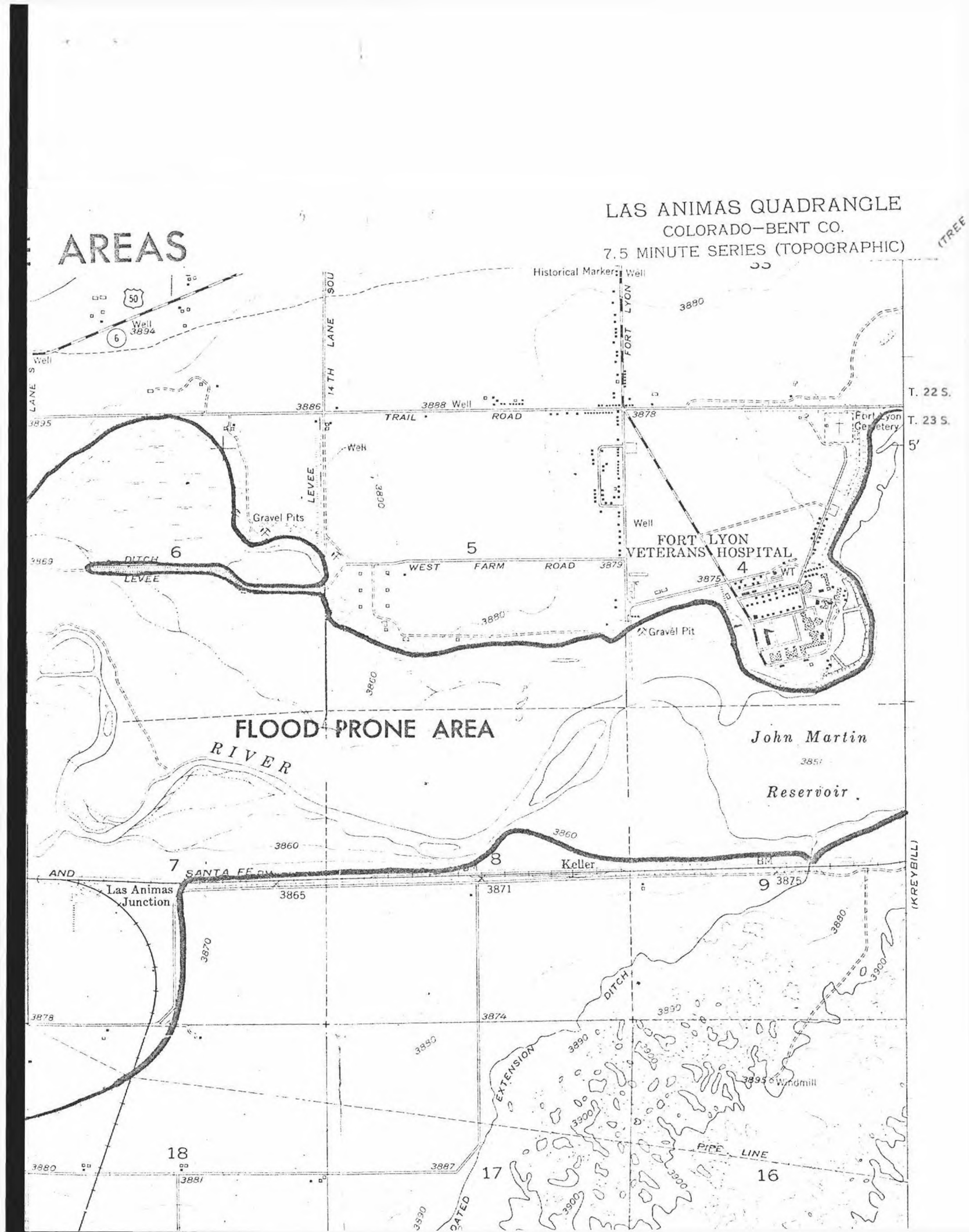
UNITED STATES
PARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

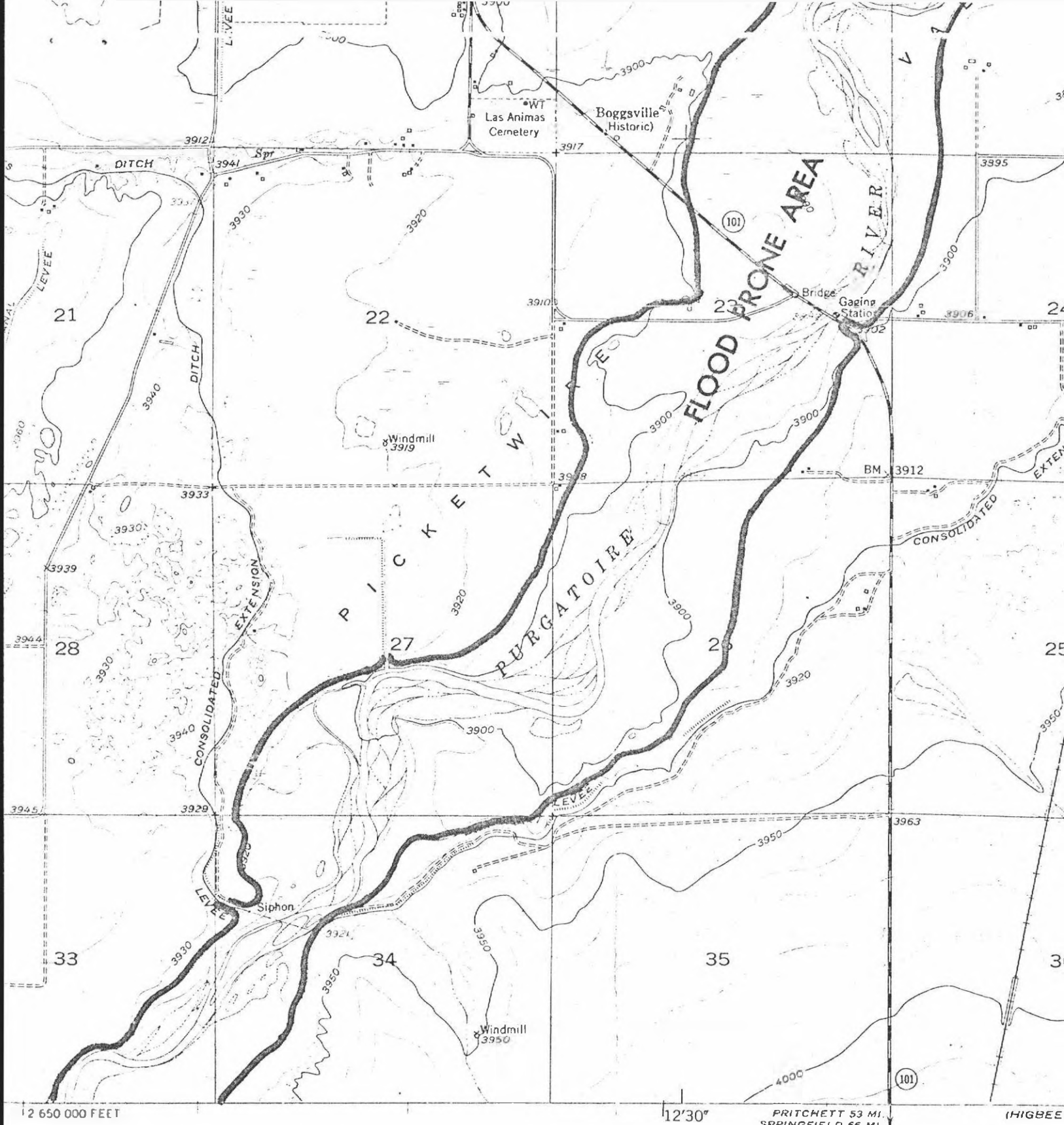
MAP OF FLOO



MAP OF FLOOD-PRONE AREAS




AREAS
LAS ANIMAS QUADRANGLE
COLORADO—BENT CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
Historical Marker
Well
50
Well 3894
6
LANE S
14TH LANE SOU
FORT LYON
3880
3886
3898 Well
TRAIL
ROAD
3878
Fort Lyon Cemetery
T. 22 S.
T. 23 S.
3895
Well
LEVEE
3890
Gravel Pits
FORT LYON VETERANS HOSPITAL
WT
3875
3879
WEST FARM ROAD
DITCH
LEVEE
3869
6
5
4
Gravel Pit
3880
3860
FLOOD PRONE AREA
RIVER
John Martin
Reservoir
3851
3860
3860
7
8
9
AND SANTA FE RY.
Keller
BM
3875
Las Animas Junction
3865
3871
3870
3880
3900
DITCH
3878
3874
3890
3880
EXTENSION
3890
3900
3895
Windmill
PIPE LINE
18
17
16
3880
3887
3881
3900
3900
3900
(KREYBILL)
(TREE



The purpose of the flood-prone area maps is to show to administrators, planners, and engineers concerned with future land developments those areas that are subject to flooding. The U.S. Geological Survey was requested by the 89th Congress to prepare these maps as expressed in House Document 465. The flood-prone areas have been delineated by the Geological Survey on the basis of readily available information.

Flood-prone area maps were delineated for those areas that meet the following criteria: (1) Urban areas where the upstream drainage area exceeds 25 square miles, (2) rural areas in humid regions where the upstream drainage area exceeds 100 square miles, and (3) rural areas in semiarid regions where the upstream drainage area exceeds 250 square miles.

The flood-prone areas shown on this map have a 1 in 100 chance on the average of being inundated during any year. Flood areas have been delineated without consideration of present or future flood-control storage that may reduce flood levels.

Flood-hazard reports provide the detailed flood information that is needed for economic studies, for formulating zoning regulations, and for setting design criteria to minimize

SCALE

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1000 0 1000 2000

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Flood-hazard reports provide the detailed flood information that is needed for economic studies, for formulating zoning regulations, and for setting design criteria to minimize future flood losses. Where detailed information such as that contained in the flood-hazard reports, is required, contact the U.S. Army, Corps of Engineers; the U.S. Geological Survey; or the Tennessee Valley Authority in the areas of their jurisdiction.

The Corps of Engineers has proposed several flood control measures for the Arkansas River below Pueblo Dam. These include a dam on Fountain Creek, flood-control levees along the Arkansas River, and, most important to Las Animas, the construction of a nine-mile long levee around Las Animas. The Las Animas levee project has been authorized by Congress and is presently awaiting the acquisition of right-of-way by the Arkansas Valley Conservancy District, the local sponsor.

The major feature of the Las Animas levee system is an earth-fill dike with a length of 50,700 feet and beginning at Highway 50 west of Las Animas in Sect. 10, T.23S, R.53W. The levee would extend around the city on the north and end 1½ miles east of the city. The design capacity of the floodway channel would be 140,000 cfs. This levee would completely eliminate any flood hazard by the Arkansas River to the City of Las Animas. How soon the levee will be built is an unanswered question.

FLOOD HYDROLOGY

The discharge of the Arkansas River at Las Animas has been measured by the U.S. Geological Survey since 1939. The gaging station was located on the north bank, 1600 feet downstream from the highway bridge, until 1966 when it was relocated to the downstream south side of the highway bridge. In 1973, the gage was relocated to the upstream south side of the highway bridge.

The annual peak discharges for the Las Animas gaging station as reported by the Geological Survey are listed in table 2 for the period 1939-1972. These peak discharges were ordered by magnitude and plotted as a logarithmic distribution on figure 4. Figure 4 also contains the flood-frequency curve published by the Corps of Engineers for the Arkansas River at Las Animas and a log Pearson Type III curve from unpublished data of the Geological Survey. The Corps of Engineers reports that the 100-year flood for the Arkansas at Las Animas as modified by Pueblo Dam is 81,000 cfs. The 100-year discharge determined by the Geological Survey is 34,500 cfs and this figure has not been modified to account for flood regulation by Pueblo Dam.

The trend of the data points on figure 4 does not support either of the frequency curves of the federal agencies. The Corps of Engineers modified curve exceeds the recorded discharge at all frequencies, while the Geological Survey unmodified curve exceeds the lower discharges and is less than the high discharges.

Based upon the discharge data as plotted on figure 4, a log-normal curve (solid line) was drawn to determine the unmodified flood frequency for the Arkansas River at Las Animas. This curve indicates a 100-year frequency flood discharge of 66,000 cfs. A second curve (dashed line) was drawn to indicate the flood frequency as modified by Pueblo Dam. This curve indicates a 100-year flood discharge of 47,000 cfs.

The actual effect of Pueblo Dam on peak reduction at Las Animas is an uncertainty. As indicated by figure 3, floods can occur downstream of Pueblo while there are insignificant flows at Pueblo. In general however, these tributary floods do not produce large peaks at Las Animas (ie. less than 20,000 cfs).

Table 2. Annual Peak Flows
Arkansas River at Las Animas

		cfs			cfs
1939	May 26	4,320	1956	Jul 23	3,150
1940	Sep 11	3.070	1957	May 17	21,480
1941	Aug 27	4,010	1958	Jul 6	6,280
1942	Apr 25	23,600	1959	Feb 16	286
1943	Jan 23	1,700	1960	Jul 13	4,950
1944	May 28	9,280	1961	Aug 13	4,340
1945	Aug 16	8,840	1962	Jul 25	3,820
1946	Aug 28	4,670	1963	Aug 3	1,830
1947	Jun 21	9,580	1964	Aug 7	1,600
1948	Jun 14	8,780	1965	Jun 19	22,100
1949	Jun 5	5,380	1966	Jul 24	6,200
1950	Jul 27	8,170	1967	May 27	4,970
1951	Aug 1	6,370	1968	Aug 11	2,660
1952	Apr 22	3,060	1969	Jul 21	3,740
1953	Jul 12	6,260	1970	Jul 20	1,240
1954	Aug 7	5,880	1971	Jul 16	1,960
1955	May 20	44,000	1972	Aug 4	4,130

from published records of U.S. Geological Survey

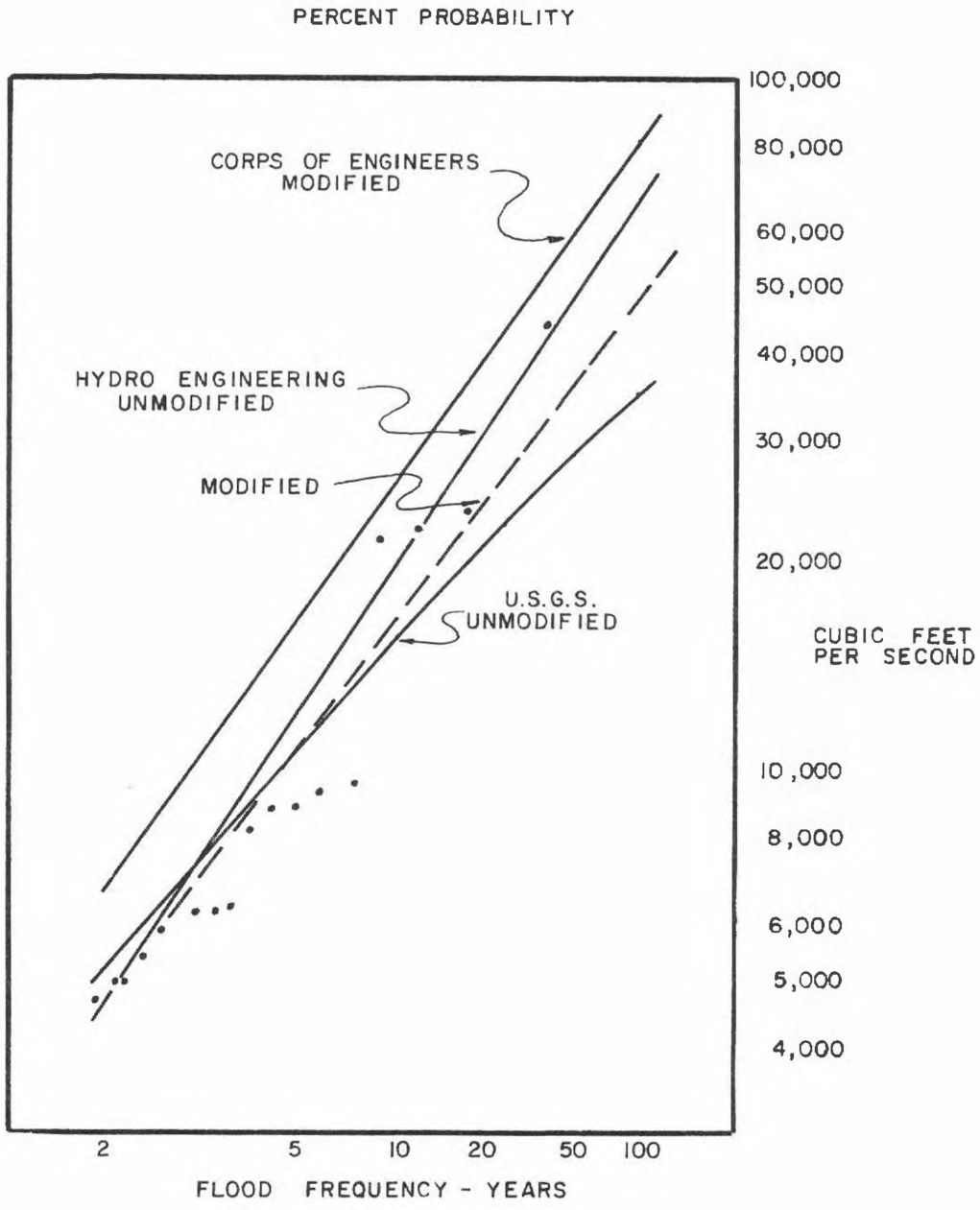

FIGURE 4: FLOOD FREQUENCY CURVES
ARKANSAS RIVER AT LAS ANIMAS

The importance of Pueblo Dam flood regulation comes into operation for wide-spread rainstorm conditions over the upper Arkansas River basin. Under these conditions, Pueblo Dam is assumed to begin flood storage early enough that the downstream flows on the river can be kept below the channel capacity. This situation will allow for greater attenuation of tributary flood peaks. This assumption is the basis for selection of the modified curve on figure 4.

Flood Elevations

To determine the flood elevations on the Arkansas River at and immediately above the Highway 50 bridge, north of Las Animas, one-foot contour topography provided by the Corps of Fngineers was used. This topography was supplemented by field surveys of the area south of the proposed flood levee. This topographic data was used to prepare the channel cross-sections shown on figure 5. The channel elevations at the upstream side of the Highway 50 bridge and the channel slope were also determined by field survey in April 1975.

From these cross-sections located at, 1000 feet, and 2000 feet upstream of the Highway 50 bridge, elevation-area tables(3) were prepared and the 100-year flow of 47,000 cfs was routed through these sections. The profile of the flood flow is shown on figure 6. This profile indicates backwater from the bridge extending upstream through the 2000-foot section. Upstream of this point, the profile is assumed to equal the 10 foot per mile profile of the 1955 flood. The calculated elevations through the cross-sections are based upon the assumptions that the channel bottom will remain as it presently is and that there will be no debris clogging the bridge opening.

The elevation at the upstream side of the bridge is calculated to be 3894.8 feet. This is 1.2 feet above the 1955 flood elevation for approximately the same discharge. The reason for this water surface rise is the progressive aggradation of the of the channel above John Martin Dam. As previously mentioned,

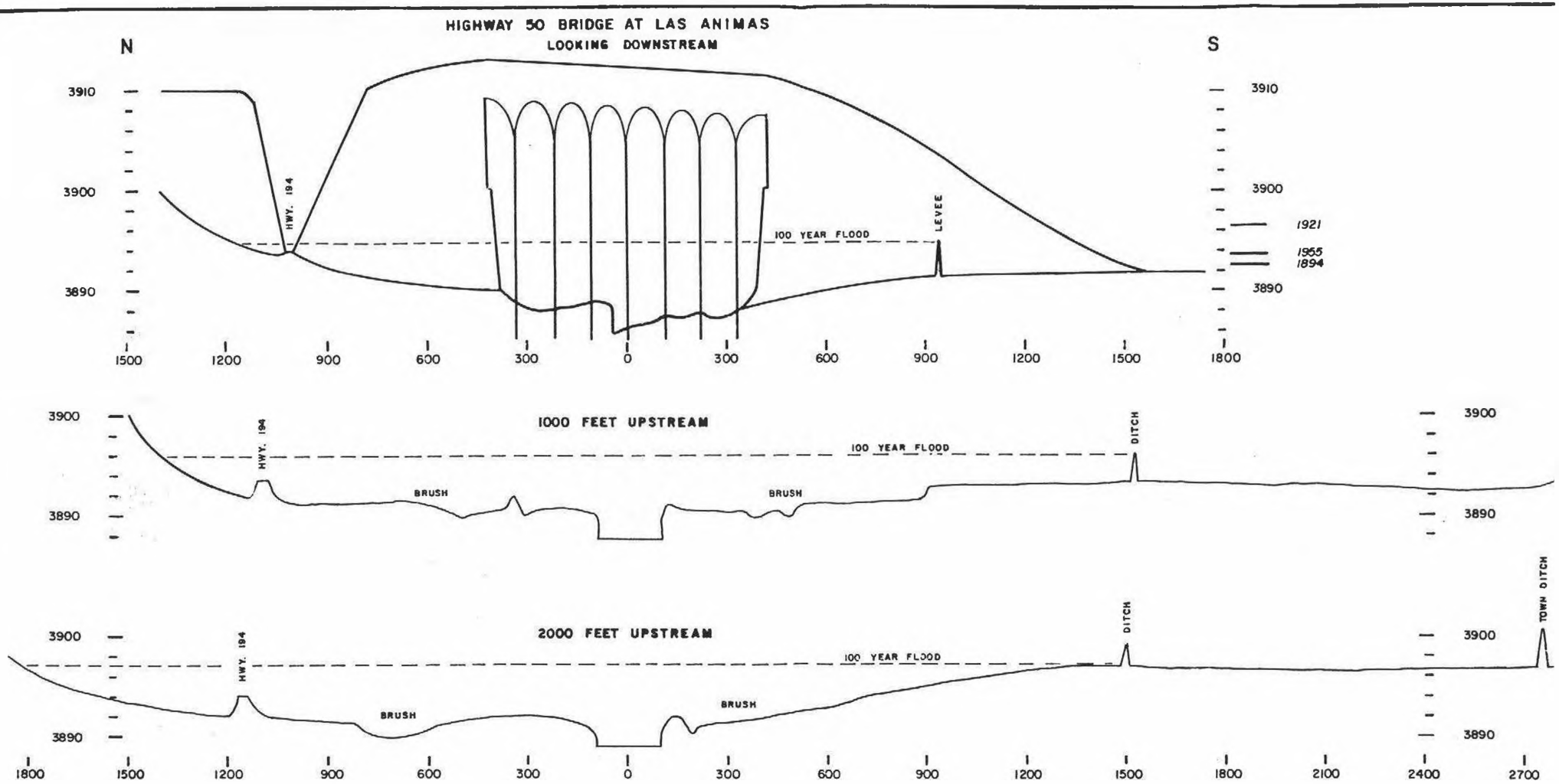

FIGURE 5. CROSS-SECTION ARKANSAS RIVER AT LAS ANIMAS

Table 3. Elevation - Area - Conveyance Tables

Elevation	Area sq.ft.	Conveyance
	Bridge Approach Section	
3892	3,400	780,000
3893	4,200	940,000
3894	5,000	1,000,000
3895	5,900	1,300,000
3896	6,700	1,700,000
	1000 Feet Upstream	
3894	8,100	600,000
3895	11,000	930,000
3896	14,000	1,300,000
3897	22,000	2,500,000
	2000 Feet Upstream	
3895	7,600	650,000
3896	10,000	940,000
3897	14,000	1,200,000
3898	17,000	1,700,000

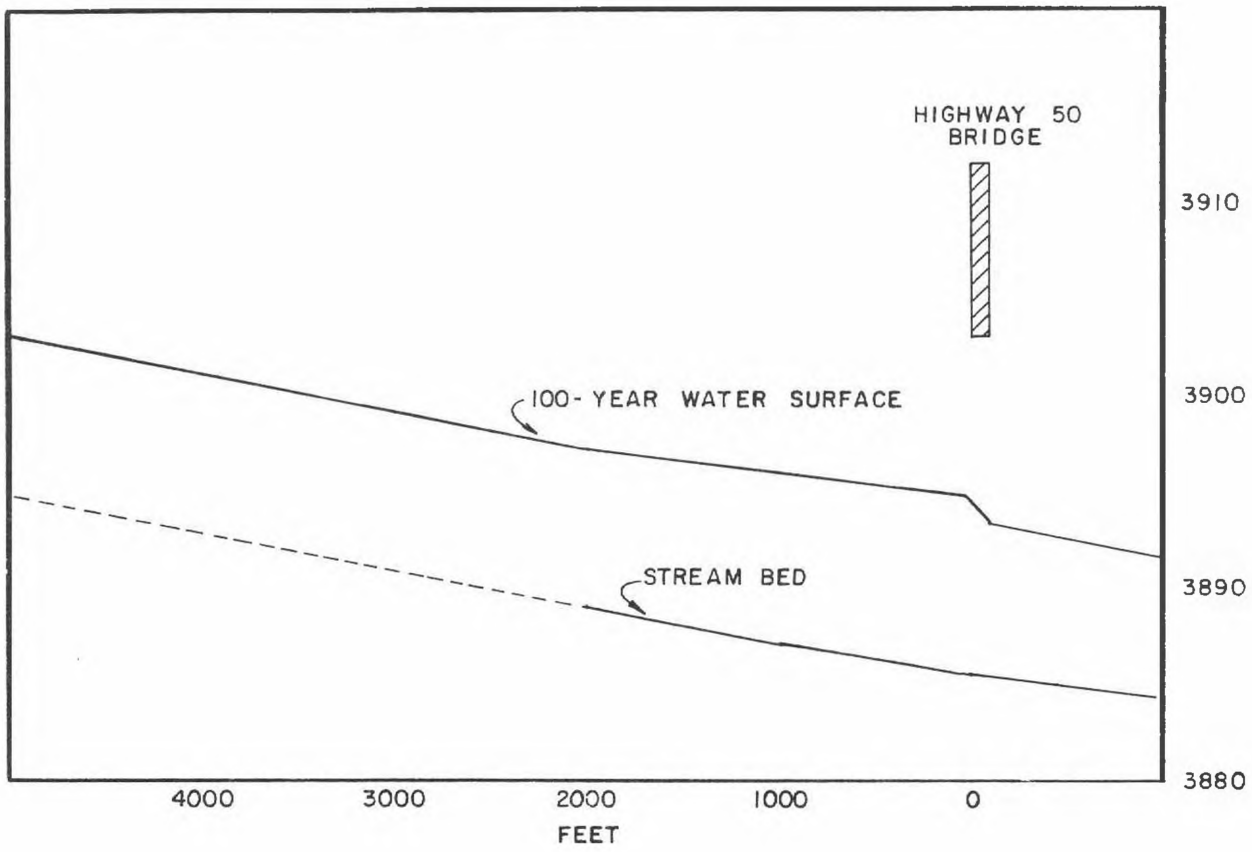

FIGURE 6: WATER SURFACE PROFILE
ARKANSAS RIVER AT LAS ANIMAS

the 1965 flood of 22,100 cfs had a higher elevation than the 1955 flood of 44,000 cfs. After the 1965 flood however, the channel bottom under the bridge was cleared during construction of the east bridge in 1973.

Flooding in Las Animas

The cross-sections on figure 5 show the calculated water surface elevations for the 100-year flood. The flood water is limited in southward extent by an irrigation ditch located 1200 feet north of the city boundary. This ditch is backed by the higher dike of the Town Ditch, located along the north boundary of the city. As a conclusion concerning the hazard of flooding in Las Animas from the 100-year flood, these two irrigation ditches in conjunction with the levee constructed in 1955 will prevent any flood encroachment into the city. It should be emphasized that this conclusion is contingent upon the Town Ditch remaining in its present condition.

The ditch right-of-way has been abandoned and has already been cut at Carson Street and on the northeast corner of the city. In its present state, the ditch embankment is a valuable flood-protection asset for the City of Las Animas -- it should not be destroyed.

In 1965, there was concern that flood water could enter the upper end of the Town Ditch or the Consolidated Ditch and thus enter the city from the west. Since that time, the Town Ditch has been abandoned and blocked in several places near the headgate, thus it does not pose a flood threat. The Consolidated Ditch-Riverside Lateral could be inundated west of the city, however the capacity of the ditch is less than 20 cfs in most places and the excess flow would spill out onto farm land west of the city. Any flows reaching Las Animas would be contained in the ditch or within the streets.

SUMMARY AND RECOMMENDATIONS

The Arkansas River at Las Animas, Colorado, has had a long history of floods caused by intense rainstorms on the high plains. Since 1939, the U.S. Geological Survey has maintained a gaging station at Las Animas and, during that period, flood peaks have exceeded 20,000 cfs four times. The flow in 1955 was 44,000 cfs, which was the second largest flood in recorded history. The largest flood occurred in 1921 with a discharge of 187,000 cfs. This is the only flood which inundated the City of Las Animas.

A log-normal frequency curve based upon flood peaks since 1939 indicates a 100-year flood discharge of 66,000 cfs at Las Animas. The recent completion of Pueblo Dam will produce partial flood control for the Arkansas River and modify the flood-frequency distribution. The resulting modification of the frequency curve indicates the 100-year flood to be 47,000 cfs.

Flood-routing calculations of this 100-year flood indicate a water surface elevation of 3894.8 feet at the highway bridge, north of Las Animas, and a backwater slope of 1.2 feet per 1000 feet upstream. The flood will be contained by an irrigation ditch embankment located 1200 feet north of the city. The Town Ditch at the north edge of the city provides a back-up levee, resulting in no flood inundation of the City of Las Animas by the 100-year flood.

It should be emphasized that this analysis was based upon the assumptions of the existing channel condition and no debris-clogging at the highway bridge. Any decrease in channel or bridge capacity will produce higher water elevations and some inundation at the north edge of the city along Highway 50.

The following recommendations should be considered by the City of Las Animas.

1. File an appeal with the Federal Insurance Administration to remove the City of Las Animas from the flood hazard area.

The following recommendations apply until the Corps of Engineers completes the Las Animas levee project.

2. Inspect and maintain the Town Ditch embankment and make emergency plans to fill the existing cuts in the ditch.

3. Raise and maintain the 1955 levee adjacent to the highway. The elevation of the levee should be increased to 3896 feet.
4. Construct a flow-limiting structure on the Riverside Lateral of the Consolidated Ditch in the area one to two miles west of the city. This stucture could incorporate one of the existing culvert crossings.
5. Undertake a program of periodic channel cleaning under and upstream from the Highway 50 bridge. It would be desirable to widen the pilot channel above the bridge and to remove more of the fill from the old railroad bridge site downstream.

It should be emphasized that, although the 100-year flood will not inundate the City of Las Animas, the city is still subject to inundation by floods of a greater return frequency. The Corps of Engineers report on the Las Animas levee project estimates that the standard project flood of 140,000 cfs would inundate most of the river valley, including the City of Las Animas.

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