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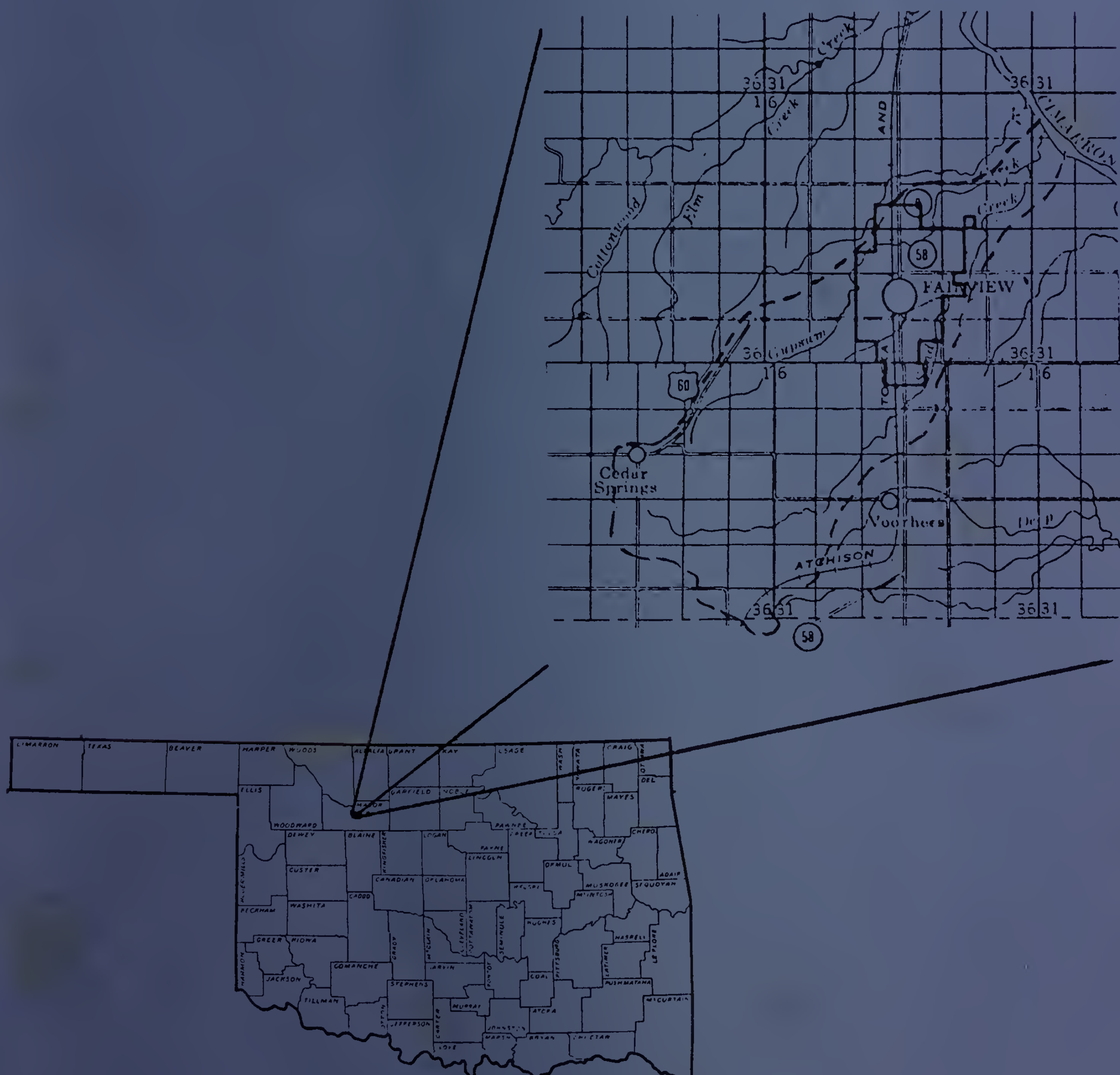
FAIRVIEW FLOOD PLAIN MANAGEMENT STUDY

Major County, Oklahoma

MAY 1986



FLOOD PLAIN MANAGEMENT STUDY

SAND AND GYPSUM CREEKS AND TRIBUTARIES

CITY OF FAIRVIEW
Major County, Oklahoma

Prepared by

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
AGRICULTURAL CENTER BUILDING
STILLWATER, OKLAHOMA

In cooperation with

CITY OF FAIRVIEW
MAJOR COUNTY CONSERVATION DISTRICT
OKLAHOMA CONSERVATION COMMISSION
and
OKLAHOMA WATER RESOURCES BOARD

FEBRUARY 1986

FLOOD PLAIN MANAGEMENT STUDY
FAIRVIEW, OKLAHOMA

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INTRODUCTION

The primary purpose of this report is to identify the present flood hazard areas in and adjacent to the city of Fairview. The report is to serve as a technical tool to enable local residents and officials, as well as state officials, to carry out an effective flood plain management program to reduce the vulnerability to flood damage.

The city of Fairview, Oklahoma, in cooperation with the Major County Conservation District, requested through the Oklahoma Conservation Commission that a flood plain management study be made within the corporate limits. A less intensive study was also done in areas outside the city, but within the areas which influence urban flooding. In addition to defining urban flooding, the results will guide the conservation district in determining the feasibility of installing floodwater retarding structures (FWRS) upstream on Sand Creek and its tributaries under the PL-566 watershed program.

In accordance with the April 1982 joint coordination agreement between the Soil Conservation Service (SCS) and the State of Oklahoma, Oklahoma Water Resources Board, and the Oklahoma Conservation Commission; the Oklahoma Conservation Commission recommended a top priority for this study to the Oklahoma Water Resources Board. The Water Resources Board (the coordinating state agency) concurred in this priority and recommended that the study be carried out by the Soil Conservation Service, U.S. Department of Agriculture as authorized under Section 6, Public Law 83-566. The SCS carries out flood plain management studies in response to Federal Level Recommendation No. 3 of the Water Resources Council's revised "Unified National Program for Flood Plain Management", September 1979; and in compliance with Executive Order 11988, dated May 24, 1977. A plan of study was prepared by SCS personnel with the concurrence of the participating agencies and a subsequent authorization to proceed with the study was issued by the SCS Chief in March 1984.

Topographic data for this study were obtained from field surveys and two-foot contour interval topographic maps. The two-foot contour maps covering about 93 percent of the corporate area were furnished by the city of Fairview. Rainfall frequency data were obtained from Weather Bureau Technical Paper No. 40, Rainfall Frequency Atlas of the United States. Frequency-discharge values were determined by flood routing a selected distribution of storm frequencies with a 24-hour rainfall duration using SCS Technical Release No. 20, A Computer Program for Project Formulation, Hydrology. Water surface profiles were developed using SCS Technical Release No. 61, WSP2, Computer Program which is a water surface profile computer program for determining flood elevations and flood areas at certain flow rates.

The computed flood elevations in this report were determined using detailed physical data and study procedures and are within the normally accepted range of accuracy for this type of study.

DESCRIPTION OF THE STUDY AREA

Study Area Limits

The areas in and near Fairview are subject to flooding by Sand and Gypsum Creeks and their tributaries. Studies were started at or near the confluence with the Cimarron River about two miles northeast of the corporate limits and continued upstream for several miles above the corporate limits. Detail studies were conducted on the approximate 12.5 miles of stream reaches within the corporate limits with lesser intensity studies of streams outside the city.

The Community

Fairview, the county seat of Major County, is located near the center of the county on the broad nearly level flood plain of Sand and Gypsum Creeks. The incorporated area encompasses 7.02 square miles. In 1980, the population of Fairview was 3,370 with a growth rate at the time of about 10 percent annually. The economy of the area is based primarily on agricultural production. The city experienced a surge in growth in the early eighties resulting form intensified petroleum production activities in the area. With this growth, city officials became more conscious of the need to obtain detailed flood data and to develop more effective programs of flood plain management.

Development Trends

Within the corporate limits there are approximately 850 acres of 100-year flood plain. The topography is generally flat, with a moderate southwest-northeast slope through the incorporated area and on to the Cimarron River. Only 29 percent of the incorporated area has been developed with the remainder devoted to agricultural uses, primarily cropland. Very little industrial and commercial development has occurred in the past few years, while population growth has encouraged residential development. Presently, development trends are to the east and northeast, where the relatively flat, open areas often encourage construction without proper consideration of an existing flood threat. This area is served by State Highways 8 and 58 to the east which will further encourage development of the area.

Soil Survey Data

The flood plain soils within the Sand and Gypsum Creeks watershed are located within two general soil associations. Most of the area is on the Port-Canadian-McLain-Reinach Association which consists of deep nearly level, loamy soils of the bottom lands along the Cimarron River and its tributaries. Most of the soils are on terraces above the level of normal flooding. A few of the areas are gently sloping and are well drained. More than 90 percent of this association is cultivated, producing crops of alfalfa, sorghums, wheat, and other small grains. Native and improved grasses make up most of the other land use and is mostly along drainage ways and in the lower part of the flood plain near the river.

The Canadian soils are the most susceptible to wind erosion.

The rest of the study area is on the Vernon-Tillman, Badland Association that is shallow to deep, nearly level to moderately sloping loamy soils with clayey subsoils, rugged draws and partly barren badland. It lies below and adjacent to the blufflike escarpments in the western part of the county and occupies the southwest part of the study area. The association slopes generally northward to northeasterly and is underlain by clayey subsoils and shaley materials. Approximately 50 percent is cultivated, mostly in wheat. Erosion is a problem in some cultivated areas and disseminated gypsum is scattered through the soil profile.

The above fine grained soils have medium to high water holding capacity, pH and shrink-swell potential. The coarser grained soils have lower shrink-swell potential and water holding capacity.

The badlands part of the association is good for building farm ponds except where there is a high presence of gypsum.

The corporate limits of Fairview sits mostly on the broad alluvial flood plain of the Cimarron River and its Sand Creek and Gypsum Creek tributaries. This quaternary alluvium of first and second bottoms contains low terrace deposits and some dune sand near the river. Upstream at the southern edge of the area siltstones and shales of the Flowerpot Shale formation, El Reno Group, Permian Age forms the badlands appearance of sharp escarpments and rugged draws. The highest elevation in the watershed is 1,700 feet, while the elevation at Fairview is 1,292 feet.

WATERSHED AND STREAM CHARACTERISTICS

Basin Designation

The study area is located in the Cimarron River portion of the Arkansas River Basin and is designated by the Water Resource Council's Hydrologic Unit and the Oklahoma Sub-State Resource Unit delineation as 11050002-010.

Sand and Gypsum Creeks

The Sand and Gypsum Creeks watershed covers an area of 57.03 square miles (36,500 acres) of which approximately 50.0 square miles are outside the corporate limits of Fairview. The two streams originate about eight miles southwest of Fairview near Cedar Springs, Oklahoma, and flow in a northeasterly direction to their confluence with the Cimarron River approximately five miles northeast of the business district.

The Fairview flood plain study is located within the drainage area of Sand and Gypsum Creeks watershed. It is on the northern flank of the Anadarko Basin geological province with red beds of the Permian Age present. The El Reno group containing the Flowerpot Shale and the overlying Blain formation are mostly siltstones and shales with various amounts of gypsum. The Flowerpot Shale is near the surface in an erosional plain adjacent to the Cimarron River and is covered by Quaternary alluvium. The Blain Formation lies above the Flowerpot Shale and in some areas south of the subject area is a commercial producer of gypsum. It is horizonally bedded and caps many of the buttes and blufflike escarpments in the foothills above the town of Fairview. Many of the shallow water wells contain high concentrations of dissolved gypsum resulting in a water quality that is marginal for domestic use.

Land use with the watershed is shown below:

Land Use	Acres	Percent
Crop	17,529	48.0
Pasture	1,711	4.7
Range	14,984	41.0
Forest	333	1.0
Urban	1,383	3.8
Roads and Misc.	560	1.5
Total	36,500	100.0

FLOOD HISTORY

Interviews with local residents reveal little history of local flooding. This is compatible with development trends which show only a recent history of development in more flood prone areas.

The flood of record for the area occurred in 1974 and the last major flood previous to that occurred in October 1959. According to a Corps of Engineers Reconnaissance Report dated June 1976, the 1974 flood caused an estimated $11,500 damage to houses and trailers in the vicinity of First Avenue and Elm Street and to houses along Ash Street and Fourth Avenue. These properties are part of a residental area developed since 1972. There has been some additional development in this specific area since the 1974 report of flooding.

The drainage basin upstream from the flood area is a tributary of Lost Creek and is about 1.0 mile long, 0.6 mile wide with a drainage area of about 0.5 square mile. The east one-third of the basin is an urban area and the remainder is agricultural land. Land adjacent to the flood area on the west has potential for development. Additional development upstream in the basin will contribute to the existing flood problem.

NATURAL VALUES

The primary natural value of the Sand and Gypsum Creeks flood plain is its ability to transport floodwaters from the basin above. In recent years, encroachment onto the flood plain with buildings, residences, streets and other obstacles has affected its natural ability to transport floodwater. Fortunately, most the past development had minor effect on the flood plain, but in the last 10 years some development has moved from the fringe areas into the flood plain. With proper management, much of the flood plain's natural value, the ability to transport floodwater, can be retained.

Most of the Sand and Gypsum Creeks soil, including the flood plain, is classified as prime farmland. A high percentage of the soil within the city of Fairview is classified as prime farmland. The amount of prime farmland in the watershed is show below:

PRIME FARMLAND
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	Rural		Urban		Total	
	(Acres)	(Percent)	(Acres)	(Percent)	(Acres)	(Percent)
Prime Farmland	15,687	49	4,113	92	19,800	54
Other	16,320	51	380	8	16,700	46
Total	32,007	100	4,493	100	36,500	100

Wildlife habitats vary considerably between upland and bottomland areas of the watershed. Land use patterns in the uplands generally result in vegetative diversity and interspersion which provides good wildlife habitat for bobwhite quail, mourning dove, cottontail rabbit, jackrabbit, coyote, bobcat, raccoon, skunk, opossum, songbirds, hawks, owls, and small rodents. Habitat conditions in some upland areas are also suitable for fox squirrel, Rio Grande turkey, and white-tailed deer. Conversely, most bottomlands are intensively cultivated and lack vegetative diversity beneficial to most wildlife species. Stream corridors which provide habitat for small game and nongame animals or travel lanes for larger animals have been eliminated in many stream reaches or remain as sparse narrow bands affording minimal habitat for most wildlife species.

There are no wetlands in the watershed as defined by U.S. Fish and Wildlife Circular 39. Watershed streams and tributaries are ephemeral and do not support significant fishery resources. More reliable water sources for fish and wildlife are found in farm ponds in upland areas of the watershed. Urban development and intensive agricultural use has reduced the aesthetic and environmental values associated with flood plain lands and stream corridors within the watershed.

FLOOD POTENTIAL

Flood Hazard Areas

The potential exists for flooding large areas from storms such as the 100- and 500-year events. The flat topography of the area allows out-of-channel flows to spread, causing transitional flows from one water course to another, in some areas. Establishing the exact lateral limits and depth in these transitional areas is difficult. In and immediately adjacent to the established water courses flow depths are greater and more easily determined. Typical velocities for in-channel flows are 2 to 7 feet per second while velocities of flows in transitional areas are normally less than 3 feet per second.

Although there are exceptions, the potential for damage to properties within shallow, transitional areas is much less than to those located in lower areas along or adjacent to water courses. The potential for damage in either area could increase substantially in the absence of proper management and orderly development plans.

The following is a tabulation of the acreage of flood plain within the incorporated area subject to inundation from the two largest storms used in the study:

FREQUENCY	AREA INUNDATED
100-yr.	850 acres
500-yr.	986 acres

Flood Hazard Exhibits

Flood hazard exhibits contained in the Technical Appendix include photobase maps of the incorporated area together with an index map showing the area covered by each photobase map. The photobase maps give the approximate areal coverage of the 100- and 500-year floods.

In addition to the photobase maps, flood profiles were prepared for the 10-, 50-, 100- and 500-year floods. The peak discharges for the subject floods were determined by flood routing procedures using SCS Technical Release No. 20. Water surface profiles were developed using stream characteristics, topographic maps, and field surveys of the flood plain, roads, and bridges. The profiles were computed assuming that all bridges would remain intact and that no clogging by obstruction or debris would occur. The SCS WSP2 Computer Program was used in computation of water surface profiles.

The water surface profiles show the elevation of the water surface anywhere along the stream reaches for the various frequency floods along with the elevation of the channel bottom. The profiles can be used to determine the depth of flooding and the flood protection levels required under existing conditions.

One valley cross section (16) located about one-fourth mile upstream from highways 8 and 58 on Sand Creek, is plotted and shows the elevation of the water surface for the same conditions described for the water surface profiles (See Technical Appendix, page 44).

Future Flood Plain Conditions

The flood plains both within and downstream of the corporate limits are in intensive agricultural production. Upstream areas are less intensively used with a transition from crops and pasture near the corporate limits to range in the upper one-third of the basin. A high percentage of the needed land treatment measure have already been installed in the watershed. Land use changes, management changes, and additional needed conservation treatment upstream from the study area on Sand Creek, Gypsum Creek, and their tributaries are not anticipated to substantially change the storm runoff or associated peak discharges entering the study area.

Within the incorporated area, there is a trend toward commercial and residential development in the flood plain area. This is most pronounced in the area to the east of the present business district. The trend has undoubtedly slowed since the peak period of petroleum production in the early eighties. Future land use change from agricultural to urban with its associated high percentage of impervious areas will significantly increase the runoff within the developed area of the study limits. The change to a high percentage of impervious area could be very dramatic on those problem reaches where a majority of the contributing drainage area originates within the corporate boundaries.

Localized flooding and drainage problems will result unless adequate planning controls are provided.

ALTERNATIVES FOR FLOOD PLAIN MANAGEMENT

Management Techniques

With flood hazard information available, the city of Fairview has the essential technical data to plan the needed land use and development regulations for its flood prone areas. The overall plan of the community for industrial, commercial, and residential areas, for streets, utilities, parks, schools, etc., can be coordinated with the need to convey, control, or floodproof against floodwaters.

Such community planning procedures are an integral part of a comprehensive flood plain management program. Flood plain management involves the full range of public policy and action for insuring wise use of the flood plains. It includes everything from collection and dissemination of flood hazard information to actual acquisition of flood plain lands, construction of upstream and instream control measure, and enactment and administration of codes, ordinances, and statutes regulating flood plain land use and development.

A total flood plain management program might be comprised of numerous elements such as structural flood control works to protect existing development, regulations to guide new development, flood insurance for owners of existing and new properties, and individual adjustment measures such as flood proofing and relocation.

National Flood Insurance Program

The National Flood Insurance Program was established by the National Flood Insurance Act of 1968 (Public Law 90-448, as amended) to make flood insurance, which was previously unavailable from private insurers, available to property owners and occupiers of identified flood plain lands. The Flood Disaster Protection Act of 1973 (Public Law 93-234, as amended) was a major expansion of the National Flood Insurance Program.

Flood insurance is available through local insurance agents and brokers only after a local governing body applies and is declared eligible for the program by the Federal Insurance and Hazard Mitigation Division of the Federal Emergency Management Agency (FEMA). Adoption and enforcement of local land use regulations and ordinances within identified flood plain areas that meet minimum FEMA flood plain management criteria is necessary to qualify and maintain eligibility.

In those communities participating in the FEMA program, owners and occupiers of all buildings and mobile homes in the entire community are eligible to obtain flood insurance coverage. Where flood insurance is available, it is recommended that buildings and mobile homes within or adjacent to the delineated flood hazard areas carry flood insurance on the structure and contents.

The city of Fairview is presently participating in the National Flood Insurance Program. The city met requirements of FEMA for participation in the emergency program in February 1975. A comprehensive local flood prevention ordinance was adopted on February 7, 1978. Provisions of the ordinance can contribute to the orderly development of flood plains and decrease the potential for future damages.

Structural Measures

Structural measures such as floodwater retarding structures and a dike were considered as a means of reducing flood flows. Three dams to check the uncontrolled flows entering the corporate limits were examined as one alternative. Locations of the dams, one each on Sand Creek, Gypsum Creek, and Lost Creek, were determined by SCS in 1981 during a preliminary field examination for the Sand Creek Watershed.

Based on costs and benefits at that time, none of the structures showed favorable economic feasibility. However, it was recognized that urban flooding and damages had not been analyzed and could potentially result in favorable economic feasibility.

The three structures would provide approximately 45 percent control of the total drainage area on Sand Creek, 20 percent control on Gypsum Creek, and 31 percent control on Lost Creek. Control for the watershed would be approximately 35 percent. The Sand Creek structure showed the greatest potential in the earlier study with a benefit-to-cost ratio of 0.8:1.0. This structure would control about 50 percent of the drainage area at cross section 16 located about one-fourth mile above highways 8 and 58 on the east side of Fairview (see Technical Appendix, page 13). Installation of this structure would reduce the peak discharges at cross section 16 by 37 percent for the 10-year frequency, 34 percent for the 100-year frequency, and 22 percent for the 500-year frequency flood event. This would result in a reduction of 1.0 foot in the water surface elevation during the 100-year storm.

Installation of the structure on Gypsum Creek would control 29 percent of the drainage area above highways 8 and 60 on the north side of Fairview at a point about one and one-fourth miles north of the corporate limits at cross section 52 (not shown in Technical Appendix). Reduction in peak discharges at the highway would be: 10-year frequency, 2 percent; 100-year frequency, 8 percent; and 500-year frequency, 7 percent. The resultant reduction in elevation of the 100-year flood event would be only 0.2 of a foot.

Potential for flooding urban properties from either Sand or Gypsum Creeks is presently very low. As shown on the Index Map (see Technical Appendix, page 5), Gypsum and Sand Creeks are on the fringe areas, flowing to the north and south, respectively, of the presently developed area.

A dam on Lost Creek, a large tributary to Sand Creek, would control 47 percent of the drainage area above highways 8 and 60 on the north side of Fairview at cross section 97 (see Technical Appendix, page 10). Reduction in discharges at the highway would be: 10-year frequency, 13 percent; 100-year frequency, 19 percent; and 500-year frequency, 22 percent. Elevations of the 100-year storm would be reduced by only 0.3 of a foot. This tributary does flow through areas of partial development. However, studies show that no flooding occurs above the first floor of buildings along the Lost Creek mainstem under present conditions.

The Lost Creek dam showed an unfavorable economic potential in the 1981 study with a benefit-to-cost ratio of 0.6:1.0. In the absence of urban benefits to add to the agricultural benefits, this structure still produces a benefit-to-cost ratio of less than 1.0:1.0.

With the lack of urban benefits identified during the study, FWRS are not economically justified and are therefore not a viable alternative. Results confirm the earlier conclusion that the three FWRS would not qualify for development under provisions of Public Law-566 at the present time.

Flooding potential is greatest on a tributary of Lost Creek which is located to the south and flows in a northeasterly direction through two existing residential developments. The FWRS studied on Lost Creek would not affect floods on this tributary.

Diking was considered to alleviate flooding in the first residential area which includes First Avenue and Elm and Fourth Avenue and Ash Street. History indicates that presently this area has the greatest potential to flood of any development in the corporate limits even though there is only 0.5 square mile of contributing drainage basin above First Avenue. This is the area in which a reconnaissance report was prepared by the Corps of Engineers in 1976.

Results of the present study show flood peaks at First Street at the west edge of the development to be as follows: 10-year frequency, 321 cfs; 100-year frequency, 597 cfs; and 500-year frequency, 780 cfs. For the 10-year flood, flooding is limited to streets and yards, creating a nuisance, but causing very little monetary damages. Approximately four houses will receive shallow flooding from the 100-year event. Flood depths will range from 0.1 foot to about 0.45 foot above the first floor elevation. Since damages are occurring only from the higher frequency storms, the resultant average annual damages are low. Average annual damages provide a base to determine the limit of expenditures for alternative measures to solve the flood problems. The estimated average annual damages are less than $1,000.

A diversion dike to intercept and divert floodwater would follow the location and alignment used by the Corps of Engineers in their 1976 report. It would intercept the existing drain about 200 feet west of First Street, run parallel to First Street in a northerly direction across west State Road than east along the north side of west State Road to a point of interception with the original drain. Estimated length would be 0.7 of a mile (3,700 feet). In addition to construction and landrights costs, a new bridge would be required where the diversion crosses west State Road. Estimated average annual cost related to installation of the diversion would be $11,000. When compared to the average annual damages, the benefit-to-cost ratio is about 0.1:1.0; therefore, installation of this structural measure would not be economically feasible.

The second area of flooding is the residential area about one block east of highways 8 and 60 in the vicinity of Sylvia and Cimarron Streets. At cross section 125 (see Technical Appendix, pages 12 and 25) immediately upstream from Sylvia Street, present condition flood peaks are as follows: 10-year frequency, 436 cfs; 100-year frequency, 540 cfs; and 500-year frequency, 601 cfs. Flooding from the 10-year event is limited to streets and yards, creating a nuisance, but causing very little dollar damage. Approximately 7 houses will flood above the first floor from the 100-year event. Flood depths range from 0.05 foot to 0.2 foot above the first floor elevation. Average annual damages would be relatively low because flooding is limited to the higher frequency storms. Average annual damages are estimated to be less than $1,200; therefore, damages on this tributary are not sufficient at present to pay for channel work or other structural measures to reduce potential flooding.

Nonstructural Measures

In addition to the National Flood Insurance program, other nonstructural measures which will help reduce or minimize flood losses include flood proofing, flood warning systems, relocation, zoning regulations, emergency preparedness, and building or development codes.

Flood proofing can reduce flood damages by a combination of structural provision and changes or adjustments to properties subject to flooding. Examples of flood proofing are sealing low window and door openings and modifying flood drains to prevent the entrance of floodwaters.

Flood warning systems should be coordinated with emergency preparedness plans. The National Weather Service issues general warnings of potential flood producing storms. Staff gages set at key locations can be monitored to give advance warnings. A float-activated electronic signal could be connected to the local police or fire station for monitoring.

Relocation involves permanent evacuation of developed areas subject to inundation, acquisition of lands by purchase, removal of improvements and relocation of the population from such areas. Such lands could be used for parks or other purposes that would not suffer large flood damages and would not interfere with flood flows.

Zoning is a legal method used to implement and enforce the details of the flood plain management program, to preserve property values, and to achieve the most appropriate and beneficial use of available land. Clear, concise, and thorough zoning bylaws with enforcement of the bylaws are essential to making zoning effective.

Emergency preparedness consists of a plan by local officials to be put into effect in the event of flooding. Procedures are worked out and personnel designated to implement the plan. Methods and procedures to alert and warn the populace of possible flooding are developed. High risk areas, handicapped, elderly or others known to need help during evacuation are located and identified. Plans are made for their evacuation or rescue. Shelters are provided for evacuees.

Building codes are developed to set up minimum standards for controlling the design, construction, and quality of materials used in buildings and structures within a given area to provide safety for life, health, property, and public welfare. Building codes can be used to minimize structural and subsequent damages resulting from inundation.

CONCLUSIONS AND RECOMMENDATIONS

Study results show very limited flood damages within the corporate limits at the present time. However, development trends indicate more building in flood prone areas. Without orderly development, properties in and near existing flood plains, will sustain increased flooding and damages.

Structural and nonstructural measures were considered as management alternatives during the study. Structural measures consisting of three floodwater retarding dams were studied to determine their effect on flooding and their economic feasibility. Cost estimates developed during the 1981 SCS field examination study were updated for the study. The costs of this alternative were high in comparison to the benefits provided and therefore, it is not a viable management alternative. Installation of a flood dike west of and parallel to First Street would eliminate flooding in the adjoining residential area. However, costs of this structure also exceeded the benefits. Nonstructural management alternatives presently offer the best opportunity to restrict flooding and damages and prevent an acceleration of damages in the future.

Nonstructural alternatives considered during the flood plain management study were discussed during meetings with local public officials and other interested members of the public. Those considered to have the greatest potential to address present flood problems are: National Flood Insurance Program, zoning and building codes, and emergency preparedness and warning systems.

GLOSSARY

<u>Channel</u> -- A natural stream that conveys water; a ditch or channel excavated for the flow of water.

<u>Channel Bottom</u> -- The elevation of the deepest part of a stream channel at a particular cross section.

<u>cfs</u> -- Cubic feet per second (unit of rate of flood discharge).

<u>Cross section</u> -- Shape and dimensions of a channel and valley perpendicular to the line of flow.

<u>Flood</u> -- An overflow or inundation that comes from a river or other body of water and causes or threatens damage.

<u>Flood Frequency</u> -- A means of expressing the probability of flood occurrences as determined from a statistical analysis of representative stream flow or rainfall and runoff records. A 10-year frequency flood would have an average frequency of occurrence in the order of once in 10 years (a ten percent chance of being equaled or exceeded in any given year). A 50-year frequency flood would have an average frequency of occurrence in the order of once in 50 years (a two percent chance of being equaled or exceeded in any given year). A 100-year frequency flood would have an average frequency of occurrence in the order of once in 100 years (a one percent chance of being equaled or exceeded in any given year). A 500-year frequency flood would have an average frequency

of occurrence in the order of once in 500 years (a 0.2 percent chance of being equaled or exceeded in any given year).

Flood peak or peak discharge -- The highest stage or discharge attained during a flood.

Flood plain -- Nearly level land situated on either or both sides of a channel which is subject to overflow flooding.

100-Year Flood plain -- The land that would be flooded on an average of once every 100 years.

500-Year Flood plain -- The land that would be flooded on an average of once every 500 years.

Flood Profile -- A graph showing the relationship of water surface elevation to location, the latter generally expressed as distance above the mouth of a stream flowing in an open channel. It is generally drawn to show surface elevation for the crest of a specific flood.

Flood Stage -- The stage at which overflow of the natural banks of a stream begins to cause damage in the reach in which the elevation is measured.

Floodwater retarding structure -- A dam, usually of earthfill, providing a reservoir for temporary storage of floodwaters. Storage for other purposes may also be included.

High Water Mark (HWM) -- The maximum observed and recorded height or elevation that floodwater reaches during a storm, usually associated with the flood peak. The high water mark may be referenced to a particular building, bridge, or other landmark, or based on debris deposits on bridges, fences or other evidence of the flood.

Land use -- Classification of type of vegetation, or other surface cover conditions on a watershed used (with a similar classification of soils) to indicate the rate and volume of flood runoff.

Low Bank -- The highest elevation of a specific channel cross section at which the water will be contained without overflowing onto adjacent flood plain areas.

Runoff -- That portion of the precipitation on a drainage area that is discharged from the area in stream channels; types include surface runoff, groundwater runoff, or seepage.

Water Surface Profile -- A graph showing the relationship of water surface elevation to stream channel location for a specific flood event.

Watershed -- All land and water within the confines of a drainage divide.

Watershed boundary -- The divide separating one drainage basin from another.

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TECHNICAL APPENDIX

APPENDIX

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TECHNICAL APPENDIX

This is the Technical Appendix to the Fairview Flood Plain Management Study Report. It is a compilation of the FPMS technical findings. It includes the photomap index, flood hazard area photomaps, flood profiles, plottings of a typical stream cross section, elevation and discharge tabulations and a listing of pertinent elevation reference marks. Other technical data developed during this study is on file in the USDA Soil Conservation Service State Office, Agricultural Center Building, Stillwater, Oklahoma 74074.

INVESTIGATIONS AND ANALYSES

Field Surveys

Topographic data were obtained from two-foot contour interval topographic maps and field surveys. Engineering surveys were made of cross sections selected to represent the stream hydraulics and flood plain areas. Elevations appearing in this report are based on permanent elevation reference marks established by Coast and Geodetic Survey. These permanent elevation reference marks were based on mean sea level (MSL) datum. Table 2, pages 47-49 shows the listings, descriptions, and location of permanent and temporary elevation reference marks.

Hydrologic and Hydraulic Methods

The Sand and Gypsum Creeks watershed boundaries were determined by use of Geological Survey topographic maps. Rainfall frequency data for the four storms used in the study were obtained from Weather Bureau

Technical Paper No. 40, Rainfall Frequency Atlas of the United States. Values greater than the 100-year frequency event were determined by extrapolation of the rainfall versus frequency graph. Peak discharge values were determined by flood routing various storm frequencies with a 24-hour rainfall duration using SCS Technical Release No. 20, A Computer Program for Project Formulation, Hydrology. The program computes surface runoff resulting from any synthetic or natural rainstorm. The program will route the flow through stream channels and reservoirs. Results include, but are not limited to, a combination of the routed hydrograph with those from other tributaries and a printout of the peak discharges, their time of occurrence, and the water surface elevations for each computed discharge at any desired cross section or structure.

Historic flood data from gaged streams in the vicinity of Fairview are limited to watersheds much larger than the creeks in the study area. In the absence of applicable gage data, comparison was made of Technical Release No. 20 routed peaks with peak discharges obtained through regionalized gage data using regression equations from the U.S. Geological Survey publication, Techniques for Estimating Flood Discharges for Oklahoma Streams, June 1977.

From the representative stream and road cross sections, water surface profiles were developed by the Modified Slope Area Method. The effects of bridges and culverts on the stream hydraulics were determined by use of the Bureau of Public Roads (BPR) Method. Computations were made using SCS's WSP2, A Computer Program for Determining Flood Elevations and Flood Areas for Certain Flow Rates. Output data from this program establishes the relationship between stage or elevation and discharge for each cross section. Water surface profiles were developed from these relationships and the computer results of TR-20 routings.

Flood Hazard Evaluation

The 500-year and 100-year frequency flood hazard areas are outlined on aerial photographs obtained from the Agricultural Stabilization and Conservation Service. The flood hazard area boundaries were developed by plotting the computed water surface elevations on the surveyed cross sections and transposing this information to the aerial photographs. The flood hazard areas between the surveyed cross sections were developed through interpretation of topographic maps and the aerial photographs in conjunction with the surveyed cross sections. Therefore, actual flood limits may vary slightly on the ground from the outlined area on the photomaps. For this reason, the water surface elevations from the flood profiles should be used for determining site specific potential flood depths.

Estimates of Flood Losses

First floor elevations of buildings located within the flood hazard areas were determined using survey instruments. The first floor elevations were compared to the computed potential floodwater surface elevations. Potential flood depths for the various flood frequency events were determined and used to estimate flood damages where flood levels exceeded first floor elevations.

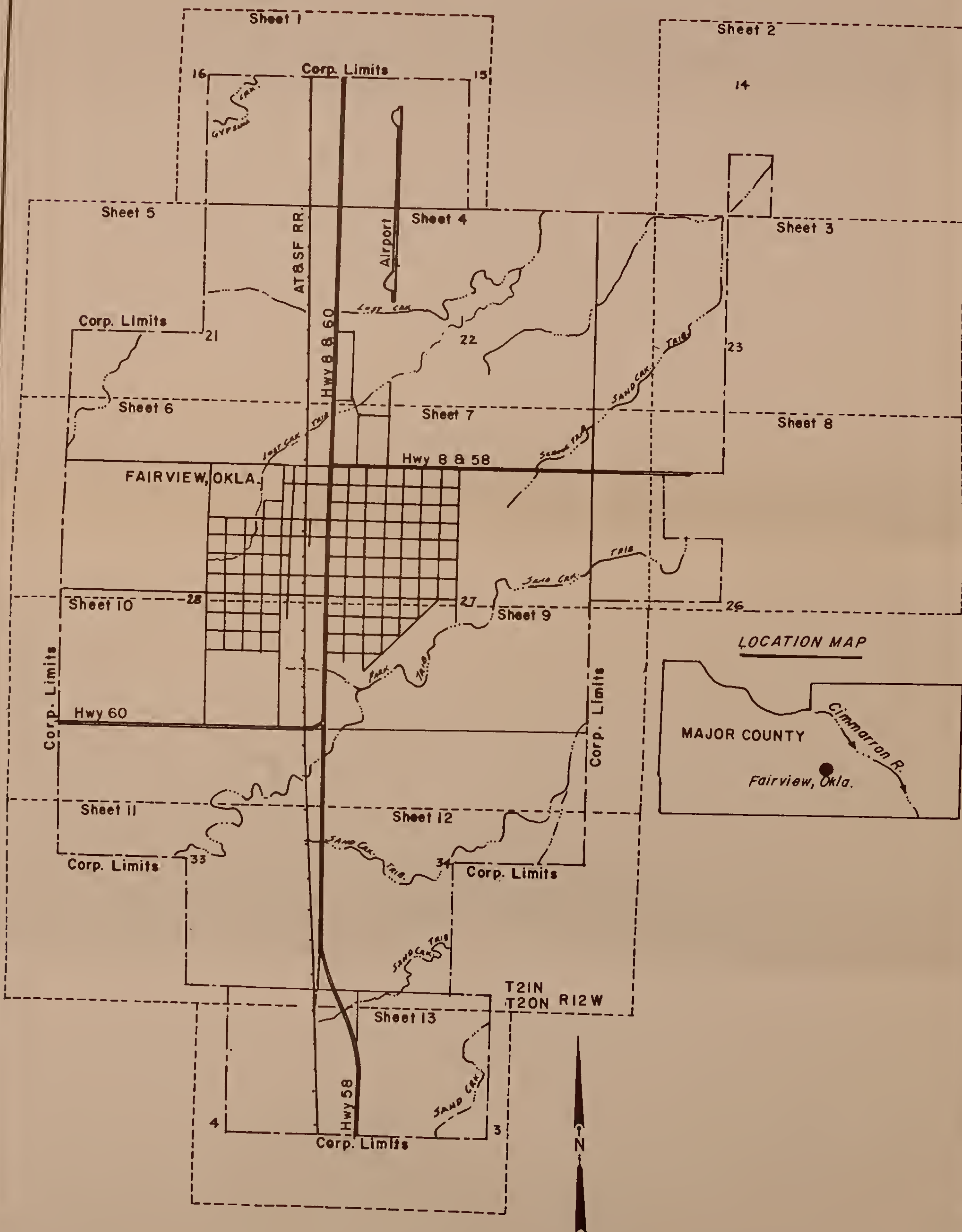
Inventory of Natural Values

The natural values of the Sand and Gypsum Creeks flood plains were determined by the Soil Conservation Service personnel through on-the-ground reconnaissance, interviews of local people and literature search.

Public Participation

The Fairview Flood Plain Management Study Plan of Work was developed through consultation with the local officials and study endorsers.

A public meeting was held during preparation of the report draft in order to get public input and participation.



U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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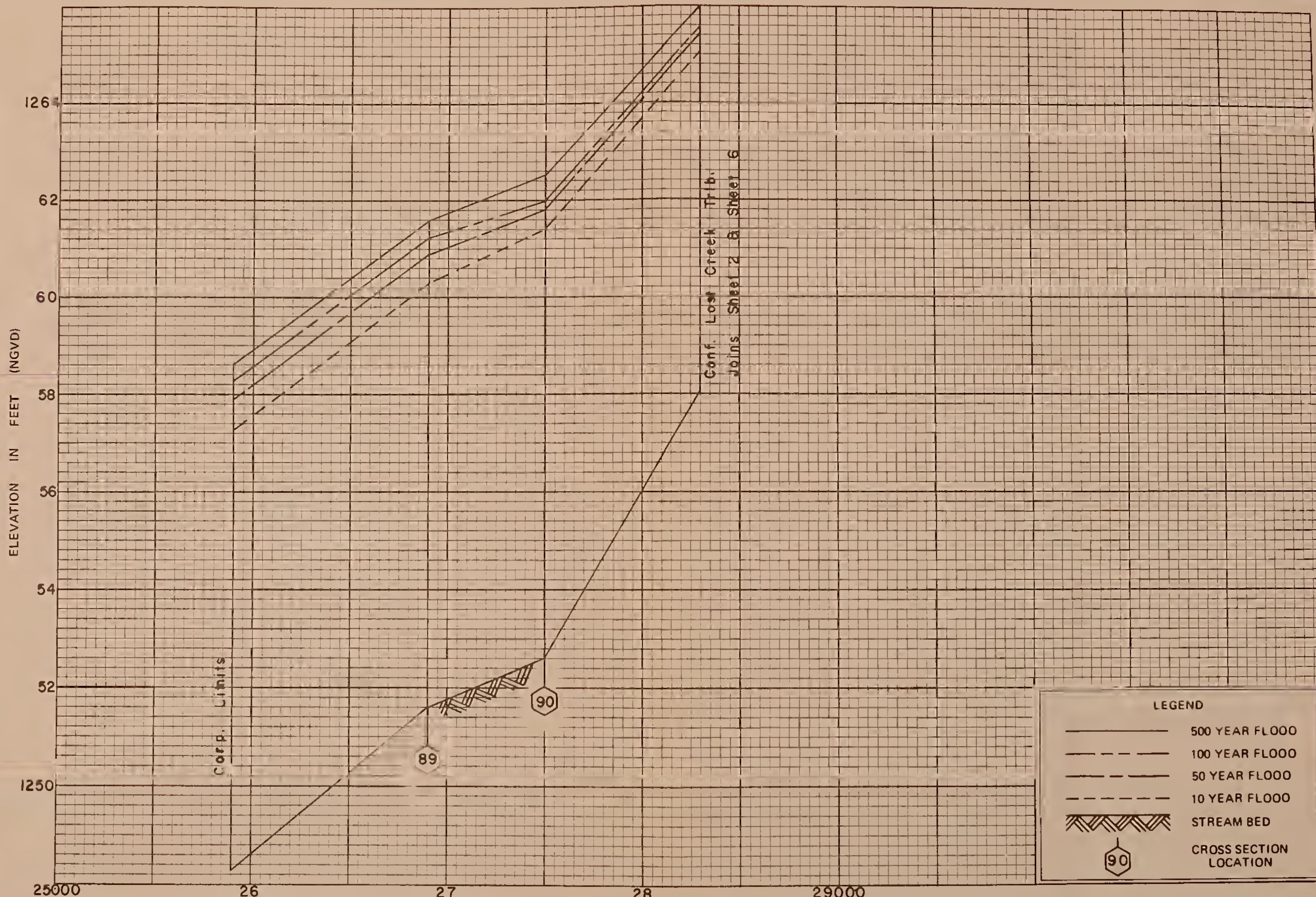

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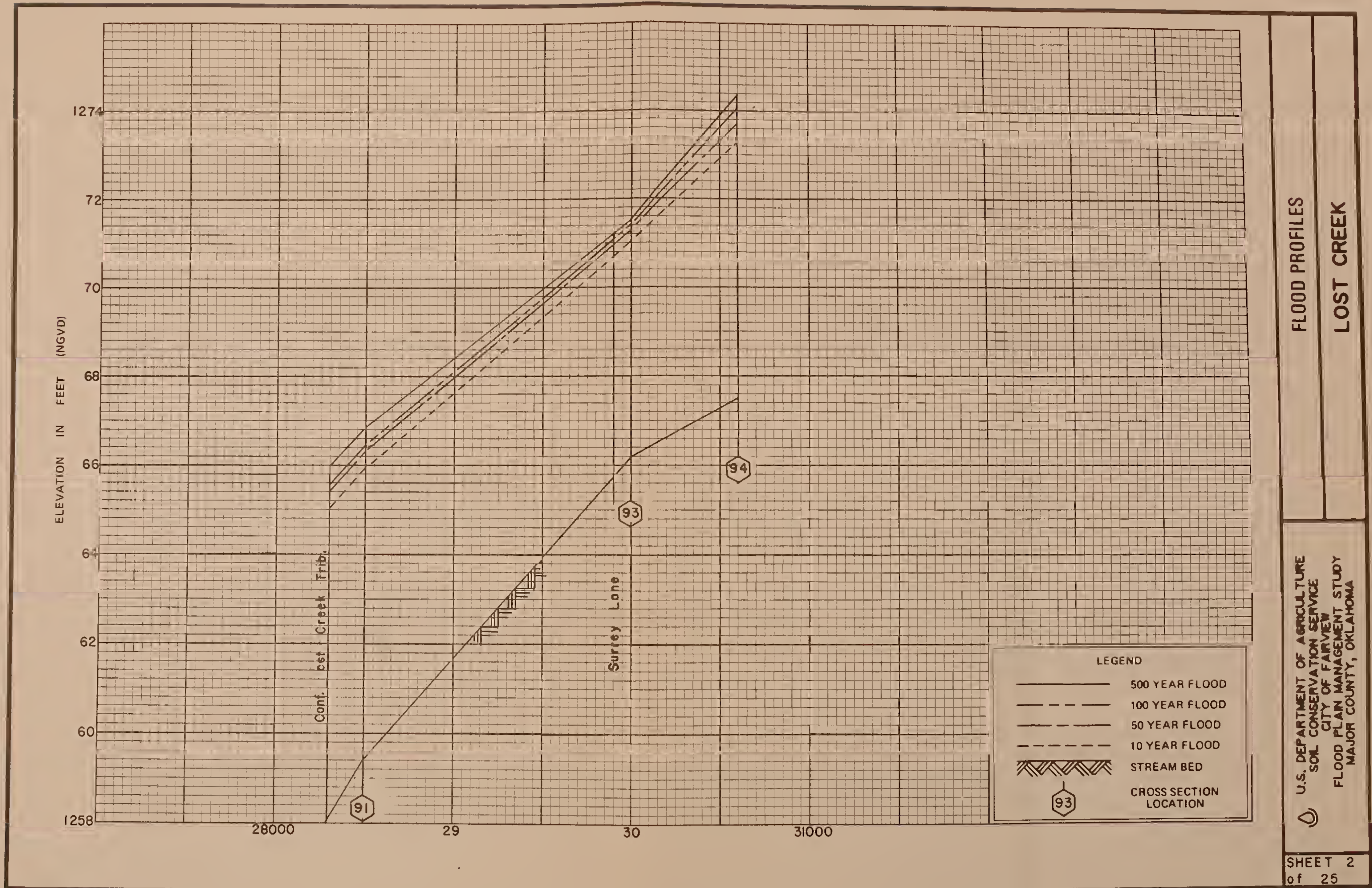

ELEVATION IN FEET (NGVD)
1274
72
70
68
66
64
62
60
1258
28000
29
30
31000
Conf. Lost Creek Trib.
Survey Lane
91
93
94
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
93
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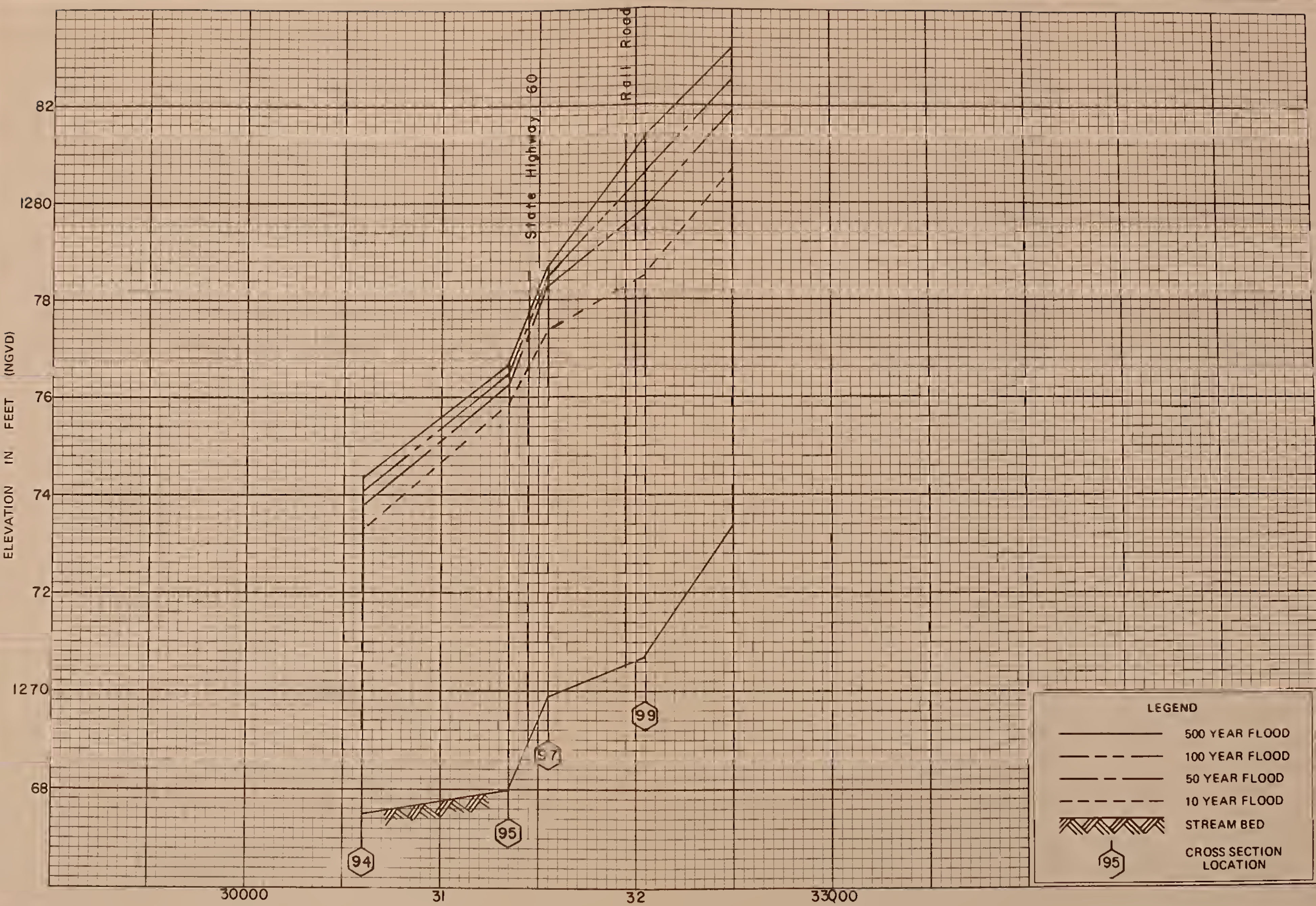

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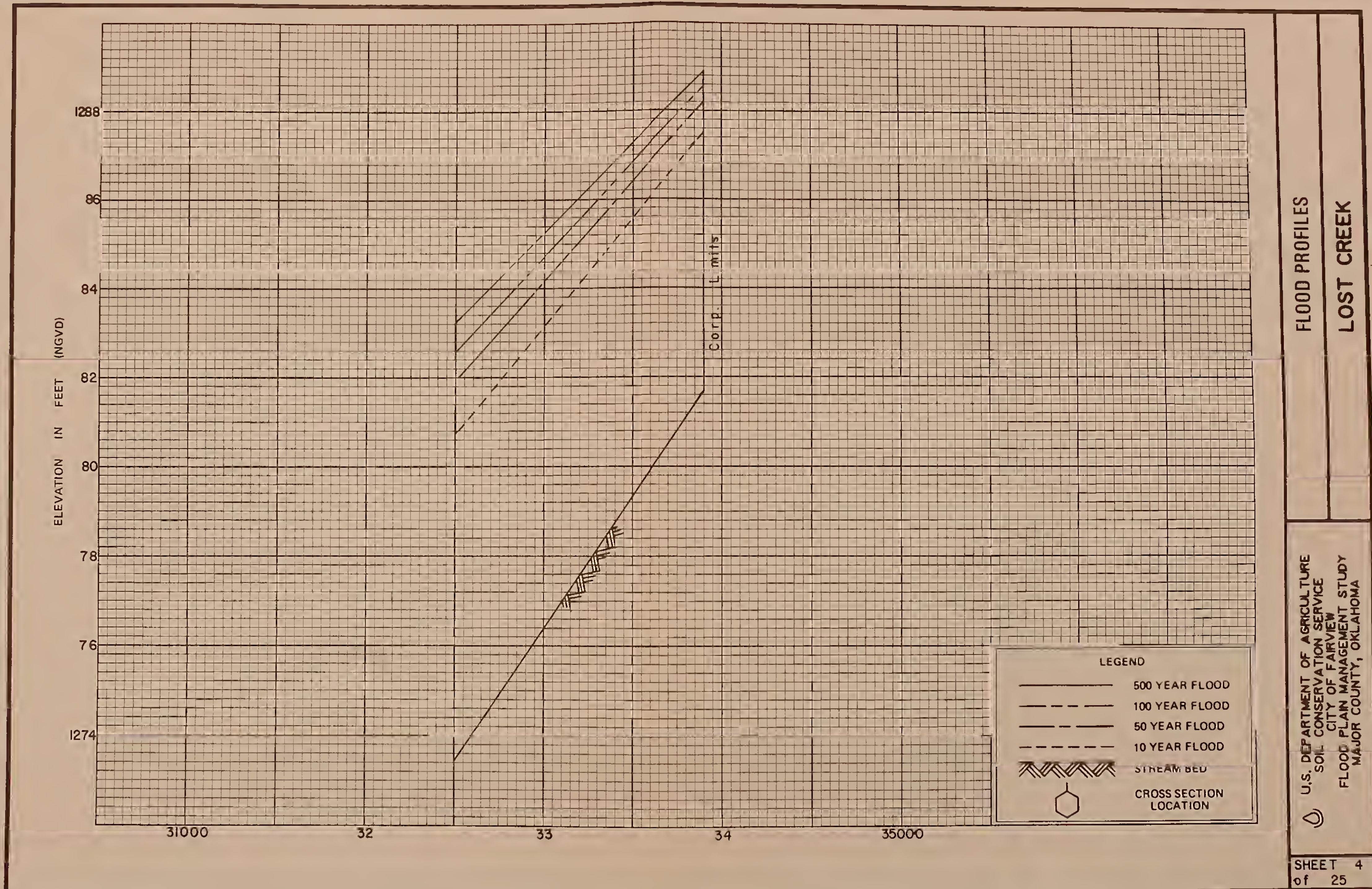

ELEVATION IN FEET (NGVD)
1288
86
84
82
80
78
76
1274
31000
32
33
34
35000
Corp. Limits
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
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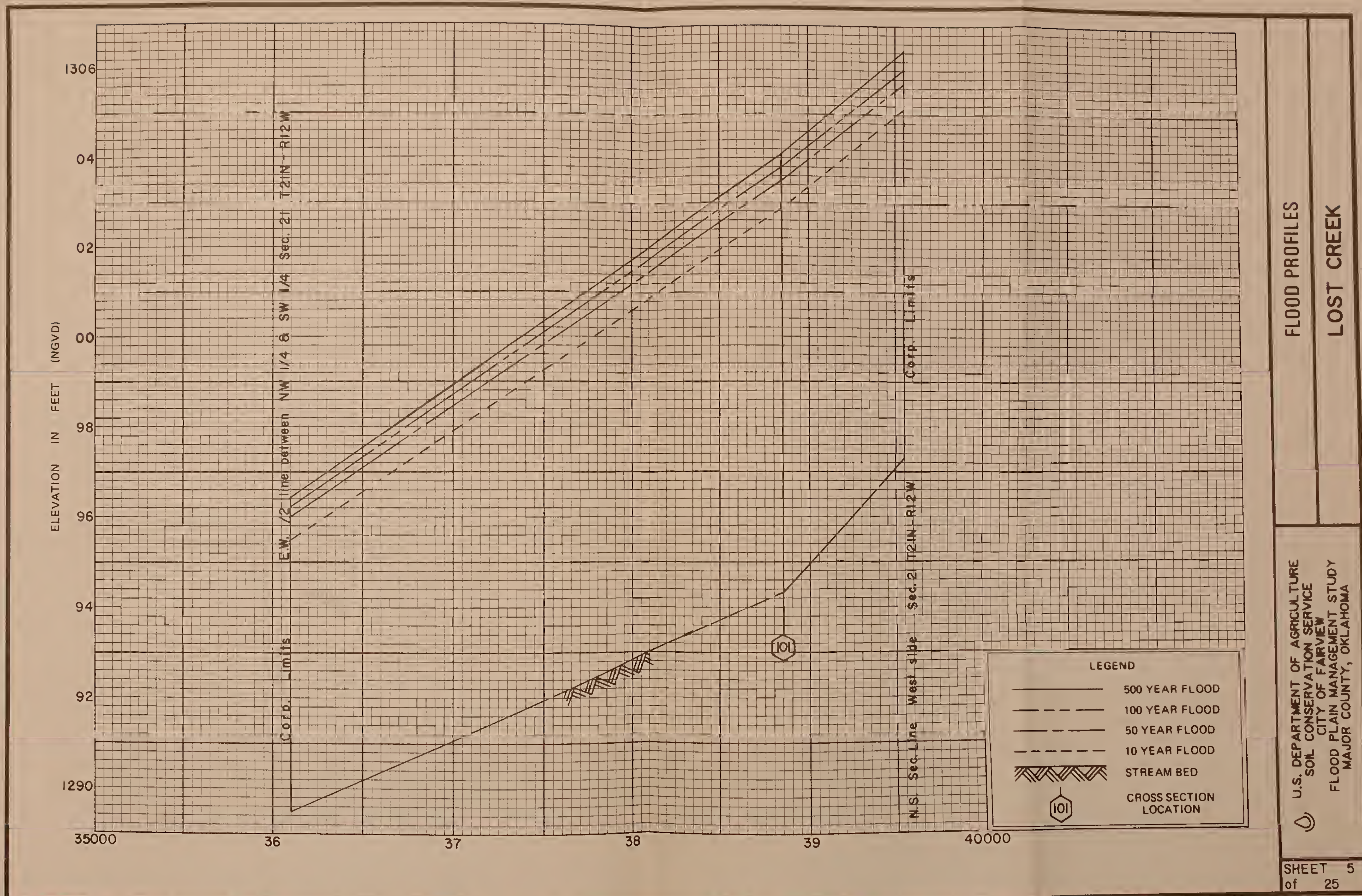

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LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
101
ELEVATION IN FEET (NGVD)
1306
04
02
00
98
96
94
92
1290
35000
36
37
38
39
40000
Corp. Limits
E.W. 1/2 line between NW 1/4 & SW 1/4 Sec. 21 T21N - R12W
N.S. Sec. Line West side Sec. 2 T21N-R12W
Corp. Limits

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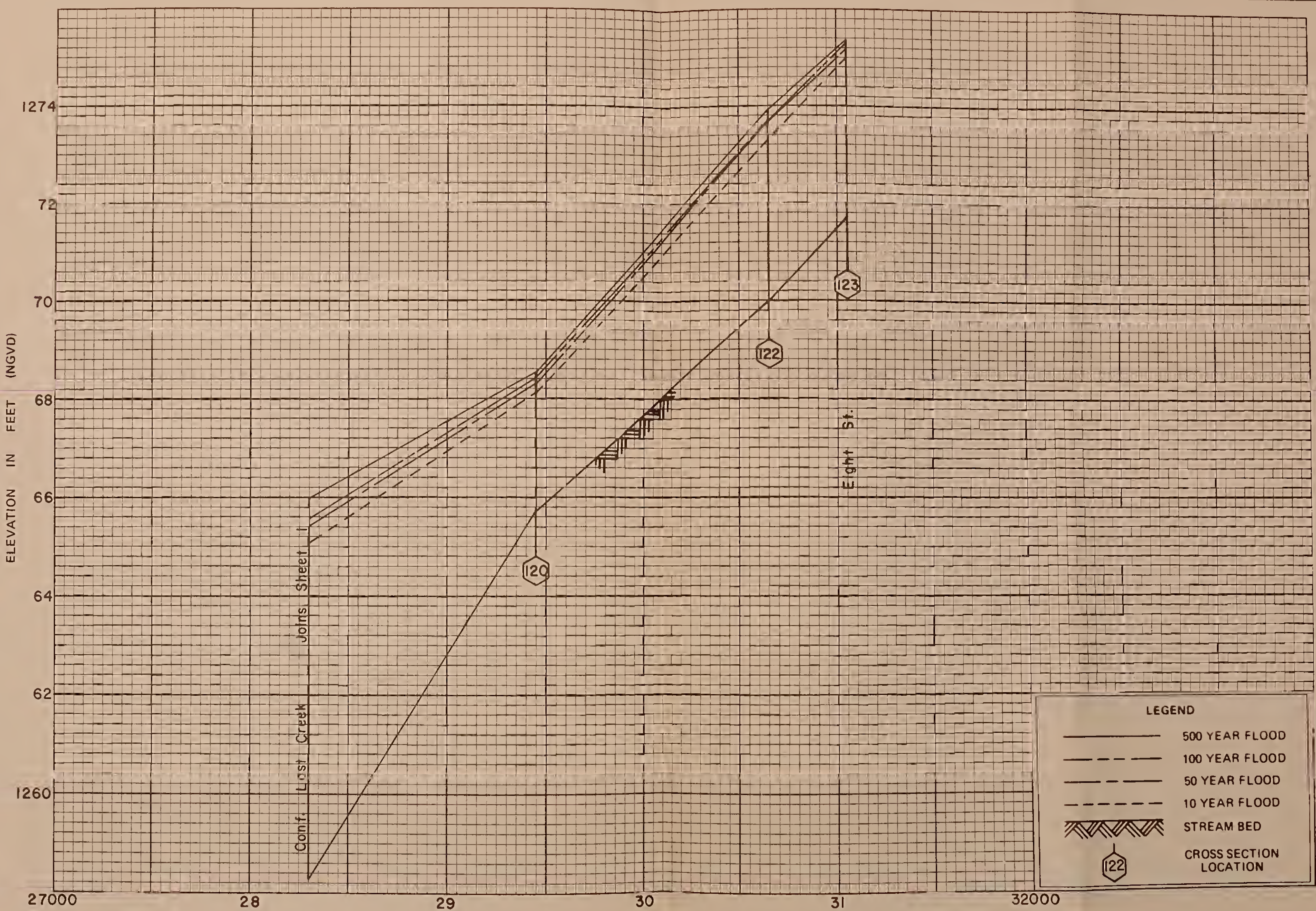

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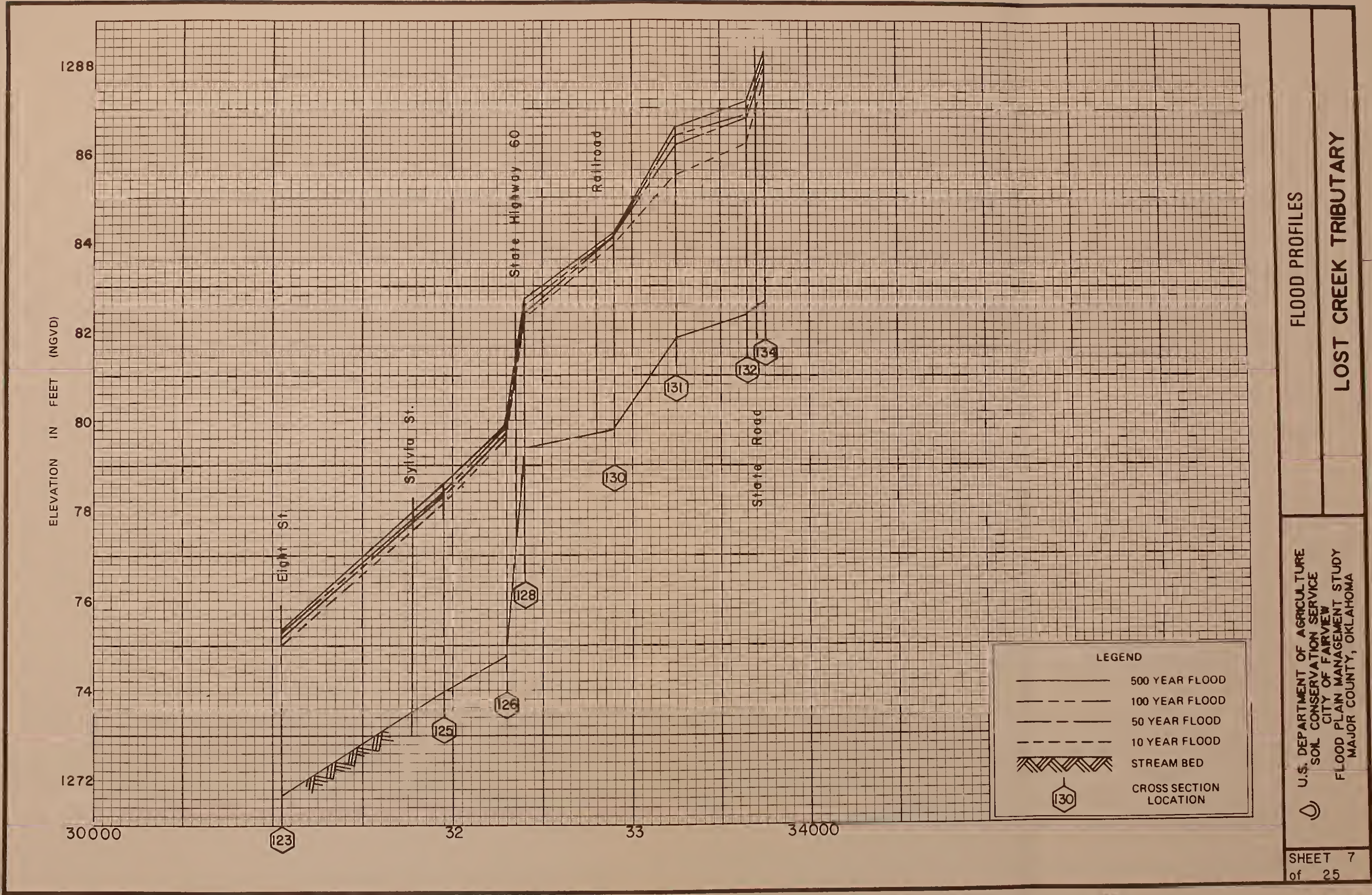

ELEVATION IN FEET (NGVD)
1288
86
84
82
80
78
76
74
1272
30000
32
33
34000
Eight St
Sylvia St.
State Highway 60
Railroad
State Road
123
125
126
128
130
131
132
134
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
130
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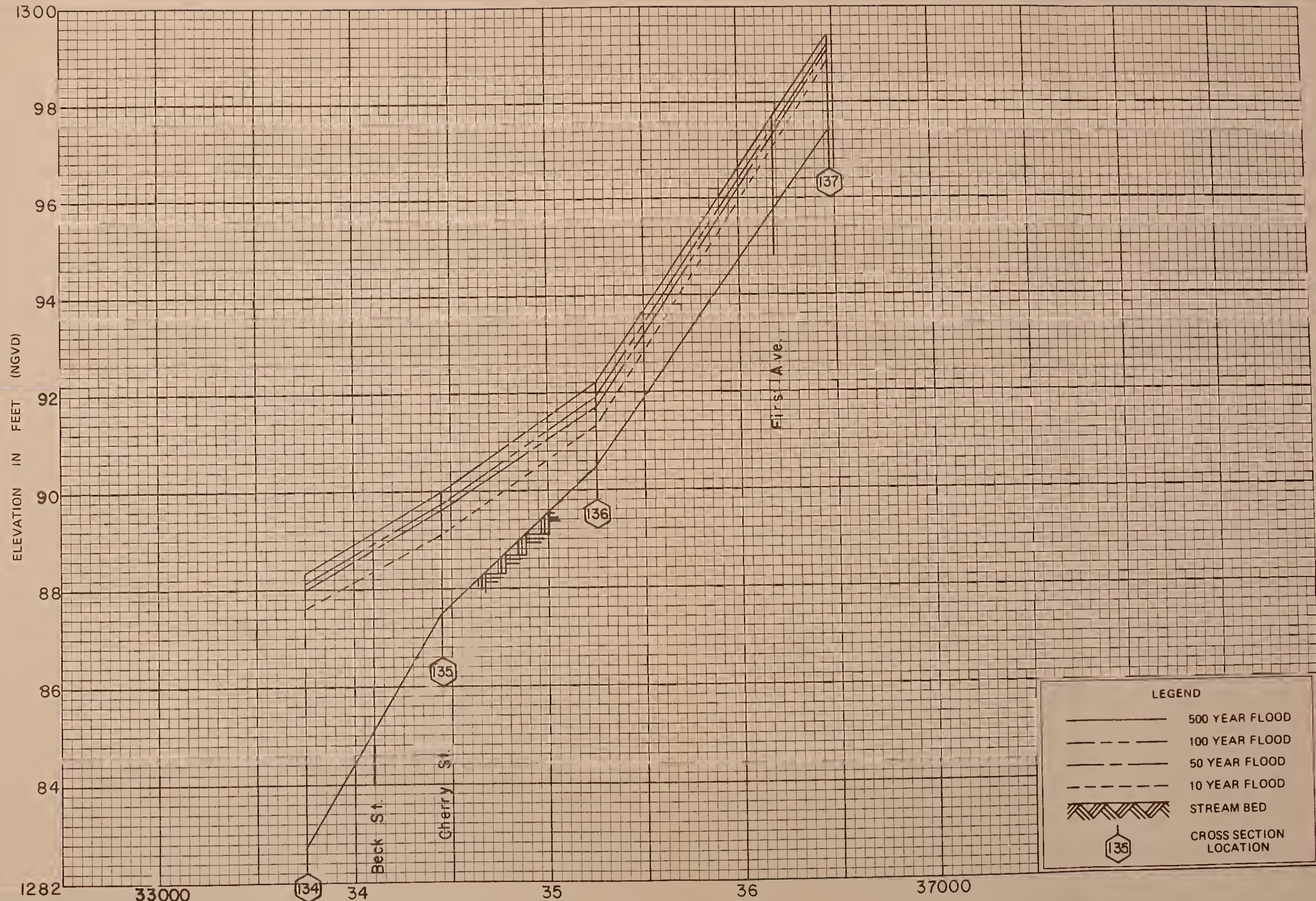

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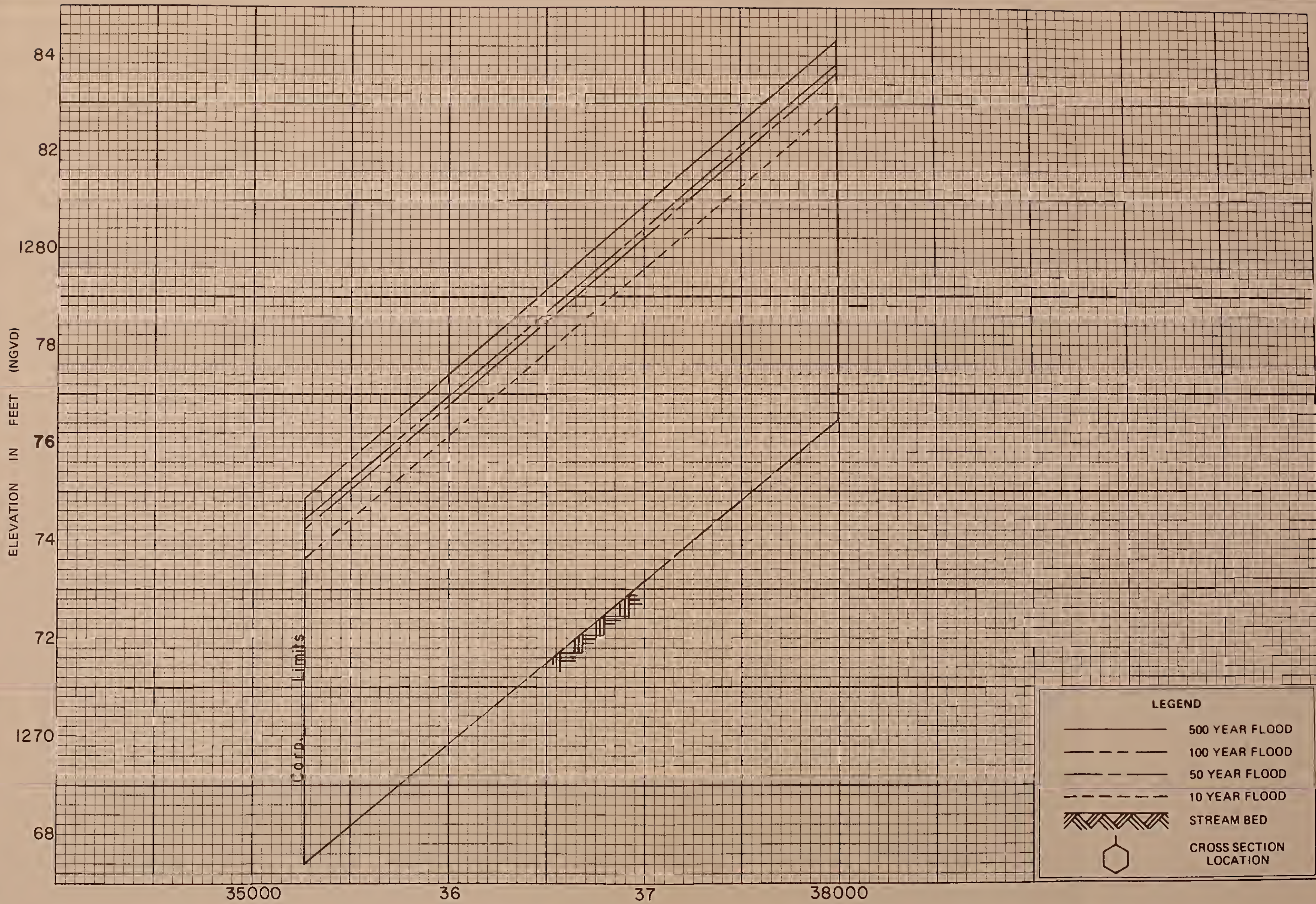

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GYPSUM CREEK

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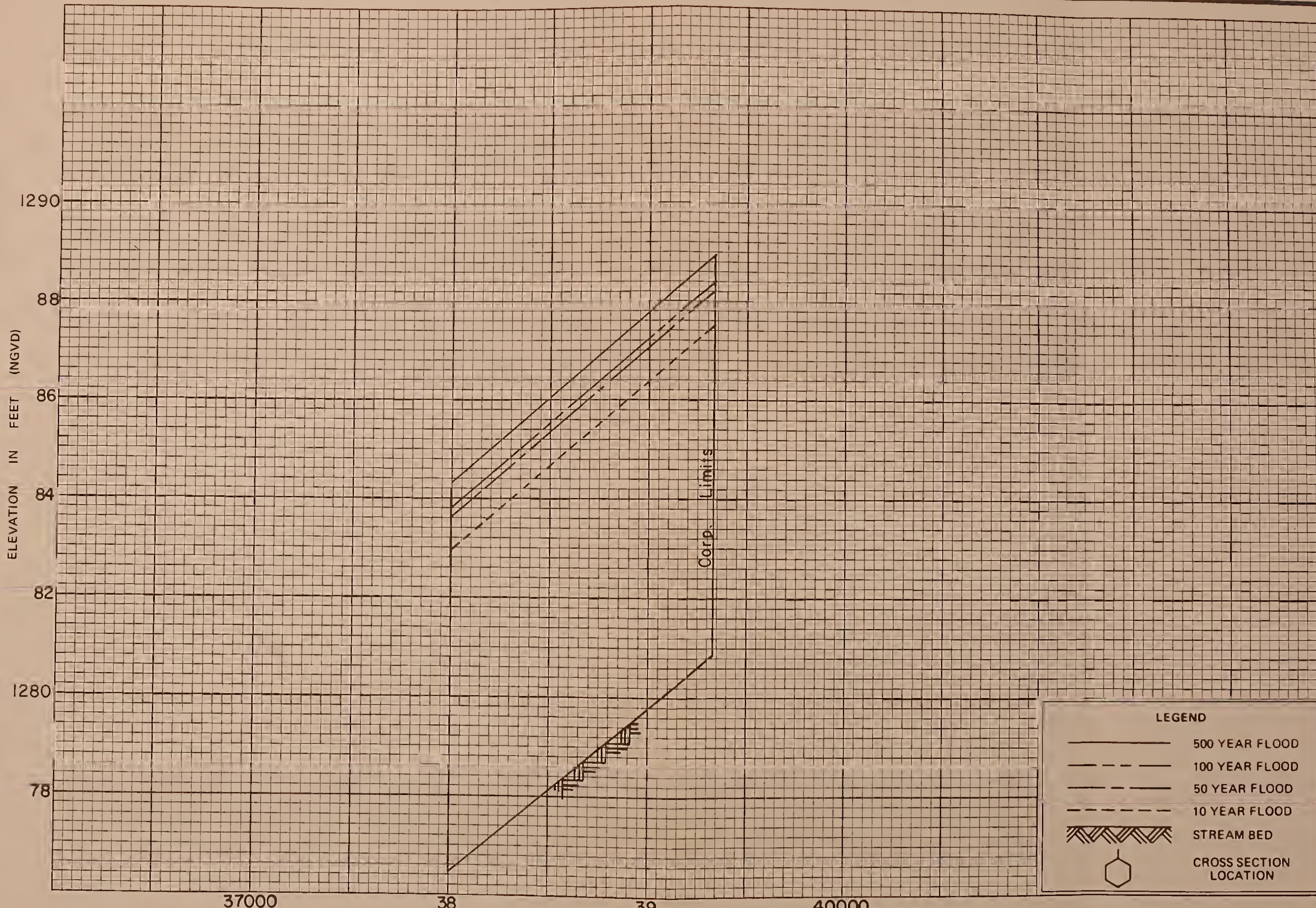

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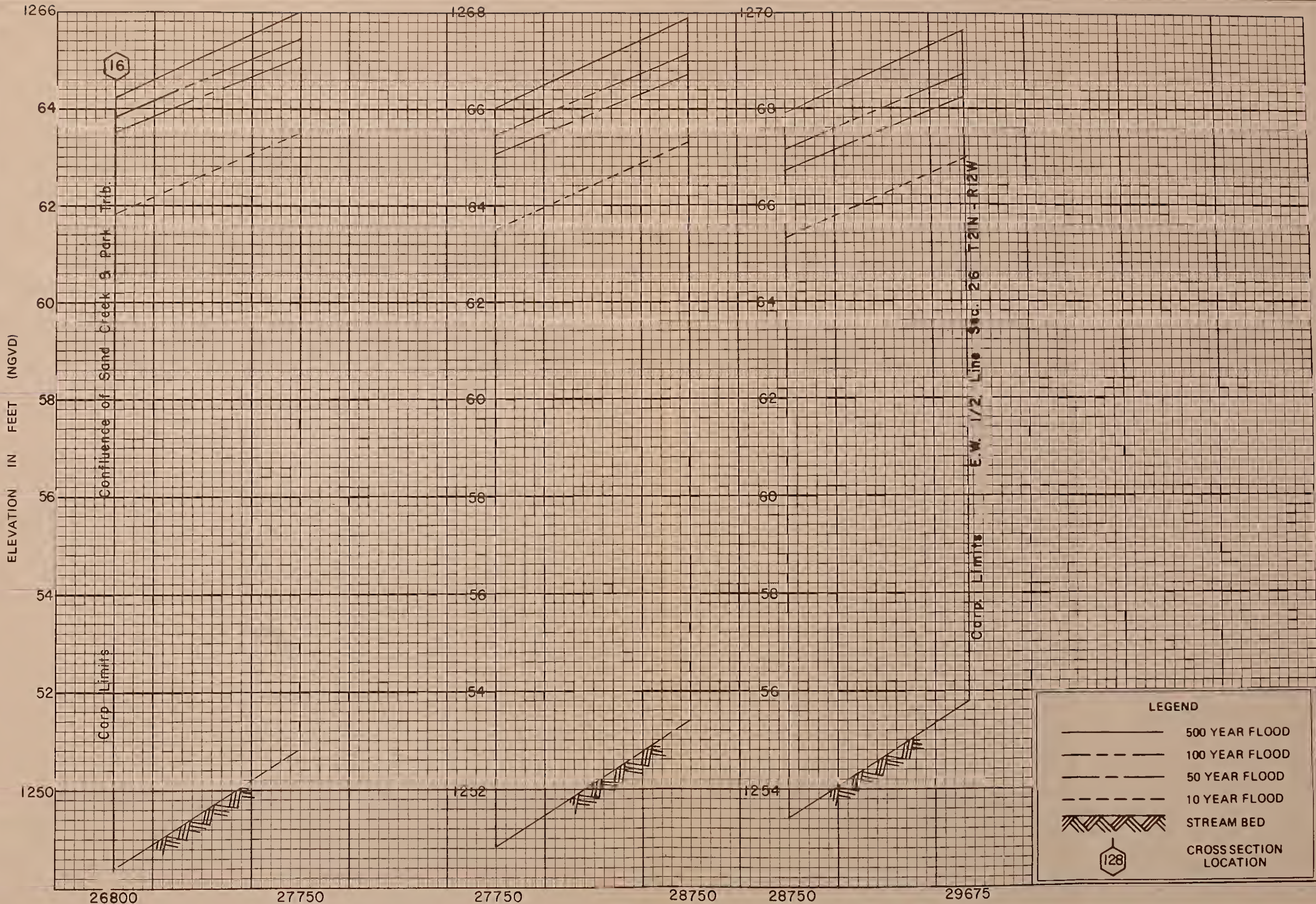

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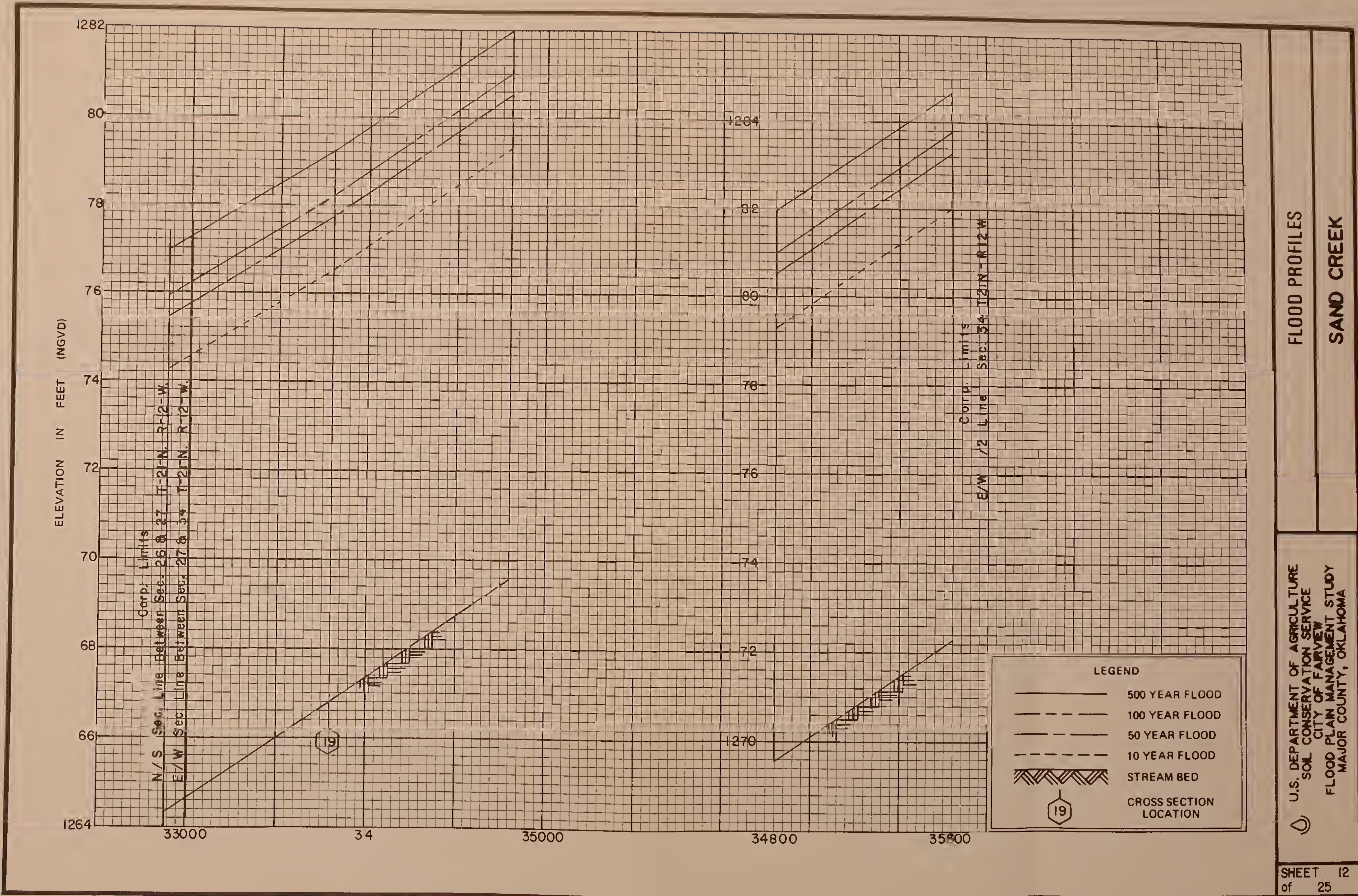
ELEVATION IN FEET (NGVD)
1282
80
78
76
74
72
70
68
66
1264
1284
82
80
78
76
74
72
1270
33000
34
35000
34800
35800
Corp. Limits
N/S Sec. Line Between Sec. 26 & 27 T-21-N. R-12-W.
E/W Sec. Line Between Sec. 27 & 34 T-21-N. R-12-W.
Corp. Limits
E/W 1/2 Line Sec. 34 T21N-R12W
19
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
FLOOD PROFILES
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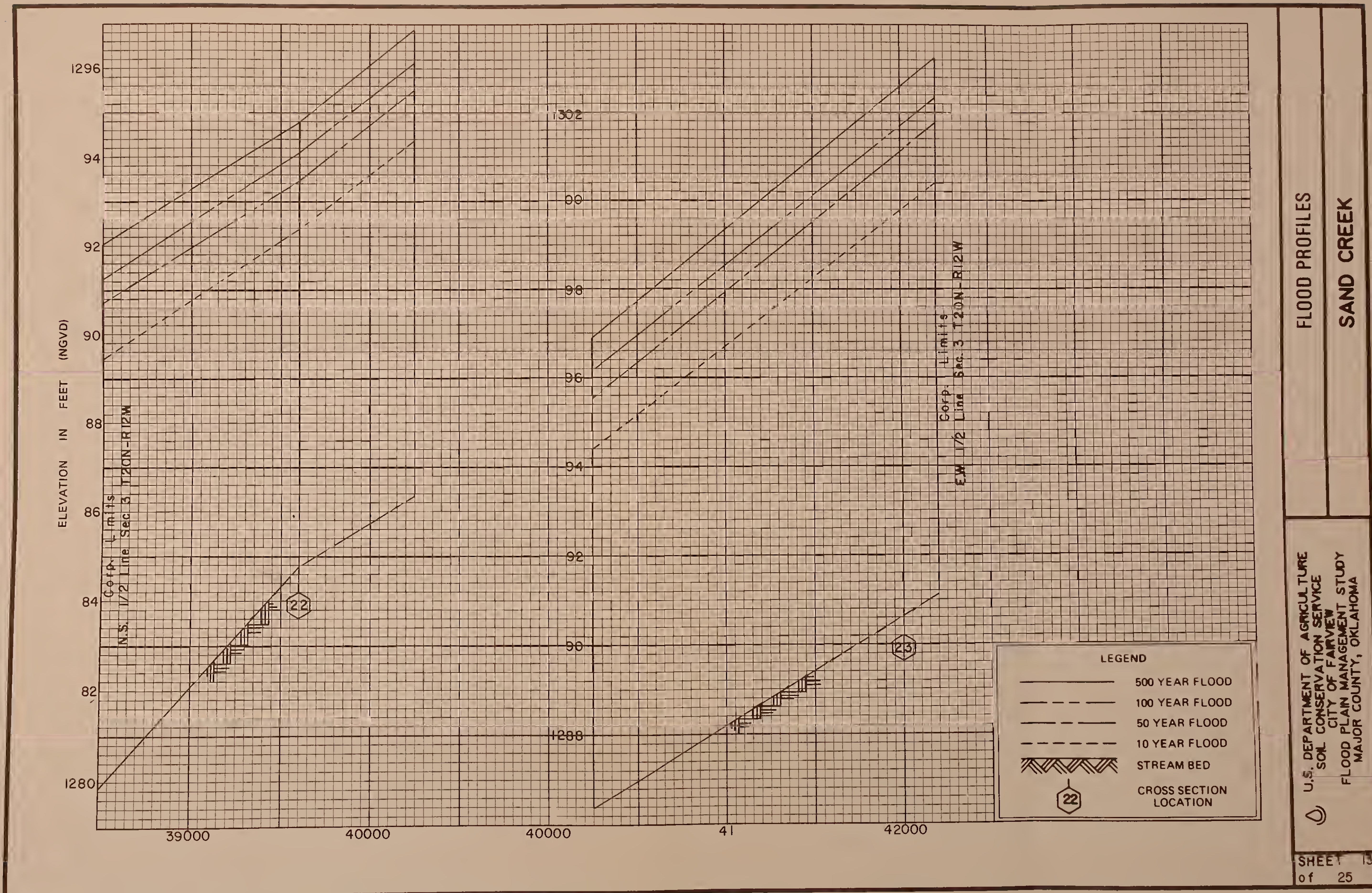
ELEVATION IN FEET (NGVD)
1296
94
92
90
88
86
84
82
1280
1302
98
96
94
92
90
1288
39000
40000
40000
41
42000
Corp. Limits N.S. 1/2 Line Sec 3 T20N-R12W
Corp. Limits E.W. 1/2 Line Sec 3 T20N-R12W
22
23
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
22
CROSS SECTION LOCATION
FLOOD PROFILES
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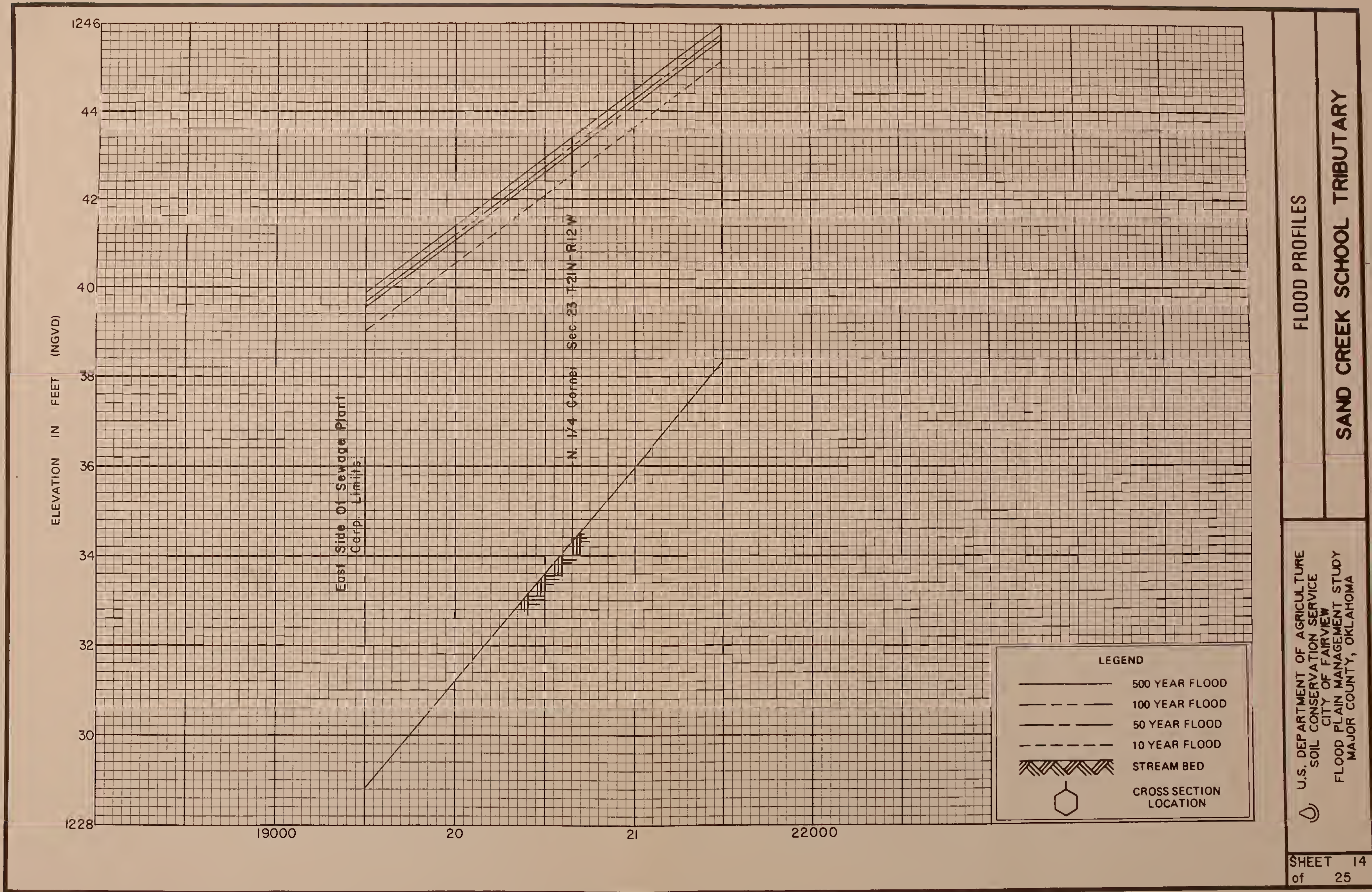
1246
44
42
40
38
36
34
32
30
1228
ELEVATION IN FEET (NGVD)
19000
20
21
22000
East Side Of Sewage Plant
Corp. Limits
N. 1/4 Corner Sec. 23 T21N-R12W
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
FLOOD PROFILES
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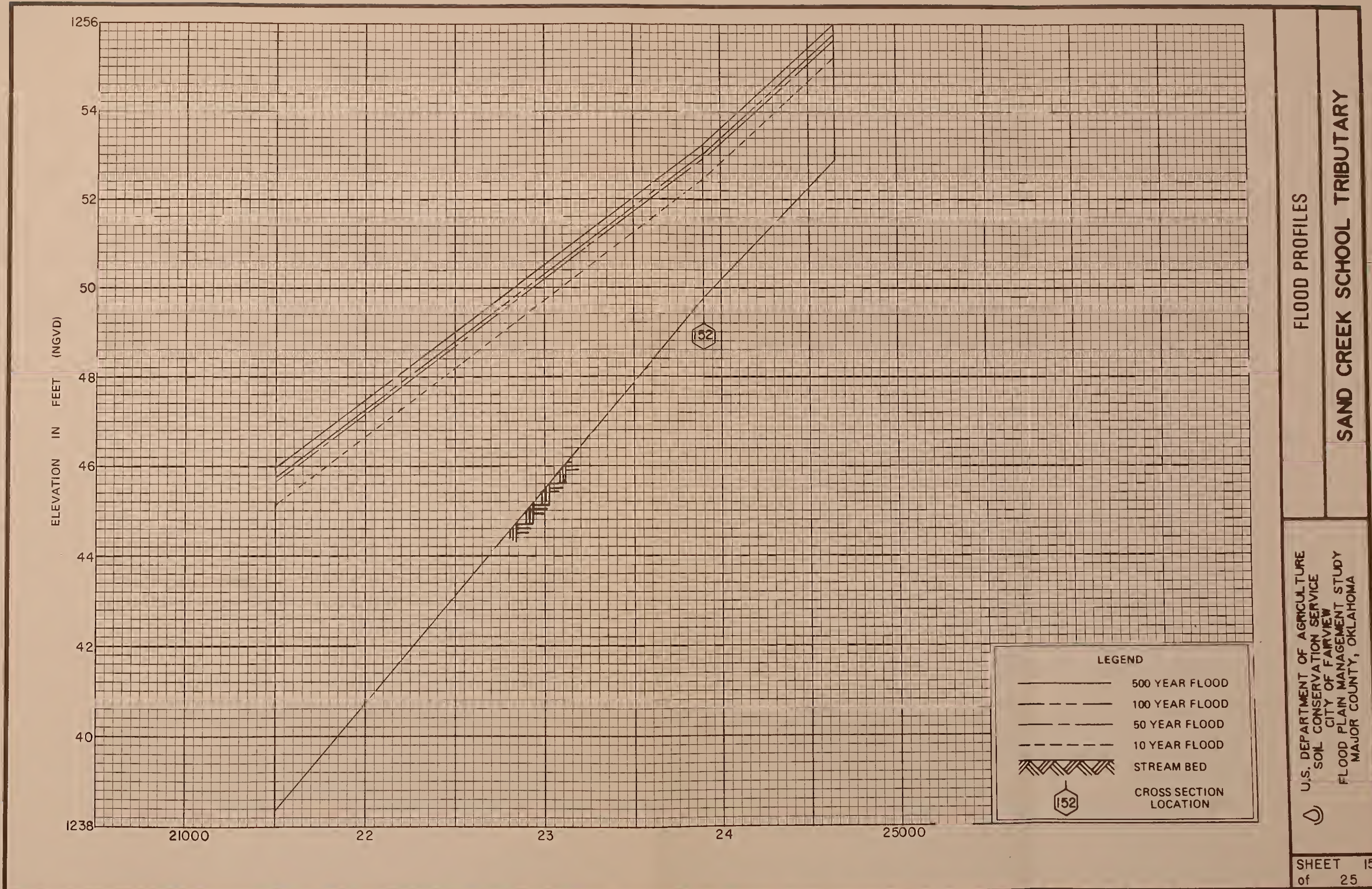

ELEVATION IN FEET (NGVD)
1256
54
52
50
48
46
44
42
40
1238
21000
22
23
24
25000
152
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
152
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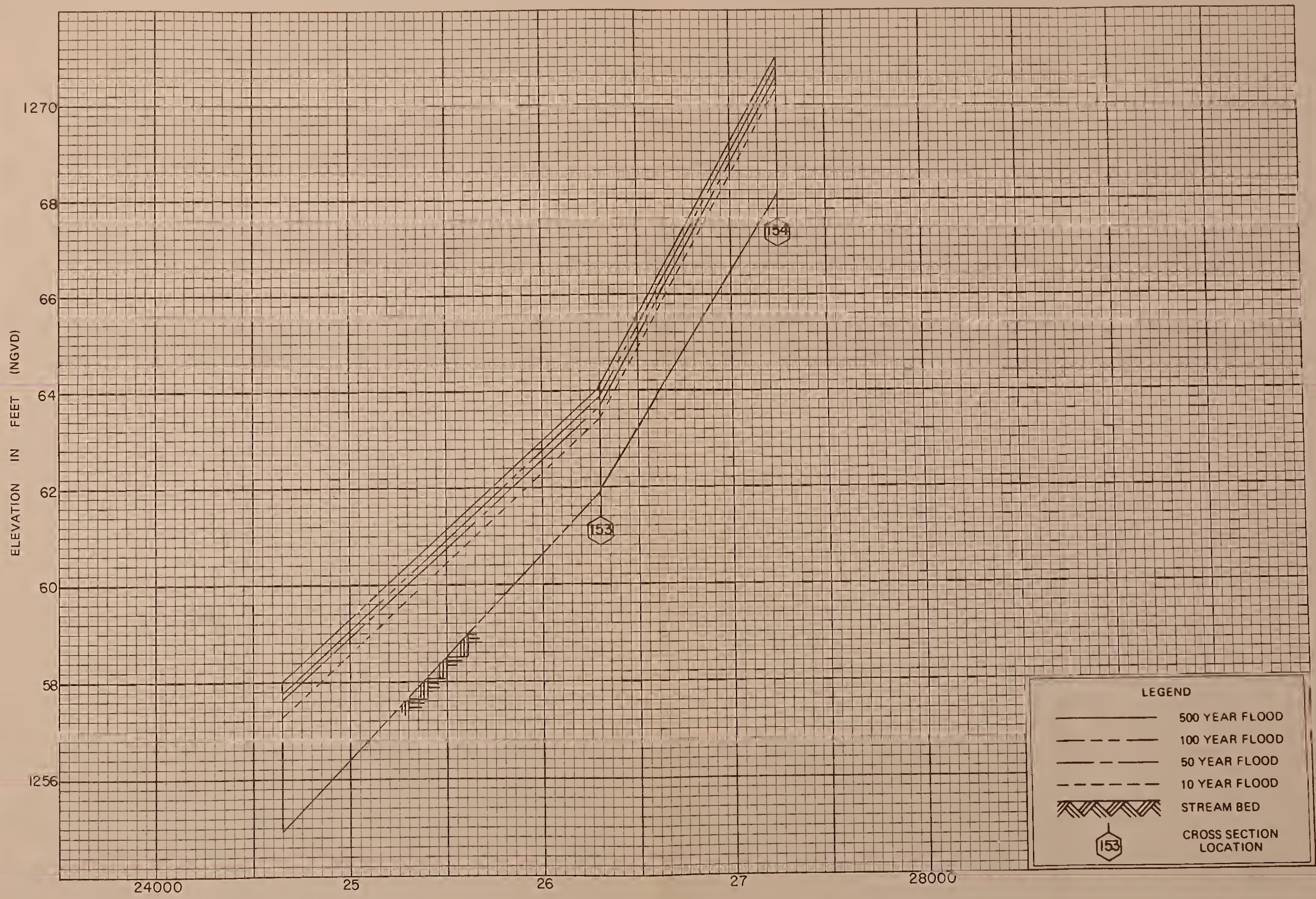

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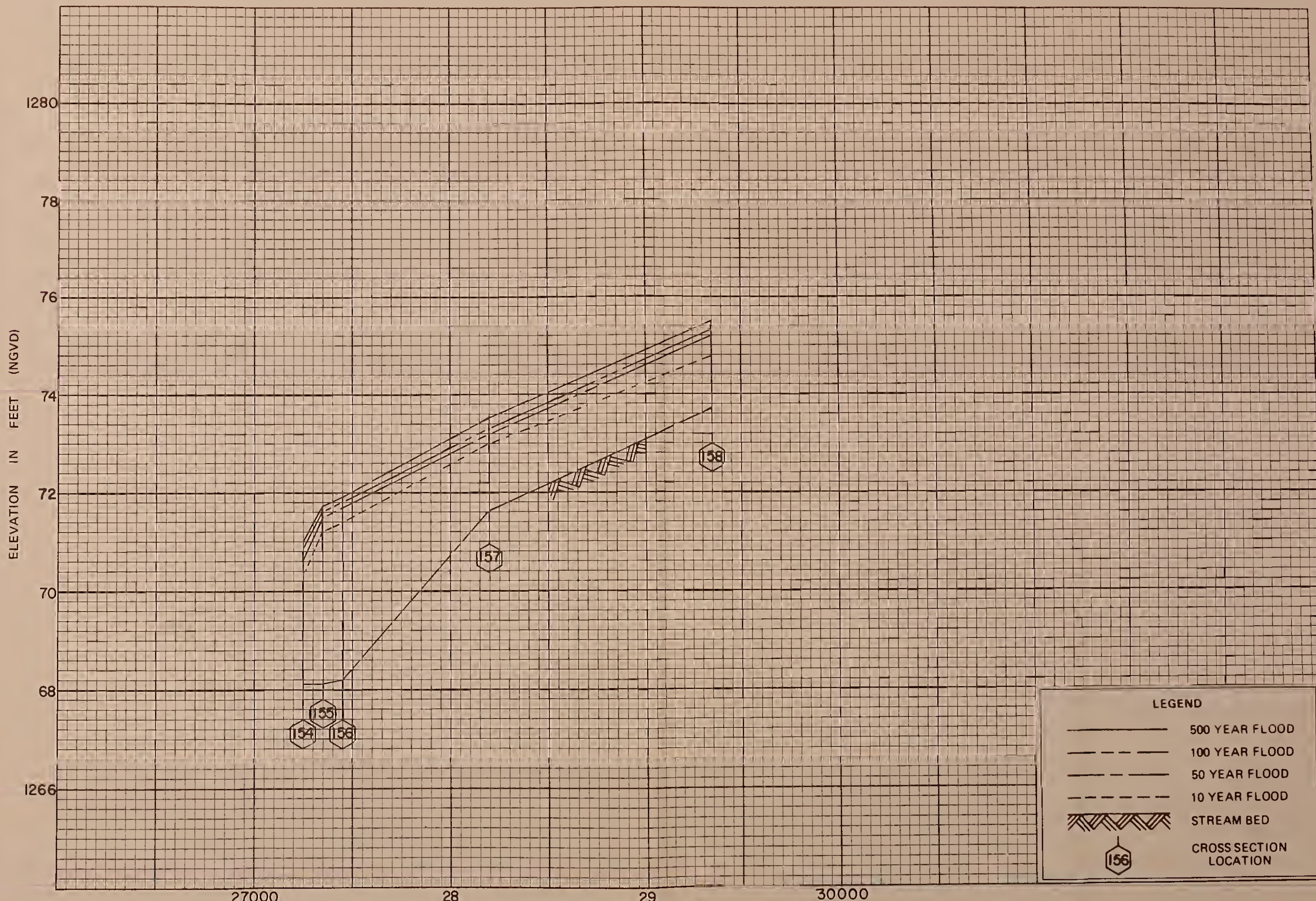

SAND CREEK SCHOOL TRIBUTARY

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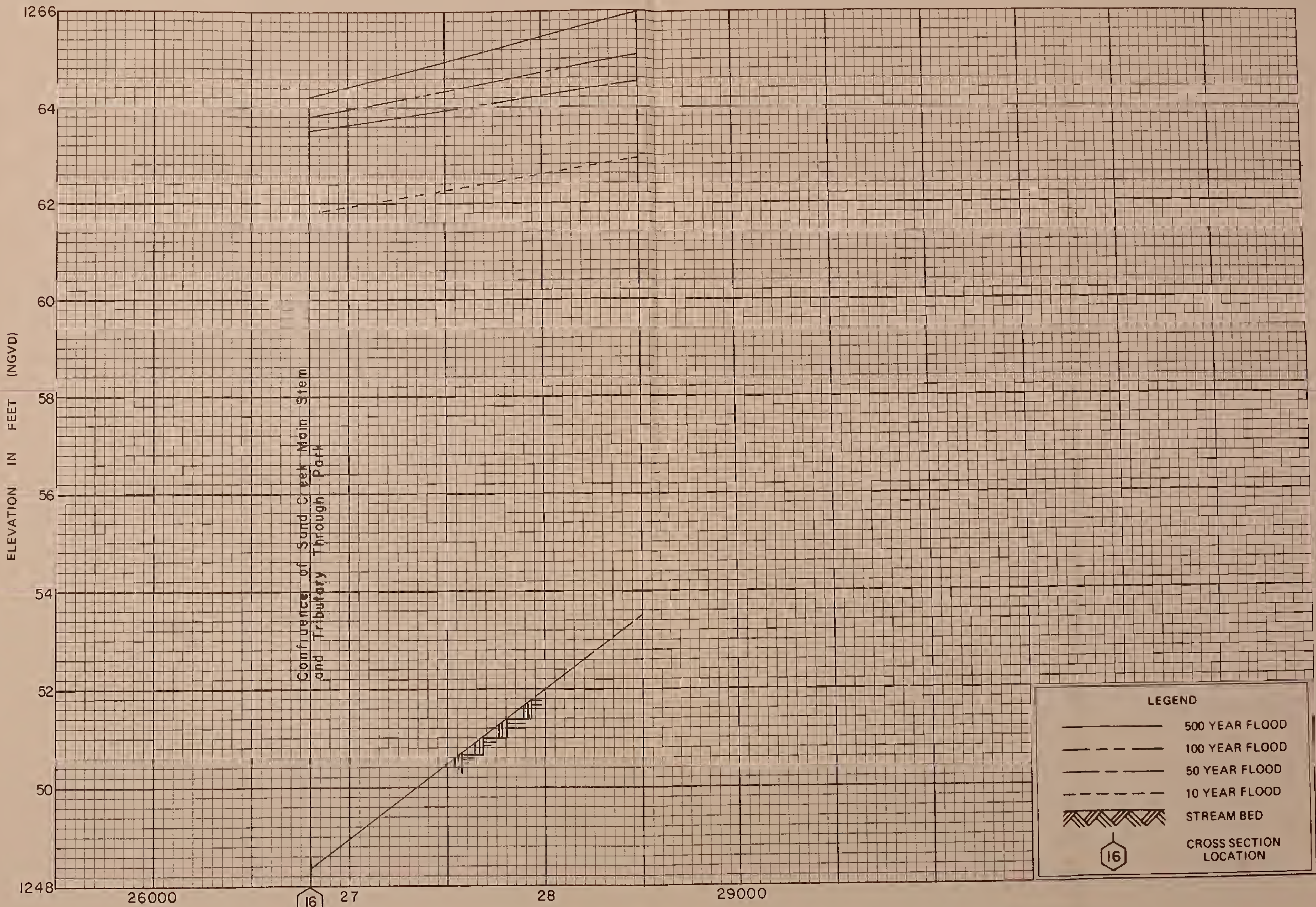

FLOOD PROFILES

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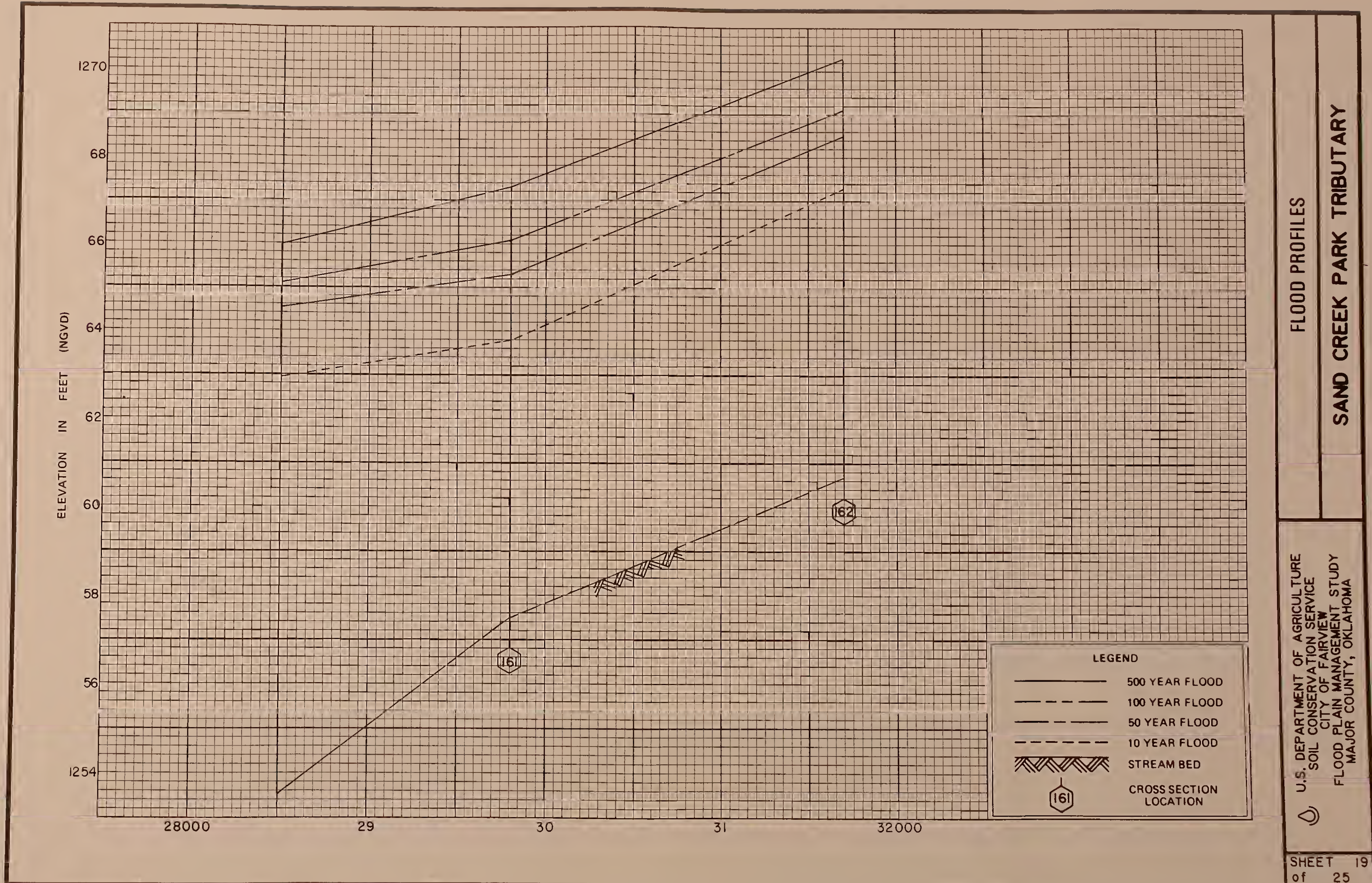
1270
68
66
64
62
60
58
56
1254
ELEVATION IN FEET (NGVD)
28000
29
30
31
32000
161
162
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
161
CROSS SECTION LOCATION
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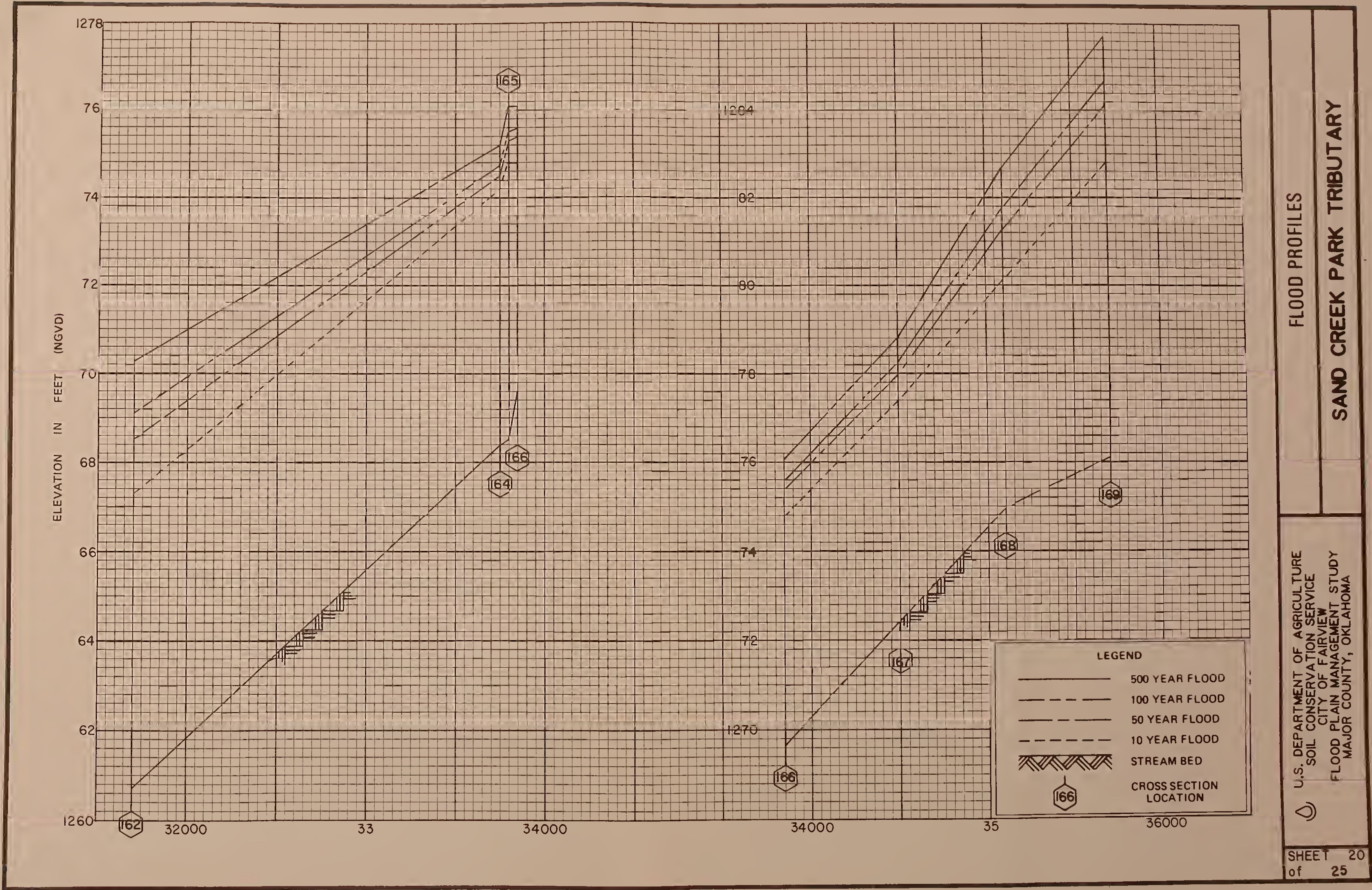
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ELEVATION IN FEET (NGVD)
1278
76
74
72
70
68
66
64
62
1260
1284
82
80
78
76
74
72
1270
32000
33
34000
34000
35
36000
162
164
165
166
166
167
168
169
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
166

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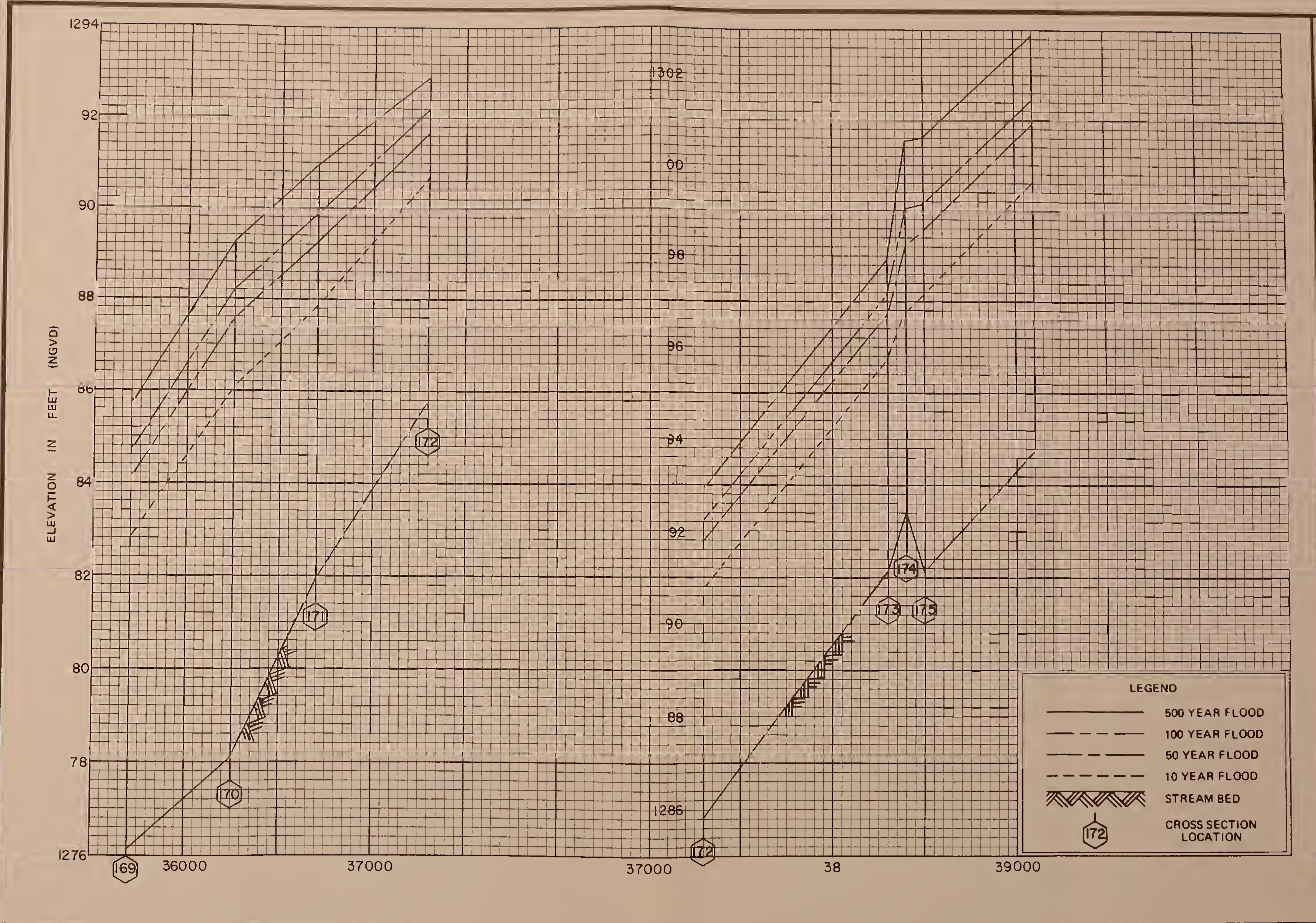

FLOOD PROFILES

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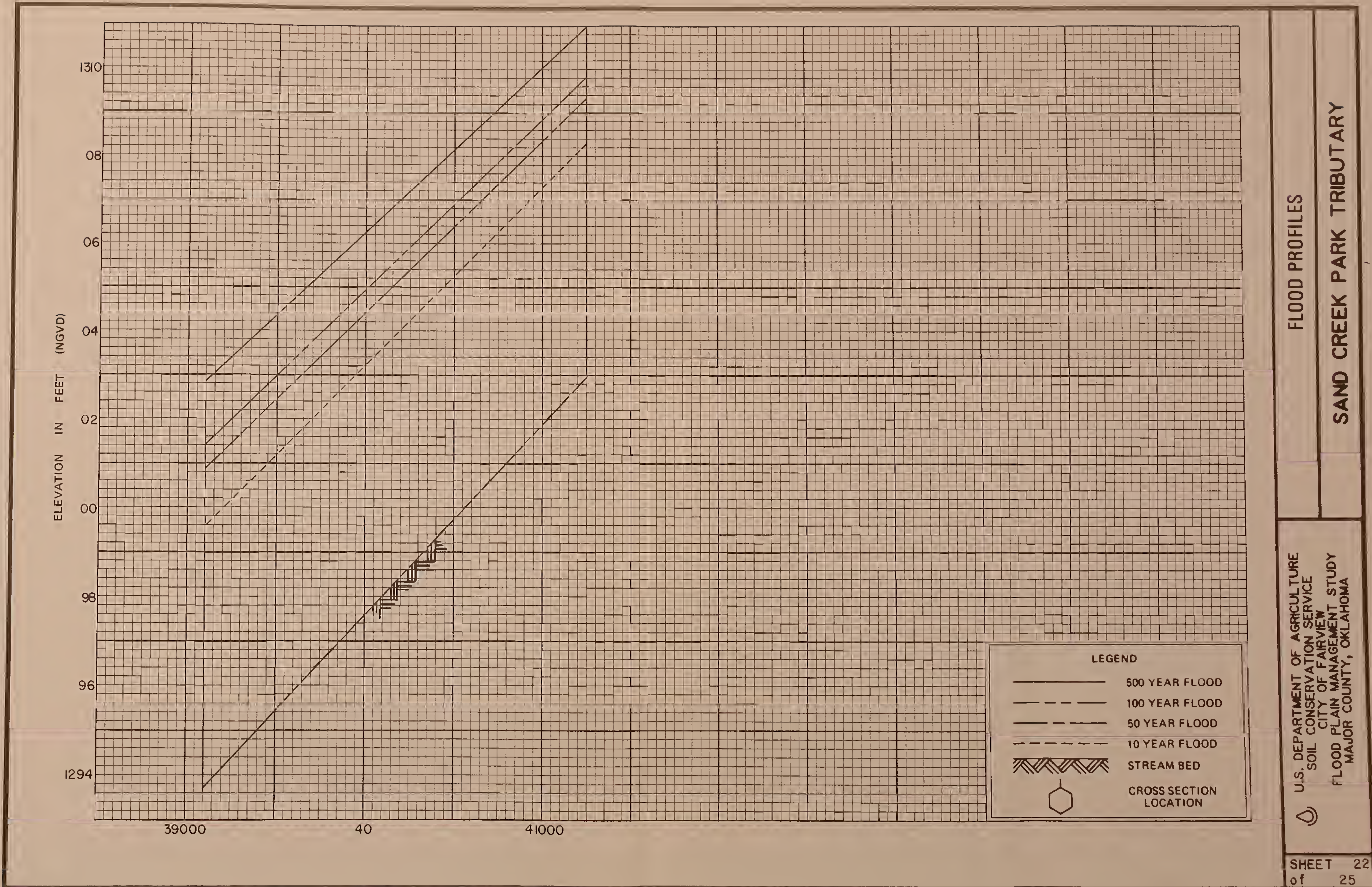

1310
08
06
04
02
00
98
96
1294
ELEVATION IN FEET (NGVD)
39000
40
41000
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
FLOOD PROFILES
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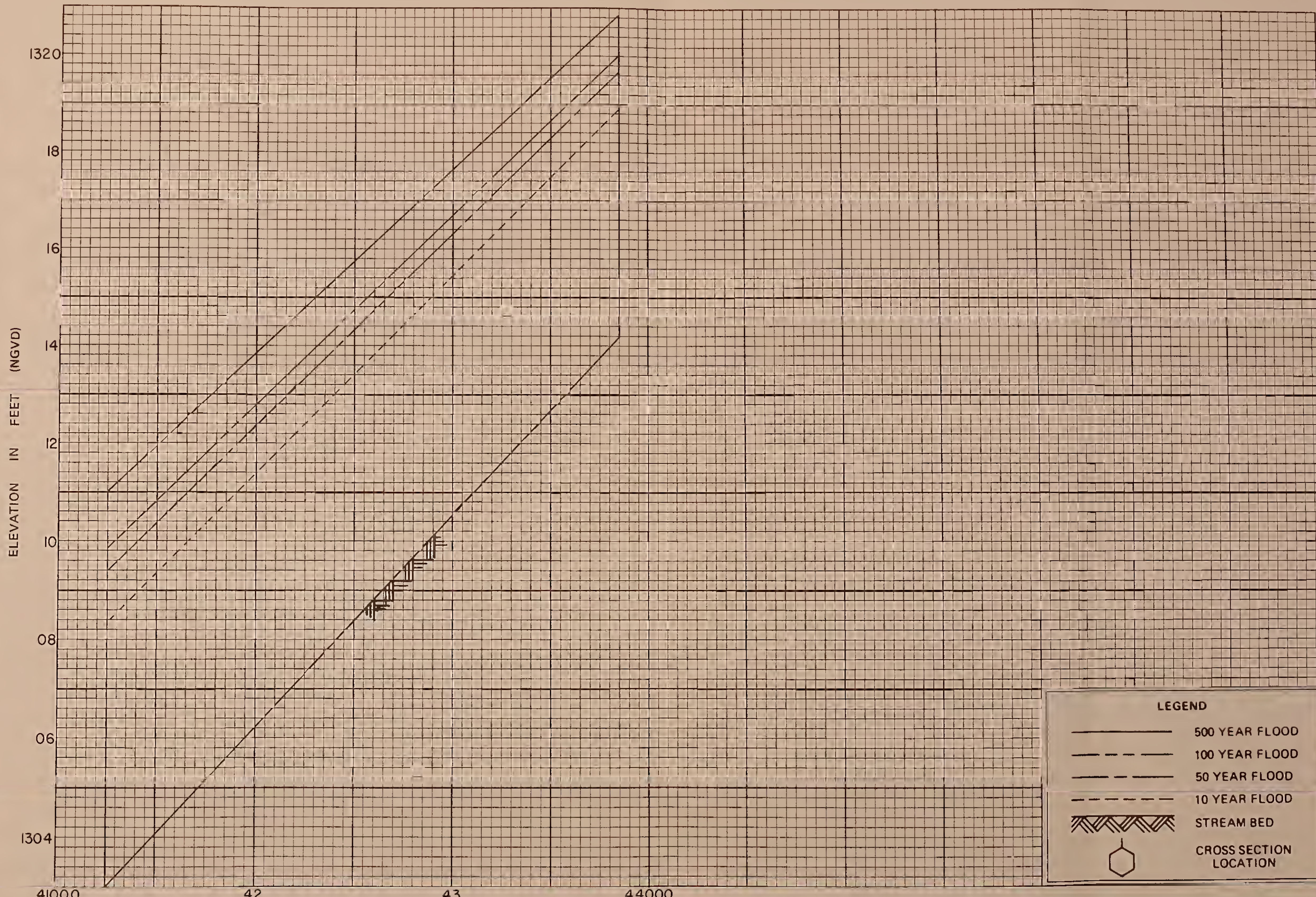

FLOOD PROFILES

SAND CREEK PARK TRIBUTARY

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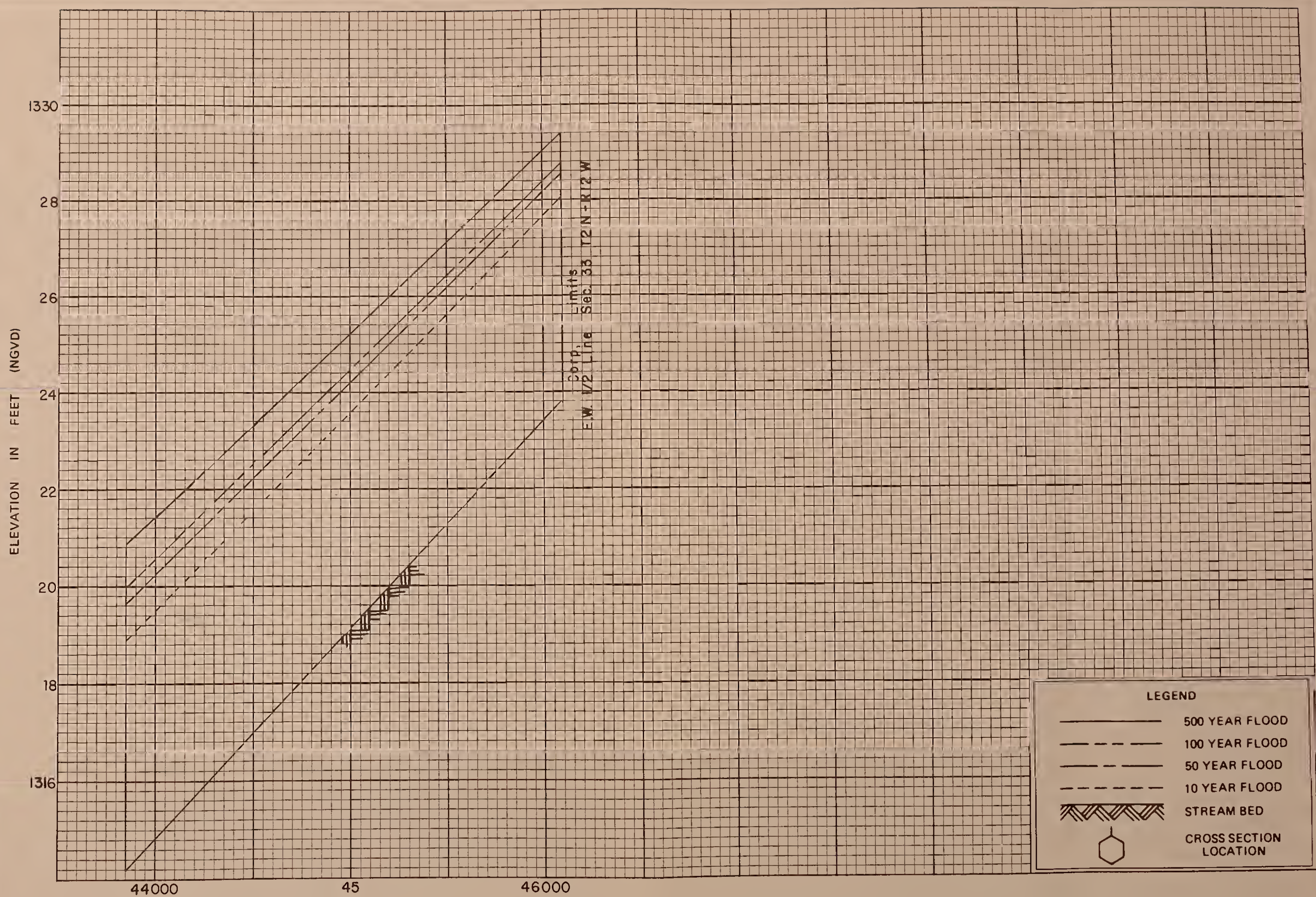

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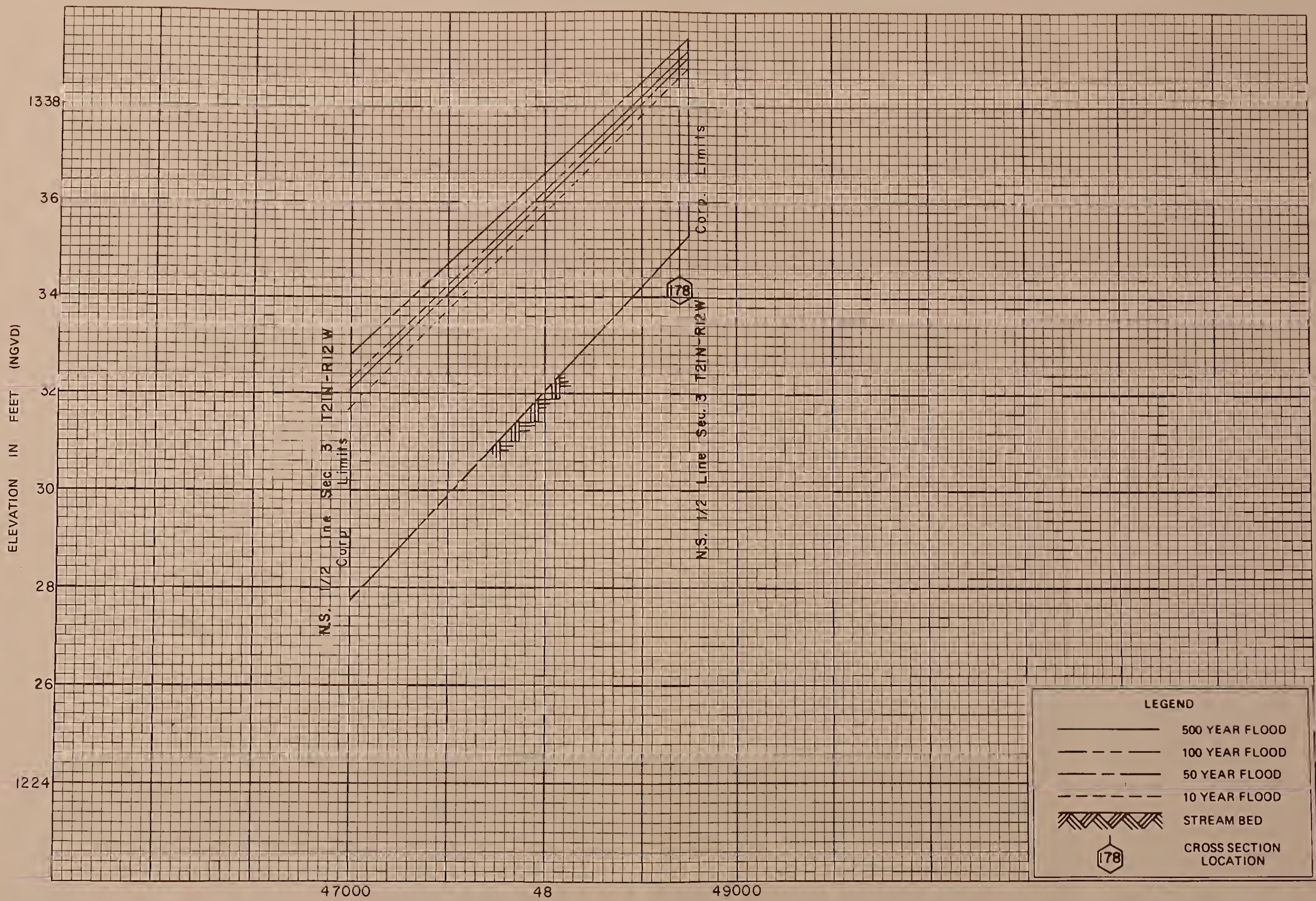
CITY OF FAIRVIEW
FLOOD PLAIN MANAGEMENT STUDY
MAJOR COUNTY, OKLAHOMA

SHEET 24 of 25

FEB. 1986



FLOOD PROFILES

SAND CREEK PARK TRIBUTARY

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
CITY OF FAIRVIEW
FLOOD PLAIN MANAGEMENT STUDY
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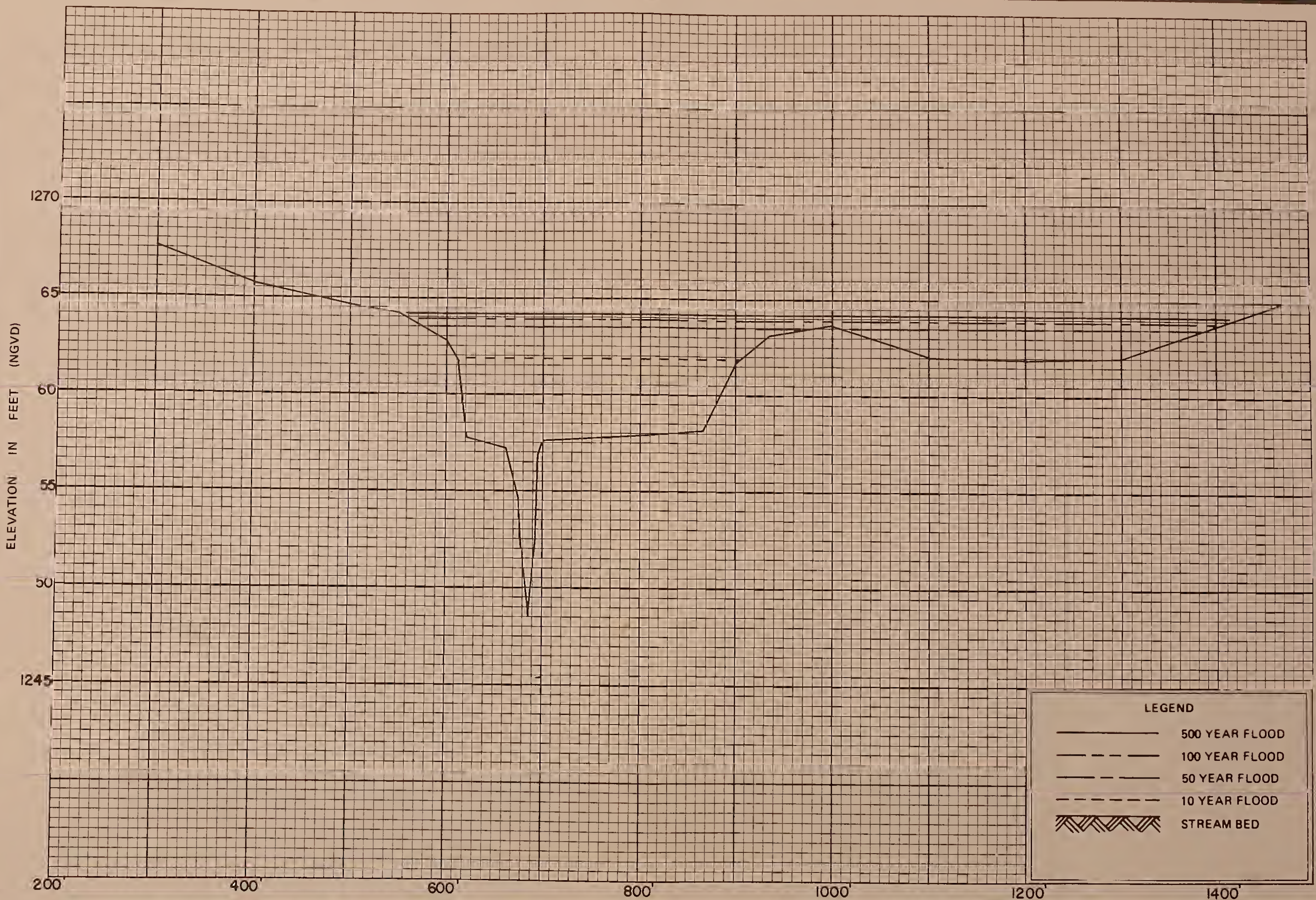

TYPICAL VALLEY CROSS SECTION

SAND CREEK - CROSS SECTION No. 16

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
CITY OF FAIRVIEW
FLOOD PLAIN MANAGEMENT STUDY
MAJOR COUNTY, OKLAHOMA

FEB. 1986

TABLE 1

FAIRVIEW FLOOD PLAIN MANAGEMENT STUDY
ELEVATION AND DISCHARGE TABULATIONS

CROSS SECTION NUMBER	10-YEAR FREQUENCY DISCHARGE C.F.S.	10-YEAR FREQUENCY ELEVATION M.S.L. FEET	50-YEAR FREQUENCY DISCHARGE C.F.S.	50-YEAR FREQUENCY ELEVATION M.S.L. FEET	100-YEAR FREQUENCY DISCHARGE C.F.S.	100-YEAR FREQUENCY ELEVATION M.S.L. FEET	500-YEAR FREQUENCY DISCHARGE C.F.S.	500-YEAR FREQUENCY ELEVATION M.S.L. FEET
SAND CREEK								
16	4068	1261.8	7349	1263.5	8399	1263.8	9853	1264.2
19	3399	1276.5	6014	1277.7	7264	1278.2	10037	1279.2
21	3206	1289.2	5698	1290.5	6924	1291.0	9550	1291.8
22	3188	1292.4	5676	1293.5	6898	1294.1	9515	1294.8
23	3152	1299.8	5631	1301.1	6846	1301.7	9444	1302.6
152	430	1252.5	656	1252.9	759	1253.0	972	1253.3
153	342	1263.4	522	1263.7	603	1263.8	772	1264.1
154	315	1270.3	480	1270.6	555	1270.8	711	1271.0
155	309	1271.2	470	1271.5	543	1271.6	696	1271.7
156	302	1271.4	460	1271.7	531	1271.8	680	1271.9
157	221	1273.0	336	1273.2	387	1273.3	496	1273.5
158	167	1274.8	253	1275.2	291	1275.3	373	1275.5
161	722	1263.8	1353	1265.3	1698	1266.1	2543	1267.3
162	720	1267.3	1349	1268.5	1692	1269.1	2534	1270.3
164	718	1274.2	1344	1274.5	1683	1274.7	2521	1275.2
165	718	1274.8	1344	1275.3	1683	1275.5	2521	1276.1
166	718	1274.8	1344	1275.4	1683	1275.6	2521	1276.1
167	717	1277.4	1342	1278.0	1680	1278.3	2517	1278.8
168	715	1280.1	1339	1281.3	1676	1281.8	2512	1282.7
169	713	1282.8	1336	1284.1	1673	1284.7	2508	1285.7
170	710	1286.1	1333	1287.6	1669	1288.2	2503	1289.3
171	705	1287.9	1325	1289.3	1660	1289.9	2492	1291.0
172	628	1290.7	1193	1291.7	1509	1292.2	2288	1292.9
173	624	1295.7	1186	1296.7	1501	1297.1	2277	1297.9
174	624	1296.7	1186	1298.2	1501	1299.0	2277	1300.5
178	598	1336.8	1152	1338.9	1465	1339.0	2238	1339.3

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FAIRVIEW FLOOD PLAIN MANAGEMENT STUDY
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CROSS SECTION NUMBER	10-YEAR FREQUENCY DISCHARGE C.F.S.	10-YEAR FREQUENCY ELEVATION M.S.L. FEET	50-YEAR FREQUENCY DISCHARGE C.F.S.	50-YEAR FREQUENCY ELEVATION M.S.L. FEET	100-YEAR FREQUENCY DISCHARGE C.F.S.	100-YEAR FREQUENCY ELEVATION M.S.L. FEET	500-YEAR FREQUENCY DISCHARGE C.F.S.	500-YEAR FREQUENCY ELEVATION M.S.L. FEET
LOST CREEK								
89	1436	1260.3	2434	1260.9	2958	1261.2	4138	1261.6
90	1433	1261.4	2430	1261.8	2954	1262.0	4131	1262.5
91	1427	1265.9	2419	1266.3	2941	1266.4	4114	1266.8
93	1302	1271.0	2199	1271.3	2678	1271.4	3745	1271.5
94	1303	1273.3	2185	1273.8	2664	1274.1	3732	1274.4
95	1303	1275.9	2174	1276.3	2651	1276.5	3725	1276.7
97	1299	1277.4	2169	1278.3	2646	1278.5	3718	1278.7
99	1293	1278.8	2163	1279.9	2646	1280.6	3700	1281.4
100	Not in corp limits.							
101	1173	1302.9	2055	1303.5	2492	1303.8	3464	1304.3
120	523	1268.1	672	1268.3	738	1268.4	860	1268.5
122	475	1273.3	611	1273.7	671	1273.7	782	1273.9
123	455	1275.0	560	1275.2	606	1275.3	691	1275.4
125	436	1278.2	510	1278.3	540	1278.4	601	1278.6
126	421	1279.6	472	1279.7	491	1279.8	533	1279.9
128	440	1282.3	475	1282.4	494	1282.5	536	1282.7
130	407	1283.9	429	1284.1	439	1284.1	465	1284.2
131	450	1285.5	673	1286.2	774	1286.4	1000	1286.6
132	449	1286.2	687	1286.8	793	1286.9	1028	1287.2
134	449	1287.6	687	1288.0	793	1288.1	1028	1288.3
135	448	1289.1	703	1289.6	816	1289.7	1061	1290.0
136	381	1292.3	602	1292.7	701	1292.9	914	1293.2
137	321	1298.9	510	1299.1	597	1299.2	780	1299.4
GYPSUM CREEK								
57	1200	1271.7	2251	1272.3	2796	1272.5	3983	1272.9

TABLE 2

BENCH MARK DESCRIPTIONS AND ELEVATIONS
FLOOD PLAIN MANAGEMENT STUDY
FAIRVIEW, OKLAHOMA

Flood Hazard Area Sheet Number	RM Name	Elevation (Ft. MSL)	Description
Out of Corp Limits	BM USGS 17 G.D.S.	1375.637	.5 mi. so. and 2.1 miles west of Fairview, OK, near corners 29, 30, 31, and 32. 19' south and 447' west on east end of south headwall of 7'x7' box culvert, standard disc.
2	RM 38	1239.21	60d nail in top of 10" piling post at northwest corner of wood bridge. Approximately 80' east of south ¼ corner section 14-T21N-R12W.
Out of Corp Limits	RM 39	1256.66	0.6' above ground, 60d nail in power pole at southwest corner section 14-T21N-R12W.
1	RM 7	1289.68	60d nail 2.0' above ground driven in 14" creosote corner post east-west-north-corner south ¼ of Section 16-21N-12W.
4	RM 40	1256.66	60d nail 1.0' above ground in power pole at east ¼ corner section 22-T21N-R12W.
4	RM 81-A	1267.22	Chiseled x on concrete slab at northwest corner of wooden bridge 400' southwest of airport runway.
5	RM 5	1305.78	60d nail 1.5' above ground driven in creosote 5" post north-south-east corner west ¼ of section 21-21N-12W.
5	RM-9	1277.61	Chiseled x on top of 18" concrete pipe approximately 150' east of north west corner section 22-21N-12W on west of North Main and south side of Oklahoma Avenue.
5	RM 84-A	1278.56	Chiseled x on south end of west headwall of bridge over Lost Creek on Highway 8.

TABLE 2

BENCH MARK DESCRIPTIONS AND ELEVATIONS
FLOOD PLAIN MANAGEMENT STUDY
FAIRVIEW, OKLAHOMA

Flood Hazard Area Sheet Number	RM Name	Elevation (Ft. MSL)	Description
5	RM 84-B	1283.82	Chiseled x on south end of west headwall of concrete bridge on Highway 8, 100' northeast of Heritage Inn Motel.
6	RM 4	1310.59	60d nail 0.5' above ground driven in light pole 100' west of southeast corner, section 20-21N-12W.
6	RM 75-A	1296.60	Top of fire hydrant at intersection of North 1st Avenue and West State Road.
7	RM 29	1270.27	Chiseled x on center of north headwall of concrete bridge at southeast corner of section 22-21N-12W.
7	RM 30	1281.13	Chiseled x on center of east headwall of concrete bridge at North ¼ corner of section 27-21N-12W.
7	RM 31	1273.90	Chiseled x on top of east curbing at intersection of Central Street and 12th Avenue at east center of section 27-21N-12W.
7	RM 32	1300.20	Chiseled x on curbing at South Main and East Central Street at West ¼ corner section 27-21N-12W.
8	RM 28	1265.84	Chiseled x on northwest wingwall of concrete bridge over Sand Creek approximately 300' east of south ¼ section 23-21N-12W.
9	RM 150	1279.859	Chiseled x in west end of north side of guard wall in Sand Creek bridge southeast ¼ of section 27-21N-12W.
10	RM 33	1303.62	Top of bent 60d nail on top of wood north east wingwall of railroad bridge. 1150' north and 400' west of south east corner of section 28-21N-12W.

TABLE 2

BENCH MARK DESCRIPTIONS AND ELEVATIONS
FLOOD PLAIN MANAGEMENT STUDY
FAIRVIEW, OKLAHOMA

Flood Hazard Area Sheet Number	RM Name	Elevation (Ft. MSL)	Description
10	RM 34	1308.10	60d nail 0.8" above ground driven in power pole west side railroad track approximately 900' west of southeast corner of section 28-21N-12W.
10	RM 35	1320.63	60d mail 1.0' above ground driven in power pole approximately 250' east of south ¼ of section 28-21N-12W.
10	RM 36	1336.25	60d nail 1.0' above ground driven in power pole northeast corner of section 32-21N-12W.
11	RM 101	1345.24	60d nail east side corner post ½ mile line east ½ of 32-21N-12W (west of northsouth road.)
11	RM 102	1357.23	Top 60d nail southwest side power pole 1.5' above ground southwest corner of southwest ¼ section 33-21N-12W.
12	RM 151	1283.176	Head 60d nail east side road in ½ line fence (east/west) 0.3' above ground. Section 35-21N-12W.
12	RM 153	1299.64	Head 60d nail 8' west of north south ½ line in brace post, 0.5' above ground, south side section 34-21N-12W.
12	RM 154	1310.552	Head 60d nail 2.0' above ground south side of highline pole ± 135' east centerline of Highway 58 section 34-21N-12W.
13	RM 155	1320.611	Head of 60d nail in fence corner at west ¼ corner section 3 20N-12W (by driveway east side Highway 58).