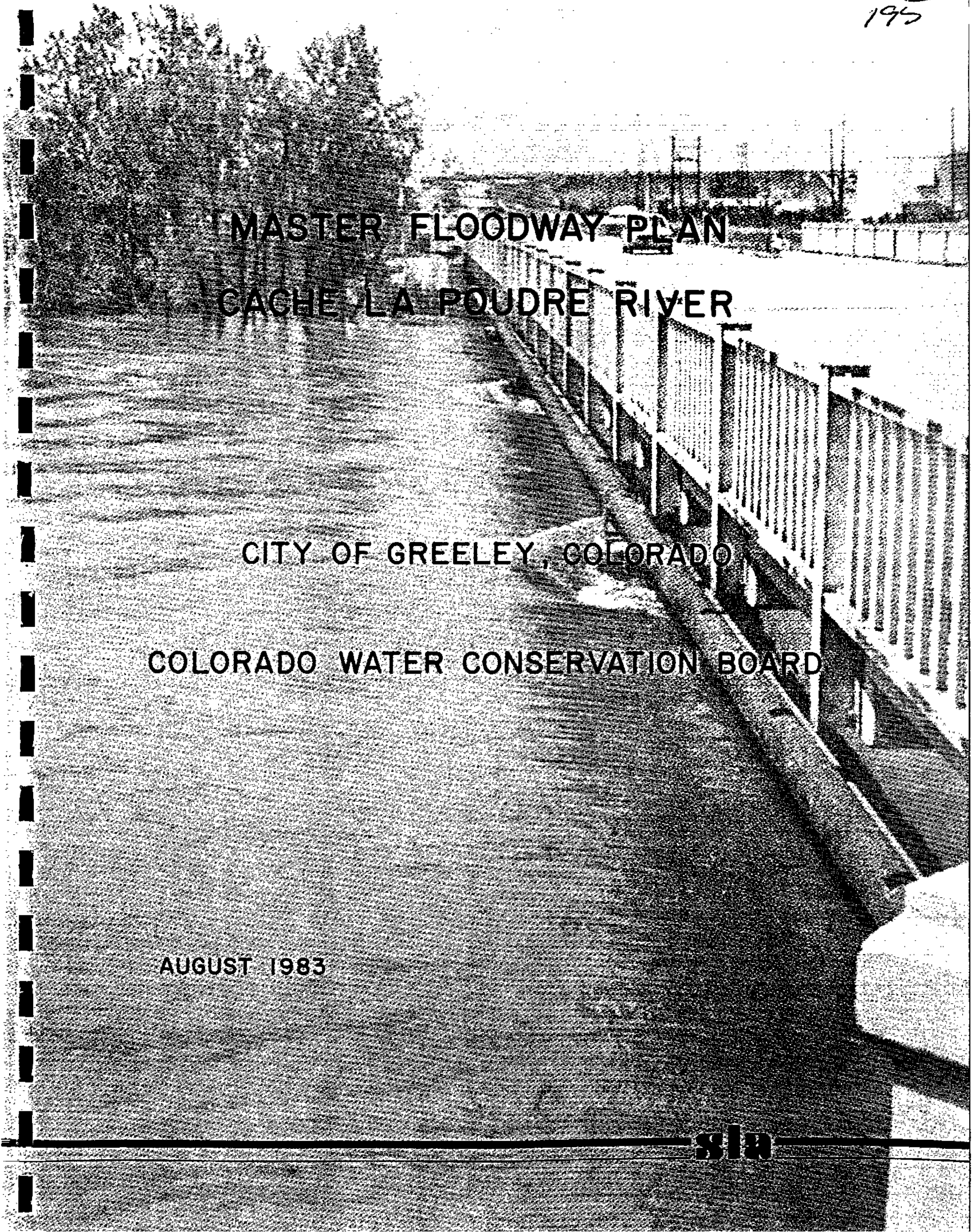

MASTER FLOODWAY PLAN
CACHE LA POUDRE RIVER

CITY OF GREELEY, COLORADO

COLORADO WATER CONSERVATION BOARD

AUGUST 1983

MASTER FLOODWAY PLAN

CACHE LA POUDRE RIVER

Prepared for

City of Greeley
919 - 7th Street
Greeley, Colorado 80631

and

Colorado Water Conservation Board
823 Centennial Building
1313 Sherman Street
Denver, Colorado 80202

By

Simons, Li & Associates, Inc.
4105 East Florida Avenue
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August 1983

This report was prepared under the supervision and direction of the undersigned, whose seal as a professional engineer is affixed.

Wen-Sheng Liang, Ph.D., P.E.
Vice President

The following members of Simons, Li & Associates, Inc. staff contributed to the preparation of this report:

Project Manager	Wen-Sheng Liang, Ph.D., P.E.
Project Engineer	Thomas C. Fairley, P.E.
Technician/Drafter	Michelle K. Beckfeld
Technical Typist	Rebecca S. Chappelle

EXECUTIVE SUMMARY

Introduction

The City of Greeley (City) retained the engineering firm of Simons, Li & Associates, Inc. (SLA) to conduct a master floodway plan for the reach of the Cache la Poudre River within the City. The purpose of the master floodway plan is to assist local officials in planning and regulation of the Cache la Poudre floodplain and to minimize flooding problems within the City. The City formed a Floodplain Panel to investigate the needs regarding the floodplain and to provide direction to the engineering consultant.

Scope of Work

This study includes descriptions of the study area, hydraulic analysis including verification of the flood insurance study results, erosion and sedimentation analysis, development of alternatives to reduce flooding problems, evaluation of alternatives, and preliminary design of the recommended alternative.

Hydraulic Analysis

Hydraulic analyses were performed to verify the results of the flood insurance study for the City of Greeley. This study utilized the methodology currently required by the Federal Emergency Management Agency. Topographic mapping and river cross-section information from the previous flood study were obtained from the Colorado Water Conservation Board and the City. The results of the hydraulic analyses indicate that the previous study is reasonable. The bridges at 8th Street, 5th Street and 6th Avenue are undersized and cause backwater behind the bridges. The floodplain is very wide and generally shallow. The floodway is wide in many locations preventing the development of property adjacent to the river.

Erosion and sedimentation analyses were also performed. The Greeley reach of the Cache la Poudre River is subject to excessive sedimentation requiring dredging to clean out the channel. The river is subject to erosion at bridge piers and at bends in the channel.

Development of Alternatives

A number of different alternatives were developed to reduce flooding problems. These included:

1. Maintaining the existing condition.
2. Raising the existing levees.
3. Channelizing the river to contain the 100-year flood. (Several different channel sections were evaluated.)
4. Improving the bridges at 8th Street, 5th Street, and 6th Avenue.
5. Dredging the channel to increase flow area.
6. Combinations of improvements.

Hydraulic analysis was performed for these alternatives to determine the feasibility of each alternative. Improving the bridges does not, by itself, solve flooding problems. Dredging the channel to increase flow area is also not practical or effective. The remaining alternatives were developed further, costs for the alternatives were estimated and other factors were considered. Several improvements are common to the improvement alternatives. The bridges at 8th Street and 5th Street must be enlarged or replaced. The 6th Avenue bridge must be enlarged, replaced, removed, or bypassed during flooding. The Great Western Sugar Company diversion structure at the City wastewater treatment plant causes flooding problems due to the constriction on the channel (as evidenced during the 1983 flood) and should be replaced with a non-constrictive structure.

Recommended Alternative

The alternative improvement plans were presented to the Floodplain Panel for review and selection of a recommended alternative. A decision was made to utilize a combination channel for the majority of the study reach and a trapezoidal channel where limited right-of-way was available. The combination channel consists of a narrow, deep, low-flow channel to continue normal stream flows with a wide overbank section to convey larger flows. A trapezoidal channel has sloping sides and a flat bottom and is utilized downstream of 8th Street and at the Union Pacific Railroad. The proposed improvements will contain the 100-year flood within the channel and allow development to the edge of the proposed channel. The cost of the channel improvements is $2.1 million

and bridge replacement costs are an additional $0.3 to $2.2 million, dependent upon which bridge alternatives are selected. The total improvement costs range from $2.4 to $4.3 million dollars.

Future Study Recommendations

The mapping used for this study was made based on aerial photography completed in 1973. Improvements made between 1973 and 1982 were added to the mapping for this study, but topographic mapping should be updated for the channel area prior to final design. Considerable excess excavated material will be available following construction of the proposed improvements and potential markets for this material should be located in order to realize significant cost savings. The 8th Street bridge is on Colorado Highway 263 and the Colorado Department of Highways should be requested to replace the structure. Transportation needs of the 6th Avenue area should be evaluated to determine which bridge alternatives are feasible.

The City should enter the National Flood Insurance program to allow proper management of the floodplain area and to allow the solicitation of Federal aid in regards to flood problems.

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I. INTRODUCTION

Authority

This report was authorized and contracted through the City of Greeley, Colorado (City) to develop preliminary designs for improvements to the Cache la Poudre River within the City. Simons, Li & Associates, Inc. (SLA) was selected by the City as the Study Contractor according to the terms of the agreement signed April 5, 1983.

Purpose and Scope of Work

This master floodway plan has been prepared to guide local officials in planning the use and regulation of the Cache la Poudre River floodway within and adjacent to the City. The master floodway plan is designed to minimize flooding impacts within the floodway area. The purpose of a floodway is to designate those areas to be kept free from future encroachment and reserve an area for conveyance of the 100-year flood along the Cache la Poudre River.

The work for this study includes hydraulic analyses (including the verification of previous hydraulic analyses), development of alternative plans of improvement, and preliminary design of the improvement alternative selected by the City. Also included are analyses of river stability and sedimentation. Floodway maps have been prepared and are available for review at the City of Greeley Planning Department Offices.

Available Data and Previous Reports

Several reports have been prepared that contain information relevant to this study. These are:

"Floodplain Information Study, Cache la Poudre River, Greeley, Colorado," 1971, prepared by the U. S. Army Corps of Engineers, Omaha District.

"Reconnaissance Report, Section 205, Cache la Poudre River, Greeley, Colorado," 1981, prepared by the U.S. Army Corps of Engineers.

"Flood Insurance Study, City of Greeley, Colorado," 1979, prepared by the Federal Insurance Administration.

"Flood Insurance Study, Weld County, Colorado," 1982, prepared by the Federal Emergency Management Agency.

Hydraulic and cross-section data prepared by the U.S. Army Corps of Engineers (COE) were obtained and utilized during the preparation of this report.

Mapping

Topographic mapping (1" = 200' with four-foot contour intervals) was obtained from Falcon Air Maps and was based on aerial photography made in 1973. Aerial photographs made in 1982 were obtained and enlarged to 1" = 200' scale. The topographic mapping was updated using the new aerial photographs (October 1982) to locate all new buildings and other physical features.

Acknowledgements

The City of Greeley assembled a Floodplain Panel in 1982 to study the problems and assess future uses of the Cache la Poudre floodplain. The Floodplain Panel provided valuable input during the course of this study regarding community concerns about existing problems and future planning for the study area.

We wish to acknowledge the following individuals for their help and guidance throughout this study:

Mr. Sam Sasaki	Community Development Director for the City of Greeley and Floodplain Panel member
Mr. Tom Cowan	Floodplain Panel member
Mr. John Pacheco	Floodplain Panel member
Mr. Tom Romero	Floodplain Panel member
Mr. Bob Stoll	Floodplain Panel member
Mr. Gerry McRae	Floodplain Panel member

We also wish to thank Mr. Larry Lang and Mr. Randy Seaholm of the Colorado Water Conservation Board for providing technical assistance and Mr. Harold Law and Ms. Ann Jamison for additional assistance.

II. STUDY AREA DESCRIPTION

Drainage Basin Characteristics

The Cache la Poudre River originates near the Continental Divide in Rocky Mountain National Park and flows through Larimer and Weld Counties before joining the South Platte River approximately five stream miles east of the Greeley corporate limits.

The drainage basin consists of heavily forested mountain areas in the western portion of the basin and rolling prairie in the eastern portion. The drainage area of the Cache la Poudre River is 1,890 square miles at the confluence with the South Platte River. The climate of the basin ranges from alpine in the headwaters to semiarid at the mouth.

Study Area

The study area consists of the floodplain of the Cache la Poudre River within the City. The river enters the corporate limits at approximately 16th Avenue and flows in a southeasterly direction about 2.5 miles to Ash Avenue where it leaves the corporate limits (see Figure 1). The river has a slope of 7.3 feet per mile in the study area. The Cache la Poudre River is crossed by 6th, 8th, 11th and Ash Avenues, 5th and 8th Streets, and the Union Pacific Railroad. A control structure located at the City wastewater treatment plant is used to divert water to the Great Western Sugar Company and also is used as a crossing structure for sewer lines connecting the two sides of the wastewater treatment plant.

The floodplain is heavily developed throughout most of the study area with residential, commercial and industrial developments. The river is channelized with flood control levees present in much of the study area. The Union Pacific Railroad tracks act as a barrier to flood flows. The tracks are several feet higher than the adjacent land creating a large ponded area during large flows. The Colorado and Southern Railroad embankment contains flood flows south of the river and west of the Union Pacific Railroad.

Immediately upstream of the study reach is an area undergoing gravel mining. Numerous active and abandoned gravel pits are located in this area. Also present in the floodplain are remnants of the old river channel and other evidence of channel migration.

The only major tributary of the Cache la Poudre River within the study reach is Eaton Draw. Eaton Draw enters the north bank of the Cache la Poudre River between 6th Avenue and the Union Pacific Railroad. Eaton Draw has a peak discharge of 2,000 cubic feet per second (cfs) for the 10-year recurrence interval and 4,470 cfs for the 100-year recurrence interval. The drainage area of Eaton Draw is 42.1 square miles at the confluence with the Cache la Poudre River.

The soils in the study area are of two predominant types, namely Aquolls and Aquents and Bankard Sandy Loams (reference 1). The Aquolls and Aquents are found on bottom lands and floodplains. They are deep, poorly drained soils subject to flooding. The water table is typically close to the surface in spring and recedes to a four-foot depth or more by late summer. The soils are suited for grassland or wetland vegetation and wildlife. Bankard Sandy Loams are deep, somewhat excessively drained soils found on floodplains. This soil unit is also best suited for grassland or wildlife habitat.

Flooding History

Major floods on the Cache la Poudre River are generally caused by intense rainfall from localized thunderstorms occurring in May through September. Flooding potential is increased due to snowmelt in May through July.

Damaging floods along the Cache la Poudre River occurred in 1876, 1884, 1904, 1917, 1923, 1947, 1949, 1951, 1964, 1965 and 1983. The largest recorded flood occurred in 1917 and had a computed discharge of 13,000 cfs. The flood of 1965 had a discharge of 3,480 cfs (reference 2).

Flooding in June of 1983 was the result of rapid snowmelt compounded by general area-wide rainfall. Frequent late spring snowfall in the mountainous portion of the drainage basin combined with cool spring weather resulted in little snowmelt until late May. The peak recorded discharge was 6,270 cfs (State Engineer's estimate) and occurred June 22, 1983. This peak flow corresponds to approximately a 50-year flood. Photographs taken during early June during a flow of approximately 4,500 cfs are shown in Figures 2, 3, and 4.

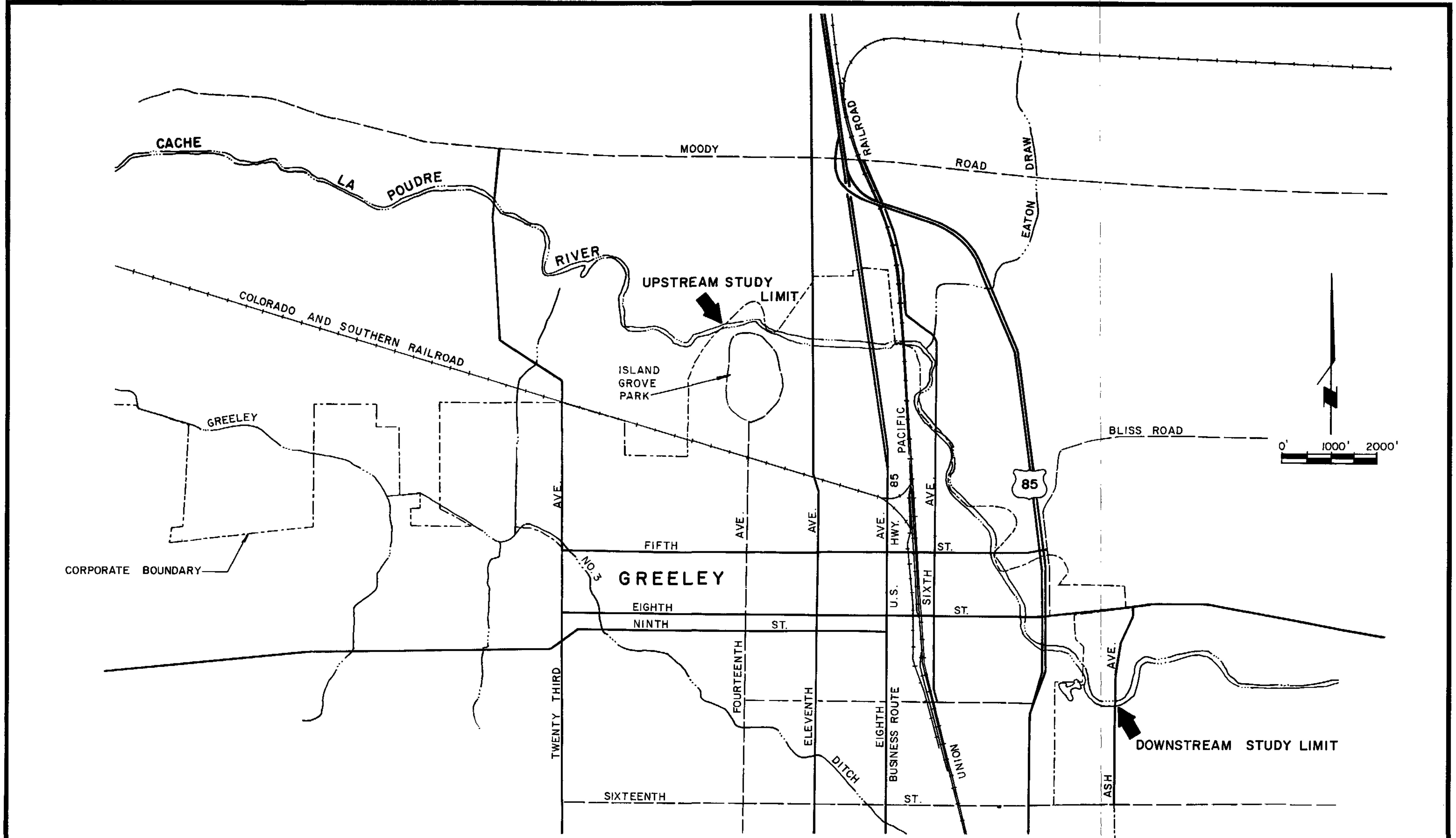
Hydrology

Flood discharges for the 10-, 50-, and 100-year floods of the Cache la Poudre River were provided by the COE (reference 2). The 500-year discharge was obtained from a straight-line extrapolation of these values on log-probability paper (reference 2). Peak discharge-drainage area relationships for the Cache la Poudre River are given in Table 1. The drainage basin of the Cache la Poudre is shown in Figure 5.

Table 1. Summary of Discharges.

Flooding Source and Location	Drainage Area (sq.mi.)	Peak Discharges in cfs			
		10-Year	50-Year	100-Year	500-Year
CACHE LA POUDRE RIVER					
At mouth	1,890	3,100	7,100	9,400	17,000
Downstream of Eaton Draw	1,875	3,500	8,000	10,700	19,000
Upstream of Eaton Draw	1,825	2,600	6,000	8,100	14,500
At 25th Avenue	1,810	3,400	7,200	9,600	17,000

Source: "Flood Insurance Study, City of Greeley, Colorado, Weld County," 1979, U.S. Department of Housing and Urban Development, Federal Insurance Administration.



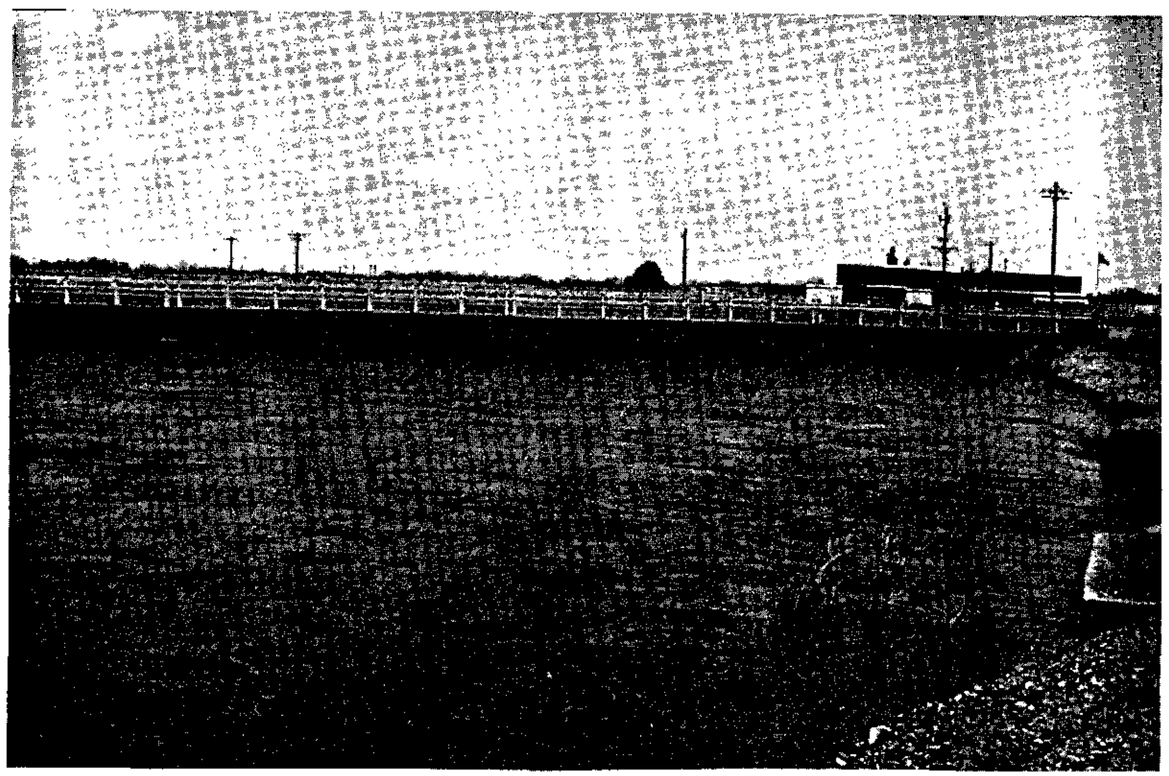
COLORADO WATER CONSERVATION BOARD
AND
CITY OF GREELEY

sla
SIMONS, LI & ASSOCIATES, INC.

STUDY AREA
MASTER FLOODWAY PLAN
CACHE LA POUDRE RIVER

FIGURE 1.

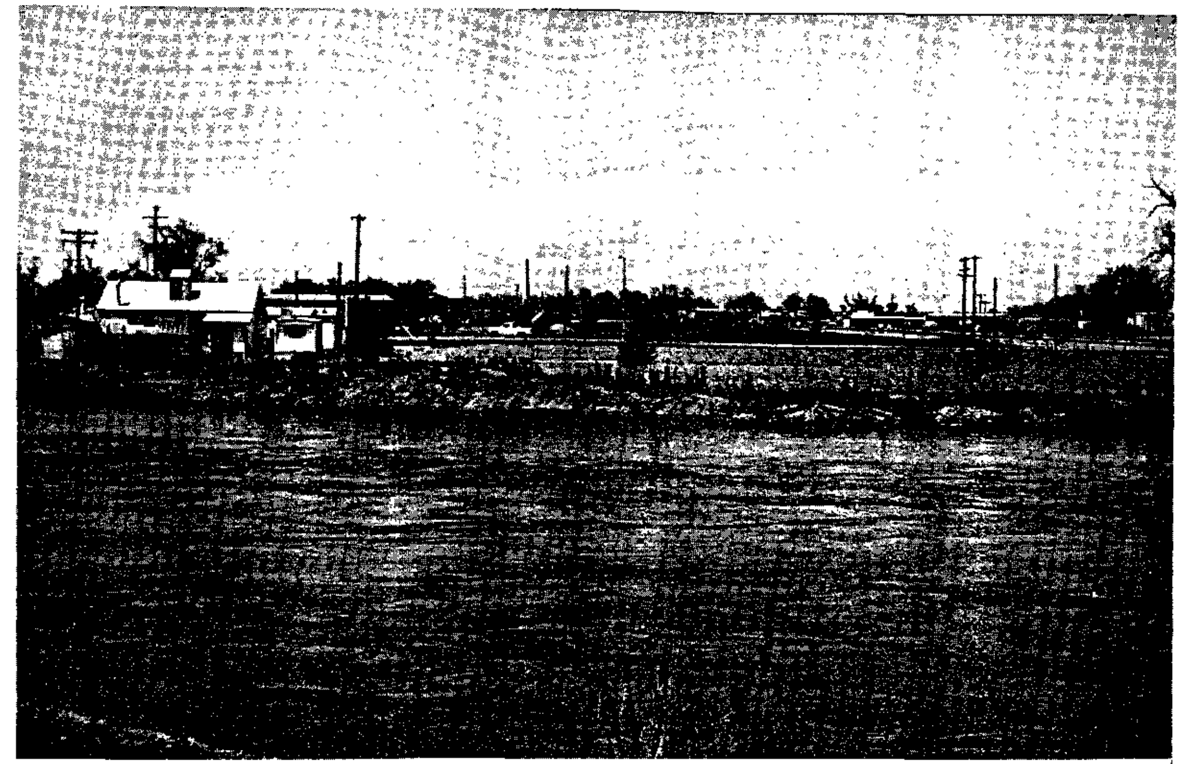
CONTROL STRUCTURE AT WASTEWATER TREATMENT PLANT



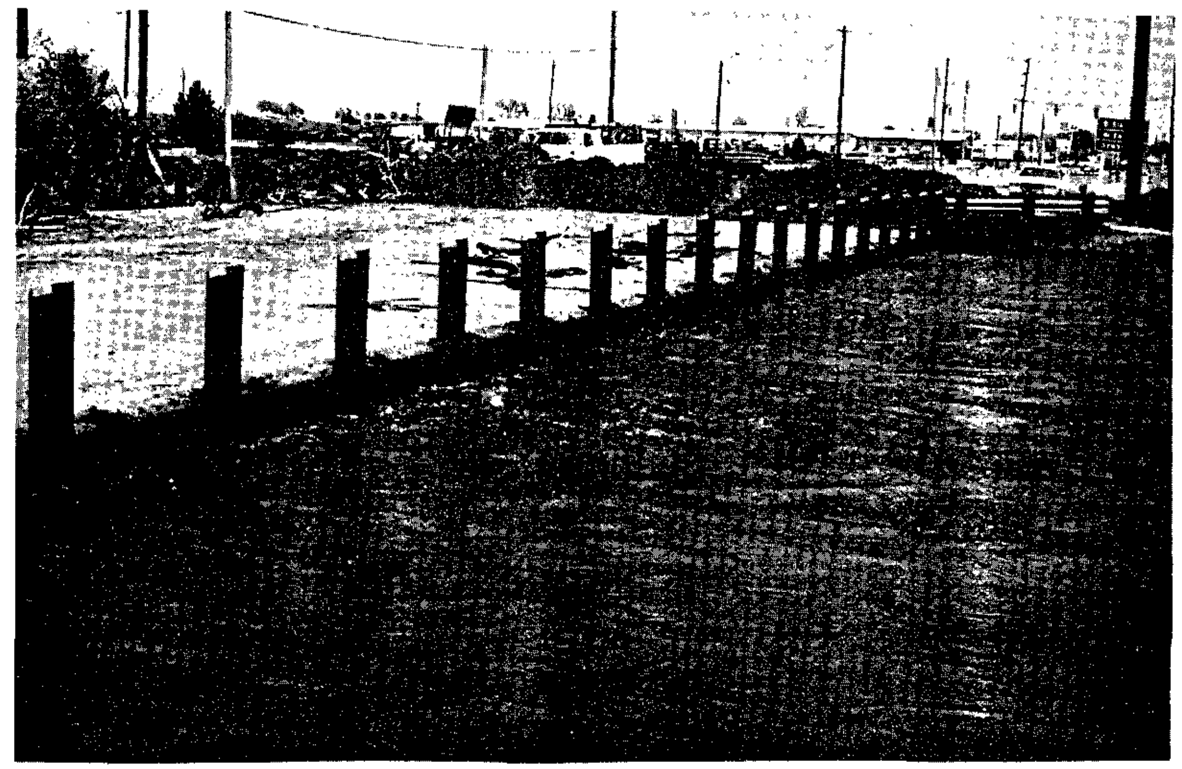
LOOKING DOWNSTREAM AT U.S. 85 BYPASS

FIGURE 2. FLOOD PHOTOGRAPHS

Photographs taken
by SLA, June 8,1983



LOOKING NORTHEAST BETWEEN 8 TH. STREET AND U.S. 85 BYPASS



8 TH. STREET BRIDGE

FIGURE 3. FLOOD PHOTOGRAPHS

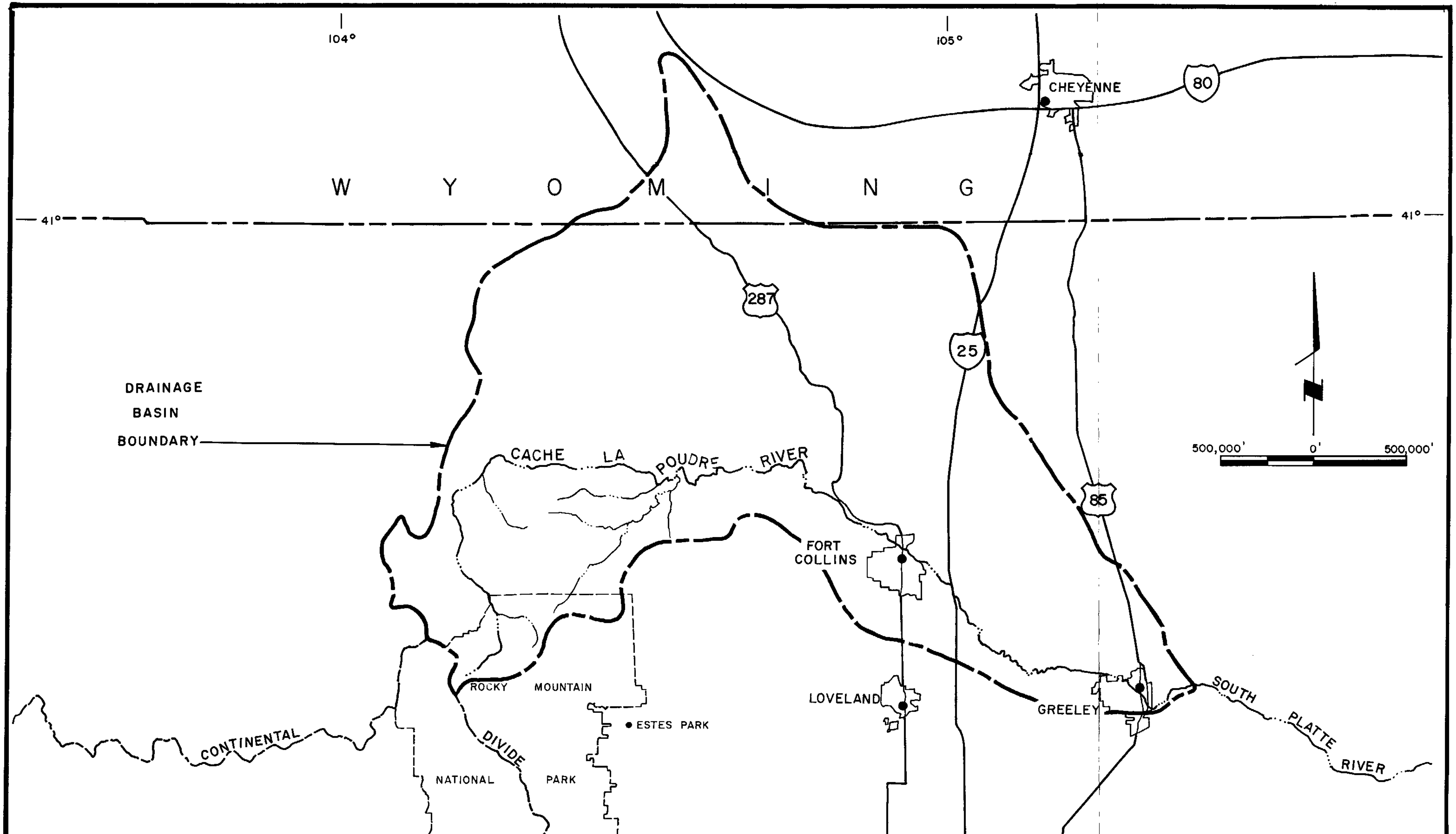
Photographs taken
by SLA, June 8,1983

LOOKING NORTH FROM 8 TH. STREET BRIDGE

LOOKING NORTH ALONG 6 TH. AVENUE

FIGURE 4. FLOOD PHOTOGRAPHS

Photographs taken
by SLA, June 8, 1983



COLORADO WATER CONSERVATION BOARD AND CITY OF GREELEY	sla SIMONS, LI & ASSOCIATES, INC.	DRAINAGE BASIN MAP MASTER FLOODWAY PLAN CACHE LA POUDRE RIVER

FIGURE 5.

III. HYDRAULIC ANALYSIS

Floodplain Analysis

The original floodplain analysis performed by the U.S. Army Corps of Engineers (COE) utilized an in-house computer model to calculate backwater curves. As part of this study, the results of the previous hydraulic analysis were verified utilizing the U.S. Army Corps of Engineers' HEC-2 water surface profile computer model (reference 4).

The first step of the verification process was to conduct field surveys to measure existing structures and to select appropriate Manning's "n" roughness coefficients. A separate "n" value report has been prepared and is on file at the City of Greeley and the Colorado Water Conservation Board (reference 5). The "n" values used in this study are from 0.035 to 0.040 for the main channel and from 0.035 to 0.055 for the overbanks. Digitized cross sections from the previous COE study were obtained and located on the topographic maps. The cross sections were checked for accuracy against the topographic mapping and, in general, no major discrepancies were noted. The digitized cross sections were then formatted into HEC-2 format. Initial analysis was performed using the original COE parameters and comparisons of the 100-year water surface elevation were made. The initial analysis showed discrepancies in water surface elevation of about one foot at some locations.

The verification process was continued by modifying the loss coefficients such as expansion and contraction losses, bridge and pier losses, and roughness values until the water surface elevations determined by the previous study and by this study were within 0.1 foot.

Floodway Analysis

Once the 100-year water surface elevation was verified, an encroached floodway section was established. The floodway is defined as that area that is required to convey the 100-year flood allowing a one-foot rise in the natural water surface elevation. A schematic of a floodway is shown in Figure 6. The overbank area is encroached to a point where the 100-year water surface is no more than one foot higher than the natural 100-year water surface. This allows development of property located within the area between the floodway boundary and floodplain boundary.

The HEC-2 water surface profile computer model has six methods for determination of the floodway. The method used in this study was to establish

encroachments based on reduced conveyance of the overbank section. This method encroaches the floodplain on either side of the channel proportional to the natural capacity of the overbank. The floodway determined in this manner is approximately equal to the floodway as given in the report entitled "Flood Insurance Study, City of Greeley, Colorado, Weld County" (reference 3). The floodway for the Greeley reach of the Cache la Poudre River is shown in Figures 7, 8, and 9.

Bridge Analysis

A factor compounding flooding problems within the City of Greeley is the presence of undersized bridges. The bridges at 8th Street, 5th Street and 6th Avenue cannot pass the 100-year flood. These bridges are overtopped by floods exceeding a 50-year return period. In addition, the limited hydraulic capacity of these three bridges causes backwater conditions resulting in increased water surface elevations upstream of the bridges. This backwater condition also results in deposition of sediment which reduces channel capacity.

The 11th Avenue, 8th Avenue, U.S. 85, and Union Pacific Railroad bridges all have sufficient hydraulic capacity to pass the 100-year flood without overtopping. A summary of bridge capacities is given in Table 2.

Flow Splits

The Greeley reach of the Cache la Poudre River experiences flow splits during flooding. At some locations along the river (i.e., upstream of 6th Avenue), the bank will be overtopped and floodwaters will flow along a path parallel to the river, rejoining the main flow further downstream. In some cases within the City, the existing flood control levee prevents these overbank flow splits from rejoining the channel, creating ponded areas within the floodplain. This occured along the west bank between 5th Street and 8th Street during the June 1983 flooding. The dikes upstream of 8th Avenue contained the floodwaters in 1983, but if the dikes had failed, a large residential and commercial area would have been inundated, resulting in considerable property damage.

Table 2. Summary of Bridge Capacities.

Location	Capacity *	Flood Frequency
U. S. 85 Bypass	8,000 cfs	50-year
8th Street (Colorado 263)	3,500 cfs	10-year
5th Street	3,500 cfs	10-year
6th Avenue	3,500 cfs	10-year
Union Pacific Railroad	15,000 cfs	500-year **
8th Avenue (U. S. 85 Business Route)	8,100 cfs	100-year
11th Avenue	15,000 cfs	500-year **

* Capacity is computed to low-chord elevation and does not include the effects of debris blockage.

** Bridge capacity exceeds channel capacity and flood flows will bypass bridge.

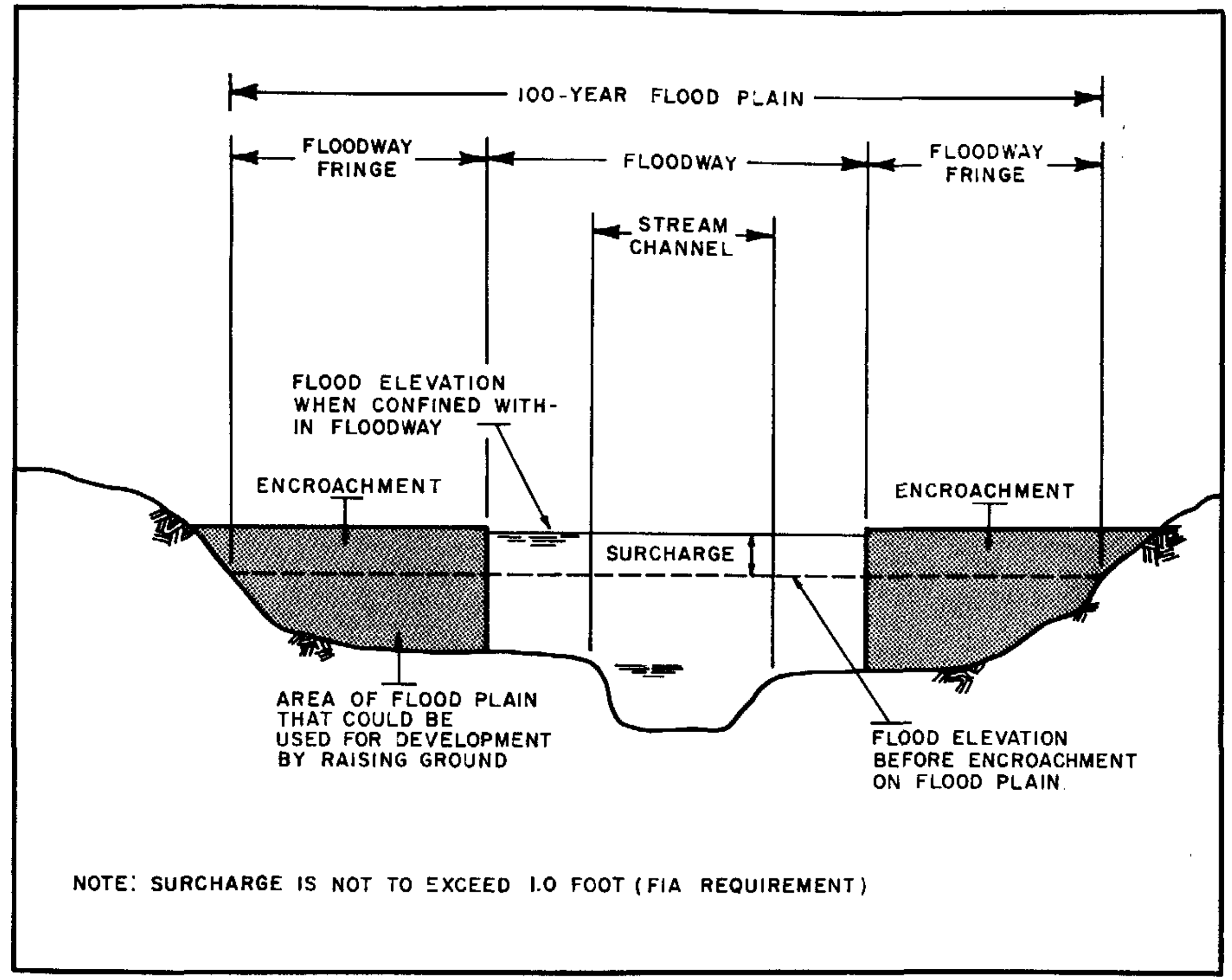
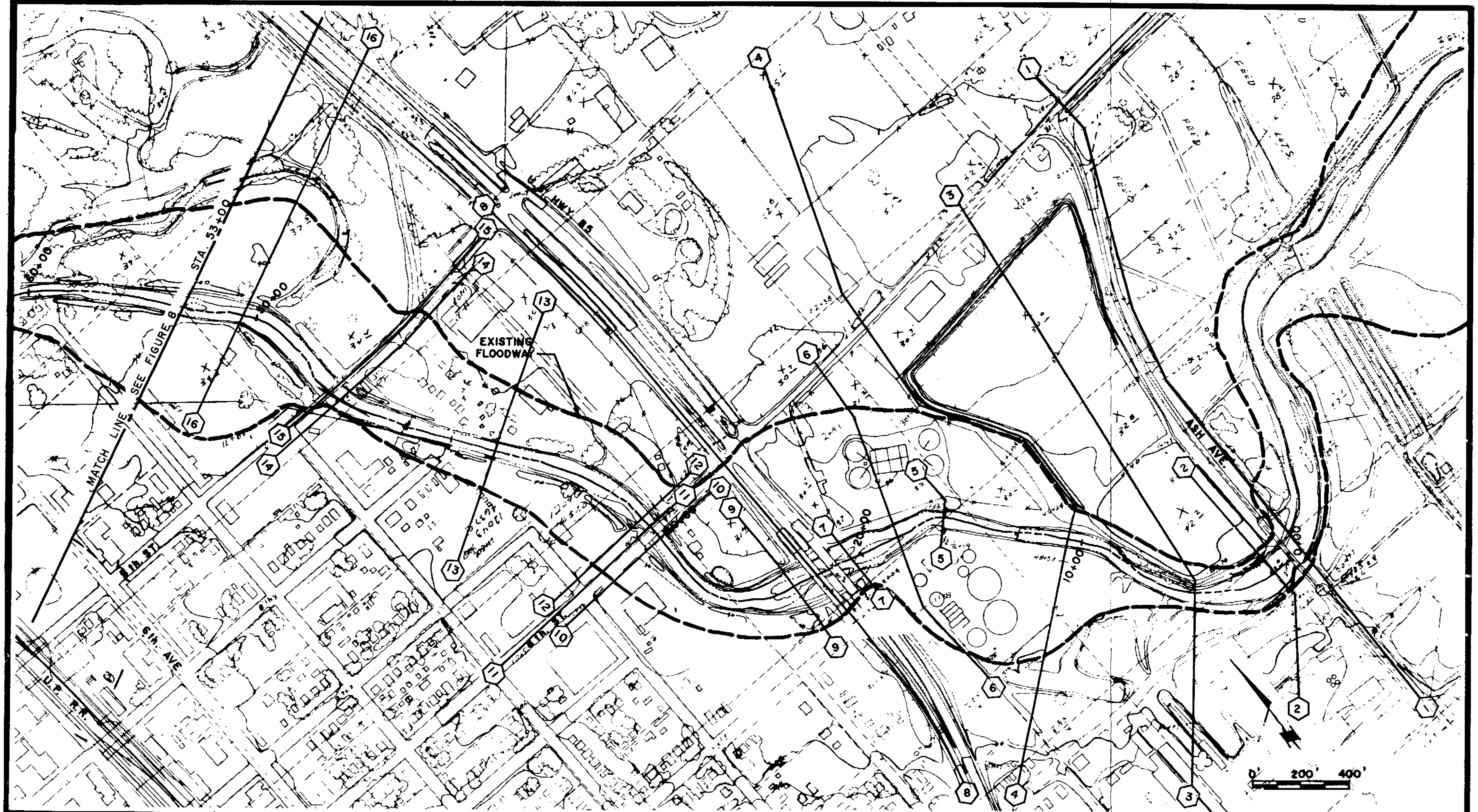


FIGURE 6. FLOODPLAIN SCHEMATIC



MAPPING

1. BASE MAPS BY FALCON AIR MAPS.
2. TOPOGRAPHY COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS.
3. TOPOGRAPHY COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY TAKEN 1973.

NOTES

REVISION	DATE	BY

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LEGEND

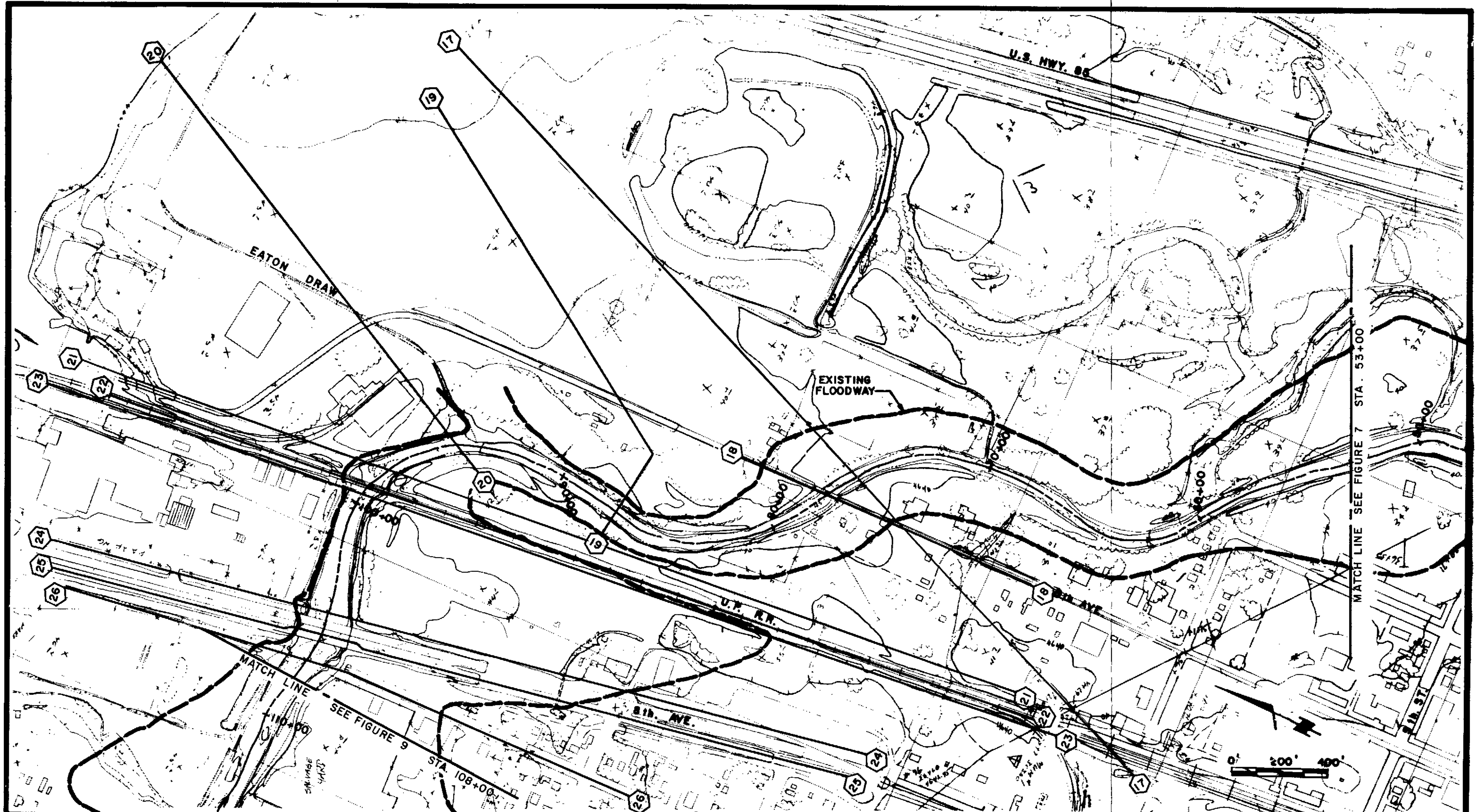
100 YEAR FLOODWAY LIMITS (EXISTING)

CHANNEL CROSS SECTION AND REFERENCE POINT

50+00

MASTER FLOODWAY PLAN
CACHE LA POUDRE RIVER
CITY OF GREELEY, COLORADO
COLORADO WATER CONSERVATION BOARD
ALTERNATIVE I
MAINTAIN EXISTING CONDITION

FIGURE 7.



MAPPING

1. BASE MAPS BY FALCON AIR MAPS.
2. TOPOGRAPHY COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS.
3. TOPOGRAPHY COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY TAKEN 1973.

NOTES

REVISION	DATE	BY

sla
SIMONS, LI & ASSOCIATES, INC.

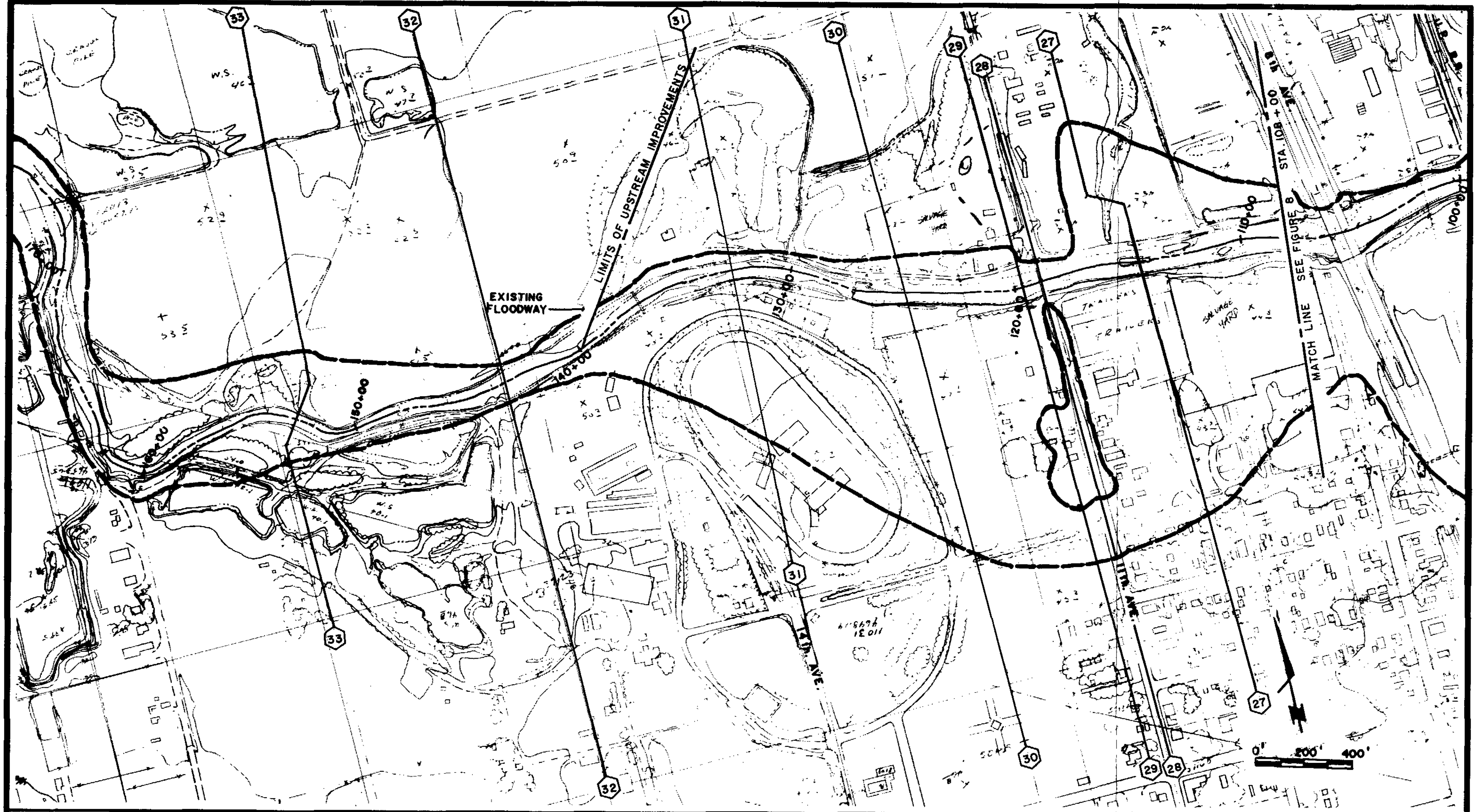
LEGEND

100 YEAR FLOODWAY LIMITS (EXISTING)

CHANNEL CROSS SECTION AND REFERENCE POINT (4, 50+00)

MASTER FLOODWAY PLAN
CACHE LA POUDRE RIVER
CITY OF GREELEY, COLORADO
COLORADO WATER CONSERVATION BOARD
ALTERNATIVE I
MAINTAIN EXISTING CONDITION

FIGURE 8.



MAPPING

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NOTES

REVISION	DATE	BY

sla
SIMONS, LI & ASSOCIATES, INC.

LEGEND

— — — 100 YEAR FLOODWAY LIMITS (EXISTING)

(4) CHANNEL CROSS SECTION AND REFERENCE POINT — 50+00

MASTER FLOODWAY PLAN
CACHE LA POUDRE RIVER
CITY OF GREELEY, COLORADO
COLORADO WATER CONSERVATION BOARD
ALTERNATIVE I
MAINTAIN EXISTING CONDITION

FIGURE 9.

IV. EROSION AND SEDIMENTATION ANALYSIS

Qualitative Geomorphic Analysis

A qualitative geomorphic analysis was conducted to determine the general characteristics of the Cache la Poudre River system. A river can be aggrading (depositing sediment) degrading (eroding away sediment) or at equilibrium depending on sediment particle size and flow rate. The long-term response of the river system must be known when designing improvements to the river channel because channel capacity is gradually reduced in an aggrading system and erosion caused by a degrading system can undercut structures and channel banks. River channels can migrate laterally as well as aggrade or degrade. Lateral migration is generally caused at river bends by eroding the outside of the bend and depositing material on the inside of the bend.

The underlying strata of the Cache la Poudre River valley consists of alluvial deposits. The age of the deposits ranges from modern alluvium to older gravel deposits laid down during periods of glacier melting in Pleistocene time. The gravel deposits have been commercially mined near the study area. The depth of gravel deposits exceeds 30 feet in some locations. Underlying the alluvial deposits are the Laramie formation and Fox Hills Sandstone. The Laramie formation consists of shale, claystone, sandstone and some coal. No major bedrock outcrops were identified in the study area.

A field investigation of the study area was conducted. Sediment samples were collected from channel banks and from sand bar deposits. The average size of materials sampled ranged from three to ten millimeters (0.12 to 0.39 inches). The largest material present is in the two- to three-inch diameter size range. The existing slope of channel banks is fairly steep, 1 horizontal to 1 vertical (1h:1v). The river has been straightened and channelized within the study area. Many sand bars are seen in the vicinity of bridges.

Aerial photographs and maps were examined to identify general characteristics of the river system; much evidence of channel migration is seen in aerial photographs. The corporate boundary of the City of Greeley was established as the centerline of the Cache la Poudre River and the fact that the river channel has migrated in some locations is clearly seen (see Figure 1).

The relationship of river length to valley length is termed sinuosity and can indicate the tendency of a channel to migrate. The sinuosity of the river in the study reach is about 1.1 indicating a fairly straight river. However,

the river has a sinuosity of about 1.4 upstream and downstream of the study area. The sinuosity within the study area was probably very close to 1.4 prior to channelization. Since rivers tend to revert to their natural state, lateral migration must be considered in any improvement alternative.

Rivers are dynamic systems in that sediment is eroded at some location and deposited at some downstream location. The rate at which materials are transported is dependent upon many factors such as flow velocity, size of transported materials, channel slope and geometry, and depth of flow among others. If the river is transporting less material than its capacity, erosion of the river bed or banks will occur. Conversely, if the transport capacity is exceeded, materials will be deposited. The sediment transport capacity of the Cache la Poudre River in the study area was compared to the sediment capacity immediately upstream of the City. The results of this analysis indicate that the river is capable of transporting more sediment upstream of the City than in the study reach. This will result in deposition of sediment in the study reach. This tendency for aggradation is confirmed by the fact that the City is required to dredge the river channel periodically. Approximately 2,500 to 3,000 tons of material is dredged annually. A summary of the City's dredging activities is given in Table 3.

Erosion of bank materials occurs in the study area. The City places approximately 500 tons of riprap annually to control bank erosion. Bank erosion generally begins at the toe of the slope and undercuts the bank resulting in bank sloughing. This process can repeat itself during high-flow periods and result in lateral migration.

Bridge Scour

Scour at bridges can undermine structure supports and cause bridge collapse. Scouring can occur locally at piers or abutments or general scour can occur across the entire width of the bridge. Local scour at piers or abutments is caused by vortex action as the flow passes around the pier and forms eddies on the downstream face. General scour is caused by a reduction in flow area at a bridge constriction which causes an increase in flow velocity.

The velocities calculated for the bridges in the Greeley reach of the Cache la Poudre River range from three feet per second (fps) at 8th Street to eight fps at 11th Avenue. Scour depths are estimated to reach four to five feet in the Greeley reach (reference 6). Scouring problems are increased if debris blocks some part of the bridge. In addition to a reduction in flow area, debris blockages also cause a sudden change in flow direction which increases turbulence. The Union Pacific Railroad bridge is especially prone to debris blockage because of the large numbers of piers.

Controlling Erosion and Sedimentation Problems

The qualitative geomorphic analysis indicates two major problems, namely, aggradation and bank erosion. Aggradation in the study reach occurs because the river upstream of the City can carry more sediment than the reach within the City. Bank erosion is generally limited to river bends and can be controlled by lining the bank on the outside of the bends. Suitable lining materials include riprap, gabions (wire mesh baskets containing rock), concrete, or soil cement.

The aggradation problem can be controlled in one of two ways, namely, remove sediment from the river upstream of the City, or increase the sediment transport capacity of the river in the study reach.

To decrease the upstream supply, sediment must be trapped upstream of Greeley. This can be accomplished by routing the river through an existing (abandoned) gravel pit. The gravel pit will then act as a sediment trap and reduce the sediment load downstream of the pit. The sediment trap will require dredging on an annual basis to maintain the necessary volume and detention time. A pit with a volume of approximately ten acre-feet is adequate to trap the majority of sediment during low flows, but a volume of about 70 acre-feet would be required to effectively trap sediment during flood flows. If sediment is trapped by a pit upstream of Greeley, precautions need to be made to protect the channel bed and banks from scouring immediately downstream of the pit. Scouring would occur because the river would be transporting less sediment than its capacity and the river would begin to pick up bed and bank materials until the sediment transport capacity is reached. This local scour potential is of concern because bank instability can result as can scouring at bridges which could undermine piers.

Sediment transport capacity can be increased in the study reach by increasing the flow velocity. Velocity can be increased by (1) increasing the channel slope, (2) providing a more efficient channel geometry, or (3) reducing channel roughness. Increasing the channel slope is difficult to

accomplish in the study area because of the following (1) the confluence with the South Platte River controls the downstream elevation, (2) several diversion structures are in the vicinity and would require relocation, (3) lowering the channel bed could undermine bridge supports and channel banks, and (4) the channel would require excavation for a considerable distance downstream of the corporate limits. Reducing channel roughness would require lining the channel with concrete at great expense. A more efficient channel geometry can be achieved by providing a narrow, deep, low-flow section. Since flow resistance is reduced with increased depth of flow, velocity is increased, as is sediment transport capacity. Larger floods would be contained in a wide overbank section. Dredging requirements would be reduced but probably not totally eliminated because the sediment supply and sediment transport cannot be balanced for all flood frequencies.

In summary, the erosion and sedimentation problems can be controlled by (1) providing riprap or other channel lining at the outside channel bends, (2) providing either an upstream sediment trap OR providing a narrow, deep, low-flow channel, and (3) limiting side slopes to a maximum of 2.5h:1v.

Local scour at bridges can be reduced by using more efficient pier shapes such as sharp-nosed piers or by providing connecting diaphragms between piers.

Table 3. Dredged Material Summary.

Location	Annual Quantity (tons)
11th Avenue Bridge	125
Between 8th Avenue and the Union Pacific Railroad	600
Between 3rd and 4th Streets	750
Between 5th Street and 8th Street	150
At U.S. 85 Bypass	1,000

Source: City of Greeley records.

V. DEVELOPMENT OF FLOODWAY IMPROVEMENT ALTERNATIVES

Floodway improvement alternatives were developed to mitigate flooding and sedimentation problems within the Greeley reach of the Cache la Poudre River.

The Greeley reach of the Cache la Poudre River was subdivided into six reaches to allow comparisons of improvement alternatives. The reach locations are as follows:

Reach 1. Ash Avenue to U.S. 85.

Reach 2. U.S. 85 to 8th Street.

Reach 3. 8th Street to 5th Street.

Reach 4. 5th Street to Union Pacific Railroad.

Reach 5. Union Pacific Railroad to 11th Avenue.

Reach 6. 11th Avenue to City limits.

Preliminary alternatives were developed considering structural and non-structural methods of flood control. Improvement alternatives considered include the following:

1. Maintain the existing condition.
2. Improved flood control levees (100-year capacity).
3. Improved river crossings at 8th Street, 5th Street, and 6th Avenue.
4. Trapezoidal channel (50- and 100-year capacity).
5. Combination channel (100-year capacity).
6. Dredging to increase flow area.
7. Combinations of the above.

A description of each alternative follows.

Maintain the Existing Condition

This alternative requires no capital improvements. The existing floodway as developed by the Federal Emergency Management Agency (FEMA) would require adoption. Flooding damages would not be reduced. The annual dredging and maintenance program would be continued.

Improved Flood Control Levees

This alternative requires raising the existing levees and widening the channel to contain the 100-year flood. The levee must be at least three feet above the 100-year water surface to satisfy FEMA criteria. An upstream sediment trap is required to reduce the sediment supply to the study reach. Improved bridges at 8th Street, 5th Street, and 6th Avenue are required.

Improved River Crossings at 8th Street, 5th Street, and 6th Avenue

This alternative considers the effect of enlarging the existing bridges at 8th Street, 5th Street, and 6th Avenue. Channel improvements are not included. An upstream sediment trap is necessary.

Trapezoidal Channel

A trapezoidal channel (a channel with sloping sides and an essentially flat bottom) with either a 50- or 100-year capacity would be constructed following the present channel alignment. The existing channel would be enlarged. Improved bridges are required at 8th Street, 5th Street, and 6th Avenue. An upstream sediment trap is required.

Combination Channel

This channel section utilizes a narrow, deep, low-flow channel (5-year capacity) and a wide overbank section to convey the 100-year flow. The channel would follow the existing alignment. Improved bridges are required at 8th Street, 5th Street, and 6th Avenue. An upstream sediment trap is not required.

Dredging to Increase Flow Area

This alternative requires dredging the existing channel to lower the channel bottom to increase flow area. Improved bridges are required at 8th Street, 5th Street, and 6th Avenue. An upstream sediment trap is required.

Several improvements are common to all alternatives, namely (1) relocation of the Great Western Sugar Company diversion structure at the City wastewater treatment plant, and (2) floodplain management by entering the National Flood Insurance Program. The Great Western Sugar Company diversion structure at present creates considerable backwater during large flows. This

backwater effect can be seen in Figure 2 and created considerable damage during the 1983 flood. The Flood Insurance Program provides flood insurance and allows controlled improvements to be made within the floodplain. Entry into the National Flood Insurance Program is essential to properly manage floodplain areas.

Hydraulic analyses were performed for each improvement alternative utilizing the U.S. Army Corps of Engineers' HEC-2 water surface profile computer model. The hydraulic information was used to determine residual flooding and to size the improvements.

A tabulation of advantages and disadvantages of each alternative is given in the following paragraphs.

1. Maintain the existing condition.

Advantages	Disadvantages
No capital improvement costs.	Prohibits development/redevelopment of area within floodway.
	Does not eliminate flooding problems.
	Requires continued dredging.

2. Improved flood control levees.

Advantages	Disadvantages
Requires limited land acquisition.	Causes increased flood elevations and velocities which may cause bank instability.
Allows development of property adjacent to the river.	Creates possibility of potentially more damaging floods if levees are breached.
	Does not allow multiple uses of river area.
	Requires continued dredging.

3. Improved river crossings at 8th Street, 5th Street, and 6th Avenue

Advantages	Disadvantages
Reduces disruption of transportation during flooding.	Does not eliminate flooding problems for the majority of the study area.
Reduces water surface elevations during flooding in the vicinity of bridges.	Does not solve sedimentation problems.
Requires no right-of-way acquisition.	Requires continued dredging.

4a. Trapezoidal channelization (100-year design flow).

Advantages	Disadvantages
Eliminates flooding problems for 100-year recurrence intervals or less.	Limited multiple use opportunities.
Allows development of property adjacent to river.	Requires continued dredging.
Requires only 230 feet of right-of-way.	Meandering low-flow channel may develop causing bank instability.

4b. Trapezoidal channelization (50-year design flow).

Advantages	Disadvantages
Eliminates flooding problems for the 50-year recurrence interval or less.	Flooding problems for 100-year recurrence interval not eliminated.
Reduces floodway width, allowing some development.	Requires continued dredging.
Requires only 200 feet of right-of-way.	Limited multiple use opportunities.
	Meandering low-flow channel may develop causing bank instability.

5. Combination channel.

Advantages	Disadvantages
Eliminates flooding problems for 100-year recurrence interval or less.	Requires 300 feet of right-of-way.
Allows development to edge of channel.	
Provides future multiple use opportunities in the form of greenbelt or a recreational trail.	

6. Dredging to increase flow area.

Advantages	Disadvantages
No right-of-way acquisition required.	Does not eliminate flooding problems.
Lowers water surface elevation and groundwater table at some locations.	Requires continued annual dredging.
	May cause bank instability.
	May lower bridge pier capacity and/or create possibilities of piers being washed out.

Five alternatives were selected for further evaluation. These are:

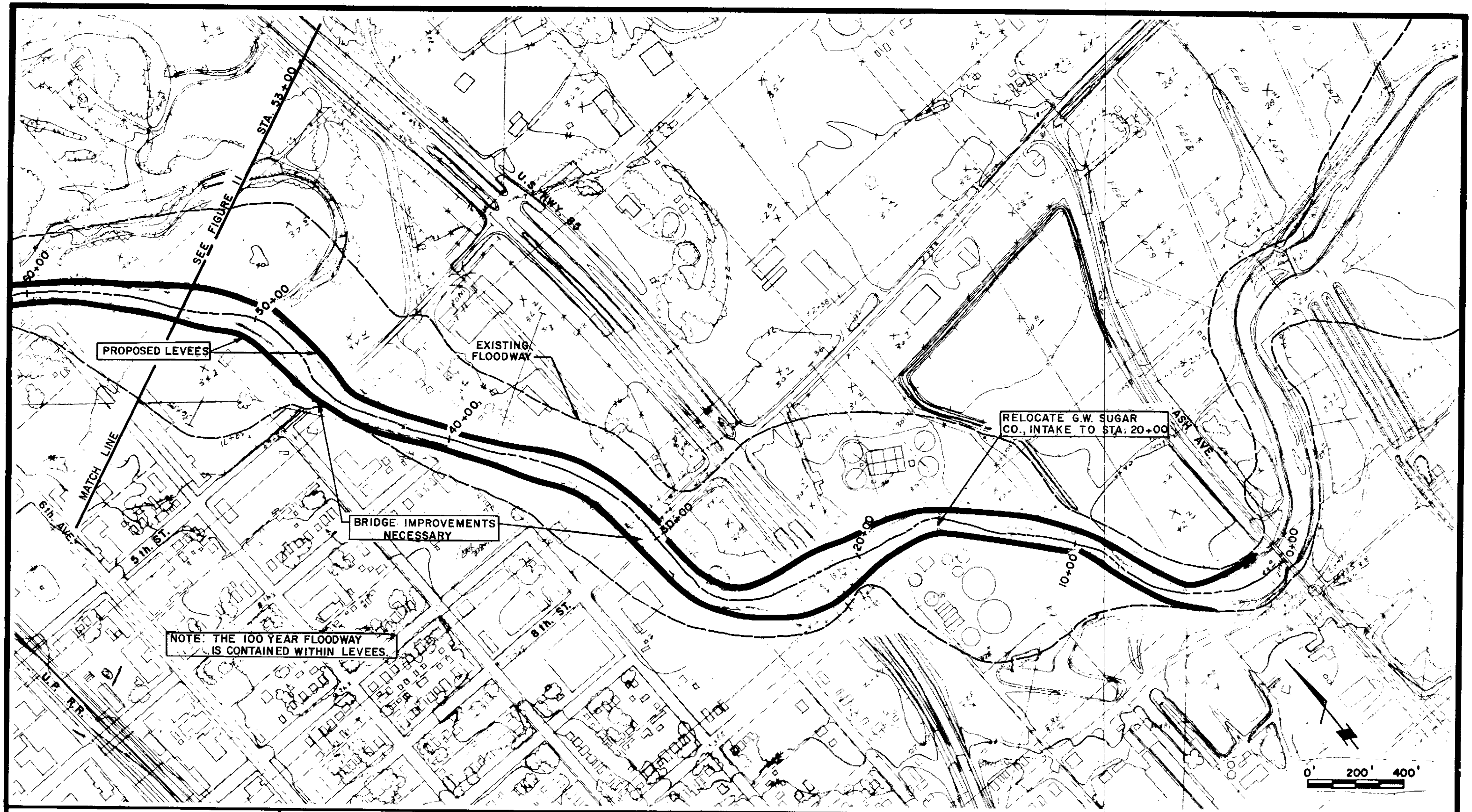
1. Maintain existing condition.
2. Improved flood control levees.
3a. Trapezoidal channel.
3b. Combination channel.
4. Combinations of improvements.

Improved river crossings at 8th Street, 5th Street, and 6th Avenue do not by themselves solve flooding problems, but are required in alternatives 2, 3a, 3b and 4 as part of the total flood control improvement alternative. Bridges at 8th Street and 5th Street require replacement or enlargement. Since 8th

Street is also Colorado Highway 263, the City should request the Colorado Department of Highways to place the structure in their improvement plan. Improvements also need to be made to the 6th Avenue crossing of the river. Three improvements were considered, namely (1) replacement of the bridge with a structure capable of passing the 100-year flood, (2) removal of the bridge, and (3) maintaining the existing bridge and providing an overflow roadway section. Either removal or replacement of the existing bridge will result in a better hydraulic section by eliminating the backwater condition created by flood overtopping of the existing bridge. Maintaining the existing bridge requires the use of flood control berms on the north and south side of the river. The total length of the berm is about 1,000 feet. This section between berms would be established as a floodway and no building improvements would be allowed. The floodway section includes property within the City on the south side of the river and property within Weld County on the north side of the river.

This study investigated the flood control aspects of the bridges. Before any selection of bridge alternatives is made, additional analysis regarding transportation needs should be completed. The structural integrity of the bridges also should be investigated to determine the feasibility of enlarging the existing structures. Dredging to increase channel capacity will not solve flooding problems and will create additional flooding and sedimentation problems downstream of the City.

All improvement alternatives (with the exception of maintaining the existing condition) require the replacement or enlargement of the 8th Street, 5th Street, and 6th Avenue bridges, and the relocation of the Great Western Sugar Company intake structure. Riprap protection is required at all outside channel bends. All alternatives, with the exception of the combination channel, require the trapping of sediment upstream of Greeley using an existing gravel pit or continued dredging. The improvement alternatives require the use of berms at the upstream study limit to guide flood flow into the improved channel. The improvement alternatives are depicted schematically in Figure 7 through 18.



MAPPING

1. BASE MAPS BY FALCON AIR MAPS.
2. TOPOGRAPHY COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS.
3. TOPOGRAPHY COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY TAKEN 1973.

NOTES

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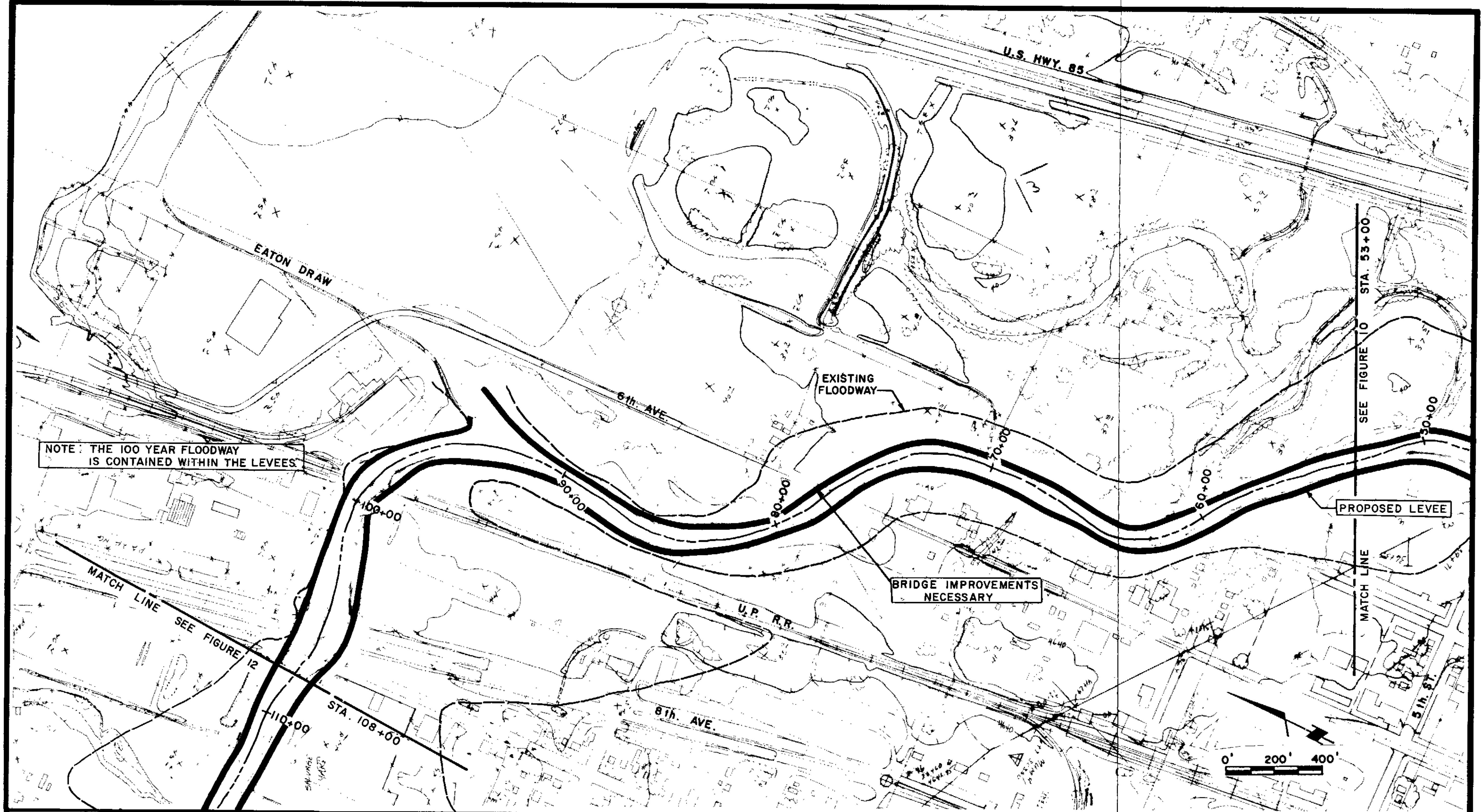
LEGEND

100 YEAR FLOODWAY LIMITS (EXISTING)

4 CHANNEL CROSS SECTION AND REFERENCE POINT 50+00

MASTER FLOODWAY PLAN
CACHE LA POUDRE RIVER
CITY OF GREELEY, COLORADO
COLORADO WATER CONSERVATION BOARD
ALTERNATIVE 2
LEVEE SYSTEM

FIGURE 10.



MAPPING

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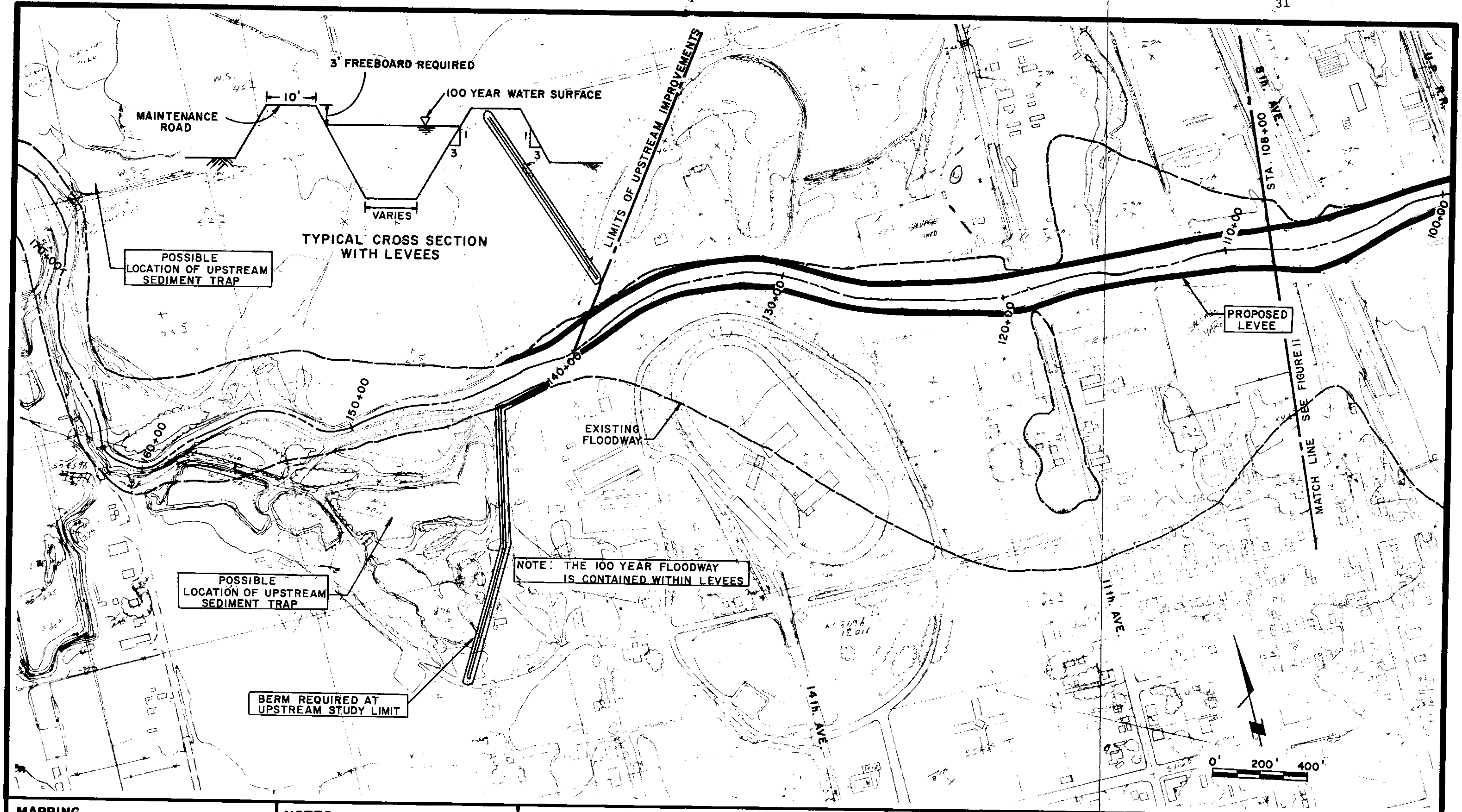
LEGEND

— — — 100 YEAR FLOODWAY LIMITS (EXISTING)

(4) CHANNEL CROSS SECTION AND REFERENCE POINT — 50+00

MASTER FLOODWAY PLAN
CACHE LA POUDRE RIVER
CITY OF GREELEY, COLORADO
COLORADO WATER CONSERVATION BOARD
ALTERNATIVE 2
LEVEE SYSTEM

FIGURE 11.



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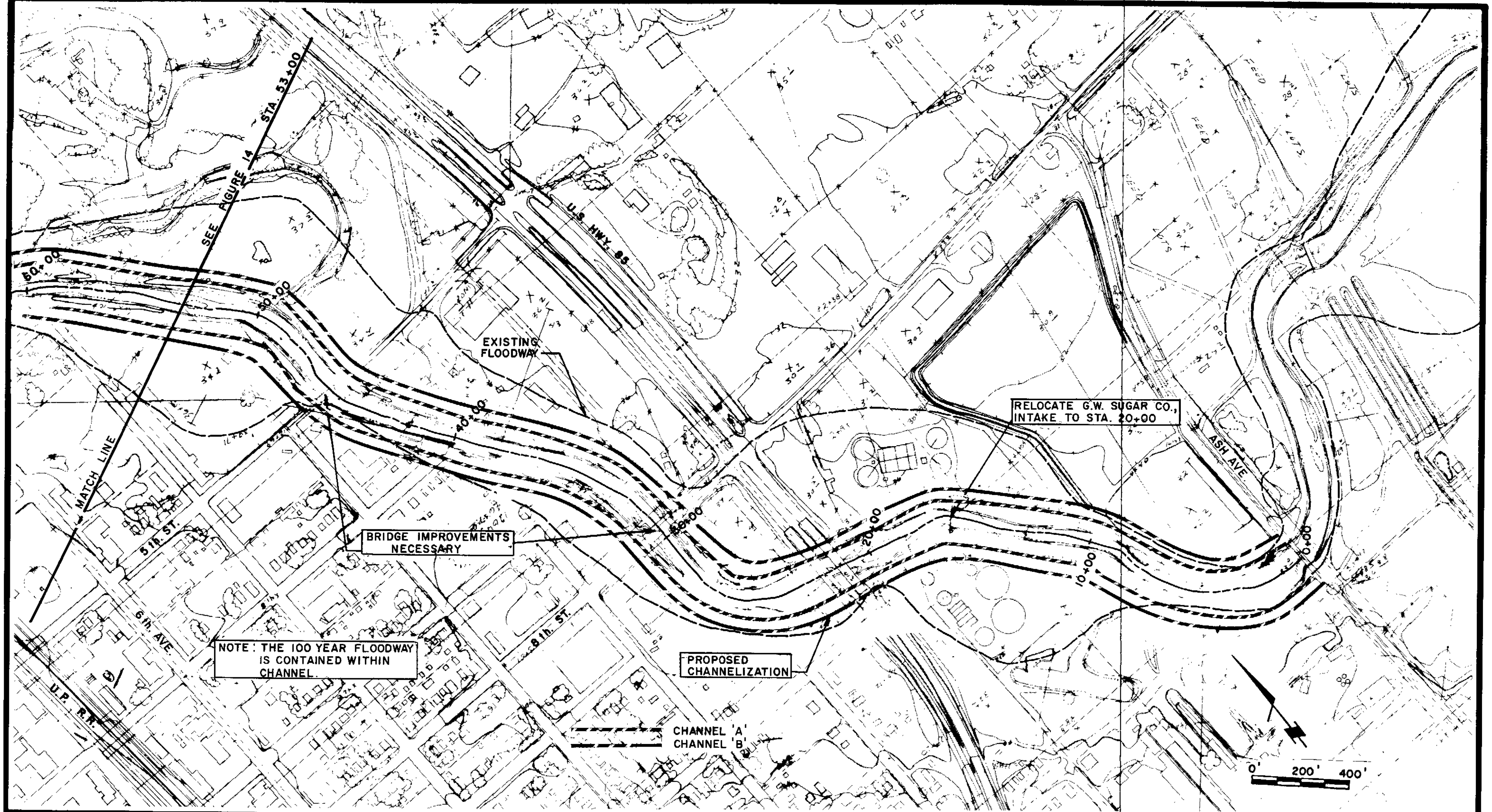
LEGEND

100 YEAR FLOODWAY LIMITS (EXISTING)

4 — 50+00 CHANNEL CROSS SECTION AND REFERENCE POINT

MASTER FLOODWAY PLAN
CACHE LA POUDRE RIVER
CITY OF GREELEY, COLORADO
COLORADO WATER CONSERVATION BOARD
ALTERNATIVE 2
LEVEE SYSTEM

FIGURE 12.



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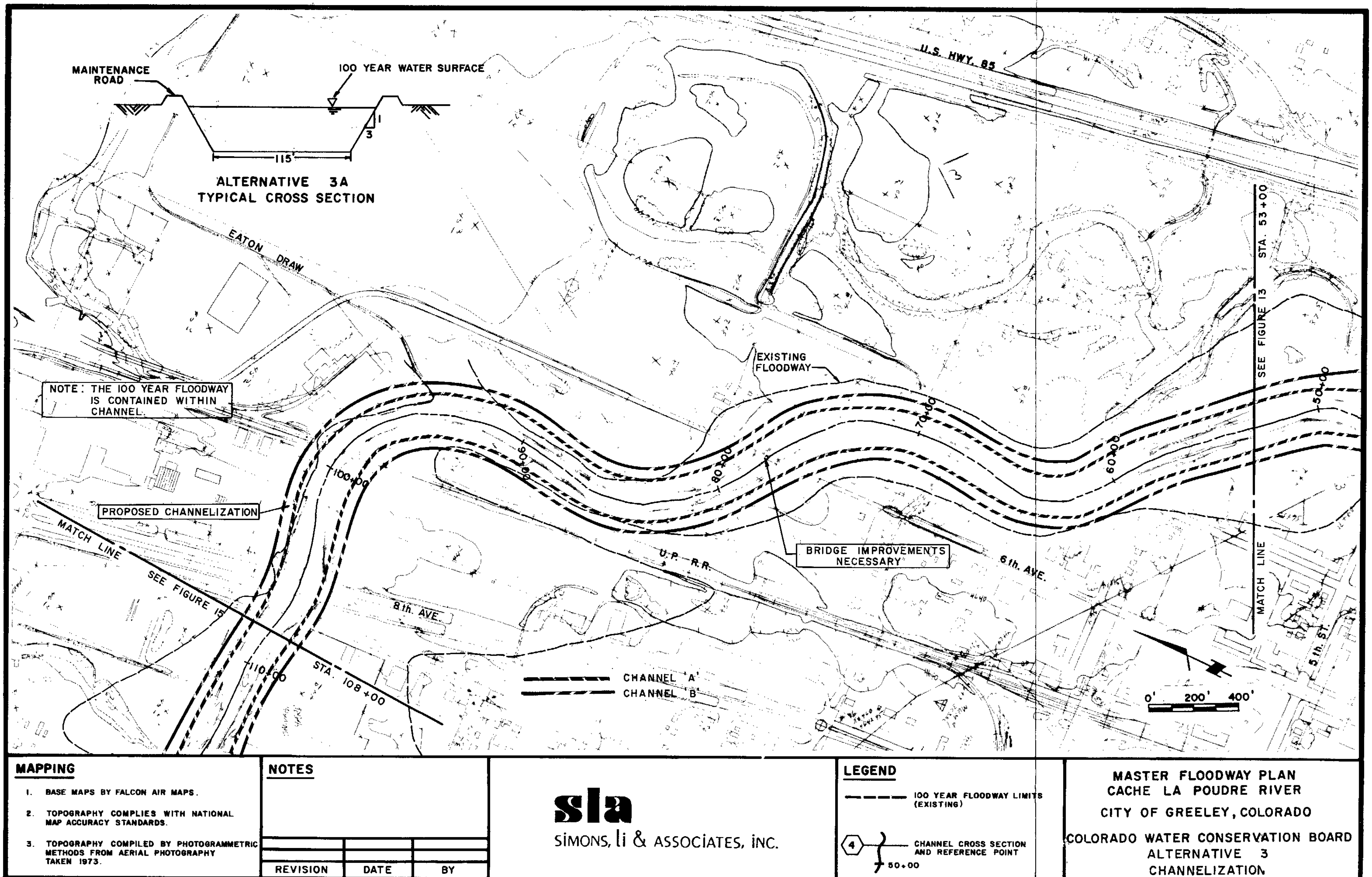
LEGEND

100 YEAR FLOODWAY LIMITS (EXISTING)

4 CHANNEL CROSS SECTION AND REFERENCE POINT 50+00

MASTER FLOODWAY PLAN
CACHE LA POUDRE RIVER
CITY OF GREELEY, COLORADO
COLORADO WATER CONSERVATION BOARD
ALTERNATIVE 3
CHANNELIZATION

FIGURE 13.


MAINTENANCE ROAD
100 YEAR WATER SURFACE
115'
1
3
ALTERNATIVE 3A
TYPICAL CROSS SECTION
U.S. HWY. 85
EATON DRAW
EXISTING FLOODWAY
NOTE: THE 100 YEAR FLOODWAY IS CONTAINED WITHIN CHANNEL.
PROPOSED CHANNELIZATION
BRIDGE IMPROVEMENTS NECESSARY
MATCH LINE SEE FIGURE 15
STA. 108+00
MATCH LINE SEE FIGURE 13 STA. 53+00
U.P. R.R.
6th. AVE.
8th. AVE.
5th. ST.
100+00
110+00
90+00
80+00
70+00
60+00
50+00
CHANNEL 'A'
CHANNEL 'B'
0' 200' 400'
MAPPING
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NOTES
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DATE
BY
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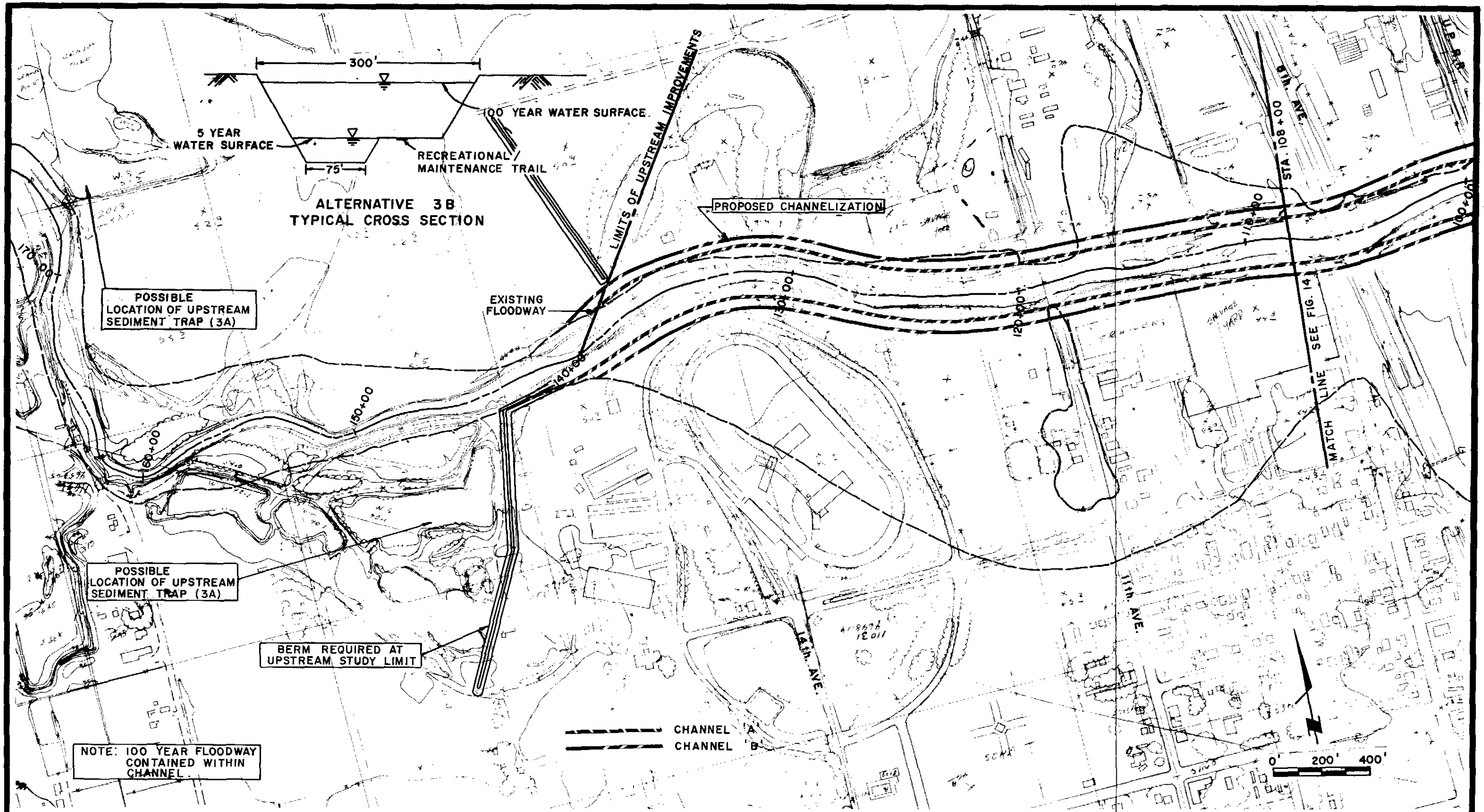
SIMONS, LI & ASSOCIATES, INC.
LEGEND
100 YEAR FLOODWAY LIMITS (EXISTING)
CHANNEL CROSS SECTION AND REFERENCE POINT
4
50+00
MASTER FLOODWAY PLAN
CACHE LA POUDRE RIVER
CITY OF GREELEY, COLORADO
COLORADO WATER CONSERVATION BOARD
ALTERNATIVE 3
CHANNELIZATION

FIGURE 14.



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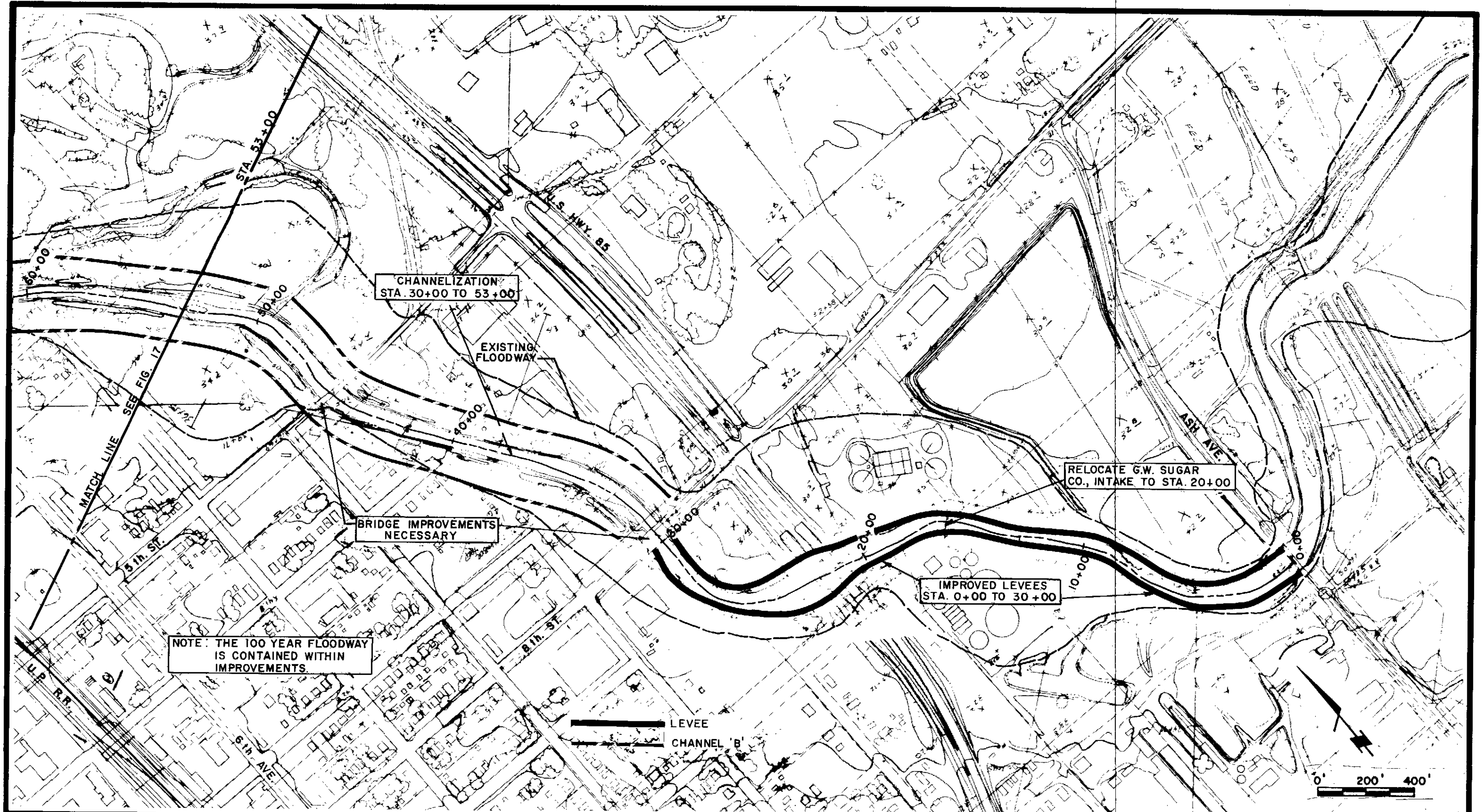
LEGEND

100 YEAR FLOODWAY LIMITS (EXISTING)

4 — CHANNEL CROSS SECTION AND REFERENCE POINT — 50+00

MASTER FLOODWAY PLAN
CACHE LA POUDRE RIVER
CITY OF GREELEY, COLORADO
COLORADO WATER CONSERVATION BOARD
ALTERNATIVE 3
CHANNELIZATION

FIGURE 15.



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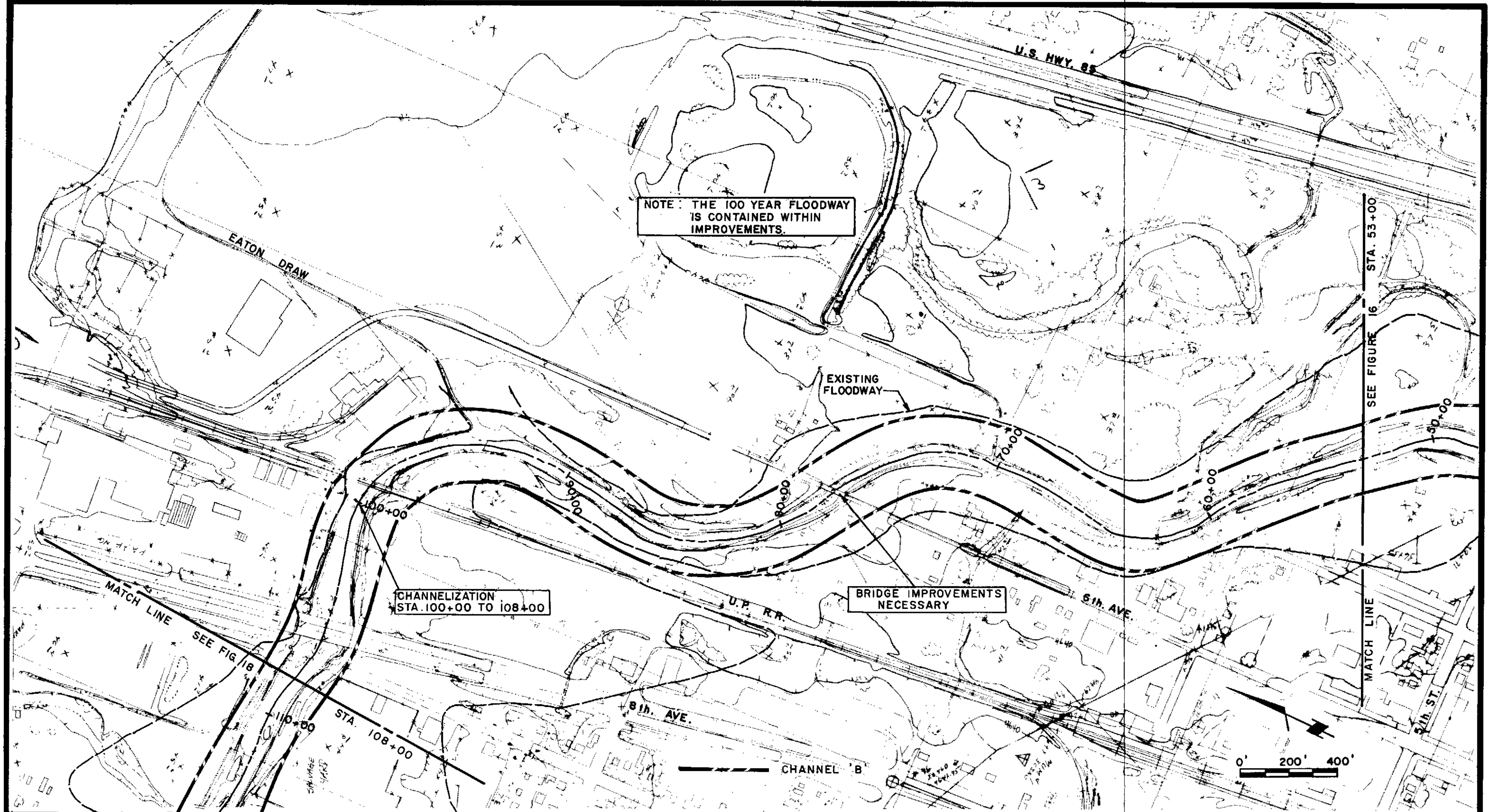
LEGEND

100 YEAR FLOODWAY LIMITS (EXISTING)

4 CHANNEL CROSS SECTION AND REFERENCE POINT 50+00

MASTER FLOODWAY PLAN
CACHE LA POUDRE RIVER
CITY OF GREELEY, COLORADO
COLORADO WATER CONSERVATION BOARD
ALTERNATIVE 4
FLOODWAY IMPROVEMENTS

FIGURE 16.



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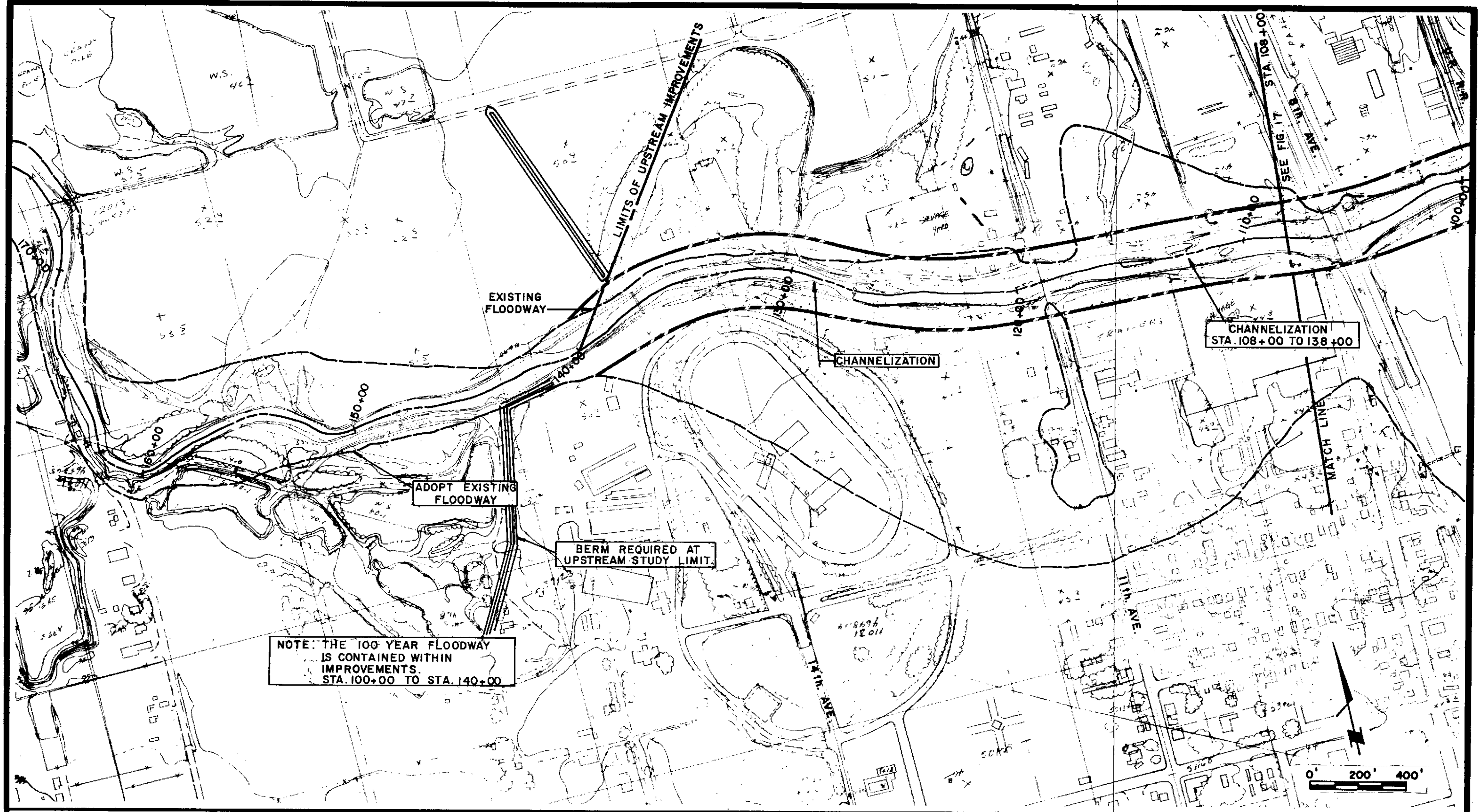
LEGEND

100 YEAR FLOODWAY LIMITS (EXISTING)

4 CHANNEL CROSS SECTION AND REFERENCE POINT 50+00

MASTER FLOODWAY PLAN
CACHE LA POUDRE RIVER
CITY OF GREELEY, COLORADO
COLORADO WATER CONSERVATION BOARD
ALTERNATIVE 4
FLOODWAY IMPROVEMENTS

FIGURE 17.



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LEGEND

100 YEAR FLOODWAY LIMITS (EXISTING)

CHANNEL CROSS SECTION AND REFERENCE POINT (4) 50+00

MASTER FLOODWAY PLAN
CACHE LA POUDRE RIVER
CITY OF GREELEY, COLORADO
COLORADO WATER CONSERVATION BOARD
ALTERNATIVE 4
FLOODWAY IMPROVEMENTS

FIGURE 18.

VI. SELECTION OF IMPROVEMENT ALTERNATIVES

Costs of Alternatives

Capital improvement costs were developed for the alternatives and are presented in Tables 4 through 7. The costs were developed in order to evaluate and compare the conceptual designs. Improvement costs have been divided into the following categories:

1. Bridge improvement.
2. Intake structure relocation.
3. Upstream sediment trap.
4. Flood control alternative.
5. Engineering and contingency costs.
6. Fiscal, legal, and administrative costs.

Land acquisition costs were not included for any alternatives. Bridge improvements and relocation of the Great Western Sugar Company diversion structure are common to all alternatives and have been considered as a separate item. A different unit cost was used for embankment material for Alternative 2 - Levees. A higher cost was assumed because the embankment material must be hauled in, while the other alternatives have excess material available.

Annual operation and maintenance costs were estimated for the alternatives. The estimated annual maintenance costs are $30,800 for improved levees, $27,300 for the trapezoidal channel, $10,500 for the combination channel and $11,250 for the combination of floodway improvements. These operation and maintenance costs include dredging (if necessary) and normal channel maintenance costs. Annualized costs were calculated for the alternatives using a 50-year project life and a 7-1/2 percent interest rate. Total annual costs for the flood control alternatives are summarized in Table 8. These costs do not reflect the costs of bridge replacement or land acquisition.

Benefits of Alternatives

Benefits of flood control projects can include the following:

1. Flood damage reduction.
2. Enhance property values of adjoining property.

3. Permit development/redevelopment of property within floodplain.
4. Tax revenue from additional property.
5. Improved aesthetics.
6. Reduction of nuisance problems.
7. Reduced operation and maintenance.
8. Multiple use opportunities.

Certain advantages and disadvantages are inherent in the different improvement alternatives. A matrix of advantages and disadvantages for each alternative is given in Table 9.

Recommended Alternative

The recommended alternative is Alternative 4, a combination of floodway improvements. The advantages of this alternative are:

1. Flooding is controlled for the 100-year event.
2. Use of levees through the wastewater treatment plant does not require additional right-of-way.
3. Development/redevelopment is allowed within the floodplain.
4. The combination channel is the best hydraulic section for flood conveyance.
5. Dredging requirements are reduced and other maintenance requirements are also reduced.
6. The combination channel has a positive visual appearance.
7. The combination channel allows future multiple uses as a greenbelt or for recreational opportunities.
8. The combination channel confines low flows to a smaller channel section, reducing vegetative growth in the channel, and eliminating stagnant water.
9. Property values are enhanced due to more pleasing appearance and reduced flooding.
10. This alternative has a lower annual cost than Alternatives 3A and 3B and is about the same as Alternative 2.

Table 4. Summary of Bridge Costs

Item		Amount
8TH STREET (COLORADO HIGHWAY 263)		
Replace Bridge		
Bridge Area	200 feet x 36 feet = 7,200 square feet	
Unit Cost	$65 per square foot	
Bridge Cost		$468,000
Removal of Existing Structure		10,000
CONSTRUCTION COST		$478,000
ENGINEERING AND CONTINGENCY COSTS (35 percent of Construction Cost)		163,300
FISCAL, LEGAL, AND ADMINISTRATIVE COSTS (7 percent of Construction Cost)		33,460
TOTAL ESTIMATED COST		$674,760
Enlarge Bridge		
Bridge Area	100 feet x 36 feet = 3,600 square feet	
Unit Cost	$75 per square foot	
CONSTRUCTION COST		$270,000
ENGINEERING AND CONTINGENCY COSTS (35 percent of Construction Cost)		94,500
FISCAL, LEGAL, AND ADMINISTRATIVE COSTS (7 percent of Construction Cost)		18,900
TOTAL ESTIMATED COST		$383,400

Table 4 (continued).

Item		Amount
5TH STREET		
Replace Bridge		
Bridge Area	250 feet x 36 feet = 9,000 square feet	
Unit Cost	$65 per square foot	
Bridge Cost		$585,000
Removal of Existing Structure		10,000
CONSTRUCTION COST		$595,000
ENGINEERING AND CONTINGENCY COSTS (35 percent of Construction Cost)		208,250
FISCAL, LEGAL, AND ADMINISTRATIVE COSTS (7 percent of Construction Cost)		41,650
TOTAL ESTIMATED COST		$844,900
Enlarge Bridge		
Bridge Area	75 feet x 36 feet = 2,700 square feet	
Unit Cost	$75 per square foot	
CONSTRUCTION COST		$202,500
ENGINEERING AND CONTINGENCY COSTS (35 percent of Construction Cost)		70,875
FISCAL, LEGAL, AND ADMINISTRATIVE COSTS (7 percent of Construction Cost)		14,175
TOTAL ESTIMATED COST		$287,550

Table 4 (continued).

Item		Amount
6TH AVENUE		
Replace Bridge		
Bridge Area	250 feet x 36 feet = 9,000 square feet	
Unit Cost	$65 per square foot	
Bridge Cost		$585,000
Removal of Existing Structure		10,000
CONSTRUCTION COST		$595,000
ENGINEERING AND CONTINGENCY COSTS (35 percent of Construction Cost)		208,250
FISCAL, LEGAL, AND ADMINISTRATIVE COSTS (7 percent of Construction Cost)		41,650
TOTAL ESTIMATED COST		$844,900
Enlarge Bridge		
Bridge Area	125 feet x 36 feet = 4,500 square feet	
Unit Cost	$75 per square foot	
CONSTRUCTION COST		$337,500
ENGINEERING AND CONTINGENCY COSTS (35 percent of Construction Cost)		118,125
FISCAL, LEGAL, AND ADMINISTRATIVE COSTS (7 percent of Construction Cost)		23,625
TOTAL ESTIMATED COST		$479,250

Table 4 (continued).

Item	Amount
Eliminate Bridge and Provide Cul-de-sac	
Remove Existing Structure	$ 10,000
Regrade Roadway	5,000
CONSTRUCTION COST	$ 15,000
ENGINEERING AND CONTINGENCY COSTS (35 percent of Construction Cost)	5,250
FISCAL, LEGAL, AND ADMINISTRATIVE COSTS (7 percent of Construction Cost)	1,050
TOTAL ESTIMATED COST	$ 21,300
Construct Overflow Path to Convey High Water Around Existing Bridge	
Regrade Roadway	$ 50,000
Construct Berm	43,000
CONSTRUCTION COST	$ 93,000
ENGINEERING AND CONTINGENCY COSTS (35 percent of Construction Cost)	32,550
FISCAL, LEGAL, AND ADMINISTRATIVE COSTS (7 percent of Construction Cost)	6,510
TOTAL ESTIMATED COST	$132,060

NOTE: Land acquisition costs are NOT included. The option to construct an overflow path around the existing bridge eliminates the need for approximately 700 feet of channel improvements at a savings of about $104,000.

Table 5. Cost to Relocate Intake Structure.

Item	Amount
Encase Sewer Line Crossing 160 cubic yards of reinforced concrete at $400.00 per cubic yard	$ 64,000
New Gate Structure	2,000
600 feet of 12-inch pipe at $15.00 per foot	9,000
New Channel Check Structure 47 cubic yards of concrete at $300.00 per cubic yard	14,000
Remove Existing Structure	10,000
CONSTRUCTION COST	$ 99,000
ENGINEERING AND CONTINGENCY COSTS (35 percent of Construction Cost)	34,700
FISCAL, LEGAL, AND ADMINISTRATIVE COSTS (7 percent of Construction Cost)	6,900
TOTAL COST	$140,600

Table 6. Cost of Upstream Sediment Trap.

Item	Amount
Channel Excavation 17,000 cubic yards at $3.00 per cubic yard	$ 51,000
Control Structures (two) 190 cubic yards at $300.00 per cubic yard	57,000
Dredge Existing Pit 4,000 cubic yards at $3.00 per cubic yard	12,000
Embankment at Pit 3,300 cubic yards at $6.00 per cubic yard	19,800
CONSTRUCTION COST	$139,800
ENGINEERING AND CONTINGENCY COSTS (35 percent of Construction Cost)	48,900
FISCAL, LEGAL, AND ADMINISTRATIVE COSTS (7 percent of Construction Cost)	9,800
TOTAL COST	$198,500

Table 7. Alternative Improvement Costs.

Item	Amount
ALTERNATIVE 2 - IMPROVED LEVEES	
Embankment 160,000 cubic yards at $6.00 per cubic yard	$ 960,000
Excavation 81,000 cubic yards at $3.00 per cubic yard	243,000
Riprap 4,000 cubic yards at $45.00 per cubic yard	180,000
CONSTRUCTION COST	$1,383,000
ENGINEERING AND CONTINGENCY COSTS (35 percent of Construction Cost)	484,100
FISCAL, LEGAL, AND ADMINISTRATIVE COSTS (7 percent of Construction Cost)	96,800
TOTAL COST - ALTERNATIVE 2 (Channel Improvements Only)	$1,963,900

Table 7 (continued).

Item	Amount
ALTERNATIVE 3A - TRAPEZOIDAL CHANNEL	
Embankment 158,000 cubic yards at $3.00 per cubic yard	$ 474,000
Excavation 253,000 cubic yards at $3.00 per cubic yard	759,000
Riprap 4,000 cubic yards at $45.00 per cubic yard	180,000
Seeding	10,000
Relocation of Utilities	50,000
CONSTRUCTION COST	$1,473,000
ENGINEERING AND CONTINGENCY COSTS (35 percent of Construction Cost)	515,600
FISCAL, LEGAL, AND ADMINISTRATIVE COSTS (7 percent of Construction Cost)	103,100
TOTAL COST - ALTERNATIVE 3A (Channel Improvements Only)	$2,091,700

Table 7 (continued).

Item	Amount
ALTERNATIVE 3B - COMBINATION CHANNEL	
Embankment 158,000 cubic yards at $3.00 per cubic yard	$ 474,000
Excavation 478,000 cubic yards at $3.00 per cubic yard	$1,434,000
Riprap 1,170 cubic yards at $45.00 per cubic yard	53,000
Seeding	10,000
Relocation of Utilities	50,000
CONSTRUCTION COST	$2,021,000
ENGINEERING AND CONTINGENCY COSTS (35 percent of Construction Cost)	707,000
FISCAL, LEGAL, AND ADMINISTRATIVE COSTS (7 percent of Construction Cost)	141,000
TOTAL COST - ALTERNATIVE 3B (Channel Improvements Only)	$2,869,000

Table 7 (continued).

Item	Amount
ALTERNATIVE 4 - COMBINATION OF IMPROVEMENTS	
Reach 1 and 2 - Levees	
Embankment 30,000 cubic yards at $6.00 per cubic yard	$ 180,000
Excavation 8,300 cubic yards at $3.00 per cubic yard	25,000
Riprap 400 cubic yards at $45.00 per cubic yard	18,000
Subtotal	$ 223,000
Reach 3 - Combination Channel	
Embankment 15,000 cubic yards at $3.00 per cubic yard	$ 45,000
Excavation 30,000 cubic yards at $3.00 per cubic yard	$ 90,000
Seeding	2,000
Relocation of Utilities	10,000
Subtotal	$ 147,000

Table 7 (continued).

Item		Amount
Reach 4 - Combination Channel		
Embankment 55,000 cubic yards at $3.00 per cubic yard		$ 165,000
Excavation 148,000 cubic yards at $3.00 per cubic yard		444,000
Riprap 800 cubic yards at $45.00 per cubic yard		36,000
Seeding		2,000
	Subtotal	$ 647,000
Reach 5 - Combination Channel		
Embankment 65,000 cubic yards at $3.00 per cubic yard		$ 195,000
Excavation 63,000 cubic yards at $3.00 per cubic yard		189,000
Seeding		2,000
Relocation of Utilities		10,000
	Subtotal	$ 396,000
Reach 6 - Combination Channel		
Excavation 94,400 cubic yards at $3.00 per cubic yard		$ 283,000
Seeding		2,000
Relocation of Utilities		10,000
	Subtotal	$ 295,000

Table 7 (continued).

Item	Amount
Reach 1 and 2 - Levees	$ 223,000
Reach 3 - Combination Channel	147,000
Reach 4 - Combination Channel	647,000
Reach 5 - Combination Channel	396,000
Reach 6 - Combination Channel	295,000
CONSTRUCTION COST	$1,708,000
ENGINEERING AND CONTINGENCY COSTS (35 percent of Construction Cost)	597,800
FISCAL, LEGAL, AND ADMINISTRATIVE COSTS (7 percent of Construction Cost)	119,600
TOTAL COST - ALTERNATIVE 4 (Channel Improvements Only)	$2,425,400

Table 8. Summary of Alternative Improvement Costs.

Item	Alternative 2 Improved Levees	Alternative 3A Trapezoidal Channel	Alternative 3B Combination Channel	Alternative 4 Combination of Floodway Improvements
Relocation of Great Western Sugar Co. Intake Structure	$ 140,600	$ 140,600	$ 140,600	$ 140,600
Upstream Sediment Trap	198,500	198,500	---	---
Alternative Cost	1,963,900	2,091,700	2,869,000	2,435,400
TOTAL CHANNEL IMPROVEMENT COST	$2,303,100	$2,430,800	$3,009,600	$2,566,000
Annualized Cost of Channel Improvements Construction	$177,570	$187,400	$232,000	$197,800
Annual Channel Maintenance Cost	30,800	27,300	10,500	11,250
TOTAL ANNUAL CHANNEL IMPROVEMENT COST	$208,370	$214,700	$242,500	$209,050

Table 8 (continued).

Item	Alternative 2 Improved Levees	Alternative 3A Trapezoidal Channel	Alternative 3B Combination Channel	Alternative 4 Combination of Floodway Improvements
Range of Bridge Cost*	$ 692,250 to 2,368,560	$ 692,250 to 2,368,560	$ 692,250 to 2,368,960	$ 692,250 to 2,368,960
Range of Annual Cost of Bridges	$ 53,370 to 182,310	$ 53,370 to 182,310	$ 53,370 to 182,310	$ 53,370 to 182,310
TOTAL PROJECT COST RANGE	$2,995,350 to 4,671,660	$3,123,050 to 4,779,360	$3,701,850 to 5,378,160	$3,258,250 to 4,934,560
TOTAL ANNUAL PROJECT COST	$ 261,740 to 390,980	$ 268,070 to 397,910	$ 295,870 to 425,110	$ 262,420 to 391,660

* See Table 4 for detailed bridge costs.

NOTE: The costs shown include the replacement or enlargement of the 8th Street bridge. If the Colorado Department of Highways elects to perform this work, cost savings to the City of betwwen $383,000 and $675,000 may be realized.

Table 9. Evaluation Matrix.

Objective	Maintain Existing Condition +	Maintain Existing Condition -	Improved Levees +	Improved Levees -	Trapezoidal Channel +	Trapezoidal Channel -	Combination Channel +	Combination Channel -	Combination Channel and Levees +	Combination Channel and Levees -
Damage Reduction		No damage reduction.	Controls flooding for 100-year event.	Can increase flood damages should levees fail.	Controls flooding for 100-year event.		Controls flooding for 100-year event.		Controls flooding for 100-year event.	
Enhance Property Values		No change.	Removes land from floodplain.		Removes land from floodplain.		Removes land from floodplain and better apperance.		Removes land from floodplain and better appearance.	
Additional Area for Development		No change.	Allows development.		Allows development.		Allows development.		Allows development.	
Aesthetics		No change.		Detracts from the view.		No significant change.	Positive effects.		Positive effects.	
Nuisance Reduction		No change.		No change.		Can cause excessive growth of vegetation and stagnant water.	Reduces problems.		Reduces problems.	
Operation and Maintenance		No change.		Increases maintenance.		Increases maintenance.	Reduces maintenance.		Reduces maintenance.	
Multiple Use Opportunities		No change.		Does not allow any other use.		Does not allow any other use.	Allows future development as greenbelt or recreation.		Allows future development as greenbelt or recreation.	
Capital Improvement Cost (not including bridges)	$ 0		$2,303,000		$2,430,800		$3,009,600		$2,566,000	
Annual Operation and Maintenance Cost	$27,300		$ 30,800		$ 27,300		$ 10,500		$ 11,250	
Annual Cost (50-Year Project Life)	$27,300		$ 208,370		$ 214,700		$ 242,500		$ 209,050	

VII. PRELIMINARY DESIGN OF RECOMMENDED ALTERNATIVE

The recommended alternative is Alternative 4, a combination of floodway improvements. Detailed hydraulic analyses were performed to size the improvements and to analyze the sediment transport characteristics of the proposed channel. Several different channel cross sections are utilized to meet the hydraulic and sediment transport requirements within the study reach. Limited right-of-way is available at the wastewater treatment plant due to the construction of improvements within the floodplain. A trapezoidal channel with 95-foot bottom width is proposed through the wastewater treatment plant. Improved flood control levees are required from the U.S. 85 Bypass to Ash Avenue to continue the 100-year flood to the channel section. A trapezoidal channel with 115-foot bottom width is required from 8th Street to the wastewater treatment plant and from the downstream part of the treatment plant to Ash Avenue. This section is approximately the same width as the existing channel. The channel improvements through the Union Pacific Railroad also utilize a trapezoidal channel with 115-foot bottom width to match the bridge section. The remaining channel improvements consist of a combination channel. The low-flow part of the combination channel has a 95-foot bottom width. The overbank section is about 78 feet wide. The low-flow channel has a capacity of 2,300 cfs which corresponds to a 5-year peak flow. All channels have a total capacity of 10,800 cfs which is the 100-year peak flow.

Riprap is required on outside bends to control local scouring. Bridge approaches also require riprap to control scour.

The combination channel was sized to match the sediment transport capacity of the natural channel upstream of the City. The low-flow channel geometry was selected to match the upstream 5-year sediment transport capacity and the total channel was sized to match the upstream 100-year transport capacity. Where the combination channel meets the trapezoidal sections, a smooth transition section is proposed. The minimum transition length is 100 feet. Some sediment deposition may still occur because sediment transport cannot be balanced for every flow condition, but dredging requirements are greatly reduced and should be limited to short sections of the channel.

A levee must be constructed adjacent to the proposed channel in some locations due to topographic constraints. This levee must have three feet of freeboard to meet FEMA requirements. Levees are not required where the existing ground is higher than the proposed channel banks. At some locations

the proposed 100-year water surface is higher than the existing 100-year water surface. This increase in water surface is required because the existing floodplain is very wide and shallow and the proposed channel section confines the flow to a width of no more than 250 feet. The channel bottom cannot be lowered very much because the overall channel slope is very mild and channel bottom elevations must match the existing channel bottom at the upstream and downstream end of the project. This rise in water surface will not have any effect on flooding because flow is confined to the channel.

New bridges are shown in the preliminary design at 8th Street, 5th Street, and 6th Avenue, but the bridge alternatives previously mentioned should be investigated prior to final design.

The Great Western Sugar Company diversion structure should be removed from the present location at the wastewater treatment plant and relocated upstream to a location close to the U.S. 85 Bypass bridge. Detailed construction plans of the diversion structure were not available and this structure should be inspected to determine the requirements for future construction. The sewer lines crossing under the diversion structure should be protected with a concrete encasement to prevent scouring which could damage or wash out the sewer lines.

Flood flows must be conveyed from the area upstream of the study area to the proposed improved channel at the upstream limit of improvements. A berm must be constructed to force the flood flows into the proposed improvements. At present, the floodplain in the upstream area is very wide but the floodway adapted by Weld County is only slightly wider than the proposed channel. The berm is required for the present, but as development occurs within the floodplain, which requires filling the land to an elevation above the 100-year flood level, portions of the berm may be removed. Eventually if the area is developed to the limits of the floodway the berm will be totally eliminated and only a short transition section will be required from the county floodway to the proposed channel.

The pedestrian bridge at Island Grove Park would probably be washed away during the 100-year flood but no improvements are proposed at this time. If the City desires to keep the pedestrian bridge, it should be elevated above the 100-year water surface. If the bridge is not desired, it should be removed.

Access to the proposed channel improvements is essential for proper operation and maintenance. Where the combination channel is proposed, a maintenance trail should be located in the overbank section. This trail can be used for maintenance on the low-flow channel and also provide recreational opportunities in the form of bike/hike trail. Where the combination channel is not feasible due to right-of-way constraints, a road should be constructed on the levee.

Project Costs

Project costs were estimated for channel improvements, bridge improvements, engineering and contingencies, and fiscal, legal and administrative costs. Costs for excavation and embankment were developed by consulting with a local contractor assuming that excess excavated material would be utilized by adjacent property owners as fill material and embankment material would be available at the site. Costs for land acquisition were estimated by measuring the area from the existing channel bank to the proposed right-of-way line. The estimated cost used for developable commercial, industrial, and multiple unit residential property was $30,000 per acre.

Costs were developed by reaches and a summary of costs is given in Table 10.

The preliminary design is presented in Figures 19 through 26. Figure 19 is an index sheet, Figures 20, 21, and 22 depict the plan view, Figures 23, 24, and 25 show the profile, and Figure 26 shows typical cross sections.

Future Study Requirements

Future engineering studies should be conducted to analyze the transportation needs of the 6th Avenue area. The existing bridges at 8th Street, 5th Street and 6th Avenue should be evaluated by a qualified structural engineer to determine if raising and enlarging the existing structures is feasible.

The mapping for this project was completed in 1973. Prior to final design of the improvements, the mapping should be updated and tied into the City benchmark system. The mapping must also be compared to the benchmarks used for flood studies upstream and downstream of the City. Significant changes in topography may result in changes to certain portions of the preliminary design, and these topographic changes should be identified as soon as possible.

Table 10. Estimated Cost of Recommended Alternative.

Item	Amount
COMBINATION OF CHANNEL IMPROVEMENTS	
Channel Improvements	
Reach 1 - Ash Avenue to U.S. 85 (Bypass)	
Embankment 5,290 cubic yards at $2.00 per cubic yard	$ 10,580
Excavation 13,780 cubic yards at $0.75 per cubic yard	10,310
Riprap 390 cubic yards at $45.00 per cubic yard	17,550
Reclocate Diversion Structure	99,000
Seeding	1,000
TOTAL CHANNEL IMPROVEMENTS - Reach 1	$ 138,440
Reach 2 - U.S. 85 to 8th Street	
Clearing and Grubbing	$ 1,000
Embankment 5,290 cubic yards at $2.00 per cubic yard	10,580
Excavation 17,460 cubic yards at $0.75 per cubic yard	13,100
Riprap 195 cubic yards at $45.00 per cubic yard	8,780
Utility Relocation	19,000
Seeding	1,000
Land Acquisition 1.65 acres of commercial property at $30,000 per acre	49,500
TOTAL CHANNEL IMPROVEMENTS - Reach 2	$ 102,960

Table 10 (continued).

Item	Amount
Reach 3 - 8th Street to 5th Street	
Clearing and Grubbing	$ 1,000
Embankment 14,660 cubic yards at $2.00 per cubic yard	29,320
Excavation 51,420 cubic yards at $0.75 per cubic yard	38,570
Utility Relocation	10,500
Seeding	1,000
Land Acquisition 3.20 acres of commercial/industrial property at $30,000 per acre	96,000
TOTAL CHANNEL IMPROVEMENTS - Reach 3	$ 176,390
Reach 4 - 5th Street to Union Pacific Railroad	
Clearing and Grubbing	$ 1,000
Embankment 42,900 cubic yards at $2.00 per cubic yard	85,800
Excavation 104,260 cubic yards at $0.75 per cubic yard	78,200
Riprap 585 cubic yards at $45.00 per cubic yard	26,330
Utility Relocation	4,200
Seeding	2,500
Land Acquisition 18.6 acres of industrial property at $30,000 per acre	558,000
TOTAL CHANNEL IMPROVEMENTS - Reach 4	$ 765,030

Table 10 (continued).

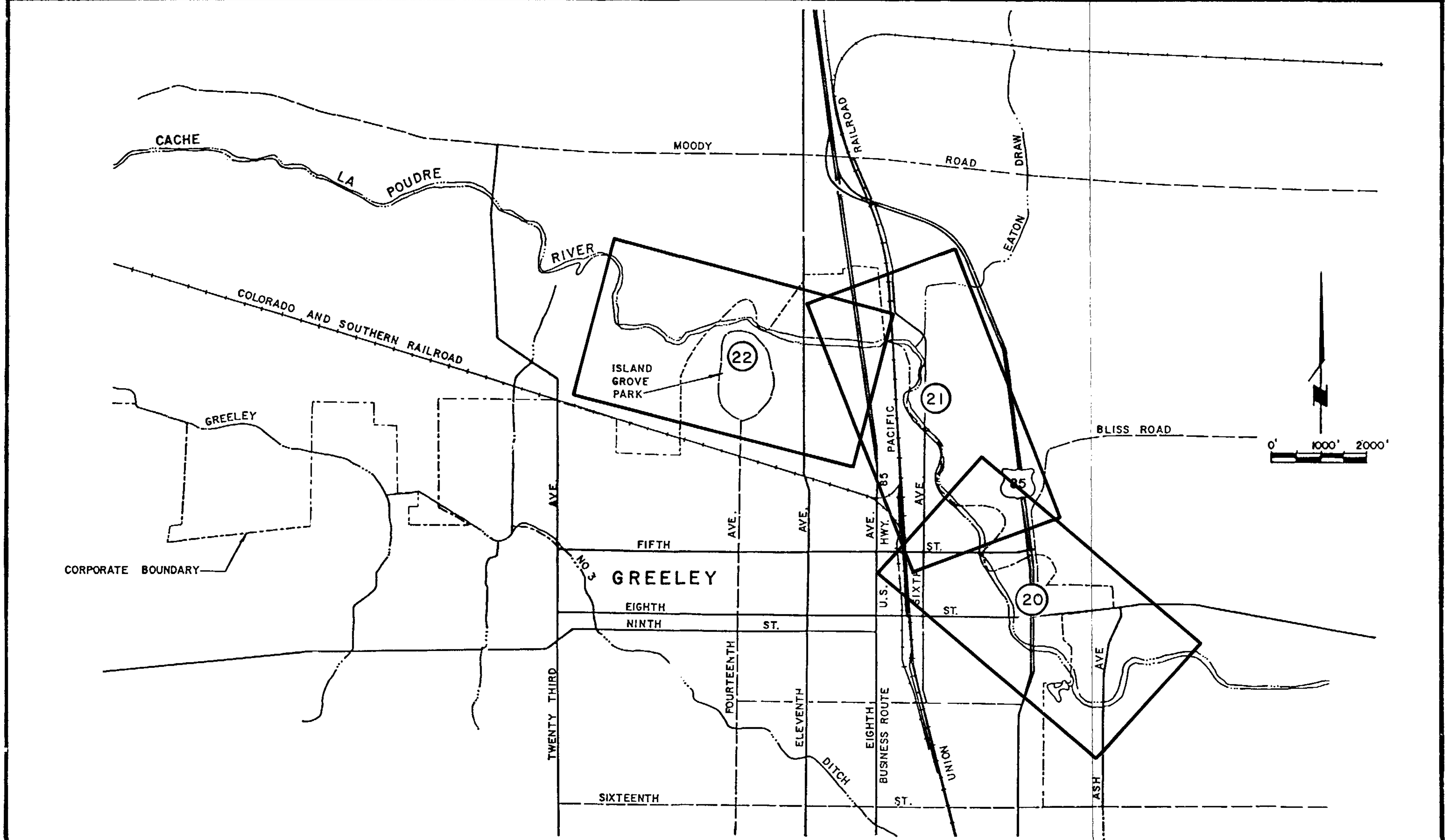
Item	Amount
Reach 5 - Union Pacific Railroad to 11th Avenue	
Clearing and Grubbing	$ 5,000
Embankment 52,200 cubic yards at $2.00 per cubic yard	104,400
Excavation 114,570 cubic yards at $0.75 per cubic yard	85,930
Seeding	2,500
Land Acquisition 2.3 acres of industrial/multiple unit residential property at $30,000 per acre	69,000
TOTAL CHANNEL IMPROVEMENTS - Reach 5	$ 266,830
Reach 6 - 11th Avenue to Island Grove Park (upstream study limit)	
Clearing and Grubbing	$ 10,000
Embankment (including upstream diversion berm) 29,425 cubic yards at $2.00 per cubic yard	58,850
Excavation 84,650 cubic yards at $0.75 per cubic yard	63,490
Utility Relocation	5,000
Seeding	2,500
TOTAL CHANNEL IMPROVEMENTS - Reach 6	$ 139,840
TOTAL CHANNEL IMPROVEMENTS (Reach 1 through 6)	$1,589,490

Table 10 (continued).

Item	Amount
Bridge Improvements	
8th Street	$ 0 - $ 478,000*
5th Street	202,000 - 595,000
6th Avenue	15,000 - 595,000
TOTAL BRIDGE COST	$217,000 - $1,668,000
Estimated Construction Cost	
Channel and Bridge Improvements	$1,806,490 - $3,257,490
ENGINEERING AND CONTINGENCIES (25 percent of Construction Cost)**	451,620 - 814,370
FISCAL, LEGAL AND ADMINISTRATIVE COSTS (7 percent of Construction Cost)	126,490 - 228,020
TOTAL PROJECT COST RANGE	$2,384,600 - $4,299,880

* No cost to City If Colorado Department of Highways replaces bridge.

** Lower rate used because preliminary engineering has been done.

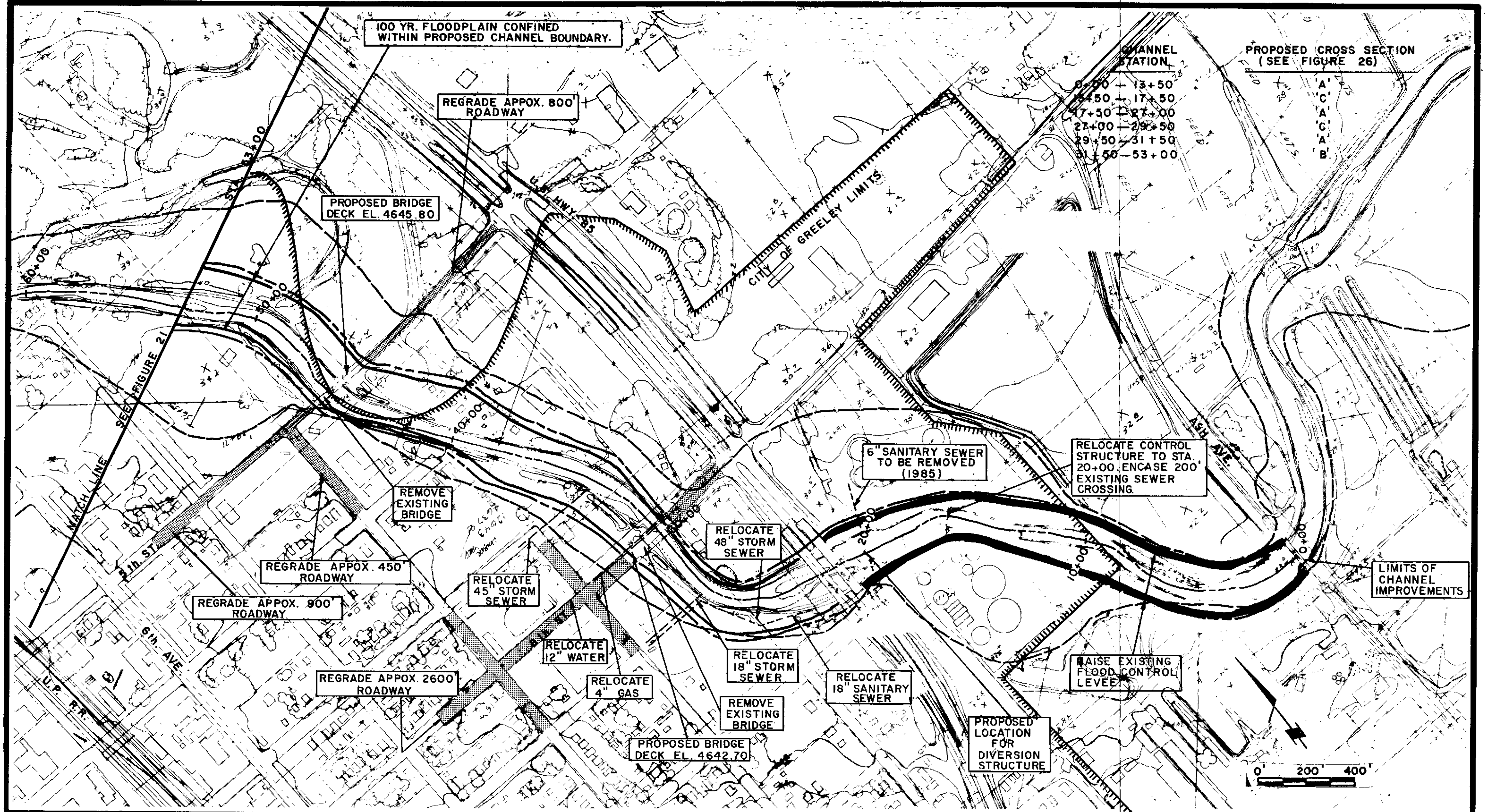


COLORADO WATER CONSERVATION BOARD
AND
CITY OF GREELEY

sla
SIMONS, LI & ASSOCIATES, INC.

INDEX MAP
PRELIMINARY DESIGN
CACHE LA POUDRE RIVER
JULY 1983

FIGURE 19.



MAPPING

1. BASE MAPS BY FALCON AIR MAPS.
2. TOPOGRAPHY COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS.
3. TOPOGRAPHY COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY TAKEN 1973.

NOTES

1. FOR LOCATION OF FIGURE, SEE INDEX MAP, PLATE 19
2. FOR PROFILE, SEE FIGURE 23

REVISION	DATE	BY

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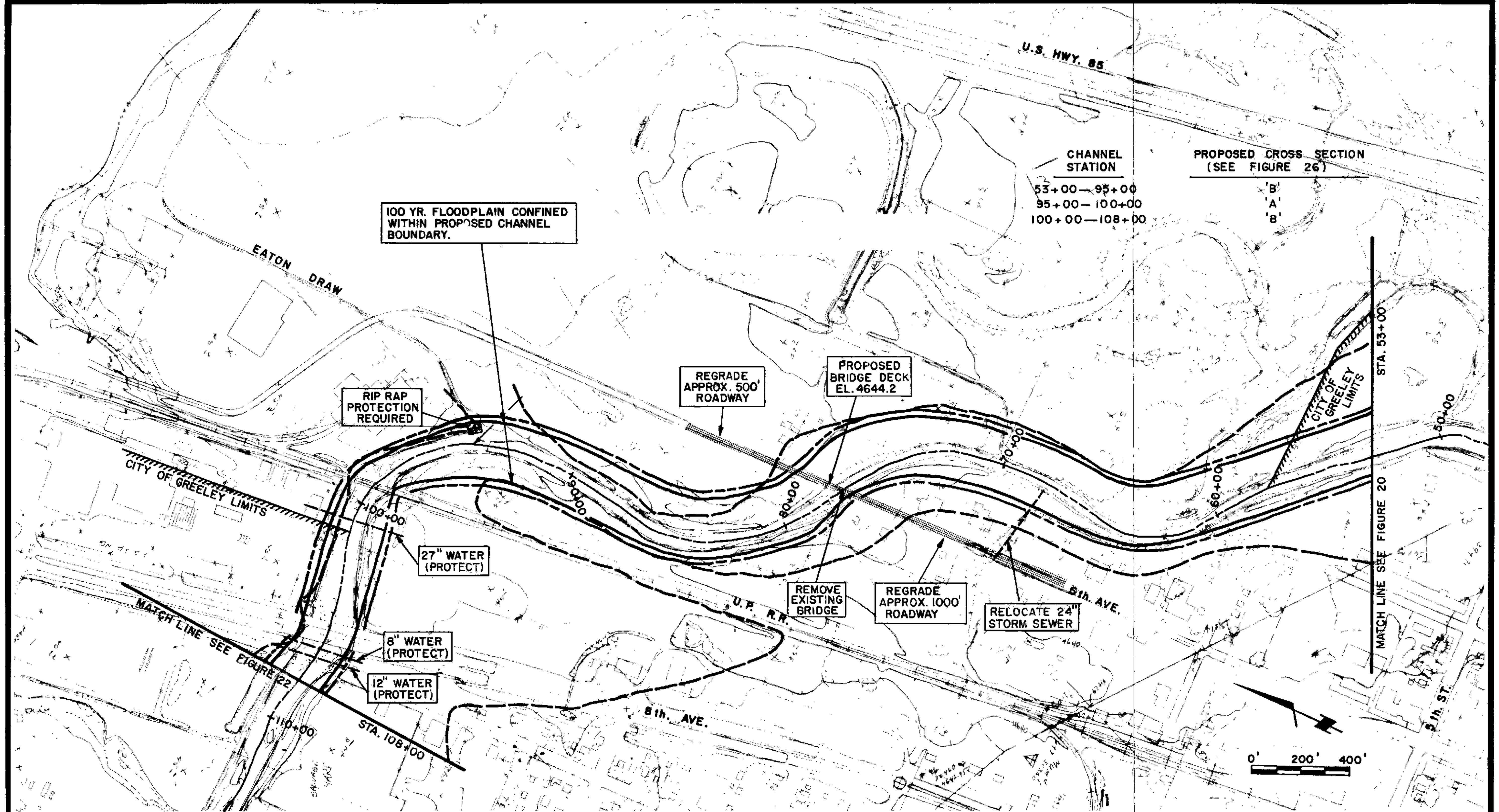
LEGEND

- CITY LIMITS
- PROPOSED R.O.W.
- EXISTING FLOODWAY
- PROPOSED CHANNEL BOUNDARY

MASTER FLOODWAY PLAN
CACHE LA POUDRE RIVER
CITY OF GREELEY, COLORADO
COLORADO WATER CONSERVATION BOARD
PRELIMINARY DESIGN - PLAN
JULY 1983

FIGURE 20.



MAPPING

1. BASE MAPS BY FALCON AIR MAPS.
2. TOPOGRAPHY COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS.
3. TOPOGRAPHY COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY TAKEN 1973.

NOTES

1. FOR LOCATION OF FIGURE, SEE INDEX MAP, PLATE 19
2. FOR PROFILE, SEE FIGURE 24

REVISION	DATE	BY

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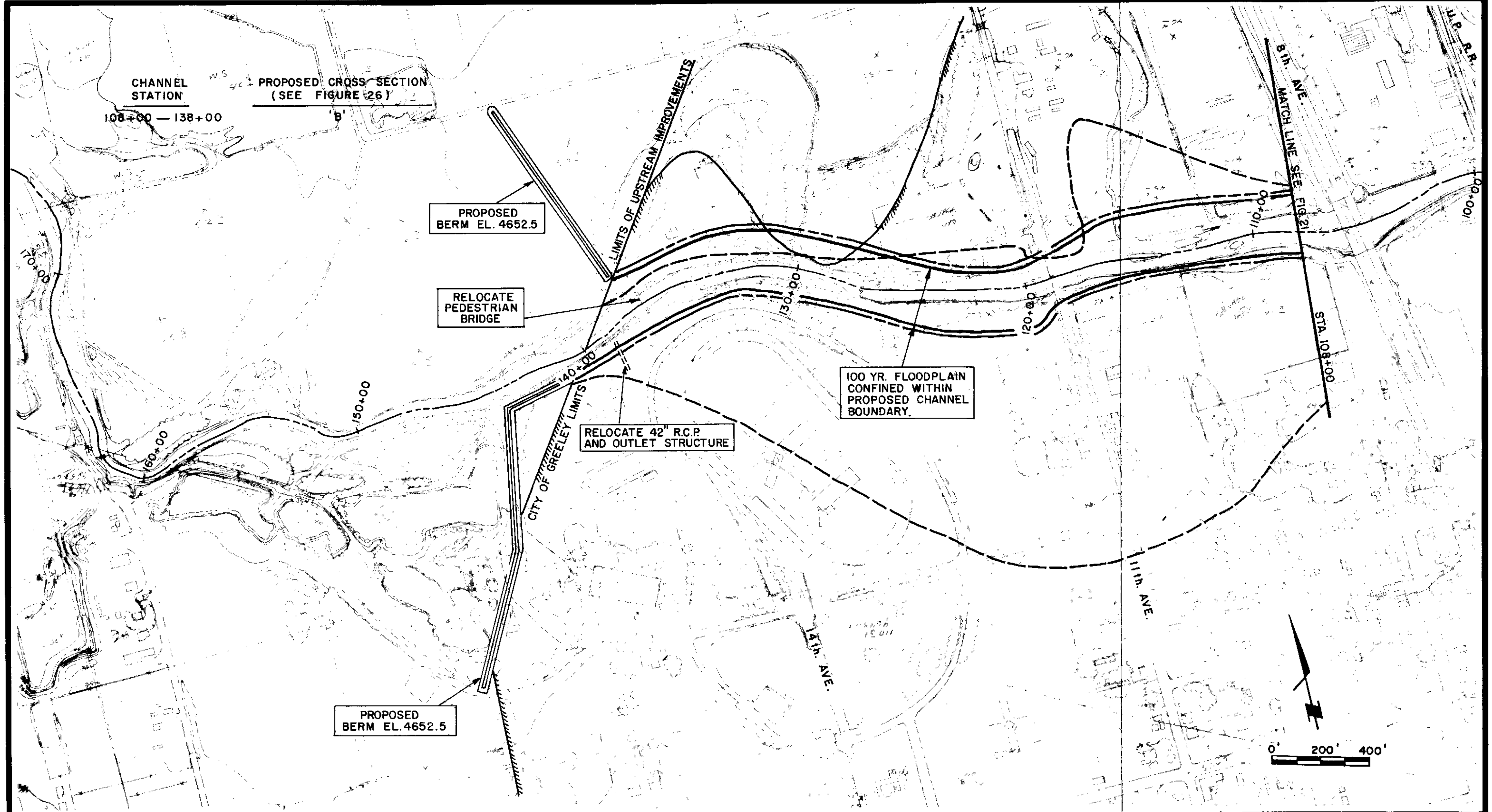
LEGEND

- CITY LIMITS
- PROPOSED R.O.W.
- EXISTING FLOODWAY
- PROPOSED CHANNEL BOUNDARY

MASTER FLOODWAY PLAN
CACHE LA POUDRE RIVER
CITY OF GREELEY, COLORADO
COLORADO WATER CONSERVATION BOARD
PRELIMINARY DESIGN - PLAN
JULY 1983

FIGURE 21.



MAPPING

1. BASE MAPS BY FALCON AIR MAPS.
2. TOPOGRAPHY COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS.
3. TOPOGRAPHY COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY TAKEN 1973.

NOTES

1. FOR LOCATION OF FIGURE, SEE INDEX MAP, PLATE 19
2. FOR PROFILE, SEE FIGURE 25

REVISION	DATE	BY

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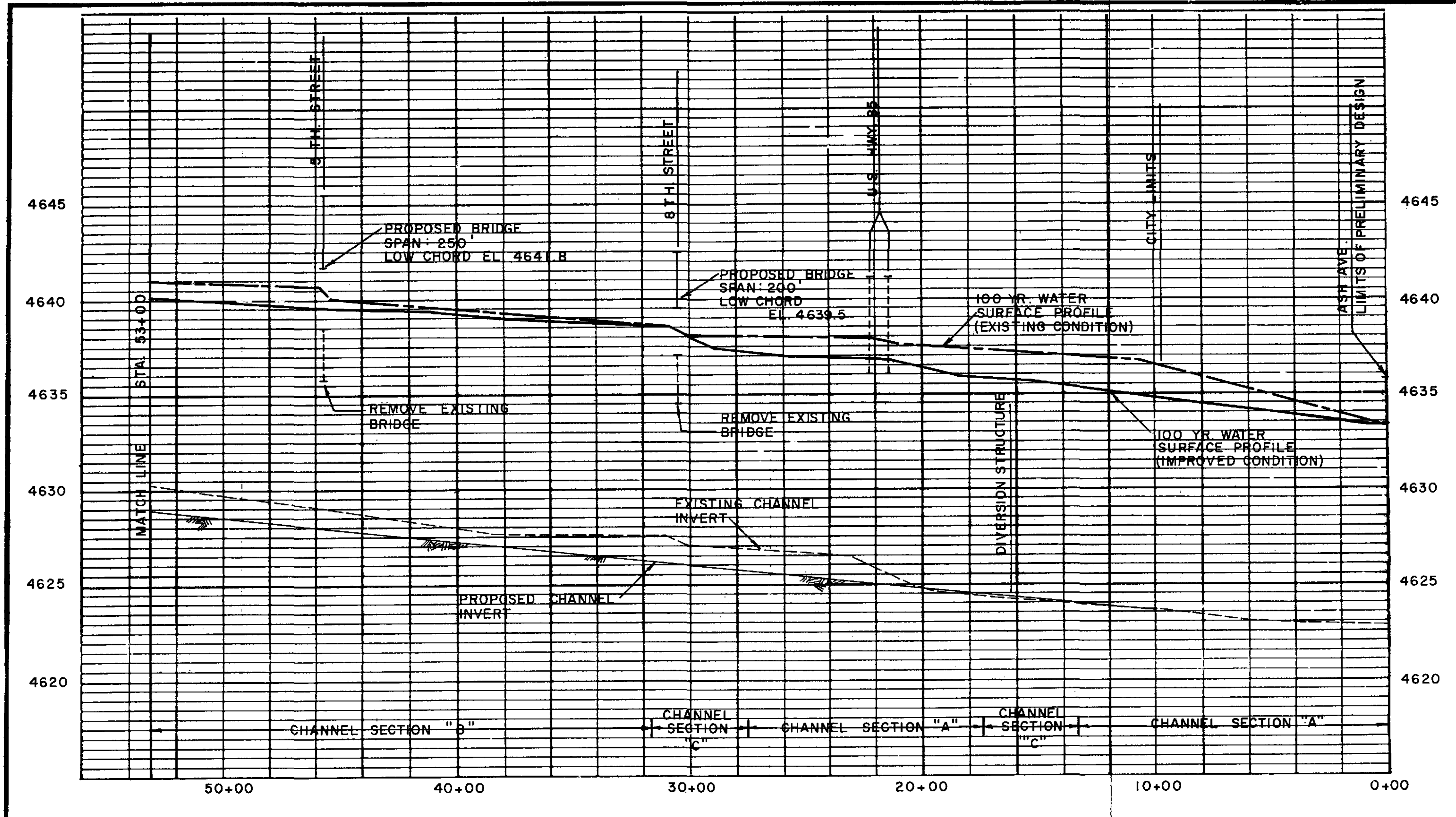
LEGEND

- CITY LIMITS
- PROPOSED R.O.W.
- EXISTING FLOODWAY
- PROPOSED CHANNEL BOUNDARY

MASTER FLOODWAY PLAN
CACHE LA POUDRE RIVER
CITY OF GREELEY, COLORADO
COLORADO WATER CONSERVATION BOARD
PRELIMINARY DESIGN - PLAN
JULY 1983

FIGURE 22.



NOTES

1. FOR PLAN, SEE PLATE
2. SCALE: 1" = 400' HORI.
   1" = 5' VERT.

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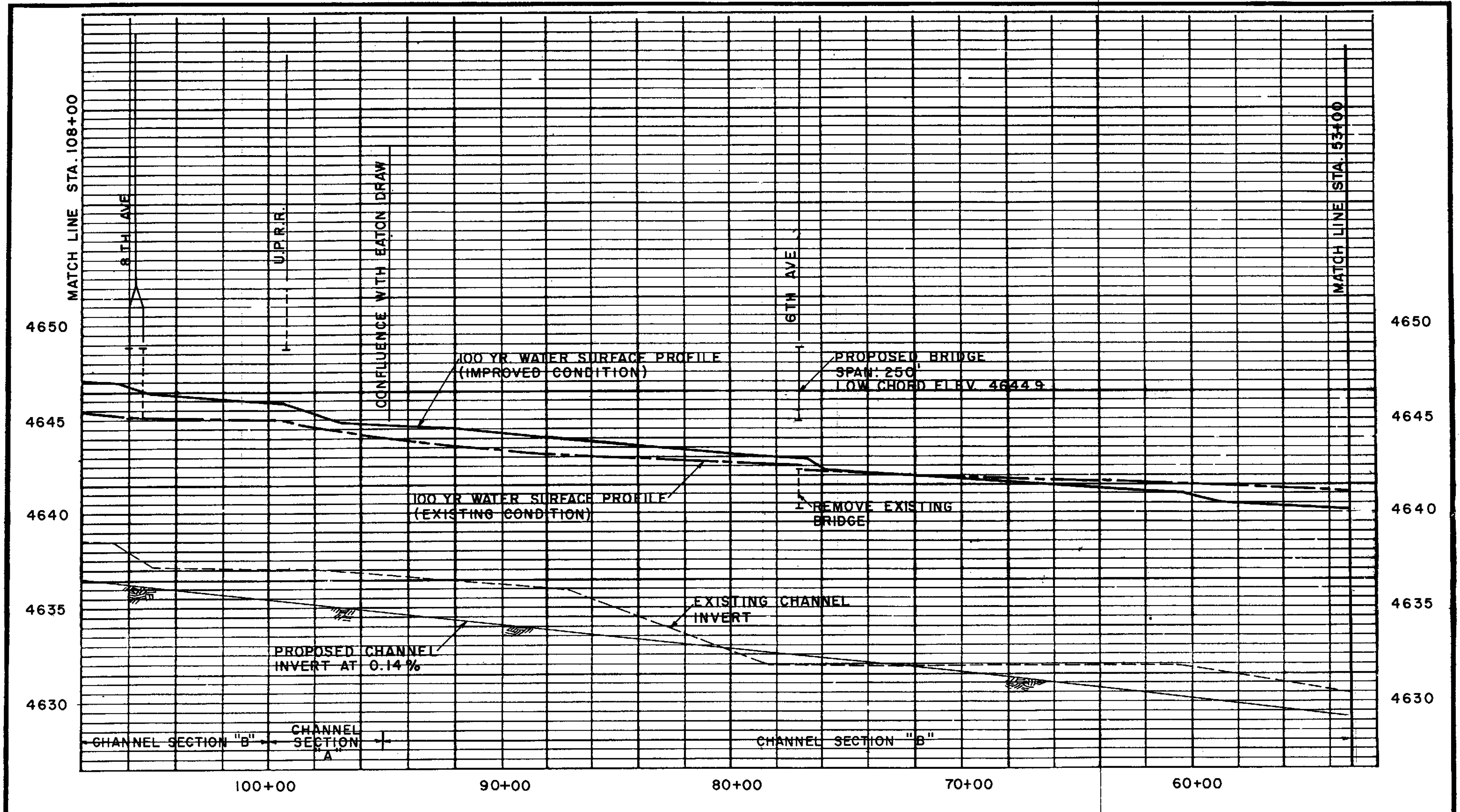
LEGEND

- EXISTING CHANNEL INVERT
- PROPOSED CHANNEL INVERT
- EXISTING BRIDGE
- PROPOSED BRIDGE
- 100 YR. WATER SURFACE PROFILE (Existing condition)
- 100 YR. WATER SURFACE PROFILE (Improved condition)

MASTER FLOODWAY PLAN
CACHE LA POUDRE RIVER
CITY OF GREELEY, COLORADO
COLORADO WATER CONSERVATION BOARD

PRELIMINARY DESIGN — PROFILE
JULY 1983

FIGURE 23.



NOTES

1. FOR PLAN, SEE PLATE
2. SCALE: 1" = 400' HORI.
   1" = 5' VERT.

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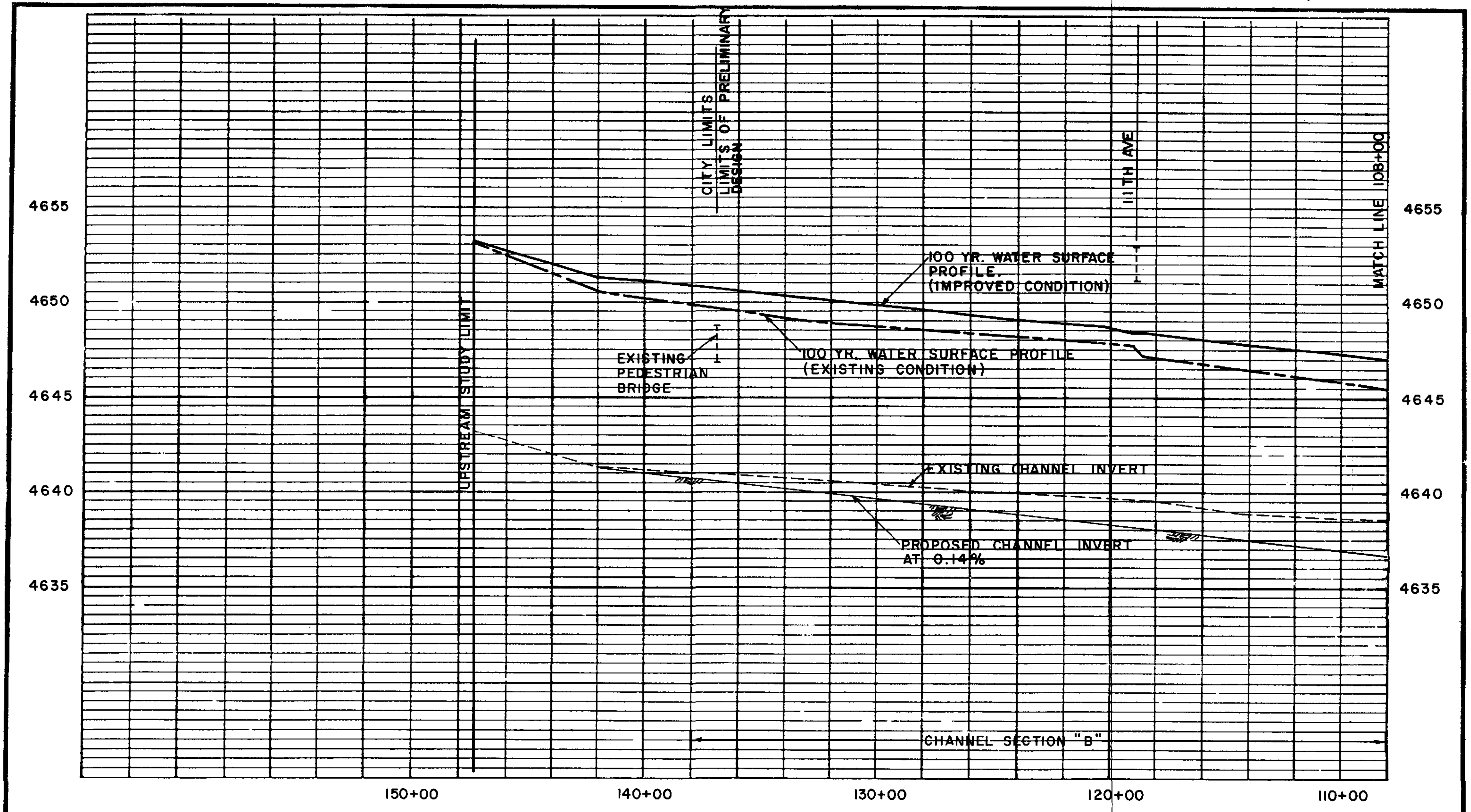
LEGEND

- EXISTING CHANNEL INVERT
- PROPOSED CHANNEL INVERT
- EXISTING BRIDGE
- PROPOSED BRIDGE
- 100 YR. WATER SURFACE PROFILE (Existing condition)
- 100 YR. WATER SURFACE PROFILE (Improved condition)

MASTER FLOODWAY PLAN
CACHE LA POUDRE RIVER
CITY OF GREELEY, COLORADO
COLORADO WATER CONSERVATION BOARD

PRELIMINARY DESIGN – PROFILE
JULY 1983

FIGURE 24.



NOTES

1. FOR PLAN, SEE PLATE
2. SCALE: 1" = 400' HORI.
   1" = 5' VERT.

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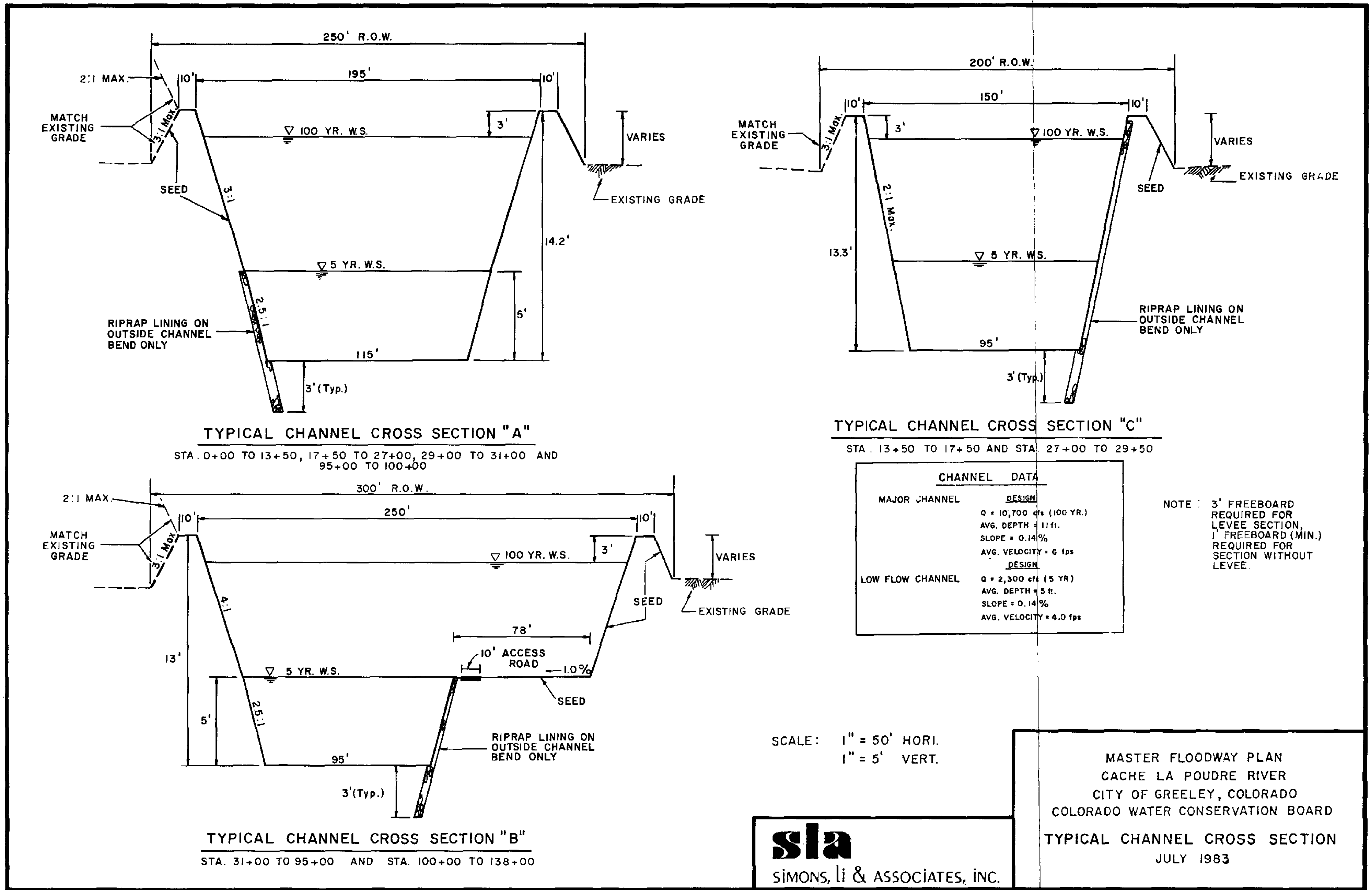
LEGEND

- EXISTING CHANNEL INVERT
- PROPOSED CHANNEL INVERT
- EXISTING BRIDGE
- PROPOSED BRIDGE
- 100 YR. WATER SURFACE PROFILE (Existing condition)
- 100 YR. WATER SURFACE PROFILE (Improved condition)

MASTER FLOODWAY PLAN
CACHE LA POUDRE RIVER
CITY OF GREELEY, COLORADO
COLORADO WATER CONSERVATION BOARD
PRELIMINARY DESIGN – PROFILE
JULY 1983

FIGURE 25.


250' R.O.W.
2:1 MAX.
10'
195'
10'
MATCH EXISTING GRADE
3:1 Max.
100 YR. W.S.
3'
VARIES
EXISTING GRADE
SEED
3:1
14.2'
5 YR. W.S.
2.5:1
5'
RIPRAP LINING ON OUTSIDE CHANNEL BEND ONLY
115'
3'(Typ.)
TYPICAL CHANNEL CROSS SECTION "A"
STA. 0+00 TO 13+50, 17+50 TO 27+00, 29+00 TO 31+00 AND 95+00 TO 100+00
200' R.O.W.
10'
150'
10'
MATCH EXISTING GRADE
3:1 Max.
3'
100 YR. W.S.
VARIES
EXISTING GRADE
SEED
2:1 Max.
13.3'
5 YR. W.S.
RIPRAP LINING ON OUTSIDE CHANNEL BEND ONLY
95'
3'(Typ.)
TYPICAL CHANNEL CROSS SECTION "C"
STA. 13+50 TO 17+50 AND STA. 27+00 TO 29+50
CHANNEL DATA
MAJOR CHANNEL
DESIGN
Q = 10,700 cfs (100 YR.)
AVG. DEPTH = 11 ft.
SLOPE = 0.14%
AVG. VELOCITY = 6 fps
LOW FLOW CHANNEL
DESIGN
Q = 2,300 cfs (5 YR)
AVG. DEPTH = 5 ft.
SLOPE = 0.14%
AVG. VELOCITY = 4.0 fps
NOTE: 3' FREEBOARD REQUIRED FOR LEVEE SECTION, 1' FREEBOARD (MIN.) REQUIRED FOR SECTION WITHOUT LEVEE.
300' R.O.W.
2:1 MAX.
10'
250'
10'
MATCH EXISTING GRADE
3:1 Max.
100 YR. W.S.
3'
VARIES
EXISTING GRADE
SEED
4:1
78'
13'
10' ACCESS ROAD
1.0%
5 YR. W.S.
SEED
2.5:1
5'
RIPRAP LINING ON OUTSIDE CHANNEL BEND ONLY
95'
3'(Typ.)
TYPICAL CHANNEL CROSS SECTION "B"
STA. 31+00 TO 95+00 AND STA. 100+00 TO 138+00
SCALE: 1" = 50' HORI.
1" = 5' VERT.
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SIMONS, LI & ASSOCIATES, INC.
MASTER FLOODWAY PLAN
CACHE LA POUDRE RIVER
CITY OF GREELEY, COLORADO
COLORADO WATER CONSERVATION BOARD
TYPICAL CHANNEL CROSS SECTION
JULY 1983

FIGURE 26.

VIII. REFERENCES

1. U.S. Department of Agriculture, Soil Conservation Service, 1980, "Soils Survey of Weld County, Colorado, Southern Part."

2. U.S. Army Corps of Engineers, unpublished, Hydraulic Analysis of Cache la Poudre River.

3. U.S. Department of Housing and Urban Development, Federal Insurance Administration, 1982 and 1979, respectively, "Flood Insurance Study, Weld County, Colorado, Unincorporated Areas and Town of Eaton, Colorado, Weld County," and "Flood Insurance Study, City of Greeley, Colorado, Weld County."

4. U.S. Army Corps of Engineers, 1976, HEC-2 Water Surface Profiles computer model.

5. Simons, Li & Associates, Inc., 1983, "N Value Report."

6. Simons, Li & Associates, Inc., 1982, Engineering Analysis of Fluvial Systems.