PRELIMINARY STUDY OF PROPOSED ALTERNATES FOR FLOOD CONTROL ON THE SALT RIVER BETWEEN HOHOKAM EXPRESSWAY AND MARICOPA FREEWAY

26.907

3A: Earth Channel: $Q = 176{,}100$ cfs

$b = 1{,}000$ ft
$D = 15$ ft
$L \approx 4{,}066$ ft

SS 4:1
$A_v V = 12$ fps
$S = 0.00193$
$n = 0.032$

SALT RIVER CHANNEL AT 40TH STREET
PROJECT A-78007.00

Abbreviated Cost Estimate for
Alternate 3A

Item	Cost
1. Construction (including 25% contingency)	
a. Channel excavation (incl. land fill area)	$ 1,820,000
b. Dike construction and protection	2,600,000
c. Cut-off walls	375,000
d. Relocate sanitary sewer	909,000
e. Protect electric transmission line	394,000
f. Realign 40th Street	140,000
g. Drainage Ditch	25,000
h. Storm Drain Alterations	38,000
Subtotal	6,301,000
2. Right of Way (including 15% contingency)	
a. Landfill area (Estes Property)	651,000
b. Other ~80 acres	276,000
Subtotal	927,000
3. Engineering and Administration (12% of Item 1)	756,000
TOTAL	$ 7,984,000
	Say $8 million

Engr. Dept.
1/29/79

CHANNEL ALTERNATES

SALT RIVER NEAR 40TH STREET

Alt. No.	Channel Type	Required R/W (ft.)	Bottom Width (ft.)	Water Depth (ft.)	Velocity Ft./Sec.	Construction Cost x $1,000	ROW Cost x $1,000	Engineering Cost x $1,000	Total Cost
1	Concrete	700	500-600	16	20.5	19,620	460	2,354	$22.5 M
2	Composite	950	800	16	20± (Conc.) 8± (Earth)	15,903	1,610	1,908	19.5 M
3A	Earth	1,200	1,000	15	12.5	6,301	927	756	8.0 M

Flood Control Meeting
2 Feb 1979

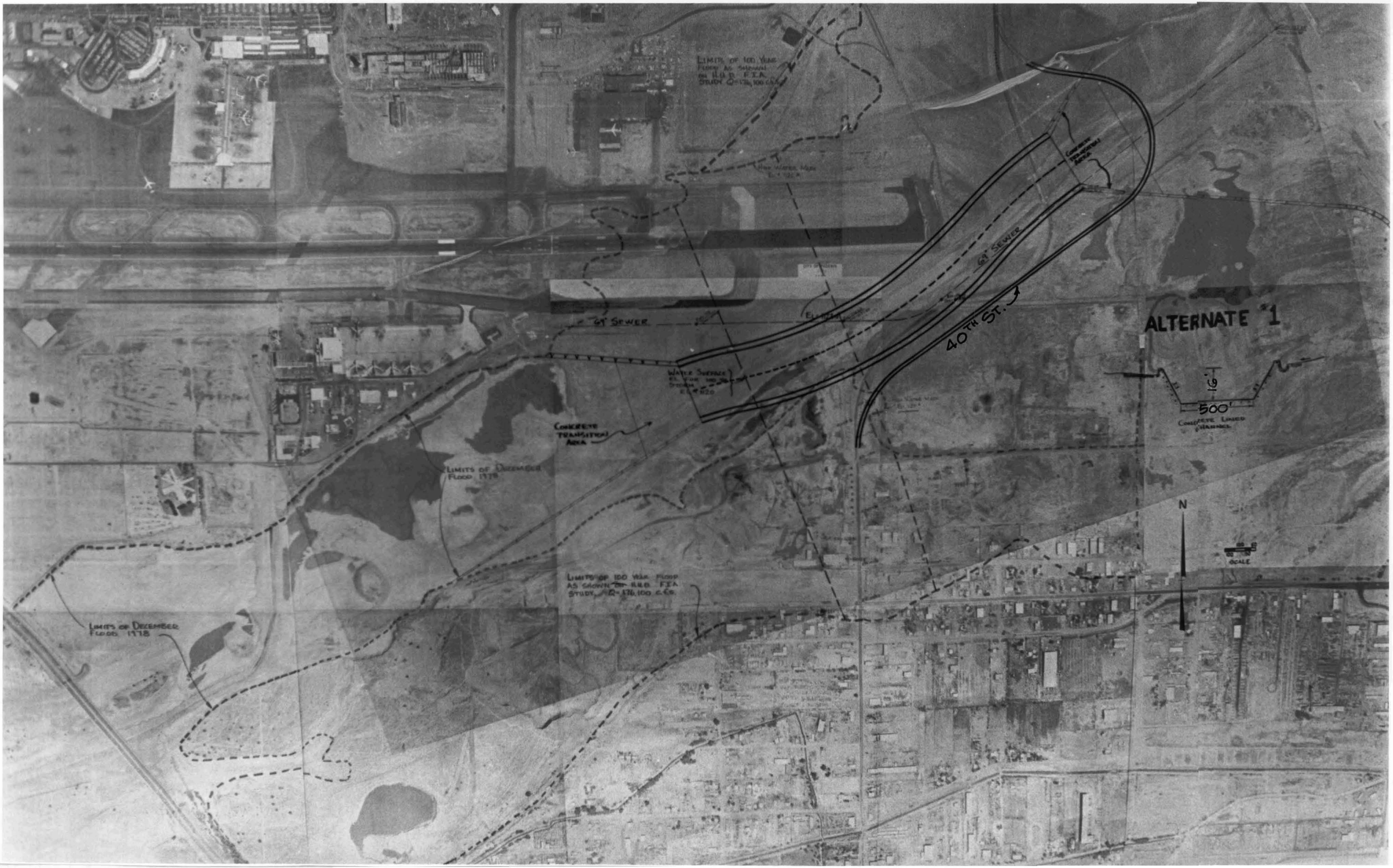
Name	Agency
Ed Hall	City of Phoenix
Chuck Christiansen	" " "
Jim Calvary	ADOT
Bill Mathews	Az Water Commission
Wes Stevens	" " "
Bob Brunton	City of Phoenix
C A HOWLETT	CITY OF PHOENIX
MAYOR HANCE	
MARVIN ANDREWS	CITY MGR
MAURICE R. TANNER	THE TANNER COMPANIES
ROBERT G. WALLACE	THE TANNER COMPANIES
Dick Lockwood	Ariz State Division of Emer Svcs.
J.E. Fitzgerald	" " " " "
PAUL D. WARD	FEDERAL DISASTER ASSISTANCE ADMIN
Roy J. Gorup	" " " "
Bob Esterbrooks	Acting County Manager
HOWARD W CLARK	AVIATION DEPT CITY OF PHX
Paul Rosenmerten	Off. of Reg. Rep of the Sec, DOT - Reg. IX
GERALD DALLAS	FEDERAL AVIATION ADMIN.
Oscar Lyon	Ariz. Dept. of Transportation
HERB DONALD	FLOOD CONTROL DIST.
DAN SAGRAMOSO	FLOOD CONTROL DISTRICT
Jim Attebery	City Engr
DAVID CLYMER	" "
LARRY LANDRY	GOV. OFFICE

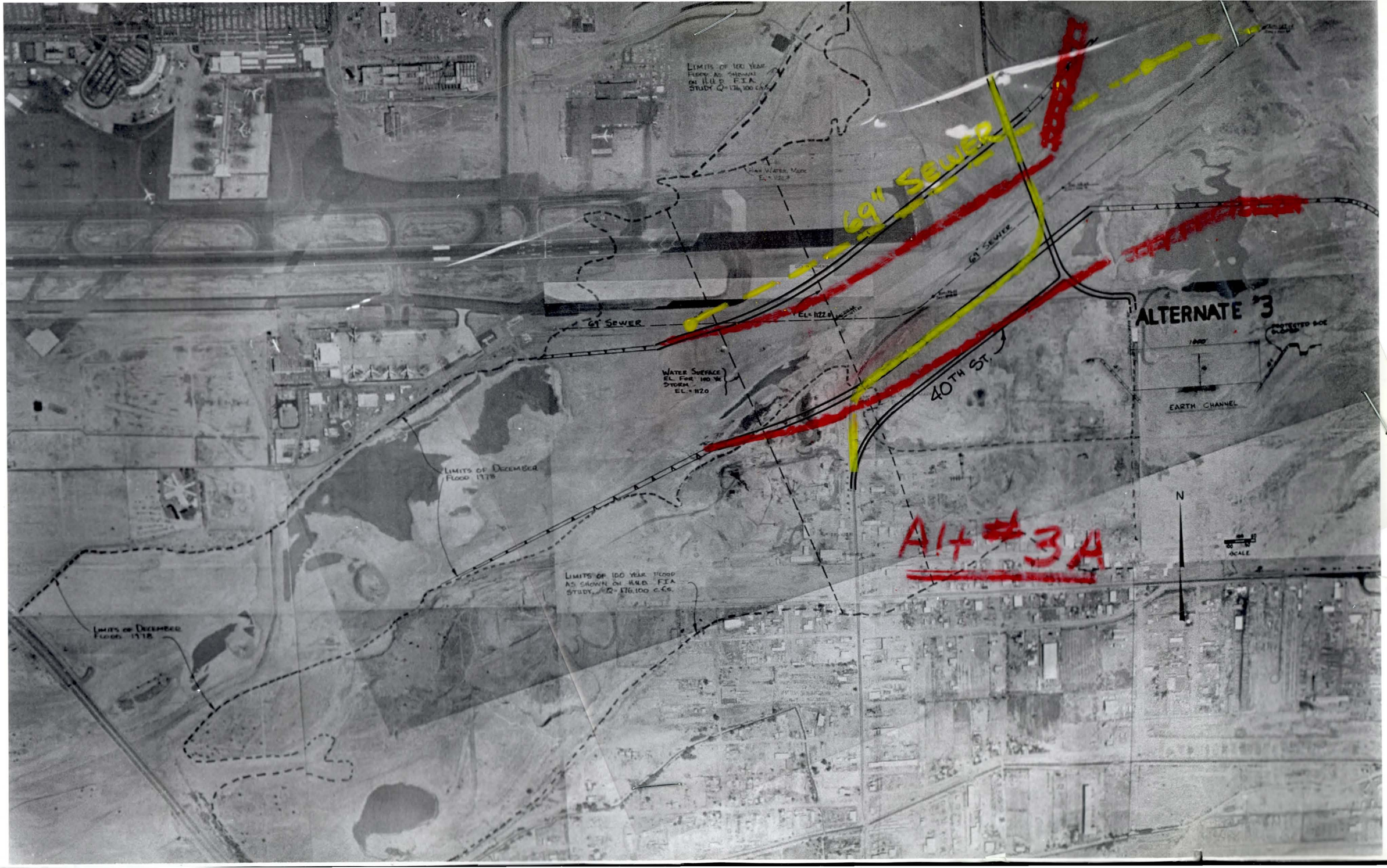
DECEMBER 1978 FLOOD

ALTERNATE #3A
1000'
15'
EARTH CHANNEL
PROTECTED SIDE SLOPES
40th St.
69" SEWER RELOCATED
69" SEWER
69" SEWER
40th St. RELOCATED
EL. 122.0
WATER SURFACE EL. FOR 100 YR STORM EL. 120
LIMITS OF DECEMBER FLOOD 1978
LIMITS OF 100 YEAR FLOOD AS SHOWN ON H.U.D. FIA STUDY, Q=176,100 C.F.S.
LIMITS OF DECEMBER FLOOD 1978
N
SCALE

Jan 25, 1979

ALTERNATE #2
LIMITS OF 100 YEAR FLOOD AS SHOWN ON H.U.D. F.I.A. STUDY Q=176,100 C.F.S.
HIGH WATER MARK
68" SEWER
68" SEWER
LOW FLOW CHANNEL
40TH ST.
CONCRETE TRANSITION AREA
CONCRETE TRANSITION AREA
LIMITS OF DECEMBER FLOOD 1978
LIMITS OF 100 YEAR FLOOD AS SHOWN ON H.U.D. F.I.A. STUDY, Q=176,100 C.F.S.
LIMITS OF DECEMBER FLOOD 1978
PROTECTED SIDE SLOPES
500'
350'
8'
5
5
300'
CONCRETE LOW FLOW CHANNEL
COMPOSITE CHANNEL
N
SCALE


ALTERNATE #1
16'
500'
CONCRETE LINED CHANNEL
N
SCALE
40TH ST.
6' SEWER
6' SEWER
CONCRETE TRANSITIONAL AREA
CONCRETE TRANSITIONAL AREA
LIMITS OF 100 YEAR FLOOD AS SHOWN ON H.U.D. F.I.A. STUDY Q=176,100 C.F.S.
LIMITS OF DECEMBER FLOOD 1978
LIMITS OF 100 YEAR FLOOD AS SHOWN ON H.U.D. F.I.A. STUDY, Q=176,100 C.F.S.
LIMITS OF DECEMBER FLOOD 1978


LIMITS OF 100 YEAR FLOOD AS SHOWN ON HUD FIA STUDY Q=176,100 C.F.S.
HIGH WATER MARK EL. 1122.8
69" SEWER
69" SEWER
69" SEWER
EL. 1122.8
ALTERNATE #3
1000'
EARTH CHANNEL
40TH ST.
WATER SURFACE EL. FOR 100 YR STORM EL. 1120
LIMITS OF DECEMBER FLOOD 1978
N
SCALE
ALT #3A
LIMITS OF 100 YEAR FLOOD AS SHOWN ON HUD FIA STUDY, Q=176,100 C.F.S.
LIMITS OF DECEMBER FLOOD 1978

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PRELIMINARY STUDY
OF
PROPOSED ALTERNATES FOR FLOOD CONTROL ON THE SALT RIVER BETWEEN HOHOKAM EXPRESSWAY AND MARICOPA FREEWAY

Registered Professional Engineer (Civil)
CERTIFICATE NO. 8166
RICHARD M. MOSEKE
Date Signed 1/12/79
ARIZONA, U.S.A.

Prepared By:
ROYDEN ENGINEERING CO.
2846 West Weldon
Phoenix, Arizona 85017
January, 1979

Royden Engineering Co.

(602) 279-3541
H. L. ROYDEN, P.E.
THOMAS S. ROYDEN, P.E.
RICHARD M. MOSEKE, P.E.

2846 W. WELDON AVENUE
P. O. BOX 3707
PHOENIX, ARIZONA 85030

January 25, 1979

CITY OF PHOENIX/THE TANNER COMPANIES

Gentlemen:

Attached is an Addendum to the Report on Alternates to Salt River Channelization between Hohokam and Maricopa Freeway Bridge. The Report is dated January, 1979.

An additional Alternate No. 3 A is reviewed. In addition, the Cost Estimate for Alternate No. One is based on a 500' wide channel while the profile and high water elevations are based on a 600' wide channel. The 500' wide channel analysis is based on a lower flow line than the 600' width. The 500' width channel is therefore a workable solution; however, the 69" sewer line would have to be relocated or protected. If the 500' channel is set to the same grade as the 600', the water surface profile would be 2 - 3' above the "before" condition. This could be taken care of with slightly higher levees in this area; however, additional study of results of higher levees should be made to check the affects on surrounding areas.

In summary, an additional figure of $800,000 should be added to the Alternate No. 1 price for relocating or protecting the sewer or 1.8 million should be added for a 600' wide channel.

Page 10 of the report which describes Alternate No. 2 should be altered to state that the low flow channel would provide for 30-40,000 cfs as velocities would be reduced as depth of flow decreases.

Sincerely,

ROYDEN ENGINEERING CO.

Richard M. Moseke

Richard M. Moseke, P. E.

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Appendix

Alternate No. 1

Alternate No. 2

Alternate No. 3

Alternate No. 3 A

Right of Way Maps

Alternate No. 1 Profiles

Hydraulic Profiles

December, 1978 Flood Photo

Computer Printouts

Registered Professional Engineer (Civil) CERTIFICATE NO. 8166 RICHARD M. MOSEKE Date Signed ARIZONA, U.S.A.

Revised: January 25, 1979

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Alternate No. 1 Profiles	
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December, 1978 Flood Photo	
Computer Printouts	

Revised: Jan 25, 1979

BACKGROUND

This study is a result of the concerns of City Officials and local business people about the recent damages to government and private property in this area.

A meeting held on January 9, 1979 resulted in a decision to prepare a study of alternates for limiting the future flood damages to facilities in the area between the Hohokam Expressway and the Maricopa Freeway.

The study is funded jointly by the City of Phoenix and The Tanner Companies and is prepared by Royden Engineering Co. in cooperation with Toups Corporation.

DEFINING THE PROBLEM

This section of the report needs little description to those living in the Phoenix area this past year.

There have been two major floods that have caused extensive damage to Airport facilities, City streets and bridges. In addition, private property has been flooded and local business has suffered substantial costs not only in damaged equipment but also in delays and added expenses due to the lack of adequate transportation corridors. Many hours of manpower and equipment time has been spent trying to protect property from being more severly

flooded. This study will not attempt to put a dollar value on these losses as they are still being incurred.

PROBLEMS TO OVERCOME TO PROVIDE SOLUTIONS TO FLOODING IN THIS AREA

A. Obtaining an agreed upon design criteria.

This is no small problem in that the questions keep arising: What about Orme Dam; What about doing something to the river over a broader reach; What are future plans for mining from the river; What about Rio Salado; What are future expansion plans of the Airport. These are all questions that must be considered in any long range solutions to flooding of the Salt River in this area.

For the purpose of this study, we will assume a 100 year storm flow of 176,100 cfs and a 50 year storm flow of 127,800 cfs. These figures are those used for the H.U.D. Federal Insurance Program and as such will therefore be accepted for the basis of requirements for flood insurance and building restrictions.

B. Items to be considered in channelization or altering river conditions in this area.

1. Sky Harbor Airport South Runway

The south runway has been partially destroyed twice in the past ten months and rebuilding it to its initial location and grade without additional flood proofing is at best a temporary solution. The runways will either have to be extended back east in conjunction with channelizing the river or be extended west. Extension to the west is an alternate that brings new problems to the surface and would not fit the Airport Master Plan.

2. Sky Harbor Radar Facility

This facility, while remaining high and dry during each of the floods, has been put out of service because of loss of support facilities to it, i.e. cables to and from it for communication and power to it were lost during each flood. A study is currently underway by the F.A.A. to find a location for it out of the flood plain. This study is in its initial stages but it is assumed that the facility can be relocated to clear the proposed channel improvements.

Cost of relocating this facility is not included in our projected cost estimates.

3. Four Cities Sewer Line

This large 69" sewer main crosses the river within the proposed study area and became a major concern in past flooding. Apparently mining activity downstream had caused the river channel to erode and the flowline to be lowered to a point that the sewer line was exposed. At that time a large amount of concrete was placed around the facility to hold it in place. Our preliminary analysis indicates that the sewer can remain at its current location if a concrete lined channel is used and the river grade is not altered considerably. There is currently 4' minimum cover over the sewer line in most areas. If an earth channel is utilized, additional protective measures such as a cut-off wall supported by piling may have to be utilized.

4. Major Transmission Towers in River

These towers are currently partially protected by large mounds of material around them. They could be relocated to be outside the proposed flood channel or be flood proofed by utilizing diversionary structures anchored to piling for protection.

5. Hohokam Expressway Bridge

Our proposed improvements would channel the floodwaters starting at the Hohokam Expressway unless a joint effort could be promoted with the City of Tempe and with the Arizona Department of Transportation. A.D.O.T. considers that the existing structure is expendable and long range plans call for large structures capable of carrying the 50 year flows be built when the Hohokam facility is constructed as a freeway. The existing 465' structure is only designed for 15,000 cfs. Every effort should be extended to work with the City of Tempe and local owners to provide diking upstream of the Hohokam. This can be seen on the enclosed aerial photo showing the December flood.

6. Existing 40th Street Structure

This structure was recently built over the river when the runways were extended easterly. Future plans for 40th Street are to keep it open as a collector street. We have not considered the 40th Street bridge to be a "fixed" feature that has to be accommodated.

7. Relocation of 40th Street through the Estes Property

This relocation presents some unique problems because the area is a former land fill site after it was mined for gravel operations. Test holes dug within the site indicate a limited amount of land fill on the northwesterly area with depths encountered 10' or less. It would be desirable to get additional tests to ascertain the limits of the land fill but for purposes of this study it is assumed that we would remove a 10' depth for the roadway area and for the area within the channel construction. This would be relocated to adjacent land fill sites and material from channel excavation could be used for backfill.

Local business interests want this roadway to remain open to provide access to the northern and eastern part of the city. Construction of the Hohokam facility along with improvements to University Road in the area may be an alternate long range plan.

8. Right of Way Requirements

Right of way will be required from private individuals or corporations for a portion of the proposed channel work and for relocation of 40th Street. There is much dispute as to what river land and land fill sites are worth but for purposes of this study we have assumed $40,000 per acre for land to have permanent facilities. i.e.: concrete channel, roadways, etc. and assumed that other land would not be purchased but that easements would be granted for improvements such as dikes, channel cleaning, etc. Right of way maps showing ownership are enclosed in this report. A major portion of the needed right of way is on City, State or Federal land.

ALTERNATES CONSIDERED

ALTERNATE NO. 1

Alternate Number One is to construct a concrete channel through a portion of the affected area. The channel would be ~~500'~~ 600' wide at the base with 3:1 side slopes. Depth would be approximately 16 feet of concrete and 2 - 3 feet of earth dike freeboard. With this alternate the water surface profile for the 100 year storm would be lowered within the affected study area and would meet projected water surface elevations within the limits of the study area. (Hohokam Expressway to Maricopa Freeway) The attached profile shows the relationship of the "before" high water surface to the "after" high water surface. It also shows the relationship of the 69" sewer and the Airport South Runway. Preliminary analysis indicates that the flow line of the proposed channel can be adjusted such that the channel can be built above the 69" sewer line.

Inlet and outlet aprons would be constructed of concrete. Dikes would be constructed at the inlet and outlet to collect the runoff and to disperse it back to the "natural" downstream condition. These dikes would be protected by rock slope protection or concrete depending on final economic studies.

This alternate would provide for the removal of the 40th Street roadway and bridge and for a new "at grade" alignment of 40th Street. Further analysis of this 40th Street alignment should be undertaken with the possibility of connecting to the Hohokam Expressway being investigated.

The alternate allows construction of the south runway to approximately the limits that it was before the previous flooding. The grade of the runway could also be raised to be more in vertical alignment with the runway to the west instead of "dipping" as it did prior to the recent floods. Local drainage would be provided by a ditch along the south side of the channel and by connecting drainage to existing storm drains on the north. The total estimated cost of this alternate is ~~Nineteen~~ Twenty-one Million, ~~Four Hundred Thirty Thousand and no/100 Dollars~~... (~~$19,430,000.00~~ $21,000,000.00)

A detailed estimate is attached.

ALTERNATE NO. 2

This alternate provides for a combination low flow channel of concrete with side channels of earth. The low flow channel would provide for ~~40 - 50,000~~ 30,000 cfs depending on the final configuration selected and the outer channel would provide again for the 100 year storm flow of 176,100 cfs. The alternate would be located such that the 69" sewer line would be to the side of the concrete or low flow channel and as such would not present a conflict problem with the grade of the low flow channel. Sizing of the channel would again be such that the design high water would be below that of the HUD-FIA study. Preliminary channel size analyzed was 300' wide low flow channel with 3:1 side slopes and an overall channel width of 800' with protected side slopes. Protection of the side slopes would be with wire basket type rip-rap anchored to the slopes or with concrete paved slopes. Depth of flow in the earth portion of the channel would be eight feet.

This alternate would provide for a relocated 40th Street roadway through the channel with a new 40th Street bridge over the low flow channel. Side drainage would again be provided as in Alternate No. 1.

The total estimated cost of this alternate would be Seventeen Million, Nine Hundred Thirty Thousand and no/100 Dollars. . . . . .($17,930,000.00)
A detailed cost estimate is attached.

ALTERNATE NO. 3

This alternate provides for a graded earth channel through the area. Side slopes or dikes to a height of 20' ± would be constructed on each side of the channel. They would be protected by either wire basket rip-rap anchored to the slopes or by paved slopes with cut-off walls anchored to the slopes. Dimensions of this channel are 1,000' at the base with a depth of 16' and with 4:1 side slopes. This alternate would probably have the least effect on the natural channel area. It would also require the most right of way. We would anticipate that 40th Street would again be reconstructed with no structure or possibly utilizing the existing structure. This alternate also would require that a large portion of the Estes Property (i.e. garbage land fill area) would have to be acquired and excavated and regraded. Copies of the soil borings showing depths of garbage under the site to be up to 20 feet in depth within the affected areas are available.

The total estimated cost of this alternate would be Eight Million, One Hundred Forty Thousand and no/100 Dollars...($8,140,000.00)

A detailed cost estimate is attached.

PRELIMINARY
COST ESTIMATE

ALTERNATE NO. 1

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	Channel Excavation	C.Y.	667,410	0.60	400,446.
2	Garbage Excavation	C.Y.	106,500	3.00	319,500.
3	Fine Grading	S.Y.	380,500	0.50	190,250.
4	Concrete Channel	S.Y.	380,500	30.00	11,415,000.
5	Construct Dikes	L.F.	13,100	6.75	88,425.
6	Dike Protection	L.F.	13,100	110.00	1,441,000.
7	Cut-off Walls	L.F.	2,400	120.00	288,000.
8	Remove Concrete from Channel	L.S.	1	40,000.00	40,000.
9	Adjust Manholes	Each	4	1,500.00	6,000.
10	Relocate or Protect Transmission Towers	Each	3	105,000.00	315,000.
11	Realign 40th Street	S.Y.	25,300	6.00	151,800.
12	Drainage Ditch	L.F.	4,000	5.00	20,000.
13	Storm Drain Alterations	L.S.	1	30,000.00	30,000.
14	Under drain system for Channel	L.S.	1	175,000.00	175,000.
15	Right of Way	Acre	10	40,000.00	400,000.
16	Remove 40th Street Bridge	L.S.	1	20,000.00	20,000.
	Subtotal				15,300,421.
	15% Contingency				2,295,063.
	12% Engineering & Administration				1,836,050.
	Total				19,431,534.

USE.... $19,430,000.00

PRELIMINARY
COST ESTIMATE
ALTERNATE NO. 2

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	Channel Excavation	C.Y.	929,660	0.60	557,796.
2	Garbage Excavation	C.Y.	242,000	3.00	726,000.
3	Fine Grading	S.Y.	484,000	0.50	242,000.
4	Concrete Channel including transitions	S.Y.	284,000	30.00	8,520,000.
5	Construct dikes	L.F.	9,600	6.75	64,800.
6	Dike Protection	L.F.	9,600	110.00	1,056,000.
7	Cut-off Walls	L.F.	2,550	120.00	306,000.
	Remove Concrete from Channel	L.S.	1	30,000.00	30,000.
9	Adjust Manholes	Each	4	1,500.00	6,000.
10	Relocate or Protect Transmission Towers	Each	3	105,000.00	315,000.
11	Realign 40th Street	S.Y.	22,667	6.00	136,002.
12	Drainage Ditch	L.F.	4,000	5.00	20,000.
13	Storm Drain Alterations	L.S.	1	30,000.00	30,000.
14	Under drain system for Channel	L.S.	1	125,000.00	125,000.
15	New 350' 40th Street Bridge	L.F.	400	1,470.00	588,000.
16	Right of Way	Acre	35	40,000.00	1,400,000.
	Subtotal				14,122,598.
	15% Contingency				2,118,390.
	12% Engineering & Administration				1,694,710.
	Total				17,935,698.

USE..... $17,930,000.00

PRELIMINARY
COST ESTIMATE

ALTERNATE NO. 3

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	Channel Excavation	C.Y.	1,633,250	0.60	979,950.
2	Garbage Excavation	C.Y.	242,000	3.00	726,000.
3	Protect or Relocate Sewer	L.F.	4,000	150.00	600,000.
4	Construct Dikes	L.F.	21,460	6.75	144,855.
5	Protect Dikes	L.F.	21,460	110.00	2,360,600.
6	Protect Transmission Lines	Each	3	105,000.00	315,000.
7	Realign 40th Street	S.Y.	24,000	6.00	144,000.
8	Drainage Ditch	L.F.	4,000	5.00	20,000.
9	Storm Drain Alterations	L.S.	1	30,000.00	30,000.
10	Cut-off Walls	L.F.	2,400	120.00	288,000.
11	Right of Way	Acre	20	40,000.00	800,000.
	Subtotal				6,408,405.
	15% Contingency				961,260.
	12% Engineering & Administration				769,000.
	Total				8,138,665.

USE.....8,140,000.00

SUMMARY AND CONCLUSIONS

This study has evaluated various alternatives to flooding problems in this area. It obviously does not consider all options or combination of options.

Further study of one of these alternates is needed to optimize the channel sizing to the hydraulic characteristics of the area. This study was performed within time restrictions that did not allow this to be done, but we do feel that a workable solution or combination of solutions is available to expand upon.

In addition, detailed mapping and subsurface exploration should be planned in conjunction with further analysis. Field elevations were checked prior to the January release of water and while the channel had changed in some areas, the overall cross sectional area of the river through this region remained reasonably close. The flow line of the river near the Hohokam Bridge and near the Maricopa Freeway Bridge did not change appreciably.

Cost estimates for these alternates were developed in conjunction with The Tanner Companies estimating department and are based on current prices. Projections for budget amounts would therefore have to be adjusted for inflation, etc.

Further analysis of the concrete channel needs to be made to provide a thickness of channel that will be sufficient to sustain river loading on top as well as uplift problems from hydrostatic pressures. For the purpose of this study, a thickness of 9" reinforced concrete was used. Increasing the thickness would increase channel costs by approximately $0.34 per square foot per inch increase in the thickness, or $169.75/L.F. to a 500' width channel.

There are many short and long range advantages and disadvantages to each of these alternatives but we did not attempt to consider all current and future plans for the area in this study because of the limited time frame. Input from additional sources need to be considered in a decision as to the exact configuration and location is selected. We do feel however that all parties concerned need to pursue a solution as soon as possible.

ALTERNATE NO. 3A

This alternate is a modification of Alternate No. 3. The same 1,000 foot channel is utilized but the alignment is moved to the south to allow for more of the runway to be replaced outside of the channel area.

It also provides for a variable width channel to accommodate the existing 40th Street bridge. The bridge would be allowed to remain in place and would act as a low flow bridge for 15,000 $\pm$ cfs. Temporary wing dikes upstream and downstream of the bridge would serve to direct flows through the structure during periods of extended low releases from the Salt River Project Dams. Fortieth Street roadbed would be aligned along the top of the south dike for some distance and then drop into the channel to cross at approximately channel grade.

Velocities in this channel would be approximately 12.5 feet per second at the 100 year flow of 176,100. At a flow of 135,000 cfs, (maximum flow of recent years) velocities would be approximately 10 feet per second.

In conjunction with this alternate it is possible to bring the east portion of the runway up to a grade level at or above the runway area to the west. We would plan to relocate the 69" sewer line to the north of the proposed channel.

This alignment would be farther south and as such would require more of the Estes property and removal of more of the land fill site for construction of channel and dikes. Airport master plans provide for future purchase of this property and for the purpose of this alternate we have used a recent City of Phoenix Appraisal for establishing a purchase price for the entire property.

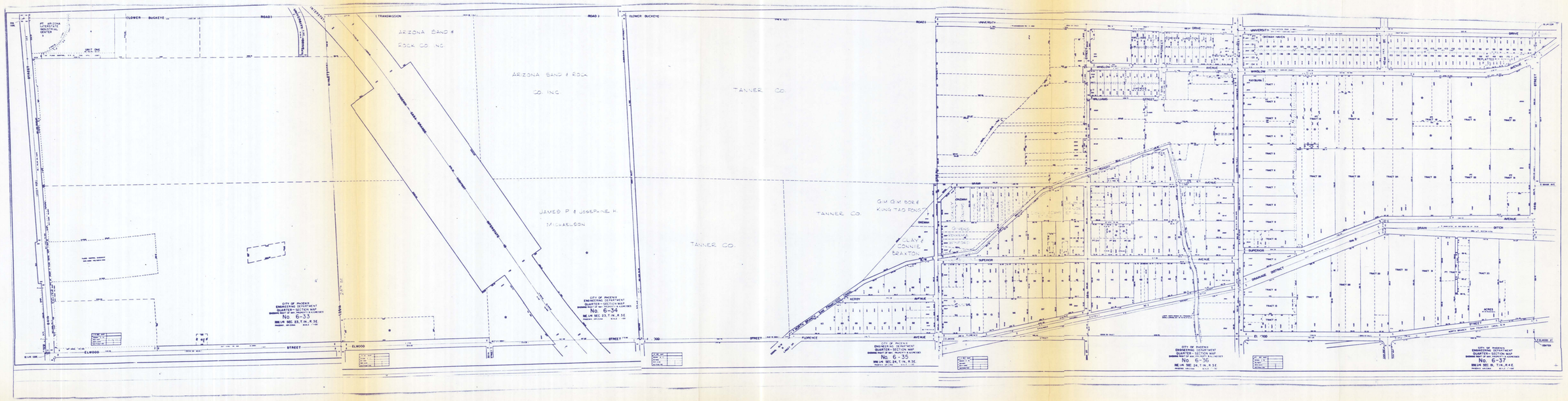
An additional figure is provided for land to be acquired outside of the land fill area. The total estimate of cost of this alternate is Seven Million, Two Hundred Thirty Thousand and no/100 Dollars.....($7,230,000.00).

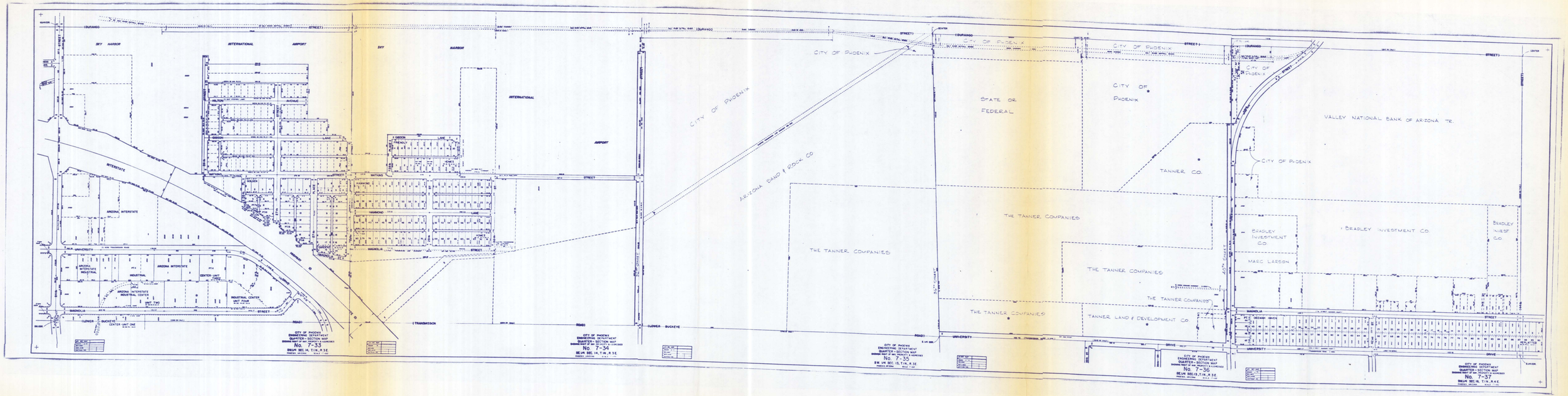
A detailed cost estimate is attached for your review.

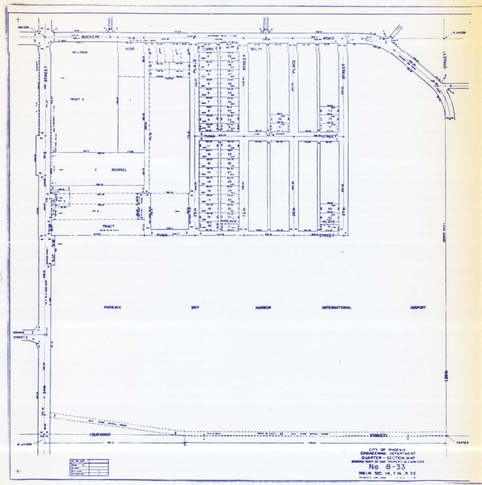
PRELIMINARY
COST ESTIMATE
ALTERNATE NO. 3 A

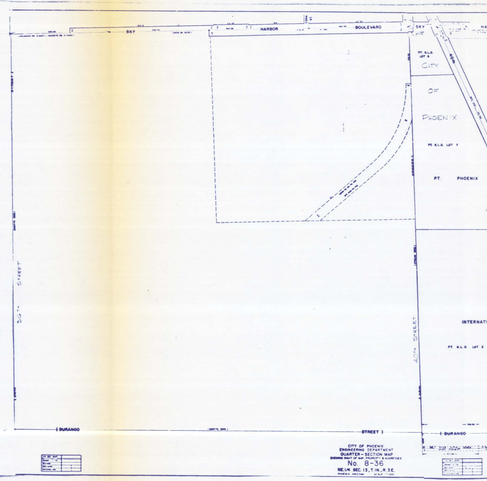
ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	Channel Excavation	C. Y.	1,206,355	0.60	723,813.
2	Garbage Excavation	C. Y.	243,443	3.00	730,329.
3	Protect ~~or~~ & Relocate Sewer	L. F.	4,850	150.00	727,500.
4	Construct Dikes	L. F.	17,790	6.75	120,083.
5	Protect Dikes	L. F.	17,790	110.00	1,956,900.
6	Protect Transmission Lines	Each	3	105,000.00	315,000.
7	Realign 40th Street	S. Y.	18,670	6.00	112,020.
8	Drainage Ditch	L. F.	4,000	5.00	20,000.
9	Storm Drain Alteration	L. S.	1	30,000.00	30,000.
10	Cut-off Walls	L. F.	2,400	120.00	288,000.
11	Right of Way				
	a) Land fill	Acre	70.9	6,000.00	425,400.
	b) Tanner Property & Estes	Acre	6.0	40,000.00	240,000.
	Subtotal				5,689,045.
	15% Contingency				853,357.
	12% Engineering & Administration				682,685.
	Total				7,225,087.

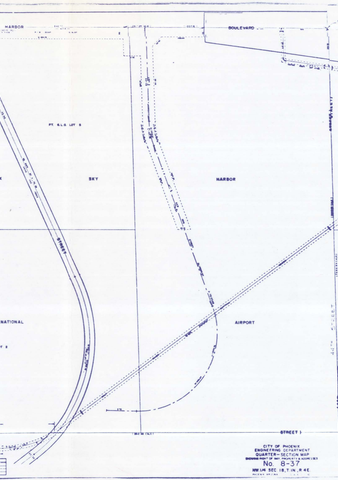
USE..... $7,230,000.00

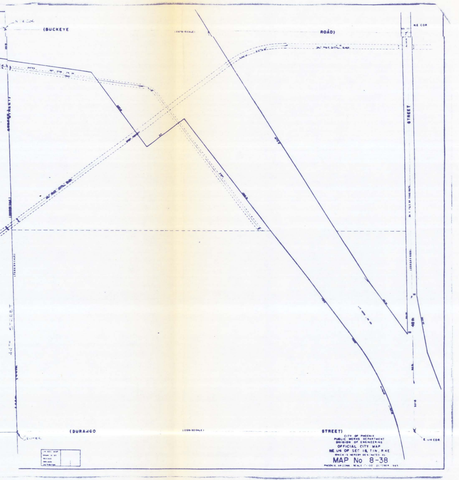

FT. ARIZONA CITY INDUSTRIAL CENTER
UNIT ONE
FLOWER BUCKEYE ROAD
ELWOOD STREET
CITY OF PHOENIX
ENGINEERING DEPARTMENT
QUARTER-SECTION MAP
No. 6-33
BM L/R SEC. 23, T.1N., R.3E
PHOENIX, ARIZONA
TRANSMISSION
ARIZONA SAND & ROCK CO. INC.
JAMES P. & JOSEPHINE H. MICHAELSON
CITY OF PHOENIX
ENGINEERING DEPARTMENT
QUARTER-SECTION MAP
No. 6-34
BM L/R SEC. 23, T.1N., R.3E
PHOENIX, ARIZONA
TANNER CO.
G.M. GIM BOR & KUNG TAO FONG
CLAYTON & CONNIE BRAXTON
SOUTHERN PACIFIC RAILROAD
KERRY AVENUE
FLORENCE AVENUE
CITY OF PHOENIX
ENGINEERING DEPARTMENT
QUARTER-SECTION MAP
No. 6-35
BM L/R SEC. 24, T.1N., R.3E
PHOENIX, ARIZONA
UNIVERSITY DRIVE
WINLOW AVENUE
BRAM AVENUE
SUPERIOR AVENUE
DRAIN DITCH
DRAINAGE DISTRICT
NORTH BRANCH SAN FRANCISCO CANAL
CITY OF PHOENIX
ENGINEERING DEPARTMENT
QUARTER-SECTION MAP
No. 6-36
BM L/R SEC. 24, T.1N., R.3E
PHOENIX, ARIZONA
CITY OF PHOENIX
ENGINEERING DEPARTMENT
QUARTER-SECTION MAP
No. 6-37
BM L/R SEC. 19, T.1N., R.4E
PHOENIX, ARIZONA

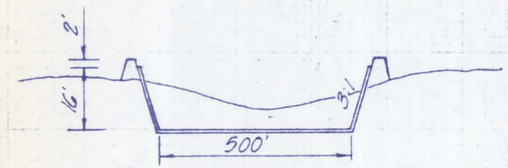

(DURANGO STREET)
SKY HARBOR
INTERNATIONAL
AIRPORT
INTERSTATE
ARIZONA INTERSTATE
ARIZONA INTERSTATE INDUSTRIAL
INDUSTRIAL
CENTER-UNIT ONE
INDUSTRIAL CENTER UNIT TWO
(UNIVERSITY STREET)
(MAGNOLIA STREET)
(LOWER BUCKEYE ROAD)
(TRANSMISSION ROAD)
WATKINS
HARMONY
MAGNOLIA
LANE
CITY OF PHOENIX
ARIZONA SAND & ROCK CO
THE TANNER COMPANIES
STATE OR FEDERAL
TANNER CO.
TANNER LAND & DEVELOPMENT CO
VALLEY NATIONAL BANK OF ARIZONA TR.
BRADLEY INVESTMENT CO.
MARC LARSON
(DRIVE)
CITY OF PHOENIX ENGINEERING DEPARTMENT QUARTER-SECTION MAP
No. 7-33
No. 7-34
No. 7-35
No. 7-36
No. 7-37


BUCKEYE
WILSON
VOID
TRACT A
SCHOOL
TRACT
PHOENIX
SKY
HARBOR
INTERNATIONAL
AIRPORT
DURANGO
STREET
CITY OF PHOENIX
ENGINEERING DEPARTMENT
QUARTER - SECTION MAP
MARICOPA COUNTY, ARIZONA
No. 8-33
NW/4 SEC 14, T 1N, R 3E


SKY
HARBOR
BOULEVARD
CITY
OF
PHOENIX
PT. PHOENIX
SKY
HARBOR
INTERNATIONAL
AIRPORT
DURANGO
STREET
CITY OF PHOENIX
ENGINEERING DEPARTMENT
QUARTER - SECTION MAP
MARICOPA COUNTY, ARIZONA
No. 8-34
NW/4 SEC 13, T 1N, R 3E


HARBOR
BOULEVARD
DURANGO
STREET
CITY OF PHOENIX
ENGINEERING DEPARTMENT
QUARTER - SECTION MAP
MARICOPA COUNTY, ARIZONA
No. 8-37
NW/4 SEC 18, T 1N, R 4E

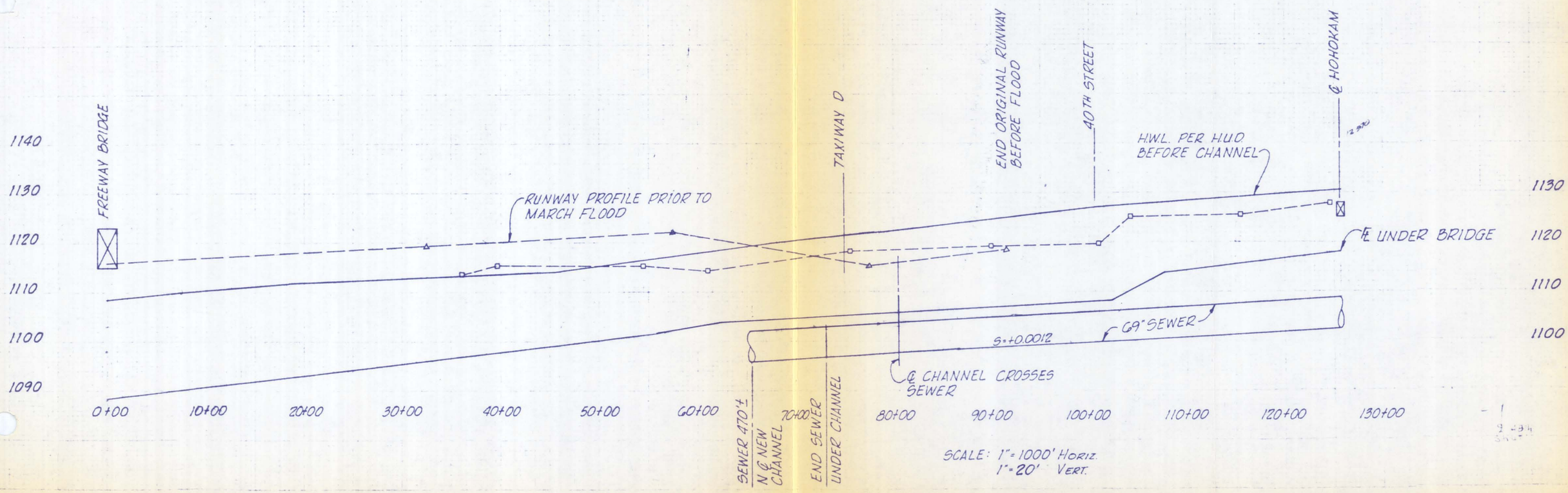

BUCKEYE
ROAD
DURANGO
STREET
CITY OF PHOENIX
ENGINEERING DEPARTMENT
QUARTER - SECTION MAP
MARICOPA COUNTY, ARIZONA
MAP No 8-38
NW/4 SEC 17, T 1N, R 4E

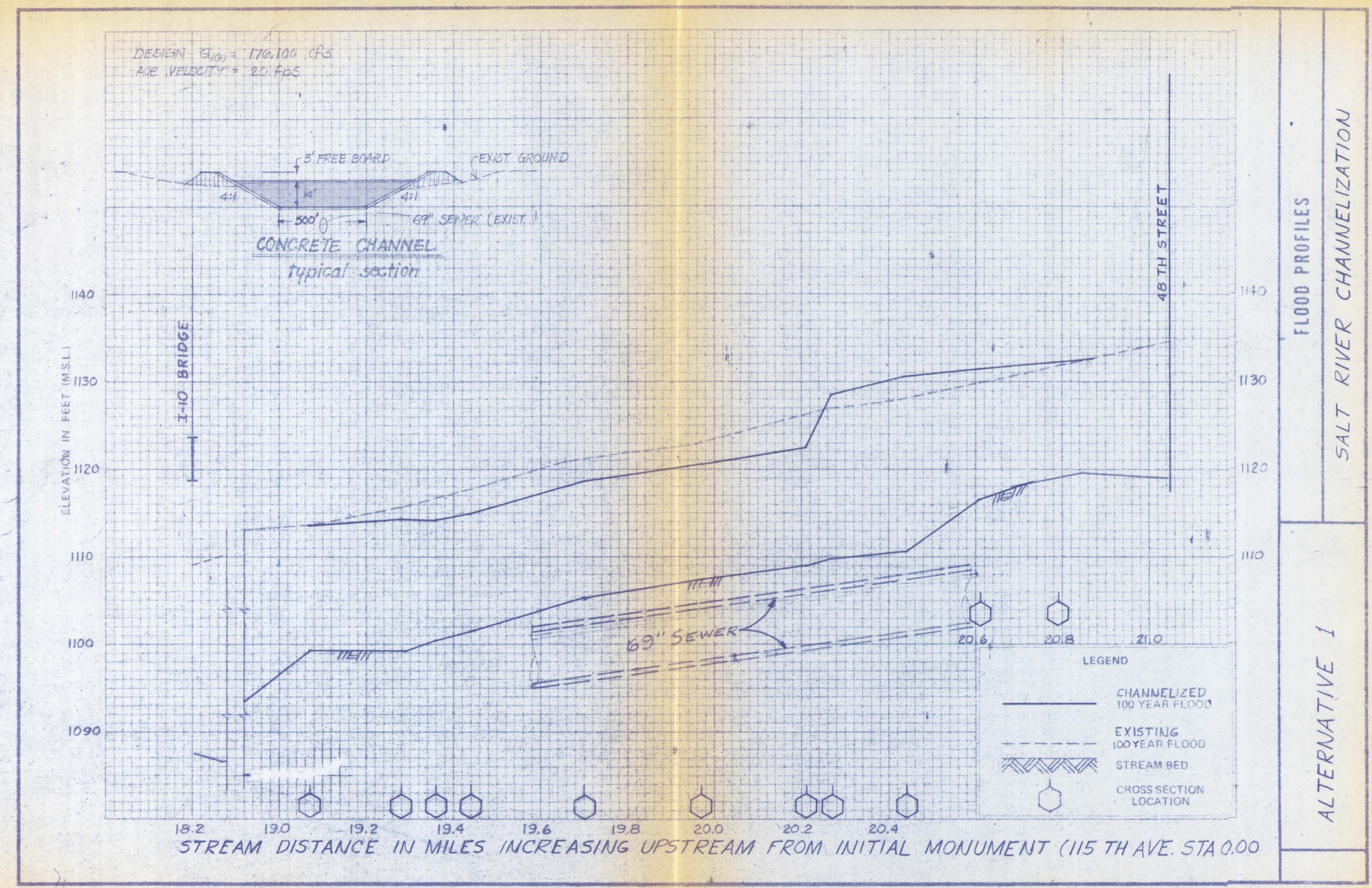


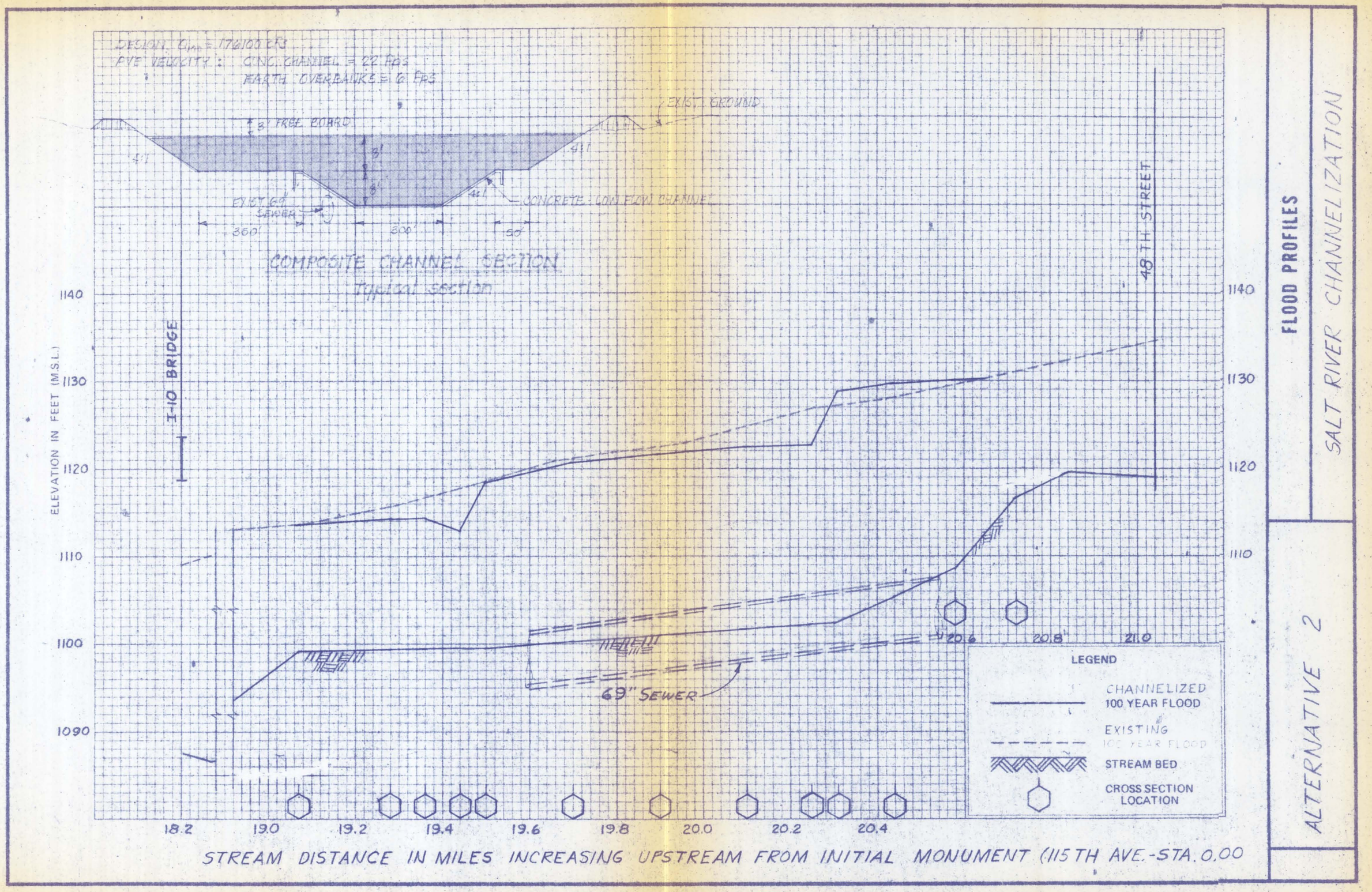
SEC. @ 90+00

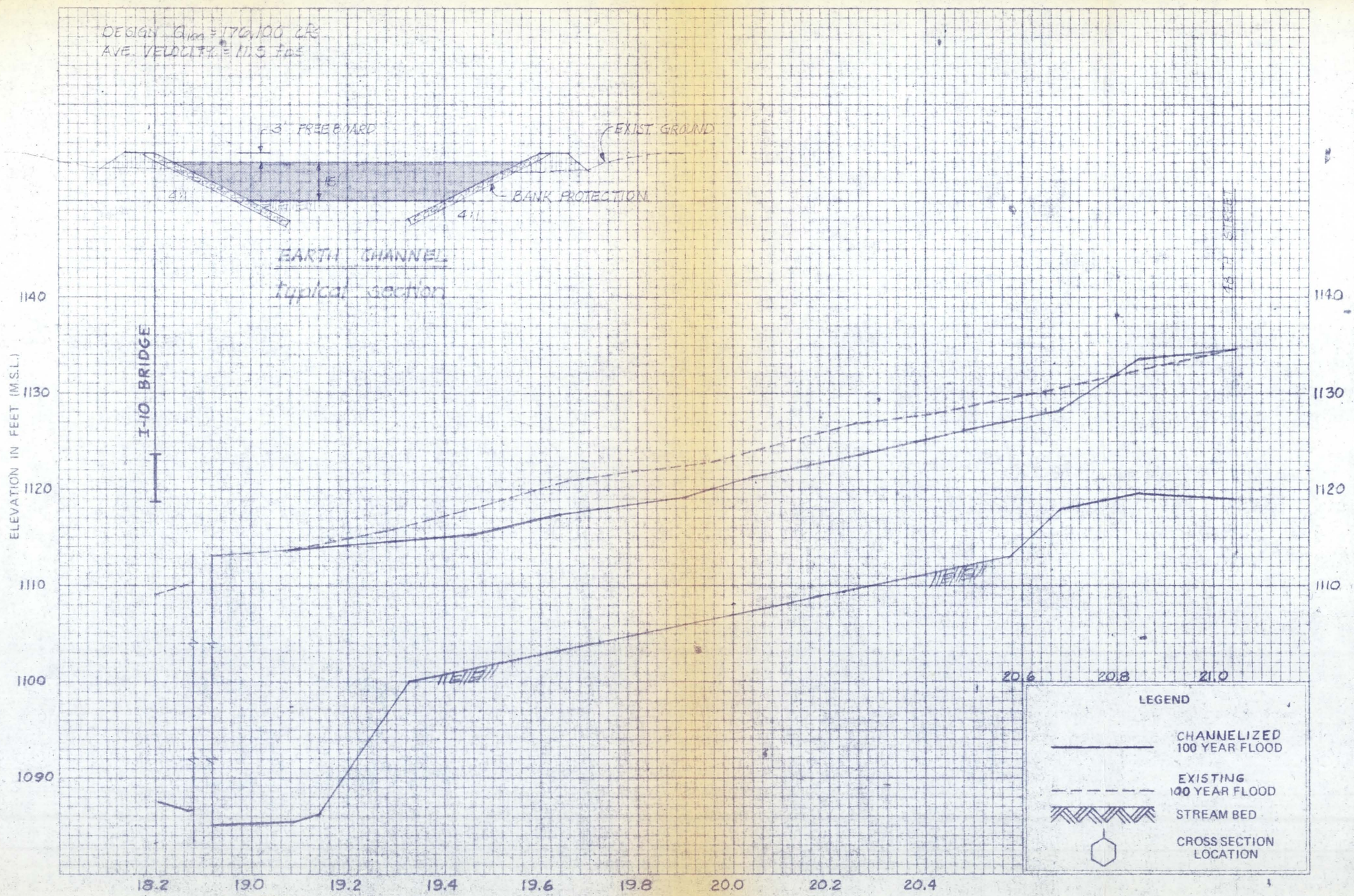
Scale: 1" = 400 Horiz.
1" = 40' Vert.

ALTERNATE #1




DESIGN Q100 = 170,100 CFS
AVE. VELOCITY = 20 FPS
3' FREE BOARD
EXIST. GROUND
4:1
14'
4:1
500'
69" SEWER (EXIST.)
CONCRETE CHANNEL
typical section
ELEVATION IN FEET (M.S.L.)
1140
1130
1120
1110
1100
1090
I-10 BRIDGE
48TH STREET
69" SEWER
20.6
20.8
21.0
LEGEND
CHANNELIZED 100 YEAR FLOOD
EXISTING 100 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
18.2
19.0
19.2
19.4
19.6
19.8
20.0
20.2
20.4
STREAM DISTANCE IN MILES INCREASING UPSTREAM FROM INITIAL MONUMENT (115 TH AVE. STA 0.00
FLOOD PROFILES
SALT RIVER CHANNELIZATION
ALTERNATIVE 1

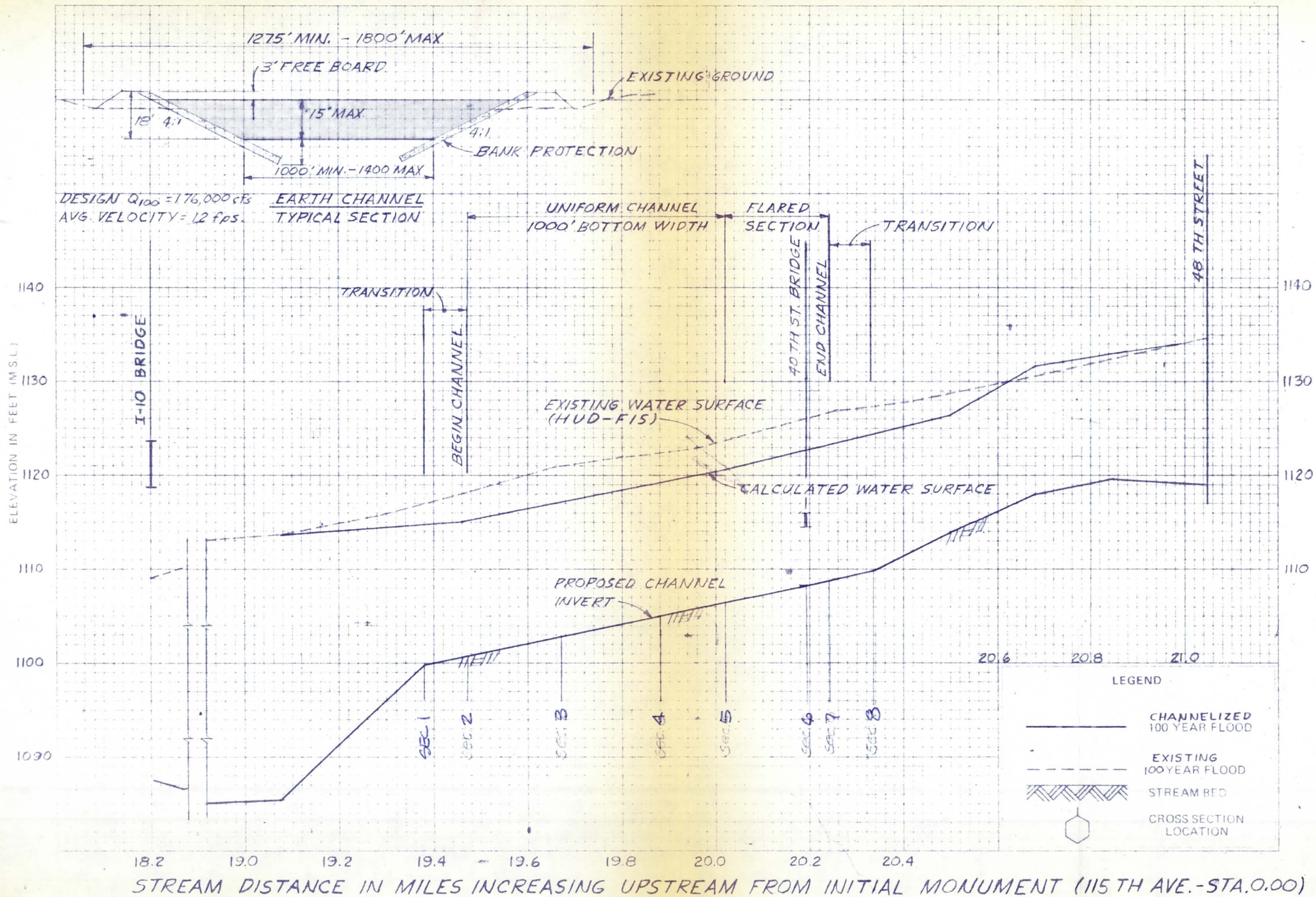

DESIGN Q100 = 176100 CFS
AVE VELOCITY: CONC CHANNEL = 22 FPS
EARTH OVERBANKS = 12 FPS
EXIST GROUND
3' FREE BOARD
3'
3'
4:1
4:1
4:1
EXIST 60" SEWER
CONCRETE LOW FLOW CHANNEL
360'
300'
50'
COMPOSITE CHANNEL SECTION
Typical section
ELEVATION IN FEET (M.S.L.)
1140
1130
1120
1110
1100
1090
I-10 BRIDGE
48TH STREET
69" SEWER
20.6
20.8
21.0
LEGEND
CHANNELIZED 100 YEAR FLOOD
EXISTING 100 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
18.2
19.0
19.2
19.4
19.6
19.8
20.0
20.2
20.4
STREAM DISTANCE IN MILES INCREASING UPSTREAM FROM INITIAL MONUMENT (115TH AVE.-STA. 0.00
FLOOD PROFILES
SALT RIVER CHANNELIZATION
ALTERNATIVE 2



FLOOD PROFILES

SALT RIVER CHANNELIZATION

ALTERNATIVE 3

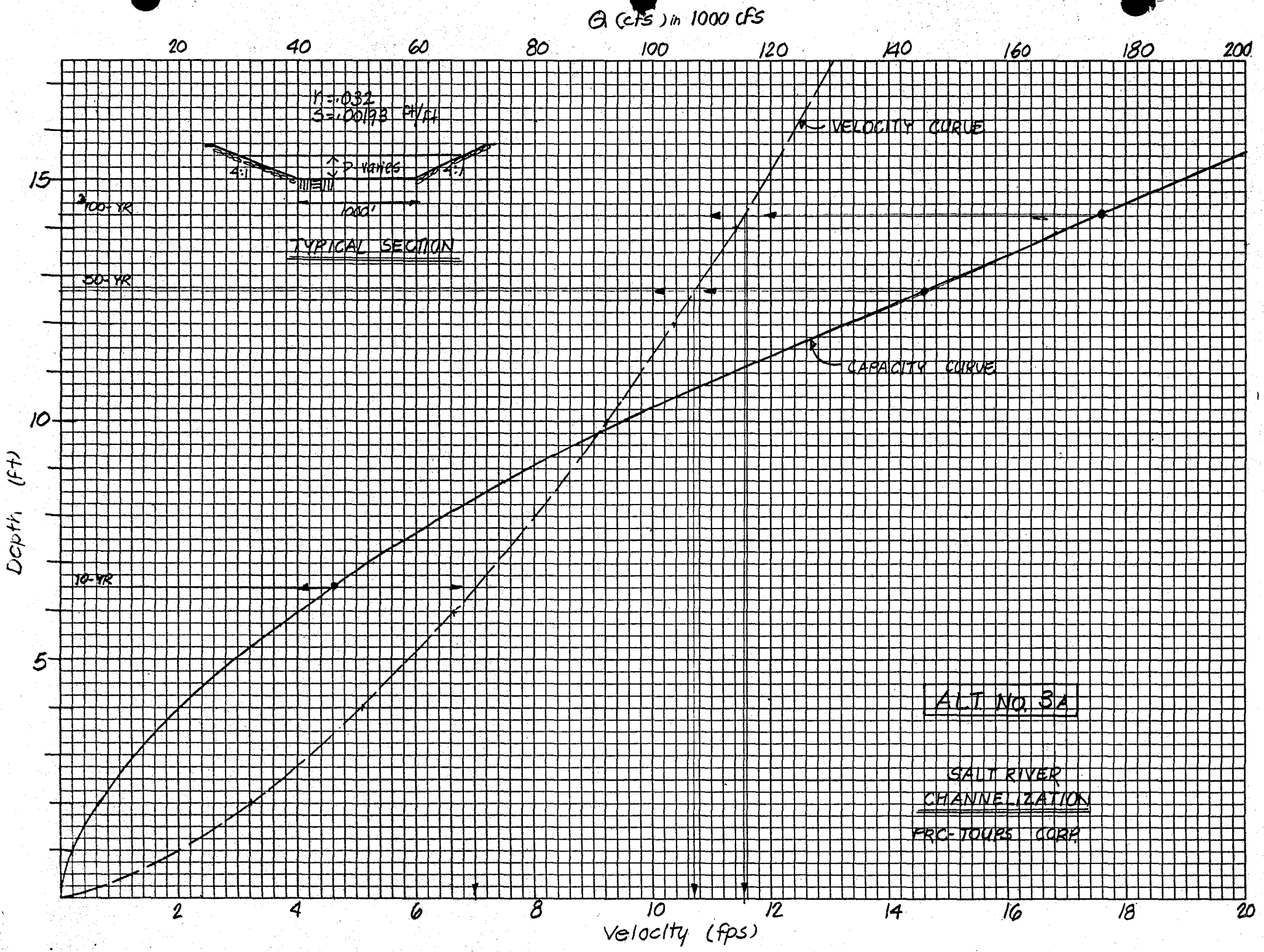


FLOOD PROFILES

SALT RIVER CHANNELIZATION

EARTH CHANNEL
ALTERNATIVE 3A

K+E 10 X 10 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.



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*****************************************
HEC2 RELEASE DATED NOV 76 UPDATED FEB 1977
ERROR CORR -  01
MODIFICATION -  50,51,52
*****************************************
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NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY

SALT RIVER CHANNELIZATION Alternate 3A page 1

SUMMARY PRINTOUT

SECNO	Q	CWSEL	CRIWS	VCH	XLCH	STCHL	STCHR	STENCL	STENCR	SSTA	ENDST
19.070	176100.00	1113.80	0.00	7.43	0.00	18686.00	20689.00	17500.00	20550.00	17500.00	20545.41
1.000	176100.00	1115.08	0.00	9.54	1380.00	19500.00	20500.00	0.00	0.00	19158.36	20841.64
2.000	176100.00	1115.13	0.00	11.87	460.00	19500.00	20500.00	0.00	0.00	19442.69	20557.31
3.000	176100.00	1117.11	0.00	11.97	1056.00	19500.00	20500.00	0.00	0.00	19443.15	20556.85
4.000	176100.00	1119.15	0.00	11.93	1056.00	19500.00	20500.00	0.00	0.00	19442.99	20557.01
5.000	176100.00	1120.74	0.00	11.94	830.00	19500.00	20500.00	0.00	0.00	19443.01	20556.99
6.000	176100.00	1123.02	0.00	9.16	900.00	19340.00	20660.00	0.00	0.00	19280.70	20719.30
7.000	176100.00	1123.57	0.00	8.30	300.00	19300.00	20700.00	0.00	0.00	19240.90	20759.10
8.000	176100.00	1124.25	0.00	7.68	500.00	19300.00	20700.00	0.00	0.00	18919.75	20913.89
*20.500	176100.00	1126.50	1126.50	13.74	720.00	19330.00	21521.00	18470.00	21250.00	18488.28	21250.00
20.680	176100.00	1131.78	0.00	6.79	900.00	19280.00	21662.00	18150.00	21700.00	18150.00	21700.00
20.850	176100.00	1133.24	0.00	10.48	960.00	19675.00	20969.00	17500.00	21000.00	17547.91	21000.00

SALT RIVER CHANNELIZATION

SUMMARY PRINTOUT

	SECNO	QLOB	QCH	QROB	VLOB	VCH	VROB	TELMX	CWSEL	DIFWSX	TOPWID	ELMIN	ALPHA
	19.070	299.36	175800.64	0.00	.85	7.43	0.00	1117.70	1113.80	0.00	2392.31	1085.40	1.02
	1.000	15585.16	144929.67	15585.16	6.01	9.54	6.01	1119.90	1115.08	1.28	1683.28	1099.90	1.09
	2.000	3008.95	170082.10	3008.95	7.33	11.87	7.33	1116.80	1115.13	.04	1114.63	1100.80	1.02
	3.000	2985.17	170129.65	2985.17	7.39	11.97	7.39	1118.90	1117.11	1.98	1113.69	1102.90	1.02
	4.000	2993.74	170112.52	2993.74	7.37	11.93	7.37	1120.90	1119.15	2.04	1114.03	1104.90	1.02
	5.000	2992.52	170114.97	2992.52	7.37	11.94	7.37	1122.50	1120.74	1.59	1113.98	1106.50	1.02
	6.000	2570.58	170958.85	2570.58	5.85	9.16	5.85	1124.20	1123.02	2.28	1438.61	1108.20	1.02
	7.000	2236.22	171627.56	2236.22	5.12	8.30	5.12	1124.80	1123.57	.55	1518.19	1108.80	1.02
	8.000	13283.91	155351.64	7464.45	4.84	7.68	4.83	1125.00	1124.25	.68	1994.15	1109.80	1.06
*	20.500	2124.42	173975.58	0.00	2.93	13.74	0.00	1135.00	1126.50	2.25	2669.79	1114.00	1.08
	20.680	24182.75	151410.92	506.34	4.07	6.79	3.00	1137.80	1131.78	5.28	3472.92	1118.00	1.09
	20.850	61229.07	114163.58	707.36	6.36	10.48	4.83	1140.20	1133.24	1.47	3324.74	1119.90	1.18

SALT RIVER CHANNELIZATION

3A-3

SUMMARY PRINTOUT

	SECNO	XLCH	K*CHSL	EG	HV	HL	OLOSS	10K*S	VOL	DEPTH	K*XNL	K*XNCH	K*XNR
	19.070	0.00	0.00	1114.66	.86	0.00	0.00	10.36	0.00	28.40	45.00	35.00	45.00
	1.000	1380.00	10.51	1116.35	1.26	1.49	.20	11.23	703.22	15.18	32.00	32.00	32.00
	2.000	460.00	1.96	1117.27	2.14	.66	.26	18.77	890.77	14.33	32.00	32.00	32.00
	3.000	1056.00	1.99	1119.29	2.18	2.01	.01	19.30	1256.45	14.21	32.00	32.00	32.00
	4.000	1056.00	1.89	1121.32	2.17	2.03	.00	19.11	1621.12	14.25	32.00	32.00	32.00
	5.000	830.00	1.93	1122.91	2.17	1.59	.00	19.14	1908.13	14.24	32.00	32.00	32.00
	6.000	900.00	1.89	1124.30	1.28	1.31	.09	11.42	2265.63	14.82	32.00	32.00	32.00
	7.000	300.00	2.00	1124.63	1.05	.30	.02	8.81	2407.17	14.77	32.00	32.00	32.00
	8.000	500.00	2.00	1125.10	.85	.41	.06	7.77	2671.62	14.45	32.00	32.00	32.00
*	20.500	720.00	5.83	1129.40	2.90	1.31	1.02	84.31	2979.38	12.50	45.00	35.00	45.00
	20.680	900.00	4.44	1132.43	.65	2.36	.67	12.88	3396.30	13.78	45.00	35.00	45.00
	20.850	960.00	1.98	1134.57	1.33	1.80	.34	35.68	3891.40	13.34	45.00	35.00	45.00

SUMMARY

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CAUTION  SECNO=   20.500  PROFILE= 1  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=   20.500  PROFILE= 1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION  SECNO=   20.500  PROFILE= 1  20 TRIALS ATTEMPTED TO BALANCE WSEL
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*************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED FEB 1977
  ERROR CORR -  01
  MODIFICATION -  50,51,52
*************************************************
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NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY

SALT RIVER CHANNELIZATION

SUMMARY PRINTOUT ALT. NO. 1 CONCRETE CHANNEL

	SECNO	Q	CWSEL	CRIWS	VCH	XLCH	STCHL	STCHR	STENCL	STENCR	SSTA	ENDST
	18.690	175000.00	1112.75	0.00	5.61	0.00	18995.00	20721.00	17770.00	20910.00	17770.00	20910.00
	19.070	176100.00	1113.65	0.00	5.43	1760.00 /	17500.00	20584.00	17500.00	20550.00	17614.70	20544.26
	19.280	176100.00	1114.34	0.00	3.00	1100.00 /	19150.00	20850.00	0.00	0.00	18967.99	27584.20
	19.360	176100.00	1114.33	0.00	4.87	400.00	19425.00	20575.00	0.00	0.00	19336.35	25131.71
*	19.440	176100.00	1114.99	1114.99	20.52	400.00	19700.00	20300.00	0.00	0.00	19641.66	20358.34
*	19.700	176100.00	1118.89	1118.89	20.58	1350.00	19700.00	20300.00	0.00	0.00	19644.92	20355.08
*	19.970	176100.00	1120.75	1120.75	20.54	1435.00	19700.00	20300.00	0.00	0.00	19639.22	20360.78
*	20.210	176100.00	1122.51	1122.51	20.58	1270.00	19700.00	20300.00	0.00	0.00	19645.96	20354.04
	20.270	176100.00	1128.64	0.00	11.11	300.00	19600.00	20400.00	0.00	0.00	19525.40	20474.60
	20.440	176100.00	1130.82	0.00	6.43	920.00	19396.00	20582.00	18800.00	21600.00	18800.00	21600.00
	20.610	176100.00	1131.30	0.00	7.37	900.00	19400.00	20689.00	18250.00	21662.00	18250.00	21662.00
	20.790	176100.00	1132.39	0.00	10.16	960.00	19516.00	20969.00	17300.00	21250.00	17630.73	21250.00

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  HEC2 RELEASE DATED NOV 76 UPDATED FEB 1977
  ERROR CORR -  01
  MODIFICATION -  50,51,52
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NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY

SALT RIVER CHANNELIZATION

SUMMARY PRINTOUT ALT. NO. 2 COMPOSITE CHANNEL

	SECNO	Q	CWSEL	CRIWS	VCH	XLCH	STCHL	STCHR	STENCL	STENCR	SSTA	ENDST
	18,690	175000.00	1112.75	0.00	5.61	0.00	18995.00	20721.00	17770.00	20910.00	17770.00	20910.00
	19,070	176100.00	1113.65	0.00	5.43	1760.00	17500.00	20584.00	17500.00	20550.00	17614.70	20544.26
	19,280	176100.00	1114.34	0.00	3.00	1100.00	19150.00	20850.00	0.00	0.00	18967.99	27584.20
	19,360	176100.00	1114.34	0.00	4.44	400.00	19425.00	20575.00	0.00	0.00	19334.23	25240.34
*	19,440	176100.00	1112.99	1112.99	20.61	400.00	19700.00	20300.00	0.00	0.00	19646.05	20353.95
*	19,500	176100.00	1118.51	1118.51	22.77	300.00	19823.00	20177.00	0.00	0.00	19582.97	20417.03
	19,700	176100.00	1120.81	0.00	20.66	1056.00	19823.00	20177.00	0.00	0.00	19576.98	20423.02
	19,900	176100.00	1121.70	0.00	20.42	1056.00	19823.00	20177.00	0.00	0.00	19576.24	20423.76
	20,100	176100.00	1122.37	0.00	20.57	1056.00	19823.00	20177.00	0.00	0.00	19576.71	20423.29
	20,250	176100.00	1122.84	0.00	20.61	680.00	19823.00	20177.00	0.00	0.00	19576.82	20423.18
	20,310	176100.00	1128.93	0.00	7.86	300.00	19600.00	20400.00	0.00	0.00	19520.73	20479.27
	20,420	176100.00	1129.94	0.00	4.26	600.00	18217.00	19672.00	18150.00	21600.00	18150.00	21600.00
	20,580	176100.00	1130.05	0.00	5.13	820.00	18325.00	19692.00	17700.00	21650.00	18143.83	21650.00
	20,720	176100.00	1130.20	0.00	7.74	740.00	18278.00	19869.00	16950.00	21200.00	16950.00	21142.92

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*****************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED FEB 1977
  ERROR CORR -  01
  MODIFICATION -  50,51,52
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NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY

SALT RIVER CHANNELIZATION

SUMMARY PRINTOUT ALTERNATIVE 3 EARTH CHANNEL

SECNO	Q	CWSEL	CRIWS	VCH	XLCH	STCHL	STCHR	STENCL	STENCR	SSTA	ENDST
19.070	176100.00	1113.80	0.00	7.43	0.00	18686.00	20689.00	17500.00	20550.00	17500.00	20545.41
19.260	176100.00	1114.67	0.00	9.31	980.00	19500.00	20500.00	0.00	0.00	19117.09	20907.13
19.330	176100.00	1114.90	0.00	10.45	350.00	19500.00	20500.00	0.00	0.00	19318.97	20719.60
19.390	176100.00	1115.06	0.00	11.93	350.00	19500.00	20500.00	0.00	0.00	19442.97	20557.03
19.590	176100.00	1117.07	0.00	12.00	1056.00	19500.00	20500.00	0.00	0.00	19443.30	20556.70
19.790	176100.00	1119.14	0.00	11.95	1056.00	19500.00	20500.00	0.00	0.00	19443.05	20556.95
19.990	176100.00	1121.17	0.00	11.92	1056.00	19500.00	20500.00	0.00	0.00	19442.91	20557.09
20.230	176100.00	1123.61	0.00	11.96	1285.00	19500.00	20500.00	0.00	0.00	19443.11	20556.89
20.300	176100.00	1125.01	0.00	10.53	390.00	19500.00	20500.00	0.00	0.00	19277.68	20722.32
20.380	176100.00	1126.09	0.00	9.15	380.00	19500.00	20500.00	0.00	0.00	18990.46	20945.37
20.590	176100.00	1128.17	0.00	11.64	1150.00	19280.00	21662.00	18200.00	21662.00	18200.00	21662.00
20.800	176100.00	1133.75	0.00	9.73	1050.00	19675.00	20969.00	17400.00	21000.00	17400.00	21000.00