EASTERN CANAL
FLOODPLAIN DELINEATION STUDY

TECHNICAL DATA NOTEBOOK

Book 1 of 2

Submitted to:

Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85008
(602) 506-1501

EASTERN CANAL TECHNICAL DATA NOTEBOOK (TDN)
STUDY DOCUMENTATION ABSTRACT

SECTION 1: GENERAL INFORMATION

1A. Community: City of Mesa
1B. Community Number: 040048
1C. County: Maricopa
1D. State: Arizona
1E. Date Study Accepted: Pending
1F. Study Contractors:

Aerial Mapping Company, Inc.
3141 West Clarendon Avenue
Phoenix, Arizona 85017
(602) 263-5728
Aerial Mapping

A-N West, Inc.
7600 N. 15th Street, Suite 200
Phoenix, Arizona 85020
(602) 861-2200
Hydraulics/Floodplain Mapping

Project Engineering Consultants, Ltd.
3130 North 35th Avenue, Suite 1
Phoenix, Arizona 85017
(602) 484-7691
Field Survey

Primatech Engineers
2929 North 44th Street, Suite 228
Phoenix, Arizona 85018
(602) 952-2828
Hydrology

1G. FEMA Technical Reviewer: Pending

1H. FEMA Regional Reviewer: Pending

1I. State Reviewer: Arizona Department of Water Resources
(602) 417-2445

1J. Local Reviewer: Flood Control District of Maricopa County
(602) 506-1501

1K. River or Stream Name: Eastern Canal

1L. Reach Description: From 200 feet downstream of Baseline to Hermosa Vista Drive, a distance of 5.5 River Miles. Located on FIRM Panel Nos. 2185D, 2195D and 2215F.

1M. Study Type: Approximate Zone A

SECTION 2: MAPPING INFORMATION

2A. USGS Quad Sheets: 7.5 Minute Series; Buckhorn, AZ, 1956, Photo Rev 1982 and Mesa, Arizona, 1952, Photo Rev. 1982.

2B. Mapping for Hydrologic Study: Same as above Section 2C.

2C. Mapping for Hydraulic Study: Aerial Photography Flown at Scale of 1:8400. Topographic Mapping Compiled at Scale of 1" = 200' and 2 feet. C.I. Photography Flown on 3/20/96. Mapping Consultant: Aerial Mapping, Co., Inc. of Phoenix, AZ

SECTION 3: HYDROLOGY

3A. Model or Method Used: Note 1: see Primatech Engineers Hydrology Report under separate cover. U.S. Army Corps of Engineers HEC-1 Model, Flood Hydrograph Package Computer Model, Version 4.0, September 1990.

3B. Storm Duration: 24-hour duration

3C. Hyetograph Type: Note 1.

3D. Peak Flow Frequencies Estimated in Hydrologic Study: 100-year storm

3E. List of Gages Used to Calibrate Model: Note 1.

3F. List of Rainfall Amounts: Note 1.

3G. Description of Unique Conditions: Note 1. Numerous split-flows at streets, and storm drains as well as retention basins were analyzed as part of study.

3H. Coordination with Applicable Agencies: Note 1.

SECTION 4: HYDRAULICS

4A. Model or Method Used: U.S. Corps of Engineers HEC-2 Model, Water Surface Profiles

Vendor: McTrans Center
512 Weil Hall
Gainesville, Florida 32611-2083

Version: 4.6.2, May, 1991

4B. Regime: Subcritical

4C. Frequency for which profiles computed: Profiles 1 and 2 represent trial discharges to estimate capacity along canal at breakout over canal berms. No specific frequency storm event analysis possible due to numerous breakouts.

4D. Method Floodway Calculation: No floodway modeled per FCDMC and City of Mesa direction.

4E. Unique Conditions and Problems: Letter Report of May 1, 1997 by A-N West, discusses preliminary hydraulic analysis estimating discharges for Profile 1, where flow begins breaking over east canal bank and Profile 2, where flow is approximately 0.5 feet over east top of canal bank. Over 14 breakout areas were identified and a detailed analysis for 100-year flood was not considered possible. Updating the Approximate Zone A floodplain was noted as possible alternate solution. Per City request in May 9, 1997 meeting updated Approximate Zone A was initiated and submitted with May 15, 1997 letter.

SECTION 5: ADDITIONAL STUDY INFORMATION

Length and Area of Floodplain Delineated

Main Channel = 5.5 Miles and 428.8 Acres
(Updated Zone A)

Length and Area of Floodway Delineated

No Floodway Delineated.

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2.7	COMMUNITY MAPS	In FIS Report
2.8	MISC. MAPS	None

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3.1 METHOD DESCRIPTION	Note 1 - Hydrology Report for Eastern Canal FIS By Primatech Engineers under separate cover
3.2 PARAMETER ESTIMATION	Note 1
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SECTION 4.0 HYDRAULIC ANALYSIS	See Attached Eastern Canal Flood Insurance Study (FIS) Report By A-N West Dated: May 1997
4.1. METHOD DESCRIPTION	See Sec. 3 of attached FIS Report
4.2 PARAMETER ESTIMATION	Note 2 - See Attached Field Reconnaissance & Hydraulic Parameter Estimation Report By A-N West Dated: Jan. 30, 1997
4.2.1 Manning's 'n' Value	See Section 4.2.1 of attached Rpt. (Note 2)

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4.2.2 Expansion and Contraction Coefficients	See Section 4.2.2 of attached Rpt. (Note 2)
4.2.3 Hydraulic Jump/Drop Analysis	See Section 4.2.3 of attached Rpt. (Note 2)
4.3 CROSS-SECTION DESCRIPTION	
4.3.1 Channel and Overbank Cross-Section Plots (17 - 24" x 36" shts.)	Under Separate Cover
4.3.2 Bridge or Constriction	See Cross-Section Plots
4.3.3 Grade Control Structures	Note 2 and FIS Rpts.
4.4 CALIBRATION	See Section 3.2 of FIS Report
4.5 SPECIAL PROBLEMS/SOLUTIONS	
Subject: Eastern Canal - Prelim. HEC-2 Model Results and Canal Breakout Identification Detailed Analysis Not Possible and Subsequent Approximate Zone A Delineation	See Letter Report By A-N West Dated: May 1 and 15, 1997 4.5 (1) - 4.5 (31)
4.6 FLOODWAY MODELING	N/A
4.7 PRELIM. (SEE SECT. 4.5) RESULTS/COMPUTER RUNS (CONDENSED)	Section 4.7 (1) and 4.7 (83)
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SECTION 5.0 EROSION/SEDIMENT TRANSPORT	N/A
SECTION 6.0 REFERENCE MATERIALS	
6.1 OTHER PUBLISHED FLOOD STUDIES	See FIS Report
6.2 PREVIOUS FEMA STUDIES	See Sec. 6 of FIS Report
6.3 OTHER APPLICABLE STUDIES	See Sec. 6 of FIS Report
6.4 PUBLISHED/UNPUBLISHED HISTORICAL FLOOD INFO.	See Sec. 2.3 and 6 of FIS Report
6.5 REFERENCED TECHNICAL PAPERS/DOCUMENTS	See Sec. 8 of FIS Report
SECTION 7.0 CROSS-REFERENCING AND LABELING INFORMATION	
7.1 OTHER STUDIES IMPACTED	N/A
7.2 KEY TO CROSS-SECTION LABELING	N/A - Mapping, Profiles and HEC-2 Model used same I.D. Nos.

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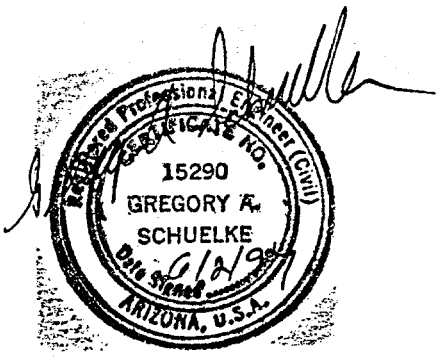
SECTION 8.0 DRAFT FIS REPORT — See Section 8.0

SECTION 9.0 FEMA REVISION REQUESTER FORMS — ----



12/19/96

G.S. called Rajh - FCD MC 506-4071

X-Section markups OK

He will have them x-sec. markups delivered to ANW

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
2801 West Durango Street
Phoenix, Arizona 85009

(602) 506-1501

LETTER OF TRANSMITTAL

TO Greg Schuelke

DATE 12/19/96	JOB NO. 96-10
ATTENTION Greg Schuelke	
RE:	
FCD 96-10	
Eastern Canal FIS	

WE ARE SENDING YOU ☒ Attached ☐ Under separate cover via _____ the following items:

☐ Shop drawings ☒ Prints ☐ Plans ☐ Samples ☐ Specifications

☐ Copy of letter ☐ Change order ☐ _____

COPIES	DATE	NO.	DESCRIPTION
1	12/19		Blueline maps of x-section layouts.

THESE ARE TRANSMITTED as checked below:

☐ For approval ☐ Approved as submitted ☐ Resubmit _____ copies for approval

☐ For your use ☐ Approved as noted ☐ Submit _____ copies for distribution

☐ As requested ☐ Returned for corrections ☐ Return _____ corrected prints

☐ For review and comment ☐ _____

☐ FOR BIDS DUE _____ 19 _____ ☐ PRINTS RETURNED AFTER LOAN TO US

REMARKS

Greg, I have looked at the locations and alignment of the x-sections. It looks fine.

COPY TO File 1.3(2)

SIGNED: [signature]

6910-009 R8-93

If enclosures are not as noted, kindly notify us at once.

2/19/97
Rajh - of FCD. called G.S.

"N" Value Report OK'd

Prematec says Preliminary Hydrology 90% Final

DATA COLLECTION SUMMARY REPORT

Project Name: Eastern Canal Floodplain Delineation Study
FCDMC No.: 96-10
A-N West No.: 7158-04
Date: 4/7/97
Discussion: The following is a summary of the data collection effort by A-N West. More detailed documentation will be included in the Technical Data Notebook.

Contact No.	Agency Organization	Contact Date	Method of Contract	Data Requested and/or Obtained Requested Flood Hazard
1	ADOT - Engr. Records	2/26/97 & 4/13/97	Meeting	Obtained As-Builts on S.R. 360 and Greenfield Rd. T.I. at Eastern Canal.
2	Salt River Project	4/4/97	Meeting Telephone	Obtained As-Builts on Eastern Canal - Baseline Rd. to Gilbert Rd.
3.	A-N West Field Survey	3/13/97	Meeting	Obtained invert elevation of Drainage Structures at Baseline Rd., Greenfield Rd., U.S. 60 (S.R. 360), Southern Ave., Broadway Rd., Apache Blvd.
4.	FCDMC - Mr. Raju Shah	12/11/96 - 4/4/97	Fax Telephone Meeting	a) Requested reproducibles of current FEMA maps. b) Obtained field survey notes, disks by Project Engineering. c) Obtained Preliminary Hydrology Summary by Primatech.

A-N WEST INC.
Consulting Engineers

7600 NORTH 15TH STREET
SUITE 200
PHOENIX, ARIZONA 85020
(602) 861-2200

Letter of Transmittal

TO: FCDMC
2801 west Durango Street
Phoenix Az 85009

DATE: 4/9/97
JOB TITLE:
JOB NO.: A-N west 7158-04
RE: Eastern Canal FIS
FCD No 96-10

ATTN: Mr Raj Shah - Proj Manager

FROM: Greg Schuelke

WE ARE SENDING YOU ☒ ATTACHED ☐ UNDER SEPARATE COVER

VIA Mail & Fax

THE FOLLOWING ITEMS:

☐ SPECIFICATIONS ☐ ORIGINALS ☒ COPY OF LETTER
☐ SHOP DRAWINGS ☐ PRINTS ☐ REPORT
☐ PLANS ☐ SAMPLES ☐ OTHER

QUAN.	I.D./DWG. NO.	TITLE/DESCRIPTION
1		Monthly Progress Report
		For Month Ending 2/23/97 and
		3/30/97
1		Data Collection Summary Report

THESE ARE TRANSMITTED ☒ FOR REVIEW ☒ FOR YOUR USE ☐ AS REQUESTED
☐ OTHER

REMARKS: Raj; Per your request attached are monthy progress reports for last months billing and this months upcoming billing:

Also I've included a data collection summary report for your review and approval/comments

REC'D. BY: DATE:

COPY TO: File 1.3(5) ☐ WITH ENCLOSURES

MONTHLY PROGRESS REPORT

Report Month Ending:	March 30, 1997
Project Name:	Eastern Canal Floodplain Delineation Study
FCDMC No.:	96-10
A-N West No.:	7158-04
Project Notice to Proceed:	11/25/96
Current Schedule Completion Date:	6/30/97

Project Task		Percent Complete Reporting Month	Cumulative Percent Complete
Task 1	Coordination	10	25
Task 2	Data Collection	60	100
Task 3	Floodplain Delineation		
	a) Reconn. Report	100	100
	b) Cross-section Location/Digitizing	15	40
	c) HEC-2 Floodplain Modeling	0	0
	d) Final Hydraulic Report	0	0
Task 4	HIS Data Preparation		
	a) A-N West	0	0
Task 5	Final Products/Deliverables	0	0
Task 6	Direct Expenses	48	90

Work Performed in Month of March, 1997

a) Field Surveyed on 3/13/97, invert elevations on culverts along Eastern Canal at Baseline, Greenfield, U.S. 60, Southern, Broadway, and Apache Boulevard.
b) Continued work on digitizing cross-sections.
c) Begin analyzing culvert capacities by HEC-5 manual at roads noted in (a) above.

Work to be Accomplished in Month of April, 1997

Digitize cross-sections and perform preliminary HEC-2 model analysis and floodplain modeling.

Problem Discussion

- Continued problems encountered in digitizing cross-section data. Attempting to resolve.
- Time Extension Request to 6/30/97; applied for on 3/26/97.
- Preliminary review of 100-year discharges received from FCD/Primatech and culvert capacity versus top of canal and road indicates canal overtopping at most major roads.

MONTHLY PROGRESS REPORT

Report Month Ending:	February 23, 1997
Project Name:	Eastern Canal Floodplain Delineation Study
FCDMC No.:	96-10
A-N West No.:	7158-04
Project Notice to Proceed:	11/25/96
Current Schedule Completion Date:	3/31/97

Project Task		Percent Complete Reporting Month	Cumulative Percent Complete
Task 1	Coordination	0	15
Task 2	Data Collection	0	40
Task 3	Floodplain Delineation		
	a) Reconn. Report	100	100
	b) Cross-section Location/Digitizing	4	25
	c) HEC-2 Floodplain Modeling	0	0
	d) Final Hydraulic Report	0	0
Task 4	HIS Data Preparation		
	a) A-N West	0	0
Task 5	Final Products/Deliverables	0	0
Task 6	Direct Expenses	32	42

Work Performed in Months of January and February, 1997

a) Got Compact Disk (CD) of Eastern Canal Digital Data (12/27/96 Revision) from Aerial Mapping Company in Micro-Station Format on 1/15/97, and sent to A-N West in Richmond, California office for conversion to Auto-Cadd format.
b) A-N West's Phoenix office got digital topo data (TIN) back, converted to Auto-Cadd on 1/31/97.
c) Sent Field Reconnaissance Report to FCDMC on 1/30/97.
d) Field Reconnaissance Report approved by Flood Control District on 2/19/97.
e) Received Preliminary Hydrology Summary from Flood Control District by Primatech on 2/26/97.

Work to be Accomplished in Month of March, 1997

Digitize cross-sections, begin HEC-2 model analysis and culvert analysis.

Problem Discussion

Some problems encountered in digitizing cross-section data. Attempting to resolve.

A-N WEST INC.
Consulting Engineers

7600 NORTH 15TH STREET
SUITE 200
PHOENIX, ARIZONA 85020
(602) 861-2200

Letter of Transmittal

TO: FCD MC
2801 West Durango St.
Phoenix AZ 85008

ATTN: Mr Rajh Shah

FROM: Greg Schuelke

DATE: 5/6/97

JOB TITLE:

JOB NO.: A-N west No 7158-04

RE: Eastern Canal FIS
FCD No 96-10

WE ARE SENDING YOU ☒ ATTACHED ☐ UNDER SEPARATE COVER

VIA Mail

THE FOLLOWING ITEMS:

☐ SPECIFICATIONS ☐ ORIGINALS ☐ COPY OF LETTER
☐ SHOP DRAWINGS ☐ PRINTS ☒ REPORT
☐ PLANS ☐ SAMPLES ☐ OTHER

QUAN.	I.D./DWG. NO.	TITLE/DESCRIPTION
1		Monthly Progress Report
		For Month Ending 4/30/97

THESE ARE TRANSMITTED ☒ FOR REVIEW ☒ FOR YOUR USE ☐ AS REQUESTED
☐ OTHER

REMARKS:

REC'D. BY: DATE:

COPY TO: File 1,3 (8) ☐ WITH ENCLOSURES

MONTHLY PROGRESS REPORT

Report Month Ending:	April 30, 1997
Project Name:	Eastern Canal Floodplain Delineation Study
FCDMC No.:	96-10
A-N West No.:	7158-04
Project Notice to Proceed:	11/25/96
Current Schedule Completion Date:	6/30/97

Project Task		Percent Complete Reporting Month	Cumulative Percent Complete
Task 1	Coordination	10	35
Task 2	Data Collection	60	100
Task 3	Floodplain Delineation		
	a) Reconn. Report	100	100
	b) Cross-section Location/Digitizing	60	100
	c) HEC-2 Floodplain Modeling	40	40
	d) Final Hydraulic Report	10	10
Task 4	HIS Data Preparation		
	a) A-N West	0	0
Task 5	Final Products/Deliverables	10	10
Task 6	Direct Expenses	48	90

Work Performed in Month of April, 1997

a) Prepared Preliminary HEC-2 Model of full length of project, which analyzed capacity of reaches of canal for Profile 1 (WSEL at critical east top of bank elevations), and Profile 2 (WSEL 0.5 foot above east top of bank. The preliminary floodplain mapping, cross-section and letter were submitted on May 1, 1997, in meeting with FCDMC. A copy was mailed to the City of Mesa.

Work to be Accomplished in Month of May, 1997

Meet with the City of Mesa and FCDMC to discuss approach for continued study, given that 100-year computed flow greatly exceeds capacity along canal.

Problem Discussion

As discussed in May 1, 1997 letter with supporting preliminary data to FCDMC and the City, the floodplain along upstream side of canal does not provide continuous conveyance of flow close to computed 100-year flows.

A-N WEST INC.
Consulting Engineers

7600 NORTH 15TH STREET
SUITE 200
PHOENIX, ARIZONA 85020
(602) 861-2200

Letter of Transmittal

TO: FCD MC
2801 West Durango St.
Phoenix AZ 85008

ATTN: Mr Rajh Shah

FROM: Greg Schuelke

DATE: 5/30/97

JOB TITLE:

JOB NO.: A-N west No 7158-04

RE: Eastern Canal FIS
FCD No 96-10

WE ARE SENDING YOU ☒ ATTACHED ☐ UNDER SEPARATE COVER

VIA Mail

THE FOLLOWING ITEMS:

☐ SPECIFICATIONS ☐ ORIGINALS ☐ COPY OF LETTER
☐ SHOP DRAWINGS ☐ PRINTS ☒ REPORT
☐ PLANS ☐ SAMPLES ☐ OTHER

QUAN.	I.D./DWG. NO.	TITLE/DESCRIPTION
1		Monthly Progress Report
		For Month Ending 5/30/97

THESE ARE TRANSMITTED ☒ FOR REVIEW ☒ FOR YOUR USE ☐ AS REQUESTED
☐ OTHER

REMARKS:

REC'D. BY: DATE:

COPY TO: File 1.3 (10) ☐ WITH ENCLOSURES

MONTHLY PROGRESS REPORT

Report Month Ending:	May 31, 1997
Project Name:	Eastern Canal Floodplain Delineation Study
FCDMC No.:	96-10
A-N West No.:	7158-04
Project Notice to Proceed:	11/25/96
Current Schedule Completion Date:	6/30/97

Project Task		Percent Complete Reporting Month	Cumulative Percent Complete
Task 1	Coordination	50	85
Task 2	Data Collection	0	100
Task 3	Floodplain Delineation		
	a) Reconn. Report	0	100
	b) Cross-section Location/Digitizing	0	100
	c) HEC-2 Floodplain Modeling	60	100
	d) Final Hydraulic Report	90	100
Task 4	HIS Data Preparation		
	a) A-N West	100	100
	b) Aerial Mapping Co.	10	10
Task 5	Final Products/Deliverables	50	60
Task 6	Direct Expenses	10	100

Work Performed in Month of May, 1997

a) Meeting held in Mesa on May 9, 1997 to discuss 5/1/97 letter report. Subsequent updated Zone A floodplain submitted 5/15/97 in draft version. On May 28, 1997, draft FIS report submitted with CADD drawn floodplain mapping which was also submitted to Aerial Mapping Company to start HIS translation.

Work to be Accomplished in month of June, 1997

Aerial Mapping Company to finish HIS translation. A-N West to submit Tech. Data Notebook.

MEETING SUMMARY

DATE: May 9, 1997

RE: Eastern Canal and UEMF FIS, FCD No. 96-10 and 94-26
Review of Preliminary Results from May 1, 1997 Letter Report
A-N West No. 7158-04 and 7158-03

AUTHOR: Mr. Greg Schuelke

ATTENDEES: Mr. Pedro Calza, FCDMC
Mr. Rajh Shah, FCDMC
Mr. Peter Knudson, City of Mesa
Mr. Keith Nath, City of Mesa
Mr. Humphreys, Primatech
Mr. Greg Schuelke, A-N West, Inc
Mr. Greg Barry, A-N West, Inc.

DISCUSSION:

1) Mr. Schuelke explained May 1, 1997 Letter Report and Mapping/Hydraulic Analysis. Mr. Schuelke noted that as A-N West evaluated potential culvert capacity of significant culverts along Eastern Canal as shown in Tables 1 and 2 and compared to 100-year discharges by Primatech, it was apparent that culverts did not have near the 100-year discharge capacity.

On discussion of above observations with Mr. Shah, A-N West recommended a preliminary HEC-2 analysis to identify conveyance capacity of various reaches along the canal that will produce Water Surface Elevations (WSEL) near the east top of canal (Profile 1) and also the capacity that would produce WSEL 0.5 foot above top of east canal bank (Profile 2).

As shown on the May 1, 1997 letter report Table 3, the resultant computed conveyance capacity for the Profile 1 or 2 analysis was only a fraction of the computed 100-year discharges to the canal and approximately 14 breakouts over the canal were identified on the floodplain mapping and Table 3.

Mr. Schuelke explained that the Profile 2 WSEL of 0.5 foot above the east top of canal was chosen as approximately the maximum potential 100-year ponding level as at this level breakouts over the canal would approximate 1 cfs/foot of weir flow length along canal. A rough estimate of the number of breaches and the 100-year computed flows suggested an equilibrium at this depth of weir flow over the canal versus 100-year inflows.

Mr. Nath stated that the City was concerned that this analysis assumed longitudinal flow along the canal between breakouts that may not be possible. Also, the potential uncertainty of inflows to the canal may not coincide with breakout locations.

Mr. Nath stated that the City didn't believe a detailed riverine analysis of the canal was feasible. Mr. Schuelke stated that this was A-N West's conclusion also.

Mr. Nath stated that the City would like to see an updated Approximate Zone A delineation for comparison to the effective Zone A delineation. Based on the City's experience the Zone A delineation should be based on the low top of high canal bank within approximately 200 feet of any point of interest along the canal. To reiterate for any point along the canal the delineation width would be based on the elevation within 200 feet longitudinally along the canal that would allow water to cross over both the top of east and west canal bank.

Mr. Nath indicated the City would then review this updated Approximate Zone A delineation to determine if an update through FEMA would be pursued.

Mr. Calza stated that A-N West should present the Profile 1 and 2 preliminary analysis and delineations along with the updated Approximate Zone A delineation in the Technical Data Notebook (TDN) supportive data as well as the floodplain mapping for digital translation to HIS format.

Mr. Calza asked if any hydrology refinements by Primatech would affect the conclusion that a detailed study was not possible. Mr. Schuelke said that A-N West did not believe any hydrology refinements would be significant, which Mr. Humphrey concurred and that therefore hydrology refinements would not result in a possible detailed floodplain analysis without canal breakouts.

Mr. Calza stated that A-N West needed to get the digital floodplain data to Aerial Mapping Co. by the end of May to allow time for their HIS translation such that completion of project by end of June could be accomplished.

2) Mr. Calza then brought up the issue of the Upper East Maricopa Floodway (UEMF) study which A-N West had also prepared and which had been on hold awaiting a decision of what type of floodplain delineation and zone to utilize based on the outcome of the Eastern Canal Study.

For this study reach, A-N West did not identify canal breakouts. However, the 100-year detailed WSEL was at the top of the east canal and bank at several cross-sections.

Mr. Nath was concerned that the hydrology analysis north of McKellips Road which was based on existing conditions concluded that runoff to this existing orchard area ponded and was stored with minimal flow bleeding off by culvert into the RWCD canal and no flow crossing McKellips Road south to the UEMF.

Mr. Nath said the City has no requirement of future development to maintain this existing storage upon development, only to provide retention for onsite runoff from the 50-year 24-hour storm. Thus, upon development this area could produce runoff south across McKellips with resultant increased discharges which could increase the WSEL's from A-N West's detailed hydraulic analysis.

Mr. Nath also questioned whether the lack of canal freeboard identified at several cross-sections by A-N West would be accepted by FEMA if a detailed analysis was pursued.

For these reasons Mr. Nath requested an updated Approximate Zone A delineation be prepared for this reach of the UEMF also, using the same procedure as discussed for the Eastern Canal. This would allow for a consistent delineation of both canal studies.

Mr. Calza stated that this delineation should also be performed and submitted to Aerial Mapping Company by the end of May to allow HIS translation and completion of this project by the end ofJune, 1997.

Meeting concluded.

FLOOD CONTROL DISTRICT
of
Maricopa County

2801 West Durango Street • Phoenix, Arizona 85009
Telephone (602) 506-1501
Fax (602) 506-4601
TT (602) 506-5859

BOARD OF DIRECTORS
Betsey Bayless
Ed King
Tom Rawles
Don Stapley
Mary Rose Garrido Wilcox

NOV 1996
A-N WEST, INC.
PHOENIX, ARIZONA

November 26, 1996

Larry Tysiac, P.E., Vice President
A-N West Engineering Consultants
7600 N. 15th Street, Suite 200
Phoenix, Arizona 85020

Subject: Contract FCD 96-10 Eastern Canal FDS

Dear Mr. Tysiac:

This will confirm our verbal notice to proceed of November 26, 1996 for the subject contract. Performance is 120 days, for expiration date of March 26, 1997. One fully executed copy of the contract is enclosed for your file.

Call the undersigned if you have any questions.

Sincerely,

Dortha Klaahsen

Dortha Klaahsen
Contracts Coordinator

1.4.1 (1)

A-N WEST INC.
Consulting Engineers

7600 NORTH 15TH STREET
SUITE 200
PHOENIX, ARIZONA 85020
(602) 861-2200

Letter of Transmittal

TO: Flood Control District of Mar. Co
2801 West Durango Str
Phoenix Az. 85009

ATTN: Mr Raju Shah

FROM: Greg Schuelke

DATE: 12/15/96

JOB TITLE:

JOB NO.: ANW # 7158-04

RE: FCD 96-10 Eastern Canal FIS

WE ARE SENDING YOU ☒ ATTACHED ☐ UNDER SEPARATE COVER VIA Delivery

THE FOLLOWING ITEMS:

☐ SPECIFICATIONS ☐ ORIGINALS ☐ COPY OF LETTER
☐ SHOP DRAWINGS ☒ PRINTS ☐ REPORT
☐ PLANS ☐ SAMPLES ☐ OTHER

QUAN.	I.D./DWG. NO.	TITLE/DESCRIPTION
1		Blueline (200 scale) markup of
		X-Section locations (5 shts. trimmed
		and taped together in one continuous
		roll)

THESE ARE TRANSMITTED ☒ FOR REVIEW ☒ FOR YOUR USE ☐ AS REQUESTED
☐ OTHER

REMARKS: Raju, Attached is a markup of proposed cross-section and hydraulic baseline locations for the referenced study with section I.D.'s in river miles. We have located the sections from downslope top of berm upslope a distance sufficient to obtain ground elevations at least one foot above adjacent canal bank elevs. Please review and return this only copy markup for our further use in preparing coded cross-sections

REC'D. BY: DATE:

COPY TO: File

1.4.1 (2)

☐ WITH ENCLOSURES

12/31/96

Karth Larry Maldonado called G.S. back
He wasn't sure if ex. culvert sizes & Inverts were surveyed abn ¢ Eastern Canal
He would check with Karl Mortensen and get back with us.

Larry Maldonado called G.S.
Didn't do ex. struct. survey.
Baker Engrs took out of scope
Re: Robert Davis.

G.S. called Robert Davies, Baker Engr 279-123.
Re: Eastern Canal FIS.
Why ~~were~~ was ex. structure survey not done?
~~How did~~ ~~was~~ were those structure
Robert to get back to G.S. on this question.
He through storm drain inventory was deleted
~~Ahp~~ Maybe Project Engr. misunderstood and assumed storm drain as well as culverts along canal were to be deleted.

12/31/96 (9:40 Am)

G.S. called Larry Maldanado Project Engr.
Ph.# 484-7691

Lt. Mess to call back

RE: Eastern Canal FIS.

12/31/96

Robert Davies called called back

Project Engr. will do those structure surveys.

Proj. Engr. busy

when do we need? G.S. couple wks.

How about pipes into or out of canal ~~in~~? G.S. No.

1/7/97 4:30 PM G.S. called Robert Parks 263-572

142 Cross-Sections

G.S. called Robert Parks 1/14/97
G.S. said we got his 1/14/97 proposal
We have Microsta. in our other office and
want to try for time and money savings to convert
the data thru ~~our~~ our other office's Microstation.

Robert to get CD-Rom of data ready tomm..
Robert said Baker had asked for street names
to be added.

G.S. called

1/15/97 Raj FCD back

Asked if conversion of data from Microstation to Autocad per Aerial Mapping Letter would result in added costs.

G.S. said A-N west just received of Microstation data 1/15/97 and was sending to Richmond, a. office to convert and didn't think there would be added cost.

aerial mapping company, inc.

3141 west clarendon avenue, phoenix, arizona 85017, (602) 263-5728 fax (602) 263-0165

Richard D. Cook, R.L.S. – President Gerald E. Francis – Director Robert G. Parks – Vice President

To: Mr. Greg Schuelke
A-N West, Inc.
7600 North 15th Street, Suite 200
Phoenix, Arizona 85028

January 14, 1997

Re: Eastern Canal Data Conversion and Cross Sections

Mr. Schuelke:

We, at Aerial Mapping Company, Inc. are pleased to present the fee estimates for conversion services on the Eastern Canal mapping and cross sections.

We will convert the MicroStation DGN file data to AutoCAD Rel-12 DWG files for your use. The area to be covered with this conversion is from the west edge of the mapping, extending approximately 1/2 mile eastward. The existing mapping will be trimmed to this line, and the data converted. All topographic and DTM data will be included in the conversion. The digital terrain data will be breaklines within the DWG files, and mass points and spot elevations as ASCII files of Easting, Northing and Elevation. A new DTM model will need to be generated by your system. Conversion to the FCDMC HIS standards is not included in this scope.

Our fee for this conversion will be Two Thousand Seven Hundred Dollars ($2,700.00), and we anticipate two weeks will be needed to accomplish this task. Delivery of the CAD data will be on CD-Rom or QIC-80 tape.

AMCI will extract cross section data from the MicroStation DTM model, locate the thalweg by coordinate comparison and provide HEC-2 GR card data for each cross section for a fee of $55.00 per each cross section. The data is sampled at each edge of the DTM surface triangles that the cross section intersects. A digital file or ASCII file of the cross section endpoint pairs will be needed from your office to locate the cross sections within the DTM model.

Aerial Mapping Company thanks you for the opportunity to provide our quality services for your use on this project. If we may assist your efforts in any other way, please contact us at our offices.

Sincerely yours,

Robert G. Parks

Robert G. Parks
Vice President
Aerial Mapping Company, Inc.
RGP/bp \docs\anwbaker
cc: Raj Shah, FCDMC

1.4.1 (7)

AERIAL MAPPING COMPANY, INC.
3141 W. Clarendon Avenue
PHOENIX, AZ 85017-4588

TEL (602) 263-5728
FAX (602) 263-0165

LETTER OF TRANSMITTAL

DATE 1/15/97	JOB NO. 96020
ATTENTION Grey Schuke	
RE: Eastern Canal DGN DATA	

TO AN West

WE ARE SENDING YOU ☐ Attached ☐ Under separate cover via _____ the following items:

☐ Shop drawings ☐ Prints ☐ Plans ☐ Samples ☐ Specifications

☐ Copy of letter ☐ Change order ☐ _____

COPIES	DATE	NO.	DESCRIPTION
1	1/15/97		CD - Eastern Canal Alt.
			12-27-96 Revision.

THESE ARE TRANSMITTED as checked below:

☐ For approval ☐ Approved as submitted ☐ Resubmit _____ copies for approval

☐ For your use ☐ Approved as noted ☐ Submit _____ copies for distribution

☐ As requested ☐ Returned for corrections ☐ Return _____ corrected prints

☐ For review and comment ☐ _____

☐ FOR BIDS DUE _____ 19 _____ ☐ PRINTS RETURNED AFTER LOAN TO US

REMARKS _____

COPY TO _____

RECYCLED PAPER:
Contents: 40% Pre-Consumer • 10% Post-Consumer

1.4.1 (8)

SIGNED: [signature]

If enclosures are not as noted, kindly notify us at once.

1/22/97
Rej. of FCDMC called Greg S.
Got field survey data from Baker and Prospect Engr. on Eastern Canal structure survey of culverts.

Survey notes only, no digital data disk
To leave at front desk for pickup.

A-N WEST INC.
Consulting Engineers

7600 NORTH 5TH STREET
SUITE 200
PHOENIX, ARIZONA 85020
(602) 861-2200

Letter of Transmittal

TO: Flood Control District of Mar. Co
2801 west Durango Str.
Phoenix, Az 85009

ATTN: Mr Raju Shah

FROM: Greg Schuelke

DATE: 1/30/97

JOB TITLE:

JOB NO.: A-N west No. 7158-04

RE: Eastern Canal FIS
FCD No. 96-10

WE ARE SENDING YOU ☒ ATTACHED ☐ UNDER SEPARATE COVER VIA Mail

THE FOLLOWING ITEMS:

☐ SPECIFICATIONS ☐ ORIGINALS ☐ COPY OF LETTER
☐ SHOP DRAWINGS ☐ PRINTS ☒ REPORT
☐ PLANS ☐ SAMPLES ☐ OTHER

QUAN.	I.D./DWG. NO.	TITLE/DESCRIPTION
1	1/30/97	T.D.N. Sec. 4.2, Field Reconnaissance and Hydraulic Parameter Report

THESE ARE TRANSMITTED ☒ FOR REVIEW ☒ FOR YOUR USE ☐ AS REQUESTED
☐ OTHER

REMARKS: Raj, Attached is a draft Field Recon. report for your review and comments. The report will eventually become a part of the Technical Data Notebook (TDN).

REC'D. BY: 1.4.1 (10) DATE:

COPY TO: City of Mesa, Mr Peter Knudson ☒ WITH ENCLOSURES
File

A-N WEST, INC.

TRANSMITTAL

DATE: 31-Jan-97

CONSULTING ENGINEERS
4123 LAKESIDE DRIVE
RICHMOND, CA 94806-1942
(510) 222-9800 FAX: (510) 222-6714

PROJECT: Eastern Canal

JOB NO: 5555-01

TO: A-N West, Inc
Phoenix

RE:

ATT: Greg Schuelke

FROM: Tony Lea

WE ARE SENDING YOU [x] ATTACHED [ ] UNDER SEPARATE COVER

VIA

THE FOLLOWING: [x] ELECTRONIC FILE [ ] SHOP DRAWINGS [ ] ORIGINALS [ ] PLANS [ ] REPRODUCIBLES [ ] CHANGE ORDER (S) [ ] SPECIFICATIONS [x] PRINTS [ ] COPY OF LETTER

QUAN.	I.D./DWG. NO.	
		Unedited cross section plots, Autocad Ver. 12 (1=50 H, 1=5V)
		Hard copy of sample computer generated HEC-2 sections
		Electronic file of Computer generated HEC-2 sections
		HEC-RAS plots of computer generated HEC-2 sections
		Electronic files of Autocad cross section plots

THESE ARE TRANSMITTED: [X] FOR REVIEW [ ] FOR YOUR USE [ ] AS REQUESTED [ ] OTHER:

REMARKS: Call me so we can review efforts to date.

COPIES TO: RJK

____ WITH ENCLOSURES
x WITHOUT ENCLOSURES

SIGNED Tony

1.4.1(11)

PRIMATECH Engineers

2929 N. 44th Street
Phoenix, Arizona 85018
(602) 952-2828
(602) 952-0808 FAX

FAX COVER SHEET

DATE: 2/25/97

NUMBER OF PAGES: 3
(Including Cover Sheet)

TO: GREG SCHUELKE

FAX NO.: 943-1989

FROM: ALISON BOLIN

REFERENCE: EASTERN CANAL FLOODPLAIN DELINEATION STUDY

COMMENTS: PRELIMINARY HEC-1 FLOW RATES FOR YOUR USE IN HEC-2 MODELLING. PLEASE CALL ME IF YOU HAVE ANY QUESTIONS.

Summary of Peak Discharges
Along the Eastern Canal

MFC001									Date
Mesa Flood Plain Delineation Study									11/5/96
			100-year		100-year		10-year		
			24-hr		6-hr		6-hr		
		PEAK	Q / A	PEAK	Q / A	PEAK	Q / A	100 - yr Critica	Critical
STATION	Drainage area	FLOW		FLOW		FLOW		Duration	Q_{100}
	(mi²)	cfs	(cfs / mi2)	cfs	(cfs / mi2)	cfs	(cfs / mi2)		cfs
CP3	0.46	273	593.5	225	489.1	76	165.6	24-hr	273
CP4	0.67	333	723.9	297	645.7	76	165.2	24-hr	333
CP17	2.45	240	521.7	217	471.7	106	230.4	24-hr	240
CP18	2.52	218	473.9	219	476.1	105	228.3	6-hr	219
CP20	2.57	216	469.6	223	484.8	106	230.4	6-hr	223
CP21	2.81	323	702.2	305	663.0	147	319.6	24-hr	323
CP37	4.48	637	1384.8	540	1173.9	98	213.0	24-hr	637
CP38	4.55	703	1528.3	615	1337.0	155	337.0	24-hr	703
CP39	4.65	692	1504.3	609	1323.9	150	326.1	24-hr	692
CP43	5.25	791	1719.6	691	1502.2	156	339.1	24-hr	791
CP44	5.3	781	1697.8	689	1497.8	119	258.7	24-hr	781
CP45	5.49	774	1682.8	667	1493.5	120	260.9	24-hr	774
CP53	6.36	767	1667.4	702	1526.1	160	347.8	24-hr	767
CP54	6.49	726	1578.3	667	1450.0	176	382.6	24-hr	726
CP56	7.22	1004	2182.6	898	1947.8	463	1006.5	24-hr	1004
CP57	7.29	1032	2243.5	948	2056.5	490	1065.2	24-hr	1032
CP58	7.34	1032	2243.5	967	2102.2	499	1084.8	24-hr	1032
CP68	8.16	1293	2810.9	1231	2676.1	539	1171.7	24-hr	1293
CP69	8.23	1326	2882.6	1265	2750.0	554	1204.3	24-hr	1326
CP70	8.28	1342	2917.4	1286	2795.7	582	1221.7	24-hr	1342
CP77	9.09	1487	3232.6	1435	3119.6	616	1339.1	24-hr	1487
CP78	9.25	1108	2408.7	1304	2834.8	115	250.0	6-hr	1304
CP79	9.3	1097	2384.8	1302	2830.4	111	241.3	6-hr	1302
CP85	10.11	1081	2350.0	1350	2934.8	107	232.6	6-hr	1350
CP91	11.13	1206	2621.7	1532	3330.4	289	628.3	6-hr	1532
CP92	11.25	869	1889.1	950	2065.2	33	71.7	6-hr	950
CP97	12.15	897	1950.0	1009	2193.5	59	128.3	6-hr	1009

Summary of Peak Discharges
Along the Eastern Canal

MFC001	Mesa Flood Plain Delineation Study				Date
STATION	Location	Drainage area (mi^2)	Q 100 cfs		11/5/96
CP3	N. Rose	0.46	273		
CP4	N. Almond Cir.	0.67	333		
CP17	E. McKellips Rd.	2.45	240		
CP18	E. Ivyglen Cir.	2.52	219		
CP20	N. Lindsay Rd.	2.57	223		
CP21	N. Lindsay Rd.	2.81	323		
CP37	E. Brown Rd.	4.48	637		
CP38	E. Fox St.	4.55	703		
CP39	E. Fairfield	4.65	692		
CP43	E. Adobe St.	5.25	791		
CP44	E. Dartmouth St.	5.3	781		
CP45	E. Covina Cir	5.49	774		
CP53	N. Val Vista Dr.	6.38	767		
CP54	Alpha St.	6.49	726		
CP56	E. Main St.	7.22	1004		
CP57	E. Alder Ave.	7.29	1032		
CP58	E. Balsam Ave.	7.34	1032		
CP68	E. Capri Ave.	8.16	1293		
CP69	E. Carol Cir.	8.23	1326		
CP70	E. Catalina Cir.	8.28	1342		
CP77	E. Pueblo Ave.	9.09	1487		
CP78	E. Emelita Ave.	9.25	1304		
CP79	E. Southern Ave.	9.3	1302		
CP85	E. Hampton Cir.	10.11	1350		
CP91	US 60 - Superstition Freeway	11.13	1532		
CP92	1400' N. Of E. Baseline Rd.	11.25	950		
CP97	E. Baseline Rd.	12.15	1009		

3/12/97

Raj. FMD called G.S

Re: Status Eastern Canal EIS.

3/31/97 contract Ends.

will need contract time extension

Baker had time extension to mid-June

→ Estimate Two month time extension

FLOOD CONTROL DISTRICT
of
Maricopa County

2801 West Durango Street • Phoenix, Arizona 85009-6399
Telephone (602) 506-1501
Fax (602) 506-4601
TT (602) 506-5859

BOARD OF DIRECTORS
Betsey Bayless
Jan Brewer
Fulton Brock
Don Stapley
Mary Rose Garrido Wilcox

MAR 1997
A-N WEST, INC.
PHOENIX, ARIZONA

March 26, 1997

A-N West, Inc.
7600 N. 15th Street, Suite 200
Phoenix, AZ 85020-4331

Subject: C/O #1 to Contract FCD 96-10
Eastern Canal FDS

Enclosed are two copies of the subject change order extending the expiration date to June 30, 1997. If you concur, please sign and return both copies.

Please call the undersigned if you have any questions.

Sincerely,

Dortha Klaahsen

Dortha Klaahsen
Contracts Coordinator

1.4.1 (16)

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Contract Change Order No. 1

Date: 3/18/1997

FCD Contract No./Name: FCD 96-10 Eastern Canal FDS

To: A-N West, Inc. Consulting Engineers, Contractor/Consultant.

APR 1997 A-N WEST INC. PHOENIX, ARIZONA

You are hereby directed to make the herein described changes from the plans and specifications or do the following described work not included in the plans and specifications on the above-mentioned project.

Changes requested by: Raj Shah, Project Manager

Provide description of work to be done, estimate of quantities, and prices to be paid. Segregate between additional work at contract price, agreed price, and actual cost. Unless otherwise stated, rates for rental of equipment on actual cost work cover only such time as equipment is actually used and no allowance will be made for idle times.

* (1) Estimate of increases and/or decreases in contract items at contract prices.
** (2) Estimate of extra work at agreed price and/or actual cost.

Sheet No. 1 of 1

Description of Change Order
Extend this contract to June 30, 1997. This contract is for the floodplain delineation of the Eastern Canal. The Contract was originally awarded to Baker Engineering, Inc. but, because of conflicts of interest between Baker Engineering and FEMA, Baker Engineering pulled out of this part of the project. The delay is caused due to the digital data transformation. The aerial mapping company delivered digital data to Baker Engineering in Microstation format, however, A-N West could not work with microstation. They needed the data in AutoCAD standard. A-N West sent digital data to their California office to translate it to AutoCAD format. The translation of data caused the delay.

We, the undersigned Contractor/Consultant, having given careful consideration to the change(s) proposed, hereby agree, if this proposal is approved, that we will provide all equipment, furnish all material (except as may otherwise be noted above), and perform all services necessary for the work above specified, and we will accept as full payment therefor the prices shown above.

By reason of this proposed change 96 days extension of time will be allowed.
Total new contract amount through this Change Order remains the same.

Contractor/Consultant: A-N West Inc. Consulting Engineers, 7600 N. 15th Street, Suite 200, Phoenix, AZ. 85020-4331

By: Gregory A. Schulle
Title: Vice President
Date: 3/28/97

Recommended by: E. Raleigh
Date: 3/22/97

Approved by: Stanley L. Gunter
Chief Engineer and General Manager
Date: 4-2-97

1.4.1 (17)

A-N WEST, INC.

Consulting Engineers

7600 North 15th Street, Suite 200
Phoenix, Arizona 85020
Phone:(602)861-2200; FAX (602)943-1989

FAX COVER SHEET

DATE: 4/4/97

ATTENTION: Mr Raju Shah

ORGANIZATION: FCDMC

RE: Eastern Canal FIS FCD No. 96-10

JOB NO. ANW# 7158-04

FROM: Greg Schuelke

REMARKS:

Raju, we request a reproducable of the current FEMA FIS maps for the Eastern Canal - Baseline Rd to Gilbert. The panel nos. are 2185, 2195 and 2215 of 4530. These exhibits will ultimately be needed to show possible the revised flood plain.

NUMBER OF PAGES (INCLUDING COVER SHEET) 1

FOR PROBLEMS REGARDING THIS FAX - CONTACT KAY, SHEILA OR SUZIE.

4/7/97

G.S. called Peter Knudson, City of Mesa 644-2514

Fax 644-3392

Re: Eastern Canal FIS

Storm Drains along Canal

Apache Blvd. north

4/9/97

Peter Knudson called back

He gave the FCD copies of their storm drain master plans at start of project. He asked if we could check with Rajh at FCD. If we still needed selected areas give him a call back.

5/8/97 : Eastern Canal FIS,
Rajh Shah of FCD called G.S
He had talked with Peter Knudson, C.O.M

Meeting set for Tomm. Fri 5/9/97 @ 11:00 AM
5TH Floor
Main Str. & Center
20 E. Main Street
City of Mesa.

A-N WEST, INC.

Consulting Engineers

7600 North 15th Street, Suite 200
Phoenix, Arizona 85020
Phone:(602)861-2200; FAX (602)943-1989

FAX COVER SHEET

DATE: 5/23/97

ATTENTION: Mr Robert Davies Fax 279-1411

ORGANIZATION: Baker Engineers

RE: Eastern Canal FIS FCD No 96-10

JOB NO.

FROM: Greg Schuelke

REMARKS:

Robert, The following additional data is desired for preparing the Technical Data Notebook and FIS Report.

1.) Affidavits of Publication
2.) Date of Contract Negotiations with FCD for FIS report

NUMBER OF PAGES (INCLUDING COVER SHEET) 1

FOR PROBLEMS REGARDING THIS FAX - CONTACT KAY, SHEILA OR SUZIE.

A-N WEST INC.
Consulting Engineers

May 28, 1997

Mr. Rajh Shah
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009

Re: FCD No. 96-10
Eastern Canal FIS
A-N West No. 7158-04

Dear Mr. Shah:

We herewith transmit the following data for your review and comment:

1) One draft Flood Insurance Study Report (T.D.N. 8.0) with Flood Profiles
2) Floodplain Work Maps, Report Exhibit 3, (8 sheets).

The draft FIS report references the earlier May 1, 1997 letter report and May 9, 1997 meeting discussing the fact that a detailed riverine analysis along the canal was not possible and that an updated Approximate Zone A delineation was to be performed.

The floodplain mapping and AUTOCADD drawing file, shows the Profile 1 and 2 floodplains as well as the effective and updated Approximate Zone A floodplains.

We are proceeding to submit the floodplain mapping to Aerial Mapping Company for them to initiate HIS translation.

For purposes of HIS translation and documentation, we understand that the FCD wishes to have both the attempted detail analysis (Profiles 1 and 2) as well as the updated Approximate Zone A.

If the City of Mesa wishes to pursue updating the Approximate Zone A delineation, a floodplain mapping exhibit showing the effective and updated Approximate Zone A floodplain only would be anticipated. Please advise us if the City wishes to pursue revising the Approximate Zone A and if this exhibit is needed.

Should you have any questions, please call.

Sincerely,

A-N West, Inc.

Greg Schuelke, P.E., R.L.S.
Vice President
Project Manager

GS/dh

cc: Mr. Peter Knudson, City of Mesa, w/enclosures

1.4.1 (22)

7600 North 15th Street, Suite 200 • Phoenix, Arizona 85020-4331 • Fax (602) 943-1989 • (602) 861-2200

A-N WEST INC.
Consulting Engineers

May 28, 1997

Mr. Rajh Shah
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009

Re: FCD No. 94-26
UEMF FIS
A-N West No. 7158-03

Dear Mr. Shah:

We herewith transmit the following data for your review and comment:
1) Floodplain Work Maps, Report Exhibit 3, (2 sheets)

The floodplain mapping and AUTOCADD drawing file, shows the detailed floodplains as well as the updated Approximate Zone A floodplains. The updated Approximate Zone A was added per our meeting of May 9, 1997, in which concern for inadequate canal berm free board and other issues prompted the City to request the updated Approximate Zone A delineation for possible FEMA submittal.

We are proceeding to submit the floodplain mapping to Aerial Mapping Company for them to initiate HIS translation.

For purposes of HIS translation and documentation, we understand that the FCD wishes to have both the detail analysis as well as the updated Approximate Zone A.

If the City of Mesa wishes to pursue updating the Approximate Zone A delineation, a floodplain mapping exhibit showing the updated Approximate Zone A floodplain only would be anticipated. Please advise us if the City wishes to pursue revising the Approximate Zone A and if this exhibit is needed.

Should you have any questions, please call.

Sincerely,

A-N West, Inc.

Greg Schuelke

Greg Schuelke, P.E., R.L.S.
Vice President
Project Manager

GS/dh

cc: Mr. Peter Knudson, City of Mesa, w/enclosures

1.4.1 (23)

7600 North 15th Street, Suite 200 • Phoenix, Arizona 85020-4331 • Fax (602) 943-1989 • (602) 861-2200

A-N WEST, INC.

Consulting Engineers

7600 North 15th Street, Suite 200
Phoenix, Arizona 85020
Phone:(602)861-2200; FAX (602)943-1989

FAX COVER SHEET

DATE: 5/29/97

ATTENTION: Mr Robert Davies FAX 279-1411

ORGANIZATION: Baker Engineers

RE: Eastern Canal FIS FCD No. 96-10

JOB NO.

FROM: Grey Schueke

REMARKS: Robert, Per our telco of today attached are the ERM's used in our draft FIS report and in our work floodplain mapping.

We await your info on NAVD 88 conversion to add to this Exhibit 2

NUMBER OF PAGES (INCLUDING COVER SHEET) 2

FOR PROBLEMS REGARDING THIS FAX - CONTACT KAY, SHEILA OR SUZIE.

A-N WEST, INC.

Consulting Engineers

7600 North 15th Street, Suite 200
Phoenix, Arizona 85020
Phone:(602)861-2200; FAX (602)943-1989

FAX COVER SHEET

DATE: 5/29/97

ATTENTION: Mr Rajh Shah

ORGANIZATION: FCDMC

RE: Eastern Canal and UEMF FCD #96-10 and 94-26

JOB NO.

FROM: Greg Schuelke

REMARKS: Copy of Transmittal Letter to Aerial Mapping Co.

NUMBER OF PAGES (INCLUDING COVER SHEET) 2

FOR PROBLEMS REGARDING THIS FAX - CONTACT KAY, SHEILA OR SUZIE.

1.4.1 (25)

A-N WEST INC.
Consulting Engineers

May 28, 1997

Mr. Richard Cook
Aerial Mapping Co.
3141 West Clarendon Ave.
Phoenix, Arizona 85017

Re: FCD 96-10 and 94-26
Eastern Canal FIS
and UEMF FIS Revision
A-N West Nos. 7158-04 and 7158-03

Dear Mr. Cook:

We herewith transmit the following:

1) Eastern Canal FIS - Bluelines and AUTOCADD Digital Drawing Files of the Draft Floodplain Mapping (8 sheets), showing the effective and updated Approximate A floodplain delineations and the Profile 1 and 2 preliminary analysis floodplains as well as cross-section locations; I.D. Nos. and letters and hydraulic base line.

2) UEMF FIS - Bluelines and AUTOCADD Digital Drawing Files of UEMF FIS Floodplain. This exhibit has had the legend revised and Approximate Zone A floodplain added and Zone AE changed to Zone A per recent city request. We have highlighted the changes in yellow to aid in your translation of these revisions as we understand you have translated the rest of this data.

Please begin the HIS translation of this data as soon as possible. Our current schedule involves finishing these projects by June 30, 1997. Should you have any questions, please contact us.

Sincerely,

A-N West, Inc.

Greg Schuelke

Greg Schuelke, P.E., R.L.S.
Vice President
Project Manager

GS/dh

cc: Mr. Rajh Shah, FCDMC

14.1.26

7600 North 15th Street, Suite 200 • Phoenix, Arizona 85020-4331 • Fax (602) 943-1989 • (602) 861-2200

Baker

1313 East Osborn Road, Suite 150, Phoenix, Arizona 85014

FAX

Date: MAY 29, 1997

Number of pages including cover sheet: 12

To:
GREG SCHUELKE

Phone:

Fax phone: ~~[illegible]~~ 943-1989

From:
BOB DAVIES

Phone: 602/279-1234

Fax phone: 602/279-1411

REMARKS: ☐ Urgent ☒ For your review ☐ Reply ASAP ☐ Please comment

AS WE DISCUSSED.

BOB.

cc: WBM/GJK/JCH/CIH/CF

1.4.1 (27)

Post-it® Fax Note 7671	Date 5-28-97	# of pages ▸ 4
To Bob Davies	From	
Co./Dept.	Co. PEC	
Phone #	Phone #	
Fax #	Fax #	

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DU2317 ******************************
DU2317  DESIGNATION -  A 518
DU2317  PID         -  DU2317
DU2317  STATE/COUNTY-  AZ/MARICOPA
DU2317  USGS QUAD   -  MESA (1983)
DU2317
DU2317  HORZ DATUM  -  NAD 83
DU2317  VERT DATUM  -  NAVD 88
DU2317
DU2317  POSITION    -  33 24 56.      (N)    111 45 33.      (W)    SCALED
DU2317  83 minus 27 -        +00.                 +02.             NADCON
DU2317
DU2317
DU2317  HEIGHT      -        388.720  (meters)   1275.32   (feet)  ADJUSTED
DU2317  88 minus 29 -         +0.534  (+/- 2 cm)                   VERTCON
DU2317  DY minus 88 -         -0.460                               COMPUTED
DU2317. (NOTE - For assistance in applying shifts see file readme.dat)
DU2317 ******************************************************************
DU2317
DU2317  GEOID HEIGHT-          -29.56                               GEOID93
DU2317  MODELED GRAV-      979,442.8                                NAVD88
DU2317
DU2317
DU2317  VERT ORDER  -  FIRST     CLASS 2
DU2317
DU2317
DU2317.The horizontal coordinates were scaled from a topographic map and have
DU2317.an estimated accuracy of +/- 6 seconds.
DU2317
DU2317.The orthometric height was determined by differential leveling
DU2317.and adjusted by the National Geodetic Survey in November 1993.
DU2317
DU2317.The dynamic height is computed by dividing the NAVD 88
DU2317.geopotential number by the normal gravity value computed on the
DU2317.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
DU2317.degrees latitude (G = 980.6199 gals.).
DU2317
DU2317.The geoid height was determined by GEOID93.
DU2317
DU2317.The modeled gravity was interpolated from observed gravity values.
DU2317
DU2317;                          North        East        Estimated Accuracy
DU2317;SPC AZ C     -        267,850.     228,010.    (+/- 180 meters Scaled)
DU2317
DU2317_STATION MARK IS A METAL ROD
DU2317_WITH SETTING: STAINLESS STEEL ROD W/O SLEEVE (10 FT.+)
DU2317_THE MARK IS STAMPED: A 518 1992
DU2317_STABILITY: A - MOST RELIABLE AND EXPECTED TO HOLD
DU2317+STABILITY: POSITION/ELEVATION WELL
DU2317_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
DU2317+SATELLITE: SATELLITE OBSERVATIONS - 1992
DU2317_ROD/PIPE-DEPTH: 5.5  meters
DU2317
DU2317  HISTORY     - Year Condition              Recov. By
DU2317  HISTORY     - 1992 STATION MONUMENTED     NATIONAL GEODETIC SURVEY
DU2317
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1.4.1 (28)

DU2317 STATION DESCRIPTION

DU2317

DU2317'DESCRIBED BY NATIONAL GEODETIC SURVEY 1992

DU2317'7.5 KM (4.65 MI) EASTERLY ALONG U.S. HIGHWAY 60 (MAIN STREET) FROM
DU2317'THE JUNCTION OF STATE HIGHWAY 87 (COUNTRY CLUB DRIVE) IN MESA. 10.0 M
DU2317'(32.8 FT) NORTH OF AND LEVEL WITH THE CENTER OF THE WESTBOUND LANES
DU2317'OF THE HIGHWAY, 9.2 M (30.2 FT) WEST OF THE CENTER OF CYPRESS ESTATES
DU2317'MOBILE HOME PARK ENTRANCE ROAD, 1.2 M (3.9 FT) NORTH OF THE SOUTH END
DU2317'OF A BRICK WALL, 0.5 M (1.6 FT) WEST OF THE WALL, AND 0.3 M (1.0 FT)
DU2317'SOUTH OF A WITNESS POST. NOTE--ACCESS TO THE DATUM POINT IS THROUGH
DU2317'A 5-INCH LOGO CAP.

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DU2319 ***********************************************************************
DU2319  DESIGNATION -  C 518
DU2319  PID         -  DU2319
DU2319  STATE/COUNTY-  AZ/MARICOPA
DU2319  USGS QUAD   -  MESA (1983)
DU2319
DU2319  HORZ DATUM  -  NAD 83
DU2319  VERT DATUM  -  NAVD 88
DU2319
DU2319  POSITION    -  33 24 56.      (N)    111 47 02.      (W)     SCALED
DU2319  83 minus 27 -      +00.                  +03.                NADCON
DU2319
DU2319
DU2319  HEIGHT      -        382.634  (meters)    1255.36   (feet)  ADJUSTED
DU2319  88 minus 29 -         +0.542  (+/- 2 cm)                    VERTCON
DU2319  DY minus 88 -         -0.453                                 COMPUTED
DU2319. (NOTE - For assistance in applying shifts see file readme.dat)
DU2319 ***********************************************************************
DU2319
DU2319  GEOID HEIGHT-         -29.59
DU2319  MODELED GRAV-      979,443.5                                 GEOID93
DU2319                                                               NAVD88
DU2319
DU2319  VERT ORDER  -  FIRST     CLASS 2
DU2319
DU2319
DU2319.The horizontal coordinates were scaled from a topographic map and have
DU2319.an estimated accuracy of +/- 6 seconds.
DU2319
DU2319.The orthometric height was determined by differential leveling
DU2319.and adjusted by the National Geodetic Survey in November 1993.
DU2319
DU2319.The dynamic height is computed by dividing the NAVD 88
DU2319.geopotential number by the normal gravity value computed on the
DU2319.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
DU2319.degrees latitude (G = 980.6199 gals.).
DU2319
DU2319.The geoid height was determined by GEOID93.
DU2319
DU2319.The modeled gravity was interpolated from observed gravity values.
DU2319
DU2319:                        North          East        Estimated Accuracy
DU2319:SPC AZ C     -        267,040.       225,710.    (+/- 180 meters Scaled)
DU2319
DU2319_STATION MARK IS A VERTICAL CONTROL DISK
DU2319_WITH SETTING: SET IN THE ABUTMENT OR PIER OF A LARGE BRIDGE
DU2319_THE MARK IS STAMPED: C 518 1992
DU2319_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
DU2319_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
DU2319+SATELLITE: SATELLITE OBSERVATIONS - 1992
DU2319
DU2319  HISTORY     - Year Condition              Recov. By
DU2319  HISTORY     - 1992 STATION MONUMENTED     NATIONAL GEODETIC SURVEY
DU2319
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DU2319 STATION DESCRIPTION
DU2319
DU2319'DESCRIBED BY NATIONAL GEODETIC SURVEY 1992
DU2319'5.2 KM (3.25 MI) EASTERLY ALONG U.S. HIGHWAY 60 (MAIN STREET) FROM
DU2319'THE JUNCTION OF STATE HIGHWAY 87 (COUNTRY CLUB DRIVE) IN MESA, IN TOP
DU2319'OF AND 0.2 M (0.7 FT) SOUTHEAST OF THE NORTHWEST END OF THE NORTHEAST
DU2319'CONCRETE ABUTMENT OF THE HIGHWAY BRIDGE SPANNING THE CONSOLIDATED
DU2319'CANAL, 2.1 M (6.9 FT) NORTH OF THE NORTH CURB OF THE HIGHWAY, 0.4 M
DU2319'(1.3 FT) NORTH OF THE BRIDGE RAILING, AND 0.3 M (1.0 FT) ABOVE THE
DU2319'LEVEL OF THE HIGHWAY.

A-N WEST INC.
Consulting Engineers

June 2, 1997

Mr. Rajh Shah
FCDMC
2801 West Durango Street
Phoenix, Arizona 85028

Re: Eastern Canal FIS
FCD 96-10
A-N West No. 7158-04

Dear Mr. Shah:

We herewith transmit one copy of the draft final Technical Data Notebook (TDN) for the referenced project as well as a copy of survey notes for the project provided by you earlier.

Referring to our Scope of Work, Deliverable, Section 5.1:

Section 5.1.1 - The TDN does not include affidavits of publication. Per telephone conversation with Mr. Bob Davies of Baker Engineering on May 29, 1997, there has not been a public notice to date and public notice is not anticipated per city direction.

Section 5.1.2 - A-N West transmitted one blueline copy of the floodplain mapping on May 28, 1997 to FCD and the City.

Section 5.1.4 - FEMA Forms. Please advise us if this project is proposed to be submitted to FEMA. If so, can you provide the current FEMA forms for A-N West to fill out?

Section 5.1.5 - Survey notes. We are returning the copy of survey notes received from you earlier. Per the scope, these notes are indicated as provided under separate cover. We have included in the TDN supplemental field survey notes by Project Engineering of the canal bridges and subsequent survey notes by A-N West of the adjacent drainage structures.

Section 5.1.6 - Current FIRM panels with proposed delineation. At present, our floodplain mapping includes the effective approximate zone 'A' delineation obtained from the FCD. Please advise us if the updated zone 'A' delineation needs to be shown on the 1,000 scale effective mapping. If so, we will need a reproducible copy of this exhibit.

We have provided a divider for Section 4.2 for insertion of the Field Reconnaissance and (N) Value Estimation Report submitted earlier. The TDN notes cross-section plots as, under separate cover, which were also submitted earlier.

1.4.1 (32)

7600 North 15th Street, Suite 200 • Phoenix, Arizona 85020-4331 • Fax (602) 943-1989 • (602) 861-2200

Other than the questions raised regarding Section 5.1.4 and Section 5.1.6, we believe we have addressed the scopes Section 5.1 submittal requirements and we await your review, comment and approval before proceeding to provide the additional final submittal data, under Section 5.2 of the Scope's Deliverables section.

Should you have any questions, please call.

Sincerely,

A-N West, Inc.

Greg Schuelke

Greg Schuelke, P.E., R.L.S.
Vice President
Project Manager

cc: Mr. Peter Knudson, City of Mesa - w/TDN only

1.4.1 (33)

EXHIBIT "A"

SCOPE OF WORK

FLOODPLAIN DELINEATION AND TOPOGRAPHIC MAPPING

FOR EASTERN CANAL FLOODPLAIN DELINEATION STUDY

SCOPE OF WORK

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
FLOODPLAIN DELINEATION AND TOPOGRAPHIC MAPPING
FOR EASTERN CANAL FLOODPLAIN DELINEATION STUDY

GENERAL

The project consists of approximately 5.5 miles of floodplain delineations for the Eastern Canal from Baseline Road to Hermosa Vista Drive as shown on Exhibit A. This will require the development of the necessary topographic data and approximately 12 square miles of watershed hydrology. The Consultant will develop the hydrology using the Corps of Engineer's HEC-1 computer model, and the floodplain and floodway delineations using primarily the HEC-2 computer model, if appropriate. The Consultant must use sound engineering judgment in the development of the hydrologic and hydraulic models. The results of the models must be analyzed carefully and refinements made to the input parameters in order to obtain the most realistic results. All work must meet Arizona Department of Water Resources (ADWR) and Federal Emergency Management Agency (FEMA) requirements for floodplain delineations. The results of this study must be reviewed and accepted by FEMA and the City of Mesa prior to the finalization of this contract. All work shall be completed within 270 calendar days from the date of Notice to Proceed, including 60 days for District reviews.

TASK 1 - COORDINATION

1.1 The Consultant shall submit a project schedule showing coordination meetings and completion dates for each of the tasks in the scope within 14 days of Notice To Proceed. The Consultant shall update this project schedule when appropriate.

1.2 The Consultant shall participate in regular coordination meetings (at least every 4 weeks) with the District's Project Manager and milestone coordination meetings for the development of the hydrologic and hydraulic analyses. The Consultant is responsible for the minutes of any meetings. Whenever possible, coordination and milestone meetings should be combined.

1.3 The Consultant shall submit a quarterly estimation of the projected billing within 14 days of Notice to Proceed. Thereafter, this estimation will be updated and submitted to the District's Project Manager at least 10 days prior to the end of each quarter.

1.4 The Consultant shall submit monthly progress reports at least 5 days before submittal of monthly invoices. The report shall be brief and should be no longer than two typed pages. At a minimum, the monthly report shall contain the following:

a. A description of the work accomplished, by task, during the reporting month.

b. Percent (%) completed for the month and percent (%) cumulative completed for each task.

c. A brief description of the work to be accomplished during the following month.

d. A description of any problems encountered.

1.5 The Consultant is responsible for placing the legal advertising at the beginning of the study, notifying the public of the study. The advertisement will be published in a widely circulated newspaper two times, with approximately one week between runs. The advertisement must also be published two times in a local newspaper that serves the area being studied. After the advertisement is run, the Consultant will supply the District with the original affidavit of publication from each of the newspapers for each day that the advertisement was published.

1.6 The Consultant will notify all property owners and obtain any necessary Rights of Entry for the study area. The Consultant will furnish the District with a list of all the property owners notified and a sample Right of Entry letter.

1.7 The Consultant shall meet with officials from the City of Mesa. The purpose of this meeting is to identify local flooding problems and obtain information on current and planned public works projects, channel modifications, storm-drainage systems, development, and corporate limits.

1.8 The District will plan and conduct two public meetings in conjunction with this study. The first meeting will be to inform the public of the purpose and scope of the study. The second meeting will be to inform the public and obtain public comment on the study results, and shall take place prior to the submittal of the final report to FEMA. The Consultant/District will be responsible for the preparation of the graphic displays for these meetings. One representative from the Consultant will attend each of the meetings. The Consultant will respond to the public's comments and make revisions to the study, if necessary.

1.9 Consultant/District Performance Evaluations will be performed. An informal evaluation will be performed at the completion of the hydrologic analysis. A formal evaluation will be performed at the completion of the project upon receipt of all deliverables.

TASK 2 - DATA COLLECTION

2.1 The Consultant will collect and review pertinent data from the District and other outside sources. Data to be collected will include previous flood hazard reports and hydrology for the study area; existing topographic mapping; historical flooding information; as-built plans for existing structures; FEMA Flood Hazard Boundary Maps and any Letters of Map Amendment and/or Revisions, and other pertinent information.

2.2 A written report summarizing the data collected will be submitted to the District for information purposes. A preliminary draft of this report is due within 90 days of Notice to Proceed.

TASK 3 - TOPOGRAPHIC MAPPING

3.1 An aerial survey subcontractor shall be retained by the Consultant as part of this contract. The Consultant shall coordinate all the aerial surveying work with the aerial surveying subcontractor to ensure that the specifications of the aerial surveying work are met. The Consultant is responsible for ensuring that the topographic mapping covers the area of delineation Quality control on surveys will be per FEMA Document 37, Flood Insurance Study Guidelines and Specifications for Study Contractors, January 1995.

3.2 Digital contour and planimetric data developed for this study shall be delivered according to the District's HIS specifications.

3.3 Prepare topographic mapping to a 2-foot contour interval, with a scale of 1 inch = 200 feet, with spot elevations on all section line and mid-section line roads.

3.4 Ground Control:

a. The Consultant shall provide all survey control using 1983 NAD.

b. The Consultant shall systematically set panel points and establish horizontal and vertical control throughout the areas to be mapped for use in compilation by the aerial survey contractor. Where readily available, surveys will tie into the State Plane Coordinate System. Field control shall be sufficient to readily allow for compilation of maps by the aerial survey contractor at the desired map scale and contour interval, and will be based on the National Geodetic Vertical Data of 1929 (NGVD). A conversion factor, including documentation of how it was derived, will be provided by the Consultant to allow comparison of NGVD 29 elevations to NAVD 88 elevations and will be included in the Technical Data Notebook. A conversion factor will be provided by the Consultant to tie the vertical datum to the City of Mesa datum.

c. The horizontal and vertical control points shall be located and marked by the Consultant. The controls for the aerial mapping shall be in sufficient numbers and shall be in locations which will be compatible with the accuracy of the mapping requirements. The controls shall be of at least third order accuracy. Section corners, quarter corners, and mid-section points shall be used for control points wherever possible.

3.5 The Consultant shall provide permanent non-erasable topographic mylars of the work study drawings. The drawings shall be 24" X 36" in size, with a scale of 1 inch = 200 feet and a contour interval of 2 feet for all mapping. A cover sheet shall be provided with the project title, date of topographic mapping, and a location map showing geographic range covered by each specific mapping sheet. Each drawing shall include the floodplain and floodway delineations and a minimum of a north arrow, scale, section corners and quarter corners, current and proposed streets and highway names, State Plane Coordinate System, major drainage features, corporate boundaries, cross section lines, channel station center line, index map, and description and elevation of elevation reference marks (ERMs). A note explaining the proper means to convert the NGVD 29 elevations to NAVD 88 elevations shall be included in "NOTES" in the map border. The mapping will have an accuracy such that ninety percent (90%) of all contours shall be within one-half contour of the true elevations and the remaining ten percent (10%) of the contours shall not be in error by more than one contour interval.

TASK 4 - FIELD SURVEY

4.1 Prepare topographic mapping to a 2-foot contour interval with a scale of 1 inch = 200 feet, with spot elevations on all section line and mid-section line roads, for floodplain/floodway delineation areas as identified in Task 6 or FEMA criteria, whichever is more stringent.

4.2 Ground Control for Floodplain Delineations:

4.2.1 All topographic mapping and survey work shall meet or exceed Federal Emergency Management Agency (FEMA) minimum criteria as defined in FEMA Document 37, Flood Insurance Study Guidelines and Specifications for Study Contractors, January 1995. This

would include, but is not limited to: the establishment of "permanent" elevation reference marks (ERMs); field control; and verification of profiles by the ground survey profile procedure.

4.2.2 Horizontal and Vertical Control: Systematically set panel points and establish horizontal and vertical control throughout the area to be mapped for use in compilation by the aeria survey contractor. Where readily available, surveys will tie into State Plane Coordinate System 1983 NAD. Field control shall be sufficient, using at least one "permanent" point per mile, and such point(s) being used as Elevation Reference Marks (ERMs). Surveys will be based on National Geodetic Vertical Datum (NGVD) 1929, per FEMA guidelines. A conversion factor, including documentation of how it was derived, will be provided by the Consultant to allow comparison of NGVD 29 elevations to NAVD 88 elevations and will be included in the Technical Data Notebook. "Permanent" survey points shall consist of existing monumentation, such as brass caps or similar survey monuments. A conversion factor will be provided by the Consultant to tie the vertical datum to the City of Mesa datum. Where additional monumentation is needed, survey markers conforming to Maricopa Association of Governments (MAG) Uniform Standard Detail for Public Works Construction, detail 120-1, Type C, shall be placed 2" +/- above grade, and topped with a brass cap. Elevation Reference Marks will be labeled on available maps and described in a manner which allow them to be readily located in the field.

4.2.3 All aerial targets are to be removed following completion of the topographic mapping.

4.3 The Consultant shall verify the accuracy of the mapping by the procedures called for in FEMA Document 37 or other methods approved by FEMA. This shall include the verification of cross sections used in the floodplain delineation.

4.4 Field surveys of bridges, culverts, and hydraulic structures are to be obtained by the Consultant when as-built plans are not available or when changes significant to the HEC-2 modeling, such as sedimentation, have occurred since the date of as-built. This information should be reduced and compiled into an 11" x 17" (maximum size) drawing for inclusion in the final report. The information presented in the drawing should be in a format appropriate for use in the HEC-2 model. Field surveys of bridges, culverts, hydraulic structures, and routing reaches must also be obtained where necessary for proper hydrologic modeling. It may be necessary to field survey some structures since the as-built plans may not be on 1929 NGVD. A significant field survey will be required along the eastern bank of Eastern Canal with spot elevations at 100-foot interval.

TASK 5 - HYDROLOGY

5.1 The hydrologic study of the watershed will be delivered to the District under separate cover from the hydraulic analysis. The Consultant shall use the U.S. Army Corps of Engineers computer program HEC-1, 1991 Version, to develop a hydrologic model for the area. Using appropriate hydrologic judgment, sub-basins that provide reasonable depiction of the watershed condition are to be identified. The sub-basins must be as homogeneous as possible, using watershed area, watershed type (mountainous and flat lands or urban and undeveloped areas), and time of concentration as criteria. Sub-basin break-downs will be done in sufficient detail to provide peak discharges at structures, major road crossings, confluences, and at boundary lines. An appropriate time step and number of ordinates is to be selected that allow for complete calculation of the flood hydrograph without sacrificing resolution of the flood peak. All calculations, or assumptions used in developing

sub-basin and routing parameters shall be documented and made a part of the appendix for the hydrology report. Field surveys may need to be taken for HEC-1 modeling purposes.

5.2 Two field trips shall be held with the Flood Control District staff at the following milestones:

a. One field trip at the start of the project to scope out the critical points of the watershed and problem areas.

b. A second field trip may be scheduled to discuss the results obtained from the study.

5.3 A meeting at the Consultant's office or an approval of the District may be necessary for the following tasks at the following milestones:

a. Meeting number 1: As soon as basic data are gathered and the sub-basins have been delineated. Sample HEC-1 parameter estimations should also be presented and discussed at this meeting. A copy of the draft maps of the sub-basins must be delivered to the District at this meeting.

b. Meeting number 2: After all the parameters have been estimated. A draft copy of the parameters must be delivered to the District at least one week prior to this meeting.

c. Meeting number 3: After the preliminary HEC-1 results have been obtained and a draft report has been prepared. A copy of the draft report and the copy of the HEC-1 on a floppy disc, compatible with the District's computer, must be delivered two weeks prior to the meeting.

d. Meeting number 4: To review comments by District staff.

5.4 The hydrology shall be done according to the Drainage Design Manual for Maricopa County, Arizona: Volume I - Hydrology. Peak discharges and peak volumes will be calculated for 100-year 6-hour storm and for 100-year 24-hour storm.

5.5 The District shall provide appropriate references to facilitate parameter estimation.

5.6 Output of the computer model should be reviewed to see if the peak flows and volumes are realistic. Make sure the results obtained from the computer model are realistic. If not, adjustment to the input may be necessary to obtain the realistic results.

5.7 Every attempt must be made to recover historic stream gage data and use it to compare with the results obtained by the hydrologic model. Major differences must be discussed in the final report.

5.8 It is required that the Consultant obtain the approval of the District at each of the following steps:

a. Soil maps, watershed boundary maps, and land use maps.

b. HEC-1 parameter estimation.

c. HEC-1 flow diagram and input parameters.

d. HEC-1 results.

5.9 The Hydrologic Report

5.9.1 The findings of the hydrologic study will be presented in Section 3 of the Technical Data Notebook and will be prepared in accordance with ADWR State Standards Attachment 1-90 (SSA 1-90). The report will be organized as specified by the District, following SSA 1-90 format.

5.9.2 Tables and Figures for the appendices:

a. Topographic base map(s) showing sub-basins, routing reaches, Tc flow paths or lag flow paths, major man-made structures, and references (i.e., street names, Township, Range, Section, etc.) at a scale of 1 inch = 2000 feet.

b. Soils map(s) at the same scale as the base map.

c. Land use map(s) at the same scale as above.

d. Schematic map for the HEC-1 showing sub-basins (area, Tc), flow paths, routing reaches (length, slope, friction, width, velocities, transmission losses, etc.), order of combining the hydrographs, channel, pipe or culvert dimensions (where appropriate).

e. Pertinent data on all structures in the watershed (such as spillway elevation, rating curves, etc.).

f. One set of study maps (i.e., sub-basin boundary maps, flow path maps, soils maps, land use maps) to be folded and delivered in a binder.

Specific deviations from this hydrologic scope shall not be undertaken without the specific written concurrence from the Flood Control District.

TASK 6 - FLOODPLAIN DELINEATION

6.1 Floodplain delineations must be obtained using the U.S. Army Corps of Engineers HEC-2 Water Surface Profiles computer model, Version 4.6.2, May 1991, and methodology acceptable to FEMA. This model will simulate the effects of floodplain geomorphology, flow changes, bridges, culverts, hydraulic roughness factors, effective flow limitations, split-flows, and other considerations. The Consultant will prepare the study using the guidelines established in FEMA Document 37, Flood Insurance Study Guidelines and Specification for Study Contractors, January 1995, and FIA Document 12, Appeals, Revisions, and Amendments to Flood Insurance Maps, January 1990.

6.2 The delineation work shall meet requirements for floodplain and floodway delineations as prescribed by FEMA and the Arizona Department of Water Resources.

6.3 The delineation study shall be based on the final results of the hydrologic study as directed by the District.

6.4 The Consultant is to make refinements to the HEC-2 model based on review of the model results by the District, ADWR, FEMA, and the Technical Evaluation Contractor. The Consultant shall review the HEC-2 model results for reasonableness. Adjustments to the input parameters for obtaining the most realistic results is normal to the scope.

6.5 Floodways are to be determined using equal conveyance encroachment method 4 to start with, but only encroachment method 1 will be used in the final analysis. The floodway encroachment is to be as near the 1-foot maximum rise in elevation as possible.

6.6 The Consultant must obtain District's approval at each of the following steps:

a. Field reconnaissance report and estimation of Manning's "n" values.

b. Proposed location and alignment of the cross sections and channel centerline.

c. Floodplain (natural) delineation.

d. Floodway delineation using equal conveyance encroachment.

e. Floodway delineation using encroachment method 1.

f. Final Hydraulics Report.

6.7 Field Reconnaissance

6.7.1 The Consultant will conduct a field reconnaissance of the full study reach. This will include observation of channel and floodplain conditions for estimation of Manning's "n" values; photographic documentation of floodplain characteristics; determination of channel bank stations; observation of possible overflow areas; inspection of levees or other flood control structures; and measurement of bridge dimensions.

6.7.2 Mannings "n" values are to be determined using the methodology in the USGS report, Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona, April 1991. Copies of the report are available through the District.

6.8 Cross Sections

6.8.1 The location and alignment of cross sections and channel centerline will be submitted for the District's review and approval prior to digitizing the cross section data. Cross section stationing will be from left to right looking downstream with the thalweg as station 10,000. Cross sections will be spaced approximately every 500 feet, unless geographic or structural constraints dictate otherwise, and will extend the full width of the area inundated by 100-year flood waters. Identification of cross sections will be in river miles, increasing upstream. The stationing will tie into the specified river mile of the existing FEMA studies. Cross section orientation may need to be altered after running of HEC-2 model to ensure that sections are perpendicular to flow per FEMA criteria.

6.8.2 All cross sections will be plotted using a pen, laser, or electrostatic plotter. The cross section plots will show water surface profiles, ineffective flow areas, "n" values, encroachments, channel stationing and other pertinent information. All plots are to be accompanied by a legend. These plots are to be available at all reviews.

6.8.3 Cross section plots are limited to one plot at the following three stages of work: (a) a plot of digitized "GR", STCHL, STCHR, centerline (station 10,000) to be used as a check of input

data and for working sections during compilation of the floodplain model; (b) a plot of the cross section for the completed floodplain run which shows the floodplain water surface elevation, ineffective flow areas, "n" factor, and encroachments to be used as working sections for development of the floodway model; (c) a plot of the final floodway model cross sections which will show Type 1 encroachments and encroached water surface, in addition to data covered in items (a) and (b). These cross sections, generated under (c), will be submitted as part of the Final Report.

6.9 Bridges and culverts must be modeled in compliance with HEC-2 modeling requirements for the selected routine. Where multiple bridges occur, each bridge will be modeled separately. The HEC-2 modeling results for bridges, culverts, and other hydraulic structures must be checked by using an independent method approved by the District to analyze these structures.

6.10 For floodplains identified as ponding areas, methodology which will provide the District with water surface elevations must be used. If appropriate, the Consultant shall identify a floodway in the ponded floodplains. The purpose of this floodway is to allow the pond to seek a constant stage throughout the areal extent of the ponds, versus the creation of two independent ponds.

6.11 Flood zones must be determined according to FEMA criteria and clearly labeled on the final drawings.

6.12 The total area of the floodplain and floodway must be determined for each reach in square miles and acres.

6.13 The findings of the floodplain/floodway delineation study will be presented in Section 4 of the Technical Data Notebook and will be prepared in accordance with ADWR State Standards Attachment 1-90 (SSA 1-90). The report will be organized as specified by District standards, following SSA 1-90 format.

TASK 7 - HIS DATA

7.1 Digital data will be prepared in conformance with the District's HIS Data Delivery Specifications, Revision 1.1, for the following themes:

a. Drainage study boundary.

b. Drainage basins.

c. Land use (if not provided by the District).

d. Soil type area (if modified from that provided by the District).

e. Elevation (land).

f. Floodplain FCD Zone.

g. Floodplain FCD Water Surface Elevation.

7.2 Separate check plots will be produced from either Arc-Info or Arc-CAD from the digital database(s) of each theme in 7.1. The check plots will be prepared with a minimum of annotation and will serve

only to verify the information in the data base. If the hydrologic and delineation maps have not derived directly from the digital data delivered to the District, then the Consultant will certify that the check plots have been examined and that the check plots faithfully represent the data and maps used in the report and /or work maps.

TASK 8 - DELIVERABLES

8.1 FEMA Submittal: The Consultant will submit the following items to the District for review by FEMA and any other appropriate governmental agency. All of the following products are considered deliverables for the FEMA submittal:

8.1.1 Original Affidavits of Publication

8.1.2 Two (2) complete sets of blueline topographic base maps with the floodplain/floodway delineations shown. All drawings will be signed and sealed by persons of appropriate professional registration(s). Each registrant will provide a specific statement as to what service they performed.

8.1.3 Two (2) complete copies of the Technical Data Notebook, including HEC-1 and HEC-2 input/output files on diskettes. The Technical Data Notebook will be prepared in accordance with ADWR State Standards Attachment 1-90 (SSA 1-90). The notebook will be organized as specified by the District, following SSA 1-90 format.

8.1.4 Two (2) sets of completed FEMA forms will be submitted in a notebook separate from the Final Report.

8.1.5 Three (3) sets of complete survey notes will be submitted in a notebook separate from the Final Report.

8.1.6 Two (2) copies of the current FIRM panels showing the proposed delineation.

8.2 Final Submittal: The following products are considered deliverables for the final submittal to the District after FEMA approval is issued:

8.2.1 One (1) complete set of non-erasable topographic mylars of the work study drawings. Sheets shall be 24" X 36" in size and numbered to correspond to the delineation maps.

8.2.2 Two (2) complete sets of mylars and five (5) complete sets of sealed blueline topographic base maps with the floodplain/floodway delineations shown. All drawings will be signed and sealed by persons of appropriate professional registration(s). Each registrant will provide a specific statement as to what service they performed.

8.2.3 One (1) complete set of transparent overlays of photo-mylars. Sheet size, numbering, and layout shall correspond to the delineation work maps.

8.2.4 One (1) complete set of 9" X 9" contact prints of the aerial stereo photographs sequentially numbered and catalogued.

8.2.5 Digitized topographic data and floodplain/floodway boundaries in conformance with the District's HIS Specifications.

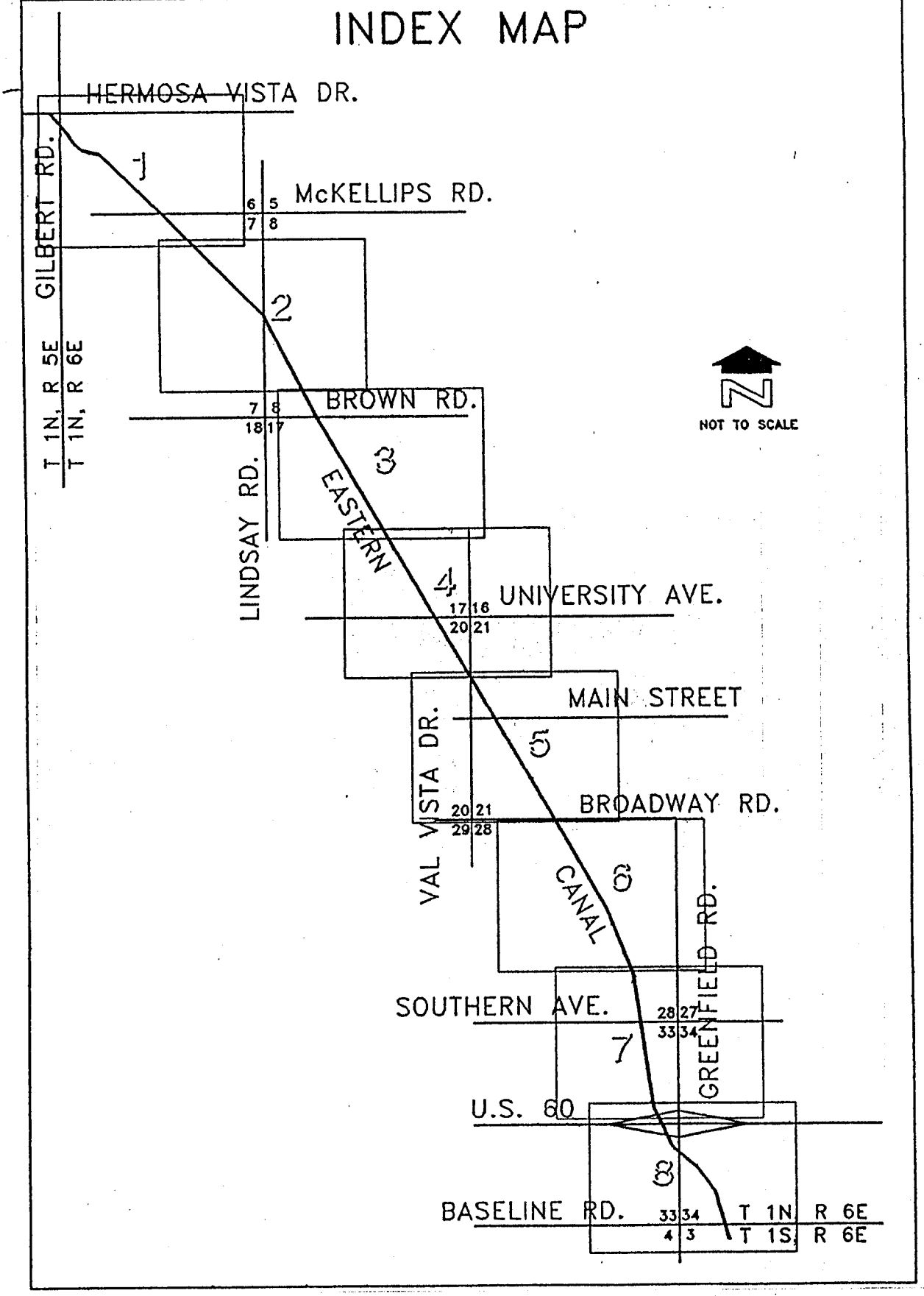
8.2.6 Four (4) complete copies of the Technical Data Notebook, including HEC-1 and HEC-2 input/output files on diskettes. The Technical Data Notebook will be prepared in accordance with ADWR State Standards Attachment 1-90 (SSA 1-90). The notebook will be organized as specified by the District, following SSA 1-90 format. This submittal of the Technical Data Notebook shall include any correspondence and/or meeting minutes with the reviewing agencies and shall reflect any revisions required by those reviewing agencies. Revisions may include, but are not limited to, modifications to the delineation maps, the HEC-1 model, the HEC-2 model, and/or the Final Report.

AERIAL MAPPING FLIGHT INDEX MAP

Approximate Scale:

1 in = 4000 ft

INDEX MAP



FCDMC NO.96-10

T.D.N.2.2 INDEX MAP OF FLOODPLAIN WORK MAPPING

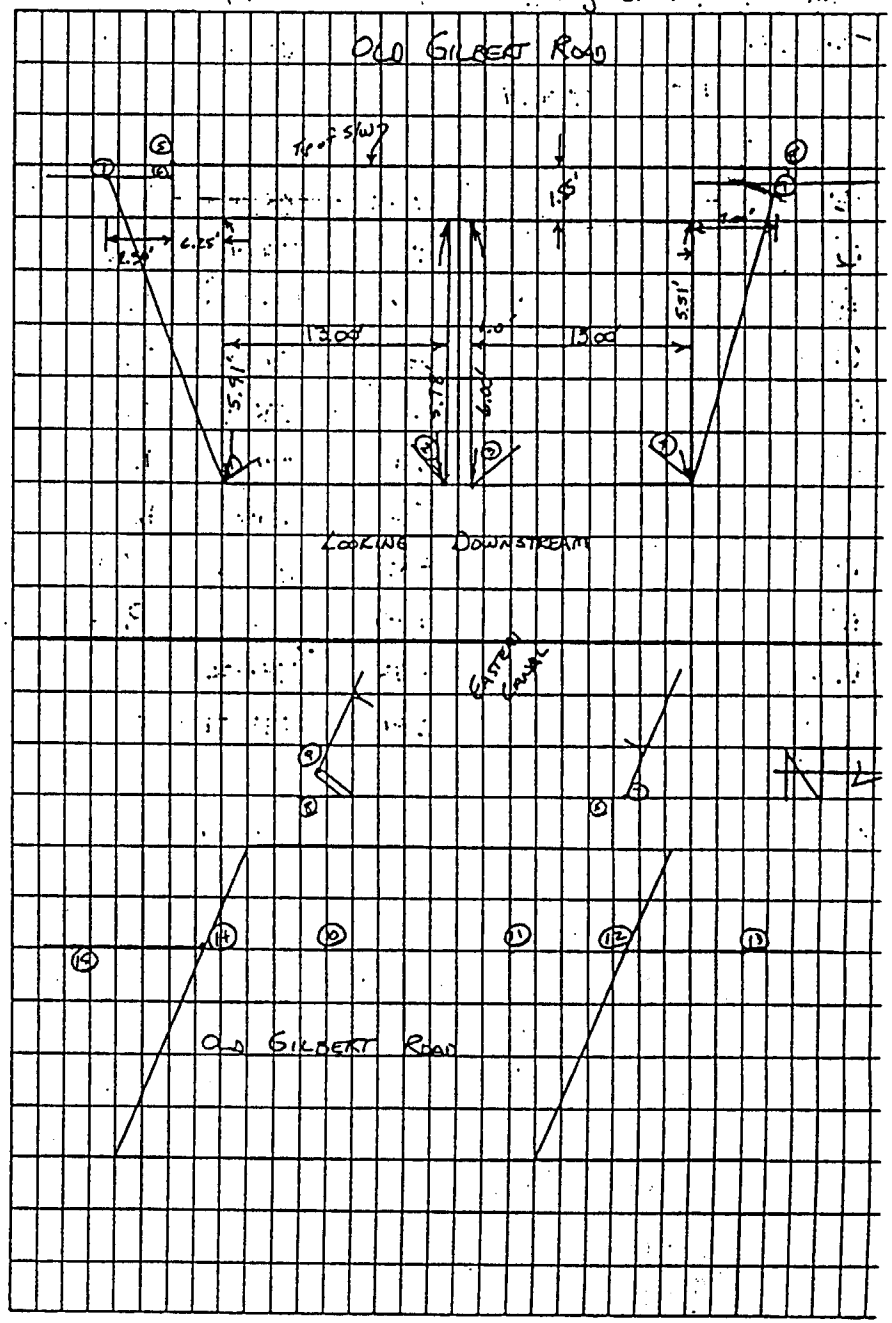
- **FIELD NOTES OF CULVERT MEASUREMENTS & INVERTS ALONG THE EASTERN CANAL**

(DELIVERED 1/17/97)

1-8-97
Clear, Cldy, Cold 45°F

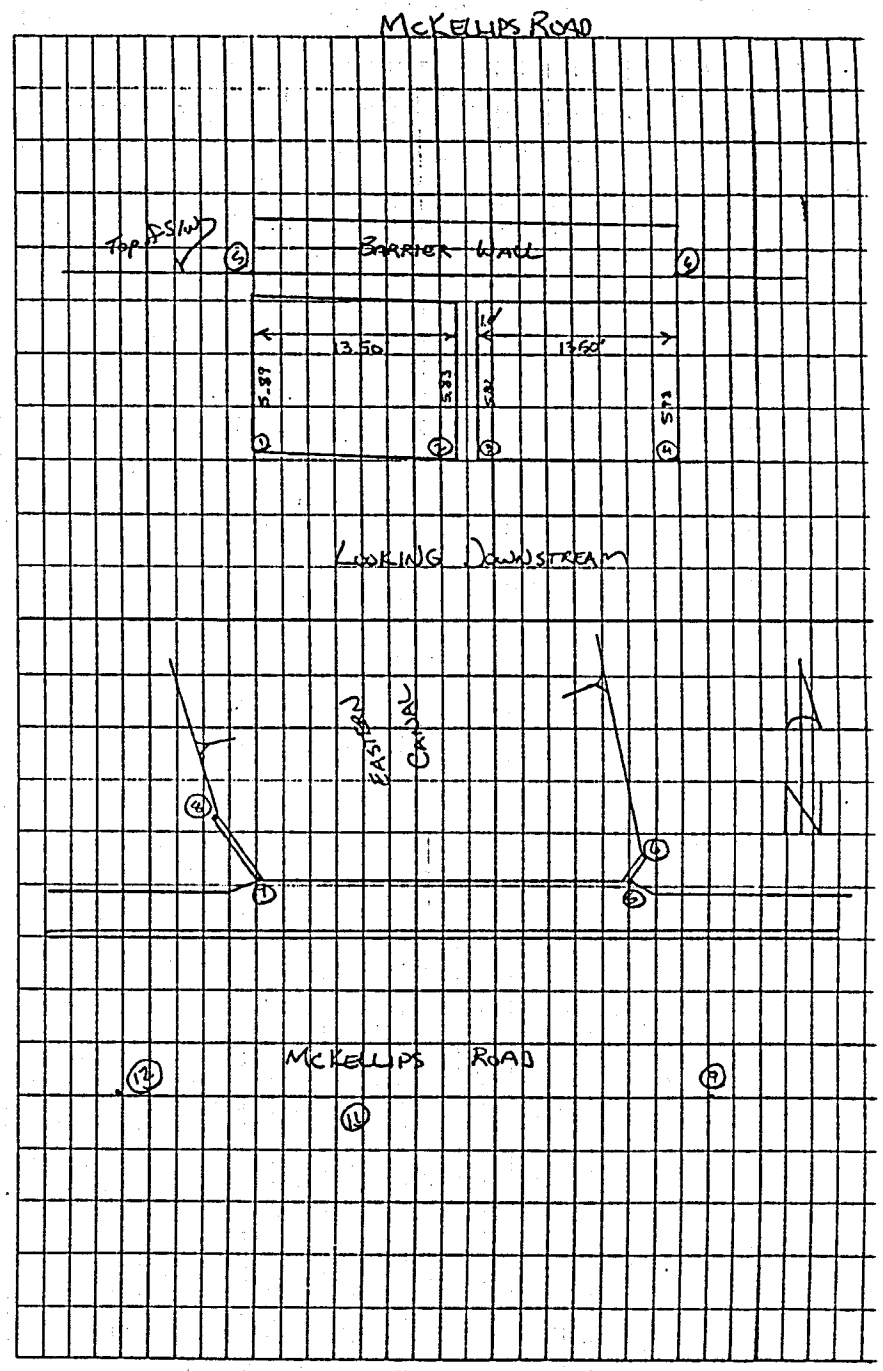
Gardiner
Mortensen
Berghian

STA	BS+	H.I.	FS-	ELEV	Pt #
TBM #100				1295.401	B.C.
	4.68	1300.08			
1			12.45	1287.63	Invert @ Toe
2			12.67	1287.41	Invert
3			12.65	1287.43	Invert
4			12.12	1287.96	Invert @ Toe
5			4.78	1295.30	T/W
6			5.50	1294.58	⊥
7			5.50	1294.58	Top of Bank
8			4.63	1295.45	T/W
9			5.50	1294.58	Top of Bank @ Wingwall
10			5.26	1294.82	M
11			5.34	1294.74	M
12			5.29	1294.79	M @ E.C.
13			5.56	1294.52	M @ E.P.
14			5.26	1294.82	M @ E.C.
15			6.11	1293.97	E.P.
TBM 100			4.68	1295.40	✓



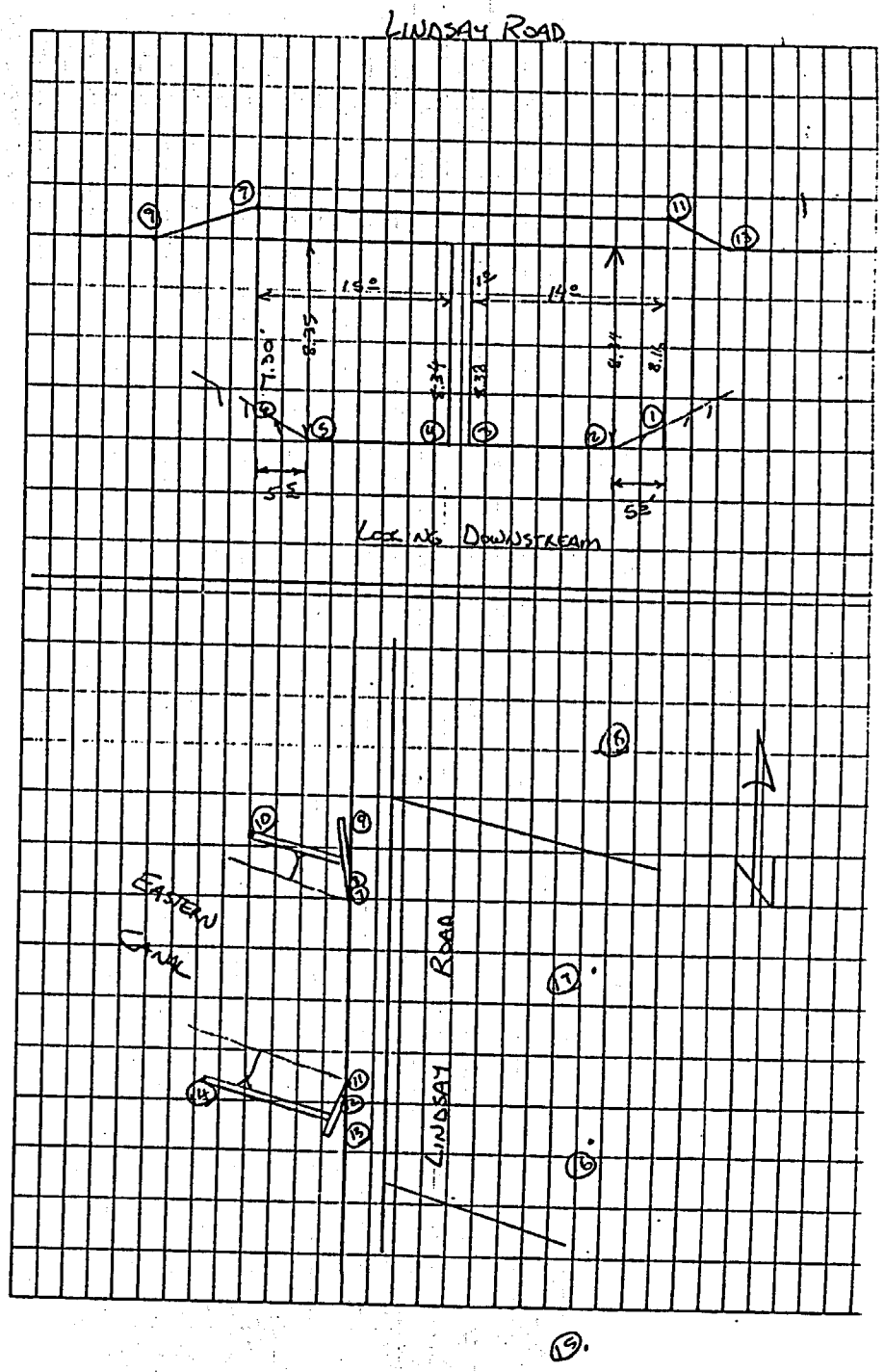
STA	BS+	H.I.	FS-	ELEV	REMARKS
TBM 102				1293.867	SRP B.C.
	5.30	1299.17			
1			12.44	1286.73	Invert @ Wingwall
2			12.72	1286.45	Invert
3			12.73	1286.44	Invert
4			12.88	1286.29	Invert @ Wingwall
5			4.85	1294.32	T/W @ Wall
6			4.82	1294.35	Top of Wingwall
7			5.15	1294.02	T/W @ Wall
8			5.16	1294.01	Top of Wingwall
9			5.40	1293.77	Pvmt
10			5.49	1293.68	Pvmt
11			5.43	1293.74	Pvmt
12			5.46	1293.71	Pvmt
TBM 102			5.30	1293.87	✓

2.3 (3)



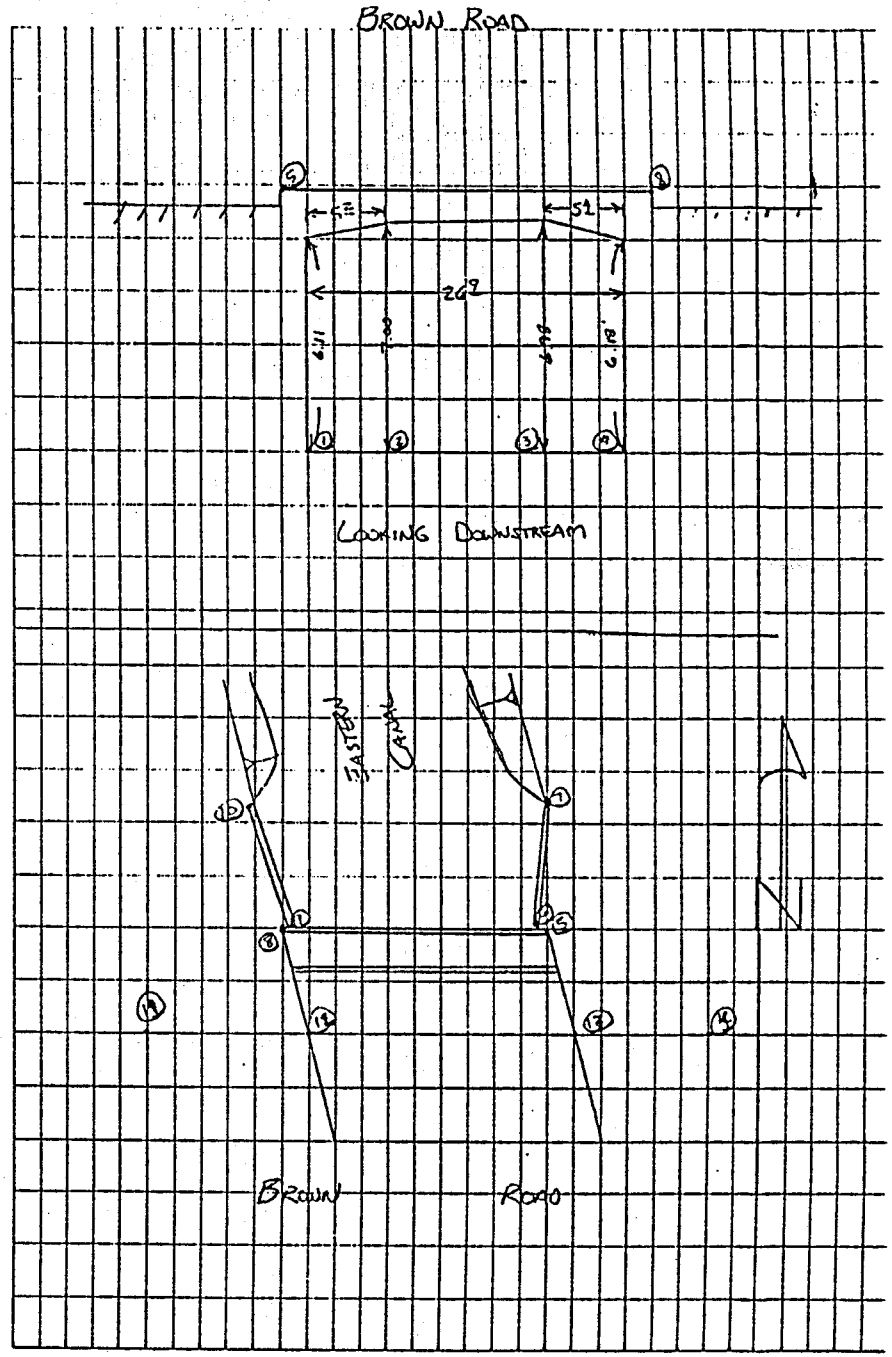
STA	BS+	H.I.	FS-	ELEV	REMARKS
TBM #134				1293.377	SRP B.C.
	4.14	1297.52			
1			12.19	1285.33	Inv @ Wingwall
2			12.44	1285.08	Inv @ Toe
3			12.33	1285.19	Invert
4			12.46	1285.06	Invert
5			12.43	1285.09	Inv @ Toe
6			11.42	1286.10	Inv (@) Wingwall
7			3.80	1293.72	Top of S/W
8			4.15	1293.37	Top of Wingwall
9			4.33	1293.19	Top of S/W
10			4.01	1293.52	Top of Wingwall
11			3.38	1294.14	Top of S/W
12			4.17	1293.35	Top of Wingwall
13			4.15	1293.37	Top of S/W
14			5.22	1292.30	Top of Wingwall
15			3.95	1293.57	Pvmt
16			3.92	1293.60	Pvmt
17			4.00	1293.52	Pvmt
18			3.99	1293.53	Pvmt
TBM #134			4.14	1293.38	✓

2.3 (4)



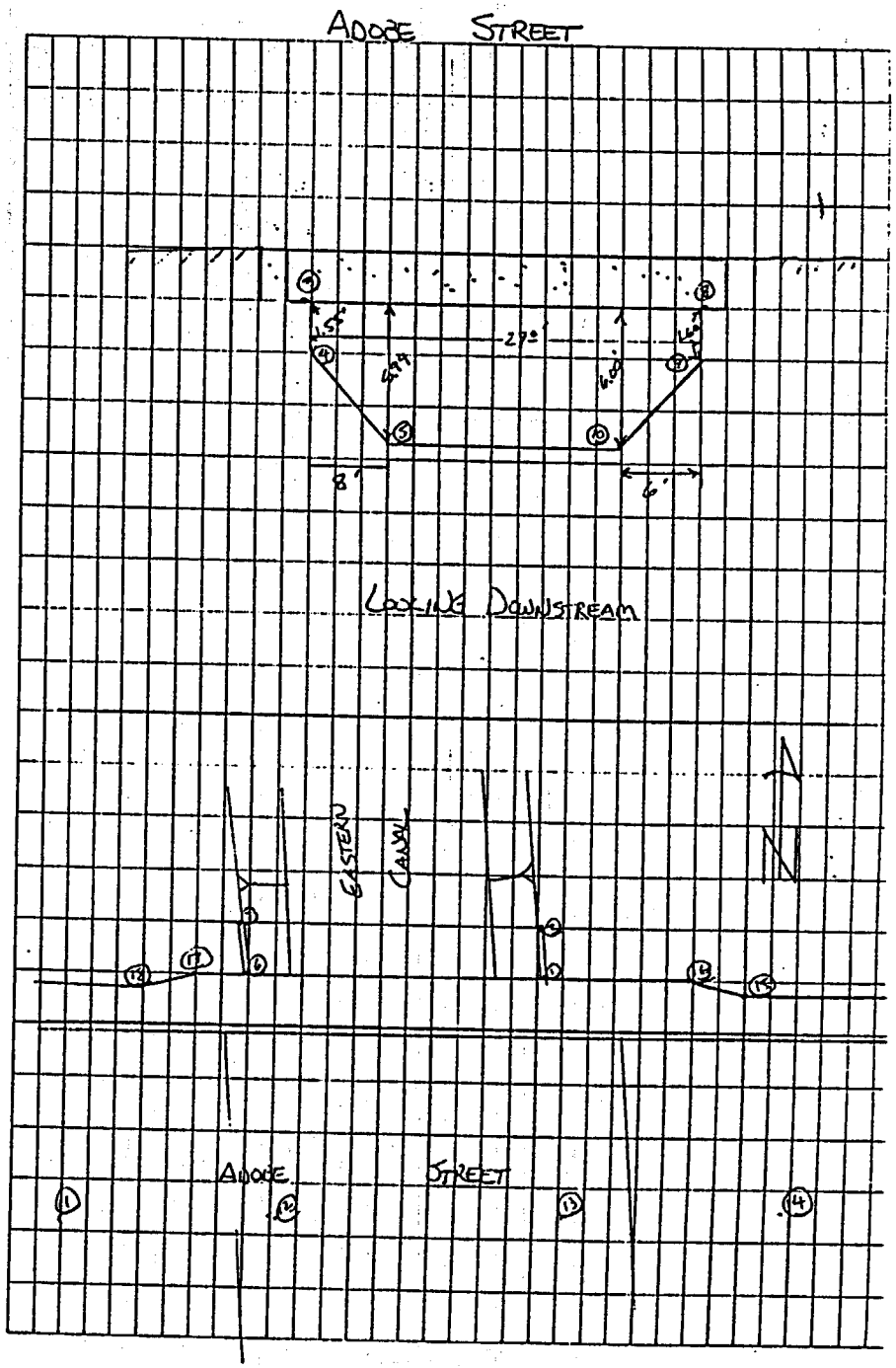
STA	BS+	H.I.	FS-	ELEV	REMARKS
TBM #136				1292.346	MCHD BC
	5.10	1297.45			
1			12.87	1284.68	Inv @ Wingwall
2			13.15	1284.30	Invert
3			13.05	1284.40	Invert
4			13.00	1284.45	Invert @ Wingwall
5			4.01	1293.44	Top of Conc
6			5.13	1292.32	Top of Wingwall
7			5.60	1291.85	Top of Wingwall
8			4.39	1293.06	Top of Conc
9			5.10	1292.35	Top of Wingwall
10			5.69	1291.76	Top of Wingwall
11			4.73	1292.72	Runt
12			4.74	1292.71	Runt
13			4.60	1292.85	Runt
14			4.64	1292.81	Runt
TBM #136			5.10	1292.35	✓

2.3(5)



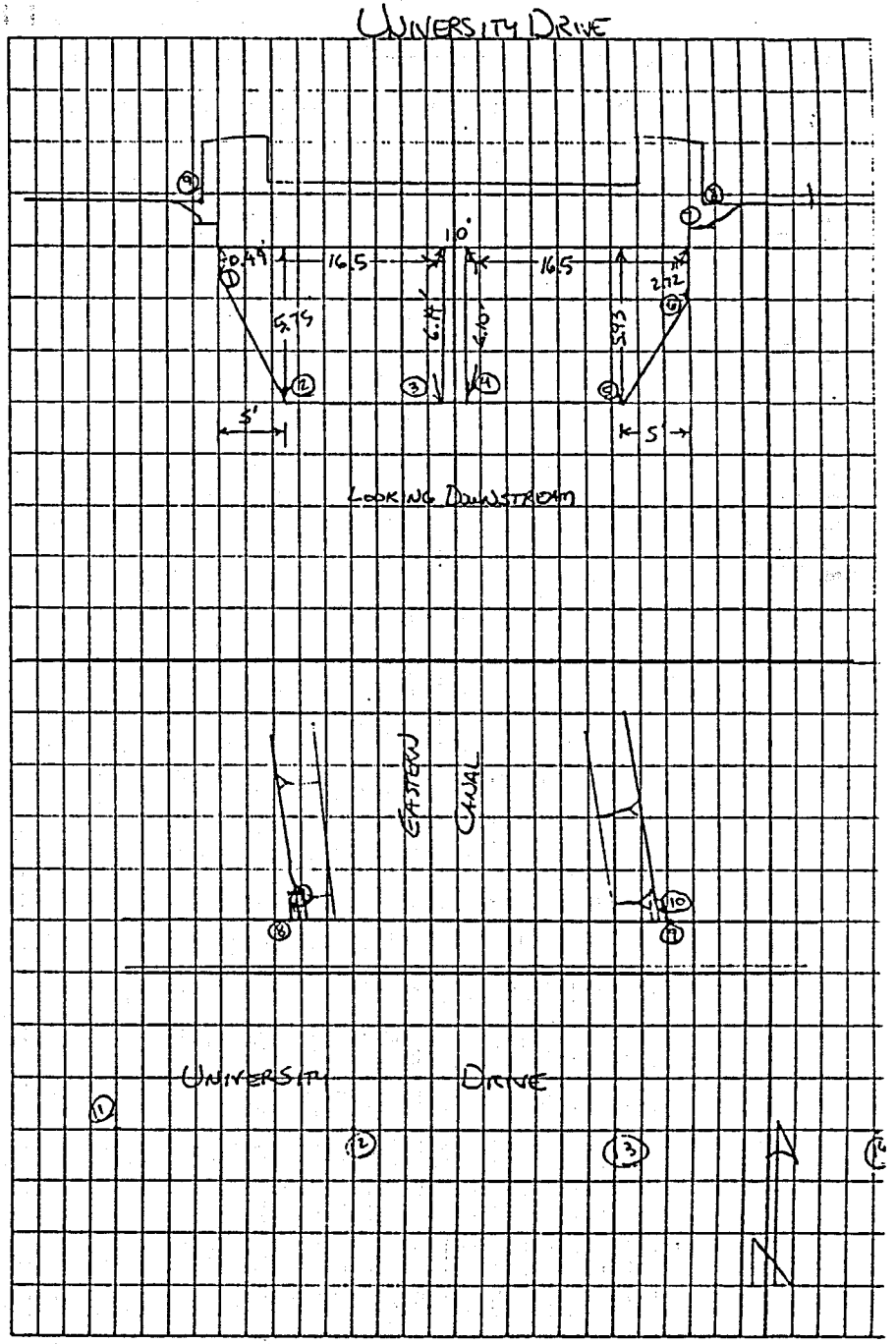
Sta	BS+	H.I.	FS-	Elev	Remarks
TBM #152				1291.050	SRP B.C.
	4.05	1295.10			
1			3.95	1291.15	Top of Wingwall
2			4.27	1290.83	Top of Wingwall
3			5.83	1289.27	Top of Abutment
4			7.38	1287.72	Top of Bnk (-) Abutment
5			11.53	1283.57	Toe of Slope
6			4.07	1291.03	Top of Wingwall
7			4.32	1290.78	Top of Wingwall
8			5.81	1289.29	Top of Abutment
9			7.41	1287.69	Top of Bnk (-) Abutment
10			11.66	1283.44	Toe of Slope
11			3.92	1291.18	Pvmt
12			3.53	1291.57	Pvmt
13			3.55	1291.55	Pvmt
14			3.83	1291.27	Pvmt
15			3.36	1291.74	B/W
16			3.93	1291.17	B/W
17			4.05	1291.05	B/W
18			3.55	1291.55	B/W
TBM #152			4.04	1291.06	✓

2.3(6)



STA	BS+	H.I.	FS-	ELEV	REMARKS
TBM#175				1288.367	SRP BC
	6.01	1294.38			
1			6.59	1287.79	Top of Slope
2			11.86	1282.52	Toe of Slope
3			12.24	1282.14	Invert
4			12.30	1282.08	Invert
5			12.12	1282.26	Toe of Slope
6			9.00	1285.38	Top of Slope
7			5.37	1289.01	Abutment
8			4.78	1289.60	B/W
9			4.67	1289.71	B/W
10			5.22	1289.16	Abutment
11			5.07	1289.31	Pvmt
12			4.87	1289.51	Pvmt
13			4.84	1289.54	Pvmt
14			4.87	1289.51	Pvmt
TBM#175			6.01	1288.37	✓

2.3 (1)

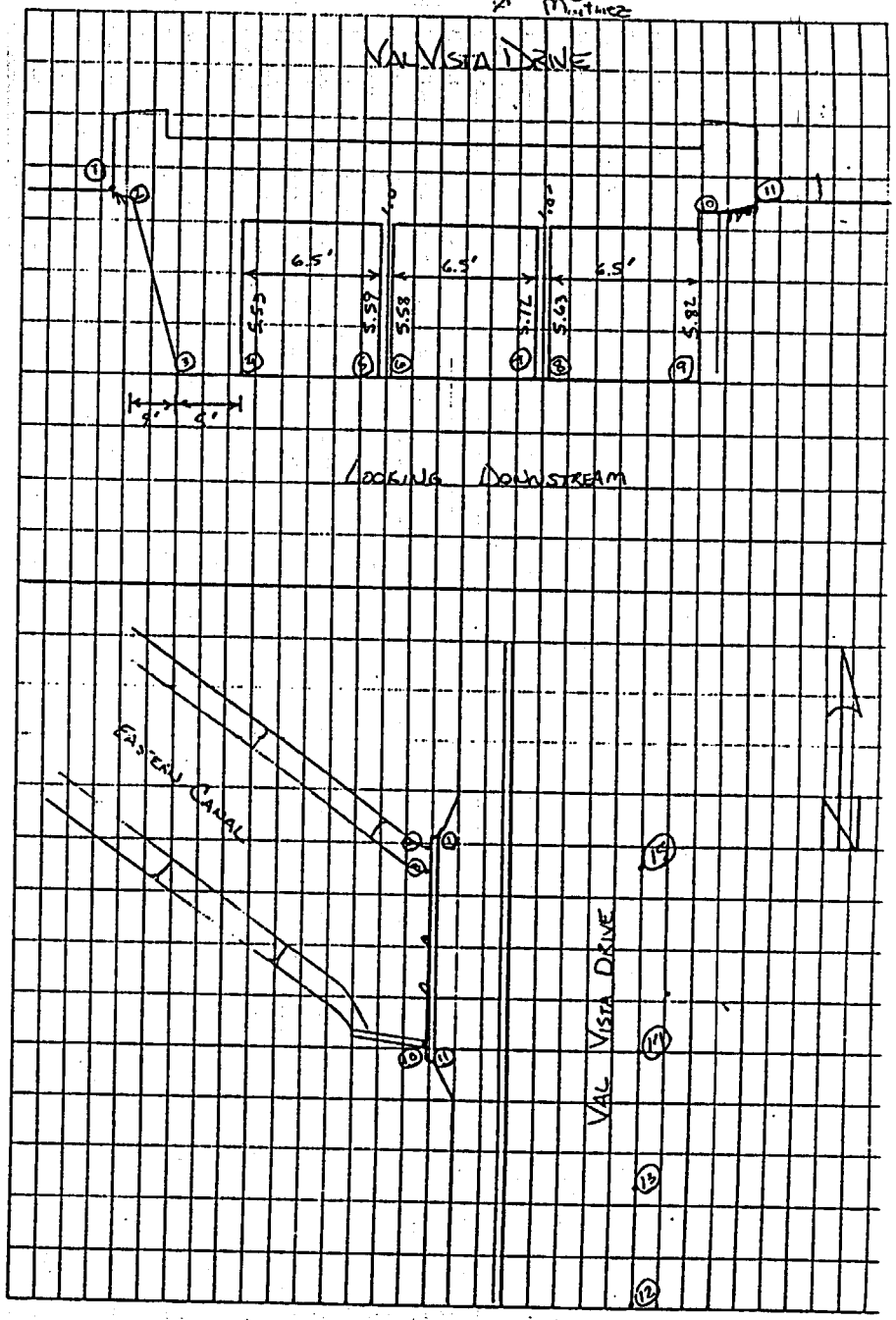


1-10-97
Clear, Calm, Cold 50°F

Gardner
Mortensen
Berghian
Martinez

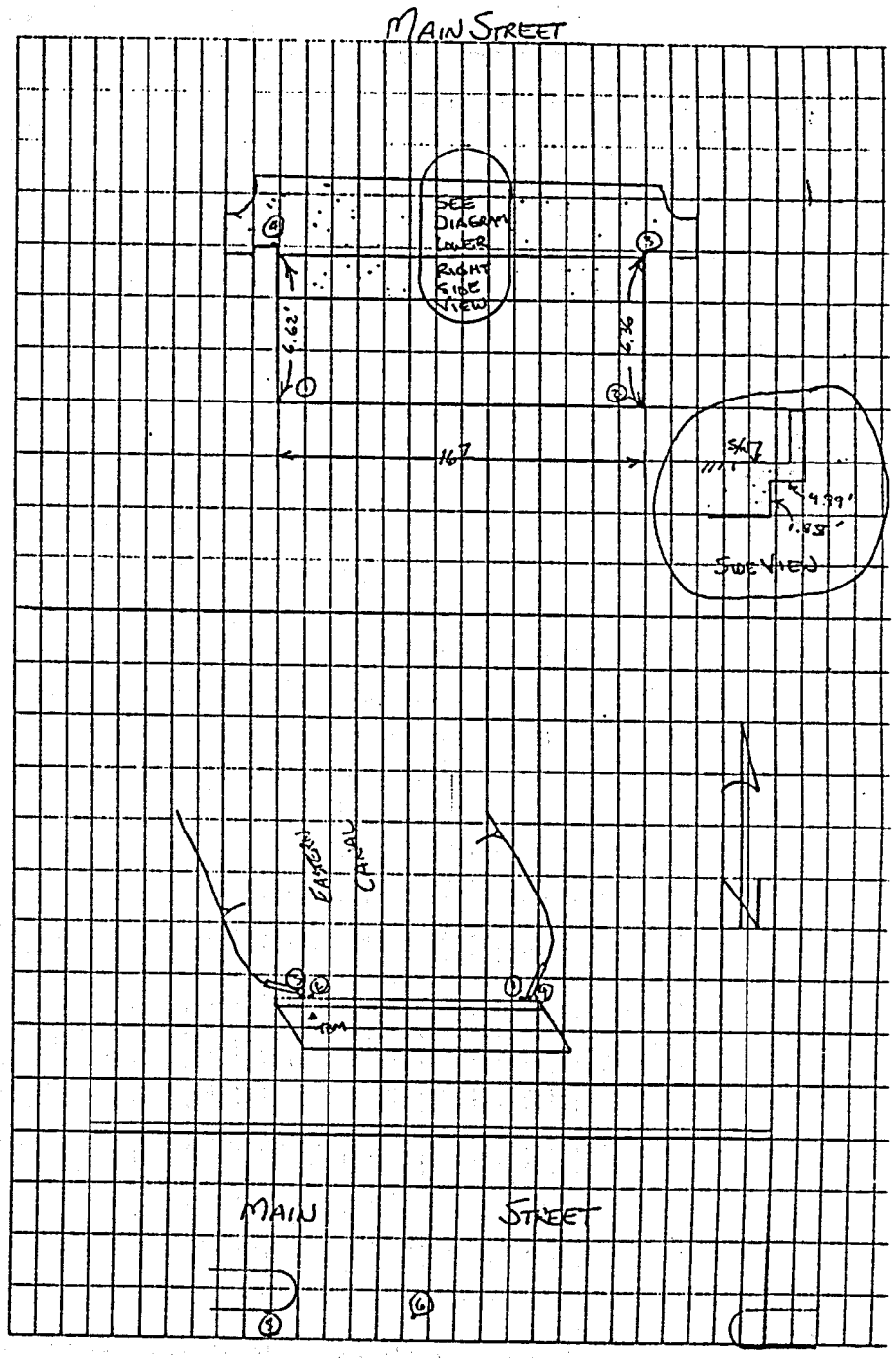
STA	BS+	H.I.	FS-	ELEV	REMARKS
TBM #182				1289.328	"X" in Concrete
	4.79	1294.12			
1			4.69	1289.43	B/W
2			5.60	1288.52	Top of Bank
3			12.11	1282.01	Toe of Slope
4			12.19	1281.93	Inv
5			12.23	1281.89	Inv
6			12.18	1281.94	Inv
7			12.19	1281.93	Inv
8			12.14	1281.98	Inv
9			12.16	1281.96	Inv
10			5.37	1288.75	Top of Wingwall
11			4.71	1289.41	B/W
12			4.87	1289.25	Pvmt
13			4.85	1289.27	Pvmt
14			4.80	1289.32	Pvmt
15			4.78	1289.34	Pvmt
TBM #182			4.78	1289.34	✓

2.3 (8)



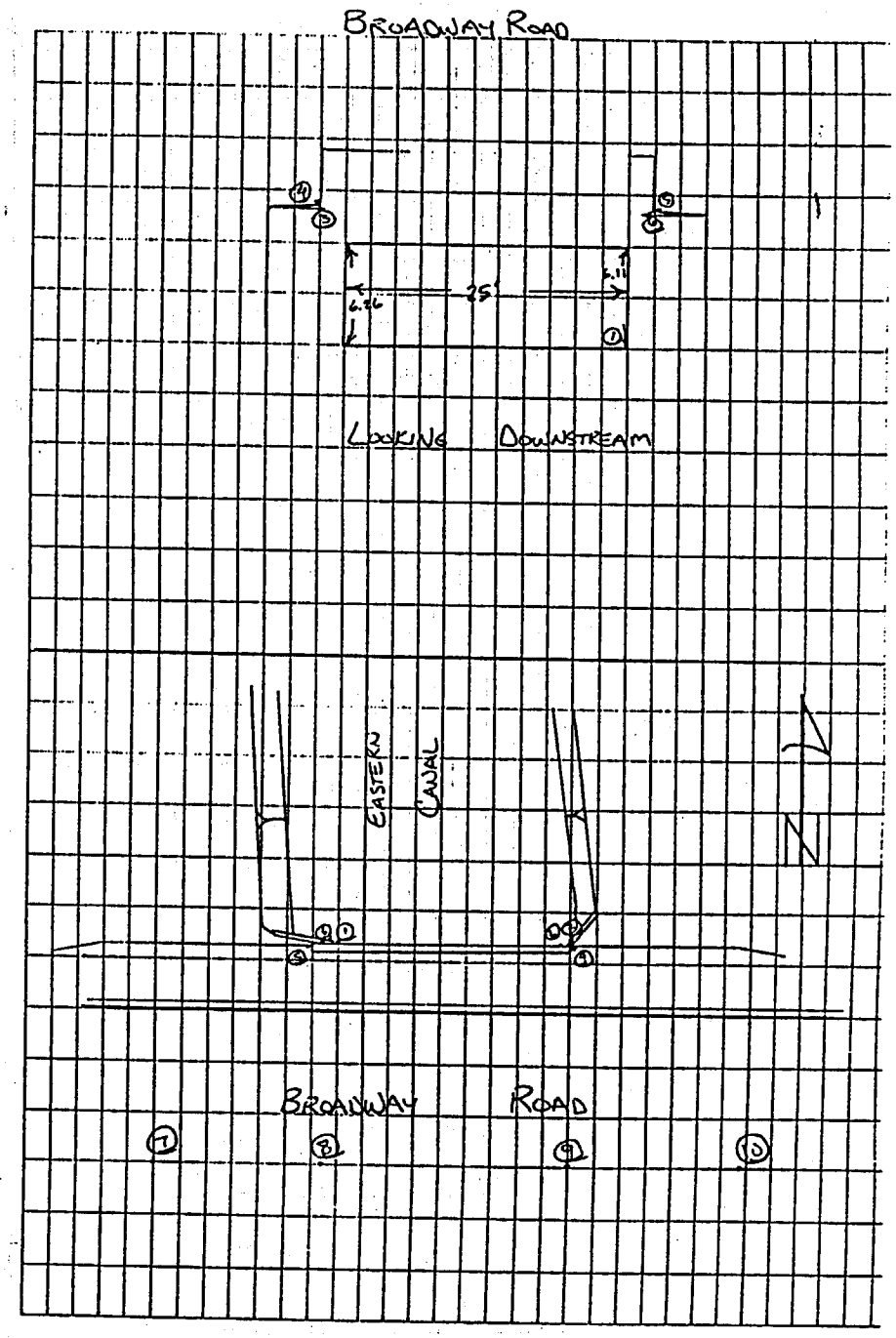
STA	BS+	H.I.	FS-	ELEV	REMARKS
TBM #183				1288.548	AHD B.C.
	5.57	1294.12			
1			12.33	1281.79	Invert
2			12.36	1281.76	Invert
3			5.58	1288.54	Top of Wingwall
4			5.41	1288.71	Top of Wingwall
5			6.39	1287.73	Pvmt
6			6.15	1287.97	Pvmt
7			6.06	1288.06	Pvmt
8			5.78	1288.34	Pvmt
TBM #183			5.56	1288.56	✓

2.3 (9)



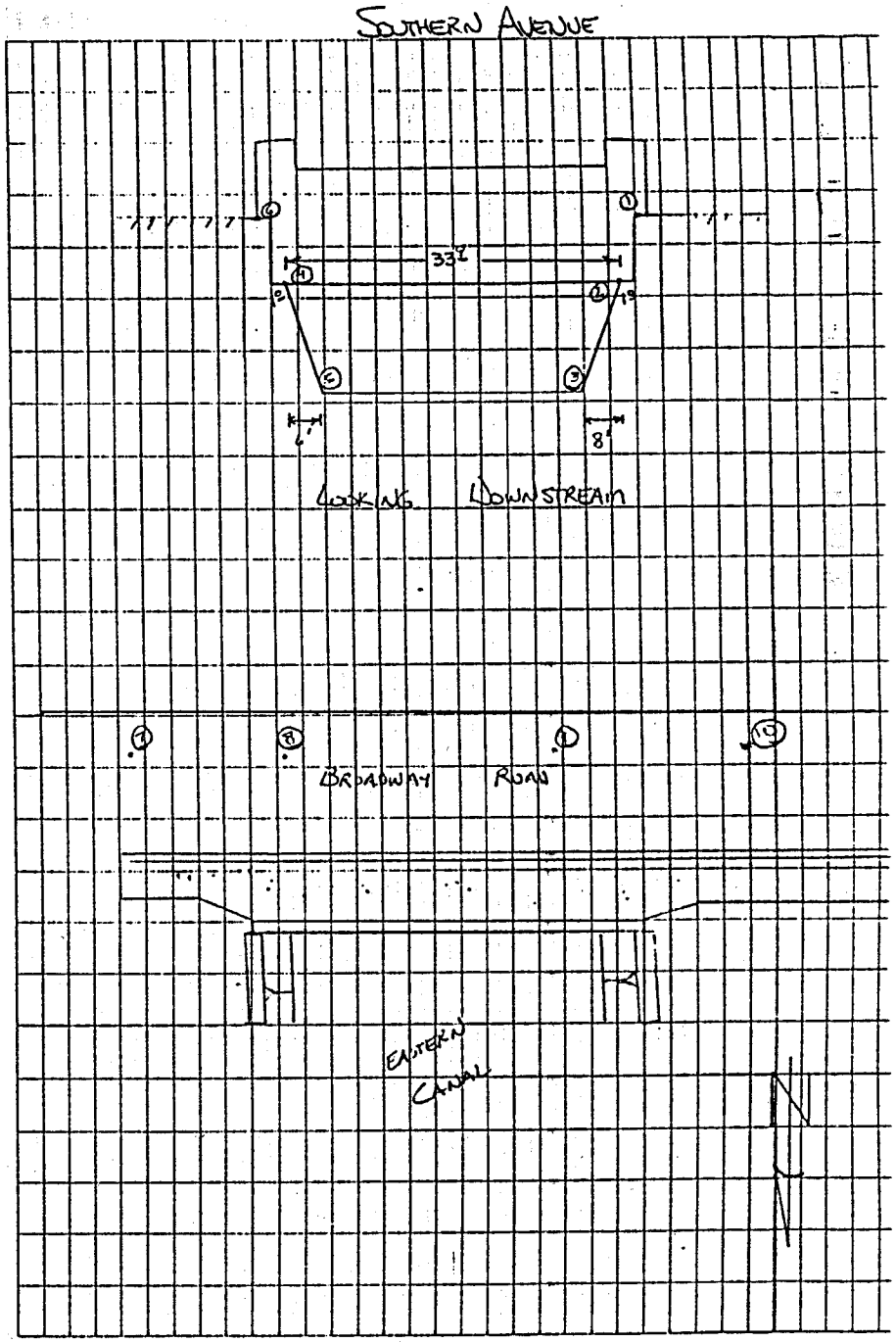
STA	BS+	H.I.	FS-	ELEV	REMARKS
TBM#190				1288.477	"+" in Conc
	4.60	1293.08			
1			12.30	1280.78	Invert
2			12.24	1280.84	Invert
3			4.60	1288.48	Top of Wingwall
4			4.31	1288.71	B/W
5			4.30	1288.78	B/W
6			4.60	1288.48	Top of Wingwall
7			4.30	1288.78	Pvmt
8			4.51	1288.57	Pvmt
9			4.50	1288.58	Pvmt
10			4.51	1288.57	Pvmt
TBM#190			4.60	1288.48	✓

2.3 (10)



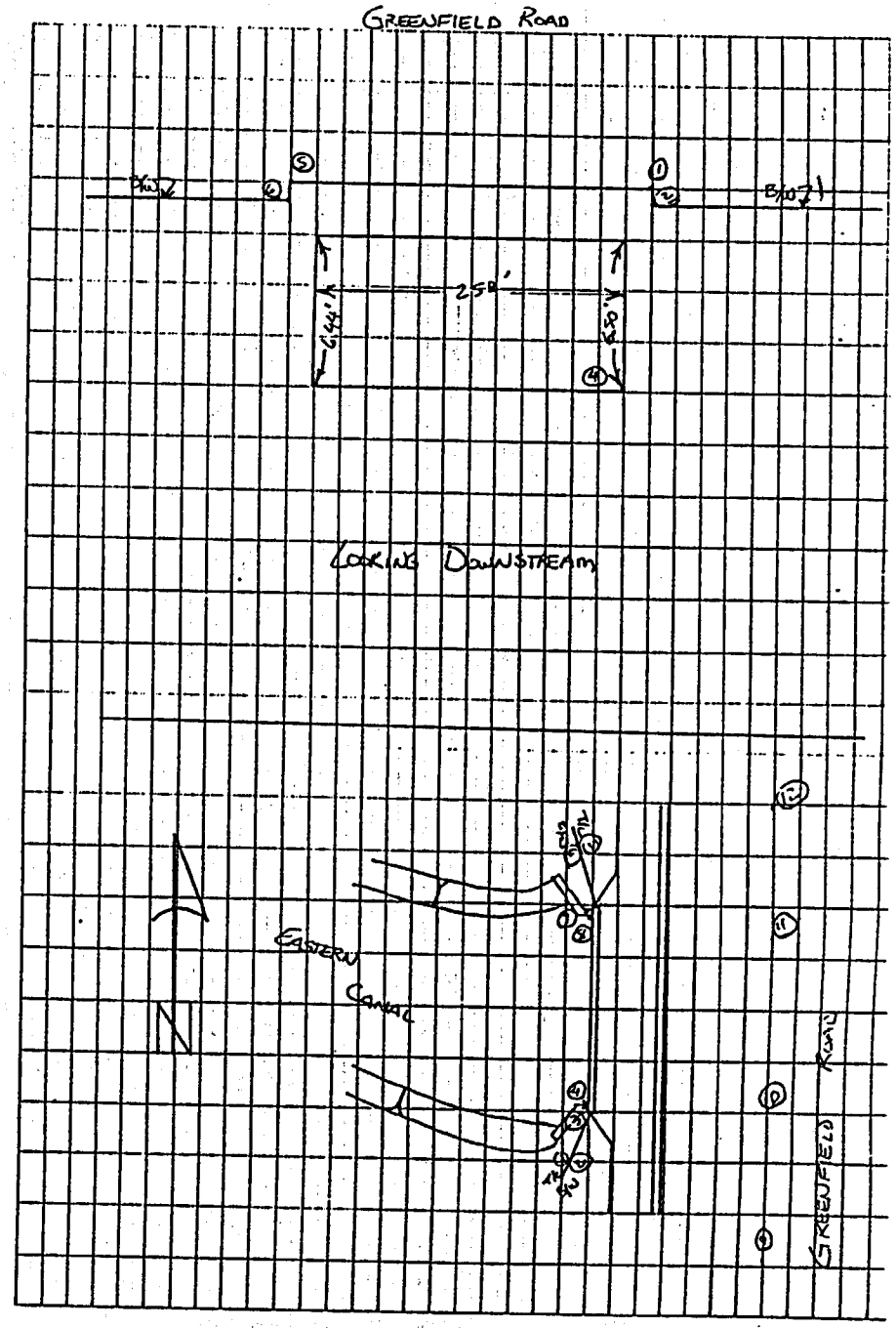
STA	BS+	H.I.	FS-	ELEV	REMARKS
TBM#216				1285.828	SRP B.C.
	5.87	1291.70			
1			4.49	1287.21	Top of Wingwall
2			7.75	1283.95	Top of Abutment
3			12.90	1278.80	Toe of Slope
4			7.65	1284.05	Top of Abutment
5			12.63	1279.07	Toe of Slope
6			4.36	1287.34	Top of Wingwall
7			4.92	1286.78	Pvmt
8			4.70	1287.00	Pvmt
9			4.93	1286.77	Pvmt
10			5.06	1286.64	Pvmt
TBM#216			5.87	1285.83	✓

2.3(11)



STA	BS	H.I.	FS	ELEV	REMARKS
TBM#75				1279.408	Rebar
	9.51	1288.92			
1			3.60	1285.32	T/C
2			3.76	1284.96	B/W
3			4.60	1284.32	Top of Wingwall
4			12.56	1276.36	Invert
5			3.55	1285.37	T/C
6			3.96	1284.96	B/W
7			4.54	1284.38	Top of Wingwall
8			12.53	1276.39	INV
9			4.27	1284.65	Pvmt
10			4.20	1284.72	Pvmt
11			4.13	1284.79	Pvmt
12			4.11	1284.81	Pvmt
TBM#75			9.52	1279.40	✓

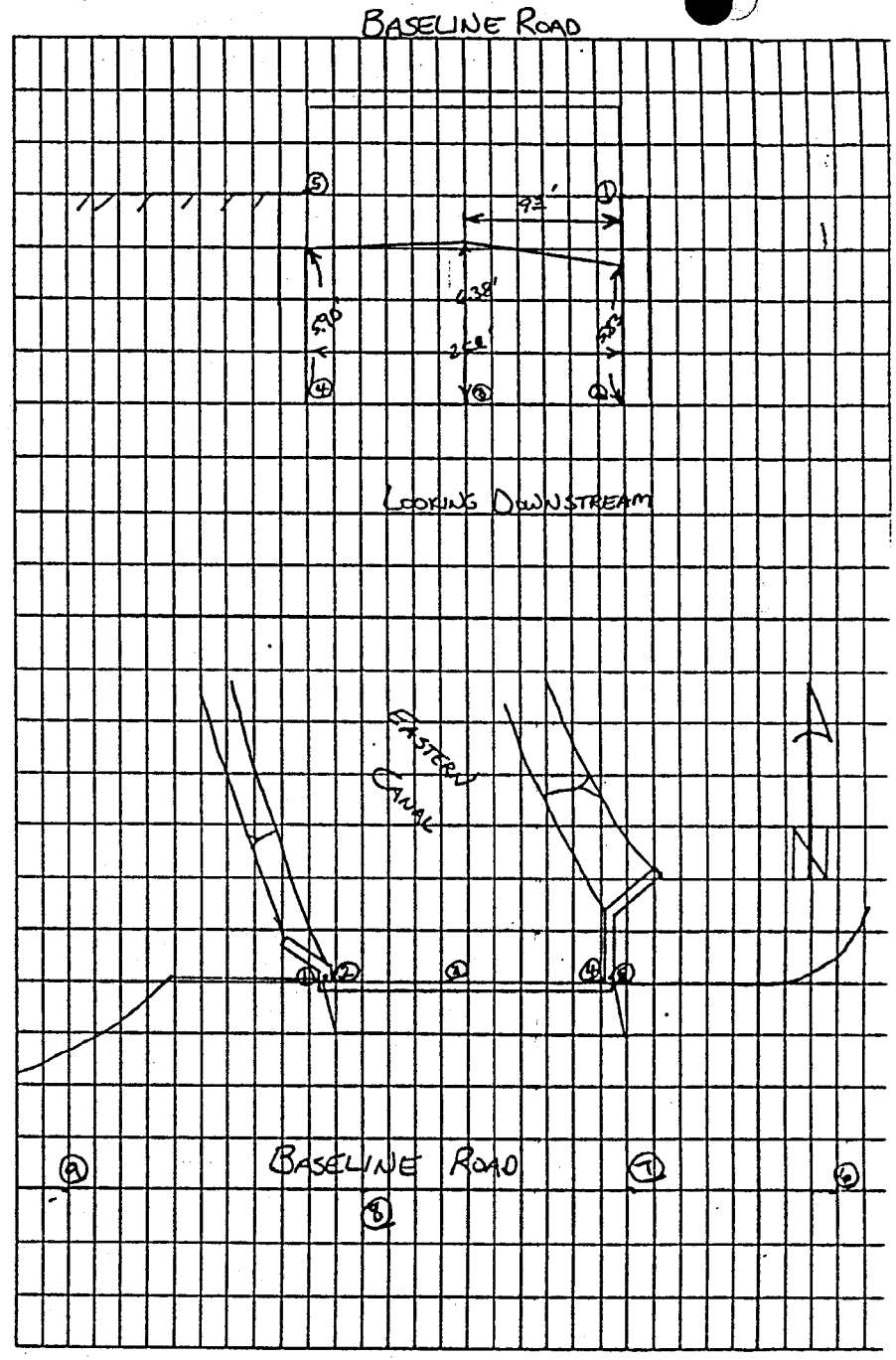
2.3 (2)



STA	BS+	H.I.	FS-	ELEV	REMARKS
TBM #227	—			1283.017	"+" in Concrete
	4.98	1288.00			
1			4.98	1283.02	Top of Wingwall
2			12.55	1275.45	Inv
3			12.62	1275.38	Inv
4			12.54	1275.46	Inv
5			5.00	1283.00	Top of Wingwall
6			3.92	1284.08	Pvmt
7			3.70	1284.30	Pvmt
8			3.74	1284.26	Pvmt
9			4.16	1283.83	Pvmt
TBM #227					✓

2.3 (13)

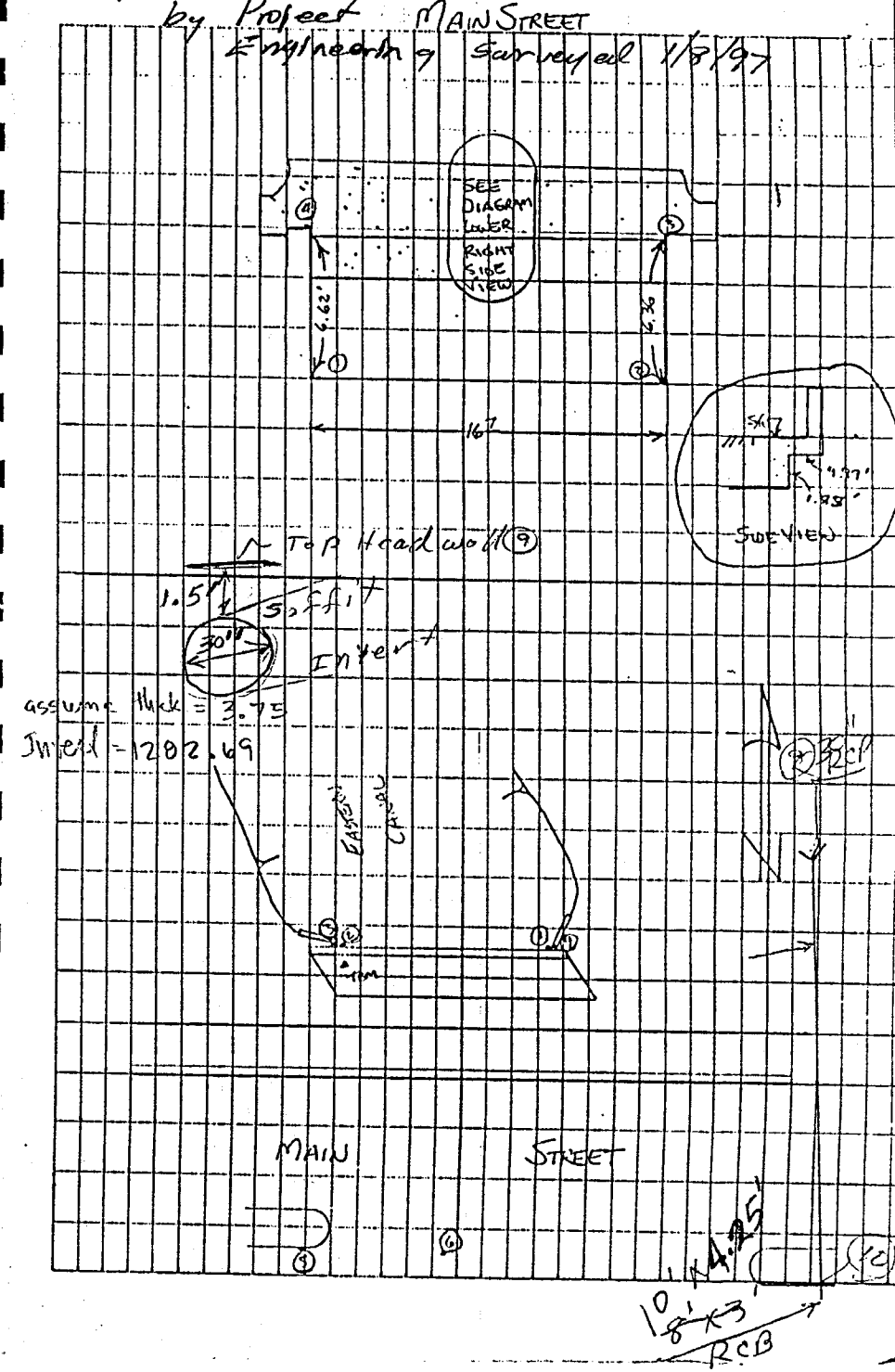
Backsight 4.98 on Wingwall
4.17 on S/W



3/13/97 Greg S. and Eddie of A-West using Field Notes of Canal Bridges by Project Main Street Engineering Surveyed 1/8/97

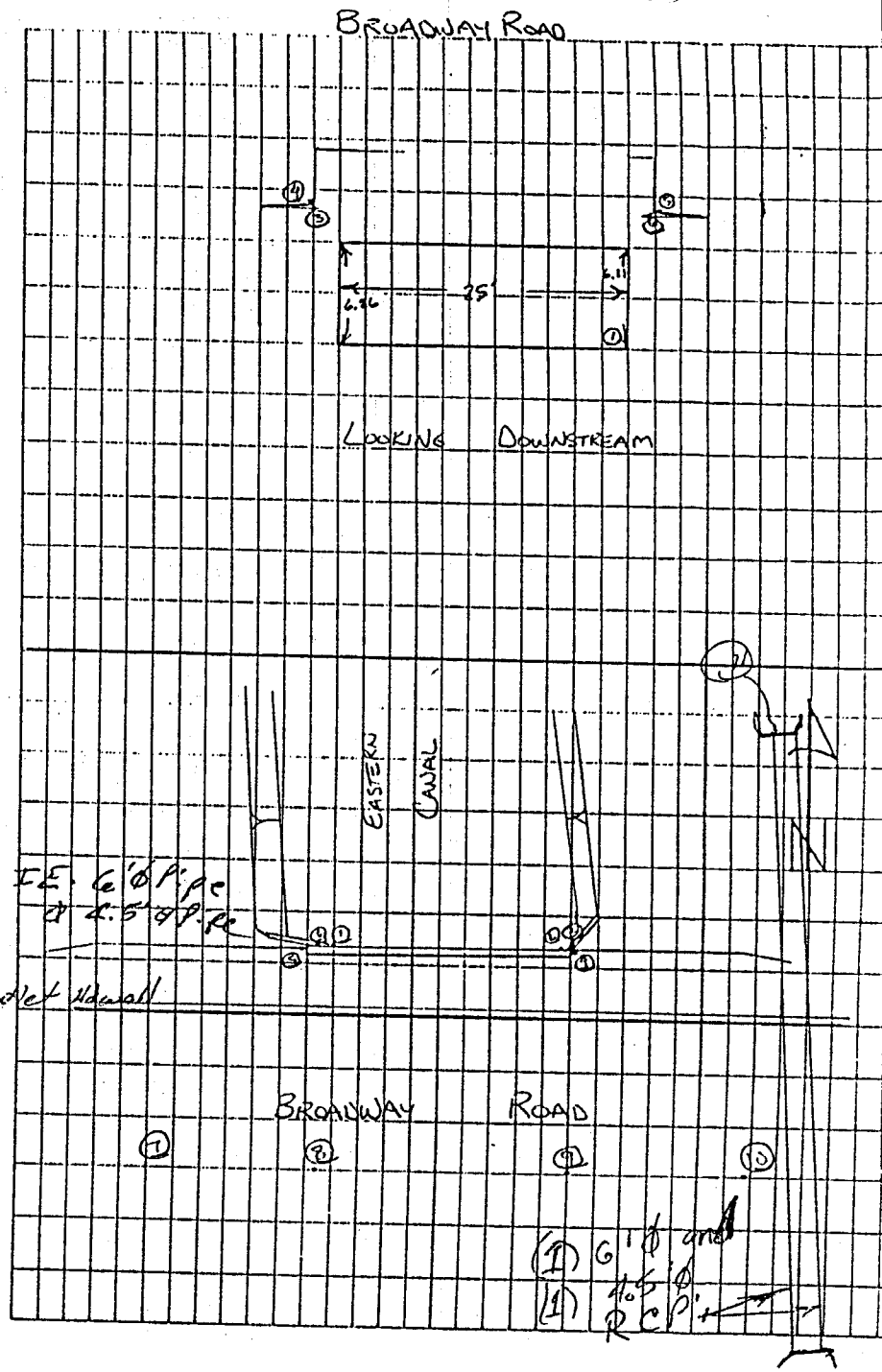
STA	BS+	H.I.	FS-	ELEV	REMARKS
TBM #183	4.38	1292.93		1288.548	AND B.C.
	5.57	1294.12			
1			12.33	1281.79	Invert
2			12.36	1281.76	Invert
3			5.58	1288.54	Top of Wingwall
4			5.41	1288.71	Top of Wingwall
5			6.39	1287.73	Point
6			6.15	1287.97	Point
7			6.06	1288.06	Point
8			5.78	1288.34	Point
TBM #183			5.56	1288.56	✓
9			5.93	1287.00	Inlet T. Hd. wall 1.5' T.H. to Soffit
10			10.66	1282.27	I.E. outlet 10.5' x 4.25' RCB.

2.3 (14)



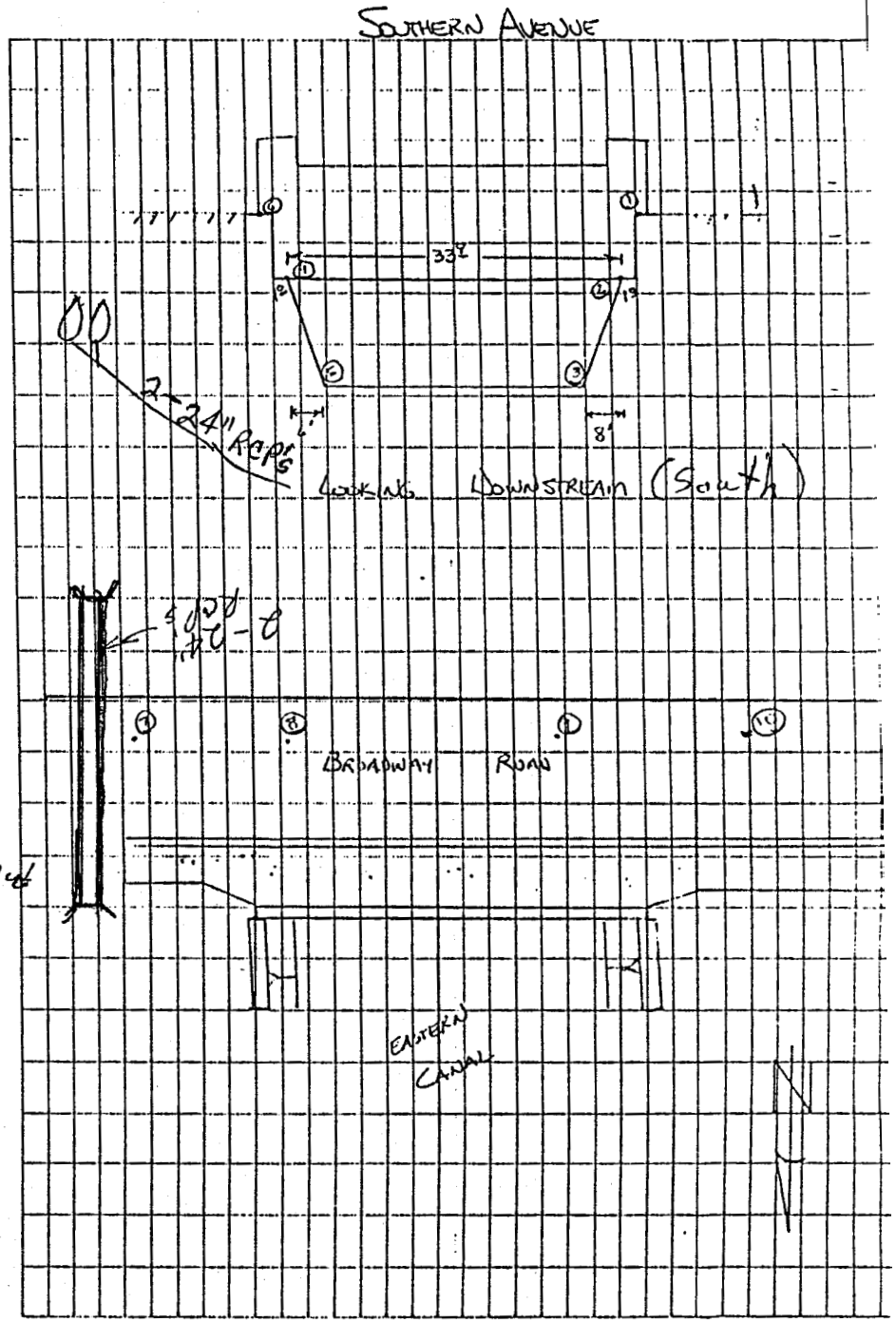
STA	BS+	H.I.	FS-	ELEV	REMARKS
TBM #190				1288.477	"+" in Conc
	4.60	1293.08			
1			12.30	1280.78	Invert
2			12.24	1280.84	Invert
3	4.05	1292.53	4.60	1288.48	Top of Wingwall
4			4.31	1288.71	B/W
5			4.30	1288.78	B/W
6			4.60	1288.48	Top of Wingwall
7			4.30	1288.78	Pvmt
8			4.51	1288.57	Pvmt
9			4.50	1288.58	Pvmt
10			4.51	1288.57	Pvmt
TBM #190			4.60	1288.48	✓
11			4.98	1287.55	Top Hdwall 8.4' Above I.E. 6'Ø Pipe & 4.5' Ø Pipe
					Invert = 1279.15
T.B.M	3.89	1291.67	4.75	1287.78	M.H. Rim 150' N. of outlet Hdwall
			7.43	1284.24	Top Hdwall outlet
					7.52' Top Hdwall to I.E.
					Invert = 1276.72

2.3(15)



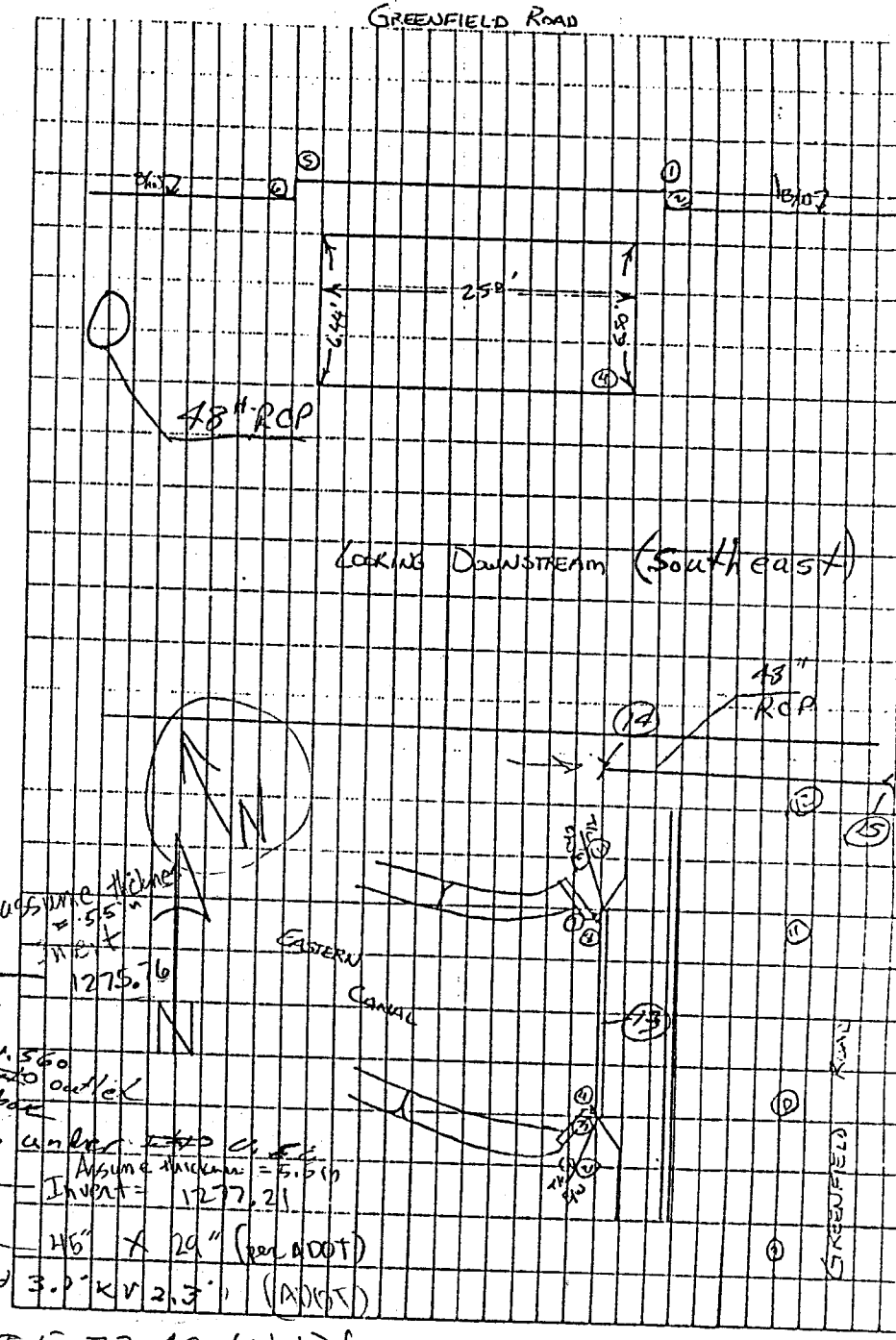
STA.	BS+	H.I.	FS-	ELEV	REMARKS
TBM#216				1285.828	SRP B.C.
	5.87	1291.70			
1			4.49	1287.21	Top of Wingwall
2			7.75	1283.95	Top of Abutment
3			12.90	1278.80	Toe of Slope
4			7.65	1284.05	Top of Abutment
5			12.63	1279.07	Toe of Slope
6	4.03	1291.37	4.36	1287.34	Top of Wingwall
7			4.92	1286.78	Pvmt
8			4.70	1287.00	Pvmt
9			4.93	1286.77	Pvmt
10			5.06	1286.64	Pvmt
TBM#216			5.87	1285.83	✓
			10.44	1280.93	Inlet I.E.
			11.29	1280.08	outlet I.E.
				+0.1 = 1279.08	+0.1 For Mud

2.3(b)



Sta	BS	H.I.	FS	Elev.	Remarks
TBM #75				1279.408	Rebar
	9.51	1288.92			
1			3.60	1285.32	T/C
2			3.76	1284.96	B/W
3			4.60	1284.32	Top of Wingwall
4			12.56	1276.36	Invert
5			3.55	1285.37	T/C
6			3.96	1284.96	B/W
7	4.86	1289.24	4.54	1284.38	Top of Wingwall
8			12.53	1276.39	Inv
9			4.27	1284.65	Pvmt
10			4.20	1284.72	Pvmt
11			4.13	1284.79	Pvmt
12			4.11	1284.81	Pvmt
TBM #75			9.52	1279.40	✓
13			4.66	1284.58	±1262-M McBC No El.
14		Greenfield	12.62	1276.62	I.E. Inlet 48" Pipe
15			9.02	1280.22	Soffit ± Outlet Pipe
16		U560	12.23	1277.01	I.E. 48" Pipe under U.560
TBM	5.56	1289.18	5.62	1283.62	T. Hdwall same as above
T.B.M.	5.23	1289.43	4.98	1284.20	T. Hdwall Inlet 48" pipe
			7.76	1281.67	Soffit Inlet 48" Pipe
		ADOT	12.96	1276.47	Top Pipe

2.3 (14)



2.98 T.P. to I.E.

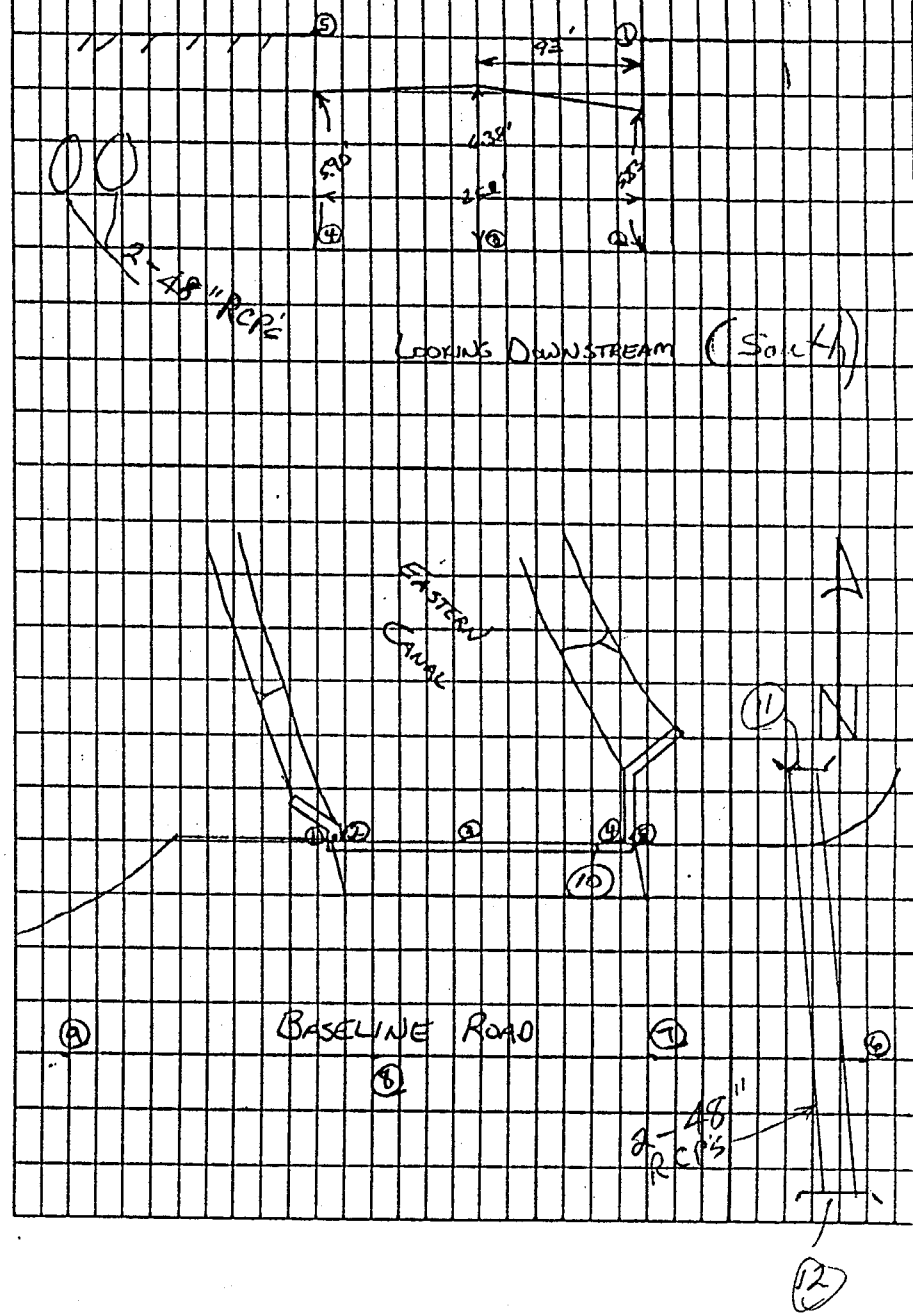
STA	BS+	H.I.	FS-	ELEV	REMARKS
TBM #227				1283.017	"4" in Concrete
	4.98	1288.00			
1			4.98	1283.02	Top of Wingwall
2			12.55	1275.45	Inv
3			12.62	1275.38	Inv
4			12.54	1275.46	Inv
5	5.58	1288.58	5.00	1283.00	Top of Wingwall
6			3.92	1284.08	Point
7			3.70	1284.30	Point
8			3.74	1284.26	Point
9			4.16	1283.83	Point
10			1.61	1286.97	MCDOT B.C
11			12.56	1276.02 2-48"	I.E. Inlet 1287.72 ✓
TBM #227					
12			12.95	1275.63	I.E. Outlet

Backsight 4.98 on Wingwall

4.17 on S/W

2.3.08

BASELINE ROAD



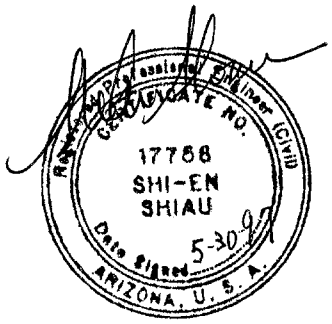
See Section 3.2.2.1 for Watershed and Hydrologic Analysis Maps

See Section 3.2.2.1 for Soil Type and Land Use Maps

SECTION 3 - HYDROLOGIC ANALYSIS

For Incorporation Into
Eastern Canal Floodplain Delineation Study
Technical Data Notebook

Primatech LLC
2929 N. 44th Street, Suite 228
Phoenix, Arizona 85018



May 1997

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Registered Professional Engineer (Civil)
Certificate No. 17756
SHI-EN SHIAU
Date Signed 5-30-97
ARIZONA, U.S.A.

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3.1 METHOD DESCRIPTION

The project consists of approximately 5.5 miles of floodplain delineation for the Eastern Canal from Baseline Road to Hermosa Vista Drive located in the City of Mesa in Township 1 North, Range 6 East of the Gila and Salt River Base and Meridian. This requires the development of approximately 12 square miles of watershed hydrology. The large array version of the US Army Corps of Engineers HEC-1 computer program, obtained from the Flood Control District of Maricopa County (FCDMC), was used to develop the hydrologic model.

The FCDMC *Drainage Design Manual for Maricopa County, Arizona, Volumes I and II,* were used to develop discharges, means of conveyance, and retention volumes for this project. Peak discharges were calculated for the 10-year, 6-hour storm; the 100-year, 6-hour storm; and the 100-year, 24-hour storm. Specific issues regarding design approach were directed to the Hydrologic and Development Sections of the FCDMC.

Drainage areas were initially delineated by hand on 1"=200' scale detailed topographic maps with 2-foot contours. Subsequently, the areas were delineated in AutoCAD using aerial mapped topography. Drainage areas were calculated using AutoCAD and checked by planimeter on hard copies of the 1"=200' scale detailed topographic maps. The drainage areas were then transposed onto the digital soils maps and the percentages of soil types for each area computed using AutoCAD. City of Mesa zoning maps were digitized into AutoCAD and the percentages of land use computed for each drainage area. Water course lengths and slopes were measured on the 200-scale detailed topographic maps.

Design discharges were computed using the HEC-1 computer model. The hydrologic variables entered into the program were computed using procedures described in the FCDMC *Drainage Design Manual for Maricopa County, Arizona, Volume I, Hydrology (Hydrology),* and entered into the FCDMC Drainage Design Menu System (DDMS). The Green and Ampt Loss parameters were calculated using the DDMS. Precipitation data was taken from the FCDMC *Hydrology* and entered into the PREFRE and the MCUHP1 program options within DDMS.

Hydrologic routing of excess rainfall was achieved using the Clark Unit Hydrograph method, as recommended by the FCDMC. The required input parameters for the Clark Unit Hydrograph method, time of concentration, and storage coefficient were calculated using the procedures outlined in the FCDMC *Hydrology*. A time-area relation provided in the FCDMC manual was used.

The Normal-Depth Routing procedure was used for flood routing of hydrographs from one concentration point to another. Routed hydrographs were then combined with the next downstream hydrograph. Reservoir routing was achieved using the storage routing procedure. Storm drain routing was accomplished using the time-lag procedure (the RT card within HEC-1).

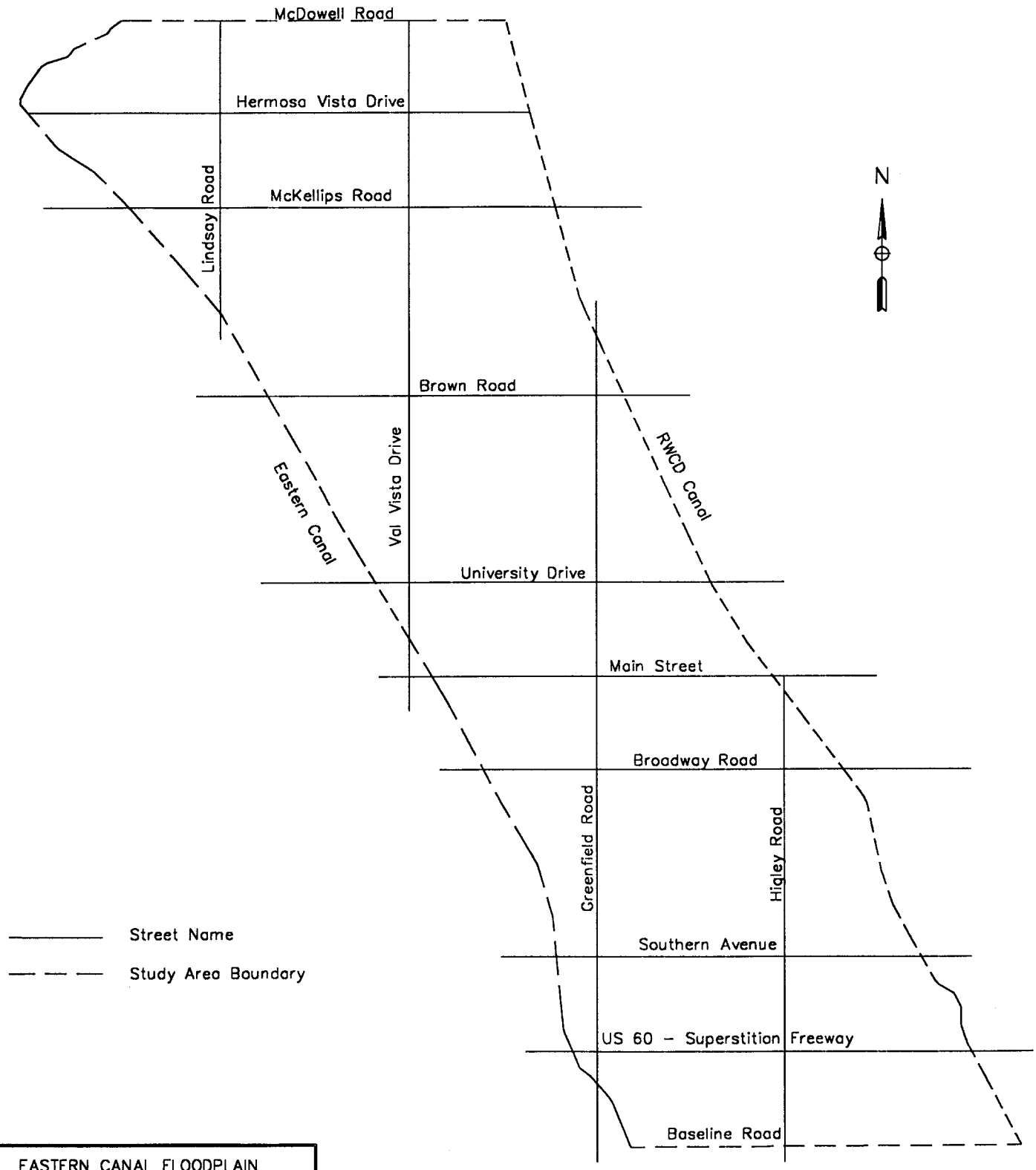
3.2.1 Drainage Area Boundaries

The project watershed is located in the City of Mesa, Arizona, in the eastern portion of Maricopa County. The watershed is bound by the Eastern Canal on the west, Roosevelt Canal on the east, Baseline Road on the south, and Hermosa Vista Drive on the north. While the study area is bound by Hermosa Vista Drive, contributing areas are bound by McDowell Road to the north. The total contributing area for the project is approximately 12 square miles. The project limits are shown in Figure 1, Study Area Boundary.

The watershed is predominantly developed residential lands of varied lot sizes. Agricultural areas as well as undeveloped lands are also located within the study area. US 60 passes through the southern end of the study area in an east-west alignment. A grid network of collector, major collector, and arterial streets channel the flow to the west.

The delineation of drainage sub-basins within the project watershed was accomplished using a 1"=200' scale, 2-foot contour interval topographic map, provided by Michael Baker Jr., Inc. Documents used for sub-basins within the contributing area north of Hermosa Vista Drive included a US Geological Survey (USGS) 7.5-minute quadrangle map for Buckhorn, AZ., with 10-foot contours, as well as aerial photographs.

The watershed was divided into 153 sub-basins which were numbered from 1 to 168, excluding numbers 7, 14, 72, 75, 78, 95, 109, 117, 119, 126, 127, 140, 145, 154, and 167, which were eliminated during the modeling process. Detention basins within the study area were identified by the sub-basin in which they are located and the sheet number of the topographic map on which the sub-basin is shown (e.g., Detention Basin 1B4 is within Sub-basin 4 shown on Sheet 1 of 5 of the topographic maps). Refer to Table 1 in Section 3.2.2.1 for a summary of the drainage sub-basins.



EASTERN CANAL FLOODPLAIN DELINEATION

FIGURE 3.1 – STUDY AREA BOUNDARY

PRIMATECH ENGINEERS
2929 N. 44th St., Phoenix, AZ 85018

Project No. : MFC001

Date : May 1997 | Drawn by : WVH

3.2.2 Physical Parameters

3.2.2.1 Sub-basin Parameters

Drainage Sub-basins

The watershed and sub-basin boundaries were delineated in AutoCAD using 2-foot contours. The drainage area delineations are shown with the study area topography on Exhibit 1 - Drainage Basin Map. The individual sub-basin areas and the watershed total area are presented in Table 1. There are 153 sub-basins which comprise the 12.147-square-mile watershed area. The sub-basin areas range between 16 acres (0.025 square mile) to 97.28 acres (0.152 square mile).

Flow path length (L), flow path slope (S), and basin resistance coefficient (K_b) were calculated for the individual drainage sub-basins. These parameters are included in Table 1 with the sub-basin areas. These basin parameters used for the Clark Unit Hydrograph calculations are described in Section 3.2.2.3. The flow path length and slope were measured from the topographic maps. The basin resistance coefficient was calculated following the procedure outlined in the FCDMC *Hydrology*.

Soil Types

Soil types for the study area were obtained from Soil Conservation Service, *Soil Survey, Eastern Maricopa and Northern Pinal Counties Area, Arizona (Nov., 1974).* Table 2 summarizes the soil types within the watershed area. Exhibit 2 - Soil Type Map shows the soil types with the drainage area delineations. The fraction of each soil type within each sub-basin is summarized in Table 3.

Land Use Types

Land use types for the study area were obtained from zoning maps issued by the City of Mesa, Community Development & Planning Department (July, 1996). Table 4 summarizes the City of Mesa land use types within the watershed area and the corresponding Maricopa County equivalent land use category, as presented in the FCDMC *Hydrology*. Exhibit 3 - Land Use Map shows the land use types with the drainage area delineations. The fraction of each land use type within each sub-basin is summarized in Table 5.

Table 1
Sub-basin Parameters

MFC001					Date:	May-97
calculations by:		WVH				
checked by:		RHF				
Drainage Area #	Area (mi^2)	L (mi)	S (ft / mi)	Land Type	Kb	
1	0.041	0.244	19.2	A	0.031	
2	0.117	0.662	18.4	A	0.028	
3	0.062	0.395	23.0	A	0.030	
4	0.093	0.608	19.7	A	0.029	
5	0.146	0.639	25.0	A	0.028	
6	0.065	0.443	23.9	A	0.030	
8	0.037	0.298	28.2	B	0.061	
9	0.067	0.415	34.2	B	0.058	
10	0.082	0.523	21.2	B	0.056	
11	0.063	0.491	20.8	A	0.030	
12	0.131	0.653	24.3	B	0.054	
13	0.183	0.909	27.3	B	0.052	
15	0.141	0.770	29.4	A	0.028	
16	0.100	0.452	27.0	B	0.055	
17	0.100	0.787	35.7	A	0.029	
18	0.108	0.634	39.0	A	0.028	
19	0.069	0.418	31.1	B	0.057	
20	0.149	0.662	35.5	B	0.053	
21	0.060	0.520	27.9	B	0.058	
22	0.053	0.369	26.3	B	0.059	
23	0.090	0.634	28.1	B	0.056	
24	0.097	0.616	28.1	B	0.055	
25	0.109	0.588	29.8	B	0.055	
26	0.165	0.705	33.1	B	0.053	
27	0.050	0.341	22.3	B	0.059	
28	0.050	0.358	24.9	B	0.058	
29	0.063	0.378	28.9	B	0.058	
30	0.063	0.381	30.5	B	0.058	
31	0.030	0.313	25.3	A	0.032	
32	0.033	0.283	31.1	B	0.062	
33	0.062	0.537	33.5	B	0.058	
34	0.065	0.540	32.4	B	0.058	
35	0.062	0.526	32.9	B	0.058	
36	0.071	0.514	31.3	B	0.057	
37	0.069	0.455	28.2	A	0.030	
38	0.049	0.361	42.7	A	0.031	
39	0.074	0.446	36.3	A	0.030	
40	0.055	0.398	31.4	A	0.030	
41	0.031	0.267	37.5	B	0.062	
42	0.073	0.682	21.1	A	0.030	
43	0.062	0.483	24.9	A	0.030	
44	0.112	0.625	20.8	A	0.028	
45	0.067	0.543	36.5	B	0.058	
46	0.058	0.568	32.4	B	0.058	
47	0.048	0.426	23.2	A	0.031	
48	0.123	0.616	27.1	B	0.054	
49	0.131	0.676	28.5	A	0.028	
50	0.071	0.599	33.2	B	0.057	

Table 1
Sub-basin Parameters

MFC001					Date:	May-97
calculations by:		WVH				
checked by:		RHF				
Drainage Area #	Area (mi^2)	L (mi)	S (ft / mi)	Land Type	Kb	
51	0.057	0.514	39.3	A	0.030	
52	0.085	0.415	40.7	A	0.029	
53	0.042	0.403	34.7	A	0.031	
54	0.060	0.395	40.3	A	0.030	
55	0.070	0.341	30.5	A	0.030	
56	0.049	0.420	43.8	B	0.059	
57	0.058	0.349	23.2	B	0.058	
58	0.075	0.560	37.0	A	0.030	
59	0.082	0.443	49.6	B	0.056	
60	0.136	0.568	24.1	A	0.028	
61	0.071	0.389	45.7	B	0.057	
62	0.025	0.293	30.8	B	0.063	
63	0.122	0.625	21.4	B	0.054	
64	0.061	0.491	23.8	A	0.030	
65	0.081	0.474	31.6	B	0.056	
66	0.068	0.366	32.7	B	0.057	
67	0.069	0.676	30.3	A	0.030	
68	0.053	0.619	22.9	A	0.030	
69	0.075	0.568	34.7	A	0.030	
70	0.055	0.540	36.9	A	0.030	
71	0.101	0.594	32.7	A	0.029	
73	0.059	0.349	34.3	A	0.030	
74	0.064	0.338	34.3	A	0.030	
76	0.132	0.682	39.2	A	0.028	
77	0.137	1.182	22.0	B	0.053	
79	0.120	0.548	36.1	B	0.054	
80	0.108	0.455	31.5	A	0.029	
81	0.054	0.531	40.7	B	0.059	
82	0.047	0.460	34.8	B	0.060	
83	0.035	0.435	32.7	A	0.032	
84	0.047	0.341	8.8	A	0.031	
85	0.121	0.560	28.6	B	0.054	
86	0.095	0.517	25.7	A	0.029	
87	0.055	0.443	27.5	A	0.030	
88	0.084	0.616	35.7	A	0.029	
89	0.067	0.690	40.8	B	0.058	
90	0.092	0.634	37.9	A	0.029	
91	0.079	0.358	34.4	B	0.057	
92	0.074	0.636	18.9	A	0.030	
93	0.048	0.460	50.0	A	0.031	
94	0.102	0.517	20.7	A	0.029	
96	0.069	0.423	15.8	B	0.057	
97	0.043	0.278	14.4	B	0.060	
98	0.045	0.347	28.9	A	0.031	
99	0.075	0.449	32.5	B	0.057	
100	0.052	0.577	30.3	A	0.031	

Table 1
Sub-basin Parameters

MFC001						
calculations by:		WVH			Date:	May-97
checked by:		RHF				
Drainage Area #	Area (mi^2)	L (mi)	S (ft / mi)	Land Type	Kb	
101	0.087	0.628	30.9	B	0.056	
102	0.097	0.682	23.5	A	0.029	
103	0.09	0.625	27.5	A	0.029	
104	0.073	0.54	29.6	A	0.03	
105	0.036	0.428	29.9	A	0.031	
106	0.067	0.537	22.3	B	0.058	
107	0.154	0.563	26.7	B	0.053	
108	0.099	0.642	25.4	A	0.029	
110	0.072	0.42	25.7	A	0.03	
111	0.056	0.395	28.4	A	0.03	
112	0.044	0.358	29.9	B	0.06	
113	0.092	0.705	23.0	A	0.029	
114	0.080	0.631	25.4	A	0.029	
115	0.042	0.341	29.3	A	0.031	
116	0.140	0.631	27.3	A	0.028	
118	0.158	0.767	31.7	A	0.027	
120	0.057	0.34	30.0	B	0.059	
121	0.040	0.364	22.0	B	0.061	
122	0.093	0.469	24.7	B	0.056	
123	0.103	0.542	33.2	B	0.055	
124	0.072	0.57	38.6	B	0.057	
125	0.101	0.7	37.2	A	0.029	
128	0.114	0.662	29.3	B	0.054	
129	0.116	0.588	30.6	B	0.054	
130	0.087	0.537	24.2	B	0.056	
131	0.051	0.349	13.7	A	0.031	
132	0.093	0.537	22.3	B	0.056	
133	0.051	0.489	18.4	B	0.059	
134	0.101	0.511	35.2	B	0.055	
135	0.105	0.645	24.8	B	0.055	
136	0.066	0.406	29.5	B	0.058	
137	0.032	0.517	75.4	B	0.062	
138	0.073	0.557	27.5	B	0.057	
139	0.098	0.54	27.8	B	0.055	
141	0.038	0.324	30.9	B	0.061	
142	0.084	0.375	32.0	B	0.056	
143	0.093	0.622	38.6	B	0.056	
144	0.069	0.491	36.6	B	0.057	
146	0.044	0.509	83.2	B	0.06	
147	0.084	0.599	33.4	B	0.056	
148	0.047	0.483	41.4	B	0.06	
149	0.087	0.767	39.1	B	0.056	
150	0.096	0.594	40.4	B	0.055	

Table 1
Sub-basin Parameters

MFC001					Date:	May-97
calculations by:		WVH				
checked by:		RHF				
Drainage Area #	Area (mi^2)	L (mi)	S (ft / mi)	Land Type	Kb	
151	0.022	0.278	37.7	A	0.033	
152	0.040	0.489	26.4	B	0.061	
153	0.039	0.349	24.9	B	0.061	
155	0.043	0.313	38.1	A	0.031	
156	0.129	0.568	18.1	A	0.028	
157	0.152	0.758	17.8	A	0.028	
158	0.089	0.455	13.9	A	0.029	
159	0.076	0.758	13.7	A	0.029	
160	0.078	0.568	19.9	A	0.029	
161	0.088	0.606	5.6	A	0.029	
162	0.137	0.653	24.0	A	0.028	
163	0.152	0.758	18.1	A	0.028	
164	0.091	0.464	35.3	B	0.056	
165	0.097	0.653	25.7	B	0.055	
166	0.081	0.786	24.2	B	0.056	
168	0.051	0.474	24.7	B	0.059	
	Total Drainage area					
		(mi^2)				
		12.146				

TABLE 2
SOIL TYPE DESCRIPTIONS

Mapping Symbol	*Mapping Unit*
PnA	Pinal gravelly loam, 0 to 1% slopes
Po	Pinal loam, moderately deep variant
PnC	Pinal gravelly loam, 1 to 3% slopes
AnA	Antho sandy loam, 0 to 1% slopes
LaA	Laveen loam, 0 to 1% slopes
Gm	Gilman loam
Co	Contine clay loam
Es	Estrella loam
Mv	Mohall loam
RlA	Rillito gravelly loam, 0 to 1% slopes
Ru	Rough broken sand
Mo	Mohall sandy loam

Table 3
Sub-basin Soil Types

MFC001						date:	May-97
calculations by:		WVH					
checked by:		RHF		Soil Types			
				(mi^2)			
Drainage	Area						
Area #	(mi^2)		PnA	Po	LaA	Mv	
1	0.041			0.037	0.004		
2	0.117		0.027	0.008	0.082		
3	0.062		0.034	0.001	0.027		
4	0.093		0.027	0.033	0.033		
5	0.146		0.047	0.055	0.044		
6	0.065		0.016	0.033	0.016		
8	0.037		0.018	0.019			
9	0.067		0.018	0.037	0.012		
10	0.082		0.021	0.044	0.017		
11	0.063		0.031	0.025	0.007		
12	0.131		0.056	0.044	0.031		
13	0.183		0.015	0.039	0.129		
15	0.141		0.001	0.009	0.131		
16	0.100				0.100		
17	0.100				0.100		
18	0.108				0.108		
19	0.069				0.069		
20	0.149				0.149		
21	0.060		0.015		0.045		
22	0.053		0.024	0.005	0.024		
23	0.090		0.008	0.031	0.051		
24	0.097			0.012	0.085		
25	0.109		0.023	0.065	0.021		
26	0.165		0.032	0.049	0.016	0.068	
27	0.050					0.050	
28	0.050				0.006	0.044	
29	0.063				0.035	0.028	
30	0.063					0.063	
31	0.030					0.030	
32	0.033					0.033	
33	0.062				0.001	0.061	
34	0.065				0.006	0.059	
35	0.062					0.062	
36	0.071					0.071	
37	0.069				0.038	0.031	
38	0.049				0.001	0.048	
39	0.074					0.074	
40	0.055					0.055	
41	0.031					0.031	
42	0.073					0.073	
43	0.062					0.062	
44	0.112					0.112	
45	0.067					0.067	
46	0.058					0.058	
47	0.048					0.048	
48	0.123					0.123	
49	0.131					0.131	
50	0.071					0.071	

Table 3
Sub-basin Soil Types

MFC001							date:	May-97
calculations by:		WVH						
checked by:		RHF		Soil Types				
				(mi^2)				
Drainage	Area							
Area #	(mi^2)		Mo	Mv	Co	Gm	Es	
51	0.057			0.057				
52	0.085			0.070		0.015		
53	0.042			0.042				
54	0.060			0.058		0.002		
55	0.070			0.070				
56	0.049			0.041		0.008		
57	0.058			0.058				
58	0.075			0.075				
59	0.083			0.040		0.043		
60	0.136			0.044	0.092			
61	0.071			0.049	0.022			
62	0.025				0.025			
63	0.122				0.122			
64	0.061				0.061			
65	0.081				0.081			
66	0.068				0.063		0.005	
67	0.069			0.004	0.065			
68	0.053			0.015	0.038			
69	0.075		0.003	0.007	0.065			
70	0.055			0.055				
71	0.101			0.075	0.026			
73	0.059			0.003	0.025		0.031	
74	0.064				0.025		0.039	
76	0.132			0.037		0.085	0.010	
77	0.137					0.068	0.069	
79	0.120				0.088	0.008	0.024	
80	0.108					0.108		
81	0.054		0.002	0.003	0.019	0.030		
82	0.047		0.008	0.011	0.006	0.022		
83	0.035					0.035		
84	0.047		0.002	0.035	0.010			
85	0.121		0.012	0.104	0.005			
86	0.095		0.001	0.060		0.034		
87	0.055		0.004	0.049			0.002	
88	0.084			0.008		0.034	0.042	
89	0.067			0.048			0.019	
90	0.092			0.059			0.033	
91	0.079		0.026	0.005			0.048	
92	0.074		0.022	0.052				
93	0.048			0.048				
94	0.102			0.101		0.001		
96	0.069			0.014		0.055		
97	0.043					0.043		
98	0.045			0.045				
99	0.075			0.075				
100	0.052			0.052				

Table 3
Sub-basin Soil Types

MFC001						date:	May-97
calculations by:		WVH					
checked by:		RHF		Soil Types			
				(mi^2)			
Drainage	Area						
Area #	(mi^2)		Gm	Mv	AnA	Es	
101	0.087		0.011	0.076			
102	0.097		0.097				
103	0.090		0.090				
104	0.073		0.072		0.001		
105	0.036			0.036			
106	0.067		0.004	0.063			
107	0.154		0.137		0.017		
108	0.099		0.068		0.031		
110	0.072		0.025	0.046		0.001	
111	0.056		0.034	0.022			
112	0.044		0.026	0.018			
113	0.092		0.046	0.046			
114	0.080		0.065	0.015			
115	0.042		0.042				
116	0.140		0.139		0.001		
118	0.158		0.112		0.046		
120	0.057		0.057				
121	0.040		0.040				
122	0.093		0.093				
123	0.103		0.103				
124	0.072		0.057		0.015		
125	0.101		0.101				
128	0.114		0.104	0.010			
129	0.116		0.059	0.057			
130	0.087		0.001		0.082	0.004	
131	0.051		0.051				
132	0.093		0.080		0.013		
133	0.051		0.026		0.025		
134	0.101		0.080		0.021		
135	0.105		0.059			0.046	
136	0.066		0.066				
137	0.032		0.032				
138	0.073		0.046		0.027		
139	0.098		0.001	0.027	0.070		
141	0.038		0.021	0.017			
142	0.084		0.001	0.036	0.047		
143	0.093		0.093				
144	0.069		0.069				
146	0.044		0.041		0.003		
147	0.084		0.048	0.006	0.030		
148	0.047		0.043		0.004		
149	0.087		0.052	0.021	0.014		
150	0.096		0.018	0.063	0.015		

Table 3
Sub-basin Soil Types

MFC001									date:	May-97
calculations by:		WVH								
checked by:		RHF		Soil Types						
				(mi^2)						
Drainage	Area									
Area #	(mi^2)		Po	PnA	LaA	Mv	PnC	RIA	Ru	
151	0.022		0.006	0.008	0.008					
152	0.040				0.040					
153	0.039		0.001	0.037	0.001					
155	0.043					0.043				
156	0.129		0.022	0.002	0.105					
157	0.152		0.048	0.054	0.050					
158	0.089		0.027	0.024	0.038					
159	0.076		0.005	0.026	0.045					
160	0.078			0.053	0.025					
161	0.088			0.039	0.049					
162	0.137		0.037	0.086	0.014					
163	0.152		0.001	0.051	0.100					
164	0.091		0.069	0.005				0.017		
165	0.097		0.009	0.008	0.032		0.048			
166	0.081		0.023	0.041	0.002		0.006	0.006	0.003	
168	0.051		0.010	0.014	0.027					

TABLE 4
LAND USE DESCRIPTIONS

Maricopa County Land Use Category	*City of Mesa Zoning Unit*	*City of Mesa Description*
Agriculture	AG	Agriculture
Low Density Residential	RI-90	Single Residence
Medium Density Residential	RI-35 RI-15	Single Residence Single Residence
Multiple Family Residence	RI-9 RI-7	Single Residence Single Residence
Industrial	M-1	Limited Industrial
Commercial	C-2 C-3 OS	Limited Commercial General Commercial Office-Services

Table 5
Sub-basin Land Use Types

MFC001									date:	May-97
calculations by:		WVH								
checked by:		RHF				Land Use				
						(mi^2)				
Drainage	Area		AG	C-2,C-3.O-S	R-2, R-3	R1-7,R1-9	R1-15, R1-35	R1-43	M-1	
Area #	(mi^2)		AG	Comm	M-F-R	M-D-R	L-D-R	V-L-D-R	Ind	
1	0.041					0.033	0.008			
2	0.117					0.083	0.034			
3	0.062			0.006	0.036	0.020				
4	0.093					0.093				
5	0.146					0.145	0.001			
6	0.065			0.001	0.041	0.023				
8	0.037			0.004	0.019	0.014				
9	0.067			0.015	0.034			0.018		
10	0.082			0.026			0.010	0.046		
11	0.063			0.063						
12	0.131						0.131			
13	0.183		0.074				0.109			
15	0.141						0.141			
16	0.100						0.100			
17	0.100						0.100			
18	0.108						0.108			
19	0.069						0.069			
20	0.149						0.149			
21	0.060		0.060							
22	0.053			0.009				0.044		
23	0.090		0.090							
24	0.097		0.097							
25	0.109		0.003				0.106			
26	0.165		0.165							
27	0.050		0.050							
28	0.050		0.050							
29	0.063		0.063							
30	0.063		0.063							
31	0.030						0.030			
32	0.033		0.033							
33	0.062		0.047				0.015			
34	0.065		0.048				0.017			
35	0.062		0.030				0.032			
36	0.071		0.053				0.018			
37	0.069						0.069			
38	0.049						0.049			
39	0.074						0.074			
40	0.055						0.055			
41	0.031						0.031			
42	0.073						0.073			
43	0.062						0.062			
44	0.112						0.112			
45	0.067						0.067			
46	0.058						0.058			
47	0.048						0.048			
48	0.123		0.123							
49	0.131					0.131				
50	0.071		0.071							

Table 5
Sub-basin Land Use Types

MFC001									date:	May-97
calculations by:		WVH								
checked by:		RHF				Land Use				
						(mi^2)				
Drainage	Area		AG	C-2,C-3.O-S	R-2, R-3	R1-7,R1-9	R1-15, R1-35	R1-43	M-1	
Area #	(mi^2)		AG	Comm	M-F-R	M-D-R	L-D-R	V-L-D-R	Ind	
51	0.057		0.045				0.012			
52	0.085		0.045				0.04			
53	0.042						0.042			
54	0.060						0.06			
55	0.070						0.07			
56	0.049						0.049			
57	0.058					0.011	0.047			
58	0.075					0.075				
59	0.082		0.056		0.026					
60	0.136			0.136						
61	0.071			0.033	0.003	0.035				
62	0.025				0.025					
63	0.122				0.122					
64	0.061			0.019	0.042					
65	0.081				0.081					
66	0.068			0.021	0.047					
67	0.069			0.047	0.022					
68	0.053				0.053					
69	0.075			0.007	0.068					
70	0.055					0.055				
71	0.101			0.015	0.086					
73	0.059			0.022	0.037					
74	0.064			0.018	0.046					
76	0.132			0.022	0.11					
77	0.137				0.137					
79	0.120			0.071	0.049					
80	0.108			0.007	0.101					
81	0.054		0.003	0.041	0.01					
82	0.047				0.047					
83	0.035			0.035						
84	0.047			0.009	0.038					
85	0.121		0.049	0.025	0.038		0.009			
86	0.095				0.095					
87	0.055				0.055					
88	0.084			0.006	0.078					
89	0.067				0.067					
90	0.092				0.092					
91	0.079				0.079					
92	0.074			0.012	0.013	0.049				
93	0.048			0.001	0.015	0.032				
94	0.102					0.1		0.002		
96	0.069							0.069		
97	0.043			0.034				0.009		
98	0.045			0.007	0.038					
99	0.075				0.075					
100	0.052				0.052					

Table 5
Sub-basin Land Use Types

MFC001									date:	May-97
calculations by:		WVH								
checked by:		RHF				Land Use				
						(mi^2)				
Drainage	Area		AG	C-2,C-3.O-S	R-2, R-3	R1-7,R1-9	R1-15, R1-35	R1-43	M-1	
Area #	(mi^2)		AG	Comm	M-F-R	M-D-R	L-D-R	V-L-D-R	Ind	
101	0.087				0.087					
102	0.097				0.097					
103	0.090				0.090					
104	0.073			0.002	0.071					
105	0.036				0.036					
106	0.067				0.067					
107	0.154				0.154					
108	0.099			0.017	0.082					
110	0.072			0.006	0.066					
111	0.056				0.056					
112	0.044		0.009	0.013	0.022					
113	0.092		0.015			0.077				
114	0.080					0.080				
115	0.042		0.022			0.020				
116	0.140					0.140				
118	0.158			0.051		0.107				
120	0.057		0.057							
121	0.040			0.040						
122	0.093						0.058	0.035		
123	0.103			0.021		0.011	0.071			
124	0.072		0.053			0.019				
125	0.101					0.099	0.002			
128	0.114		0.018	0.012		0.081	0.003			
129	0.116						0.067		0.049	
130	0.087		0.056						0.031	
131	0.051			0.007			0.044			
132	0.093			0.017		0.076				
133	0.051					0.051				
134	0.101		0.061			0.040				
135	0.105		0.097	0.006					0.002	
136	0.066		0.012			0.043			0.011	
137	0.032					0.032				
138	0.073		0.036			0.037				
139	0.098		0.098							
141	0.038		0.027			0.011				
142	0.084		0.084							
143	0.093				0.008	0.083	0.002			
144	0.069			0.013	0.017	0.039				
146	0.044					0.044				
147	0.084		0.027			0.057				
148	0.047		0.038			0.009				
149	0.087		0.087							
150	0.096		0.072	0.021			0.003			

Table 5
Sub-basin Land Use Types

MFC001									date:	May-97
calculations by:		WVH								
checked by:		RHF				Land Use				
						(mi^2)				
Drainage	Area		AG	C-2,C-3.O-S	R-2, R-3	R1-7,R1-9	R1-15, R1-35	R1-43	M-1	
Area #	(mi^2)		AG	Comm	M-F-R	M-D-R	L-D-R	V-L-D-R	Ind	
151	0.022						0.022			
152	0.040						0.040			
153	0.039					0.039				
155	0.043			0.006	0.014		0.023			
156	0.129						0.129			
157	0.152						0.152			
158	0.089						0.089			
159	0.076						0.076			
160	0.078						0.078			
161	0.088					0.082	0.006			
162	0.137					0.133	0.004			
163	0.152					0.138	0.014			
164	0.091					0.020	0.071			
165	0.097					0.016	0.081			
166	0.081					0.029	0.052			
168	0.051			0.009				0.042		

3.2.2.2 Green and Ampt Parameters

Rainfall losses were estimated using the Green and Ampt infiltration method. This method is based on the assumption that rainfall loss is a two-part process. Initially, all rainfall is lost until the accumulated rainfall value equals the initial abstraction value (IA). The initial abstraction value is dependent upon land use and soil cover. The second phase of loss is infiltration.

The Green and Ampt equation is based upon three infiltration parameters, hydraulic conductivity at natural saturation (XKSAT), wetting front capillary suction (PSIF), and volumetric soil moisture deficit (DTHETA). These infiltration parameters are functions of soil characteristics, ground surface characteristics, and land management practices.

In addition to the three infiltration parameters, the HEC-1 application of the Green and Ampt method requires the input of an initial abstraction (IA) parameter and the impervious percentage of the sub-basin (RTIMP).

3.2.2.3 Clark Unit Hydrograph Parameters

The Clark Unit Hydrograph method was used to produce storm discharge hydrographs at sub-basin concentration points. This method involves three parameters: time of concentration (T_c), a storage coefficient (R), and a graphical time-area relation.

The time of concentration is described as the travel time for a flood wave to move from the most hydraulically distant point in the watershed to the concentration point. The FCDMC *Hydrology*, provides an empirical equation for calculating T_c. This equation is based upon the average rainfall intensity (*I*) and the following sub-basin characteristics described in Section 3.2.2.1: the length of the flow path (L), a representative watershed resistance coefficient (K_b), and the slope of the watercourse (S).

The storage coefficient represents the effect that temporary storage within the watershed has on the hydrograph. The manual also provides the equation for estimating R in Maricopa County. This equation is based upon T_c, the drainage area, and the length of the flow path.

The time-area relation provides the cumulative area of the watershed that is contributing runoff to the outlet at a given time. The FCDMC *Hydrology* provides values for three synthetic dimensionless time-area relations for the Clark Unit Hydrograph method. One time-area relation provided applies to urban watersheds. The second time-area relation provided in the manual applies to natural, undeveloped watersheds, and the third time-area relation is manually input by the user. The time-area relation for urban watersheds was used for most sub-basins within the study area, with the exception of agricultural area to which the natural watershed time-area relation was applied.

3.2.2.4 Reach Routing Parameters

The Normal-Depth Routing procedure was used for flood routing of hydrographs. This method uses the Modified Puls procedure with storage and discharge information calculated by HEC-1 from the channel characteristics entered on the RC, RX, and RY cards.

The routing cross-sections were developed using several different methods. The different types of channels considered were street cross-sections, well defined channels, and poorly defined overland flow.

Street sections were classified based upon City of Mesa standard street types. All street sections within a range of width were similarly typed and an equivalent street section was developed for that type. The equivalent section was determined by calculating the hydraulic radius of the typical street section and calculating a rectangular channel with an equal hydraulic radius and similar width.

For well defined channels, a cross-section was taken and its dimensions obtained through interpolation of contour line on the topographic map.

For poorly defined overland flow, a cross-section was taken at approximately uniform sections and a trapezoidal shape was approximated. The cross-section was given a large width to hold a shallow flow.

Values used for Manning's 'n' are as follows. A value of n=0.016 was used for street sections with n=0.013 for the overbanks (sidewalks). For earthen channels, a value of n=0.027 was used. For shotcrete channels, a value of n=0.022 was used. A value of n=0.055 was used for poorly defined overland flow channels.

Infiltration or percolation within routing sections was not considered due to most of the channel sections being impervious (either street sections or shotcrete channels).

3.2.2.5 Storage Routing Parameters

Reservoir storage routing was performed at existing retention basins. Retention basin sizes were calculated using the 1"=200' scale detailed topographic maps. Storage volumes were calculated for different elevations using the conic method presented in the Section 3.6.6 of the HEC-1 manual. The HEC-1 cards were then encoded with storage-elevation information.

3.2.2.6 HEC-1 Model Set-Up

The five Green and Ampt loss rate parameters described in Section 3.2.2.2 were calculated using the Sub-basin Preparation portion of the FCDMC Drainage Design Menu System for HEC-1 input. This portion of the menu system prompts the user to enter a data

set for each sub-basin. The data entered includes the sub-basin identifier, the location within Maricopa County (Aguilla-Carefree area, central area, or eastern area) and the sub-basin size. Next, soil types are entered with the corresponding areal size within the sub-basin. Using this information, the program calculates the percentage of each soil type within the sub-basin. Similarly, the area for each land use type present within the sub-basin is entered into the Land Use Table and the program calculates the percentage of the sub-basin for each land use type. With this information, the program calculates the IA, DTHETA, PSIF, XKSAT, and RTIMP for input into the HEC-1 LG card.

The Maricopa County Unit Hydrograph Procedure 1 (MCUHP-1) was used to calculate the T_c and R parameters and build the HEC-1 input file for the Clark Unit Hygrograph. To achieve this, the program first prompts for the input of several rainfall parameters. Then, the basin characteristics of area, flow path length resistance coefficient (Kb), and slope are entered. The Green and Ampt parameters, as described in Section 3.2.2.2, are also entered. The program then prompts for the selection of the time-area relation, either urban or natural basin synthetic relation or a manually input relation. The program then provides a HEC-1 input file which contains the appropriate Clark input (UC and UA cards).

The output from the MCUHP1 program was edited and assembled according to Exhibit 4 - HEC-1 Flow Schematic. This exhibit was developed to logically describe the sequence of the HEC-1 model. It depicts the order of hydrograph generation, reach routing, hydrograph combination, and storage routing. The HEC-1 simulation is completed at the concentration point located at the watershed outlet located at the southwest corner of the study area.

3.2.3 Statistical Parameters

The statistical parameters used for this study are based upon information obtained from the FCDMC *Hydrology.*

3.2.4 Precipitation

3.2.4.1 Rainfall Depth

The design storms studied for this hydrologic analysis are the 10-year, 6-hour, 100-year, 6-hour, and 100-year, 24-hour storms. The rainfall depth-duration-frequency statistics for use in Maricopa County are described in the FCDMC *Hydrology.* This section of the manual contains isopluvial maps for Maricopa County which have been taken from the NOAA Precipitation-Frequency Atlas of the Western United States. The project watershed area was located on the isopluvial maps and the rainfall depth was determined for the 2-, 5-, 10-, 25-, 50-, and 100-year frequencies, 6-hour and 24-hour duration storms.

With these values, the FCDMC PREFRE program developed a line of best fit to the points read from the isopluvial maps. The program then recalculated the frequency-duration depths for the project watershed area based upon the best fit relationship. Point rainfall depths calculated using PREFRE for the study watershed area are listed in Table 6. The

point rainfall depth calculated for the 10-year, 6-hour storm is 1.88 inches, the 100-year, 6-hour depth is 2.96 inches, and the 100-year, 24-hour depth is 3.39 inches.

3.2.4.2 Depth-Area Reduction Factors

The point rainfall depth represents the value that is expected to occur at a point in the watershed for a specific frequency-duration storm event. This point depth is converted to an areally-averaged rainfall that is expected to fall over the entire watershed by multiplying the point rainfall depth by a depth-area reduction factor.

The factors for the 6-hour storm used by Maricopa County are from the depth-area reduction curve developed by the US Army Corps of Engineers for a historical 1954 Queen Creek storm. The depth area reduction factors corresponding to this curve are presented in Table 2.2 of the FCDMC *Hydrology* and reproduced in Table 7 of this report.

The factors for the 24-hour storm used by Maricopa County are from the NWS HYDRO-40. These depth area reduction factors are given in Table 2.1a of the FCDMC *Hydrology* and presented in Table 8 of this report.

Based upon the size of the watershed entered into the FCDMC DDMS, the program determined the appropriate reduction factor and applied it to the point rainfall depths to obtain the areally-averaged depths. The 6-hour reduction factor applied is 0.934. The 24-hour reduction factor applied is also 0.934. These factors are multiplied by the appropriate point rainfall depth for each of the three design frequency-duration storms in Table 9.

3.2.4.3 Rainfall Distributions

The MCUHP1 program within the FCDMC DDMS was used to convert the rainfall depths into the appropriate storm pattern based upon the drainage area size. The 6-hour and the 24-hour storm distributions have been encoded in the FCDMC MCUHP programs.

Maricopa County uses five patterns of dimensionless 6-hour storm distributions. The patterns are dependent upon drainage area size. The FCDMC Hydrology manual provides a figure to determine which pattern is appropriate based upon drainage area size. For the 6-hour storm, the program used Pattern No. 2.84. This pattern distribution is listed in Table 10.

For the 24-hour storm distribution, Maricopa County recommends the use of the SCS Type II distribution, which is presented in Table 11.

TABLE 6
POINT RAINFALL VALUES

POINT VALUES (Inches)							
	Return Period						
Duration	*2-YR*	*5-YR*	*10-YR*	*25-YR*	*50-YR*	*100-YR*	*500-YR*
5-MIN	.30	.40	.48	.58	.66	.74	.92
10-MIN	.44	.61	.73	.88	1.01	1.13	1.41
15-MIN	.54	.77	.92	1.13	1.29	1.45	1.82
30-MIN	.72	1.03	1.24	1.52	1.74	1.96	2.47
1-HR	.87	1.27	1.53	1.90	2.18	2.45	3.09
2-HR	.95	1.37	1.65	2.04	2.33	2.63	3.31
3-HR	1.00	1.44	1.73	2.13	2.44	2.74	3.45
6-HR	1.10	1.56	1.88	2.30	2.64	2.96	3.72
12-HR	1.19	1.69	2.02	2.47	2.83	3.18	3.98
24-HR	1.28	1.81	2.16	2.64	3.02	3.39	4.25

TABLE 7
DEPTH-AREA REDUCTION FACTORS FOR 6-HOUR DURATION RAINFALL

Area Square Miles	*Ratio to Point Rainfall*
0	1.0
1	0.987
5	0.96
10	0.94
20	0.91
30	0.89
40	0.87
50	0.86
100	0.80
200	0.72
300	0.66
400	0.61
500	0.57

TABLE 8
DEPTH-AREA REDUCTION FACTORS FOR 24-HOUR DURATION RAINFALL

Area Square Miles	*Ratio to Point Rainfall*
0	1.0
10	0.94
20	0.91
30	0.90
40	0.88
50	0.87
60	0.86
70	0.856
80	0.855
90	0.846
100	0.842
110	0.838
120	0.834
130	0.833
140	0.829
150	0.825
200	0.817
300	0.80
400	0.79
500	0.78

TABLE 9
AREALLY-AVERAGED RAINFALL VALUES

Design Storm	***Point Rainfall Value***	***Depth-Area Reduction Factor***	***Drainage Area Average Rainfall Value***
10-year 6-hour	1.88	0.934	1.756
100-year 6-hour	2.96	0.934	2.765
100-year 24-hour	3.39	0.934	3.166

TABLE 10
6-HOUR DISTRIBUTION

Time (Hrs)	*Pattern 2.84 (Fraction Rainfall Depth)*
0:00	0.0
0:15	0.014
0:30	0.019
0:45	0.029
1:00	0.046
1:15	0.060
1:30	0.072
1:45	0.085
2:00	0.099
2:15	0.112
2:30	0.127
2:45	0.143
3:00	0.166
3:15	0.212
3:30	0.295
3:45	0.469
4:00	0.674
4:15	0.803
4:30	0.873
4:45	0.916
5:00	0.947
5:15	0.960
5:30	0.973
5:45	0.987
6:00	1.000

TABLE 11
SCS 24-HOUR DISTRIBUTION
TYPE II

Time (Hrs)	Fraction of Rainfall Depth	Time (Hrs)	Fraction of Rainfall Depth	Time (Hrs)	Fraction of Rainfall Depth	Time (Hrs)	Fraction of Rainfall Depth
0:00	0.000	6:15	0.085	12:15	0.707	18:15	0.926
0:15	0.002	6:30	0.090	12:30	0.735	18:30	0.930
0:30	0.005	6:45	0.095	12:45	0.758	18:45	0.934
0:45	0.008	7:00	0.100	13:00	0.776	19:00	0.938
1:00	0.011	7:15	0.105	13:15	0.791	19:15	0.942
1:15	0.014	7:30	0.110	13:30	0.804	19:30	0.946
1:30	0.017	7:45	0.115	13:45	0.815	19:45	0.950
1:45	0.020	8:00	0.120	14:00	0.825	20:00	0.953
2:00	0.023	8:15	0.126	14:15	0.834	20:15	0.956
2:15	0.026	8:30	0.133	14:30	0.842	20:30	0.959
2:30	0.029	8:45	0.144	14:45	0.849	20:45	0.962
2:45	0.032	9:00	0.147	15:00	0.856	21:00	0.965
3:00	0.035	9:15	0.155	15:15	0.863	21:15	0.968
3:15	0.038	9:30	0.163	15:30	0.869	21:30	0.971
3:30	0.041	9:45	0.172	15:45	0.875	21:45	0.974
3:45	0.044	10:00	0.181	16:00	0.881	22:00	0.977
4:00	0.048	10:15	0.191	16:15	0.887	22:15	0.980
4:15	0.052	10:30	0.203	16:30	0.893	22:30	0.983
4:30	0.056	10:45	0.218	16:45	0.898	22:45	0.986
4:45	0.060	11:00	0.236	17:00	0.903	23:00	0.898
5:00	0.064	11:15	0.257	17:15	0.908	23:15	0.992
5:15	0.068	11:30	0.283	17:30	0.913	23:30	0.995
5:30	0.072	11:45	0.387	17:45	0.918	23:45	0.998
5:45	0.076	12:00	0.663	18:00	0.922	24:00	1.000
6:00	0.080						

3.2.5 Gage Data

There is no stream flow gage data available from the FCDMC or City of Mesa for the study area. The FCDMC does have historical precipitation data for the area but there is no historical stage data for model calibration.

3.3 CALIBRATION

Calibration of the HEC-1 models for this study was not performed due to the lack of historical storm and runoff data.

3.4.1 Storm Drain Diversions

The storm drain system was modeled using diversion cards within HEC-1. Flows which were considered to be diverted through a storm drain to a detention basin in another drainage area were handled as follows.

Using invert elevations for manholes along the storm drain and pipe sizes provided by the City of Mesa, the capacity for each segment of pipe was calculated. The Chezy-Manning equation was applied assuming full flowing pipes with a Manning coefficient of n=0.013. The slope was calculated using the change in invert elevations between manholes for the length of the pipe. The maximum amount of flow that could be intercepted by the storm drain was determined to be the capacity of the pipe between the last catch basin in an area and the outfall from the area. These values are calculated in Table 12, Summary of Storm Drain Diversion Data. The amount of flow intercepted by a storm drain in a drainage area was determined by multiplying the limiting flow in the storm drain system by the ratio of the sub-basin area to the area contributing to the storm drain. These values are summarized in Table 12 and Table 13, Summary of Storm Drain Intercepted Flows. This is best represented through the following example.

Maps supplied by the City of Mesa indicate a storm drain which runs beneath Greenfield Road beginning in Sub-basin Area 41 and through all intermediate sub-areas until it outlets to the detention basin in Sub-area 128. Storm drain records from the City of Mesa show that this is a 24-inch RCP from its first catch basin located north of Brown Road until it reaches University Drive where it transitions to a 42-inch RGRCP. Pipe lengths and invert elevations between manholes were obtained from City records and the slope of the pipe segments were calculated. Application of the Chezy-Manning equation yielded a limiting flow through each pipe segment. The assumption was made that flow through the limiting section of pipe would be at capacity.

In the Greenfield storm drain, it was determined that approximately 11 cfs could pass through the section of storm drain south of Adobe Drive. The sub-basins contributing to the storm drain flow through this segment of pipe were Areas 41, 52, 54 and 56. The sum of these four areas is the total area contributing to the storm drain flow and is approximately 0.222 square mile. The ratio of each individual area to the total area multiplied by the limiting flow rate of 11 cfs is the amount of flow that was diverted through the storm drain from each area. For example:

Area 41 = 0.03 sq. mi.
Ratio to total area = (0.03/0.222) = 0.135
Total flow intercepted = 0.135 x 11 cfs ≈ 1.5 cfs

Area 52 = 0.083 sq. mi.
Ratio to total area = (0.083/0.222) = 0.374
Total flow intercepted = 0.374 x 11 cfs ≈ 4.1 cfs

Area 54 = 0.057 sq. mi.
Ratio to total area = (0.057/0.222) = 0.257
Total flow intercepted = 0.257 x 11 cfs ≈ 2.8 cfs

Area 56 = 0.052 sq. mi.
Ratio to total area = (0.052/0.222) = 0.234
Total flow intercepted = 0.234 x 11 cfs ≈ 2.6 cfs

Engineering judgements were used to determine the final value of diverted flow to be used in the HEC-1 model. These judgements were based upon the number of catch basins within an area and the position of the catch basins with respect to their location along the flow path. The final values used are listed in Table 12.

After diverting flows from a drainage area through the storm drain system, the diverted flows were recovered and combined at the detention basins with the flow that had remained on the surface.

3.4.2 RT Card

The RT Record - Straddle / Stagger Routing was utilized to assist in modeling the diverted flows from the surface into the storm drain system. This method introduces a lag time into the model to minimize distortion of the computed hydrographs based upon travel time in the pipe. Table 14 summarizes the values computed for this record. The value input into the third field of the record is the number of ordinate steps for the hydrograph of the intercepted flow to be lagged when it is reintroduced to the system at an outflow point in another drainage basin. This value is the reach length divided by the velocity multiplied by the ordinate step value and converted into equivalent units. The RT card was chosen over Kinematic Wave routing for the storm drains since for full flowing pipes, the two methods result in essentially the same result. These values were spot checked using the Kinematic Wave routing by the FCDMC during the generation of the model.

3.4.3 Surface Diversions

For some drainage areas, a difficulty in modeling occurred when it was found that storm drain flow and overland flow conflicted. For instance, some drainage areas had a storm drain system which diverted flow to a detention basin located in an area that contributed surface flow to the initial drainage area. This modeling problem was resolved by first calculating the hydrograph for the area without the detention basin, then using diversion cards to divert the surface flow. The remaining flow intercepted by the storm drain was routed to the detention basin and combined with surface flow from the drainage area within

which the detention basin is located. The surface flow from the initial drainage area was retrieved. The flows were then combined and routed to the next concentration point.

One such situation occurred in Areas 15 and 151. Local topography shows that surface runoff from Area 151 will reach its concentration point, flow through Area 15, and combine with surface flow from Area 15 at its concentration point. However, some rainfall from Area 15 will be intercepted by a catch basin and storm drain system and be diverted to the detention basin in Area 151.

To solve the modeling problem created by this situation, the surface flow from Area 15 was diverted using HEC-1 diversion cards and the flow intercepted by the storm drain was routed from Area 15 to Area 151. Then, the surface flow from Area 151 was recalled and combined with the recalled surface flow from Area 15 and routed normally through the rest of the model. A similar situation occurred within Areas 116 and 118.

Table 12
Summary of Storm Drain Diversion Data

MFC001			Storm Drain Diversion data						"n" value		by	Bil Haas
					Values for flow limiting pipe section				0.013		date	May-97
diversion area ID	return area ID	Map ID	Street	begin MH ID	invert el. (ft)	end MH ID	invert el. (ft)	length (ft)	pipe dia. (in)	Vel (ft / s)	Q_{max} (ft^3 / s)	$Q_{intercepted}$ (ft^3 / s)
2	4		N. 24th St.		1299.30		1297.86	600	30	4.1	20.1	
15	151		N. Glenview		1296.25		1296.00	165	30	3.3	16.0	
6	25											56
8	25											8
25	26	59B	Eastern Canal	2235	1283.70	2244	1283.16	2160	72	2.4	67.0	67
36	N / A	67B										10
27	N / A	59B	Eastern Canal	2348	1282.96	2349	1282.89	610	48	1.2	15.4	5
71	N / A											10
49	N / A											14
60	N / A											30
63	N / A											4
62	N / A											4
		69A	N. Val Vista Dr.	2273	1271.24	2037	1270.34	245	48	6.9	87.1	
41	59											2
52	59											3
54	59											2
56	59											2
59	76	76B	N. Greenfield Rd.	1746	1318.00	1743	1315.90	605	24	4.2	13.3	13
76	77	76B	N. Greenfield Rd.	1740	1313.80	1739	1308.85	326	24	8.9	27.9	28
77	79	77A	N. Greenfield Rd.	1842	1307.50	1843	1307.00	280	42	4.4	42.5	42
79	86											49
81	86											1
82	86											1
86	101											59
98	101											1
100	101											1
101	104	78B	N. Greenfield Rd.	1506	1272.53	1518.00	1271.52	820	54	4.3	69.0	69
114	115											8
115	116											16
116	118											20
118	108											28
108	104	78B	E. Southern Ave.	1539	1286.83	1540.00	1284.92	437	36	6.2	44.1	44
103	104											7
104	128	71C	S. Greenfield Rd	1446	1267.87	1447.00	1267.20	679	72	4.7	133.0	133

Table 13
Summary of Storm Drain Intercepted Flows

MFC001						
		Storm Drain Intercepted flows for Individual Areas				
Area ID	total drainage area (mi^2)	% of total system drainage area	System Q_{max} (cfs)	$Q_{intercepted}$ by % (cfs)	sub - System Q_{max} (cfs)	ID for sub basins which drain to the intercepting sub basin
			67			
6	1.64	83.7%		56		156, 157, 158, 159, 160, 161, 162
8	0.076	3.9%		3		153
25	0.244	12.4%		8		10 , 22
			15			
36	0.538	69.7%		10		33, 34, 35, 37, 38, 39, 40, 41
27	0.234	30.3%		5		30, 31, 32
			72			
71	0.639	30.9%		22		52, 54, 56, 58, 59, 70, 76
49	0.131	6.3%		5		
60	1.151	55.7%		40		42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 53, 55, 57, 155
63	0.122	5.9%		4		
62	0.025	1.2%		1		
			69			
41	0.031	1.9%		1		
52	0.085	5.3%		4		
54	0.06	3.7%		3		
56	0.049	3.0%		2		
59	0.082	5.1%		3	13	
76	0.132	8.2%		6	28	
77	0.137	8.5%		6	42	
79	0.263	16.2%		11		80, 83
81	0.054	3.3%		2		
82	0.047	2.9%		2		
86	0.472	29.2%		20		87, 88, 89, 90, 91
98	0.12	7.4%		5		99
101	0.087	5.4%		4	69	
			44			
114	0.08	15.4%		7		
115	0.042	8.1%		4		
116	0.14	27.0%		12	22	
118	0.158	30.4%		13		
108	0.099	19.1%		8	44	
			133			
101	1.619	70.4%		94	69	
108	0.519	22.6%		30	44	
103	0.09	3.9%		5		
104	0.073	3.2%		4	133	

Table 14
Summary of RT Card Values

MFC001					
Calculation of the number of ordinate steps to be used in field 3 of the RT card					
Area ID		velocity (ft / s)	reach length (ft)		field 3 value
6		2.4	2780		3.9
8		2.4	3695		5.1
25		2.4	3595		5.0
41		4.1	4561		3.7
52		4.1	3643		3.0
54		4.1	1212		1.0
56		4.1	440		0.4
59		4.2	1201		1.0
76		4.4	1080		0.8
77		4.4	1350		1.0
79		4.3	2520		2.0
81		4.3	2013		1.6
82		4.3	1230		1.0
86		4.3	2625		2.0
98		4.3	1973		1.5
100		4.3	800		0.6
101		4.3	2404		1.9
114		6.2	1470		0.8
115		6.2	1037		0.6
116		6.2	1060		0.6
118		6.2	2181		1.2
108		6.2	2890		1.6
103		4.7	466		0.3
104		4.7	2615		1.9

3.5 Final Results

The watershed hydrology for the Eastern Canal was developed using HEC-1 models for the 10-year, 6-hour, 100-year, 6-hour, and 100-year, 24-hour duration storms. The results of the peak flows at concentration points along the Eastern Canal are summarized in Table 15. Table 16 summarizes the peak 100-year discharges and describes their location along the Eastern Canal.

From Table 16, the peak flow for the watershed is the result of the 100-year, 6-hour storm and occurs where US 60 meets the Eastern Canal (Concentration Point 91). The discharge is 1,532 cfs for an 11.13-square-mile drainage area.

Evaluation of the peak discharges along the canal and the 10-foot artificial extensions used in the routing procedures indicate that the entire 100-year flow rates are not contained within the existing canal configuration. This is further validated by the preliminary HEC-2 study performed by AN West which indicated that the actual capacity of the canal is much less than the flow rates generated by the watershed. Therefore, it was determined jointly by the City of Mesa and the Flood Control District of Maricopa County to discontinue with modeling of the break-outs that occur along the canal and instead describe the flood plain based upon the elevation of the top of bank. However, the hydrology of this project can be used as a guide for future projects or improvements in the watershed.

Table 15
Summary of Discharges
Along the Eastern Canal

MFC001									Date
Mesa Flood Plain Delineation Study									May-97
			100-year 24-hr		100-year 6-hr		10-year 6-hr		
STATION	Drainage Area (mi^2)	PEAK FLOW cfs	Q / A (cfs / mi2)	PEAK FLOW cfs	Q / A (cfs / mi2)	PEAK FLOW cfs	Q / A (cfs / mi2)	100-yr Critical Duration	Critical Q_{100} cfs
CP3	0.46	273	593.5	225	489.1	78	169.6	24-hr	273
CP4	0.67	333	723.9	297	645.7	76	165.2	24-hr	333
CP17	2.45	240	521.7	217	471.7	106	230.4	24-hr	240
CP18	2.52	218	473.9	219	476.1	105	228.3	6-hr	219
CP20	2.57	216	469.6	223	484.8	106	230.4	6-hr	223
CP21	2.81	323	702.2	305	663.0	147	319.6	24-hr	323
CP37	4.48	637	1384.8	540	1173.9	98	213.0	24-hr	637
CP38	4.55	703	1528.3	615	1337.0	155	337.0	24-hr	703
CP39	4.65	692	1504.3	609	1323.9	150	326.1	24-hr	692
CP43	5.25	791	1719.6	691	1502.2	156	339.1	24-hr	791
CP44	5.3	781	1697.8	689	1497.8	119	258.7	24-hr	781
CP45	5.49	774	1682.6	687	1493.5	120	260.9	24-hr	774
CP53	6.36	767	1667.4	702	1526.1	160	347.8	24-hr	767
CP54	6.49	726	1578.3	667	1450.0	176	382.6	24-hr	726
CP56	7.22	1004	2182.6	896	1947.8	463	1006.5	24-hr	1004
CP57	7.29	1032	2243.5	946	2056.5	490	1065.2	24-hr	1032
CP58	7.34	1032	2243.5	967	2102.2	499	1084.8	24-hr	1032
CP68	8.16	1293	2810.9	1231	2676.1	539	1171.7	24-hr	1293
CP69	8.23	1326	2882.6	1265	2750.0	554	1204.3	24-hr	1326
CP70	8.28	1342	2917.4	1286	2795.7	562	1221.7	24-hr	1342
CP77	9.09	1487	3232.6	1435	3119.6	616	1339.1	24-hr	1487
CP78	9.25	1108	2408.7	1304	2834.8	115	250.0	6-hr	1304
CP79	9.3	1097	2384.8	1302	2830.4	111	241.3	6-hr	1302
CP85	10.11	1081	2350.0	1350	2934.8	107	232.6	6-hr	1350
CP91	11.13	1206	2621.7	1532	3330.4	289	628.3	6-hr	1532
CP92	11.25	869	1889.1	950	2065.2	33	71.7	6-hr	950
CP97	12.15	897	1950.0	1009	2193.5	59	128.3	6-hr	1009

Table 16
Summary of 100-year Discharges
Along the Eastern Canal

MFC001	Mesa Flood Plain Delineation Study			Date
				May-97
STATION	Location	Drainage area	Q_{100}	
		(mi^2)	cfs	
CP3	N. Rose	0.46	273	
CP4	N. Almond Cir.	0.67	333	
CP17	E. McKellips Rd.	2.45	240	
CP18	E. Ivyglen Cir.	2.52	219	
CP20	N. Lindsay Rd.	2.57	223	
CP21	N. Lindsay Rd.	2.81	323	
CP37	E. Brown Rd.	4.48	637	
CP38	E. Fox St.	4.55	703	
CP39	E. Fairfield	4.65	692	
CP43	E. Adobe St.	5.25	791	
CP44	E. Dartmouth St.	5.3	781	
CP45	E. Covina Cir	5.49	774	
CP53	N. Val Vista Dr.	6.36	767	
CP54	Alpha St.	6.49	726	
CP56	E. Main St.	7.22	1004	
CP57	E. Alder Ave.	7.29	1032	
CP58	E. Balsam Ave.	7.34	1032	
CP68	E. Capri Ave.	8.16	1293	
CP69	E. Carol Cir.	8.23	1326	
CP70	E. Catalina Cir.	8.28	1342	
CP77	E. Pueblo Ave.	9.09	1487	
CP78	E. Emelita Ave.	9.25	1304	
CP79	E. Southern Ave.	9.3	1302	
CP85	E. Hampton Cir.	10.11	1350	
CP91	US 60 - Superstition Freeway	11.13	1532	
CP92	1400' N. Of E. Baseline Rd.	11.25	950	
CP97	E. Baseline Rd.	12.15	1009	

3.6 FINAL MODELING RESULTS ON DISKETTE

HEC-1 models were developed for the 10-year, 6-hour storm and the 100-year, 6-hour and 24-hour storms for the Eastern Canal study drainage area. The following table describes the models included on the diskette.

TABLE 17
HEC-1 MODELS

Input File	*Description*
REV_10_6.DAT	Eastern Canal HEC-1 Model for 10-year, 6-hour storm with storm drain diversions
REV100_6.DAT	Eastern Canal HEC-1 Model for 100-year, 6-hour storm with storm drain diversions
REV10024.DAT	Eastern Canal HEC-1 Model for 100-year, 24-hour storm with storm drain diversions

LIST OF REFERENCES

1. Aerial Mapping Company, Inc., Topographic Maps, Scale 1"=200', 2' contour intervals, 1996.

2. Arizona Department of Water Resources, "Instructions for Organizing and Submitting Technical Documentation for Flood Studies," Engineering Division, August 1991, revised September 1991.

3. City of Mesa, Land Use Map for Study Area, not dated.

4. City of Mesa, Zoning Maps, Community Development and Planning Department, revised July 1996.

5. City of Mesa Geosystem, Storm Drain, Retention Basins and Mains Map, Engineering Division, copyright 1988 & 1996, plot compilation August 13, 1996.

6. Flood Control District of Maricopa County, "Hydrologic Design Manual for Maricopa County, Arizona," September 1, 1990.

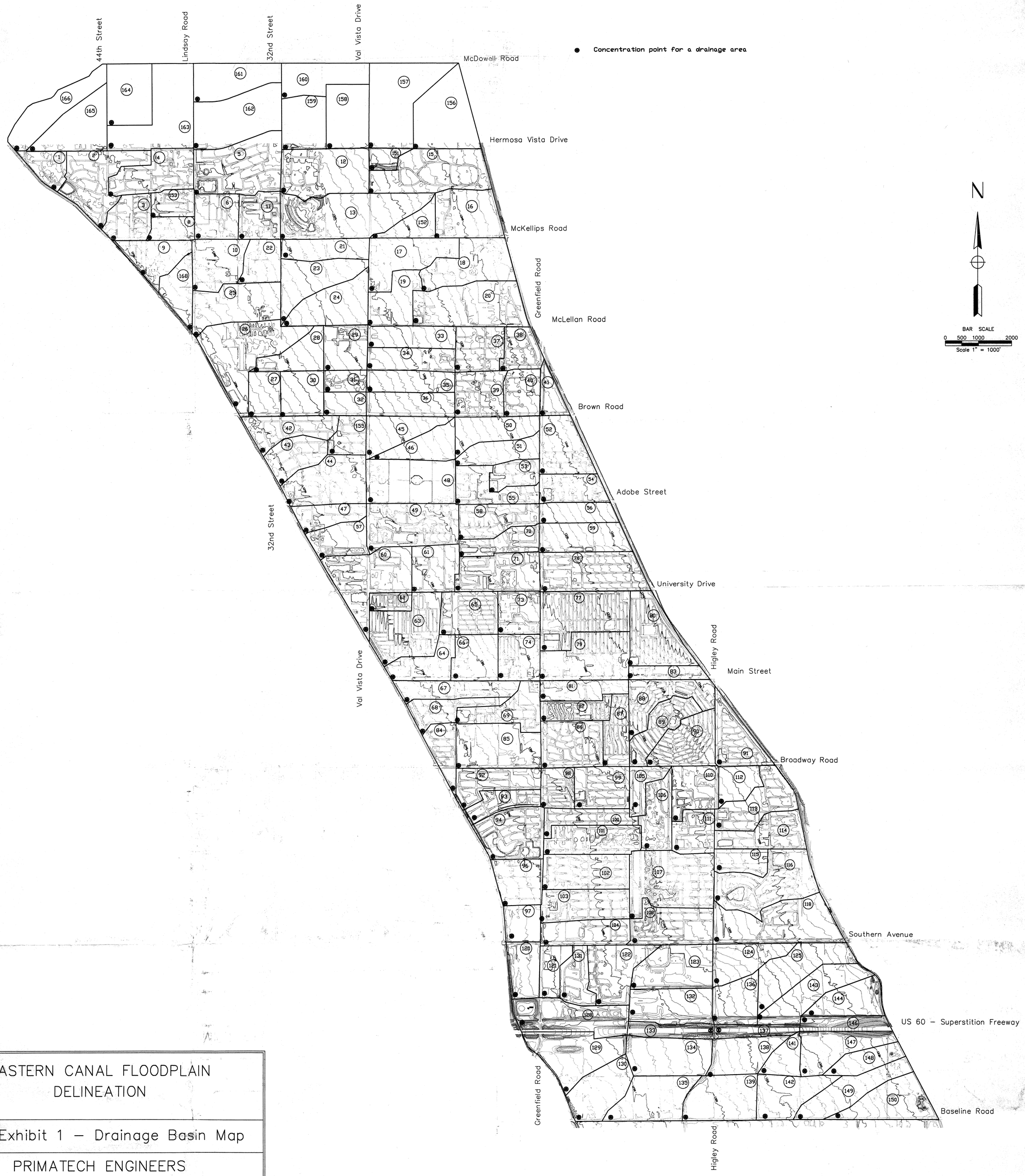
7. Franzoy-Corey Engineering Company, "Flood Insurance Study, Gilbert-Chandler Area, Maricopa County, Arizona," Prepared for the Flood Control District of Maricopa County, draft October 1989, revised July 1990, revised September 1990.

8. Soil Conservation Service, "Soil Survey Eastern Maricopa and Northern Pinal Counties Area, Arizona," November 1974.

9. US Army Corps of Engineers, "HEC-1 Flood Hydrograph Package, User's Manual and Computer Program," Hydrologic Engineering Center, September 1990.

10. US Geological Survey, 7.5-minute Quadrangle Map for Buckhorn, Arizona, 1956, photo revised 1982.

11. US Geological Survey, 7.5-minute Quadrangle Map for Mesa, Arizona, 1952, photo revised 1982.



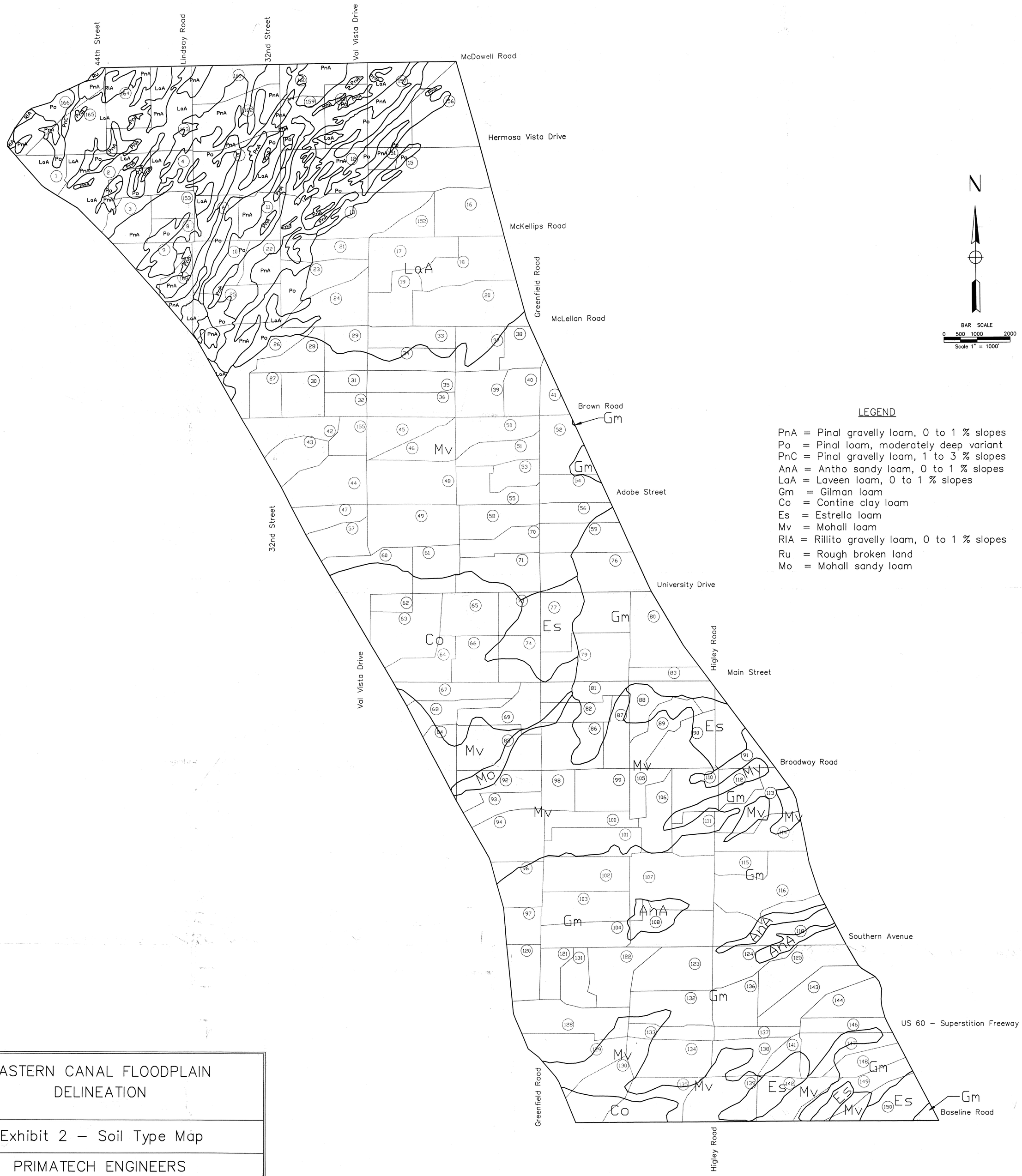
NOTE:
Topography for northernmost portion of watershed was not included in the aerial mapping provided. This area was delineated using the USGS 7.5–minute Quadrangle map for Buckhorn, Az.

EASTERN CANAL FLOODPLAIN DELINEATION

Exhibit 1 – Drainage Basin Map

PRIMATECH ENGINEERS
2929 N. 44th St. Phoenix, AZ 85018

Project No. :	MFC001
Date : May 1997	Drawn by : WVH



LEGEND

PnA = Pinal gravelly loam, 0 to 1 % slopes
Po = Pinal loam, moderately deep variant
PnC = Pinal gravelly loam, 1 to 3 % slopes
AnA = Antho sandy loam, 0 to 1 % slopes
LaA = Laveen loam, 0 to 1 % slopes
Gm = Gilman loam
Co = Contine clay loam
Es = Estrella loam
Mv = Mohall loam
RlA = Rillito gravelly loam, 0 to 1 % slopes
Ru = Rough broken land
Mo = Mohall sandy loam

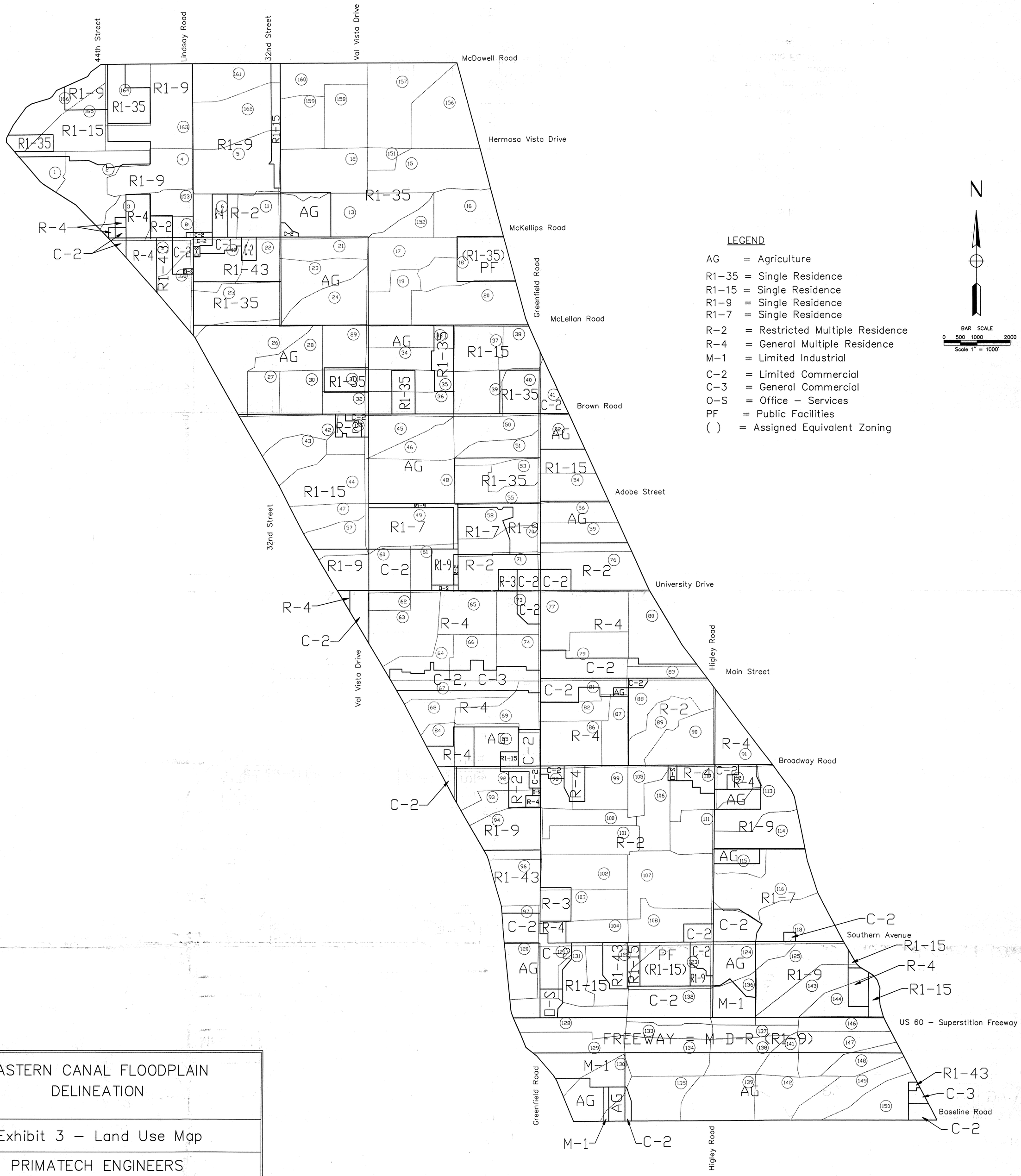
EASTERN CANAL FLOODPLAIN DELINEATION

Exhibit 2 – Soil Type Map

PRIMATECH ENGINEERS
2929 N. 44th St. Phoenix, AZ 85018

Project No. : MFC001

Date : May 1997 | Drawn by : WVH



LEGEND

AG = Agriculture
R1-35 = Single Residence
R1-15 = Single Residence
R1-9 = Single Residence
R1-7 = Single Residence
R-2 = Restricted Multiple Residence
R-4 = General Multiple Residence
M-1 = Limited Industrial
C-2 = Limited Commercial
C-3 = General Commercial
O-S = Office – Services
PF = Public Facilities
( ) = Assigned Equivalent Zoning

EASTERN CANAL FLOODPLAIN DELINEATION

Exhibit 3 – Land Use Map

PRIMATECH ENGINEERS
2929 N. 44th St. Phoenix, AZ 85018

Project No. : MFC001

Date : May 1997 | Drawn by : WVH

TECHNICAL DATA NOTEBOOK
EASTERN CANAL FIS
SECTION 4.2 FIELD RECONNAISSANCE AND HYDRAULIC PARAMETER ESTIMATION
FCD NO. 96-10

JANUARY 30, 1997

PREPARED FOR:
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
2801 WEST DURANGO STREET
PHOENIX ARIZONA 85009

AND

CITY OF MESA
ENGINEERING DEPARTMENT
55 NORTH CENTER STREET
MESA, ARIZONA 85211-1466

Registered Professional Engineer (Civil)
CERTIFICATE NO.
15290
GREGORY A.
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Date Signed 1/30/97
ARIZONA, U.S.A.

A-N WEST NO. 7158-04

A-N WEST INC.
Consulting Engineers
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ARIZONA, U.S.A.

TECHNICAL DATA NOTEBOOK
EASTERN CANAL FIS
SECTION 4.2 FIELD RECONNAISSANCE AND HYDRAULIC PARAMETER ESTIMATION

4.2 FIELD RECONNAISSANCE & HYDRAULIC PARAMETER ESTIMATION

4.2.1 Manning's 'n' Values

4.2.1.1 Introduction. On September 6, 1996 and January 14, 1997, A-N West, Inc. made a reconnaissance field trip to the Eastern Canal to photograph and evaluate Manning's 'n' values. The study reach proceeded from the Baseline Road north to Hermosa Vista Drive, along the upstream (east side) of the Eastern canal, a distance of approximately 6.5 miles. The Eastern Canal study reach area is shown on Figures 1 and 2. Figure 1 shows the extent of the study in reference to the surrounding area. Figure 2 shows the location of photograph I.D. numbers and their directions.

4.2.1.2 Methodology. Manning's 'n' values were estimated using two references. The first document, "Estimated Manning's Roughness Coefficients for Stream Channels and Floodplains in Maricopa County, Arizona", was prepared by U.S. Geological Survey (USGS) Water Resources Division by B.W. Thompson and H.W. Hyalmarsen for the Flood Control District of Maricopa County, dated, April, 1991. The other reference used was "Open Channel Hydraulics" which was written by Ven Te Chow, Ph.D.; published by McGraw Hill Book Company in 1959.

Field visit observations of vegetation, and channel and overbank 'n' value characteristics were noted and representative photographs were taken. The photos are included in this report and are referenced with orientation of photo, estimated 'n' values and location by geographical proximity to landmarks such as streets, Eastern Canal.

Using the USGS document, "Open Channel Hydraulics," field photos and site observations, Manning's 'n' values were estimated at several key locations of the floodplain just east of the Eastern Canal. In some cases, a typical cross section will indicate overbanks with different 'n' values to account for different vegetation. Dr. Chow's text, "Open Channel Hydraulics", was used for special topography like the citrus groves because the USGS document did not cover this vegetation adequately.

It is anticipated that the NH record option of the HEC-2 model will be used to subdivide the distinct 'n' value sub-elements which were noted in the channel and overbank areas.

4.2.2 Expansion and Contraction Coefficients:

Expansion and contraction of flows due to changes in channel cross section were estimated to be somewhat abrupt as flow expands and contracts through the developed area. Therefore, expansion and contraction coefficients of 0.5 and 0.3, respectively, are proposed based on the HEC-2 model user manual's discussion of these parameters. Because of the low velocities along the canal due to the mild longitudinal slope of approximately 0.00032 ft/ft, expansion and contraction losses are not expected to be significant.

4.2.3 Hydraulic Jump/Drop Analysis:

Hydraulic jumps are not anticipated along the study reach. The overall slope along the 6.5 mile study reach is 0.00032 ft/ft, which is very mild.

4.2.4 Inventory of Road Crossings & Drainage Structures:

The following Table 1 shows an inventory of road crossings, drainage structures and sizes along the Eastern Canal study limits.

As noted on Table 1, the culverts under several of the downstream road crossings are expected to be accounted for by either modeling the culverts by special culvert routine or by subracting the estimate culvert capacity from the discharge being modeled at the road crossing cross-sections, where culverts are located.

TABLE 1

EASTERN CANAL FIS
ROAD CROSSING AND DRAINAGE STRUCTURE SUMMARY

River Mile	Location	Description	Structure Type/Size
16.477	Baseline Road	Major Street with 1± Foot Dip(2)	2-4' RCP's x 130'/Hdwall and Trsh RK(1)
16.938	Greenfield Rd.	Major Street with 0.3± foot Dip(2)	1-4' RCP x 95'/Hdwall(1)
17.160	U.S. 60 Freeway	Freeway with overpass, No Dip(2)	1-4' RCP x 135'/Hdwall and ½ TRSH RK(1)
17.59	Southern Avenue	Major Street with 1.3± foot Dip(2)	2-24" RCP's x 160' with Hdwall (Bell End)(1)
18.680	Broadway Road	Major Street with 0.5± foot Dip(2)	1-6' and 1-4.5' RCP x 1100' with Hdwall and vertical TRSH RK(1)
19.251	Main St. (Apache Blvd)	Major Street, No Dip(2)	Inlet-1-30" RCP x 260' with Hdwall (Bell End)(1). Outlet - 1-8' x 3' RCB±
19.526	Val Vista Dr.	Major Street, with 0.5± foot Dip(2)	1-30" RCP x 1780' with Hdwall and TRSH RK(3)
19.832	University Dr.	Major Street with 0.5± foot Dip(2)	same as pipe at Val Vista Drive(3)
20.402	Adobe Street	Major Street with 3± foot Dip(2)	Approx. 2 foot storm sewer size(3)
20.987	Brown Road	Major Street with 1± foot Dip(2)	Approx. 2 foot storm sewer size(3)
21.529	Lindsay Road	Major Street with 2± foot Dip(2)	Approx. 2 foot storm sewer size(3)
22.230	McKellips Road	Major Street with 1.1± foot Dip(2)	1-24" RCP with Hdwall(3)
22.916	Gilbert Road	Major Street with 2± foot Dip(2)	No Culvert/S.D.

Notes:

1. Anticipate modeling culverts in HEC-2 model by special culvert option with road profile for weir flow over road or by subtracting the estimated culvert capacity from flow at cross-section locations where culverts are located.
2. Dip denotes road profile which dips or is depressed below adjacent top of road at the canal to cause flow over road before flow over canal on road.
3. Where storm drain is noted, it is assumed the hydrology modeling reflects storm drain capacity.
4. TRSH RK = Trash Rack. Hdwall = Headwall. RCP = Reinforced Concrete Pipe. RCB = Reinforced Concrete Box Culvert.

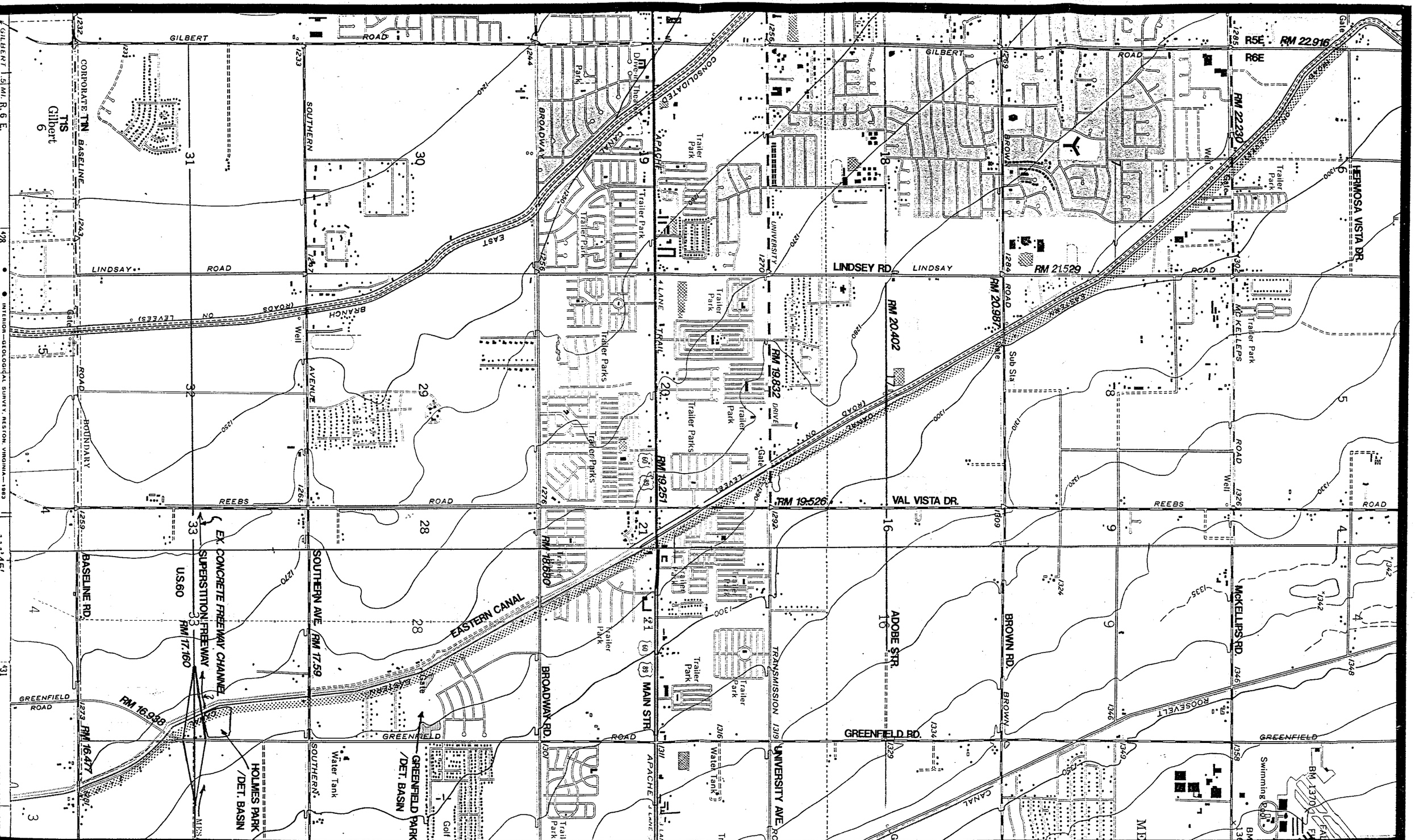
4.2.5 Observation of Possible Overflow Areas: The continuous conveyance capacity along the upslope side of Eastern Canal is limited by a number of factors including:

a) Very mild average longitudinal slope over 6.5 mile project length of 0.00032 ft/ft.
b) As shown by Table 1, small culverts and storm drains and minimal or no dip or depressed roadway upslope of the canal to convey flow across the roads.
c) Mild, natural ground ridges (as shown on project 200 scale, 2 ft. C.I. mapping), which intersect the Eastern Canal, most notably at River Mile 20.268 (700 ft. south of Adobe Street) and River Mile 22.331 (500 ft. north of McKellips Road).

At the U.S. 60 freeway, for example, the 4 foot diameter x 195 foot long RCP has a capacity of approximately 65 CFS (5 fps., velocity) at an assumed 1 foot head loss. Flow over this capacity would overflow into the Eastern Canal and then likely into the freeway drainage channel (flowing westerly along the north side of freeway).

At Main Street, the 30 inch RCP culvert at the upstream side has approximately 25 CFS capacity. With no significant dip or depressed road profile, breakout across the canal on the street bridge would be anticipated for flows over this 25 CFS.

At the two ridges noted at River Mile 20.268 and 22.331, there was a small swale noted during field site visits along the immediate upslope side of the canal. The swales were perhaps 15 feet wide x 0.5 deep from top of adjacent canal bank. Assuming 5 fps velocity, such a swale could convey approximately 40 CFS before overtopping of the adjacent canal bank occurs.



ANW NO.7158-04
FCDMC NO.96-10

A-N WEST INC.
Consulting Engineers

0 2000
SCALE 1"=2000'

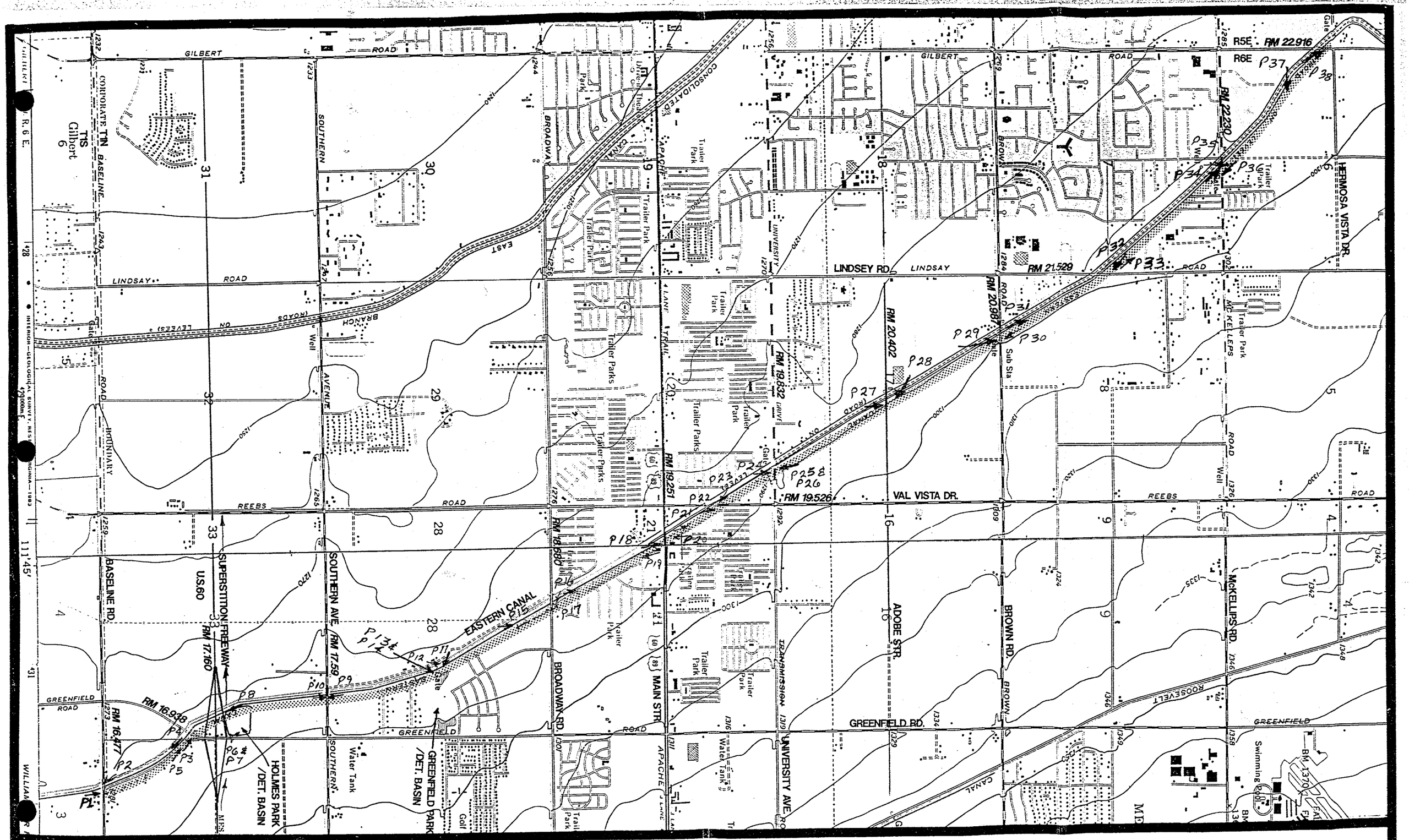
EXPLANATION

STUDY LIMITS

RM 16.477 RIVER MILE NO.

LOCATION MAP
EASTERN CANAL FIS

FIGURE 1



ANW NO.7158-04
FCDMC NO.96-10

A·N WEST INC.
Consulting Engineers

0 2000
SCALE: 1"=2000'

EXPLANATION

STUDY LIMITS

P1 *SITE PHOTO I.D. AND DIRECTION*

SITE VISIT PHOTO LOCATION MAP
EASTERN CANAL FIS

FIGURE 2

Appendix A

#1 Upstream at Baseline Rd.

2 - 48" RCP's in Inlet and outlet Headwall.

Inlet Headwall has Trash Rack with 30° Angle From Vertical

2 Downstream From Baseline Rd.

$n_{(LOB)} = 0.03$

$n_{(C)} = 0.04$

#3 Upstream From Greenfield Rd.

1 - 48" RCP in Headwall (Inlet and outlet)

Field Visit Photos Along Eastern Canal

4 Downstream From Greenfield Rd.

$n_{(LOB)} = 0.035$
$n_{(C)} = 0.04$

5 Upstream at Outlet Headwall of 1-48" RCP Under Greenfield Rd.

6 Downstream at concrete channel Flowing west Along North side U.S. 60 and Detention Basin/ Holmes Park From near Greenfield Rd.

In Background is 48" RCP, Mitered End Under Eastern Canal.

Match P. A-3 Top

Match PA-2 Bottom

#7
Looking Northwest From Same Location As Photo # 6 at Detention Basin / Holmes Park

Eastern Canal In Background.

#8

Downstream at Inlet of 48" RCP Across U.S. 60 with Head wall and Damaged (1/2 Gone) of Vertical Trash Rack

Conc. Chann. $n = 0.015$

#9
Downstream at One 24" RCP Culvert Under Southern Ave. with Headwall (Bell End).

Earth Chann. $n = 0.035$

Field Visit Photos Along Eastern Canal

A-3

#10

Upstream From Southern Ave.

$n_{LOB} = 0.035$
$n_{(C)} = 0.035$

#11

Downstream at Concrete Channel Into Greenfield Park / Detention Basin.

$n_{LOB} = 0.03$
$n_{channel} = 0.015$

#12

Upstream at Concrete Channel From Greenfield Park / Detention Basin.

Weighted
$n_{channel} = 0.024$
Top Bank to Wall
$n_{Houses} = \underline{0.25}$

#13 Upstream at Greenfield Park / Detention Basin At Pump outfall

Match Below Lt.

Match Above, Rt.

#14 Same as #13 Above

#15 Upstream At 1-6'Ø RCP (Left) and 1-4.5'Ø RCP (Right) with Headwalls and Vert. Trash Racks.

Approx. 950 FT South of Broadway Rd.

#16 Downstream at Inlet of 1 - 4.5' ϕ RCP and 1 - 6' ϕ RCP with Headwall and Vert. Trash Racks

Approx. 100 Foot North of Broadway Rd.

#17 Upstream From Same Location as Photo #16 At Concrete Channel

Approx. 5' Deep, 2' Bottom 12' Topwidth 1:1 sideslopes

Wtd. n (Channel - Fence To Top Bank = 0.024

#18 Upstream at Box Culvert Outlet At Main Str. (Apache Blvd.)

Note: The north side of Road, has 30 inch ϕ RCP Per Photo # 20.

n(conc. chann.) = 0.015

#19
Downstream From South side of Main Street (Apache Blvd.) at Concrete Channel

Bottom 2'±
Topwidth 10'±
Depth 4'±

n (conc. chann.) = 0.015

#20
Downstream at 30"ø RCP In Headwall (Bell End) At Main Street (Apache Blvd.)

Note: Box Culvert At outlet End Per Photo #18

#21
Upstream at Point of Photo #20 Just Upstream (North) of Main Str. (Apache Blvd.)

wtd channel n = .035
(Top /Bank to Large Trees)

22

Upstream at Pipe Outlet At Val Vista Blvd.

2'ø± RCP In Headwall

Wtd. Chann. n = .035
(Top Bank to Large Trees)

23 Downstream at Val Vista Blvd. (Background) and Catch Basin (Foreground with 15" to 18" Connector Pipe To 24"? RCP

n chann. = 0.030
(Top/Bank to Fence or shrubs - width = 25'±

24

Upstream at University Dr. sign Noting "city of Mesa Storm Drain In Background.

Shallow Swale This Location

n chann. = 0.030
(Top Bank To Fence or Shrubs - width = 25'±

#25
Downstream at University Dr and 30" RCP In Drop Inlet with Headwall and Trash Rack

#26

Closeup of same 30" RCP / Headwall as Photo #24

#27 Upstream at Adobe Street

Note: "City of Mesa storm Drain" sign In Background, Rt."

#28 Downstream at Inlet of 18" RCP In Headwall w/ Trash Rack, North side of Adobe street.

Pipe Angles To East Toward small Detention Basin Behind Block wall

#29 Upstream at Brown Road

Note: "City of Mesa Storm Drain" sign To Rt. side

#30 Downstream at Brown Rd.

#31
Upstream
North side of
Brown Road

n = 0.030 (open land)

#32
Downstream at
Lindsey Rd.
Pipe Headwall To
Left (In Trees)
With 2' Ø RCP
(Square Edge)

#33
Upstream From
North side Lindsey
Road

n(chann) = 0.035
(Top Bank to Fence)

34

Upstream at Outlet of 24"ϕ RCP Under McKellips Road

n(chann.) = 0.035
(Top Bank to Fence)

35

Upstream From McKellips Road Depressed Parking In Apartment complex with Retention and Pump

Note: A 24" RCP In Headwall Is In Background

36 Downstream From North Side of McKellips Rd.

nchann. = 0.035
(Top Bank to Fence)

#37
Downstream at Park Along Canal Between McKellips and Gilbert Rd

$n_{chann} = 0.030$
(Top Bank to Fence)

$n_{LOB} = 0.030$
(Park / Det. Basin

#38
Upstream at Gilbert Rd / Hermosa Vista Dr.

$n = 0.030$ (Chann.)
(Top / Bank To Fence)

Table 2.--*Adjustment factors for the determination of overall Manning's n values*

[Modified from Chow, 1959]

Channel conditions	Manning's n adjustment[1]	Example
Degree of irregularity:		
Smooth	0.000	Smoothest channel attainable in given bed material.
Minor	.001- .005	Channels with slightly eroded or scoured side slopes.
n_1 Moderate	.006- .010	Channels with moderately sloughed or eroded side slopes.
Severe	.011- .020	Channels with badly sloughed banks; unshaped, jagged, and irregular surfaces of channels in rock.
Effects of obstruction[2]:		
Negligible	.000- .004	A few scattered obstructions, which include debris deposits, stumps, exposed roots, logs, piers, or isolated boulders, that occupy less than 5 percent of the cross-sectional area.
Minor	.005- .015	Obstructions occupy 5 to 15 percent of the cross-sectional area and the spacing between obstructions is such that the sphere of influence around one obstruction does not extend to the sphere of influence around another obstruction. Smaller adjustments are used for curved smooth-surfaced objects than are used for sharp-edged angular objects.
n_2 Appreciable	.020- .030	Obstructions occupy from 15 to 50 percent of the cross-sectional area or the space between obstructions is small enough to cause the effects of several obstructions to be additive, thereby blocking an equivalent part of a cross section.
Severe	.040- .060	Obstructions occupy more than 50 percent of the cross-sectional area or the space between obstructions is small enough to cause turbulence across most of the cross section.
Vegetation:		
Small	.002- .010	Dense growths of flexible turf grass, such as Bermuda, or weeds where the average depth of flow is at least two times the height of the vegetation; supple tree seedlings such as willow, cottonwood, arrow weed, or saltcedar where the average depth of flow is at least three times the height of the vegetation.
n_3 Medium	.010- .025	Grass or weeds where the average depth of flow is from one to two times the height of the vegetation; moderately dense stemmy grass, weeds, or tree seedlings where the average depth of flow is from two to three times the height of the vegetation; moderately dense brush, similar to 1- to 2-year-old saltcedar in the dormant season, along the banks and no significant vegetation along the channel bottoms where the hydraulic radius exceeds 2 feet.
Large	.025- .050	Turf grass or weeds where the average depth to flow is about equal to the height of vegetation; small trees intergrown with some weeds and brush where the hydraulic radius exceeds 2 feet.

See footnotes at end of table.

A common method of selecting the roughness coefficient, *n*, is to first select a base value of *n* for the bed material (table 1). The base values of *n* are for a straight uniform channel of a given bed material. Cross-section irregularities, channel alignment, obstructions, vegetation, and other factors that increase roughness are accounted for by adding increments of roughness to the base value of *n*. Ranges of adjustments for the factors that may add to channel roughness are shown in table 2.

Many alluvial channels in Maricopa County have bed material that moves during floodflow. In addition to the changing channel geometry of these channels, the roughness coefficient may change during floodflow because of the changing form of the channel bed in parts of the channel cross section (Davidian, 1984). Bedforms, such as dunes, antidunes, and plane bed have been observed during large floods. Within a few minutes, dunes can appear, disappear, and reappear at different locations across a large stream channel. The Manning roughness coefficient can double or triple when the bedform changes from plane to dunes. A method of defining reliable values of Manning's *n* for unstable alluvial channels is not available. A plane bedform is common during large floods, and for this report, plane-bed conditions are assumed where the roughness coefficient is related to the size of the channel material and not the form of the channel bed. Plane-bed conditions were assumed for nearly all indirect measurements of peak discharge where the slope-area method was used.

Table 1.--*Base values of Manning's n for stable channels*

[Modified from Aldridge and Garrett, 1973, table 1]

Channel material	Size of bed material		Base *n* values	
	Millimeters	Inches	Benson and Dalrymple (1967)[1]	Chow (1959)[2]
Concrete.....	-------	--------	0.012-0.018	0.011
Rock cut.....	-------	--------	----------	.025
Firm soil.....	-------	--------	.025- .032	.020
Coarse sand.....	1-2	--------	.026- .035	-----
Fine gravel.....	-------	--------	----------	.024
Gravel.....	2-64	0.08-2.5	.028- .035	-----
Coarse gravel.....	-------	--------	----------	.028
Cobble.....	64-256	2.5-10.0	.030- .050	-----
Boulder.....	>256	>10.0	.040- .070	-----

[1]Straight uniform channel.
[2]Smoothest channel attainable in indicated material.

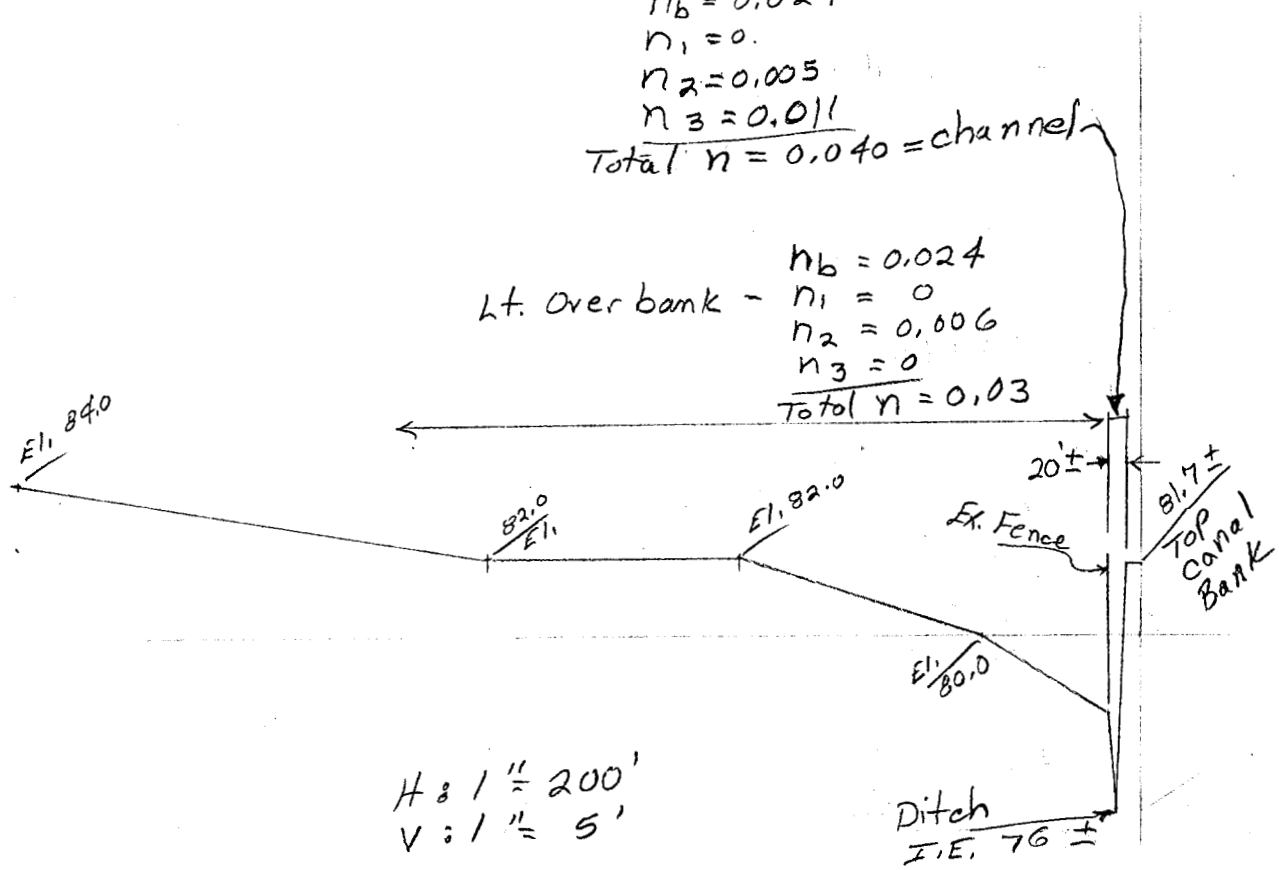
n_b

SOURCE:ESTIMATED MANNING'S ROUGHNESS COEFFICIENTS...BY B.W.THOMPSEN AND H.W.HJALMARSON,APRIL,1991

A-15

$n_b = 0.024$
$n_1 = 0.$
$n_2 = 0.005$
$n_3 = 0.011$
Total $n = 0.040$ = channel

Lt. Overbank – $n_b = 0.024$
$n_1 = 0$
$n_2 = 0.006$
$n_3 = 0$
Total $n = 0.03$

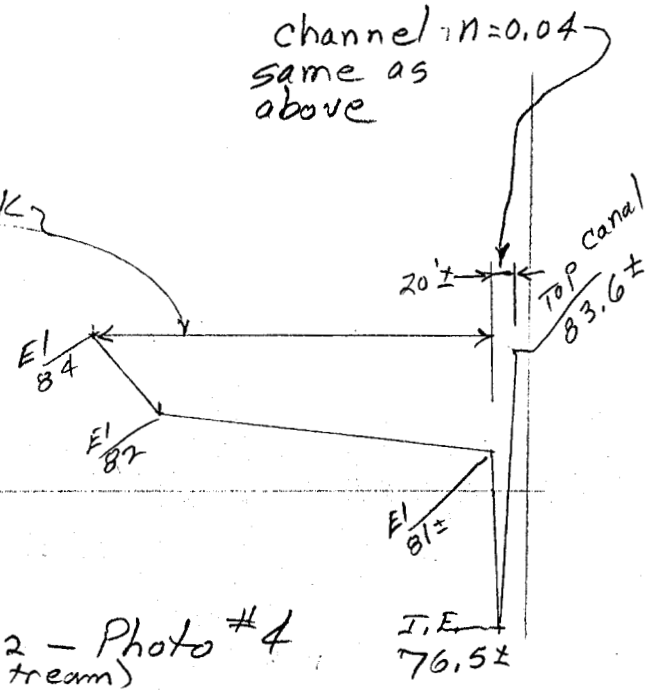


H: 1" = 200'
V: 1" = 5'

Section @ R.M. 16.424 – Photo #2
(Looking Downstream)

$n_b = 0.024$
$n_1 = 0$
$n_2 = 0.006$
$n_3 = 0.005$
Total $n = 0.035$, Lt. overbank

channel $n = 0.04$
same as above

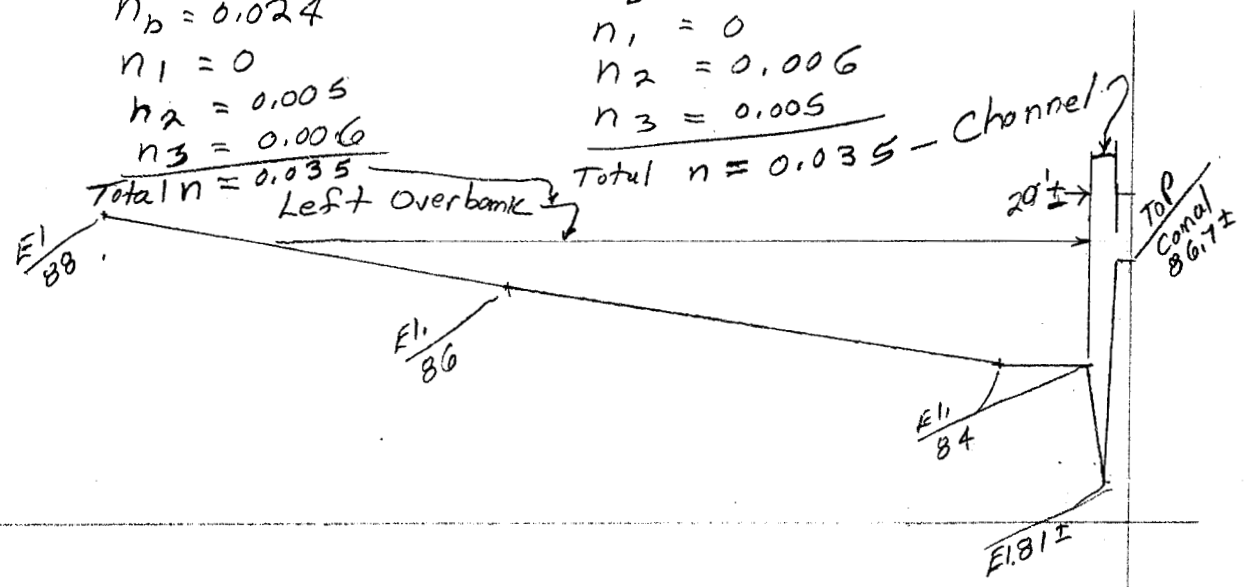


H: 1" = 200'
V: 1" = 5'

Section @ R.M 16.872 – Photo #4
(Looking Downstream)

$n_b = 0.024$
$n_1 = 0$
$n_2 = 0.005$
$n_3 = 0.006$
Total $n = 0.035$ Left Overbank

$n_b = 0.024$
$n_1 = 0$
$n_2 = 0.006$
$n_3 = 0.005$
Total $n = 0.035$ – Channel

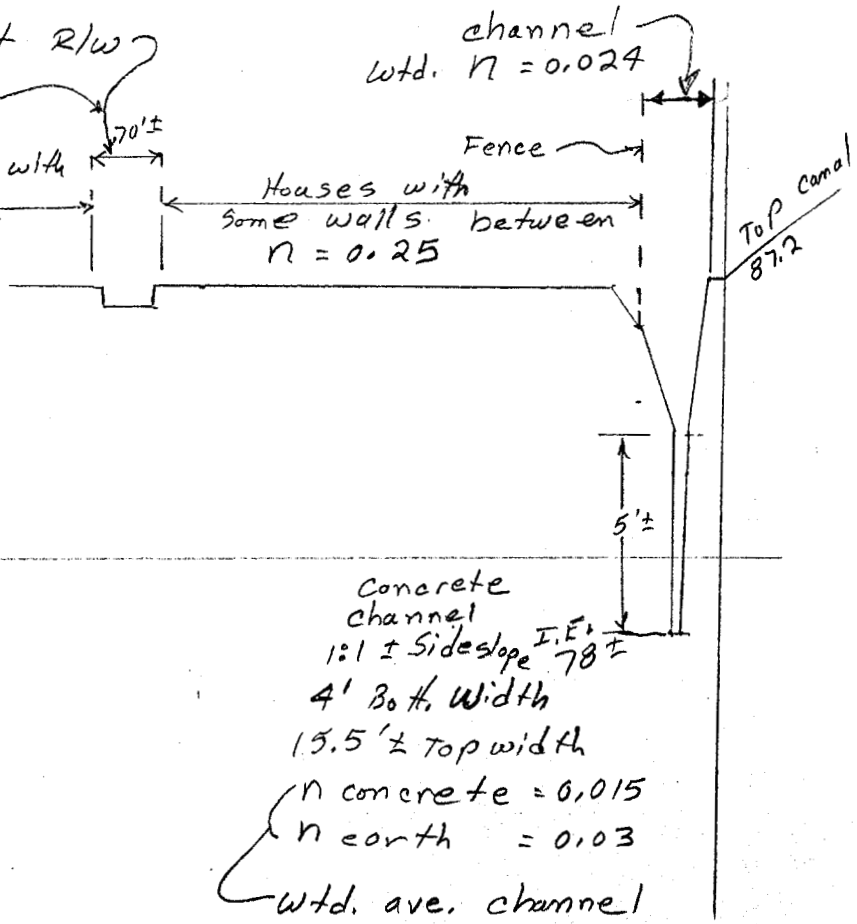


H: 1" = 200'
V: 1" = 5'
Section @ RM 17.685 – Photo #10

Norwalk Street R/W

$n_{pavement} = 0.015$
n Between S/W and Prop. Line $= 0.035$
Wtd $n = 0.020$ street

channel
wtd. $n = 0.024$



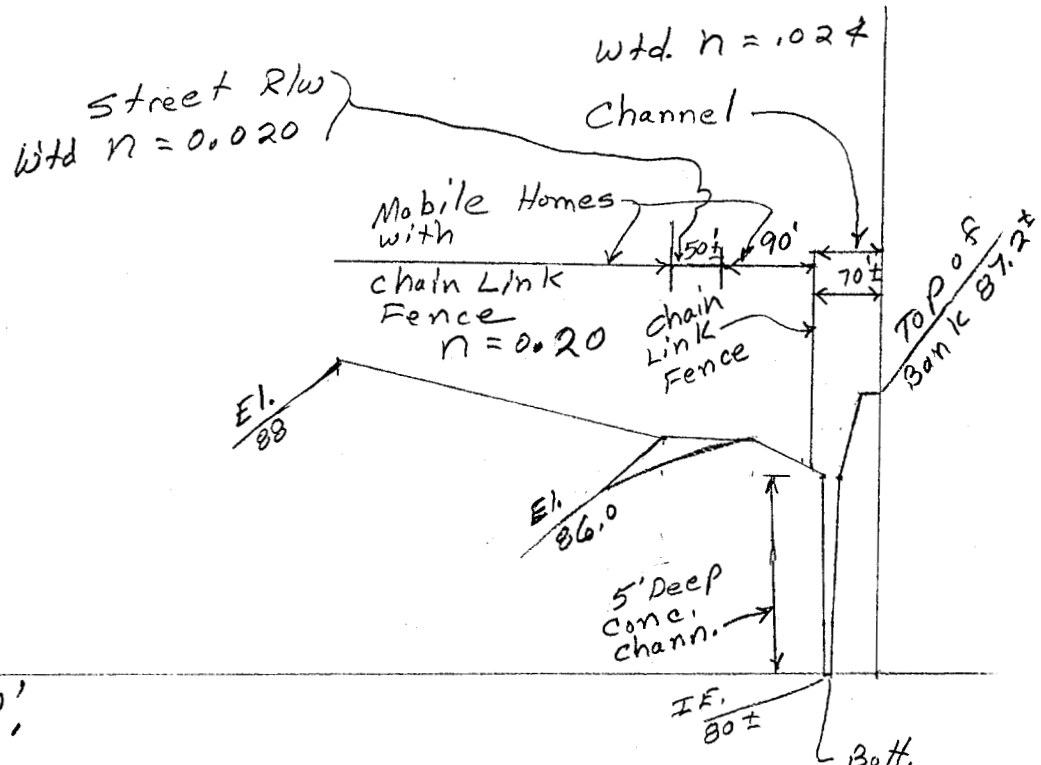
4' Bot. Width
15.5'± Top width
n concrete $= 0.015$
n earth $= 0.03$
Wtd. ave. channel $n = 0.024$

H: 1" = 200'
V: 1" = 5'
Section @ RM 18.215 – Photo #12

AMWEST INC.
Consulting Engineers
Richmond, California
San Jose, California
Phoenix, Arizona

Eastern Canal FIS

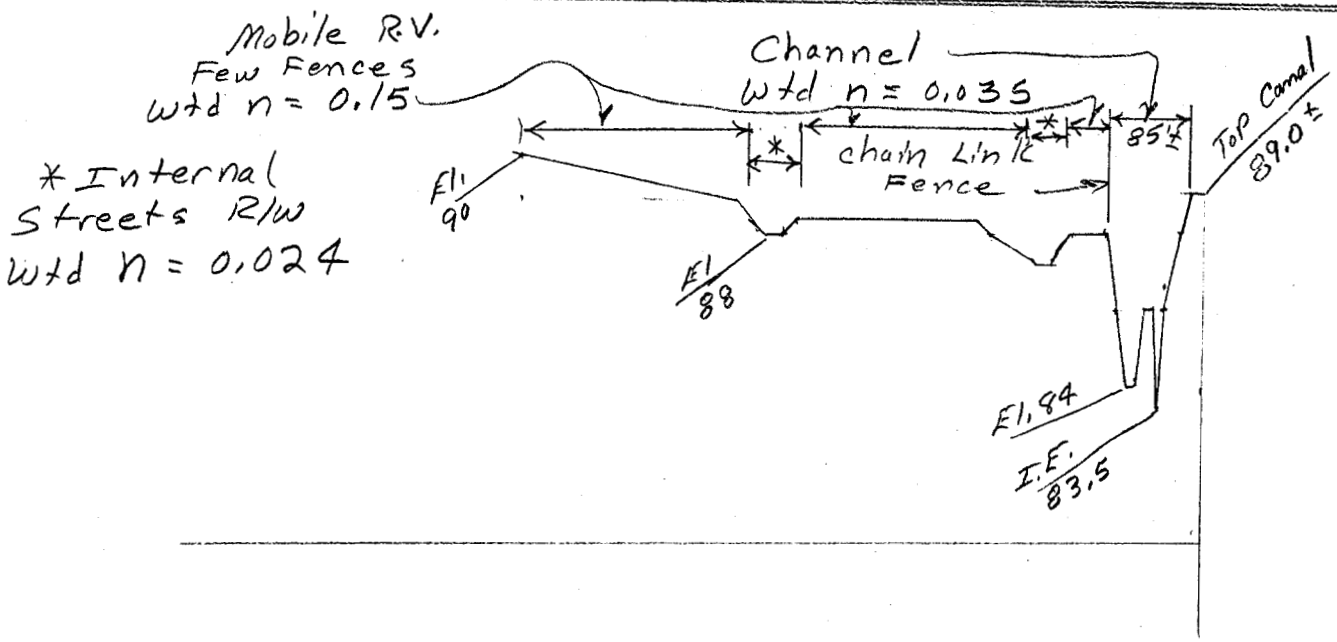
Project 1158-04 Sht. ___ of ___
Calc. By GAS Date 1/29/97
Chkd. ___ Date ___



H: 1" = 200'
V: 1" = 5'

Section @ R.M. 18.865 – Photo. 17

Bott. width 2'±
1:1 side-slopes
12'± Top width



Section @ R.M. 19.455 – Photos 21 and 22

EASTERN CANAL
FLOODPLAIN DELINEATION STUDY
FCDMC NO. 96-10
TECHNICAL DATA NOTEBOOK

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JUNE, 1997
REVISED DECEMBER, 1997

PREPARED FOR:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
2801 WEST DURANGO STREET
PHOENIX, ARIZONA 85009

Registered Professional Engineer (Civil)
Certificate No.
15290
GREGORY A.
SCHUELKE
Date Signed 12/3
Arizona, U.S.A.

PREPARED BY:

A-N WEST, INC.
7600 NORTH 15TH STREET, SUITE 200
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(602) 861-2200

A-N WEST NO. 7158-04

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7600 North 15th Street, Suite 200
Phoenix, Arizona 85020
(602) 861-2200

EASTERN CANAL TECHNICAL DATA NOTEBOOK (TDN)
STUDY DOCUMENTATION ABSTRACT

SECTION 1: GENERAL INFORMATION

1A. Community: City of Mesa
1B. Community Number: 040048
1C. County: Maricopa
1D. State: Arizona
1E. Date Study Accepted: Pending
1F. Study Contractor: Michael Baker, Jr., Inc.
1313 East Osborn Road
Suite 150
Phoenix, Arizona 85014
(602) 279-1234
FCDMC Contract No. 96-10

Subconsultants: Aerial Mapping Company, Inc.
3141 West Clarendon Avenue
Phoenix, Arizona 85017
(602) 263-5728
Aerial Mapping

A-N-West, Inc.
7600 N. 15th Street, Suite 200
Phoenix, Arizona 85020
(602) 861-2200
Hydraulics/Floodplain Mapping

Project Engineering Consultants, Ltd.
2320 W. Peoria Avenue, Suite C-122
Phoenix, Arizona 85029
(602) 906-1901
Field Survey

Primatech Engineers
2929 North 44th Street
Phoenix, Arizona 85018
(602) 952-2828
Hydrology

1G. FEMA Technical Reviewer: Pending
1H. FEMA Regional Reviewer: Pending
1I. State Reviewer: Arizona Department of Water Resources
(602) 417-2445
1J. Local Reviewer: Flood Control District of Maricopa County
(602) 506-1501
1K. River or Stream Name: Eastern Canal
1L. Reach Description: From 200 feet downstream of Baseline to Hermosa Vista Drive, a distance of 5.5 River Miles. Located on FIRM Panel Nos. 2185D, 2195D and 2215F.
1M. Study Type: Approximate Zone A

SECTION 2: MAPPING INFORMATION

2A. USGS Quad Sheets: 7.5 Minute Series; Buckhorn, AZ, 1956, Photo Rev. 1982 and Mesa, Arizona, 1952, Photo Rev. 1982.
2B. Mapping for Hydrologic Study: Same as Section 2C.
2C. Mapping for Hydraulic Study: Aerial Photography Flown at Scale of 1:8400. Topographic Mapping Compiled at Scale of 1" = 200' and 2 feet. C.I. Photography Flown on 3/20/96.
Mapping Consultant: Aerial Mapping Company, Inc., of Phoenix, Arizona.

SECTION 3: HYDROLOGY

3A. Model or Method Used: Note 1: see Primatech Engineers Hydrology Report under separate cover. U.S. Army Corps of Engineers HEC-1 Model, Flood Hydrograph Package Computer Model, Version 4.0, September 1990.
3B. Storm Duration: 24-hour duration
3C. Hyetograph Type: Note 1.
3D. Peak Flow Frequencies Estimated in Hydrologic Study: 100-year storm
3E. List of Gauges Used to Calibrate Model: Note 1.
3F. List of Rainfall Amounts: Note 1.
3G. Description of Unique Conditions: Note 1. Numerous split-flows at streets, and storm drains as well as retention basins were analyzed as part of study. Hydrology assumed no breakout of flow over canal which was determined to occur in preliminary hydraulic analysis. Thus, approximate Zone A floodplain pursued with no refinement of hydrology.
3H. Coordination with Applicable Agencies: Note 1.

SECTION 4: HYDRAULICS

4A. Model of Method Used: U.S. Corps of Engineers HEC-2 Model, Water Surface Profiles
Vendor: McTrans Center
512 Weil Hall
Gainesville, Florida 32611-2083
Version: 4.6.2, May, 1991
4B. Regime: Subcritical

4C. Frequency for which profiles computed: No specific storm events modeled as detailed floodplain not considered possible as flow not contained upstream of canal.

4D. Method Floodway Calculation: No floodway modeled per FCDMC and City of Mesa direction.

4E. Unique Conditions and Problems: Letter Report of May 1, 1997 by A-N West, discusses preliminary hydraulic analysis estimating discharges for Profile 1, where flow begins breaking over east canal bank and Profile 2, where flow is approximately 0.5 feet over east top of canal bank. Over 14 breakout areas were identified and a detailed analysis for 100-year flood was not considered possible. Updating the Approximate Zone A floodplain was noted as possible alternate solution. Per City request May 9, 1997, meeting updated Approximate Zone A was initiated and submitted with May 15, 1997 letter.

SECTION 5: ADDITIONAL STUDY INFORMATION

Length and Area of Floodplain Delineated

Main Channel - 5.5 Miles and 428.8 Acres
(Updated Zone A)

Length and Area of Floodway Delineated

No Floodway Delineated.

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		1.4.3 Other Agencies	—
		1.4.4 FEMA Regional Office	—
		1.4.5 FEMA Washington	—
		1.4.6 FEMA Technical Consultant	—
		1.4.7 Copy of Public Notices - No Public Notice Published Per City Direction	—
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	2.2	INDEX OF MAPS	Under Separate Cover
	2.3	SURVEY FIELD NOTES - BY PROJECT ENGINEERING	
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		SUPPLEMENTAL FIELD SURVEY NOTES - BY A-N WEST ON 3/13/97 OF DRAINAGE STRUCTURES ALONG EASTERN CANAL USING FIELD NOTES BY PROJECT ENGINEER OF CANAL BRIDGES	2.3 (14) - 2.0 (18)
	2.4	WATERSHED MAPS, HYDROLOGIC ANALYSIS MAPS	See Section 3.0
	2.5	HYDRAULIC ANALYSIS MAPS	See Exhibit 3 of Attached FIS Study
	2.6	FIRM, FHBM DRAFT MAPS; EFF. DELINEATION INCL. ON EXHIBIT 3 OF ATTACHED FIS STUDY	
	2.7	COMMUNITY MAPS	In FIS Report
	2.8	MISCELLANEOUS MAPS	None
SECTION	3.0	HYDROLOGIC ANALYSIS	
	3.1	METHOD DESCRIPTION	Note 1 - Hydrology Report for Eastern Canal FIS By Primatech Engineers under separate cover
	3.2	PARAMETER ESTIMATION	Note 1
		3.2.1 Drainage Area Boundaries	
		3.2.2 Physical Parameters	
		3.2.3 Statistical Parameters	
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	3.5	FINAL RESULTS/COMPUTER RUNS	Note 1
	3.6	FINAL MODELING RESULTS ON DISKETTE(S)	Note 1

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SECTION 4.0	HYDRAULIC ANALYSIS	See Attached Eastern Canal Flood Insurance Study (FIS) Report By A-N West Dated: May, 1997
4.1	METHOD DESCRIPTION	See Section 3 of attached FIS Report
4.2	PARAMETER ESTIMATION	Note 2 - See Attached Field Reconnaissance & Hydraulic Parameter Estimation Report By A-N West Dated: January 30, 1997
4.2.1	Manning's 'n' Value	See Section 4.2.1 of attached Report (Note 2)
4.2.2	Expansion and Contraction Coefficients	See Section 4.2.2 of attached Report (Note 2)
4.2.3	Hydraulic Jump/Drop Analysis	See Section 4.2.3 of attached Report (Note 2)
4.3	CROSS-SECTION DESCRIPTION	
4.3.1	Channel and Overbank Cross-Section Plots (17 - 24" x 36" sheets)	Under Separate Cover
4.3.2	Bridge or Constriction	See Cross-Section Plots
4.3.3	Grade Control Structures	Note 2 and FIS Reports
4.4	CALIBRATION	See Section 3.2 of FIS Report
4.5	SPECIAL PROBLEMS/SOLUTIONS	
	Subject: Eastern Canal - Preliminary HEC-2 Model Results and Canal Breakout Identification Detailed Analysis Not Possible and Subsequent Approximate Zone A Delineation	See Letter Report By A-N West Dated: May 1 and 15, 1997 4.5(1) - 4.5 (31)
4.6	FLOODWAY MODELING	N/A
4.7	FINAL RESULTS/COMPUTER RUNS	N/A
4.8	FINAL MODELING RUN ON DISKETTES	N/A
SECTION 5.0	EROSION/SEDIMENT TRANSPORT	N/A
SECTION 6.0	REFERENCE MATERIALS	
6.1	OTHER PUBLISHED FLOOD STUDIES	See FIS Report
6.2	PREVIOUS FEMA STUDIES	See Section 6 of FIS Report
6.3	OTHER APPLICABLE STUDIES	See Section 6 of FIS Report
6.4	PUBLISHED/UNPUBLISHED HISTORICAL FLOOD INFO.	See Section 2.3 and 6 of FIS Report
6.5	REFERENCED TECHNICAL PAPERS/DOCUMENTS	See Section 8 of FIS Report
SECTION 7.0	CROSS-REFERENCE AND LABELING INFORMATION	
7.1	OTHER STUDIES IMPACTED	N/A
7.2	KEY TO CROSS-SECTION LABELING	N/A - Mapping and Cross-Section Plots
SECTION 8.0	DRAFT FIS REPORT	See Section 8.0
SECTION 9.0	FEMA REVISION REQUESTER FORMS	See Section 9.0

Registered Professional Engineer (Civil) CERTIFICATE NO. 15290 GREGORY A. SCHUELKE Exp. 12/31/ ARIZONA, U.S.A.

T.D.N. NO. 8.0
FLOOD INSURANCE STUDY
EASTERN CANAL
CITY OF MESA
MARICOPA COUNTY, ARIZONA

T.D.N. 8.0

PREPARED FOR:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
2801 WEST DURANGO STREET
PHOENIX, ARIZONA 85009

AND

CITY OF MESA
ENGINEERING DEPARTMENT
55 NORTH CENTER STREET
MESA, ARIZONA 85211-1466

Registered Professional Engineer (Civil)
CERTIFICATE NO.
15290
GREGORY A.
SCHUELKE
12/3/97
ARIZONA, U.S.A.

MAY, 1997
REVISED DECEMBER, 1997

FCDMC NO. 96-10
A-N WEST, INC., JOB NO. 7158-04

A-N WEST INC.
Consulting Engineers
7600 North 15th Street, Suite 200
Phoenix, Arizona 85020
(602) 861-2200

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FIGURES

FIGURE 1 - Vicinity Map — Follows Page 1

TABLES

TABLE 1 - Updated Road Crossing and Drainage Structure Summary — 4

EXHIBITS

EXHIBIT 1 - Flood Profiles — N/A
EXHIBIT 2 - Elevation Reference Mark Descriptions — Follows Exhibit 1
EXHIBIT 3 - Draft Floodplain Work Maps - 200 Scale (8 sheets) — Under Separate Cover

FLOOD INSURANCE STUDY
EASTERN CANAL
CITY OF MESA, MARICOPA COUNTY, ARIZONA

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in Maricopa County, Arizona, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in their efforts to promote sound floodplain management.

1.2 Authority and Acknowledgments

The hydrologic analysis for this study was performed by Primatech Engineers and the hydraulic analysis was performed by A-N West, Inc., for the Flood Control District of Maricopa County, under Contract No., FCD 96-10. This study was completed in June, 1997.

1.3 Coordination

The areas to be studied were provided by the Flood Control District of Maricopa County during contract negotiations in _____.

A public notice was published in the Arizona Republic/Phoenix Gazette on _____ and _____ and the Mesa Tribune on _____ to notify all interested parties of the commencement of this study.

The following agencies on companies were contacted by A-N West for the hydraulic analysis to obtain information on the study: Flood Control District of Maricopa County, Arizona Department of Transportation, Salt River Project (SRP), and the City of Mesa.

2.0 AREA STUDIED

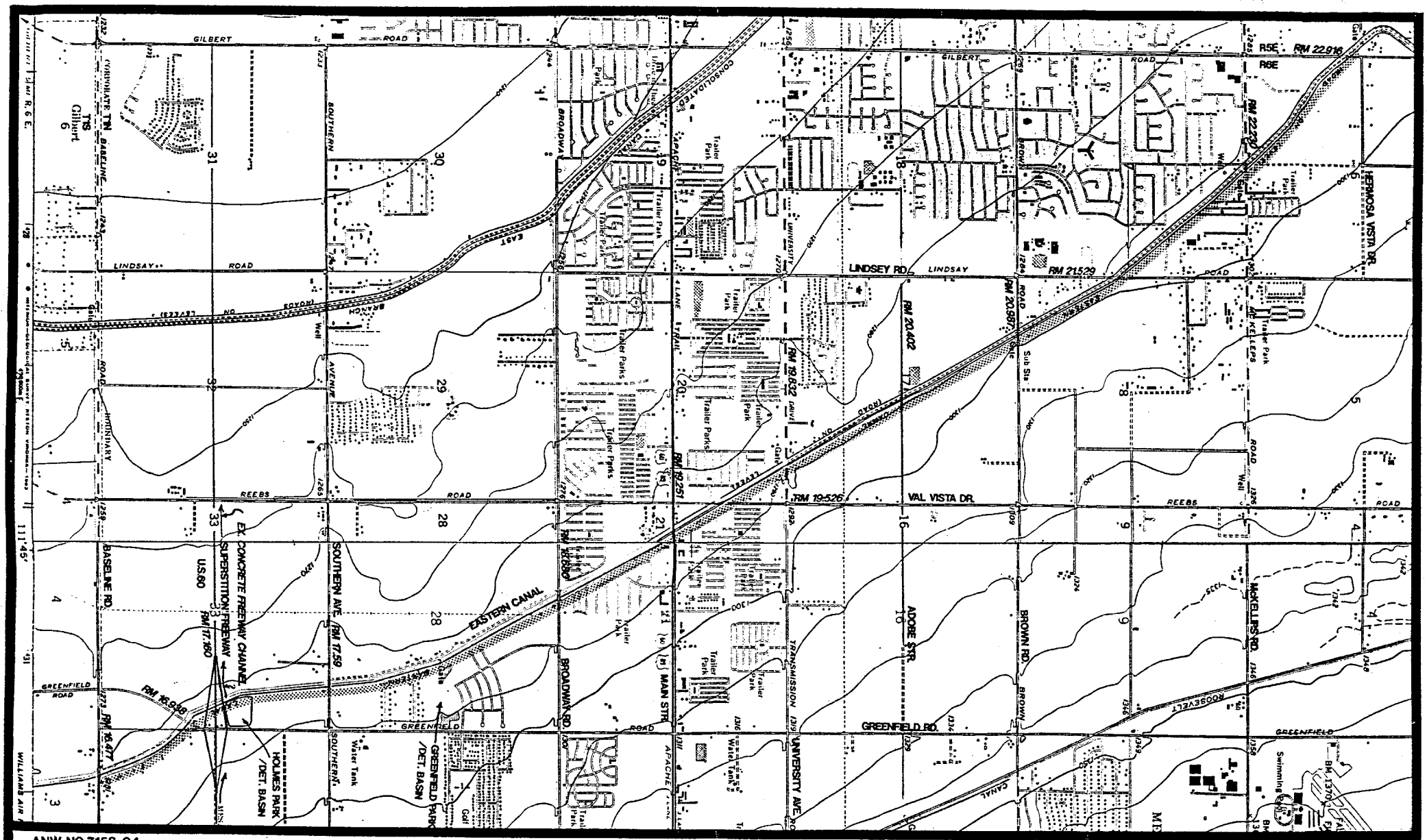
2.1 Scope of Study

The limits of detailed study in these areas of the City of Mesa, Maricopa County, Arizona were determined by the Flood Control District of Maricopa County in association with the City of Mesa and were forwarded to the study contractor during contract negotiations in _____. The detailed study areas included along the upstream side of the Eastern Canal from Baseline Road to Hermosa Vista Drive, a distance of approximately 5.5 miles.

The general study area is shown on the Vicinity Map (Figure 1).

2.2 Community Description

The study area is currently in the City of Mesa corporate limits of Maricopa County, Arizona. The floodplain study area from Baseline Road north 5.5 river miles to Hermosa Vista Drive along the Eastern Canal of concrete lined channel, earthen channel, and earthen swales.



ANW NO.7158-04
FCDMC NO.96-10

A-N WEST INC.
Consulting Engineers

0 2000
SCALE 1"=2000'

EXPLANATION

STUDY LIMITS

RM 16.477 *RIVER MILE NO.*

LOCATION MAP
EASTERN CANAL FIS

FIGURE 1

From Baseline Road to Greenfield Road along the canal, the floodplain study area is currently an excavated un-lined channel with residential/horse properties to cultivated crop land east of the Eastern Canal.

From Greenfield Road north along the canal to the U.S. 60 Freeway Interchange is mostly vacant land with Greenfield Road running perpendicular to north at the canal.

North of the U.S. 60 Freeway is the Holmes Park Detention Basin which has c concrete channel along the freeway and culvert of approximately 100 cfs capacity conveying storm water under the Eastern Canal to the west. From Holmes Park Detention Basin north along the canal to Southern Avenue, the channel is earthen and a strip of vacant land containing material stockpiles along with an orchard to the east of the canal.

From Southern Avenue, 750 feet north along the canal, the floodplain study area is an earthen channel with cultivated crop land to the east of the canal. From 750 feet north of Southern Avenue to Greenfield Park Detention Basin, an excavated un-lined channel with residential/horse properties to the east of the canal make up the study area. In the Greenfield Park area, the channel is lined with concrete and the park is landscaped with turf grass and trees.

From Greenfield Park north to Broadway Road the study area is a concrete lined channel with single-family residences to the east and concrete masonry unit (cmu) between the channel and the residential development fence running parallel to the east of the canal.

From Broadway Road to 650 feet north, the study area is an un-lined channel with mobile homes, chain line and cmu fence to the east of the canal. From 650 feet north to 2450 feet north of Broadway Road there is a concrete lined channel with mobile homes and paved roads to the east of the canal. From 2450 feet north to Main Street, the study area is a concrete lined channel and a commercial building with a paved parking lot and a cmu fence, and a vacant parcel of land to the east of the canal.

From Main Street north to Val Vista Drive, the study area is an un-lined channel with a 90 foot wide strip of landscaping with mobile homes and chain link fences to the east of the canal.

From Val Vista Drive north to University Drive, the study area is an un-lined channel with commercial buildings and a paved parking lot with intermittent vacant parcels and residential properties to the east of the canal.

From University Drive north 1200 feet, the study area is an un-lined channel with a vacant parcel east of the canal. From 1200 feet north of University Drive to Adobe Street is an un-lined channel with landscaped detention basin and power line easement with turf grass and trees east of the canal, along with single-family residences with paved streets and an orchard east of the canal.

From Adobe Street north to Brown Road, the floodplain study area in an un-lined channel/swale with a detention basin/par and single-family residences, cmu fences and paved streets east of the canal.

From Brown Road north 650 feet, the study area is an un-lined swale with citrus harvest box storage and citrus orchard east of the canal. From 650 feet north to Lindsay Road, the study area is an un-lined swale with vacant land to the east of the canal.

From Lindsay Road north 1400 feet, the floodplain study area is an un-lined swale with commercial buildings/school and landscaping to the east of the canal. From 1400 feet north of Lindsay Road to 2200 feet north is an un-lined swale with a landscaped residential apartment complex and cmu fence east of the canal. From 2200 feet north to McKellips Road, the study area is an un-lined swale with mobile homes, intermittent hedges and a former automobile service station with paved parking east of the canal.

From McKellips Road north to Hermosa Vista Drive, the floodplain study area is a residential apartment complex and cmu fence with paved parking with single-family residences, cmu fences and paved streets with a landscaped park/detention basin east of the canal.

The study area lies at an elevation of approximately 1350 feet.

The climate of the study area is typically desert in character with short, mild winters and long, hot summers. Wide diurnal temperature variations are also characteristic. Temperatures generally range between 35 degrees Fahrenheit (°F) and 105° F, with an annual average of 71° F. The prevailing winds are from the east and are usually light, although severe windstorms occur occasionally during the summary thunderstorm season. The annual precipitation for the study area averages approximately 7.4 inches.

There are two separate rainfall seasons. The first occurs during the winter months, from November to March, when the area is subject to storms from the Pacific Ocean. While this is classified as a rainfall season, there can be periods of a month or more, in this or any other season, when practically no precipitation falls. No significant snowfall occurs over the study area. The second rainfall season occurs during July and August when Arizona is subjected to widespread thunderstorms activity. These thunderstorms are extremely variable in intensity and location. The spring and fall months are generally dry, although precipitation in substantial amounts has fallen on occasion during every month of the year.

2.3 Principal Flood Problems

The current Eastern Canal floodplain is approximately 60 percent developed.

2.4 Flood Protection Measures

The East Maricopa Floodway (EMF) which parallels the Eastern Canal - 1½ miles to the east intercepts stormwater from the east. The EMF was built by the Soils Conservation Service, nor the National Resource Conservation Service, with the Flood Control District of Maricopa County (FCDMC) as the local sponsor. The FCDMC owns this facility and is responsible for inspection and maintenance.

This flood insurance study is intended to be utilized in the planning and regulation of future development within the study area to provide for adequate drainage and flood proofing of development.

3.0 ENGINEERING METHODS

3.1 Hydrologic Analysis

The hydrology for the Eastern Canal was performed for this study by Primatech Engineers and is summarized in a report under separate cover. The peak discharges were computed for the 100-year, 24-hour storm event by the HEC-1 computer model (Ref. 5) using the Flood Control District of Maricopa County Hydrology Manual (Ref. 6).

This hydrologic analysis assumed no breakout of flow across the canal and assumed the peak discharges flowed along upslope (east) side of the canal. Based on the preliminary hydraulic analysis (Ref. 9), which determined that breakouts over the canal were expected, an approximate Zone A floodplain was pursued and no further refinement to the hydrology analysis was pursued.

3.2 Hydraulic Analysis

Cross-sections were digitized from a Digital Terrain Model (DTM) provided with the topographic mapping (Ref. 1) that was completed. The culverts along the upstream side of the Eastern Canal at Baseline, Greenfield, U.S. 60, Southern, Broadway, and Main Streets were field surveyed for inlet and outlet inverts and the length and wingwall configuration was obtained from as-built plans and site visits. The capacities of these field surveyed culverts was estimated by the HEC-5 manual method and were modeled in the HEC-2 model analysis as discussed in Reference 9.

TABLE 1

EASTERN CANAL FIS
UPDATED ROAD CROSSING AND DRAINAGE STRUCTURE SUMMARY

River Mile	Location	Description	Structure Type/Size
16.447	Baseline Road	Major Street with 1± foot Dip(2)	2-4' RCP's x 130' Hdwall and Trsh RK(1)
16.938	Greenfield Road	Major Street with 0.3± foot Dip(2)	1-4' RCP x 95' Hdwall (1)
17.160 (5)	U.S. 60 Culvert Under Canal	Culvert along channel under canal	1-45" x 29" x 196" long HECP, mitered inlet
17.160	U.S. 60 Culvert Along Canal	Freeway with overpass, No Dip(2)	1-4' RCP x 730'/Hdwall and ½ Trsh Rk(1)
17.59	Southern Avenue	Major Street with 1.2± foot Dip(2)	2-24" RCP's x 160' with Hdwall (Bell End) (1)
18.680	Broadway Road	Major Street with 0.6± foot Dip(2)	1-6' and 1-4.5' RCP x 1100' with Hdwall and vertical TRSH RK(1)
19.251	Main Street (Apache Blvd.)	Major Street, No Dip (2)	Inlet 1-30" RCP x 260' with Hdwall (Bell End) (1). Outlet - 1-10' x 4.25' RCB
19.526	Val Vista Drive	Major Street, with 1.7± foot Dip(2)	1-30" RCP x 1780' with Hdwall and TRSH RK (3)
19.832	University Dr.	Major Street with 0.5± foot Dip(2)	same as pipe at Val Vista Drive (3)
20.402	Adobe Street	Major Street with 3.3± foot Dip(2)	Approx. 2 foot storm sewer size (3)
20.987	Brown Road	Major Street with 2± foot Dip(2)	Approx. 2 foot storm sewer size (3)
21.529	Lindsay Road	Major Street with 2.3± foot Dip(2)	Approx. 2 foot storm sewer size (3)
22.230	McKellips Road	Major Street with 0.9± foot Dip(2)	1-24" RCP with Hdwall (3)
22.916	Gilbert Road	Major Street with 2.5± foot Dip(2)	No Culverts/S.D.

Notes:

1. Anticipate modeling culverts in HEC-2 model by special culvert option with road profile for weir flow over road or by subtracting the estimated culvert capacity from flow at cross-section locations where culverts are located.

2. Dip denotes road profile which dips or is depressed below adjacent top of road at the canal to cause flow over road before flow over canal on road. Note: flow upstream may be overflowing canal before flow over road occurs.

3. Where storm drain is noted, it is assumed the hydrology modeling reflects storm drain capacity.

4. TRSH RK = Trash Rack. Hdwall - Headwall. RCP = Reinforced Concrete Pipe. RCB = Reinforced Concrete Box Culvert.

5. This 45" span x 29' rise Horizontal Elliptical Concrete Pipe (HECP) conveys flow in concrete channel along north side.

Other street crossings along the canal to the north, including Val Vista, University, Adobe, Brown, Lindsay, McKellips and Hermosa Vista Streets are drained of nuisance storm water runoff by a small capacity (15 cfs) 24± inch storm drain along the canal. Table 1 summarizes the road crossing inventory and drainage structure summary along the upslope (east) side of the Eastern Canal.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks and descriptions used in this study are shown on the maps (Exhibit 3) and summarized in this report (Exhibit 2). A conversion to North American Vertical Datum 1988 (NAVD88) is also included in Exhibit 2.

A review of the hydrology results along the canal in conjunction with the road crossing structure inventory and preliminary hydraulic analysis (Ref. 9) indicated that there was inadequate capacity to convey the 100-year discharges along the upstream side of the canal and that breakouts over the canal were expected.

A meeting was held on May 9. 1997 with representatives of the City of Mesa, FCDMC, A-N West, Inc., and Primatech Engineers, Inc., to review the results of the May 1, 1997 (Ref. 9) letter report.

At this meeting, the City of Mesa requested that an updated Approximate Zone A 100-year floodplain be delineated. This delineation was to be based on their experience in administering and identifying the floodplain limits for the effective Approximate Zone A 100-year floodplain. The delineation was identified as the floodplain width and water surface elevation associated with the low top of high east or west top of canal bank within approximately 200 feet longitudinally of any location of interest along the canal. The digitized cross-sections from the mapping (Ref. 1), of which cross-section locations are shown on Exhibit 3, were utilized to determine this floodplain width for plotting on Exhibit 3.

This updated Approximate Zone A was transmitted to the FCDMC and the City of Mesa in a letter form A-N West (Ref. 10) with supportive preliminary mapping and data table.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

4.1 Floodplain Boundaries

For the streams studied, the flood boundaries were delineated using the topographic maps at a scale of 1:2,400 and with contour interval of 2 feet (Ref. 1).

The effective (Ref. 10) and updated Approximate Zone A 100-year floodplain boundaries are shown on the Flood Insurance Rate Map (Exhibit 3). On this map, the 100-year floodplain boundary corresponds to the boundary of the areas of special flood hazard. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

No floodway was prepared for this study.

5.0 INSURANCE APPLICATION

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone A
Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by approximate methods. Because detailed hydraulic analyses are not performed for such area, no base flood elevations or depths are shown within this zone.

Zone AO
Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths area between 1.0 and 3.0 feet; depths are shown, but no FHFs are determined.

Zone AH
Zone AH is the flood insurance rate zone that corresponds to the areas of 100-year shallow flooding with a constant water-surface elevation (usually areas of ponding) where average depths are between 1 and 3 feet. The BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AE
Zone AE is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by detailed methods. In most instances, whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X
Zone X is the flood insurance rate zone that corresponds to areas outside the 100-year floodplain, and areas of 100-year sheet flow flooding where average depths are less than 1 foot; areas of 100-year stream flooding, where the contributing drainage area is less than one square mile; or areas protected

from the 100-year flood by levees. No base flood elevations or depths are shown within this zone.

6.0 OTHER STUDIES

No previous FEMA Flood Insurance Studies were found for the study area. The effective FEMA Flood Hazard Zone for the study area was an approximate Zone A (no discharges or BFE's presented).

7.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, FEMA, Presidio of San Francisco, Building 105, San Francisco, California, 94129.

8.0 BIBLIOGRAPHY AND REFERENCES

1. Aerial Mapping Company, Inc., Phoenix, Arizona, Aerial Photography (1:8400 Scale) and 200 Scale, 2 Foot Contour Mapping. Photography Flown: March 20, 1996.

2. U.S. Department of Army, Corps of Engineers, Hydrologic Engineering Center, Davis California 95616, HEC-2 Computer Program, Water Surface Profiles Version 4.6.2.. Dated May, 1992.

3. U.S. Geological Survey, Water Resources Division, 375 South Euclid Avenue, Tucson, Arizona 85719, Estimated Manning's Roughness Coefficients for Stream Channels and Floodplains in Maricopa County, Arizona, by B.W. Thompson and H.W. Hjalmarson, for Flood Control District of Maricopa County; April, 1991.

4. Hydrology Report for Eastern Canal, FCD No. 96-10, by Primatech Engineers.

5. U.S. Department of Army, Corps of Engineers, Hydrologic Engineering Center, Davis California 95616, HEC-1 Flood Hydrograph Package Computer Program, Version 4.0, September, 1990.

6. Hydrologic Design Manual for Maricopa County, Arizona, prepared by Special Projects Branch, Hydrology Division, Flood Control District of Maricopa County, Dated: September, 1990 with June, 1992 revisions.

7. Estimating Manning's Roughness Coefficients for Stream Channels and Floodplain in Maricopa County, Arizona, prepared by U.S. Geological Survey, Water Resources Division, prepared for Flood Control District of Maricopa County, April, 1994.

8. Chow, Ven T., Open Channel Hydraulics, New York: McGraw-Hill Book Company 1959.

9. A-N West letter report of May 1, 1997 to Flood Control District of Maricopa County and the City of Mesa transmitting preliminary hydraulic HEC-2 model analysis results which identified numerous breakouts over the Eastern Canal.

10. A-N West letter of May 15, 1997 to Flood Control District of Maricopa County and the City of Mesa transmitting preliminary updated Approximate Zone A 100-year floodplain mapping and data table.

11. Flood Insurance Rate Maps (FIRMs), Federal Emergency Management Agency, Maricopa County, Arizona and Incorporated Areas, Panel 2215 (effective date 12/3/93), and Panels 2185D and 2195D (effective date 4/15/88) of 4530.

Ernest F. Brater and Horace Williams King, Handbook of Hydraulics, Sixth Edition, New York: McGraw-Hill Book Company, 1976.

U.S. Geological Survey, Topographic Maps, 7.5 Minute Series: Buckhorn, Arizona; 1956, Photo Revision 1982 and Mesa, Arizona, A52, Photo Revision, 1982.

U.S. Department of Transportation, Federal Highway Administration, Hydraulic Charts for the Selection of Highway Culverts, Hydrologic Engineering Circular No. 5 (HEC-5), December, 1965.

FEDERAL EMERGENCY MANAGEMENT AGENCY **REVISION REQUESTER AND COMMUNITY OFFICIAL FORM**	O.M.B No. 3067-0148 Expires July 31, 1997

Public reporting burden for this form is estimated to average 2.13 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing and reviewing the form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, Federal Emergency Management Agency, 500 C Street, S.W., Washington DC 20472; and to the Office of Management and Budget, Paperwork Reduction Project (3067-0148), Washington, DC 20503.

You are not required to respond to this collection of information unless a valid OMB Control Number is displayed in the upper right corner of this form.

1. REQUESTED RESPONSE FROM FEMA

This request is for a:

☐ CLOMR A letter from FEMA commenting on whether a proposed project, if built as proposed, would justify a map revision, or proposed hydrology changes (See 44 CFR Ch. 1, Parts 60,65 & 72).

☒ LOMR A letter from FEMA officially revising the current NFIP map to show the changes to floodplains, floodway or flood elevations. LOMRs typically decrease flood hazards. (See 44 CFR Ch. 1 Parts 60 & 65.)

☐ Other Describe: _____

2. OVERVIEW

1. The basis for this revision request is (are): (check all that apply)

☐ Physical Change ☒ Improved Methodology/Data ☐ Floodway Revision

☐ Other Describe: New and more detailed mapping

Note: A photograph is not required, but is very helpful during review.

2. Flooding Source: Ponding along upslope side of Eastern Canal

3. Project Name/Identifier: Eastern Canal

4. FEMA zone designations affected: Approximate Zone A
(example: A, AH, AO, A1-A30, A99, AE, V, V1-V30, VE, B, C, D, X)

5. The NFIP map panel(s) affected for all impacted communities is (are):

Community No.	Community Name	State	Map No.	Panel No.	Effective Date
Ex: 480301 480287	Katy, City Harris County	TX TX	480301 48201C	0005D 0220G	02/08/83 09/28/90
040048	City of Mesa	AZ	04013C	2185D	4/15/88
040048	City of Mesa	AZ	04013C	2195D	4/15/88
040048	City of Mesa	AZ	04013C	2215F	12/3/93

6. The area of revision encompasses the following types of flooding and structures. Check all that apply.

Types of Flooding	Structures
☐ Riverine	☐ Channelization
☐ Coastal	☐ Levee/Floodwall
☐ Alluvial fan	☐ Bridge/Culvert
☒ Shallow Flooding (e.g. Zones AO and AH) Zone A	☐ Dam
☐ Lakes	☐ Fill
☐ Other (describe)	☐ Other (describe)

PLEASE REFER TO THE INSTRUCTIONS FOR THE APPROPRIATE MAILING ADDRESS

T.D.M. 9.2

4. ENCROACHMENT INFORMATION

1. Does the State have jurisdiction over the floodway or its adoption by communities participating in the NFIP? ☐ Yes ☐ No N/A

If Yes, attach a copy of a letter notifying the appropriate State agency of the floodway revision and documentation of the approval of the revised floodway by the appropriate State agency.

2. Does the development in the floodway cause the 1% annual chance (base) elevation to increase at any location by more than 0.000 feet? ☐ Yes ☐ No ☐ N/A

3. Does the cumulative effect of all development that has occurred since the effective SFHA was originally identified cause the base flood elevation to increase at any location by more than one foot (or other increase limit if community or state has adopted more stringent criteria - even if a floodway has not been delineated by FEMA)? ☐ Yes ☐ No

If the answer to either items is Yes, please attach documentation that all requirements of Section 65.12 of the NFIP regulations have been met, regarding evaluation of alternatives, notice to individual legal property owners, concurrence of CEO, and certification that no insurable structures are impacted.

5. MAINTENANCE RESPONSIBILITY

The community is willing to assume responsibility for ☐ performing ☐ overseeing compliance with the maintenance and operation plans of the _____
(Name)
flood control structure. If not performed promptly by an owner other than the community, the community will provide the necessary services without cost to the Federal government.

Operation and maintenance plans are attached. ☐ **Yes** ☐ **No** ☒ **N/A**

6. REVIEW FEE

The review fee for the appropriate request category has been included. ☐ Yes Fee amount: $_____

OR

This request is based on a federally sponsored flood-control project where 50 percent or more of the project's cost is federally sponsored, or the request is based on detailed hydrologic and hydraulic studies conducted by Federal, State, or local agencies to replace approximate studies conducted by FEMA and shown on the effective FIRM; thus the project is fee exempt.
☐ Yes

Please see Instructions for Fee Amounts

7. SIGNATURE

Note: **I understand that my signature indicates that all information submitted in support of this request is correct**

Signature of Revision Requester

Printed Name and Title of Revision Requester

Company Name

Telephone No. Date

Note: **Signature indicates that the community understands, from the revision requester, the impacts of the revision on flooding conditions in the community.**

Signature of Community Official

Printed Name and Title of Community Official

Community Name

Telephone No. Date

CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER AND/OR LAND SURVEYOR

This certification is in accordance with 44 CFR Ch. 1, Sect 65.2

Gregory A. Schuelke

Signature

Gregory A. Schuelke

Printed Name and Title of Revision Requester

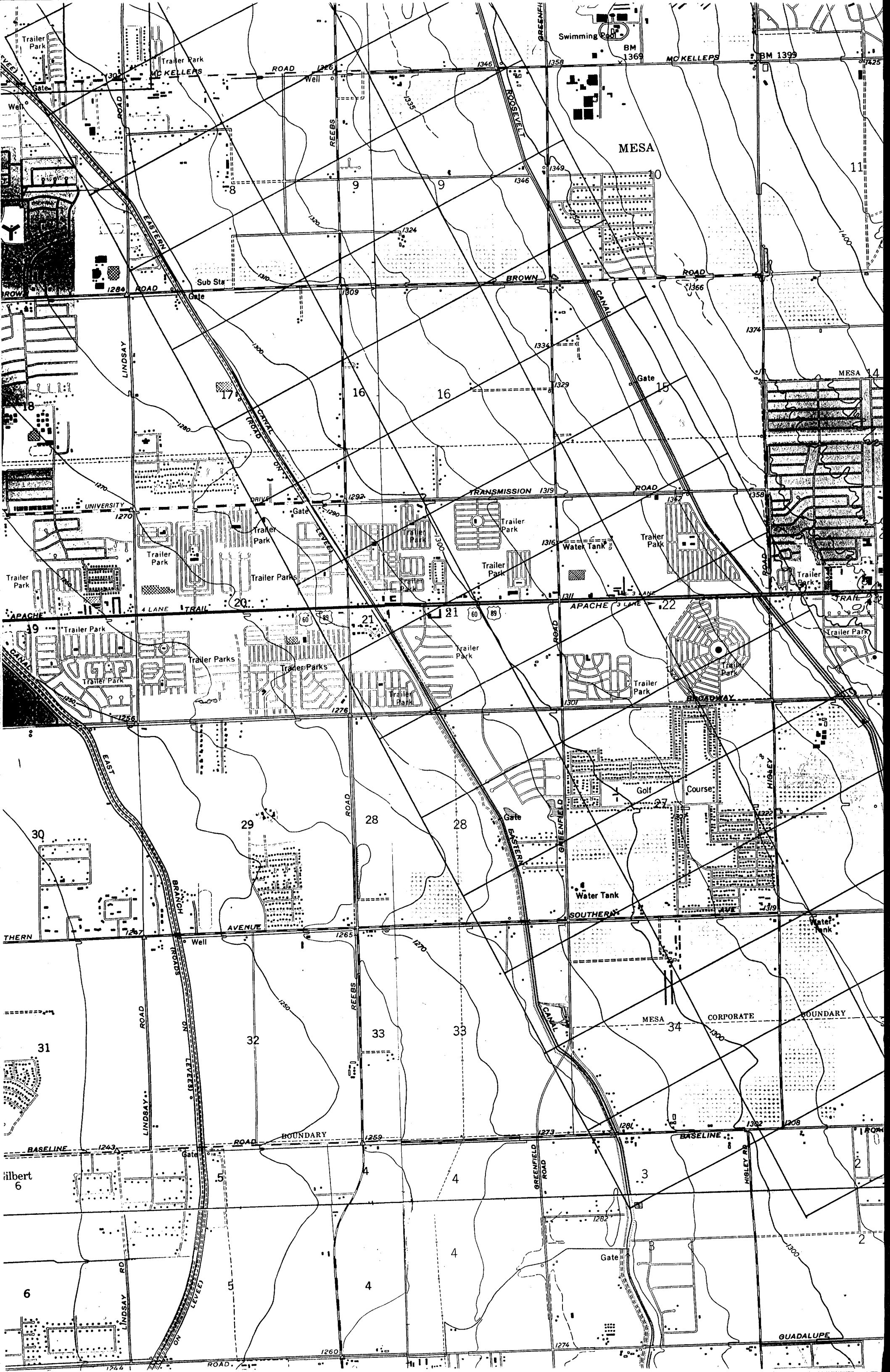
Registr No. 15290 Expires (Date) 6/30/98 State AZ

Type of License/Expertise: Civil Engineer

Certification limited to Floodplain Delineation, Mapping and Field Survey by Others.

Check which forms have been included with this request

Form Name and (Number)	Required if .....
☐ **Hydrologic** (3)	new or revised discharges
☐ **Hydraulic** (4)	new or revised water-surface elevations
☐ **Mapping** (5)	floodplain/floodway changes
☐ **Channelization** (6)	channel is modified
☐ **Bridge/Culvert** (7)	addition/revision of bridge/culvert
☐ **Levee/Floodwall** (8)	addition/revision of levee/floodwall
☐ **Coastal** (9)	new or revised coastal elevations
☐ **Coastal Structures** (10)	addition/revision of coastal structure
☐ **Dam** (11)	addition/revision of dam
☐ **Alluvial Fan** (12)	structures proposed on alluvial fan


Trailer Park
Trailer Park
MC KELLEPS
ROAD
Well
Gate
Well
ROAD
REEBS
ROOSEVELT
GREENFIELD
Swimming Pool
BM 1369
MC KELLEPS
BM 1399
MESA
EASTERN
Sub Sta
Gate
BROWN
ROAD
CANAL
LINDSAY
CANAL
ROAD
Gate
MESA
UNIVERSITY
DRIVE
Gate
LEVEE
TRANSMISSION
ROAD
Trailer Park
Trailer Park
Trailer Park
Trailer Park
Trailer Park
Water Tank
Trailer Park
Trailer Park
Trailer Parks
APACHE
4 LANE
TRAIL
APACHE
3 LANE
TRAIL
Trailer Park
Trailer Park
Trailer Parks
Trailer Parks
Trailer Park
Trailer Park
Trailer Park
Trailer Park
Trailer Park
BROADWAY
CANAL
EAST
ROAD
Golf
Course
HIGLEY
Gate
EASTERN
GREENFIELD
Water Tank
SOUTHERN
AVE
Water Tank
THERN
AVENUE
Well
BRANCH
ROADS
ON
LEVEES
LINDSAY
ROAD
REEBS
CANAL
MESA
CORPORATE
BOUNDARY
BASELINE
ROAD
BOUNDARY
Gilbert
Gate
GREENFIELD
ROAD
HIGLEY RD
BASELINE
Gate
LINDSAY
RD
ON
LEVEE
GUADALUPE
ROAD

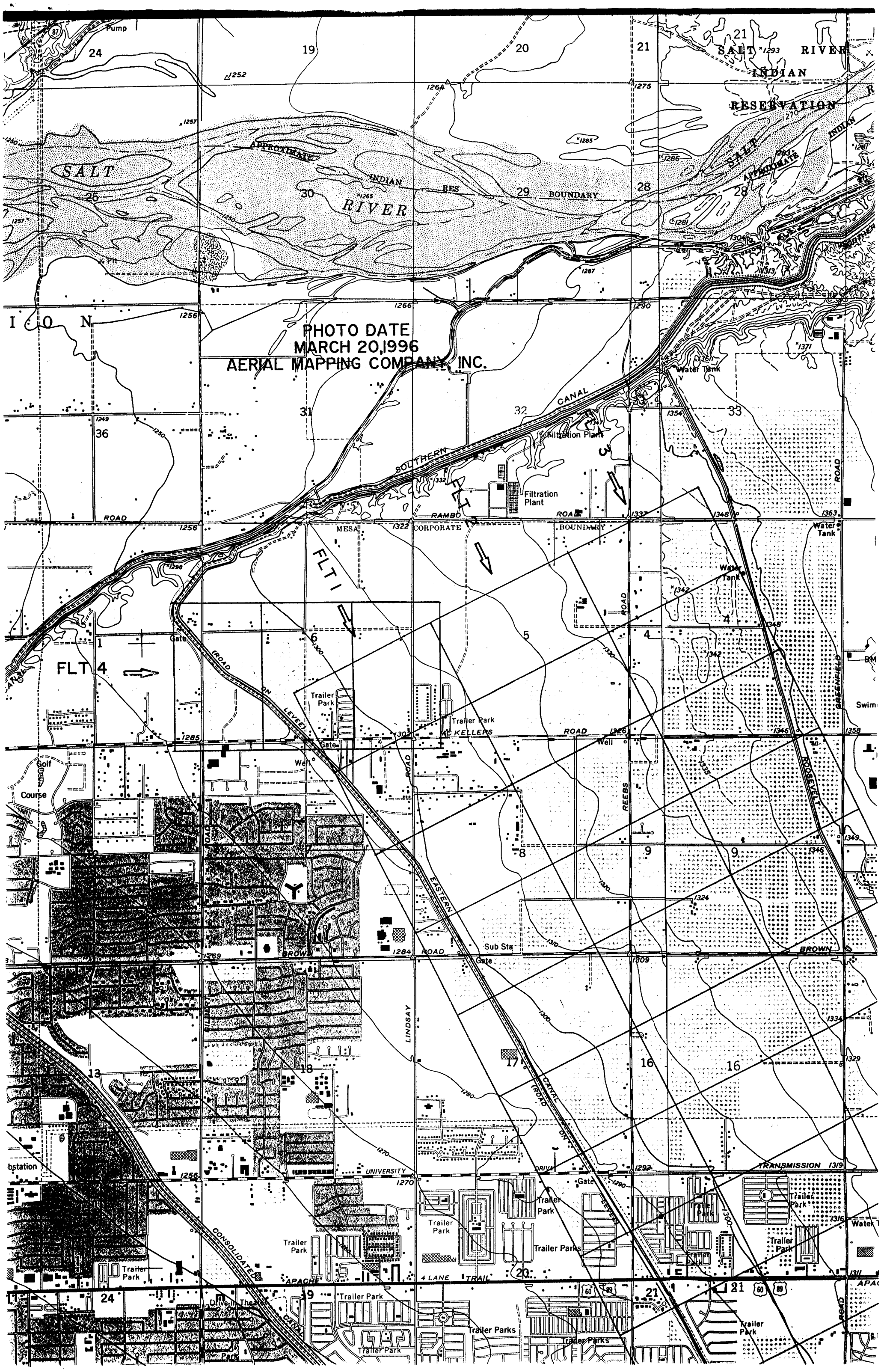


PHOTO DATE
MARCH 20,1996
AERIAL MAPPING COMPANY, INC.
SALT RIVER INDIAN RESERVATION
SALT RIVER
APPROXIMATE INDIAN RES BOUNDARY
FLT 1
FLT 4
SOUTHERN CANAL
Filtration Plant
Water Tank
Trailer Park
Trailer Parks
Golf Course
Sub Sta
Gate
Well
Pump
Pit
RAMBO ROAD
MESA CORPORATE BOUNDARY
McKELLERS ROAD
BROWN ROAD
UNIVERSITY DRIVE
APACHE TRAIL
4 LANE
CONSOLIDATED CANAL
EASTERN CANAL
ROOSEVELT ROAD
GREENFIELD ROAD
REEBS ROAD
LINDSAY ROAD
TRANSMISSION
Drive-in Theatre
Swim
Park