NOT FEMA APPROVED

TECHNICAL DATA NOTEBOOK:

Approximate Zone A Floodplain Delineation Study of White Tank

Fans 7, 8 & 12

Flood Control District of Maricopa County

December 2007

Important Notice:

Not Yet Approved by FEMA

Subject to Change per FEMA Review

NOT FEMA APPROVED

TECHNICAL DATA NOTEBOOK:

APPROXIMATE ZONE A
FLOODPLAIN DELINEATION STUDY
of
WHITE TANK FANS 7, 8, & 12

FCD CONTRACT NO. 2005 C024

Task 8

December 2007

Prepared for:

Flood Control District of Maricopa County

2801 W. Durango Street

Phoenix, AZ 85009

(602) 506-1501

Prepared by:

JE Fuller/ Hydrology & Geomorphology

8400 S. Kyrene Rd., Suite 201

Tempe, Arizona 85284

(480) 752-2124

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

26840
JONATHAN E.
FULLER
Date Signed 12-24-07
ARIZONA, U.S.A.

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Appendix E: Hydraulic Analysis Supporting Documentation
Appendix F: Erosion/Sediment Transport
Appendix G: Geomorphology Analyses Supporting Documentation

DISKETTES

Digital data files on CD with a copy of the "readme" file

EXHIBITS

A. Hydrology Plates
- **Hydrologic Subbasins**
- **NRCS Soils and XKSAT**
- **Existing Land Use**

B. Geomorphology Exhibit Maps
- **Stage 1 - Landform Map**
- **Stage 2 - Stability Map**
- **Stage 3 – Floodplain Map**

C. Hydraulics Study Work Maps

1. INTRODUCTION

1.1 Study Purpose

The purpose of this floodplain delineation study is to delineate an approximate method 100-year floodplain for alluvial fan Sites 7, 8 and 12 on the White Tank Piedmont as identified in the Buckeye Sun Valley Area Drainage Master Study (PBSJ, 2005). The names, Sites 7, 8 and 12, will be used frequently in this report to refer to the alluvial fans which are the subject of this report, to distinguish them from other alluvial fans on the western piedmont of the White Tank Mountains. This study incorporates the assessment methods for piedmont flood hazards as outlined in Piedmont Flood Hazard Assessment Manual for Maricopa County (PFHAM) (Hjalmarson, 2003) and for alluvial fans in the Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix G: Guidance for Alluvial Fan Flooding Analyses and Mapping (FEMA Guidelines) (FEMA, 2002), as well as approximate method riverine floodplain delineations for reaches upstream of the alluvial fan apex.

1.2 Study Authority

The current study was authorized by the Flood Control District of Maricopa County (District) under contract FCD 2005 C024, Task 8. The study was performed by JE Fuller/Hydrology & Geomorphology, Inc. on behalf of the District.

1.3 Study Location

Figure 1.1 shows the location of the White Tank Mountain Piedmont study area. Figure 1.2 shows the Sites 7, 8 and 12 alluvial fans and their watersheds. The study area is located in western Maricopa County, Arizona, within the Town of Buckeye and portions of unincorporated Maricopa County. The piedmont watershed heads in the White Tank Mountains and generally drains toward the Hassayampa River, or one of its tributaries. Some piedmont runoff outfalls at the Buckeye Flood Retarding Structures (FRS) before being released into the Hassayampa River.

The study area has a semi-arid desert climate with an average annual precipitation of generally less than 10 inches. Precipitation is typically divided between two seasons with comparable rainfall amounts: summer and winter. Summer storms are associated with warm, moist tropical air masses that enter the state from the Gulf of Mexico and Gulf of California, producing moderate to intense localized thundershowers. Winter precipitation usually originates from the Pacific Ocean and produces light to moderate precipitation over relatively large areas. A third source of precipitation is from dissipating

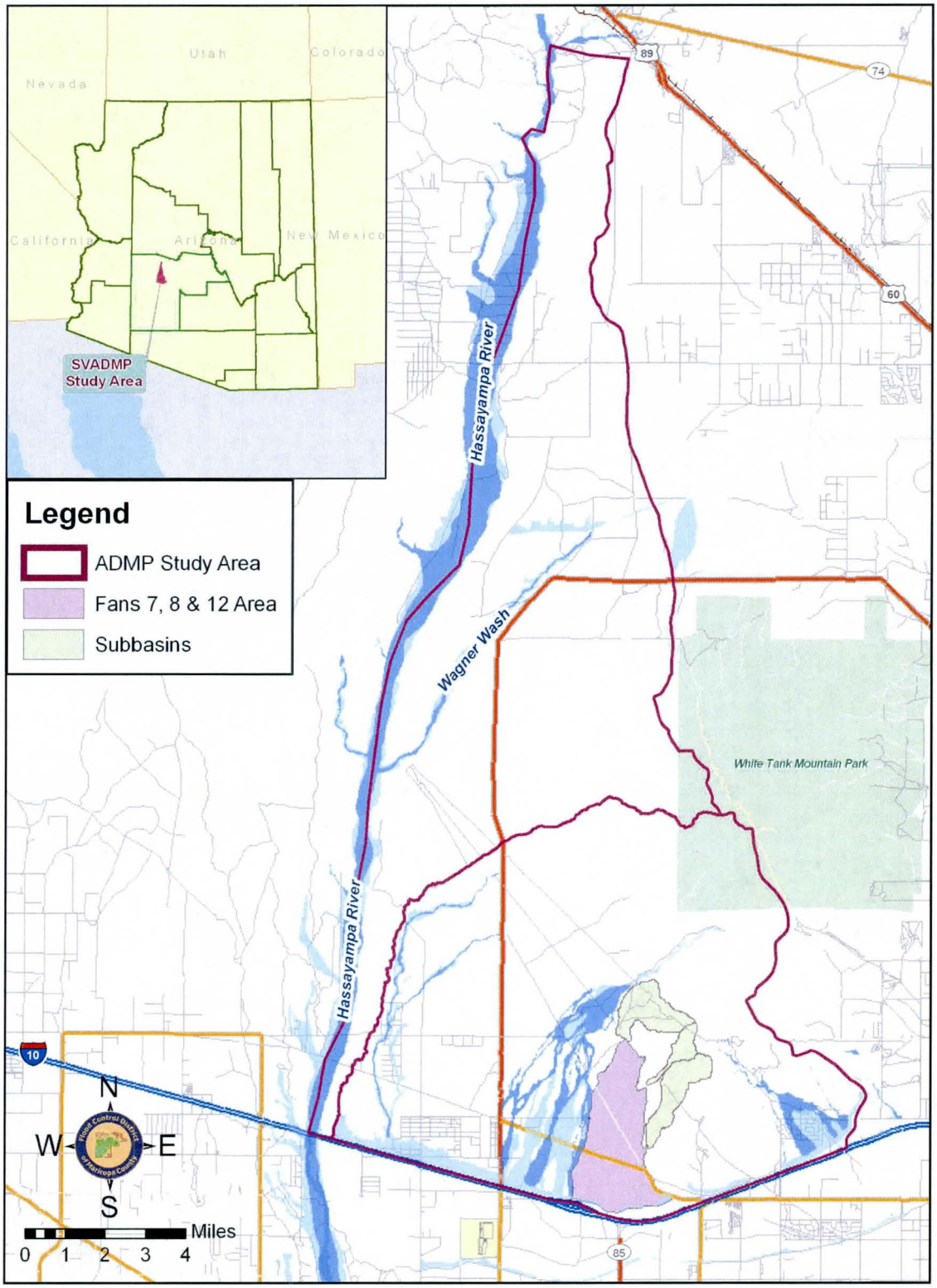

Figure 1.1Location of Study Area

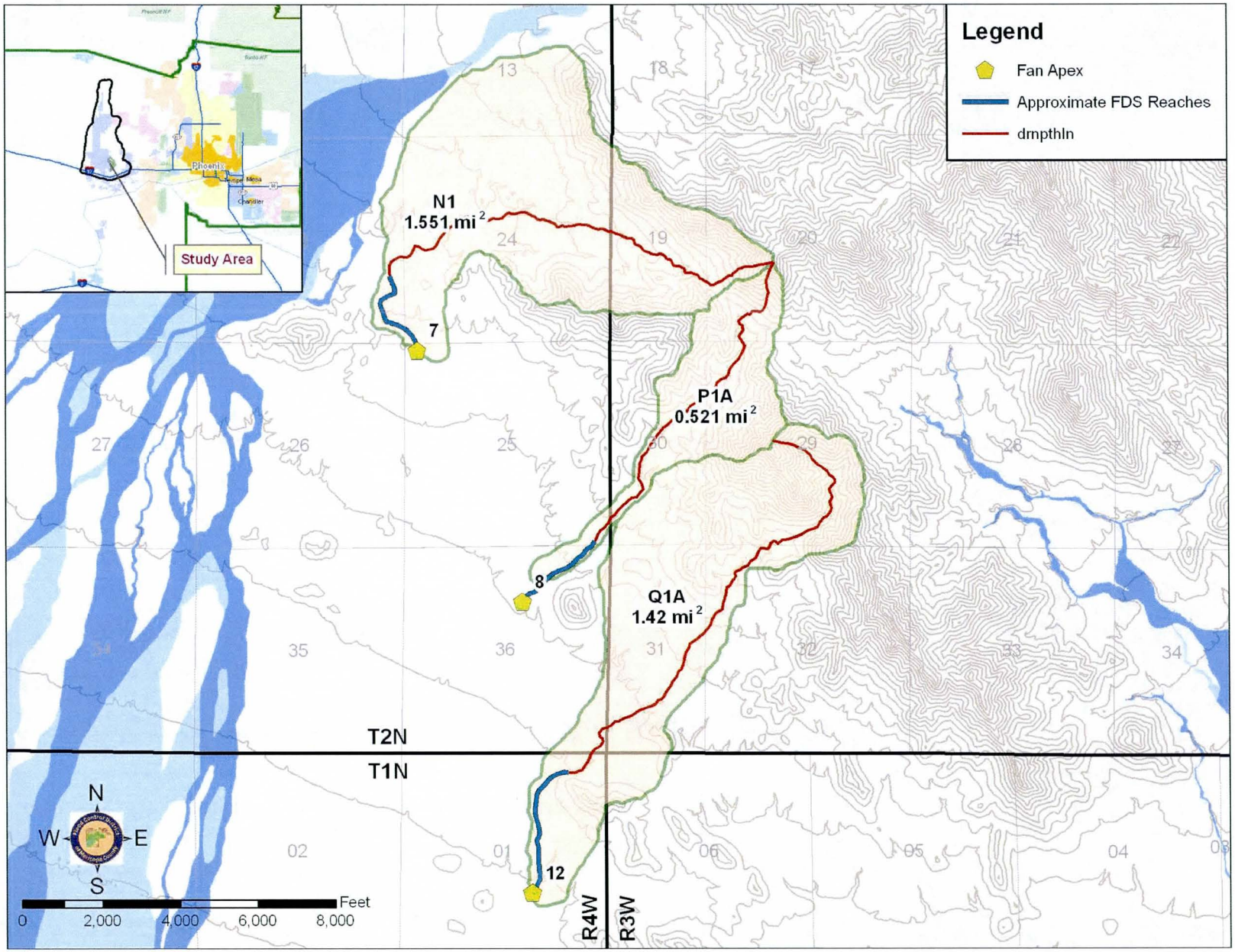

Figure 1.2 Location of Fan Study Area

tropical storm and/or hurricane remnants, which typically occur in fall, and which generate moderate to high rainfall intensities of moderate to long duration.

1.4 Methodology

This study used methods outlined in the Drainage Design Manuals for Maricopa County. In addition, the study uses piedmont flood hazard assessment methods outlined in the District's PFHAM and in the FEMA Guidelines. These two documents were published in response to the National Research Council's Alluvial Fan Flooding report (NRC, 1996). The FEMA Guidelines are targeted at determination of flood hazards on alluvial fan landforms. The PFHAM, which is recommended for use in Maricopa County, Arizona, is intended to be applicable to the entire piedmont, not just alluvial fans. The PFHAM methodology incorporates geomorphic methods into the flood hazard assessment of piedmont surfaces. According to the FEMA Guidelines, the geomorphic approach is considered an "approximate method" (FEMA Guidelines p. G-12, Table G-1) because no base flood elevations are calculated.

1.4.1 Hydrology

The U.S. Army Corps of Engineers HEC-1 model (version 4.1) was used to compute runoff hydrographs and peak discharges. Parameters were processed into HEC-1 through the DDMSW version 3.2.8 software from the FCDMC. Documentation of the hydrologic modeling for this study is provided in Section 4.0 of this Technical Documentation Notebook (TDN).

1.4.2 Hydraulics

The U.S Army Corps of Engineers HEC-RAS model (version 3.1.3) was used to compute the water surface profiles used for the riverine approximate floodplain delineations upstream of the Site 7, 8 and 12 alluvial fan hydrographic apexes. A description of the approximate method riverine floodplain delineation is provided in Section 5.0 of this TDN.

1.4.3 Geomorphology

Geomorphic methods that incorporate landform characteristics, surficial geologic mapping, soils mapping, field observations and aerial photograph interpretation as described in the PFHAM and FEMA Guidelines were used to delineate floodplains on the alluvial fan surfaces. A description of the geomorphic method floodplain delineation is provided in Section 6B of this TDN.

1.5 Acknowledgements

This study was funded entirely by the Flood Control District of Maricopa County. Assistance and review from their staff was critical to the success of this project. In addition, staff at the Town of Buckeye supplied valuable information used in the completion of this project.

1.6 Study results

The study resulted in the delineation of 1.7 miles of approximate riverine 100-year floodplain and 5.75 square miles of alluvial fan floodplain. The inundation areas for the newly delineated floodplains are shown on the maps in Section 6B and 7 and the Exhibit Maps at the end of this notebook. The floodplain mapping also includes administrative flood hazard zones defined by the Flood Control District of Maricopa County for the local management of flood hazards on the alluvial fan.

2. ADWR/FEMA FORMS

2.1 Study Documentation Abstract for FEMA Submittals

Study Documentation Abstract For FEMA Submittals		Initial Study	Restudy	CLOMR	LOMR	X	Other
2.1.1	Date Study Accepted						
2.1.2	Study Prime Contractor	JE Fuller / Hydrology and Geomorphology, Inc.					
	Contact(s)	Brian R. Iserman, P.E. & Jonathan E. Fuller, P.E., R.G., CFM					
	Address	8400 S. Kyrene Rd., Suite 201 Tempe, AZ 85284					
	Phone	(480) 752-2124					
	Internal Reference Number	2005C024					
2.1.2	Study Sub-Contractor	None					
	Contact(s)						
	Address						
	Phone						
	Internal Reference Number						
2.1.2	Sub Study Sub-Contractor						
	Contact(s)						
	Address						
	Phone						
	Internal Reference Number						
2.1.3	FEMA Technical Review						
	Contractor	Michael Baker, Jr.					
	Contact(s)	Mounir Boudjemaa					
	Address	3600 Eisenhower Ave. Suite 600 Alexandria, VA 22304					
	Phone	703-960-8800					
	Internal Reference Number						
2.1.4	FEMA Regional Reviewer	Michael Baker, Jr. Engineering					
	Phone	(703) 960-8800					
2.1.5	State Technical Reviewer	None					
	Phone						
2.1.6	Local Technical Reviewer	Flood Control District of Maricopa County (FCDMC) Kathryn Gross, CFM					
	Phone	(602) 506-1501					
2.1.7	Reach Description	White Tank Mountains Fans 7, 8, 12					
2.1.8	USGS Quad Sheet(s) with original photo date & latest photo revision date	Valencia, Arizona, 1954, Photo revision 1978 Buckeye NW, Arizona, 1958, Photo revision 1982					
2.1.9	Unique Conditions and Problems	Alluvial Fan Flooding					
2.1.10	Coordination of Peak Discharges (Agency, Date, Comments)	FCDMC – Sun Valley ADMS (2005); Sun Valley ADMP (2006) Existing Conditions HEC-1 Model Results					

2.2 FEMA Forms

FEDERAL EMERGENCY MANAGEMENT AGENCY

OVERVIEW & CONCURRENCE FORM

O.M.B No. 3067-0148
Expires September 30, 2005

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 1 hour per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this 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, SW, Washington DC 20472, Paperwork Reduction Project (3067-0148). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

A. REQUESTED RESPONSE FROM FEMA

This request is for a (check one):

☐ 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, regulatory floodway or flood elevations. (See Parts 60 & 65 of the NFIP Regulations.)

B. OVERVIEW

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

Community No.	Community Name	State	Map No.	Panel No.	Effective Date
040037 040039	Maricopa County, Arizona and Unincorporated Areas Town of Buckeye	AZ	04013C	2010 H	9/30/2005
040037 040039	Maricopa County, Arizona and Unincorporated Areas Town of Buckeye	AZ	04013C	2030H	9/30/2005
040037 040039	Maricopa County, Arizona and Unincorporated Areas Town of Buckeye	AZ	04013C	2040H	9/30/2005
040037 040039	Maricopa County, Arizona and Unincorporated Areas Town of Buckeye	AZ	04013C	2040G	9/30/2005

2. Flooding Source: White Tank Mountains Fans 7, 8, 12

3. Project Name/Identifier: Approximate Zone A Floodplain Delineation Study of White Tank Fans 7, 8, & 12

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

5. Basis for Request and Type of Revision:

a. The basis for this revision request is (check all that apply)

☐ Physical Change ☒ Improved Methodology/Data

☐ Regulatory Floodway Revision ☐ Other (Attach Description)

Note: A photograph and narrative description of the area of concern is not required, but is very helpful during review.

b. The area of revision encompasses the following types of flooding and structures (check all that apply)

Types of Flooding: ☒ Riverine ☐ Coastal ☐ Shallow Flooding (e.g., Zones AO and AH)

☒ Alluvial fan ☐ Lakes ☐ Other (Attach Description)

Structures: ☐ Channelization ☐ Levee/Floodwall ☐ Bridge/Culvert

☐ Dam ☐ Fill ☐ Other, Attach Description

C. REVIEW FEE

Has the review fee for the appropriate request category been included?

☐ Yes Fee amount: $_____

☒ No, Explanation: New Delineation by Agency

Map changes based on flood hazard information meant to improve upon that shown on the flood map or within the flood study.
Please see the FEMA Web site at http://www.fema.gov/mit/tsd/frm_fees.htm **for Fee Amounts and Exemptions.**

D. SIGNATURE

All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Name: Kathryn Gross, CFM, Project Manager	Company: Flood Control District of Maricopa County	
Mailing Address: 2801 West Durango Street Phoenix, AZ 85009	Daytime Telephone No.: (602) 506 1501	Fax No.: 602-506-4601
	E-Mail Address: kag@mail.maricopa.gov	
Signature of Requester (required):		Date:

As the community official responsible for floodplain management, I hereby acknowledge that we have received and reviewed this Letter of Map Revision (LOMR) or conditional LOMR request. Based upon the community's review, we find the completed or proposed project meets or is designed to meet all of the community floodplain management requirements, including the requirement that no fill be placed in the regulatory floodway, and that all necessary Federal, State, and local permits have been, or in the case of a conditional LOMR, will be obtained. In addition, we have determined that the land and any existing or proposed structures to be removed from the SFHA are or will be reasonably safe from flooding as defined in 44CFR 65.2(c), and that we have available upon request by FEMA, all analyses and documentation used to make this determination.

Community Official's Name and Title:		Telephone No.:
Community Name:	Community Official's Signature (required):	Date:

CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER AND/OR LAND SURVEYOR

This certification is to be signed and sealed by a licensed land surveyor, registered professional engineer, or architect authorized by law to certify elevation information. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name: Jonathan Fuller, P.E.	License No.: 26846	Expiration Date: March 31, 2008
Company Name: JE Fuller/Hydrology & Geomorphology, Inc.	Telephone No.: 480-752-2124	Fax No.: 480-839-2193
Signature:		Date: 12.24.07

ENSURE THE FORMS THAT ARE APPROPRIATE TO YOUR REVISION REQUEST ARE INCLUDED IN YOUR SUBMITTAL.

Form Name and (Number)	Required if ...
☒ Riverine Hydrology and Hydraulics Form (Form 2)	New or revised discharges or water-surface elevations
☐ Riverine Structures Form (Form 3)	Channel is modified, addition/revision of bridge/culverts, addition/revision of levee/floodwall, addition/revision of dam
☐ Coastal Analysis Form (Form 4)	New or revised coastal elevations
☐ Coastal Structures Form (Form 5)	Addition/revision of coastal structure
☒ Alluvial Fan Flooding Form (Form 6)	Flood control measures on alluvial fans

Registered Professional Engineer (Civil)
CERTIFICATE NO. 26846
JONATHAN E. FULLER
Date Signed 12-24-07
ARIZONA, U. S. A.

Seal (Optional)

D. SIGNATURE (continued)

All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Name: Kathryn Gross, CFM, Project Manager	Company: Flood Control District of Maricopa County	
Mailing Address: 2801 West Durango Street Phoenix, AZ 85009	Daytime Telephone No.: (602) 506 1501	Fax No.: 602-506-4601
	E-Mail Address: mwd@mail.maricopa.gov	
Signature of Requester (required):		Date:

As the community official responsible for floodplain management, I hereby acknowledge that we have received and reviewed this Letter of Map Revision (LOMR) or conditional LOMR request. Based upon the community's review, we find the completed or proposed project meets or is designed to meet all of the community floodplain management requirements, including the requirement that no fill be placed in the regulatory floodway, and that all necessary Federal, State, and local permits have been, or in the case of a conditional LOMR, will be obtained. In addition, we have determined that the land and any existing or proposed structures to be removed from the SFHA are or will be reasonably safe from flooding as defined in 44CFR 65.2(c), and that we have available upon request by FEMA, all analyses and documentation used to make this determination.

Community Official's Name and Title:		Telephone No.:
Community Name:	Community Official's Signature (required):	Date:

CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER AND/OR LAND SURVEYOR

This certification is to be signed and sealed by a licensed land surveyor, registered professional engineer, or architect authorized by law to certify elevation information. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name: Jonathan Fuller, P.E.	License No.: 26846	Expiration Date: March 31, 2008
Company Name: JE Fuller/Hydrology & Geomorphology, Inc.	Telephone No.: 480-752-2124	Fax No.: 480-839-2193
Signature:		Date: 12.24.07

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE HYDROLOGY AND HYDRAULICS FORM

O.M.B No. 3067-0148
Expires September 30, 2005

PAPERWORK REDUCTION ACT

Public reporting burden for this form is estimated to average 3 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this 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, SW, Washington DC 20472, Paperwork Reduction Project (3067-0148). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

Flooding Source: White Tank Mountains Fans 7
Note: Fill out one form for each flooding source studied

A. HYDROLOGY

1. Reason for New Hydrologic Analysis (check all that apply)

☐ Not revised (skip to section 2) ☒ No existing analysis ☒ Improved data
☐ Alternative methodology ☐ Proposed Conditions (CLOMR) ☐ Changed physical condition of watershed

2. Comparison of Representative 1%-Annual-Chance Discharges

Location	Drainage Area (Sq. Mi.)	FIS (cfs)	Revised (cfs)

3. Methodology for New Hydrologic Analysis (check all that apply)

☐ Statistical Analysis of Gage Records ☒ Precipitation/Runoff Model HEC-1 [TR-20, HEC-1, HEC-HMS etc.]
☐ Regional Regression Equations ☐ Other (please attach description)

Please enclose all relevant models in digital format, maps, computations (including computation of parameters) and documentation to support the new analysis. The document, "Numerical Models Accepted by FEMA for NFIP Usage" lists the models accepted by FEMA. This document can be found at: http://www.fema.gov/mit/tsd/en_modl.htm.

4. Review/Approval of Analysis

If your community requires a regional, state, or federal agency to review the hydrologic analysis, please attach evidence of approval/review.

5. Impacts of Sediment Transport on Hydrology

Was sediment transport considered? ☐ Yes ☒ No If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation for why sediment transport was not considered. Explanation: Sediment transport is not an element in the local approved hydrologic modeling procedures, nor is it a variable in the local USGS discharge regression equations. Sediment transport is considered explicitly in the alluvial fan floodplain delineation.

B. HYDRAULICS

1. Reach to be Revised: No existing delineations are revised. New approximate riverine delineations are submitted upstream of fan apexes.

	Description	Cross Section	Water-Surface Elevations (ft.)	
			Effective	Proposed/Revised
Downstream Limit	See attached annotated FIRMs			
Upstream Limit	See attached annotated FIRMs			

2. Hydraulic Method Used

Hydraulic Analysis HEC-RAS [HEC-2 , HEC-RAS, Other (Attach description)]

B. HYDRAULICS (CONTINUED)

3. Pre-Submittal Review of Hydraulic Models

FEMA has developed two review programs, CHECK-2 and CHECK-RAS, to aid in the review of HEC-2 and HEC-RAS hydraulic models, respectively. These review programs verify that the hydraulic estimates and assumptions in the model data are in accordance with NFIP requirements, and that the data are comparable with the assumptions and limitations of HEC-2/HEC-RAS. CHECK-2 and CHECK-RAS identify areas of potential error or concern. These tools do not replace engineering judgment. CHECK-2 and CHECK-RAS can be downloaded from http://www.fema.gov/mit/tsd/frm_soft.htm. We recommend that you review your HEC-2 and HEC-RAS models with CHECK-2 and CHECK-RAS. If you disagree with a message, please attach an explanation of why the message is not valid in this case. Review of your submittal and resolution of valid modeling discrepancies will result in reduced review time.

HEC-2/HEC-RAS models reviewed with CHECK-2/CHECK-RAS? ☐ Yes ☒ No

4. Models Submitted

Duplicate Effective Model*	Natural File Name:	Floodway File Name:
Corrected Effective Model*	Natural File Name:	Floodway File Name:
Existing or Pre-Project Conditions Model	Natural File Name: Fan7_8_12	Floodway File Name: Fan7_8_12
Revised or Post-Project Conditions Model	Natural File Name:	Floodway File Name:
Other - (attach description)	Natural File Name:	Floodway File Name:

*Not required for revisions to approximate 1%-annual-chance floodplains (Zone A) – for details, refer to the corresponding section of the instructions.

The document "Numerical Models Accepted by FEMA for NFIP Usage" lists the models accepted by FEMA. This document can be found at:

http://www.fema.gov/mit/tsd/en_modl.htm.

C. MAPPING REQUIREMENTS

A **certified topographic map** must be submitted showing the following information (where applicable): the boundaries of the effective, existing, and proposed conditions 1%-annual-chance floodplain (for approximate Zone A revisions) or the boundaries of the 1%- and 0.2%-annual-chance floodplains and regulatory floodway (for detailed Zone AE, AO, and AH revisions); location and alignment of all cross sections with stationing control indicated; stream, road, and other alignments (e.g., dams, levees, etc.); current community easements and boundaries; boundaries of the requester's property; certification of a registered professional engineer registered in the subject State; location and description of reference marks; and the referenced vertical datum (NGVD, NAVD, etc.).

Note that the boundaries of the existing or proposed conditions floodplains and regulatory floodway to be shown on the revised FIRM and/or FBFM must tie-in with the effective floodplain and regulatory floodway boundaries. Please attach **a copy of the effective FIRM and/or FBFM,** annotated to show the boundaries of the revised 1%- and 0.2%-annual-chance floodplains and regulatory floodway that tie-in with the boundaries of the effective 1%- and 0.2%-annual-chance floodplain and regulatory floodway at the upstream and downstream limits of the area of revision.

D. COMMON REGULATORY REQUIREMENTS

1. For CLOMR requests, do Base Flood Elevations (BFEs) increase? ☐ Yes ☐ No

For CLOMR requests, if either of the following is true, please submit evidence of compliance with Section 65.12 of the NFIP regulations:

- The proposed project encroaches upon a regulatory floodway and would result in increases above 0.00 foot.
- The proposed project encroaches upon a SFHA with BFEs established and would result in increases above 1.00 foot.

2. Does the request involve the placement or proposed placement of fill? ☐ Yes ☒ No

If Yes, the community must be able to certify that the area to be removed from the special flood hazard area, to include any structures or proposed structures, meets all of the standards of the local floodplain ordinances, and is reasonably safe from flooding in accordance with the NFIP regulations set forth at 44 CFR 60.3(a)(3), 65.5(a)(4), and 65.6(a)(14). Please see the MT-2 instructions for more information.

3. For LOMR requests, is the regulatory floodway being revised? ☐ Yes ☒ No

If Yes, attach evidence of regulatory floodway revision notification. As per Paragraph 65.7(b)(1) of the NFIP Regulations, notification is required for requests involving revisions to the regulatory floodway. (Not required for revisions to approximate 1%-annual-chance floodplains [studied Zone A designation] unless a regulatory floodway is being added. Elements and examples of regulatory floodway revision notification can be found in the MT-2 Form 2 Instructions.)

4. For LOMR requests, does this request require property owner notification and acceptance of BFE increases? ☐ Yes ☒ No

If Yes, please attach proof of property owner notification and acceptance (if available). Elements of and examples of property owner notification can be found in the MT-2 Form 2 Instructions.

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE HYDROLOGY AND HYDRAULICS FORM

O.M.B No. 3067-0148
Expires September 30, 2005

PAPERWORK REDUCTION ACT

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Flooding Source: White Tank Mountains Fan 8
Note: Fill out one form for each flooding source studied

A. HYDROLOGY

3. Reason for New Hydrologic Analysis (check all that apply)

☐ Not revised (skip to section 2) ☒ No existing analysis ☒ Improved data
☐ Alternative methodology ☐ Proposed Conditions (CLOMR) ☐ Changed physical condition of watershed

2. Comparison of Representative 1%-Annual-Chance Discharges

Location	Drainage Area (Sq. Mi.)	FIS (cfs)	Revised (cfs)

3. Methodology for New Hydrologic Analysis (check all that apply)

☐ Statistical Analysis of Gage Records ☒ Precipitation/Runoff Model HEC-1 [TR-20, HEC-1, HEC-HMS etc.]
☐ Regional Regression Equations ☐ Other (please attach description)

Please enclose all relevant models in digital format, maps, computations (including computation of parameters) and documentation to support the new analysis. The document, "Numerical Models Accepted by FEMA for NFIP Usage" lists the models accepted by FEMA. This document can be found at: http://www.fema.gov/mit/tsd/en_modl.htm.

4. Review/Approval of Analysis

If your community requires a regional, state, or federal agency to review the hydrologic analysis, please attach evidence of approval/review.

5. Impacts of Sediment Transport on Hydrology

Was sediment transport considered? ☐ Yes ☒ No If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation for why sediment transport was not considered. Explanation: Sediment transport is not an element in the local approved hydrologic modeling procedures, nor is it a variable in the local USGS discharge regression equations. Sediment transport is considered explicitly in the alluvial fan floodplain delineation.

B. HYDRAULICS

1. Reach to be Revised: No existing delineations are revised. New approximate riverine delineations are submitted upstream of fan apexes.

	Description	Cross Section	Water-Surface Elevations (ft.)	
			Effective	Proposed/Revised
Downstream Limit	See attached annotated FIRMs			
Upstream Limit	See attached annotated FIRMs			

2. Hydraulic Method Used

Hydraulic Analysis HEC-RAS [HEC-2 , HEC-RAS, Other (Attach description)]

B. HYDRAULICS (CONTINUED)

3. Pre-Submittal Review of Hydraulic Models

FEMA has developed two review programs, CHECK-2 and CHECK-RAS, to aid in the review of HEC-2 and HEC-RAS hydraulic models, respectively. These review programs verify that the hydraulic estimates and assumptions in the model data are in accordance with NFIP requirements, and that the data are comparable with the assumptions and limitations of HEC-2/HEC-RAS. CHECK-2 and CHECK-RAS identify areas of potential error or concern. These tools do not replace engineering judgment. CHECK-2 and CHECK-RAS can be downloaded from http://www.fema.gov/mit/tsd/frm_soft.htm. We recommend that you review your HEC-2 and HEC-RAS models with CHECK-2 and CHECK-RAS. If you disagree with a message, please attach an explanation of why the message is not valid in this case. Review of your submittal and resolution of valid modeling discrepancies will result in reduced review time.

HEC-2/HEC-RAS models reviewed with CHECK-2/CHECK-RAS? ☐ Yes ☒ No

4. Models Submitted

Duplicate Effective Model*	Natural File Name:	Floodway File Name:
Corrected Effective Model*	Natural File Name:	Floodway File Name:
Existing or Pre-Project Conditions Model	Natural File Name: Fan7_8_12	Floodway File Name: Fan7_8_12
Revised or Post-Project Conditions Model	Natural File Name:	Floodway File Name:
Other - (attach description)	Natural File Name:	Floodway File Name:

*Not required for revisions to approximate 1%-annual-chance floodplains (Zone A) – for details, refer to the corresponding section of the instructions.

The document "Numerical Models Accepted by FEMA for NFIP Usage" lists the models accepted by FEMA. This document can be found at:

http://www.fema.gov/mit/tsd/en_modl.htm.

C. MAPPING REQUIREMENTS

A **certified topographic map** must be submitted showing the following information (where applicable): the boundaries of the effective, existing, and proposed conditions 1%-annual-chance floodplain (for approximate Zone A revisions) or the boundaries of the 1%- and 0.2%-annual-chance floodplains and regulatory floodway (for detailed Zone AE, AO, and AH revisions); location and alignment of all cross sections with stationing control indicated; stream, road, and other alignments (e.g., dams, levees, etc.); current community easements and boundaries; boundaries of the requester's property; certification of a registered professional engineer registered in the subject State; location and description of reference marks; and the referenced vertical datum (NGVD, NAVD, etc.).

Note that the boundaries of the existing or proposed conditions floodplains and regulatory floodway to be shown on the revised FIRM and/or FBFM must tie-in with the effective floodplain and regulatory floodway boundaries. Please attach **a copy of the effective FIRM and/or FBFM,** annotated to show the boundaries of the revised 1%- and 0.2%-annual-chance floodplains and regulatory floodway that tie-in with the boundaries of the effective 1%- and 0.2%-annual-chance floodplain and regulatory floodway at the upstream and downstream limits of the area of revision.

D. COMMON REGULATORY REQUIREMENTS

1. For CLOMR requests, do Base Flood Elevations (BFEs) increase? ☐ Yes ☐ No

For CLOMR requests, if either of the following is true, please submit evidence of compliance with Section 65.12 of the NFIP regulations:

- The proposed project encroaches upon a regulatory floodway and would result in increases above 0.00 foot.
- The proposed project encroaches upon a SFHA with BFEs established and would result in increases above 1.00 foot.

4. Does the request involve the placement or proposed placement of fill? ☐ Yes ☒ No

If Yes, the community must be able to certify that the area to be removed from the special flood hazard area, to include any structures or proposed structures, meets all of the standards of the local floodplain ordinances, and is reasonably safe from flooding in accordance with the NFIP regulations set forth at 44 CFR 60.3(a)(3), 65.5(a)(4), and 65.6(a)(14). Please see the MT-2 instructions for more information.

3. For LOMR requests, is the regulatory floodway being revised? ☐ Yes ☒ No

If Yes, attach evidence of regulatory floodway revision notification. As per Paragraph 65.7(b)(1) of the NFIP Regulations, notification is required for requests involving revisions to the regulatory floodway. (Not required for revisions to approximate 1%-annual-chance floodplains [studied Zone A designation] unless a regulatory floodway is being added. Elements and examples of regulatory floodway revision notification can be found in the MT-2 Form 2 Instructions.)

4. For LOMR requests, does this request require property owner notification and acceptance of BFE increases? ☐ Yes ☒ No

If Yes, please attach proof of property owner notification and acceptance (if available). Elements of and examples of property owner notification can be found in the MT-2 Form 2 Instructions.

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE HYDROLOGY AND HYDRAULICS FORM

O.M.B No. 3067-0148
Expires September 30, 2005

PAPERWORK REDUCTION ACT

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Flooding Source: White Tank Mountains Fan 12
Note: Fill out one form for each flooding source studied

A. HYDROLOGY

1. Reason for New Hydrologic Analysis (check all that apply)

☐ Not revised (skip to section 2) ☒ No existing analysis ☒ Improved data
☐ Alternative methodology ☐ Proposed Conditions (CLOMR) ☐ Changed physical condition of watershed

2. Comparison of Representative 1%-Annual-Chance Discharges

Location	Drainage Area (Sq. Mi.)	FIS (cfs)	Revised (cfs)

3. Methodology for New Hydrologic Analysis (check all that apply)

☐ Statistical Analysis of Gage Records ☒ Precipitation/Runoff Model HEC-1 [TR-20, HEC-1, HEC-HMS etc.]
☐ Regional Regression Equations ☐ Other (please attach description)

Please enclose all relevant models in digital format, maps, computations (including computation of parameters) and documentation to support the new analysis. The document, "Numerical Models Accepted by FEMA for NFIP Usage" lists the models accepted by FEMA. This document can be found at: http://www.fema.gov/mit/tsd/en_modl.htm.

4. Review/Approval of Analysis

If your community requires a regional, state, or federal agency to review the hydrologic analysis, please attach evidence of approval/review.

5. Impacts of Sediment Transport on Hydrology

Was sediment transport considered? ☐ Yes ☒ No If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation for why sediment transport was not considered. Explanation: Sediment transport is not an element in the local approved hydrologic modeling procedures, nor is it a variable in the local USGS discharge regression equations. Sediment transport is considered explicitly in the alluvial fan floodplain delineation.

B. HYDRAULICS

1. Reach to be Revised: No existing delineations are revised. New approximate riverine delineations are submitted upstream of fan apexes.

	Description	Cross Section	Water-Surface Elevations (ft.)	
			Effective	Proposed/Revised
Downstream Limit	See attached annotated FIRMs			
Upstream Limit	See attached annotated FIRMs			

B. HYDRAULICS (CONTINUED)

2. Pre-Submittal Review of Hydraulic Models

FEMA has developed two review programs, CHECK-2 and CHECK-RAS, to aid in the review of HEC-2 and HEC-RAS hydraulic models, respectively. These review programs verify that the hydraulic estimates and assumptions in the model data are in accordance with NFIP requirements, and that the data are comparable with the assumptions and limitations of HEC-2/HEC-RAS. CHECK-2 and CHECK-RAS identify areas of potential error or concern. These tools do not replace engineering judgment. CHECK-2 and CHECK-RAS can be downloaded from http://www.fema.gov/mit/tsd/frm_soft.htm. We recommend that you review your HEC-2 and HEC-RAS models with CHECK-2 and CHECK-RAS. If you disagree with a message, please attach an explanation of why the message is not valid in this case. Review of your submittal and resolution of valid modeling discrepancies will result in reduced review time.

HEC-2/HEC-RAS models reviewed with CHECK-2/CHECK-RAS? ☐ Yes ☒ No

3. Models Submitted

Duplicate Effective Model*	Natural File Name:	Floodway File Name:
Corrected Effective Model*	Natural File Name:	Floodway File Name:
Existing or Pre-Project Conditions Model	Natural File Name: Fan7_8_12	Floodway File Name: Fan7_8_12
Revised or Post-Project Conditions Model	Natural File Name:	Floodway File Name:
Other - (attach description)	Natural File Name:	Floodway File Name:

*Not required for revisions to approximate 1%-annual-chance floodplains (Zone A) – for details, refer to the corresponding section of the instructions.

The document "Numerical Models Accepted by FEMA for NFIP Usage" lists the models accepted by FEMA. This document can be found at:

http://www.fema.gov/mit/tsd/en_modl.htm.

C. MAPPING REQUIREMENTS

A **certified topographic map** must be submitted showing the following information (where applicable): the boundaries of the effective, existing, and proposed conditions 1%-annual-chance floodplain (for approximate Zone A revisions) or the boundaries of the 1%- and 0.2%-annual-chance floodplains and regulatory floodway (for detailed Zone AE, AO, and AH revisions); location and alignment of all cross sections with stationing control indicated; stream, road, and other alignments (e.g., dams, levees, etc.); current community easements and boundaries; boundaries of the requester's property; certification of a registered professional engineer registered in the subject State; location and description of reference marks; and the referenced vertical datum (NGVD, NAVD, etc.).

Note that the boundaries of the existing or proposed conditions floodplains and regulatory floodway to be shown on the revised FIRM and/or FBFM must tie-in with the effective floodplain and regulatory floodway boundaries. Please attach **a copy of the effective FIRM and/or FBFM,** annotated to show the boundaries of the revised 1%- and 0.2%-annual-chance floodplains and regulatory floodway that tie-in with the boundaries of the effective 1%- and 0.2%-annual-chance floodplain and regulatory floodway at the upstream and downstream limits of the area of revision.

D. COMMON REGULATORY REQUIREMENTS

1. For CLOMR requests, do Base Flood Elevations (BFEs) increase? ☐ Yes ☐ No

For CLOMR requests, if either of the following is true, please submit evidence of compliance with Section 65.12 of the NFIP regulations:

- The proposed project encroaches upon a regulatory floodway and would result in increases above 0.00 foot.
- The proposed project encroaches upon a SFHA with BFEs established and would result in increases above 1.00 foot.

2. Does the request involve the placement or proposed placement of fill? ☐ Yes ☒ No

If Yes, the community must be able to certify that the area to be removed from the special flood hazard area, to include any structures or proposed structures, meets all of the standards of the local floodplain ordinances, and is reasonably safe from flooding in accordance with the NFIP regulations set forth at 44 CFR 60.3(a)(3), 65.5(a)(4), and 65.6(a)(14). Please see the MT-2 instructions for more information.

3. For LOMR requests, is the regulatory floodway being revised? ☐ Yes ☒ No

If Yes, attach evidence of regulatory floodway revision notification. As per Paragraph 65.7(b)(1) of the NFIP Regulations, notification is required for requests involving revisions to the regulatory floodway. (Not required for revisions to approximate 1%-annual-chance floodplains [studied Zone A designation] unless a regulatory floodway is being added. Elements and examples of regulatory floodway revision notification can be found in the MT-2 Form 2 Instructions.)

4. For LOMR requests, does this request require property owner notification and acceptance of BFE increases? ☐ Yes ☒ No

If Yes, please attach proof of property owner notification and acceptance (if available). Elements of and examples of property owner notification can be found in the MT-2 Form 2 Instructions.

FEDERAL EMERGENCY MANAGEMENT AGENCY

O.M.B. No. 3067-0148
Expires September 30, 2005

ALLUVIAL FAN FLOODING FORM

PAPERWORK REDUCTION ACT

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Flooding Source: Fan Site 7

Note: Fill out one form for each flooding source studied

A. THREE-STAGE ANALYSIS (Based on FEMA Guidelines dated February 23, 2000)

1. Stage 1 Analysis

   a. The landform is composed of (check one) ☒ alluvial ☐ debris flow deposits.

   b. Source of data used to determine composition, morphology, and location of the landform:

   NRCS Soils Maps, AZ Geologic Survey Geology Maps, USGS Topographic Maps, Aerial Photos, Field Observation

   c. Is there an NRCS soils survey and soil survey map available? ☒ Yes ☐ No

   If Yes, please include a copy of the map and any pertinent sections of the soil survey

2. Stage 2 Analysis

   a. The alluvial fan exhibits ☐ active ☐ inactive ☒ a combination of active and inactive alluvial fan flooding.

   b. Approximate age of inactive fan surfaces (thousands of years): yrs.

   c. Is there an opportunity for avulsions that could lead channels or sheetfloods across the older fan surfaces?
   ☐ Yes ☒ No

   d. Is there evidence of headcutting that could lead to stream piracy? ☒ Yes ☐ No (Only in active, unstable areas)

   e. Is there geomorphic evidence of past avulsions during the Holocene epoch? ☒ Yes ☐ No (Only in active, unstable areas)

   f. The fan exhibits the following types of flooding (check one):

   ☒ Flooding along stable channels

   ☒ Sheetflow

   ☐ Debris flow

   ☒ Unstable flow path flooding

3. Stage 3 Analysis

   The boundaries of the 1%-annual-chance floodplain have been determined using (check one):

   ☐ Risk-Based Analysis

   ☐ FEMA FAN program (if discharge at the apex is different than that given in the effective FIS, then attach MT-2, Form 2 along with a plot of the flood frequency curve on log-normal probability paper and include the drainage area above the hydrographic apex, and the mean, standard deviation, and skew coefficient of the curve)

   ☐ Sheetflow Methods

   ☐ Hydraulic Analytical Methods

   ☒ Geomorphic Data, Post-Flood Hazard Verification, and Historical Information

   ☐ Composite Methods

B. STRUCTURAL FLOOD CONTROL MEASURES

1. The following structural flood control measures are proposed or built (check one): **No Structural Measures are Proposed**

   ☐ Channelization ☐ Levee/Floodwall ☐ Dam ☐ Sedimentation Basin

2. Do the constructed or proposed structural measures affect flood hazards (including velocity, scour, and sediment deposition) on other areas of the fan? ☐ Yes ☐ No

3. Attach completed Form 3 (Riverine Structures Form).

4. Sediment Transport Considerations:
   Was sediment transport considered? ☐ Yes ☐ No If Yes, then fill out Form 3, Section F (Sediment Transport).
   If No, then attach your explanation for why sediment transport was not considered.

5. Please attach a copy of the formal Operations and Maintenance Plan.

C. MAPPING REQUIREMENTS

Attach a certified topographic work map showing the following:

- The boundaries of the alluvial fan including: toe, topographic and hydrographic apexes, and lateral boundaries
- The delineation of the active and inactive portions of the fan as determined by the Stage 2 analysis
- The revised 1%-annual-chance floodplain boundaries, as determined by the Stage 3 Analysis, that tie into the effective floodplain boundaries
- The correct alignment of all structural features
- The map scale

FEDERAL EMERGENCY MANAGEMENT AGENCY

O.M.B. No. 3067-0148
Expires September 30, 2005

ALLUVIAL FAN FLOODING FORM

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Flooding Source: Fan Site 8

Note: Fill out one form for each flooding source studied

A. THREE-STAGE ANALYSIS (Based on FEMA Guidelines dated February 23, 2000)

1. Stage 1 Analysis
   a. The landform is composed of (check one) ☒ alluvial ☐ debris flow deposits.
   b. Source of data used to determine composition, morphology, and location of the landform:
      NRCS Soils Maps, AZ Geologic Survey Geology Maps, USGS Topographic Maps, Aerial Photos, Field Observation
   c. Is there an NRCS soils survey and soil survey map available? ☒ Yes ☐ No
      If Yes, please include a copy of the map and any pertinent sections of the soil survey
2. Stage 2 Analysis
   a. The alluvial fan exhibits ☐ active ☐ inactive ☒ a combination of active and inactive alluvial fan flooding.
   b. Approximate age of inactive fan surfaces (thousands of years): yrs.
   c. Is there an opportunity for avulsions that could lead channels or sheetfloods across the older fan surfaces?
      ☐ Yes ☒ No
   d. Is there evidence of headcutting that could lead to stream piracy? ☒ Yes ☐ No (Only in active, unstable areas)
   e. Is there geomorphic evidence of past avulsions during the Holocene epoch? ☒ Yes ☐ No (Only in active, unstable areas)
   f. The fan exhibits the following types of flooding (check one):
      ☒ Flooding along stable channels
      ☒ Sheetflow
      ☐ Debris flow
      ☒ Unstable flow path flooding
3. Stage 3 Analysis
   The boundaries of the 1%-annual-chance floodplain have been determined using (check one):
   ☐ Risk-Based Analysis
      ☐ FEMA FAN program (if discharge at the apex is different than that given in the effective FIS, then attach MT-2, Form 2 along with a plot of the flood frequency curve on log-normal probability paper and include the drainage area above the hydrographic apex, and the mean, standard deviation, and skew coefficient of the curve)
   ☐ Sheetflow Methods
   ☐ Hydraulic Analytical Methods
   ☒ Geomorphic Data, Post-Flood Hazard Verification, and Historical Information
   ☐ Composite Methods

B. STRUCTURAL FLOOD CONTROL MEASURES

1. The following structural flood control measures are proposed or built (check one): **No Structural Measures are Proposed**

   ☐ Channelization ☐ Levee/Floodwall ☐ Dam ☐ Sedimentation Basin

2. Do the constructed or proposed structural measures affect flood hazards (including velocity, scour, and sediment deposition) on other areas of the fan? ☐ Yes ☐ No

3. Attach completed Form 3 (Riverine Structures Form).

4. Sediment Transport Considerations:

   Was sediment transport considered? ☐ Yes ☐ No If Yes, then fill out Form 3, Section F (Sediment Transport).

   If No, then attach your explanation for why sediment transport was not considered.

5. Please attach a copy of the formal Operations and Maintenance Plan.

C. MAPPING REQUIREMENTS

Attach a certified topographic work map showing the following:

- The boundaries of the alluvial fan including: toe, topographic and hydrographic apexes, and lateral boundaries
- The delineation of the active and inactive portions of the fan as determined by the Stage 2 analysis
- The revised 1%-annual-chance floodplain boundaries, as determined by the Stage 3 Analysis, that tie into the effective floodplain boundaries
- The correct alignment of all structural features
- The map scale

FEDERAL EMERGENCY MANAGEMENT AGENCY

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ALLUVIAL FAN FLOODING FORM

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Flooding Source: Fan Site 12

Note: Fill out one form for each flooding source studied

A. THREE-STAGE ANALYSIS (Based on FEMA Guidelines dated February 23, 2000)

1. Stage 1 Analysis
   a. The landform is composed of (check one) ☒ alluvial ☐ debris flow deposits.
   b. Source of data used to determine composition, morphology, and location of the landform.

      NRCS Soils Maps, AZ Geologic Survey Geology Maps, USGS Topographic Maps, Aerial Photos, Field Observation

   c. Is there an NRCS soils survey and soil survey map available? ☒ Yes ☐ No
      If Yes, please include a copy of the map and any pertinent sections of the soil survey
2. Stage 2 Analysis
   a. The alluvial fan exhibits ☐ active ☐ inactive ☒ a combination of active and inactive alluvial fan flooding.
   b. Approximate age of inactive fan surfaces (thousands of years): yrs.
   c. Is there an opportunity for avulsions that could lead channels or sheetfloods across the older fan surfaces?
      ☐ Yes ☒ No
   d. Is there evidence of headcutting that could lead to stream piracy? ☒ Yes ☐ No (Only in active, unstable areas)
   e. Is there geomorphic evidence of past avulsions during the Holocene epoch? ☒ Yes ☐ No (Only in active, unstable areas)
   f. The fan exhibits the following types of flooding (check one):
      ☒ Flooding along stable channels
      ☒ Sheetflow
      ☐ Debris flow
      ☒ Unstable flow path flooding
3. Stage 3 Analysis

   The boundaries of the 1%-annual-chance floodplain have been determined using (check one):

   ☐ Risk-Based Analysis
      ☐ FEMA FAN program (if discharge at the apex is different than that given in the effective FIS, then attach MT-2, Form 2 along with a plot of the flood frequency curve on log-normal probability paper and include the drainage area above the hydrographic apex, and the mean, standard deviation, and skew coefficient of the curve)
   ☐ Sheetflow Methods
   ☐ Hydraulic Analytical Methods
   ☒ Geomorphic Data, Post-Flood Hazard Verification, and Historical Information
   ☐ Composite Methods

B. STRUCTURAL FLOOD CONTROL MEASURES

1. The following structural flood control measures are proposed or built (check one): **No Structural Measures are Proposed**

   ☐ Channelization ☐ Levee/Floodwall ☐ Dam ☐ Sedimentation Basin

2. Do the constructed or proposed structural measures affect flood hazards (including velocity, scour, and sediment deposition) on other areas of the fan? ☐ Yes ☐ No

3. Attach completed Form 3 (Riverine Structures Form).

4. Sediment Transport Considerations:
   Was sediment transport considered? ☐ Yes ☐ No If Yes, then fill out Form 3, Section F (Sediment Transport).
   If No, then attach your explanation for why sediment transport was not considered.

5. Please attach a copy of the formal Operations and Maintenance Plan.

C. MAPPING REQUIREMENTS

Attach a certified topographic work map showing the following:

- The boundaries of the alluvial fan including: toe, topographic and hydrographic apexes, and lateral boundaries
- The delineation of the active and inactive portions of the fan as determined by the Stage 2 analysis
- The revised 1%-annual-chance floodplain boundaries, as determined by the Stage 3 Analysis, that tie into the effective floodplain boundaries
- The correct alignment of all structural features
- The map scale

3. MAPPING AND SURVEY INFORMATION

3.1 Field Survey Information

Ground control survey work associated with the topographic mapping was performed by RBF Consulting of Phoenix, Arizona under contract with the FCDMC. The survey data for this project is presented in the North American Datum of 1983 (NAD 83), 1992 Central Zone of Arizona State Plane Coordinate System. Elevations are referenced to the North American Vertical Datum of 1988 (NAVD88). All survey was provided under separate contract to the Flood Control District of Maricopa County in association with the topographic mapping described below.

3.2 Mapping

The topographic mapping was provided by Landata Airborne Systems of Irvine California, under contract with the FCDMC in 2000/2001. The flight dates for the mapping were 12-16-00, 12-17-00, and 12-27-00. The topographic mapping was prepared by photogrammetric methods to national map accuracy standards for 1-inch equals 500 feet with a 10-foot contour interval. Topographic mapping was provided by the Flood Control District of Maricopa County.

4. HYDROLOGY

4.1 Method Description

The methods employed in this study were those outlined in the current Drainage Design Manual for Maricopa County, Volume I, Hydrology (1995) and 2003 draft revised Hydrology Manual. The DDMSW version 3.2.8 was used to assist in the development of the HEC-1 models. The U.S. Army Corps of Engineers HEC-1 model (version 4.1) was used to compute runoff hydrographs and peak discharges.

Rainfall losses were calculated by use of the Green and Ampt infiltration equation with an allowance for surface retention loss within HEC-1. The Phoenix Mountain S-Graph was used to generate unit hydrographs. Channel routing was performed using the normal depth Modified Puls method.

Peak discharges were estimated at various concentration points. Rainfall-runoff models were generated for the 100-year return period for the 6- and 24-hour durations. The larger estimate is recommended for use in the floodplain delineation.

4.2 Parameter Estimation

4.2.1 Drainage Area Boundaries

The study area watershed and hydrologic subbasins are shown on Plate 1. The total watershed area modeled is approximately 3.5 square miles. Three individual subbasins were modeled varying in size from 0.52 to 1.55 square miles in size. Subbasin boundaries were delineated in ArcGIS 9.2 based on examination of the 2005 0.8 ft pixel color orthorectified aerial photographs and the 10-foot topography (dated 2001). Watershed areas were computed using XTools within ArcGIS.

4.2.2 Watershed work maps

Refer to Plate 1 for the watershed work map used for the HEC-1 modeling. Plate 2 shows the Natural Resources Conservation Service (NRCS) soils data and the distribution of saturated conductivity values for the area. Plate 3 shows the existing conditions land use distributions for the watersheds.

4.2.3 Gage data

No streamflow gage data were available for the washes in the study area. Therefore, the results of the rainfall-runoff modeling are compared with the U.S. Geological Survey (USGS) regional regression equations and previous studies in Section 4.5.

Historical Flooding Information

Field (1994) describes significant channel changes resulting from a large tropical storm in 1951 as reported in Kangieser (1969). The National Weather Service (NWS) Buckeye station (#021026) recorded 1.00", 2.60", 0.75", and 0.80" of rainfall on August 27, 28, 29, and 30, 1951, respectively for a total of 5.15". This may be the rainfall event(s) responsible for the large channel changes reported by Field (1994) on Site 36. Other significant channel changes are noted throughout the area on the 1953 aerial photographs of the ADMP study area, particularly in the White Tank Wash watershed. The largest daily total during the period of record for the NWS station is 4.90" recorded on September 2, 1894. The 2nd largest rainfall recorded since March 1893 occurred on September 8, 1916 when 3.29" of rainfall was recorded.

The SCS (1963) indicates that the August 1951 storm inundated 12,240 acres and was similar in magnitude to events in January 1916 and September 1939. In January 1916, 2.26" of rain was recorded over five consecutive days. During September 1939, 4.5" of precipitation was recorded between the 4th and 13th of the month. The highest single daily total during the period occurred on the 4th when 2.27" of rain were recorded at the NWS Buckeye station. It is unknown if the daily values recorded in August 1951 represent a single storm. If they do, it would be one of the highest storm totals in this long record.

CH2M Hill (1992) performed a paleoflood survey that indicated that a flood between 2,000 cfs and 5,000 cfs occurred at some time in the past 100 years. They also report a more recent event of 500 to 1,000 cfs. They suggest that the large flood attributed to a tropical storm in 1951, as reported in Field (1994), may be responsible for emplacing the slackwater deposits used in the 2,000 to 5,000 cfs estimate. The more recent flood reported by CH2M Hill may have been the August 15, 1990 storm recorded by the FCD ALERT gage #5200 which is the largest and most intense rainfall recorded in the 16 years of operation of this station (3.15" in 24 hours and 2.20" in 3 hours).

4.2.4 Statistical parameters

The only statistical data used directly in the study were the precipitation statistics obtained from the NOAA Atlas 2, Arizona. The statistics from the NOAA Atlas were analyzed to develop the rainfall depth-duration-frequency table for the watershed. The analysis was

performed using the PREFRE program within DDMSW. The program output is provided in Appendix D.

4.2.5 Precipitation

The rainfall depths used for the HEC-1 model were obtained from the NOAA Atlas 2 maps for Arizona. The NOAA Atlas 2 maps are reproduced in the Hydrology Manual and copies of these are included in Appendix D. Figure 4.1 shows the location of the Sun Valley ADMP study area on the NOAA maps for the data required for input into the PREFRE program. The multiple storm option (JD records) was used to determine the critical storm at each concentration point in the HEC-1 model. The depth-area reduction factors were applied as computed by the DDMSW computer program for use with HEC-1. Note that the point values used for the modeling were taken as the value over the mountainous area. This represents a conservative assessment of the rainfall potential over the primary runoff generating areas for the study area watershed contributing to alluvial fan apexes.

The storm duration modeled was the 6-hour storm as described in the Drainage Design Manual for Maricopa County. The temporal distributions for the 6-hour storms with the JD records were implemented via the DDMSW program.

The 24-hour storm used was the SCS Type II distribution as coded by the DDMSW as PC records for HEC-1.

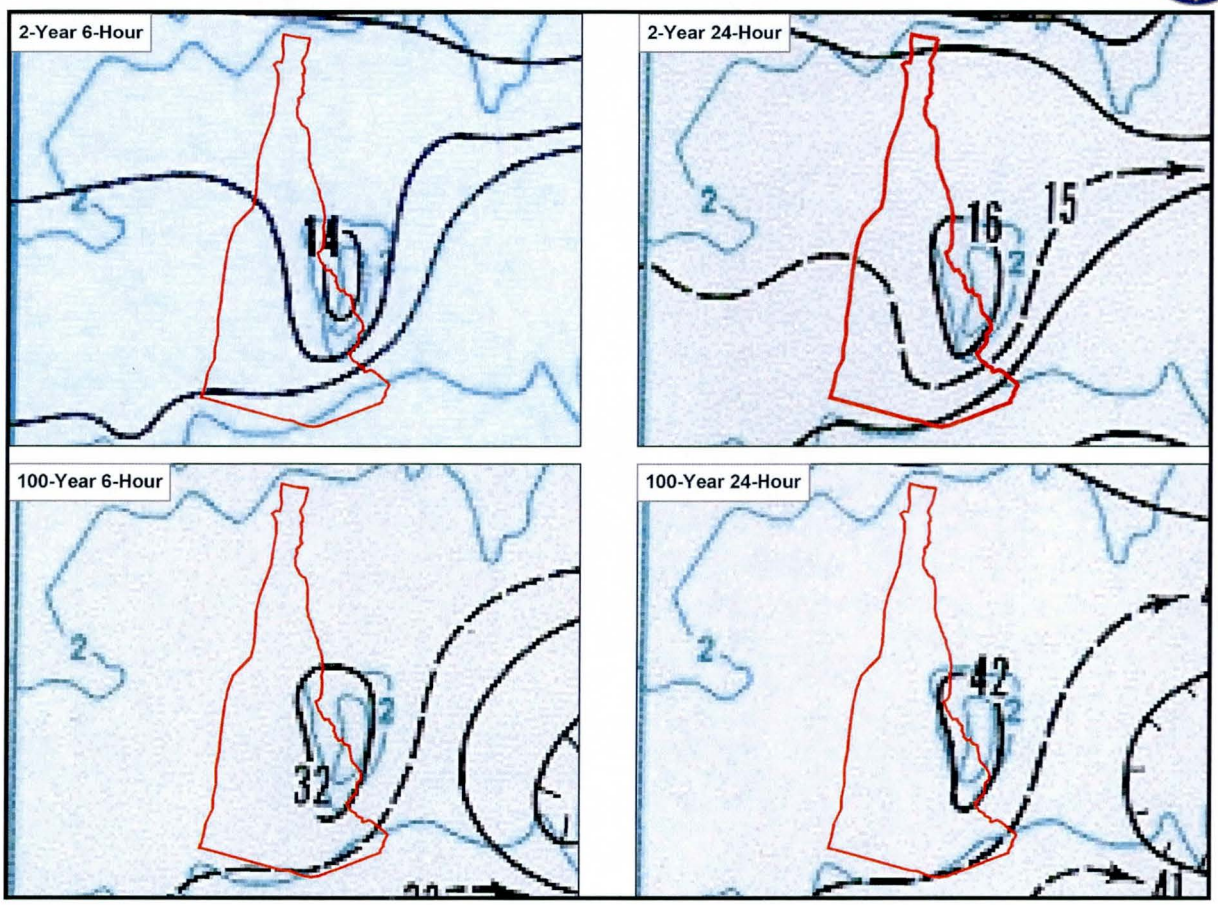


Figure 4.1Watershed Location on NOAA Atlas II Maps

4.2.6 Physical parameters

Rainfall Losses

Rainfall losses were computed using the Green and Ampt method as outlined in the Drainage Design Manual for Maricopa County, Volume I, Hydrology. The County's preprocessing program for HEC-1, DDMSW, version 3.2.8 was used to perform the lumped parameter calculations and to develop the draft HEC-1 models. The development of the soils, land use, and subbasin data for use in the DDMSW is described briefly below.

Soils

The NRCS (formerly SCS) *Soil Survey of Aguila-Carefree Area* (Camp, 1986) and *Soil Survey of Maricopa County, Central Part* (Hartman, 1977) presents the descriptions of the soils in the study watershed. Appendix A and B of the Drainage Design Manual provide loss rate parameters for the map units for this soil survey. The loss rates from the Appendices of the Manual are integrated into the DDMSW. Natural rock outcrop percentages from the Manual were assumed to be 50 percent effective for the purposes of computing RTIMP.

The spatial distribution of the soil map units for the watershed area is shown on Plate 2. Plate 2 also shows the saturated conductivity values (XKSAT) for the soil units in the watershed. Note these values are based on the data in the Appendices of the Drainage Design Manual.

Areas of each soil unit in each subbasin were computed using ArcMap – ArcView 9.2 software. These data were imported into the DDMSW. Average subbasin XKSAT values were then computed using logarithmic averaging as implemented in the DDMSW version 3.2.8.

The subbasin soil data, soil map unit descriptions, and subbasin average results are provided in Appendix D.

Land Use

Existing land use conditions were evaluated based on examination of the aerial photographs and a slope map generated from the 10-foot contour data. Since the entire modeling area was essentially undeveloped at the time of this study, land use categories were assigned based on a range of slope observed. Guidance from the Drainage Design Manual was used to differentiate three land use categories based on slope: 1) Natural Desert Rangeland (slopes 0-5%), 2) Natural Hillslopes, Sonoran Desert (slopes 5-10%), and 3) Natural Mountain Terrain (slopes > 10%). Figure 4.2 shows the shaded slope map overlain with the generalized land use categories delineated for the existing conditions in this study. Existing land uses are also presented on Plate 3. Only the Natural Desert Rangeland and Natural Mountain Terrain categories were selected for the Fan 7, 8 and 12 watersheds as shown on Figure 4.2.

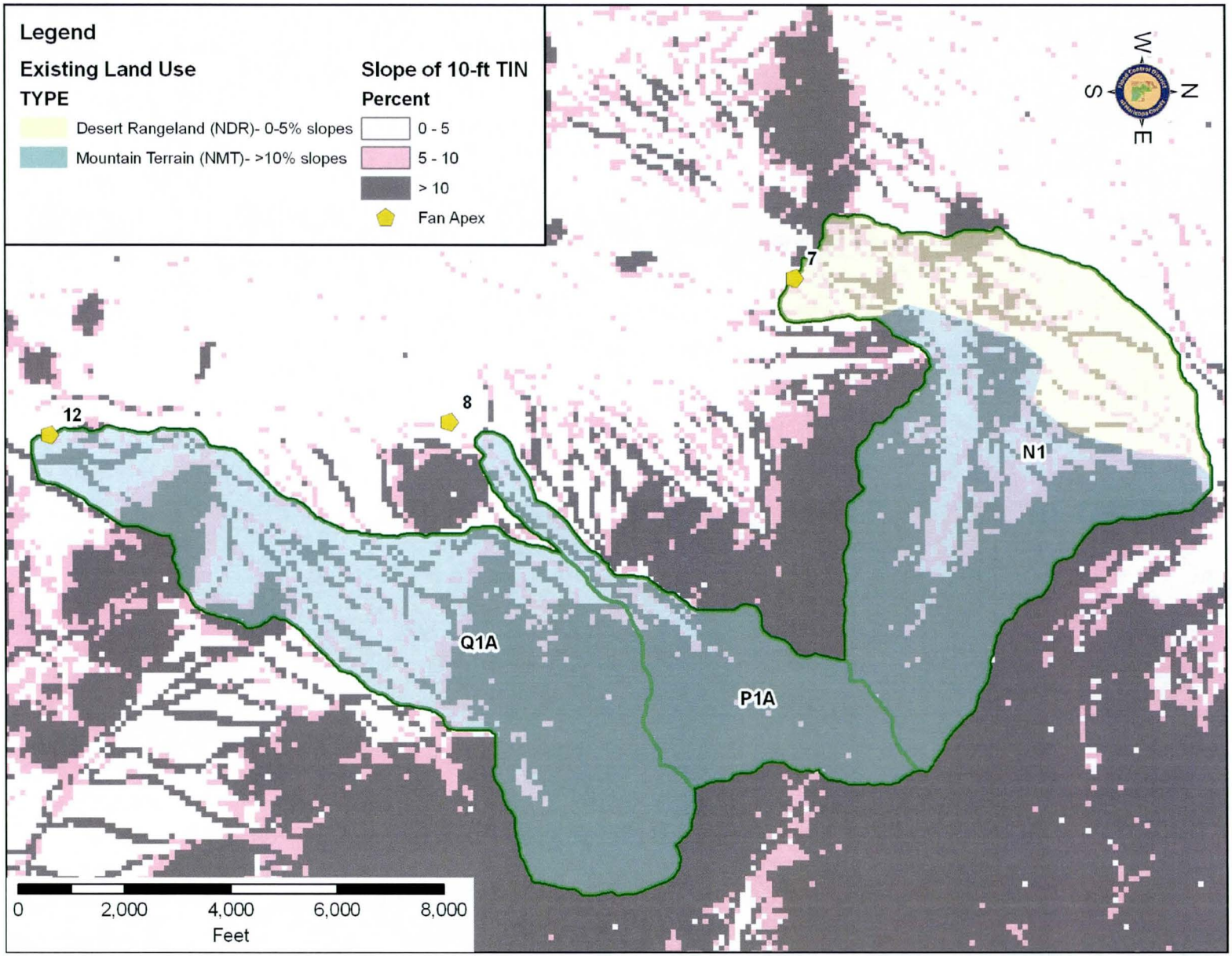


Figure 4.2 Slope and Assignment of Existing (Natural) Land Use Types

Table 4.1 summarizes the hydrologic parameters related to the land use categories used in the analyses for estimation of rainfall excess using the Green and Ampt method and Maricopa County procedures. These parameters include surface retention loss (IA), effective impervious area (RTIMP), basin roughness (Kn), vegetation cover (%), and antecedent moisture conditions (DTHETA Condition).

The subbasin existing land use data are provided in Appendix D.

Table 4.1 Land Use Types and Hydraulic Parameters

Land Use Code	Description	DTHETA Condition	Vegetation Cover (%)	RTIMP (%)*	IA (in)	Kn
910	Natural desert rangeland, slopes 0 – 5 %	Dry	30	0	0.35	0.025
930	Natural Mountain Terrain, slopes > 10 %	Dry	30	0	0.25	0.05

* Note: RTIMP for natural land use types taken from soils data and assumed 50% effective

Unit Hydrograph

The S-Graph unit hydrograph method as outlined in the Drainage Design Manual was used in the HEC-1 modeling of the watershed. Watershed drainage areas, lag time flow path lengths, Lca lengths, and slopes were delineated manually based on examination of the 2005 aerial photographs, and 2001 10-foot contour data for the area. Areas, lengths, and subbasin centroids were computed using ArcMap – ArcView 9.2 GIS software.

Dimensionless S-graphs were assigned based on whether the basin was predominantly mountainous terrain or not from examination of the existing land use data. The watersheds for Fan 7, 8 and 12 were considered mountainous and therefore were assigned the Phoenix Mountain S-graph described in the Drainage Design Manual.

Surface roughness values were assigned as shown in Table 4.1 described above. These values come from guidance provided in Table 5.6 and Appendix D.2 of the 2003 Drainage Design Manual, Volume I, Hydrology. Lag times were calculated based on the geometric and land use parameters for each subbasin. Tables summarizing the lag time calculations and S-graph assignment are provided in Appendix D.

Routing Parameters

No hydrologic routings were performed as part of the hydrology for this study.

4.3 Problems Encountered During the Study

4.3.1 Special problems and solutions

No special problems were encountered in the hydrologic modeling for this study.

4.3.2 Modeling warning and error messages

No warnings or error messages occur in the HEC-1 models.

4.4 Calibration

No calibration of the models was performed as part of this study. However, the results were compared to previous studies and regional regression equations and found to be reasonable. In addition, the methods used in this study have been designed for application to the area and have been found to produce reasonable results in hundreds of studies throughout Maricopa County.

4.5 Final Results

4.5.1 Hydrologic analysis results

Table 4.2 shows the peak discharges and total runoff volumes results. The 6-hour storm produces higher peak discharges for drainage areas less than about 1.5 square miles. The 24-hour storm produces the higher 100-year peak discharges for the larger drainage basins.

Table 4.2 100-Year Peak Discharge and Total Runoff Volume to Fans 7, 8 and 12 Apices

Fan #	KKID	AREA	24-hour					6-hour			
			Q100	Time	Vol.	Vol.		Q100	Time	Vol.	Vol.
		(sq.mi.)	(cfs)	(hrs)	(in)	(ac-ft)		(cfs)	(hrs)	(in)	(ac-ft)
7	N1	1.55	**1453**	12.25	1.095	91		1343	4.33	1.132	94
8	P1A	0.52	518	12.25	1.202	33		**646**	4.25	1.438	40
12	Q1A	1.42	**1050**	12.42	1.140	86		1042	4.50	1.209	92

4.5.2 Verification of results

Figure 4.3 shows a plot of the peak discharge results for the 100-year models with the USGS regional regression equations for Region 12. The model results fall below the 100-year regression curve for the region.

Given the predominance of sandy loam textured soils in the watersheds, these results are considered reasonable. In addition, it should be noted that the average elevation for the area

(about 1300 feet) falls below the "cloud of common values" for Region 12. That is, the data used to develop the Region 12 equations did not include watersheds with average elevations below about 2000 feet. Most of the gages included in the Region 12 datasets drain higher elevation areas from the Bradshaw Mountains and along the Mogollon Rim, including the Salt-Verde River basins. Those watersheds experience higher annual precipitation amounts and have higher 100-year point rainfall statistics than the White Tank Mountains. Therefore, results falling below the regional curves are not considered surprising or unreasonable.

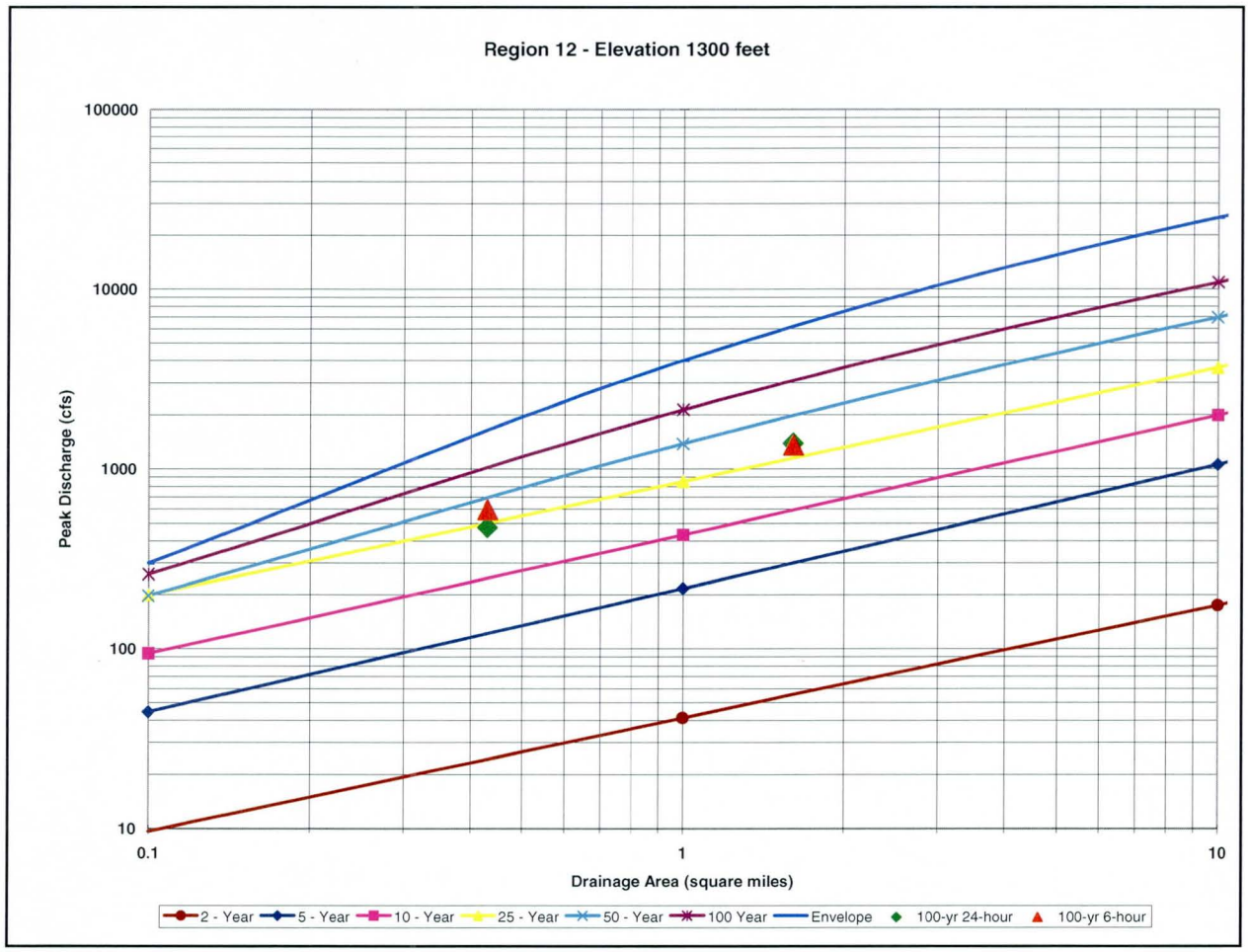


Figure 4.3. Comparison of 100-year HEC-1 Model Results with USGS Regression Equations

4.5.3 Comparison with Previous Studies

Table 4.3 shows a comparison of the results of the existing condition 6-hour and 24-hour models with the previous Floodplain Delineation Study model results by the Alpha Engineering (1994). The FDS used the Phoenix Mountain S-Graphs and the Green-Ampt loss method for computation of rainfall excess. The rainfall data are similar to the models for the current study. The exact drainage basins were not modeled. The current watersheds S800, S810, and S820 lie

within the Alpha T1 basin. A watershed boundary comparison map is provided in Appendix D. Comparison of the unit discharge (cfs/sq.mi.) shows comparable results between the two studies.

Table 4.3 Comparison of 100-Year Peak Discharges with White Tank Wash FDS (Alpha, 1994)

Location	Area (sq.mi.)	Alpha 6-hr (cfs)	Alpha 24-hr (cfs)	This Study 6-hr (cfs)	This Study 24-hr (cfs)	Q/A for Controlling Q (cfs/mi2)
N1	1.55			1353	**1453**	**873**
P1A	0.52			**646**	518	**1242**
Q1A	1.42			1042	**1050**	**739**
N1	1.46	749	**1475**			**1010**
P2	1.43	581	**1065**			**745**
Q1	1.09	524	**992**			**910**

4.6 References

1. Alpha Engineering Group, Inc., 1994, White Tanks Wash Flood Insurance Study, FCD No. 90-64: for FCDMC, Phoenix, Arizona.

2. CH2M Hill, 1992, Alluvial Fan Data Collection and Monitoring Study: Tempe, Arizona, CH2M Hill and R.H. French, Ph.D., P.E. Consulting Engineer for the Flood Control District of Maricopa County, 204 p.

3. Field, John J., 1994, Processes of Channel Migration on Fluvially Dominated Alluvial Fans in Arizona. Arizona Geological Survey OFR 94-13, 40 p.

4. FCDMC, 2003, Drainage Design Manual for Maricopa County – Hydrology.

5. Hjalmarson, H.W., 1994, Potential flood hazards and hydraulic characteristics of distributary-flow areas in Maricopa County, Arizona: U.S. Geological Survey Water Resources Investigations Report 93-4169, 56 p.

6. Hjalmarson, H.W., and Kemna, S.P., 1992, Flood hazards of distributary-flow areas in southwestern Arizona: U.S. Geological Survey Water Resources Investigations Report 91-4171, 68 p.

7. Kangieser, P.C., 1969, Major rainstorms and snowstorms in Arizona 1897-1969 [unpublished report]: Tempe, Arizona, Arizona Weather Bureau, 25 p.

8. National Archive, 1954, Black and white aerial photographs, scale 1:20,000.

9. National Archive, 1949, Black and white aerial photographs, scale 1:20,000.

10. Soil Conservation Service, 1963, Buckeye Watershed: Watershed Work Plan: USDA.

11. Thomas, Blakemore E, Hjalmarson, H.W., and Waltemeyer, S.D., 1997, Methods for Estimating Magnitude and Frequency of Floods in the Southwest United States: U.S. Geological Survey, Water Supply Paper 2433, 195 p.

12. U.S. Army Mapping Service, 1953, Large format black and white aerial photography. From FCDMC archives. Scale = approximately 1:14,400.

13. U.S. Geological Survey, 1988, Wagner Wash Well, Ariz. Quadrangle, 7.5 minute series, Provisional Edition, 1:24,000 (photo date 1984).

14. U.S. Geological Survey, 1982, Buckeye NW, Ariz. Quadrangle, 7.5 minute series, 1:24,000 (photo date 1955, originally published 1958; photo revised in 1982 using 1978 photography).

15. U.S. Geological Survey, 1982, Valencia, Ariz. Quadrangle, 7.5 minute series, 1:24,000 (original photo date 1954, originally published 1958; photo revised in 1982 using 1978 photography).

16. U.S. Geological Survey, 1978, White Tank Mtns NE, Ariz. Quadrangle, 7.5 minute series, 1:24,000 (original photo date 1954, published 1957; photo revised 1971, and photo inspected with no changes made in 1978).

17. Waters, Stephen D., 1991, Hydrologic analysis for White Tanks Distributary Flow Area: Phoenix, Arizona, Flood Control District of Maricopa County, 29 p.

5. HYDRAULIC ANALYSIS

5.1 Method Description

Approximate method hydraulic modeling was used to delineate riverine floodplains on reaches upstream of the alluvial fan apexes. Normal depth computations for representative cross sections were performed using HEC-RAS to estimate the depth and width of inundation from the 100-year flood. The resultant width was applied to the stream reach for each representative cross section. In some cases, adjustments to the computed floodplain widths were made based on aerial photograph interpretation and application of geomorphic principles.

100-year floodplains were delineated using approximate methods upstream of the hydrographic apexes of White Tank Fans 7, 8 and 12. The U.S. Army Corp of Engineers HEC-RAS v. 3.1.3 was used to perform the hydraulic rating calculations. Cross section locations along the study reaches were selected depending on the variability of the channel geometry. On average, the cross section spacing for the channel upstream (north) of Site 7 is approximately 450 feet, approximately 400 feet for the channel upstream (northeast) of Site 8, and approximately 500 feet for the channel upstream of Site 12. Cross section data were collected from the base map using various software tools available in Geo-Ras, an extension used in ArcGIS 9.2. The base map used includes that described in Section 5.2 (below). Appendix E includes the HEC-RAS cross sections and detailed input and output.

5.2 Study Work Maps

The Zone A delineations for the Site 7, 8 and 12 alluvial fans are shown on 1"= 400', 10' contour interval base mapping with orthographic aerial photography. The work study map and Index Sheet are presented with this Technical Data Notebook (TDN) on 24"x36" sheets. Reduced-scale copies of the work map are included on Figure 5.1. The full-size sheets are contained in Exhibit Map C of the TDN.

The work map includes cross-section locations, floodplain boundaries, zone designations, road names, state-plane coordinate grid, section lines, corporate boundaries and stream names/numbers. The flood zones delineated using approximate method hydraulic modeling of the reaches upstream of the alluvial fan apexes are shown as Zone A administrative floodways on the work maps and annotated FIRM panels.

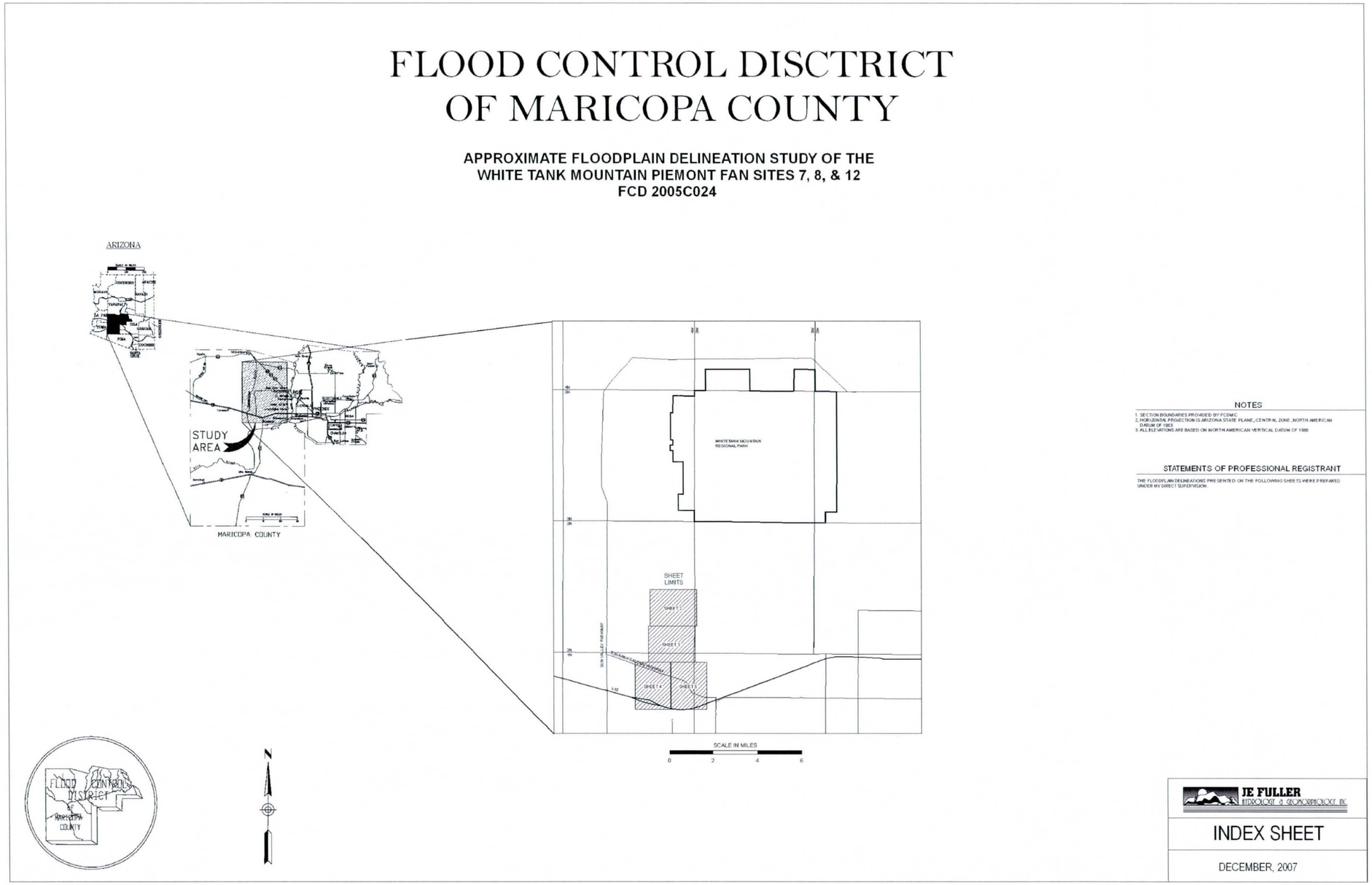
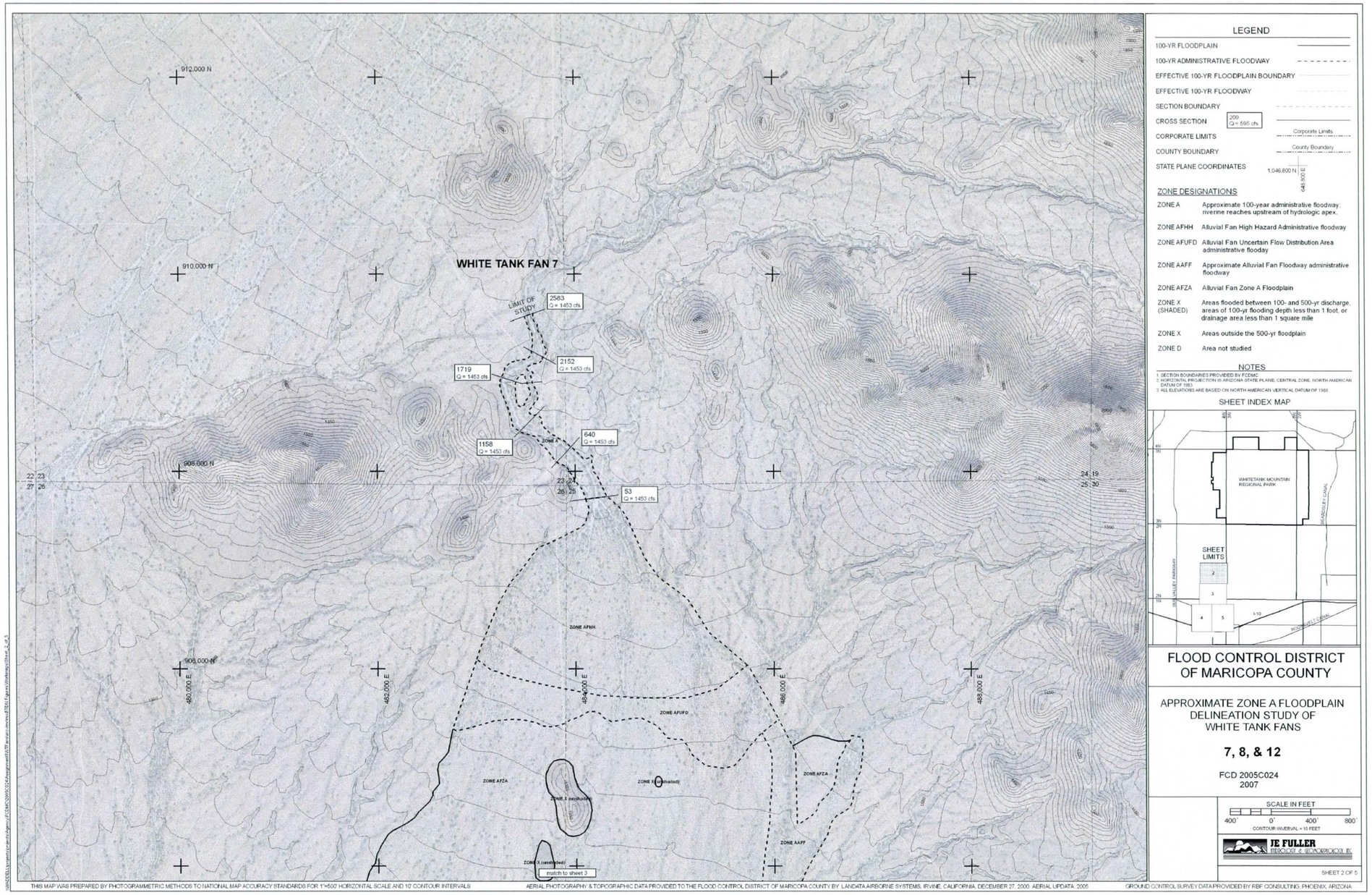


Figure 5.1 Reduced Floodplain Workmaps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484,000 E
486,000 E
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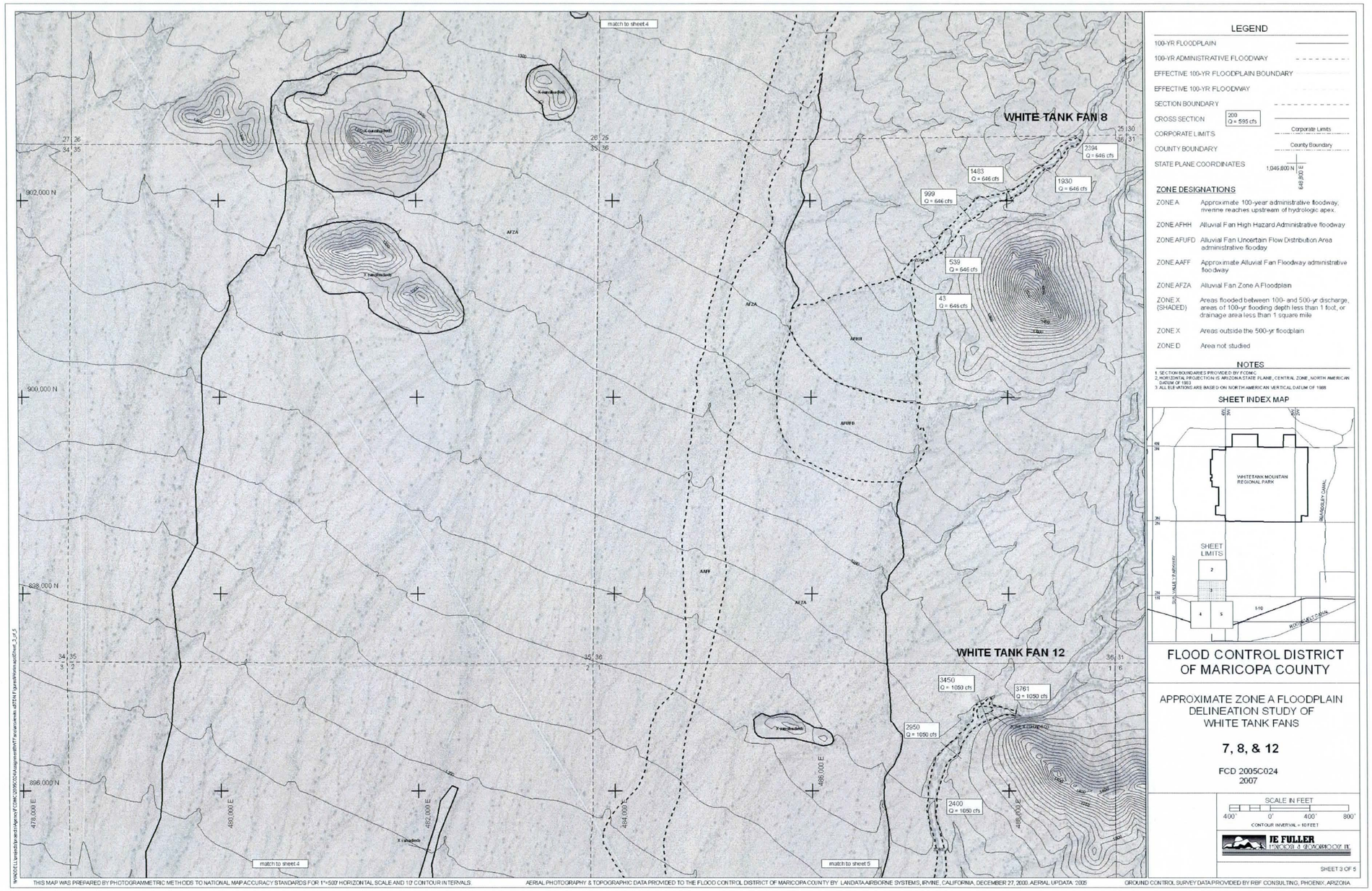
LIMIT OF STUDY
2583 Q = 1453 cfs
2152 Q = 1453 cfs
1719 Q = 1453 cfs
1158 Q = 1453 cfs
640 Q = 1453 cfs
53 Q = 1453 cfs
ZONE A
ZONE AFHH
ZONE AFUFD
ZONE AFZA
ZONE X (shaded)
ZONE X (excluded)
ZONE AAFF
ZONE X (unshaded)
match to sheet 3
LEGEND
100-YR FLOODPLAIN
100-YR ADMINISTRATIVE FLOODWAY
EFFECTIVE 100-YR FLOODPLAIN BOUNDARY
EFFECTIVE 100-YR FLOODWAY
SECTION BOUNDARY
CROSS SECTION
200 Q = 595 cfs
CORPORATE LIMITS
Corporate Limits
COUNTY BOUNDARY
County Boundary
STATE PLANE COORDINATES
1,046,600 N
648,900 E
ZONE DESIGNATIONS
ZONE A Approximate 100-year administrative floodway; riverine reaches upstream of hydrologic apex.
ZONE AFHH Alluvial Fan High Hazard Administrative floodway
ZONE AFUFD Alluvial Fan Uncertain Flow Distribution Area administrative flooday
ZONE AAFF Approximate Alluvial Fan Floodway administrative floodway
ZONE AFZA Alluvial Fan Zone A Floodplain
ZONE X (SHADED) Areas flooded between 100- and 500-yr discharge, areas of 100-yr flooding depth less than 1 foot, or drainage area less than 1 square mile
ZONE X Areas outside the 500-yr floodplain
ZONE D Area not studied
NOTES
1. SECTION BOUNDARIES PROVIDED BY FCDMC
2. HORIZONTAL PROJECTION IS ARIZONA STATE PLANE, CENTRAL ZONE, NORTH AMERICAN DATUM OF 1983
3. ALL ELEVATIONS ARE BASED ON NORTH AMERICAN VERTICAL DATUM OF 1988
SHEET INDEX MAP
WHITETANK MOUNTAIN REGIONAL PARK
SHEET LIMITS
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
APPROXIMATE ZONE A FLOODPLAIN DELINEATION STUDY OF WHITE TANK FANS
7, 8, & 12
FCD 2005C024
2007
SCALE IN FEET
400' 0' 400' 800'
CONTOUR INVERVAL = 10 FEET
JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.
SHEET 2 OF 5
THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS FOR 1"=500' HORIZONTAL SCALE AND 10' CONTOUR INTERVALS
AERIAL PHOTOGRAPHY & TOPOGRAPHIC DATA PROVIDED TO THE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY BY: LANDATA AIRBORNE SYSTEMS, IRVINE, CALIFORNIA, DECEMBER 27, 2000. AERIAL UPDATA: 2005
GROUND CONTROL SURVEY DATA PROVIDED BY: RBF CONSULTING, PHOENIX, ARIZONA


match to sheet 4
WHITE TANK FAN 8
WHITE TANK FAN 12
1483
Q = 646 cfs
2394
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1930
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3450
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3761
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2950
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2400
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486,000 E
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AFZA
AFHH
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AAFF
match to sheet 4
match to sheet 5
LEGEND
100-YR FLOODPLAIN
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400' 0' 400' 800'
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match to sheet 3
X (shaded)
X (unshaded)
AFZA
AAFF
LIMIT OF STUDY
MATCH TO FEMA FLOODPLAIN ZONE
480,000 E
478,000 E
476,000 E
694,000 N
690,000 N
686,000 N
682,000 N
678,000 N
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JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.
SHEET 4 OF 5
THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS FOR 1"=500' HORIZONTAL SCALE AND 10' CONTOUR INTERVALS
AERIAL PHOTOGRAPHY & TOPOGRAPHIC DATA PROVIDED TO THE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY BY: LANDDATA/AIRBORNE SYSTEMS, IRVINE, CALIFORNIA, DECEMBER 27, 2000. AERIAL UPDATA: 2005
GROUND CONTROL SURVEY DATA PROVIDED BY RBF CONSULTING, PHOENIX, ARIZONA

LEGEND
100-YR FLOODPLAIN
100-YR ADMINISTRATIVE FLOODWAY
EFFECTIVE 100-YR FLOODPLAIN BOUNDARY
EFFECTIVE 100-YR FLOODWAY
SECTION BOUNDARY
CROSS SECTION
200
Q = 595 cfs
CORPORATE LIMITS
Corporate Limits
COUNTY BOUNDARY
County Boundary
STATE PLANE COORDINATES
1,046,800 N
648,600 E
ZONE DESIGNATIONS
ZONE A
Approximate 100-year administrative floodway, riverine reaches upstream of hydrologic apex.
ZONE AFHH
Alluvial Fan High Hazard Administrative floodway
ZONE AFUFD
Alluvial Fan Uncertain Flow Distribution Area administrative flooday
ZONE AAFF
Approximate Alluvial Fan Floodway administrative floodway
ZONE AFZA
Alluvial Fan Zone A Floodplain
ZONE X (SHADED)
Areas flooded between 100- and 500-yr discharge, areas of 100-yr flooding depth less than 1 foot, or drainage area less than 1 square mile
ZONE X
Areas outside the 500-yr floodplain
ZONE D
Area not studied
NOTES
1. SECTION BOUNDARIES PROVIDED BY FCDMC
2. HORIZONTAL PROJECTION IS ARIZONA STATE PLANE, CENTRAL ZONE, NORTH AMERICAN DATUM OF 1983
3. ALL ELEVATIONS ARE BASED ON NORTH AMERICAN VERTICAL DATUM OF 1988
SHEET INDEX MAP
WHITETANK MOUNTAIN REGIONAL PARK
SHEET LIMITS
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
APPROXIMATE ZONE A FLOODPLAIN DELINEATION STUDY OF WHITE TANK FANS
7, 8, & 12
FCD 2005C024
2007
SCALE IN FEET
400' 0' 400' 800'
CONTOUR INVERVAL = 10 FEET
JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.
SHEET 5 OF 5
MATCH TO FEMA FLOODPLAIN ZONE
match to sheet 4
match to sheet 3
ZONE A
ZONE AFHH
ZONE AAFF
ZONE AFUFD
ZONE AFZA
ZONE X (unshaded)
ZONE X (shaded)
799
Q = 1050 cfs
166
Q = 1050 cfs
1528
Q = 1050 cfs
490,000 E
488,000 E
486,000 E
484,000 E
884,000 N
886,000 N
888,000 N
890,000 N
892,000 N
LIMIT OF STUDY
THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS FOR 1"=500' HORIZONTAL SCALE AND 10' CONTOUR INTERVALS
AERIAL PHOTOGRAPHY & TOPOGRAPHIC DATA PROVIDED TO THE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY BY: LANDATA AIRBORNE SYSTEMS, IRVINE, CALIFORNIA, DECEMBER 27, 2000. AERIAL UPDATA: 2005
GROUND CONTROL SURVEY DATA PROVIDED BY RBF CONSULTING, PHOENIX, ARIZONA

5.3 Parameter Estimation

HEC-RAS v3.1.3 was used to determine the flow width and depth for each cross section. All of the reaches were modeled in the sub-critical flow regime and the downstream boundary conditions were set at normal depth.

5.3.1 Roughness Coefficients

Manning's roughness coefficient (n value) describes the friction attributable to the channel, banks and overbank areas. The n value generally varies with depth of flow, so it is determined assuming a flow depth associated with the 100-year discharge. Manning's "n" values were determined using the methodology outlined in the USGS report titled, "Selection of Manning's Roughness Coefficient for Natural and Constructed Vegetated and Non-Vegetated Channels, and Vegetation Maintenance Plan Guidelines for Vegetated Channels in Central Arizona" by J.V Phillips and S. Tadoyon (2006)[2]. Field reconnaissance was undertaken to photograph typical reaches in the study area and to document channel and overbank conditions. The findings of these field investigations were summarized in Appendix E.1.

5.3.2 Expansion and Contraction Coefficients

The expansion and contraction coefficients used throughout the study were 0.3 and 0.1, respectively. No abrupt changes in the floodplain width were encountered that would warrant modification of these coefficients.

5.4 Cross-section descriptions

Cross section geometry was developed from the elevation contours and refined based on field reconnaissance and interpretation of surficial observations from the aerial base mapping. The most typical refinements to the channel geometry occur in the low flow channel areas that are not adequately represented by the 10' contour interval topography. Cross section stationing is from left to right if viewed in the downstream direction. Cross section plots are located in Appendix E.2

5.5 Modeling Considerations

5.5.1 Hydraulic Jump and drop analysis

No hydraulic jump or drop analyses were conducted in this study.

5.5.2 Bridge or Culverts

No bridge or culvert analyses were conducted in this study.

5.5.3 Levees and Dikes

There are no levees or dikes within the project area.

5.5.4 Islands and Flow Splits

In general, small islands were not delineated on the work maps.

5.5.5 Ineffective Flow Areas

No significant ineffective flow areas exist in the natural channels in this study.

5.5.6 Supercritical Flow

Supercritical flow does not occur for significant lengths along any reach in this study.

5.6 Floodway modeling

Floodway modeling was not conducted for this study. The Flood Control District of Maricopa County (FCDMC) manages the approximate floodplain delineations as Administrative floodways and shows them as such on the floodplain workmaps (i.e. floodplain = floodway). In addition, the FCDMC administers certain approximate method alluvial fan zone designations as administrative floodways. The alluvial fan delineations are described in Section 6B.

5.7 Special problems encountered during the study

No special problems were encountered.

5.8 Calibration

No hydraulic calibration was performed during this study.

5.9 Final Results

This portion of this study resulted in 100-year Zone A riverine delineations for 0.5 miles of Fan 7, 0.5 miles for Fan 8, and 0.7 miles for Fan 12. A summary of the hydraulic analysis results are provided in the following HEC-RAS Summary below (Table 5.1). Appendix E.3 contains the HEC-RAS model detailed input and output.

Table 5.1 HEC-RAS Summary

River	River Sta	Q Total (cfs)	W.S. Elev (ft)	Crit W.S. (ft)	Vel Total (ft/s)	Top Width (ft)	Max Chl Dpth (ft)	Froude # XS	Sta W.S. Lft (ft)	Sta W.S. Rgt (ft)
FAN 7	2583.162	1453	1412.93	1412.89	7.88	93.85	3.6	0.99	130.65	224.5
FAN 7	2152.126	1453	1407.52	1407.52	6.9	137.36	2.71	0.98	143.12	280.48
FAN 7	1719.538	1453	1401.72	1401.38	5.6	149.82	2.25	0.75	274.68	424.51
FAN 7	1158.618	1453	1396.15	1396.15	5.72	170.6	3.45	0.83	120.15	354.07
FAN 7	640.0357	1453	1389.47	1389.47	5.24	211.01	3.13	0.8	128.06	339.07
FAN 8	2394.158	646	1358.27	1358.27	9.37	45.59	3.15	0.87	10.97	56.56
FAN 8	1930.623	646	1346.92	1346.92	8.21	49.54	2.44	0.97	68.87	118.41
FAN 8	1483.011	646	1336.8	1336.8	7.08	70.15	1.75	0.98	52.86	123.01
FAN 8	998.943	646	1326.04	1326.04	5.95	117.85	1.6	0.98	15.8	133.65
FAN 8	539.2312	646	1317.52	1317.52	7.45	99.05	1.98	0.82	25.13	124.18
FAN 8	43.04325	646	1307.27	1307.27	6.24	197.98	1.88	0.73	263.99	461.97
FAN 12	3761.932	1050	1243.06	1243.06	9.31	50.89	4.26	0.99	35.75	86.64
FAN 12	3449.982	1050	1236.51	1236.51	7.47	98.06	3.26	0.96	177.87	359.08
FAN 12	2950.532	1050	1229.65	1229.46	5.83	130.88	1.9	0.82	58.25	189.12
FAN 12	2400.759	1050	1223.23	1223.15	8	89.84	2.91	0.88	51.96	141.8
FAN 12	1528.313	1050	1212.48	1212.48	8.05	85.51	2.56	0.97	63.43	148.95
FAN 12	799.0694	1050	1203.05	1203.05	8.3	89.4	2.54	0.92	48.99	138.38
FAN 12	166.1562	1050	1194.04	1194.04	8.25	106.72	2.79	0.89	145.08	251.8

5.10 References

1. Phillips, J. V. and Ingersoll, T.L., 1998, *Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona*: U.S. Geological Survey Professional Paper 1584, 77 p.

2. Phillips, J.V., and Tadayon, S., 2006, Selection of Manning's roughness coefficient for natural and constructed vegetated and non-vegetated channels, and vegetation maintenance plan guidelines for vegetated channels in central Arizona: U.S. Geological Survey Scientific Investigations Report 2006-5108, 41 p.

3. U.S. Army Corps of Engineers, HEC-RAS River Analysis System Users Manual, Version 3.1, November, 2002.

4. U.S. Army Corps of Engineers, HEC-RAS River Analysis System Hydraulic Reference Manual, Version 3.1, November, 2002.

5. U.S. Army Corps of Engineers, HEC-RAS River Analysis System, Version 3.1.3, May, 2005.

6. SEDIMENT TRANSPORT/EROSION

SECTION 6A: EROSION AND SEDIMENT TRANSPORT

No specific erosion or sediment transport analyses were conducted as part of this study. However, implicit to the geomorphic assessment of the active alluvial fan areas were considerations of sedimentary processes on the White Tank Mountain Piedmont. Therefore, areas of erosion hazards associated with the active alluvial fan flooding have been included in the floodplain delineation.

Sediment yield estimates were performed for the Buckeye Sun Valley ADMS (Ayres, 2004) and are used without modification for this study.

SECTION 6B: GEOMORPHOLOGY

This section of the Technical Data Notebook describes the geomorphic methods used to delineate the flood hazards on the Site 7, 8 and 12 alluvial fans. Section 6B is organized to follow the outline of the Piedmont Flood Hazard Assessment Manual (PFHAM) (Hjalmarson, 2003) format, as well as the FEMA Guidelines (FEMA, 2002). Hydrology and hydraulic data used in the delineation are described in Sections 4 and 5 of this TDN. Both the PFHAM and the FEMA Guidelines describe a three stage delineation process. The FEMA Guidelines are intended only for alluvial fans, whereas the PFHAM is applicable to a wider range of piedmont surfaces. The three stage delineation process includes the following steps:

- Stage 1: Recognizing and Characterizing Alluvial Fan Landforms
- Stage 2: Defining Active and Inactive Areas of Erosion and Deposition
- Stage 3: Defining the 100-Year Floodplain

Geomorphic methods, historical data, and limited post-flood hazard verification data were used downstream of the hydrographic apex to delineate the flood hazard zones, as specified in Table G-1 of the FEMA Guidelines. Upstream of the hydrographic apex, geomorphic methods were used to complement and refine conventional approximate normal-depth hydraulic methods, as described in Section 5 of the TDN.

6B.1 Previous Studies

Several previous studies of the geomorphology and relative flood hazards have been conducted in and around the study area. These studies include the following:

- Hjalmarson and Kemna (1991) *Flood Hazards of Distributary-Flow Areas in Southwestern Arizona*: U.S. Geological Survey Water Resources Investigations Report 91-4171.

  This report identified White Tank Piedmont Sites 36-39 and described methods of identifying flood hazards associated with distributary flow networks.

- CH2M Hill (1992) *Alluvial Fan Data Collection and Monitoring Study*: Tempe, Arizona, CH2M Hill and R.H. French, Ph.D., P.E. Consulting Engineer for the Flood Control District of Maricopa County, 204 p.

  This report identified Site 36 as an active alluvial fan, included geomorphic mapping and historical data, and recommended a flood monitoring and data collection program.

- Field & Pearthree (1991), *Surficial Geology around the White Tank Mountains, Central Arizona.* AZGS Open File Report 91-8.

This mapping effort included nine 7.5' quadrangles around the White Tank Mountain piedmont. Piedmont mapping distinguished Holocene fans (Y) from Pleistocene fans (M).

- Field & Pearthree (1992), *Geologic Mapping of Flood Hazards in Arizona: An Example from the White Tank Mountains, Maricopa County*. AZGS Open File Report 91-10.

  This mapping effort related surficial characteristics to the degree flood hazard on piedmont surfaces surrounding the White Tank Mountains. Primary flow paths were also identified.

- Alpha Engineering Group, Inc., 1994, *White Tanks Wash Flood Insurance Study, FCD No. 90-64*: for FCDMC, Phoenix, Arizona.

  This detailed riverine floodplain delineation for White Tank Wash, the axial drainage for White Tank Piedmont Sites 6, and 36-39. The delineation extended from the Buckeye FRS to Sun Valley Parkway and included a tributary that is one of the primary flow paths for Fan 39.

- Field (1994), Surficial Processes on Two Fluvially Dominated Alluvial Fans in Arizona, AZGS Open File Report 94-12. Also: Field (1994), *Processes of Channel Migration on Fluvially Dominated Alluvial Fans in Arizo*na, AZGS Open File Report OFR-94-13.

  These studies document the importance of stream piracy processes in developing distributary flow networks and causing channel movement on fans dominated by fluvial processes. Historical evidence from White Tank Piedmont Site 36 is used as one of five case histories presented.

- Hjalmarson (1994), *Potential Flood Hazards and Hydraulic Characteristics of Distributary-Flow Areas in Maricopa County, Arizona*: U.S. Geological Survey Water Resources Investigations Report 93-4169, 56 p.

  This study defined measurable parameters intended to assess the degree of flood hazard on distributary flow systems. White Tank Piedmont Sites 36-39 were used as example sites.

- JE Fuller/Hydrology & Geomorphology, Inc. (1999), *Approximate Floodplain Delineation Study for White Tank Fan (Site 36)*. TDN prepared for the Flood Control District of Maricopa County.

  This approximate method floodplain delineation study used the NRC three-stage process to delineate the floodplain for Site 36. The study established the TDN format for alluvial fan floodplain delineation studies in Maricopa County.

- Robinson (2002), *Cosmogenic Nuclides, Remote Sensing, and Field Studies Applied to Desert Piedmonts*. ASU Geology Department PhD Dissertation.

This study used remote sensing techniques to perform geomorphic mapping of portions of the White Tank Piedmont.

- Ferguson and others (2004), *Geologic Map of the Wagner Wash Well 7.5' Quadrangle, Maricopa County, Arizona.*

  This mapping project is the most recent AZGS geologic and surficial mapping of the White Tank Piedmont area.

- Field and others (2004), *Geologic Map of the Buckeye NW 7.5' Quadrangle, Maricopa County, Arizona.*

  This mapping project is the most recent AZGS geologic and surficial mapping of the White Tank Piedmont area.

- Ayres Associates (2004), Buckeye Sun Valley ADMP Piedmont Landform Delineations Technical Memorandum to the Flood Control District of Maricopa County.

  This report describes the results of Stage 1 and Stage 2 delineations from the NRC three-stage alluvial fan delineation process. In general, the Ayres results were not relied on for the current delineation study.

- Ayres Associates (2004), Buckeye Sun Valley ADMP Sediment Yield Analysis. Technical Memorandum to the Flood Control District of Maricopa County.

  This report summarizes an analysis of potential sediment yield to the Buckeye FRS.

In addition to this TDN, other TDN's have been or are presently being prepared for alluvial fans located along the White Tank Piedmont. These TDN's include the following alluvial fan flooding sources:

- Alluvial Fan Floodplain Delineations by JE Fuller/Hydrology & Geomorphology, Inc. for the Flood Control District of Maricopa County Sun Valley ADMP:
  - White Tank Piedmont Fan Sites 10-11-20
  - White Tank Piedmont Fan Sites 1-2
  - White Tank Piedmont Fan Sites 4-5
  - White Tank Piedmont Fan Site 6
  - White Tank Piedmont Fan Sites 3-13-16
  - White Tank Piedmont Fan Sites 17-19
- Alluvial Fan Floodplain Delineations by Others:

- White Tank Piedmont Fan Site 37 and Portions of Fan Site 36. TDN prepared by Coe & Van Loo Consulting, Inc. for Lennar Properties.
- White Tank Piedmont Fan Site 38. TDN prepared by David Evans & Associates for Stardust Properties.
- White Tank Piedmont Fan Site 39. TDN prepared by CMX, Inc for Pulte Homes.

An alluvial fan floodplain delineation was also previously prepared by the Flood Control District of Maricopa County for the Skyline Wash Alluvial Fan, which is located on the southern flank of the White Tank Mountain Piedmont, as documented in the PFHAM Section 5.3. Finally, preliminary alluvial fan delineations (Stage 1-2) were prepared but not finalized by WEST Consultants, Inc. for portions of the northeast flank of the White Tank Piedmont as part of the Flood Control District of Maricopa County Wittmann Area Drainage Master Study Update. Except where specifically referenced or noted as such, this study does not rely on any of the previous or on-going alluvial fan floodplain delineation studies cited above.

6B.2 Data Sources

6B.2.1 NRCS Soils Map Unit Interpretation

The soils data used in this study were derived from two NRCS soil survey reports entitled *Soil Survey of Maricopa County, Arizona, Central Part* (Hartman, 1977) and *Soil Survey of Aguila-Carefree Area, Parts of Maricopa and Pinal Counties, Arizona* (Camp, 1986). These detailed soil surveys were developed for use by land planners, farmers, ranchers, agronomists, rangeland managers, community officials, geologists, engineers, developers, builders, home buyers, and watershed and wildlife managers. In 1999 the NRCS converted the soil survey data from the Hartman (1977) report to a digital database and GIS format. The Camp (1986) soil survey data was converted to a digital format in 2001. Digital versions of the NRCS soils data obtained from the NRCS web site were used for this study.

6B.2.2 AZGS Map Unit Interpretation

The Arizona Geological Survey (AZGS) published multiple surficial geologic maps at varying scales within the SVADMP study area. Table 6.1 lists the AZGS maps available for the study area.

Table 6.1 Collected AZGS Geology Maps

Map Name	Map Format	Scale	Year	Authors
Geologic Map of Wagner Wash Well 7.5' Quadrangle, Maricopa County	Scanned raster	1:24,000	2004	C.A. Ferguson, J.E. Spencer, P.A. Pearthree, A. Youberg, J.J. Field
Geologic Map of the Buckeye NW 7.5' Quadrangle, Maricopa County, Arizona	Scanned raster	1:24,000	2004	J.J. Field, P.A. Pearthree, C.A. Ferguson
Geologic Map of the Vulture Mine 7.5' Quadrangle, Maricopa County, Arizona	Scanned raster	1:24,000	2004	M.J. Grubensky, T.C. Shipman
Geologic Map of the Daggs Tank 7.5' Quadrangle, Maricopa County, Arizona	Scanned raster	1:24,000	2004	P.A. Pearthree, A. Youberg, J.J. Field, C.A. Ferguson, J.W. Spencer
Geologic Map of the White Tank Mountains, Central Arizona	Scanned raster	1:24,000	2002	S.J. Reynolds, S.E. Wood, P.A. Pearthree, J.J. Field
Geologic Map of the Wickenburg SW 7.5' Quadrangle, Maricopa County	Scanned raster	1:24,000	2004	T.C. Shipman, M.J. Grubensky
Geologic Map for the Buckeye 7.5' Quadrangle, Maricopa County, Arizona	Scanned raster	1:24,000	2002	S.J. Skotnicki
Geologic Map of the Phoenix North 30' x 60' Quadrangle, Central Arizona	Digital GIS	1:100,000	1997	S.J. Reynolds, M.J. Grubensky
Geologic Map of the Phoenix South 30' x 60' Quadrangle, Central Arizona	Digital GIS	1:100,000	1997	S.J. Reynolds, S.J. Skotnicki
Geologic Mapping of Flood Hazards in Arizona: An Example from the White Tank Mountains Area, Maricopa County	Scanned raster	1:24,000	1992	Field, J.J., Pearthree, P.A.

6B.2.3 Aerial Photography

Modern Orthophotography

Color, digital, orthophotography covering the entire SVADMP study area was provided by the Flood Control District of Maricopa County. Over 400 image tiles were collected, each covering approximately 0.90 square miles at a resolution of 1-foot/pixel.

Historical Aerial Photography

Limited historical aerial photography was collected from the Flood Control District of Maricopa County. The photos were provided as digital image files scanned from the original photo prints. Table 6.2 lists the years of historical photos coverage used in this study.

Table 6.2 Collected historical aerial photography		
Photo Year	**Original Photo Print Scale**	**Format**
1953	1:20,000	B&W scanned

6B.2.4 Topographic Mapping

The primary mapping source used in this study was 10-foot contour interval, digital topography provided by the Flood Control District of Maricopa County. The mapping was performed county-wide scale in December 2000. Additional 2- to 4-foot digital topography was provided by the Flood Control District of Maricopa County for limited areas within the SVADMP study area. Table 6.3 lists the digital topographic data collected for this study.

Table 6.3 Collected digital topography		
Contour Interval	**Mapping Year**	**FCDMC Source Project**
10-foot	2000	County-wide mapping
2-foot	1990	White Tanks-Agua Fria ADMS
4-foot	1990	Wickenburg ADMS
2-foot	1991	Buckeye Area FDS
4-foot	1991	White Tanks Wash FDS
4-foot	1991 and 1993	Salt/Gila River Master Plan
2-foot	1992	Daggs Wash FDS
2-foot	1994	Buckeye FRS
2-foot	1997	Skyline Wash FDS
2-foot	2002	Buckeye/Sun Valley Mapping
2-foot	2002	Wittmann ADMP Mapping
2-foot	2002	Hassayampa North Extension Mapping

6B.3 Method Description

The PFHAM alluvial fan floodplain delineation methodology is based on the three stage process outlined in the National Research Council's (NRC, 1996) report, *Alluvial Fan Flooding*. Both the PFHAM and NRC documents describe a three stage method used to identify alluvial fan flood hazards, which was later

adapted for the FEMA Guidelines Appendix G (2002). The PFHAM broadens the three-stage delineation approach to cover a variety of piedmont landforms.

Stage 1 of the PFHAM/FEMA alluvial fan methodology is the recognition and characterization of piedmont landforms. The intent of the Stage 1 analysis is to distinguish alluvial fan landforms from riverine, sheet flow, ponding, or coastal landforms.[1] If the landform in question is identified as an alluvial fan, then the delineation may proceed using the PFHAM/FEMA Stage 2 and 3 procedures. If the landform is not an alluvial fan, then more traditional floodplain delineation procedures should be applied. The Stage 1 delineation relies on the following types of information:

- Composition. Alluvial fans are composed of loose, unconsolidated materials transported by fluvial or debris flow processes (a.k.a., "alluvium").
- Morphology. Alluvial fans have the shape of a partially or fully extended fan as observed on topographic maps or aerial photographs.
- Location. Alluvial fans are usually found at a topographic break where stream channels become less confined than upstream of the break.
- Boundaries. The downstream boundary of an alluvial fan is called the "toe," which is located at an axial stream, lake or landform not dominated by alluvial fan flooding processes. The lateral boundaries of the fan are defined by a transition from alluvial fan flooding processes to riverine processes, although an alluvial fan may also coalesce into adjacent alluvial fans to form a bajada.[2]

Data sources for the Stage 1 delineation included topographic maps, NRCS soil surveys, geologic mapping, aerial photographs, and field observations. These data were used to differentiate piedmont landforms which included mountains, inselbergs[3], alluvial fans, pediments, and riverine floodplains. The locations of the topographic and hydrographic apexes on the alluvial fan were also identified in Stage 1. The topographic apex is the extreme upstream extent of the alluvial fan landform, which is often located at the mountain front or within a mountain front embayment. The hydrographic apex is the location at which flow of water and sediment becomes unconfined and spreads out rapidly. Sudden expansion of flow at the hydrographic apex causes sediment deposition, uncertain flood flow paths, and uncertain flow distribution below the apex. The complex hydraulics associated with this flow expansion and sediment deposition create significant

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[1] FEMA Guidelines, p. G-6, 1st paragraph.

[2] A bajada is "a low-lying area of confluent pediment slopes and alluvial fans at the base of mountains around a desert" (The New Penguin Dictionary of Geology, 1996).

[3] An inselberg is "an isolated residual knob or hill, rising abruptly from a lowland erosion surface." (Dictionary of Geological Terms, Anchor Books, 1984)

uncertainties (unpredictability) that "cannot be set aside in the realistic assessment of the flood hazard" (FEMA, 2002), which is the defining characteristic for alluvial fan flooding.

The White Tank Piedmont consists of an extensive bajada that rings the White Tank Mountains, rather than a series of distinct, separate alluvial fans. The active fan areas within the bajada are located well away from the mountain front, and are inset within the original alluvial fans, sometimes with two or more hydrographic apexes on what was once (in geologic time) a single alluvial fan landform. This bajada landform, in conjunction with the complicated hydrographic apex locations, makes delineating individual alluvial fan landforms somewhat problematic. Therefore, because of the bajada condition, and because JE Fuller/ Hydrology & Geomorphology, Inc. was under contract to delineate alluvial fan floodplain over much of the White Tank Piedmont, the Stage 1 delineation was performed for the entire White Tank Piedmont area, rather than just the portion of the bajada surrounding the Site 7, 8 and 12 alluvial fans.

Stage 2 of the PFHAM/FEMA alluvial fan methodology consists of defining active and inactive[1] areas portions of the alluvial fan landform. Active areas are those locations where uncertainties about channel geometry and hydraulic conditions of water and sediment discharge cannot be set aside in the realistic assessment of flood hazard. Active areas on alluvial fans experience sediment deposition, erosion and unstable flow paths in addition to flood inundation. Generally, active alluvial fans have experienced these processes within the past 10,000 years (the Holocene Epoch). Inactive alluvial fan areas are the portions of the alluvial fan where active fan processes do not occur. Generally, inactive alluvial fans have not experienced such processes within the past 10,000 years, but may have done so during much older geologic periods (the Pleistocene Epoch or Tertiary Period). Stage 2 also identifies portions of the piedmont subject to various types of flooding such as stable riverine flooding, active alluvial fan flooding, inactive alluvial fan flooding, and sheet flooding.

According to FEMA Guidelines, a Stage 2 delineation may be completed using a geomorphic-based approach, if the alluvial fan has little or no urbanization (Table G-1, FEMA, 2002), as is the case for the Site 7, 8 and 12 alluvial fans. In the geomorphic approach, the following surficial stability characteristics are compiled and evaluated:

- Detailed Soils Mapping. Detailed soils maps prepared by the USDA Natural Resource Conservation Service (NRCS) are available for the entire study area. NRCS soils maps describe soil composition, as well as provide some degree of landform interpretation.

[1] FEMA uses the terms "active" and "inactive." The PFHAM uses "stable" and "unstable," respectively, for the same concept.

- Surficial Geologic Mapping. The Arizona Geological Survey (AZGS) has prepared several types of surficial geology and flood hazard assessment maps for the entire study area. The AZGS maps indicate surface age, degree of flood hazard, and landform type.
- Topographic Mapping. Topographic data to be considered include the fan profile, degree of contour crenulation index (a measure of incision), fan shape, and slope. 10-foot contour interval topographic data are available for the study area. Topographic data are also used to estimate flow containment when defining fan boundaries. The topographic data were also used to construct longitudinal profiles of the alluvial fans.
- Vegetation. Vegetation patterns can be used to identify flow paths or areas of more frequent inundation (dense vegetation), sheet flow (uniform vegetation), the degree soil development (e.g., ocotillo are a marker species for carbonate soil horizons), soil material (e.g., saguaro cacti prefer rocky, well drained soils), surface age (e.g., old surfaces have more slow growing species, creosote clone rings are wider on older surfaces), and surface boundaries (e.g., vegetation suites change with soil types and landform).
- Surficial Characteristics. Older, inactive surfaces tend to have well developed surficial features such as desert varnish, desert pavement, soil reddening, and incised, well-defined drainage patterns.
- Sediment Delivery Potential Sediment yield estimates can be used to estimate fan aggradation rates and define a zone of aggradation more likely to experience active fan processes.
- Drainage Pattern. Inactive fans tend to have tributary drainage patterns with well defined divides. Active fans tend to have distributary drainage patterns with poorly defined divides and/or perched flow paths.
- Historical Aerial Photographs. Channel positions from historical 1953 aerial photographs were digitized and compared with channel positions on 2005 aerial photographs to identify areas of known channel movement and changes in channel pattern.
- Numerical Procedures. Hjalmarson's (1994) procedures for assessment the degree of flood hazard were applied to the alluvial fan data.

Stage 3 of the PFHAM/FEMA alluvial fan methodology involves identifying the areas subject to flooding in a 100-year flood event. Stage 3 methodologies range from conventional detailed or approximate hydraulic methods using fixed-bed hydraulic models, such as Manning's equation, to geomorphic interpretation based field observations and aerial photographs. For this study, geomorphic methods were used for all of the alluvial fan areas downstream of the hydrographic apex.

6B.4 Stage 1: Recognizing and Characterizing Piedmont Landforms

Stage 1 of the PFHAM/FEMA alluvial fan methodology consists of recognizing and characterizing piedmont landforms. The primary objective of the Stage 1 analysis is to distinguish alluvial fan landforms from riverine, sheet flow, ponding, or coastal landforms. If an alluvial fan landform is identified, the location of the topographic and hydrographic apexes also must be determined. The Stage 1 assessment uses geomorphic characteristics obtained from soils maps, surficial geology maps, topographic maps, and aerial photographs, as well as field observations. As described above, a Stage 1 delineation was performed for the entire White Tank Piedmont, which includes the Site 7, 8 and 12 alluvial fans.

The White Tank Mountain Piedmont consists of an alluvial fan bajada that rings the entire White Tank Mountains. Although minor portions of the upper White Tank Mountain Piedmont have been mapped as a pediment, and a large number of inselbergs crop out within the bajada, the vast majority of the piedmont is composed of alluvium deposited below the mountain front in a radiating (albeit coalesced) pattern. The White Tank Piedmont is bounded by the Wagner Wash floodplain to the north and northwest and the Hassayampa River and White Tank Wash floodplains to the west. Historically, along the southern boundary, the piedmont transitioned gradually into the geologic floodplain of the Gila River. Today, a series of flood control dams (FRS – Flood Retarding Structures) truncate the piedmont upstream of the Interstate 10 alignment (Figure 1.1). The FRS were originally constructed by the USDA Soil Conservation Service (SCS) in the 1970's and are currently operated and maintained by the Flood Control District of Maricopa County. The FRS fully contains (at least) the 100-year flood, with adequate capacity for antecedent and flood sedimentation.

6B.4.1 Composition

NRCS soils mapping (Figure 6.1; adapted from Camp, 1986; and Hartman, 1977) and AZGS surficial geologic mapping (Figure 6.2; adapted from Reynolds and Grubensky (1997); and Reynolds and Skotnicki (1997)) show that the entire White Tank Mountain Piedmont is composed of alluvial sediments, with the exception of a few inselbergs.

6B.4.1.1 Soils Data

Figure 6.1 shows the NRCS soil map units overlain on the USGS topographic quadrangles. The soil unit polygons were obtained from the Soil Survey of Aguila-Carefree Area (Camp, 1986) and the Soil Survey of Maricopa County, Central Part (Hartman, 1977). Table 6B.4 gives a list and description of the NRCS soil units within the study area. In addition to showing the map unit boundaries and designations, Figure 6.1 shows by color the setting or type of landforms generally associated with

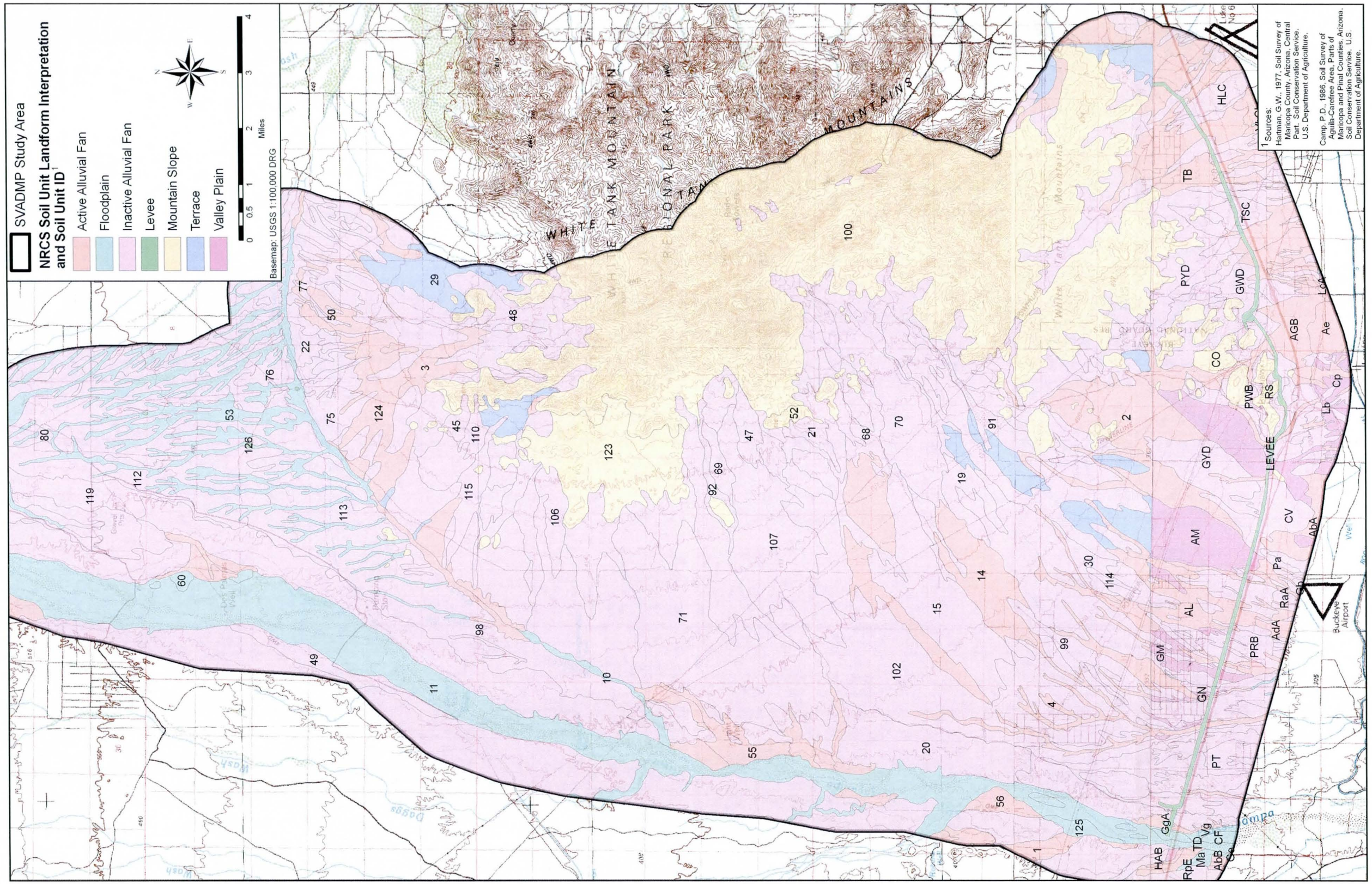


Figure 6.1 NRCS soils mapping with landform interpretations

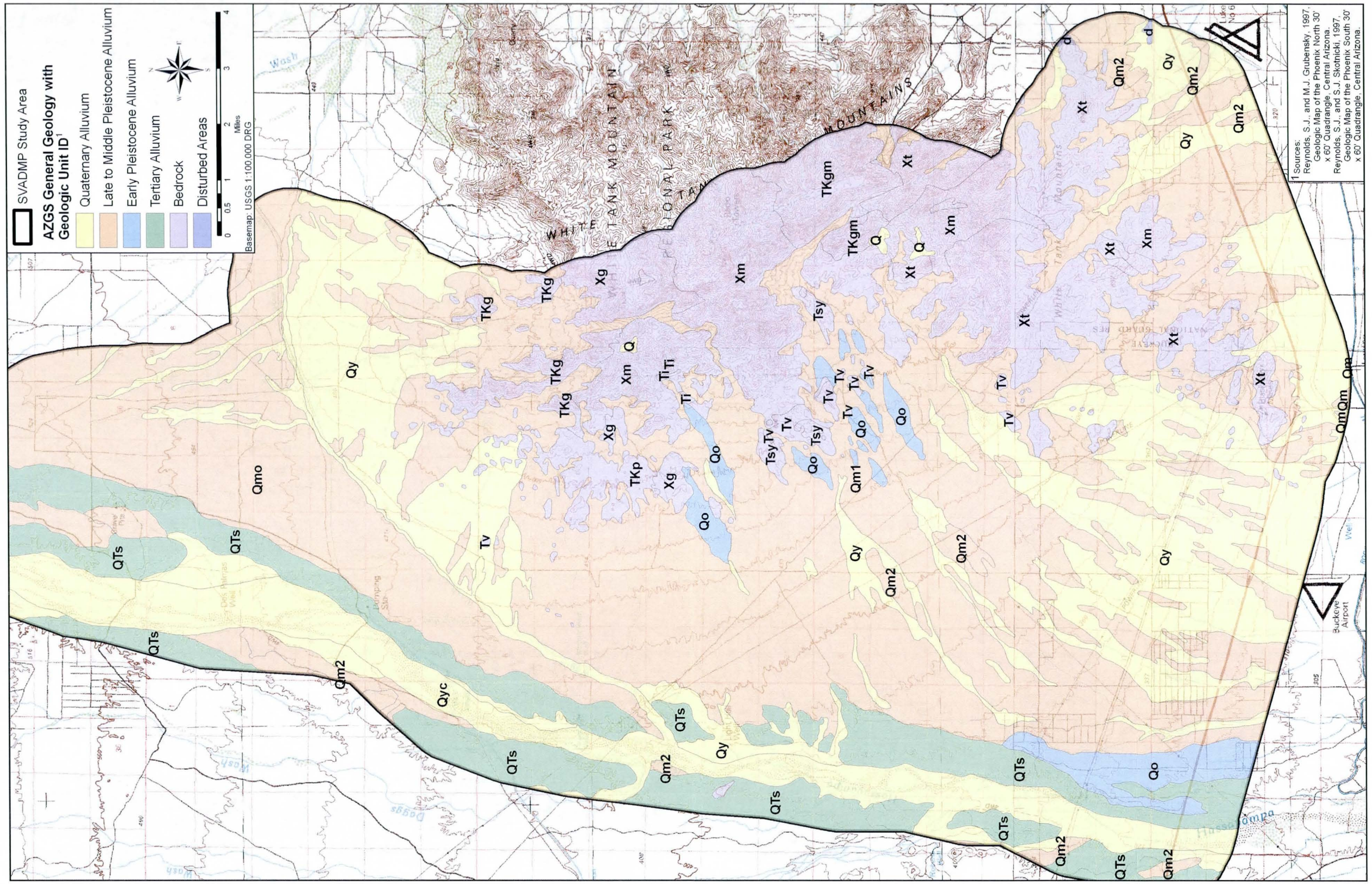


Figure 6.2 AZGS geologic mapping (1:100,000 scale)

each of the various map units as distinguished by the NRCS. The three main categories of landforms distinguished by the NRCS map unit descriptions are: 1) drainageways, floodplains, and alluvial fans, 2) alluvial fan terraces, and 3) mountains and hillslopes. Complete soil unit descriptions for the study area are provided in Camp (1986) and Hartman (1977).

The NRCS soils map units are grouped into broad soil associations as shown on the General Soils Maps provided in the NRCS soils reports. On the General Soils Maps, the bedrock areas of the White Tank Mountains are mapped as the Gachado-Rock Outcrop-Quilotosa Association (Camp, 1986), or as the Cherioni-Rock Outcrop Association (Hartman, 1977), both of which consist of very shallow and shallow gravelly soils and rock outcrop on hill slopes and mountain slopes. The majority of the piedmont bounding the mountain bedrock core is mapped as Gunsight-Rillito-Chuckawalla Association (Camp, 1986), which is found on gently to moderately steep slopes and consists of gravelly and very gravelly loamy soils on fan terraces, or the Gunsight-Rillito-Perryville Association (Hartman, 1977), which is found on nearly level to moderately steep surfaces and consists of gravelly loams and loams on old alluvial fans and valley plains. The northern portion of the piedmont is mapped (Camp, 1986) as the Mohall-Contine Association, which consists of loamy and clayey soils on fan terraces. Hartman (1977) mapped portions of the southern piedmont near the Buckeye FRS as the Antho-Valencia Association, a sandy loam soil on recent alluvial fans and valley plains.

Table 6B.4 also shows the relationship between the detailed NRCS soil map units and the White Tank Piedmont landforms. As can be seen from the table, each soil map unit is actually comprised of several soil series. Each series has its own associated position or landform which is identified in the table. Characteristics important to the soil series age, stability, and flood history are also presented in Table 6B.4. These characteristics help identify the landform type, as well as the stability and the flood history and flood potential of the unit, as described in the Stage 2 analysis.

The key facts derived from the NRCS soils mapping with respect to the Stage 1 delineation are that the piedmont area is underlain by alluvium and that soils are associated with alluvial fans, alluvial fan terraces (inactive alluvial fans), and alluvial plains. The NRCS soil descriptions provided in Table 6B.4 are consistent with the common soil types for alluvial fans shown in Table 2.1 of the PFHAM.

B.4.1.2 Surficial Geology

Figure 6.2 shows the 1:100,000 scale surficial geologic mapping of the White Tank Piedmont adapted from Reynolds and Grubensky (1997) and Reynolds and Skotnicki (1997) of the Arizona Geological Survey (AZGS). Figure 6.2 shows the entire piedmont study area is composed of alluvium of either Pleistocene or Holocene in age. More detailed AZGS surficial mapping at a scale 1:24,000 indicates pediment surfaces near the deeply embayed mountain front and around many of the bedrock

inselbergs. Phil Pearthree (personal communication, 1999) indicated that the pediment designation was identified solely on the basis of the inselbergs and that no subsurface data were used in the delineation of the pediment boundary shown on the AZGS maps. The 1:24,000 scale surficial mapping is difficult to interpret when illustrating the entire study area (as in Figure 6.2), thus the 1:100,000 scale mapping was used. The more detailed 1:24,000 scale mapping is shown later in this report in Figure 6.21.

Complete descriptions of the surficial geologic units are provided in Field and Pearthree (1991). The following units were mapped by the AZGS:

- Holocene Alluvial Fans & Drainageways (Y1 and Y2). These surfaces have experienced active deposition and erosion during the last 10,000 years. The Y2 unit is the youngest unit. It is found on alluvial fans, low terraces, and active channels
- Pleistocene Alluvial Fans (M1 and M2). The M units are of Pleistocene age, that is, greater than 10,000 years old, and have been subject to erosion and transport in recent geologic time.
- Older Alluvial Fans (O). The O units represent very old Pleistocene to Pliocene aged surfaces of relict alluvial fans greater than 1 million years old.
- Bedrock Units (X and T). Bedrock units occur within the White Tank Mountains, on pediments, and as inselbergs that crop out on the piedmont.

The surficial geology as mapped by the AZGS shows a general pattern of decreasing alluvial surface age moving downslope from the White Tank Mountains, and generally broader extent of younger surfaces with distance from the mountain front. Field and Pearthree (1991) hypothesized that the location of active alluvial fan and distributary flow areas on the piedmont has not shifted significantly since the Pleistocene, and that the younger M2, Y1, and Y2 surfaces in the middle and lower piedmont were derived primarily by erosion of the M1 and O surfaces on the upper piedmont. That is, most of the sediment deposited on the lower piedmont is being eroded from older upstream piedmont surfaces, rather than from the upper mountainous watersheds. The differing sediment source areas may be responsible for the contrast in sediment size and surface texture between the gravelly active alluvial fan areas on the piedmont immediately below the hydrographic apexes and the silty-sand younger surfaces near the toe of portions of the piedmont.

In addition to the surficial geology, the AZGS generated a series of flood hazard maps for the White Tank Mountains (Field and Pearthree, 1992). These maps identify areas of high, intermediate, and low flood hazard. Figure 6.3 is an example map for a portion of the White Tank Piedmont. Figure 6.22 shows the site-specific flood hazard mapping for this analysis.

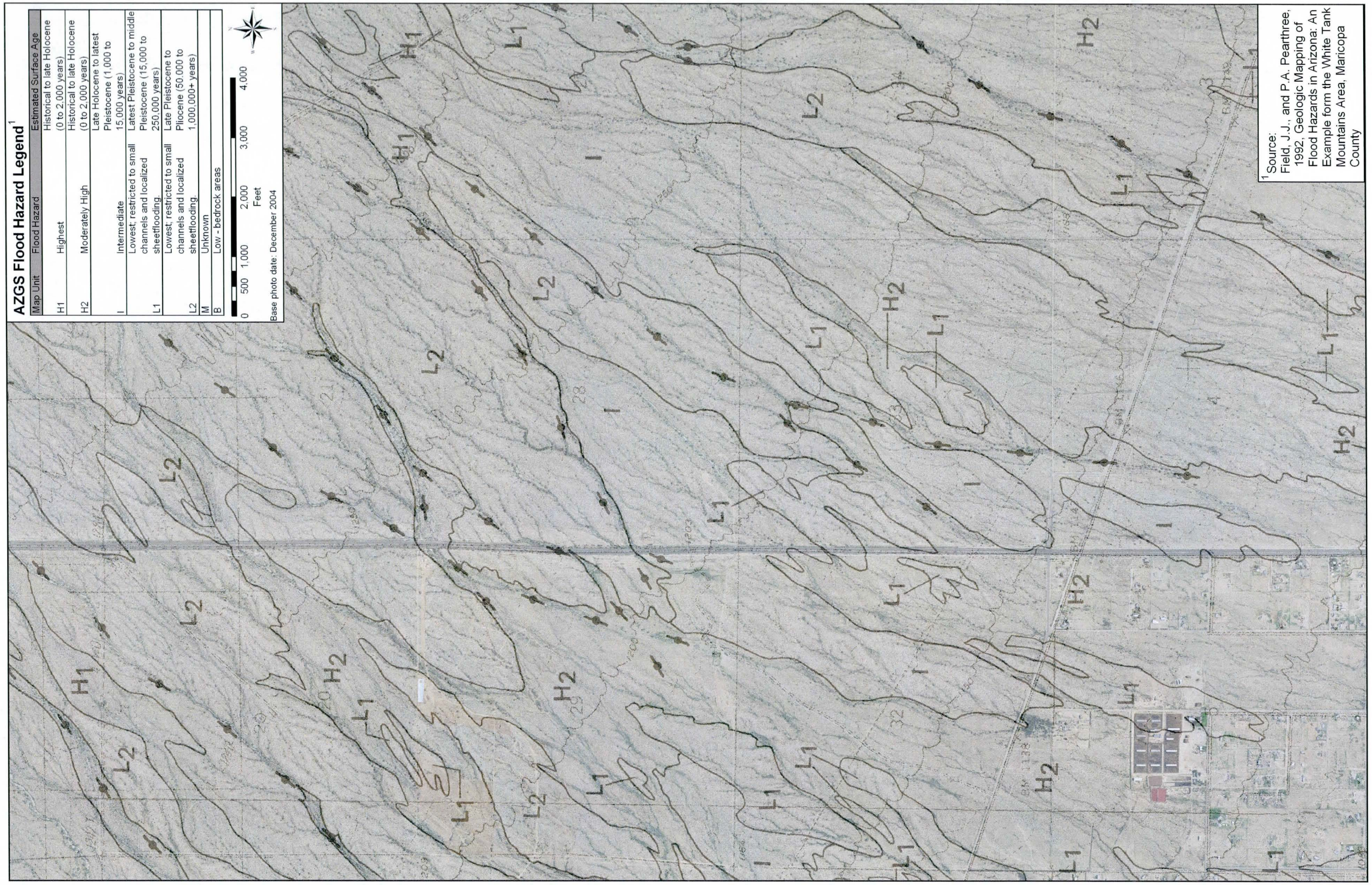


Figure 6.3 Example of AZGS flood hazard mapping

6B.4.1.3 Field Observations

Extensive field work was completed as part of the alluvial fan floodplain delineations studies performed by JE Fuller/Hydrology & Geomorphology, Inc. In addition, aerial photography was inspected to identify features consistent with alluvial deposits. Field observations made throughout the White Tank Piedmont and aerial photographic interpretation confirm that the piedmont is composed of alluvial materials, except where inselbergs crop out.

6B.4.1.4 Summary

The NRCS soils mapping, AZGS surficial geologic mapping, and field observations all yield similar findings regarding the alluvial composition of the White Tank Piedmont. Therefore, it is concluded that the White Tank Piedmont is composed of non-consolidated alluvium deposited by fluvial processes, which meets the composition criteria specified in the PFHAM and FEMA Guidelines.

6B.4.2 Morphology

According to the National Research Council definition (1996), "alluvial fans are landforms that have the shape of a fan, either partly or fully extended." The White Tank Piedmont study area consists of a series of coalescing landforms each with the shape of a partially extended alluvial fan. These coalescing alluvial fans comprise a bajada (Figure 6.5) which also shows a somewhat distorted, partially extended fan shape wrapped around the White Tank Mountains. The coalesced fan shape is readily visible on aerial photographs of the study area (Figure 6.4).

Topographic contour data also support the morphological definition of an alluvial fan. The USGS 1:100,000 scale quadrangle topographic maps, as well as the District's 10-foot contour interval mapping (Figure 6.5), show radial patterns across the piedmont surface. The contour crenulations, which range from highly crenulated to smooth radial lines, indicate the degree of fan incision and channel confinement, but uniformly depict an extended fan shape. The central west portion of the fan is the most highly crenulated, whereas the northern and southern portions of the piedmont have the smoothest contours.

Other morphologic features which support defining the White Tank Piedmont as an alluvial fan landform include the slope, drainage patterns, and surficial characteristics. The piedmont slope ranges from less than one percent to almost four percent (1-4%), which is much steeper than nearly all valley riverine drainage systems in central Arizona, which typically have slopes of less than one percent. Steep slopes are characteristic of alluvial fan landforms, which provide a transition from steep mountain slopes to flatter axial valley streams. The drainage pattern on the White Tank Piedmont includes vast areas of distributary channels as illustrated by the plot of flow bifurcations in Figure 6.6 and the stream channel network plot shown in

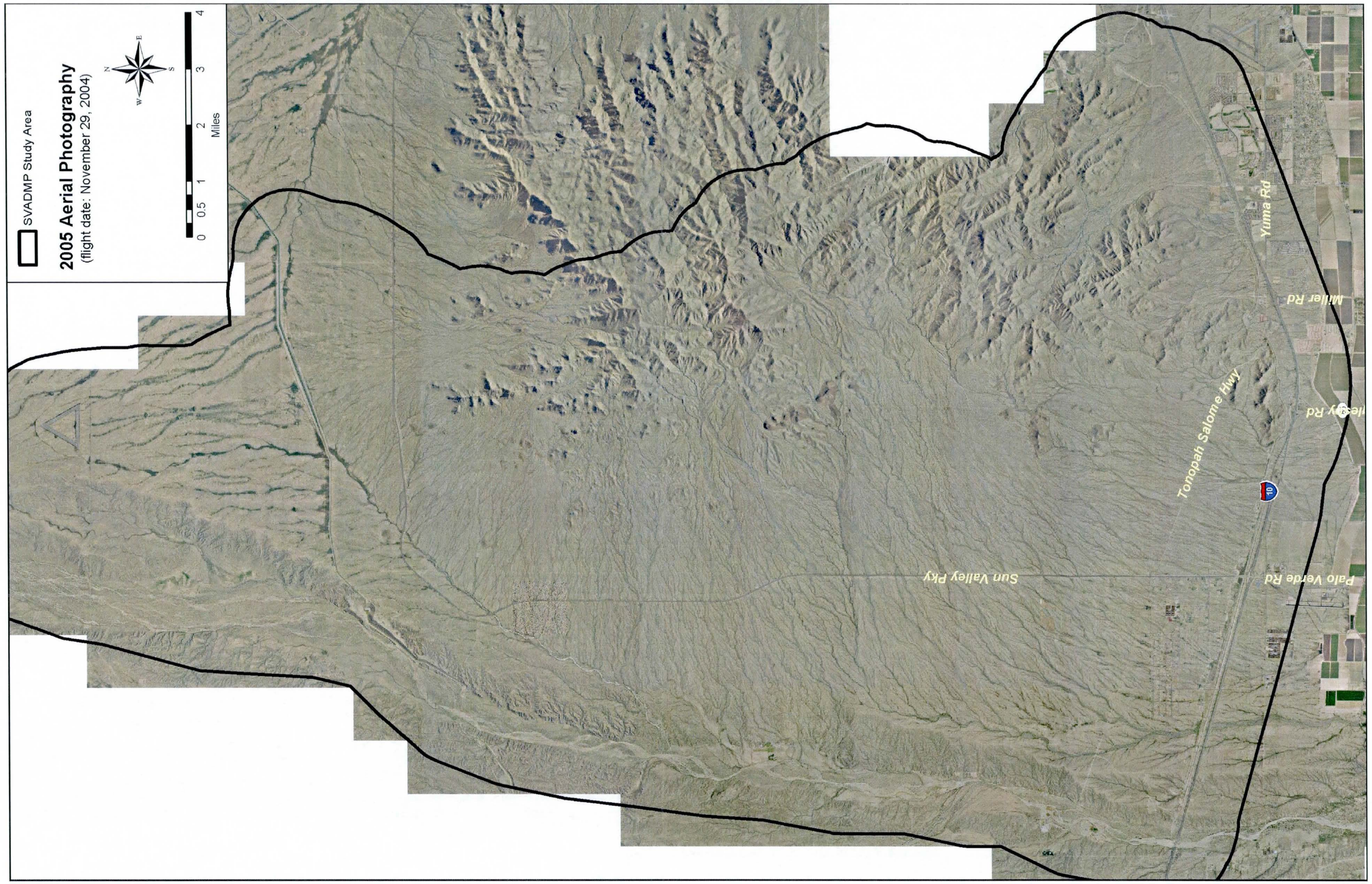


Figure 6.4 2005 aerial photography

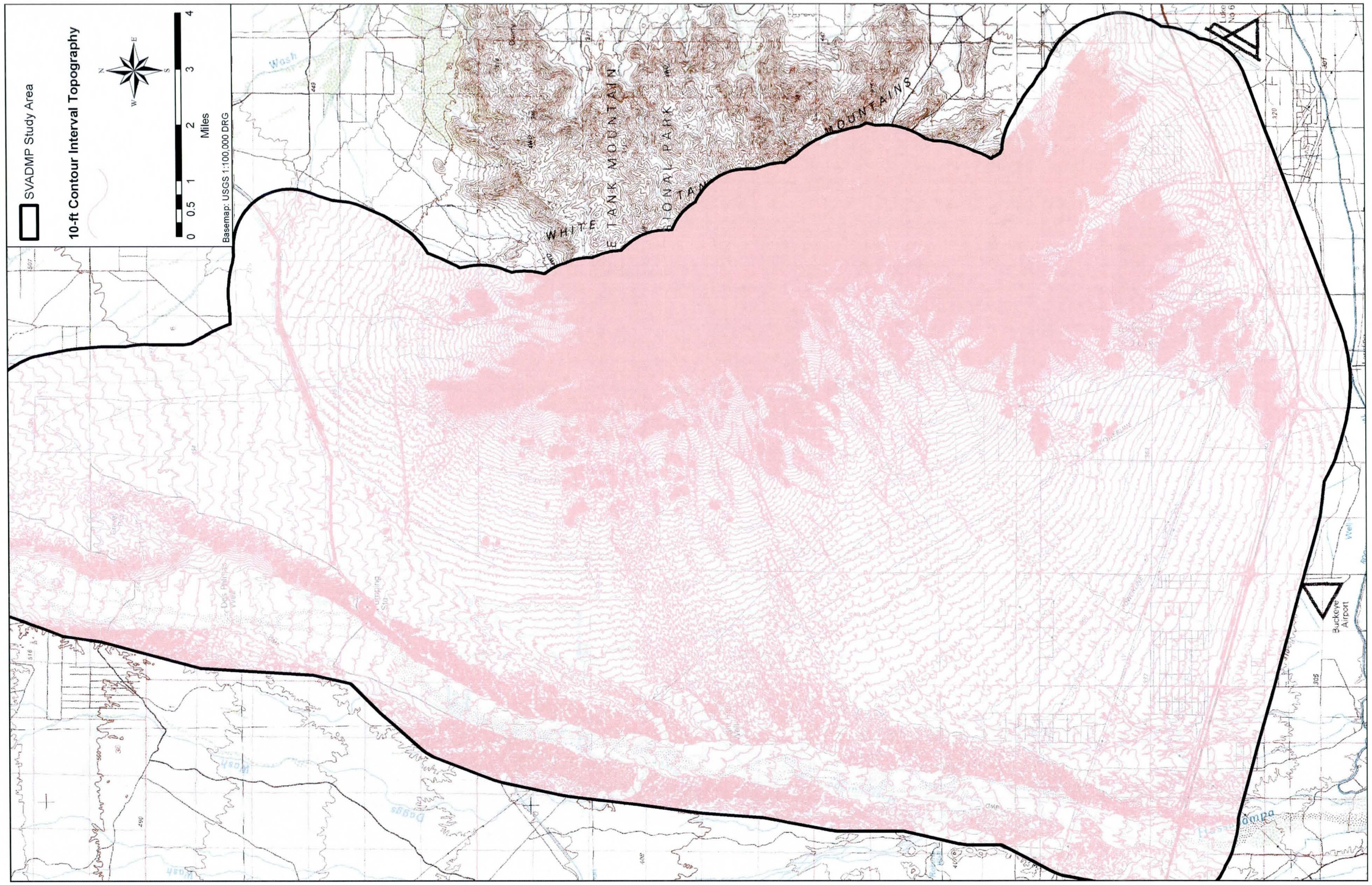


Figure 6.5 10-foot contour interval topography

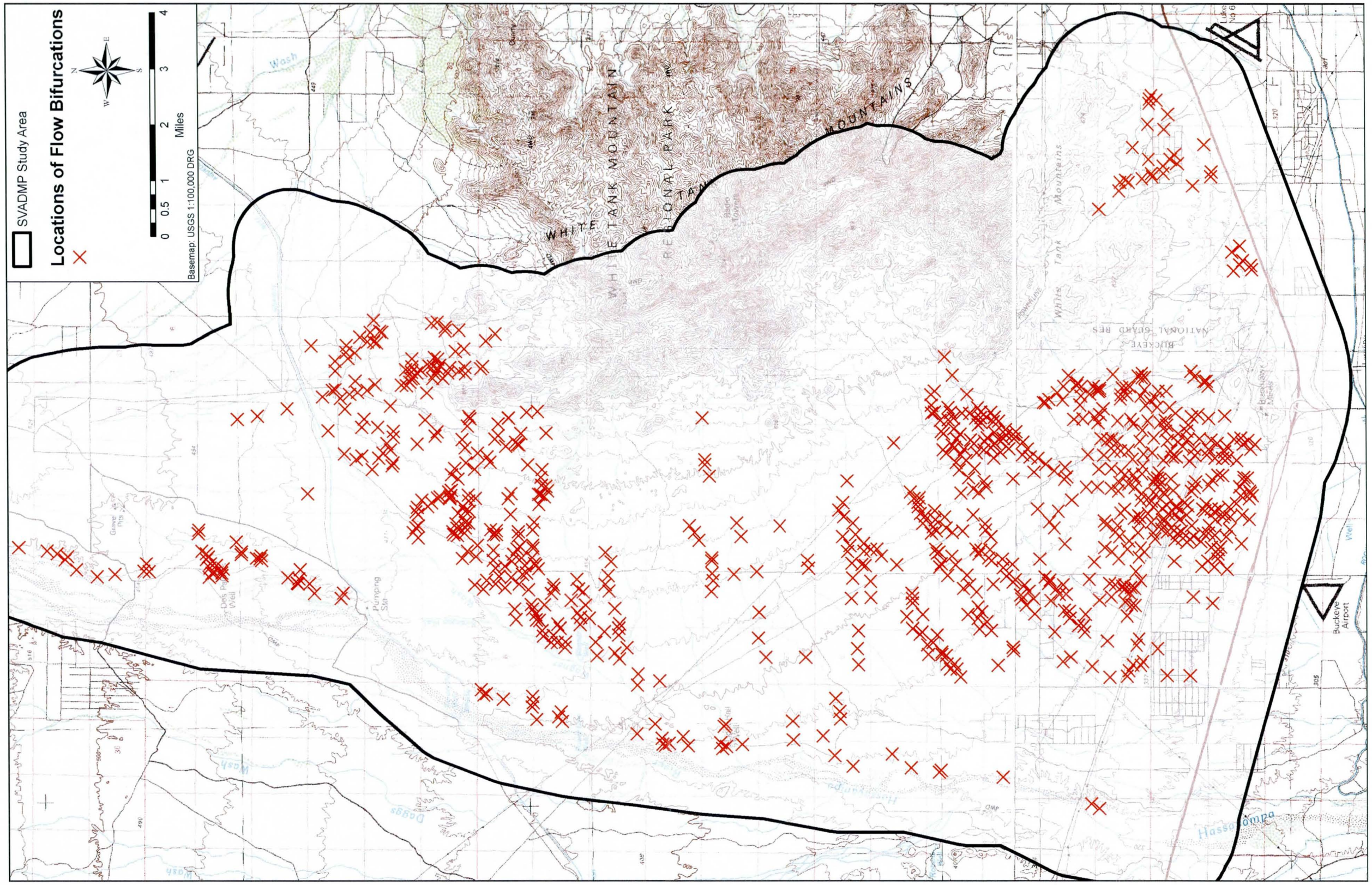


Figure 6.6 Locations of flow bifurcations

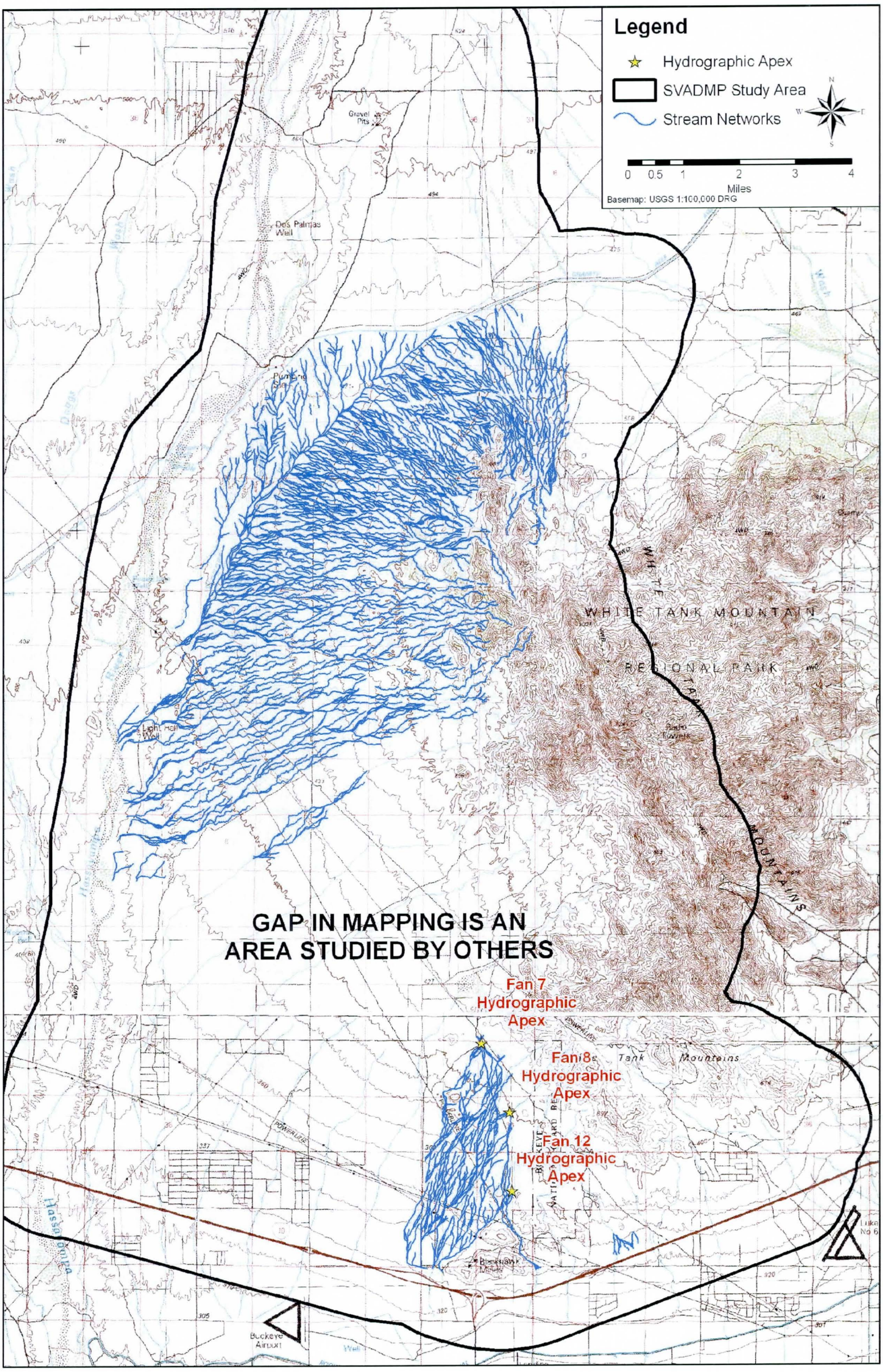


Figure 6.7 Stream channel networks. No drainage networks are delineated in the central portion of the White Tank Piedmont because that area is being studied by others.

Figure 6.7. Surficial characteristics indicative of an alluvial fan landform observed in the study area on aerial photographs and in the field included non-linear (i.e., riverine) and radial surface distributions, low divides between adjacent flow paths, small poorly integrated channels, perched flow paths, decreasing channel widths and depths in the downstream direction transitioning to sheet flow, and a rapid decrease in bed sediment sizes.

Based on the analysis of the topographic and morphologic data, it is concluded that the shape of the White Tank Piedmont meets the PFHAM/FEMA Guidelines definition of an alluvial fan landform.

6B.4.3 Location

The NRC (1996) definition of an alluvial fan landform states that "alluvial fan landforms are located at a topographic break where long-term channel migration and sediment accumulation becomes markedly less confined than upstream of the break." The White Tank Piedmont abuts the steep mountain front of the White Tank Mountains as indicated by the change in the topographic contour density shown on Figure 6.5. The mountain front is deeply embayed, which reflects the age and long erosional history of the mountains and creates a sinuous upstream boundary at the topographic break. At the mountain front, the fluvial environment transitions from one of net erosion and bedrock outcrop to a depositional environment and alluvium, at least within geologic time. A second topographic break occurs at the toe of the piedmont where alluvial fan landform is truncated by Wagner Wash and the Hassayampa River, the (riverine) axial valley streams.

6B.4.4 Hydrographic and Topographic Apex Location

Topographic apexes occur at the mountain front, and represent the extreme upstream extent of the alluvial fan landform. For the White Tank Piedmont, the topographic apexes reflect locations where deposition of alluvium began in the geologic past. In all cases, the topographic apexes are located on relict or inactive alluvial fans, and are well upstream of the hydrographic apexes. Topographic apexes were identified by aerial photograph interpretation, consideration of AZGS surficial and geologic mapping, field observations, and review of topographic and morphologic features in the study area. The topographic apex locations identified for the White Tank Piedmont are shown in Figure 6.8.

Hydrographic apexes are located at the highest point on an alluvial fan landform where there is physical evidence of flow bifurcation and/or significant flow outside the defined channel. The hydrographic apexes were defined by plotting the location of flow bifurcations observed on aerial photographs (Figure 6.6), in conjunction with field observations and geomorphic mapping. In some cases, the point of flow bifurcation is indicated a split stream symbol or a stippled pattern (deposition) on the USGS topographic maps. Interestingly, the longitudinal profiles often have a slight hump at the hydrographic apex, which probably reflects recent local aggradation. Experience indicates that the hydrographic apexes should be located where the Holocene surfaces that bound the main channels are pinched out by older, stable surfaces, points which are often upstream of the existing flow bifurcations (JEF, 2000). These Holocene surfaces represent areas that are still receiving alluvial deposits and are subject to overbank flows, and thus are vulnerable to flow path

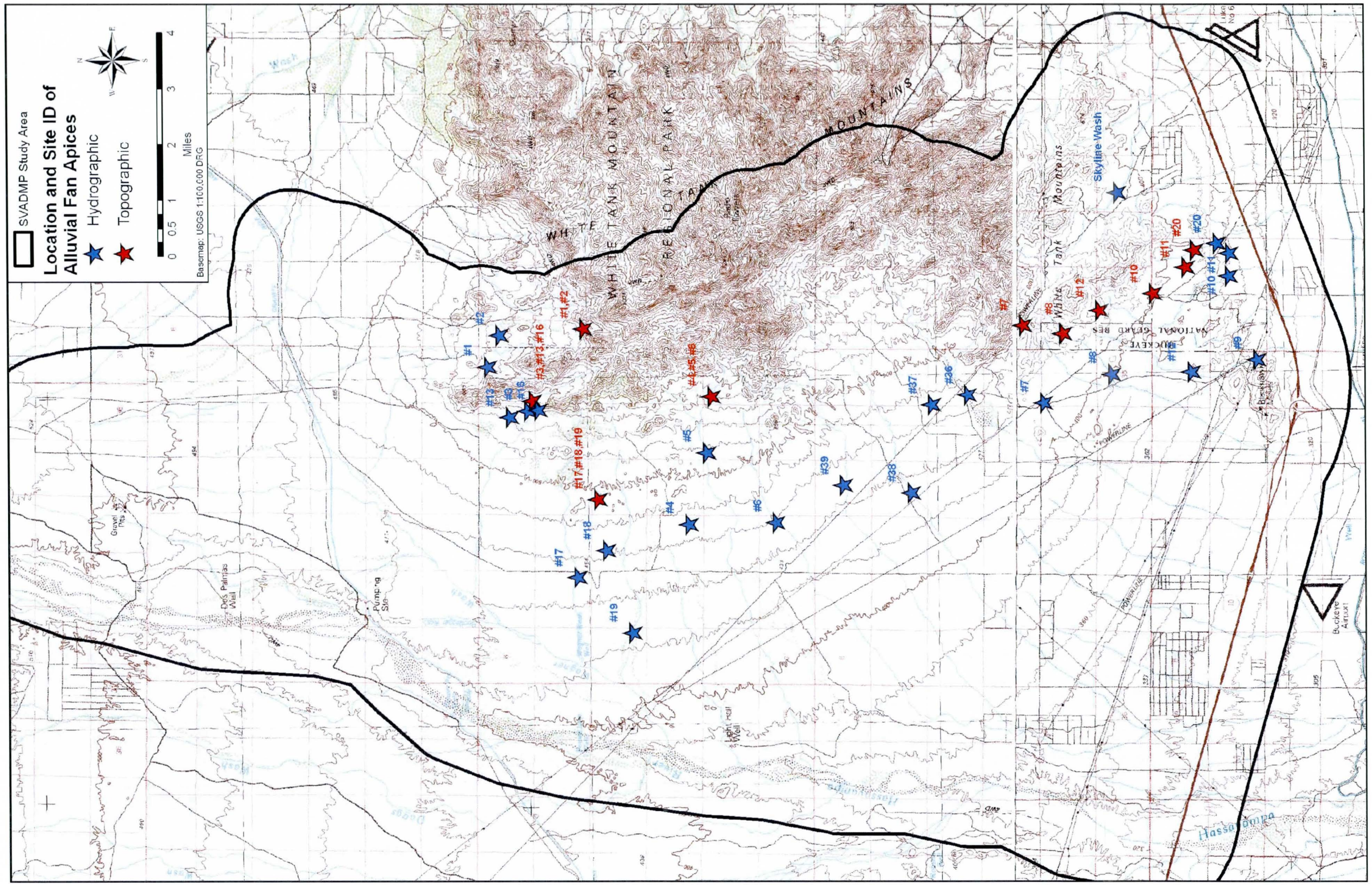


Figure 6.8 Alluvial fan apex locations

movement, either by avulsion or piracy. In some cases, the upstream limits of the Holocene surfaces were coincident with the flow bifurcation points. The hydrographic apex locations identified for the White Tank Piedmont are shown in Figure 6.8, and use the alluvial fan naming conventions established by Hjalmarson and Kemna (1994) and continued by Ayres (2004) for the Sun Valley Buckeye ADMS.

6B.4.5 Boundaries

The lateral and distal limits of the White Tank Piedmont alluvial fan landform were determined from examination of the NRCS soil and AZGS surficial geologic mapping, field observations, interpretation of recent and historical aerial photographs, and experience. The extreme northeast and southeast lateral limits of the landform shown in Figure 6.9 were dictated by the scope of services, but were extended to logical limits with defined physical characteristics. That is, the White Tank Piedmont also extends along the east flank of the White Tank Mountains, but that area is outside the limits of the currently authorized study. The southeast study limit was extended to a bedrock ridge that extends from the mountain area to the FRS just west of Skyline Wash (Figure 6.10). The northeast study limit was extended to the margin of the active alluvial fan surfaces that topographically and geologically abuts active flow paths that originate at Fan Site #2 (Figure 6.11).

The upper limit of the White Tank Piedmont alluvial fan landform is defined by the mountain front, as indicated by the topographic break described above. The toe or distal terminus of the White Tank Piedmont alluvial fan landform is defined by the intersection of the long sloping piedmont plain with the flatter slopes of the Hassayampa River and White Tank Wash floodplains on the west, the Wagner Wash floodplain to the west and north, and the Gila River geologic floodplain on the south. In the existing condition, the Buckeye FRS truncates the southern margin of the White Tank Piedmont, and now forms the effective toe of the alluvial fan landform, at least with respect to alluvial fan flooding. The Buckeye FRS impounds, stores and diverts the entire 100-year hydrograph and sediment load.[1] Furthermore, the Flood Control District of Maricopa County established the FRS as the downstream limit of study for the Sun Valley ADMP floodplain mapping tasks.

6B.4.6 Conclusion

The NRCS soil mapping, AZGS surficial geologic mapping data, and field observations clearly show that the White Tank Piedmont is composed of sedimentary deposits (alluvium). The topographic mapping shows that the White Tank Piedmont landform is located at the base of a mountain front and has the shape of a partially extended fan, has steep slopes, and radiating contours. Morphologic data, such as the drainage

[1] Studies are currently underway by the Flood Control District of Maricopa County to evaluate the Probable Maximum Flood (PMF) capacity of the Buckeye FRS and to upgrade, repair, or replace the FRS. Regardless of the outcome of the PMF and FRS evaluation, the FRS is known to control at least the 100-year event and remove any alluvial fan flooding from downstream reaches.

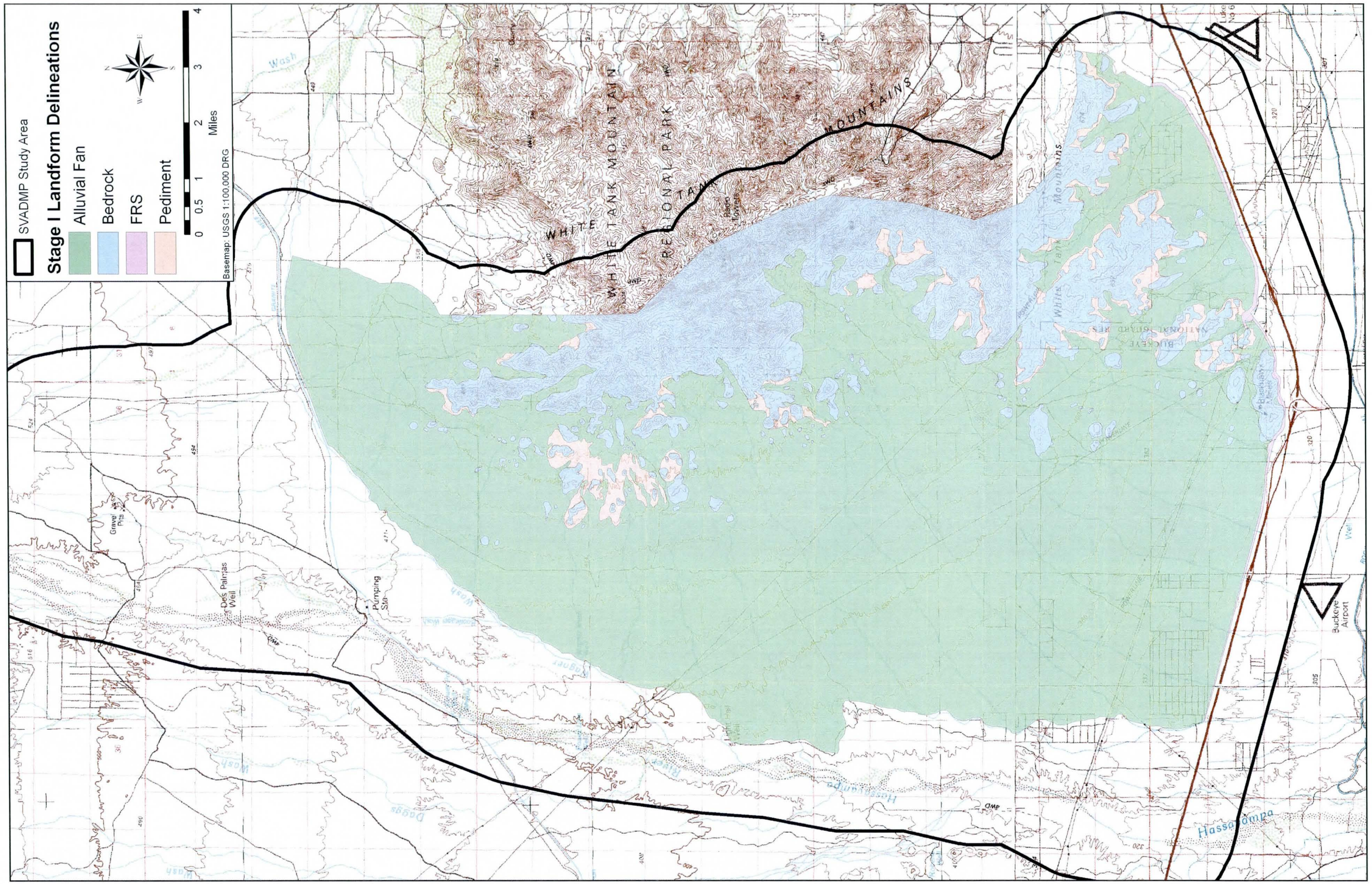


Figure 6.9 Stage I delineations

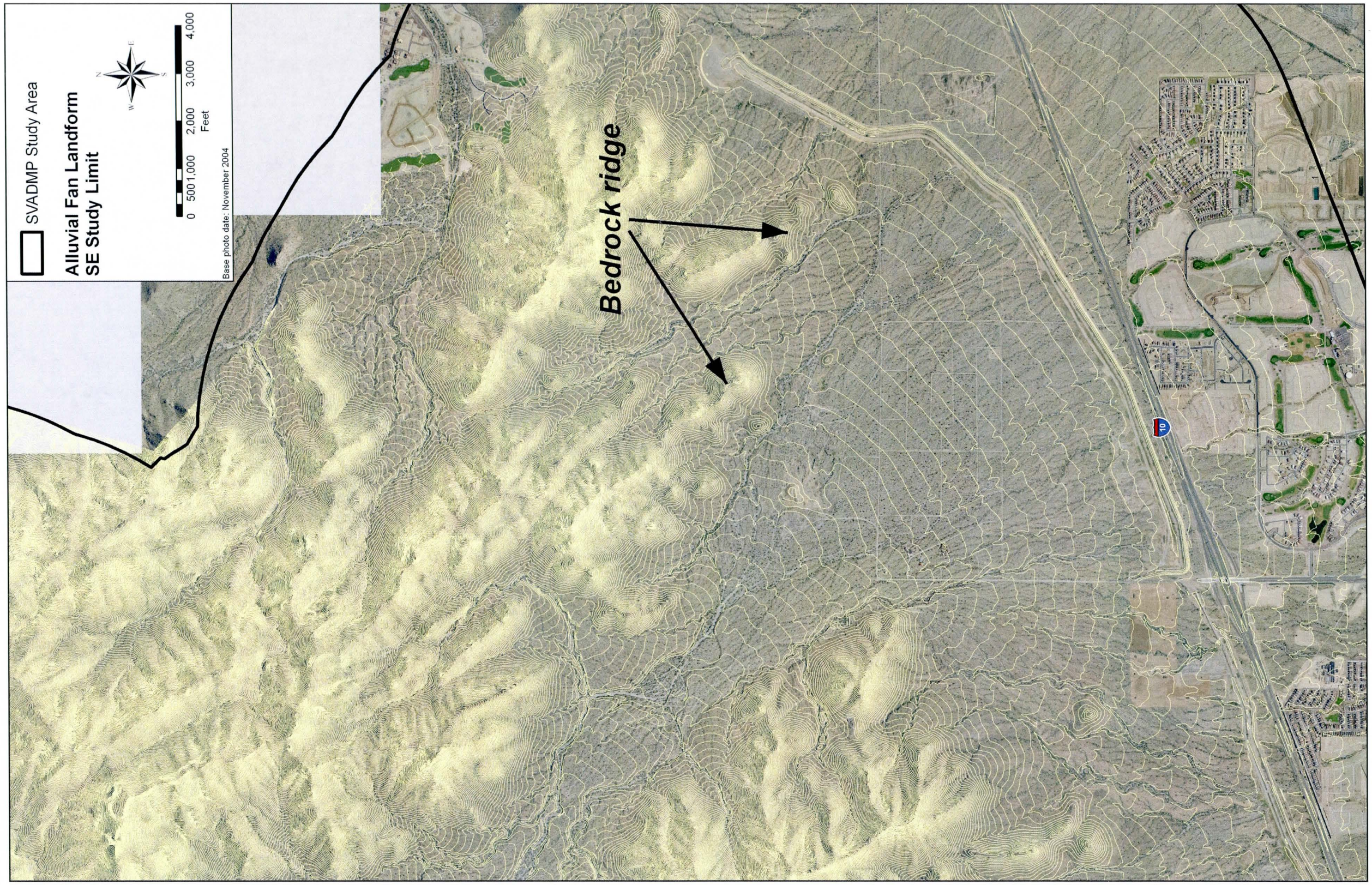


Figure 6.10 Close-up of the SE study area

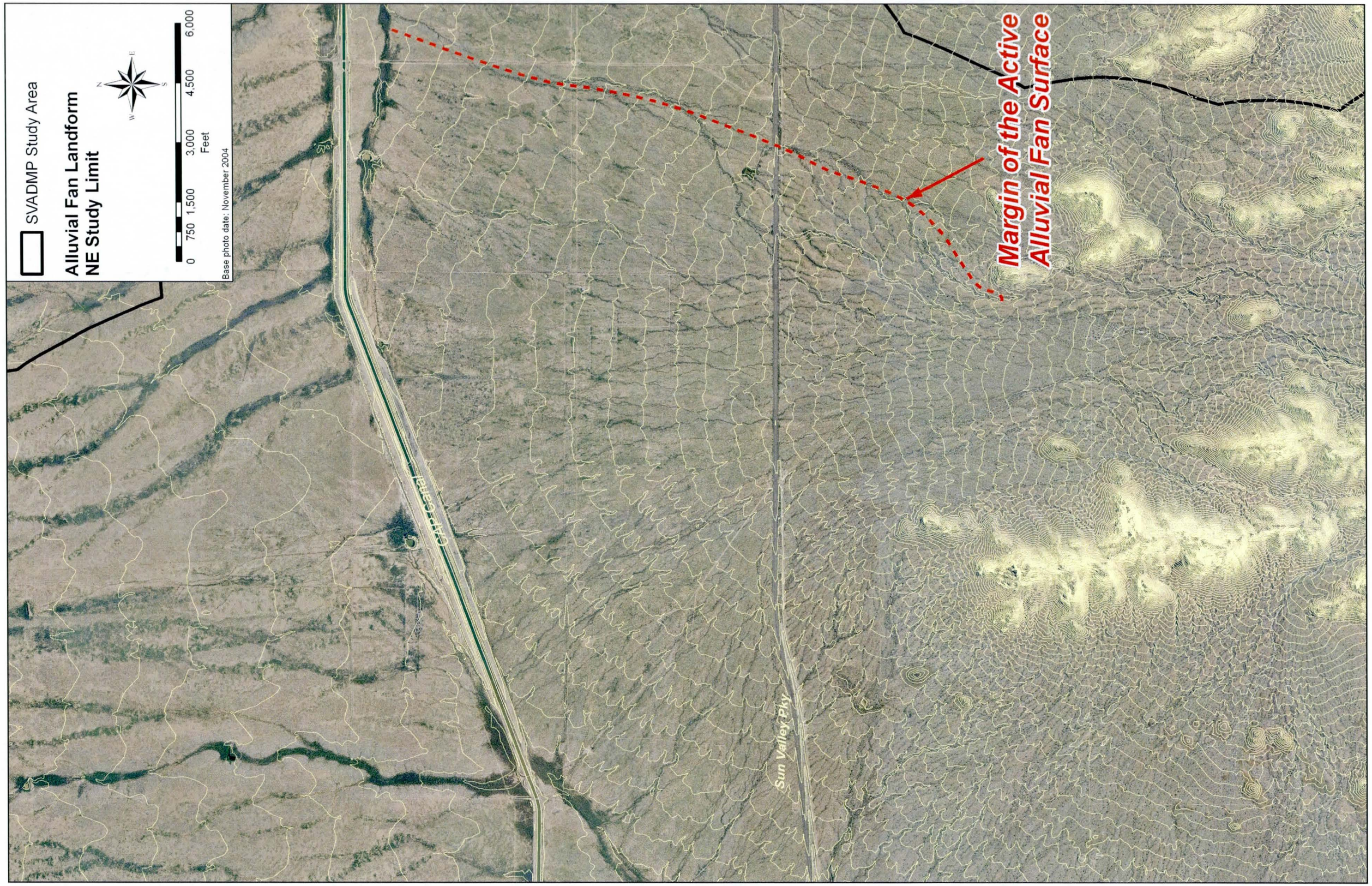


Figure 6.11 Close-up of the NE study area

pattern, surface distribution, relief, and channel geometry, are also characteristic of an alluvial fan landform. Therefore, it can be concluded that, with the exception of a few bedrock islands, the White Tank Piedmont in the study area is an alluvial fan landform.

6B.5 Stage 2: Defining Active and Inactive Areas

Stage 2 of the PFHAM/FEMA alluvial fan methodology consists of defining active and inactive areas within specific portions of the White Tank Piedmont alluvial fan landform, as well as characterizing the nature and types of flooding that are associated with a specific hydrographic apex. The hydrographic apex for the Site 7, 8 and 12 alluvial fans were identified in the Stage 1 analysis and are located as shown in Figure 6.8. Active areas on an alluvial fan consist of those portions of the landform where uncertainties about channel geometry and hydraulic conditions of water and sediment discharge cannot be realistically set aside in the assessment of the flood hazard. Active areas on alluvial fans experience sediment deposition, erosion and unstable flow paths in addition to flood inundation. Inactive alluvial fan areas are the portions of the alluvial fan landform where active fan processes do not occur. Inactive portions of the alluvial fan are those areas where flow path uncertainty can "be set aside in realistic assessments of flood risk."

6B.5.1 Overview of Stage 2 Methodology Concepts

The physical characteristics of a landform provide clues as to its depositional history, existing level of stability, and future flood potential. If a portion of the landform becomes isolated from its original watershed and watercourse, it ceases to receive new deposits and its surface will begin to age and develop specific physical characteristics indicative of its age. These physical characteristics include soil profile development, an integrated tributary drainage network, desert varnish, desert pavement, topographic relief, color, and distinctive vegetative suites.

In a semi-arid environment like that of the White Tank Piedmont, the degree of soil development is directly proportional to surface age. As the surface ages, a soil profile develops, and its structure, color and content changes. Clay and calcium carbonate accumulate in the soil from aeolian sources and chemical weathering of the parent material, forming distinct soil horizons (Figure 6.12). The degree of soil profile development, particularly in the clay and carbonate horizons, can be used as a proxy for surface age. The soil surface also tends to become reddish in color with time due to oxidation of iron (rubification) as well as accumulation and weathering of clay. Young, active surfaces lack soil profile development, and on active alluvial fans consist of stream bed alluvium (Figure 6.13).

Geomorphic surfaces may also develop an accumulation of pebbles and cobbles at the surface as they age. These gravel coverings are known as desert pavement, which form as a byproduct of windblown silt and clay accumulation in the soil column. Repeated wetting by precipitation causes the fine-grained materials to

swell, lifting the larger gravels to the surface. Repeated surface drying creates cracks into which more fine windblown material may accumulate. Over thousands of years these processes form a mantle of closely packed gravels that resembles asphalt pavement (Dohrenwend, 1987; Vanden Dolder, 1992). The pebbles and cobbles that form the pavement surface, if they contain sufficient ferromagnesian minerals, will develop a dark black patina (manganese-oxide) on their tops and an orange (iron-oxide) coating underneath that is known as desert varnish (Figure 6.14).

Landform surfaces free from new deposition will also begin to erode due to direct rainfall and the ensuing runoff on the surface. As the surface erodes, new tributary channel networks develop which become more incised and integrated with time. The channels gradually deepen and widen, creating a greater degree of relief between the channel bottoms and the ridges which separate them. The degree of relief can be directly observed in the field or on aerial photographs (Figure 6.15), but can also be detected by the examining the crenulation (curviness) of topographic map contours (Figure 6.16).

The degree of relief of an apparently inactive landform relative to adjacent active, young surfaces is also an important characteristic. Because active alluvial fans are aggrading landforms, it follows that some older surfaces may gradually become buried by sediment deposition derived from the adjacent younger active alluvial fan (Figure 6.17). Therefore, where there is little topographic difference between younger and older surfaces, the investigator must take care to evaluate the rate of, and potential for, long-term aggradation of the fan (Figure 6.18). Typically, the rate of fan aggradation is greatest near the hydrographic apex, with lower accumulation rates as the distance from the apex increases and/or the active fan widens.

In a semi-arid environment, it takes thousands of years for many of these geomorphic characteristics to develop. Therefore, surfaces that exhibit well developed soils, red color, significant carbonate development, desert pavement composed of strongly varnished gravels, and tributary drainage networks have been relatively free from flooding for thousands of years. These features provide a record of non-inundation that extends back thousands of years. The non-inundation record can be interpreted and used as a historical record of fan behavior in the same way as historical records of flood peaks are used to predict future flood peaks. As such, without external disturbance, it can be reasonably assumed that the flood hazard potential on geomorphically old (stable) surfaces will be low in the future.

The NRCS soils survey data and AZGS surficial geology mapping differentiate surfaces based on the types of geomorphic characteristics discussed above. Therefore, the map data also provide information about surface age, stability, and flood potential. Young surfaces with little soil development are likely to continue to experience flood inundation, sediment deposition, and channel movement. Older surfaces are unlikely to experience such processes. Older surfaces with cemented soils and entrenched channels also tend to be more stable because their soils are more resistant due to the cohesion provided by clay, carbonate, and pavement, as well as due to containment of flow within defined, vegetation-lined channels. That is, the likelihood of the

channel changing its location over time is greatly diminished. Conversely, areas with non-cohesive, coarse soil materials and little lateral relief are more susceptible to lateral changes in channel position.

Active alluvial fans are those where the uncertainty associated with flow path location is so great that it cannot be set aside in realistic assessments of the flood risk. Where risk of flow path change is not so great, that portion of the alluvial fan landform is considered inactive. The Stage 2 geomorphic analyses are intended to distinguish active, unstable, young landforms from inactive, stable, or old landforms.

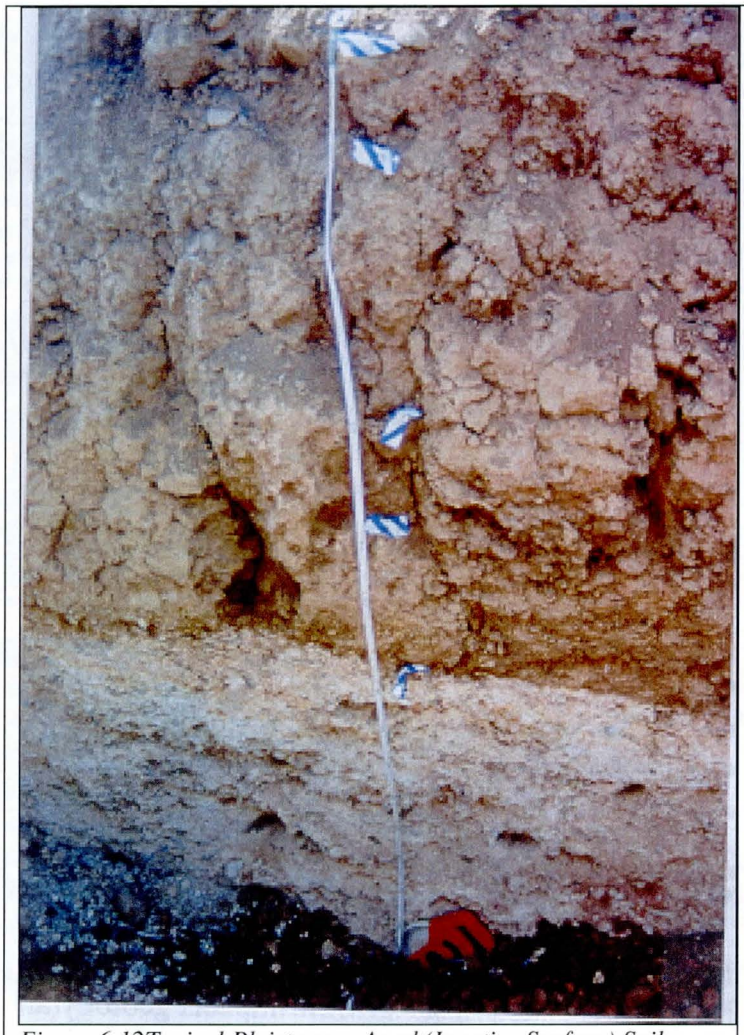


Figure 6.12Typical Pleistocene-Aged (Inactive Surface) Soil Profile WithWell-Developed Carbonate and Clay Horizons.

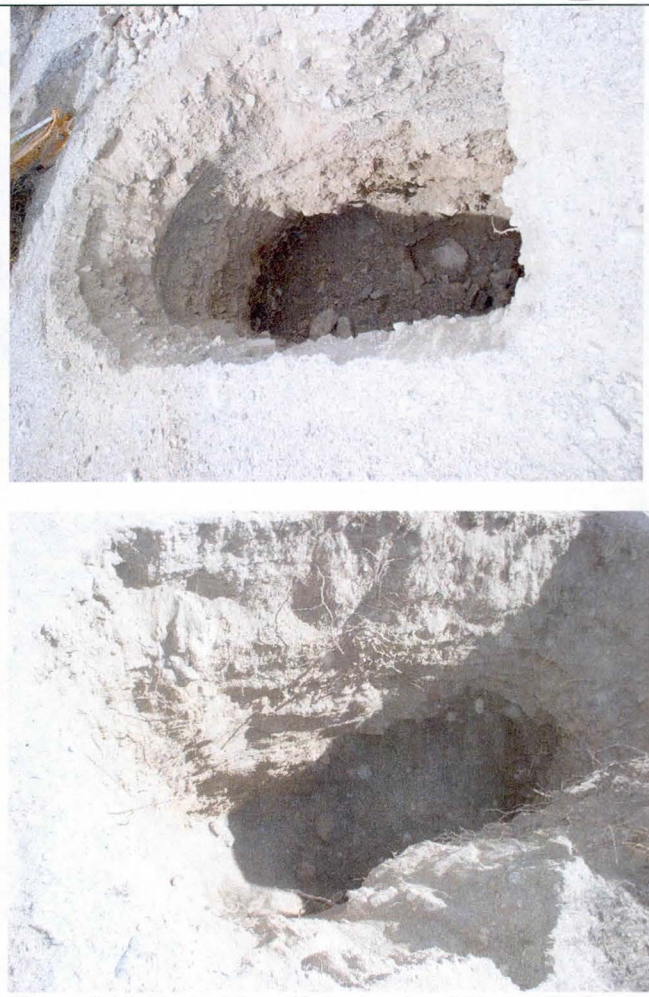


Figure 6.13 Typical Late Holocene-Aged (Active Surface) Soil Profiles With No Soil Development.

Figure 6.14 Varnished Desert Pavement Surface on Inactive Portion of an Alluvial Fan Landform. Note the reddened clay-rich soil excavated from the soil pit.

Figure 6.15 Aerial Photograph Showing Tributary Drainage Network on Old, Inactive Surface Adjacent to Distributary & Sheet Flow Pattern in Active Area.

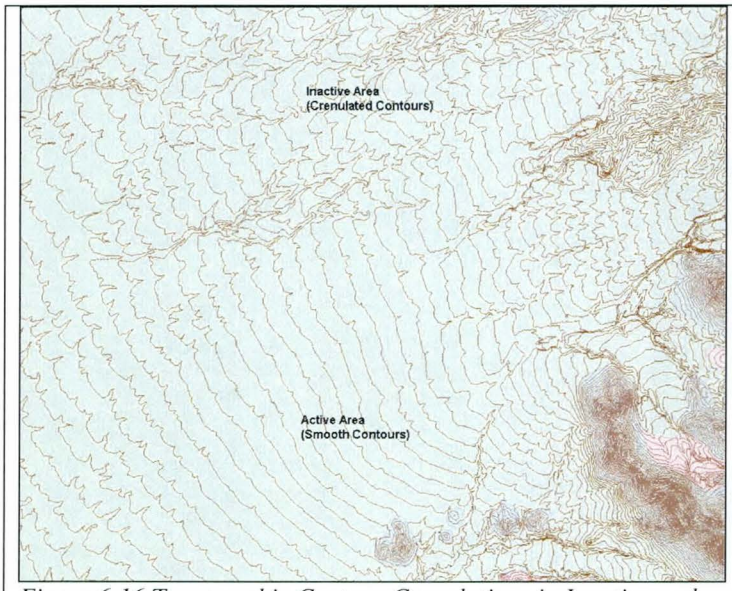


Figure 6.16 Topographic Contour Crenulations in Inactive and Active Areas of an Alluvial Fan Landform.

Figure 6.17 Photograph of Older Varnished Pavement Surface Partially Buried by Recent Flood Deposition (Tiger Wash, Maricopa County, Arizona).

Figure 6.18 Photograph of Active Surface Topographically Confined by Older Surface.

6B.5.2 Overview of Flooding on Site 7, 8 and 12 Piedmont

Fan Sites 7, 8 and 12 are located within the southernmost portion of White Tank Mountain piedmont, in Township 1 North, Range 3, Township 1 North, Range 4 West, and Township 2 North, Range 4 West. The topographic apexes are located at the mountain front-piedmont boundary (Figure 6.8). Fan 7 hydrographic apex is located in the northwest portion of Township 2 North, Range 4 West, sections 25. Fan 8 hydrographic apex is located in the central portion of Township 2 North, Range 4 West, sections 36. Fan 12 hydrographic apex is located in the central portion Township 1 North, Range 4 West, sections 1.

Between the topographic apex at the mountain front and the hydrographic apex, flood flow is conveyed in a well-defined tributary drainage system. The distance between the topographic apex and the hydrographic apex is 11,000 feet, 6000 feet, and 11,500 feet for Fans 7, 8 and 12, respectively. Channel depths range from approximately 15 feet near the topographic apex to less than 3 feet immediately upstream of the hydrographic apex. Channel slopes in the well-defined channels above the hydrographic apexes range from about 0.090 to 0.012 feet/feet, decreasing in the downstream direction.

At the hydrographic apexes, the drainage networks change from well-defined tributary patterns to unconfined distributary patterns on active alluvial fans. The drainage areas above the Fan 7, 8 and 12 hydrographic apexes are approximately 1.55, 0.52, and 1.42 square miles, respectively. The alluvial fan areas below the hydrographic apexes for Fan 7, 8 and 12 total 12.05 square miles. The active alluvial fan areas downstream of the hydrographic apexes are bounded laterally on the east by older, stable surface with tributary drainage patterns, and on the west by alluvial fan #36. Fan 7, 8 and 12 coalesce upstream of the Buckeye FRS #3. The toes of Fans 7, 8 and 12 are now defined by the Buckeye FRS dam embankment. The active portions of the fans were truncated by the Buckeye FRS, eliminating the other natural portions of the alluvial fan drainage system.

6B.5.3 Identification of Active Areas

Field and Pearthree (1991) suggest that the younger sediments (active areas) on the lower portions of the White Tank Piedmont are eroded primarily from older surfaces in the middle and upper piedmont at or below the hydrographic apex, rather than from the upper mountain watershed. During the more frequent runoff events, flood water and sediment originate from both the middle and lower piedmont. Only the largest, most rare runoff events translate significant flood water and sediment across the entire piedmont downstream of the hydrographic apex to the toe of the piedmont. High infiltration rates in the broad areas of sand and gravel within the active areas transmit the most frequent runoff events into the subsurface before runoff can pass to the lower piedmont. Channel sediment size decreases down piedmont, yielding lower infiltration rates. Therefore, while it is concluded that the piedmonts surrounding Fans 7, 8 and 12 are mostly eroding landforms, [1] some level of aggradation and active alluvial fan flooding occurs in the areas immediately downstream of the hydrographic apexes, covering a limited area of the total Site 7, 8 and 12 landform (Figure 6.19).

The limits of the active areas within the Site 7, 8 and 12 alluvial fan landforms are shown in Figure 6.19. These areas were identified through the use of NRCS soils surveys, AZGS surficial geology mapping, historical aerial photographs, interpretation of USGS 7.5 minute contour maps and FCDMC 10-ft contour

[11] Note that this statement applies to the whole of the piedmont landform (Stage 1), rather than the active alluvial fan area (Stage2).

interval topographic mapping, field observations, surficial characteristics, and other geomorphic features. The relationship of each of these types of evidence to the limits of active and inactive areas is discussed below.

6B.5.3.1 NRCS Soils Data

The study area containing fan sites 7, 8 and 12 is split horizontally by two different NRCS soil surveys. The northern half of the study area, containing both fan 7 and 8 hydrographic apices was mapped by the NRCS Soil Survey of Maricopa County, Arizona, Central Part (Hartman, G. W., 1977). Soil units in the Hartman soil survey are identified with a number and described in Table 6.4. The southern half of the study area, containing the lower coalesced halves of fans 7, 8 and the whole of fan 12 was mapped by the Soil Survey of Aguila-Carefree Area, Parts of Maricopa and Pinal Counties, Arizona (Camp. P.D., 1986). Soils units in the Camp survey are identified with the initial and are also described in Table 6.4.

The active areas on Fan Sites 7, 8 and 12 are mapped on the NRCS soils maps (Figure 6.20) as the:

- Antho gravelly sandy loams (2)
- Antho-Carrizo-Maripo complex (3)
- Antho-Carrizo complex (AGB),
- Antho-association (AL)
- Antho-Valencia association (AM)
- Gunsight-rillito complex (GYD, 70)

Units 2, 3, AGB, AL, AM are described as young soils located on drainageways and active alluvial fans subject to frequent flooding and erosion. The Antho-Carrizo and Antho soil units have minimal soil profile development (Torrifluvents) and minimal clay or carbonate accumulation. Soil units GYD and 70, two different names for the Gunsight-Rillito complex, are described by the NRCS as being 7000-10,000 years old and occurring on old alluvial fans, and fan terraces. The Gunsight-Rillito (GYD, 70) soil unit while described as an old soil forming on geomorphically stable landforms has been mapped partially as active due to extensive field investigation. Parts of this unit are topographically lower than active units upstream of them and are in the process of aggradation. Historically old sediments in the lower half of fan 7 are being buried younger sediments originating upstream.

Gunsight-Rillito (70) is also mapped directly below the hydrographic apex of fan 8. The inclusion of unit (70) on fan 8 may be due to error associated with the scale of the NRCS mapping rather than as in the case above where an old existing soil is being buried with new sediment.

The whole of Fan 12 is contained in the Antho-Carrizo complex (AGB) described as a young soil located on drainageways and active alluvial fans and subject to frequent flooding and erosion.

The inactive areas on Fan Sites 7, 8 and 12 bound the active areas laterally and in the upstream direction. The upper piedmont above the Fan 7, 8 and 12 hydrographic apexes is underlain by the Gunsight-Rillito (70), Pinampt-Tremant (98), Tremant-Rillito (TSC) Complexes, all of which are described by the NRCS as old (inactive) alluvial fans and fan terraces. Rock outcrop areas (CO, RS and 100) are also mapped by the NRCS as outcrops in or near Fans 7, 8 and 12.

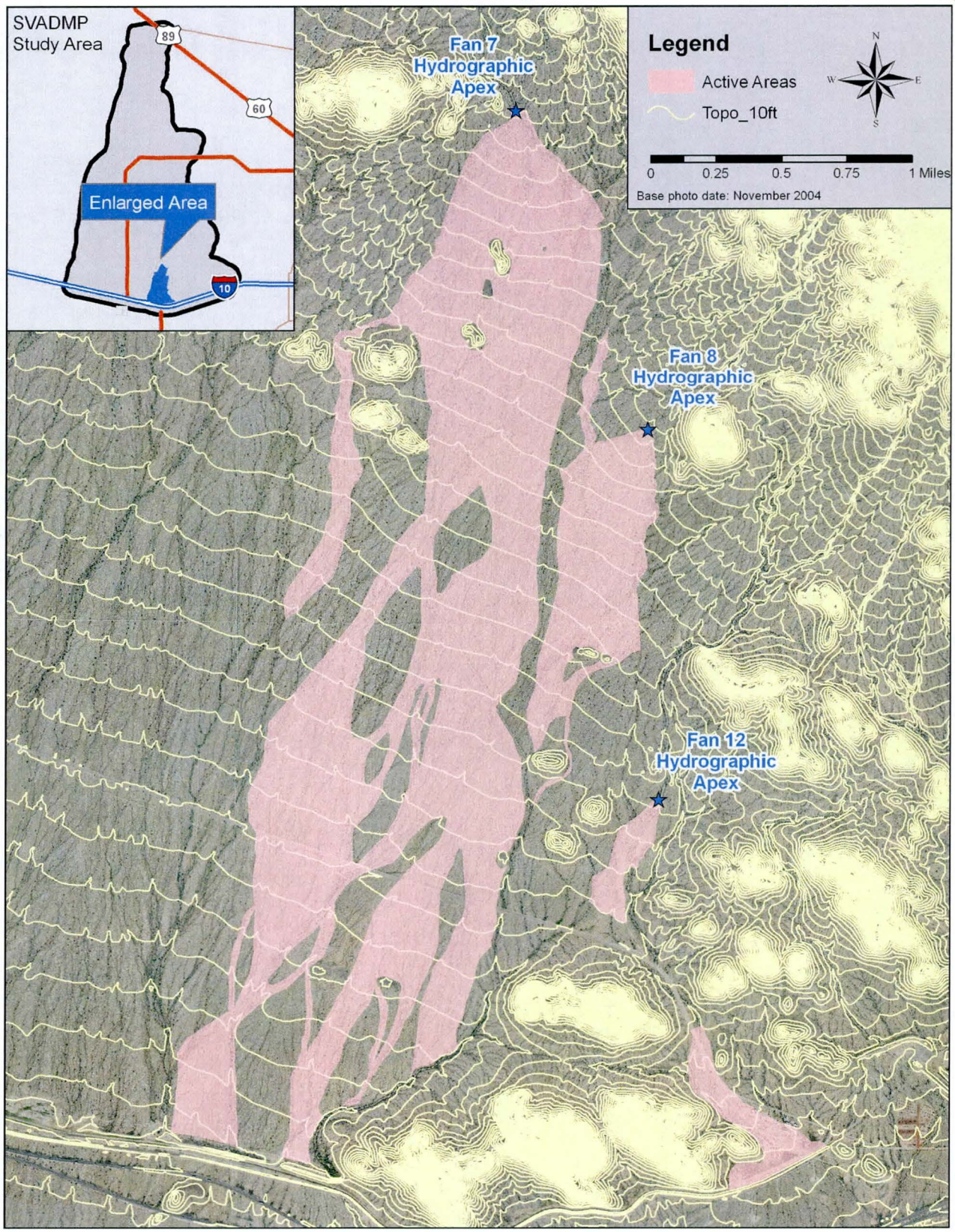


Figure 6.19 Fans 7, 8 and 12 active areas

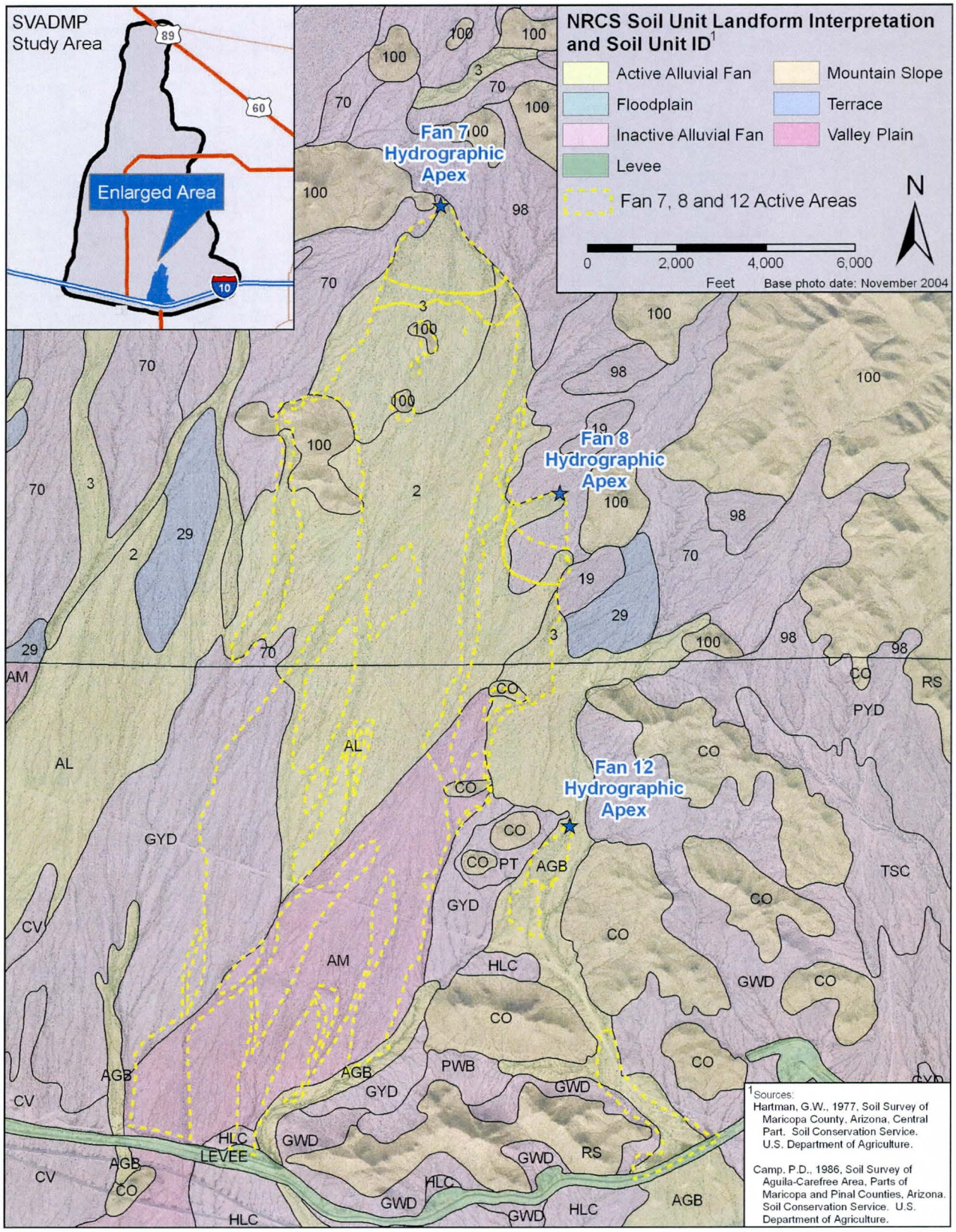


Figure 6.20 NRCS soils mapping for Fans 7, 8 and 12

Table 6.4 NRCS Soil Unit Descriptions for Fan sites 7, 8 and 12

Map Symbol	Soil Unit Name	Geomorphic Position	Characteristics	Soil Subgroup & Order	Geologic Age	PFHAM Landform
AGB	Antho-Carrizo complex, 0-3% slopes	Floodplains, alluvial fans, and drainageways	Subject to occasional flooding; hazard due to water erosion is severe; channeling, deposition, and streambank erosion occur during flooding; subject to rare periods of flooding	Typic Torrifluvents Entisols	Few hundred to 1,000 years	**Active Alluvial Fan**
AL	Antho association	Alluvial fans that radiate out from mountains	Slopes<1%; slow runoff; slight erosion hazard; dentritic drainage pattern; 100-900 acres in size	Typic Torrifluvents Entisols	Few hundred to 800 years	**Active Alluvial Fan**
AM	Antho-Valencia association	Long, smooth valley plains 1-3 miles from base of mountains	0-1% slopes; slow runoff; slight erosion hazard; dentritic drainage; 200-2,000 acres in size	Typic Torrifluvents Entisols	Few hundred to 800 years	**Valley Plain**
CO	Cheriono-Rock outcrop complex	Low hills and lower slopes of mountains	Dissected by low stream channels 3-20 feet in depth and 50-200 feet apart; 50-90% of the surface is gravel, cobbles, and stones; slopes are complex and range from 3-25%	Typic Durothids Aridsols	-	**Mountain Slope**
CV	Coolidge-Laveen association	Inactive Alluvial Fan	Coolidge-40%, Laveen-40%	Typic Calciorthids Aridsols	-	**Inactive Alluvial Fan**
GWD	Gunsight-Pinal complex, 1-10% slopes	Old alluvial fans	Dissected by drainageways 2-15 feet deep at 50-300 foot intervals; 30-70% of surface is covered with angular cobbles and gravel	Typic Calciorthids Aridsols	7,000 to 10,000 years	**Inactive Alluvial Fan**
GYD	Gunsight-Rillito complex, 0-10% slopes	Old alluvial fans	Dissected by stream channel at 100-500 foot intervals up to 30 feet in depth; slopes <1%; 500-1,000 acres in area; Gunsight soils slightly saline below 30 inches in depth	Typic Calciorthids Aridsols	7,000 to 10,000 years	**Inactive Alluvial Fan**
HLC	Harqua-Gunsight complex, 0 to 5 % slopes	Old alluvial fans / Terrace	Slopes <1% on fan tops, 5% slopes near drainageways; 20-500 acres in area; Harqua soil surface is covered with varnished desert pavement.	Typic Haplargids Aridsols	-	**Inactive Alluvial Fan**
PT	Pinal gravelly loam	Old alluvial fans around margins of low hills and mountains	Slopes on tops of fans <1%, fan side slopes 3%; 100-500 acres in area; 30-40% of surface is covered with gravel and cobbles; 60% of gravel is pan fragments; sides of fans	Typic Durothids Aridsols	900,000 years	**Inactive Alluvial Fan**

Table 6.4 NRCS Soil Unit Descriptions for Fan sites 7, 8 and 12 (continued)

Map Symbol	Soil Unit Name	Geomorphic Position	Characteristics	Soil Subgroup & Order	Geologic Age	PFHAM Landform
PWB	Pinal-Suncity complex, 0 to 3 % slopes	On old alluvial fans	Soil most extensive about 4 miles morth of Sun City on both sides of the Agua Fria River. Surface is almost gravel free is most areas, while in other areas gravel covers	Typic Durorthids Aridsols	-	**Inactive Alluvial Fan**
PYD	Pinamt-Tremant commplex, 1-10% slopes	Old alluvial fans	Disseted by shallow stream channels and about 50- to 100-foot intervals. About 40 to 80 percent of surface is covered with angluar cobbles, gravel, and a few stones.	Typic Haplargids Aridsols	-	**Inactive Alluvial Fan**
RS	Rock outcrop-Cherioni complex	Mountainsides and low hills	Slopes 5-90%; areas are large and irregular in shape; Cherioni soil very cobbly or stony in areas	-	-	**Mountain Slope**
TSC	Tremant-Rillito complex, 0-5% slopes	Old alluvial fans	Dissected by intermittent stream channels at 100- to 300-foot intervals. Channels have cut 1 foot to 15 feet below the surface. Erosion hazard is moderate.	Typic Haplargids Aridsols	-	**Inactive Alluvial Fan**
2	Antho gravelly sandy loams	On floodplains, alluvial fans, and drainageways	55% with non-calcareous surface layer & calcareous below, 25% calcareous throughout; main limitation to development is hazard of flooding	Typic Torrifluvents Entisols	Few hundred to 800 years	**Active Alluvial Fan**
3	Antho-Carrizo-Maripo complex	On floodplains, alluvial fans, and drainageways	Subject to occassional flooding; hazard due to water erosion is severe; channeling, deposition,and streambank erosion occur during flooding; subject to rare periods of fl	Typic Torrifluvents Entisols	Few hundred to 1,000 years	**Active Alluvial Fan**
19	Chuckawalla-Gunsight complex, 1 to 8 % slopes	On fan terraces	Chuckwalls is on tops of fan terraces, Gunsight is on sides of fan terraces. Surface is covered with varnished desert pavement. Rapid runoff, slight erosion hazard.	Typic Haplargids, Typic Calciort Aridsols	-	**Inactive Alluvial Fan**
29	Denure-Momoli-Carrizo complex	On stream terraces and fan terraces	Calcareous below about 8 inches; B horizon development; buried calcic or argillic horizon present in some pedons; B horizon development; strongly effervescent at depth	Typic Camborthids Aridsols	-	**Terrace**

Table 6.4 NRCS Soil Unit Descriptions for Fan sites 7, 8 and 12 (continued)						
Map Symbol	**Soil Unit Name**	**Geomorphic Position**	**Characteristics**	**Soil Subgroup & Order**	**Geologic Age**	**PFHAM Landform**
70	Gunsight-Rillito complex, 1 to 25 % slopes	On fan terraces	Runoff is slow to medium, slight erosion hazard. Weakly cemented calcic horizon at 4 to 36 inches	Typic Camborthids Aridsols	7,000 to 10,000 years	**Inactive Alluvial Fan**
98	Pinamt-Tremant complex, 1 to 10 % slopes	On fan terraces	Yellowish red B horizons which are strongly to violently effervescent; light reddish brown B horizons, caclic horizon at 5 to 24 inches, strongly to violently effervescent	Typic Haplargids Aridisols	900,000 years	**Inactive Alluvial Fan**
100	Quilotosa-Vaiva-Rock outcrop complex, 20 to 65 % slopes	On hillslopes and mountain slopes	Mapped on surfaces with 20 to 65% slopes; basically thin hillslope soils in the mountains	Lithic Torriorthents Entisols	-	**Mountain Slope**

6B.5.3.2 AZGS Surficial Geology

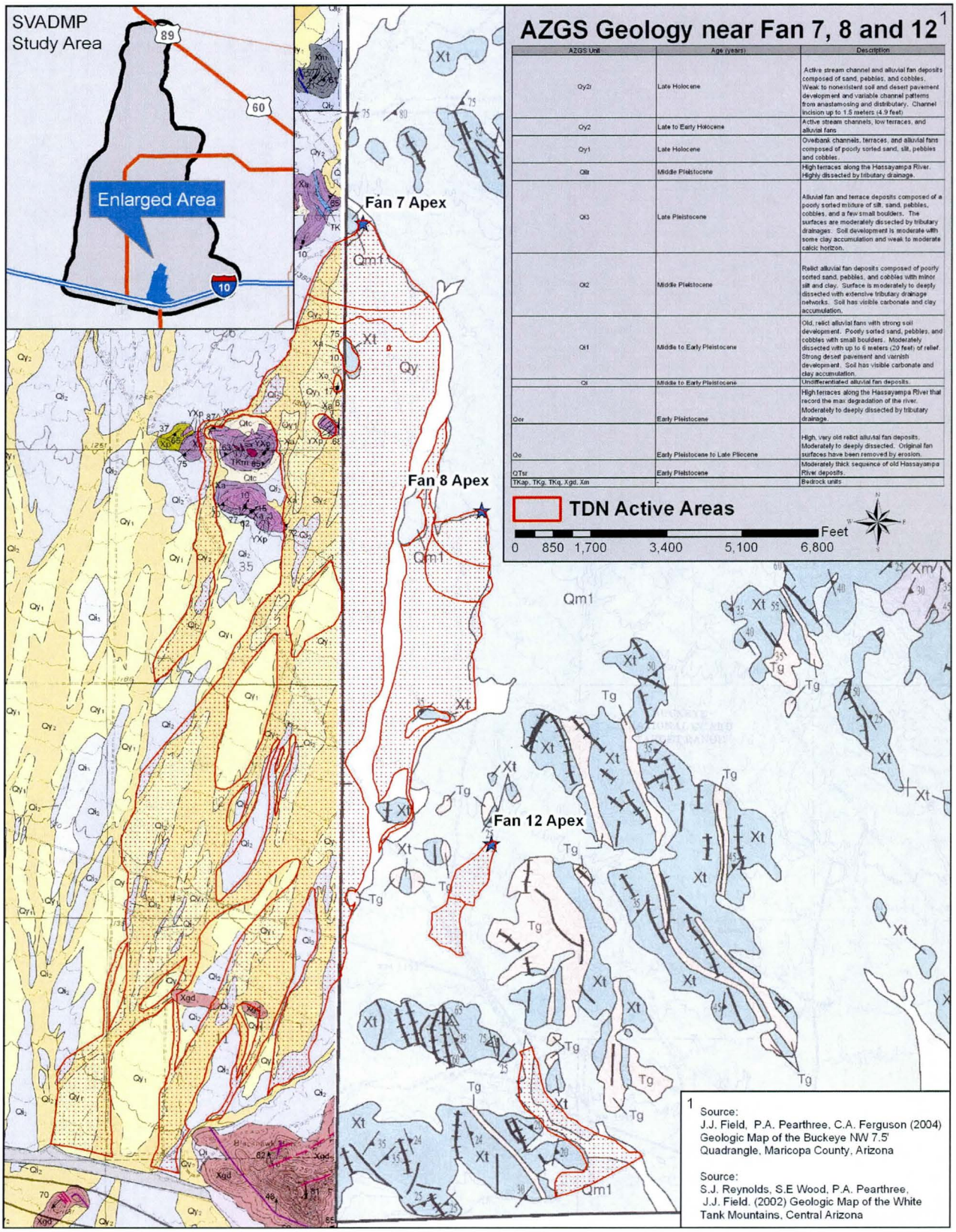
The study area containing fan sites 7, 8 and 12 is split vertically by two different AZGS surficial geology maps. As a result of the study area being dissected by two different maps the west portion of fan 7 is mapped at a more detailed scale than the rest of the study area. (Figure 6.21)

The AZGS surficial geology mapping (Figure 6.21) shows two units on the Fan 7, 8, 12 piedmont. Most of the upper piedmont is mapped as unit Qm1and Qi2. Qm1 is a middle to late quaternary alluvial deposit in terraces and surfaces well above active channels, and well developed desert varnish and pavements. Qi2 is described by the AZGS as a middle Pleistocene relict alluvial fan deposit composed of poorly sorted sand, pebbles and cobbles, and a few small boulders. Qi2 surfaces are moderately to deeply dissected with extensive tributary drainage networks. Soil has visible carbonate and clay accumulation.

The AZGS mapped the active areas of Fan 7, 8 and 12 as late to early Holocene alluvial fan (Qy2), late Holocene alluvial fans (Qy1). The geologic map of the White Tanks does not differentiate between Qy1 and Qy2 but lists the active areas as late Quaternary young alluvium (Qy).

The AZGS describes Qy2 as active stream channels, low terraces and alluvial fans. Qy1 is described as overbank channels, terraces, and alluvial fans compose of poorly sorted sand, silt, pebbles and cobbles.

The AZGS also prepared flood hazard mapping (Figure 6.22) for the White Tank Piedmont, including the areas near Fans 7, 8 and 12. The AZGS maps the highest flood hazards H1 and H2 near the apexes. Portions of the active areas are also mapped as Intermediate flood hazard (I) and (L1) Low Flood hazard.



AZGS Geology near Fan 7, 8 and 12[1]

AZGS Unit	Age (years)	Description
Qy2i	Late Holocene	Active stream channel and alluvial fan deposits composed of sand, pebbles, and cobbles. Weak to nonexistent soil and desert pavement development and variable channel patterns from anastamosing and distributary. Channel incision up to 1.5 meters (4.9 feet)
Qy2	Late to Early Holocene	Active stream channels, low terraces, and alluvial fans
Qy1	Late Holocene	Overbank channels, terraces, and alluvial fans composed of poorly sorted sand, silt, pebbles and cobbles.
Qlt	Middle Pleistocene	High terraces along the Hassayampa River. Highly dissected by tributary drainage.
Qt3	Late Pleistocene	Alluvial fan and terrace deposits composed of a poorly sorted mixture of silt, sand, pebbles, cobbles, and a few small boulders. The surfaces are moderately dissected by tributary drainages. Soil development is moderate with some clay accumulation and weak to moderate calcic horizon.
Qt2	Middle Pleistocene	Relict alluvial fan deposits composed of poorly sorted sand, pebbles, and cobbles with minor silt and clay. Surface is moderately to deeply dissected with extensive tributary drainage networks. Soil has visible carbonate and clay accumulation.
Qt1	Middle to Early Pleistocene	Old, relict alluvial fans with strong soil development. Poorly sorted sand, pebbles, and cobbles with small boulders. Moderately dissected with up to 6 meters (20 feet) of relief. Strong desert pavement and varnish development. Soil has visible carbonate and clay accumulation.
Qt	Middle to Early Pleistocene	Undifferentiated alluvial fan deposits.
Qer	Early Pleistocene	High terraces along the Hassayampa River that record the max degradation of the river. Moderately to deeply dissected by tributary drainage.
Qe	Early Pleistocene to Late Pliocene	High, very old relict alluvial fan deposits. Moderately to deeply dissected. Original fan surfaces have been removed by erosion.
QTsr	Early Pleistocene	Moderately thick sequence of old Hassayampa River deposits.
TKap, TKg, TKq, Xgd, Xm	-	Bedrock units

Figure 6.21 AZGS surficial geology for Fans 7, 8, and 12

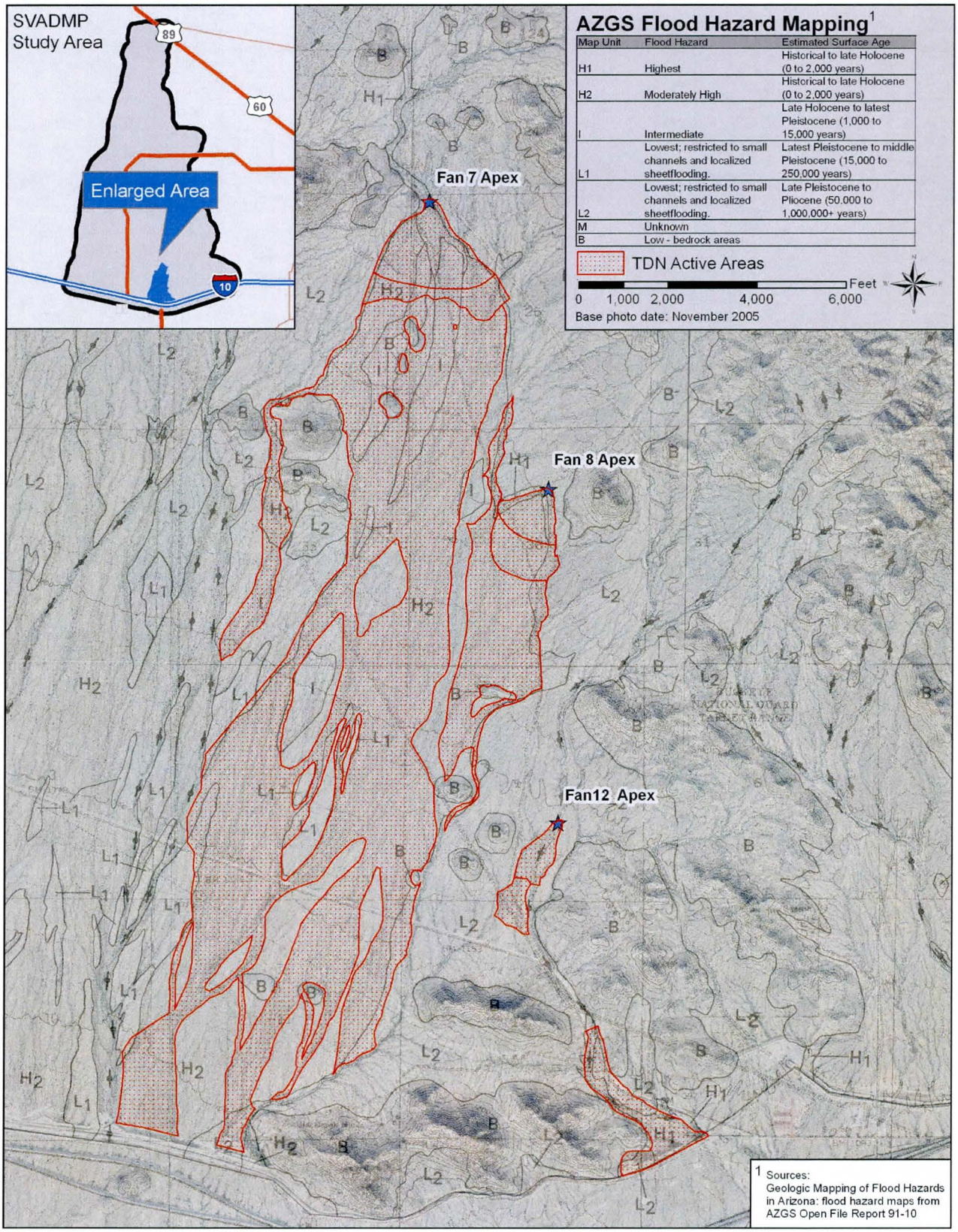


Figure 6.22 AZGS flood hazard mapping for Fans 7, 8, and 12

The NRCS and AZGS mapping, and the stable/unstable area delineations performed for this study are compared in Figure 6.23. The NRCS, AZGS, and TDN mapping are broadly similar. The minor differences are attributed to the lower resolution, large scale mapping performed by the NRCS and AZGS, as well as rectification issues associated with converting paper maps to digital coverages. The NRCS, AZGS, and TDN mapping all identify unstable, active alluvial fan areas downstream of the hydrographic apexes of Fans 7, 8 and 12 and inactive, stable piedmont surfaces for the remainder of the piedmont.

6B.5.3.3 Interpretation of Topography

Topographic data were available from USGS 7.5-minute quadrangle maps and from FCDMC 10-foot contour interval mapping (Figure 6.24). Topographic data can be used in the following ways to identify stable and unstable (active/inactive) portions of alluvial fan landforms:

- Contour crenulation. Contour crenulations are "wiggles" in topographic contour lines. Since older, stable surfaces tend to have greater internal relief, better developed drainage networks, and are largely erosive landforms, the contours over such surfaces are more crenulated. Contours over younger, active, unstable surfaces tend to be smoother, reflecting the more uniform, less incised topography.
- Contour shape. Contours on active, unstable alluvial fan surfaces tend to bend downstream in a smooth radial pattern. Contours on inactive or relict fans tend to be more parallel to the mountain front.
- Contour direction. A marked change in the contour orientation occurs at the toe of the alluvial fan, where it enters the floodplain of the axial stream, which is frequently orthogonal to the fan contour orientation.
- Relief. The boundaries of active fan areas are typically confined by older, higher inactive surfaces which constrain alluvial fan flooding to topographically lower unstable surfaces. Topographic relief is addressed more directly in the Stage 3 analysis.
- Longitudinal profile. A longitudinal profile is a plot of elevation versus distance. A profile of an actively aggrading alluvial fan usually in convex (steepens downstream), whereas inactive alluvial fans typically have concave profiles (flattens downstream).
- Map symbols. Symbols on the USGS topographic maps useful for fan identification include stream channel bifurcation, stippling of depositional areas, termination of stream symbols in the downstream direction,

The topographic data within the active, unstable area of Fan 7, 8 and 12 are less crenulated than the adjacent, stable portions of the piedmont, indicating that the active surface is not incised and that the

flow paths are shallow. The topographic data indicate that the inactive portions of the piedmont are incised by up to 15 feet in place.

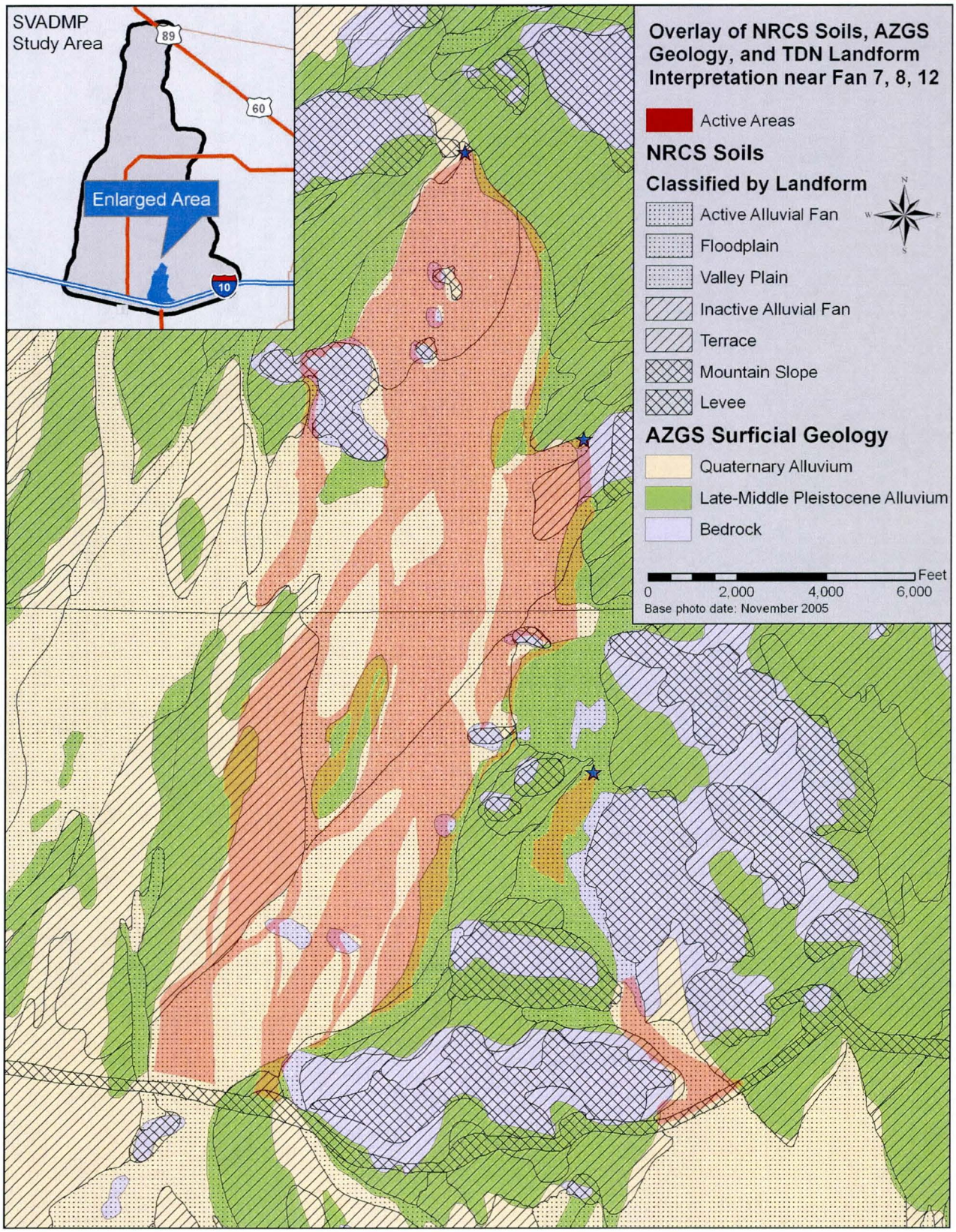


Figure 6.23 NRCS, AZGS, and unstable area mapping overlay

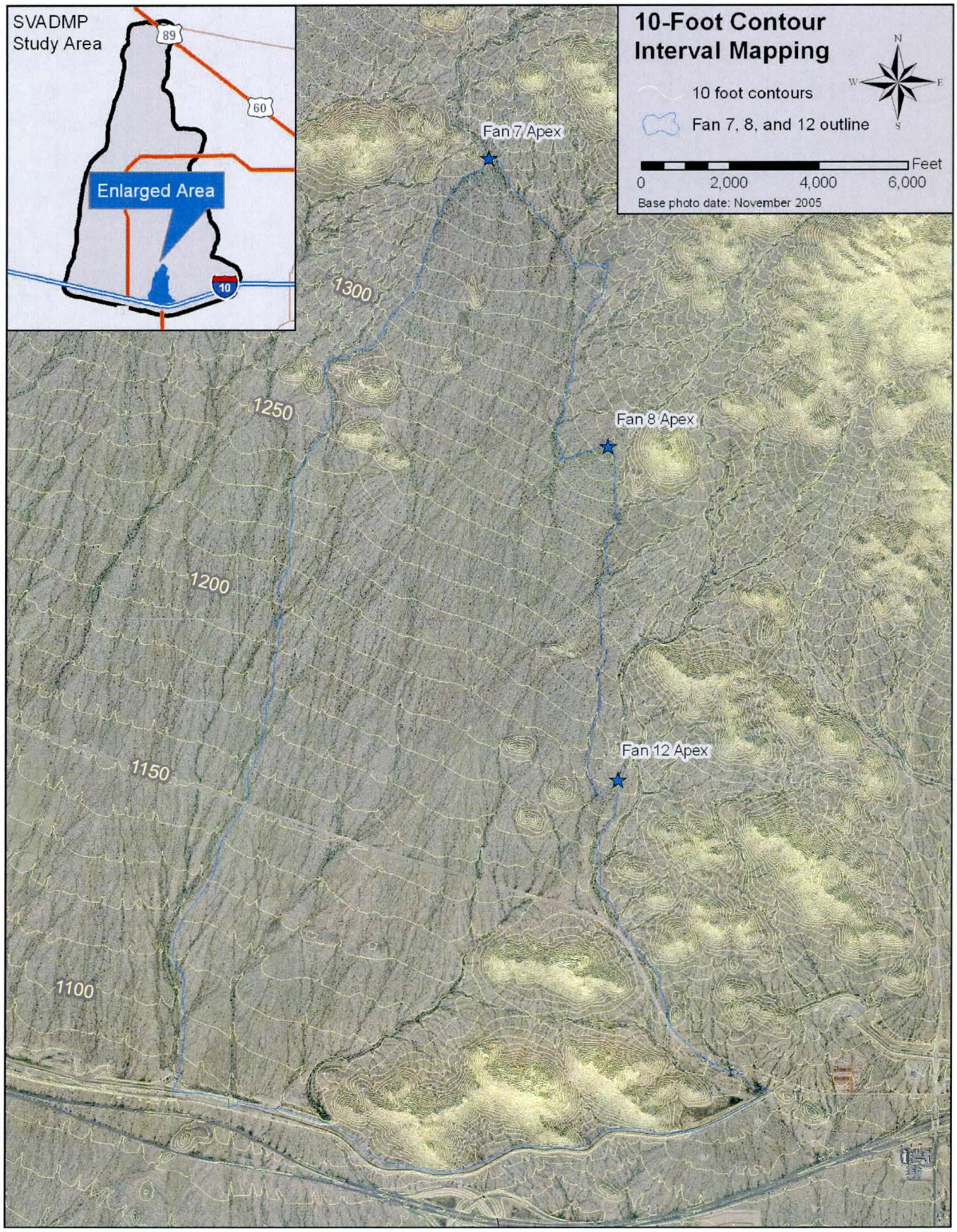
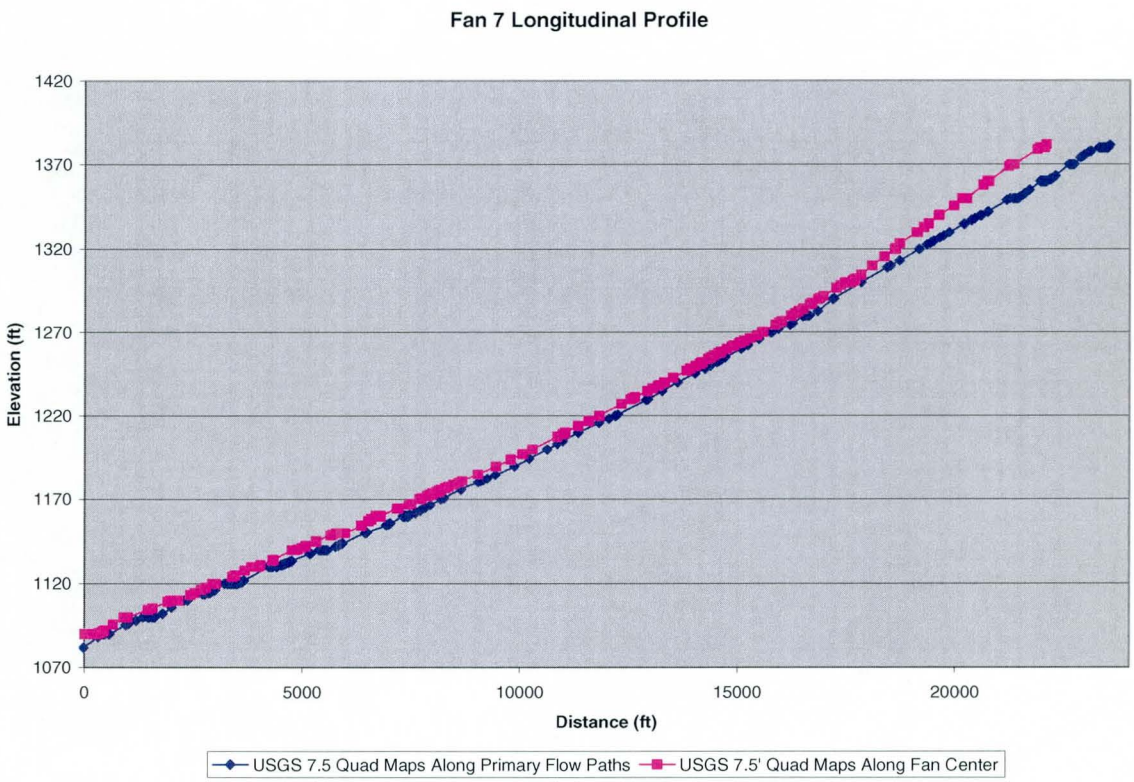
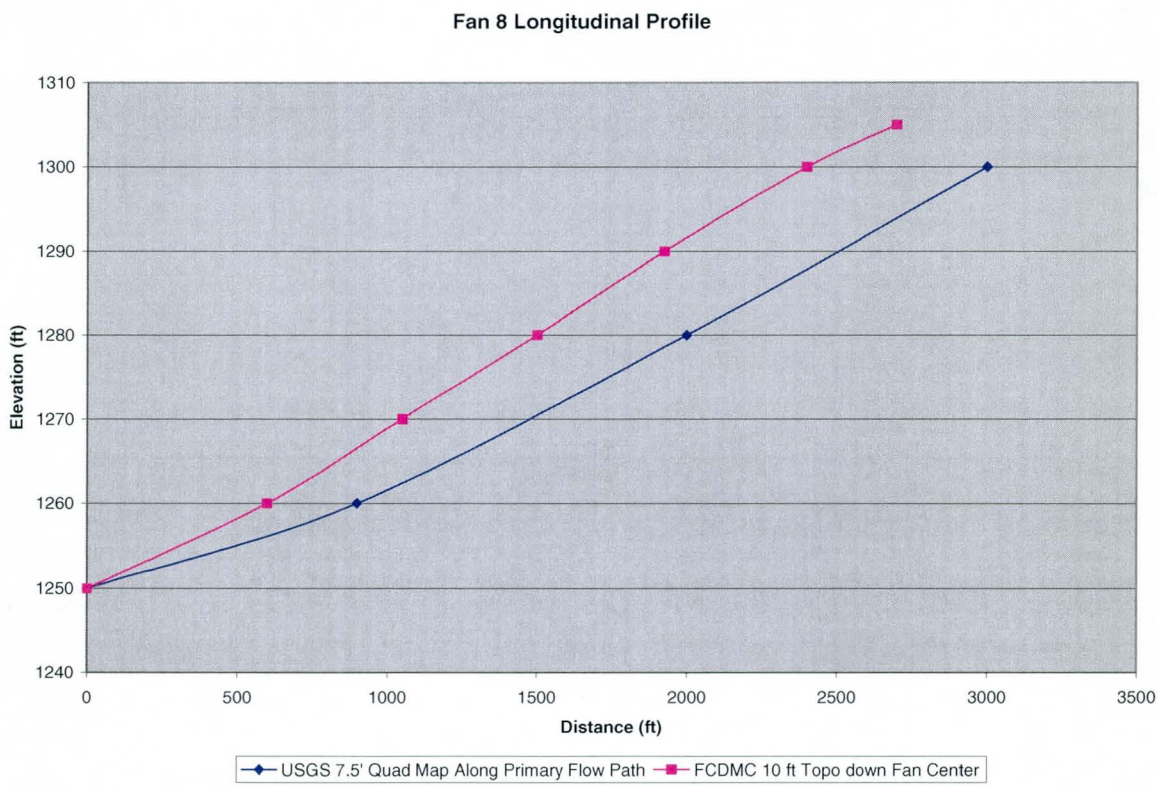


Figure 6.24 10-foot contour interval mapping


Fan 7 Longitudinal Profile
Elevation (ft)
1420
1370
1320
1270
1220
1170
1120
1070
0
5000
10000
15000
20000
Distance (ft)
USGS 7.5 Quad Maps Along Primary Flow Paths
USGS 7.5' Quad Maps Along Fan Center


Fan 8 Longitudinal Profile
Elevation (ft)
1310
1300
1290
1280
1270
1260
1250
1240
0
500
1000
1500
2000
2500
3000
3500
Distance (ft)
USGS 7.5' Quad Map Along Primary Flow Path
FCDMC 10 ft Topo down Fan Center

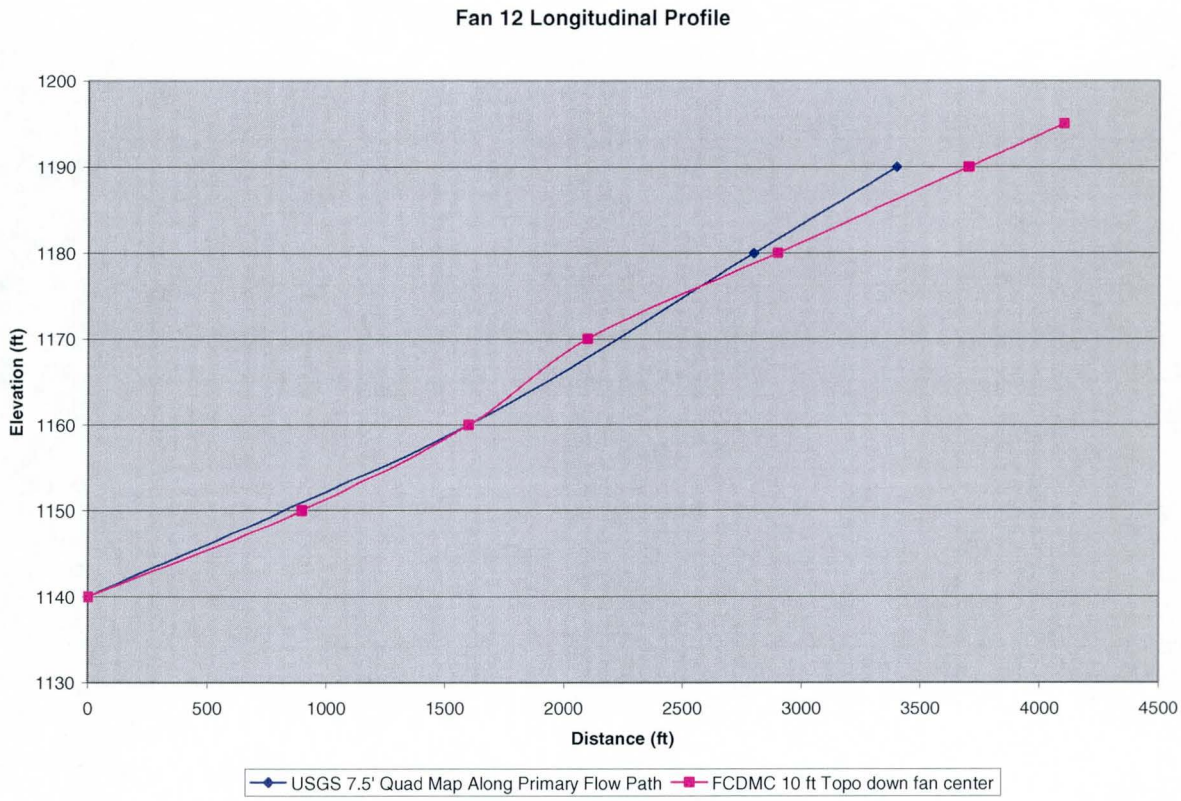


Figure 6.25 Longitudinal Profiles for Fans 7, 8 & 12 (continued from previous page)

6B.5.3.4 Historical Aerial Photography

Historical aerial photographic coverage from 1953 and 2005 were available for the Site 7, 8 and 12 alluvial fans (Figure 6.26). The 1953 digital aerial photographs were obtained from the District GIS (Table 6.5). Channel thalweg locations were plotted on the 1953 and 2005 aerials to identify channel movement, channel avulsions, or other changes in channel characteristics (Figure 6.27).

Table 6.5 List of Historical Aerial Photographs of White Tank Fan Study Area

Source	Photo Date	Scale	Type	Digital
FCDMC Archives	1953	digital	Black & white prints	Scanned
FCDMC	2005	1:32,000	Color orthophotos	Yes

Comparison of thalweg locations shown in Figure 6.27 indicates that there has been definite channel movement on fans 7, 8 and 12 during the 52 years of record. Many new channels have formed in the study area, concentrated in the west and central portion of fan 7. Although there were

no 1953 thalwegs delineated on Fan 12, examination of the historical aerial photograph comparison indicates there has been little channel movement on Fan 12 within the period of record.

There were no changes in vegetative cover, distribution or density that could be discerned at the scale of the aerial photographs. The primary human impact on Fans 7, 8 and 12 was construction of the Buckeye FRS and associated maintenance activities in the FRS impoundment area.

6B.5.3.5 Drainage Pattern

Drainage pattern is indicative of alluvial fan stability. Inactive, stable alluvial fans typically have a tributary, well-defined drainage pattern, with channels that generally increase in size with distance downstream. Active, unstable alluvial fans typically have poorly defined distributary or sheet flow drainage patterns, which have channels that often decrease (or disappear) in the downstream direction. The drainage pattern can be readily identified from aerial photographs (Figure 6.19) by the light-toned sandy channel bed materials and/or the bank vegetation which is usually denser and with different species than floodplain and terrace areas.

The drainage pattern in the unstable portions of Fan 7, 8 and 12 is distributary with strong components of unconfined and sheet flow. Field observations suggest that large percentages of the active areas are inundated during significant floods. The stable portions of the piedmont have a well-defined tributary drainage pattern. The drainage pattern changes from tributary to distributary at the hydrographic apex. The distributary pattern persists from the hydrographic apex to the Buckeye FRS impoundment limits where maintenance activities obscure the natural drainage pattern.

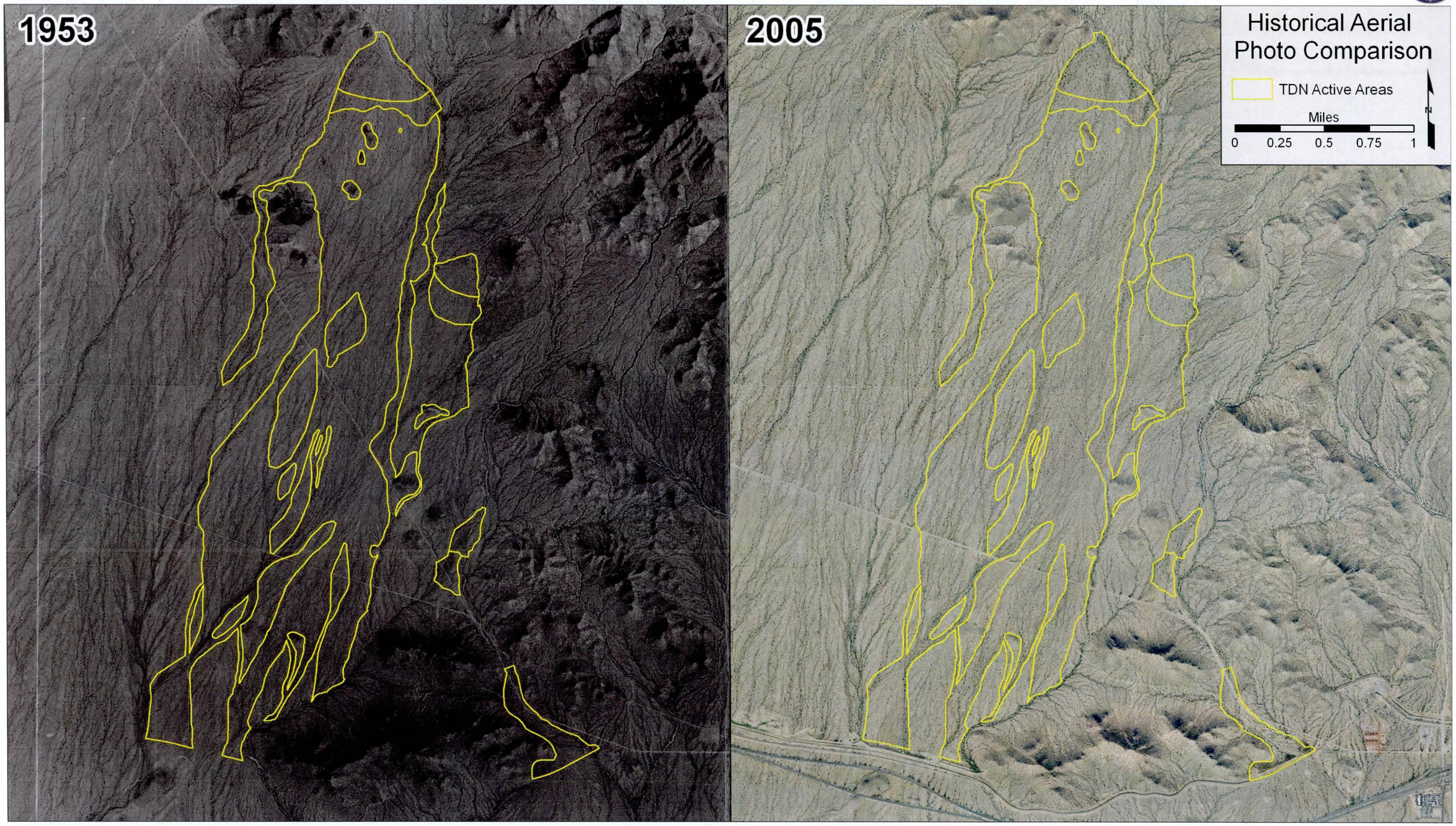


Figure 6.26 Historical aerial photo comparison

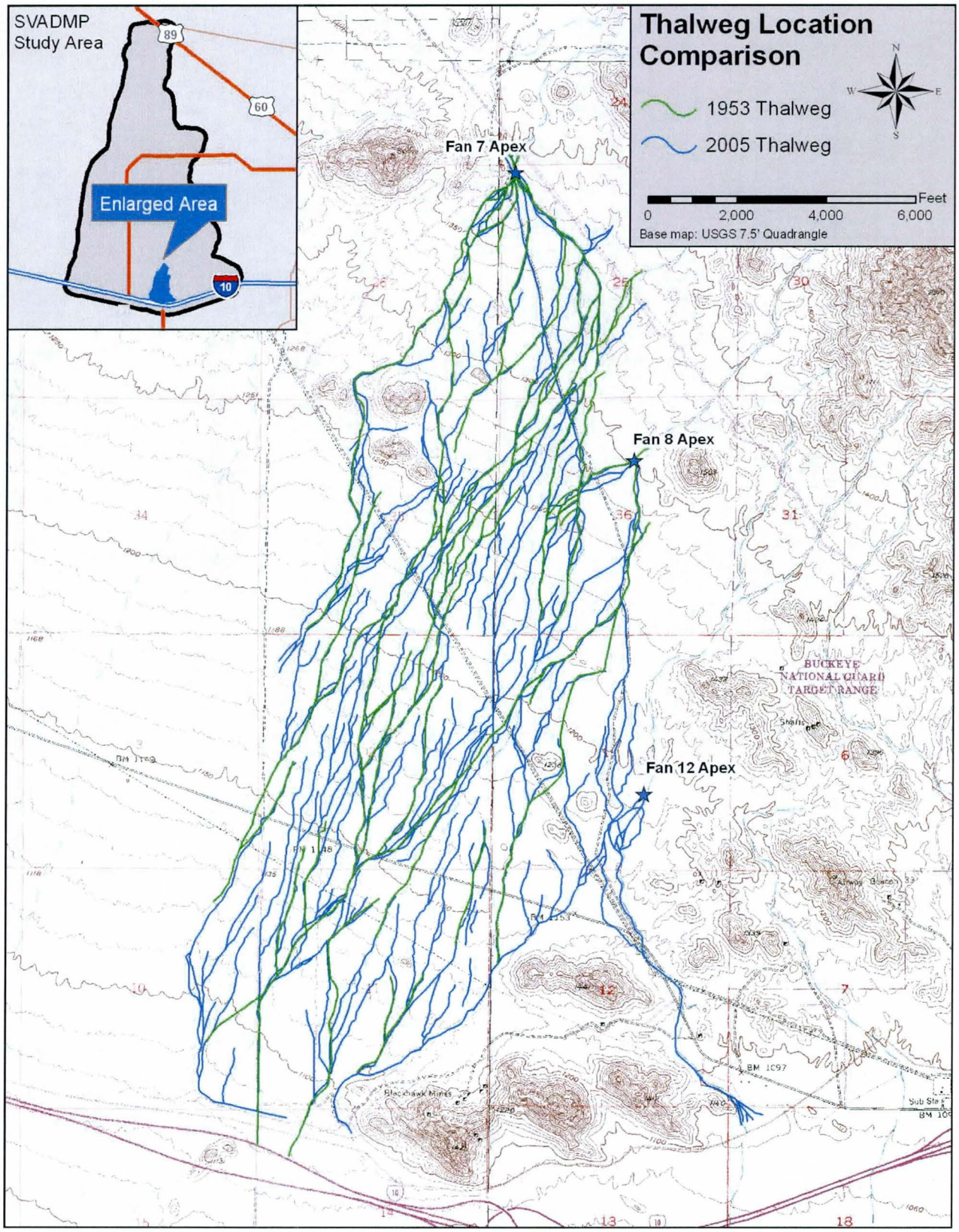


Figure 6.27 Historical thalweg locations

6B.5.3.6 Surficial Characteristics

Surficial landform characteristics can be used to identify stable and unstable alluvial fan surfaces, as described in Section 6B.5.1 and the PFHAM. Landform characteristics were identified during field visits, by interpretation of aerial photographs, and from NRCS soils and AZGS geologic maps. Key surficial characteristics considered for the Site 7, 8 and 12 delineation included the following:

- Surface Texture
- Surface Color
- Desert Varnish
- Desert Pavement

The active, unstable fan areas shown in Figure 6.19 generally lacked surface reddening, desert varnish and desert pavement, and had relatively uniform surface texture. Limited areas with moderate desert pavements were observed on the southwest portion of the Fan 7 active unstable area. However, field evidence including flotsam and silt deposits indicated that pavements had recently been inundated. There is little or no relief between these pavement surfaces in the active area and the active flow paths. Inactive, stable surfaces had distinct surface texture, soil reddening, and desert varnish and pavement areas.

6B.5.3.7 Vegetation

Vegetation was used in the following ways to distinguish stable and unstable alluvial fan surfaces on the Site 7, 8 and 12 Fans:

- Vegetative Suites. The types of vegetation on any geomorphic surface are a function of the micro-climate (aspect, elevation, etc.), soil substrate, frequency and concentration of runoff, soil permeability, and soil chemistry. Because adjacent geomorphic surfaces on alluvial fan landforms differ in degree of clay and carbonate accumulation (substrate, chemistry, permeability), incision (runoff characteristics), and frequency of inundation, the vegetation suites on each surface are likely to vary slightly, either by species type and/or by species density or robustness.
- Marker Species. Certain species are almost always found in specific geomorphic and fluvial environments. For example: (1) ocotillo thrive in carbonate rich soils, and usually indicate that a caliche layer underlies the surface, (2) saguaro, barrel, and cholla cacti grow well in rocky, well-drained soils are usually found outside the active floodplain, (3) ironwood, palo verde, and mesquite trees typically are found on channel banks or where runoff concentrates frequently.

- Species Age. The apparent age of vegetation is used to distinguish geomorphic surface age. The age of vegetation is directly proportional to overall plant size, as well as trunk diameter (woody trees), presence or number of branches (saguaro cacti branch after about 70 to 100 years), or other factors (creosote clone ring diameter). Old vegetation is indicative of stability or at least non-erosion.
- Burial or Exposure. Burial of the plant base by sediment deposition may indicate aggradation or active alluvial fan flooding. Exposure of a plant's roots by erosion indicates scour or lateral erosion which may be associated with either stable or unstable surfaces, depending on other geomorphic characteristics.

Vegetation characteristics for the Site 7, 8 and 12 Fans were identified in the field and on aerial photographs (Figure 6.28). Differences in vegetation between stable and unstable portions of the piedmont near Fan 7, 8 and 12 include vegetative density, distribution, size, and type. Active fan areas had denser vegetative cover, with larger plant sizes, especially on the interfluve areas than the inactive surfaces. Channel bank vegetation in the active fans areas tended to be smaller than along channels on inactive surfaces. Inactive surfaces tended to have more cholla and saguaro cacti than active surfaces.

6B.5.3.8 Sediment Delivery Potential

Sediment yield estimates were not performed as part of this TDN.

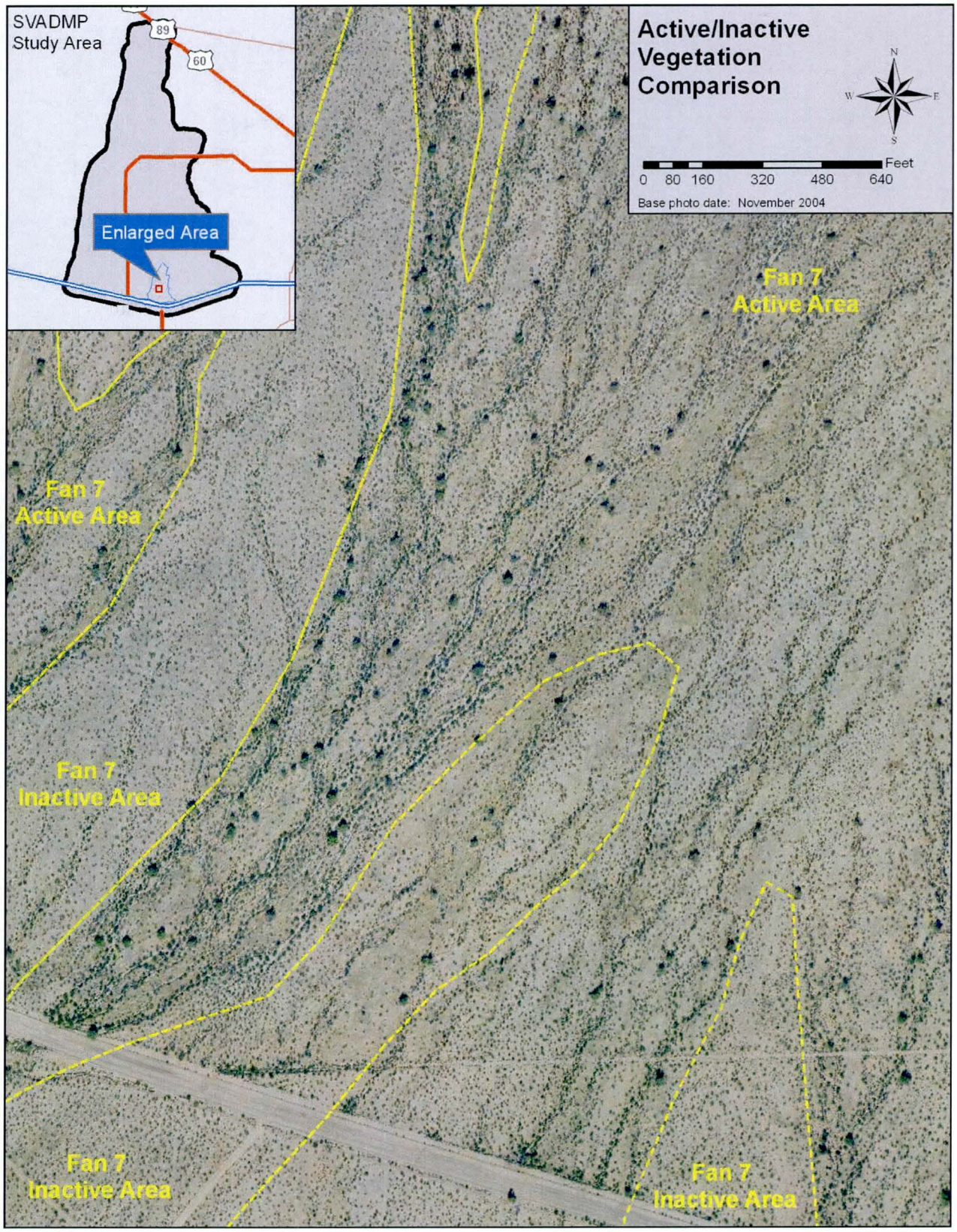


Figure 6.28 Active/Inactive vegetation characteristics

6B.5.3.9 Summary

Active and inactive portions of the Site 7, 8 and 12 alluvial fan landforms were identified using the geomorphic characteristics described above. The characteristics are best used in conjunction with each other, since no single characteristic is universally diagnostic of the level of stability. The stable/unstable landform delineation for the Site 7, 8and 12 Fans are shown in Figure 6.19.

6B.5.4 Alluvial Fan Floodplains Downstream of Active Unstable Areas

The active unstable alluvial fan areas on the White Tank Piedmont that experience alluvial fan flooding with flow path uncertainty, are located immediately downstream of a hydrographic apex, either the primary hydrographic apex, or a secondary inset hydrographic apex located further downstream. Runoff that passes through the entire active unstable portion of the alluvial fan before reaching the toe of the alluvial fan landform is conveyed downstream through one or more of the following types of drainage networks:

- Stable Distributary Systems
- Stable Tributary Systems
- Sheet Flow Areas

In the case of the Fan 7, 8 and 12 alluvial fans, the Buckeye FRS truncates the alluvial fan about three miles down fan from the hydrographic apex. Large portions of fan 7 are defined as active. It is likely that large floods on the fans include some component of sheet flow within the active areas.

6B.5.5 Identification of Inactive Areas

Along with the active alluvial fan areas at Site 7, 8 and 12, Figure 6.19 also shows the inactive alluvial fan areas. Basically, the inactive areas are those portions of the alluvial fan landform that are not active, as described in the Section 6B.5.3. As shown in Figure 6.19, a large portion of the Site 7, 8 and 12 piedmont landform consists of active, unstable surfaces.

6B.5.6 Types of Flooding on the Piedmont

Based on the evaluation of active and inactive areas on the Site 7, 8 and 12, the following locations and types of flood hazards were defined.

6B.5.6.1 Flooding Along Stable Channels: Upstream of the Hydrographic Apex

Riverine flooding upstream of the hydrographic apex was delineated using approximate method riverine delineation techniques, as described in Section 5. The riverine reach upstream of the hydrographic apex is considered stable surface flooding.

6B.5.6.2 Unstable Flow Path Flooding

Active alluvial fan flooding on the Site 7, 8 and 12 piedmont are very extensive when compared to other fans in the area. These unstable areas represent significant flood and sediment hazards. On Fan 7 there are areas mapped within the unstable areas where incipient tributary drainage networks have formed. While tributary drainage networks are often an indicator of stability, in the cases of Fans 7, the degree of relief between the unstable distributary areas and the areas with incipient tributary systems is too small to warrant considering them as stable. On Fan 8 unstable flow paths are mapped over the entire fan area until fan coalesces with fan 7. Fan 12 has two active, unstable portions. The first occurs directly below the hydrographic apex. The second unstable flow path flooding area on fan 12 is at the southeastern-most portion of the study area. Historical grading associated with construction and maintenance of the Buckeye FRS creates an additional source of instability at the southern limit of the study area.

6B.5.6.3 Sheetflow Areas

Sheetflow probably occurs over much of the active area on fan 7, 8 and 12 in conjunction with unstable flow path flooding. During large events sheetflow flooding is expected to be one of the primary methods of flooding on the active unstable areas of fans 7, 8 and 12.

6B.5.6.4 Debris Flow Areas

No evidence of debris flows was observed in the field, on topographic maps, or on aerial photographs. The NRCS soils mapping and AZGS geologic mapping do not mention debris flow hazards or deposits within the study area. The hydrographic apexes are located too far from the mountain front for debris flows to be of concern for the flood hazard inundation areas mapped in this study.

6B.5.7 Summary of Stage 2 Delineation

Figure 6.19 shows the limits of the active and inactive areas of the Site 7, 8 and 12 piedmont. The Stage 2 active/inactive area delineation is the foundation for the Stage 3 floodplain delineation. The most active areas of the Fan 7, 8 and 12 piedmont landform are very extensive, covering more than 75% of the area downstream of the hydrographic apexes.

6B.6 Stage 3: Defining the Approximate 100-Year Floodplain

The 100-year flood hazard assessment is an outgrowth of the information and results identified and generated in Stages 1 and 2. In Stage 1, Sites 7, 8 and 12 were identified as part of an alluvial fan landform.

In Stage 2, the unstable (active) and stable (inactive) portions of the alluvial fan landform were identified. According to the FEMA Guidelines, "the delineated floodprone areas of Stage 2 should approximate the largest possible extent of the 100-year flood." In Stage 3, floodplain limits for the 100-year (1%) flood are delineated for each of the types of the following types of flooding identified in Section 6B.5:

- Flooding Along Stable Channels: Upstream of the Hydrographic Apex. The floodplain along the main channel upstream of the hydrographic apex was delineated using riverine approximate method techniques, as described in Section 5.0.
- Unstable Flow Path Flooding. The floodplain in the areas with unstable flow path flooding (active alluvial fan flooding) downstream of the hydrographic apex were delineated using geomorphic data. In general, the 100-year floodplain delineated in the active alluvial fan areas is coincident with the Stage 2 unstable area delineation.
- Flooding Along Stable Channels: Downstream of the Hydrographic Apex. The floodplain along stable distributary and tributary channels located downstream of the active alluvial fan areas were delineated using geomorphic data.
- Sheetflow. Areas of sheet flooding were delineated using geomorphic data. In the case of Sites 7, 8 and 12, the sheet flow areas could not be reliably distinguished from the areas of unstable flow path flooding and were therefore included in the latter category.

The Stage 3 100-year floodplain delineations for the Site 7, 8 and 12 alluvial fans are shown in Figure 6.29.

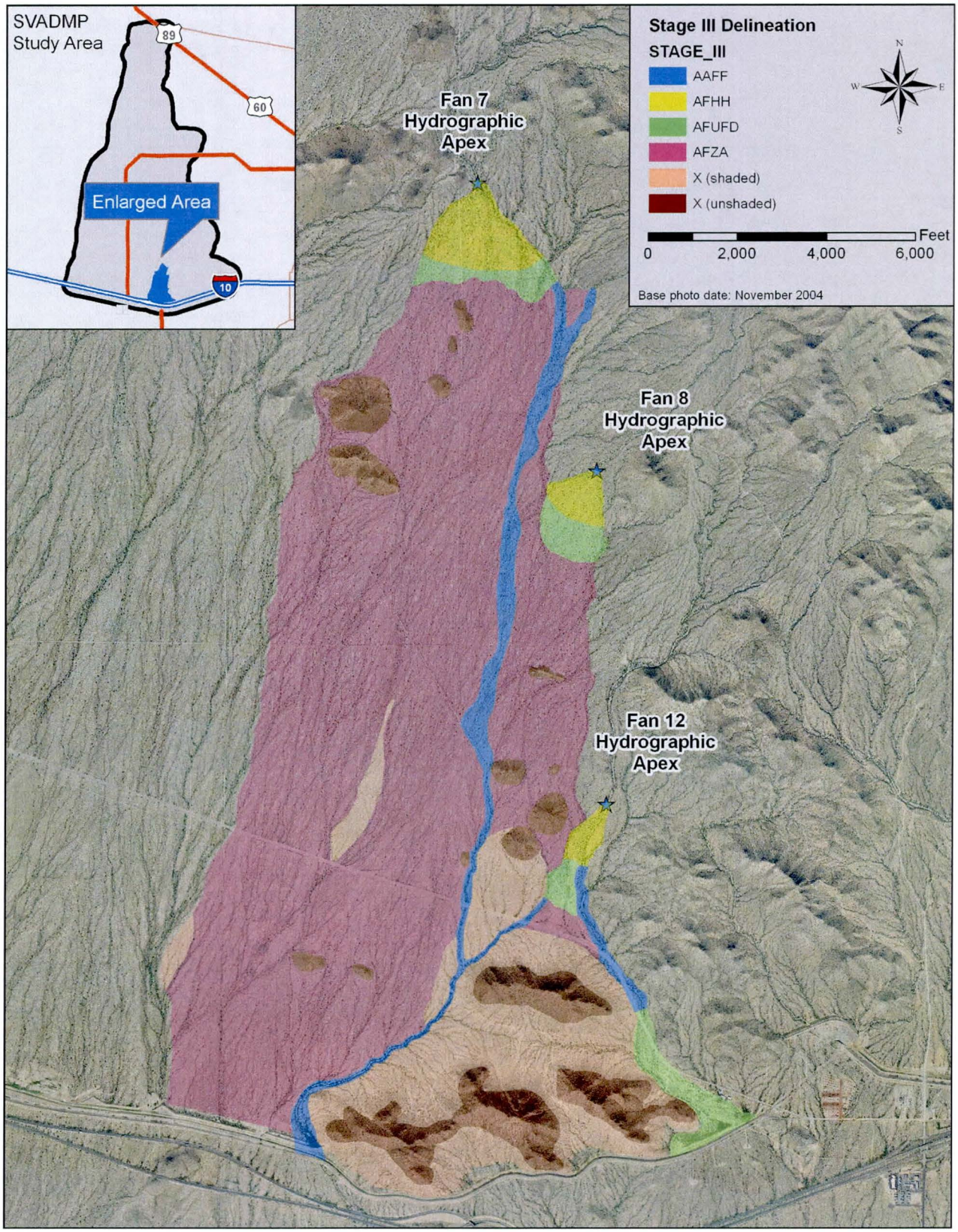


Figure 6.29 Stage III delineations

6B.6.1 Flood Hazard Zones

Table 6.6 lists and describes the flood hazard zones identified and shown in Figure 6.29 and the Stage 3 – 100-year Floodplain Map in the Floodplain Delineation Exhibits included in the TDN Appendix. These zones are defined for use in piedmont flood hazard delineation in Maricopa County by the Flood Control District of Maricopa County, and were approved the Maricopa County Board of Supervisors on November 1, 2000. The flood hazard zones shown on Figure 6B.29 are given in Table 6B.7. The resulting flood hazard map is similar in nature to the one shown in Example 4 (Figure G-9) in FEMA Guidelines.

The unstable areas delineated in the Stage 2 analysis were used to identify the location of the Zone A – Administrative Floodway Active Alluvial Fan (Zone AFHH). The AFHH (active alluvial fan) zone lies within the unstable area. The AFUFD (uncertain flow distribution) zone encompasses the remainder of the unstable area as well as an additional buffer area along the downstream edge of the unstable area identified in Stage 2. This buffer area was determined by use of the soils, surficial geology data, interpretation of recent and historical aerial photographs, and engineering judgment.

Zone A – Administrative Floodway Inactive Alluvial Fan (Local Community Zone AAFF) were used along stable throughflow channel corridors which traverse the inactive portions of the alluvial fan landform.

Table 6.6 Flood Hazard Zones Mapped in White Tank Fan 7, 8 and 12 Approximate FDS		
Zone Name	**Local Community Zone Designation**	**Description**
Zone A	Zone A	Approximate 100-year floodplain; riverine reaches upstream of hydrographic apex, and previously mapped ponding area behind Buckeye FRS #1
Zone A – Administrative Floodway Riverine	Zone A	Approximate 100-year floodplain, riverine reaches upstream of hydrographic apex, managed as a floodway district.
Zone A – Administrative Floodway Active Alluvial Fan	AFHH – Administrative Floodway	Alluvial Fan High Hazard, community to treat as a floodway district
Zone A – Administrative Floodway Active Alluvial Fan	AFUFD – Administrative Floodway	Alluvial Fan Uncertain Flow Distribution Area; transitional area downstream of AFHH zone characterized by channelized and sheet flooding generally becoming more stable and less uncertain with increasing downstream distance from the AFHH zone; community to treat as a floodway district
Zone A – Administrative Floodway Inactive Alluvial Fan	AAFF - Administrative Floodway	Approximate Alluvial Fan Floodway; corridors for conveyance of water and sediment on a stable alluvial fan surface downstream of the AFHH and AFUFD; community to treat as a floodway district
Zone A – Inactive Alluvial Fan	AFZA	Alluvial Fan Zone A; areas within the 100-year floodplain on an inactive alluvial fan characterized by shallow channelized flow and sheet flooding in stable channels; zone is considered approximate because no base flood elevations are provided; flood hazards within this zone are not necessarily equal throughout, that is, the frequency and magnitude of flooding with respect to depth and velocity of flow may vary within the AFZA zone; floodplain managers should consult available aerial photographs and topographic maps for more detailed evaluation of site specific flood hazard within this zone; development will be allowed in this zone given demonstration of adequacy of site and/or design which addresses safety from inundation and sedimentation hazards
Zone A – Administrative Floodway	A	Areas of riverine floodway upstream of the hydrographic apex are shown as administrative floodways. Flooding on inactive alluvial fans.
X (shaded) – Inactive Alluvial Fan	X (shaded)	Areas flooded between 100-yr and 500-yr discharge; or areas of flooding with depth of 100-year flood less than 1 foot; or drainage area less than 1 square mile
X (unshaded)	X (unshaded)	Areas outside the 500-year floodplain; shown only on rocky hills
D	D	Area not studied

The Zone A - Inactive Alluvial Fan (AFZA) designation was to be used for sheet flooding areas within the alluvial fan landform. The AFZA zone is generally characterized by sheet flooding and flooding within relatively small stable channels. These small channels may either represent small distributary drainages connected to the primary floodways, small local drainages, or various paths where broad sheet flooding

recollects as it flows down the piedmont in an effort to reorganize itself. On fans 7, 8 and 12 field evidence indicated that some AFZA were more active than other AFZA zones. The more active portions of AFZA exhibited strong characteristics of sheet flooding while other areas of AFZA exhibited more tributary drainage network development and slightly weaker sheet flooding characteristics.

6B.6.2 Verification of Results

Verification of the Stage 3 floodplain delineation was accomplished by comparison with an AZGS flood hazard zone evaluation (AZGS Open File Report 91-10).

The AZGS flood hazard evaluation is shown in Figure 6.22 (Sites 7, 8 and 12), overlain on the Stage 3 floodplain delineation. The entire active alluvial fan areas for both Sites 7, 8 and 12 were mapped as H1, H2 and I surfaces by the AZGS, the areas of highest flood hazard. For this study, Stage III AFHH zones generally correlated with H1 zones on the AZGS maps. Fan 12 zone AFHH, just below the hydrologic apex, was mapped as L2 on the Flood hazard map. This discrepancy is most likely due to the large scale the AZGS flood hazards were mapped at.

Overall, the 100-year flood hazard assessment of the Site 7, 8 and 12 piedmont and alluvial fan is believed to be reasonable, sound, and defensible based on the data presented in this Technical Data Notebook. However, revisions to the mapping presented here could be justified based on more detailed topographic mapping, detailed hydraulic analyses, or structural flood control measures.

6B.6.3 Limitations

Every modeling and mapping methodology has limitations. The limitations of the approximate geomorphic floodplain delineation method used for the Site 7, 8 and 12 alluvial fan are summarized below.

6B.6.3.1 Scale of mapping

The mapping for this study was compiled onto 1:12000 scale maps. The 2004 aerial photographs used are of excellent resolution that did not limit interpretation at the map scale. Nevertheless, the size of the alluvial fan landforms considered precludes the level of detail possible when mapping at an individual lot basis.

6B.6.3.2 Accuracy of mapping

Map accuracy is also a limitation for some of the data sources used such as NRCS and AZGS soils and flood hazard mapping. These maps were scanned and semi-rectified, but some horizontal displacement remained. Additionally, in the process of transferring field and photo interpretations to the DOQs, the accuracy is limited to one's ability to identify precisely identical locations on each

photograph. Through the use of landmarks, distinctive channel features and patterns, large trees, etc. it is believed that these errors have been minimized.

6B.6.3.3 Time period of historical photo record

Period of record for historical aerial photos spans 50 years. While this is a reasonably long period, it does not ensure that a 100-year event occurred during this time period, or that the full range of expected alluvial fan processes has been observed. However, use of geomorphic data extends the period of record significantly.

6B.7 Work Study Maps

This study includes geomorphic mapping and floodplain delineation of parts of the Site 7-8-12 alluvial fans. The figures for Section 6B, including a cover sheet showing the project location and 11" x 17" versions of the Stage 1 Landform map, Stage 2 Stability map, and Stage 3 Floodplain map, are located at the end of Section 6B of the Technical Data Notebook.

6B.8 References

1. Aerial Mapping Company, 1999, Color stereographic aerial photographs of White Tank fan approximate delineation study area, flight date 9-25-99, scale 1:9,600 and flight date 10-6-99, scale 1:32,000.

2. Alpha Engineering Group, Inc., 1994, White Tanks Wash Flood Insurance Study, FCD No. 90-64: for FCDMC, Phoenix, Arizona.

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7. FCDMC, 1996 and 1998. Black and white semi-rectified aerial photographs from FCDMC image database. Original photography from which digital versions were created 1:7,200 scale.

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7. DRAFT FIS

7.1 Summary of Discharges

See Section 4 and Table 4.2 for detail regarding the origin of the discharges presented below.

	Drainage Area	Peak Discharges (cfs)			
Flooding Source and Location	(Square Miles)	10-Year	50-year	100-Year	500-Year
White Tank Fan 7 – Section 2583 (N1)	1.351			1453	
White Tank Fan 8 – Section 2394 (P1A)	0.521			646	
White Tank Fan 12 – Section 3761 (Q1A)	1.42			1050	

7.2 Floodway Data

Floodway data tables are not presented in this TDN.

7.3 Annotated Flood Insurance Rate Maps

See C. Maps of this TDN

7.4 Flood Profiles

Flood profiles are not presented in this TDN.

Appendix A

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Appendix B

Correspondence

APPENDIX B

B.1 Special Problem Reports

B.2 Contact (telephone) Reports

B.3 Meeting Minutes or Reports

B.4 General Correspondence

B.5 Contract Documents

B.6 Public Notification

B.7 FEMA Correspondence

B.1 Special Problem Reports

B.2 Contact (telephone) Reports

B.3 Meeting Minutes or Reports

B.4 General Correspondence

B.5 Contract Documents

B.6 Public Notification

B.7 FEMA Correspondence

Appendix C

Survey Field Notes

Additional survey field notes were not gathered for this study.

Appendix D

Hydrologic Analysis Supporting Documentation

APPENDIX D

D.1 Precipitation Data

D.2 Physical Parameter Calculations

D.3 Hydrologic Calculations

D.1 Precipitation Data

D.2 Physical Parameter Calculations

D.3 Hydrologic Calculations

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*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                    *   U.S. ARMY CORPS OF ENGINEERS       *
*             JUN   1998               *                                    *   HYDROLOGIC ENGINEERING CENTER      *
*           VERSION 4.1                *                                    *         609 SECOND STREET            *
*                                      *                                    *      DAVIS, CALIFORNIA 95616         *
*  RUN DATE   01OCT07  TIME  09:09:12  *                                    *          (916) 756-1104              *
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                                        X     X  XXXXXXX   XXXXX           X
                                        X     X  X        X     X         XX
                                        X     X  X        X               X
                                        XXXXXXX  XXXX     X        XXXXX  X
                                        X     X  X        X               X
                                        X     X  X        X     X         X
                                        X     X  XXXXXXX   XXXXX         XXX

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                                HEC-1 INPUT                                                    PAGE  1

      LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

        1           ID   HYDROLOGY FOR FAN SYSTEM 7, 8, 12
        2           ID
        3           ID   FCD 2005C024
        4           ID   APPROXIMATE METHOD ALLUVIAL FAN FLOODPLAIN DELINEATION STUDY
        5           ID
        6           ID   JE FULLER / HYDROLOGY & GEOMORPHOLOGY, INC.
        7           ID   MODELER: DAVID MEYER
        8           ID   FILENAME: F78126.DAT
        9           ID
       10           ID   100-YEAR 6-HOUR MODEL
       11           ID   EXISTING CONDITIONS
       12           ID            MODELED AREA = 3.492 SQ. MILES
       13           ID
       14           ID   GREEN-AMPT LOSS METHOD
       15           ID
       16           ID   S-GRAPH UNIT HYDROGRAPHS
       17           ID     - MOUNTAIN
       18           ID     - DESERT/RANGELAND
       19           ID
       20           ID   NORMAL-DEPTH CHANNEL ROUTING
       21           ID
       22           ID   LAND USE DATA FROM EXAMINATION OF SLOPE FROM 10-FT DTM TO DISTINGUISH
       23           ID     - UNDEVELOPED DESERT RANGELAND (NDR) - SLOPES < 5 %
       24           ID     - HILLSLOPES, SONORAN DESERT (NHS) - SLOPES 5 - 10 %
       25           ID     - MOUNTAIN TERRAIN (NMT) - SLOPES > 10 %
       26           ID
       27           ID   SOILS DATA FROM FCDMC GIS DATABASE (RECEIVED FROM FCDMC JULY 2005)
       28           IT       5  1JAN99    1200    2000
       29           IN      15
       30           IO       3
                    *DIAGRAM
                    *
       31           JD   3.196  0.1000
       32           PC   0.000   0.008   0.016   0.025   0.033   0.041   0.050   0.058   0.066   0.074
       33           PC   0.087   0.099   0.118   0.138   0.216   0.377   0.834   0.911   0.931   0.950
       34           PC   0.962   0.972   0.983   0.991   1.000
       35           JD   3.181  0.5000
       36           PC   0.000   0.008   0.016   0.025   0.033   0.041   0.050   0.058   0.066   0.074
       37           PC   0.087   0.099   0.118   0.138   0.216   0.377   0.834   0.911   0.931   0.950
       38           PC   0.962   0.972   0.983   0.991   1.000
       39           JD   3.120     2.8
       40           PC   0.000   0.009   0.016   0.025   0.034   0.042   0.051   0.059   0.068   0.077
       41           PC   0.088   0.101   0.121   0.164   0.253   0.451   0.694   0.836   0.900   0.938
       42           PC   0.950   0.963   0.975   0.988   1.000
       43           JD   2.950    16.0
       44           PC   0.000   0.015   0.020   0.030   0.048   0.063   0.076   0.090   0.105   0.119
       45           PC   0.135   0.152   0.175   0.222   0.304   0.472   0.670   0.796   0.868   0.912
       46           PC   0.946   0.960   0.973   0.987   1.000
                    *
1                                                HEC-1 INPUT                                                    PAGE  2

      LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


       47           KK      N1   BASIN
       48           KM        Compute runoff from subbasin N1
       49           BA   1.551
       50           LG    0.29    0.35    4.10    0.46       4
       51           UI     167     360     818    1147    1504    1739    1094     928     788     652
       52           UI     524     414     367     295     215     188     157     128      98      83
       53           UI      82      46      33      32      32      32      32      32       0       0
       54           ZW                 C=FLOW
                    *

       55           KK     P1A   BASIN
       56           KM        Compute runoff from subbasin P1A
       57           BA   0.521
       58           LG    0.25    0.35    4.10    0.46       8
       59           UI      57     126     281     397     526     574     363     312     260     218
       60           UI     172     140     121      94      73      62      49      43      30      28
       61           UI      28      11      11      11      11      11      11      11       0       0
       62           ZW                 C=FLOW
                    *

       63           KK     Q1A   BASIN
       64           KM        Compute runoff from subbasin Q1A
```

```
          65          BA   1.420
          66          LG    0.25    0.35    4.15    0.44       5
          67          UI     108     109     333     512     697     807     981    1264     819     672
          68          UI     609     536     480     430     356     297     266     243     211     177
          69          UI     138     129     119      96      83      84      53      52      54      52
          70          UI      26      21      21      21      21      20      21      21      21      20
          71          UI       0       0       0       0       0       0       0       0       0       0
          72          ZW                  C=FLOW
          73          ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    47          N1
                 .
                 .
    55           .         P1A
                 .           .
                 .           .
    63           .           .        Q1A

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                    ****************************************
*                                         *                                    *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)     *                                    *   U.S. ARMY CORPS OF ENGINEERS       *
*              JUN   1998                 *                                    *   HYDROLOGIC ENGINEERING CENTER      *
*            VERSION 4.1                  *                                    *         609 SECOND STREET            *
*                                         *                                    *      DAVIS, CALIFORNIA 95616         *
*  RUN DATE   01OCT07  TIME  09:09:12     *                                    *          (916) 756-1104              *
*                                         *                                    *                                      *
*****************************************                                    ****************************************
```

```
                         HYDROLOGY FOR FAN SYSTEM 7, 8, 12

                         FCD 2005C024
                         APPROXIMATE METHOD ALLUVIAL FAN FLOODPLAIN DELINEATION STUDY

                         JE FULLER / HYDROLOGY & GEOMORPHOLOGY, INC.
                         MODELER: DAVID MEYER
                         FILENAME: F78126.DAT

                         100-YEAR 6-HOUR MODEL
                         EXISTING CONDITIONS
                                  MODELED AREA = 3.492 SQ. MILES

                         GREEN-AMPT LOSS METHOD

                         S-GRAPH UNIT HYDROGRAPHS
                           - MOUNTAIN
                           - DESERT/RANGELAND

                         NORMAL-DEPTH CHANNEL ROUTING

                         LAND USE DATA FROM EXAMINATION OF SLOPE FROM 10-FT DTM TO DISTINGUISH
                           - UNDEVELOPED DESERT RANGELAND (NDR) - SLOPES < 5 %
                           - HILLSLOPES, SONORAN DESERT (NHS) - SLOPES 5 - 10 %
                           - MOUNTAIN TERRAIN (NMT) - SLOPES > 10 %

                         SOILS DATA FROM FCDMC GIS DATABASE (RECEIVED FROM FCDMC JULY 2005)

  30 IO          OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE

  29 IN          TIME DATA FOR INPUT TIME SERIES
                      JXMIN         15  TIME INTERVAL IN MINUTES
                     JXDATE     1JAN99  STARTING DATE
                     JXTIME       1200  STARTING TIME

     IT          HYDROGRAPH TIME DATA
                       NMIN          5  MINUTES IN COMPUTATION INTERVAL
                      IDATE     1JAN99  STARTING DATE
                      ITIME       1200  STARTING TIME
                         NQ       2000  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE     8JAN99  ENDING DATE
                     NDTIME       1035  ENDING TIME
                      ICENT         19  CENTURY MARK

                 COMPUTATION INTERVAL     .08 HOURS
                      TOTAL TIME BASE  166.58 HOURS

          ENGLISH UNITS
               DRAINAGE AREA          SQUARE MILES
               PRECIPITATION DEPTH    INCHES
               LENGTH, ELEVATION      FEET
               FLOW                   CUBIC FEET PER SECOND
               STORAGE VOLUME         ACRE-FEET
               SURFACE AREA           ACRES
               TEMPERATURE            DEGREES FAHRENHEIT

  31 JD          INDEX STORM NO. 1
                       STRM        3.20  PRECIPITATION DEPTH
                       TRDA         .10  TRANSPOSITION DRAINAGE AREA

  32 PI            PRECIPITATION PATTERN
                      .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                      .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                      .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                      .00       .00       .00       .01       .01       .01       .01       .01       .01       .03
                      .03       .03       .05       .05       .05       .15       .15       .15       .03       .03
                      .03       .01       .01       .01       .01       .01       .01       .00       .00       .00
                      .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                      .00       .00

  35 JD          INDEX STORM NO. 2
                       STRM        3.18  PRECIPITATION DEPTH
```

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                    TRDA          .50  TRANSPOSITION DRAINAGE AREA

  36 PI          PRECIPITATION PATTERN
                    .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                    .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                    .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                    .00       .00       .00       .01       .01       .01       .01       .01       .01       .03
                    .03       .03       .05       .05       .05       .15       .15       .15       .03       .03
                    .03       .01       .01       .01       .01       .01       .01       .00       .00       .00
                    .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                    .00       .00

  39 JD         INDEX STORM NO. 3
                    STRM         3.12  PRECIPITATION DEPTH
                    TRDA         2.80  TRANSPOSITION DRAINAGE AREA

  40 PI          PRECIPITATION PATTERN
                    .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                    .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                    .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                    .00       .00       .00       .01       .01       .01       .01       .01       .01       .03
                    .03       .03       .07       .07       .07       .08       .08       .08       .05       .05
                    .05       .02       .02       .02       .01       .01       .01       .00       .00       .00
                    .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                    .00       .00

  43 JD         INDEX STORM NO. 4
                    STRM         2.95  PRECIPITATION DEPTH
                    TRDA        16.00  TRANSPOSITION DRAINAGE AREA

  44 PI          PRECIPITATION PATTERN
                    .01       .01       .00       .00       .00       .00       .00       .00       .00       .01
                    .01       .01       .00       .01       .00       .00       .00       .00       .00       .00
                    .00       .00       .01       .00       .00       .00       .00       .01       .01       .01
                    .01       .01       .01       .01       .01       .01       .02       .02       .02       .03
                    .03       .03       .06       .06       .06       .07       .07       .07       .04       .04
                    .04       .02       .02       .02       .01       .01       .01       .01       .01       .01
                    .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                    .00       .00


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
  47 KK     *      N1    *        BASIN
            *            *
            **************
                                Compute runoff from subbasin N1

               SUBBASIN RUNOFF DATA

  49 BA          SUBBASIN CHARACTERISTICS
                      TAREA        1.55  SUBBASIN AREA

  50 LG          GREEN AND AMPT LOSS RATE
                      STRTL         .29  STARTING LOSS
                        DTH         .35  MOISTURE DEFICIT
                       PSIF        4.10  WETTING FRONT SUCTION
                      XKSAT         .46  HYDRAULIC CONDUCTIVITY
                      RTIMP        4.00  PERCENT IMPERVIOUS AREA

  48 UI          INPUT UNITGRAPH,  28 ORDINATES,  VOLUME = 1.00
                    167.0     360.0     818.0    1147.0    1504.0    1739.0    1094.0     928.0     788.0     652.0
                    524.0     414.0     367.0     295.0     215.0     188.0     157.0     128.0      98.0      83.0
                     82.0      46.0      33.0      32.0      32.0      32.0      32.0      32.0
                                                                                  ***

      ***            ***            ***            ***            ***

                       HYDROGRAPH AT STATION       N1
                     TRANSPOSITION AREA       .1 SQ MI

    TOTAL RAINFALL =    3.20, TOTAL LOSS =    1.83, TOTAL EXCESS =    1.37

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1870.      4.25                227.         57.         19.          8.
                        (INCHES)    1.363       1.364       1.364       1.364
                         (AC-FT)     113.        113.        113.        113.

                       CUMULATIVE AREA =    1.55 SQ MI


      ***            ***            ***            ***            ***

                       HYDROGRAPH AT STATION       N1
                     TRANSPOSITION AREA       .5 SQ MI

    TOTAL RAINFALL =    3.18, TOTAL LOSS =    1.83, TOTAL EXCESS =    1.36

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1856.      4.25                226.         56.         19.          8.
                        (INCHES)    1.352       1.353       1.353       1.353
                         (AC-FT)     112.        112.        112.        112.

                       CUMULATIVE AREA =    1.55 SQ MI


      ***            ***            ***            ***            ***

                       HYDROGRAPH AT STATION       N1
                     TRANSPOSITION AREA      2.8 SQ MI

    TOTAL RAINFALL =    3.12, TOTAL LOSS =    2.10, TOTAL EXCESS =    1.02
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```
  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1093.      4.33                170.         42.         14.           6.
                       (INCHES)    1.017       1.018       1.018        1.018
                        (AC-FT)     84.         84.         84.          84.

                       CUMULATIVE AREA =    1.55 SQ MI


      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION       N1
                      TRANSPOSITION AREA     16.0 SQ MI

    TOTAL RAINFALL =    2.95, TOTAL LOSS =    2.24, TOTAL EXCESS =     .71

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     731.      4.33                117.         29.         10.           4.
                       (INCHES)     .703        .705        .705         .705
                        (AC-FT)     58.         58.         58.          58.

                       CUMULATIVE AREA =    1.55 SQ MI

    -----DSS---ZOPEN:  Existing File Opened,  File: F78126.DSS
                      Unit:  71;  DSS Version: 6-JG
 -----DSS---ZWRITE Unit  71; Vers.    3:  //N1/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    3:  //N1/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    3:  //N1/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    3:  //N1/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    3:  //N1/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    3:  //N1/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    3:  //N1/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    3:  //N1/FLOW/08JAN1999/5MIN//
      ***            ***            ***            ***            ***


                       INTERPOLATED HYDROGRAPH AT       N1

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1343.      4.33                189.         47.         16.           7.
                       (INCHES)    1.132       1.133       1.133        1.133
                        (AC-FT)     94.         94.         94.          94.

                       CUMULATIVE AREA =    1.55 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
  55 KK     *       P1A  *        BASIN
            *            *
            **************
                                Compute runoff from subbasin P1A

               SUBBASIN RUNOFF DATA

  57 BA          SUBBASIN CHARACTERISTICS
                       TAREA         .52  SUBBASIN AREA

  58 LG          GREEN AND AMPT LOSS RATE
                       STRTL         .25  STARTING LOSS
                         DTH         .35  MOISTURE DEFICIT
                        PSIF        4.10  WETTING FRONT SUCTION
                       XKSAT         .46  HYDRAULIC CONDUCTIVITY
                       RTIMP        8.00  PERCENT IMPERVIOUS AREA

  56 UI          INPUT UNITGRAPH,  28 ORDINATES,  VOLUME = 1.00
                      57.0     126.0     281.0     397.0     526.0     574.0     363.0     312.0     260.0     218.0
                     172.0     140.0     121.0      94.0      73.0      62.0      49.0      43.0      30.0      28.0
                      28.0      11.0      11.0      11.0      11.0      11.0      11.0      11.0
                                                                                ***

      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION      P1A
                      TRANSPOSITION AREA       .1 SQ MI

    TOTAL RAINFALL =    3.20, TOTAL LOSS =    1.73, TOTAL EXCESS =    1.46

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     657.      4.25                 82.         20.          7.           3.
                       (INCHES) .   1.458       1.460       1.460        1.460
                        (AC-FT)     41.         41.         41.          41.

                       CUMULATIVE AREA =     .52 SQ MI


      ***            ***            ***            ***            ***

                        HYDROGRAPH AT STATION      P1A
                      TRANSPOSITION AREA       .5 SQ MI

    TOTAL RAINFALL =    3.18, TOTAL LOSS =    1.73, TOTAL EXCESS =    1.45

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
```

```
+   (CFS)        (HR)
                                (CFS)
+     652.       4.25                  81.          20.           7.           3.
                            (INCHES)     1.446        1.449        1.449        1.449
                             (AC-PT)      40.          40.          40.          40.

                             CUMULATIVE AREA =      .52 SQ MI


      ***             ***             ***             ***             ***

                              HYDROGRAPH AT STATION      P1A
                            TRANSPOSITION AREA      2.8 SQ MI

    TOTAL RAINFALL =    3.12, TOTAL LOSS =    2.00, TOTAL EXCESS =    1.12

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR        24-HR        72-HR    166.58-HR
+   (CFS)        (HR)
                                (CFS)
+     389.       4.33                  63.          16.           5.           2.
                            (INCHES)     1.120        1.124        1.124        1.124
                             (AC-PT)      31.          31.          31.          31.

                             CUMULATIVE AREA =      .52 SQ MI


      ***             ***             ***             ***             ***

                              HYDROGRAPH AT STATION      P1A
                            TRANSPOSITION AREA     16.0 SQ MI

    TOTAL RAINFALL =    2.95, TOTAL LOSS =    2.14, TOTAL EXCESS =     .81

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR        24-HR        72-HR    166.58-HR
+   (CFS)        (HR)
                                (CFS)
+     265.       4.33                  45.          11.           4.           2.
                            (INCHES)      .809         .813         .813         .813
                             (AC-PT)      22.          23.          23.          23.

                             CUMULATIVE AREA =      .52 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.    3:  //P1A/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    3:  //P1A/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    3:  //P1A/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    3:  //P1A/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    3:  //P1A/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    3:  //P1A/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    3:  //P1A/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    3:  //P1A/FLOW/08JAN1999/5MIN//
      ***             ***             ***             ***             ***


                             INTERPOLATED HYDROGRAPH AT      P1A

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR        24-HR        72-HR    166.58-HR
+   (CFS)        (HR)
                                (CFS)
+     646.       4.25                  81.          20.           7.           3.
                            (INCHES)     1.438        1.441        1.441        1.441
                             (AC-PT)      40.          40.          40.          40.

                             CUMULATIVE AREA =      .52 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
   63 KK    *     Q1A    *        BASIN
            *            *
            **************
                                Compute runoff from subbasin Q1A

              SUBBASIN RUNOFF DATA

   65 BA        SUBBASIN CHARACTERISTICS
                      TAREA        1.42  SUBBASIN AREA

   66 LG        GREEN AND AMPT LOSS RATE
                      STRTL         .25  STARTING LOSS
                        DTH         .35  MOISTURE DEFICIT
                       PSIF        4.15  WETTING FRONT SUCTION
                      XKSAT         .44  HYDRAULIC CONDUCTIVITY
                      RTIMP        5.00  PERCENT IMPERVIOUS AREA

   64 UI        INPUT UNITGRAPH,  40 ORDINATES,  VOLUME = 1.00
                    108.0     109.0     333.0     512.0     697.0     807.0     981.0    1264.0     819.0     672.0
                    609.0     536.0     480.0     430.0     356.0     297.0     266.0     243.0     211.0     177.0
                    138.0     129.0     119.0      96.0      83.0      84.0      53.0      52.0      54.0      52.0
                     26.0      21.0      21.0      21.0      21.0      20.0      21.0      21.0      21.0      20.0
                                                                                   ***
      ***             ***             ***             ***             ***

                              HYDROGRAPH AT STATION      Q1A
                            TRANSPOSITION AREA       .1 SQ MI

    TOTAL RAINFALL =    3.20, TOTAL LOSS =    1.77, TOTAL EXCESS =    1.43

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR        24-HR        72-HR    166.58-HR
+   (CFS)        (HR)
                                (CFS)
+    1349.       4.42                 217.          54.          18.           8.
                            (INCHES)     1.421        1.424        1.424        1.424
```

```
                    (AC-FT)      108.        108.        108.        108.

                    CUMULATIVE AREA =    1.42 SQ MI

     ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION      Q1A
                    TRANSPOSITION AREA       .5 SQ MI

    TOTAL RAINFALL =    3.18, TOTAL LOSS =    1.77, TOTAL EXCESS =    1.41

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1339.      4.42                215.         54.         18.          8.
                       (INCHES)    1.409      1.413       1.413       1.413
                       (AC-FT)      107.        107.        107.        107.

                    CUMULATIVE AREA =    1.42 SQ MI

     ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION      Q1A
                    TRANSPOSITION AREA      2.8 SQ MI

    TOTAL RAINFALL =    3.12, TOTAL LOSS =    2.04, TOTAL EXCESS =    1.08

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     853.      4.50                165.         41.         14.          6.
                       (INCHES)    1.078      1.082       1.082       1.082
                       (AC-FT)      82.         82.         82.         82.

                    CUMULATIVE AREA =    1.42 SQ MI

     ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION      Q1A
                    TRANSPOSITION AREA     16.0 SQ MI

    TOTAL RAINFALL =    2.95, TOTAL LOSS =    2.18, TOTAL EXCESS =     .77

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     583.      4.50                117.         29.         10.          4.
                       (INCHES)     .764       .768        .768        .768
                       (AC-FT)       58.         58.         58.         58.

                    CUMULATIVE AREA =    1.42 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.    3:  //Q1A/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    3:  //Q1A/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    3:  //Q1A/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    3:  //Q1A/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    3:  //Q1A/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    3:  //Q1A/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    3:  //Q1A/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    3:  //Q1A/FLOW/08JAN1999/5MIN//
     ***            ***            ***            ***            ***


                    INTERPOLATED HYDROGRAPH AT      Q1A

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1042.      4.50                185.         46.         15.          7.
                       (INCHES)    1.209      1.212       1.212       1.212
                       (AC-FT)      92.         92.         92.         92.

                    CUMULATIVE AREA =    1.42 SQ MI

1
                                          RUNOFF SUMMARY
                                     FLOW IN CUBIC FEET PER SECOND
                                   TIME IN HOURS,  AREA IN SQUARE MILES

                                 PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN     MAXIMUM     TIME OF
        OPERATION       STATION  FLOW    PEAK                                           AREA      STAGE     MAX STAGE
+                                                     6-HOUR     24-HOUR     72-HOUR

        HYDROGRAPH AT
+                          N1    1343.   4.33         189.        47.         16.       1.55

        HYDROGRAPH AT
+                          P1A    646.   4.25          81.        20.          7.        .52

        HYDROGRAPH AT
+                          Q1A   1042.   4.50         185.        46.         15.       1.42


 *** NORMAL END OF HEC-1 ***


    -----DSS---ZCLOSE Unit:  71,   File: F78126.DSS
              Pointer Utilization:   .31
              Number of Records:    136
              File Size:    241.5  Kbytes
              Percent Inactive:    .0
```

```
1*************************************                    *************************************
 *                                   *                    *                                   *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                    *    U.S. ARMY CORPS OF ENGINEERS     *
 *             JUN   1998            *                    *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1             *                    *          609 SECOND STREET          *
 *                                   *                    *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   01OCT07  TIME  09:40:25   *                    *           (916) 756-1104          *
 *                                   *                    *                                   *
 *************************************                    *************************************

                                    X     X  XXXXXXX   XXXXX           X
                                    X     X  X        X     X         XX
                                    X     X  X        X               X
                                    XXXXXXX  XXXX     X        XXXXX  X
                                    X     X  X        X               X
                                    X     X  X        X     X         X
                                    X     X  XXXXXXX   XXXXX          XXX

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                                HEC-1 INPUT                                                    PAGE  1

      LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

        1           ID   HYDROLOGY FOR FAN SYSTEM 7, 8, 12
        2           ID
        3           ID   FCD 2005C024
        4           ID   APPROXIMATE METHOD ALLUVIAL FAN FLOODPLAIN DELINEATION STUDY
        5           ID
        6           ID   JE FULLER / HYDROLOGY & GEOMORPHOLOGY, INC.
        7           ID   MODELER: DAVID MEYER
        8           ID   FILENAME: F78126.DAT
        9           ID
       10           ID   100-YEAR 24-HOUR MODEL
       11           ID   EXISTING CONDITIONS
       12           ID            MODELED AREA = 3.492 SQ. MILES
       13           ID
       14           ID   GREEN-AMPT LOSS METHOD
       15           ID
       16           ID   S-GRAPH UNIT HYDROGRAPHS
       17           ID     - MOUNTAIN
       18           ID     - DESERT/RANGELAND
       19           ID
       20           ID   NORMAL-DEPTH CHANNEL ROUTING
       21           ID
       22           ID   LAND USE DATA FROM EXAMINATION OF SLOPE FROM 10-FT DTM TO DISTINGUISH
       23           ID     - UNDEVELOPED DESERT RANGELAND (NDR) - SLOPES < 5 %
       24           ID     - HILLSLOPES, SONORAN DESERT (NHS) - SLOPES 5 - 10 %
       25           ID     - MOUNTAIN TERRAIN (NMT) - SLOPES > 10 %
       26           ID
       27           ID   SOILS DATA FROM FCDMC GIS DATABASE (RECEIVED FROM FCDMC JULY 2005)
       28           IT       5  1JAN99    1200    2000
       29           IN      15
       30           IO       3
                   *DIAGRAM
                   *
       31           JD   4.198  0.1000
       32           PC   0.000   0.002   0.005   0.008   0.011   0.014   0.017   0.020   0.023   0.026
       33           PC   0.029   0.032   0.035   0.038   0.041   0.044   0.048   0.052   0.056   0.060
       34           PC   0.064   0.068   0.072   0.076   0.080   0.085   0.090   0.095   0.100   0.105
       35           PC   0.110   0.115   0.120   0.126   0.133   0.140   0.147   0.155   0.163   0.172
       36           PC   0.181   0.191   0.203   0.218   0.236   0.257   0.283   0.387   0.663   0.707
       37           PC   0.735   0.758   0.776   0.791   0.804   0.815   0.825   0.834   0.842   0.849
       38           PC   0.856   0.863   0.869   0.875   0.881   0.887   0.893   0.898   0.903   0.908
       39           PC   0.913   0.918   0.922   0.926   0.930   0.934   0.938   0.942   0.946   0.950
       40           PC   0.953   0.956   0.959   0.962   0.965   0.968   0.971   0.974   0.977   0.980
       41           PC   0.983   0.986   0.989   0.992   0.995   0.998   1.000
       42           JD   3.990    10.0
                   *

       43           KK      N1   BASIN
       44           KM        Compute runoff from subbasin N1
       45           BA   1.551
       46           LG    0.29    0.35    4.10    0.46       4
       47           UI     167     360     818    1147    1504    1739    1094     928     788     652
       48           UI     524     414     367     295     215     188     157     128      98      83
       49           UI      82      46      33      32      32      32      32      32       0       0
       50           ZW                C=FLOW
                   *
1                                                HEC-1 INPUT                                                    PAGE  2

      LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

       51           KK     P1A   BASIN
       52           KM        Compute runoff from subbasin P1A
       53           BA   0.521
       54           LG    0.25    0.35    4.10    0.46       8
       55           UI      57     126     281     397     526     574     363     312     260     218
       56           UI     172     140     121      94      73      62      49      43      30      28
       57           UI      28      11      11      11      11      11      11      11       0       0
       58           ZW                C=FLOW
                   *

       59           KK     Q1A   BASIN
       60           KM        Compute runoff from subbasin Q1A
       61           BA   1.420
       62           LG    0.25    0.35    4.15    0.44       5
       63           UI     108     109     333     512     697     807     981    1264     819     672
       64           UI     609     536     480     430     356     297     266     243     211     177
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          65          UI     138     129     119      96      83      84      53      52      54      52
          66          UI      26      21      21      21      21      20      21      21      21      20
          67          UI       0       0       0       0       0       0       0       0       0       0
          68          ZW                  C=FLOW
          69          ZZ
1
                SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    43          N1
                 .
                 .
    51           .         P1A
                 .           .
                 .           .
    59           .           .         Q1A

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*************************************                                    *************************************
*                                   *                                    *                                   *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                *   U.S. ARMY CORPS OF ENGINEERS    *
*              JUN   1998           *                                   *   HYDROLOGIC ENGINEERING CENTER   *
*           VERSION 4.1             *                                   *         609 SECOND STREET         *
*                                   *                                   *      DAVIS, CALIFORNIA 95616      *
*  RUN DATE   01OCT07  TIME  09:40:25   *                               *          (916) 756-1104           *
*                                   *                                   *                                   *
*************************************                                    *************************************
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                    HYDROLOGY FOR FAN SYSTEM 7, 8, 12

                    FCD 2005C024
                    APPROXIMATE METHOD ALLUVIAL FAN FLOODPLAIN DELINEATION STUDY

                    JE FULLER / HYDROLOGY & GEOMORPHOLOGY, INC.
                    MODELER: DAVID MEYER
                    FILENAME: F78126.DAT

                    100-YEAR 24-HOUR MODEL
                    EXISTING CONDITIONS
                            MODELED AREA = 3.492 SQ. MILES

                    GREEN-AMPT LOSS METHOD

                    S-GRAPH UNIT HYDROGRAPHS
                      - MOUNTAIN
                      - DESERT/RANGELAND

                    NORMAL-DEPTH CHANNEL ROUTING

                    LAND USE DATA FROM EXAMINATION OF SLOPE FROM 10-FT DTM TO DISTINGUISH
                      - UNDEVELOPED DESERT RANGELAND (NDR) - SLOPES < 5 %
                      - HILLSLOPES, SONORAN DESERT (NHS) - SLOPES 5 - 10 %
                      - MOUNTAIN TERRAIN (NMT) - SLOPES > 10 %

                    SOILS DATA FROM FCDMC GIS DATABASE (RECEIVED FROM FCDMC JULY 2005)

  30 IO         OUTPUT CONTROL VARIABLES
                      IPRNT          3  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

  29 IN         TIME DATA FOR INPUT TIME SERIES
                      JXMIN         15  TIME INTERVAL IN MINUTES
                     JXDATE     1JAN99  STARTING DATE
                     JXTIME       1200  STARTING TIME

     IT         HYDROGRAPH TIME DATA
                       NMIN          5  MINUTES IN COMPUTATION INTERVAL
                      IDATE     1JAN99  STARTING DATE
                      ITIME       1200  STARTING TIME
                         NQ       2000  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE     8JAN99  ENDING DATE
                     NDTIME       1035  ENDING TIME
                     ICENT         19  CENTURY MARK

                  COMPUTATION INTERVAL     .08 HOURS
                       TOTAL TIME BASE  166.58 HOURS

          ENGLISH UNITS
               DRAINAGE AREA         SQUARE MILES
               PRECIPITATION DEPTH   INCHES
               LENGTH, ELEVATION     FEET
               FLOW                  CUBIC FEET PER SECOND
               STORAGE VOLUME        ACRE-FEET
               SURFACE AREA          ACRES
               TEMPERATURE           DEGREES FAHRENHEIT

  31 JD         INDEX STORM NO. 1
                      STRM       4.20  PRECIPITATION DEPTH
                      TRDA        .10  TRANSPOSITION DRAINAGE AREA

  32 PI           PRECIPITATION PATTERN
                     .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                     .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                     .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                     .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                     .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                     .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                     .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                     .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                     .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                     .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                     .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
                     .00       .00       .00       .00       .00       .00       .00       .01       .00       .01
                     .01       .01       .01       .01       .01       .01       .01       .01       .03       .03
                     .03       .09       .09       .09       .01       .01       .01       .01       .01       .01
```

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                    .01      .01      .01      .01      .01      .01      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00

 42 JD          INDEX STORM NO. 2
                     STRM        3.99  PRECIPITATION DEPTH
                     TRDA       10.00  TRANSPOSITION DRAINAGE AREA

  0 PI            PRECIPITATION PATTERN
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .01      .00      .01
                    .01      .01      .01      .01      .01      .01      .01      .01      .03      .03
                    .03      .09      .09      .09      .01      .01      .01      .01      .01      .01
                    .01      .01      .01      .01      .01      .01      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
                    .00      .00      .00      .00      .00      .00      .00      .00

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
 43 KK      *        N1  *        BASIN
            *            *
            **************
                                Compute runoff from subbasin N1

              SUBBASIN RUNOFF DATA

 45 BA          SUBBASIN CHARACTERISTICS
                      TAREA        1.55  SUBBASIN AREA

 46 LG          GREEN AND AMPT LOSS RATE
                      STRTL         .29  STARTING LOSS
                        DTH         .35  MOISTURE DEFICIT
                       PSIF        4.10  WETTING FRONT SUCTION
                      XKSAT         .46  HYDRAULIC CONDUCTIVITY
                      RTIMP        4.00  PERCENT IMPERVIOUS AREA

 44 UI          INPUT UNITGRAPH,  28 ORDINATES,  VOLUME = 1.00
                    167.0     360.0     818.0    1147.0    1504.0    1739.0    1094.0     928.0     788.0     652.0
                    524.0     414.0     367.0     295.0     215.0     188.0     157.0     128.0      98.0      83.0
                     82.0      46.0      33.0      32.0      32.0      32.0      32.0      32.0
                                                                      ***

     ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION       N1
                    TRANSPOSITION AREA       .1 SQ MI

    TOTAL RAINFALL =    4.20, TOTAL LOSS =    3.00, TOTAL EXCESS =    1.20

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                         (CFS)
+    1524.     12.25                192.         50.         17.           7.
                       (INCHES)    1.151       1.200       1.200       1.200
                       (AC-FT)      95.         99.         99.         99.

                       CUMULATIVE AREA =    1.55 SQ MI

     ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION       N1
                    TRANSPOSITION AREA     10.0 SQ MI

    TOTAL RAINFALL =    3.99, TOTAL LOSS =    2.88, TOTAL EXCESS =    1.11

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                         (CFS)
+    1404.     12.25                176.         46.         15.           7.
                       (INCHES)    1.056       1.102       1.103       1.103
                       (AC-FT)      87.         91.         91.         91.
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                    CUMULATIVE AREA =    1.55 SQ MI

   -----DSS---ZOPEN:  Existing File Opened,  File: F781224.DSS
                      Unit:  71;  DSS Version: 6-JG
 -----DSS---ZWRITE Unit  71; Vers.    4:  //N1/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    4:  //N1/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    4:  //N1/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    4:  //N1/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    4:  //N1/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    4:  //N1/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    4:  //N1/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    4:  //N1/FLOW/08JAN1999/5MIN//
      ***            ***            ***            ***            ***


                    INTERPOLATED HYDROGRAPH AT       N1

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1453.     12.25                183.         48.         16.           7.
                       (INCHES)    1.095      1.142       1.142       1.142
                        (AC-FT)     91.         94.         94.         94.

                    CUMULATIVE AREA =    1.55 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
  51 KK     *      P1A   *        BASIN
            *            *
            **************
                              Compute runoff from subbasin P1A

               SUBBASIN RUNOFF DATA

  53 BA          SUBBASIN CHARACTERISTICS
                      TAREA         .52  SUBBASIN AREA

  54 LG          GREEN AND AMPT LOSS RATE
                      STRTL         .25  STARTING LOSS
                        DTH         .35  MOISTURE DEFICIT
                       PSIF        4.10  WETTING FRONT SUCTION
                      XKSAT         .46  HYDRAULIC CONDUCTIVITY
                      RTIMP        8.00  PERCENT IMPERVIOUS AREA

  52 UI          INPUT UNITGRAPH,  28 ORDINATES,  VOLUME = 1.00
                      57.0     126.0     281.0     397.0     526.0     574.0     363.0     312.0     260.0     218.0
                     172.0     140.0     121.0      94.0      73.0      62.0      49.0      43.0      30.0      28.0
                      28.0      11.0      11.0      11.0      11.0      11.0      11.0      11.0
                                                                                  ***
      ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION      P1A
                    TRANSPOSITION AREA       .1 SQ MI

    TOTAL RAINFALL =    4.20, TOTAL LOSS =    2.86, TOTAL EXCESS =    1.34

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     532.     12.25                 69.         19.          6.           3.
                       (INCHES)    1.236      1.333       1.334       1.334
                        (AC-FT)     34.         37.         37.         37.

                    CUMULATIVE AREA =     .52 SQ MI

      ***            ***            ***            ***            ***

                      HYDROGRAPH AT STATION      P1A
                    TRANSPOSITION AREA     10.0 SQ MI

    TOTAL RAINFALL =    3.99, TOTAL LOSS =    2.76, TOTAL EXCESS =    1.23

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     492.     12.25                 64.         17.          6.           2.
                       (INCHES)    1.140      1.232       1.233       1.233
                        (AC-FT)     32.         34.         34.         34.

                    CUMULATIVE AREA =     .52 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.    4:  //P1A/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    4:  //P1A/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    4:  //P1A/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    4:  //P1A/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    4:  //P1A/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    4:  //P1A/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    4:  //P1A/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    4:  //P1A/FLOW/08JAN1999/5MIN//
      ***            ***            ***            ***            ***


                    INTERPOLATED HYDROGRAPH AT      P1A

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+     518.     12.25                 67.         18.          6.           3.
```

```
                    (INCHES)     1.202       1.297       1.298       1.298
                     (AC-FT)      33.         36.         36.         36.

                    CUMULATIVE AREA =     .52 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
  59 KK     *     Q1A    *        BASIN
            *            *
            **************
                              Compute runoff from subbasin Q1A

              SUBBASIN RUNOFF DATA

  61 BA         SUBBASIN CHARACTERISTICS
                      TAREA        1.42  SUBBASIN AREA

  62 LG         GREEN AND AMPT LOSS RATE
                      STRTL         .25  STARTING LOSS
                        DTH         .35  MOISTURE DEFICIT
                       PSIF        4.15  WETTING FRONT SUCTION
                      XKSAT         .44  HYDRAULIC CONDUCTIVITY
                      RTIMP        5.00  PERCENT IMPERVIOUS AREA

  60 UI         INPUT UNITGRAPH,  40 ORDINATES,  VOLUME = 1.00
                    108.0     109.0     333.0     512.0     697.0     807.0     981.0    1264.0     819.0     672.0
                    609.0     536.0     480.0     430.0     356.0     297.0     266.0     243.0     211.0     177.0
                    138.0     129.0     119.0      96.0      83.0      84.0      53.0      52.0      54.0      52.0
                     26.0      21.0      21.0      21.0      21.0      20.0      21.0      21.0      21.0      20.0

                                                                                  ***

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION      Q1A
                      TRANSPOSITION AREA       .1 SQ MI

    TOTAL RAINFALL =    4.20, TOTAL LOSS =    2.94, TOTAL EXCESS =    1.26

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1098.     12.42                182.         48.         16.          7.
                      (INCHES)     1.195       1.256       1.256       1.256
                       (AC-FT)      90.         95.         95.         95.

                      CUMULATIVE AREA =    1.42 SQ MI

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION      Q1A
                      TRANSPOSITION AREA     10.0 SQ MI

    TOTAL RAINFALL =    3.99, TOTAL LOSS =    2.83, TOTAL EXCESS =    1.16

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1014.     12.42                168.         44.         15.          6.
                      (INCHES)     1.100       1.158       1.159       1.159
                       (AC-FT)      83.         88.         88.         88.

                      CUMULATIVE AREA =    1.42 SQ MI

 -----DSS---ZWRITE Unit  71; Vers.    4:  //Q1A/FLOW/01JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    4:  //Q1A/FLOW/02JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    4:  //Q1A/FLOW/03JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    4:  //Q1A/FLOW/04JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    4:  //Q1A/FLOW/05JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    4:  //Q1A/FLOW/06JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    4:  //Q1A/FLOW/07JAN1999/5MIN//
 -----DSS---ZWRITE Unit  71; Vers.    4:  //Q1A/FLOW/08JAN1999/5MIN//
      ***             ***             ***             ***             ***


                      INTERPOLATED HYDROGRAPH AT      Q1A

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR    166.58-HR
+   (CFS)       (HR)
                          (CFS)
+    1050.     12.42                174.         46.         15.          7.
                      (INCHES)     1.140       1.199       1.200       1.200
                       (AC-FT)      86.         91.         91.         91.

                      CUMULATIVE AREA =    1.42 SQ MI

1
                                                RUNOFF SUMMARY
                                          FLOW IN CUBIC FEET PER SECOND
                                       TIME IN HOURS,  AREA IN SQUARE MILES

                                     PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN     MAXIMUM     TIME OF
          OPERATION       STATION    FLOW    PEAK                                          AREA      STAGE     MAX STAGE
+                                                          6-HOUR     24-HOUR     72-HOUR
          HYDROGRAPH AT
+                           N1       1453.   12.25         183.         48.         16.      1.55
          HYDROGRAPH AT
+                          P1A        518.   12.25          67.         18.          6.       .52
          HYDROGRAPH AT
+                          Q1A       1050.   12.42         174.         46.         15.      1.42
```

```
*** NORMAL END OF HEC-1 ***


  -----DSS---ZCLOSE Unit:  71,   File: F781224.DSS
             Pointer Utilization:    .31
             Number of Records:     136
             File Size:     241.5  Kbytes
             Percent Inactive:     .0
```

Appendix E

Hydraulic Analysis Supporting Documentation

E.1 Roughness Coefficient Estimation

E.2 Cross Section Plots

E.3 Detailed HEC-RAS Output

E.1 Roughness Coefficient Estimation

Preface

The following describes the evaluation of Manning's roughness coefficients for this floodplain delineation study.

1. Introduction

JE Fuller/Hydrology & Geomorphology, Inc., (JEF), performed field reconnaissance along 3 selected water courses studies during July 2007. The reconnaissance was performed to document channel and overbank conditions for the purpose of determining Manning's Roughness Coefficient for the selected 3 water courses throughout the study area.

2. Manning's "n" Values

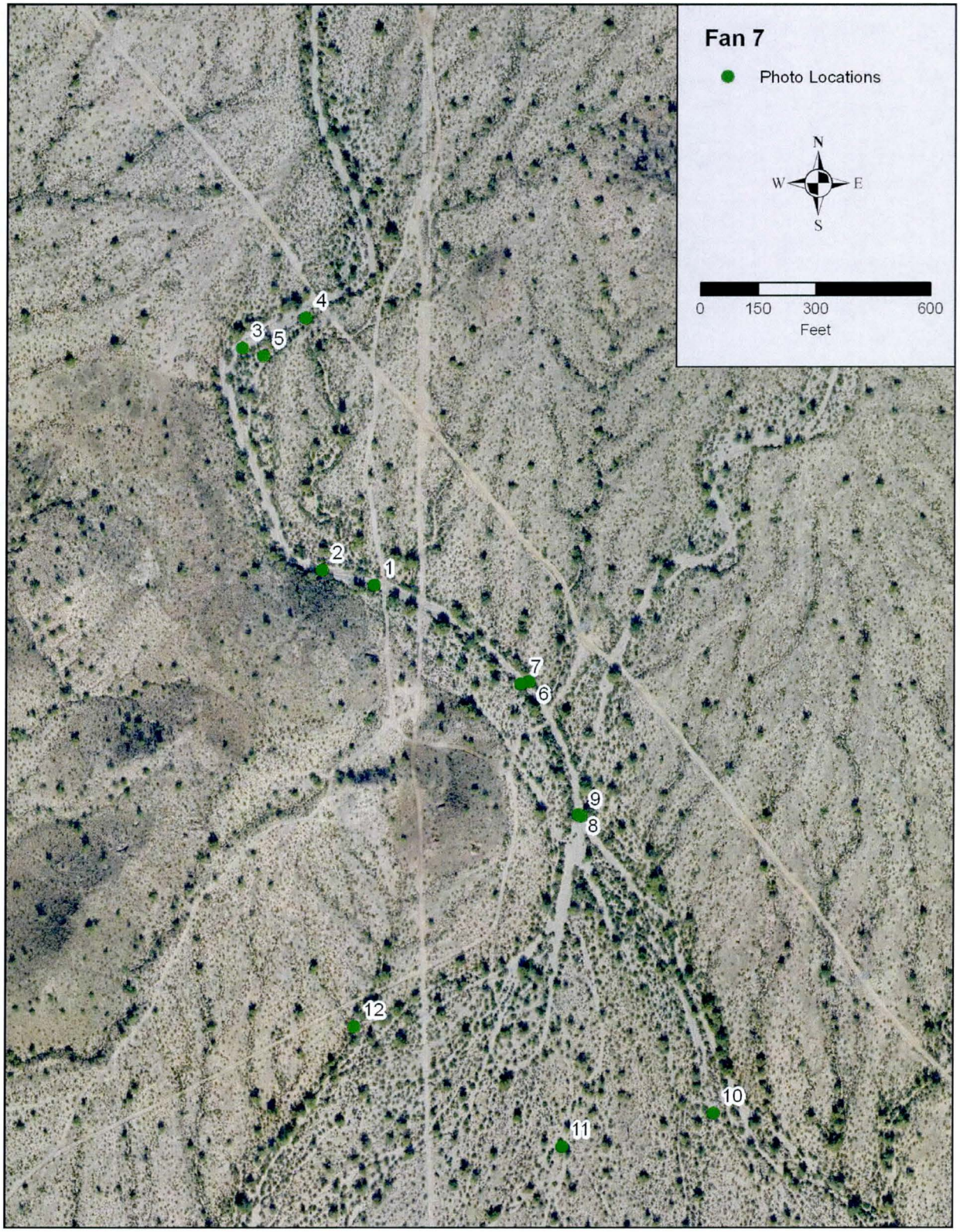
Manning's "n" values were determined using the methodology outlined in the USGS report titled, "Selection of Manning's Roughness Coefficient for Natural and Constructed Vegetated and Non-Vegetated Channels, and Vegetation Maintenance Plan Guidelines for Vegetated Channels in Central Arizona" by J.V Phillips and S. Tadoyon (2006). Reach designations were assigned based on distinctions in general channel morphology, vegetation, and channel and overbank soil characteristics.

On the following pages, photographs showing typical reach conditions are preceded by the worksheet used to determine the reach-average Manning's "n" values for the reach depicted in the photographs. Figures E.1, E.2 and E.3 illustrate field reconnaissance photo locations as well as the study reaches. References to left bank and right bank associated with a downstream viewing orientation.

DETERMINATION OF MANNING'S ROUGHNESS COEFFICIENTS BY FCDMC METHOD

Project: Alluvial Fan Floodplain Delineation Study—Fan 7, 8 & 12
Location: **Fan 7**

Channel Conditions		Manning's n Adjustment		Left Overbank	Main Channel	Right Overbank
Channel Bed Material	Concrete	n0	0.012-0.018			
	Rock Cut		0.025			
	Firm Soil		0.025-0.032			
	Fine Sand		0.023-0.036			
	Coarse Sand		0.026-0.035		0.026	
	Gravel		0.028-0.035	0.028		0.028
	Cobble		0.030-0.050			
	Boulder		0.040-0.070			
Degree of Irregularity	Smooth	n1	0			
	Minor		0.001-0.005	0.002	0.002	0.002
	Moderate		0.006-0.010			
	Severe		0.011-0.020			
Effects of Obstructions	Negligible	n2	0.000-0.004			
	Minor		0.005-0.015		0.005	
	Appreciable		0.020-0.030	0.020		0.020
	Severe		0.040-0.060			
Vegetation	Small	n3	0.002-0.010		0.002	
	Medium		0.010-0.025	0.010		0.010
	Large		0.025-0.050			
	Very Large		0.050-0.100			
Variations in the Channel Cross Section	Gradual	n4	0	0	0	0
	Alternating (occasionally)		0.001-0.005			
	Alternating (frequently)		0.010-0.015			
Degree of Meandering	Minor	m	1	1	1	1
	Appreciable		1.15			
	Severe		1.3			
n=(n0+n1+n2+n3+n4)m				0.06	0.035	0.06
			Use	**0.06**	**0.035**	**0.06**



Fan 7 Photo Location Map

Photo 1: Looking Upstream

Photo 2: Looking Upstream

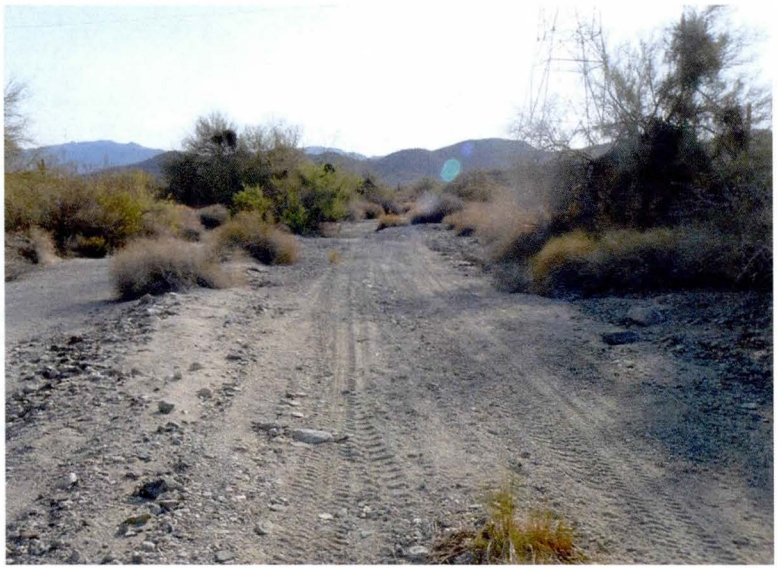


Photo 3: Looking Upstream

Photo 4: Left Overbank

Photo 5: Looking Downstream

Photo 6: Looking at Right Bank

Photo 7: Looking at Left Bank

Photo 8: At Apex Looking Downstream

Photo 9: At Apex Looking Downstream at Right Bank

Photo 10: Looking Downstream at Floodplain

Photo 11: Looking East at Floodplain

Photo 12: Looking West at Floodplain

DETERMINATION OF MANNING'S ROUGHNESS COEFFICIENTS BY FCDMC METHOD

Project: Alluvial Fan Floodplain Delineation Study – Fan 7, 8 & 12
Location: **Fan 8**

Channel Conditions		Manning's n Adjustment		Left Overbank	Main Channel	Right Overbank
Channel Bed Material	Concrete	n0	0.012-0.018			
	Rock Cut		0.025			
	Firm Soil		0.025-0.032			
	Fine Sand		0.023-0.036			
	Coarse Sand		0.026-0.035			
	Gravel		0.028-0.035		0.028	0.028
	Cobble		0.030-0.050	0.040		
	Boulder		0.040-0.070			
Degree of Irregularity	Smooth	n1	0			
	Minor		0.001-0.005	0.002	0.002	0.002
	Moderate		0.006-0.010			
	Severe		0.011-0.020			
Effects of Obstructions	Negligible	n2	0.000-0.004			
	Minor		0.005-0.015		0.010	
	Appreciable		0.020-0.030	0.025		0.020
	Severe		0.040-0.060			
Vegetation	Small	n3	0.002-0.010		0.002	0.010
	Medium		0.010-0.025	0.015		
	Large		0.025-0.050			
	Very Large		0.050-0.100			
Variations in the Channel Cross Section	Gradual	n4	0	0	0	0
	Alternating (occasionally)		0.001-0.005			
	Alternating (frequently)		0.010-0.015			
Degree of Meandering	Minor	m	1	1	1	1
	Appreciable		1.15			
	Severe		1.3			
n=(n0+n1+n2+n3+n4)m				0.082	0.042	0.060
			Use	**0.082**	**0.042**	**0.060**

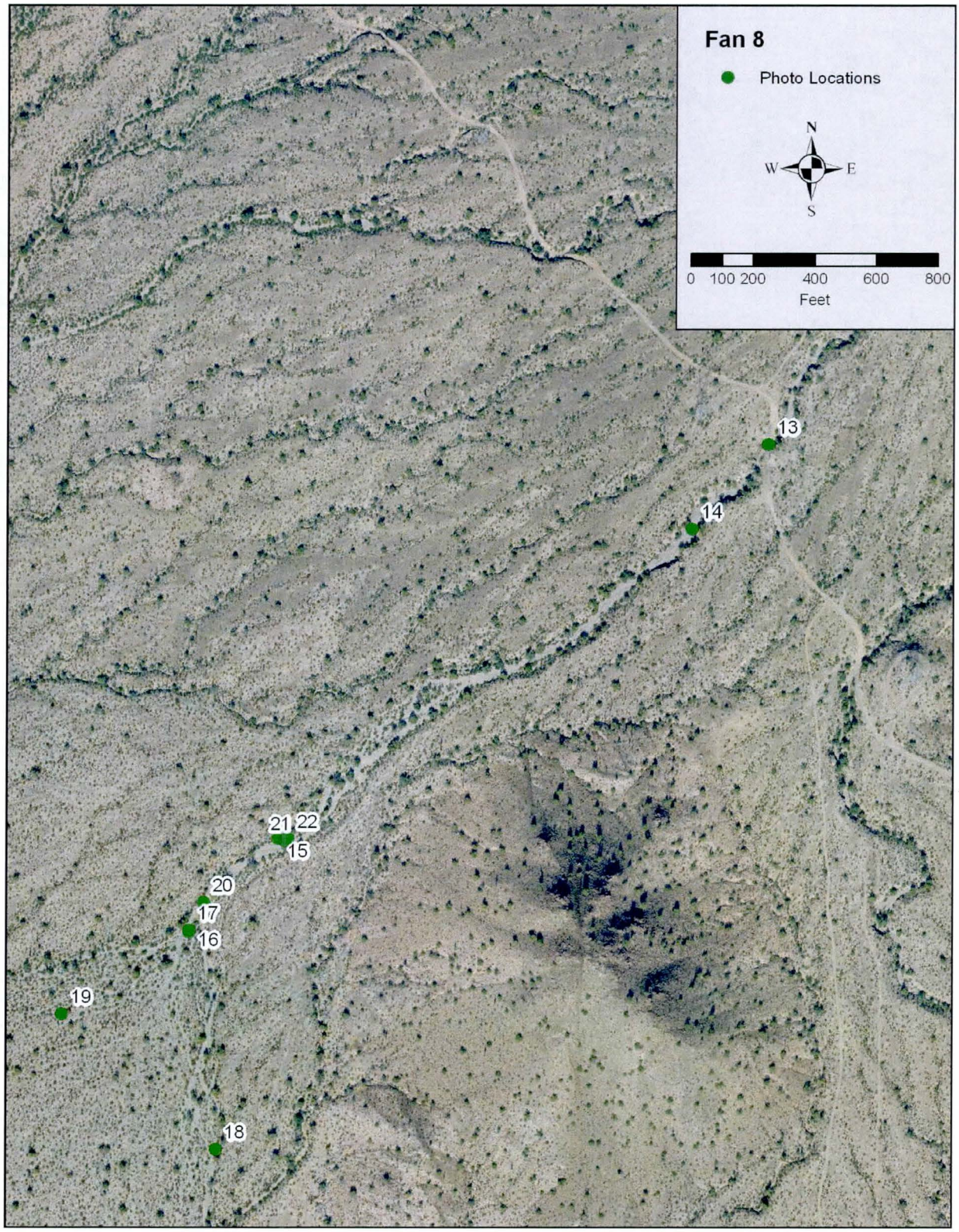

Fan 8
Photo Locations
N
W
E
S
0 100 200 400 600 800
Feet
13
14
21
22
15
20
17
16
19
18

Photo 13: Looking Downstream

Photo 14: Looking Downstream at Left Bank

Photo 15: Looking Downstream

Photo 16:Looking south-east

Photo 17: Looking south-west

Photo 18: Looking Downstream

Photo 19: Looking north-west

Photo 20:Looking north

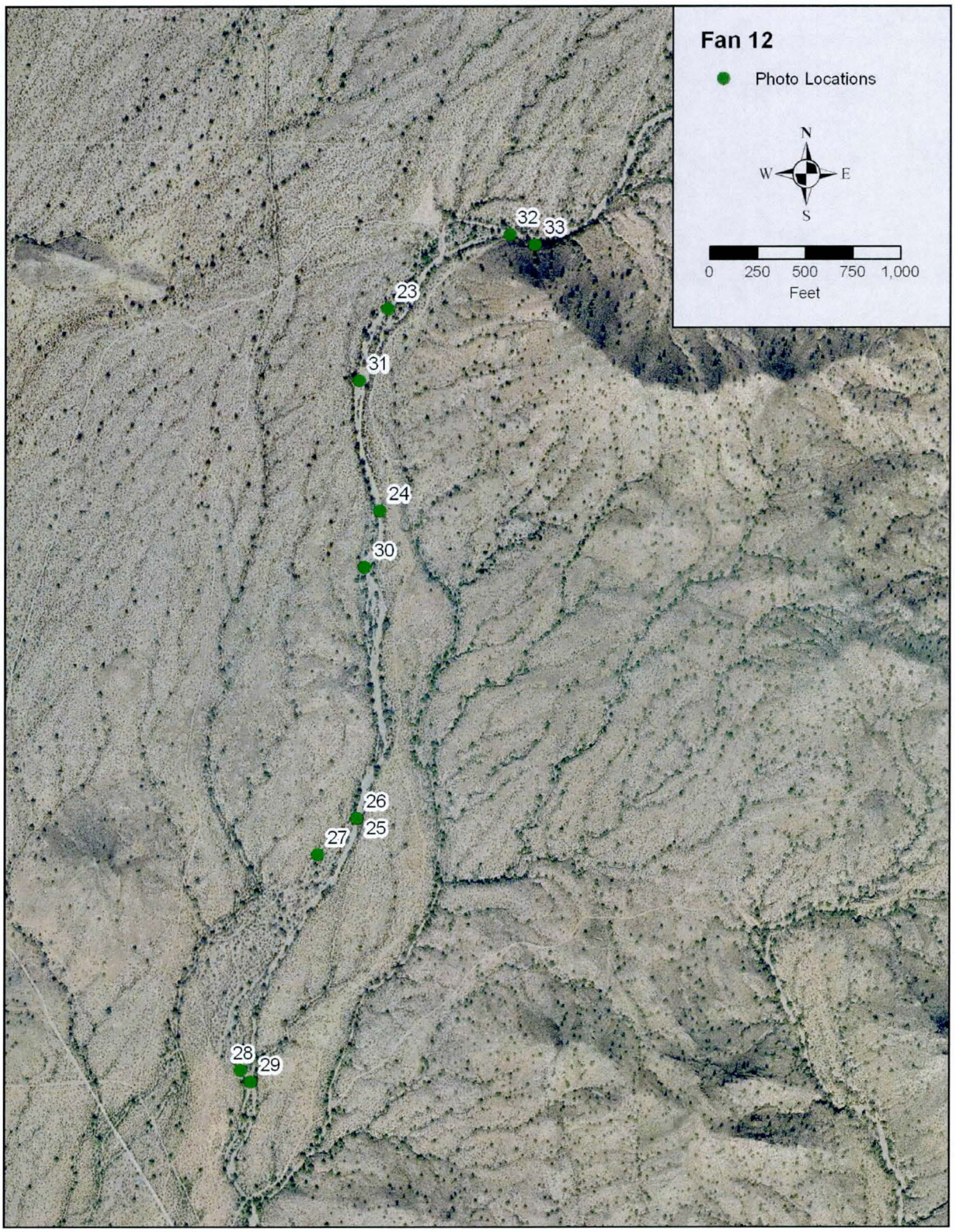
Photo 21: Looking at Left Bank

Photo 22: Looking at Right Bank

DETERMINATION OF MANNING'S ROUGHNESS COEFFICIENTS BY FCDMC METHOD

Project: Alluvial Fan Floodplain Delineation Study – Fan 7, 8 & 12
Location: **Fan 12**

Channel Conditions		Manning's n Adjustment		Left Overbank	Main Channel	Right Overbank
Channel Bed Material	Concrete	n0	0.012-0.018			
	Rock Cut		0.025			
	Firm Soil		0.025-0.032			
	Fine Sand		0.023-0.036			
	Coarse Sand		0.026-0.035		0.026	
	Gravel		0.028-0.035	0.028		0.028
	Cobble		0.030-0.050			
	Boulder		0.040-0.070			
Degree of Irregularity	Smooth	n1	0			
	Minor		0.001-0.005	0.002	0.002	0.002
	Moderate		0.006-0.010			
	Severe		0.011-0.020			
Effects of Obstructions	Negligible	n2	0.000-0.004			
	Minor		0.005-0.015		0.010	
	Appreciable		0.020-0.030	0.020		0.020
	Severe		0.040-0.060			
Vegetation	Small	n3	0.002-0.010		0.005	
	Medium		0.010-0.025	0.010		0.010
	Large		0.025-0.050			
	Very Large		0.050-0.100			
Variations in the Channel Cross Section	Gradual	n4	0	0	0	0
	Alternating (occasionally)		0.001-0.005			
	Alternating (frequently)		0.010-0.015			
Degree of Meandering	Minor	m	1	1	1	1
	Appreciable		1.15			
	Severe		1.3			
n=(n0+n1+n2+n3+n4)m				0.060	0.043	0.060
			Use	**0.060**	**0.043**	**0.060**



Fan 12 Photo Location Map

Photo 23: Looking Downstream

Photo 24: Looking Downstream

Photo 25: Looking Downstream

Photo 26: Looking Downstream at Right Bank

Photo 27: Looking north-west

Photo 28: Looking south-east

Photo 29: Looking Downstream

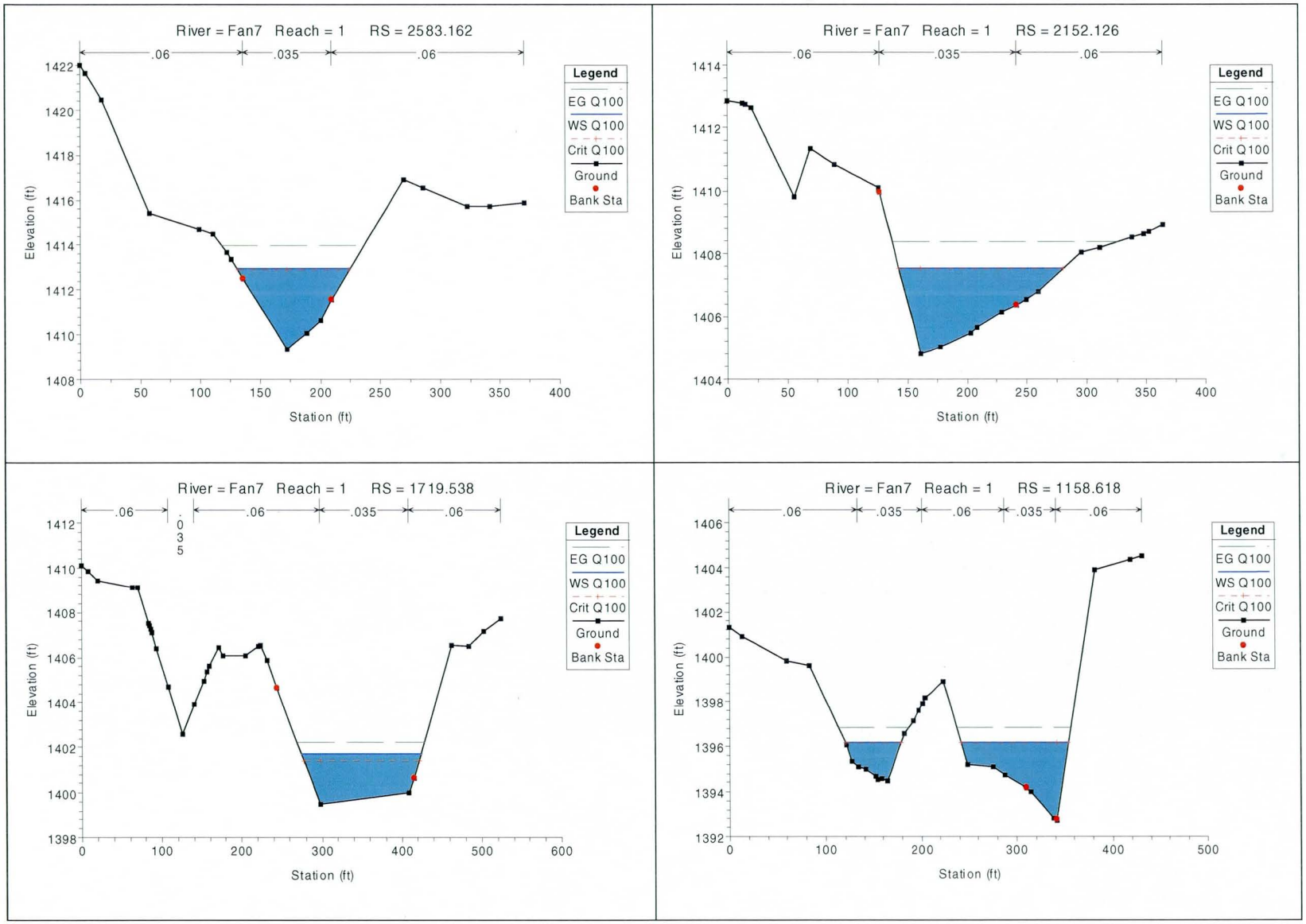
Photo 30: Looking Upstream

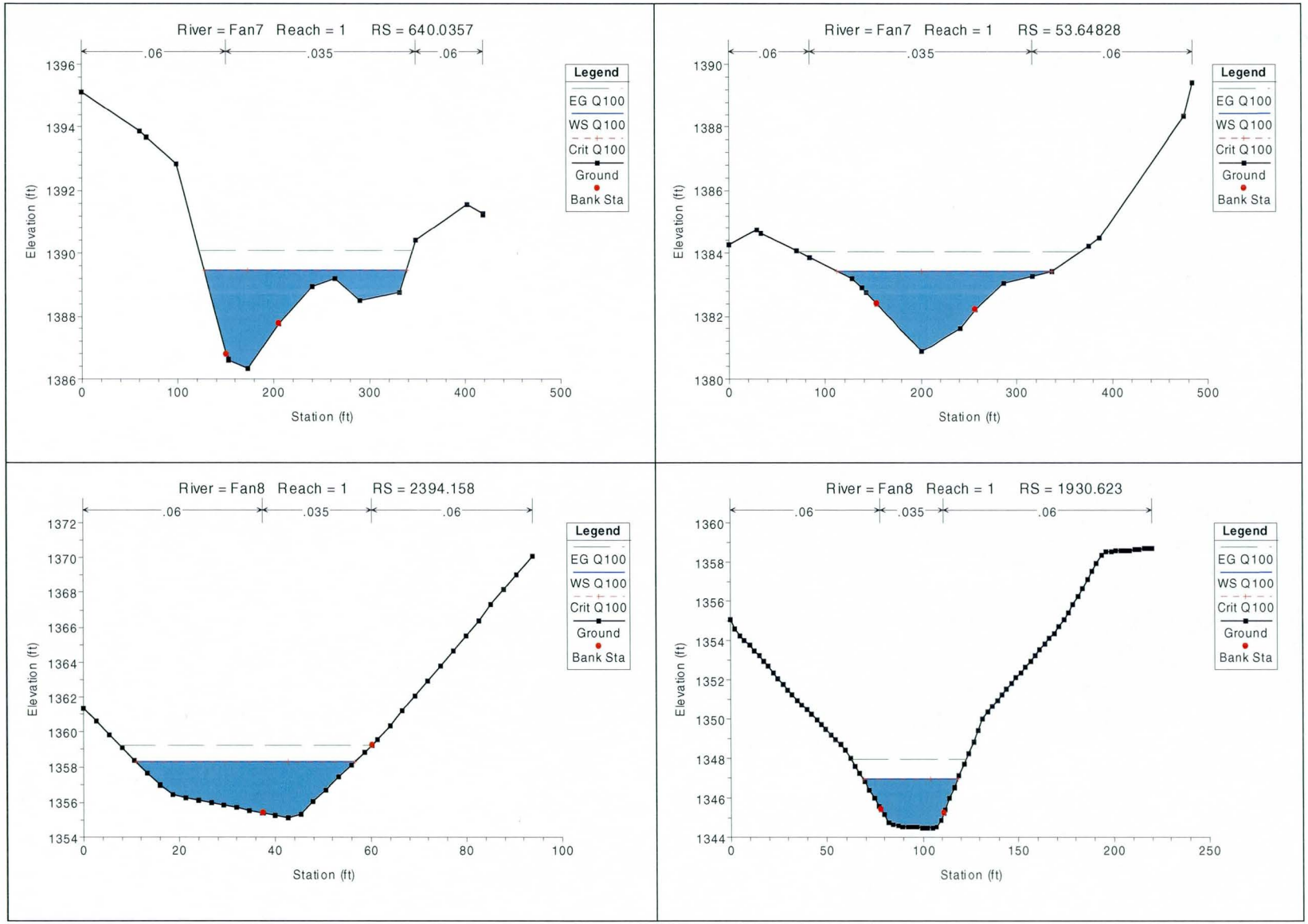
Photo 31: Looking Downstream

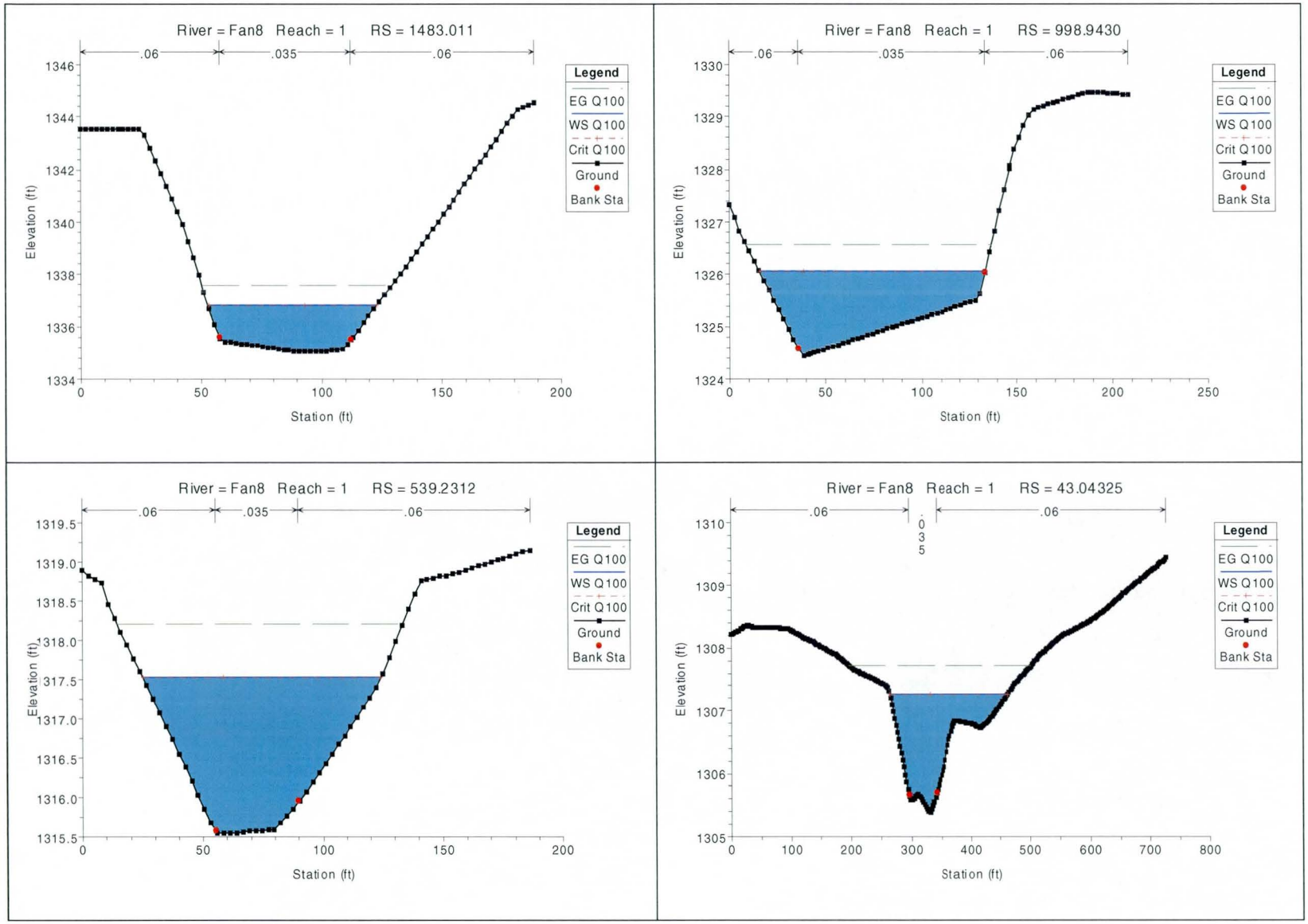
Photo 32: Looking at Left Bank

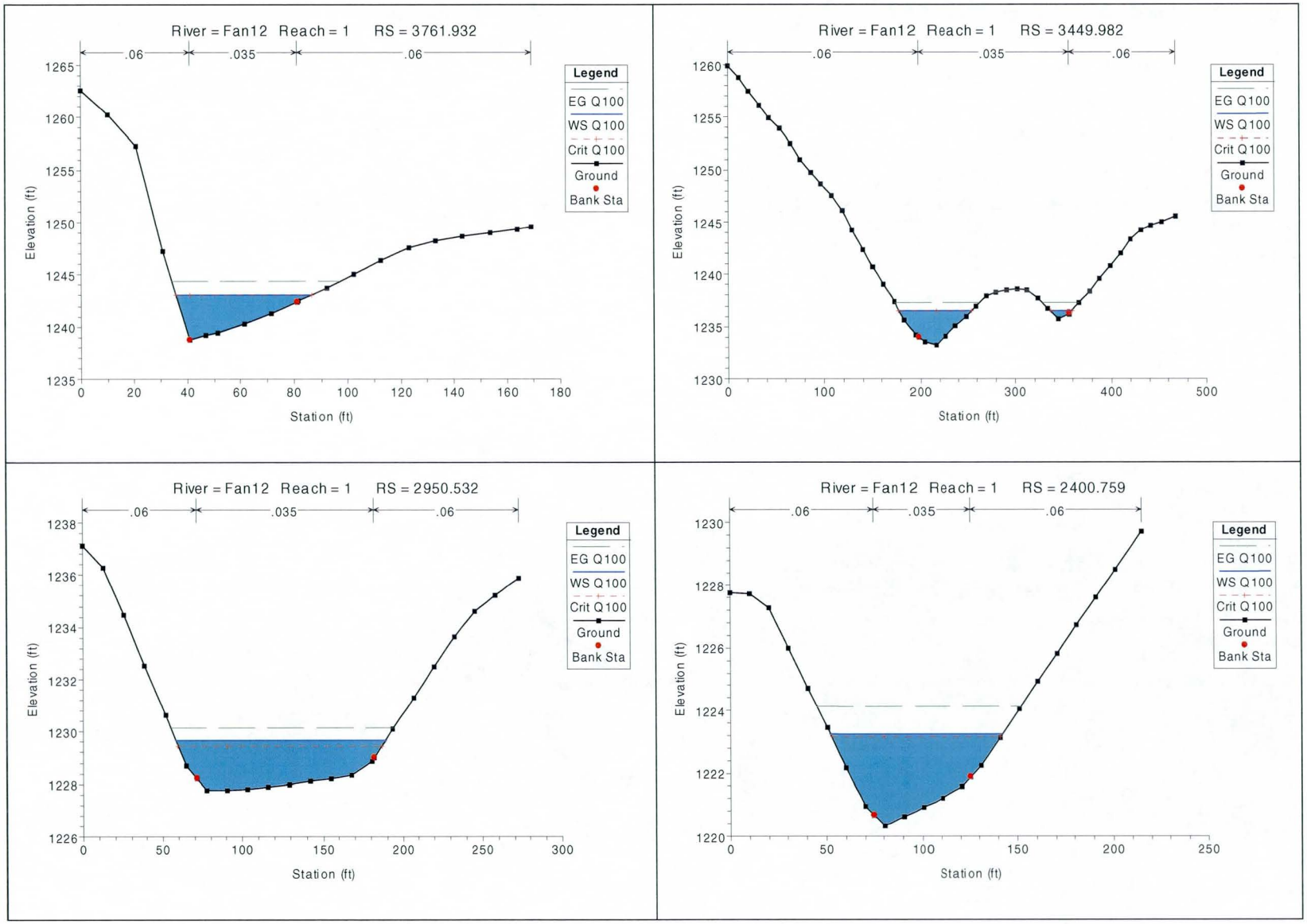
Photo 33. Look at Left Bank Bedrock

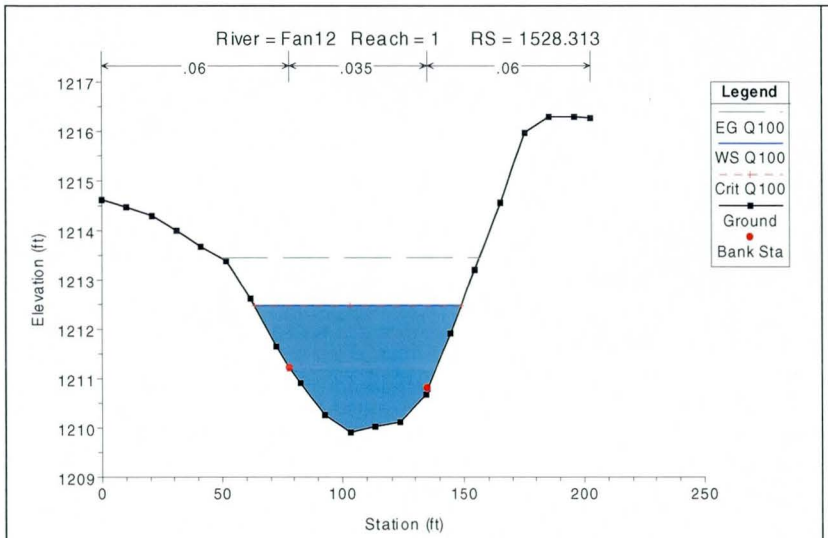
E.2 Cross Section Plots


River = Fan7 Reach = 1 RS = 2583.162
.06
.035
.06
Legend
EG Q100
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
River = Fan7 Reach = 1 RS = 2152.126
.06
.035
.06
Legend
EG Q100
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
River = Fan7 Reach = 1 RS = 1719.538
.06
.06
.035
.06
.035
Legend
EG Q100
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
River = Fan7 Reach = 1 RS = 1158.618
.06
.035
.06
.035
.06
Legend
EG Q100
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)


River = Fan7 Reach = 1 RS = 640.0357
.06
.035
.06
Legend
EG Q100
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
River = Fan7 Reach = 1 RS = 53.64828
.06
.035
.06
Legend
EG Q100
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
River = Fan8 Reach = 1 RS = 2394.158
.06
.035
.06
Legend
EG Q100
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
River = Fan8 Reach = 1 RS = 1930.623
.06
.035
.06
Legend
EG Q100
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)


River = Fan8 Reach = 1 RS = 1483.011
.06
.035
.06
Elevation (ft)
Station (ft)
Legend
EG Q100
WS Q100
Crit Q100
Ground
Bank Sta
River = Fan8 Reach = 1 RS = 998.9430
.06
.035
.06
Elevation (ft)
Station (ft)
Legend
EG Q100
WS Q100
Crit Q100
Ground
Bank Sta
River = Fan8 Reach = 1 RS = 539.2312
.06
.035
.06
Elevation (ft)
Station (ft)
Legend
EG Q100
WS Q100
Crit Q100
Ground
Bank Sta
River = Fan8 Reach = 1 RS = 43.04325
.06
.035
.06
Elevation (ft)
Station (ft)
Legend
EG Q100
WS Q100
Crit Q100
Ground
Bank Sta


River = Fan12 Reach = 1 RS = 3761.932
.06
.035
.06
Legend
EG Q100
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
River = Fan12 Reach = 1 RS = 3449.982
.06
.035
.06
Legend
EG Q100
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
River = Fan12 Reach = 1 RS = 2950.532
.06
.035
.06
Legend
EG Q100
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
River = Fan12 Reach = 1 RS = 2400.759
.06
.035
.06
Legend
EG Q100
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)


River = Fan12 Reach = 1 RS = 1528.313
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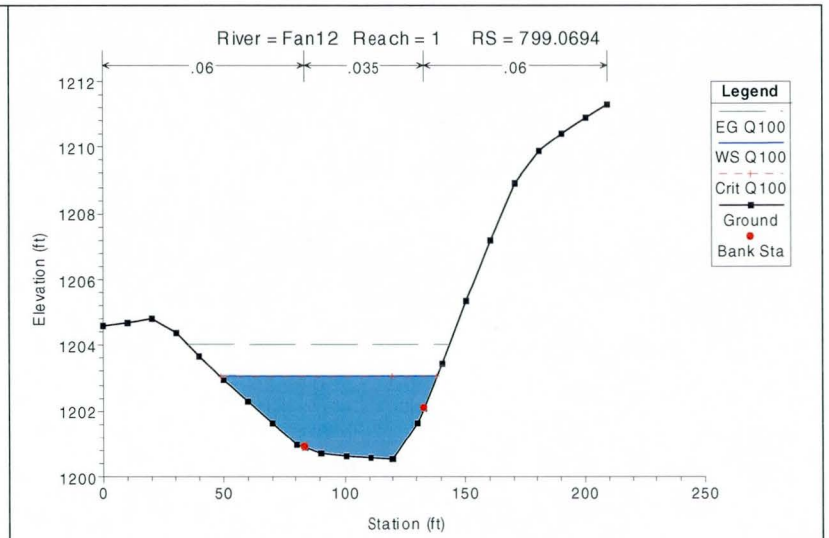
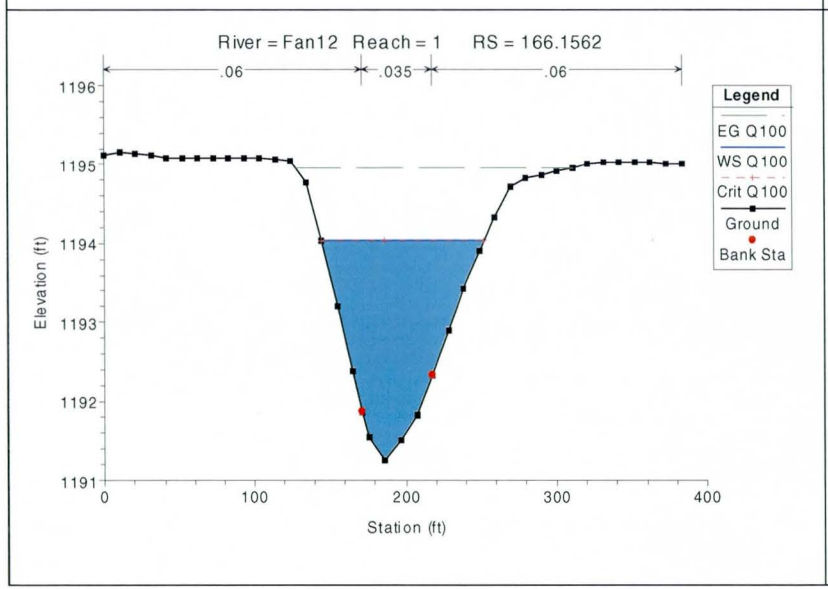
.035
.06
Legend
EG Q100
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)


River = Fan12 Reach = 1 RS = 799.0694
.06
.035
.06
Legend
EG Q100
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)


River = Fan12 Reach = 1 RS = 166.1562
.06
.035
.06
Legend
EG Q100
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)

E.3 Detailed HEC-RAS Output

```
                    HEC-RAS Version 3.1.3 May 2005
                     U.S. Army Corp of Engineers
                    Hydrologic Engineering Center
                          609 Second Street
                          Davis, California

          X     X  XXXXXX    XXXX        XXXX       XX      XXXX
          X     X  X        X    X       X   X     X  X    X
          X     X  X        X            X   X    X    X   X
          XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
          X     X  X        X            X  X     X    X        X
          X     X  X        X    X       X   X    X    X        X
          X     X  XXXXXX    XXXX        X    X   X    X   XXXXX


PROJECT DATA
Project Title: Fan7-8-12
Project File : Fan7_8_12.prj
Run Date and Time: 10/1/2007 9:48:31 AM

Project in English units

Project Description:
Approximate Zone A Floodplain Delineation Study for select washes on the White
Tank Mountains upstream of the alluvial fan apecies.  This study was performed
under contract to the Flood Control Disctrict of Maricopa County (2005C024), by
JE Fuller Hydrology & Geomorphology, Inc., in Sept, 2007.  This model was
developed in HEC-RAS v3.1.3 (May 2005), Based on 1"=500', 10' contour interval
topographic mapping provided by FCDMC, Flown by Landata Airborne Systems,
Flight Date = December 2000, vertical datum = NAVD88, horizontal projection =
NAD83.  Discharges are from HEC-1 modeling produced from this same contract by
JEF, Inc.  Starting water surface elevation determined using normal depth
proceedures.  This run assumes sub-critical flow conditions.


PLAN DATA

Plan Title: Fan7
Plan File : x:\projects\Agency\FCDMC\2005C024\Assignment8WTFans\hec-ras\Fan7_8_12.p01

          Geometry Title: Fan7
          Geometry File : x:\projects\Agency\FCDMC\2005C024\Assignment8WTFans\hec-ras\Fan7_8_12.g01

          Flow Title    : Fan7
          Flow File     : x:\projects\Agency\FCDMC\2005C024\Assignment8WTFans\hec-ras\Fan7_8_12.f01

Plan Summary Information:
Number of:  Cross Sections =    6    Multiple Openings  =    0
            Culverts       =    0    Inline Structures  =    0
            Bridges        =    0    Lateral Structures =    0

Computational Information
    Water surface calculation tolerance  =  0.01
    Critical depth calculation tolerance =  0.01
    Maximum number of iterations         =  20
    Maximum difference tolerance         =  0.3
    Flow tolerance factor                =  0.001

Computation Options
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Subcritical Flow


FLOW DATA

Flow Title: Fan7
Flow File : x:\projects\Agency\FCDMC\2005C024\Assignment8WTFans\hec-ras\Fan7_8_12.f01

Flow Data (cfs)

  River           Reach           RS                  Q100
  Fan7            1               2583.162            1453


Boundary Conditions

  River           Reach           Profile                     Upstream                Downstream

  Fan7            1               Q100                                              Normal S = 0.012


GEOMETRY DATA

Geometry Title: Fan7
Geometry File : x:\projects\Agency\FCDMC\2005C024\Assignment8WTFans\hec-ras\Fan7_8_12.g01

CROSS SECTION


RIVER: Fan7
REACH: 1                  RS: 2583.162

INPUT
Description:
Station Elevation Data    num=      18
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0    1422    4.87 1421.65   18.01 1420.48   57.79 1415.42   98.98  1414.7
  110.71 1414.49  121.83 1413.68  125.87 1413.34  135.61  1412.5  172.22 1409.33
  188.52 1410.08  200.12  1410.6   209.1 1411.57  269.46 1416.89  285.54 1416.52
  322.37 1415.71   341.9 1415.71  370.72 1415.87

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0     .06  135.61    .035   209.1     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        135.61   209.1             452.23  431.04  433.85            .1       .3

CROSS SECTION OUTPUT  Profile #Q100

  E.G. Elev (ft)          1413.98    Element                  Left OB    Channel   Right OB
  Vel Head (ft)              1.05    Wt. n-Val.                0.060      0.035     0.060
  W.S. Elev (ft)          1412.93    Reach Len. (ft)          452.23     431.04    433.85
  Crit W.S. (ft)          1412.89    Flow Area (sq ft)          1.06     172.77     10.45
  E.G. Slope (ft/ft)     0.012207    Area (sq ft)               1.06     172.77     10.45
  Q Total (cfs)           1453.00    Flow (cfs)                 1.03    1429.93     22.04
  Top Width (ft)            93.85    Top Width (ft)             4.96      73.49     15.40
```

Vel Total (ft/s)	7.88	Avg. Vel. (ft/s)	0.98	8.28	2.11
Max Chl Dpth (ft)	3.60	Hydr. Depth (ft)	0.21	2.35	0.68
Conv. Total (cfs)	13151.3	Conv. (cfs)	9.4	12942.5	199.5
Length Wtd. (ft)	431.12	Wetted Per. (ft)	4.98	73.71	15.46
Min Ch El (ft)	1409.33	Shear (lb/sq ft)	0.16	1.79	0.52
Alpha	1.09	Stream Power (lb/ft s)	0.16	14.78	1.09
Frctn Loss (ft)	5.55	Cum Volume (acre-ft)	2.33	9.84	2.14
C & E Loss (ft)	0.06	Cum SA (acres)	2.15	4.74	2.95

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Fan7
REACH: 1 RS: 2152.126

INPUT
Description:
Station Elevation Data num= 26

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1412.86	12.55	1412.78	14.91	1412.74	19.35	1412.64	55.84	1409.81
69.21	1411.37	88.83	1410.82	125.63	1410.09	125.79	1410.09	126	1410.07
126.09	1410.05	126.64	1409.97	161.33	1404.81	178.13	1405.02	203.19	1405.47
208.81	1405.64	228.84	1406.12	241.56	1406.36	250.22	1406.54	259.52	1406.78
295.86	1408.06	310.58	1408.18	338.2	1408.52	347.54	1408.63	352.52	1408.7
364.38	1408.94								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	126.64	.035	241.56	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
126.64	241.56		432.08	432.59	454.66	.1	.3

CROSS SECTION OUTPUT Profile #Q100

E.G. Elev (ft)	1408.37	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.85	Wt. n-Val.		0.035	0.060
W.S. Elev (ft)	1407.52	Reach Len. (ft)	432.08	432.59	454.66
Crit W.S. (ft)	1407.52	Flow Area (sq ft)		185.47	24.97
E.G. Slope (ft/ft)	0.013612	Area (sq ft)		185.47	24.97
Q Total (cfs)	1453.00	Flow (cfs)		1399.35	53.65
Top Width (ft)	137.36	Top Width (ft)		98.44	38.92
Vel Total (ft/s)	6.90	Avg. Vel. (ft/s)		7.54	2.15
Max Chl Dpth (ft)	2.71	Hydr. Depth (ft)		1.88	0.64
Conv. Total (cfs)	12454.0	Conv. (cfs)		11994.2	459.9
Length Wtd. (ft)	433.05	Wetted Per. (ft)		98.65	38.94
Min Ch El (ft)	1404.81	Shear (lb/sq ft)		1.60	0.54
Alpha	1.15	Stream Power (lb/ft s)		12.05	1.17
Frctn Loss (ft)	4.62	Cum Volume (acre-ft)	2.32	8.06	1.96
C & E Loss (ft)	0.11	Cum SA (acres)	2.12	3.89	2.68

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: Fan7
REACH: 1 RS: 1719.538

INPUT
Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1410.11	7.62	1409.83	19.96	1409.42	63.82	1409.11	70.24	1409.11
83.84	1407.51	84.77	1407.4	85.86	1407.27	87.14	1407.12	93.39	1406.38
107.49	1404.68	124.92	1402.56	140.64	1403.92	152.23	1404.94	157.05	1405.37
159.77	1405.6	170.79	1406.42	176.22	1406.09	205.04	1406.06	221.79	1406.51
224.39	1406.56	232.34	1405.9	244.29	1404.63	298.14	1399.47	409.02	1400.02
415.79	1400.62	462.73	1406.53	484.47	1406.51	502.46	1407.18	524.82	1407.75

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.06	107.49	.035	140.64	.06	298.14	.035	409.02	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
244.29	415.79		543.61	560.92	579.21	.1	.3

CROSS SECTION OUTPUT Profile #Q100

E.G. Elev (ft)	1402.22	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.50	Wt. n-Val.		0.037	0.060
W.S. Elev (ft)	1401.72	Reach Len. (ft)	543.61	560.92	579.21
Crit W.S. (ft)	1401.38	Flow Area (sq ft)		254.55	4.78
E.G. Slope (ft/ft)	0.008586	Area (sq ft)		254.55	4.78
Q Total (cfs)	1453.00	Flow (cfs)		1445.68	7.32
Top Width (ft)	149.82	Top Width (ft)		141.11	8.72
Vel Total (ft/s)	5.60	Avg. Vel. (ft/s)		5.68	1.53
Max Chl Dpth (ft)	2.25	Hydr. Depth (ft)		1.80	0.55
Conv. Total (cfs)	15680.7	Conv. (cfs)		15601.6	79.0
Length Wtd. (ft)	557.56	Wetted Per. (ft)		141.24	8.79
Min Ch El (ft)	1399.47	Shear (lb/sq ft)		0.97	0.29
Alpha	1.02	Stream Power (lb/ft s)		5.49	0.45
Frctn Loss (ft)	5.34	Cum Volume (acre-ft)	2.32	5.88	1.81
C & E Loss (ft)	0.02	Cum SA (acres)	2.12	2.70	2.43

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Fan7
REACH: 1 RS: 1158.618

INPUT
Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1401.32	13.26	1400.93	59.59	1399.8	83.41	1399.61	120.89	1396.08
126.64	1395.37	133.26	1395.08	141.32	1394.99	151.53	1394.66	153.42	1394.54
158.83	1394.56	164.33	1394.48	182.53	1396.6	190.59	1397.17	196.7	1397.6
201.02	1397.91	203.87	1398.18	223.71	1398.92	248.38	1395.18	275.56	1395.1
287.09	1394.72	309.86	1394.16	314.44	1394.03	338.64	1392.83	341.47	1392.704
341.57	1392.7	341.74	1392.77	382.35	1403.9	418.81	1404.34	431.11	1404.52

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val

```
      0     .06  133.26    .035  201.02     .06  287.09    .035  341.74     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        309.86  341.74             521.63  518.58  523.55             .1       .3

CROSS SECTION OUTPUT  Profile #Q100

  E.G. Elev (ft)           1396.86    Element                    Left OB    Channel   Right OB
  Vel Head (ft)               0.71    Wt. n-Val.                  0.040      0.035     0.060
  W.S. Elev (ft)           1396.15    Reach Len. (ft)            521.63     518.58    523.55
  Crit W.S. (ft)           1396.15    Flow Area (sq ft)          147.39      85.73     20.84
  E.G. Slope (ft/ft)      0.010733    Area (sq ft)               147.39      85.73     20.84
  Q Total (cfs)            1453.00    Flow (cfs)                 650.53     728.42     74.05
  Top Width (ft)            170.60    Top Width (ft)             126.39      31.88     12.33
  Vel Total (ft/s)            5.72    Avg. Vel. (ft/s)             4.41       8.50      3.55
  Max Chl Dpth (ft)           3.45    Hydr. Depth (ft)             1.17       2.69      1.69
  Conv. Total (cfs)        14024.8    Conv. (cfs)                6279.1     7031.0     714.7
  Length Wtd. (ft)          520.03    Wetted Per. (ft)           126.64      31.93     12.79
  Min Ch El (ft)           1392.70    Shear (lb/sq ft)             0.78       1.80      1.09
  Alpha                       1.39    Stream Power (lb/ft s)       3.44      15.29      3.88
  Frctn Loss (ft)             4.79    Cum Volume (acre-ft)         1.40       3.69      1.64
  C & E Loss (ft)             0.02    Cum SA (acres)               1.33       1.59      2.29

Warning: The energy equation could not be balanced within the specified number of iterations.  The
         program used critical depth for the water surface and continued on with the calculations.
Warning: Divided flow computed for this cross-section.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross
         section.  This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical
         depth, the calculated water surface came back below critical depth.  This indicates that there
         is not a valid subcritical answer.  The program defaulted to critical depth.

CROSS SECTION


RIVER: Fan7
REACH: 1                    RS: 640.0357

INPUT
Description:
Station Elevation Data     num=       18
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
       0 1395.12   60.76 1393.86   67.32  1393.7   99.28 1392.84     1511386.778
  151.07 1386.77   152.4 1386.61  153.32  1386.6  172.95 1386.34  206.01 1387.78
  240.85 1388.94  263.91  1389.2  289.74  1388.5  331.63 1388.74  348.82 1390.42
  402.55 1391.55  418.57 1391.25  419.46 1391.22

Manning's n Values         num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
       0     .06  151.07    .035  348.82     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        151.07  206.01             596.47  586.39  582.53             .1       .3

CROSS SECTION OUTPUT  Profile #Q100

  E.G. Elev (ft)           1390.09    Element                    Left OB    Channel   Right OB
  Vel Head (ft)               0.63    Wt. n-Val.                  0.060      0.035     0.035
  W.S. Elev (ft)           1389.47    Reach Len. (ft)            596.47     586.39    582.53
  Crit W.S. (ft)           1389.47    Flow Area (sq ft)           31.03     144.72    101.80
  E.G. Slope (ft/ft)      0.007985    Area (sq ft)                31.03     144.72    101.80
  Q Total (cfs)            1453.00    Flow (cfs)                  83.43    1046.59    322.98
  Top Width (ft)            211.01    Top Width (ft)              23.01      54.94    133.06
  Vel Total (ft/s)            5.24    Avg. Vel. (ft/s)             2.69       7.23      3.17
  Max Chl Dpth (ft)           3.13    Hydr. Depth (ft)             1.35       2.63      0.77
  Conv. Total (cfs)        16260.2    Conv. (cfs)                933.6    11712.1    3614.4
  Length Wtd. (ft)          586.28    Wetted Per. (ft)            23.17      54.98    133.12
  Min Ch El (ft)           1386.34    Shear (lb/sq ft)             0.67       1.31      0.38
  Alpha                       1.47    Stream Power (lb/ft s)       1.80       9.49      1.21
  Frctn Loss (ft)             5.30    Cum Volume (acre-ft)         0.33       2.32      0.90
  C & E Loss (ft)             0.00    Cum SA (acres)               0.44       1.07      1.42

Warning: The energy equation could not be balanced within the specified number of iterations.  The
         program used critical depth for the water surface and continued on with the calculations.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross
         section.  This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical
         depth, the calculated water surface came back below critical depth.  This indicates that there
         is not a valid subcritical answer.  The program defaulted to critical depth.

CROSS SECTION


RIVER: Fan7
REACH: 1                    RS: 53.64828

INPUT
Description:
Station Elevation Data     num=       21
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
       0 1384.26   28.86 1384.76   34.17 1384.65   70.96 1384.08   84.56 1383.87
   127.8 1383.19  138.73 1382.91  143.07 1382.75  153.62 1382.38  199.67 1380.87
  199.69 1380.87  199.79 1380.87  242.03 1381.61  257.83 1382.22  286.15 1383.04
  317.18 1383.26  336.54 1383.42  374.85 1384.21  386.94 1384.47  474.97 1388.33
  483.89 1389.41

Manning's n Values         num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
       0     .06   84.56    .035  317.18     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        153.62  257.83              31.8   53.65   19.97             .1       .3

CROSS SECTION OUTPUT  Profile #Q100

  E.G. Elev (ft)           1384.06    Element                    Left OB    Channel   Right OB
  Vel Head (ft)               0.63    Wt. n-Val.                  0.035      0.035     0.035
  W.S. Elev (ft)           1383.42    Reach Len. (ft)
  Crit W.S. (ft)           1383.42    Flow Area (sq ft)           17.48     199.28     32.64
  E.G. Slope (ft/ft)      0.010303    Area (sq ft)                17.48     199.28     32.64
  Q Total (cfs)            1453.00    Flow (cfs)                  42.87    1322.69     87.44
  Top Width (ft)            223.85    Top Width (ft)              40.72     104.21     78.92
  Vel Total (ft/s)            5.83    Avg. Vel. (ft/s)             2.45       6.64      2.68
  Max Chl Dpth (ft)           2.55    Hydr. Depth (ft)             0.43       1.91      0.41
  Conv. Total (cfs)        14314.5    Conv. (cfs)                422.3    13030.7     861.5
  Length Wtd. (ft)                    Wetted Per. (ft)            40.74     104.25     78.93
  Min Ch El (ft)           1380.87    Shear (lb/sq ft)             0.28       1.23      0.27
  Alpha                       1.20    Stream Power (lb/ft s)       0.68       8.16      0.71
  Frctn Loss (ft)                     Cum Volume (acre-ft)
  C & E Loss (ft)                     Cum SA (acres)

Warning: Slope too steep for slope area to converge during supercritical flow calculations (normal depth
         is below critical depth). Water surface set to critical depth.
```

SUMMARY OF MANNING'S N VALUES

River:Fan7

Reach	River Sta.	n1	n2	n3	n4	n5
1	2583.162	.06	.035	.06		
1	2152.126	.06	.035	.06		
1	1719.538	.06	.035	.06	.035	.06
1	1158.618	.06	.035	.06	.035	.06
1	640.0357	.06	.035	.06		
1	53.64828	.06	.035	.06		

SUMMARY OF REACH LENGTHS

River: Fan7

Reach	River Sta.	Left	Channel	Right
1	2583.162	452.23	431.04	433.85
1	2152.126	432.08	432.59	454.66
1	1719.538	543.61	560.92	579.21
1	1158.618	521.63	518.58	523.55
1	640.0357	596.47	586.39	582.53
1	53.64828	31.8	53.65	19.97

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: Fan7

Reach	River Sta.	Contr.	Expan.
1	2583.162	.1	.3
1	2152.126	.1	.3
1	1719.538	.1	.3
1	1158.618	.1	.3
1	640.0357	.1	.3
1	53.64828	.1	.3

Profile Output Table - Standard Table 1

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	2583.162	Q100	1453.00	1409.33	1412.93	1412.89	1413.98	0.012207	8.28	184.28	93.85	0.95
1	2152.126	Q100	1453.00	1404.81	1407.52	1407.52	1408.37	0.013612	7.54	210.44	137.36	0.97
1	1719.538	Q100	1453.00	1399.47	1401.72	1401.38	1402.22	0.008586	5.68	259.34	149.82	0.75
1	1158.618	Q100	1453.00	1392.70	1396.15	1396.15	1396.86	0.010733	8.50	253.96	170.60	0.91
1	640.0357	Q100	1453.00	1386.34	1389.47	1389.47	1390.09	0.007985	7.23	277.55	211.01	0.79
1	53.64828	Q100	1453.00	1380.87	1383.42	1383.42	1384.06	0.010303	6.64	249.40	223.85	0.85

```
                    HEC-RAS Version 3.1.3 May 2005
                     U.S. Army Corp of Engineers
                    Hydrologic Engineering Center
                          609 Second Street
                          Davis, California

          X     X  XXXXXX    XXXX        XXXX       XX      XXXX
          X     X  X        X    X       X   X     X  X    X
          X     X  X        X            X   X    X    X   X
          XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
          X     X  X        X            X  X     X    X        X
          X     X  X        X    X       X   X    X    X        X
          X     X  XXXXXX    XXXX        X    X   X    X   XXXXX


PROJECT DATA
Project Title: Fan7-8-12
Project File : Fan7_8_12.prj
Run Date and Time: 9/28/2007 3:32:28 PM

Project in English units

Project Description:
Approximate Zone A Floodplain Delineation Study for select washes on the White
Tank Mountains upstream of the alluvial fan apecies.  This study was performed
under contract to the Flood Control Disctrict of Maricopa County (2005C024), by
JE Fuller Hydrology & Geomorphology, Inc., in Sept, 2007.  This model was
developed in HEC-RAS v3.1.3 (May 2005), Based on 1"=500', 10' contour interval
topographic mapping provided by FCDMC, Flown by Landata Airborne Systems,
Flight Date = December 2000, vertical datum = NAVD88, horizontal projection =
NAD83.  Discharges are from HEC-1 modeling produced from this same contract by
JEF, Inc.  Starting water surface elevation determined using normal depth
proceedures.  This run assumes sub-critical flow conditions.


PLAN DATA

Plan Title: Fan8
Plan File : x:\projects\Agency\FCDMC\2005C024\Assignment8WTFans\hec-ras\Fan7_8_12.p02

          Geometry Title: Fan8
          Geometry File : x:\projects\Agency\FCDMC\2005C024\Assignment8WTFans\hec-ras\Fan7_8_12.g02

          Flow Title    : Fan8
          Flow File     : x:\projects\Agency\FCDMC\2005C024\Assignment8WTFans\hec-ras\Fan7_8_12.f02

Plan Summary Information:
Number of:  Cross Sections =    6    Multiple Openings  =    0
            Culverts       =    0    Inline Structures  =    0
            Bridges        =    0    Lateral Structures =    0

Computational Information
    Water surface calculation tolerance  =  0.01
    Critical depth calculation tolerance =  0.01
    Maximum number of iterations         =  20
    Maximum difference tolerance         =  0.3
    Flow tolerance factor                =  0.001

Computation Options
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Subcritical Flow


FLOW DATA

Flow Title: Fan8
Flow File : x:\projects\Agency\FCDMC\2005C024\Assignment8WTFans\hec-ras\Fan7_8_12.f02

Flow Data (cfs)

  River          Reach          RS                  Q100
  Fan8           1              2394.158             646

Boundary Conditions

  River          Reach          Profile                      Upstream                Downstream

  Fan8           1              Q100                                               Normal S = 0.02


GEOMETRY DATA

Geometry Title: Fan8
Geometry File : x:\projects\Agency\FCDMC\2005C024\Assignment8WTFans\hec-ras\Fan7_8_12.g02

CROSS SECTION


RIVER: Fan8
REACH: 1                  RS: 2394.158

INPUT
Description:
Station Elevation Data    num=      38
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0 1361.37    2.66 1360.61    5.33 1359.85    7.99 1359.09   10.66 1358.35
   13.32 1357.66   15.98 1357.01   18.65 1356.47   21.31 1356.27   23.98 1356.13
   26.64 1355.99    29.3 1355.84   31.97  1355.7   34.63 1355.55    37.3  1355.4
   37.64 1355.38   39.96 1355.25   42.62 1355.12   45.29 1355.33   47.95 1356.02
   50.62 1356.72   53.28 1357.41   55.94 1358.11   58.61  1358.8   60.14 1359.22
   61.27 1359.53   63.94 1360.32    66.6 1361.19   69.26 1362.06   71.93 1362.93
   74.59 1363.79   77.26 1364.66   79.92 1365.53   82.59  1366.4   85.25 1367.27
   87.91 1368.13   90.58    1369   93.86 1370.07

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0     .06   37.64    .035   60.14     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          37.64   60.14             476.27  463.54  477.74             .1       .3

CROSS SECTION OUTPUT  Profile #Q100

  E.G. Elev (ft)          1359.24    Element                    Left OB    Channel   Right OB
  Vel Head (ft)              0.97    Wt. n-Val.                  0.060      0.035
  W.S. Elev (ft)          1358.27    Reach Len. (ft)            476.27     463.54     477.74
```

Crit W.S. (ft)	1358.27	Flow Area (sq ft)	52.15	39.77	
E.G. Slope (ft/ft)	0.018574	Area (sq ft)	52.15	39.77	
Q Total (cfs)	646.00	Flow (cfs)	273.56	372.44	
Top Width (ft)	45.59	Top Width (ft)	26.67	18.92	
Vel Total (ft/s)	7.03	Avg. Vel. (ft/s)	5.25	9.37	
Max Chl Dpth (ft)	3.15	Hydr. Depth (ft)	1.96	2.10	
Conv. Total (cfs)	4740.1	Conv. (cfs)	2007.3	2732.8	
Length Wtd. (ft)	466.56	Wetted Per. (ft)	26.91	19.31	
Min Ch El (ft)	1355.12	Shear (lb/sq ft)	2.25	2.39	
Alpha	1.26	Stream Power (lb/ft s)	11.79	22.37	
Frctn Loss (ft)	7.05	Cum Volume (acre-ft)	1.06	4.20	0.82
C & E Loss (ft)	0.00	Cum SA (acres)	1.07	2.72	1.25

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: Fan8
REACH: 1 RS: 1930.623

INPUT
Description:
Station Elevation Data num= 92

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1355.07	2.48	1354.58	4.97	1354.25	7.45	1353.99	9.94	1353.74
12.42	1353.5	14.91	1353.24	17.39	1352.97	19.87	1352.68	22.36	1352.38
24.84	1352.08	27.33	1351.78	29.81	1351.49	32.3	1351.22	34.78	1350.96
37.26	1350.71	39.75	1350.46	42.23	1350.21	44.72	1349.95	47.2	1349.7
49.69	1349.45	52.17	1349.2	54.65	1348.94	57.14	1348.69	59.62	1348.39
62.11	1348.01	64.59	1347.61	67.08	1347.21	69.56	1346.81	72.04	1346.41
74.53	1346	77.01	1345.59	78.16	1345.4	79.5	1345.18	81.98	1344.78
84.47	1344.62	86.95	1344.58	89.43	1344.54	91.92	1344.52	94.4	1344.5
96.89	1344.5	99.37	1344.49	101.86	1344.48	104.34	1344.48	106.82	1344.53
109.31	1344.88	111.02	1345.26	111.79	1345.43	114.28	1345.99	116.76	1346.55
119.25	1347.11	121.73	1347.68	124.21	1348.24	126.7	1348.83	129.18	1349.42
131.67	1350	134.15	1350.37	136.64	1350.66	139.12	1350.95	141.61	1351.23
144.09	1351.52	146.57	1351.81	149.06	1352.09	151.54	1352.38	154.03	1352.66
156.51	1352.95	159	1353.24	161.48	1353.52	163.96	1353.81	166.45	1354.09
168.93	1354.38	171.42	1354.68	173.9	1355.03	176.39	1355.41	178.87	1355.82
181.35	1356.23	183.84	1356.66	186.32	1357.1	188.81	1357.53	191.29	1357.97
193.78	1358.38	196.26	1358.53	198.74	1358.55	201.23	1358.56	203.71	1358.58
206.2	1358.59	208.68	1358.61	211.17	1358.63	213.65	1358.66	216.13	1358.68
218.62	1358.7	220.24	1358.71						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	78.16	.035	111.02	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
78.16	111.02	438.49	447.61	461.29	.1	.3

CROSS SECTION OUTPUT Profile #Q100

E.G. Elev (ft)	1347.92	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.00	Wt. n-Val.	0.060	0.035	0.060
W.S. Elev (ft)	1346.92	Reach Len. (ft)	438.49	447.61	461.29
Crit W.S. (ft)	1346.92	Flow Area (sq ft)	7.02	74.91	6.15
E.G. Slope (ft/ft)	0.012532	Area (sq ft)	7.02	74.91	6.15
Q Total (cfs)	646.00	Flow (cfs)	16.02	615.14	14.83
Top Width (ft)	49.54	Top Width (ft)	9.29	32.86	7.39
Vel Total (ft/s)	7.33	Avg. Vel. (ft/s)	2.28	8.21	2.41
Max Chl Dpth (ft)	2.44	Hydr. Depth (ft)	0.76	2.28	0.83
Conv. Total (cfs)	5770.5	Conv. (cfs)	143.1	5494.9	132.5
Length Wtd. (ft)	447.77	Wetted Per. (ft)	9.41	32.98	7.57
Min Ch El (ft)	1344.48	Shear (lb/sq ft)	0.58	1.78	0.64
Alpha	1.20	Stream Power (lb/ft s)	1.33	14.59	1.53
Frctn Loss (ft)	6.08	Cum Volume (acre-ft)	0.74	3.59	0.79
C & E Loss (ft)	0.07	Cum SA (acres)	0.87	2.45	1.21

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: Fan8
REACH: 1 RS: 1483.011

INPUT
Description:
Station Elevation Data num= 88

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1343.55	2.22	1343.55	4.44	1343.55	6.65	1343.55	8.87	1343.55
11.09	1343.55	13.31	1343.55	15.53	1343.54	17.74	1343.54	19.96	1343.54
22.18	1343.54	24.4	1343.51	26.62	1343.3	28.83	1342.81	31.05	1342.33
33.27	1341.85	35.49	1341.36	37.71	1340.88	39.92	1340.39	42.14	1339.89
44.36	1339.26	46.58	1338.62	48.8	1337.97	51.01	1337.33	53.23	1336.7
55.45	1336.06	57.45	1335.6	57.67	1335.55	59.89	1335.43	62.1	1335.4
64.32	1335.37	66.54	1335.34	68.76	1335.31	70.98	1335.28	73.19	1335.26
75.41	1335.23	77.63	1335.2	79.85	1335.17	82.07	1335.14	84.28	1335.11
86.5	1335.09	88.72	1335.07	90.94	1335.06	93.16	1335.05	95.37	1335.06
97.59	1335.07	99.81	1335.07	102.03	1335.08	104.25	1335.09	106.46	1335.09
108.68	1335.13	110.9	1335.33	112.32	1335.51	113.12	1335.6	115.34	1335.87
117.55	1336.14	119.77	1336.41	121.99	1336.68	124.21	1336.95	126.43	1337.21
128.64	1337.48	130.86	1337.76	133.08	1338.02	135.3	1338.3	137.52	1338.58
139.73	1338.86	141.95	1339.15	144.17	1339.43	146.39	1339.72	148.61	1340.01
150.82	1340.29	153.04	1340.58	155.26	1340.86	157.48	1341.15	159.7	1341.44
161.91	1341.72	164.13	1342.01	166.35	1342.3	168.57	1342.58	170.79	1342.87
173	1343.15	175.22	1343.44	177.44	1343.73	179.66	1344.01	181.88	1344.26
184.09	1344.37	186.31	1344.44	188.87	1344.53				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	57.45	.035	112.32	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
57.45	112.32	541.58	484.07	484.35	.1	.3

CROSS SECTION OUTPUT Profile #Q100

E.G. Elev (ft)	1337.56	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.75	Wt. n-Val.	0.060	0.035	0.060
W.S. Elev (ft)	1336.80	Reach Len. (ft)	541.58	484.07	484.35
Crit W.S. (ft)	1336.80	Flow Area (sq ft)	2.91	88.20	6.95
E.G. Slope (ft/ft)	0.014760	Area (sq ft)	2.91	88.20	6.95

Q Total (cfs)	646.00	Flow (cfs)	6.32	624.06	15.63
Top Width (ft)	70.15	Top Width (ft)	4.59	54.87	10.69
Vel Total (ft/s)	6.59	Avg. Vel. (ft/s)	2.17	7.08	2.25
Max Chl Dpth (ft)	1.75	Hydr. Depth (ft)	0.63	1.61	0.65
Conv. Total (cfs)	5317.3	Conv. (cfs)	52.0	5136.7	128.6
Length Wtd. (ft)	486.15	Wetted Per. (ft)	4.74	54.90	10.77
Min Ch El (ft)	1335.05	Shear (lb/sq ft)	0.57	1.48	0.59
Alpha	1.12	Stream Power (lb/ft s)	1.23	10.47	1.34
Frctn Loss (ft)	8.02	Cum Volume (acre-ft)	0.69	2.75	0.72
C & E Loss (ft)	0.07	Cum SA (acres)	0.80	2.00	1.12

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: Fan8
REACH: 1 RS: 998.9430

INPUT
Description:
Station Elevation Data num= 84

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1327.33	2.57	1327.08	5.14	1326.83	7.71	1326.63	10.28	1326.44
12.84	1326.26	15.41	1326.07	17.98	1325.88	20.55	1325.7	23.12	1325.51
25.69	1325.32	28.26	1325.14	30.83	1324.95	33.4	1324.76	35.96	1324.58
38.53	1324.44	41.1	1324.47	42.21	1324.48	43.67	1324.5	46.24	1324.53
48.81	1324.56	51.38	1324.59	53.95	1324.62	56.52	1324.65	59.09	1324.68
61.65	1324.71	64.22	1324.74	66.79	1324.77	69.36	1324.8	71.93	1324.83
74.5	1324.86	77.07	1324.9	79.64	1324.93	82.21	1324.96	84.77	1324.99
87.34	1325.02	89.91	1325.05	92.48	1325.08	95.05	1325.11	97.62	1325.14
100.19	1325.17	102.76	1325.2	105.33	1325.23	107.89	1325.26	110.46	1325.29
113.03	1325.32	115.6	1325.35	118.17	1325.39	120.74	1325.42	123.31	1325.45
125.88	1325.48	128.45	1325.51	131.01	1325.63	133.58	1326.03	136.15	1326.43
138.72	1326.82	141.29	1327.22	143.86	1327.62	146.43	1328.02	146.75	1328.07
149	1328.39	151.57	1328.61	154.14	1328.83	156.7	1329.02	159.27	1329.15
161.84	1329.18	164.41	1329.21	166.98	1329.24	169.55	1329.27	172.12	1329.3
174.69	1329.33	177.26	1329.36	179.82	1329.39	182.39	1329.42	184.96	1329.45
187.53	1329.47	190.1	1329.48	192.67	1329.47	195.24	1329.46	197.81	1329.45
200.38	1329.44	202.94	1329.44	205.51	1329.43	208.56	1329.42		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	35.96	.035	133.58	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
35.96	133.58	491.83	459.71	462.63	.1	.3

CROSS SECTION OUTPUT Profile #Q100

E.G. Elev (ft)	1326.56	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.52	Wt. n-Val.	0.060	0.035	0.000
W.S. Elev (ft)	1326.04	Reach Len. (ft)	491.83	459.71	462.63
Crit W.S. (ft)	1326.04	Flow Area (sq ft)	14.75	101.80	0.00
E.G. Slope (ft/ft)	0.018580	Area (sq ft)	14.75	101.80	0.00
Q Total (cfs)	646.00	Flow (cfs)	40.37	605.63	0.00
Top Width (ft)	117.85	Top Width (ft)	20.16	97.62	0.07
Vel Total (ft/s)	5.54	Avg. Vel. (ft/s)	2.74	5.95	0.10
Max Chl Dpth (ft)	1.60	Hydr. Depth (ft)	0.73	1.04	0.01
Conv. Total (cfs)	4739.2	Conv. (cfs)	296.2	4443.1	0.0
Length Wtd. (ft)	462.96	Wetted Per. (ft)	20.21	97.66	0.07
Min Ch El (ft)	1324.44	Shear (lb/sq ft)	0.85	1.21	
Alpha	1.10	Stream Power (lb/ft s)	2.32	7.19	
Frctn Loss (ft)	7.16	Cum Volume (acre-ft)	0.58	1.70	0.68
C & E Loss (ft)	0.02	Cum SA (acres)	0.65	1.15	1.06

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: Fan8
REACH: 1 RS: 539.2312

INPUT
Description:
Station Elevation Data num= 73

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1318.9	2.66	1318.82	5.32	1318.78	7.98	1318.73	10.64	1318.45
13.29	1318.28	15.95	1318.11	18.61	1317.94	21.27	1317.77	23.93	1317.6
26.59	1317.43	29.25	1317.25	31.91	1317.08	34.57	1316.9	37.23	1316.73
39.88	1316.55	42.54	1316.38	45.2	1316.2	47.86	1316.03	50.52	1315.85
53.18	1315.68	55.32	1315.57	55.84	1315.54	58.5	1315.54	61.16	1315.54
63.82	1315.55	66.47	1315.56	69.13	1315.57	71.79	1315.57	74.45	1315.58
77.11	1315.59	79.77	1315.59	82.43	1315.67	85.09	1315.76	87.75	1315.86
90.06	1315.95	90.41	1315.96	93.06	1316.08	95.72	1316.19	98.38	1316.31
101.04	1316.43	103.7	1316.55	106.36	1316.67	109.02	1316.78	111.68	1316.9
114.34	1317.02	117	1317.14	119.65	1317.26	122.31	1317.39	124.97	1317.58
127.63	1317.78	130.29	1317.98	132.95	1318.19	135.61	1318.39	138.27	1318.59
140.93	1318.76	143.59	1318.78	146.24	1318.8	148.9	1318.82	151.56	1318.83
154.22	1318.85	156.88	1318.87	159.54	1318.89	162.2	1318.92	164.86	1318.95
167.52	1318.97	170.18	1319	172.83	1319.03	175.49	1319.05	178.15	1319.08
180.81	1319.1	183.47	1319.13	186.69	1319.15				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	55.32	.035	90.06	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
55.32	90.06	509.5	496.19	491.5	.1	.3

CROSS SECTION OUTPUT Profile #Q100

E.G. Elev (ft)	1318.21	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.68	Wt. n-Val.	0.060	0.035	0.060
W.S. Elev (ft)	1317.52	Reach Len. (ft)	509.50	496.19	491.50
Crit W.S. (ft)	1317.52	Flow Area (sq ft)	29.95	66.09	27.99
E.G. Slope (ft/ft)	0.013067	Area (sq ft)	29.95	66.09	27.99
Q Total (cfs)	646.00	Flow (cfs)	84.22	492.37	69.40
Top Width (ft)	99.05	Top Width (ft)	30.19	34.74	34.12
Vel Total (ft/s)	5.21	Avg. Vel. (ft/s)	2.81	7.45	2.48
Max Chl Dpth (ft)	1.98	Hydr. Depth (ft)	0.99	1.90	0.82
Conv. Total (cfs)	5651.2	Conv. (cfs)	736.8	4307.3	607.1
Length Wtd. (ft)	496.99	Wetted Per. (ft)	30.26	34.75	34.16
Min Ch El (ft)	1315.54	Shear (lb/sq ft)	0.81	1.55	0.67

Alpha	1.62	Stream Power (lb/ft s)	2.27	11.56	1.66
Frctn Loss (ft)	5.82	Cum Volume (acre-ft)	0.33	0.81	0.53
C & E Loss (ft)	0.07	Cum SA (acres)	0.37	0.45	0.87

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: Fan8
REACH: 1 RS: 43.04325

INPUT
Description:
Station Elevation Data num= 333

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1308.21	2.23	1308.22	4.46	1308.23	6.69	1308.25	8.92	1308.26
11.15	1308.27	13.38	1308.28	15.61	1308.3	17.84	1308.31	20.07	1308.32
22.3	1308.34	24.53	1308.35	26.76	1308.36	28.99	1308.36	31.22	1308.35
33.44	1308.34	35.67	1308.33	37.9	1308.33	40.13	1308.32	42.36	1308.32
44.59	1308.32	46.82	1308.32	49.05	1308.32	51.28	1308.32	53.51	1308.32
55.74	1308.32	57.97	1308.32	60.2	1308.32	62.43	1308.32	64.66	1308.32
66.89	1308.32	69.12	1308.32	71.35	1308.32	73.58	1308.32	75.81	1308.32
78.04	1308.32	80.27	1308.32	82.5	1308.31	84.73	1308.31	86.96	1308.31
89.19	1308.31	91.42	1308.31	93.65	1308.31	95.88	1308.3	98.11	1308.29
100.33	1308.28	102.56	1308.27	104.79	1308.26	107.02	1308.24	109.25	1308.23
111.48	1308.22	113.71	1308.21	115.94	1308.19	118.17	1308.18	120.4	1308.17
122.63	1308.16	124.86	1308.15	127.09	1308.14	129.32	1308.13	131.55	1308.12
133.78	1308.11	136.01	1308.1	138.24	1308.09	140.47	1308.07	142.7	1308.06
144.93	1308.05	147.16	1308.03	149.39	1308.02	151.62	1308.01	153.85	1308
156.08	1307.99	158.31	1307.97	160.54	1307.96	162.77	1307.95	164.99	1307.94
167.22	1307.93	169.45	1307.92	171.68	1307.91	173.91	1307.9	176.14	1307.89
178.37	1307.87	180.6	1307.85	182.83	1307.83	185.06	1307.82	187.29	1307.8
189.52	1307.78	191.75	1307.76	193.98	1307.74	196.21	1307.72	198.44	1307.71
200.67	1307.69	202.9	1307.67	205.13	1307.65	207.36	1307.64	209.59	1307.63
211.82	1307.62	214.05	1307.61	216.28	1307.6	218.51	1307.59	220.74	1307.58
222.97	1307.57	225.2	1307.56	227.43	1307.55	229.66	1307.54	231.88	1307.53
234.11	1307.52	236.34	1307.51	238.57	1307.5	240.8	1307.49	243.03	1307.48
245.26	1307.47	247.49	1307.45	249.72	1307.44	251.95	1307.43	254.18	1307.42
256.41	1307.4	258.64	1307.39	260.87	1307.37	263.1	1307.31	265.33	1307.2
267.56	1307.09	269.79	1306.98	272.02	1306.87	274.25	1306.76	276.48	1306.65
278.71	1306.54	280.94	1306.43	283.17	1306.32	285.4	1306.21	287.63	1306.1
289.86	1305.98	292.09	1305.87	294.32	1305.76	296.41	1305.66	296.55	1305.65
298.77	1305.58	301	1305.59	303.23	1305.61	305.46	1305.64	307.69	1305.67
309.92	1305.68	312.15	1305.65	314.38	1305.62	316.61	1305.58	318.84	1305.55
321.07	1305.51	323.3	1305.48	325.53	1305.44	327.76	1305.4	329.99	1305.39
332.22	1305.44	334.45	1305.49	336.68	1305.55	338.91	1305.62	341.14	1305.69
343.37	1305.76	345.6	1305.83	347.83	1305.9	350.06	1305.97	352.29	1306.04
354.52	1306.11	356.75	1306.21	358.98	1306.35	361.21	1306.46	363.44	1306.54
365.67	1306.6	367.89	1306.67	370.12	1306.74	370.74	1306.76	372.35	1306.8
374.58	1306.84	376.81	1306.83	379.04	1306.83	381.27	1306.83	383.5	1306.82
385.73	1306.82	387.96	1306.82	390.19	1306.82	392.42	1306.81	394.65	1306.81
396.88	1306.81	399.11	1306.8	401.34	1306.8	403.57	1306.79	405.8	1306.78
408.03	1306.77	410.26	1306.75	412.49	1306.74	414.72	1306.73	416.75	1306.73
418.91	1306.74	421.08	1306.76	423.24	1306.78	425.41	1306.8	427.58	1306.82
429.74	1306.84	431.91	1306.86	434.07	1306.89	436.24	1306.91	438.41	1306.94
440.57	1306.97	442.74	1307	444.91	1307.03	447.07	1307.06	449.24	1307.09
451.4	1307.12	453.57	1307.15	455.74	1307.18	457.9	1307.21	460.07	1307.24
462.24	1307.27	464.4	1307.3	466.57	1307.33	468.73	1307.36	470.9	1307.39
473.07	1307.42	475.23	1307.45	477.4	1307.47	479.57	1307.49	481.73	1307.51
483.9	1307.53	486.06	1307.55	488.23	1307.57	490.4	1307.59	492.56	1307.62
494.73	1307.64	496.9	1307.67	499.06	1307.69	501.23	1307.71	503.39	1307.74
505.56	1307.76	507.73	1307.79	509.89	1307.81	512.06	1307.84	514.23	1307.86
516.39	1307.88	518.56	1307.9	520.72	1307.92	522.89	1307.94	525.06	1307.95
527.22	1307.97	529.39	1307.99	531.55	1308.01	533.72	1308.03	535.89	1308.05
538.05	1308.07	540.22	1308.09	542.39	1308.11	544.55	1308.12	546.72	1308.14
548.88	1308.16	551.05	1308.18	553.22	1308.2	555.38	1308.21	557.55	1308.22
559.72	1308.23	561.88	1308.24	564.05	1308.25	566.21	1308.26	568.38	1308.27
570.55	1308.28	572.71	1308.29	574.88	1308.3	577.05	1308.31	579.21	1308.32
581.38	1308.33	583.54	1308.35	585.71	1308.36	587.88	1308.37	590.04	1308.38
592.21	1308.39	594.37	1308.4	596.54	1308.41	598.71	1308.42	600.87	1308.44
603.04	1308.45	605.21	1308.47	607.37	1308.48	609.54	1308.5	611.7	1308.51
613.87	1308.53	616.04	1308.54	618.2	1308.56	620.37	1308.57	622.54	1308.59
624.7	1308.6	626.87	1308.62	629.03	1308.64	631.2	1308.65	633.37	1308.67
635.53	1308.69	637.7	1308.71	639.86	1308.73	642.03	1308.75	644.2	1308.77
646.36	1308.79	648.53	1308.81	650.7	1308.83	652.86	1308.85	655.03	1308.87
657.19	1308.88	659.36	1308.9	661.53	1308.92	663.69	1308.94	665.86	1308.96
668.03	1308.97	670.19	1308.99	672.36	1309.01	674.52	1309.02	676.69	1309.04
678.86	1309.06	681.02	1309.07	683.19	1309.09	685.36	1309.11	687.52	1309.12
689.69	1309.14	691.85	1309.16	694.02	1309.17	696.19	1309.19	698.35	1309.21
700.52	1309.22	702.68	1309.24	704.85	1309.26	707.02	1309.27	709.18	1309.29
711.35	1309.31	713.52	1309.33	715.68	1309.35	717.85	1309.37	720.01	1309.38
722.18	1309.4	724.35	1309.42	726.66	1309.44				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	296.41	.035	341.14	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
296.41	341.14	71.84	43.04	24.56	.1	.3

CROSS SECTION OUTPUT Profile #Q100

E.G. Elev (ft)	1307.73	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.46	Wt. n-Val.	0.060	0.035	0.060
W.S. Elev (ft)	1307.27	Reach Len. (ft)			
Crit W.S. (ft)	1307.27	Flow Area (sq ft)	26.00	76.40	66.08
E.G. Slope (ft/ft)	0.010570	Area (sq ft)	26.00	76.40	66.08
Q Total (cfs)	646.00	Flow (cfs)	57.10	476.40	112.50
Top Width (ft)	197.98	Top Width (ft)	32.42	44.73	120.83
Vel Total (ft/s)	3.83	Avg. Vel. (ft/s)	2.20	6.24	1.70
Max Chl Dpth (ft)	1.88	Hydr. Depth (ft)	0.80	1.71	0.55
Conv. Total (cfs)	6283.3	Conv. (cfs)	555.4	4633.7	1094.3
Length Wtd. (ft)		Wetted Per. (ft)	32.46	44.74	120.85
Min Ch El (ft)	1305.39	Shear (lb/sq ft)	0.53	1.13	0.36
Alpha	2.01	Stream Power (lb/ft s)	1.16	7.03	0.61
Frctn Loss (ft)		Cum Volume (acre-ft)			
C & E Loss (ft)		Cum SA (acres)			

Warning: Slope too steep for slope area to converge during supercritical flow calculations (normal depth is below critical depth). Water surface set to critical depth.

SUMMARY OF MANNING'S N VALUES

River:Fan8

Reach	River Sta.	n1	n2	n3
1	2394.158	.06	.035	.06

1	1930.623	.06	.035	.06
1	1483.011	.06	.035	.06
1	998.9430	.06	.035	.06
1	539.2312	.06	.035	.06
1	43.04325	.06	.035	.06

SUMMARY OF REACH LENGTHS

River: Fan8

Reach	River Sta.	Left	Channel	Right
1	2394.158	476.27	463.54	477.74
1	1930.623	438.49	447.61	461.29
1	1483.011	541.58	484.07	484.35
1	998.9430	491.83	459.71	462.63
1	539.2312	509.5	496.19	491.5
1	43.04325	71.84	43.04	24.56

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: Fan8

Reach	River Sta.	Contr.	Expan.
1	2394.158	.1	.3
1	1930.623	.1	.3
1	1483.011	.1	.3
1	998.9430	.1	.3
1	539.2312	.1	.3
1	43.04325	.1	.3

Profile Output Table - Standard Table 1

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	2394.158	Q100	646.00	1355.12	1358.27	1358.27	1359.24	0.018574	9.37	91.91	45.59	1.14
1	1930.623	Q100	646.00	1344.48	1346.92	1346.92	1347.92	0.012532	8.21	88.08	49.54	0.96
1	1483.011	Q100	646.00	1335.05	1336.80	1336.80	1337.56	0.014760	7.08	98.07	70.15	0.98
1	998.9430	Q100	646.00	1324.44	1326.04	1326.04	1326.56	0.018580	5.95	116.55	117.85	1.03
1	539.2312	Q100	646.00	1315.54	1317.52	1317.52	1318.21	0.013067	7.45	124.04	99.05	0.95
1	43.04325	Q100	646.00	1305.39	1307.27	1307.27	1307.73	0.010570	6.24	168.48	197.98	0.84

```
                    HEC-RAS Version 3.1.3 May 2005
                     U.S. Army Corp of Engineers
                    Hydrologic Engineering Center
                          609 Second Street
                          Davis, California

          X     X  XXXXXX    XXXX        XXXX       XX      XXXX
          X     X  X       X    X       X   X     X  X    X
          X     X  X       X            X   X    X    X   X
          XXXXXXX  XXXX    X       XXX  XXXX     XXXXXX    XXXX
          X     X  X       X            X  X     X    X        X
          X     X  X       X    X       X   X    X    X        X
          X     X  XXXXXX    XXXX       X    X   X    X   XXXXX
```

PROJECT DATA
Project Title: Fan7-8-12
Project File : Fan7_8_12.prj
Run Date and Time: 9/28/2007 3:39:16 PM

Project in English units

Project Description:
Approximate Zone A Floodplain Delineation Study for select washes on the White Tank Mountains upstream of the alluvial fan apecies. This study was performed under contract to the Flood Control Disctrict of Maricopa County (2005C024), by JE Fuller Hydrology & Geomorphology, Inc., in Sept, 2007. This model was developed in HEC-RAS v3.1.3 (May 2005), Based on 1"=500', 10' contour interval topographic mapping provided by FCDMC, Flown by Landata Airborne Systems, Flight Date = December 2000, vertical datum = NAVD88, horizontal projection = NAD83. Discharges are from HEC-1 modeling produced from this same contract by JEF, Inc. Starting water surface elevation determined using normal depth proceedures. This run assumes sub-critical flow conditions.

PLAN DATA

Plan Title: Fan12
Plan File : x:\projects\Agency\FCDMC\2005C024\Assignment8WTFans\hec-ras\Fan7_8_12.p03

Geometry Title: Fan12
Geometry File : x:\projects\Agency\FCDMC\2005C024\Assignment8WTFans\hec-ras\Fan7_8_12.g03

Flow Title : Fan12
Flow File : x:\projects\Agency\FCDMC\2005C024\Assignment8WTFans\hec-ras\Fan7_8_12.f03

Plan Summary Information:

Number of:	Cross Sections	= 7	Multiple Openings	=	0
	Culverts	= 0	Inline Structures	=	0
	Bridges	= 0	Lateral Structures	=	0

Computational Information
Water surface calculation tolerance = 0.01
Critical depth calculation tolerance = 0.01
Maximum number of iterations = 20
Maximum difference tolerance = 0.3
Flow tolerance factor = 0.001

Computation Options
Critical depth computed only where necessary
Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Subcritical Flow

FLOW DATA

Flow Title: Fan12
Flow File : x:\projects\Agency\FCDMC\2005C024\Assignment8WTFans\hec-ras\Fan7_8_12.f03

Flow Data (cfs)

River	Reach	RS	Q100
Fan12	1	3761.932	1050

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Fan12	1	Q100		Normal S = 0.02

GEOMETRY DATA

Geometry Title: Fan12
Geometry File : x:\projects\Agency\FCDMC\2005C024\Assignment8WTFans\hec-ras\Fan7_8_12.g03

CROSS SECTION

RIVER: Fan12
REACH: 1 RS: 3761.932

INPUT
Description:
Station Elevation Data num= 20

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1262.59	10.23	1260.24	20.47	1257.32	30.7	1247.21	40.94	1238.79
46.76	1239.15	51.17	1239.43	61.41	1240.33	71.64	1241.26	81.2	1242.37
81.88	1242.45	92.11	1243.75	102.35	1245.05	112.58	1246.35	122.82	1247.61
133.05	1248.27	143.29	1248.63	153.52	1248.99	163.76	1249.35	169.07	1249.54

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	40.94	.035	81.2	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
40.94	81.2	304.36	311.95	367.52	.1	.3

CROSS SECTION OUTPUT Profile #Q100

E.G. Elev (ft)	1244.35	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.30	Wt. n-Val.	0.060	0.035	0.060
W.S. Elev (ft)	1243.06	Reach Len. (ft)	304.36	311.95	367.52
Crit W.S. (ft)	1243.06	Flow Area (sq ft)	11.06	107.86	1.88
E.G. Slope (ft/ft)	0.012988	Area (sq ft)	11.06	107.86	1.88
Q Total (cfs)	1050.00	Flow (cfs)	43.54	1003.87	2.59
Top Width (ft)	50.89	Top Width (ft)	5.19	40.26	5.44

Vel Total (ft/s)	8.69	Avg. Vel. (ft/s)	3.94	9.31	1.38
Max Chl Dpth (ft)	4.26	Hydr. Depth (ft)	2.13	2.68	0.35
Conv. Total (cfs)	9213.2	Conv. (cfs)	382.0	8808.4	22.8
Length Wtd. (ft)	311.48	Wetted Per. (ft)	6.71	40.43	5.48
Min Ch El (ft)	1238.79	Shear (lb/sq ft)	1.34	2.16	0.28
Alpha	1.10	Stream Power (lb/ft s)	5.26	20.14	0.38
Frctn Loss (ft)	4.45	Cum Volume (acre-ft)	1.98	10.35	0.71
C & E Loss (ft)	0.15	Cum SA (acres)	1.75	5.14	1.01

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: Fan12
REACH: 1 RS: 3449.982

INPUT
Description:
Station Elevation Data num= 46

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1259.94	10.78	1258.74	21.56	1257.47	32.34	1256.19	43.13	1254.96
53.91	1253.88	64.69	1252.53	75.47	1251	86.25	1249.7	97.03	1248.62
107.81	1247.54	118.6	1246.15	129.38	1244.25	140.16	1242.34	150.94	1240.67
161.72	1239	172.5	1237.34	183.28	1235.67	194.07	1234.23	197.6	1234.01
204.85	1233.56	215.63	1233.25	226.41	1234.1	237.19	1235.03	247.97	1235.99
258.75	1236.97	269.54	1237.89	280.32	1238.28	291.1	1238.44	301.88	1238.59
312.66	1238.46	323.44	1237.67	334.23	1236.75	345.01	1235.74	355.79	1236.17
356.74	1236.27	366.57	1237.27	377.35	1238.37	388.13	1239.6	398.91	1240.8
409.7	1242.03	420.48	1243.35	431.26	1244.23	442.04	1244.64	452.82	1245.05
467.92	1245.58								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	197.6	.035	356.74	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
197.6	356.74	499.05	499.45	598.24	.1	.3

CROSS SECTION OUTPUT Profile #Q100

			Left OB	Channel	Right OB
E.G. Elev (ft)	1237.31	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.80	Wt. n-Val.	0.060	0.035	0.060
W.S. Elev (ft)	1236.51	Reach Len. (ft)	499.05	499.45	598.24
Crit W.S. (ft)	1236.51	Flow Area (sq ft)	27.51	126.29	0.28
E.G. Slope (ft/ft)	0.015792	Area (sq ft)	27.51	126.29	0.28
Q Total (cfs)	1050.00	Flow (cfs)	106.23	943.56	0.21
Top Width (ft)	98.06	Top Width (ft)	19.73	75.99	2.34
Vel Total (ft/s)	6.81	Avg. Vel. (ft/s)	3.86	7.47	0.75
Max Chl Dpth (ft)	3.26	Hydr. Depth (ft)	1.39	1.66	0.12
Conv. Total (cfs)	8355.6	Conv. (cfs)	845.3	7508.6	1.7
Length Wtd. (ft)	499.56	Wetted Per. (ft)	19.90	76.20	2.35
Min Ch El (ft)	1233.25	Shear (lb/sq ft)	1.36	1.63	0.12
Alpha	1.11	Stream Power (lb/ft s)	5.26	12.21	0.09
Frctn Loss (ft)	6.27	Cum Volume (acre-ft)	1.85	9.52	0.70
C & E Loss (ft)	0.09	Cum SA (acres)	1.66	4.73	0.98

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: Divided flow computed for this cross-section.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: Fan12
REACH: 1 RS: 2950.532

INPUT
Description:
Station Elevation Data num= 24

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1237.12	12.92	1236.3	25.84	1234.47	38.76	1232.55	51.68	1230.63
64.6	1228.7	71.39	1228.22	77.52	1227.78	90.44	1227.75	103.36	1227.82
116.29	1227.91	129.21	1228	142.13	1228.11	155.05	1228.22	167.97	1228.33
180.89	1228.87	182.11	1228.99	193.81	1230.09	206.73	1231.3	219.65	1232.47
232.57	1233.64	245.49	1234.62	258.41	1235.23	272.79	1235.89		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	71.39	.035	182.11	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
71.39	182.11	519.31	549.77	567.87	.1	.3

CROSS SECTION OUTPUT Profile #Q100

			Left OB	Channel	Right OB
E.G. Elev (ft)	1230.17	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.52	Wt. n-Val.	0.060	0.035	0.060
W.S. Elev (ft)	1229.65	Reach Len. (ft)	519.31	549.77	567.87
Crit W.S. (ft)	1229.46	Flow Area (sq ft)	11.09	175.46	2.31
E.G. Slope (ft/ft)	0.010205	Area (sq ft)	11.09	175.46	2.31
Q Total (cfs)	1050.00	Flow (cfs)	24.67	1022.58	2.75
Top Width (ft)	130.88	Top Width (ft)	13.14	110.72	7.01
Vel Total (ft/s)	5.56	Avg. Vel. (ft/s)	2.22	5.83	1.19
Max Chl Dpth (ft)	1.90	Hydr. Depth (ft)	0.84	1.58	0.33
Conv. Total (cfs)	10394.2	Conv. (cfs)	244.2	10122.8	27.2
Length Wtd. (ft)	548.08	Wetted Per. (ft)	13.23	110.76	7.04
Min Ch El (ft)	1227.75	Shear (lb/sq ft)	0.53	1.01	0.21
Alpha	1.07	Stream Power (lb/ft s)	1.19	5.88	0.25
Frctn Loss (ft)	6.01	Cum Volume (acre-ft)	1.63	7.79	0.68
C & E Loss (ft)	0.04	Cum SA (acres)	1.48	3.66	0.92

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Fan12
REACH: 1 RS: 2400.759

INPUT
Description:
Station Elevation Data num= 24

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev

0	1227.77	10.06	1227.71	20.12	1227.28	30.18	1226	40.23	1224.72
50.29	1223.44	60.35	1222.16	70.41	1220.95	74.95	1220.67	80.47	1220.32
90.53	1220.61	100.59	1220.91	110.65	1221.2	120.7	1221.58	125.08	1221.88
130.76	1222.26	140.82	1223.14	150.88	1224.03	160.94	1224.92	171	1225.82
181.06	1226.72	191.12	1227.61	201.17	1228.51	214.99	1229.7		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	74.95	.035	125.08	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
74.95	125.08	874.71	872.45	881.43	.1	.3

CROSS SECTION OUTPUT Profile #Q100

			Left OB	Channel	Right OB
E.G. Elev (ft)	1224.11	Element			
Vel Head (ft)	0.89	Wt. n-Val.	0.060	0.035	0.060
W.S. Elev (ft)	1223.23	Reach Len. (ft)	874.71	872.45	881.43
Crit W.S. (ft)	1223.15	Flow Area (sq ft)	32.27	114.56	11.92
E.G. Slope (ft/ft)	0.011801	Area (sq ft)	32.27	114.56	11.92
Q Total (cfs)	1050.00	Flow (cfs)	108.37	916.11	25.52
Top Width (ft)	89.84	Top Width (ft)	22.99	50.13	16.72
Vel Total (ft/s)	6.61	Avg. Vel. (ft/s)	3.36	8.00	2.14
Max Chl Dpth (ft)	2.91	Hydr. Depth (ft)	1.40	2.29	0.71
Conv. Total (cfs)	9665.7	Conv. (cfs)	997.6	8433.2	234.9
Length Wtd. (ft)	872.83	Wetted Per. (ft)	23.14	50.17	16.78
Min Ch El (ft)	1220.32	Shear (lb/sq ft)	1.03	1.68	0.52
Alpha	1.30	Stream Power (lb/ft s)	3.45	13.45	1.12
Frctn Loss (ft)	10.67	Cum Volume (acre-ft)	1.37	5.96	0.59
C & E Loss (ft)	0.01	Cum SA (acres)	1.26	2.64	0.76

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Fan12
REACH: 1 RS: 1528.313

INPUT
Description:
Station Elevation Data num= 23

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1214.61	10.31	1214.46	20.63	1214.28	30.94	1213.99	41.26	1213.69
51.57	1213.39	61.89	1212.63	72.2	1211.65	78.31	1211.21	82.52	1210.92
92.83	1210.25	103.14	1209.92	113.46	1210.04	123.77	1210.12	134.09	1210.67
135.02	1210.78	144.4	1211.91	154.72	1213.21	165.03	1214.56	175.35	1215.97
185.66	1216.29	195.97	1216.28	202.67	1216.25				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	78.31	.035	135.02	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
78.31	135.02	734.69	729.24	752.68	.1	.3

CROSS SECTION OUTPUT Profile #Q100

			Left OB	Channel	Right OB
E.G. Elev (ft)	1213.44	Element			
Vel Head (ft)	0.96	Wt. n-Val.	0.060	0.035	0.060
W.S. Elev (ft)	1212.48	Reach Len. (ft)	734.69	729.24	752.68
Crit W.S. (ft)	1212.48	Flow Area (sq ft)	10.09	124.06	11.98
E.G. Slope (ft/ft)	0.012669	Area (sq ft)	10.09	124.06	11.98
Q Total (cfs)	1050.00	Flow (cfs)	21.65	998.31	30.05
Top Width (ft)	85.51	Top Width (ft)	14.88	56.71	13.93
Vel Total (ft/s)	7.19	Avg. Vel. (ft/s)	2.15	8.05	2.51
Max Chl Dpth (ft)	2.56	Hydr. Depth (ft)	0.68	2.19	0.86
Conv. Total (cfs)	9328.7	Conv. (cfs)	192.3	8869.4	267.0
Length Wtd. (ft)	730.01	Wetted Per. (ft)	14.93	56.77	14.03
Min Ch El (ft)	1209.92	Shear (lb/sq ft)	0.53	1.73	0.68
Alpha	1.20	Stream Power (lb/ft s)	1.15	13.91	1.69
Frctn Loss (ft)	9.32	Cum Volume (acre-ft)	0.94	3.57	0.35
C & E Loss (ft)	0.00	Cum SA (acres)	0.88	1.57	0.45

Warning: The energy equation could not be balanced within the specified number of iterations. The program selected the water surface that had the least amount of error between computed and assumed values.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: Fan12
REACH: 1 RS: 799.0694

INPUT
Description:
Station Elevation Data num= 24

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1204.61	10.04	1204.66	20.08	1204.81	30.11	1204.37	40.15	1203.66
50.19	1202.97	60.23	1202.3	70.27	1201.64	80.3	1200.98	83.97	1200.88
90.34	1200.7	100.38	1200.63	110.42	1200.58	120.46	1200.51	130.49	1201.63
132.93	1202.07	140.53	1203.44	150.57	1205.34	160.61	1207.21	170.65	1208.92
180.68	1209.88	190.72	1210.4	200.76	1210.88	209.56	1211.3		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	83.97	.035	132.93	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
83.97	132.93	645.99	632.91	625.33	.1	.3

CROSS SECTION OUTPUT Profile #Q100

			Left OB	Channel	Right OB
E.G. Elev (ft)	1204.01	Element			
Vel Head (ft)	0.96	Wt. n-Val.	0.060	0.035	0.060
W.S. Elev (ft)	1203.05	Reach Len. (ft)	645.99	632.91	625.33
Crit W.S. (ft)	1203.05	Flow Area (sq ft)	40.38	110.96	2.68
E.G. Slope (ft/ft)	0.012867	Area (sq ft)	40.38	110.96	2.68
Q Total (cfs)	1050.00	Flow (cfs)	124.68	920.69	4.64
Top Width (ft)	89.40	Top Width (ft)	34.98	48.96	5.45
Vel Total (ft/s)	6.82	Avg. Vel. (ft/s)	3.09	8.30	1.73
Max Chl Dpth (ft)	2.54	Hydr. Depth (ft)	1.15	2.27	0.49
Conv. Total (cfs)	9256.5	Conv. (cfs)	1099.1	8116.5	40.9
Length Wtd. (ft)	633.95	Wetted Per. (ft)	35.05	49.06	5.54
Min Ch El (ft)	1200.51	Shear (lb/sq ft)	0.93	1.82	0.39
Alpha	1.32	Stream Power (lb/ft s)	2.86	15.07	0.67
Frctn Loss (ft)	7.80	Cum Volume (acre-ft)	0.52	1.60	0.22
C & E Loss (ft)	0.01	Cum SA (acres)	0.46	0.69	0.28

Warning: The energy equation could not be balanced within the specified number of iterations. The

program used critical depth for the water surface and continued on with the calculations.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: Fan12
REACH: 1 RS: 166.1562

INPUT
Description:
Station Elevation Data num= 40

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1195.11	10.36	1195.15	20.72	1195.14	31.08	1195.12	41.44	1195.09
51.8	1195.08	62.16	1195.08	72.52	1195.09	82.88	1195.09	93.24	1195.09
103.6	1195.08	113.96	1195.06	124.33	1195.05	134.69	1194.77	145.05	1194.04
155.41	1193.2	165.77	1192.37	172.04	1191.87	176.13	1191.55	186.49	1191.25
196.85	1191.52	207.21	1191.82	217.56	1192.32	217.57	1192.32	227.93	1192.89
238.29	1193.43	248.65	1193.91	259.01	1194.33	269.37	1194.72	279.73	1194.82
290.09	1194.86	300.45	1194.91	310.81	1194.96	321.17	1195	331.53	1195.02
341.89	1195.02	352.26	1195.02	362.62	1195.02	372.98	1195.01	383.77	1195

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.06	172.04	.035	217.56	.06

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
172.04	217.56	189.56	166.16	130.21	.1	.3

CROSS SECTION OUTPUT Profile #Q100

E.G. Elev (ft)	1194.96	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.92	Wt. n-Val.	0.060	0.035	0.060
W.S. Elev (ft)	1194.04	Reach Len. (ft)			
Crit W.S. (ft)	1194.04	Flow Area (sq ft)	29.33	109.22	27.96
E.G. Slope (ft/ft)	0.011773	Area (sq ft)	29.33	109.22	27.96
Q Total (cfs)	1050.00	Flow (cfs)	83.17	901.24	65.58
Top Width (ft)	106.72	Top Width (ft)	26.96	45.52	34.24
Vel Total (ft/s)	6.31	Avg. Vel. (ft/s)	2.84	8.25	2.35
Max Chl Dpth (ft)	2.79	Hydr. Depth (ft)	1.09	2.40	0.82
Conv. Total (cfs)	9677.0	Conv. (cfs)	766.6	8306.0	604.4
Length Wtd. (ft)		Wetted Per. (ft)	27.05	45.56	34.28
Min Ch El (ft)	1191.25	Shear (lb/sq ft)	0.80	1.76	0.60
Alpha	1.49	Stream Power (lb/ft s)	2.26	14.54	1.41
Frctn Loss (ft)		Cum Volume (acre-ft)			
C & E Loss (ft)		Cum SA (acres)			

Warning: Slope too steep for slope area to converge during supercritical flow calculations (normal depth is below critical depth). Water surface set to critical depth.

SUMMARY OF MANNING'S N VALUES

River:Fan12

Reach	River Sta.	n1	n2	n3
1	3761.932	.06	.035	.06
1	3449.982	.06	.035	.06
1	2950.532	.06	.035	.06
1	2400.759	.06	.035	.06
1	1528.313	.06	.035	.06
1	799.0694	.06	.035	.06
1	166.1562	.06	.035	.06

SUMMARY OF REACH LENGTHS

River: Fan12

Reach	River Sta.	Left	Channel	Right
1	3761.932	304.36	311.95	367.52
1	3449.982	499.05	499.45	598.24
1	2950.532	519.31	549.77	567.87
1	2400.759	874.71	872.45	881.43
1	1528.313	734.69	729.24	752.68
1	799.0694	645.99	632.91	625.33
1	166.1562	189.56	166.16	130.21

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: Fan12

Reach	River Sta.	Contr.	Expan.
1	3761.932	.1	.3
1	3449.982	.1	.3
1	2950.532	.1	.3
1	2400.759	.1	.3
1	1528.313	.1	.3
1	799.0694	.1	.3
1	166.1562	.1	.3

Profile Output Table - Standard Table 1

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	3761.932	Q100	1050.00	1238.79	1243.06	1243.06	1244.35	0.012988	9.31	120.79	50.89	1.00
1	3449.982	Q100	1050.00	1233.25	1236.51	1236.51	1237.31	0.015792	7.47	154.07	98.06	1.02
1	2950.532	Q100	1050.00	1227.75	1229.65	1229.46	1230.17	0.010205	5.83	188.86	130.88	0.82
1	2400.759	Q100	1050.00	1220.32	1223.23	1223.15	1224.11	0.011801	8.00	158.74	89.84	0.93
1	1528.313	Q100	1050.00	1209.92	1212.48	1212.48	1213.44	0.012669	8.05	146.12	85.51	0.96
1	799.0694	Q100	1050.00	1200.51	1203.05	1203.05	1204.01	0.012867	8.30	154.02	89.40	0.97
1	166.1562	Q100	1050.00	1191.25	1194.04	1194.04	1194.96	0.011773	8.25	166.51	106.72	0.94

Appendix F

Erosion/Sediment Transport

No erosion or sediment transport analyses were conducted for this study.

Appendix G

Geomorphology Analyses Supporting Documentation

Appendix G is a separate volume previously submitted as part of the Sun Valley Area Drainage Master Plan.

EXHIBIT A

HYDROLOGY EXHIBIT MAPS

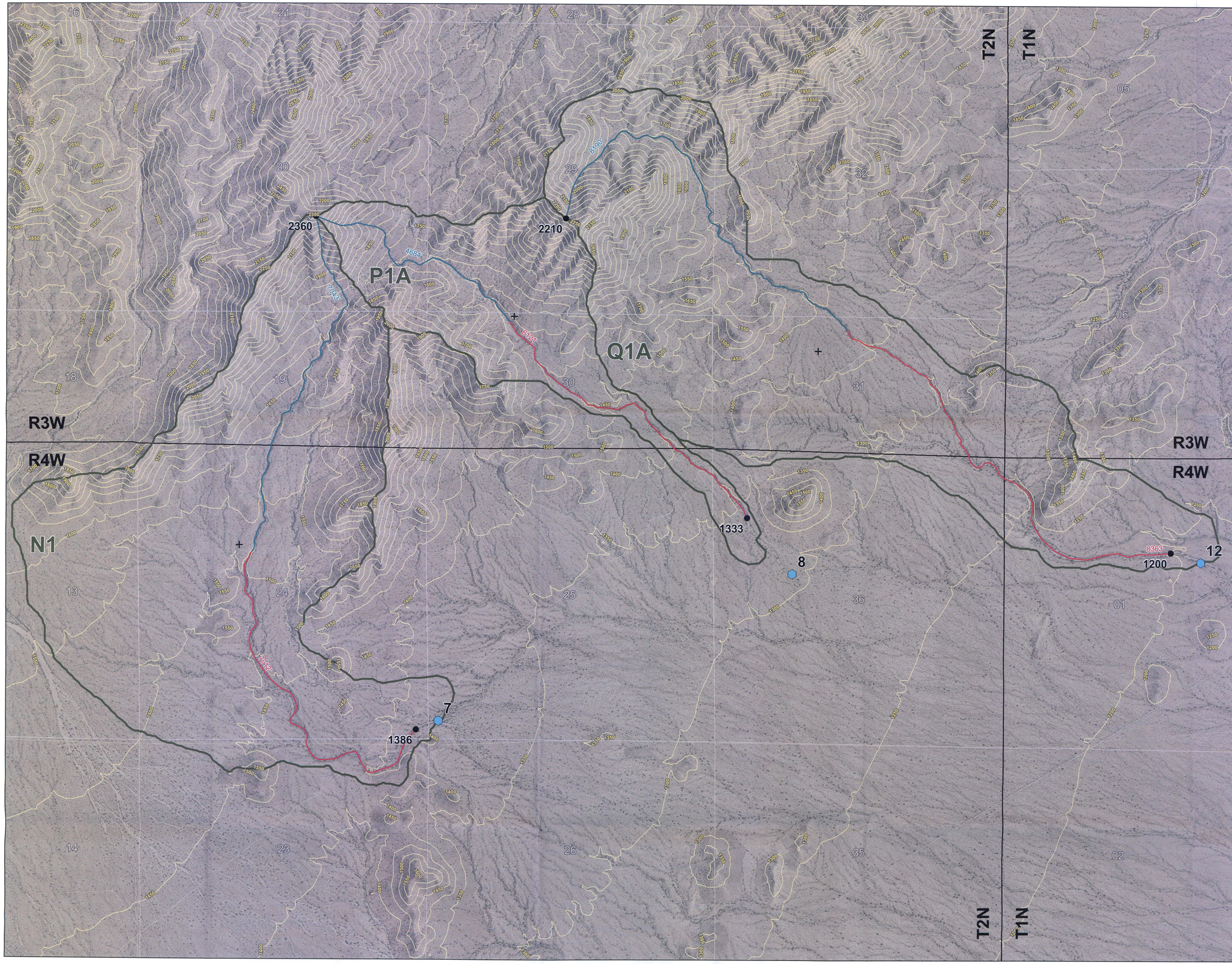
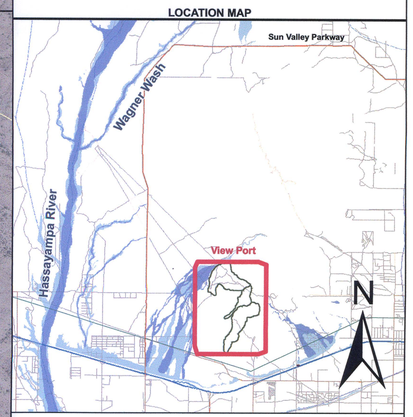


PLATE 1
WATERSHED MAP

HYDROLOGY FOR FANS 7, 8, & 12 APPROXIMATE FDS

- Subbasin Boundaries
- Lca Paths
- Lag Time Paths
- Fan Apices
- Subbasin Centroids
- Elevation Points
- 50-ft Index Contours

LOCATION MAP



FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

APPROXIMATE ZONE A
FLOODPLAIN DELINEATION STUDY OF

FAN SYSTEM 7, 8, & 12

SHEET 1 OF 3
FCD 2005C024
2007

Feet
0 800 1,600 2,400

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC

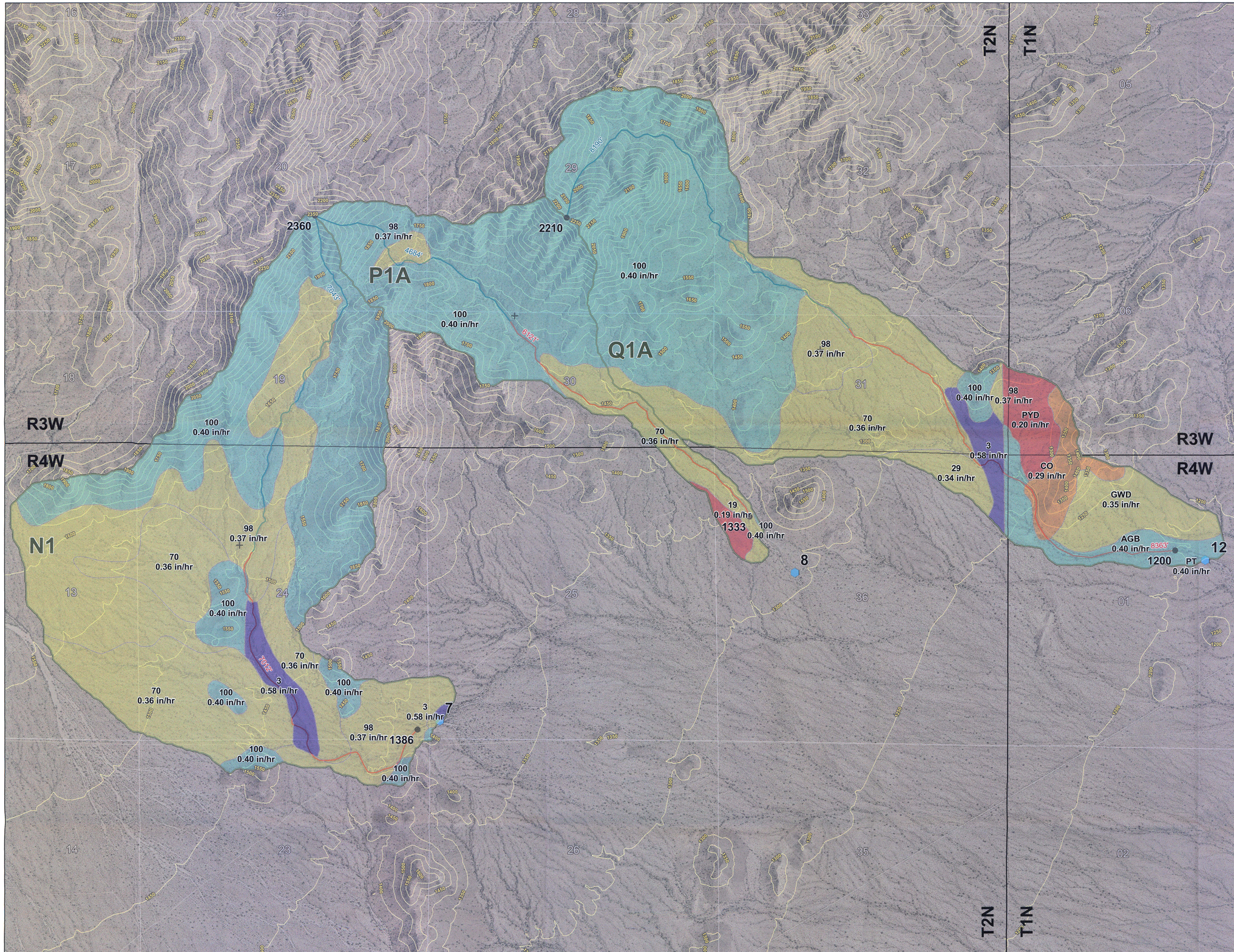


PLATE 2
SOIL MAP

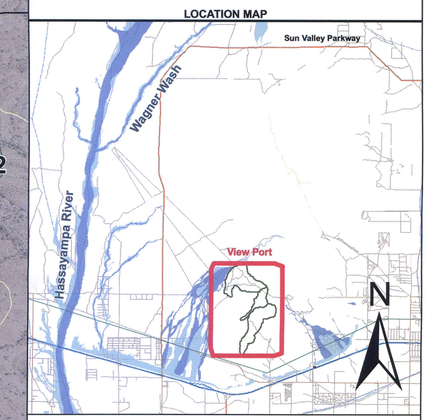
HYDROLOGY FOR FANS 7, 8, & 12 APPROXIMATE FDS

NRCS Soil Data

XKSAT (in/hr)

- 0.19 - 0.25
- 0.26 - 0.32
- 0.33 - 0.38
- 0.39 - 0.45
- 0.46 - 0.51
- 0.52 - 0.58
- Elevation Points
- Subbasin Centroids
- Fan Apices
- Lag Time Paths
- Lca Paths
- Subbasin Boundaries
- 50-ft Index Contours

LOCATION MAP



FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

APPROXIMATE ZONE A
FLOODPLAIN DELINEATION STUDY OF

FAN SYSTEM 7, 8, & 12

SHEET 2 OF 3
FCD 2005C024
2007

Feet
0 800 1,600 2,400

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC

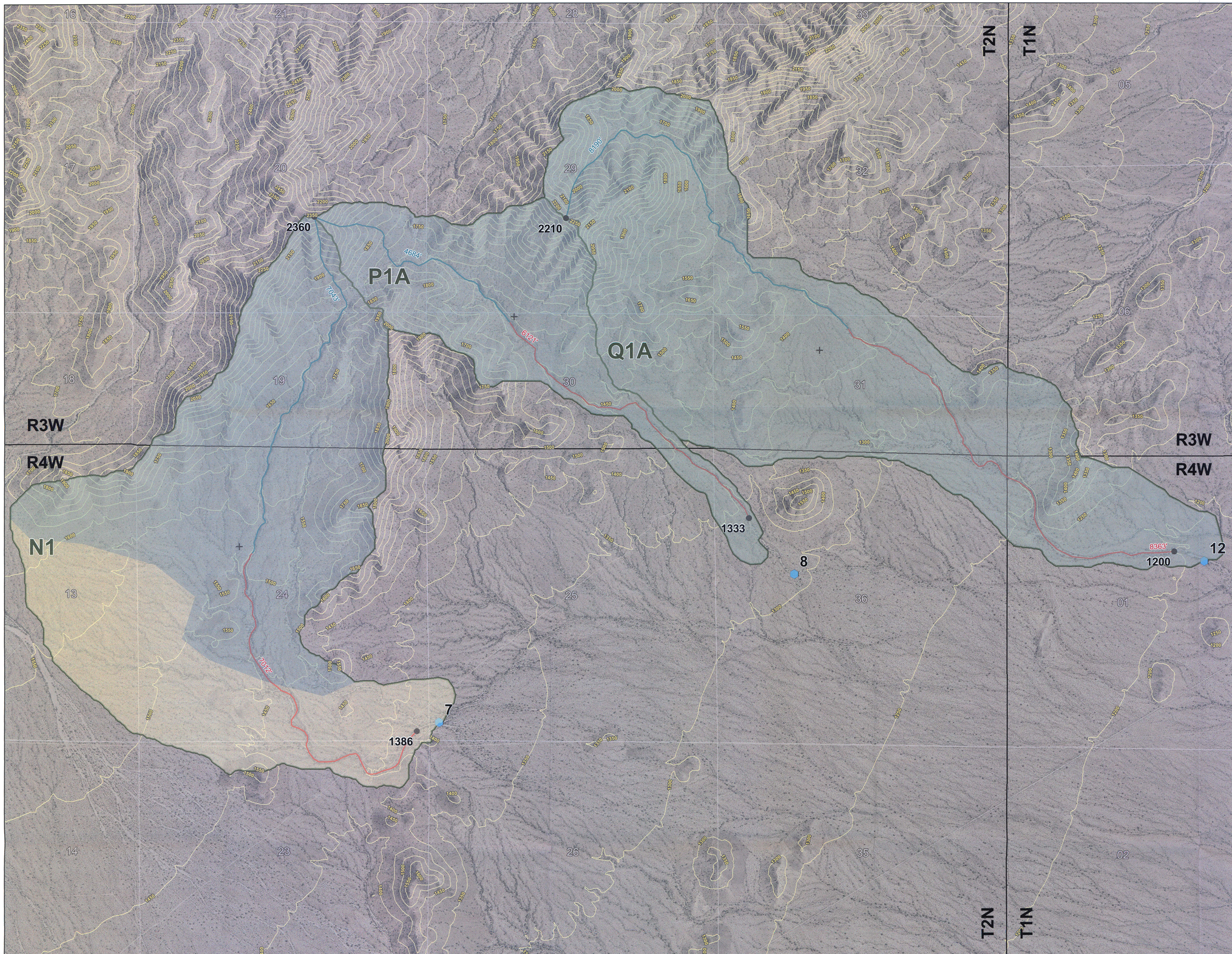


PLATE 3
LAND USE MAP

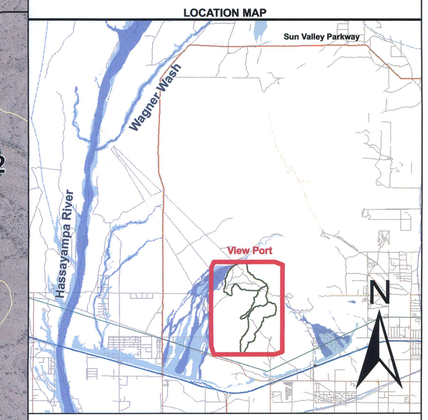
HYDROLOGY FOR FANS 7, 8, & 12 APPROXIMATE FDS

Existing Land Use

TYPE

- Desert Rangeland (NDR)- 0-5% slopes
- Mountain Terrain (NMT)- >10% slopes
- Elevation Points
- Subbasin Centroids
- Fan Apices
- Lag Time Paths
- Lca Paths
- Subbasin Boundaries
- 50-ft Index Contours

LOCATION MAP



FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

APPROXIMATE ZONE A
FLOODPLAIN DELINEATION STUDY OF

FAN SYSTEM 7, 8, & 12

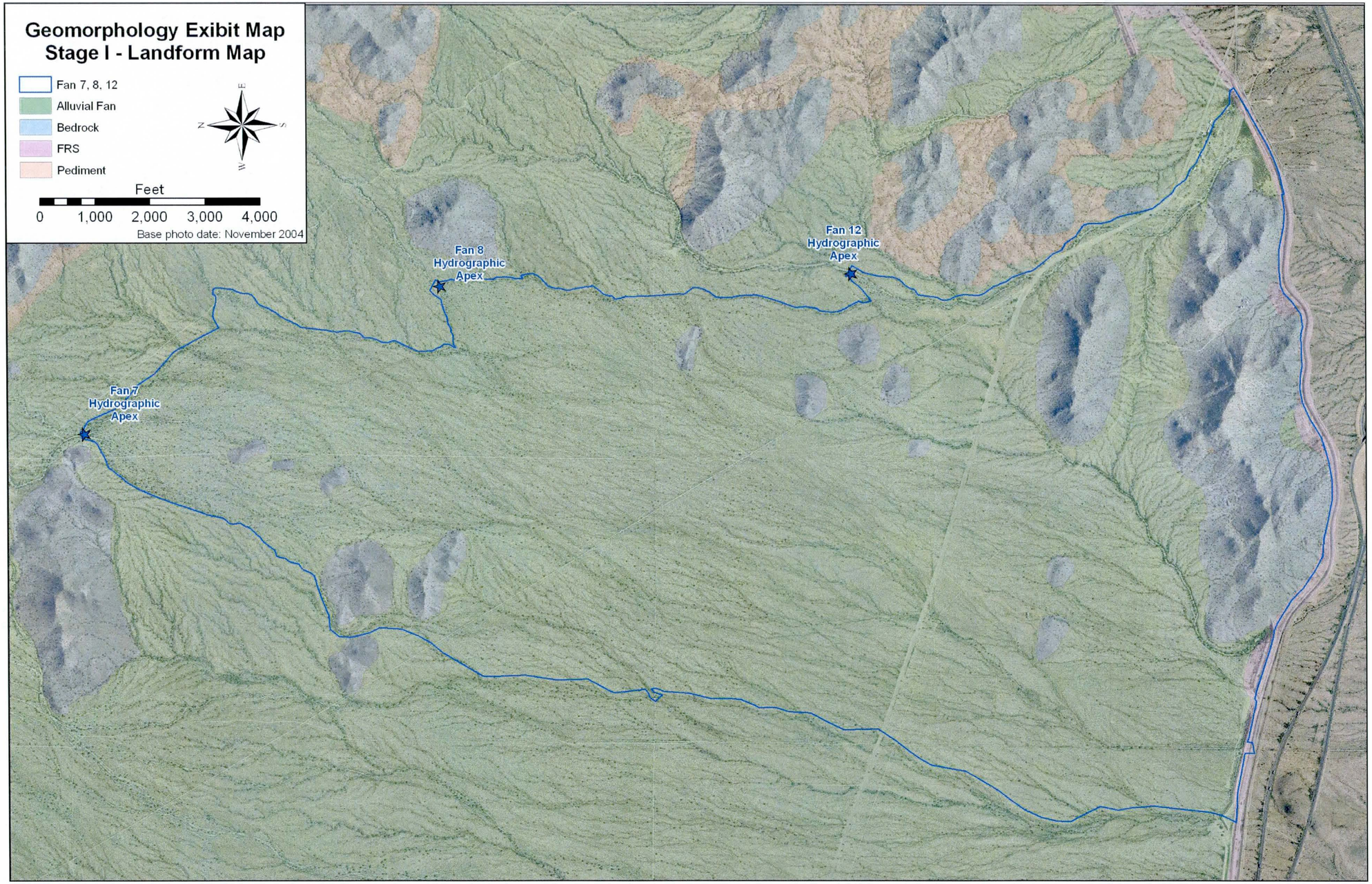
SHEET 2 OF 3
FCD 2005C024
2007

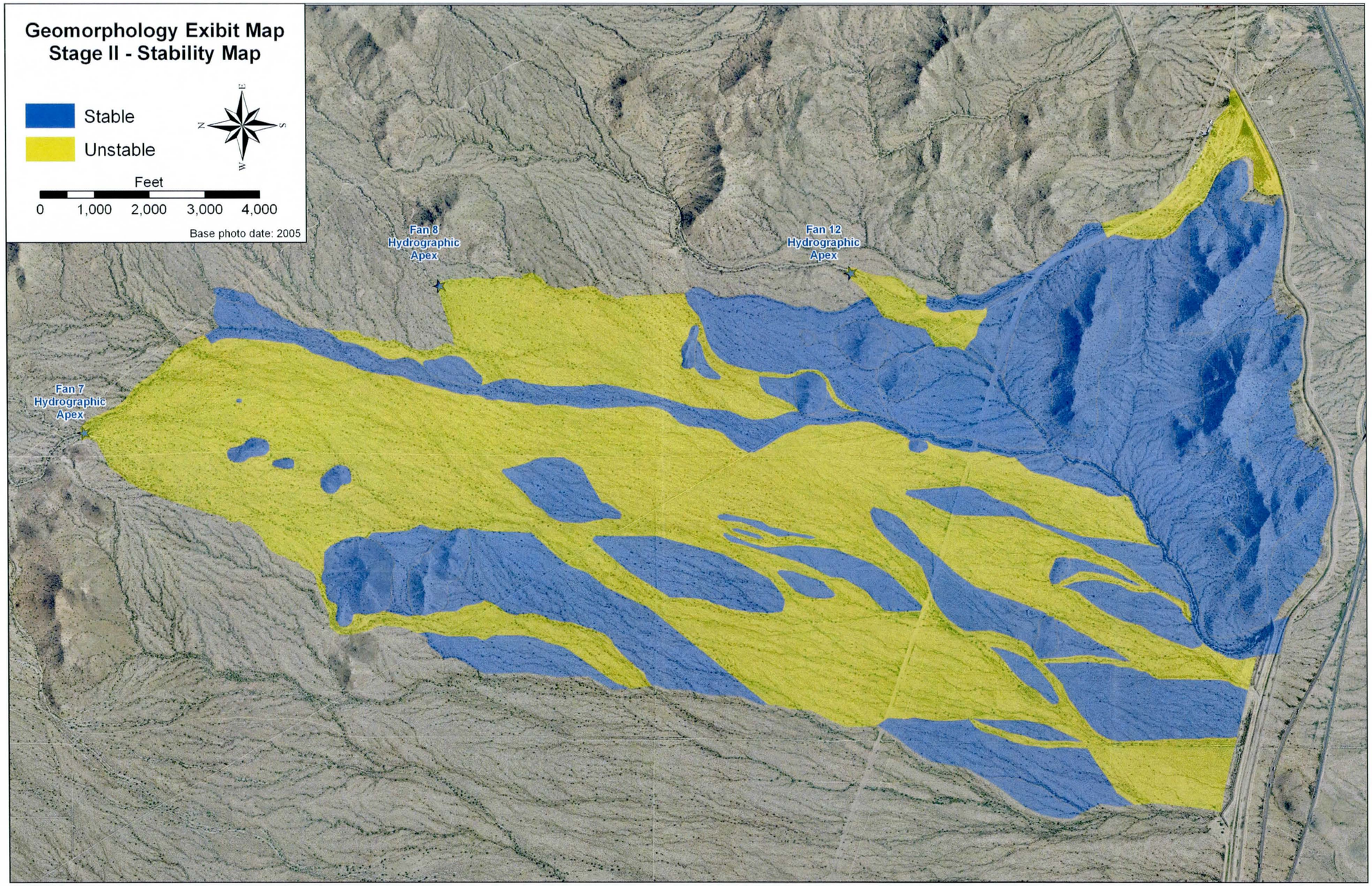
Feet
0 800 1,600 2,400

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC

EXHIBIT B

GEOMORPHOLOGY EXHIBIT MAPS


Geomorphology Exibit Map
Stage I - Landform Map
Fan 7, 8, 12
Alluvial Fan
Bedrock
FRS
Pediment
Feet
0
1,000
2,000
3,000
4,000
Base photo date: November 2004
Fan 7
Hydrographic
Apex
Fan 8
Hydrographic
Apex
Fan 12
Hydrographic
Apex


Geomorphology Exibit Map
Stage II - Stability Map
Stable
Unstable
Feet
0
1,000
2,000
3,000
4,000
Base photo date: 2005
Fan 8
Hydrographic
Apex
Fan 12
Hydrographic
Apex
Fan 7
Hydrographic
Apex

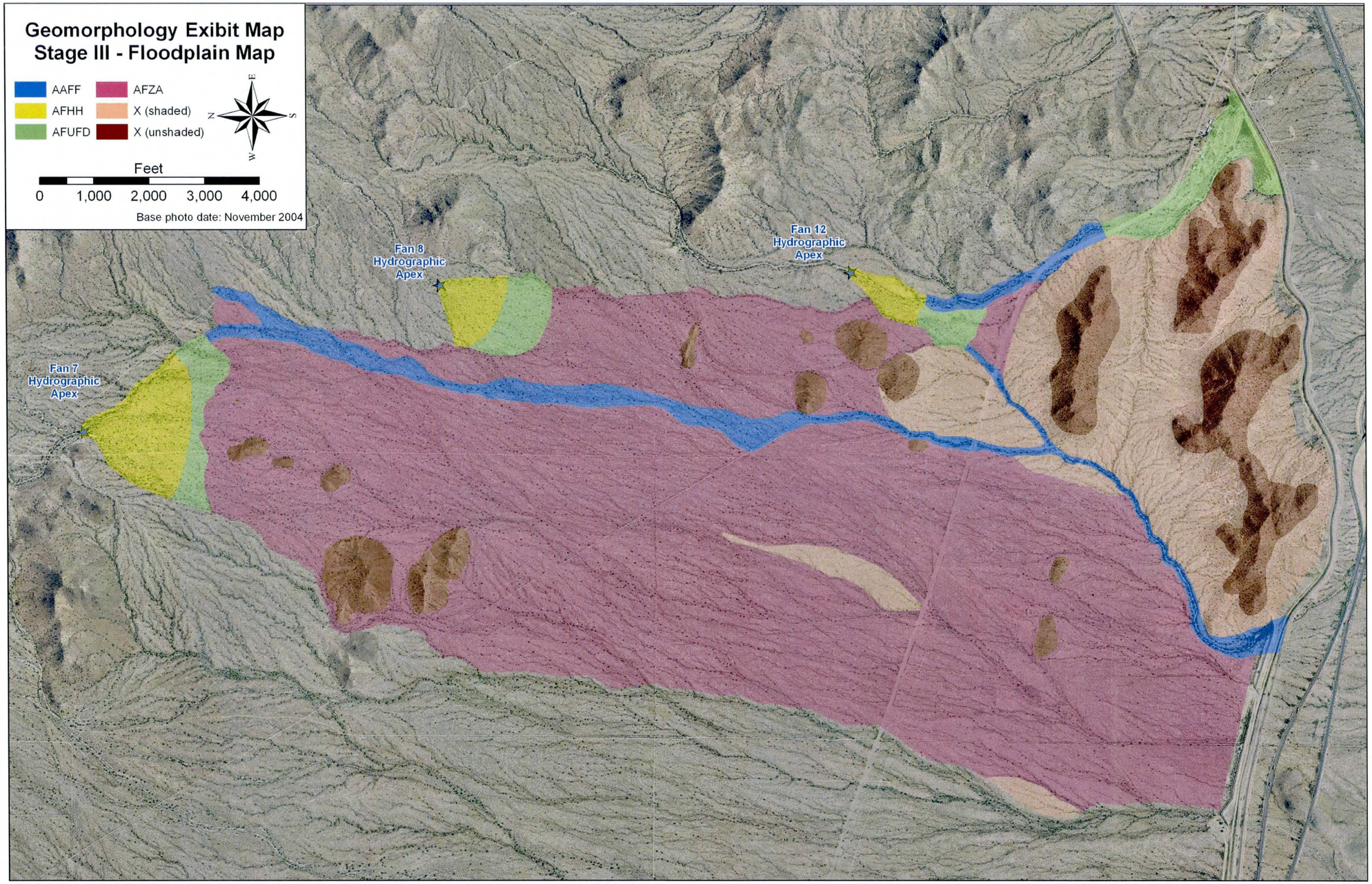

Geomorphology Exibit Map
Stage III - Floodplain Map
AAFF
AFHH
AFUFD
AFZA
X (shaded)
X (unshaded)
E
N
S
W
Feet
0
1,000
2,000
3,000
4,000
Base photo date: November 2004
Fan 8
Hydrographic
Apex
Fan 12
Hydrographic
Apex
Fan 7
Hydrographic
Apex

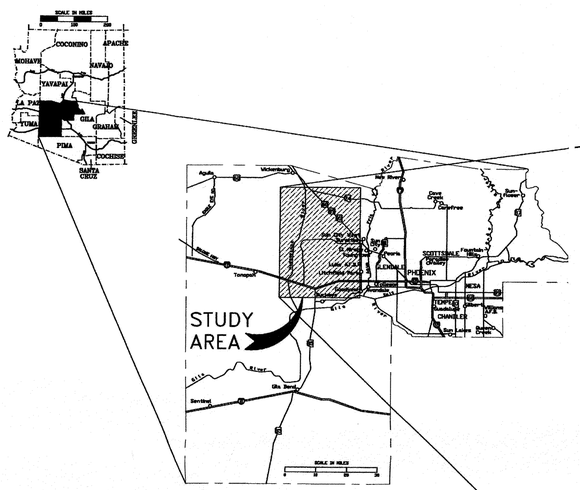
EXHIBIT C

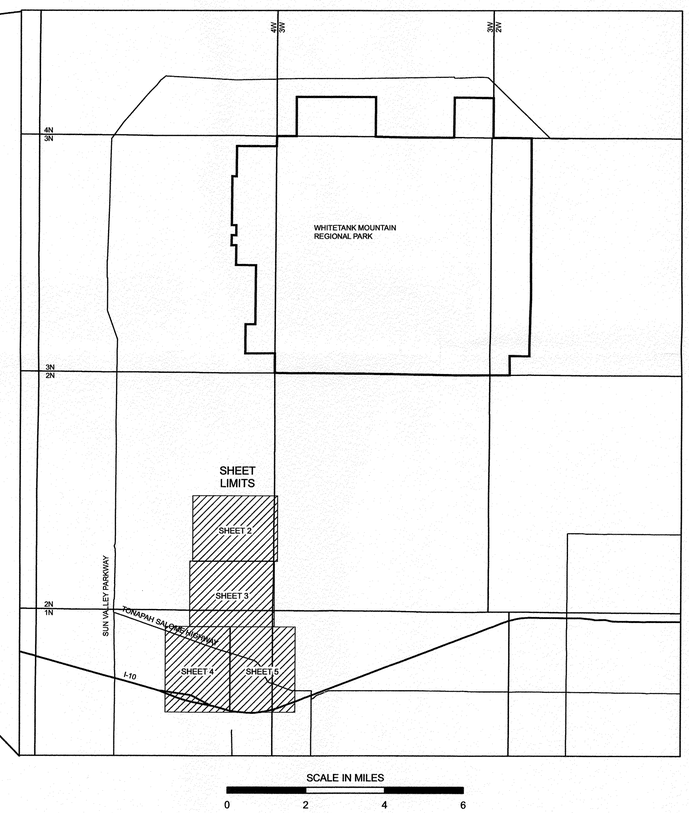
HYDRAULICS STUDY WORK MAPS

FLOOD CONTROL DISCTRICT OF MARICOPA COUNTY

APPROXIMATE FLOODPLAIN DELINEATION STUDY OF THE WHITE TANK MOUNTAIN PIEMONT FAN SITES 7, 8, & 12
FCD 2005C024

ARIZONA





NOTES

1. SECTION BOUNDARIES PROVIDED BY FCDMC
2. HORIZONTAL PROJECTION IS ARIZONA STATE PLANE, CENTRAL ZONE, NORTH AMERICAN DATUM OF 1983
3. ALL ELEVATIONS ARE BASED ON NORTH AMERICAN VERTICAL DATUM OF 1988

STATEMENTS OF PROFESSIONAL REGISTRANT

THE FLOODPLAIN DELINEATIONS PRESENTED ON THE FOLLOWING SHEETS WERE PREPARED UNDER MY DIRECT SUPERVISION.

Registered Professional Engineer (Civil) CERTIFICATE NO. 26846 JONATHAN E. FULLER Date Signed 2-24-08 ARIZONA, U.S.A.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

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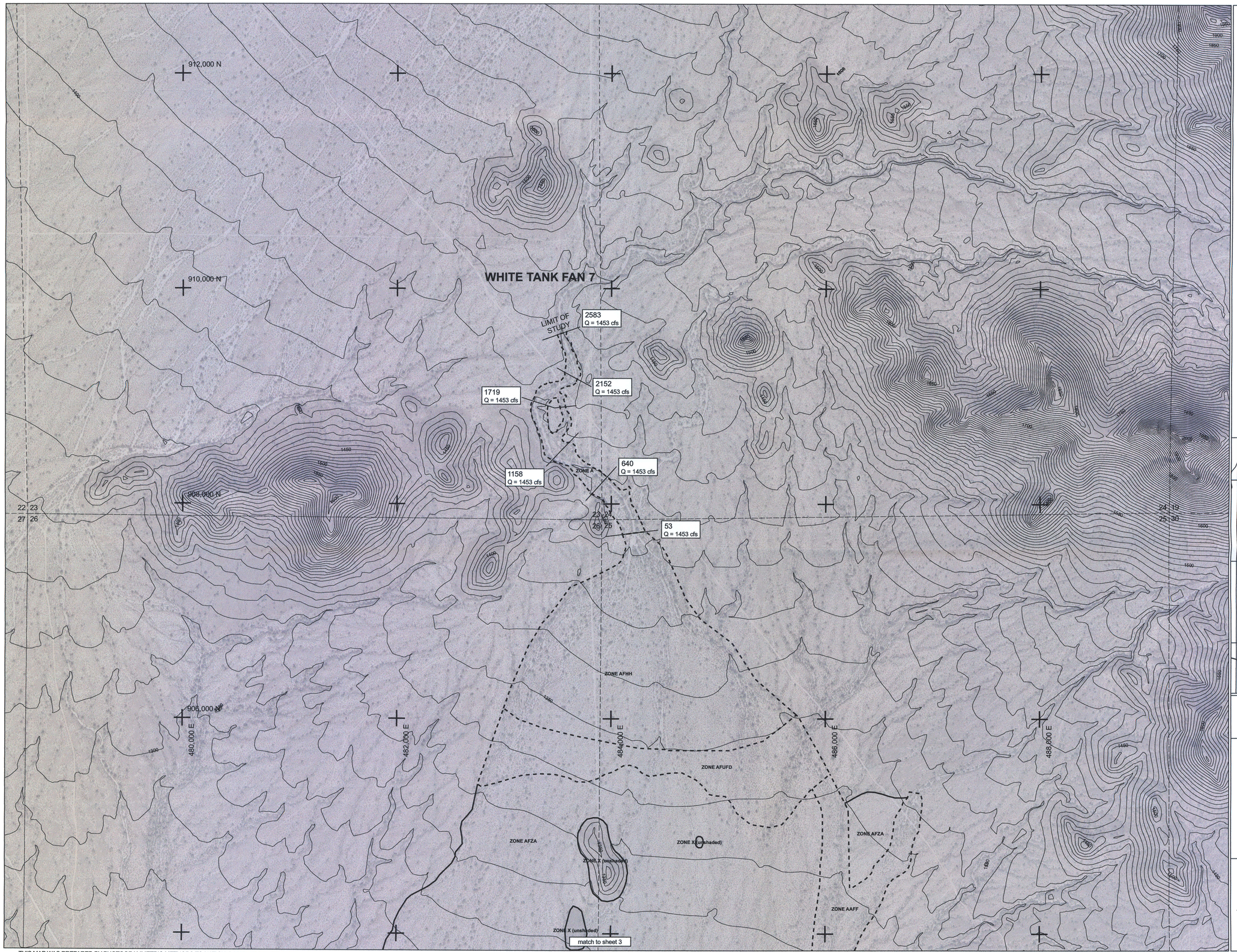
JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC

INDEX SHEET

DECEMBER, 2007



LEGEND

100-YR FLOODPLAIN	
100-YR ADMINISTRATIVE FLOODWAY	
EFFECTIVE 100-YR FLOODPLAIN BOUNDARY	
EFFECTIVE 100-YR FLOODWAY	
SECTION BOUNDARY	
CROSS SECTION	200 Q = 595 cfs
CORPORATE LIMITS	Corporate Limits
COUNTY BOUNDARY	County Boundary
STATE PLANE COORDINATES	1,046,800 N / 648,800 E

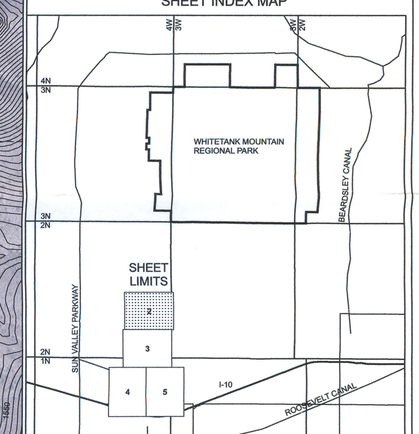
ZONE DESIGNATIONS

ZONE A	Approximate 100-year administrative floodway; riverine reaches upstream of hydrologic apex.
ZONE AFHH	Alluvial Fan High Hazard Administrative floodway
ZONE AFUFD	Alluvial Fan Uncertain Flow Distribution Area administrative flooday
ZONE AAFF	Approximate Alluvial Fan Floodway administrative floodway
ZONE AFZA	Alluvial Fan Zone A Floodplain
ZONE X (SHADED)	Areas flooded between 100- and 500-yr discharge, areas of 100-yr flooding depth less than 1 foot, or drainage area less than 1 square mile
ZONE X	Areas outside the 500-yr floodplain
ZONE D	Area not studied

NOTES

1. SECTION BOUNDARIES PROVIDED BY FCDMC
2. HORIZONTAL PROJECTION IS ARIZONA STATE PLANE, CENTRAL ZONE, NORTH AMERICAN DATUM OF 1983
3. ALL ELEVATIONS ARE BASED ON NORTH AMERICAN VERTICAL DATUM OF 1988

SHEET INDEX MAP



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

APPROXIMATE ZONE A FLOODPLAIN DELINEATION STUDY OF WHITE TANK FANS

7, 8, & 12

FCD 2005C024
2007

N

SCALE IN FEET
400' 0' 400' 800'
CONTOUR INVERVAL = 10 FEET

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

SHEET 2 OF 5

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS FOR 1"=500' HORIZONTAL SCALE AND 10' CONTOUR INTERVALS.

AERIAL PHOTOGRAPHY & TOPOGRAPHIC DATA PROVIDED TO THE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY BY LANDATA AIRBORNE SYSTEMS, IRVINE, CALIFORNIA, DECEMBER 27, 2000. AERIAL UPDATA: 2005

GROUND CONTROL SURVEY DATA PROVIDED BY RBF CONSULTING, PHOENIX, ARIZONA

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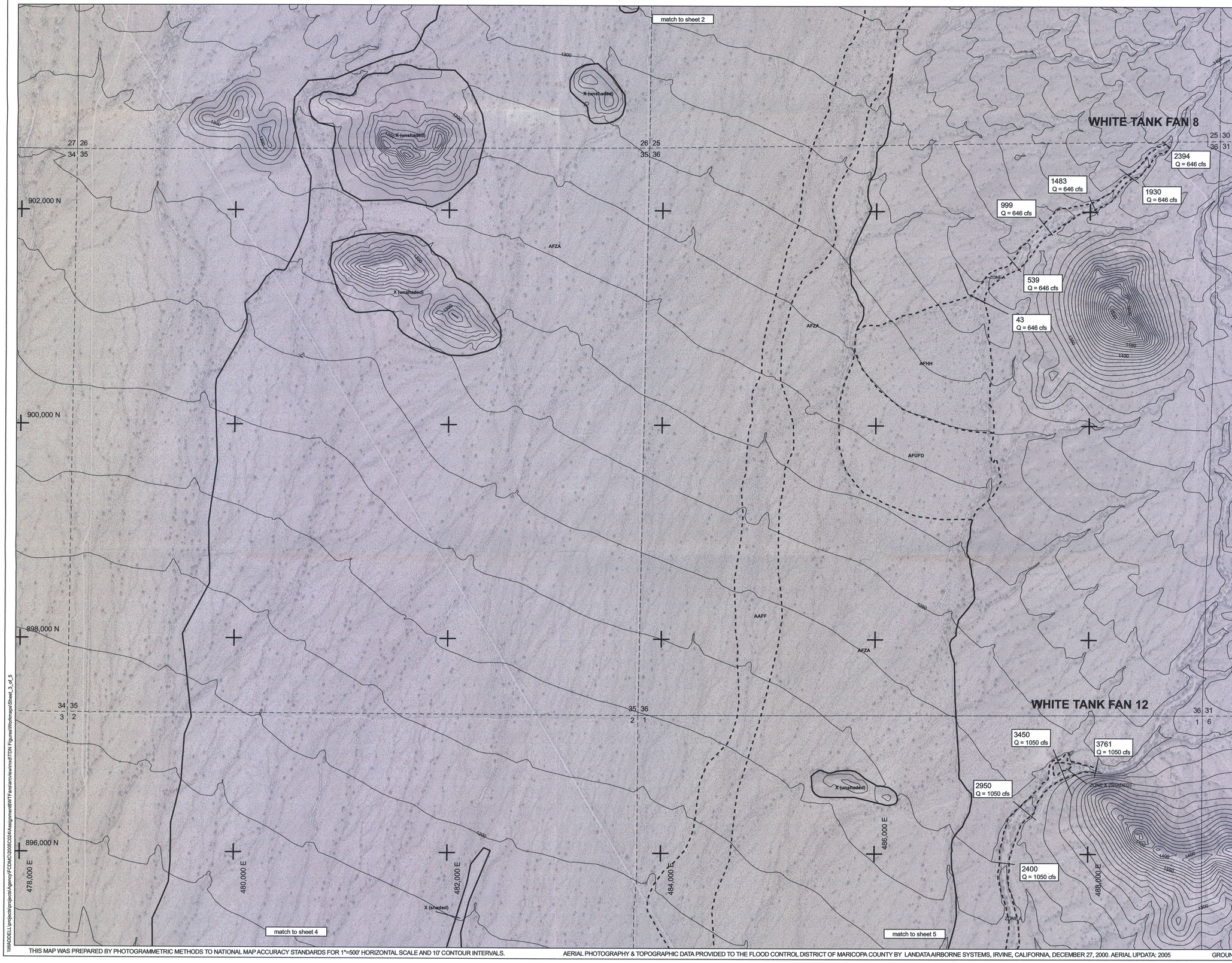

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- 100-YR ADMINISTRATIVE FLOODWAY
- EFFECTIVE 100-YR FLOODPLAIN BOUNDARY
- EFFECTIVE 100-YR FLOODWAY
- SECTION BOUNDARY
- CROSS SECTION — 200 / Q = 595 cfs
- CORPORATE LIMITS — Corporate Limits
- COUNTY BOUNDARY — County Boundary
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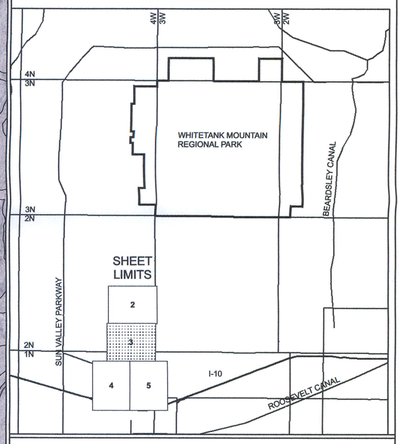

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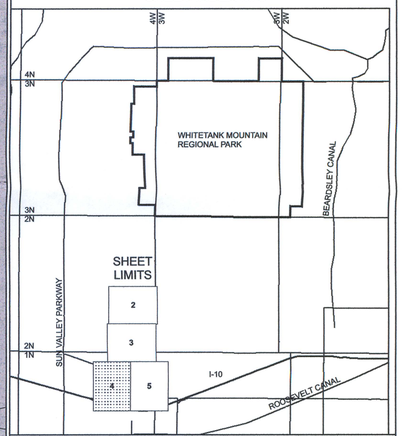

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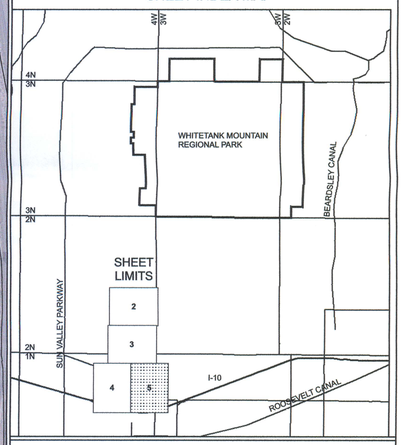

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NOTES TO USERS

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To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles, Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

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Spatial Reference System Division
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Silver Spring Metro Center
1315 East-West Highway
Silver Spring, Maryland 20910
(310) 713-3191

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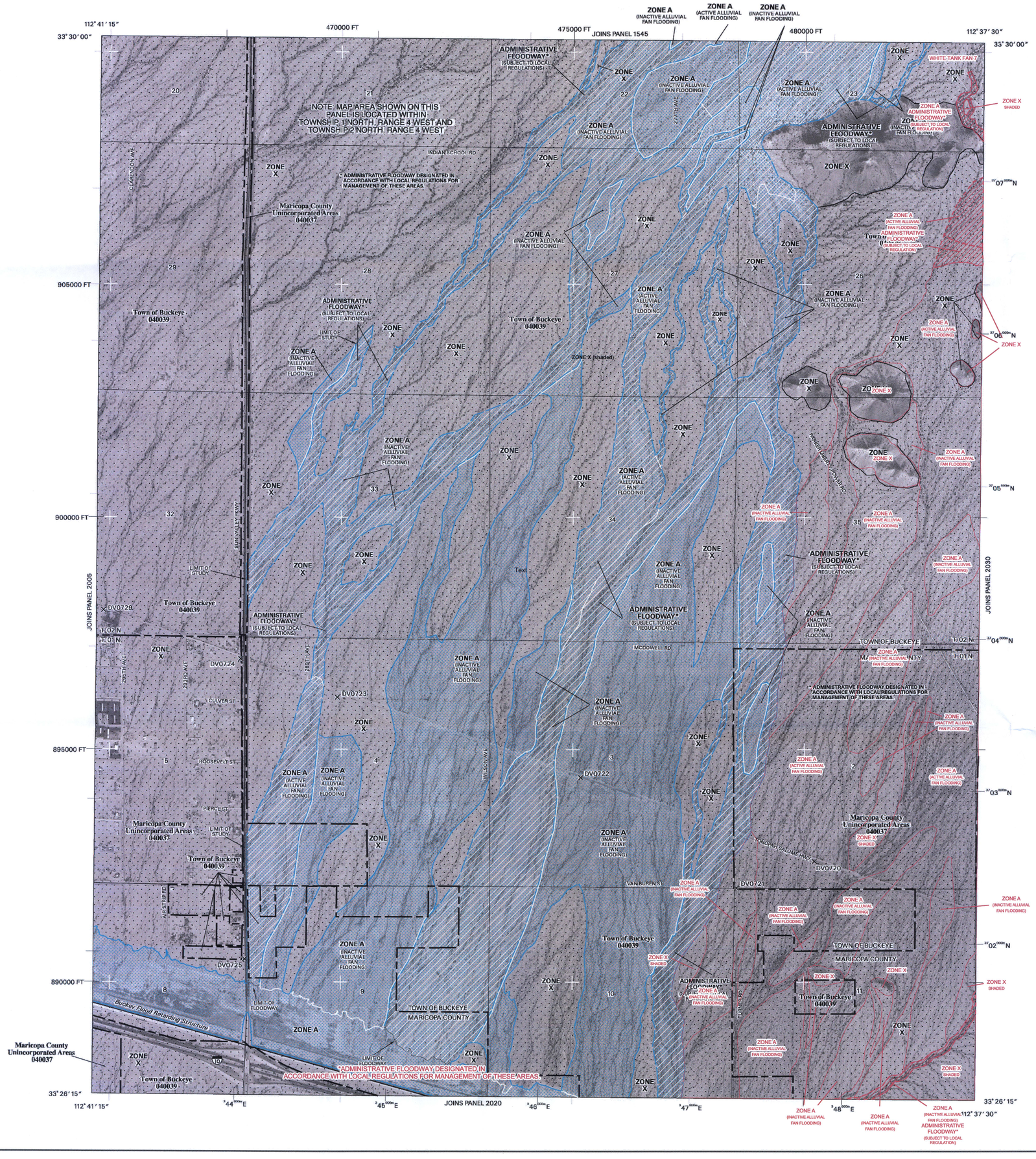
Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMAMAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/.

LEGEND FOR ANNOTATION

100-YEAR ADMINISTRATIVE FLOODWAY - - - - - -

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC. 2007



LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary

0.2% annual chance floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones, and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.

~~513~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the National Geodetic Vertical Datum of 1929

(A)———(A)	Cross section line
(2)- - - - -(2)	Transect line
112° 07′ 08″, 33° 25′ 41″	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere.
43 76000m E	1000-meter Universal Transverse Mercator grid tick values zone 12.
875000 FT	5000-foot grid tick values: Arizona State Plane coordinate system, central zone (FIPSZONE 3176) NAD83 (Transverse Mercator)
×DV2313	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORY
Refer to Repositories Listing on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
April 15, 1988

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
September 4, 1991, September 30, 1995, July 19, 2001

September 30, 2005 - to update corporate limits, to change Base Flood Elevations, to add Base Flood Elevations, to add Special Flood Hazard Areas, to change Special Flood Hazard Areas, to change zone designations, to add roads and road names, to incorporate previously issued Letters of Map Revision, and to incorporate previously issued Letters of Map Amendment.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 2010H

FIRM
FLOOD INSURANCE RATE MAP
MARICOPA COUNTY, ARIZONA
AND INCORPORATED AREAS

PANEL 2010 OF 4350

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
BUCKEYE, TOWN OF	040039	2010	H
MARICOPA COUNTY	040037	2010	H

(ANNOTATED 2007)

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
04013C2010H

MAP REVISED
SEPTEMBER 30, 2005

Federal Emergency Management Agency

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100-YEAR ADMINISTRATIVE FLOODWAY - - - - - -

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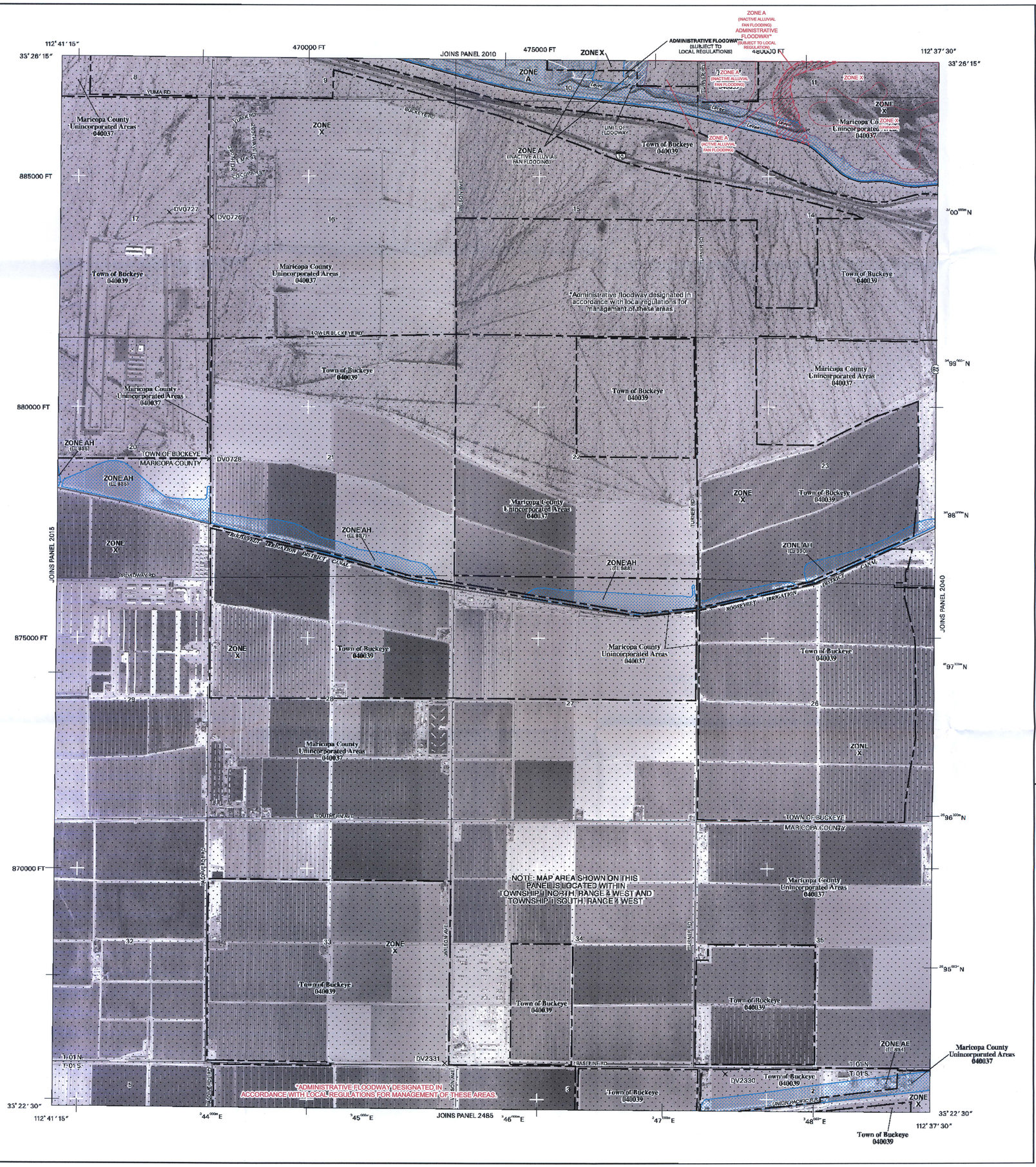

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The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	1% annual chance floodplain boundary
	0.2% annual chance floodplain boundary
	Floodway boundary
	Zone D boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Areas Zones, and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.
~~513~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the National Geodetic Vertical Datum of 1929

(A)——(A)	Cross section line
(2)- - - -(2)	Transect line
112° 07' 08", 33° 26' 41"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere.
4076000mE	1000-meter Universal Transverse Mercator grid tick values zone 12
875000 FT	5000-foot grid tick values: Arizona State Plane coordinate system, central zone (FIPSZONE 3176) NAD83 (Transverse Mercator)
×DV2313	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORY
Refer to Repositories Listing on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
April 15, 1988

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
September 4, 1991, September 30, 1995, July 19, 2001

September 30, 2005 - to update corporate limits, to change Base Flood Elevations, to add Base Flood Elevations, to add Special Flood Hazard Areas, to change Special Flood Hazard Areas, to change zone designations, to add roads and road names, to incorporate previously issued Letters of Map Revision, and to incorporate previously issued Letters of Map Amendment.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 2020H

FIRM
FLOOD INSURANCE RATE MAP
MARICOPA COUNTY, ARIZONA
AND INCORPORATED AREAS

PANEL 2020 OF 4350

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
BUCKEYE, TOWN OF	040039	2020	H
MARICOPA COUNTY	040037	2020	H

(ANNOTATED 2007)

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
04013C2020H

MAP REVISED
SEPTEMBER 30, 2005

Federal Emergency Management Agency

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles, Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' National Geodetic Vertical Datum of 1929 (NGVD 29). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was *Arizona State Plane Zone 3176 (central Arizona)*. The **horizontal datum** was *NAD83, GRS80 spheroid*. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the *National Geodetic Vertical Datum of 1929*. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

Spatial Reference System Division
National Geodetic Survey, NOAA
Silver Spring Metro Center
1315 East-West Highway
Silver Spring, Maryland 20910
(310) 713-3191

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was derived from multiple sources. Base map files were provided in digital format by Maricopa County. Orthophoto images were produced at a scale of 1:6000 using HARN for control. Aerial photography is dated December 2000 to December 2002.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

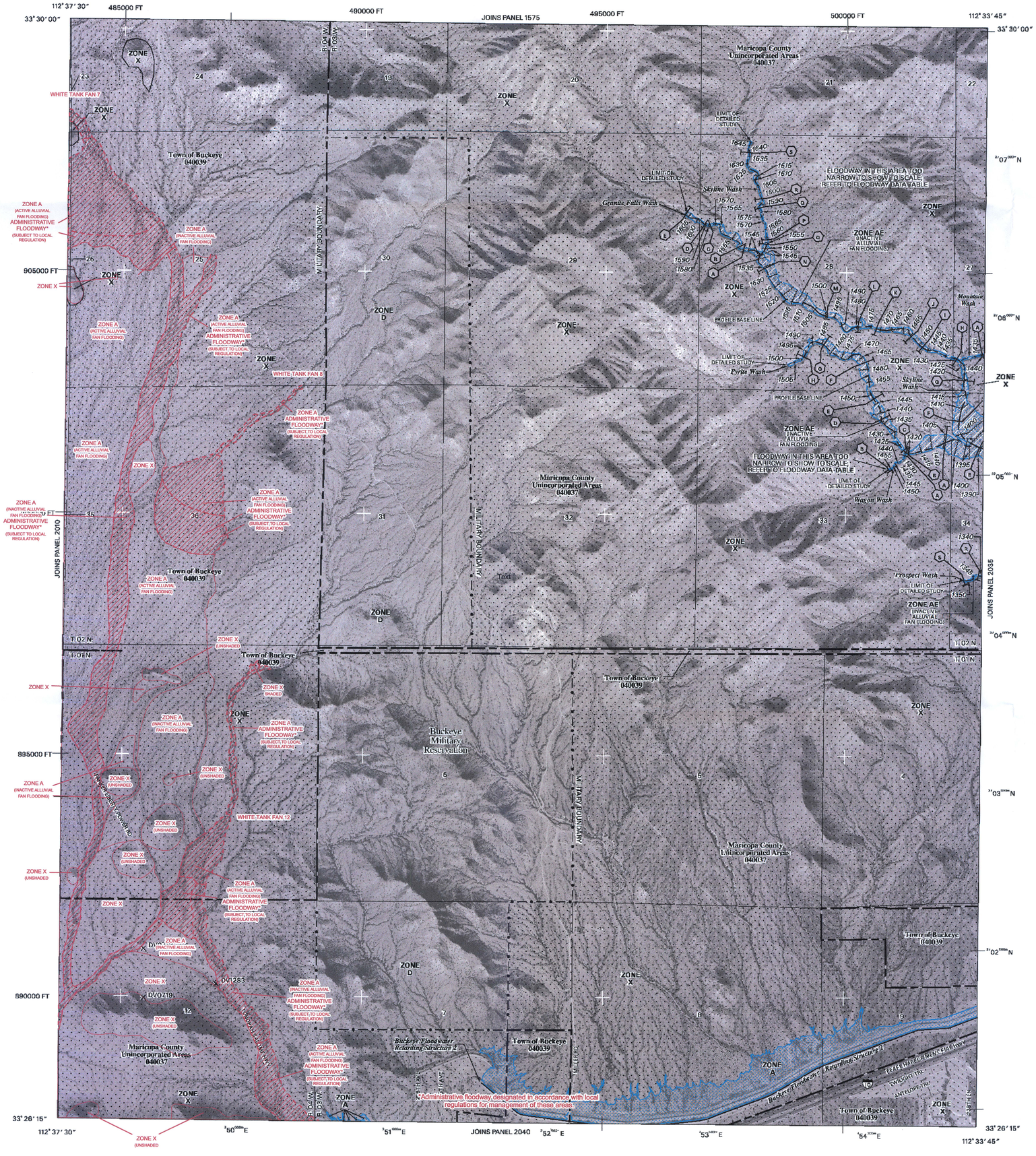
Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMAMAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/.

LEGEND FOR ANNOTATION

100-YEAR ADMINISTRATIVE FLOODWAY - - - - - -

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC. 2007



LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	1% annual chance floodplain boundary
	0.2% annual chance floodplain boundary
	Floodway boundary
	Zone D boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Area Zones, and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.
513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the National Geodetic Vertical Datum of 1929

A — A	Cross section line
2 - - - 2	Transect line
112° 07' 08", 33° 25' 41"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere.
3776000m E	1000-meter Universal Transverse Mercator grid tick values, zone 12
875000 FT	5000-foot grid tick values: Arizona State Plane coordinate system, central zone (FIPSZONE 3176) NAD83 (Transverse Mercator)
X DV2313	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORY
Refer to Repositories Listing on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
April 15, 1988

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
September 4, 1991, September 30, 1995, July 19, 2001

September 30, 2005 - to update corporate limits, to change Base Flood Elevations, to add Base Flood Elevations, to add Special Flood Hazard Areas, to change Special Flood Hazard Areas, to change zone designations, to add roads and road names, to incorporate previously issued Letters of Map Revision, and to incorporate previously issued Letters of Map Amendment.

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MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 2030H

FIRM
FLOOD INSURANCE RATE MAP
MARICOPA COUNTY, ARIZONA
AND INCORPORATED AREAS

PANEL 2030 OF 4350

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
BUCKEYE, TOWN OF	040039	2030	H
MARICOPA COUNTY	040037	2030	H

(ANNOTATED 2007)

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
04013C2030H

MAP REVISED
SEPTEMBER 30, 2005

Federal Emergency Management Agency

NOTES TO USERS

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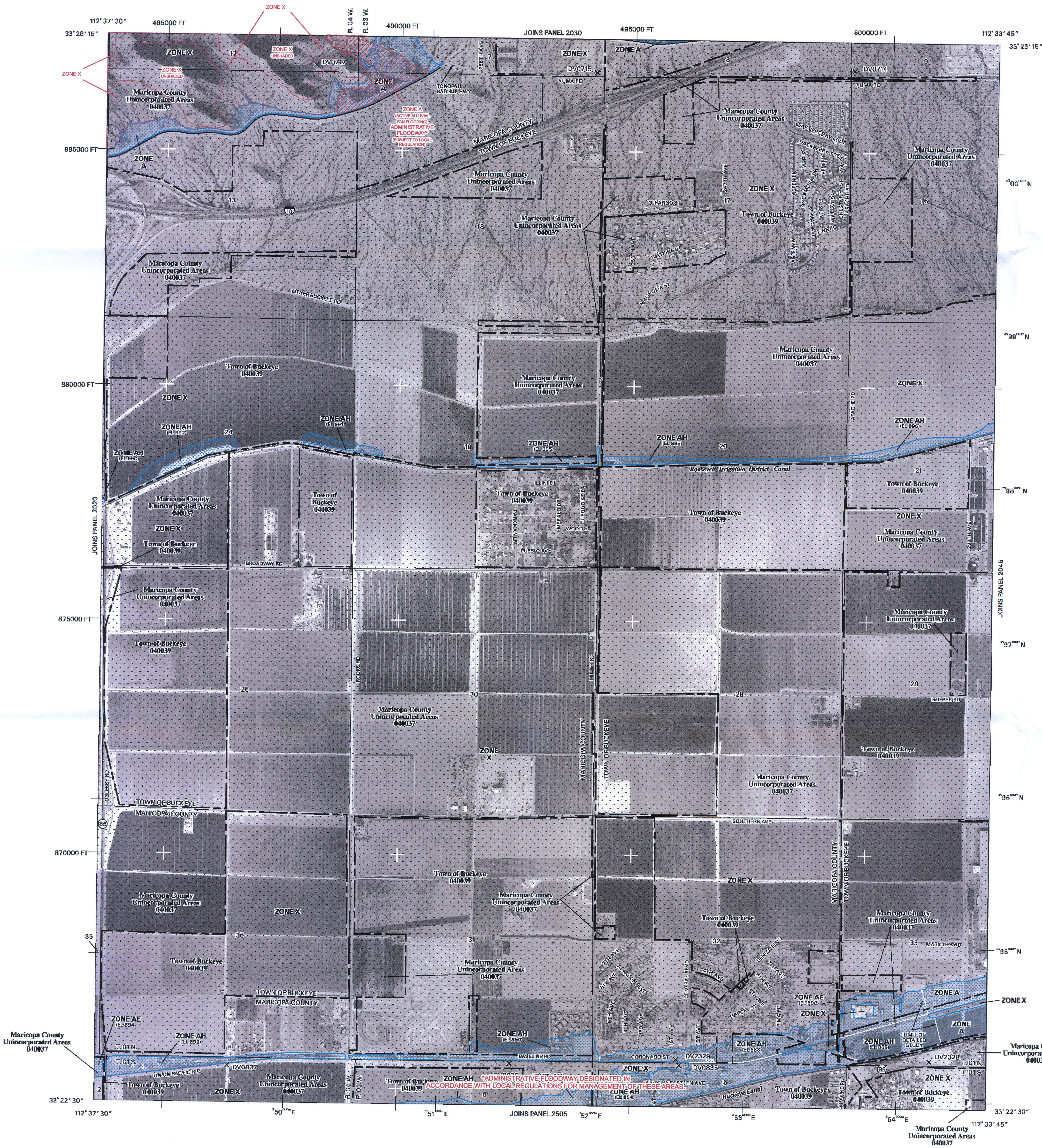
LEGEND FOR ANNOTATION

100-YEAR ADMINISTRATIVE FLOODWAY - - - - - -

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC. 2007



LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
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ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

———	1% annual chance floodplain boundary
———	0.2% annual chance floodplain boundary
— — —	Floodway boundary
— —	Zone D boundary
••••••••••	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Area Zones, and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.
~~513~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the National Geodetic Vertical Datum of 1929

(A)——(A)	Cross section line
(2)- - - -(2)	Transect line
112° 07′ 08″, 33° 25′ 41″	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere.
4276000m E	1000-meter Universal Transverse Mercator grid tick values zone 12.
875000 FT	5000-foot grid tick values: Arizona State Plane coordinate system, central zone (FIPSZONE 3176) NAD83 (Transverse Mercator)
×DV2313	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORY
Refer to Repositories Listing on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
April 15, 1988

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
September 30, 1995, July 19, 2001

September 30, 2005 - to update corporate limits, to change Base Flood Elevations, to add Base Flood Elevations, to add Special Flood Hazard Areas, to change Special Flood Hazard Areas, to change zone designations, to add roads and road names, to incorporate previously issued Letters of Map Revision, and to incorporate previously issued Letters of Map Amendment.

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To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 2040G

FIRM
FLOOD INSURANCE RATE MAP
MARICOPA COUNTY, ARIZONA
AND INCORPORATED AREAS

PANEL 2040 OF 4350

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
BUCKEYE, TOWN OF	040039	2040	G
MARICOPA COUNTY	040037	2040	G

(ANNOTATED 2007)

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
04013C2040G

MAP REVISED
SEPTEMBER 30, 2005

Federal Emergency Management Agency