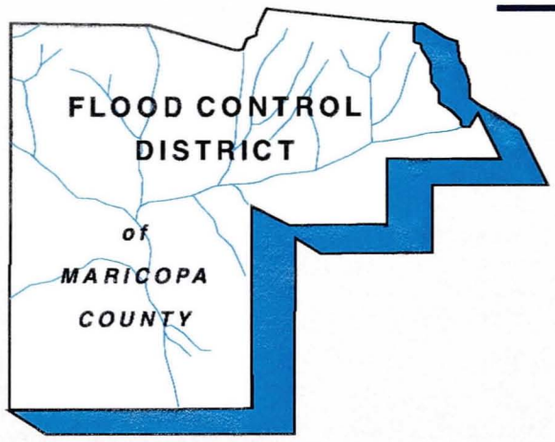

IONA WASH
FLOODPLAIN DELINEATION STUDY

TECHNICAL SUPPORT DATA NOTEBOOK

VOLUME 3 OF 3
SECTIONS 5-8

CH2M HILL

IONA WASH
FLOODPLAIN DELINEATION STUDY

TECHNICAL SUPPORT DATA NOTEBOOK

VOLUME 3 OF 3

Prepared For:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
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October 5, 1993

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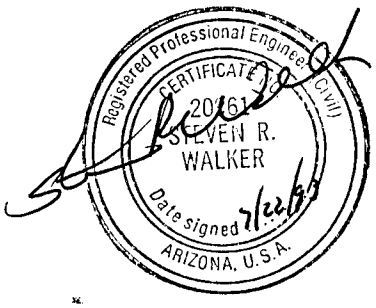

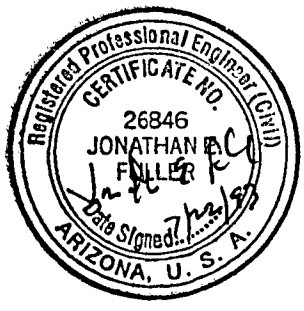

Section 5: Erosion/Sediment Transport

An erosion/sediment transport analysis was not performed for this study.

Section 6: Reference Materials

Section 6: Reference Materials

6.3 Other Applicable Studies

By: CH2M Hill

Ione Wash F.I.S.
Applicable Studies Index

For: Unincorporated Maricopa County/Surprise, AZ

Description

Field Reconnaissance Report

Data Collection Report

Iona Wash Flood Insurance Study

Field Reconnaissance Report

Prepared for

Flood Control District
of
Maricopa County

Prepared by

CH2M HILL
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December 1992

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Figures

Tables

Appendixes

Introduction

This report summarizes the results of field reconnaissance for the Iona Wash Flood Insurance Study (FIS). The purpose of the report is to:

- Document field conditions relevant to floodplain modeling
- Demonstrate the procedures used to estimate Manning's "n" values

This report is the deliverable for Tasks 6.6.1 and 6.6.2 of Flood Control District of Maricopa County (FCDMC) contract number FCD 92-07.

Field Reconnaissance

The Iona Wash study area extends approximately 13.5 river miles from the confluence with Trilby Wash in T.4N., R3W., Section 25 to State Route 89 (Grand Avenue) in T.6N., R.3W., Section 29 as shown in Figure 1. Iona Wash includes reaches of channelized and unconfined sheet flow.

CH2M HILL project staff conducted field reconnaissance visits to the study area on October 14, 1992 and December 10, 1992. The overall goal of field reconnaissance was to become familiar with the study area prior to floodplain modeling. Specific goals of field reconnaissance were to:

- Observe channel conditions to support Manning's "n" value estimates
- Obtain photographic documentation of field conditions
- Determine channel bank stations
- Observe potential overflow and breakover areas
- Identify levees and other flood control structures
- Measure bridges and other hydraulic structures

Reach Definition. Within the study area, Iona Wash can be divided into six reaches of relatively uniform geomorphic and hydraulic characteristics (Figure 2). These six reaches are described in Table 1. In addition, flood overflows occur in other reaches as indicated. The six reaches include three basic channel types: (1) reaches with well-defined channels and limited riparian vegetation near the banks (reaches 2, 4, and 6), (2) braided reaches with narrow, poorly defined channels and extensive riparian zones (reaches 1 and 5), and (3) poorly defined sheet flow areas with minor channel conveyance (reach 3 and flood overflow reaches).

Table 1. Iona Wash Reach Definition.		
Reach	Reach Limits	Description
1	Trilby Wash to Crozier Rd.	Braided w/ Dense Riparian Veg'n
2	Reach 1 to 237th Ave.	Channelized w/ Riparian Veg'n
3	Reach 2 to Beadly Rd.	Sheet Flow, Unconfined
4	Reach 3 to 1/2 mi. N of Lone Mtn Rd	Channelized w/ Riparian Veg'n
5	Reach 4 to 1 mi. S of Rt. 89	Braided, Very Poorly Defined
6	Reach 5 to Rt. 89	Channelized, wide channels
Breakover	Iona Wash to Trilby Wash	Sheet Flow to Braided

Channel Conditions. For this report, two definitions of "channels" will be used, as illustrated in Figure 3. For well-defined reaches the standard definition of a channel, the wash bottom and bank slope, applies. For braided and sheet flow reaches, the term "channel" includes the wash bottom and the surrounding riparian zone. This broader definition will be used for several reasons. First, a single flow path cannot be easily identified in the field or on phototopography due to the presence of multiple channels, the a tree canopy which hides channels, and the inaccessibility of most of the wash. Including riparian zone makes identifying the channels using aerial photography possible. Second, the channel and riparian zone are better characterized by a single composite "n" value. Third, this broader definition will facilitate floodway mapping.

The degree of channel definition varies considerably within the study area. Near State Route 89 in reach 6, Iona Wash has a well defined channel with sand and gravel beds, and cut banks or mature riparian vegetation. The defined channel transitions first to a braided pattern which continues to lose definition, nearly becoming sheet flow in reach 5. Some of this flow breaks over into Trilby Wash. Poorly defined flow is collected into a well defined channel in reach 4 where a major tributary joins Iona Wash. This defined channel also becomes braided and transitions to sheet flow-like conditions in reach 3, before becoming re-channelized upstream of the Central Arizona Project Granite Reef Aqueduct (CAP) in reach 2. Channel definition is lost again near the confluence of Iona Wash and another unnamed tributary with Trilby Wash.

Channel sediment and vegetation also varies throughout the study area. Sediment in defined channels varies from course gravel and angular cobbles in reach 6 to coarse sands in reach 2. Reaches with braided and unconfined flow typically have sand beds. Riparian vegetation also varies with channel type. Braided channel and sheet

flow areas typically have denser vegetation and wider riparian zones than do channelized reaches. Vegetative density is easily estimated from aerial photography.

Channel Bank Stations. Channel bank stations for hydraulic modeling will be defined in two ways[1]. First, for wide, well-defined channelized reaches, bank stations will defined at top of the bank slope adjacent to the margins of the sandy channel bottom. Using this first definition, separate "n" values can be selected for the channel characteristics, the riparian zone, the floodplain. For braided and sheet flow areas with limited conveyance in channels, the channel bank stations will defined at the margins of the riparian zone. A composite "n" value will be used to estimate roughness in the braided channel area which has only minor topographic relief.

Overbank Floodplain Conditions. Floodplain areas are very similar throughout the study reach. Topographically lower floodplain areas are extremely flat and are characterized by creosote-bursage vegetative communities and sandy silt soils. These lower floodplain areas have essentially no drainage network despite relatively large areal extent. Topographically higher floodplain areas typically have some desert pavement surfaces and some cacti species in addition the creosote-bursage vegetation. The lower and higher floodplain surface can be modeled using the same manning's "n" value.

Given the limited size of channel in most reaches in the study area and the 100-year discharge rates, it is likely that significant overbank flow will occur along Iona Wash. Signs of recent overbank flooding, including ripple marks in silty soils in reach 5, were observed during the October field visit. These data confirm overbank and breakover flow characteristics indicated by the drainage patterns visible in aerial photographs.

Breakover Reaches. Breakover from Iona Wash to Trilby Wash is possible in reach 5. This breakover reach will be modeled separately from the rest of the Iona Wash floodplain using approximate methods. Breakover flow is predicted on the basis of topographic, geomorphic, and field evidence, and is supported by the HEC-2 modeling. Contours on the USGS topographic maps indicate a drainage divide (grade break) in reach 5 at the point where breakover is predicted. Flow crossing this divide does not return to Iona Wash. Vegetative and channel patterns also indicate that flow crosses the divide in the breakover area. Several minor flow paths directly connect Iona and Trilby Washes. Field evidence of recent sheet flow along the predicted breakover zone was observed during the October field visit.

Distributary Flow. There are no natural distributary flow areas in the study area, as defined in the proposed ADWR state standard for development in sheet flow areas. Several man-made diversions to stockponds look like distributary flow bifurcations,

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[1] Actual bank stations cannot be defined for individual cross sections until cross section alignments are approved.

but are not active channels downstream of the stockponds. The multiple channels in reaches 1, 3, and 5 are braided washes, rather than distributary. Braided channels along Iona Wash can be modeled as a single channel with a composite "n" value, particularly at high flow rates such as the 100-year flood.

Levees and Stockponds. There several abandoned stockponds and levees in the study area (Figure 1). All but one of the stockponds are off-channel features, not directly connected to the main channel of Iona Wash. The single in-channel stockpond is located in reach 3, which is a sheet flow area. The off-channel stockponds are generally located along tributary channels upstream of the tributary confluence with Iona Wash. Man-made diversions may direct runoff from Iona Wash into the ponds. Levees were constructed in conjunction with the stockpond diversions in reaches 2 and 6. It is unlikely that these levees or the stockponds will meet FEMA criteria.

Most of the stockponds and all of the levees identified during field reconnaissance are in disrepair. Only the stockponds in reaches 3 and 5 still pond water. The other stockponds have partially silted in. The east banks of the stockpond in Reach 6 are severely eroded. Both diversion levees are breached in places.

The CAP levee is the only levee in the study area in good condition and likely to have been designed by a registered engineer. The hydrologic analysis completed for the Wittmann ADMS indicates that the CAP levee overtops in the 100-year flood. Field conditions indicate that significant ponding of runoff and sedimentation occurs upstream of the CAP overchute.

Hydraulic Structures. There are two hydraulic structures within the study area. Four 42-inch reinforced concrete pipes are located at the Patton Road crossing of Iona Wash in reach 3. A concrete overchute conveys Iona Wash over the CAP canal in reach 2. As-built plans for these structures are provided under separate cover, in the Iona Wash FIS Data Collection Report. The SR 89 bridge is outside the study area.

Manning's N Values

Methodology. Manning's roughness coefficients, or "n" values, were determined using procedures adopted by the FCDMC[2]. In addition, the following materials were used to support the analysis:

- Aerial Photographs. 1992 1:12,000 contact prints by Kenney Aerial photographs to be used for base mapping of study area.

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[2] Thomsen, B.W., and Hjalmarson, H.W., 1991, *Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona*, Report by the USGS to the FCDMC, April.

- Ground Photographs. Color photographs taken during field reconnaissance trips.

- Field Data. Hydraulic information and geomorphic data gathered during field reconnaissance trips.

The FCDMC procedure consists of selection of a base "n" value and addition of several adjustment factors to determine a composite roughness coefficient for hydraulic modeling. The base "n" value accounts for roughness due to the bed material. Adjustments to the base "n" value include factors for the degree of channel irregularity, obstructions, vegetation, variations in cross section geometry, and degree of meandering. Tables from the FCDMC manual which describe each of the adjustment factors are attached in Appendix A.

For the Iona Wash FIS, base "n" values were estimated using field estimates of bed sediment characteristics, and Table 1 of the FCDMC manual. N value adjustment factors were estimated by comparison of values in Table 2 of the FCDMC manual and field conditions observed during field reconnaissance. Photographs which document field conditions at the time of the field visits are attached in Appendix B.

General Approach. There are three general types of channels in the study area: defined channels, braided channels, and sheet flow, as discussed in the field reconnaissance section above. Channel "n" values for braided and sheet flow areas will be composites of the channel and riparian zone, as defined by denser vegetation visible on aerial photographs. In defined channels, "n" values represent just the bed of the defined channel. N values for riparian zones adjacent to defined channels will be assigned a separate "n" value. NH records will be required to model roughness coefficients along defined channels in the study area.

Floodplain areas will be assigned a Manning's "n" value of 0.045 to 0.055 within the entire study area. As illustrated in the photographs attached in Appendix B, floodplain characteristics are similar for the entire study reach. Riparian zones, except composite zones in braided and sheet flow areas, are also hydraulically similar throughout the study area. Riparian zones will be assigned "n" values of 0.075 to 0.105. N values for floodplain and riparian zones are based on the information and procedures presented in the FCDMC manual and engineering judgement.

Sample N Value Procedure. To illustrate use of the FCDMC methodology, "n" value estimates for reaches 5 and 6 and the floodplain are described in detail.

Table 3 of the FCDMC manual (See Appendix A) lists values of Manning's "n" for floodplains. None of the categories are identical to field conditions in the Iona Wash floodplain. However, field conditions are most similar to light brush and trees in summer (n = 0.040-0.080). Iona wash floodplains have somewhat coarser floodplain sediments than were assumed for the FCDMC table 3. Therefore, composite values of 0.045 to 0.055 were selected based on vegetative density. These

values are intended to reflect maximum roughness which occurs during the growing season, prior to grazing.

Reach 5 has braided and sheet flow areas. Where channels exist, they are typically sand bedded. Floodplain soils and sheet flow areas are also typically composed of sandy soil material. Therefore, a base "n" value of 0.022 was selected by interpolating between values given in the last column in Table 1 of the FCDMC manual (See Appendix A). Channel irregularity, obstruction, and cross section variation are typically minor in braided and sheet flow areas, therefore adjustment factors of 0.003, 0.002, and 0.005 were added (Table 2 of FCDMC manual, Appendix A). However, vegetative influence is significant, but highly variable from section to section, so adjustment factors from 0.010 to 0.040 were added. Finally, meandering along Iona Wash is minor, so no meandering adjustment was needed (Meander factor = 1.0, Table 2 of FCDMC manual, Appendix A). Adding these adjustment factors to the base "n" value results in a composite "n" values of 0.042 to 0.072.

Reach 6 has a well-defined channel with a riparian zone of varying width. The channel sediments consist of sands, gravels and small cobbles. A base "n" value of 0.026 was selected (Table 1 of FCDMC manual, Appendix A). The well defined channel is relatively free of obstructions, vegetation, and drastic geometry changes, so adjustment factors of 0.003, 0.002, and 0.002 were used. However, an adjustment factor of 0.006 was needed to account for the cutbanks and other channel irregularities. Since meandering is limited, the resulting composite "n" value was estimated at about 0.038 to 0.045, depending on section characteristics.

Manning's N Values. Photographs of channels in each reach and floodplains are attached in Appendix B. Composite channel "n" values are shown in Table 2 for each reach, and for overbank and riparian zones. Overbanks and riparian zones are similar throughout the study area and were each given similar "n" values.

Table 2. Iona Wash FIS, Typical Manning's N Estimates							
Reach	Base N	Irregularity Adjustment	Obstruction Adjustment	Vegetation Adjustment	Variation Adjustment	Meandering Adjustment	Composite N
1	0.022	0.003	0.002	0.050	0.005	1.0	0.082
2	0.026	0.007	0.001	0.002	0.001	1.0	0.038
3	0.022	0.003	0.002	0.050	0.005	1.0	0.082
4	0.028	0.005	0.001	0.005	0.001	1.0	0.040
5	0.022	0.003	0.002	0.040	0.005	1.0	0.072
6	0.026	0.006	0.003	0.002	0.002	1.0	0.039
Floodplain, Sheet Flow Areas, Flood Overflow Areas: Light brush and small trees with summer grass							0.045-0.065
Riparian Zones: Mesquite & Palo Verde with dense catclaw, grass and brush understory							0.075-0.105

Summary

Field reconnaissance of the Iona Wash study area was conducted to support the floodplain delineation. Field tasks included collection of data to assist in "n" value estimation, identification and observation of significant channel features and floodplain characteristics. Manning's "n" values were estimated for six channel reaches, as well as overbank floodplain areas using FCDMC procedures. Photographic documentation of channel conditions was provided to support the field reconnaissance report and "n" value estimates.

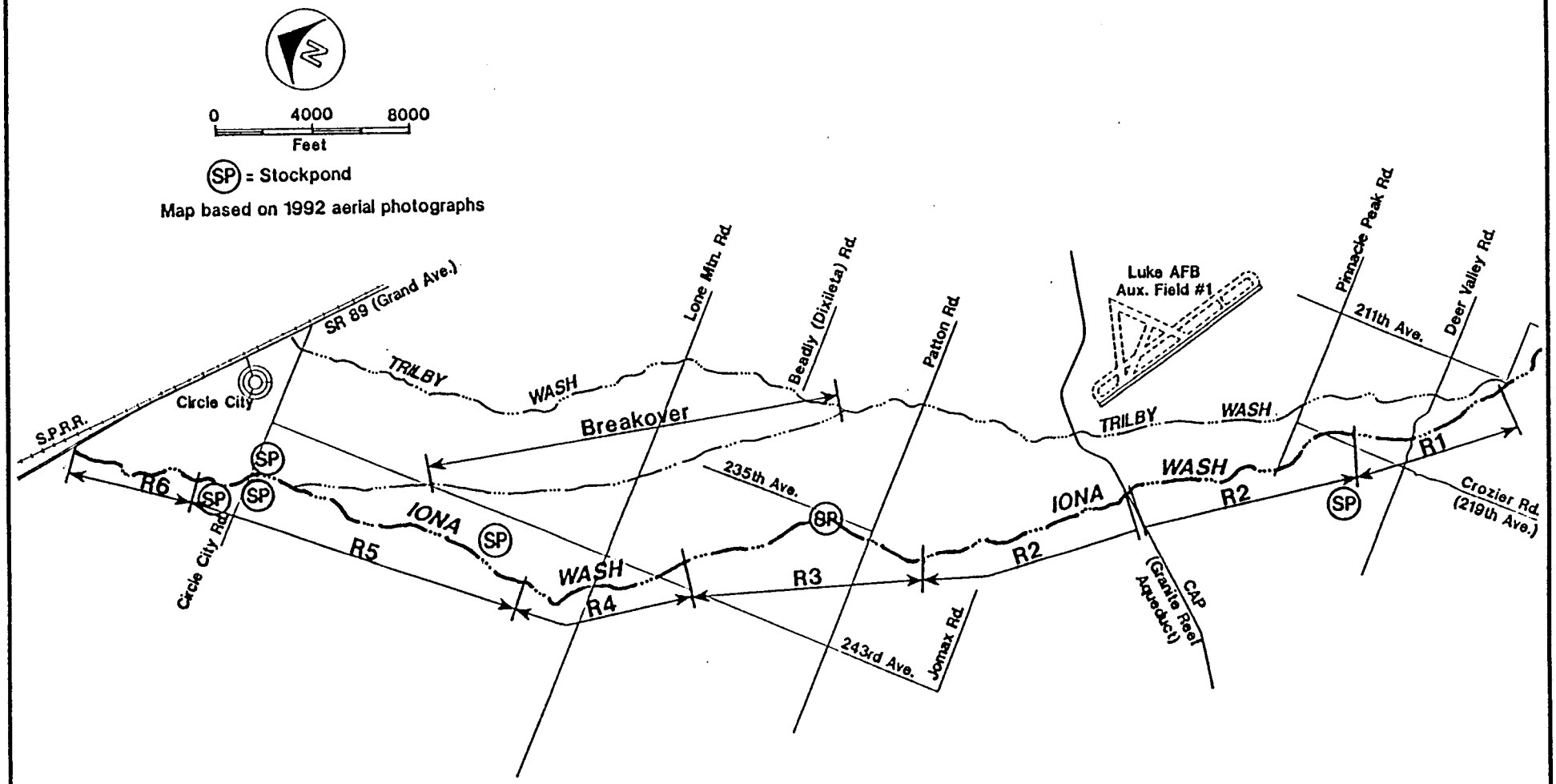
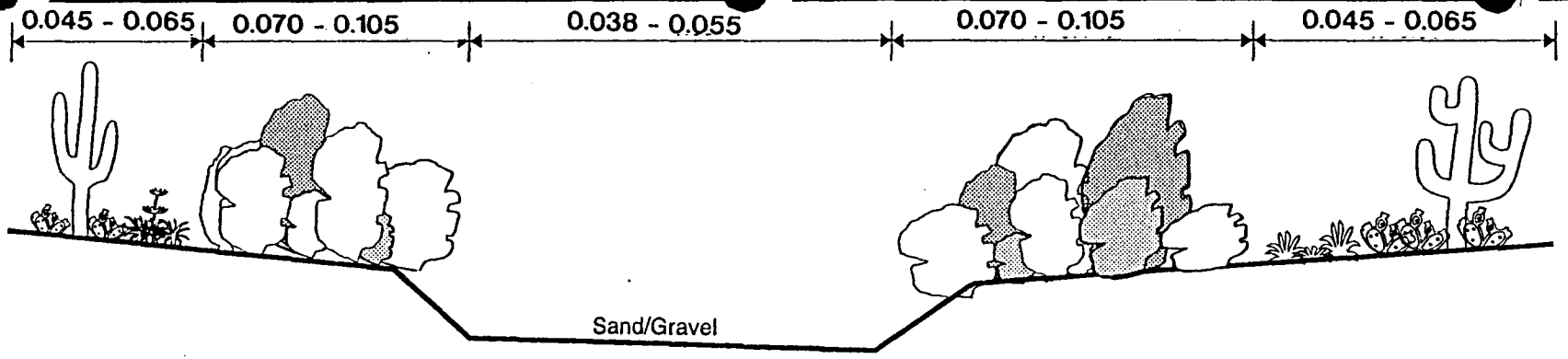


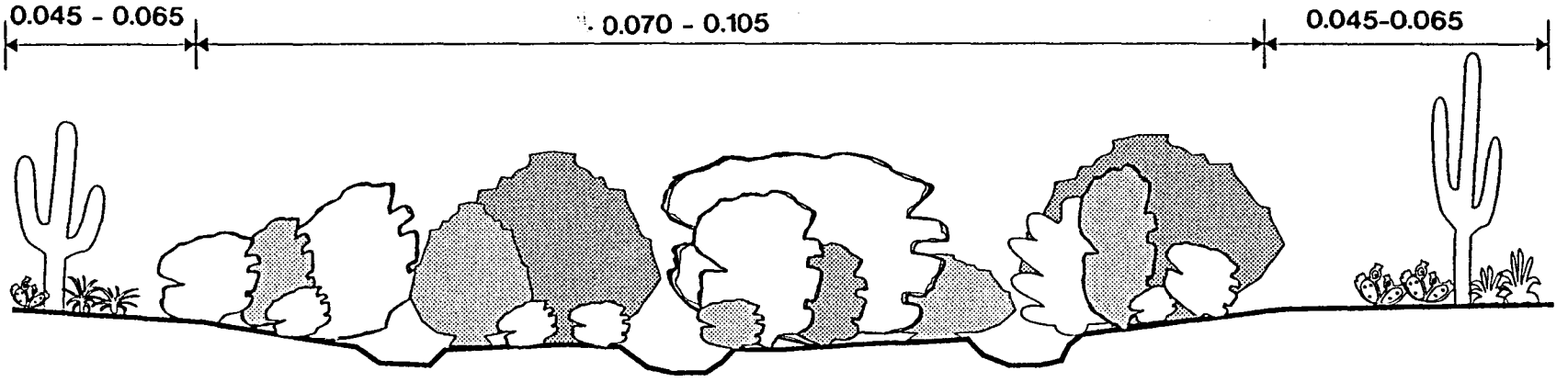
FIGURE 2
REACH DESIGNATIONS

Maricopa County, Arizona
June, 1993 CH2M HILL
Iona Wash FIS PHX34747.A0

CH2M HILL



TYPICAL CHANNELIZED REACH (3A)



TYPICAL BRAIDED OR SHEET FLOW REACH (3B)

FIGURE 3
CHANNEL BANK AND "N" VALUE DESIGNATION

Maricopa County, Arizona
June, 1993 CH2M HILL
Iona Wash FIS PHX34747.A0

CH2M HILL

Appendix A

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

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

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

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

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

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

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

[Modified from Chow, 1959]

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

See footnotes at end of table.

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

Channel conditions	Manning's n adjustment[1]	Example
Vegetation—Continued:		
Very large	.050- .100	Turf grass or weeds where the average depth of flow is less than half the height of vegetation; small bushy trees intergrown with weeds along side slopes of dense cattails growing along channel bottom; trees intergrown with weeds and brush.
Variations in channel cross section:		
Gradual	.000	Size and shape of cross sections change gradually.
Alternating	.001- .005	Large and small cross sections alternate occasionally, or the main flow occasionally shifts from side to side owing to changes in cross-sectional shape.
Alternating	.010- .015	Large and small cross sections alternate frequently, or the main flow frequently shifts from side to side owing to changes in cross-sectional shape.
Degree of meadering[3]:		
Minor	1.00	Ratio of the meander length to the straight length of the channel reach is 1.0 to 1.2.
Appreciable	1.15	Ratio of the meader length to the straight length of channel is 1.2 to 1.5.
Severe	1.30	Ratio of the meander length to the straight length of channel is greater than 1.5.

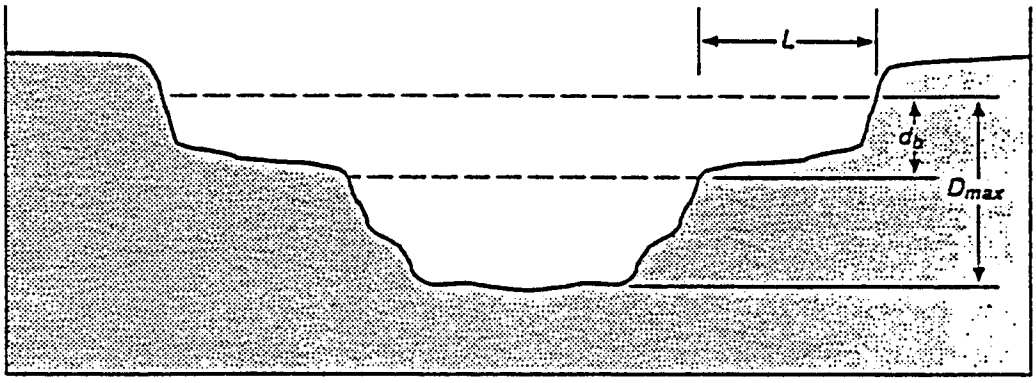
[1]Adjustments for degree of irregularity, variations in cross section, effect of obstructions, and vegetation are added to the base n value (table 1) before multiplying by the adjustment for meander.

[2]Conditions considered in other steps must not be reevaluated or duplicated in this section.

[3]Adjustment values apply to flow confined in the channel and do not apply where downvalley flow crosses meanders. The adjustment is a multiplier.

For floodflows in sand channels with moveable beds, roughness mainly is a function of the size of the bed material as shown in the following table (Benson and Dalrymple, 1967, p. 22).

Median grain size, in millimeters	Manning's *n*	Median grain size, in millimeters	Manning's *n*
0.2	0.012	0.6	.023
.3	.017	.8	.025
.4	.020	1.0	.026
.5	.022		



Subdivide if D_{max} is greater than or equal to $2d_b$

Subdivide if D_{max} is approximately equal to $2d_b$ and if L/d_b is equal to or greater than 5

L = width of flood plain
d_b = depth of flow on flood plain, in feet
D_{max} = maximum depth of flow in cross section, in feet

Modified from Davidian (1984)

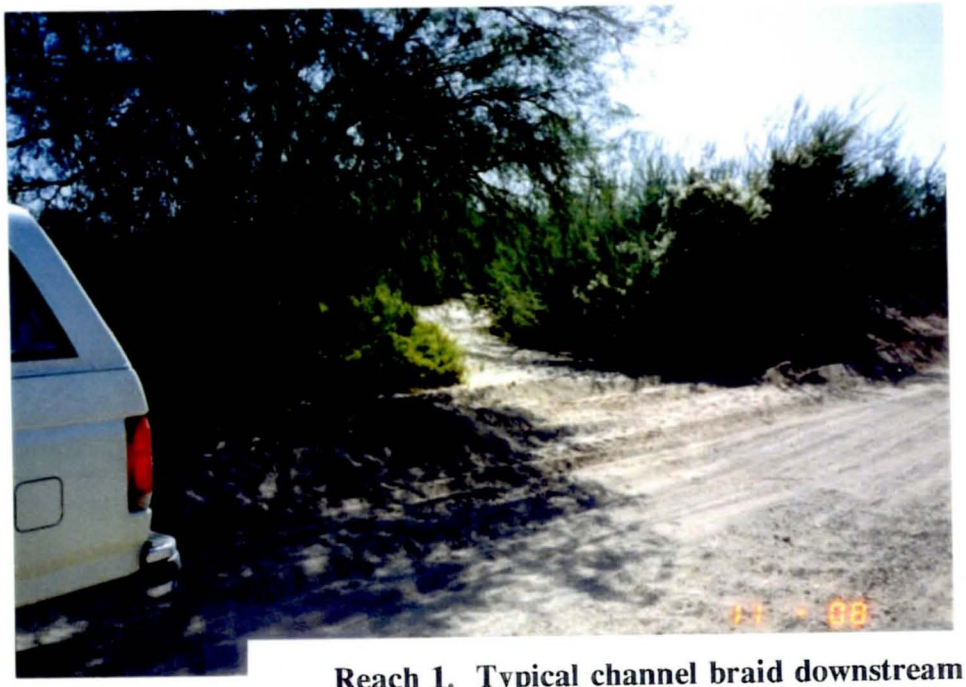
Figure 2.--Subdivision criteria commonly used for streams in Maricopa County, Arizona.

Table 3.--*Values of Manning's n for flood plains*

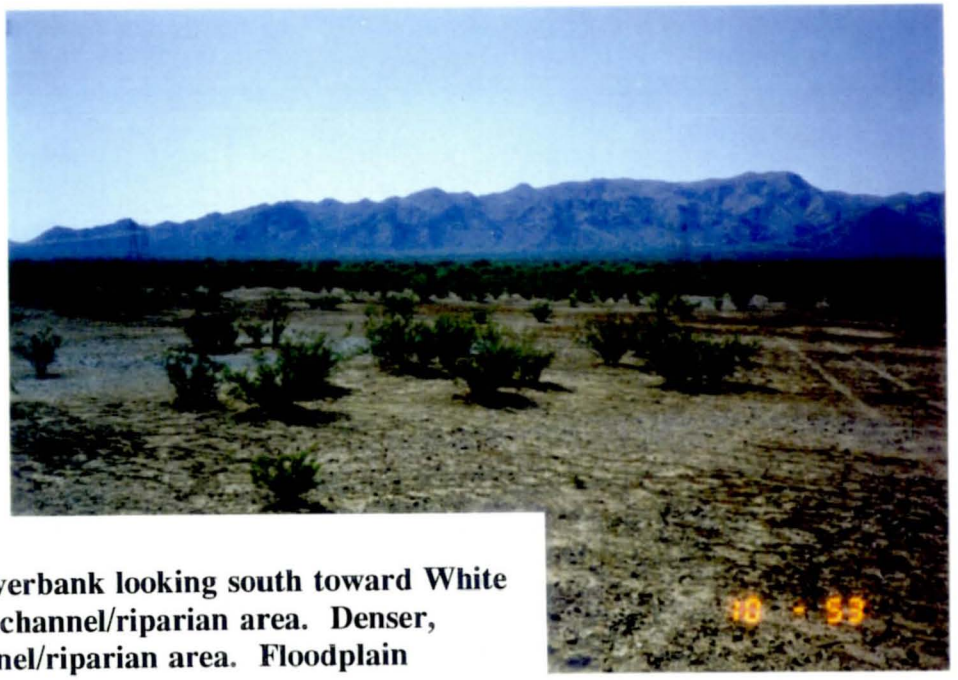
[Modified from Chow, 1959]

Description	Minimum	Normal	Maximum
Pasture, no brush:			
Short grass	0.025	0.030	0.035
High grass	.030	.035	.050
Cultivated areas:			
No crop	.020	.030	.040
Mature row crops	.025	.035	.045
Mature field crops	.030	.040	.050
Brush:			
Scattered brush, heavy weeds	.035	.050	.070
Light brush and trees, in winter	.035	.050	.060
Light brush and trees, in summer	.040	.060	.080
Medium to dense brush, in winter	.045	.070	.110
Medium to dense brush, in summer	.070	.100	.160
Trees:			
Dense willows, summer, straight	.110	.150	.200
Cleared land with tree stumps, no sprouts	.030	.040	.050
Same as above, but heavy growth off sprouts	.050	.060	.080
Heavy stand of timber, a few down trees, little undergrowth, flood stage below branches	.080	.100	.120
Same as above, but with flood stage reaching branches	.100	.120	.160

Appendix B



Reach 1. Typical channel braid downstream of Crozier Road. Base n value = 0.022; Composite n including riparian vegetation = 0.105.



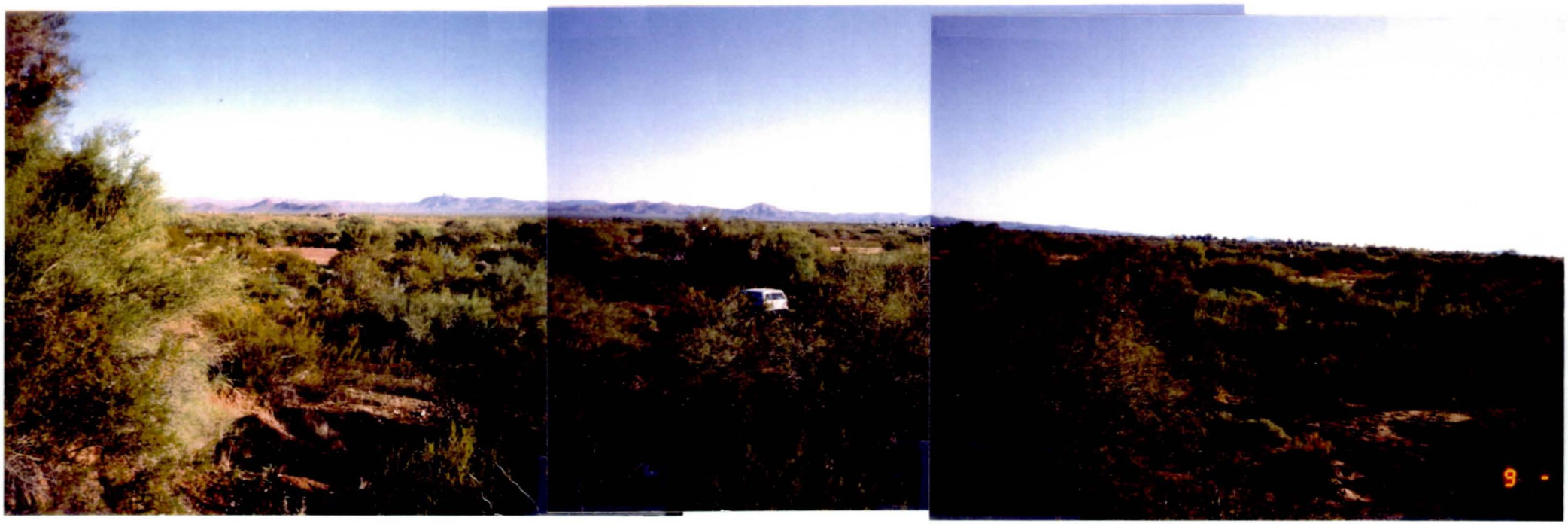
Reach 1. View of left overbank looking south toward White Tank Mountains across channel/riparian area. Denser, taller vegetation is channel/riparian area. Floodplain n value = 0.070.

Reach 2. Looking upstream at typical channel in Reach 2. Base n value = .026. N value for riparian zone adjacent to channel = 0.115.

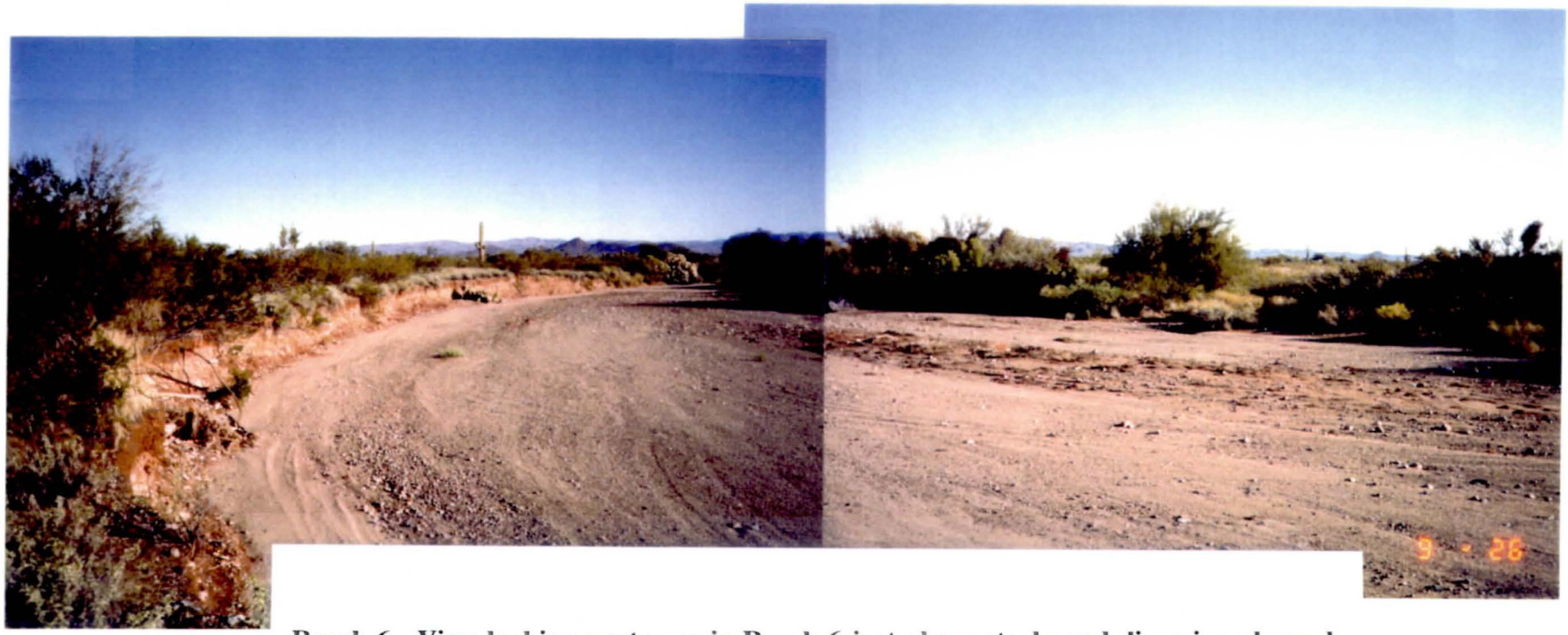
Reach 3. View of typical channel in braided flow area in Reach 3. Channel shown is one of many upstream of Patton Road. Base n value = 0.022. Composite n value includes riparian vegetation.

Reach 3. Right overbank in heavily grazed part of Reach 3. Dense vegetation lines channel.

Reach 4. Looking upstream at defined channel in Reach 4. Base n value = 0.028. N value for riparian zone adjacent to channel = 0.115. View from Lone Mountain Road.

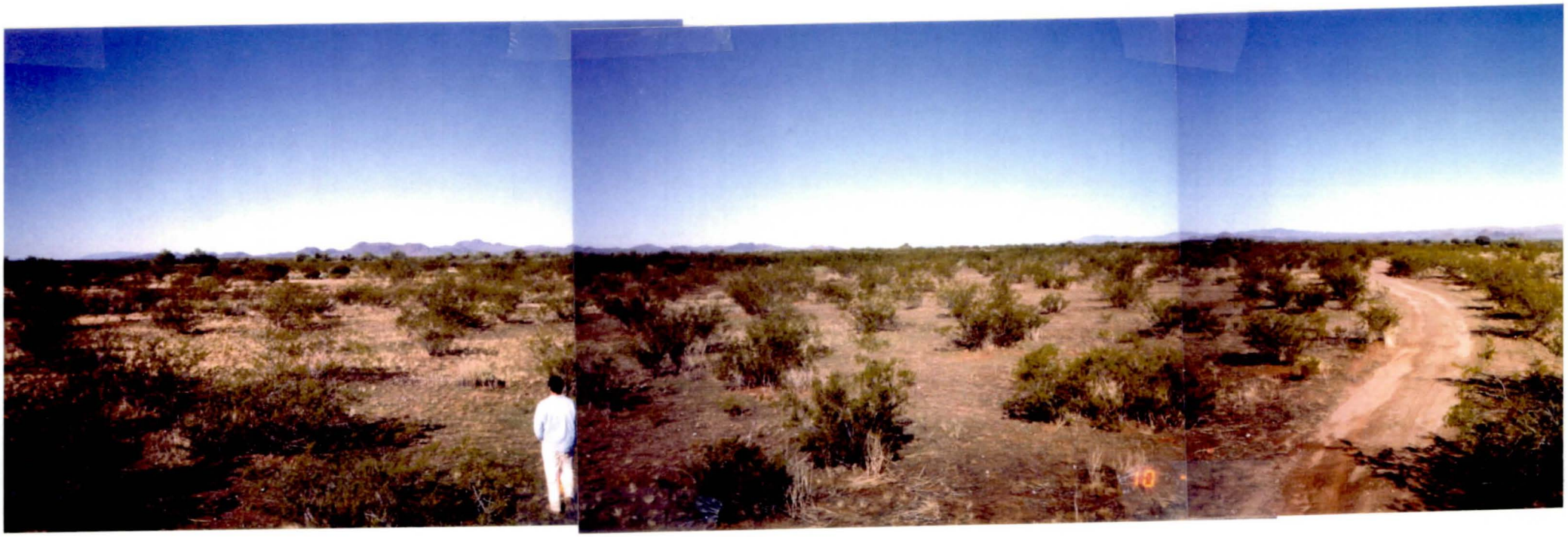


Reach 5. Looking north from stockpond embankment across braided flow area in Reach 5. Base n value = 0.022; composite n value including riparian vegetation = 0.095. Truck is parked between several active flow paths. Hieroglyphic Mountains in distance.



Reach 6. View looking upstream in Reach 6 just above stockpond diversion channel. Base n value = 0.028.

Typical floodplain with creosote bursage vegetative community with a heavily grazed low grass understory. Floodplain n value of 0.070 applies to all overbank areas in study area except riparian zones. View looking north from CAP levee in left overbank in Reach 2.



Typical floodplain with creosote bursage vegetative community and heavily grazed low grass. Floodplain n value of 0.070 applies to all overbank areas in study areas except riparian zones. View looking south toward White Tank Mountains in right overbank in Reach 5.

MEMORANDUM CH2MHILL

TO: Sandy Story/FCDMC

COPIES: Steve Walker
Henry Allen

FROM: Jon Fuller

DATE: December 21, 1992

SUBJECT: Iona Wash Floodplain Delineation Study; FCD 92-07
Data Collection Report

PROJECT: PHX34747.DC

Introduction

This memorandum summarizes data collected in support of the Iona Wash Floodplain Delineation Study, performed by CH2M HILL on behalf of the Flood Control District of Maricopa County (FCDMC). Data collected included previous flood hazard and hydrology reports for the study area, existing topographic mapping and aerial photography, historical flooding information, as-built plans for existing structures, FEMA Flood Hazard Boundary Maps (FHBM) or Flood Insurance Rate Maps (FIRM), and other pertinent information.

The Iona Wash study area extends approximately 13.5 river miles from the confluence with Trilby Wash in T.4N., R3W., Section 25 to State Route 89 (a.k.a. Grand Avenue) in T.6N., R.3W., Section 29 as shown in Figure 1. Iona Wash includes reaches of channelized and relatively unconfined sheet flow.

Previous Reports

Hydrologic information for the study area is limited. Hydrologic data for Iona Wash were previously estimated for the Wittmann Area Drainage Master Study (ADMS)[1]. Estimated 100-year flow rates vary from 5309 cfs at the confluence with Trilby Wash to 2371 cfs at State Route 89 (Grand Avenue). Other hydrologic data are available from design drawings prepared for the Central Arizona Project (CAP) overchute.

[1] The WLB Group, 1989, Wittmann Area Drainage Master Study, Part A: Hydrology and Hydraulics, Report to the FCDMC.

These data indicate that the Bureau of Reclamation estimated a 100-year discharge[2] of 1255 cfs at the downstream side of the CAP overchute (inflow of 1990 cfs)[3].

Floodplain information for the study area consists of limited detail studies performed for FEMA, and approximate mapping prepared for the Wittmann ADMS. The original FHBM prepared for FEMA[4] did not delineate flood hazards along Iona Wash. The existing Flood Insurance Study (FIS) for Unincorporated Maricopa County provides floodplain designations for portions of Iona Wash[5]. However, support data for these studies are now unavailable from FEMA archives[6]. Approximate floodplain delineations were completed for portions of Iona Wash covered by topographic mapping for the Wittmann ADMS, as well as for the Trilby Wash FIS[7]. These approximate delineations may not be directly comparable with the results of detailed mapping to be completed for the Iona Wash FIS.

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2 US Bureau of Reclamation, 1990, As-Built Plans for Granite Reef Aqueduct, Reach 8, Sheet 344-330-18 and 344-D-1659.

3 Johnson, R.E., undated, Letter to Dan Sagramoso, P.E./FCDMC from Robert Johnson/BuRec Construction Engineer received by FCDMC on November 15, 1990, BuRec correspondence APO-2223.

NOTE: BuRec as-built plan sheets indicate a 6-hr, 100-year design storm was used. BuRec correspondence cited states that the design storm had a 50-year recurrence interval.

4 US Department of Housing and Urban Development, 1978, Flood Hazard Boundary Maps for Surprise.

5 Harris-Toups Associates, 1979 (January), Flood Insurance Study Approximate Study for Unincorporated Area of Maricopa County, Arizona: Prepared for the U.S. Dept. of Housing and Urban Development, Federal Insurance Administration, unpublished.

6 Personal communication from Venkat, Archivist, Michael Baker, Jr., Inc. on October 29, 1992.

7 P&D Technologies, 1992 (February 6), Flood Insurance Study for Trilby Wash, Report submitted to the FCDMC, Contract 90-24.

Topographic Mapping

Detailed topographic mapping is available only for limited portions of the study area. The best available topographic mapping for the study area includes:

- The WLB Group, 1986, Aerial Mapping for Wittmann ADMS, 1"=400', 4 ft. contour interval: Sheets 2 & 3 of 55 (Circle City, C-1 & C-2), and Sheet 14 of 55 (Area Between McMicken Dam & C.A.P., MC-4, MC-5).

- USGS, 1971 (photo-revision), White Tanks Mts. NE, Ariz. 7.5 minute Topographic Quadrangle Map, 1"=2000', 20 foot contour interval, based on 1954 aerial photography.

- USGS, 1981 (photo-revision), Wittmann, Ariz. 7.5 minute Topographic Quadrangle Map, 1"=2000', 10 foot contour interval, based on 1962 aerial photography.

No significant conclusions can be drawn from the existing topographic data.

Aerial Photography

A 40 year photographic record exists for the study area, including:

- SCS, 1951, Orthophotography for NE1/4 Arizona-289, 1:30,000, Available from the National Archives - Arizona Folder 7, Sheet 289. Corresponds to area of White Tanks Mts. NE Quadrangle.

- SCS, 1951, Orthophotography for SE1/4 Arizona-276, 1:30,000, Available from the National Archives - Arizona Folder 6, Sheet 276. Corresponds to area of Wittmann Quadrangle.

- SCS, 1972, Orthophotography for Wittmann, AZ 2076, 1:24,000. Available from ASU Science Library.

- SCS, 1972, Orthophotography for White Tank Mts, NE, AZ 2077, 1:24,000. Available from ASU Science Library.

- Cooper Aerial of Phoenix, 1986, Aerial photographs #2-4 to 2-7, 3-4 to 3-7, 1:21,120, Photo date 12-11-86.

- Kenney Aerial Mapping Co., 1992, Photography prepared for Iona Wash FIS, 1"=200', 2 ft contour interval.

No other aerial photography or mapping was available from local mapping companies including Kenney, Landis, Cooper, or AMC. The search for historical photography included retrieval from the US National Archives in Washington, D.C.

Review of historical aerial photographs indicates that there has been only minor changes along the watercourse during the past 40 years. Those few changes are direct result of development. Development along Iona Wash includes diversions to stock ponds, grading for an agricultural area, and clearing for several unpaved roads. There does not appear to be any significant net loss of riparian vegetation in the study area, although vegetative densities have changed in some places. In all cases, the location of primary channels have not changes, except where diverted for stock ponds.

Historical Flooding

No systematic flood records are available for the study area[8,9]. However, limited rainfall data is available from FCDMC gauges. Telemetered precipitation gauges are located at Circle City, and southwest of Circle City (Castle Hot Springs; T5N, R3W, sec. 7). Recording precipitation gauges are located in Wittmann and near Patton Road and 239th Avenue (Patton Road; T5N, R3W, sec. 33). Significant recorded rainfall events (greater than 2 inches/24 hours) are summarized in Table 1.

Attempts to collect anecdotal accounts of flooding from local residents and community officials were unsuccessful. No responses to public notices placed in the local and regional newspapers or to over 80 property owner notification letters were received. In addition, no flood information was obtained from participants in a public meeting held in Morristown on November 16, 1992.

Community officials from Wittmann and the Town of Surprise were also contacted to obtain historical flood information. Kathy Welch, a Wittmann school official, long-term resident, and wife of the local fire chief, reported that she knew of no flooding

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[8] Personal communication from Steve Waters, Hydrologist II, FCDMC on October 26, 1992.

[9] Garrett, J.M., and Gellenbeck, D.J., 1991, Basin Characteristics and Streamflow Statistics in Arizona as of 1989, USGS Water Resources Investigations Report 91-4041.

or flood damage on Iona Wash[10]. Herschell Morrow, Town Engineer for Surprise, reported that flooding damages the dirt roads in the area downstream of the C.A.P., but he could not provide any specific dates of floods, or information regarding flood damages[11].

Very little historical flood information was available from public agencies with maintenance or regulatory authority over the study area. The FCDMC reports that no drainage complaints have ever been recorded for the area[12]. The Arizona Department of Water Resources (ADWR) Floodplain Section also reports that no flood damages or floods have been recorded for the area[13].

Some anecdotal accounts of flooding on Iona Wash were provided by Jim Brundage, Highway Operations Superintendent for Maricopa County Department of Transportation[14]. According to Mr. Brundage, storm runoff frequently flows outside of the defined Iona Wash channels. The floods of 1978, 1982, 1988, and 1990 flowed well outside the defined channels, mostly as sheet flow. Sheet flow occurs north of Patton Road, and crosses the road and returns to the channel. Road overflows typically deposit several inches of sandy sediment on the roadways, but have also eroded the culvert embankments at Patton Road. At State Route 89, due to the undersized culverts, some runoff is occasionally diverted to the east toward Circle City.

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[10] Telephone conversation with Kathy Welch and Mr. Yokobosky, Principal, Wittmann School on October 8, 1992.

[11] Personal communication from Herschell Morrow, Town Engineer, on October 8, 1992.

[12] Nevitt, Ron, 1992 (October 8), Personal communication to Sandy Story/FCDMC.

[13] Personal communication from Terri Miller, ADWR State Floodplain Coordinator, on October 16, 1992, and October 26, 1992.

[14] Personal communication from Jim Brundage to Henry Allen/CH2M HILL on December 18, 1992.

Table 1. Significant Rainfall Daily Totals Iona Wash FIS Study Area (Inches)				
Event Date	Precipitation Gauge Name & Installation Date			
	Circle City (9/17/82)	Wittmann (5/13/92)	Castle H.S. (10/20/81)	Patton Rd. (5/13/92)
9/19-20/92		3.1		
2/7/92		1.4	2.0	1.4
2/28-3/1/91	2.5		2.5	
9/3/90		1.8		
8/19-21/88			3.3	1.9
12/17/87		1.6		1.2
8/17/84		2.1		
7/21/84		1.7		
7/27/82		1.6		
12/17/78		1.7		1.4
3/1/78		2.1		2.1
* blank cell indicates no information or rainfall less than 1.0 inch.				

Structures As-Built Plans

Only two engineered structures are located in the study area, the Patton Road culvert crossing and the CAP overchute. As-built plans are attached for the 47 ft. by 7 ft. structural concrete overchute at CAP station 572+50. As-built plans were not available for the 4-cell, 42-inch reinforced concrete culverts with projecting inlet and upstream and downstream grouted road embankment protection. The appearance of the grouted slope protection indicates that the County has attempted to protect the crossing from damage during overtopping. As-built plans for the bridge crossing at State Route 89 (Station 1496) are also attached, although this structure is outside the study limits.

There are five stock ponds which may collect runoff from Iona Wash. Four of the five stock ponds were built between 1951 and 1992, but none are licensed by ADWR. Therefore, no as-built plans are available for any of these structures.

FEMA Maps

Portions of the study area are shown on FIRM panels for unincorporated Maricopa County[15]. FIRM panel are available for the area immediately downstream of State Route 89, and the reach between Patton Road and the confluence with Trilby Wash. The reach from the C.A.P. overchute (including the ponding area upstream of the C.A.P.) to Trilby Wash is mapped as an unnumbered A zone. The remaining mapped areas are shown as shaded X zones. Shaded X zones indicate areas within the 500-year floodplain, or 100-year floodplain areas with depths less than one foot. There have been no LOMRs, LOMAs, or CLOMRs within the study area[16].

The majority of the study area is not shown on any published FIRM panel.

Other Information

Field Data. Data collected in the field included limited high water marks, approximate channel bed sediment sizes, stream geomorphic characteristics, and vegetative characteristics of the wash and floodplain. Overbank floodplains are very uniform throughout the study area, consisting of flat, sandy-silt soils. Vegetation in the floodplains are generally creosote, bursage, and other desert brush. Channel dimensions and characteristics vary somewhat in the study. Where the wash is channelized, bed sediment sizes do not change significantly in the downstream direction. However, bed sediments become somewhat finer in the reaches downstream of sheet flow and breakover areas. Most of the channel banks are lined

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[15] FEMA, September 4, 1991, FIRM Panel 680 of 4350, Maricopa County, Arizona and Incorporated Areas. Map Number 04013C0680 E.

FEMA, September 4, 1991, FIRM Panel 1105 of 4350, Maricopa County, Arizona and Incorporated Areas. Map Number 04013C1105 E.

FEMA, September 4, 1991, FIRM Panel 1110 of 4350, Maricopa County, Arizona and Incorporated Areas. Map Number 04013C1110 E.

[16] Nevitt, Ron, 1992 (October 8), Personal communication to Sandy Story/FCDMC.

by thick brush and trees. This riparian vegetation makes the channel boundaries easily identifiable on aerial photographs. High water marks along the wash indicate that significant flooding has occurred in the recent past. This flooding consisted of both in-channel flow and shallow overbank flow. Some portions of the study reach experience considerable sheet flow.

Geologic Data. Some limited geologic and geomorphic data are available for the study area. The Soil Conservation Service maps the area as fan terraces, with gently sloping to moderately steep, gravelly and very gravelly, loamy and clayey soils[17]. The Arizona Geological Survey maps most of the study area as Holocene to late Pleistocene aged sand and silt soils characterized by gullies with bar and swale topography[18]. Iona Wash is bounded to the west by geologically much older, topographically higher, early-Pleistocene relict surfaces which direct runoff to the southeast. The two areas of youngest soils in the study area correspond to areas where the Iona Wash appears to lose confinement, and sheet flow may occur. Stream patterns throughout the study area are tributary, except where diversions were created for stock ponds.

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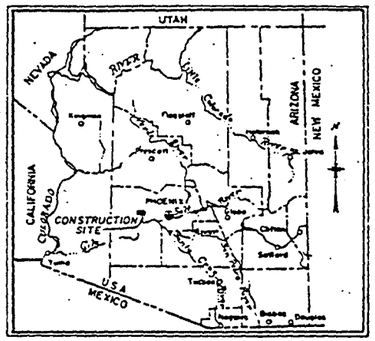
[17] USDA Soil Conservation Service, 1986, Soil Survey of Aguila-Carefree Area, Parts of Maricopa and Pinal Counties, Arizona.

[18] Dempsey, K.A., 1988, Geologic Map of Quaternary and Upper Tertiary Alluvium in the Phoenix North 30'x60' Quadrangle, Arizona, Arizona Geological Survey Open File Report 88-17.



KEY MAP

EXPLANATION

- OPEN AQUEDUCT AND BRIDGE
- CHECK
- OVERCHUTE
- WASH SIPHON
- DRAINAGE INLET
- FLOATWELL
- DIKE
- DRAINAGE DITCH
- CATTLE CROSSING
- OBSERVATION WELL

CROSS DRAINAGE STRUCTURES

STATION	SIZE	PEAK Qin (cfs)	STORAGE CAPACITY (ac ft)	PEAK Qout (cfs)	DESIGN STORM
189+00	18'x5'-6" OVERCHUTE	3338	584	356	100yr 6hr GENERAL STORM
248+00	18'x6'-0" OVERCHUTE			356	"
	WASH SIPHON	3365	137	2389	"
	47'-4"x3' OVERCHUTE	1250	102	1255	"
609+00	135'-0"x8'-6" OVERCHUTE	6908	0	6903	"
688+00	87'-2"x6'-6" OVERCHUTE	3234	193	2266	"
804+50	67'-6"x8'-6" OVERCHUTE	3715	51	3225	"

TYPICAL ENVIRONMENTAL MONITORING PLOT FENCING DETAILS

NOTE
Arizona state plane coordinate system, central zone

SCALE OF FEET
2000 0 2000 4000 6000

8-70-90 330-	ADDED OVERCHUTE TEXT, WASH SIPHON TEXT
9-28-89 330-	ADDED DESIGNATION WELLS
2-28-86 330-	ADDED CROSS DRAINAGE STRUCTURES CHART.
6-16-82 D-G.L.S.	AS BUILT BY 330, LTR. 9-24-81
2-1-79 D- G.L.S.	ADDED ENVIRONMENTAL MONITORING PLOTS IN SECTION 21.
10-11-79 D- G.L.S.	ADDED CATTLE CROSSING, CHANGED LOCATION OF TWO DRAINAGE INLETS.

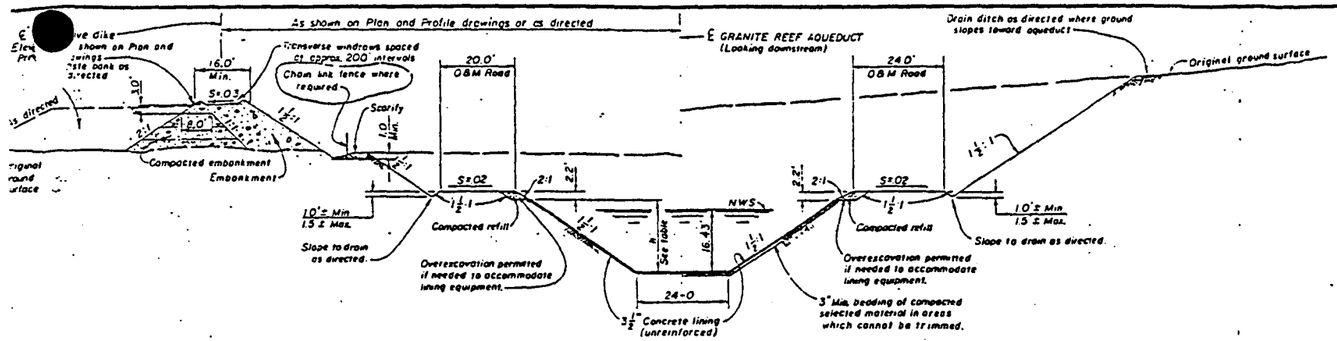
ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
GRANITE REEF DIVISION-ARIZONA

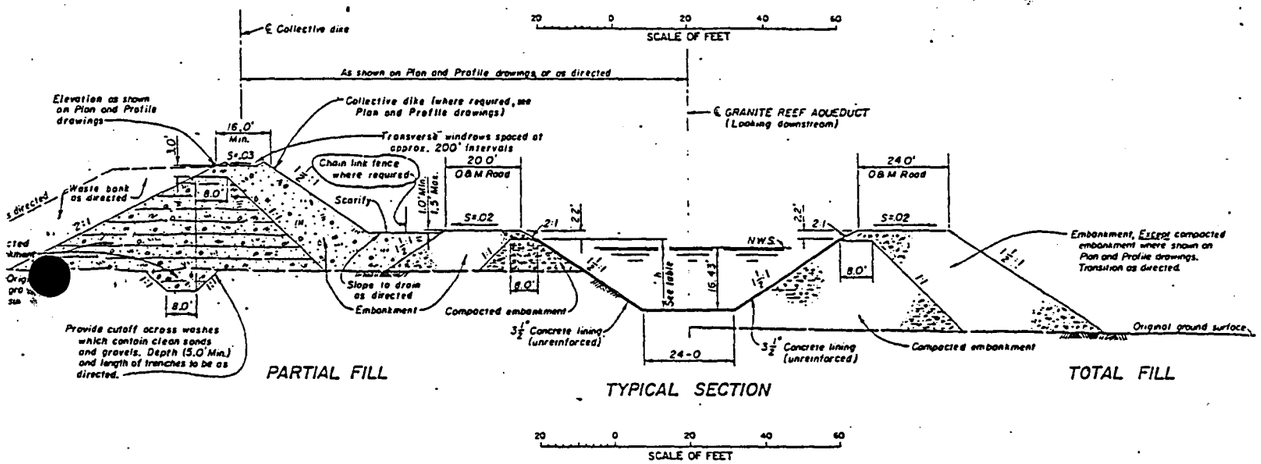
GRANITE REEF AQUEDUCT
REACH 8
LOCATION MAP

DESIGNED D.G.S. SUBMITTED R.R. Miller
DRAWN T.C.P. RECOMMENDED Donald B. Rice
CHECKED Ed T.C. Parker Jr. APPROVED Robert B. Jansen
ASST COM-ENGINEERING AND RESEARCH

PHOENIX, ARIZONA APRIL 22, 1977 | 344-330-18

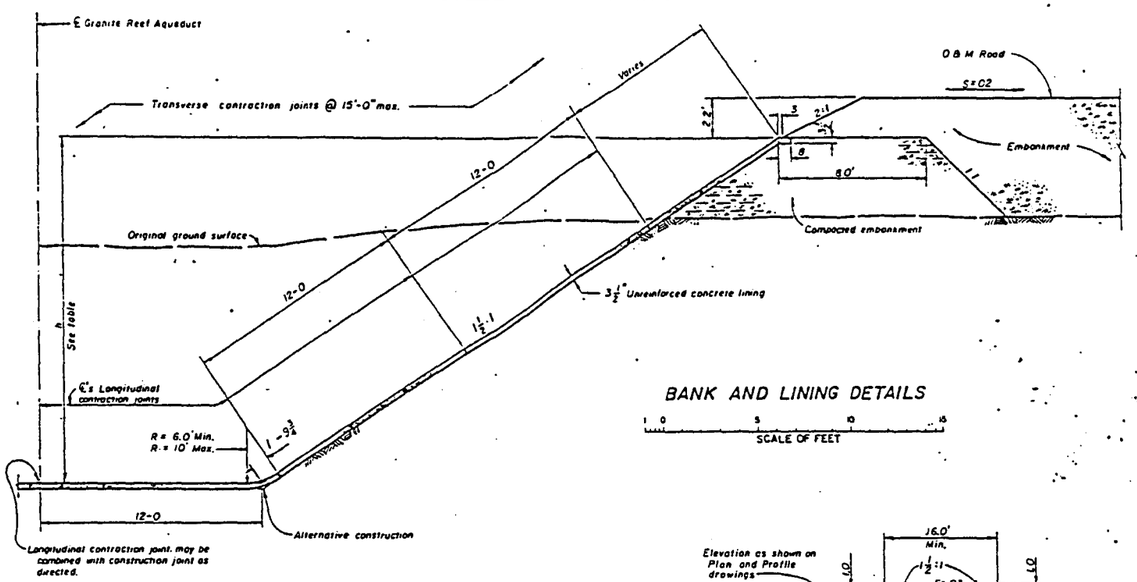


TYPICAL SECTION
(THOROUGH CUT)



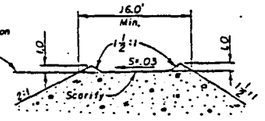
TYPICAL SECTION

20 0 20 40 60
SCALE OF FEET

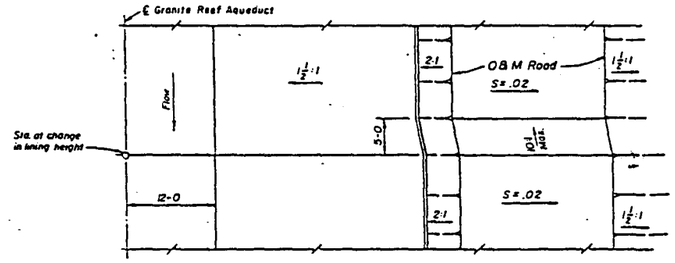


BANK AND LINING DETAILS

0 5 10 15
SCALE OF FEET



TOP OF COLLECTIVE DIKE DETAIL



TYPICAL PLAN - LINING TRANSITION

10 0 10 20 30
SCALE OF FEET

NOTES

Transverse contraction joints around curves to be on radial lines @ 15'-0" centers, spaced along ℄ aqueduct.

For details of contraction joints, see 344-D-1244.

For details and spacing of safety ladders, see 344-D-4020.

Concrete lining design is based on a compressive strength of 3000 p.s.i @ 28 days.

For waste bank locations, see plan and profile drawings.

LINING HEIGHT TABLE

STATION			h
102+00	to	353+00	18.6
353+00	to	383+00	19.0
383+00	to	433+00	19.5
434+16.29	to	672+00	18.6
672+00	to	702+00	19.0
702+00	to	752+00	19.5
753+16.29	to	811+64.42	18.6

HYDRAULIC PROPERTIES

A	V	Q	r	n	s	b	d
799.24	3.75	3,000	9.60	.016	.00008	124.0	16.43

6-16-82 D-6.L.S.	AS BUILT BY 330, LTR 9-24-81
8-9-79 D-Q.S.M.	CHANGED SAFETY LADDER REFERENCE DRAWING NUMBER IN T NOTES IN ACCORDANCE WITH SUPPL. NOTICE No. 6.
10-24-78 D-Q.S.M.	DELETED TYPICAL SECTION FOR SIDE SLOPE OVEREXCAVATION. SHOWED CHAIN LINK FENCE LOCATION.

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
GRANITE REEF DIVISION - ARIZONA

GRANITE REEF AQUEDUCT

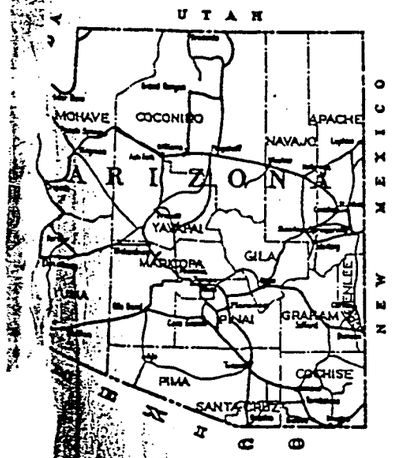
REACH 8

TYPICAL SECTIONS

DESIGNED A.J. Wood TECHNICAL APPROVAL A.J. Wood
DRAWN SUBMITTED Ed d'Long
CHECKED L.C. Rogers APPROVED E.D. Nelson
CHIEF, WATER CONVEYANCE BR.

DENVER, COLORADO JUNE 8, 1978 344-D-165

B.P.R. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT.
7	ARIZ.	NON F-022-2-504	1		
		F-022-2-(7)	1	23	
		F-022-2(8)	1	32	
		F-FG-022-2-(11)	1		
			1		



STATE OF ARIZONA
STATE HIGHWAY DEPARTMENT

PLAN AND PROFILE OF PROPOSED

STATE HIGHWAY

WICKENBURG—PHOENIX

MARICOPA COUNTY

PLANS DIVISION
MAR 2 1964
FILE COPY

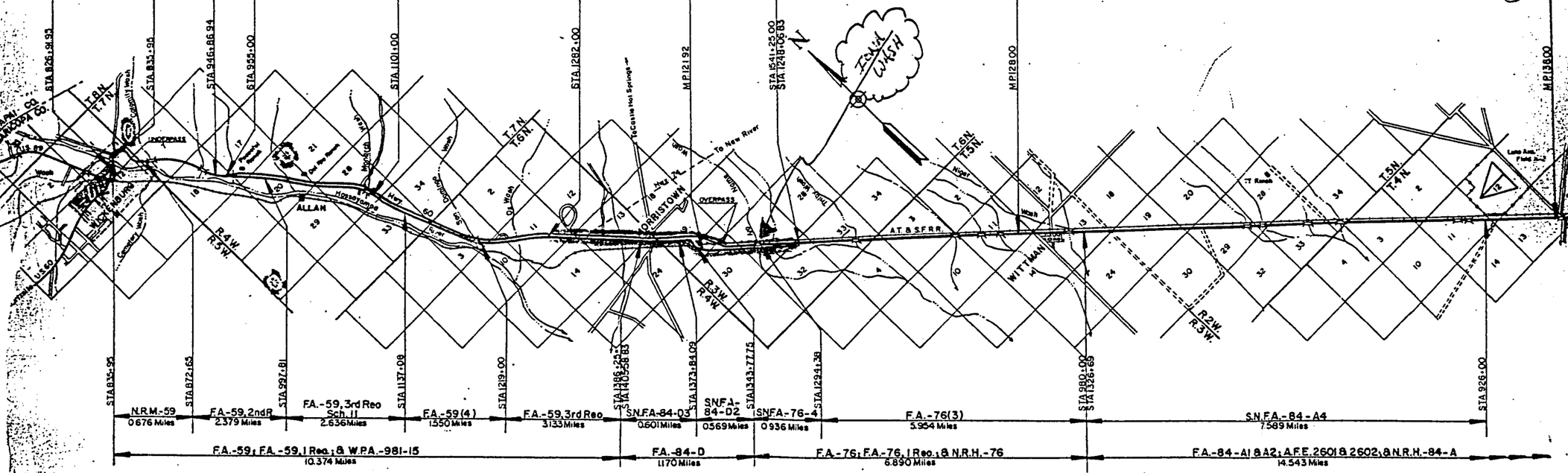
PLANS DIVISION
MAR 1964
FILE COPY

F-FG-022-2(11)
AS BUILT

862-122.10

F-022-2-(7) 2.914 Miles | F-022-2(8) 3.428 Miles | F-F.G.-022-2-(11) 4.947 Miles

NON.F-022-2(61)A 0.171 Miles | F-022-2(1) 2.249 Miles | NON.F-022-2-504 6.080 Miles | NON.F-022-2(60)C 10.000 Miles



UPDATED
FEB 5 - 1974

ARIZONA STATE HIGHWAY COMMISSION
APPROVED. WM. N. PRICE
STATE HIGHWAY ENGINEER.

APPROVED DATE
DEPUTY STATE ENGINEER

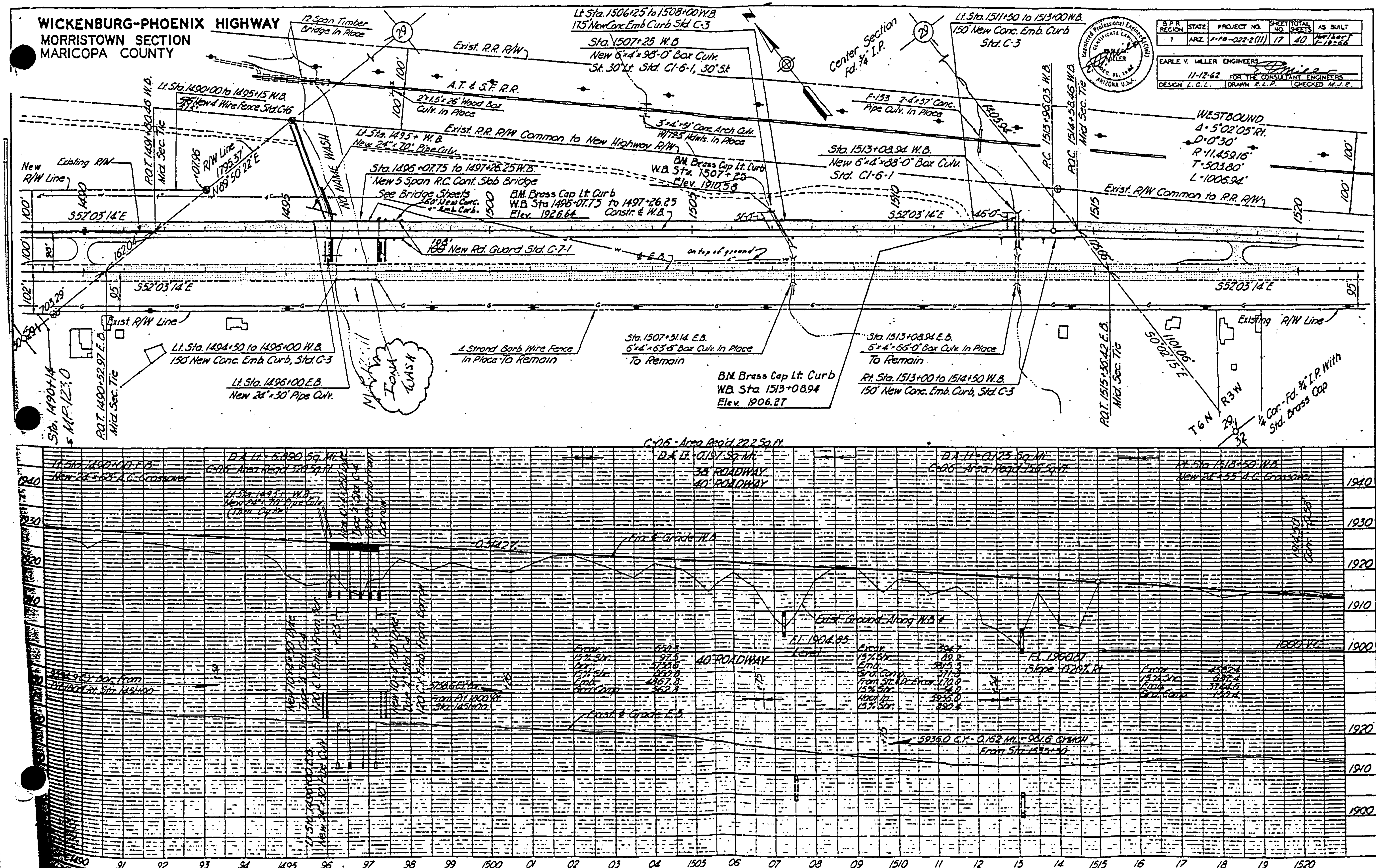
APPROVED DATE 3-9-64
ASSISTANT STATE ENGINEER
R. E. Laynedo

DEPARTMENT OF COMMERCE.
BUREAU OF PUBLIC ROADS.

RECOMMENDED FOR APPROVAL DATE
DIVISION ENGINEER.

APPROVED DATE
REGIONAL ENGINEER

SCALE: 1" = 1 Mile



WICKENBURG-PHOENIX HIGHWAY
MORRISTOWN SECTION
MARICOPA COUNTY
B.P.R. REGION 7
STATE ARIZ
PROJECT NO. F-FG-022-2(11)
SHEET NO. 17
TOTAL SHEETS 40
AS BUILT
EARLE V. MILLER ENGINEERS
11-12-62
FOR THE CONSULTANT ENGINEERS
DESIGN L.C.L.
DRAWN R.L.P.
CHECKED M.J.E.
12 Span Timber Bridge In Place
Exist. R.R. R/W
A.T. & S.F. R.R.
Lt Sta. 1506+25 to 1508+00 W.B.
175' New Conc. Emb Curb Std. C-3
Sta. 1507+25 W.B.
New 6'x4'x98'-0" Box Culv.
Sk. 30° Lt. Std. C1-6-1, 30° Sk
Center Section Fd. 3/4" I.P.
Lt. Sta. 1511+50 to 1513+00 W.B.
150' New Conc. Emb. Curb
Std. C-3
Lt. Sta. 1490+00 to 1495+15 W.B.
515' New 4 Wire Fence Std. C-16
2'x1.5'x26' Wood Box Culv. In Place
3'x4'x51' Conc. Arch Culv. W/T&S Hdwls. In Place
F-153 2-6'x57' Conc. Pipe Culv. In Place
Exist. R.R. R/W Common to New Highway R/W
P.O.T. 1491+20.46 W.B. Mid Sec. Tie
R/W Line 1795.37'
N89°50'22"E
Lt. Sta. 1495+ W.B.
New 24"x70' Pipe Culv.
NO NAME WASH
Sta. 1496+07.75 to 1497+26.25 W.B.
New 5 Span R.C. Cont. Slab Bridge
See Bridge Sheets
50' New Conc. Emb. Curb
B.M. Brass Cap Lt. Curb
W.B. Sta. 1496+07.75
Elev. 1926.64
to 1497+26.25 Constr. ℄ W.B.
B.M. Brass Cap Lt. Curb
W.B. Sta. 1507+25
Elev. 1910.58
Sta. 1513+08.94 W.B.
New 6'x4'x88'-0" Box Culv.
Std. C1-6-1
P.C. 1513+96.03 W.B.
P.O.C. 1514+58.46 W.B. Mid Sec. Tie
WESTBOUND
Δ=5°02'05" Rt.
D=0°30'
R=11,459.16'
T=503.80'
L=1006.94'
Exist. R/W Common to R.R. R/W
New R/W Line
Existing R/W
S52°03'14"E
108' New Rd. Guard Std. C-7-1
℄ E.B.
on top of ground
Existing R/W Line
Exist. R/W Line
Lt. Sta. 1494+50 to 1496+00 W.B.
150' New Conc. Emb. Curb, Std. C-3
Lt. Sta. 1496+00 E.B.
New 24"x30' Pipe Culv.
IONA WASH
4 Strand Barb Wire Fence In Place To Remain
Sta. 1507+51.14 E.B.
6'x4'x65'6" Box Culv. In Place
To Remain
Sta. 1513+08.94 E.B.
6'x4'x65'-0" Box Culv. In Place
To Remain
B.M. Brass Cap Lt. Curb
W.B. Sta. 1513+08.94
Elev. 1906.27
Rt. Sta. 1513+00 to 1514+50 W.B.
150' New Conc. Emb. Curb, Std. C-3
Sta. 1490+14 = M.P. 123.0
P.O.T. 1490+52.97 E.B. Mid Sec. Tie
P.O.T. 1515+36.42 E.B. Mid Sec. Tie
T6N R3W
1/4 Cor. Fd. 3/4" I.P. With Std. Brass Cap
C=0.6 - Area Req'd 22.2 Sq. Ft.
Lt. Sta. 1490+00 E.B.
New 24"x 63' A.C. Crossover
D.A. II - 6.880 Sq. Mi.
C=0.6 - Area Req'd 320 Sq. Ft.
D.A. II - 0.197 Sq. Mi.
38' ROADWAY
40' ROADWAY
D.A. II - 0.123 Sq. Mi.
C=0.6 - Area Req'd 15.6 Sq. Ft.
Rt. Sta. 1518+50 W.B.
New 24"x 55' A.C. Crossover
-0.5142%
Fin. ℄ Grade W.B.
Exist. Ground Along W.B. ℄
F.L. 1904.85 Level
F.L. 1900.87 Slope 1.20% Rt.
40' ROADWAY
1000' V.C.
Exist. ℄ Grade E.B.
5936.0 C.Y. - 0.162 Mi. = 961.6 CYMOH
From Sta. 1533+30
1940
1930
1920
1910
1900
1490
91
92
93
94
1495
96
97
98
99
1500
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02
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1505
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Section 6: Reference Materials

6.5 Referenced Technical Papers

SOLVING THE HORIZONTAL CONTROL DEFICIENCIES OF FIA FIRMs-- A LOGICAL, ACCURATE, AND COST-EFFECTIVE APPROACH TO USING FIRMs IN A GIS

Kevin M. Winne
Michael Baker Jr.,Inc.

David J. Greenwood
Michael Baker Jr.,Inc.

Introduction

One of the most difficult problems we all face when converting Flood Insurance Rate Maps (FIRMs) to a digital format in a GIS environment is the establishment of accurate horizontal positioning of the floodplain. The use of optical scanning equipment coupled with interactive simultaneous raster/vector processing provides a solution to this problem.

History of Mapping Effort

The key element to enhancing the horizontal control of FIRMs is to have a knowledge of how the FIRMs were first created. The FIRMs' base maps have been developed using various sources--some very accurate and some with less than desirable accuracy. In general, the supporting information used to develop the 100-year floodplain delineation has, as a minimum, horizontal accuracy consistent with the USGS quadrangle available at the time the study was completed (1970-1992) in the majority of the situations. In many cases, the horizontal accuracy in the floodplain area is extremely precise and is supported by detailed photogrammetric mapping at scales of between 1:1,200 to 1:12,000. However, for the areas outside the floodplain, the sources may have very questionable positional accuracy. Many of the FIRMs were prepared from community-supplied bases outside the floodplain, and the very detailed

floodplain maps were strip-registered into the community base. Therefore, the end result could be very good horizontal positions within the floodplain and very poor horizontal positioning outside it.

Therefore, based on this historical perspective, the following process was designed to hold the floodplain area accuracy intact while at the same time improving the accuracy of those areas outside the floodplain.

Conversion to Digital

The process of converting the hardcopy FIRM to a digital format begins with obtaining all the source material (FIRMs) for the area. Typically the conversion is done for an entire county, including county panels and panels for the incorporated communities. Because these documents will be optically scanned (i.e., converted to a raster image), the quality of the FIRMs must be taken into consideration. The best results have been obtained by using composite negatives, i.e., the original artwork composite from which the hardcopy maps are printed. Each of the negatives is optically scanned, and a file is created for the panel. During the scanning process, the dot pattern within the screened areas, which are seen as shading on the printed FIRMs, are eliminated from the file. This not only conserves file space but also enhances legibility of the image.

Because the scanning process creates the raster image at a scale of 1:1 or one inch to one inch, the data must be scaled as the first step. The raster data are sized to match the FIRMs' published scale (i.e., 500 feet per inch, etc.), prior to vectorizing. The data capture, or vectorizing, that follows is done in a "heads-up" mode. This "heads-up" digitizing is accomplished by a CADD operator who traces over the raster image of features as they appear on the screen. Intelligent vector data are created to replace

the unintelligent raster data. Four themes of data, outlined in Reference 1 are captured: flood, political, panel, and hydrography. The flood theme includes the flood hazard zone data, such as the delineation of the flood zones and their attributes, and base flood elevation (BFE) lines. The political theme includes city, county, and other political subdivision boundary lines. FIRM panel neatlines and their numbers are contained in the map panel theme. The last theme is the hydrography, which contains data such as the cross sections, streams, elevation reference marks, and dams. No base-map information, such as roads or township/range lines, is captured.

Following completion of the data capture, each panel undergoes rigorous quality control. The first phase, a visual inspection of the file, begins by plotting the file at the same scale as the original FIRM. The plot is compared to the source and checked for completeness and correctness. If any missing data or incorrect data are detected, the necessary revisions are indicated on the plot in red and returned to a CADD operator for correction.

A digital validation is performed once the file is visually correct. The first phase of the digital validation is the "linecheck" process. This is a batch operation that checks the linework in the file to detect any free endpoints or crossing lines. Because the flood data will be output as polygons, the linework that makes up these polygons must be "clean", i.e. the endpoints of each line must meet the endpoints of another line and two lines cannot cross without breaking. Any errors detected by the software will be flagged in the file: free endpoints with a circle and intersecting lines with a square. An operator will then review the file, locate each error by the shape, and correct the error. This process is repeated until the software certifies "zero errors."

The next phase of the digital validation is the "polygon check." This process takes the "clean" linework as certified previously and creates polygons. Each polygon is then checked to verify that it is labeled and that no polygon has more than one label. Any polygons found to be in error are outlined in red for correction by an operator. As each file is corrected, the polygon check process is repeated until the software certifies "zero errors."

Establishing Horizontal Control

After completion of both quality control steps, the panel is completed and ready to be "fitted" to the landbase. For the purpose of this paper, fitting is defined as "locating the floodplain delineations from an uncontrolled FIRM on a horizontally controlled USGS quadrangle." This is accomplished by scaling, moving, and/or rotating the panel data to fit common points on the FIRM and quad within the floodplain. There is no warping or "rubber-sheeting" of the data.

The process begins by creating an index of the USGS quads for the area being converted, usually a county. The corners of each quad are mathematically placed in a file based on the latitude/longitude of each corner. A paper copy of each quad is then optically scanned to be used as the base map for the fitting process. The resulting raster data is then adjusted to fit the four corners which were mathematically placed in the index. This is accomplished by identifying the visual corner of the quad using the raster data followed by the mathematical or exact corner using the index. The raster quad data are then transformed to fit their true location. This process is repeated for each quad until the base map is complete for the county.

Once a controlled base map is available, fitting the panel information to this base can begin. Before any manipulations are performed, the panels

are reviewed and a logical approach is defined for each one. The normal approach is to fit each individual river or stream reach, beginning with the largest and progressing to the smallest. The actual location of the flood areas is determined by identifying points within the floodplain on the FIRMs and locating those same points on the USGS quad. Two points, one at each end of the area to be fitted, are used to determine the angle of rotation. The bearing between the two points is measured from the panel file and also from the quad file. The difference is applied to the panel file as the angle of rotation. Next, any scale discrepancies must be resolved. Normally this requires converting from feet to meters. The last step actually moves the panel data to its "fitted" location. During this first pass, the entire panel has been processed through the scale/move/rotate operation.

Once moved, the primary stream is examined to determine how well the vectorized FIRM data matches the evidence of the USGS base map. Any subtle adjustments needed to complete the primary stream will be made before proceeding.

The secondary streams are examined next to determine what, if any, further adjustments are necessary for each to conform to the base map. In some instances, it may be necessary to rotate a secondary stream while holding the primary stream in place. Also, another stream may be shown on the panel with no connection to the first. The fitting of this stream will be performed independent of the first.

This process is repeated for each panel and each stream, as necessary, in the county, including the incorporated communities. Upon completion of the fitting process, the flood information is considered to now be correctly positioned. Mismatches at panel lines, which were present in the original panels, are not modified except as required to close polygons.

Output By Quadrangle

The final fitted data is output in quad format. The data from each panel needed for a quad is copied from the panel file to a newly created quad file. Once created, the quad file passes through the same quality control steps as the panels. The visual inspection begins with a plot of the final fitted panel data and the raster quad base map. A review of the results is completed before the file is output. Also, because the linework of the original panels has been manipulated, the digital validation processes are repeated for the quad files to verify the proper polygon structure prior to translation.

The completed quads are output in DLG format (Reference 1), four files for each quad. Each file contains the data for one theme: (1) flood hazard zones, (2) political areas, (3) map panels, or (4) hydrography.

Summary

This paper has presented, in condensed form, a process that capitalizes on the accuracies of the FIRMs while overcoming the inadequacies. The results can be used in most GIS applications. Although this enhancement has been outlined for use with a readily available source, the 7 1/2 minute USGS quadrangle, the same procedures can be applied for any reliable horizontally controlled base map. The same procedures outlined above have been used to enhance U.S. Census TIGER files and other public domain data sets.

References

Federal Emergency Management Agency
1991 Standards for Digital Flood Insurance Rate Maps. Washington, D.C.: Office of Risk Assessment, Federal Insurance Administration

Section 6: Reference Materials

6.5 Field Reconnaissance

12-10-92 Photo Log

From STOCKPOND 3 @ 9:10-11, 2 @ 9:14(?), 1 @ 9:13

Look N X FP @ LOB old surf 1 of 2 minor (main) chls

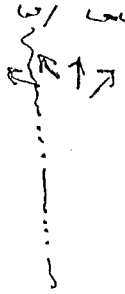
(2) From LOB W/S STOCKPOND 9:25-27

3 From/AT ROB, 2 From ROB of CHL

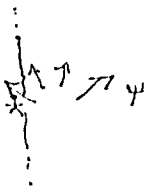
1 IN LOB (slightly lower than ROB

(3) ROB TYPICAL CREOSOTE 4-5' HIGH W/ LOW GRASS

4 @ 10:10 Look S

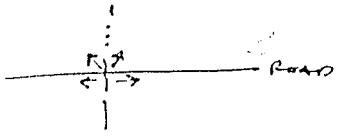


3B) 4 UP @ 10:20

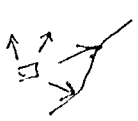


Add to 3 to complete xn typical creosote plan

(4) 4 From CHL BOTTOM - CONFINED REACH

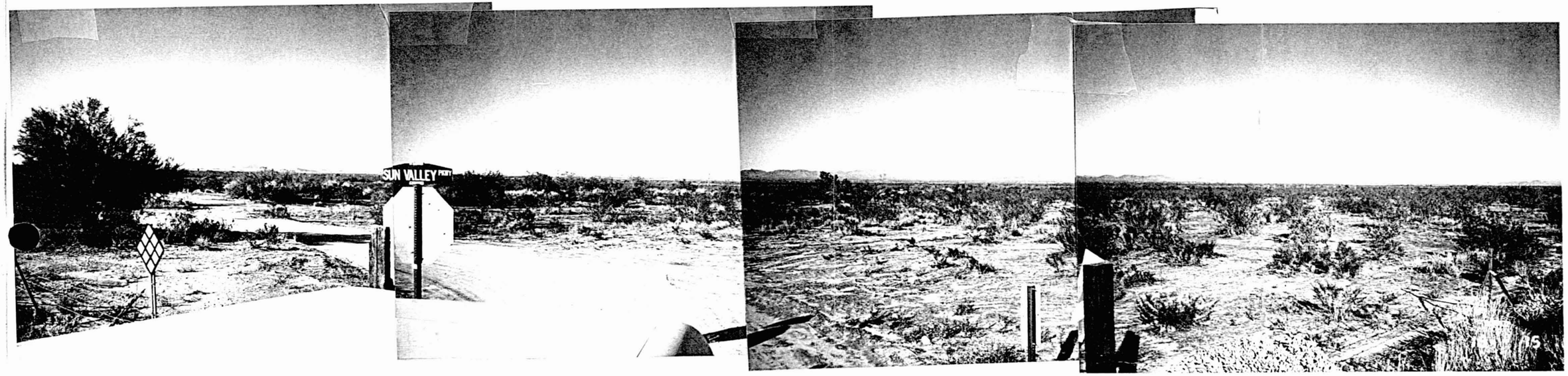


(5) 4 From ROB W/S 13:50



14:01 - 2 @ LOB

PANORAMA #6

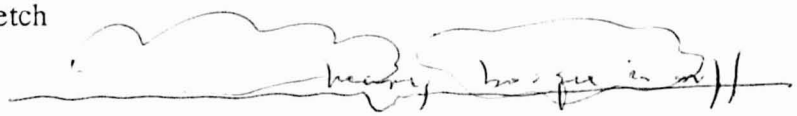


Iona Wash FIS
FCDMC - Phoenix, AZ

Field Investigation Notes

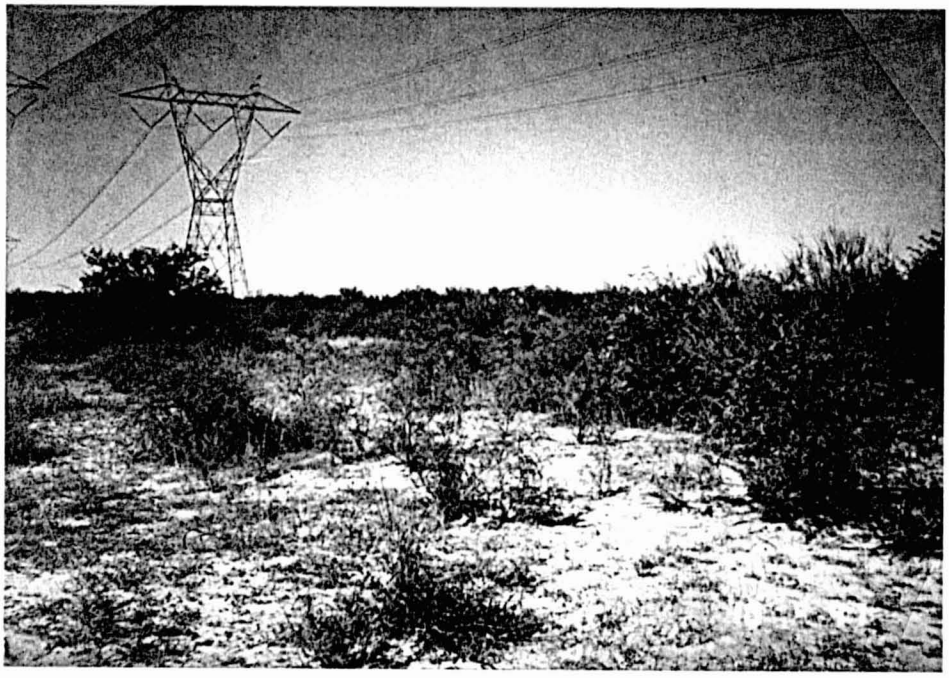
1. Location: (1) at trib / Trib Confluence @ Power line
2. Mark Location
   a. Aerial: ✓ #1
   b. Topo: ✓
3. Structure Dimensions:
   a. Width: None
   b. Depth: _____
   c. N Value: _____
   d. Sketch

4. Photograph Time and Aspect: 10:41 - Look NW (u/s) at merge bosque
5. Highwater Marks? silt deposit in H/P
6. Flood Characteristics:
   a. Sheet? ✓
   b. Overbank? ✓
   c. Channelized? minor cuts 4' max in silty H/P deposits
7. Channel Characteristics: BED MATERIAL (D_{50})
   a. Width: 10-20' } .03 sand
   b. Depth: 2-4' }
   c. N Value: .08
   d. Obstructions, Levees? None seen
   e. Sketch



8. Other Comments

9. By: JAS Date: 10/14

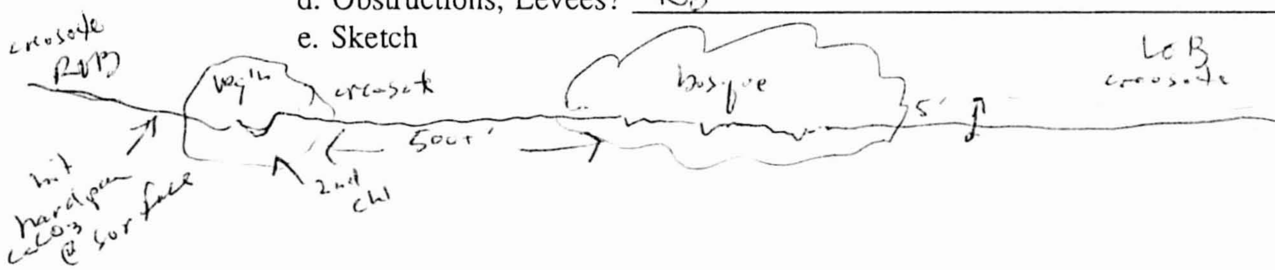


REACH 1

Iona Wash FIS
FCDMC - Phoenix, AZ

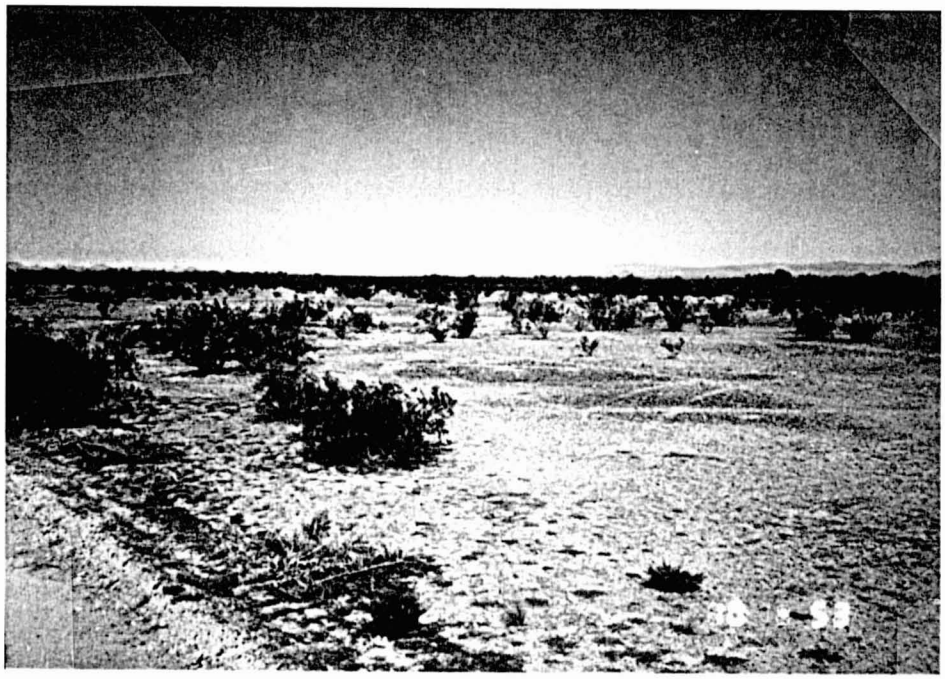
Field Investigation Notes

1. Location: (L) Deer Valley Rd Xing
2. Mark Location
   a. Aerial: ✓
   b. Topo: ✓
3. Structure Dimensions:
   a. Width: None
   b. Depth:
   c. N Value:
   d. Sketch
4. Photograph Time and Aspect: LOB - 2 @ 10:53 1 u/s 1 d/s; CHL - 2 @ 10:56 {1 ⊥ to chl @ truck, 2 slightly d/s - hole ripple mark; ROB 1 @ 11:01 look d/s
5. Highwater Marks? ripple marks in chl - recent flow; not overbank
6. Flood Characteristics:
   a. Sheet? ✓ OB
   b. Overbank? isolated perennial channelized in LOB
   c. Channelized? @ high flow n in chl higher than in OB, low flow chl Q<2yr [illegible]
7. Channel Characteristics: - not well defined
   a. Width: Several @ 2-8 ft
   b. Depth: 0.5 - 1'
   c. N Value: .025 + heavy bosque
   d. Obstructions, Levees? No
   e. Sketch



8. Other Comments

9. By: Jef Date: 10/14



10:53

REACH 1
CHANNEL

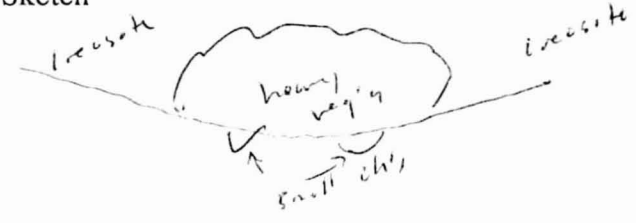
Iona Wash FIS
FCDMC - Phoenix, AZ

Field Investigation Notes

1. Location: (3) at 219th just E of Road
2. Mark Location
   a. Aerial: ✓
   b. Topo: ✓
3. Structure Dimensions:
   a. Width: _____
   b. Depth: None
   c. N Value: 4 ea
   d. Sketch

11:12 - look d/s @ Rd 3
11:12 look U/S W across wash - note much denser veg'n & development
11:07 look N along 219 @ existing spoil
11:08 d/s @ main chl.
11:29 d/s @ " " (2nd one

4. Photograph Time and Aspect: _____
5. Highwater Marks? 1.5' of sight debris
6. Flood Characteristics:
   a. Sheet? _____
   b. Overbank? _____
   c. Channelized? many
7. Channel Characteristics:
   a. Width: 5-12'
   b. Depth: max of 3'
   c. N Value: .030 in sand - high 6's with higher
   d. Obstructions, Levees? No
   e. Sketch



8. Other Comments

9. By: _____ Date: _____

veg'n

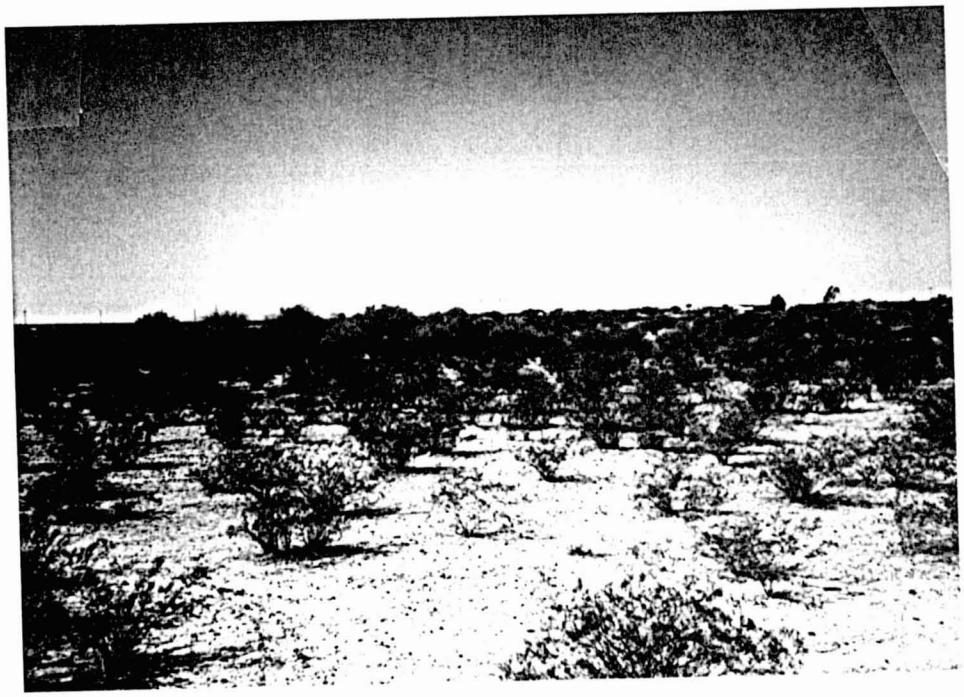
veg'n

CHANNEL

11:08

TRUCK

ROAD



Iona Wash FIS
FCDMC - Phoenix, AZ

Field Investigation Notes

1. Location: (4) on 221st - identical to (5) section - see notes & photos
2. Mark Location
   a. Aerial: _____
   b. Topo: _____
3. Structure Dimensions:
   a. Width: at grade
   b. Depth: _____
   c. N Value: _____
   d. Sketch

20 11:16 u/s & d/s

4. Photograph Time and Aspect: 11:21 Looking
5. Highwater Marks? No
6. Flood Characteristics:
   a. Sheet? All areas so far have evidence of sheet flow
   b. Overbank? in overbank
   c. Channelized? Yes, some
7. Channel Characteristics:
   a. Width: 12
   b. Depth: 4'
   c. N Value: .03
   d. Obstructions, Levees? trees / weeds (see photo)
   e. Sketch

8. Other Comments

9. By: VHT Date: _____

Iona Wash FIS
FCDMC - Phoenix, AZ

Need topo section here!

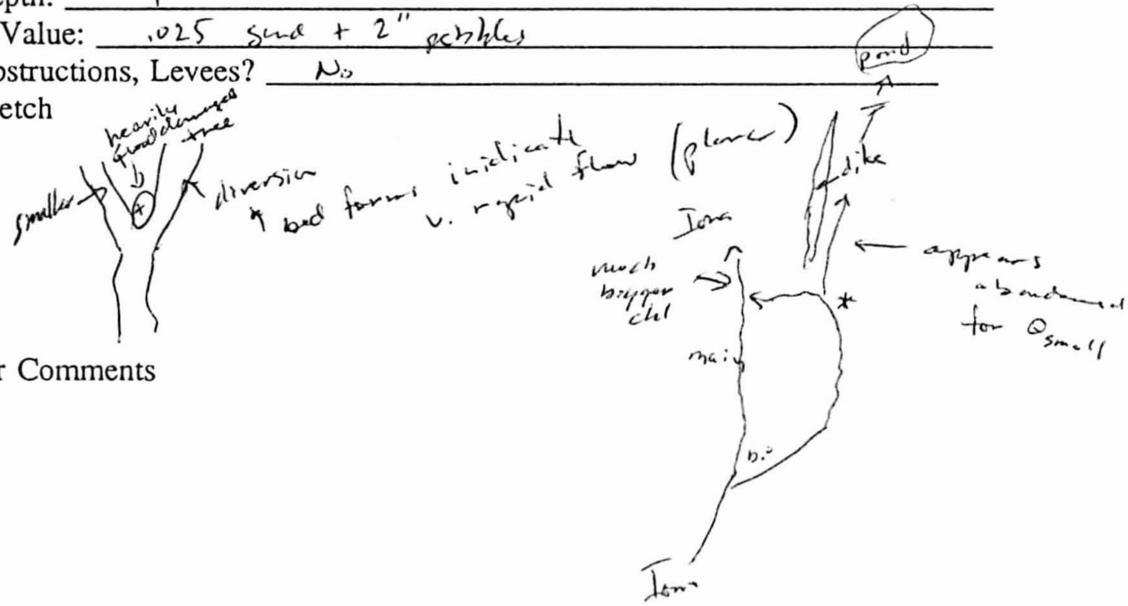
Field Investigation Notes

1. Location: (1) @ breakout
2. Mark Location
   a. Aerial: ✓
   b. Topo: ✓
3. Structure Dimensions: Dike
   a. Width: 15-20 BW 6 ft TW Sand
   b. Depth: 6'' (goes to 0' by Peak Rd)
   c. N Value: ______
   d. Sketch

11:42 - dike
11:42 — ROB area ~ LOB

*11:36 at break area return area look d/s
11:35 u/s at main chl
11:35 d/s at recombined chl

4. Photograph Time and Aspect: 11:31 u/s d/s
5. Highwater Marks? debris pile in tree - see photo d/s
6. Flood Characteristics:
   a. Sheet? no   bed mat'l = med to fine gravel - Lots a bank cutting
   b. Overbank? yes, same as elsewhere creosote + sand
   c. Channelized? Minor to large
7. Channel Characteristics: (u/s break)
   a. Width: 15
   b. Depth: 4
   c. N Value: .025 sand + 2" pebbles
   d. Obstructions, Levees? No
   e. Sketch



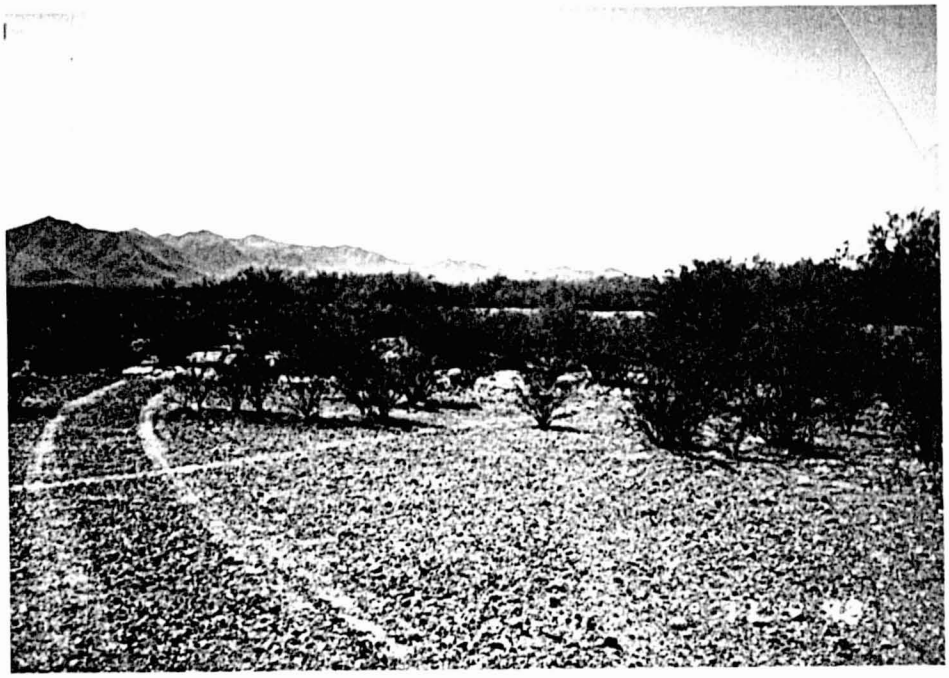
8. Other Comments

9. By: ______ Date: ______


11 - 35


11 - 36


11 - 38



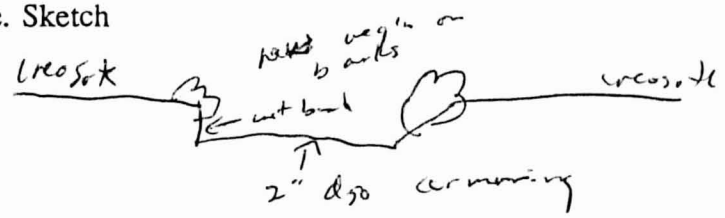
Iona Wash FIS
FCDMC - Phoenix, AZ

Field Investigation Notes

1. Location: 7A d/s of arroyo; u/s of bridge
2. Mark Location
   a. Aerial: ✓
   b. Topo: ✓
3. Structure Dimensions:
   a. Width: None
   b. Depth: _____
   c. N Value: _____
   d. Sketch

2:12:04 – look u/s & d/s

4. Photograph Time and Aspect: _____
5. Highwater Marks? No
6. Flood Characteristics:
   a. Sheet? No
   b. Overbank? No
   c. Channelized? yes
7. Channel Characteristics:
   a. Width: 50
   b. Depth: 4-5
   c. N Value: .032
   d. Obstructions, Levees? No
   e. Sketch



8. Other Comments

ch1 widens here from 10-20' to 50' / see aerial

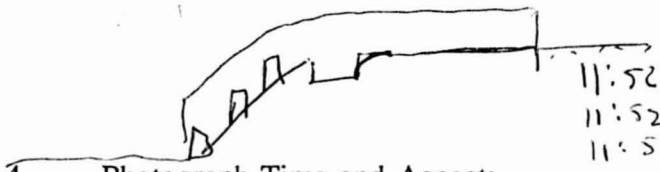
9. By: JJF Date: _____

12:04

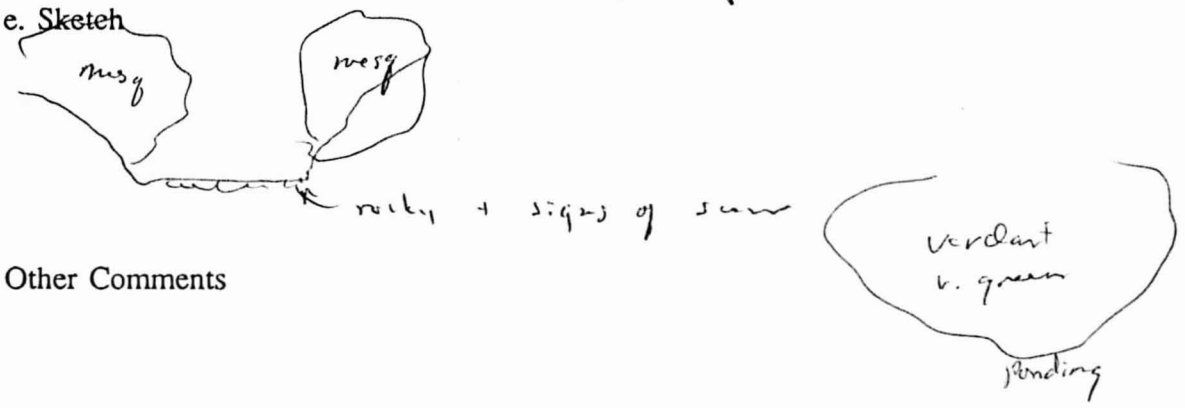
Iona Wash FIS
FCDMC - Phoenix, AZ

Field Investigation Notes

1. Location: (7) @ CAP crossing
2. Mark Location
   a. Aerial: ✓
   b. Topo: _____
3. Structure Dimensions:
   a. Width: ~50'
   b. Depth: 6'
   c. N Value: .012
   d. Sketch – see as built plans



4. Photograph Time and Aspect: 12:20 u/s area from CAP
5. Highwater Marks? in overbank 1'
6. Flood Characteristics:
   a. Sheet? No
   b. Overbank? No
   c. Channelized? Yes
7. Channel Characteristics: crop w/ trees in stag banks
   a. Width: 40
   b. Depth: 10-15
   c. N Value: .032 rocky – bd dso 4"
   d. Obstructions, Levees? bw fence d/s drop
   e. ~~Sketch~~



8. Other Comments

9. By: JRB Date: _____

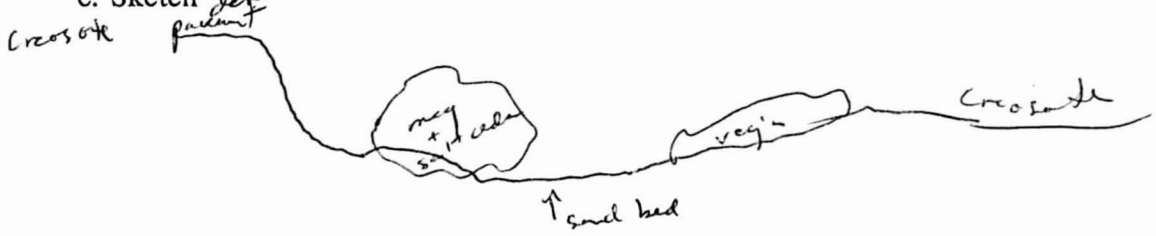
Iona Wash FIS
FCDMC - Phoenix, AZ

Field Investigation Notes

1. Location: 8 couplo 1500 ft u/s CAP
2. Mark Location
   a. Aerial: ✓
   b. Topo: ✓
3. Structure Dimensions:
   a. Width: _____
   b. Depth: None
   c. N Value: _____
   d. Sketch

12:20 – pending area

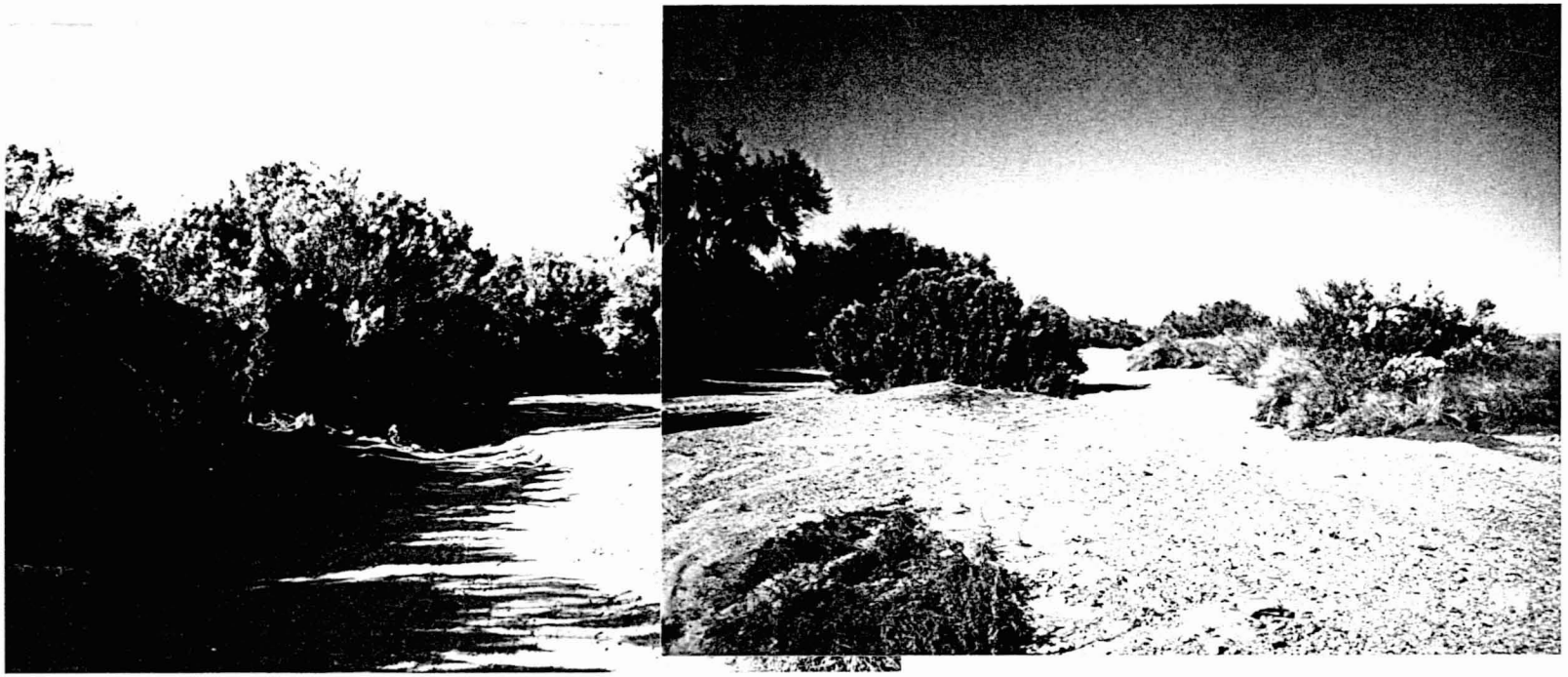
4. Photograph Time and Aspect: 2 @ 12:25 u/s & d/s
5. Highwater Marks? 1-2'
6. Flood Characteristics:
   a. Sheet? No, well yes in flat overbanks
   b. Overbank? Not likely
   c. Channelized? Yes
7. Channel Characteristics:
   a. Width: 50'
   b. Depth: 10'
   c. N Value: bed d50 CS to FG
   d. Obstructions, Levees? No
   e. Sketch



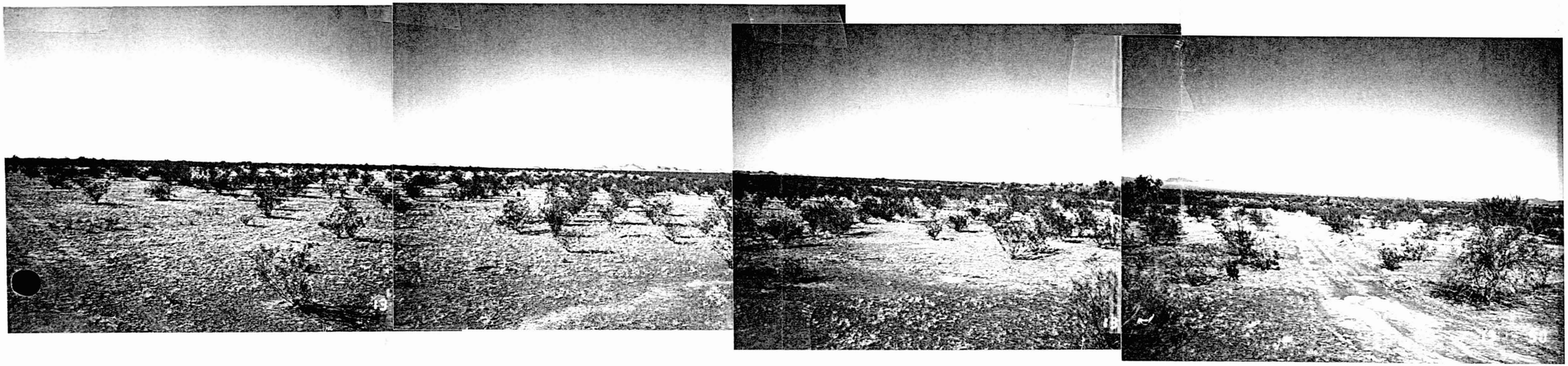
8. Other Comments

9. By: _____ Date: _____

PANORAMIC #5



PANORA # 5



RIGHT BANK [illegible] OF [illegible]
[illegible] PHOTO

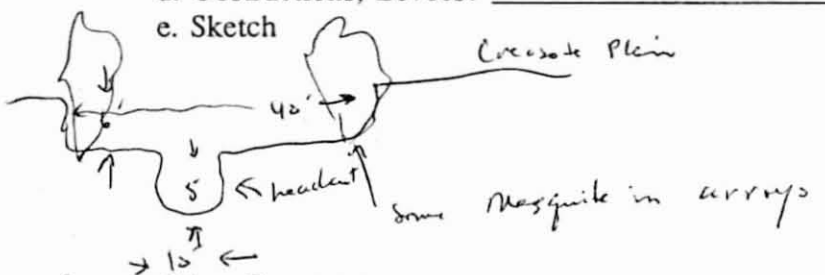
Iona Wash FIS
FCDMC - Phoenix, AZ

Field Investigation Notes

1. Location: 26 m
2. Mark Location
   a. Aerial: ✓
   b. Topo: ✓
3. Structure Dimensions:
   a. Width: _____
   b. Depth: None
   c. N Value: _____
   d. Sketch

overbank Same as everywhere else

4. Photograph Time and Aspect: 16:45 - Look u/s at chl + headcut out of frame
5. Highwater Marks? No
6. Flood Characteristics:
   a. Sheet? No
   b. Overbank? No
   c. Channelized? Yes
7. Channel Characteristics:
   a. Width: See below
   b. Depth: _____
   c. N Value: .04
   d. Obstructions, Levees? _____
   e. Sketch



8. Other Comments

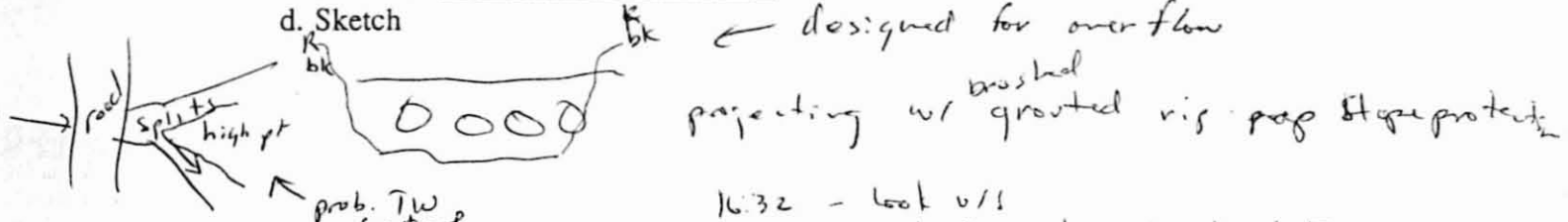
9. By: JF Date: _____


16 - 45

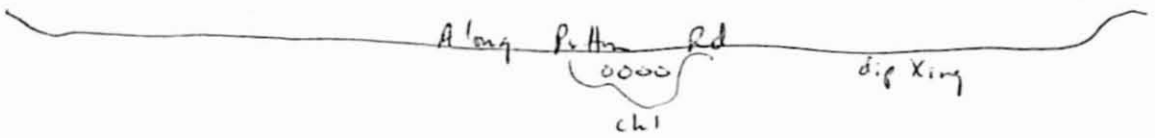
Iona Wash FIS
FCDMC - Phoenix, AZ

Field Investigation Notes

1. Location: (25) along Patton Rd
2. Mark Location
   a. Aerial: ✓
   b. Topo: ✓
3. Structure Dimensions:
   a. Width: 4-42 RCP
   b. Depth: mx HW=5'
   c. N Value: .013
   d. Sketch



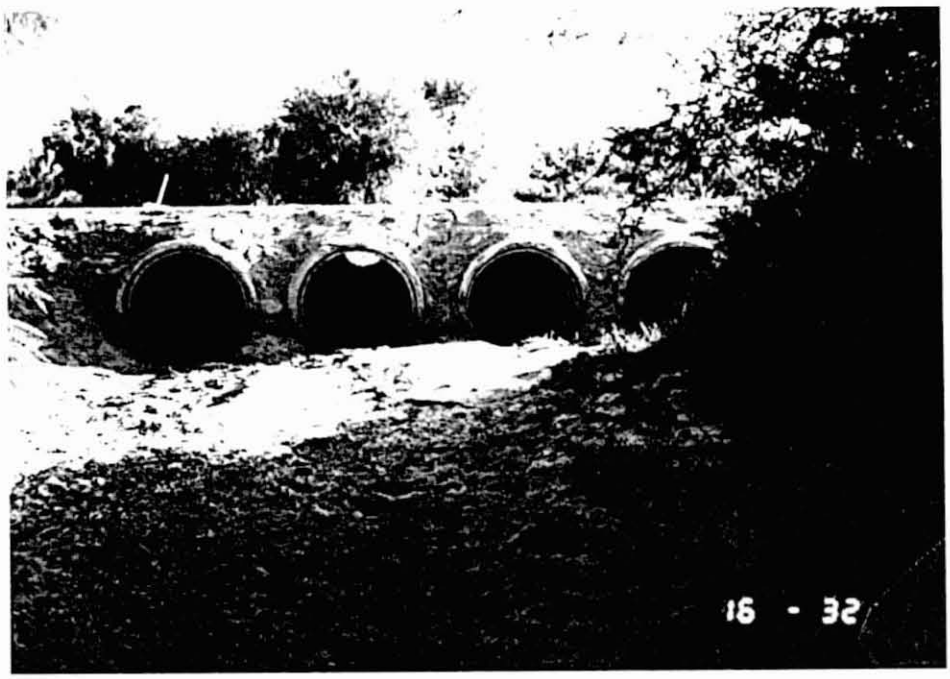
4. Photograph Time and Aspect: 1632 - look u/s - look d/s at culvert inlet
5. Highwater Marks? No
6. Flood Characteristics:
   a. Sheet? No
   b. Overbank? Yes
   c. Channelized? Some
7. Channel Characteristics:
   a. Width: 25
   b. Depth: 4-5
   c. N Value: .028
   d. Obstructions, Levees? Road w/ culverts
   e. Sketch



8. Other Comments

9. By: _____ Date: _____

16:32

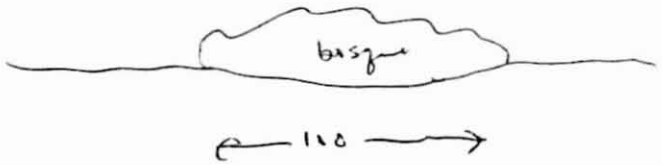


Iona Wash FIS
FCDMC - Phoenix, AZ

Field Investigation Notes

1. Location: (24) d/s stock pond
2. Mark Location
   a. Aerial: ✓
   b. Topo: No
3. Structure Dimensions:
   a. Width: _____
   b. Depth: None
   c. N Value: _____
   d. Sketch

4. Photograph Time and Aspect: 16:21 - of RAB x ch1 to SE
5. Highwater Marks? No
6. Flood Characteristics:
   a. Sheet? Sheet
   b. Overbank? Yes
   c. Channelized? Minor
7. Channel Characteristics: hardly any chls, indiv.
   a. Width: 2'
   b. Depth: 1/2 - 1'
   c. N Value: .07
   d. Obstructions, Levees? No
   e. Sketch



8. Other Comments

9. By: JF Date: _____

chl riparian

dirt

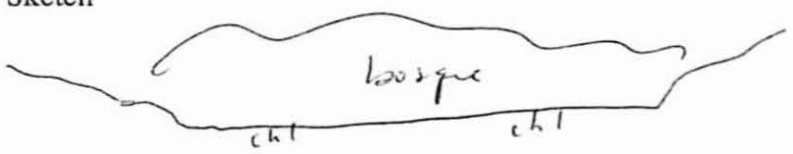
16:21

Iona Wash FIS
FCDMC - Phoenix, AZ

Field Investigation Notes

1. Location: (22) - just d/s of (24) on E-W Rd
2. Mark Location
   a. Aerial: L
   b. Topo: No
3. Structure Dimensions:
   a. Width: _____
   b. Depth: None
   c. N Value: _____
   d. Sketch

4. Photograph Time and Aspect: None. Looks like (22)
5. Highwater Marks? Debris @ 2-3'
6. Flood Characteristics:
   a. Sheet? No
   b. Overbank? yes Most
   c. Channelized? yes
7. Channel Characteristics: - multiple channels - also a 3 ft head cut on R bank
   a. Width: essentially same as (22)
   b. Depth: _____
   c. N Value: _____
   d. Obstructions, Levees? _____
   e. Sketch



8. Other Comments

9. By: JF Date: _____

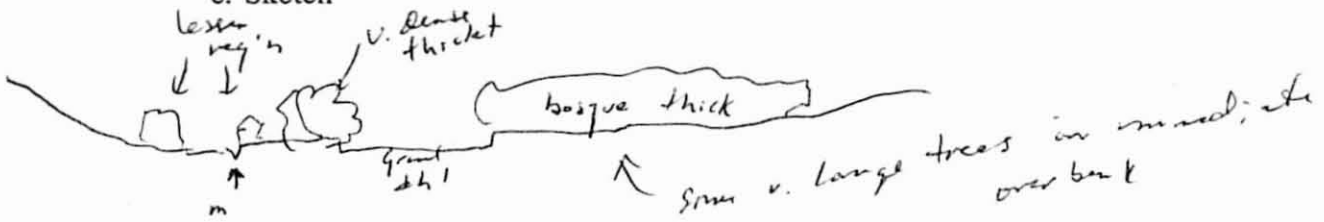
Iona Wash FIS
FCDMC - Phoenix, AZ

Field Investigation Notes

1. Location: (31) @ 243rd N-S road - main branch Iona
2. Mark Location
   a. Aerial: ✓
   b. Topo: ✓
3. Structure Dimensions:
   a. Width: _____
   b. Depth: _____
   c. N Value: _____
   d. Sketch

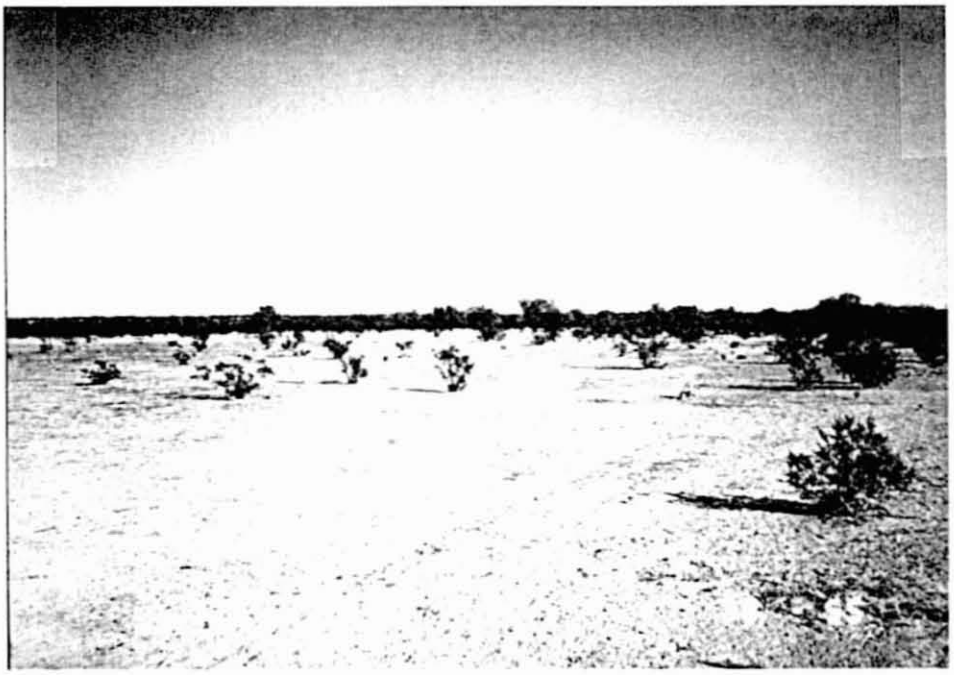
2015:55 - 1 in Loop Look d/s
1 x ch1 look S
15:58 Look d/s along main ch1

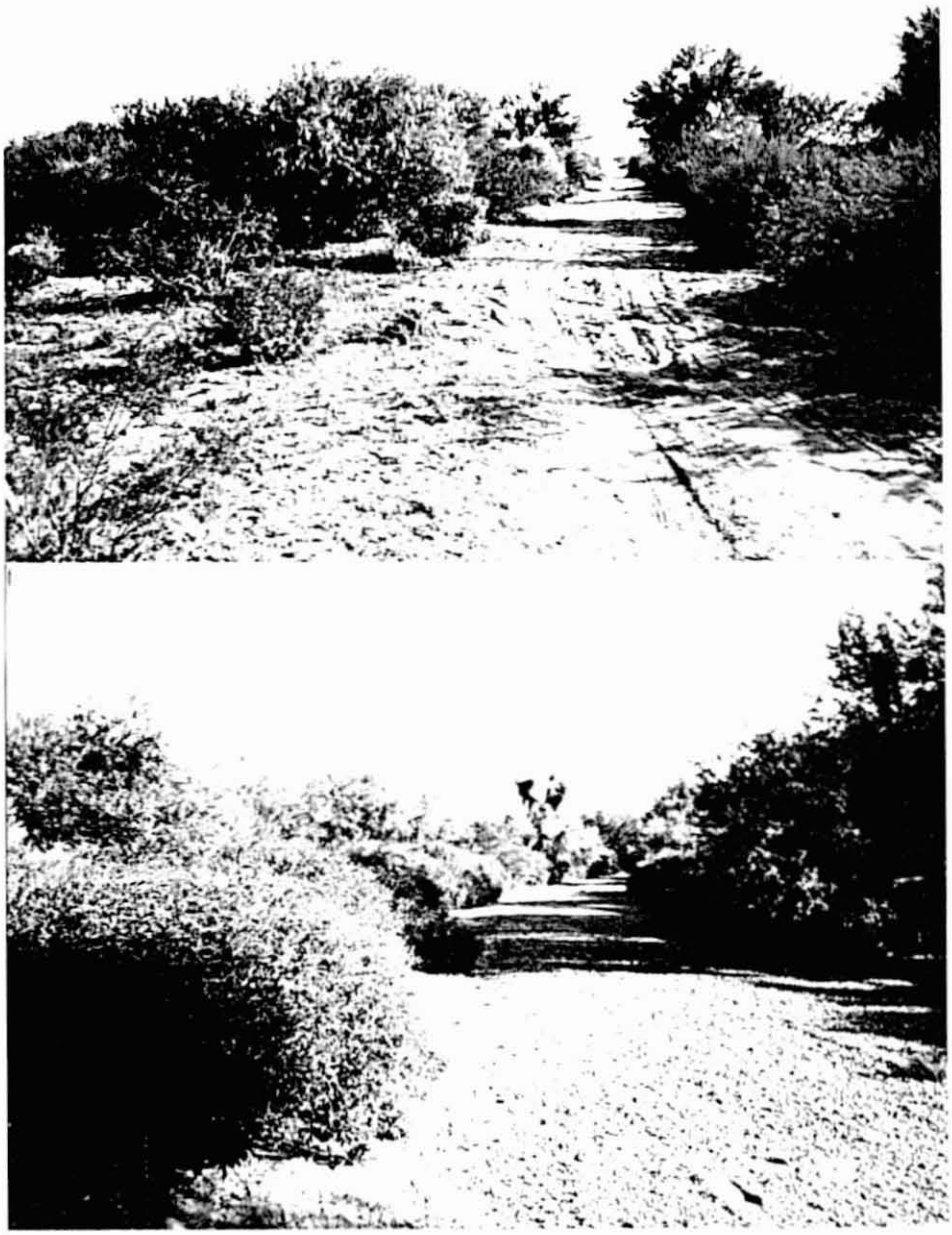
4. Photograph Time and Aspect: _____
5. Highwater Marks? No
6. Flood Characteristics:
   a. Sheet? Yes
   b. Overbank? Yes
   c. Channelized? minor
7. Channel Characteristics: - main ; then the minor chls in f/p
   a. Width: 18' d_{50} = 1" gravel
   b. Depth: 2'
   c. N Value: .03
   d. Obstructions, Levees? No
   e. Sketch



8. Other Comments

9. By: JC Date: _____





Iona Wash FIS
FCDMC - Phoenix, AZ

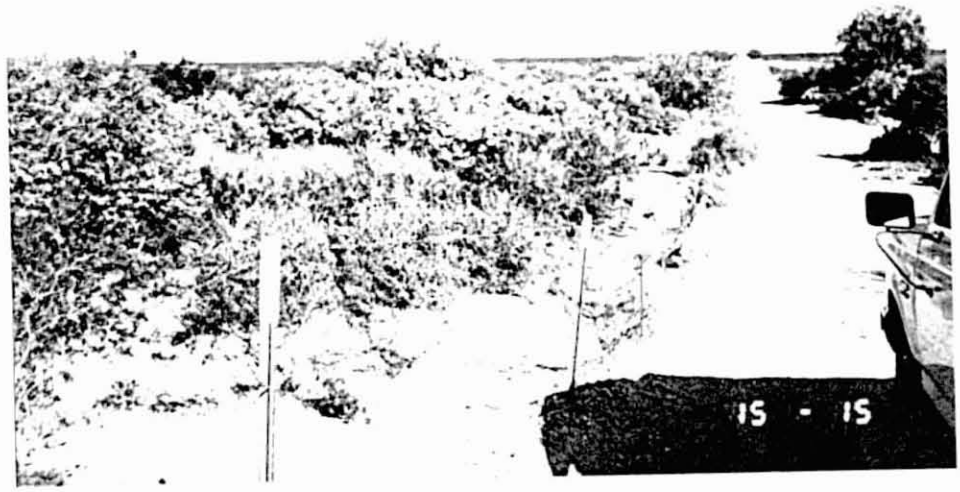
Field Investigation Notes

1. Location: (18)
2. Mark Location
   a. Aerial: ~
   b. Topo: ~
3. Structure Dimensions:
   a. Width: _____
   b. Depth: None
   c. N Value: _____
   d. Sketch

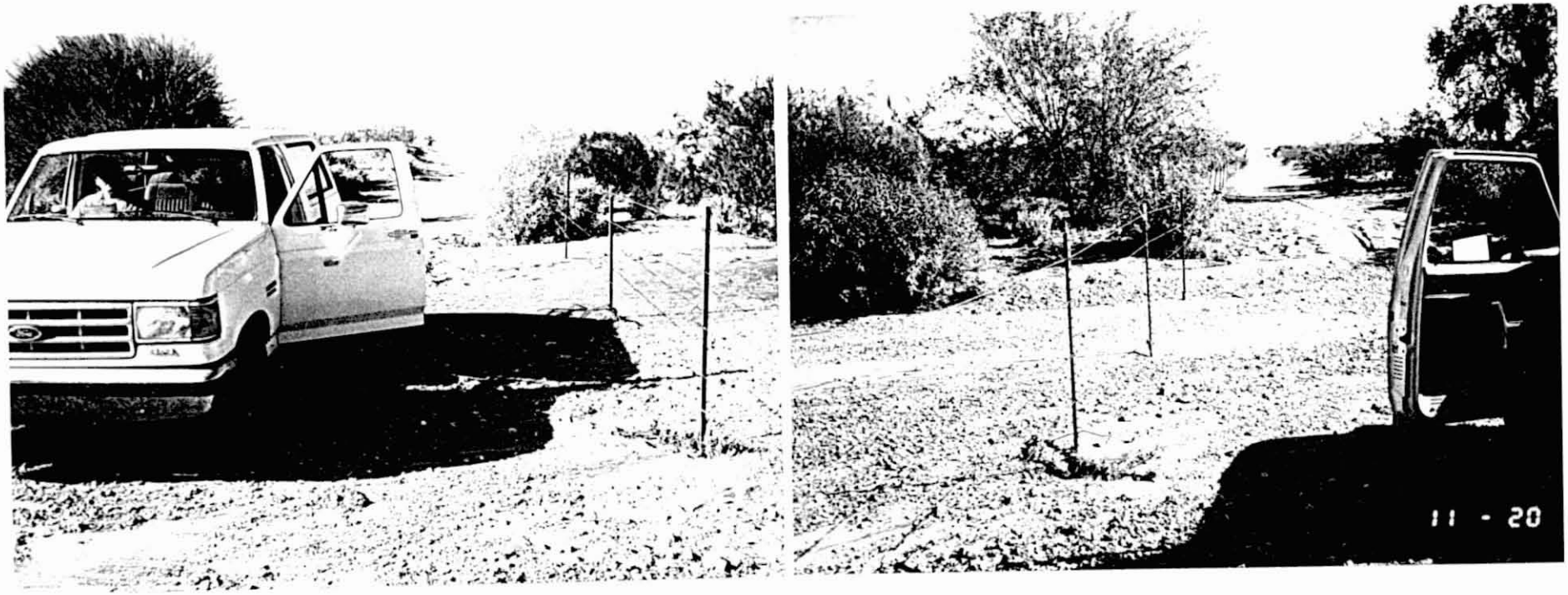
4. Photograph Time and Aspect: 15:15 Lok E X ch1
5. Highwater Marks? ?
6. Flood Characteristics:
   a. Sheet? No
   b. Overbank? No
   c. Channelized? Yes
7. Channel Characteristics:
   a. Width: ~2 to
   b. Depth: 10'
   c. N Value: .05 ← unclear why
   d. Obstructions, Levees? No
   e. Sketch

8. Other Comments

9. By: JF Date: _____


15 - 15

PANORAMIC #4



(No #16)

Iona Wash FIS
FCDMC - Phoenix, AZ

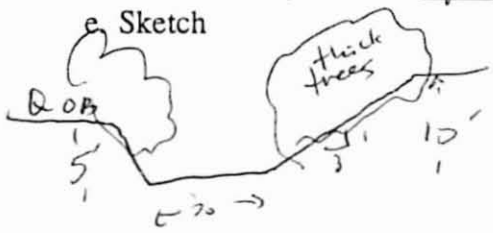
Field Investigation Notes

1. Location: (17) road crossing in section 17 plot 3-2
2. Mark Location
   a. Aerial: ✓
   b. Topo: ✓
3. Structure Dimensions:
   a. Width: _____
   b. Depth: None
   c. N Value: _____
   d. Sketch

15:25? Lot of pics — see last of for LOB photos

also veg in debris in LOB at 4'

4. Photograph Time and Aspect: _____
5. Highwater Marks? Slack sands @ 3.5' · some break out @ at same EL
6. Flood Characteristics:
   a. Sheet? No — ch1 is in more dissected, pronounced
   b. Overbank? Yes terrain, this is good bypass ch1
   c. Channelized? yes
7. Channel Characteristics:
   a. Width: 30-40'
   b. Depth: 5-10'
   c. N Value: .025
   d. Obstructions, Levees? No
   e. Sketch



8. Other Comments

9. By: ✓ Date: _____

Iona Wash FIS
FCDMC - Phoenix, AZ

Field Investigation Notes

1. Location: 15A W of cattle stock pond breakout over chl flows W of pond
2. Mark Location
   a. Aerial: ✓
   b. Topo: ✓
3. Structure Dimensions:
   a. Width: None
   b. Depth:
   c. N Value:
   d. Sketch

no photo of DD - looks like all the rest

4. Photograph Time and Aspect: 14:43 look d/s in chl
5. Highwater Marks? barely above veg
6. Flood Characteristics:
   a. Sheet? ?
   b. Overbank? Prob
   c. Channelized? Minor
7. Channel Characteristics:
   a. Width: 30-50 w/ brush in bottom - seldom used $d_{50} = 1/2 - 1"$
   b. Depth: 4' max
   c. N Value: .04
   d. Obstructions, Levees? Pond to S
   e. Sketch

8. Other Comments

9. By: JF Date:

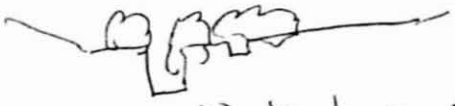
Iona Wash FIS
FCDMC - Phoenix, AZ

Field Investigation Notes

1. Location: 15B
2. Mark Location
   a. Aerial: ~
   b. Topo: _____
3. Structure Dimensions:
   a. Width: _____
   b. Depth: None
   c. N Value: _____
   d. Sketch

2 @ 15:01 in OB between (15) & (17) — no obvious signs of sheet flow

4. Photograph Time and Aspect: 14:45? Look S/S
5. Highwater Marks? No
6. Flood Characteristics:
   a. Sheet? Yes
   b. Overbank? Yes
   c. Channelized? Barely
7. Channel Characteristics:
   a. Width: 4
   b. Depth: 1
   c. N Value: 0.05
   d. Obstructions, Levees? none
   e. Sketch



→ barely a ch! — this one flows to pond which was full today - ∴ is most active

8. Other Comments

9. By: _____ Date: _____

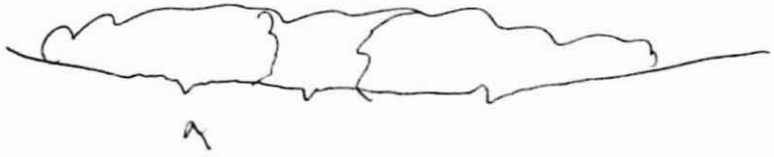
Iona Wash FIS
FCDMC - Phoenix, AZ

Field Investigation Notes

1. Location: (H)
2. Mark Location
   a. Aerial: ✓
   b. Topo: _____
3. Structure Dimensions:
   a. Width: _____
   b. Depth: _____
   c. N Value: None
   d. Sketch

14:31 in LOB sheet flow area - see flow marks in silt on bed
Lack of veg in - overgrazed

4. Photograph Time and Aspect: 14:27 Look u/s
5. Highwater Marks? No (v. low)
6. Flood Characteristics:
   a. Sheet? Yes
   b. Overbank? Yes
   c. Channelized? Minor
7. Channel Characteristics:
   a. Width: 3-4
   b. Depth: ½ - 2
   c. N Value: .05
   d. Obstructions, Levees? No
   e. Sketch



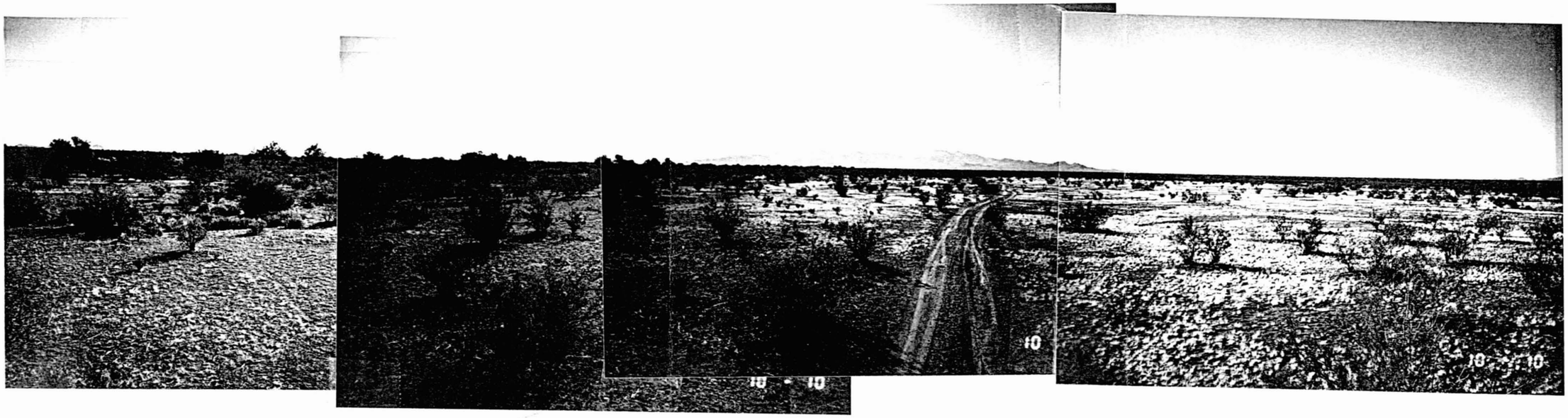
several minor chls w/ dimensions above
to bigger chls See photos

8. Other Comments

Wide b/c

9. By: _____ Date: _____

PANORAMIC
#3



CHANNEL

LINE OF TREES

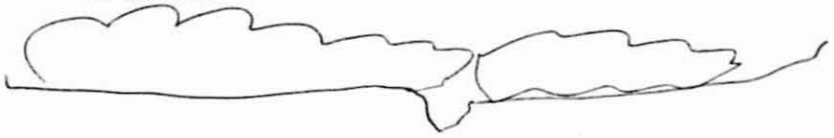
LIGHT OVERBANK

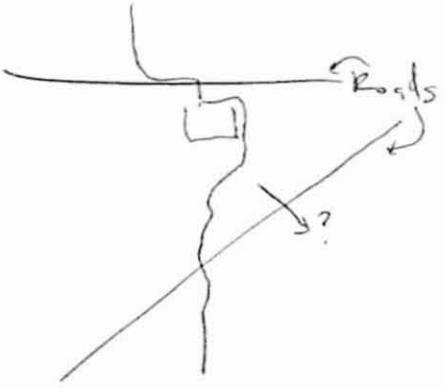
Iona Wash FIS
FCDMC - Phoenix, AZ

Field Investigation Notes

1. Location: 13 in field see photo nr Ocity
2. Mark Location
   a. Aerial: ✓
   b. Topo: No
3. Structure Dimensions: concrete ditches
   a. Width: Bw = 1
   b. Depth: HW = 3 y = 1.5
   c. N Value: .013
   d. Sketch

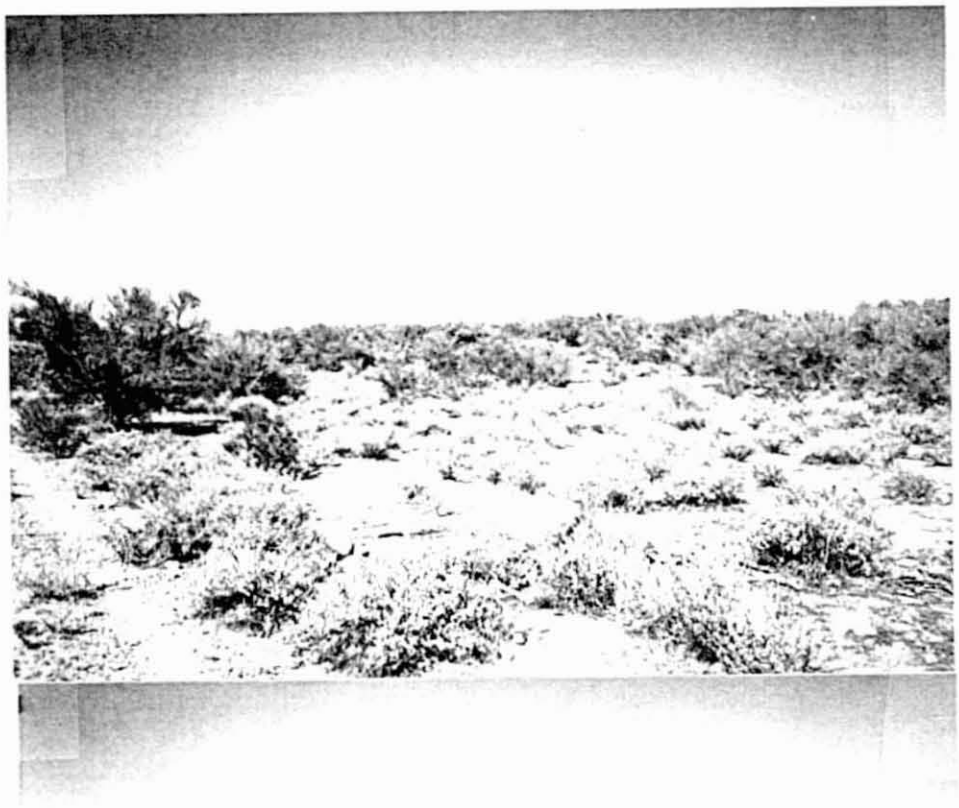
4. Photograph Time and Aspect: 2-14:05 of ROB / close 14:08 ROB } look us ch / u/s further from the ch
5. Highwater Marks? No
6. Flood Characteristics:
   a. Sheet? No
   b. Overbank? Yes
   c. Channelized? Minor
7. Channel Characteristics:
   a. Width: 15 d_{50} = 2"
   b. Depth: 3
   c. N Value: .03
   d. Obstructions, Levees? No
   e. Sketch

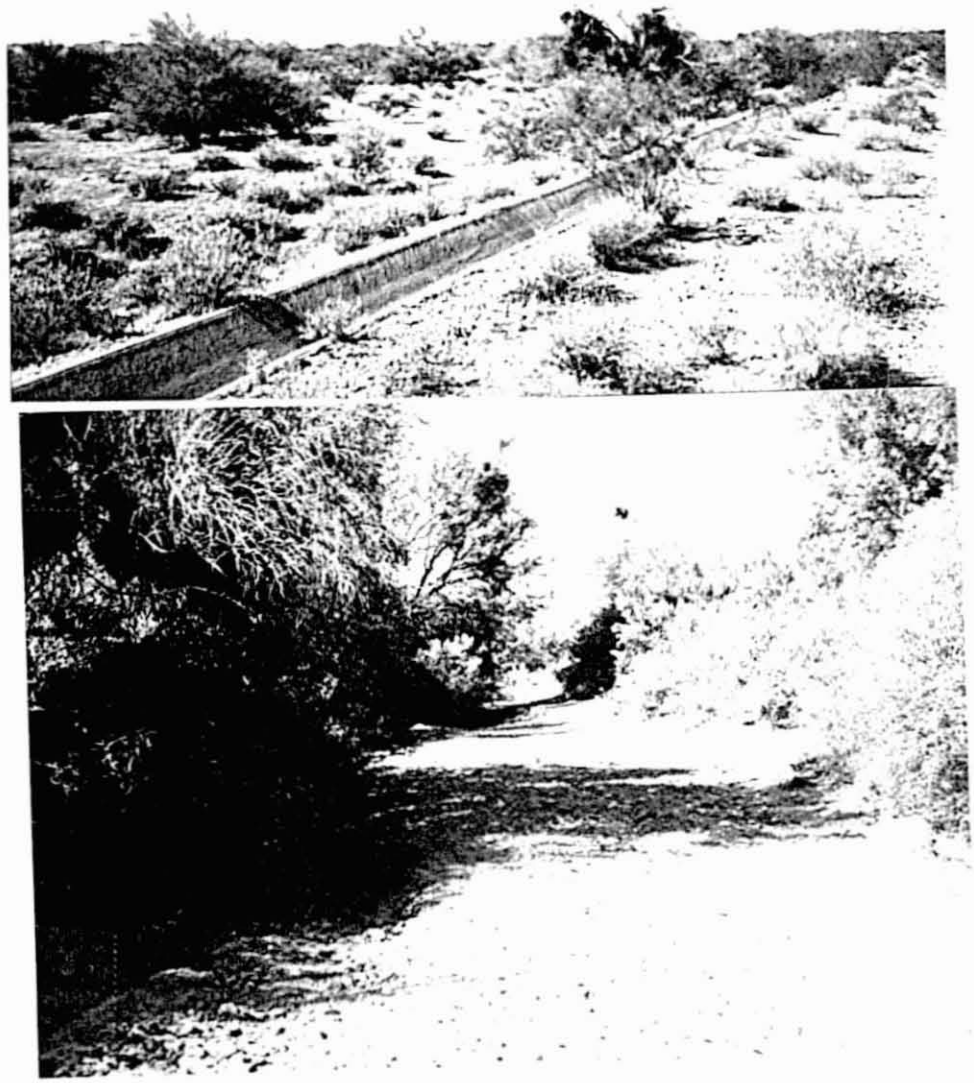




8. Other Comments

9. By: JF Date:





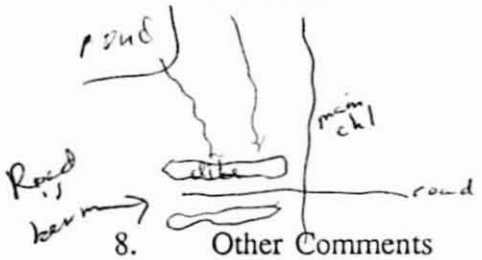
Iona Wash FIS
FCDMC - Phoenix, AZ

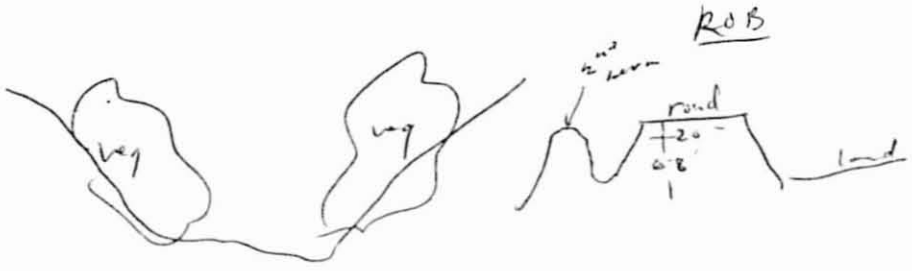
Field Investigation Notes

1. Location: (10) on TGN/TSN line section 32/5
2. Mark Location
   a. Aerial: ✓
   b. Topo: ✓
3. Structure Dimensions:
   a. Width: _____
   b. Depth: none
   c. N Value: _____
   d. Sketch

13:26 look d/s

4. Photograph Time and Aspect: 13:26 look E & wash @ trail
5. Highwater Marks? 2-3' silt lines
6. Flood Characteristics:
   a. Sheet? No
   b. Overbank? No
   c. Channelized? ✓
7. Channel Characteristics:
   a. Width: 15 d_{50} = 2" Lots mud in trees
   b. Depth: 10
   c. N Value: .035
   d. Obstructions, Levees? to W (ROD
   e. Sketch





8. Other Comments

9. By: JEF Date: _____

PANORAMIC TO #1

TYPICAL CHANNEL

EDGE OF CHANNEL AREA

TRIBUTARIES

LEFT EVERBANK

Iona Wash FIS
FCDMC - Phoenix, AZ

Field Investigation Notes

at dirt rd crossing

1. Location: (11) u/s dam d/s Rt 89
2. Mark Location
   a. Aerial: ✓
   b. Topo: No
3. Structure Dimensions:
   a. Width: _____
   b. Depth: None
   c. N Value: _____
   d. Sketch

4. Photograph Time and Aspect: 2 at 13:36 ~ d/s cl RB Int u/s (NW)
5. Highwater Marks? in tree on LB see phot + 2.5'
6. Flood Characteristics:
   a. Sheet? No
   b. Overbank? Yes (esp LB)
   c. Channelized? Yes - mostly
7. Channel Characteristics:
   a. Width: 25'
   b. Depth: 3'
   c. N Value: .028 - .03 pea gravel bed ; planar
   d. Obstructions, Levees? No
   e. Sketch

8. Other Comments

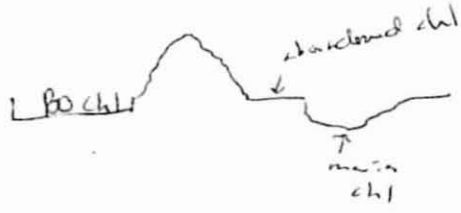
9. By: JF Date: _____

Iona Wash FIS
FCDMC - Phoenix, AZ

Need XS (more rating)

Field Investigation Notes

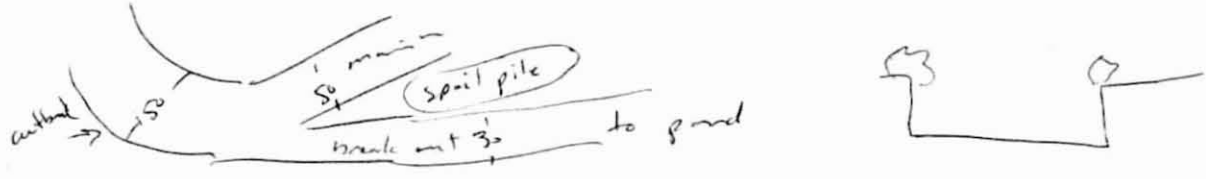
1. Location: (12) at breakout u/s pond d/s Grand
2. Mark Location
   a. Aerial: ✓
   b. Topo: No
3. Structure Dimensions:
   a. Width: None
   b. Depth:
   c. N Value:
   d. Sketch



Good Recent Scour. 2-4 feet in main chl made of terrace + cut banks

13:42 at main chl caCO3 layer

4. Photograph Time and Aspect: 13:44 - at d/s/ break
5. Highwater Marks? Yes in both chls @ 2-2½'
6. Flood Characteristics:
   a. Sheet? No
   b. Overbank? Yes
   c. Channelized? Yes
7. Channel Characteristics:
   a. Width: below LOB = small pebbles in CS matrix
   b. Depth: 3-4'
   c. N Value: .025-.03 in chl - minor veg on bks
   d. Obstructions, Levees? No - spoil pile
   e. Sketch



8. Other Comments

Locate OB's

9. By: JF Date:

PANORAMIC #2

↑ RIGHT CHANNEL BANK

RIGHT OVER BANK

PANORAMIC #2

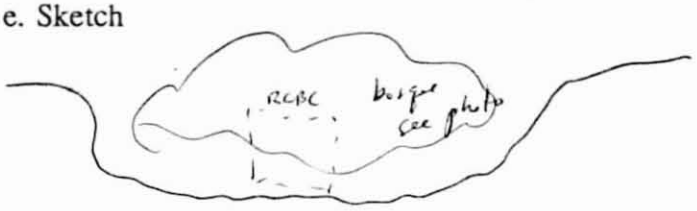
LEFT OVERBANK

Iona Wash FIS
FCDMC - Phoenix, AZ

Field Investigation Notes

1. Location: 9 d/s Grand Ave NW Circle City
2. Mark Location
   a. Aerial: ✓
   b. Topo: ✓
3. Structure Dimensions:
   a. Width: 66 x 66" RCBC
   b. Depth: _____
   c. N Value: .012
   d. Sketch

4. Photograph Time and Aspect: 1:10 look d/s from Rd at bosque
5. Highwater Marks? 2.5 ft in RCBC Hw good
6. Flood Characteristics:
   a. Sheet? No
   b. Overbank? No
   c. Channelized? Yes
7. Channel Characteristics: bits veg d_{50} = 1"
   a. Width: _____
   b. Depth: _____
   c. N Value: .07
   d. Obstructions, Levees? No (Rock)
   e. Sketch



8. Other Comments

9. By: JPC Date: 10/14

BREAK OUT #1

Iona Wash FIS
FCDMC - Phoenix, AZ

Field Investigation Notes

1. Location: BA Brock and Ch1 in fields
2. Mark Location
   a. Aerial: ✓
   b. Topo: ~~No~~ ✓
3. Structure Dimensions:
   a. Width: _____
   b. Depth: None
   c. N Value: _____
   d. Sketch

4. Photograph Time and Aspect: 14:12 Look u/s
5. Highwater Marks? Silt coating on dry = 2-3' pebbles in ch1 bottom
6. Flood Characteristics:
   a. Sheet? No
   b. Overbank? Yes
   c. Channelized? Minor
7. Channel Characteristics:
   a. Width: 6'
   b. Depth: 2'
   c. N Value: .035
   d. Obstructions, Levees? to E on diagonal? See stereo
   e. Sketch

8. Other Comments

9. By: JF Date: _____

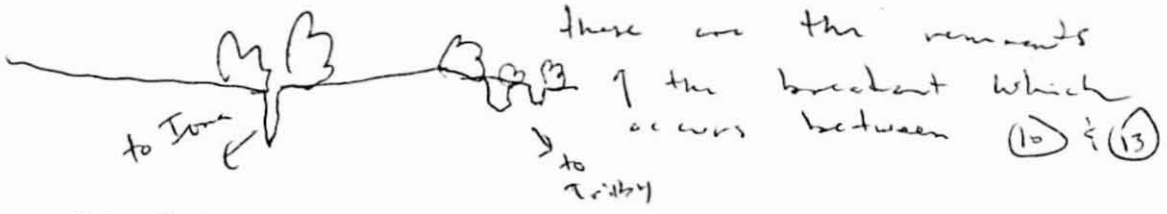
BREAK OUT
#1

Iona Wash FIS
FCDMC - Phoenix, AZ

Field Investigation Notes

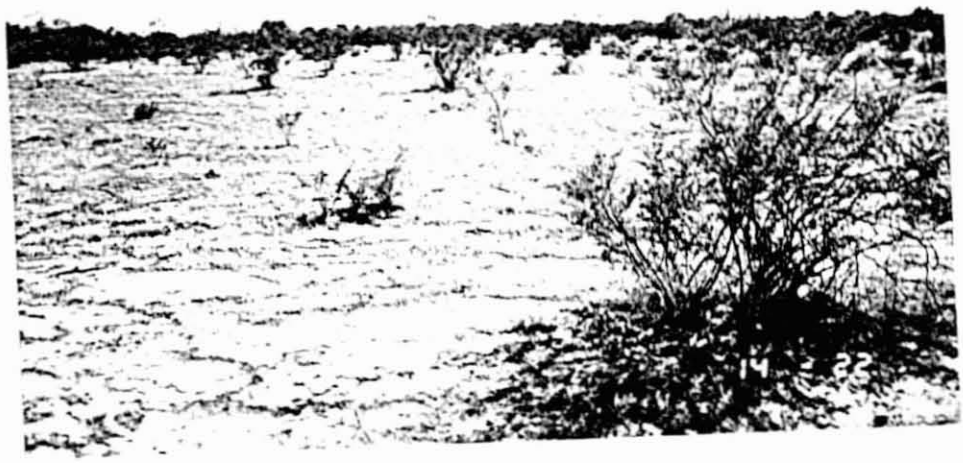
1. Location: 14A
2. Mark Location
   a. Aerial: —
   b. Topo: No
3. Structure Dimensions:
   a. Width: _____
   b. Depth: None
   c. N Value: _____
   d. Sketch

4. Photograph Time and Aspect: 14:22 Looking W in LOB creosote plain
5. Highwater Marks? No
6. Flood Characteristics:
   a. Sheet? Yes
   b. Overbank? Yes
   c. Channelized? Minor
7. Channel Characteristics:
   a. Width: 2'
   b. Depth: 4'
   c. N Value: .04
   d. Obstructions, Levees? NO
   e. Sketch



8. Other Comments

9. By: _____ Date: _____



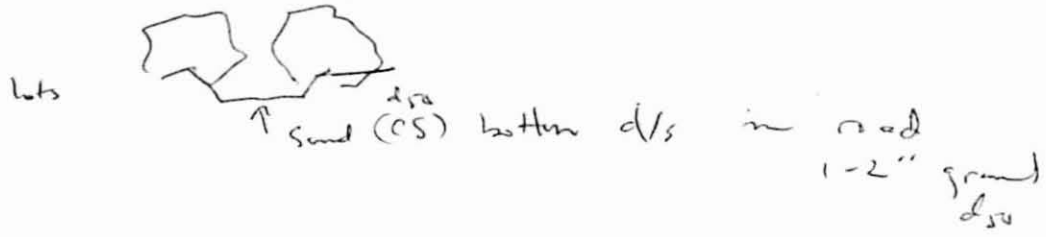
BREAKOUT #1

Iona Wash FIS
FCDMC - Phoenix, AZ

Field Investigation Notes

1. Location: (19) on N-S Section Line Rd — break out to tributary
2. Mark Location
   a. Aerial: ✓
   b. Topo: _____
3. Structure Dimensions:
   a. Width: _____
   b. Depth: _____
   c. N Value: _____
   d. Sketch

4. Photograph Time and Aspect: 15:26 Look W u/s of ℄
5. Highwater Marks? No
6. Flood Characteristics:
   a. Sheet? No
   b. Overbank? Yes
   c. Channelized? Minor
7. Channel Characteristics:
   a. Width: 6-10'
   b. Depth: 3-4'
   c. N Value: .05
   d. Obstructions, Levees? No (regin)
   e. Sketch



8. Other Comments

9. By: _____ Date: _____

Iona Wash FIS
FCDMC - Phoenix, AZ

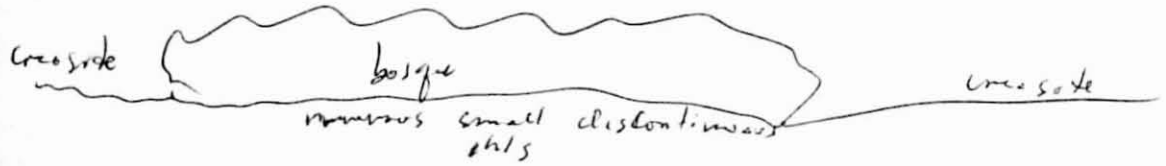
BREAK OUT #1

Field Investigation Notes

1. Location: (20) break out to trib by clong
2. Mark Location
   a. Aerial: ✓
   b. Topo: ✓
3. Structure Dimensions:
   a. Width: _____
   b. Depth: None
   c. N Value: _____
   d. Sketch

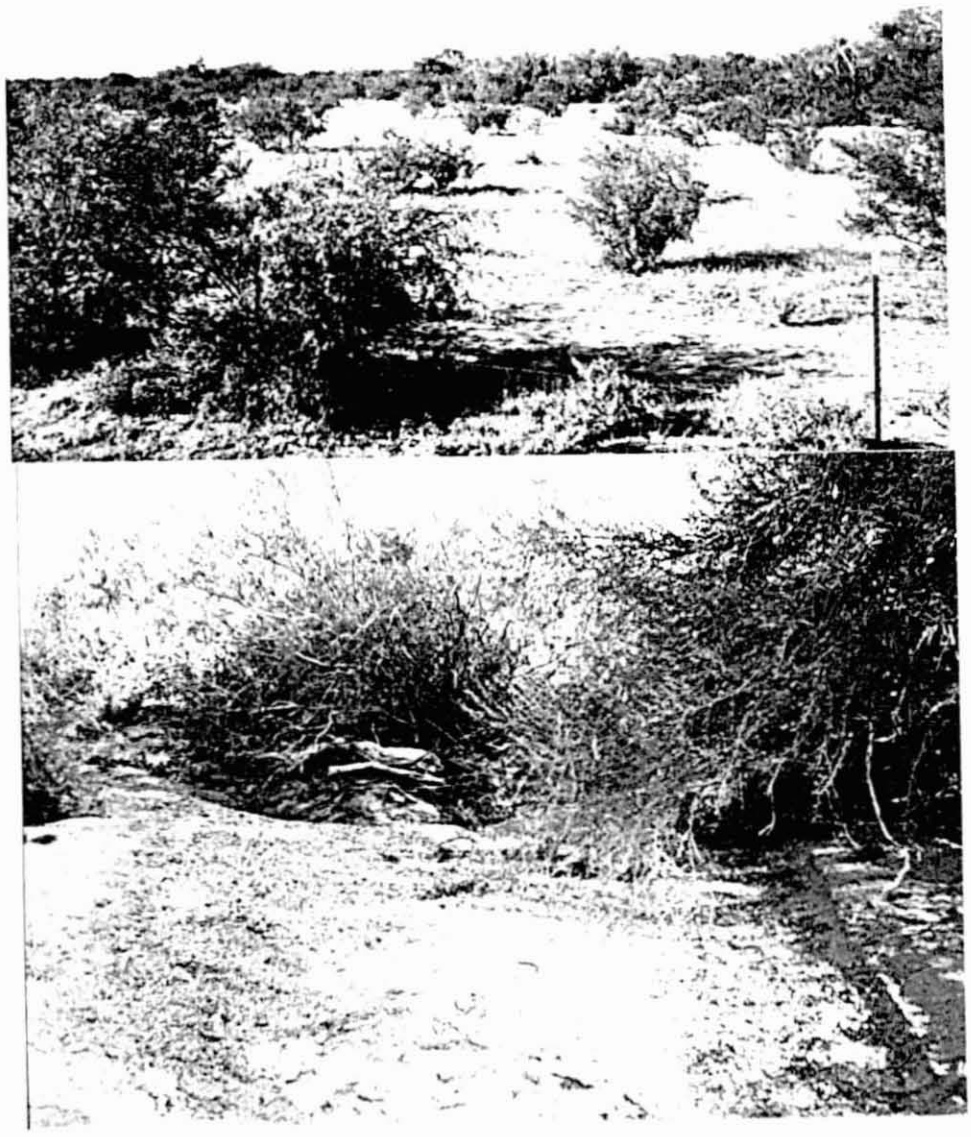
15:40 look u/s clong RoB / ch1 area boundary
15:43 LB ch1 area in riparian zone
15:45 - d/s ch1 typical

4. Photograph Time and Aspect: _____
5. Highwater Marks? veg in @ 2'
6. Flood Characteristics: d_{50} = 1" to FG Lotic loose mat /
   a. Sheet? _____
   b. Overbank? Yes
   c. Channelized? Minor
7. Channel Characteristics: (typical flow path)
   a. Width: 10'
   b. Depth: 1'
   c. N Value: .07
   d. Obstructions, Levees? No
   e. Sketch



8. Other Comments

9. By: JF Date: _____

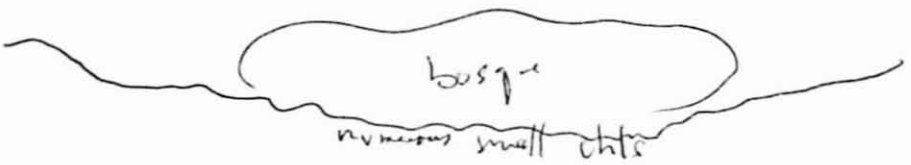


Iona Wash FIS
FCDMC - Phoenix, AZ

Field Investigation Notes

1. Location: (23) just -15 Iona b.o. / trilby conf
2. Mark Location
   a. Aerial: —
   b. Topo: X No
3. Structure Dimensions:
   a. Width: _____
   b. Depth: None
   c. N Value: _____
   d. Sketch

4. Photograph Time and Aspect: No photo's taken like 22
5. Highwater Marks? usual
6. Flood Characteristics:
   a. Sheet? No
   b. Overbank? Yes, but more topo relief - OB being collected to main
   c. Channelized? _____
7. Channel Characteristics:
   a. Width: see topo
   b. Depth: _____
   c. N Value: _____
   d. Obstructions, Levees? No
   e. Sketch



8. Other Comments

9. By: JF Date: _____

Section 7: Cross-Referencing and Labeling Information

Section 7: Cross-Referencing and Labeling Information

7.2 Key to Cross Section Labeling

CH2MHILL

SUBJECT STATIONING FOR IONA WASH FLOOD INSURANCE STUDY

BY K. BRADFORD DATE 6-21-93

SHEET NO. 1 OF 5

PROJECT NO. PHX 34747.FF

RIVER MILE	SECTION
0.640	A
0.734	B
0.819	C
0.912	D
0.999	E
1.101	F
1.189	G
1.285	H
1.386	I
1.480	J
1.578	K
1.670	L
1.764	M
1.866	N
1.967	O
2.064	P
2.159	Q
2.251	R
2.346	S
2.442	T
2.537	U
2.631	V
2.727	W
2.827	X
2.927	Y
3.027	Z
3.137	AA
3.224	AB

SUBJECT STATIONING FOR IONA WASH FLOOD INSURANCE STUDY

BY K. BRADFORD DATE 6-21-93

SHEET NO. 2 OF 5

PROJECT NO. PHX 34747.FE

RIVER MILE		SECTION
3.321		AC
3.413		AD
3.514		AE
3.617		AF
3.651	NOT SHOWN	AG
3.670	NOT SHOWN	AH
3.713		AI
3.821		AJ
3.917		AK
4.010		AL
4.119		AM
4.214		AN
4.306		AO
4.403		AP
4.497		AQ
4.596		AR
4.694		AS
4.789		AT
4.893		AU
4.988		AV
5.095		AW
5.189		AX
5.287		AY
5.386		AZ
5.485		BA
5.577		BB
5.668		BC
5.765		BD

CRMHILL

SUBJECT STATIONING FOR IOWA WASH FLOOD INSURANCE STUDY

BY K. BRADFORD DATE 6-21

SHEET NO. 3 OF 5

PROJECT NO. PHX 3147.FF

RIVER MILE	SECTION
5.858	BE
5.945	BF
6.026	BG
6.067	BH
6.135	BI
6.223	BJ
6.321	BK
6.413	BL
6.511	BM
6.603	BN
6.704	BO
6.801	BP
6.897	BQ
6.986	BR
7.077	BS
7.167	BT
7.264	BU
7.352	BV
7.438	BW
7.533	BX
7.624	BY
7.709	BZ
7.800	CA
7.896	CB
7.995	CC
8.088	CD
8.182	CE
8.273	CF

CH2MHILL

SUBJECT STATIONING FOR IONA WASH FLOOD INSURANCE STUDY

BY K. BRADFORD DATE 6-21-93

SHEET NO. 4 OF 5

PROJECT NO. PHX 3411.EE

RIVER MILE	SECTION
8.374	CG
8.465	CH
8.560	CI
8.654	CJ
8.740	CK
8.844	CL
8.940	CM
9.032	CN
9.119	CO
9.202	CP
9.289	CQ
9.387	CR
9.480	CS
9.588	CT
9.677	CU
9.770	CV
9.865	CW
9.963	CX
10.054	CY
10.139	CZ
10.232	DA
10.320	DB
10.426	DC
10.516	DD
10.620	DE
10.710	DF
10.802	DG
10.891	DH

SUBJECT STATIONING FOR IONA WASH FLOOD INSURANCE STUDY

BY K.BRADFORD DATE 6-21-93

SHEET NO. 5 OF 5

PROJECT NO. PHX 3411.FE

RIVER MILE	SECTION
10.982	DI
11.079	DJ
11.174	DK
11.264	DL
11.368	DM
11.469	DN
11.570	DO
11.666	DP
11.750	DQ
11.847	DR
11.920	DS
12.010	DT
12.101	DU
12.191	DV
12.281	DW
12.369	DX
12.464	DY
12.614	DZ
12.692	EA
12.752	EB
12.849	EC
12.942	ED
13.025	EE
13.127	EF
13.221	EG
13.325	EH
13.419	EI
13.499	EJ

Iona Wash FIS

Manning's N Estimates

Reach	Channel Segment	Base N	Irregularity Adjustment	Obstruction Adjustment	Vegetation Adjustment	XN Variation Adjustment	Meandering Adjustment	Composite N
1	CHL	0.022	0.003	0.025	0.050	0.005	1.0	0.105
2	CHL	0.026	0.007	0.010	0.002	0.001	1.0	0.046
3	CHL	0.022	0.003	0.025	0.050	0.005	1.0	0.105
4	CHL	0.028	0.008	0.010	0.005	0.001	1.0	0.052
5	CHL	0.022	0.003	0.025	0.040	0.005	1.0	0.095
6	CHL	0.028	0.009	0.005	0.002	0.002	1.0	0.046
Breakout	CHL	0.022	0.003	0.025	0.050	0.005	1.0	0.105
Floodplain		Light brush and small trees with summer grass						0.070
Riparian Zones		Mesquite & Palo Verde with dense catclaw, grass and brush understory						0.115

Section 8: Draft FIS Report - Revised Text

By: CH2M Hill

Iona Wash F.I.S.
Section 8 Index

For: Unincorporated Maricopa County/Surprise, AZ

Description

Draft F.I.S. report

Exhibit 1: Natural-condition flood profiles for 100 year discharge
Includes sheets P-1 through P-12
(Following report)

Exhibit 2: Floodplain-Floodway boundary maps
Includes sheets M-1 through M-21
(Attached)

SECTION 8 DRAFT FIS REPORT -- REVISED TEXT

Insert Volume 1 of 7, Section 1, 2. Insert after Paragraph 13

Additional hydraulic analyses for Iona Wash between the confluence with Trilby Wash and State Route 89 were performed for the Flood Control District of Maricopa county. Work was performed by CH2M HILL and was completed in August 1993.

Insert 2, Volume 1 of 7, Table 1. Insert after last entry

Flooding Source	Limit of Study
Iona Wash	From the Iona Wash/Trilby Confluence 13.5 miles upstream to SR 89

Insert 3, Volume 1 of 7, Section 2.2

Iona Wash, a major tributary to Trilby Wash, flows southerly from SR 89 for approximately 13.5 miles to its confluence with Trilby Wash. At the confluence, it has a drainage area of approximately 32.6 square miles.

Insert 4, Volume 1 of 7, Section 2.4. Insert after last entry.

Flooding Source and Location	Drainage Area (square miles)	Peak Discharge (cfs)		
		10-year	50-year	100-year
Confluence with Trilby	32.58			5,001
CAP	31.33	--1	--1	5,309
Minor Tributary 1	23.77	--1	--1	5,360
Minor Tributary 2	22.11	--1	--1	4,915
SR 89	8.87	--1	--1	2,371

Insert 5, Volume 1 of 7, Table 4. Insert alphabetically.

Table 2. Manning's "N" Values	
Reach Type	**Range of "N" Values**
Defined Channel	0.035 - 0.048
Braided Channel	0.065 - 0.105
Riparian Vegetation	0.070 - 0.115
Sheet Flow Area	0.045 - 0.065
Floodplain	0.045 - 0.055

Insert 6, Volume 1 of 7, Section 3.2.

Cross-section data for delineations performed for the Iona Wash FIS were developed from 1"=200 foot scale, 2-foot contour interval, topographic mapping compiled for the Iona Wash FIS.

Starting water surface elevations were obtained from the Trilby Wash FIS. At the downstream side of the CAP overshoot, critical depth was assumed for computing upstream water surface elevations.

A levee protecting the upstream face of the Central Arizona Project canal intersects Iona Wash. This levee is designed to withstand the 100-year, 6-hour storm predicted by the Bureau of Reclamation. The design storm is smaller than the 100-year discharge estimated for this study The CAP levee is overtopped by the base flood.

SUPPLEMENTAL TEXT

Flood Insurance Study
Iona Wash
Maricopa County, Arizona

for

Flood Control District
of
Maricopa County

Contract FCD 92-07

Prepared by

CH2M HILL
1620 W. Fountainhead Parkway, Suite 550
Tempe, Arizona 85282

July 1993

Table of Contents

FLOOD INSURANCE STUDY
IONA WASH
MARICOPA COUNTY, ARIZONA

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study includes revised floodplain and floodway delineations for approximately 13.5 miles of Iona Wash. The Iona Wash study area is located in northwestern Maricopa County, Arizona, and includes portions of unincorporated Maricopa County and portions of the Town of Surprise, Arizona. The study reach begins at the confluence of the Trilby and Iona washes extending north to State Route 89 (Figure 1). The information in this study will be used to update existing floodplain information as part of the regular phase of the National Flood Insurance Program (NFIP). The information will also be used by local and regional planners to further promote sound land use and floodplain development.

1.2 Authority and Acknowledgements

This study was performed by CH2M HILL, with assistance from Project Engineering Consultants, Ltd. (PEC). The study was prepared for the Flood Control District of Maricopa County (FCDMC) under Contract Number FCD 92-07. Topographic mapping was prepared by Kenney Aerial Mapping. Ground control and check surveys were performed by Brady-Aulerich, Inc. The study was completed in July, 1993.

1.3 Coordination

The areas of approximate and detailed studies were coordinated with the FCDMC. Officials from the Town of Surprise were also contacted for community coordination (Reference 1). The FCDMC conducted a public meeting at the Morristown, Arizona school on November 16, 1992. Public notices for the study were published in the Wickenburg Sun (a local newspaper) and the Phoenix Business Gazette (a widely circulated newspaper). In addition, notification was sent to each property owner within the study area.

The Initial Consultation and Coordination Meeting was held on October 26, 1992. Representatives of the FCDMC (Sandy Story, Pedro Calza) and CH2M HILL (Steve Walker, Jon Fuller) attended this meeting and

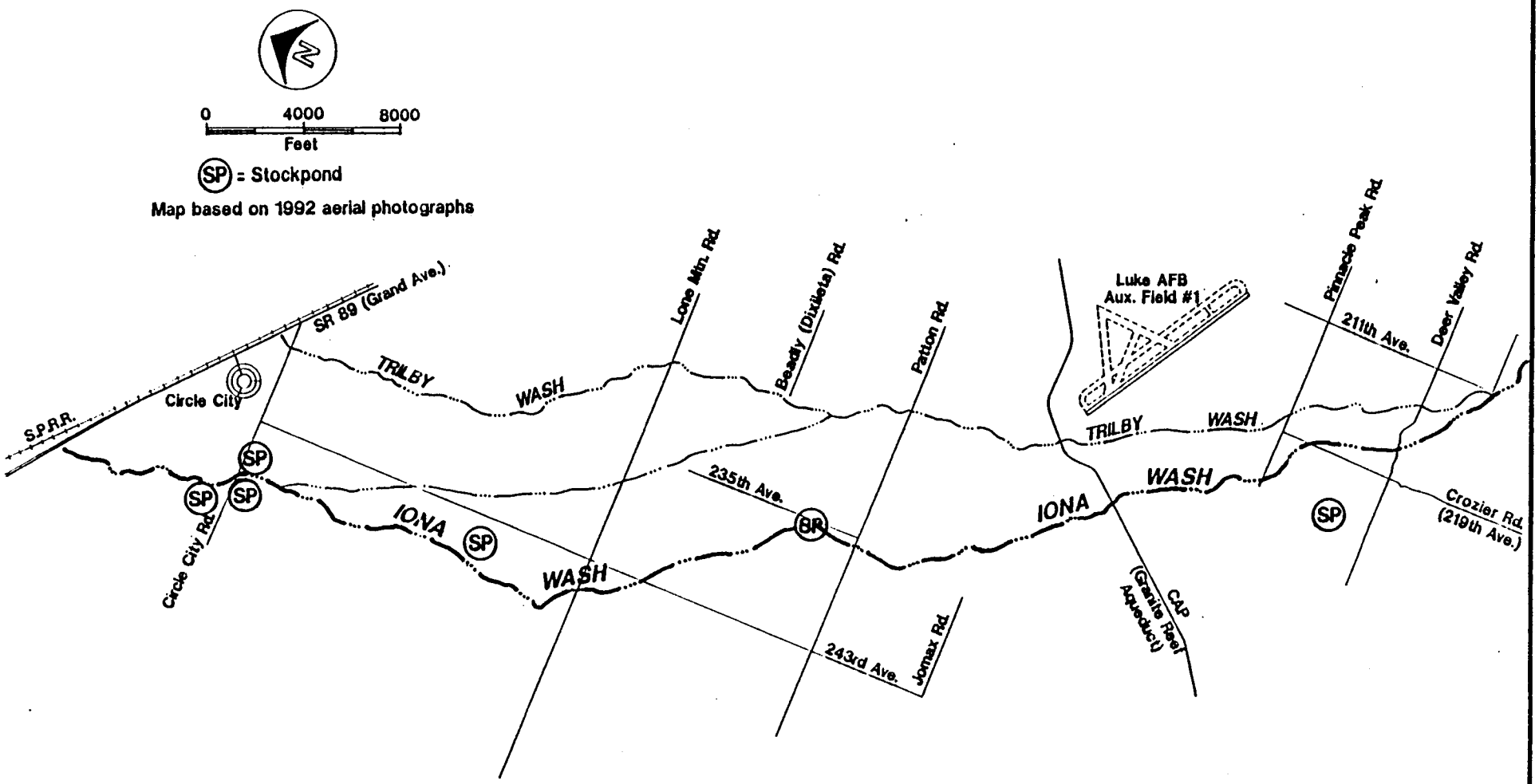


FIGURE 1
LOCATION MAP

Maricopa County, Arizona
June, 1993 CH2M HILL
Iona Wash FIS PHX34747.A0

CH2M HILL

discussed scheduling, study methods, assumptions, and the format of the deliverable items. Throughout the project coordination meetings were held in conjunction with project deliverables and at three month intervals, with the forenamed parties to discuss progress and preliminary study results. In addition, FCDMC participated in the initial field reconnaissance of the study area.

Requests for information were solicited from the following agencies:

- FEMA (Michael Baker, Jr. Inc.- Previous FIS Records)
- Arizona Dept of Water Resources
- U.S. Soil Conservation Service
- U.S. Bureau of Reclamation
- Arizona Department of Transportation
- Maricopa County Highway Department

Information obtained from community coordination and agency contact is summarized in Reference 2.

2.0 AREA STUDIED

2.1 Scope of Study

The Iona Wash study area extends approximately 13.5 river miles from the confluence with Trilby Wash in T.4N., R3W., Section 25 to State Route 89 (Grand Avenue) in T.6N., R.3W., Section 29 as shown in Figure 1. Iona Wash includes reaches of channelized and unconfined sheet flow. Flooding sources include only natural runoff from the Iona Wash watershed.

2.2 Community Description

The study area is located northwest of metropolitan Phoenix, in portions of unincorporated Maricopa County, and the Town of Surprise, Arizona. Development within the study area is extremely limited. North of the Central Arizona Project (CAP) canal there no engineered structures or habitable structures in the floodplain. South of the CAP, within the Town of Surprise, some rural development is present in the floodplain. Development south of the CAP is limited to multi-acre lots, many with mobile home residences. Vacant land is generally used for cattle grazing, although in the past some areas were used as crop land. Several small stockponds are located within the floodplain in the study area.

Floodplain vegetation in the area consists mainly of desert brush, including creosote, mesquite, palo verde and catclaw. Vegetative cover densities reflect land use and proximity to Iona Wash; most dense vegetation occurs along the wash in areas not currently grazed or developed.

2.3 Principal Flood Problems

No systematic historical flood information is available for the Iona Wash study area. No stream gage data, flood photographs, flood damage reports, or other flood information are available for the study reach.

Reference 2 describes some anecdotal information regarding past floods in the general study area. No formal drainage complaints have been logged by the Town of Surprise, the FCDMC, the Arizona Department of Water Resources, or other agencies and communities contacted for this study. The Town Engineer for Surprise reports that flooding sometimes damages unpaved roads downstream of the C.A.P. at-grade crossings. The Maricopa County Highway Operations Superintendent for Maricopa County Department of Transportation reports that storm runoff frequently flows outside the defined channels as sheet flow. Floods occurred in 1978, 1982, 1988, and 1990 that flowed well outside the defined channels, deposited several inches of sandy sediment on the roadways, and eroded the culvert embankments at Patton Road.

2.4 Flood Protection Measures

Only two engineered drainage structures are located in the study area: the Patton Road culvert crossing and the CAP overchute (Reference 2). The CAP overchute is a 47 ft. by 7 ft. structural concrete channel over the CAP, with a "dragon's tooth" energy dissipator and drop structure on the downstream end. The Patton Road culverts consist of four 42-inch reinforced concrete culverts with projecting inlet and upstream and downstream grouted road embankment protection.

The upstream face of the CAP is protected by levee which directs runoff toward the overchutes. This levee is designed to withstand the 100-year, 6-hour storm predicted by the Bureau of Reclamation (BuRec). However, the BuRec design storm is smaller than the base flood estimated in Reference 3 and used for this study. The CAP levee is overtopped by the base flood used in this study.

There are no other flood control levees within the study area. There are, however, five stock ponds and associated diversions which may affect

runoff along Iona Wash. Four of the five stock ponds were built between 1951 and 1992, but none are licensed by ADWR. Therefore, no engineering data are available for any of the stock ponds. Stock ponds are discussed in more detail in Reference 2.

3.0 ENGINEERING METHODS

3.1 Hydrologic Analyses

Hydrologic data for detailed methods in this flood study were provided by the FCDMC from the Wittmann ADMS (References 3, 4). Discharges used in this study are summarized in Table 1.

Table 1. Base Flood Discharge Rates (cfs)

ADMS Discharge	Drainage Area (mi^2)	Downstream HEC-2 Cross Section	Location
5,001	32.58	0.640	Trilby Confluence
5,309	31.33	3.713	CAP
5,360	23.77	7.709	Minor Tributary
4,915	22.11	7.800	Minor Tributary
2,371	8.87	9.289	SR 89

Other flow rates used in floodplain and floodway modeling were determined from hydraulic analysis of Iona Wash at flood overflow reaches at points between concentration points listed in Table 1.

3.2 Hydraulic Analyses

Detailed floodplain and floodway delineations were determined using the computer model HEC-2, version 4.6.2 (Reference 5). HEC-2 model input includes cross section geometry, hydraulic variables such as manning's roughness coefficients, starting water surface elevations, and effective flow boundaries.

Cross section data were developed directly from a digital terrain model of the study area with 2-foot contour interval accuracy, prepared specifically for this project. Topography was based on aerial photography dated

November 12, 1992. Vertical control was based on (NGVD 1929) with horizontal control tied to the Arizona State Plane Coordinate System (NAD 1983). Cross sections alignments were developed to be perpendicular to the primary flow direction along the main channel as well as the overbank floodplains. Dimensions of hydraulic structures were obtained from certified as-built plans, and by field survey and measurement.

Starting water surface elevations for floodplain and floodway runs were obtained from the Trilby Wash Flood Insurance Study (Reference 6). Cross section 0.640 of the Iona Wash Study corresponds to cross section 7.134 of the Trilby Wash Study. Cross section 0.640 was used as the downstream end of the Iona Wash Study. At the downstream side of the CAP overchute and drop structure, critical depth was assumed for computing upstream water surface elevations.

Manning's roughness coefficients, or "n" values, were determined using procedures adopted by the FCDMC (Reference 7). In addition, the following materials were used to support the analysis: (1) 1:12000 1992 aerial photographs by Kenney Aerial Mapping; (2) ground photographs taken during field reconnaissance; and (3) field data including hydraulic information and geomorphic data gathered during field reconnaissance. The FCDMC procedure consists of selection of a base "n" value and addition of several adjustment factors to determine a composite roughness coefficient for hydraulic modeling. The base "n" value accounts for roughness due to the bed material. Adjustments to the base "n" value include factors for the degree of channel irregularity, obstructions, vegetation, variations in cross section geometry, and degree of meandering.

The highly variable density of riparian vegetation, bank conditions, bed sediment size, and degree of channel condition are reflected in the variability of "n" values between adjacent cross sections. Therefore, "n" values can be better reported for types of channel reaches found in the study area rather than by specific cross section. There are three general types of channels in the study area: defined channels, braided channels, and sheet flow areas (Reference 8). Channel "n" values for braided and sheet flow areas are composites of the channel and riparian zone, as defined by denser vegetation visible on aerial photographs. In defined channels, "n" values represent just the bed of the defined channel. N values for riparian zones adjacent to defined channels were assigned a separate "n" value. Floodplains were assigned a composite "n" value according to criteria outlined in Reference 7.

Table 2. Manning's "N" Values.	
Reach Type	Range of "N" Values
Defined Channel	0.035 - 0.048
Braided Channel	0.065 - 0.105
Riparian Vegetation	0.070 - 0.115
Sheet Flow Area	0.045 - 0.065
Floodplain	0.045 - 0.055

Several flood overflows occur along Iona Wash due to perched channels, historical stock pond diversions, and inadequate channel capacity. Flood overflows were modeled according to procedures published in Reference 9 and guidelines set by the FCDMC. Where flood overflows did not flow parallel to the main channel and did not return to Iona Wash, the base flood was reduced by the amount of the overflow, when the flow rate could be determined by HEC-2 split flow analyses. Floodplain boundaries for the flood overflow areas were determined by approximate methods. Approximate method analyses included single section HEC-2 ratings within the overflow areas. Reference 10 describes specific modeling approaches for each flood overflow area.

Stock ponds and levees overtopped by the base flood were removed from the hydraulic model prior to final floodplain and floodway modeling, as directed by Reference 11.

A summary of the results of the hydraulic analyses is given in Table 3.

Natural condition water surface profiles are found at the end of this report (See Exhibit 1).

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

4.1 Floodplain Boundaries

Floodplain boundaries for the detailed studies were delineated on topographic maps with a scale of 1"=200' and a contour interval of two feet

Flooding Source		Floodway			Base Flood Water Surface Elevation			
Cross Section	Distance (miles above Trilby Wash)	Width (feet)	Section Area (square feet)	Mean Velocity (feet per second)	Regulatory (feet NGVD)	Without Floodway (feet NGVD)	With Floodway (feet NGVD)	Increase * (feet)
Iona Wash								
A	0.640	385	1065	4.7	1461.0	1461.0	1462.0	1.0
B	0.734	410	1530	3.3	1464.4	1464.9	1465.4	1.0
C	0.819	476	1667	3.0	1466.9	1467.2	1467.7	0.8
D	0.912	416	1437	3.5	1469.5	1469.7	1470.5	1.0
E	0.999	391	1411	3.5	1471.7	1471.7	1472.6	0.9
F	1.101	503	1624	3.1	1473.9	1473.9	1474.9	1.0
G	1.189	460	1470	3.4	1476.3	1476.3	1477.3	1.0
H	1.285	448	1684	3.0	1478.8	1478.8	1479.8	1.0
I	1.386	475	1645	3.0	1481.3	1481.3	1482.3	1.0
J	1.480	403	1503	3.3	1483.7	1483.7	1484.7	1.0
K	1.578	410	1367	3.7	1486.1	1486.1	1487.1	1.0
L	1.670	376	1163	4.3	1489.0	1489.0	1489.9	0.9
M	1.764	436	1582	3.2	1491.3	1491.3	1492.3	1.0
N	1.866	368	1132	4.4	1493.8	1493.8	1494.8	1.0
O	1.967	512	1402	3.6	1496.9	1496.9	1497.9	1.0
P	2.064	605	1621	3.1	1498.7	1498.7	1499.7	1.0
Q	2.159	465	1186	4.2	1501.1	1501.1	1502.1	1.0
R	2.251	562	1428	3.5	1503.5	1503.5	1504.5	1.0
S	2.346	535	1248	4.0	1506.1	1506.1	1507.1	1.0
T	2.442	561	1377	3.6	1509.2	1509.2	1510.2	1.0
U	2.537	615	1380	3.6	1512.1	1512.1	1513.1	1.0
V	2.631	646	1514	3.3	1514.6	1514.6	1515.6	1.0
W	2.727	482	1342	3.7	1517.6	1517.6	1518.4	0.8
X	2.827	551	1419	3.5	1520.6	1520.6	1521.6	1.0
Y	2.927	683	1533	3.3	1523.0	1523.0	1524.0	1.0

Table 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNINCORPORATED MARICOPA COUNTY/
SURPRISE, AZ

FLOODWAY DATA

IONA WASH

* Increase, I: Sections 0.640 to 0.999, I = Floodway El. - Regulatory El.
Sections 1.101 to 13.499, I = Floodway El. - "Without Floodway" El.(see SPR #9)

FWDATTBL.XLS

Flooding Source		Floodway			Base Flood Water Surface Elevation			
Cross Section	Distance (miles above Trilby Wash)	Width (feet)	Section Area (square feet)	Mean Velocity (feet per second)	Regulatory (feet NGVD)	Without Floodway (feet NGVD)	With Floodway (feet NGVD)	Increase * (feet)
Z	3.027	468	1171	4.3	1526.0	1526.0	1526.9	0.9
AA	3.137	346	1091	4.6	1529.2	1529.2	1530.2	1.0
AB	3.224	345	1134	4.4	1532.0	1532.0	1533.0	1.0
AC	3.321	316	1183	4.2	1534.9	1534.9	1535.9	1.0
AD	3.413	204	935	5.4	1537.6	1537.6	1538.5	0.9
AE	3.514	270	1450	3.4	1540.1	1540.1	1541.1	1.0
AF	3.617	84	552	9.1	1541.7	1541.7	1542.6	0.9
AG	3.651	562	1208	4.2	1553.1	1553.1	1553.6	0.5
AH	3.670	670	1327	3.8	1553.6	1553.6	1554.0	0.4
AI	3.713	1159	11814	0.4	1554.3	1554.3	1555.3	1.0
AJ	3.821	1050	9171	0.6	1554.3	1554.3	1555.3	1.0
AK	3.917	686	4530	1.2	1554.4	1554.4	1555.4	1.0
AL	4.010	540	2480	2.1	1554.6	1554.6	1555.6	1.0
AM	4.119	265	1066	5.0	1555.8	1555.8	1556.8	1.0
AN	4.214	214	1039	5.1	1558.8	1558.8	1559.8	1.0
AO	4.306	200	917	5.8	1561.6	1561.6	1562.6	1.0
AP	4.403	205	1069	5.0	1564.5	1564.5	1565.5	1.0
AQ	4.497	142	816	6.5	1566.9	1566.9	1567.8	0.9
AR	4.596	146	1077	4.9	1569.3	1569.3	1570.3	1.0
AS	4.694	111	773	6.9	1571.5	1571.5	1572.2	0.7
AT	4.789	115	951	5.6	1574.5	1574.5	1575.1	0.6
AU	4.893	116	688	7.7	1578.4	1578.4	1578.9	0.5
AV	4.988	149	936	5.7	1582.8	1582.8	1583.2	0.4
AW	5.095	118	911	5.8	1585.8	1585.8	1586.5	0.7
AX	5.189	206	1268	4.2	1587.9	1587.9	1588.5	0.6
AY	5.287	466	1016	5.2	1592.5	1592.5	1593.1	0.6

Table 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNINCORPORATED MARICOPA COUNTY/ SURPRISE, AZ

FLOODWAY DATA

IONA WASH

* Increase, I: Sections 0.640 to 0.999, I = Floodway El. - Regulatory El.
Sections 1.101 to 13.499, I = Floodway El. - "Without Floodway" El.(see SPR #9)

FWDATTBL.XLS

Flooding Source		Floodway			Base Flood Water Surface Elevation			
Cross Section	Distance (miles above Trilby Wash)	Width (feet)	Section Area (square feet)	Mean Velocity (feet per second)	Regulatory (feet NGVD)	Without Floodway (feet NGVD)	With Floodway (feet NGVD)	Increase * (feet)
AZ	5.386	485	1400	3.8	1596.6	1596.6	1597.6	1.0
BA	5.485	324	1068	5.0	1599.6	1599.6	1600.4	0.8
BB	5.577	132	705	7.6	1602.0	1602.0	1602.9	0.9
BC	5.668	740	1854	2.9	1605.0	1605.0	1606.0	1.0
BD	5.765	690	1598	3.3	1607.9	1607.9	1608.8	0.9
BE	5.858	690	2087	2.6	1611.1	1611.1	1612.1	1.0
BF	5.945	1046	2155	2.5	1613.6	1613.6	1614.3	0.7
BG	6.026	1192	1898	2.8	1615.4	1615.4	1616.3	0.9
BH	6.067	564	1632	3.3	1617.0	1617.0	1618.0	1.0
BI	6.135	440	1302	4.1	1618.7	1618.7	1619.7	1.0
BJ	6.223	617	1953	2.7	1621.5	1621.5	1622.5	1.0
BK	6.321	581	1549	3.4	1624.0	1624.0	1625.0	1.0
BL	6.413	489	1477	3.6	1627.5	1627.5	1628.5	1.0
BM	6.511	390	1345	4.0	1630.3	1630.3	1631.3	1.0
BN	6.603	371	1364	3.9	1633.5	1633.5	1634.4	0.9
BO	6.704	400	1484	3.6	1636.2	1636.2	1637.2	1.0
BP	6.801	546	1865	2.9	1638.9	1638.9	1639.9	1.0
BQ	6.897	832	2054	2.6	1641.8	1641.8	1642.8	1.0
BR	6.986	769	1462	3.7	1644.7	1644.7	1645.7	1.0
BS	7.077	975	1944	2.8	1647.9	1647.9	1648.9	1.0
BT	7.167	836	1599	3.3	1651.9	1651.9	1652.9	1.0
BU	7.264	1174	2360	2.3	1655.3	1655.3	1656.3	1.0
BV	7.352	867	1634	3.3	1658.2	1658.2	1659.0	0.8
BW	7.438	585	1611	3.3	1661.3	1661.3	1662.2	0.9
BX	7.533	485	1638	3.3	1664.8	1664.8	1665.8	1.0
BY	7.624	446	1527	3.5	1668.0	1668.0	1668.8	0.8

Table 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNINCORPORATED MARICOPA COUNTY/ SURPRISE, AZ

FLOODWAY DATA

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FWDATTBL.XLS

Flooding Source		Floodway			Base Flood Water Surface Elevation			
Cross Section	Distance (miles above Trilby Wash)	Width (feet)	Section Area (square feet)	Mean Velocity (feet per second)	Regulatory (feet NGVD)	Without Floodway (feet NGVD)	With Floodway (feet NGVD)	Increase * (feet)
BZ	7.709	430	1668	3.2	1670.7	1670.7	1671.5	0.8
CA	7.800	455	1527	3.5	1673.4	1673.4	1674.2	0.8
CB	7.896	520	1765	3.0	1676.0	1676.0	1677.0	1.0
CC	7.995	406	1244	4.2	1678.8	1678.8	1679.7	0.9
CD	8.088	340	1272	4.1	1681.5	1681.5	1682.2	0.7
CE	8.182	225	639	8.2	1684.9	1684.9	1685.4	0.5
CF	8.273	265	1380	3.8	1688.5	1688.5	1689.5	1.0
CG	8.374	198	1028	5.0	1691.2	1691.2	1691.9	0.7
CH	8.465	141	783	6.6	1693.9	1693.9	1694.8	0.9
CI	8.560	290	1662	3.1	1695.9	1695.9	1696.9	1.0
CJ	8.654	252	1082	4.7	1697.4	1697.4	1698.1	0.7
CK	8.740	172	744	6.8	1699.7	1699.7	1699.9	0.2
CL	8.844	153	630	8.0	1703.6	1703.6	1703.7	0.1
CM	8.940	205	1135	4.4	1707.1	1707.1	1708.1	1.0
CN	9.032	260	1172	4.3	1709.3	1709.3	1709.9	0.6
CO	9.119	210	680	7.3	1711.6	1711.6	1712.4	0.8
CP	9.202	99	754	6.5	1715.4	1715.4	1716.3	0.9
CQ	9.289	135	551	8.9	1718.8	1718.8	1719.0	0.2
CR	9.387	162	551	1.2	1720.5	1720.5	1721.5	1.0
CS	9.480	79	212	3.2	1721.6	1721.6	1722.1	0.5
CT	9.588	54	93	7.2	1725.5	1725.5	1725.4	-0.1
CU	9.677	57	150	4.5	1730.6	1730.6	1730.9	0.3
CV	9.770	50	108	6.2	1735.0	1735.0	1735.7	0.7
CW	9.865	146	181	3.7	1740.6	1740.6	1740.8	0.2
CX	9.963	115	175	3.8	1745.5	1745.5	1745.4	-0.1
CY	10.054	69	136	4.9	1749.3	1749.3	1749.9	0.6

Table 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

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FWDATTBL.XLS

Flooding Source		Floodway			Base Flood Water Surface Elevation			
Cross Section	Distance (miles above Trilby Wash)	Width (feet)	Section Area (square feet)	Mean Velocity (feet per second)	Regulatory (feet NGVD)	Without Floodway (feet NGVD)	With Floodway (feet NGVD)	Increase * (feet)
CZ	10.139	52	105	6.3	1754.2	1754.2	1754.9	0.7
DA	10.232	120	196	3.4	1759.2	1759.2	1759.5	0.3
DB	10.320	79	168	4.0	1762.6	1762.6	1763.0	0.4
DC	10.426	124	230	2.9	1766.9	1766.9	1767.5	0.6
DD	10.516	181	205	3.3	1771.8	1771.8	1772.6	0.8
DE	10.620	90	202	3.3	1777.0	1777.0	1778.0	1.0
DF	10.710	195	239	2.8	1781.3	1781.3	1782.1	0.8
DG	10.802	117	215	3.1	1785.6	1785.6	1786.5	0.9
DH	10.891	255	317	2.1	1789.9	1789.9	1790.3	0.4
DI	10.982	124	201	3.3	1794.4	1794.4	1795.1	0.7
DJ	11.079	146	234	2.9	1798.7	1798.7	1799.7	1.0
DK	11.174	150	213	3.3	1804.0	1804.0	1804.8	0.8
DL	11.264	79	207	3.4	1807.9	1807.9	1808.8	0.9
DM	11.368	172	452	4.4	1813.0	1813.0	1813.8	0.8
DN	11.469	244	698	3.1	1817.0	1817.0	1817.9	0.9
DO	11.570	365	652	3.3	1822.1	1822.1	1823.1	1.0
DP	11.666	572	1069	2.2	1827.0	1827.0	1828.0	1.0
DQ	11.750	327	862	2.8	1830.9	1830.9	1831.9	1.0
DR	11.847	334	1002	2.4	1835.0	1835.0	1836.0	1.0
DS	11.920	540	1150	2.1	1837.3	1837.3	1837.7	0.4
DT	12.010	521	926	2.6	1839.9	1839.9	1839.9	0.0
DU	12.101	358	294	2.9	1844.2	1844.2	1845.2	1.0
DV	12.191	300	424	2.0	1849.6	1849.6	1849.7	0.1
DW	12.281	394	400	2.4	1853.3	1853.3	1853.1	-0.2
DX	12.369	335	530	3.4	1857.6	1857.6	1857.9	0.3
DY	12.464	420	468	3.9	1862.2	1862.2	1863.2	1.0

Table 3

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FWDATTBL.XLS

Flooding Source		Floodway			Base Flood Water Surface Elevation			
Cross Section	Distance (miles above Trilby Wash)	Width (feet)	Section Area (square feet)	Mean Velocity (feet per second)	Regulatory (feet NGVD)	Without Floodway (feet NGVD)	With Floodway (feet NGVD)	Increase * (feet)
DZ	12.614	712	573	4.1	1869.3	1869.3	1870.3	1.0
EA	12.692	528	421	5.6	1874.8	1874.8	1875.4	0.6
EB	12.752	400	502	4.7	1878.0	1878.0	1878.9	0.9
EC	12.849	126	306	7.7	1882.6	1882.6	1883.5	0.9
ED	12.942	165	408	5.8	1887.7	1887.7	1888.6	0.9
EE	13.025	96	254	9.3	1892.9	1892.9	1893.2	0.3
EF	13.127	113	384	6.2	1898.4	1898.4	1899.3	0.9
EG	13.221	163	423	5.6	1903.4	1903.4	1903.6	0.2
EH	13.325	109	330	7.2	1908.5	1908.5	1908.3	-0.2
EI	13.419	174	488	4.9	1913.4	1913.4	1914.2	0.8
EJ	13.499	52	224	10.6	1918.9	1918.9	1919.5	0.6

Table 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNINCORPORATED MARICOPA COUNTY/
SURPRISE, AZ

FLOODWAY DATA

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Sections 1.101 to 13.499, I = Floodway El. - "Without Floodway" El.(see SPR #9)

(See Exhibit 2). The boundaries of the 100-yr flood were delineated using the elevations computed at each cross section by the HEC-2 models. The delineations were interpolated between cross sections using engineering judgement in conjunction with the topographic map features and known field conditions. The ponding area upstream of the CAP extends west of the area covered by detailed topographic mapping, and was therefore delineated on the U.S.G.S. quadrangle map (Reference 12). The 500-year flood elevations were not determined by this study.

Because cross section data were obtained directly from the DTM models, the accuracy of the cross section data exceeds that of the contour mapping. As a result, slight discrepancies may appear between the computed elevations and the intersections of the flood limits with the contour lines.

4.2 Floodways

For Flood Insurance Studies, floodways are typically defined as the main channel of a watercourse and the adjacent land width that must remain free of encroachments so as not to raise the 100-yr water surface elevation in the watercourse more than a specified amount. The allowable rise determined for this study is 1.0 foot.

Floodway delineations were computed based on equal conveyance methods using HEC-2 encroachment method 4. Method 4 encroachment stations were converted to HEC-2 encroachment method 1 target stations for final floodway modeling. Final floodway model was performed to ensure that no encroachments greater than 1.0 foot occurred within the study area. Floodway boundaries were then plotted at the cross sections on the topographic maps. Engineering judgement was used to appropriately interpolate and smooth the floodplain delineation. Floodway delineations are shown on Exhibit 2.

5.0 INSURANCE APPLICATION

For flood insurance rating purposes, each floodplain area was divide into appropriate rate zones based on the floodplain boundaries and the engineering analyses. The areas were divided into flood insurance rate zones based on the following criteria:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 100-yr floodplains that are determined in the FIS by approximate methods. Because detailed

hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 100-yr floodplains that are determined in the FIS by detailed methods. BFE's derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AH

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

6.0 OTHER STUDIES

This study is intended to update and supersede the previous study performed in 1979 (Reference 13). Portions of the study area were previously mapped by approximate methods, and are shown as Zone A or shaded Zone X on Panels 680 and 1110 of 4350 for Unincorporated Maricopa County. Reference 2 describes other studies and information relevant to this Flood Insurance Study.

7.0 LOCATION OF DATA

All data developed for this can be obtained from the Flood Control District of Maricopa County, Floodplain Management Section at 2801 West Durango, Phoenix, AZ 85009 (602)506-1501.

8.0 BIBLIOGRAPHY

1. CH2M HILL, 1992, Memorandum from Jon Fuller/CH2M HILL to Sandy Story/FCDMC dated October 26, 1992. Memorandum describes Community Officials Meeting of October 14, 1992.

2. CH2M HILL, 1992, Memorandum entitled "Data Collection Report" from Jon Fuller/CH2M HILL to Sandy Story/FCDMC dated December 21, 1992.

3. The WLB Group, 1989, Wittmann Area Drainage Master Study, Part A: Hydrology and Hydraulics. Report to the FCDMC.

4. CH2M HILL, 1993, Memorandum from Jon Fuller/CH2M HILL to Sandy Story/FCDMC dated March 3, 1993. Memorandum discussed flow rates for use in hydraulic modeling.

5. U.S. Army Corps of Engineers, Hydrologic Engineering Center, 1991, "HEC-2 Water Surface Profiles, User's Manual."

6. P&D Technologies, 1992 (February 6), "Flood Insurance Study for Trilby Wash," Report submitted to FCDMC, Contract #90-24.

7. Thomsen, B.W., and Hjalmarson, H.W., 1991, "Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona," Report by the U.S. Geological Survey to the FCDMC.

8. CH2M HILL, 1992, "Field Reconnaissance Report." Report submitted to FCDMC, December.

9. U.S. Army Corps of Engineers, Hydrologic Engineering Center, 1988, "Floodway Determination Using Computer Program HEC-2." Training Document No. 5, January.

10. CH2M HILL, 1993, Technical Study Documentation Notebook for Iona Wash Flood Insurance Study, Appendix A, Special Problems Reports. Document submitted to FCDMC, July.

11. Federal Emergency Management Agency, 1991, "FEMA 37: Flood Insurance Study Guidelines and Specifications for Study Contractors," March.

12. U.S. Geological Survey, 1978, White Tanks Mtn, NE, Arizona - 7.5 minute quadrangle map.

13. Harris-Toups Associates, 1979, Flood Insurance Study Approximate Study for Unincorporated Area of Maricopa County, Arizona. Prepared for the U.S. Department of Housing and Urban Development, unpublished.

9.0 REDUCED DELINEATION MAPS

Will be include upon FEMA acceptance of work maps.

10.0 ELEVATION REFERENCE MARKS

NO.	ELEVATION	DESCRIPTION
ERM 1	1605.88	Top of Maricopa County Highway Department Brass Cap flush with pavement at the intersection of 230th Avenue and Patton Road.
ERM 2	1613.46	Top of Maricopa County Highway Department Brass Cap in handhole located at the intersection of Patton Road and 235th Avenue.
ERM 3	1622.28	Top of Maricopa County Highway Department Brass Cap flush with pavement at the intersection of Patton Road and 239th Avenue.
ERM 4	1636.61	Top of Maricopa County Highway Department Brass Cap flush with pavement at the intersection of Patton Road and 243rd Avenue.
ERM 5	1650.98	Top of 1 1/2" Aluminum Cap marked Iona Wash FS ERM #5 located 0.5 miles North of Patton Road on 243rd Avenue on the West side of roadway.
ERM 6	1665.63	Top of 1 1/2" Aluminum Cap marked Iona Wash FS ERM #6 located 1 mile North of Patton Road on 243rd Avenue (dirt), 125' North of a water tank on the West side of roadway.
ERM 7	1679.60	Top of 1 1/2" Aluminum Cap marked Iona Wash FS ERM #7 located 325'+ South of the centerline of the Iona Wash and 20' + West of the existing dirt roadway; also 3'+ Southwest of a found 1 1/2" Aluminum Cap marked FCDMC 14".
ERM 8	1696.93	Top of G.L.O. Brass Cap marked S17■S16 1916 S20■S21.
ERM 9	1717.54	Top of G.L.O. Brass Cap marked 1/4 S17■S16 1916.
ERM 10	1735.29	Top of G.L.O. Brass Cap marked S8■S9 1916 S17■S16.
ERM 11	1758.40	Top of G.L.O. Brass Cap marked 1/4 S8■S9 1916.

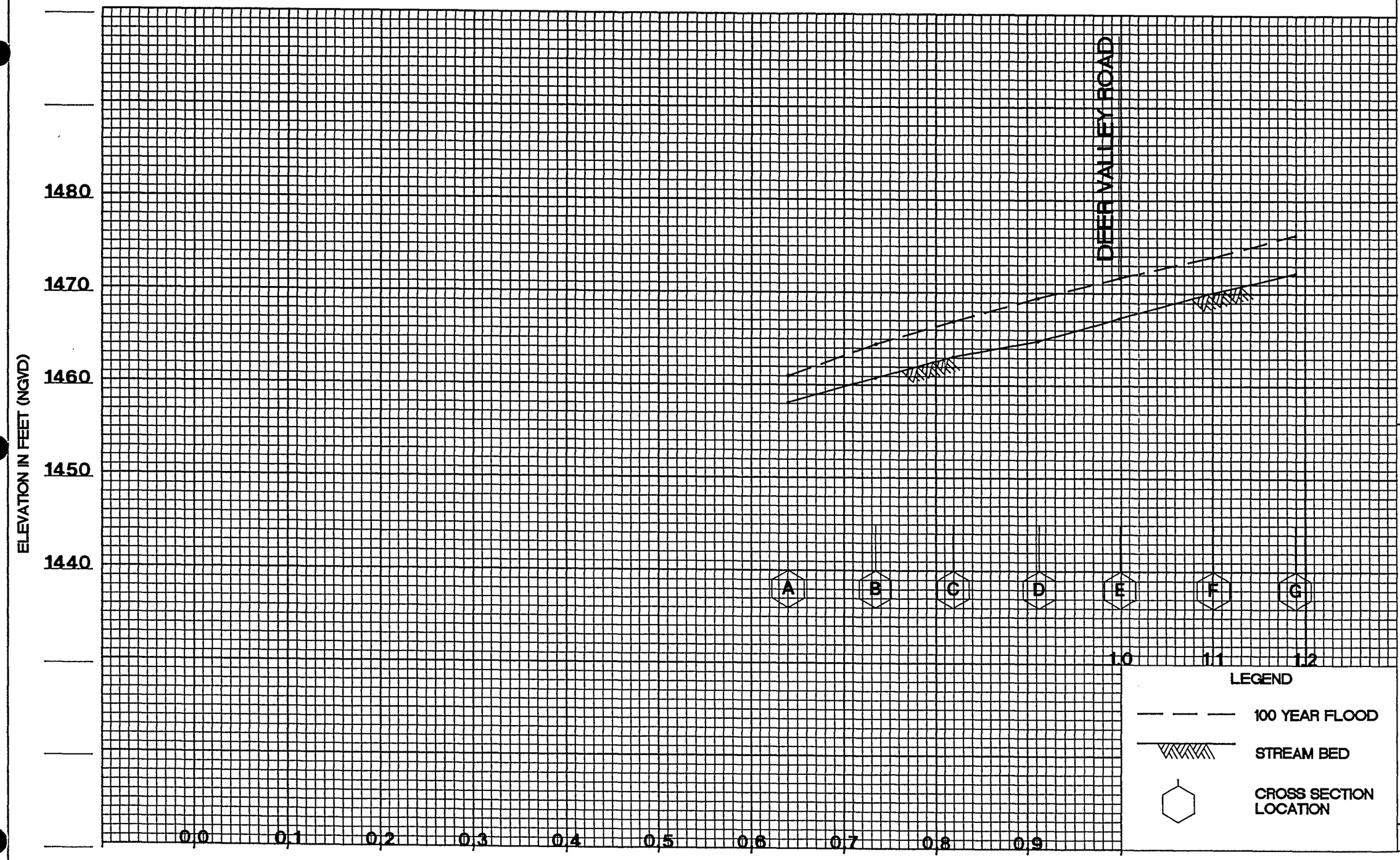
ERM 12	1786.77	Top of G.L.O. Brass Cap marked S5■S4 T5N R3W S8■S9.
ERM 13	1814.28	Top of G.L.O. Brass Cap marked 1/4 S5■S4.
ERM 14	1947.54	Top of G.L.O. Brass Cap marked S32■S33 T6N R3W 1916 S5■S4.
ERM 15	1838.91	Top of 1 1/2" Aluminum Cap marked Iona Wash FS ERM #15 located on the South side of an East West roadway 10'+ North and an East West fence line.
ERM 16	1862.43	Top of 1 1/2" Aluminum Cap marked Iona Wash FS ERM #16 of the Iona Wash road crossing, 0.5+ miles North of Township line.
ERM 17	1902.43	Top of G.L.O. Brass Cap marked 1/4 S29■S32.
ERM 18	1593.64	Top of Maricopa County Highway Department Brass Cap located near the Southwest corner of Section 26, T5N R3W.
ERM 19	1569.93	Top of G.L.O. Brass Cap marked 1/4 S34■S35 1916 located 70'+ North of the Iona Wash.
ERM 20	1570.45	Top of G.L.O. Brass Cap marked S34■S35 1916 SC.
ERM 21	1551.74	Top of 1 1/2 Aluminum Cap marked Iona Wash FS ERM #21 located 2' North of a concrete cattle guard 150' South of the Central Arizona Project Canal 200'+ East of the Trilby Wash.
ERM 22	1543.08	Top of 1 1/2" Aluminum Cap marked Iona Wash FS ERM #22 located 15'+ West of the West edge of a dirt roadway.
ERM 23	1527.02	Top of 1 1/2" Aluminum Cap marked Iona Wash FS ERM #23 located 30'+ West of the West side of the dirt roadway.
ERM 24	1510.67	Top of 1 1/2" Aluminum Cap marked Iona Wash FS ERM #24 located 23'+ West of the West edge of the dirt roadway.
ERM 25	1498.53	Top of 1 1/2" Aluminum Cap marked Iona Wash FS ERM #25 located 11.0'+ South of street sign marked "Pinnacle Peak Road" and 219th Avenue.

ERM 26	1483.46	Top of 1 1/2" Aluminum Cap marked Iona Wash FS ERM #26 located 7.5'+ South, Southwest of the G.L.O. Brass Cap marked 1/4 S14■S13 1915.
ERM 27	1473.51	Top of "Bureau of Reclamation Brass Cap" located at the Northwest corner of Deer Valley Road and 219th Avenue.

Section 8: Draft FIS Report - Revised Text

Exhibit 1: Natural Condition Flood Profiles

DATE



FLOOD PROFILES

IONA WASH

FEMA EMERGENCY MANAGEMENT AGENCY

UNINCORPORATED MARICOPA COUNTY / SURPRISE, ARIZONA

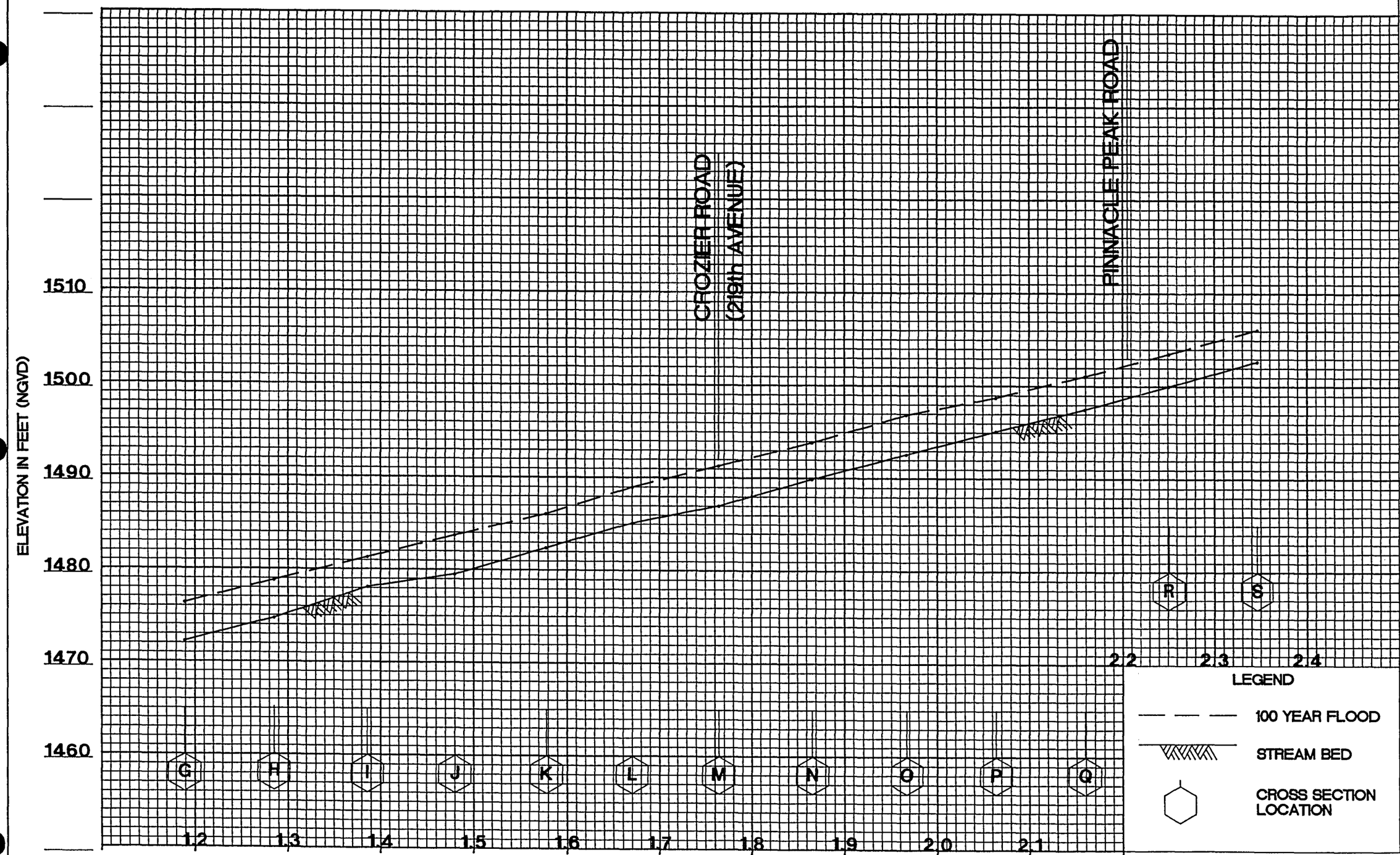
SHT. P-1

CH2MHILL

FILENAME.EXT

1-10

DATE



FLOOD PROFILES

IONA WASH

FEMA EMERGENCY MANAGEMENT AGENCY

UNINCORPORATED MARICOPA COUNTY / SURPRISE, ARIZONA

SHT. P-2

CH2M HILL

FILENAME.EXT

1-10

DATE

ELEVATION IN FEET (NGVD)

1550
1540
1530
1520
1510
1500

S T U V W X Y Z AA AB AC AD AE AF

2.4 2.5 2.6 2.7 2.8 2.9 3.0 3.1 3.2 3.3 3.4 3.5 3.6

STREAM DISTANCE IN MILES UPSTREAM FROM CONFLUENT CENTERLINE TRILBY WASH

LEGEND

100 YEAR FLOOD

STREAM BED

CROSS SECTION LOCATION

FLOOD PROFILES

IONA WASH

FEMA EMERGENCY MANAGEMENT AGENCY

UNINCORPORATED MARICOPA COUNTY / SURPRISE, ARIZONA

SHT. P-3

CH2MHILL

FILENAME.EXT

P-10

DATE

FLOOD PROFILES

IONA WASH

ELEVATION IN FEET (NGVD)

1580

1570

1560

1550

1540

1530

CAP CANAL

AF AG AH AI AJ AK AL AM AN AO AP AQ AR AS AT

3.6 3.7 3.8 3.9 4.0 4.1 4.2 4.3 4.4 4.5 4.6 4.7 4.8

LEGEND

100 YEAR FLOOD

STREAM BED

CROSS SECTION LOCATION

STREAM DISTANCE IN MILES UPSTREAM FROM CONFLUENT CENTERLINE TRILBY WASH

FEMA EMERGENCY MANAGEMENT AGENCY

UNINCORPORATED MARICOPA COUNTY / SURPRISE, ARIZONA

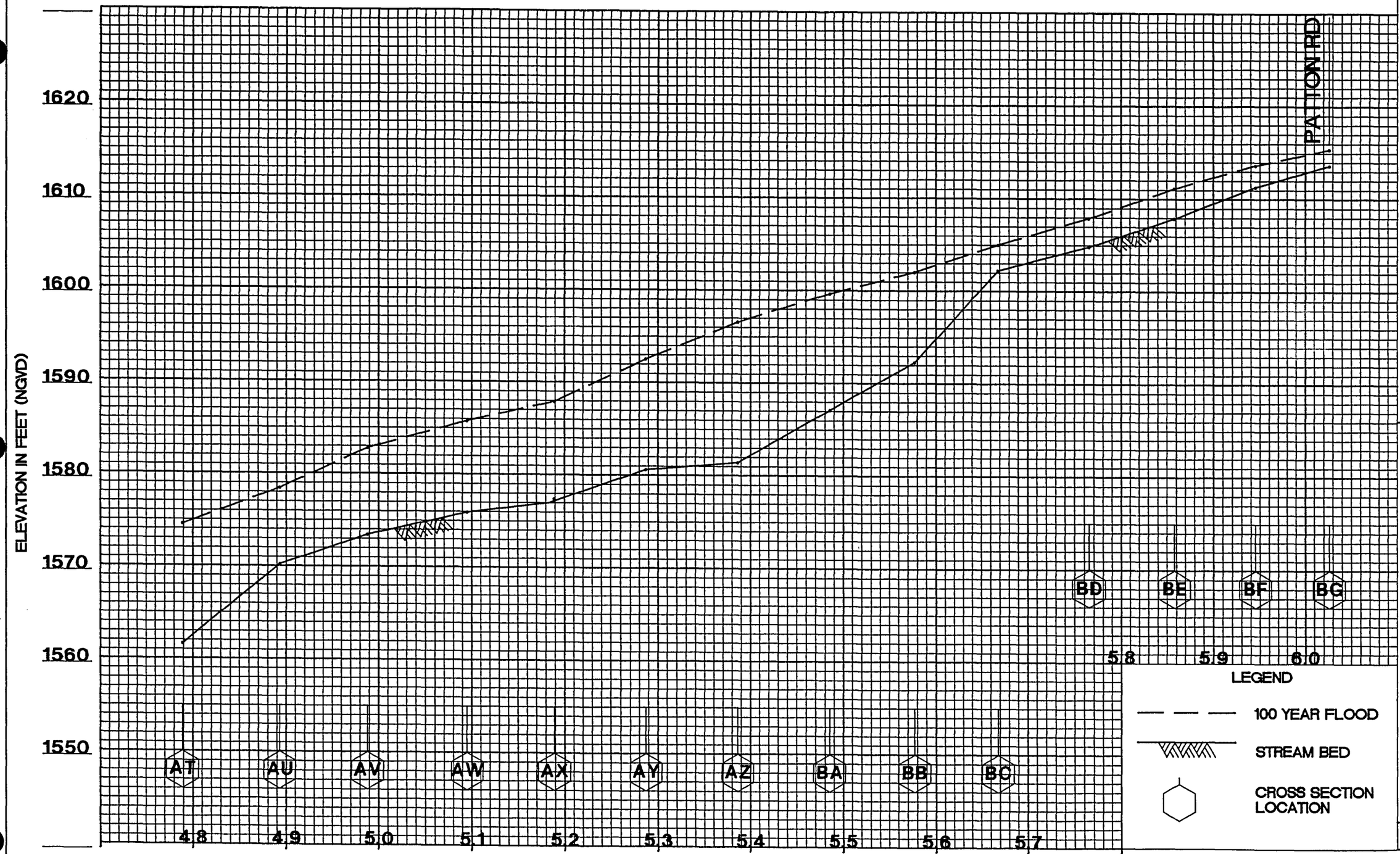
SHT. P-4

CH2MHILL

FILENAME.EXT

1-10

DATE



FLOOD PROFILES

IONA WASH

FEMA EMERGENCY MANAGEMENT AGENCY

UNINCORPORATED MARICOPA COUNTY / SURPRISE, ARIZONA

SHT. P-5

CH2MHILL

FILENAME.EXT

1-10

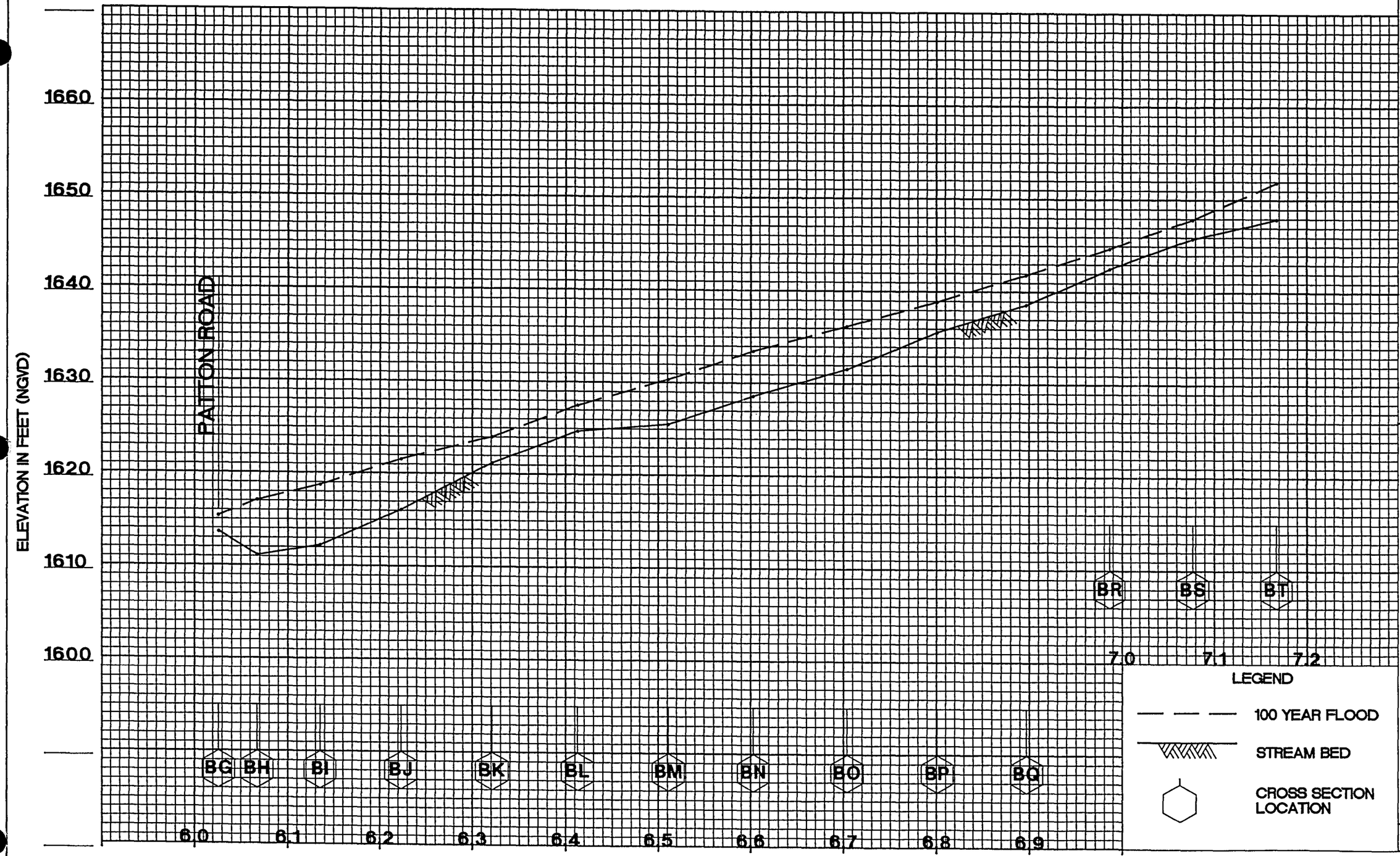
DATE

FLOOD PROFILES

IONA WASH

FEMA EMERGENCY MANAGEMENT AGENCY

UNINCORPORATED MARICOPA COUNTY / SURPRISE, ARIZONA



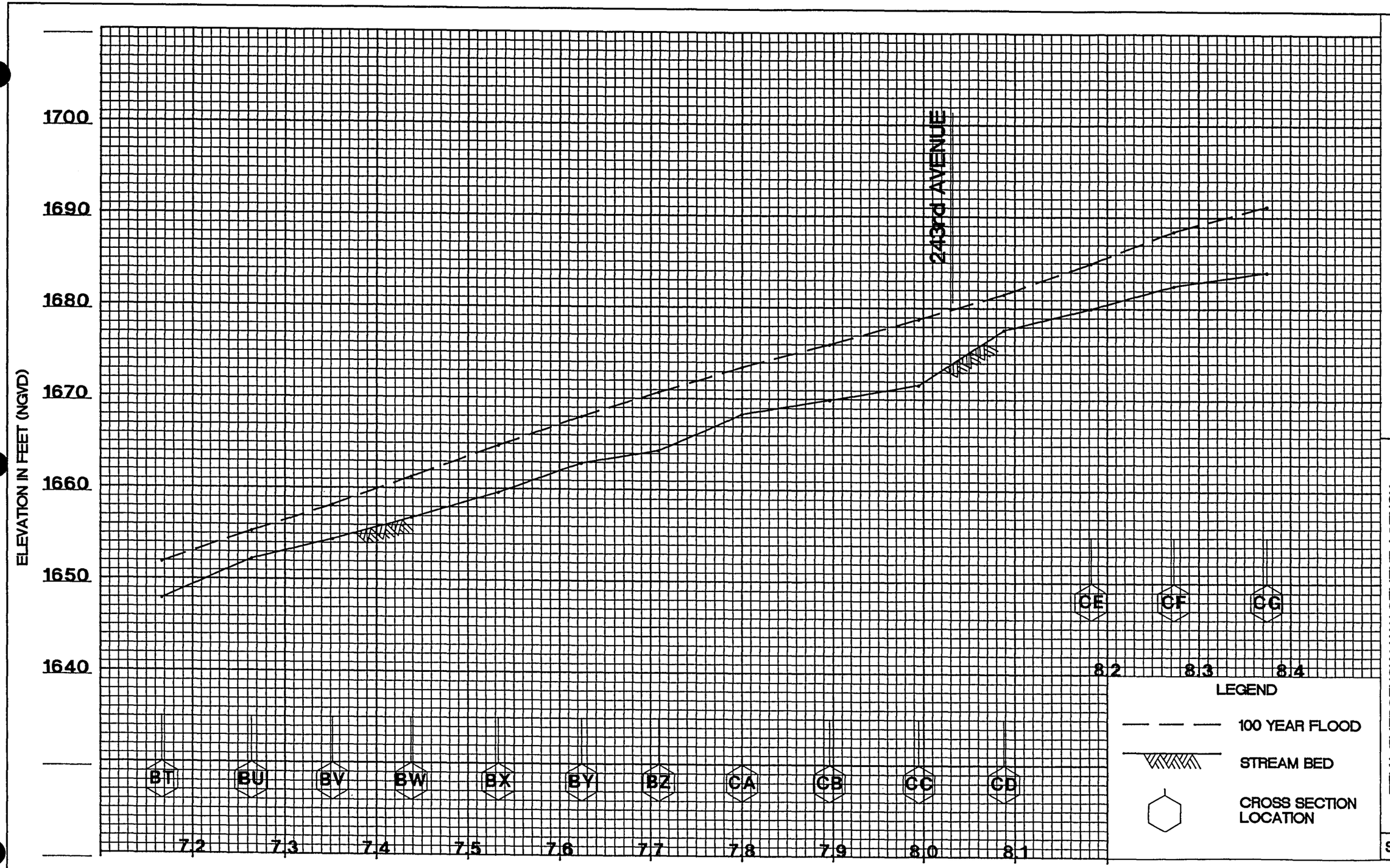
SHT. P-6

CH2MHILL

FILENAME.EXT

1-10

DATE



FLOOD PROFILES

IONA WASH

FEMA EMERGENCY MANAGEMENT AGENCY

UNINCORPORATED MARICOPA COUNTY / SURPRISE, ARIZONA

SHT. P-7

CH2MHILL

FILENAME.EXT

1-10

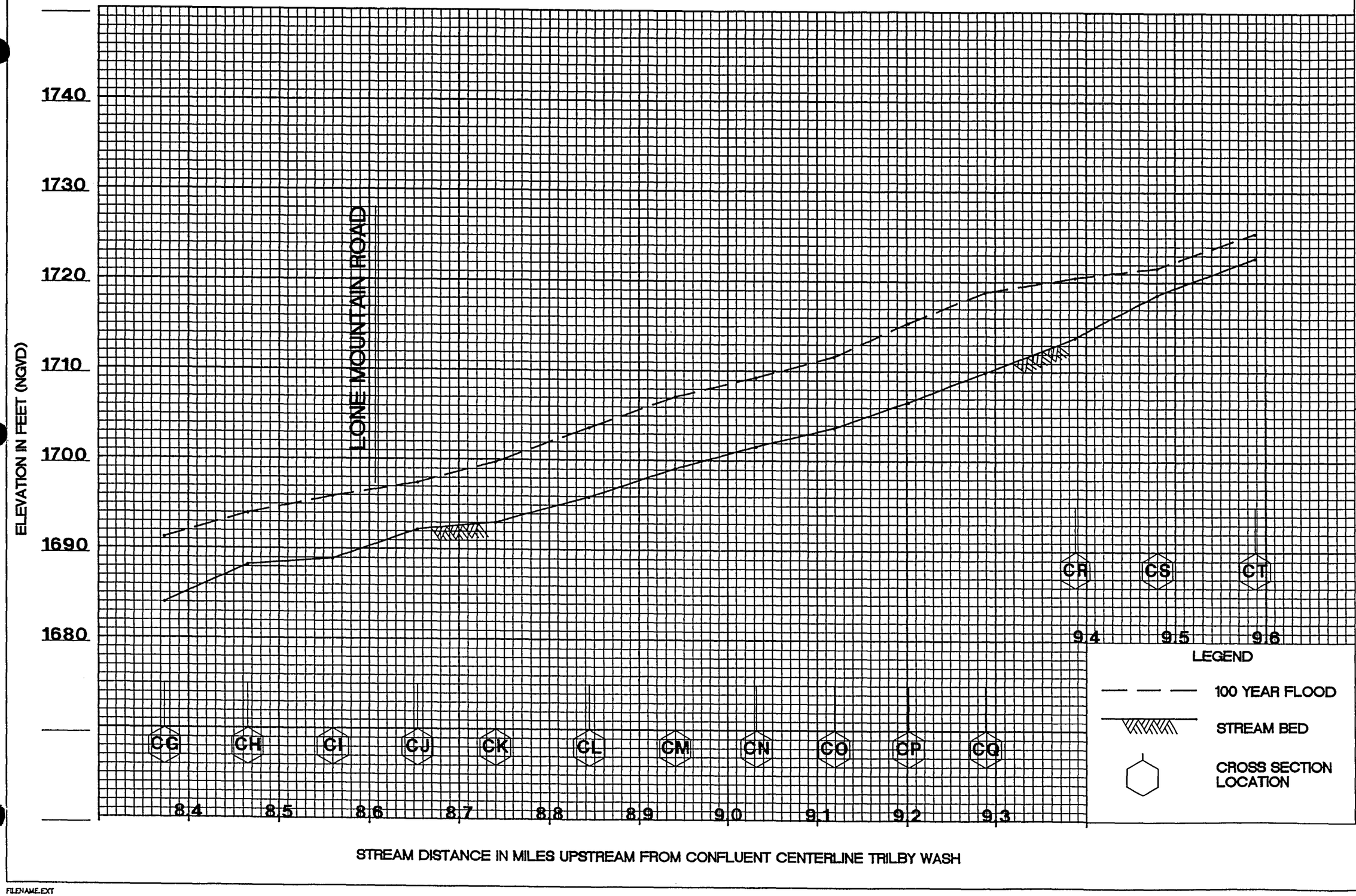
DATE

FLOOD PROFILES

IONA WASH

FEMA EMERGENCY MANAGEMENT AGENCY

UNINCORPORATED MARICOPA COUNTY / SURPRISE, ARIZONA



SHT. P-8

CH2M HILL

FILENAME.EXT

1-10

DATE

FLOOD PROFILES

IONA WASH

FEMA EMERGENCY MANAGEMENT AGENCY

UNINCORPORATED MARICOPA COUNTY / SURPRISE, ARIZONA

ELEVATION IN FEET (NGVD)

1790
1780
1770
1760
1750
1740
1730
1720

CT CU CV CW CX CY CZ DA DB DC DD DE DF DG

9.6 9.7 9.8 9.9 10.0 10.1 10.2 10.3 10.4 10.5 10.6 10.7 10.8

STREAM DISTANCE IN MILES UPSTREAM FROM CONFLUENT CENTERLINE TRILBY WASH

LEGEND

100 YEAR FLOOD

STREAM BED

CROSS SECTION LOCATION

SHT. P-9

CH2MHILL

FILENAME.EXT

1-10

DATE

FLOOD PROFILES

IONA WASH

FEMA EMERGENCY MANAGEMENT AGENCY

UNINCORPORATED MARICOPA COUNTY / SURPRISE, ARIZONA

SHT. P-10

ELEVATION IN FEET (NGVD)

1840
1830
1820
1810
1800
1790
1780

CIRCLE CITY RD.

DG DH DI DJ DK DL DM DN DO DP DQ DR DS DT

10.8 10.9 11.0 11.1 11.2 11.3 11.4 11.5 11.6 11.7 11.8 11.9 12.0

LEGEND

100 YEAR FLOOD

STREAM BED

CROSS SECTION LOCATION

STREAM DISTANCE IN MILES UPSTREAM FROM CONFLUENT CENTERLINE TRILBY WASH

CH2M HILL

FILENAME.EXT

1-10

DATE

FLOOD PROFILES

IONA WASH

FEMA EMERGENCY MANAGEMENT AGENCY

UNINCORPORATED MARICOPA COUNTY / SURPRISE, ARIZONA

SHT. P-11

ELEVATION IN FEET (NGVD)

1910
1900
1890
1880
1870
1860
1850
1840
1830

DT DU DV DW DX DY DZ EA EB EC ED FE EF EG

12.0 12.1 12.2 12.3 12.4 12.5 12.6 12.7 12.8 12.9 13.0 13.1 13.2

LEGEND

100 YEAR FLOOD

STREAM BED

CROSS SECTION LOCATION

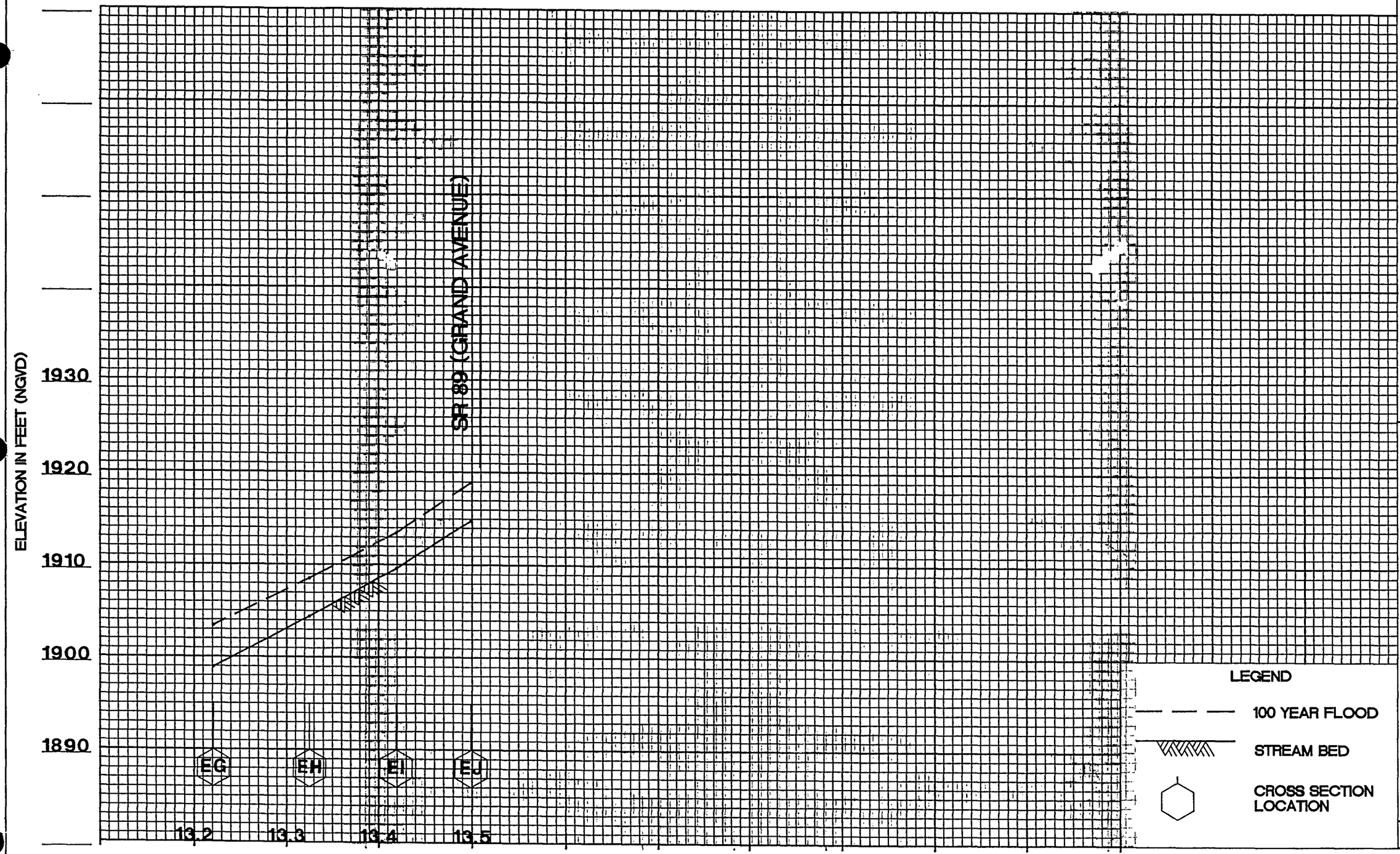
STREAM DISTANCE IN MILES UPSTREAM FROM CONFLUENT CENTERLINE TRILBY WASH

CH2MHILL

FILENAME.EXT

1-10

DATE



FLOOD PROFILES

IONA WASH

FEMA EMERGENCY MANAGEMENT AGENCY

UNINCORPORATED MARICOPA COUNTY / SURPRISE, ARIZONA

SHT. P-12

CH2MHILL

FILENAME.EXT

1-1.0