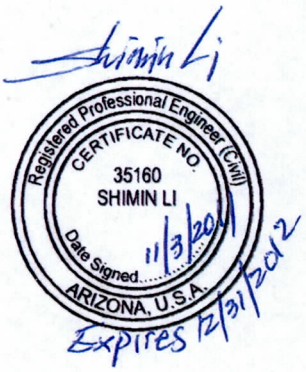
Sediment Yield Analysis

For Pass Mountain Diversion Levee ID #291 Certification



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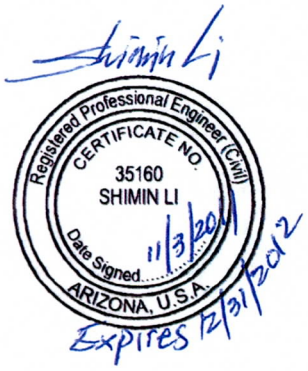

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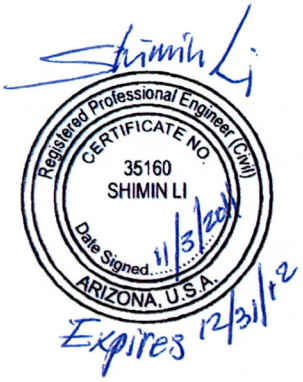
Table of Contents



Purpose

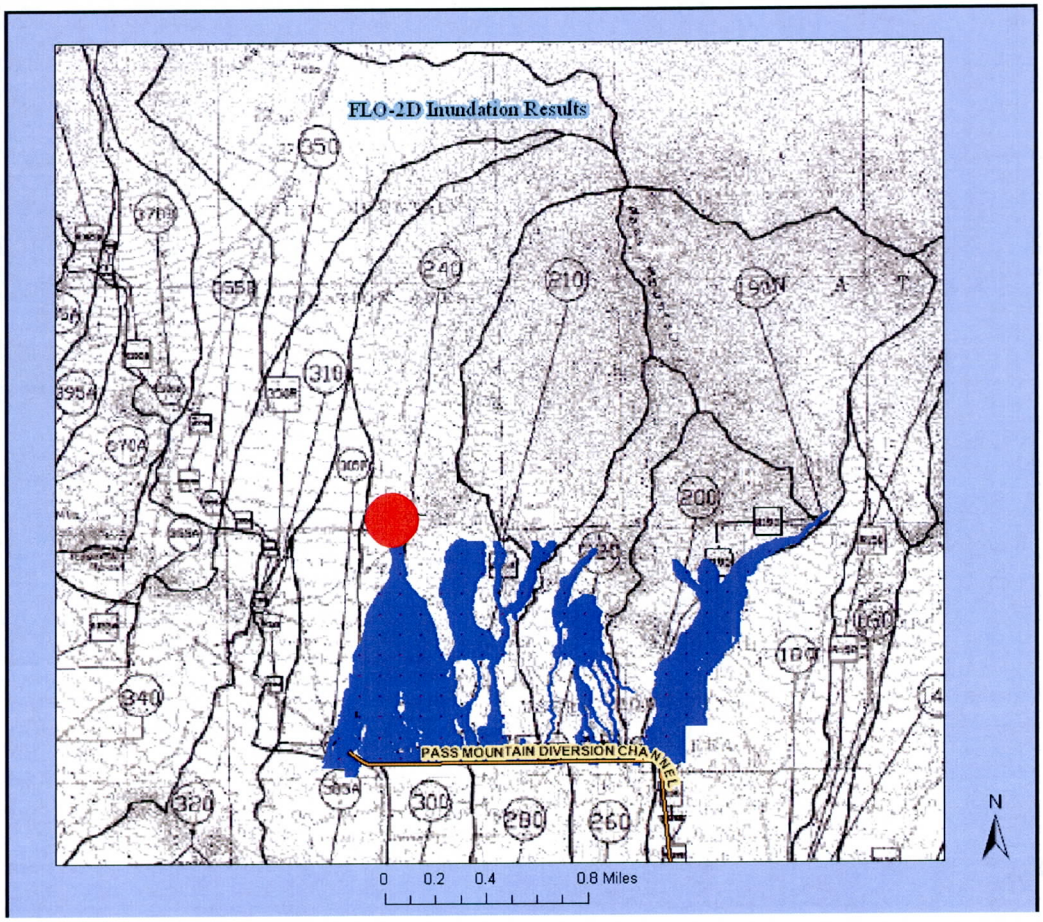
The purpose of this report is to address one of FEMA's review comments provided in the October 3, 2011 letter to Mr. Frank Brown of Flood Control District of Maricopa County (FCDMC) from Mr. Robert J. Bezek, Regional Engineer, Mitigation Division, FEMA regarding a report titled "Levee Certification Report – Pass Mountain Diversion Levee ID #291 – Maricopa County, Arizona" prepared by AMEC in June 2011. The FEMA's comment is as follows:

> "Although the report explains that sediment is not an issue and the maintenance records do not show any major erosion or sedimentation problems, please address the concern that these areas may be active alluvial fans that could produce sediment that might impact the structure during the flood event. As long as the sediment is not so significant that it would impact the safety of the structure during the flood event, then it could be handled under the O&M plan, as part of their normal post-flood event maintenance."

Background

AMEC's FLO-2D results display a distributary flow area (Figure 1). To address FEMA's concern for sediment, FCDMC performed a sediment yield analysis near the split flow location on the distributary flow area (see the red dot in Figure 1). This location is about 1 mile upstream of Pass Mountain Diversion Levee. To accomplish the sediment yield analysis, a hydrologic study is performed by using DDMSW 4.6.0 to estimate the peak discharges and volumes for the required storm events for sediment yield analysis since there is no hydrologic concentration point near this location in the original hydrologic study from the Spook Hill ADMP Update (Wood Patel, 2002). Sediment yield analysis is performed by using DDMSW 4.6.0.

Figure1. FLO-2D Inundation Area for Pass Mountain Division Levee ID #291



Hydrology

Figure 2 shows a portion of Spook Hill ADMP drainage map, which drains to Pass Mountain Diversion Levee (Wood Patel, 2002). DDMSW 4.6.0 software is used to prepare the HEC-1 input file and generate the peak flows and runoff volumes for a number of return periods. DDMSW is FCDMC's standard software for hydrologic modeling for floodplain delineation and river mechanics analysis for engineering design. The software can directly use land use, soil, and drainage basin GIS shape files. Figure 3 shows the drainage basin identified as 240a in this sediment yield analysis for the drainage outlet at the top of the distributary flow area.

Rainfall calculation for the drainage area 240a is based on NOAA 2 Rainfall Contours (1973) to be consistent with Spook Hill ADMP Update (Wood Patel, 2002). The four rainfall points for DDMSW Prefre model input are shown in Figure 4. Calculation of rainfall losses is based on the Green-Ampt method which requires land use data and soil data. Land use data are based on MAG 2000 land use data and are shown in Figure 5. Soil data are based on NRCS SSURGO soil data shown in Figure 6. However, soil data is not available for a small area. To create a soil type map for the drainage area 240a, the available soil type areas are extended and the resulting soil type map for the drainage area 240a is shown in Figure 7. Table 1 lists the hydrologic parameters for land uses of the drainage area 240a. Table 2 lists the hydrologic parameters for soils in the drainage area 240a. Clark unit hydrograph is used to produce the storm hydrographs of different return intervals. The length for time of concentration (Figure 8) is determined by using distance measuring tool provided in ArcGIS 10.0. The peak flows and runoff volumes for 24-hour storms of 2-yr, 5-yr, 10-yr, 25-yr, 50-yr and 100-yr return intervals are shown in Table 3. These results will be used for sediment yield analysis.

Table 1. Hydrological Parameters for Each Land Use Type

Land use	Code	Area (mi^2)	Area %	IA (in)	RTIMP (%)	Vegetation Cover (%)	DTHETA	Kb
Active Open Space	710	0.5368	79.2	0.35	5	90	Normal	0.024
Passive Open Space	730	0.1406	20.8	0.35	0	90	Normal	0.084

Table 2. Hydrological Parameters for Each Soil Type

Soil ID	Area (mi^2)	Area in Percent	XKSAT (in/hr)	Rock %
64547	0.0036	0.5	0.11	0.00
64548	0.2834	41.8	0.06	0.00
64563	0.0382	5.6	0.14	25
64568	0.298	44.0	0.63	0.00
64598	0.0543	8	0.37	0.00

Table 3. Storm Flood Discharges and Volumes Calculated by HEC-1

	Return Interval (year)					
	2	5	10	25	50	100
Discharge (CFS)	29	158	258	411	542	702
Volume (Acre-Feet)	3.63	11.69	17.10	24.16	30.88	37.66

Figure 2. Drainage Map for Pass Mountain Diversion Levee

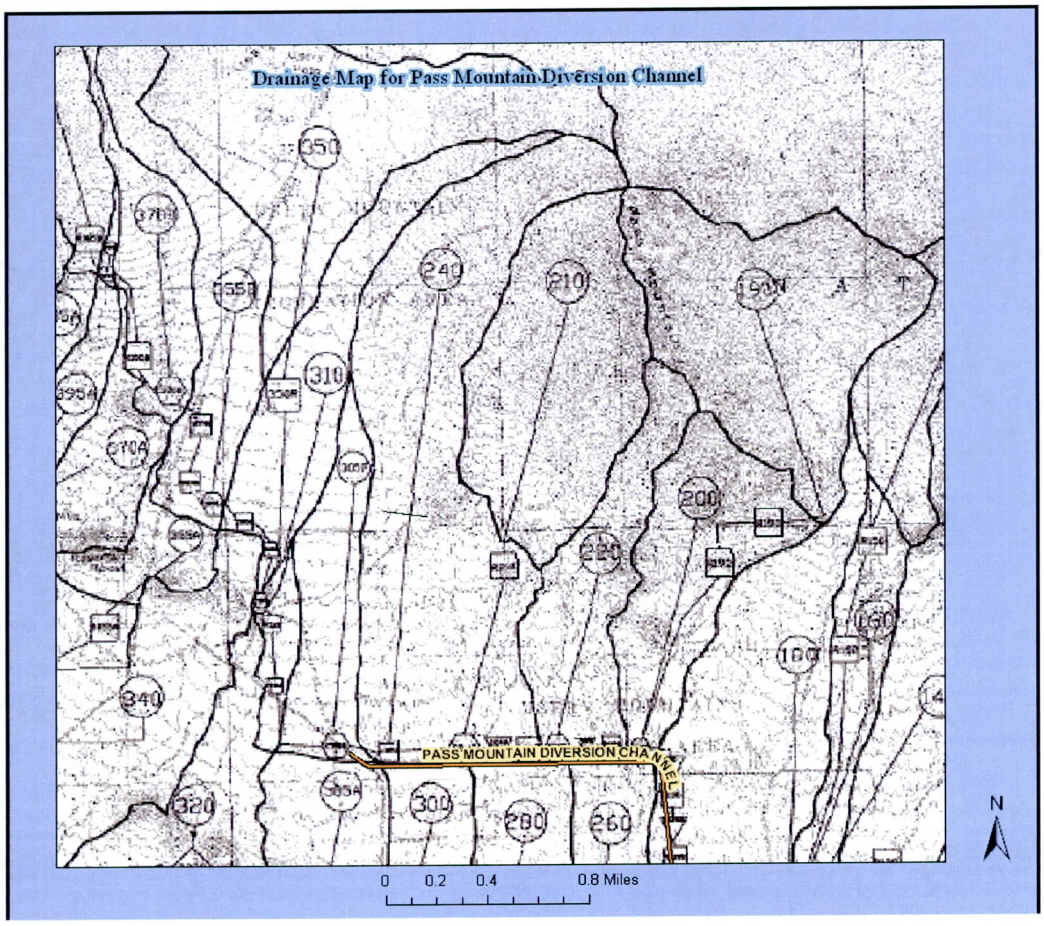


Figure 3. Drainage Area 240a for Sediment Analysis (inside red line)

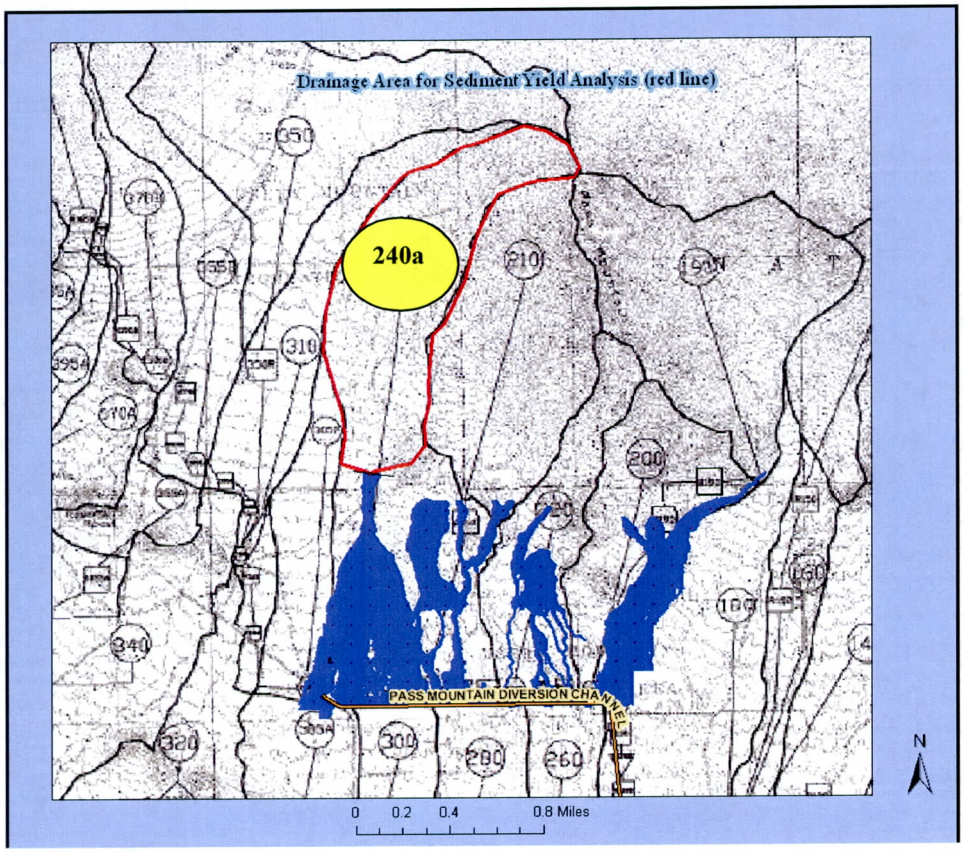


Figure 4. NOAA 2 Rainfall Points

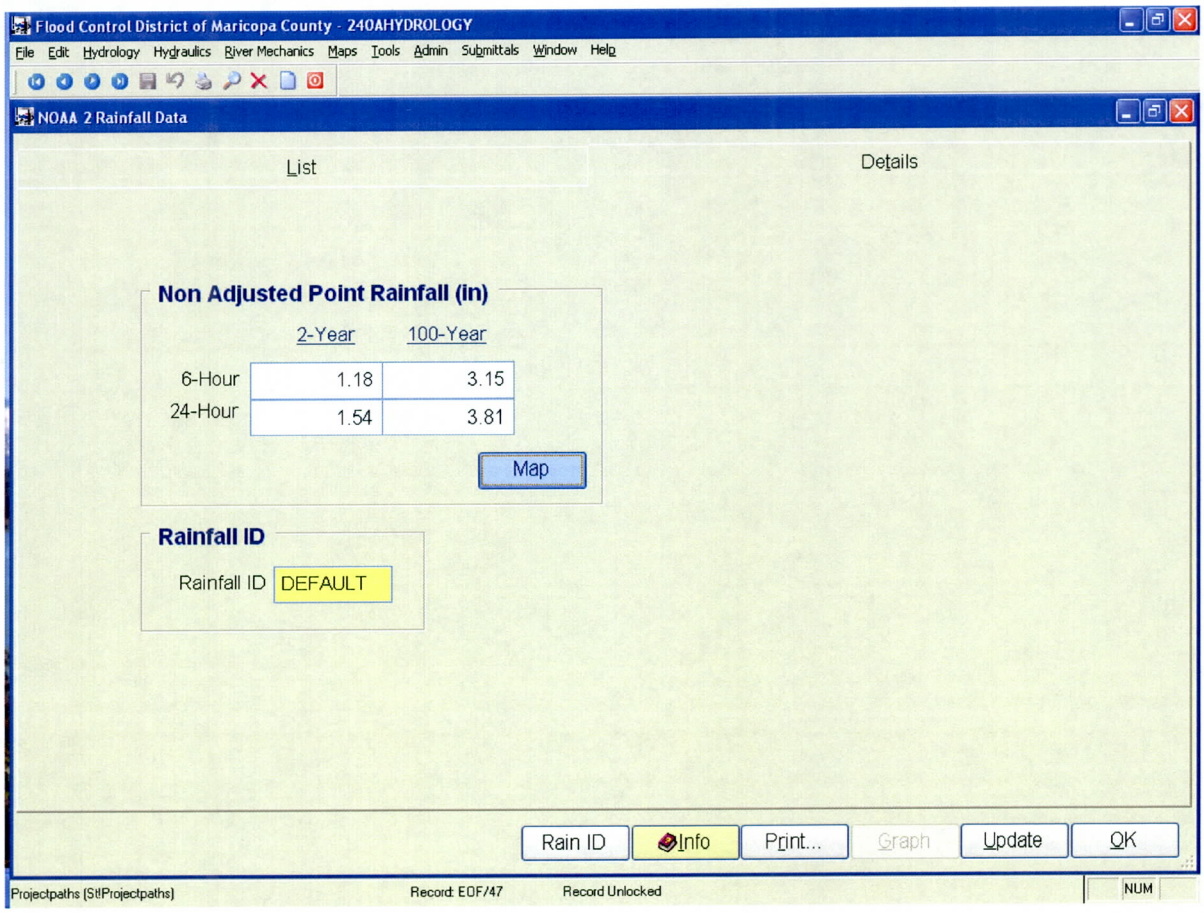


Figure 5. Land Use Map

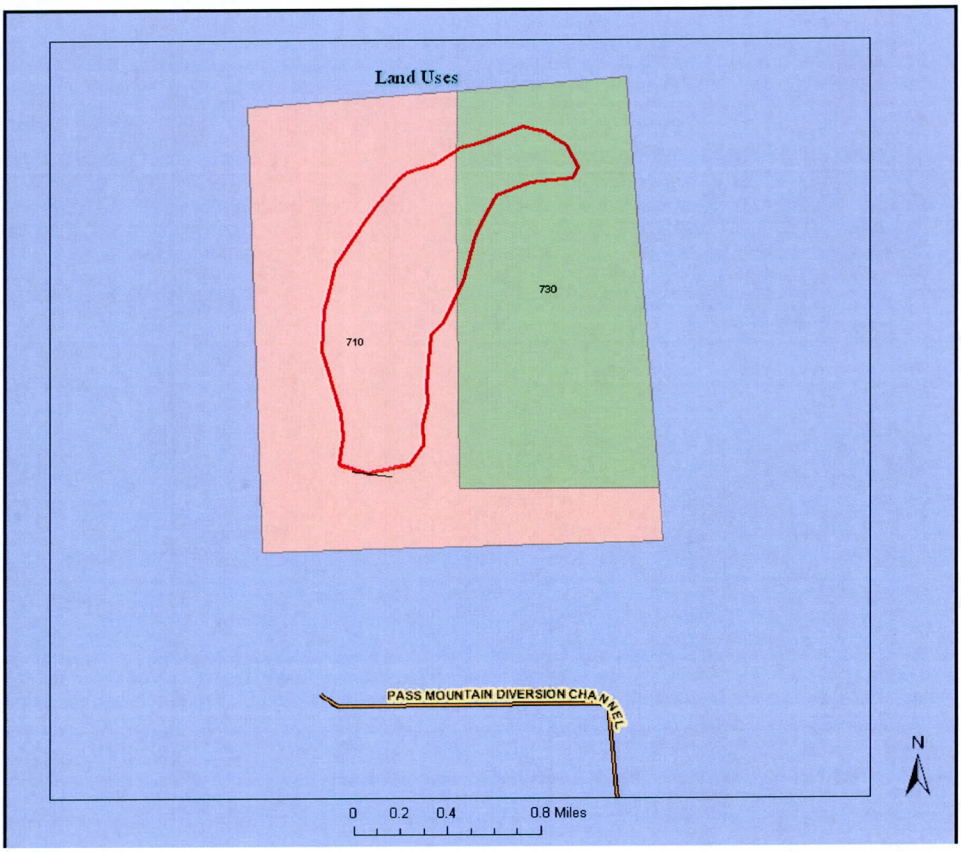


Figure 6. Available Soil Map

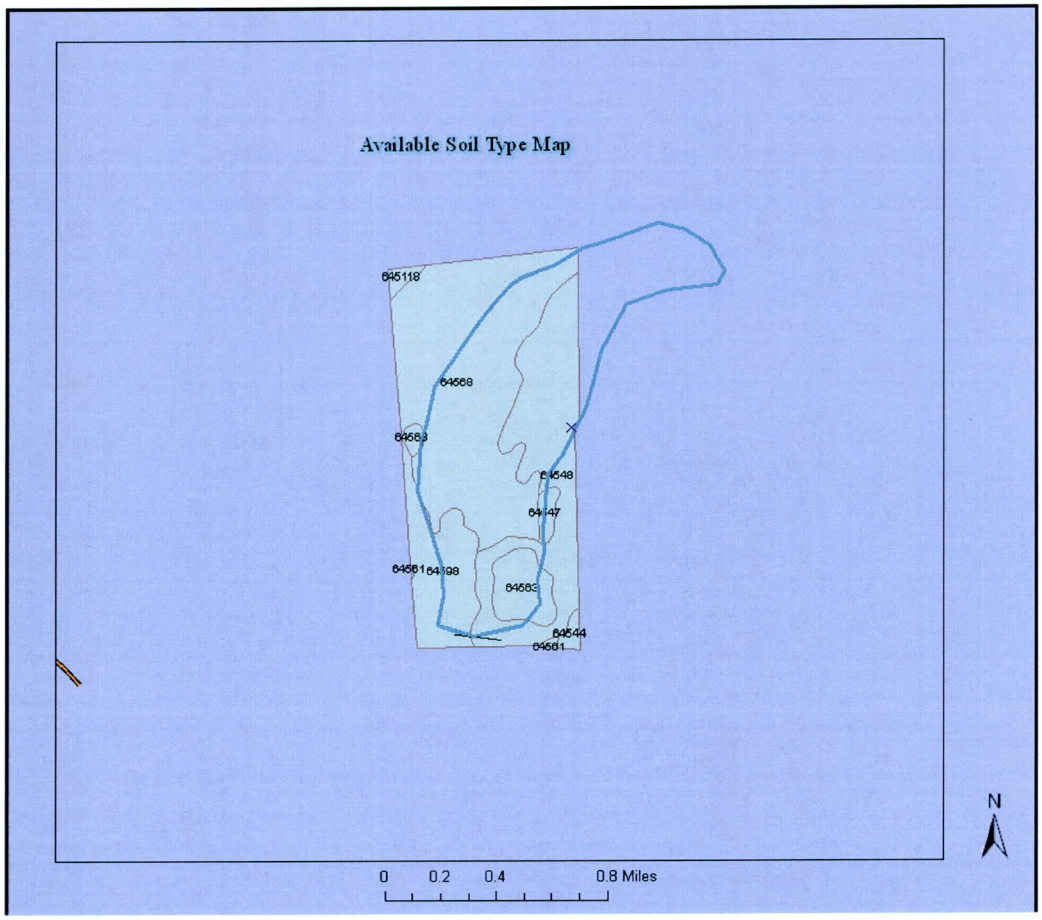


Figure 7. Extended Soil Type Map

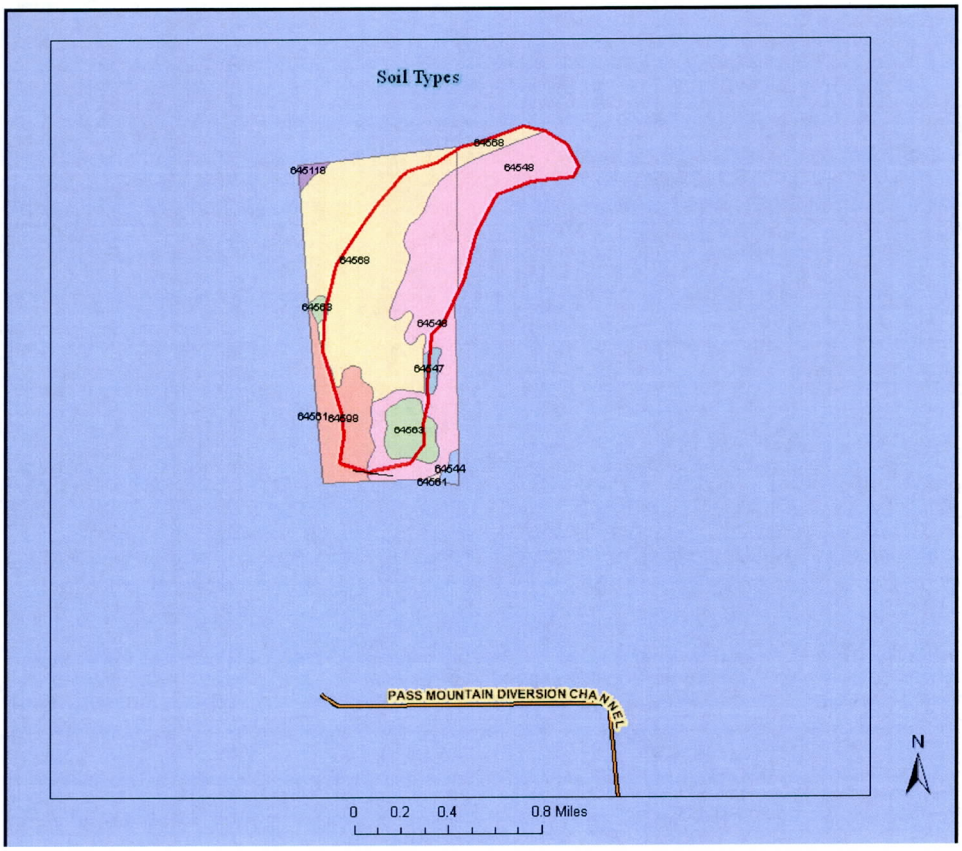
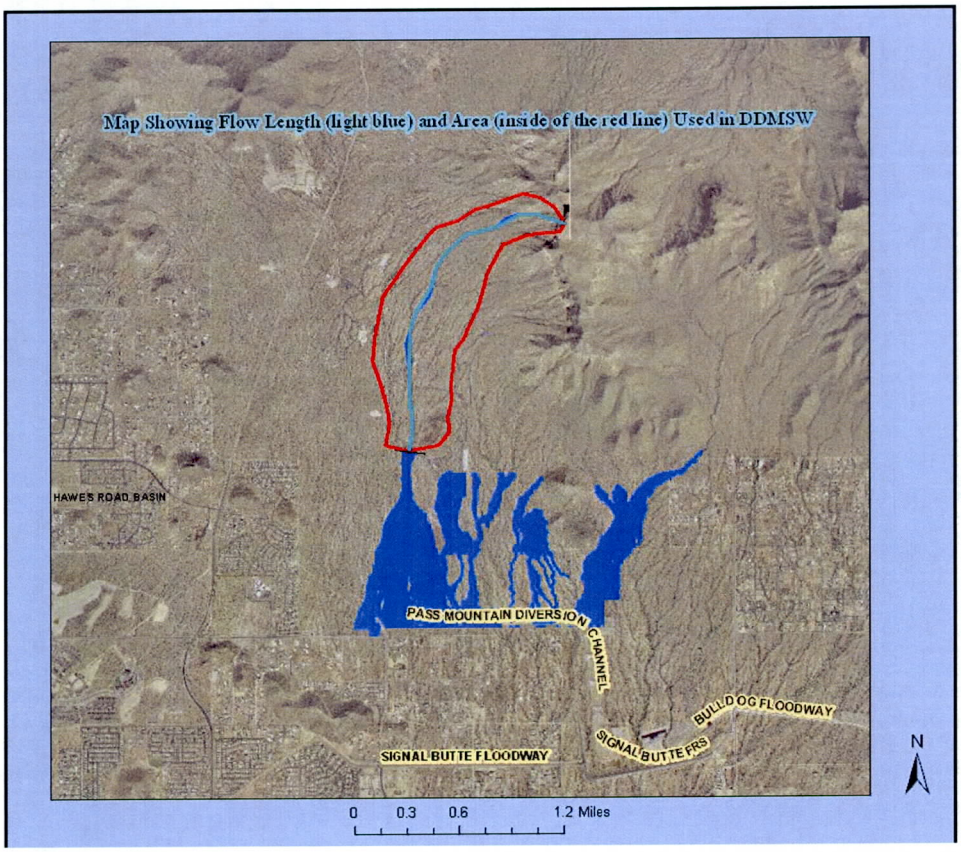


Figure 8. Time of Concentration Flow Length



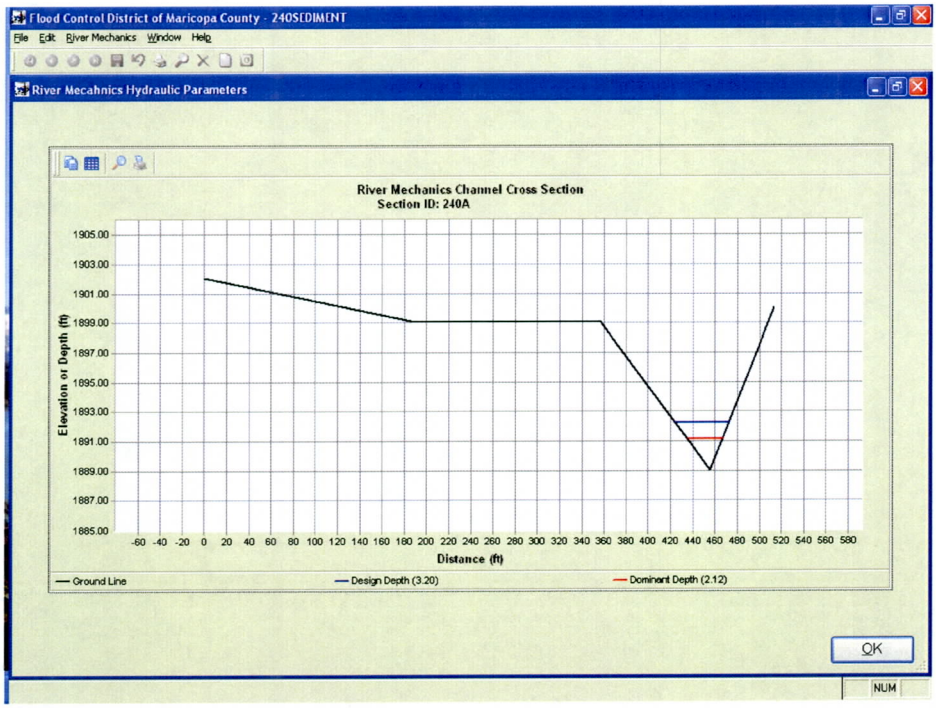
Sediment Yield

DDMSW 4.6.0 is used to calculate the sediment yield which includes wash load and total bed material load (FCDMC, 2010). The peak flows and runoff volumes from the hydrologic study are used. DDMSW 4.6.0 uses Modified Universal Soil Loss Equation (MUSLE) (SLA, 1985) to calculate the wash load and Zeller-Fullerton equation (Zeller and Fullerton, 1983) to calculate the total bed material load.

For the wash load calculation, the two topographic factors, slope length and slope are determined based on a Maricopa County-wide 10' contour map and aerial photos. They are determined via measuring the length of the line between the most distant boundary line of the drainage area 240a and a well-defined channel and taking the elevation difference between the two locations from the contour map.

For the total bed material load calculation, the wash cross section is selected right at the top of the distributary flow area. The cross section is obtained using ArcGIS 3D analysis tool and is based on a Maricopa County-wide 10' contour map shape file. The cross section is shown in Figure 9. The wash channel slope is determined via measuring distance between two contour lines selected near the top of the distributary flow area and via calculating the elevation difference of the two selected contour lines. Sediment size gradation input data, required for the bed material load calculation, are derived based on NRCS soil survey report issued April 1986 and titled "Soil Survey Aguila-Carefree Area, Parts of Maricopa and Pinal Counties, Arizona." According to this report (page 275), the top 1 to 43" of type 48 soil has 20-30% of its particles passing #200 sieve and 45-55%

Figure 9. Wash Cross Section for Bed Material Load Calculation



passing #4 sieve. Based on these soil gradation values, D50 of 4.76 mm and D16 of 0.074 mm are assumed. D84 is calculated as 1.3 times D50 assuming the soil is well graded (FCDMC, 2010).

The hydraulic parameters used for sediment yield calculation are shown in the Figure 10.

The calculated sediment yields for storms of selected return intervals are shown in Figure 11. The annual sediment supply to the distributary flow area is 0.138 ac-ft. The 100-year flood sediment supply to the area is 1.028 ac-ft.

As can be seen, the sediment amount is not significant and therefore can be easily handled through O&M plan as part of normal post-flood event maintenance. It should be mentioned that the sediment yield results are for the location about 1 mile north of the levee. The actual sediment that may reach the levee may be much less since the distributary flow area is a depositional area. However, the FCDMC will conservatively assume that this insignificant amount of sediment will reach the levee and the sediment will be handled through post-flood event maintenance as part of FCDMC's O&M plan.

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US Department of Agriculture Soil Conservation Services, April 1986, Soil Survey of Aguila-Carefree Area, Parts of Maricopa and Pinal Counties, Arizona.

Figure 10. Hydraulic Parameters for Sediment Claculation

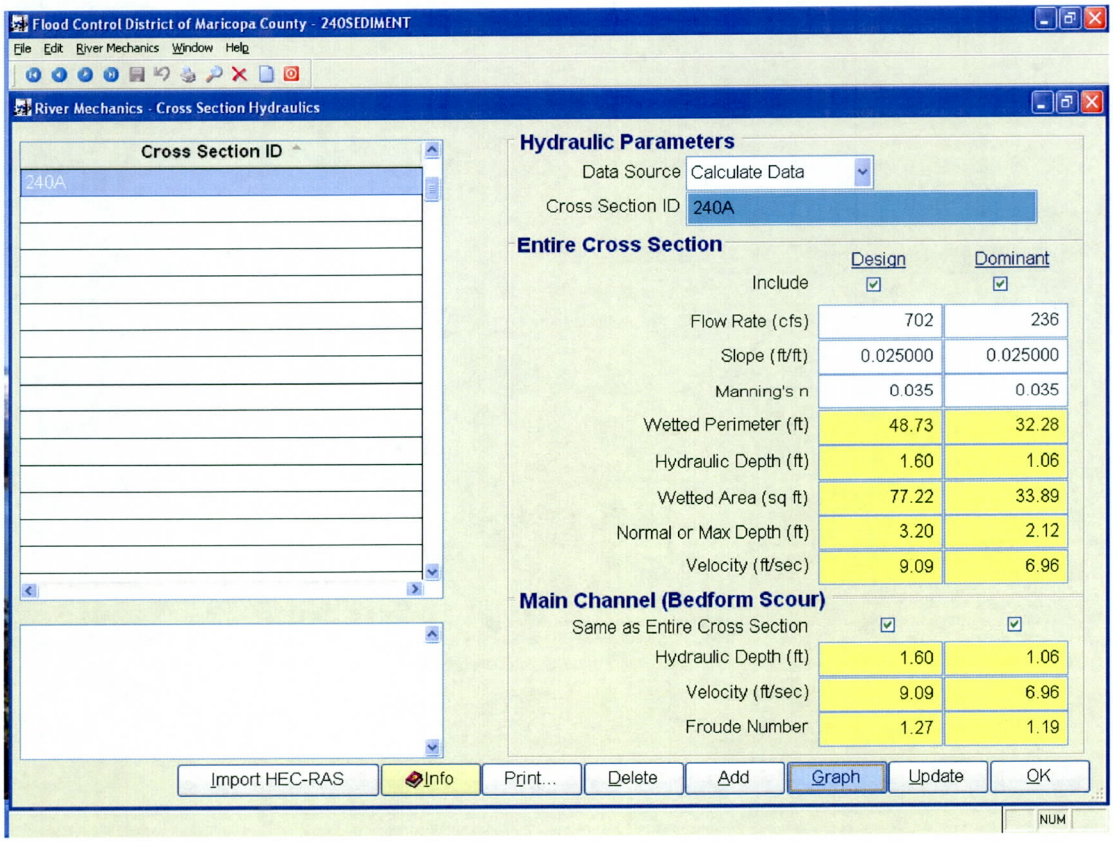

Figure 11. Calculated Sediment Yield