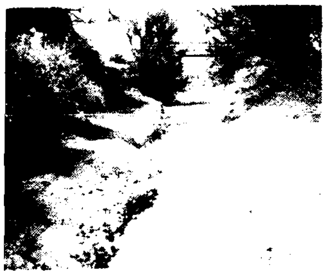
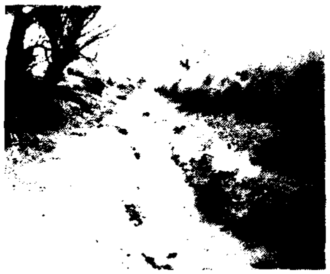
US Army Corps of Engineers





MISCELLANEOUS PAPER HL-91-1

RIO HONDO SEDIMENT ASSESSMENT ANALYSIS USING SAM

Numerical Model Investigation

by

Nolan K. Raphelt, Michael J. Trawle, William A. Thomas

Hydraulics Laboratory

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
3909 Halls Ferry Road, Vicksburg, Mississippi 39180-6199

May 1991

Final Report

Approved For Public Release; Distribution Unlimited

HYDRAULICS LABORATORY

Prepared for US Army Engineer District, Albuquerque
Albuquerque, New Mexico 87103-1580

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
May 1991

3. REPORT TYPE AND DATES COVERED
Final report

4. TITLE AND SUBTITLE
Rio Hondo Sediment Assessment Analysis Using SAM; Numerical Model Investigation

5. FUNDING NUMBERS

6. AUTHOR(S)
Nolan K. Raphelt
Michael J. Trawle
William A. Thomas

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
USAE Waterways Experiment Station, Hydraulics Laboratory, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199

8. PERFORMING ORGANIZATION REPORT NUMBER
Miscellaneous Paper HL-91-1

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
USAE District, Albuquerque, PO Box 1580, Albuquerque, NM 87103-1580

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

A sedimentation study of a local flood protection project on the Rio Hondo through Roswell, NM, was conducted. The investigation represented a sediment assessment level study conducted to test for potential sedimentation problems. Project features for the proposed project included channel grade control structures and a side-channel detention basin. The approach included the use of a sediment budget analysis to test for deposition of sand and gravel and a field reconnaissance to evaluate overall stability of the existing channel. The sediment assessment is suggested in EM 1110-2-4000 "Sedimentation Investigations of Rivers and Reservoirs," for use in early stages of project formulation such as the reconnaissance stage to help identify potential sediment problems. The assessment technique used in this study is a software package for a personal computer titled Hydraulic Design of Flood Control Channels, generally referred to as SAM. The SAM assessment indicated potential sedimentation problems, resulting in severe approach channel deposition for the sediment yield tested.

14. SUBJECT TERMS
Detention basin
Flood protection
SAM
Sediment assessment
Sediment yield
Sedimentation

15. NUMBER OF PAGES
34

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED		

PREFACE

The work described herein was conducted and this report was prepared at the US Army Engineer Waterways Experiment Station (WES) at the request of the US Army Engineer District, Albuquerque.

This investigation was conducted during the period January 1990–June 1990 in the Hydraulics Laboratory, WES, under the direction of Messrs. Frank A. Herrmann, Jr., Chief of the Hydraulics Laboratory; R. A. Sager, Assistant Chief of the Hydraulics Laboratory; and Marden B. Boyd, Chief of the Waterways Division, Hydraulics Laboratory. The project was conducted and the report prepared by Messrs. Nolan K. Raphelt, Michael J. Trawle, and William A. Thomas, Math Modeling Branch, Waterways Division.

Commander and Director of WES during preparation of this report was COL Larry B. Fulton, EN. Technical Director was Dr. Robert W. Whalin.

CONTENTS

CONVERSION FACTORS, NON-SI TO SI (METRIC) UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
acres	4,046.873	square metres
acre-feet	1,233.489	cubic metres
cubic feet	0.02831685	cubic metres
cubic yards	0.7645549	cubic metres
feet	0.3048	metres
miles (US statute)	1.609347	kilometres
pounds (mass) per cubic foot	16.01846	kilograms per cubic metre
square miles (US statute)	2.589998	square kilometres
tons (2,000 pounds, mass)	907.1847	kilograms

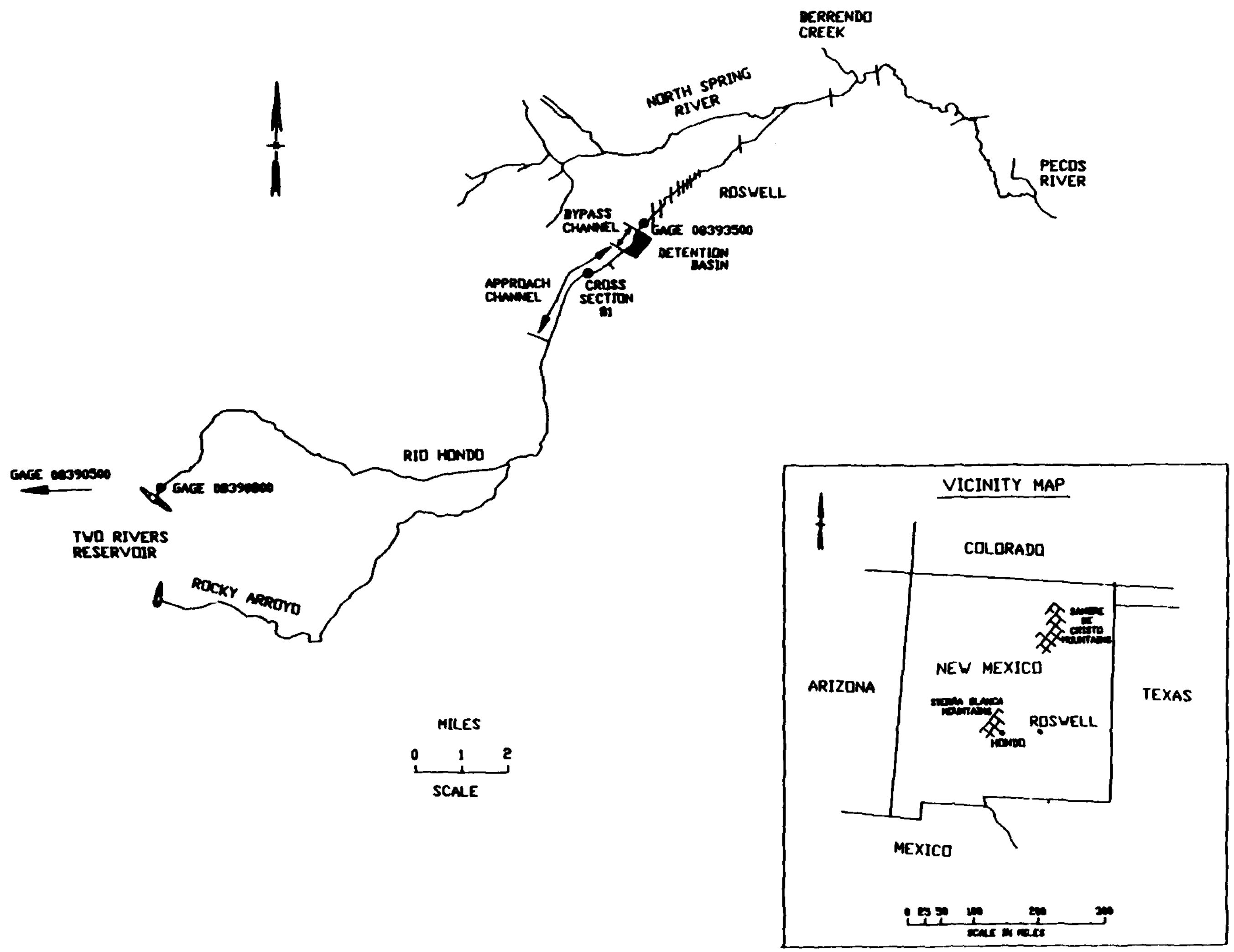


Figure 1. Location map (with project features)

RIO HONDO SEDIMENT ASSESSMENT

ANALYSIS USING SAM

Numerical Model Investigation

PART I: INTRODUCTION

Description of Project

1. Roswell, New Mexico, is located in the southwestern part of New Mexico in the Pecos River watershed (Figure 1). The source of the Pecos River basin is in the Sangre de Cristo Mountains about 395 miles* north of Roswell. The basin is long and narrow and comprises a drainage area of about 44,530 square miles. Tributary watersheds in the vicinity of Roswell include Rio Hondo, North Spring River, and Berrendo Creek. Elevations** vary from about 3440 ft at the confluence of the Rio Hondo with the Pecos River to about 12,000 ft in the upper Rio Hondo watershed.†

2. Rio Hondo is formed at the confluence of the Rio Ruidoso and Rio Bonito, near the village of Hondo in the foothills region of the Sierra Blanca Mountains. From this point it flows eastward for about 81 miles to its confluence with the Pecos River, 7 miles east of Roswell. The stream is perennial from its source to about the Lincoln-Chaves county line. From this point it is intermittent to the US Army Corps of Engineers Two Rivers Reservoir and intermittent from the dam to the mouth (Figure 1). The river has been controlled by Two Rivers Dam since 1963 but runoff originating below the dam still causes flooding problems. The channel capacity of the Rio Hondo still remains very small through Roswell. In most areas, flood damages will occur with any flood larger than about 2000 cfs (10-year flood). The size of the

---

* A table of factors for converting non-SI units of measurement to SI (metric) units is found on page 3.

** Elevations cited in this report are in feet referred to the National Geodetic Vertical Datum (NGVD).

† Resource Technology. 1990 (Jan). "Sedimentation Report, Two Rivers Reservoir, New Mexico," prepared for US Army Engineer District, Albuquerque, by Resource Technology, Albuquerque, NM.

Rio Hondo drainage area from below the Two Rivers Dam to its confluence with the North Spring River is 63 square miles.*

3. North Spring River has its source in the low hills about 6 miles west of Roswell (Figure 1). The drainage system is ill-defined in the upper reaches and consists of a group of broad, shallow draws which converge into a well-defined channel near the western edge of Roswell. From this point the stream continues eastward through the irrigated area west of Roswell to its confluence with the Rio Hondo. North Spring River has a drainage area of 28 square miles.*

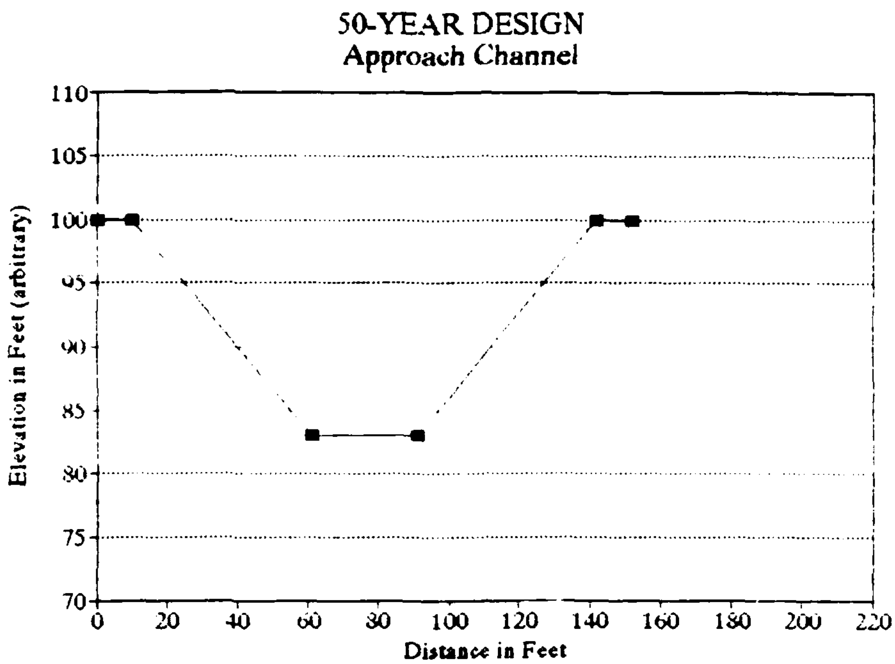
4. The Berrendo Creek watershed begins on the eastern slopes of the Capitan Mountains between Hondo and Arabela, New Mexico (Figure 1). From this point it flows eastward for about 56 miles to its confluence with the Rio Hondo about 3 miles east of Roswell. The size of the drainage area is 518 square miles. Berrendo Creek does not contribute to flooding in Roswell.*

5. The Corps of Engineers is formulating a local flood protection project for Roswell (Figure 1). The problem is that flow in the Rio Hondo just upstream of Roswell breaks out of the bank on the left side (looking downstream) and flows northeast into the North Spring River drainage basin. Flooding problems along the North Spring River are a result of Rio Hondo flow spilling into the North Spring River. If the larger flows from the Rio Hondo can be contained or at least controlled then flooding along North Spring River can be greatly reduced. The plan tested in this study provides for wing dikes on the Rio Hondo to keep water from spilling into the North Spring River drainage basin and a side-channel detention basin just above Roswell to attenuate peak flows so that no more than the existing channel capacity will enter the reach through town. The plan also requires an enlarged channel to carry the increased flows from the wing dikes to the detention basin, a distance of about 2 miles.

6. Two alternate project designs are being considered by the US Army Engineer District, Albuquerque (SWA), referred to in this report as the 50-year project and the 100-year project. These projects are essentially the same except for channel and detention basin dimensions. Channel cross sections for the 50-year and 100-year designs are shown in Figures 2 and 3,

---

* US Army Engineer District, Albuquerque. 1990. "Roswell Feasibility Report," Albuquerque, NM.



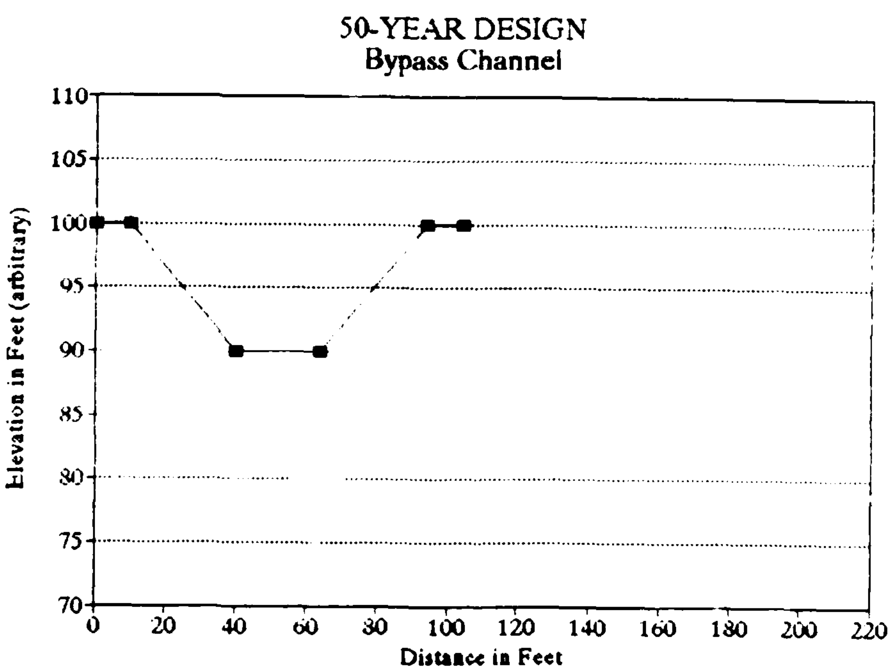
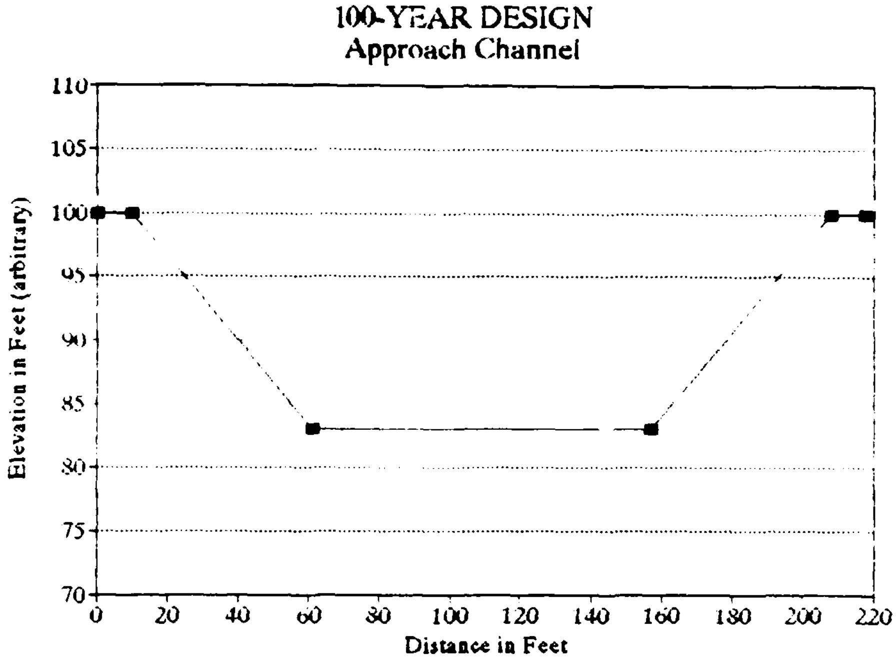


Figure 2. 50-year project approach and bypass channel cross sections



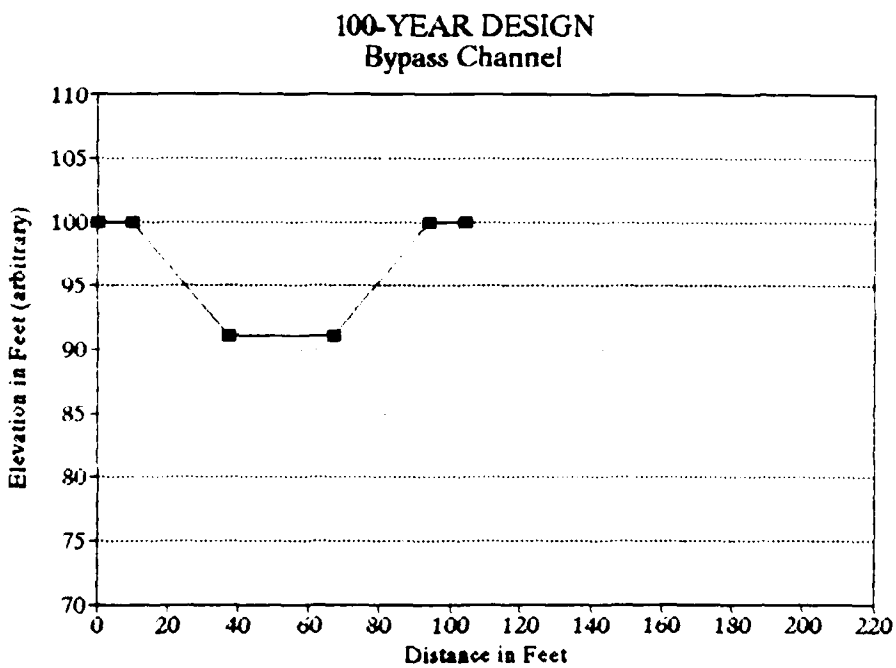


Figure 3. 100-year project approach and bypass channel cross sections

respectively. Both projects consist of earth-lined channels. Project feature dimensions for each is given in Table 1.

Table 1

Project Design Features

	50-Year Project	100-Year Project
Approach Channel		
Length	10,500 ft	10,500 ft
Depth	17 ft	17 ft
Bottom Width	40 ft	96 ft
Side Slopes	1 on 3	1 on 3
Bed Slope	0.00030	0.00025
Drop Structures	3	3
Q_{max}	5800 cfs	10000 cfs
V_{max}	5 fps	5 fps
Bypass Channel		
Length	3000 ft	3000 ft
Depth	10 ft	9 ft
Bottom Width	24 ft	30 ft
Side Slopes	1 on 3	1 on 3
Bed Slope	0.00045	0.00090
Drop Structures	1	1
Q_{max}	1250 cfs	1250 cfs
V_{max}	4 fps	5 fps
Detention Basin		
Plan Area	190 acres	290 acres
Volume	2100 acre-ft	3300 acre-ft

7. The purpose of this study is to provide the technical basis for informing the project sponsor on the long term stability of the approach channel and the bypass channel downstream from the side-channel detention basin diversion structure.

Scope and Purpose

8. This effort represents a "sediment assessment" level study conducted to test for potential sedimentation problems. It uses a sediment budget analysis to test for deposition of sand and gravel and, in this case, a field reconnaissance to evaluate the overall channel stability of the existing project. The sediment impact assessment is suggested in Engineer Manual

(EM) 1110-2-4000* for use in early stages of project formulation such as the reconnaissance stage to help identify potential sediment problems. The assessment technique has been packaged in a PC code titled Hydraulic Design of Flood Control Channels, generally referred to as SAM.

* US Army Corps of Engineers. 1989 (15 Dec). "Sedimentation Investigations of Rivers and Reservoirs," EM 1110-2-4000, US Government Printing Office, Washington, DC.

PART II: INVENTORY OF PROTOTYPE DATA

Stream Gage Records

9. There are three USGS gaging stations on the Rio Hondo in the vicinity of Roswell. Station 08393500 on the Rio Hondo in Roswell has daily discharge data for the water years 1981 to 1988 only. This station is located on the reach just below the proposed detention basin (Figure 1). Station 08390500 is located on the Rio Hondo above the Two Rivers Reservoir and provides daily discharge data for the years 1940 through 1988 (Figure 1). Station 08390800 is located on the Rio Hondo below the Two Rivers Reservoir and has daily discharge data for the years 1964 through 1988 (Figure 1).

Hydraulic Data

10. Stage data are provided at USGS gage 08393500, located on the channel reach just below the proposed detention basin, for the years 1981 through 1985 only.

Suspended Sediment Data

11. Suspended sediment data in the form of suspended sediment concentrations (mg/l) and suspended sediment load (tons/day) are available at USGS gage 08390500, located above the Two Rivers Reservoir, for the years 1956 to 1962 only. No suspended sediment data are available below the reservoir. The US Geological Survey's map of conterminous United States showing sediment concentrations of rivers indicates average concentrations of 5000 to 15000 mg/l for the region.*

Bed Gradation Data

12. In April 1990 City of Roswell personnel collected a sediment sample from the channel bed at each of 12 locations along the project reach. One

---

* F. H. Rainwater. 1962. "Stream Composition of the Conterminous United States," Hydrologic Investigations Atlas HA-61, US Geological Survey, Washington, DC.

additional sample was collected in the Rio Hondo channel below Roswell. The samples were collected in depositional zones along the reach. The samples were sieved separately, and the resulting gradations plotted in Plates 1-4.

PART III: SITE RECONNAISSANCE

13. On the afternoon of 21 March 1990, Pete Doles, SWA, and Mike Trawle, US Army Engineer Waterways Experiment Station, visited the study reach of the Rio Hondo, as well as the Two Rivers Reservoir, about 20 miles upstream and the City of Roswell reach downstream of the study reach.

City of Roswell Reach

14. The channel through Roswell, downstream of the study reach, appeared extremely stable with no evidence of significant bed aggradation or degradation, bank erosion, or meandering tendencies (Figures 4 and 5). The channel bed overall was well armored by gravel and cobbles. The channel did seem to be sensitive to flow obstructions from a localized depositional standpoint. Wherever an obstruction existed, significant local sand deposits occurred just upstream. Overall the banks appeared extremely stable, mostly exhibiting a cemented nature with a extremely stable appearance.

Channel Reach Downstream from Detention Basin

15. The USGS gage 08393500 station is located just downstream from the detention basin reach. The station includes a concrete sill on the channel bottom (Figure 6). Upstream from the sill, a sand deposit extending several hundred feet was observed (Figure 7). Downstream from the sill for about 50 ft, localized bed and bank scour was noted (Figure 6). This was the only location along the study reach where any significant scour was observed.

Detention Basin Reach

16. The channel width along this reach was only 6 to 10 ft and appeared to be very stable, with little evidence of any significant bank erosion (Figure 8). The bed was generally well armored with gravel and cobbles and appeared stable (Figure 8). At one spot some trash had been dumped into the channel (a water heater, an old stuffed chair, and a few smaller items). Downstream from this trash a center sand bar had developed with a maximum

Figure 4. Rio Hondo channel in Roswell downstream of study reach (looking downstream)

Figure 5. Rio Hondo channel in Roswell downstream of study reach (looking upstream)

Figure [illegible]. El Burro channel at [illegible]
looking downstream

Figure [illegible]. El Burro channel [illegible]
[illegible]

thickness of about one foot (Figure 9). Also, upstream of the water heater, a sand deposit was observed (Figure 10).

Bridge Upstream of Detention Basin Reach

17. The Brasker Road bridge is about 1.6 miles above the detention basin reach, about a thousand feet below the point where the proposed wing dikes meet the channel (Figure 11). A barbed-wire fence crossed the channel just upstream of the bridge. The debris trapped by the fence created an obstruction to flow, resulting in a sand deposit extending several hundred feet upstream of the fence (Figure 12). Upstream of the sand deposit, the channel was again well armored and both banks and bed appeared very stable (Figure 13). As part of the original flood control project built in the mid sixties (Two Rivers Reservoir), this reach of the Rio Hondo had been straightened for a distance of several miles. The channel is still straight with little evidence of any meandering tendency or bed movement (Figure 13).

Two Rivers Reservoir

18. The Two Rivers Reservoir is located approximately twenty miles upstream of the project reach. The reservoir actually has two separate dams, the Rio Hondo Dam and The Rocky Arroyo Dam. The purpose of the Two Rivers Reservoir Project is to provide flood protection to the City of Roswell from floods originating in the Rio Hondo Basin. The reservoir was dry during the reconnaissance visit, which is representative of most of the year. A gaging station is located just downstream of the Rio Hondo Dam, including a concrete sill across the channel bottom. A deposit of sand extending upstream of the sill was noted. Overall the channel in this area was very rugged looking, with limited degradation and bank erosion occurring with boulders and cobbles in abundance.

Figure 10. Rio Hondo channel in vicinity of detention basin reach (looking upstream)

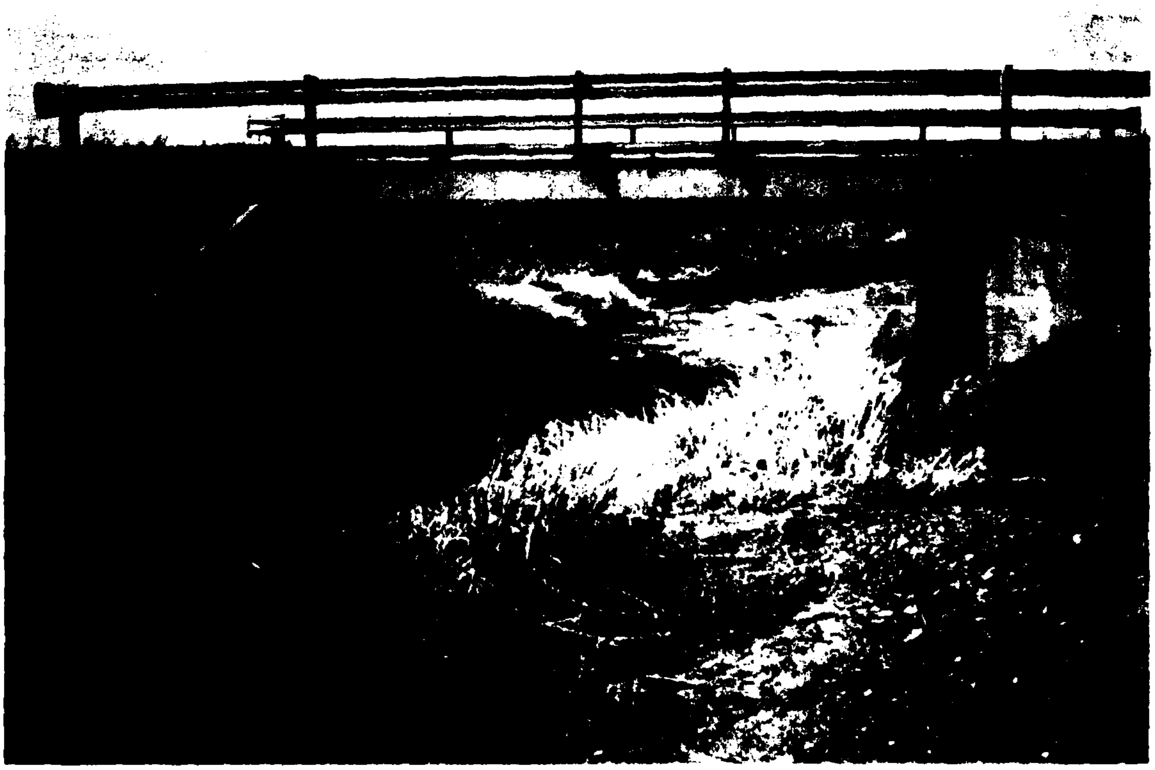


Figure 11. Rio Hondo channel at Brasher Road Bridge (looking downstream)

PART IV: SAM ASSESSMENT

Methodology

19. The potential for sedimentation is estimated by using a sediment budget analysis for the sand and gravel sized sediments. In the general case the sediment budget approach is a comparison between the annual sediment yield from the existing channel and the annual sediment yield from the project channel. In this case annual sediment yield data were not available. The unavailability of data required that sediment transport be calculated using appropriate transport theory, with the resulting sediment discharge rating curve plotted for both the existing and project conditions. These rating curves are then integrated with a representative flow-duration curve to obtain annual sediment yields. The difference in sediment yields between existing and project conditions is then used to calculate channel trap efficiency, which represents the project's ability to transport the historical sediment load. This procedure for calculating annual load is generally referred to as the Flow-Duration Sediment-Discharge Rating Curve Method (EM 1110-2-4000).*

Data Requirements

Geometric data

20. The existing channel geometry was acquired from HEC-2 data files furnished by SWA. Project channel dimensions were provided by SWA.

Sediment data

21. Suspended sediment concentration data within the study reach were not available. Bed sediment gradation data as discussed in paragraph 12 were supplied by SWA. Based on an analysis of the data, a D_{50} grain size of about 8 mm was selected as representative for the study reach.

Flow-duration data

22. Flow-duration data for the Rio Hondo basin below Two Rivers Dam were not available. To conduct this assessment, SWA provided an "equivalent basin" flow-duration curve. The flow-duration curve from the Gallinas Creek gage near Montezuma, New Mexico (USGS station number 08380500) was selected by

---

* Op. cit.

SWA as representative for this study. Daily discharge data are available at the Gallinas Creek gage from 1927 and the drainage area is 84 square miles. The flow-duration data for the Gallinas Creek are given in Table 2.

Table 2

Annual Flow Duration, Gallinas Creek

Percent of Time Q is Equaled or Exceeded	Q cfs
0.01	760.0
0.04	590.0
0.10	460.0
0.25	350.0
0.44	270.0
0.75	210.0
1.30	160.0
1.81	130.0
3.12	97.0
4.82	75.0
6.76	58.0
9.45	45.0
12.68	35.0
16.43	27.0
21.40	21.0
26.81	16.0
33.91	12.0
39.56	9.6
48.51	7.4
59.15	5.7
70.91	4.4
82.27	3.4
90.42	2.6
95.10	2.0
97.09	1.6
98.33	1.2
99.03	0.9
99.32	0.7
99.55	0.6
99.77	0.4
99.86	0.3

Channel hydraulic data

23. No measured velocities in the study reach were available.

Sediment transport function

24. The sediment yield was calculated using the Yang D_{50} function for bed material transport. The SAM procedure indicated that the Yang D_{50} approach was appropriate, which agreed with the findings presented by Brownlie.*

Calculated sediment inflow to study reach

25. The HEC-2 cross section 81 was used to calculate the existing sediment inflow to the project (Figure 14). This section was selected as

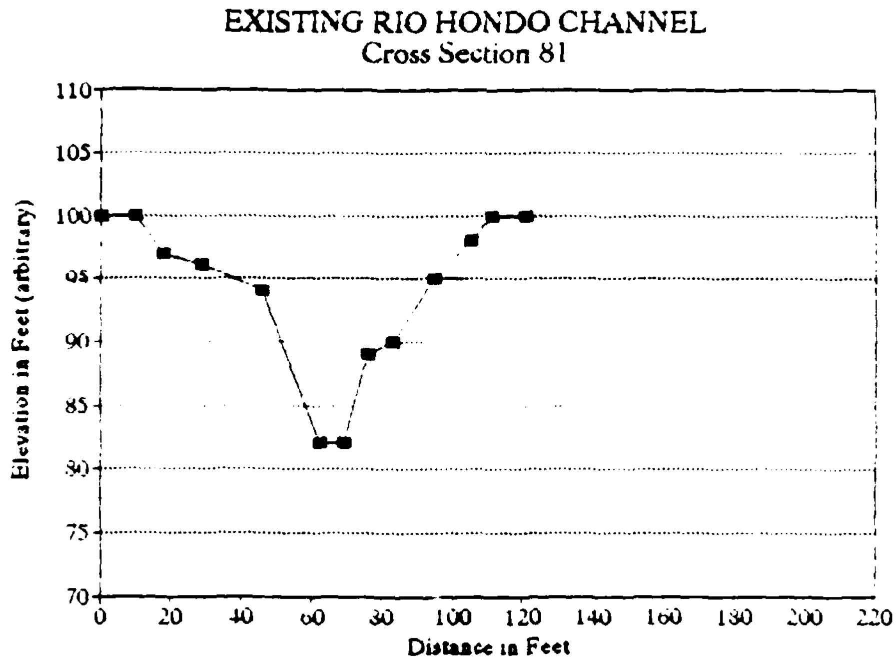


Figure 14. Existing Rio Hondo channel at cross section 81

representative with respect to geometry and hydraulic performance. Water velocity, depth, width, and slope were calculated using SAM. Channel roughness was calculated using the Strickler bed roughness predictor. An evaluation of this section indicated that the Yang transport function was satisfactory for describing the equilibrium condition in the system. The resulting

* William R. Brownlie. 1983 (Jul). "Flow Depth in Sand-Bed Channels," Journal of Hydraulic Engineering, American Society of Civil Engineers, Vol 109, No. 7, pp 959-990.

inflowing sediment discharge rating curve is given in Table 3.

Table 3

Existing Channel Sediment Discharge Rating Curve

Q cfs	Normal Depth ft	Top Width ft	N value	Velocity fps	Sediment Transport tons/day
50	1.3	10.0	0.027	4.4	80
100	1.9	12.0	0.028	5.5	180
500	4.5	18.0	0.029	8.8	650
750	5.6	20.0	0.029	9.8	880
1000	6.4	22.0	0.029	10.6	1060
2000	8.9	35.0	0.030	12.2	1700
3000	10.5	41.0	0.030	13.3	2300
6000	13.7	65.0	0.030	15.4	3700
8000	15.2	84.0	0.030	16.1	4620
10000	16.3	94.0	0.030	16.7	5520

Integrating the flow-duration curve (Gallinas Creek) with the sediment discharge rating curve resulted in an annual sediment yield for the existing approach channel of about 9000 cubic yards.

Calculated sedimentation in the approach channel

26. 50-year project. The SAM assessment estimated trap efficiency for the approach channel to be 100 percent for the sediment tested. This is due to both the slope reduction resulting from the drop structures and the significantly enlarged cross-sectional area. The sediment discharge rating curve is given in Table 4. Integrating the flow-duration curve (Gallinas Creek) with the sediment discharge rating curve resulted in an annual sediment yield of 0 cubic yards.

27. 100-year project. The SAM assessment estimated trap efficiency for the approach channel to be 100 percent for the sediment tested. Again, this is due to both the bottom slope reduction resulting from the drop structures and the significantly enlarged cross-sectional area.

Calculated sedimentation in the bypass channel

28. 50-year project. Since the approach channel trapped all inflowing sediment, bypass channel deposition rates will necessarily be low. Also, the

Table 4

Approach Channel Sediment Discharge Rating Curve

50-Year Project

Q cfs	Normal Depth ft	Top Width ft	N value	Velocity fps	Sediment Transport tons/day
50	1.1	47.0	0.027	1.0	0.0
100	1.7	50.0	0.027	1.3	0.0
500	4.2	65.0	0.027	2.3	0.0
750	5.2	71.0	0.027	2.6	2.0
1000	6.0	76.0	0.028	2.9	8.0
2000	8.7	92.0	0.028	3.5	43.0
3000	10.6	104.0	0.028	3.9	84.0
6000	14.9	129.0	0.028	4.8	214.0
8000	17.2	142.0	0.028	5.1	290.0
10000	18.9	142.0	0.028	5.5	372.0

reduced bed slope and enlarged cross-sectional area should eliminate any significant bed degradation trend.

29. 100-year project. Again, the 100-percent trap efficiency of the approach channel means that the bypass channel will not have depositional problems.

Calculated sedimentation in the detention basin

30. For both the 50-year and 100-year project designs, the 100 percent trap efficiency of the approach channel means that the detention basin should not accumulate any significant amount of sediment.

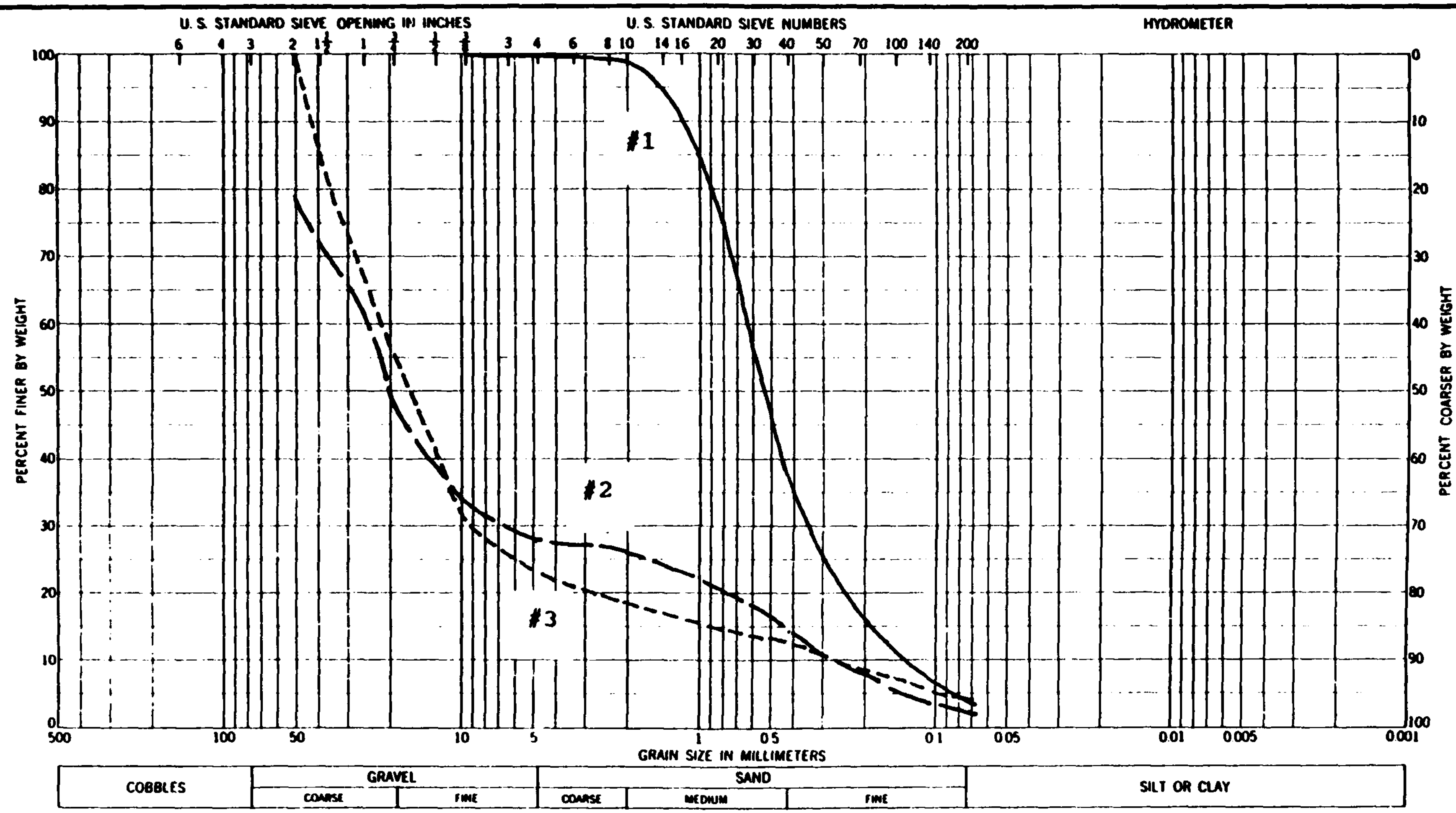
PART V: SUMMARY AND RECOMMENDATIONS

31. The SAM assessment indicates potential sedimentation problems for both the 50-year and 100-year projects. Both project designs result in trap efficiencies of 100 percent for the sediment tested.

32. The magnitude of the problem will depend on the inflowing sediment yield. If the calculated sediment yield using SAM is representative, then the deposition in the approach channel will be a tremendous problem, requiring extensive maintenance to maintain the project. Even if the inflowing sediment yield is much less than that estimated, the project will still require periodic removal of sediment from the approach channel to maintain conveyance.

33. It is recommended that project modifications to achieve a more stable project from a sedimentation standpoint be considered and that a more detailed sedimentation analysis using HEC-6 be considered.

34. After preliminary evaluation of results presented in this report, the SWA requested an assessment of an "existing slope" alternative. The purpose of this project alternative was to reduce sedimentation problems. Sediment assessment results for the existing slope alternative are discussed in Appendix A of this report.



Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
#1	Between CS 85 and 86					
#2	Between CS 85 and 86					
#3	Between CS 83 and 84					

Project Rio Hondo

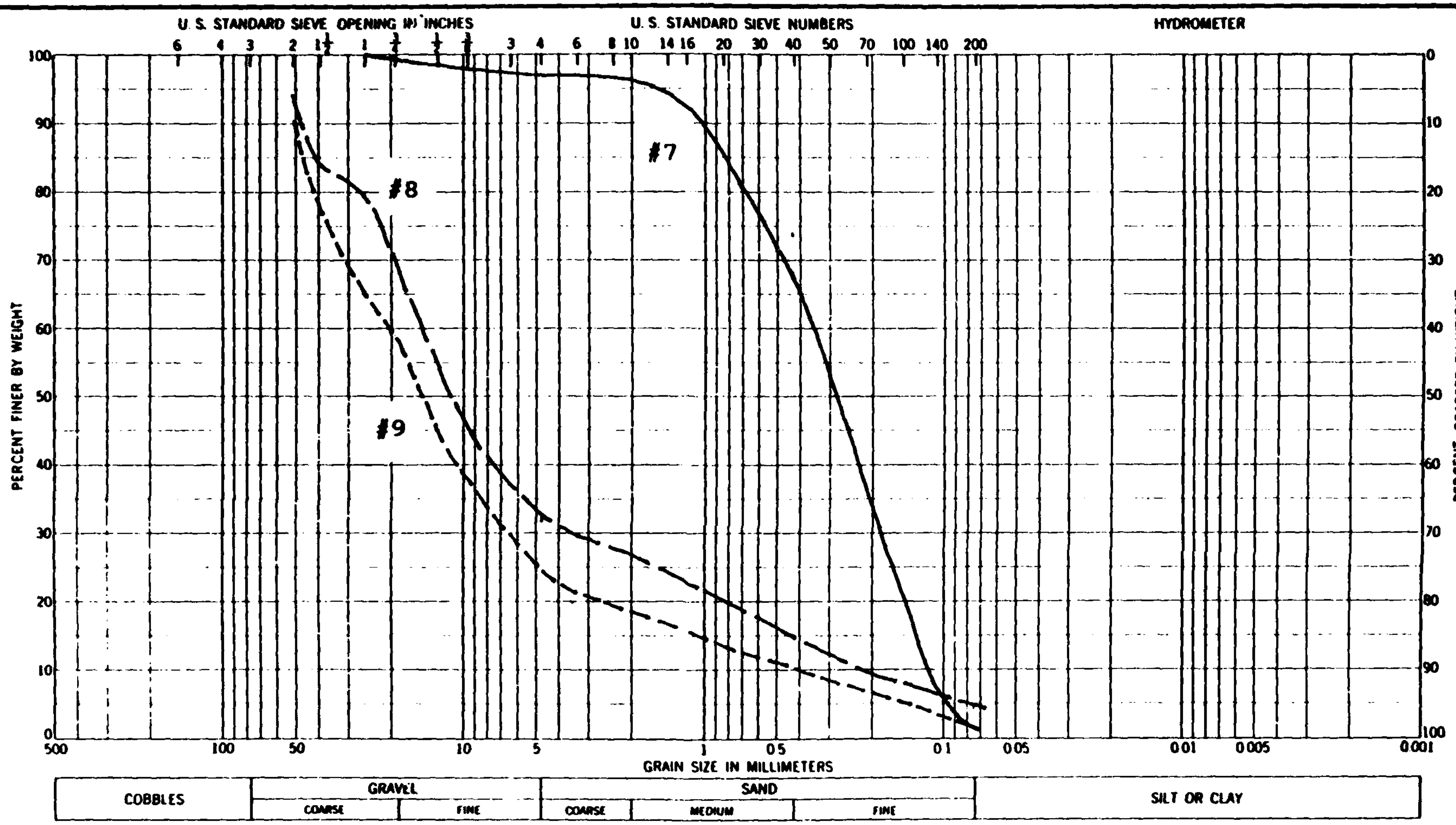
Area

Boring No

Date May 1990

GRADATION CURVES

ENG FORM 1 MAY 63 2087



Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
#7	Between CS 78 and 79					
#8	Between CS 77 and 78					
#9	Between CS 76 and 77					

Project: Rio Hondo

Area:

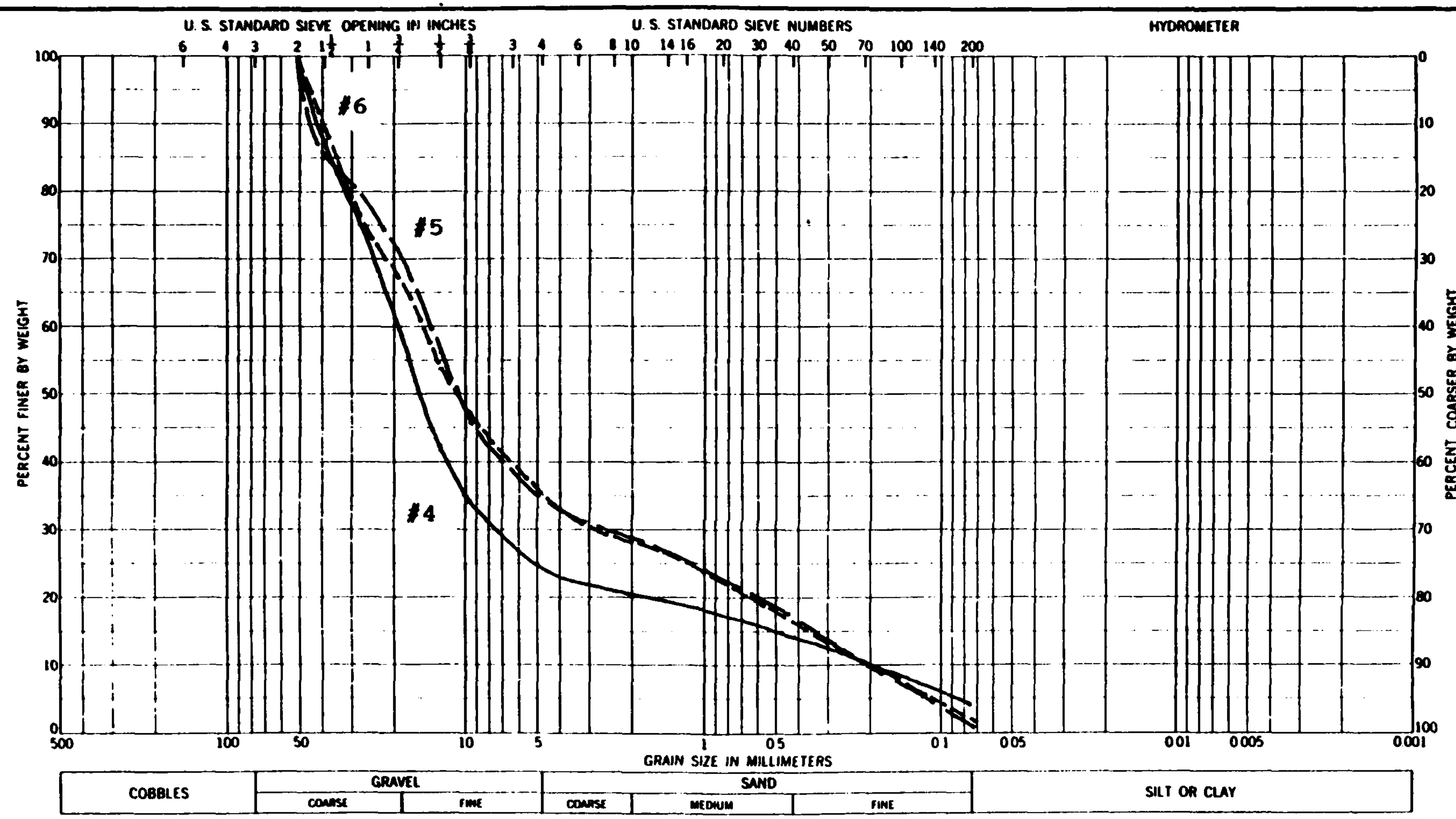
Boring No:

Date: May 1990

GRADATION CURVES

ENG FORM 1 MAY 63 2087

PLATE 2



Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
#4	Between CS 82 and 83					
#5	Between CS 80 and 81					
#6	Between CS 78 and 79					

Project Rio Hondo

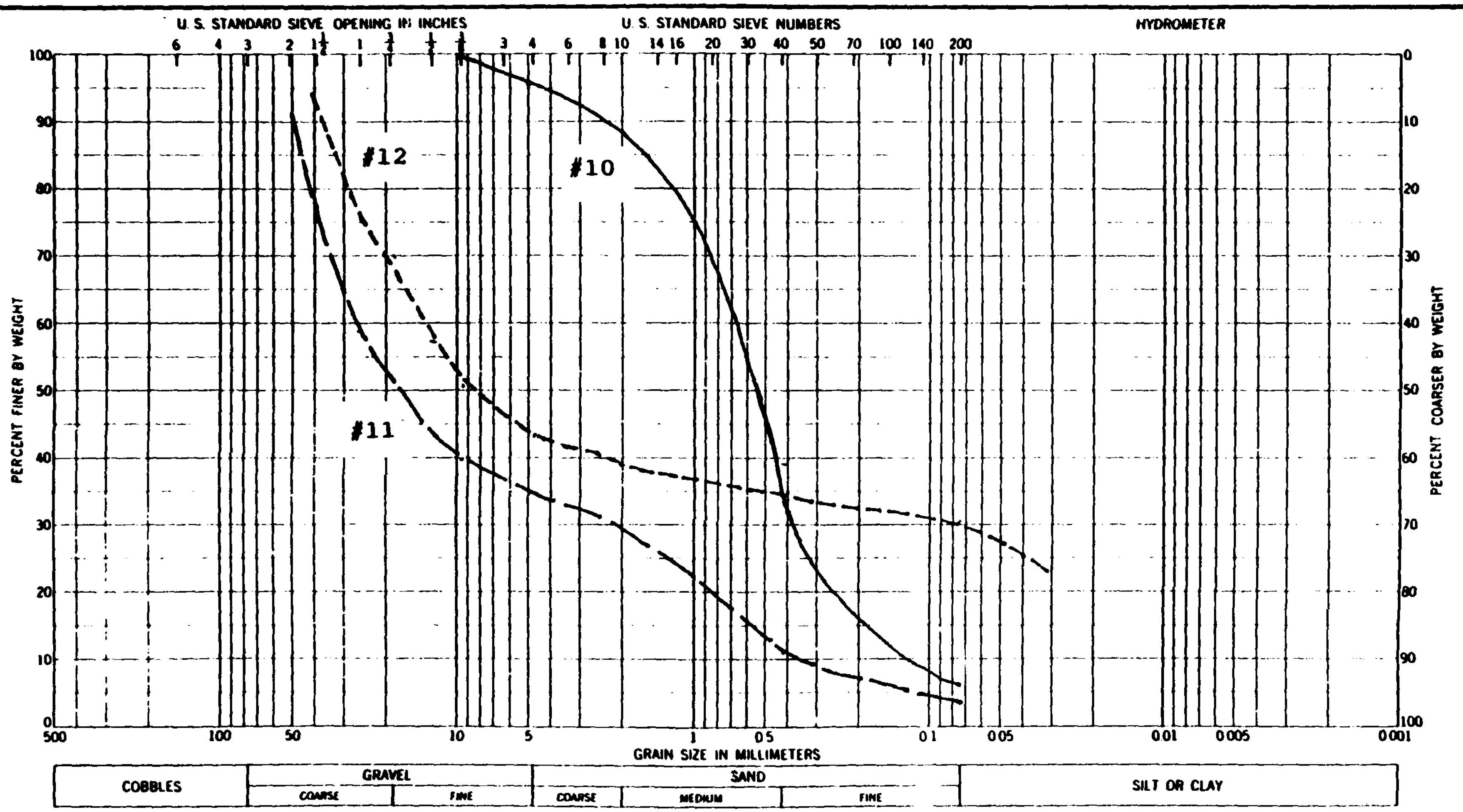
Area

Boring No.

Date May 1990

GRADATION CURVES

ENG FORM (MAY 63) 2087



Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
#10	Twin Dams outlet channel					
#11	Twin Dams inlet structure					
#12	East of Roswell river bottom					

Project Rio Hondo

Area

Boring No

Date May 1990

GRADATION CURVES

ENG FORM 1 MAY 63 2087

PLATE 4

APPENDIX A: EXISTING SLOPE DESIGN

1. The US Army Engineer Waterways Experiment Station (WES) was requested by Mrs. Olga Boberg of the US Army Engineer District, Albuquerque (SWA), to conduct a sediment assessment for the proposed Rio Hondo Flood Control Project using an "existing slope" conceptual design.

Channel Dimensions

2. The approach channel selected for assessment was a compound channel with dimensions as shown in Figure A1. The bypass channel dimensions, a simple trapezoidal channel, are also shown in Figure A1. For both channels, the slope specified as the existing slope was 0.0036.

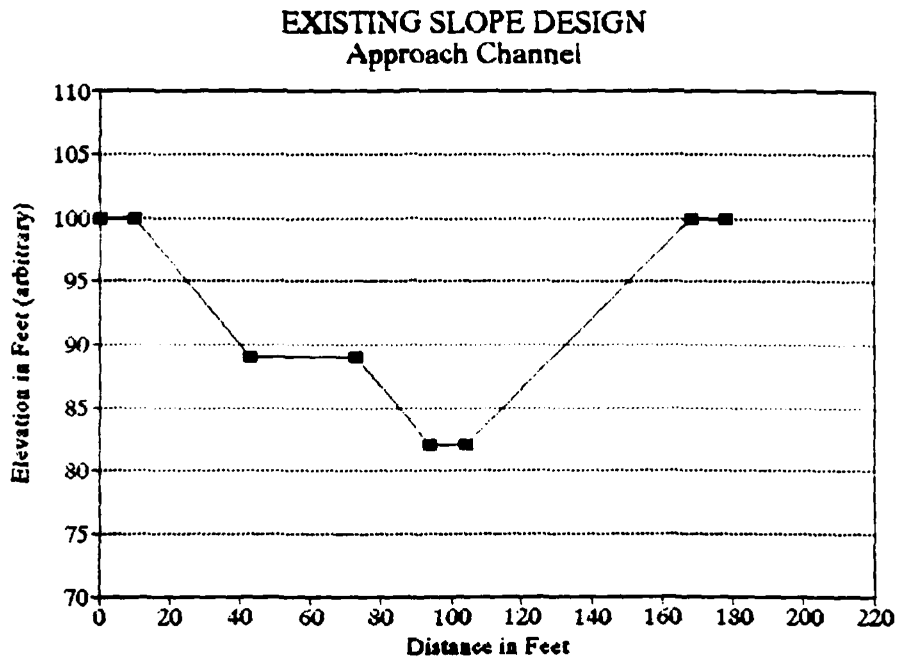
Channel Hydraulics

3. The approach and bypass channel hydraulics calculated using the PC code titled Hydraulic Design of Flood Control Channels, generally referred to as SAM, are given in Table A1.

Table A1

"Existing Slope" Channel Hydraulics

Q cfs	Normal Depth ft	Top Width ft	N value	Velocity fps
		Approach Channel		
50	1.1	17	0.027	3.3
100	1.6	20	0.028	4.1
500	3.7	32	0.028	6.5
1000	5.1	41	0.028	7.7
2000	7.0	82	0.028	9.2
3000	8.1	89	0.029	9.5
6000	10.5	103	0.029	11.2
10000	12.7	116	0.028	12.8
		Bypass Channel		
50	1.1	17	0.027	3.3
100	1.6	20	0.028	4.1
500	3.7	32	0.028	6.5
1000	5.1	41	0.028	7.7
1250	5.7	44	0.028	8.2



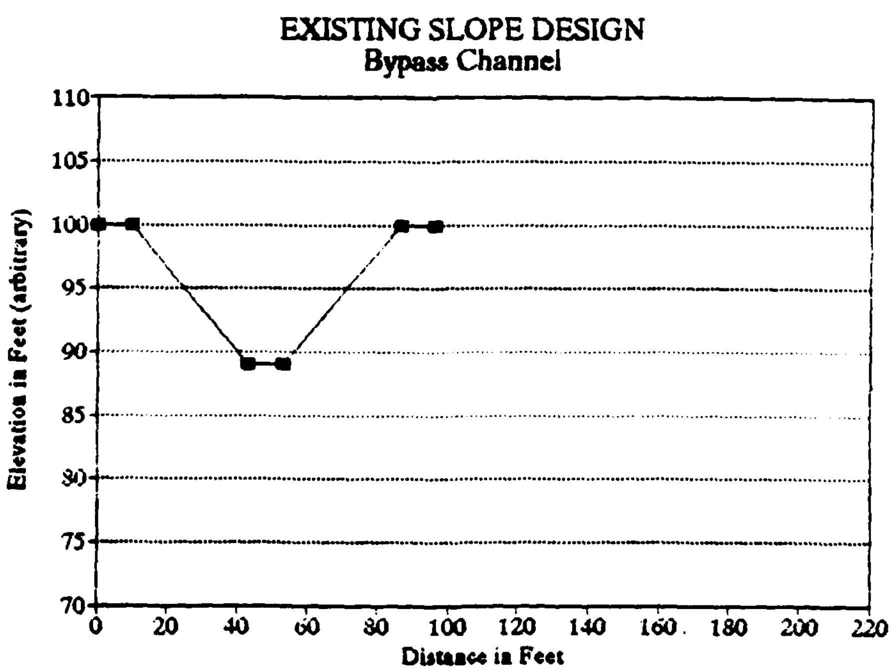


Figure A1. Existing-slope project approach and bypass channel cross sections

Sediment Yield Calculations

4. Sediment yield was calculated by SAM using the Yang D_{50} transport function for bed material transport. The D_{50} size used in the analysis was approximately 8 mm.

5. The resulting approach channel inflowing sediment discharges, calculated by SAM, for the existing and plan conditions are given in Table A2.

Table A2

Approach Channel Sediment Discharge Ratings

Q cfs	Existing Sediment Transport tons/day	Plan Sediment Transport tons/day
50	43	30
100	101	94
500	416	533
750	563	745
1000	691	944
2000	1119	1657
3000	1547	2302
6000	2561	4044
8000	3168	4977
10000	3827	5784

6. By integrating the above sediment discharge ratings with the flow duration curve, an annual sediment yield can be calculated. Since a flow duration curve for the Rio Hondo was not available, the SWA supplied, equivalent-basin curve was used. The equivalent basin curve (Gallinas Creek) was also modified by WES to include consideration of flows exceeding 1000 cfs. The resulting flow-duration relationship is given in Table A3.

7. After integrating the flow-duration and sediment discharge rating curves, the annual sediment yield for the existing and plan approach channels are 5359 and 5474 tons, respectively. These results indicate that the plan approach channel would not be depositional.

8. The bypass channel annual sediment yield was calculated to be 3919 tons. If one uses the approach channel sediment yield (5474 tons) as the inflowing load, the difference of 1525 tons annually can be considered as bypass channel deposition. Assuming a density of 95 pcf, this represents a volume deposition of 1190 cubic yards deposition annually. The quantity can

Table A3

Flow-Duration Relationship

Used for Approach Channel

Q cfs	Percent of Time Exceeded
0.2	100.0
9.5	40.0
17.0	25.0
30.0	15.0
44.0	10.0
75.0	5.0
97.0	3.0
185.0	1.0
260.0	0.5
330.0	0.3
460.0	0.1
570.0	0.05
760.0	0.01
1000.0	0.008
2000.0	0.005
3000.0	0.001
6000.0	0.0005
8000.0	0.0003
10000.0	0.0002

be reduced or eliminated by reducing the bypass channel width slightly.

Detention Basin Sedimentation Calculations

9. By assuming a weir overflow concentration of suspended sediment for water entering the detention basin and applying the flow duration relationship, the mass of sediment entering the basin annually can be estimated. Since the field data needed to determine representative suspended sediment concentrations are not available, an assumption on concentration was necessary.

10. Based on the evaluation of limited suspended sediment data collected on the Rio Hondo at Diamond A Ranch near Roswell during the period 1956 to 1961 (USGS gage 08390500), it was estimated that a reasonable concentration during high flow is about 8000 mg/l, which includes wash load.

11. Furthermore, this analysis assumed a constant concentration over the range of flows entering the basin. The analysis was accomplished using

overflow suspended sediment concentrations of 400 mg/l and 8000 mg/l. The 8000 mg/l concentration is considered to be the worst case scenario because it assumes a uniform concentration over depth at the detention basin weir, resulting in a weir concentration of 8000 mg/l. The 400 mg/l concentration is considered to the best case scenario because, even though the average concentration is still 8000 mg/l, it assumes the near surface concentration is only 400 mg/l. Actual weir concentrations will most likely be somewhere in between. To convert mass to volume, it was assumed that the density of deposited material was 95 lbs per cubic foot.

12. Integrating the flow duration relationship with the estimated concentration of 400 mg/l and 8000 mg/l for flow exceeding 1250 cfs results in an annual sediment load to the detention basin of about 70 and 1400 cubic yards, respectively.

13. The technique was also applied to the 10-, 50-, and 100-year floods, resulting in the sediment loads to the basin of approximately 20, 750, and 1600 cubic yards, respectively, for the 400 mg/l inflow concentration and 400, 15000, and 32000 cubic yards, respectively for the 8000 mg/l inflow concentration.

Summary

14. The "existing slope design" analysis indicated that such a design can significantly reduce or eliminate depositional problems in the approach channel. However, consideration must be given to the potentially erosive velocities which would occur during high flow events.

15. The detention basin sediment budget analysis indicated that sediment deposition in the detention basin should be within acceptable limits. However, it must be emphasized that the analysis was made using assumptions concerning suspended sediment concentrations. An effort should be made to better determine representative concentrations to be expected.