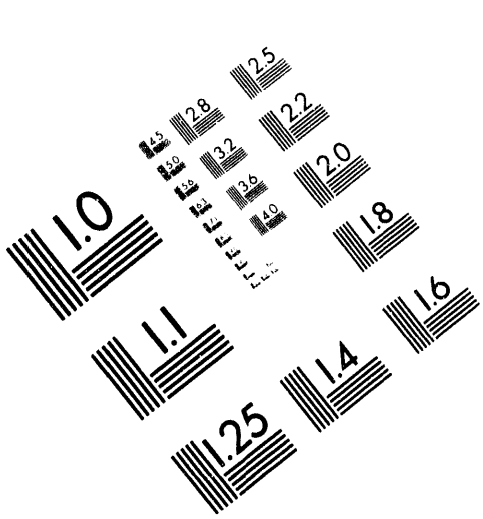

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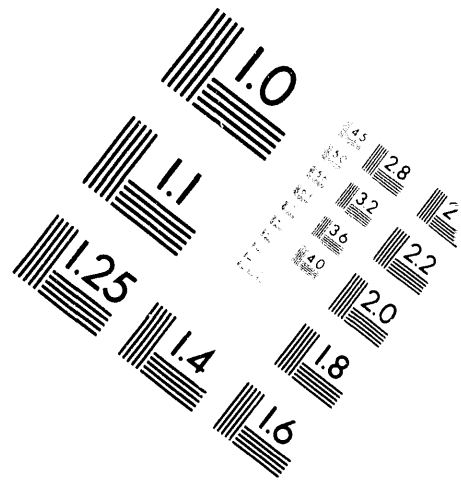

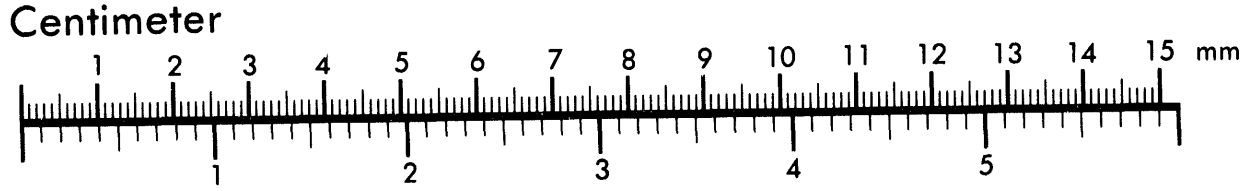

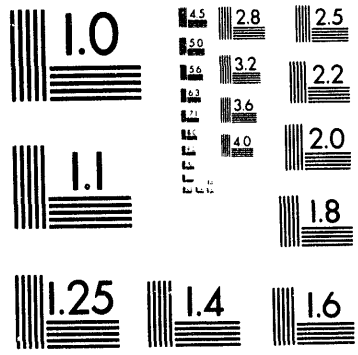

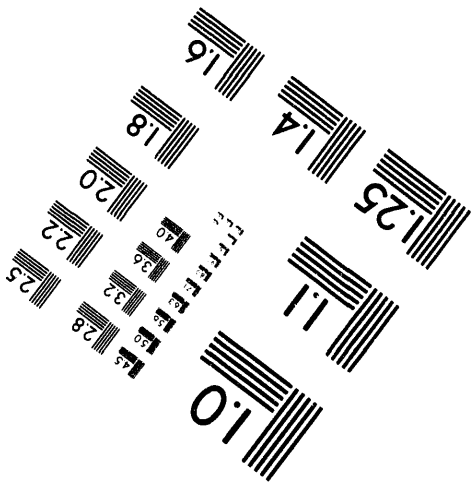

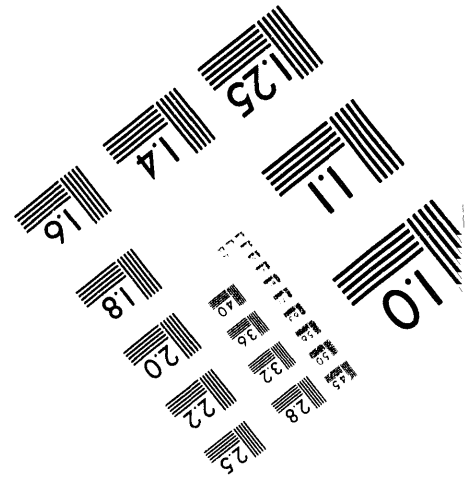

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Nevada Test Site
Flood Inundation Study

Part of U.S. Geological Survey Flood Potential
and Debris Hazard Study
Yucca Mountain Site
for United States Department of Energy
Office of Civilian Radioactive Waste
Management

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Nevada Test Site
Flood Inundation Study
Part of a Geological Survey Flood Potential
and Debris Hazard Study
Yucca Mountain Site
For Department of Energy
Office of Civilian Radioactive Waste Management

Authority

The Geological Survey (GS), as part of the Yucca Mountain Project (YMP), is conducting studies at Yucca Mountain, Nevada. The purposes of these studies are to provide hydrologic and geologic information to evaluate the suitability of Yucca Mountain for development as a high-level nuclear waste repository, and to evaluate the ability of the mined geologic disposal system (MGDS) to isolate the waste in compliance with regulatory requirements. In particular, the project is designed to acquire information necessary for the Department of Energy (DOE) to demonstrate in its environmental impact statement and license application whether the MGDS will meet the requirements of federal regulations 10 CFR Part 60, 10 CFR Part 960, and 40 CFR Part 191 [1].

Complete study plans for this part of the project were prepared by the GS and approved by the DOE in August and September 1990. The Bureau of Reclamation (Reclamation) was selected by the GS as a contractor to provide probable maximum flood (PMF) magnitudes and associated inundation maps for preliminary engineering design of the surface facilities at Yucca Mountain. These PMF peak flow estimates and associated inundation maps are necessary for successful waste repository design and construction. The PMF technique was chosen for two reasons: (1) this technique complies with American National Standards Institute (ANSI) requirements that PMF technology be used in the design of nuclear related facilities (ANSI/ANS, 1981) [2], and (2) the PMF analysis has become a commonly used technology to predict a "worst possible case" flood scenario. This Reclamation PMF study fulfills part 3.1.3.1.2 of the approved GS study plan [1].[3]

The standard step method for backwater computations, incorporating the Bernouli energy equation and the results of the PMF study were chosen as the basis for defining the areal extent of flooding. The method is defined in the Reclamation Technical Procedure YMP-USBR-HP-03,-R0 [4].

Study Site Description

The geographical area of concern is located in southern Nevada, approximately 120 miles northwest of Las Vegas at altitudes ranging from about 6700 feet above sea level at the headwaters of the Yucca Wash tributary to about 3000 feet above sea level where the Forty Mile Wash leaves the study area. The three particular structural features of concern in this area are proposed to be located within the Forty Mile Wash drainage (Figure 1). The drainage area contributing to Forty Mile Wash is bordered by Yucca Mountain on the

southwest, Timber Mountain on the northwest, Pahute Mesa on the north, Shoshone Mountain on the east and northeast, and Jackass Flats on the southeast [5].

The streambeds within the drainage are usually dry, experiencing flow briefly during and after rainstorms or during snowmelt runoff. The channel bed materials range from sand and small gravel near the mouth of the tributaries to coarse gravel and small cobbles in the upstream headwater areas [5].

The final location of the structural facilities will be determined pending the results of the ongoing hydrological and geological investigation. As of now the proposed locations of the structural features, which are in proximity of the PMF flood zones, are as follows:

Facility	Easting	Northing
Boundary Ridge Portal	566,351	756,520
Exile Hill Portal	570,034	765,251
Shaft Site No. 2	563,966	766,745

For purposes of the inundation study, the stream channel referred to in the PMF study as Boundary Ridge Portal is henceforth referred to as South Portal. The name change to South Portal came from the principal contractor, Raytheon Services. The general locations of these facilities are shown on Figure 1.

PMF Study

The results of the PMF Study are contained in the Reclamation report by Kenneth R. Bullard entitled "Nevada Test Site Probable Maximum Flood." [3] The recommended clear water local storm PMF peaks for the Nevada Test Site inundation study are presented in Table 2 of the report and are shown in the second column below:

Site designation	PMF peak (ft^3/s)	2xPMF(ft^3/s)
Mid Valley Wash-1	33,500	67,000
Mid Valley Wash-2	33,000	66,000
Drill Hole Wash	21,000	42,000
Coyote Wash	3,300	6,600
Boundary Ridge Portal-1	3,580	7,160
Boundary Ridge Portal-2	360	720
Boundary Ridge Portal-3	1,370	2,740

Based on field inspections made in December 2, 1985, and again on May 29 and 30, 1991, a conclusion was drawn for the PMF study that due to overall steepness of terrain and lack of dense surface vegetation in the drainage basin, a very short lag time should be used to compute the PMF. The conclusion was also drawn that during times of high flows, large quantities of sand, silt, and other natural debris could be carried in the steep narrow channels. It has been estimated that the potential sediment and debris loads could represent a large portion of the PMF or other large magnitude flows within the test site. After considering the natural ground condition within

the small drainage basins and the steepness of the drainage slopes, it was further concluded that a factor of 2.0 should be applied to the PMF values to represent sediment and debris in transport during the flood event.

Flood profiles

The water surface profiles were computed for the five stream reaches using the Reclamation Method A as defined in the Reclamation Technical Procedure YMP-USBR-HP-03-RO [4]. Cross section data defining the geometry of each stream reach were acquired by the principal contractor's survey crew at the request of Reclamation in May and July 1991. These cross sections were chosen to contain the flow as best possible and to represent the geometry of the channels perpendicular to the direction of flow.

The method used for selecting the roughness coefficient (n of the Manning equation) is described in the Reclamation publication, "Design of Small Dams" [6]. Photographs taken during field reconnaissance trips were used to assist in determining the roughness coefficient. Since the sections were relatively wide with small changes in elevation across most of the sections, with the exception of Drill Hole Wash, one roughness segment was considered adequate for each section. For Drill Hole Wash the sections were segmented with left and right overbank segments and a main channel segment. The similarity of physical conditions within each reach led to a selection of a common roughness of 0.045 for all study reaches and all sections. The relative importance of computed roughness was diminished by the steep slope conditions along each study reach leading to a determination of critical flow in each reach.

The contour map on which the cross sections are plotted, which are used to define flood inundation areas, were produced for DOE by E. G. & G. Energy Measurements, Inc. from photographs taken in July 1990. The map has a 1:6000 scale and a 10 foot contour interval. The map displays the Nevada State Plane Coordinate System. Elevations are referenced to the 1927 North American Datum.

A. Mid Valley Wash

The channel reach on Mid Valley Wash adjacent to the Exile Hill Portal Site is shown on Figure 2. The seven cross sections representing that reach are plotted on Figures 3 through 9. The topographic contour map was used to extend Section 7 above water surface on the right side facing downstream. All other sections were surveyed to elevations beyond the computed maximum water surface.

Flood flows enter this reach of Mid Valley Wash from two sub-areas of the basin. The PMF flood entering the reach at Section 1 is at a discharge of 33,000 ft^3/s, derived from the basin shown on Figure 11 of the PMF Flood Study [3]. When the flood reaches Section 4, flow entering the reach from the east increases the discharge to 33,500 ft^3/s, derived from the expanded basin shown on Figure 10 of the PMF Flood Study.

To begin the step backwater computation at Section 7, a beginning hydraulic slope of 0.0273 was computed based on the thalweg slope between Sections 7 and 6. Because the computed hydraulic slope was a steep slope, the step backwater computation was begun assuming critical flow at the downstream section. The step backwater computation was made from section to section with a critical constraint imposed. By assuming critical flow conditions at the beginning section, a water surface elevation was computed at the next upstream section. By making a critical elevation check at this section, it was determined that the computed elevation was supercritical. With critical constraint imposed, supercritical flow was not permitted and the critical water surface elevation was selected to replace it. This procedure was repeated from section to section until reaching the last upstream section, Section 1.

The resulting critical water surface elevations for the PMF and double PMF flows are given in Table 1. The hydraulic characteristics of the flow, including flow area, flow depth, flow width, average velocity, and water surface elevation at each section, are shown in Tables 2 and 3. The hydraulic characteristic, average velocity, for 2 x PMF represents the clear water condition for that discharge and not the mass flow velocity to be encountered with bulking.

The water surface profiles, using values from Table 1, are plotted on Figure 10. The first profile above the plotted thalweg represents the PMF flood profile as a clear water discharge. The second profile above the thalweg represents the same PMF flood flow including the effect of bulking arrived at by doubling the discharge.

Water surface elevations for the bulking condition were transferred to the topographic map at points on the cross sections where the section lines intersect the computed elevation contour. A flood boundary line was drawn connecting the points. The flood inundation boundary for the Mid Valley Wash study reach is shown on Figure 2. Some discretion was used in drawing the boundary lines since the cross section elevations did not agree in all locations with the contour map. The horizontal position of the Exile Hill Portal is shown to be outside of the flood boundary.

B. Drill Hole Wash

The channel reach on Drill Hole Wash adjacent to the Shaft No. 2 Site is shown on Figure 11. The location of the three surveyed cross sections, representing that reach, are also shown on the plot. Plots of cross sections 1 through 3 are shown on Figures 12 through 14. All three sections were surveyed to elevations beyond the computed maximum water surface.

Flood flows enter this reach of Drill Hole Wash from the southwest coming off the east slope of Yucca Mountain. The PMF flood entering the reach at Section 1 is estimated to be 21,000 ft^3/s derived from a drainage basin of 2.40 square miles shown on Figure 12 of the PMF Flood Study [3].

To begin the step backwater computation at Section 3, a beginning hydraulic slope of 0.0538 was computed based on the thalweg slope between Sections 3 and 2. Since the computed hydraulic slope was a steep slope, the step backwater computation was begun assuming critical flow at the downstream section. With a steep slope condition prevailing throughout the reach, the step backwater computation was made from section to section with a critical constraint imposed. The same technique used in computing water surface elevations for Mid-Valley Wash was used for Drill Hole Wash, resulting in a critical water surface profile for the PMF flood.

The resulting water surface elevations for the PMF and double PMF flows are given on Table 4. Hydraulic characteristics of the flow, are shown on Tables 5 and 6. The average velocity given in the table for 2 x PMF represents the clear water condition for that discharge, not the mass flow velocity to be encountered with bulking.

The water surface profiles using values from Table 4 are plotted on Figure 15. The first profile above the plotted thalweg represents the PMF flood profile as a clear water discharge. The second profile above the thalweg represents the same PMF flood flow including the effects of bulking arrived at by doubling the discharge.

The flood inundation boundaries shown on Figure 11 were developed by transferring the water surface elevations for the bulking condition to the topographic map at points where the section lines intersected the computed elevation contours. A flood boundary line was drawn connecting the points. The horizontal position of the Shaft No. 2 Site is shown to be outside of the flood boundary.

C. Coyote Wash

The channel reach on Coyote Wash, also adjacent to Shaft No. 2 Site, is shown on Figure 16. The location of the three surveyed cross sections representing that reach are also shown on the plot. Profiles of Sections 1 through 3 are shown on Figures 17 through 19. The left and right bank of each section were surveyed to elevations beyond the computed maximum water surface.

Flood flows enter this reach of Coyote Wash from the west coming off the east slope of Yucca Mountain. The PMF flood entering the reach at Section 1, estimated to be 3300 ft^3/s, was derived from a drainage basin of 0.23 square miles shown on Figure 13 of the PMF Flood Study [3].

To begin the step backwater computation at Section 3, a beginning hydraulic slope of 0.0525 was used based on the thalweg slope between Sections 3 and 2. Because the computed hydraulic slope was a steep slope, the step backwater computation was begun assuming critical flow at the downstream section. The step backwater computation was made from section to section with critical constraint imposed. The technique used for computing water surface elevations for Mid-Valley Wash was also used for Coyote Wash, resulting in a critical water surface profile for the PMF flood.

The resulting water surface elevations for the PMF and double PMF flows are given in Table 7. Hydraulic characteristics of flow at each cross section are shown on Tables 8 and 9. The average velocity given in the table for 2 x PMF represents the clear water condition for that discharge, not the mass flow velocity to be encountered with bulking.

The water surface profiles, using values from Table 7, are plotted on Figure 16. The first profile above the plotted thalweg represents the PMF flood profile with a clear water discharge. The second profile above the thalweg represents the same PMF flood flow, including the effect of bulking simulated by doubling the discharge.

The flood inundation boundaries shown on Figure 16 were developed by transferring the water surface elevations for the bulking condition to the topographic map at points where the section lines intersect the computed elevation contours. A flood boundary was drawn connecting the points. The horizontal position of the Shaft No. 2 Site is shown to be well outside of the flood boundary.

D. South Portal

The channel study reach for the unnamed stream adjacent to the South Portal site, otherwise referred to as Boundary Ridge Portal, is shown on Figure 20. For this study area four sections were surveyed to represent the potential flooded area. The four sections are plotted on Figure 21 through 24. Sections 2 through 4 describe a small channel east of the portal site sloping downstream in a northerly direction. Section 1 partially describes an adjacent small channel northeast of the portal site and sloping downstream in an easterly direction. Section 1 intersects the line of Section 2 at the left end of Section 2 facing downstream. All sections with the exception of Section 1 were surveyed to elevations beyond the maximum computed water surface.

Flood flows enter these two streams from two small subareas, one north of the portal site and the other southeast of the site. The streams join at a location about 1700 feet east of the portal site. The PMF flood entering the channel reach at Section 1 is at a discharge of 1730 ft^3/s, a combination of the peaks for Boundary Ridge Portal 2 (BPR2) and Boundary Ridge Portal 3 (BPR3) given in Table 2 of the PMF Flood Study [3]. The PMF flood entering the channel defined by Sections 2, 3, and 4 enters at Section 2 at a discharge of 3580 ft^3/s. Those three subareas, BPR1, BPR2, and BPR3, are shown on Figures 14, 15, and 16 of the PMF Flood Study. Since Section 4 is downstream of the confluence of the two streams, the flows passing Section 4 combine the flows for the two subareas.

To begin the step backwater computation at Section 4, a beginning hydraulic slope of 0.0317 was computed based on the thalweg slope between Sections 3 and 4. Since the computed hydraulic slope was a steep slope, the step backwater computation was begun assuming critical flow at the downstream section. Because of the steep slope condition prevailing throughout the reach, a step backwater computation was made from section to section with critical constraint imposed. The technique used in computing water surface

elevations for Mid Valley Wash was used for the South Portal study reach resulting in a critical water surface profile for the PMF flood.

The water surface elevations at Section 1 crossing the smaller drainage to the northeast of the portal site were determined by a step backwater computation between Section 4 and Section 1. The beginning hydraulic slope in this instance was computed to be 0.0621, based on the thalweg slope between the two sections. Because of the steep slope condition, critical constraint was again imposed resulting in a critical water surface at both sections for the PMF flood.

The resulting critical water surface elevations for the PMF and double PMF flows are given in Table 10. The hydraulic characteristics of the flow are shown in Tables 11 and 12. The average velocity shown in the table for 2 x PMF represents the clear water condition for the discharge and not the mass flow velocity to be encountered with bulking.

The water surface profiles for the two reaches, defined by Sections 1 and 4 and by Sections 2, 3, and 4, are plotted on Figures 25 and 26 respectively. The first profile above the plotted thalweg represents the PMF flood profile for a clear water discharge. The second profile above the thalweg represents the same PMF flood including the effects of bulking simulated by doubling the discharge.

Water surface elevations for the bulking condition were transferred to the topographic map at points on the cross sections where the section lines intersected the computed elevation contour. A flood boundary line was drawn connecting the points. The flood inundation boundary for the South Portal study reach is shown on Figure 20. Some discretion was used in drawing the boundary lines and connecting the flow boundary at Section 1 with the flow boundary in the other reach. The horizontal position of the South Portal site is shown to be well outside of the flood boundaries.

Recommendations

The flood inundation boundaries for the PMF flood peak delineated on Figures 2, 11, 16, and 20 are recommended for use in establishing the location of Nevada Nuclear Waste Site facilities. These plotted boundaries represent flood conditions which include the bulking effect caused by the entrainment of air, sediment, and debris.

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5. Flood Potential of Fortymile Wash and its Principle Southwestern Tributaries, Nevada Test Site, Southern Nevada, Geological Survey, Water Resources Investigations Report 83-4001, Carson City, Nevada, 1984.

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TABLE 1

Mid Valley Wash - Water Surface Profile Data

Section No.	Thalweg (Ft)	Channel Distance (Ft)	PMF W.S. Elev. (Ft)	2 x PMF W.S. Elev. (Ft)
7	3634.9	0	3642.1	3644.0
6	3651.0	590	3657.7	3659.7
5	3660.8	990	3669.6	3671.4
4	3669.7	1265	3678.0	3680.2
3	3684.1	1705	3691.4	3693.1
2	3700.5	2340	3710.9	3712.8
1	3717.0	2860	3726.4	3729.4

TABLE 2

Mid Valley Wash - Hydraulic Tables for PMF Flood

Section No.	Discharge (Ft^3/s)	Flow Area (Ft^2)	Flow Depth (Ft)	Flow Width (Ft)	Average Velocity (Ft/s)	W. S. Elevation (Ft)
7	33,500	3411	9.2	1138	9.82 [1/]	3642.1
6	33,500	3473	6.7	1201	9.65 [1/]	3657.7
5	33,500	3540	8.8	1272	9.46 [1/]	3669.6
4	33,500	3276	8.3	1008	10.23 [1/]	3678.0
3	33,000	3533	7.3	1303	9.34 [1/]	3691.4
2	33,000	3289	10.4	1052	10.03 [1/]	3710.9
1	33,000	2742	9.4	610	12.04 [1/]	3726.4

TABLE 3

Mid Valley Wash - Hydraulics for 2 x PMF [2/]

Section No.	Discharge (Ft^3/s)	Flow Area (Ft^2)	Flow Depth (Ft)	Flow Width (Ft)	Average Velocity (Ft/s)	W. S. Elevation (Ft)
7	67,000	6731	9.1	2187	9.95 [3/]	3644.0
6	67,000	6975	8.7	2433	9.61 [3/]	3659.7
5	67,000	6934	10.6	2381	9.66 [3/]	3671.4
4	67,000	6829	10.5	2282	9.81 [3/]	3680.2
3	66,000	6222	9.0	1779	10.61 [3/]	3693.1
2	66.000	5432	12.3	1184	12.15 [3/]	3712.8
1	66,000	5047	12.4	950	13.08 [3/]	3729.4

[1/] Critical velocity.

[2/] This computation represents the water surface related to bulking caused by air, sediment, and debris entrained in the flow during the PMF flood.

[3/] Critical velocity associated with the discharge and not with the bulking condition.

TABLE 4

Drill Hole Wash - Water Surface Profile Data

Section No.	Thalweg (Ft)	Channel Distance (Ft)	PMF W.S. Elev. (Ft)	2 x PMF W.S. Elev. (Ft)
3	4035.2		4044.8	4047.3
		260		
2	4049.6		4057.9	4060.1
		250		
1	4061.2		4069.5	4071.7

TABLE 5

Drill Hole Wash - Hydraulics for PMF Flood

Section No.	Discharge (Ft^3/s)	Flow Area (Ft^2)	Flow Depth (Ft)	Flow Width (Ft)	Average Velocity (Ft/s)	W. S. Elevation (Ft)
3	21,000	1877	9.6	481	11.20 [1/]	4044.8
2	21,000	1993	8.3	576	10.54 [1/]	4057.9
1	21,000	1955	8.3	548	10.75 [1/]	4069.5

TABLE 6

Drill Hole Wash - Hydraulics for 2 x PMF [2/]

Section No.	Discharge (Ft^3/s)	Flow Area (Ft^2)	Flow Depth (Ft)	Flow Width (Ft)	Average Velocity (Ft/s)	W. S. Elevation (Ft)
3	42,000	3219	12.1	611	13.16 [3/]	4047.3
2	42,000	3278	10.5	640	12.83 [3/]	4060.1
1	42,000	3235	10.5	609	13.16 [3/]	4071.7

[1/] Critical velocity

[2/] This computation represents the water surface related to bulking caused by air, sediment, and debris entrained in the flow during the PMF flood.

[3/] Critical velocity associated with the discharge and not with the bulking condition.

TABLE 7

Coyote Wash - Water Surface Profile Data

Section No.	Thalweg (Ft)	Channel Distance (Ft)	PMF W.S. Elev. (Ft)	2 x PMF W.S. Elev. (Ft)
3	4064.5		4068.1	4068.9
		200		
2	4075.0		4082.3	4083.3
		160		
1	4087.5		4092.7	4094.7

TABLE 8

Coyote Wash - Hydraulics for PMF Flood

Section No.	Discharge (Ft^3/s)	Flow Area (Ft^2)	Flow Depth (Ft)	Flow Width (Ft)	Average Velocity (Ft/s)	W. S. Elevation (Ft)
3	3300	501	3.6	371	6.59 [1/]	4068.1
2	3300	454	7.3	276	7.28 [1/]	4082.3
1	3300	338	5.3	338	9.77 [1/]	4092.7

TABLE 9

Coyote Wash - Hydraulics for 2 x PMF [2/]

Section No.	Discharge (Ft^3/s)	Flow Area (Ft^2)	Flow Depth (Ft)	Flow Width (Ft)	Average Velocity (Ft/s)	W. S. Elevation (Ft)
3	6600	819	4.4	405	8.06 [3/]	4068.9
2	6600	789	8.3	363	8.36 [3/]	4083.3
1	6600	762	7.2	327	8.66 [3/]	4094.7

[1/] Critical velocity.

[2/] This computation represents the water surface related to bulking caused by air, sediment, and debris entrained in the flow during the PMF flood.

[3/] Critical velocity associated with the discharge and not with the bulking condition.

TABLE 10

South Portal - Water Surface Profile Data

Section No.	Thalweg (Ft)	Channel Distance (Ft)	PMF W.S. Elev. (Ft)	2 x PMF W.S. Elev. (Ft)
4	3751.7		3757.7	3759.5
		290		
3	3760.9		3765.6	3767.0
		250		
2	3770.6		3774.8	3776.2
1	3798.3	-	3801.7	3802.5

TABLE 11

South Portal - Hydraulics for PMF Flood

Section No.	Discharge (Ft^3/s)	Flow Area (Ft^2)	Flow Depth (Ft)	Flow Width (Ft)	Average Velocity (Ft/s)	W. S. Elevation (Ft)
4	5310	549	6.0	189	9.67 [1/]	3757.7
3	3580	412	4.7	176	8.68 [1/]	3765.6
2	3580	423	4.2	190	8.46 [1/]	3774.8
1	1730	262	3.4	191	6.60 [1/]	3801.7

TABLE 12

South Portal - Hydraulics for 2 x PMF [2/]

Section No.	Discharge (Ft^3/s)	Flow Area (Ft^2)	Flow Depth (Ft)	Flow Width (Ft)	Average Velocity (Ft/s)	W. S. Elevation (Ft)
4	10,620	939	2.8	236	11.31 [3/]	3759.5
3	7,160	699	6.1	214	10.25 [3/]	3767.0
2	7,160	703	5.6	218	10.18 [3/]	3776.2
1	3,460	437	4.2	224	7.93 [3/]	3802.5

[1/] Critical velocity.

[2/] This computation represents the water surface related to bulking caused by air, sediment, and debris entrained in the flow during the PMF flood.

[3/] Critical velocity associated with the discharge and not with the bulking condition.

FIGURES

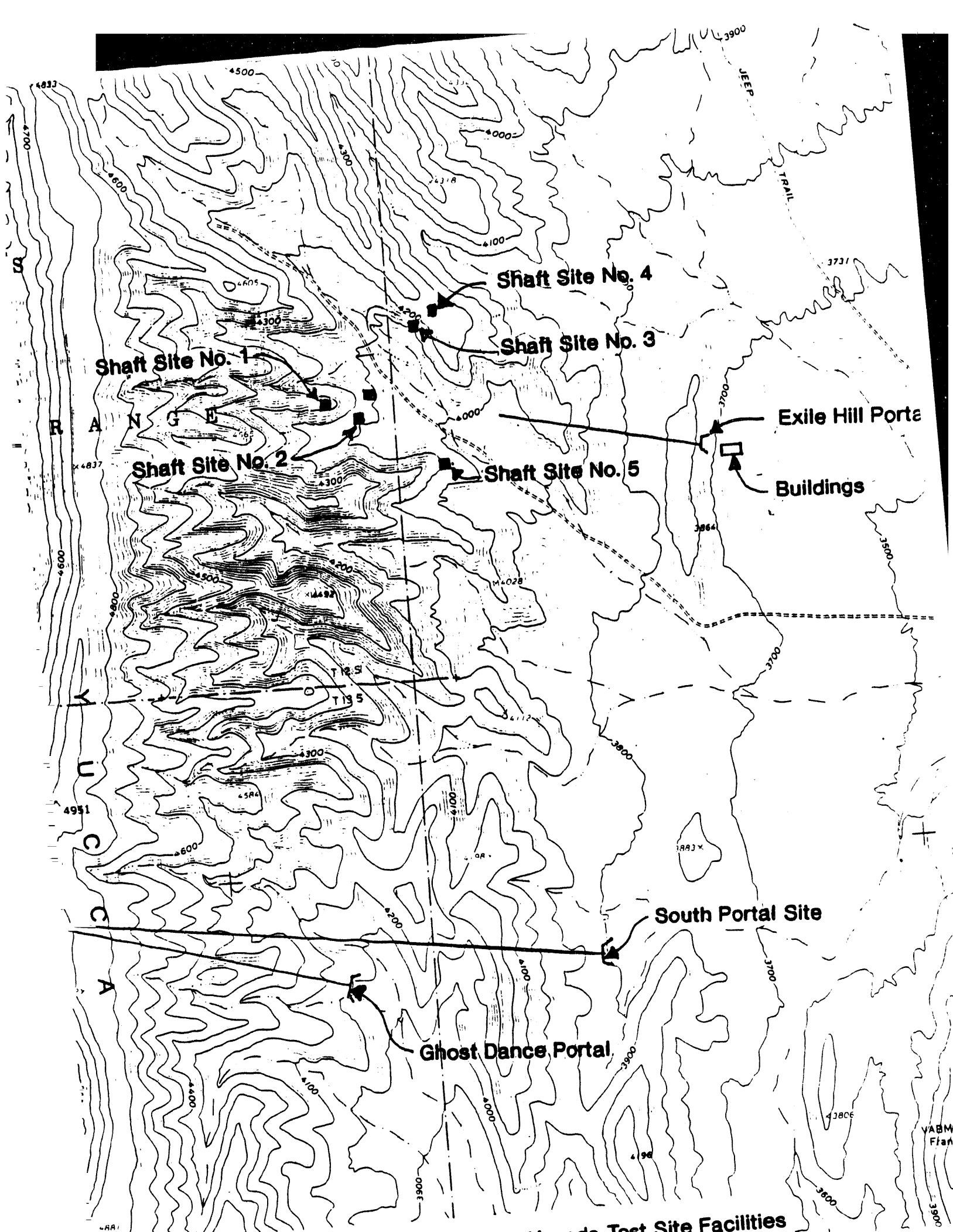
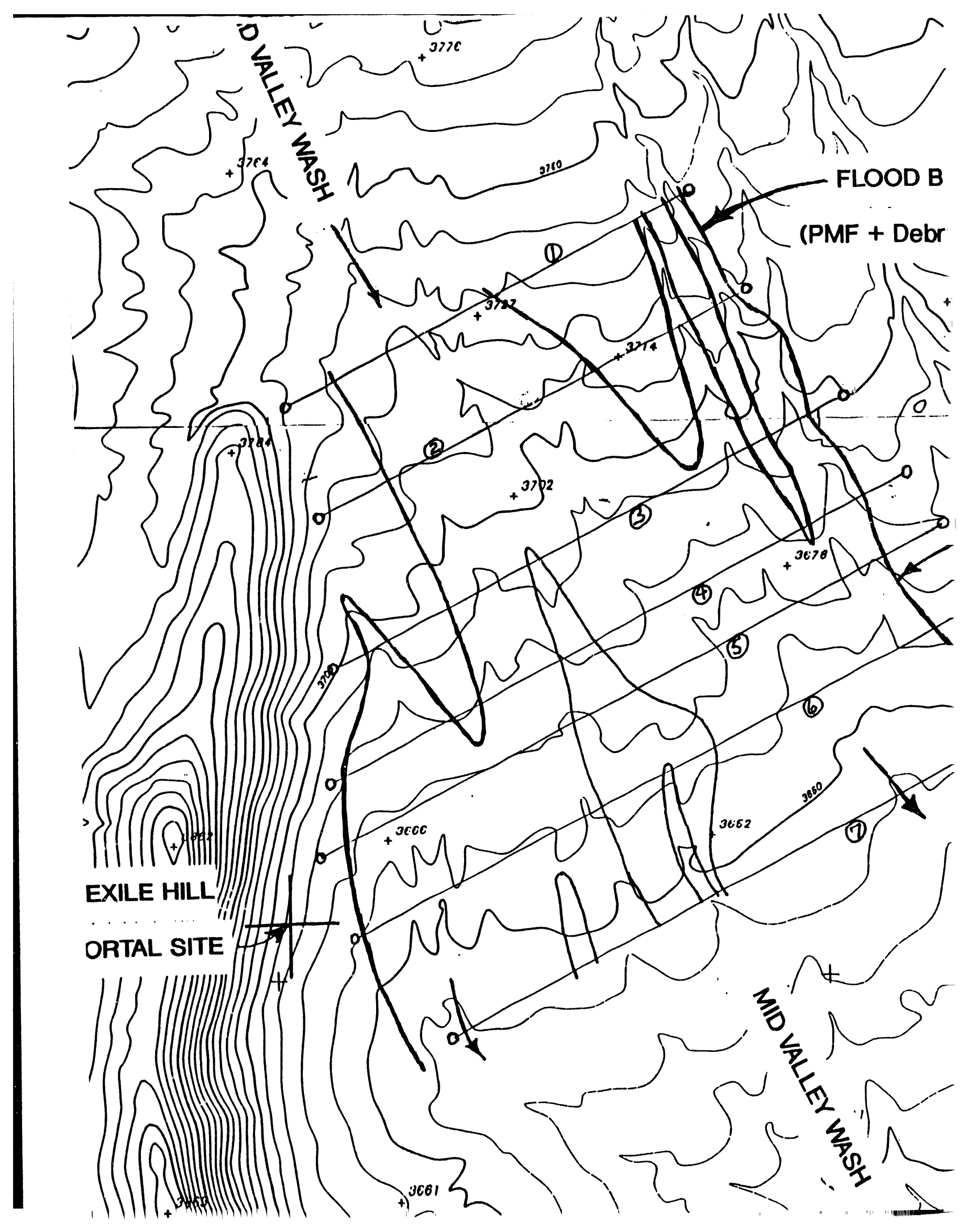


Figure 1 - Location Map for Nevada Test Site Facilities


D VALLEY WASH
FLOOD B
(PMF + Debr
EXILE HILL
ORTAL SITE
MID VALLEY WASH
3770
3764
3760
3722
3714
3704
3702
3678
3660
3652
3661
1
2
3
4
5
6
7

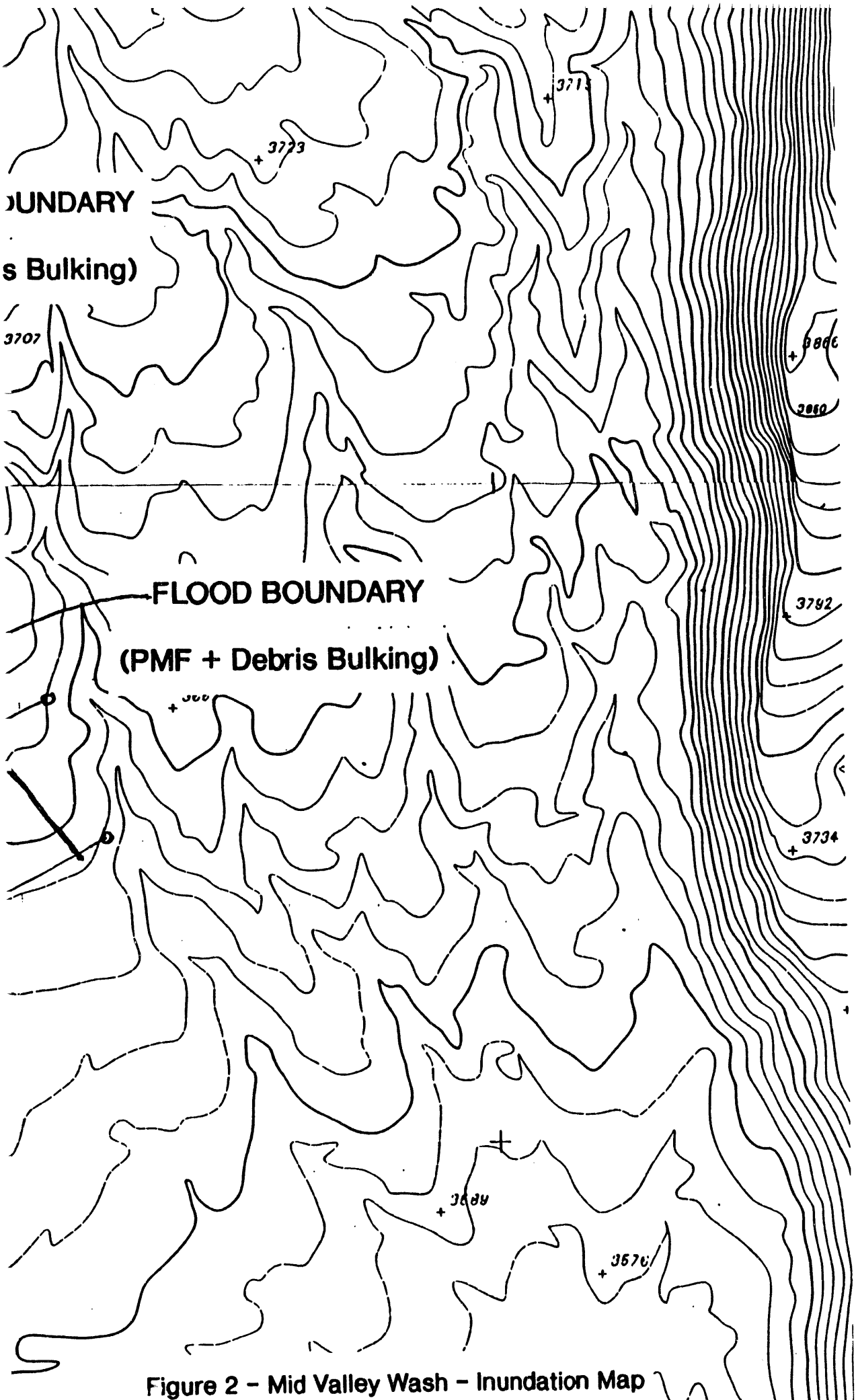


Figure 2 - Mid Valley Wash - Inundation Map

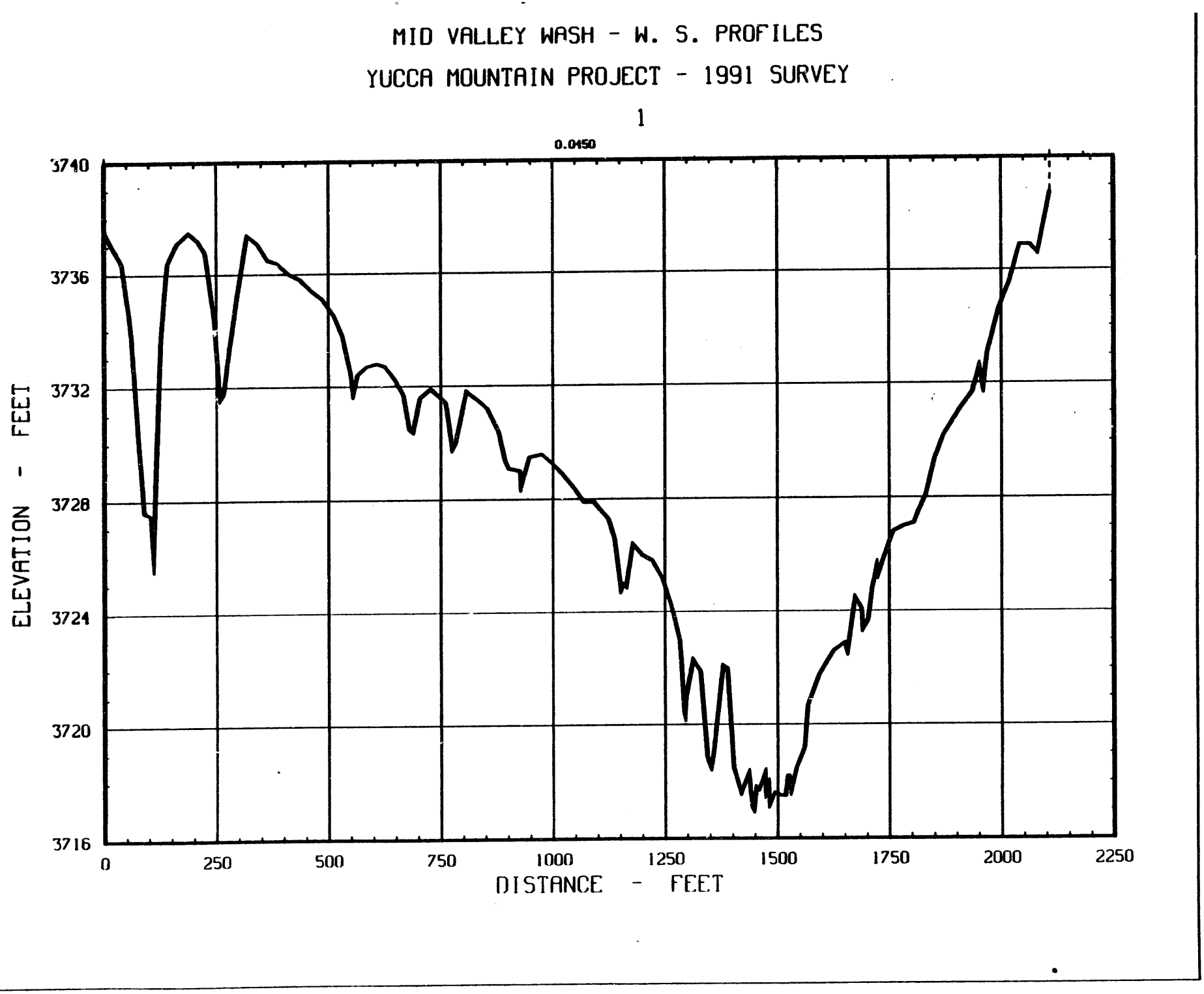


Figure 3 – Mid Valley Wash – Section

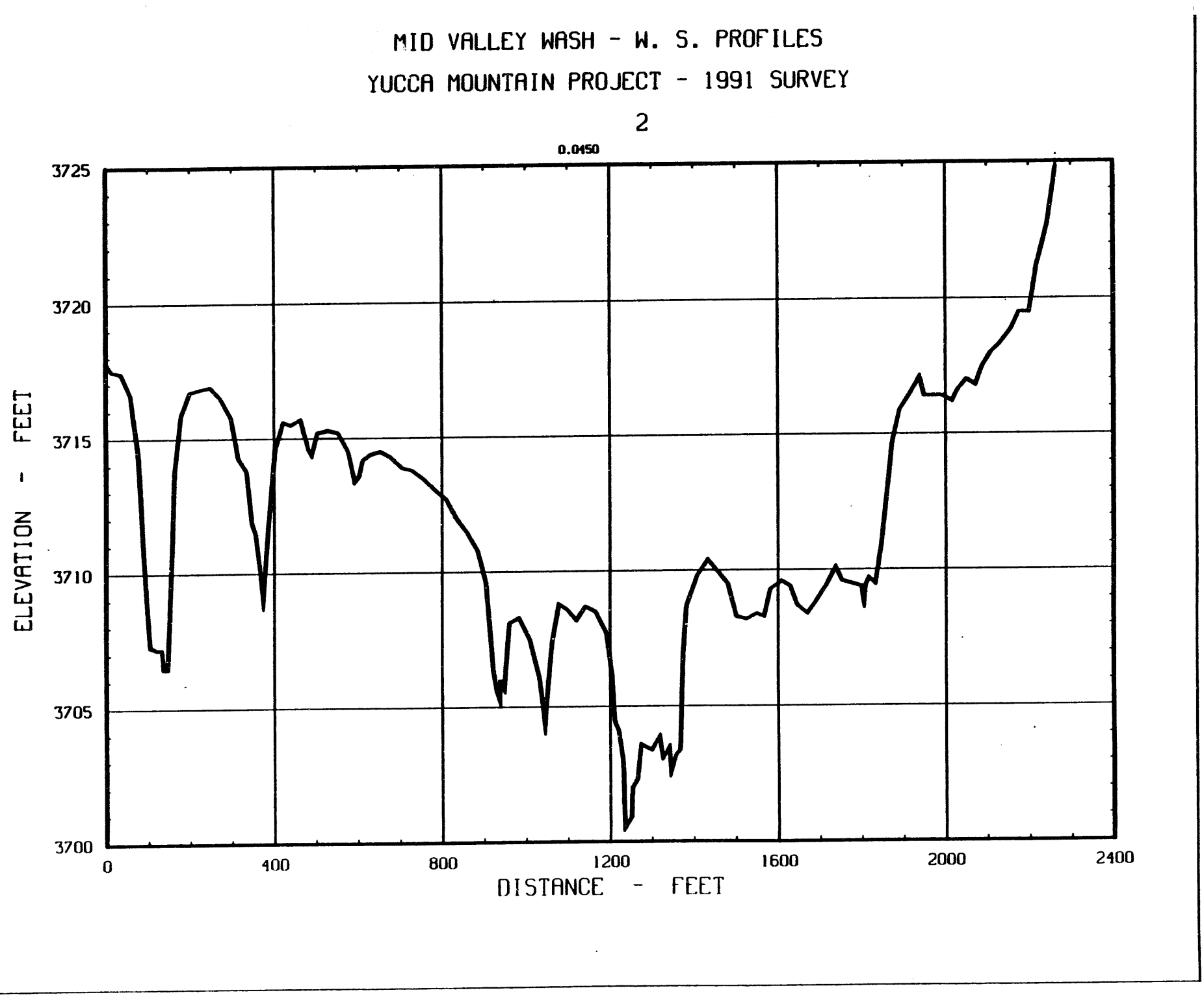


Figure 4 – Mid Valley Wash – Section 2

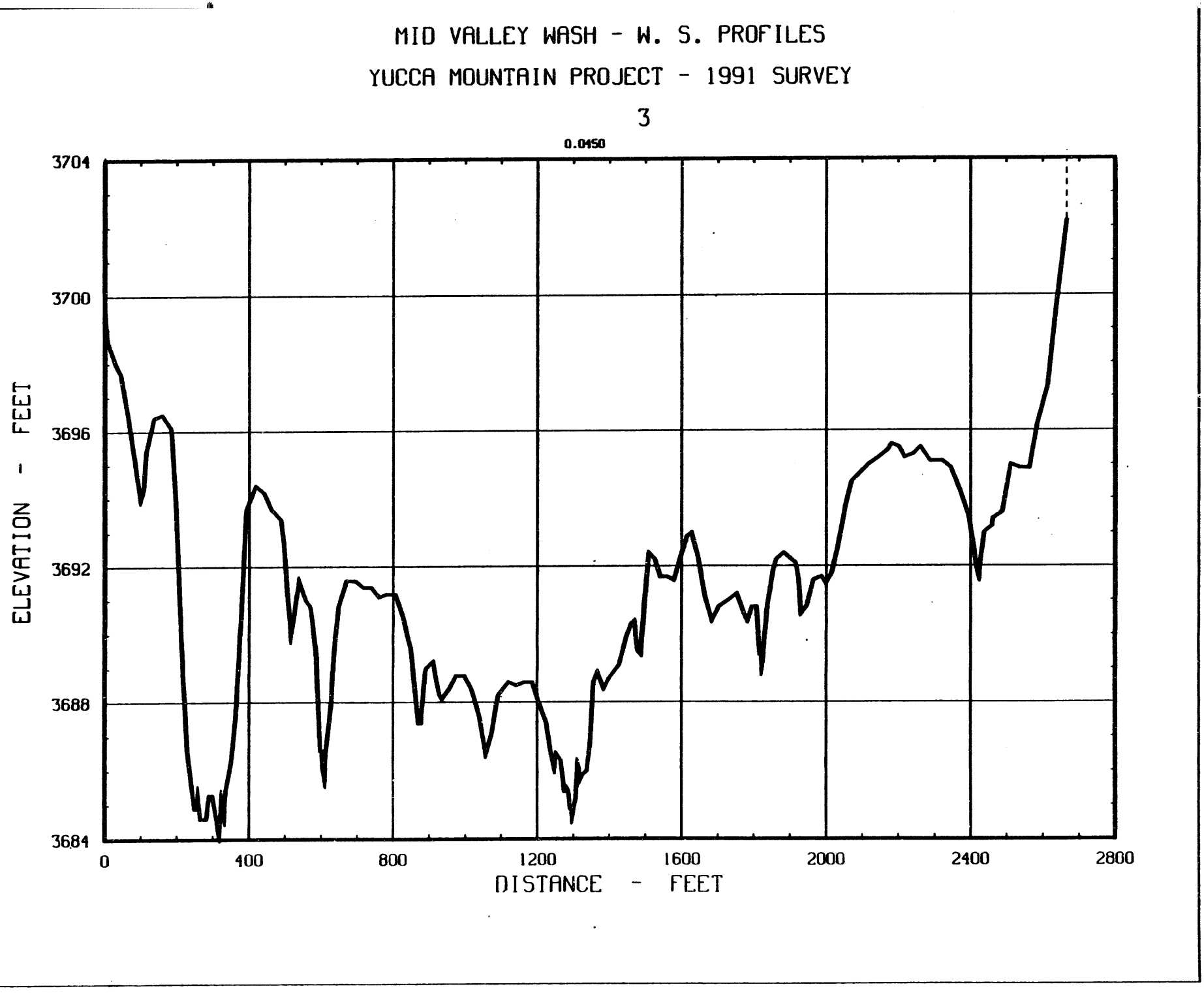


Figure 5 - Mid Valley Wash - Section 3

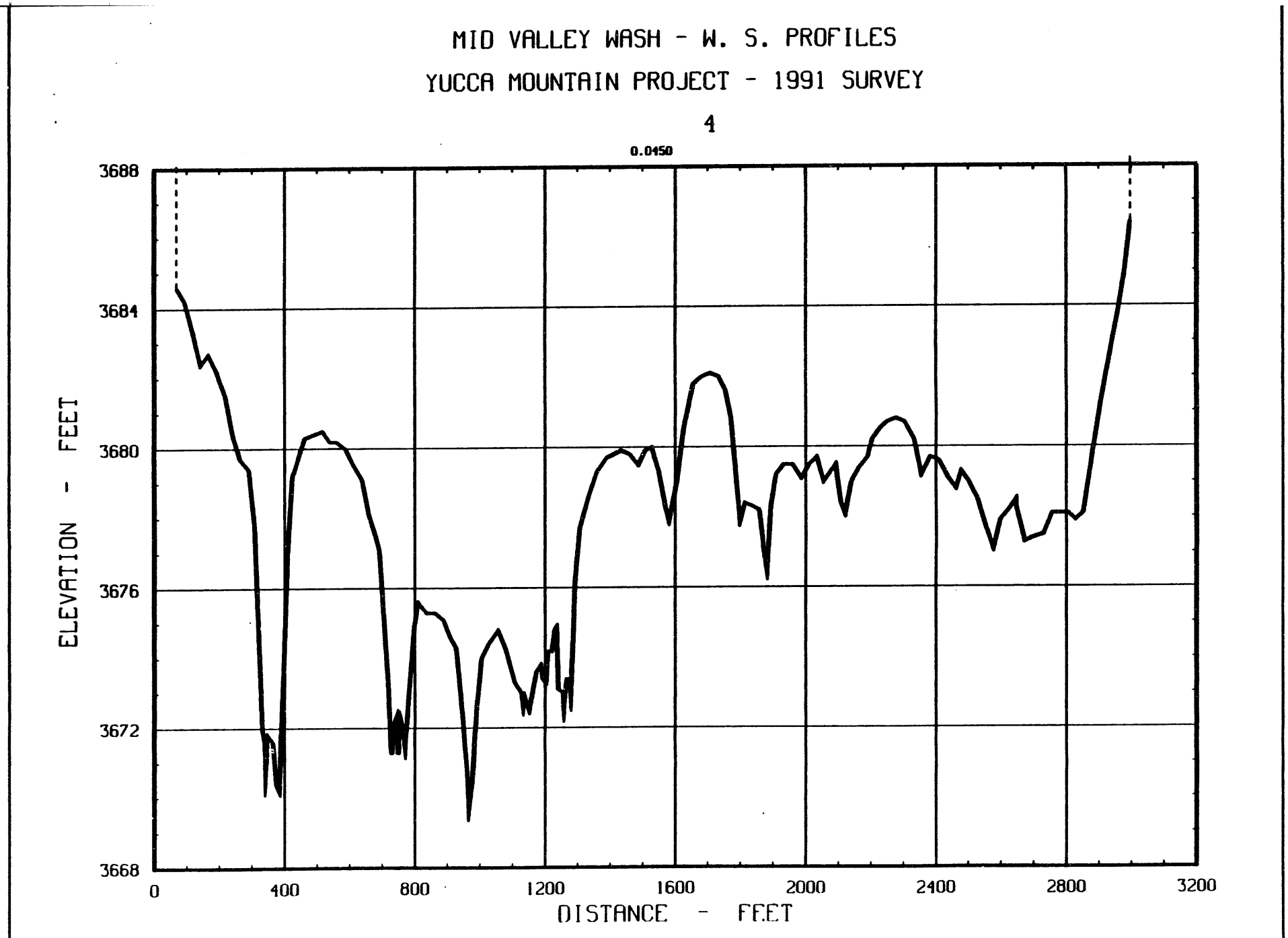


Figure 6 – Mid Valley Wash – Section 4

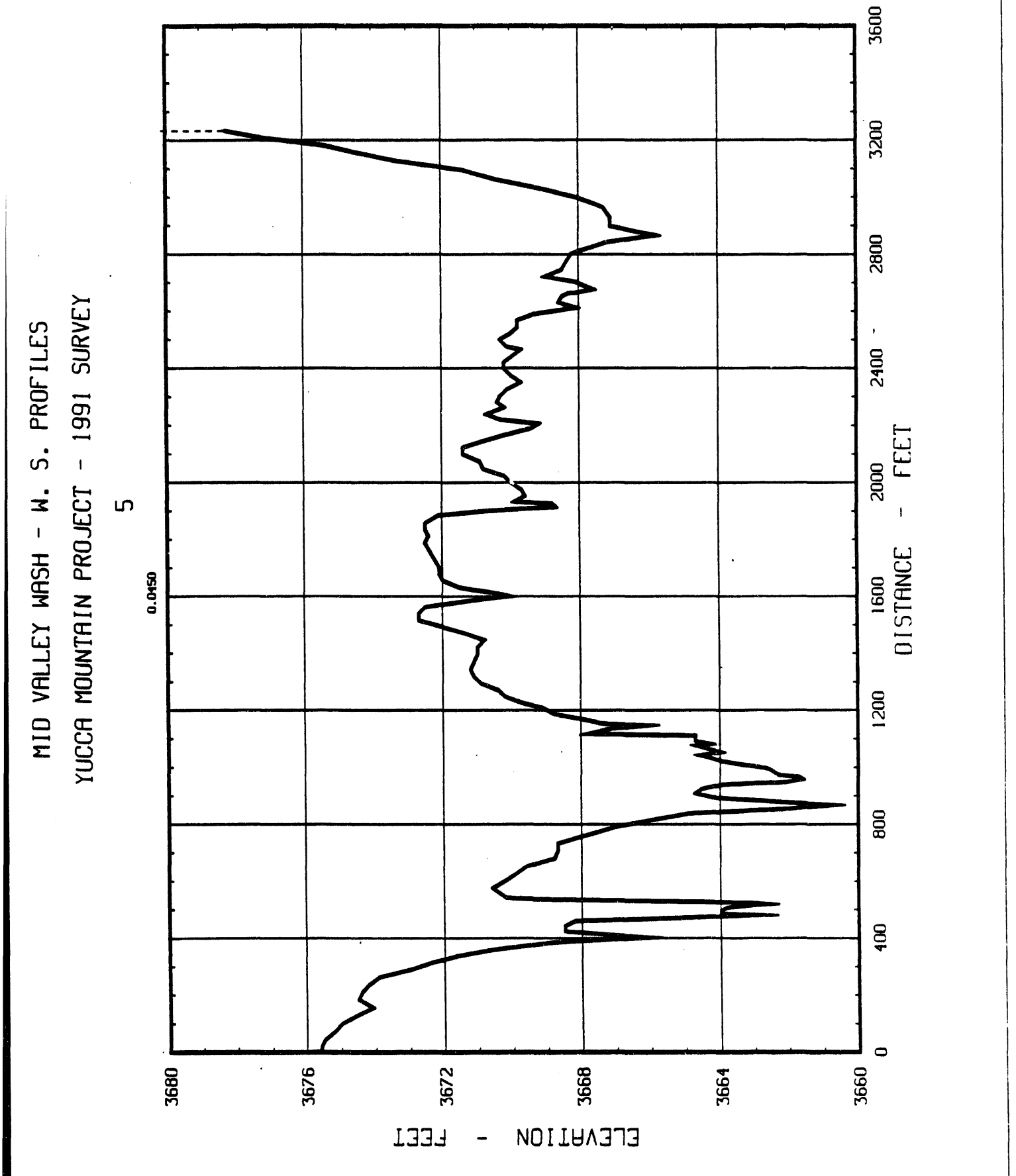


Figure 7 – Mid Valley Wash – Section 5

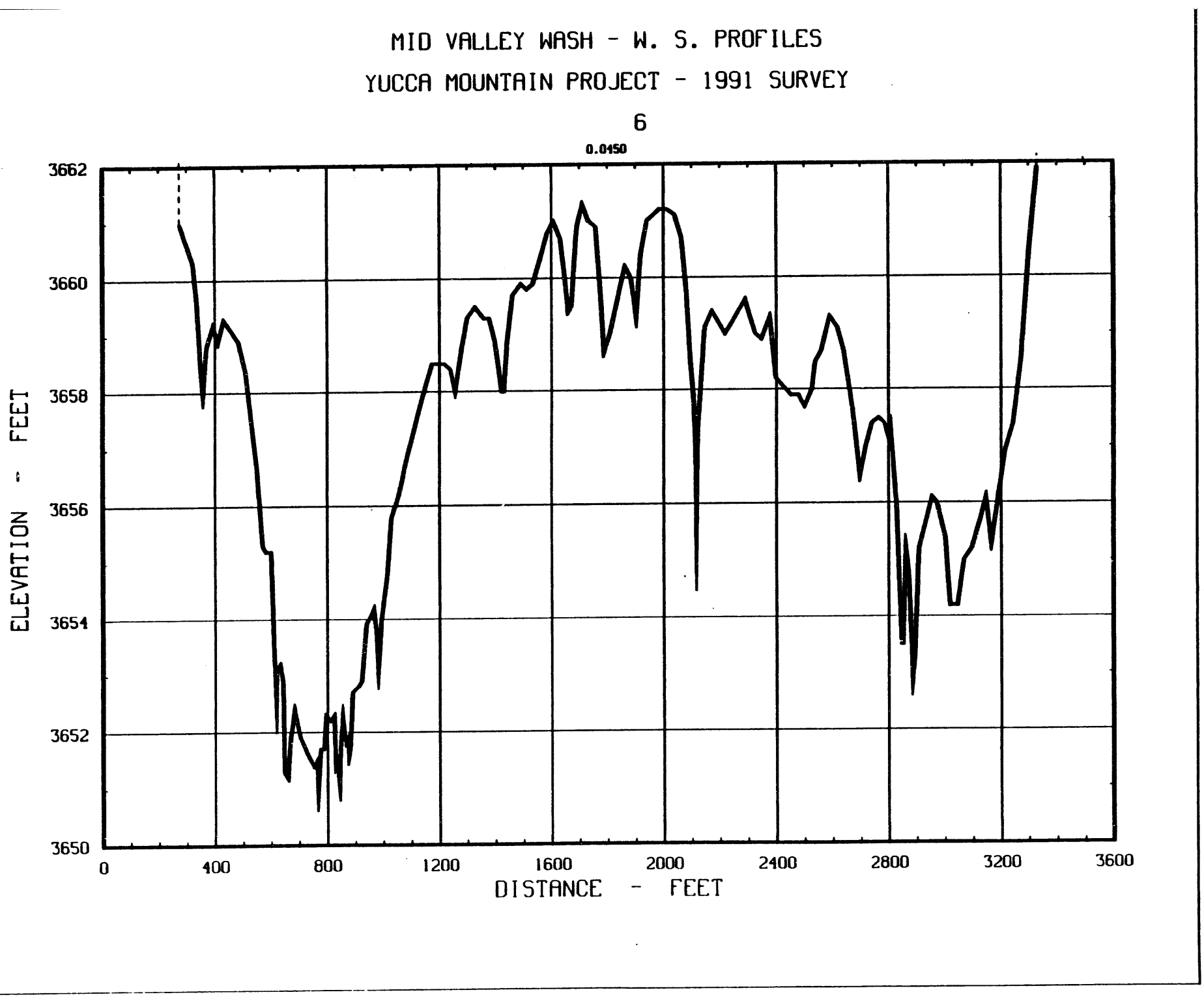


Figure 8 – Mid Valley Wash – Section

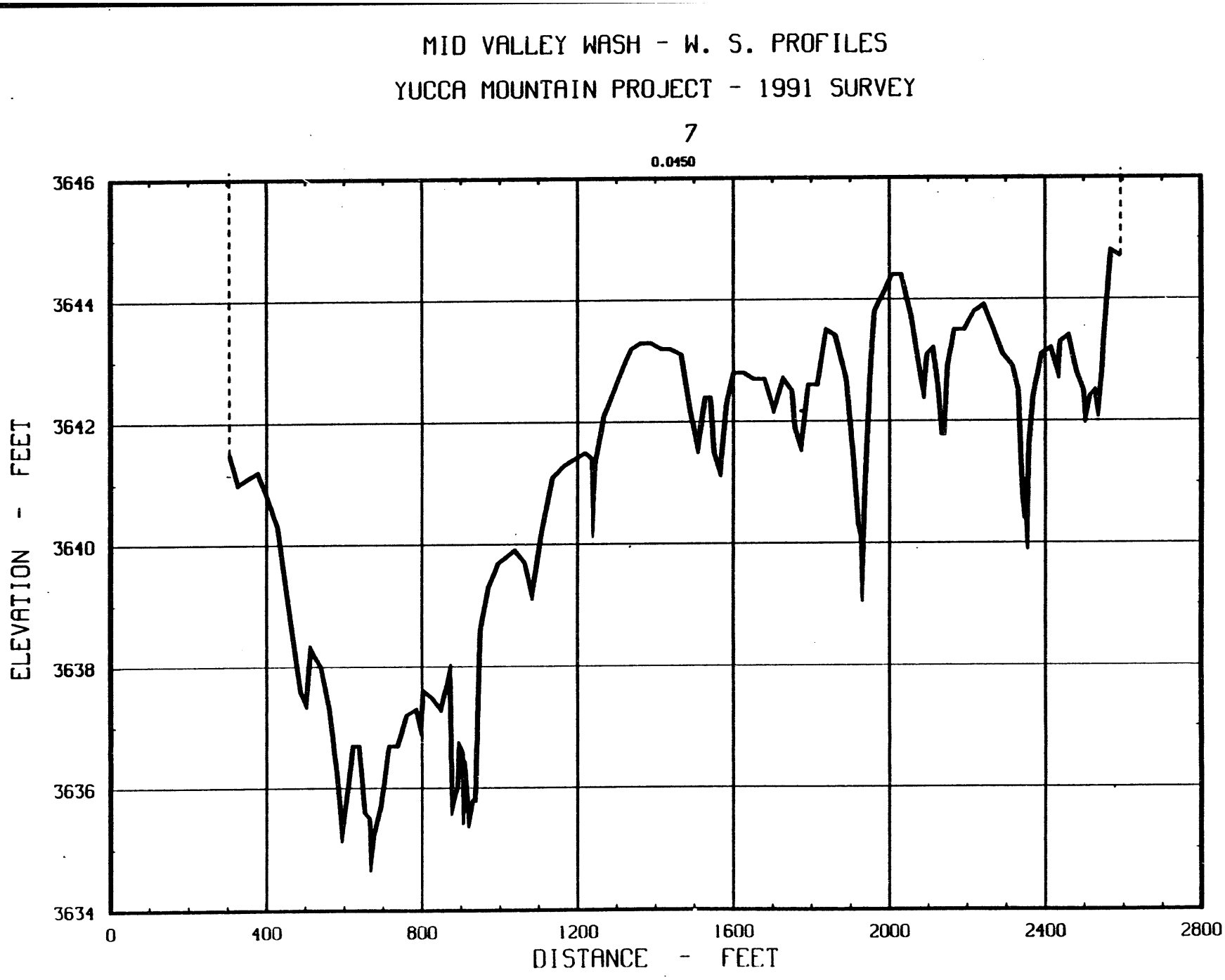
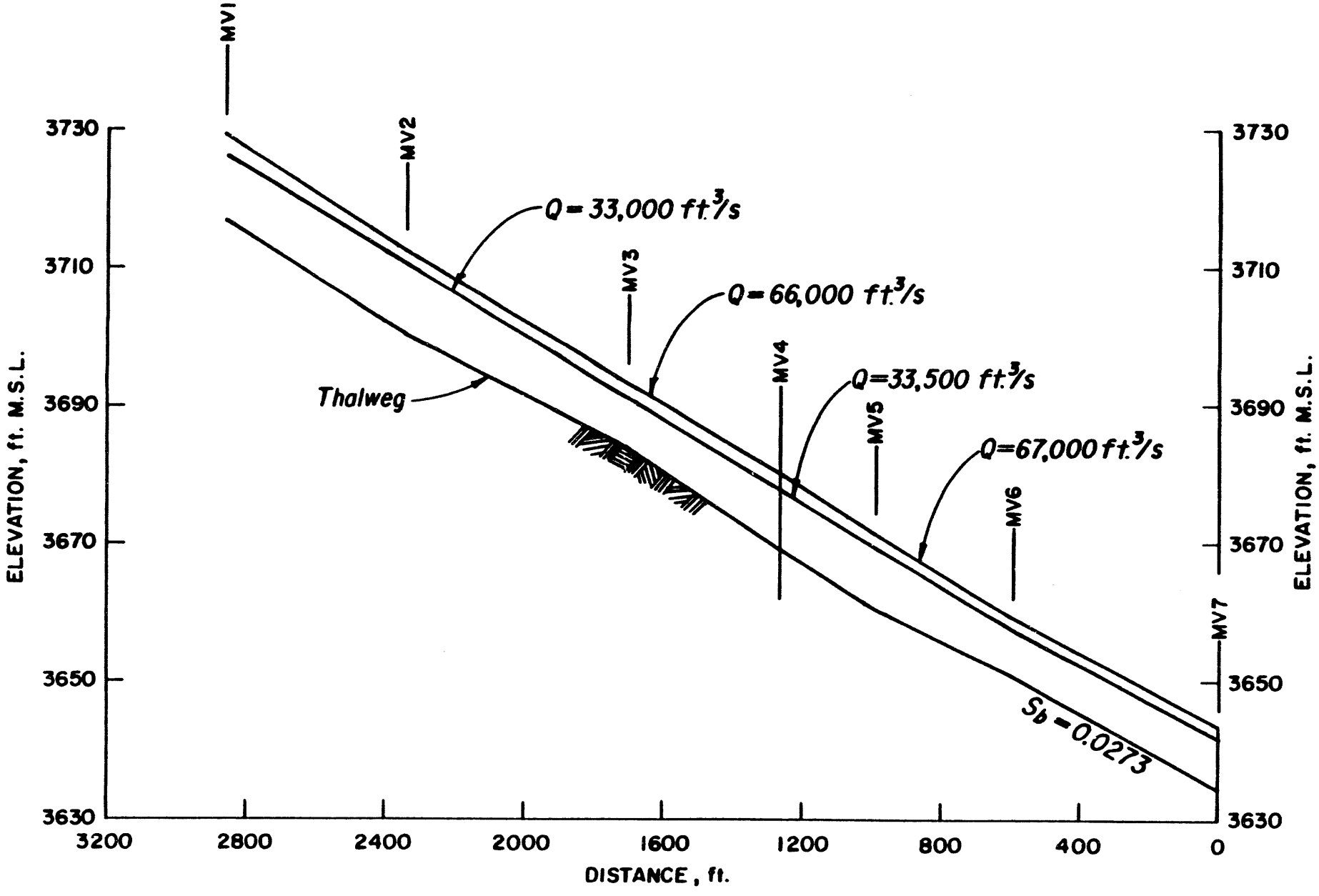


Figure 9 - Mid Valley Wash - Section



MID VALLEY WASH – WATER SURFACE PROFILES

Figure 10 – Mid Valley Wash – Water Surface Profiles

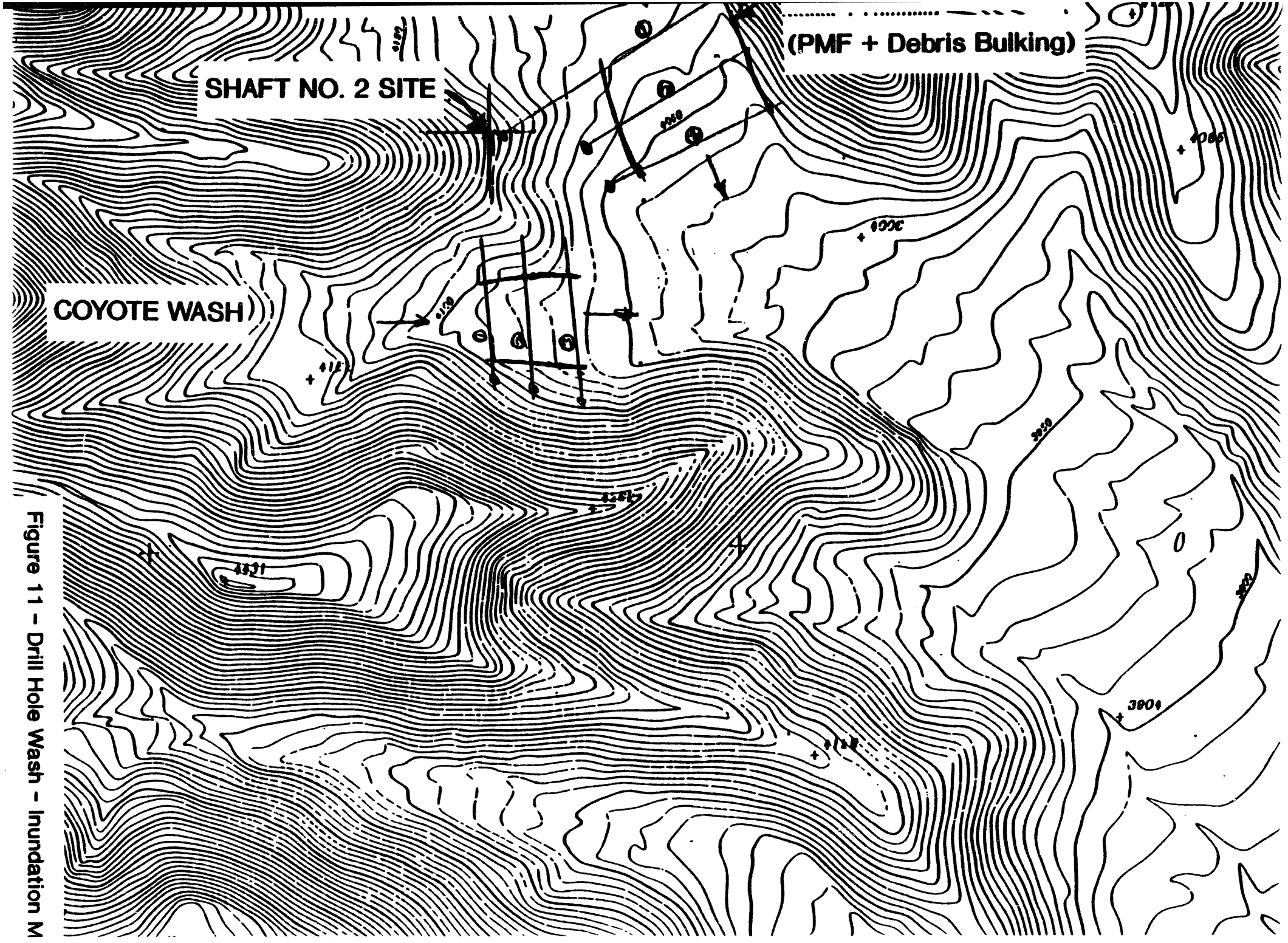


Figure 11 – Drill Hole Wash – Inundation M

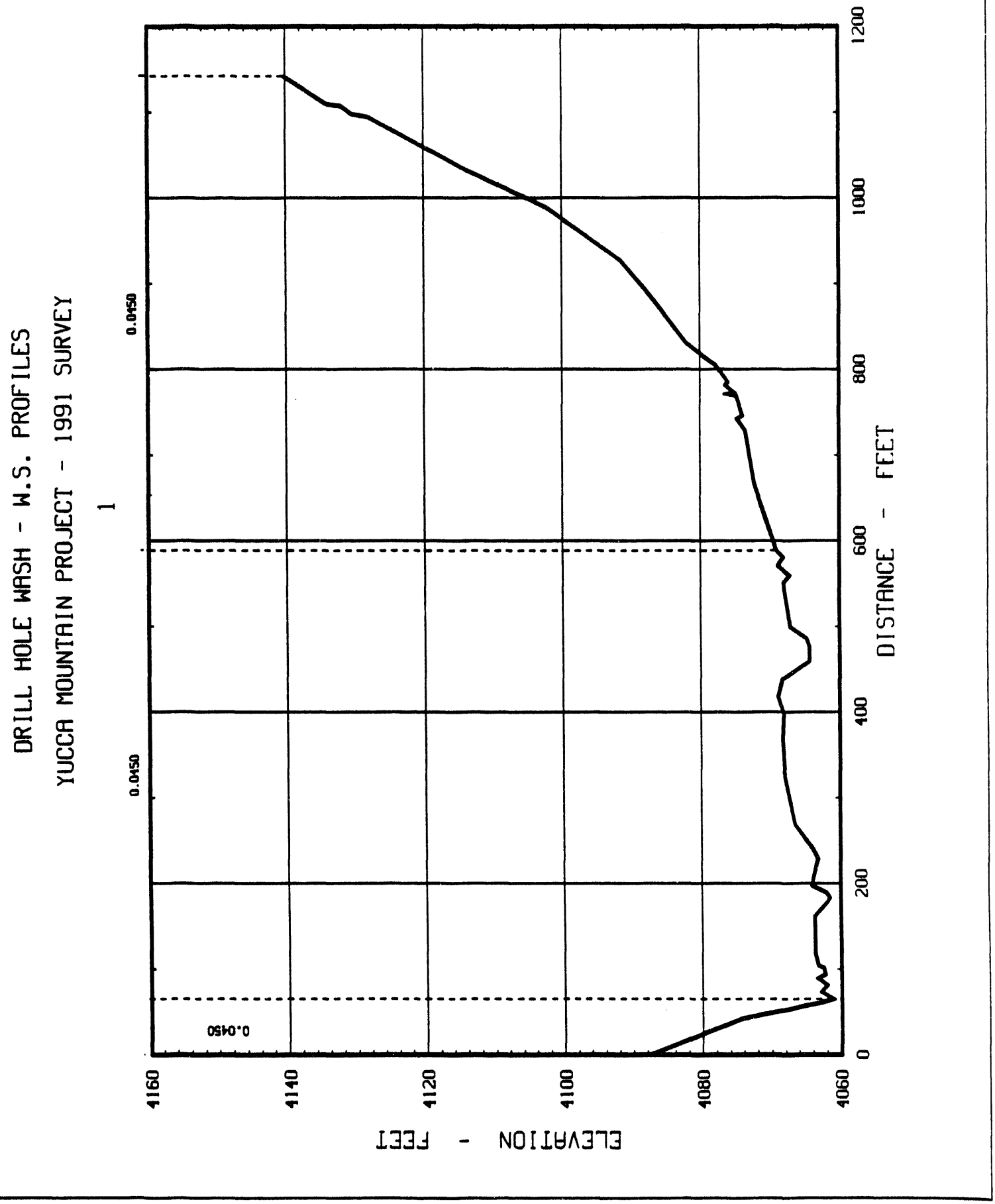


Figure 12 - Drill Hole Wash - Section 1

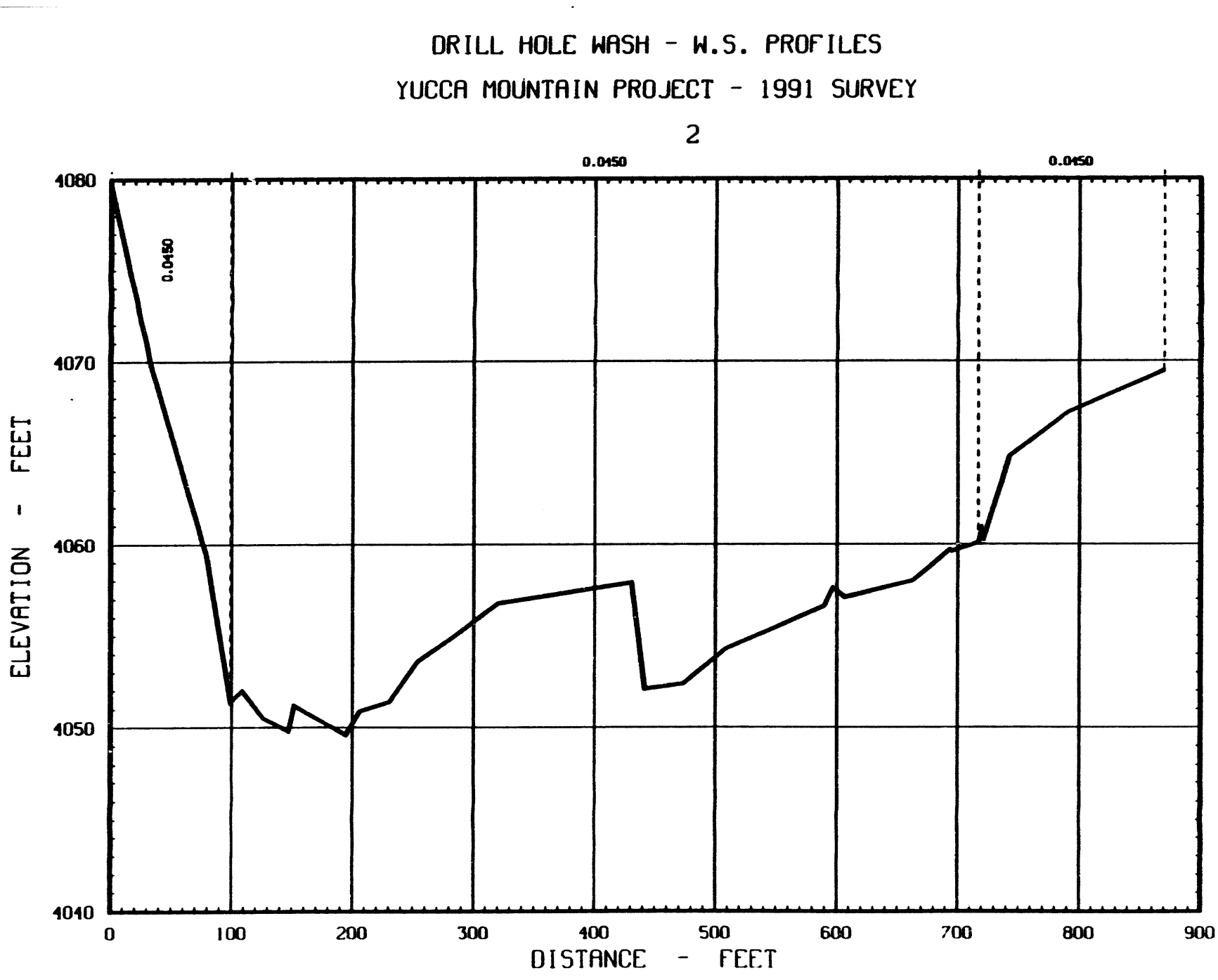


Figure 13 - Drill Hole Wash - Section 2

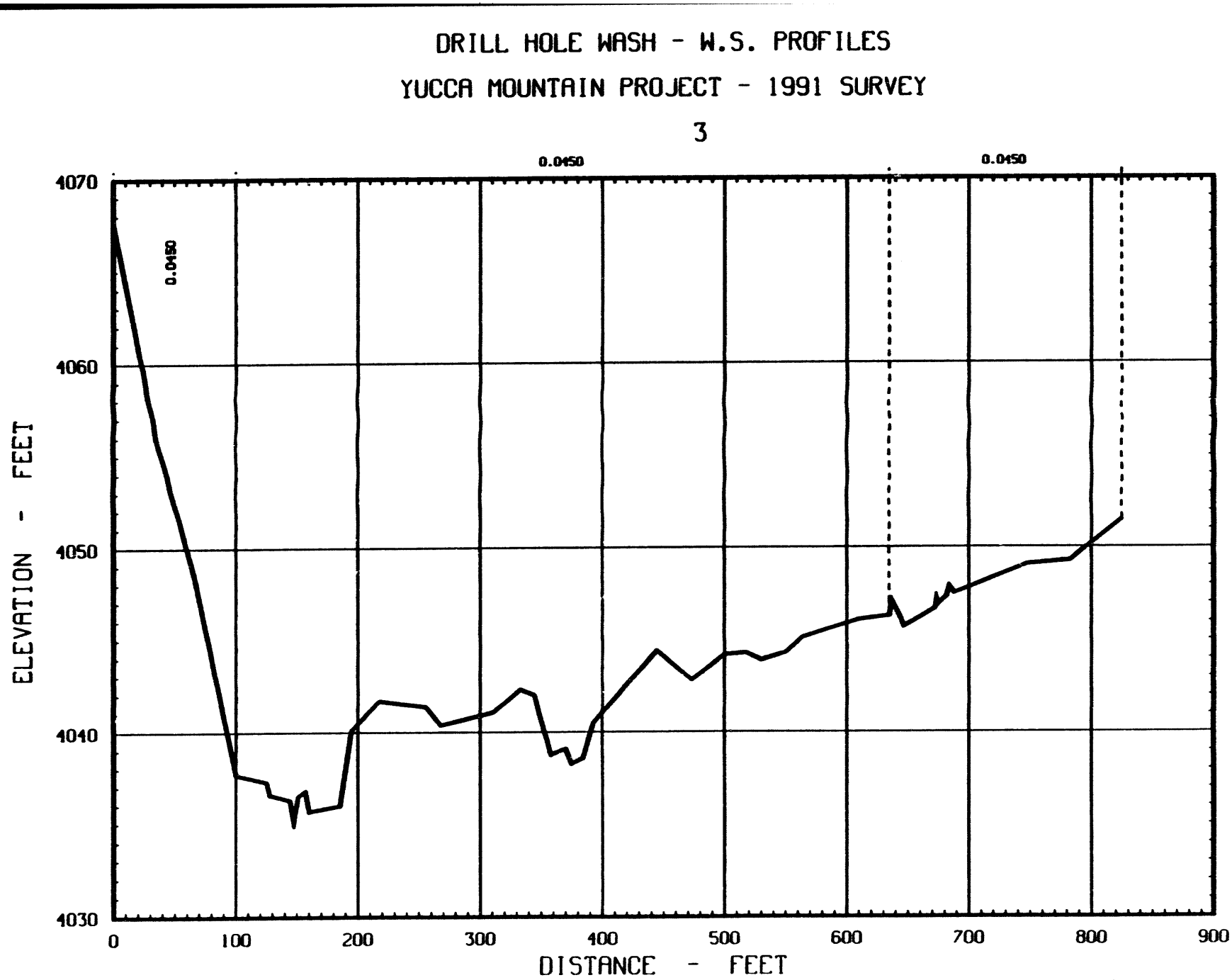
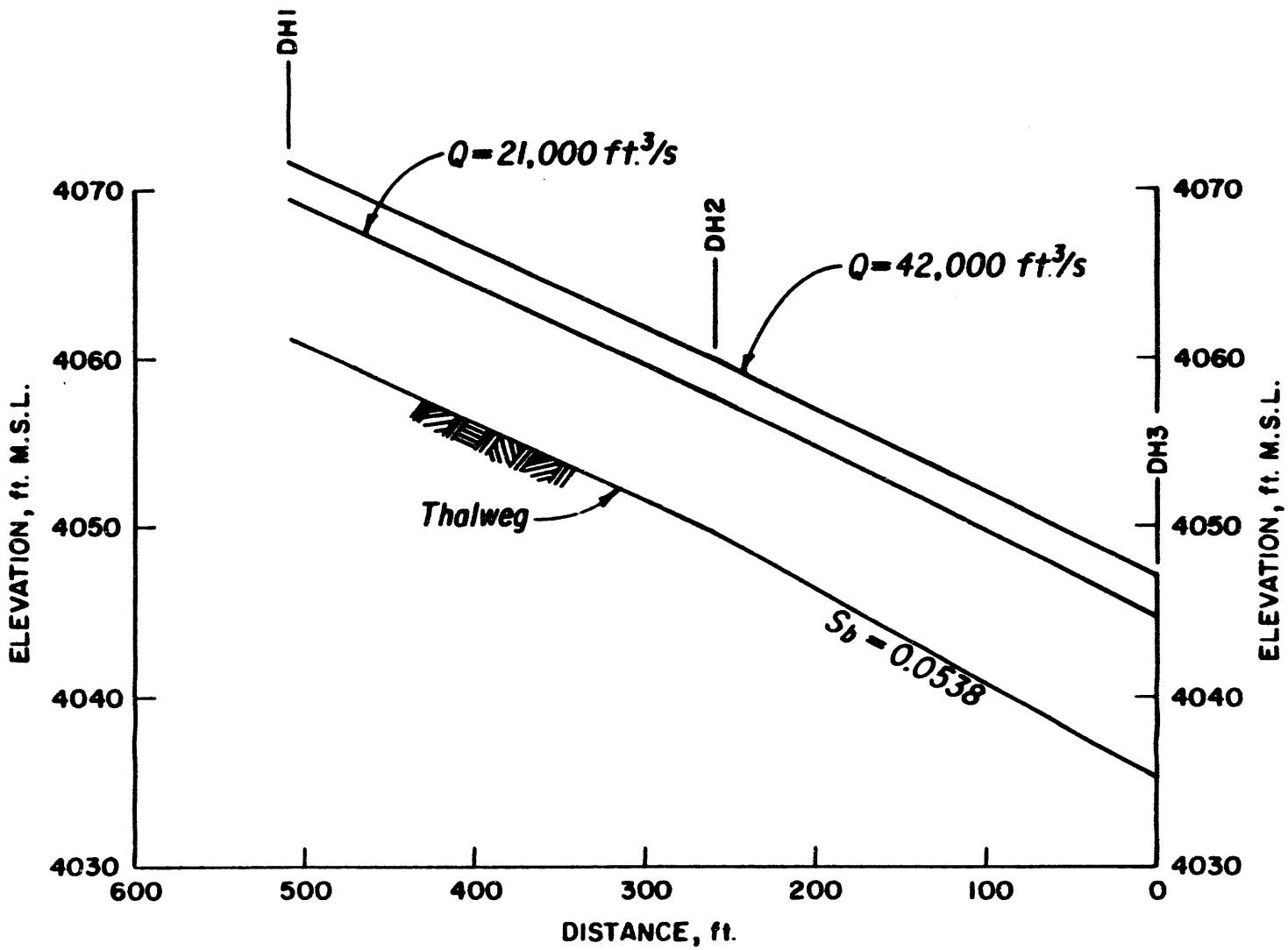


Figure 14 - Drill Hole Wash - Section



DRILL HOLE WASH – WATER SURFACE PROFILES

Figure 15 – Drill Hole Wash – Water Surface Profile

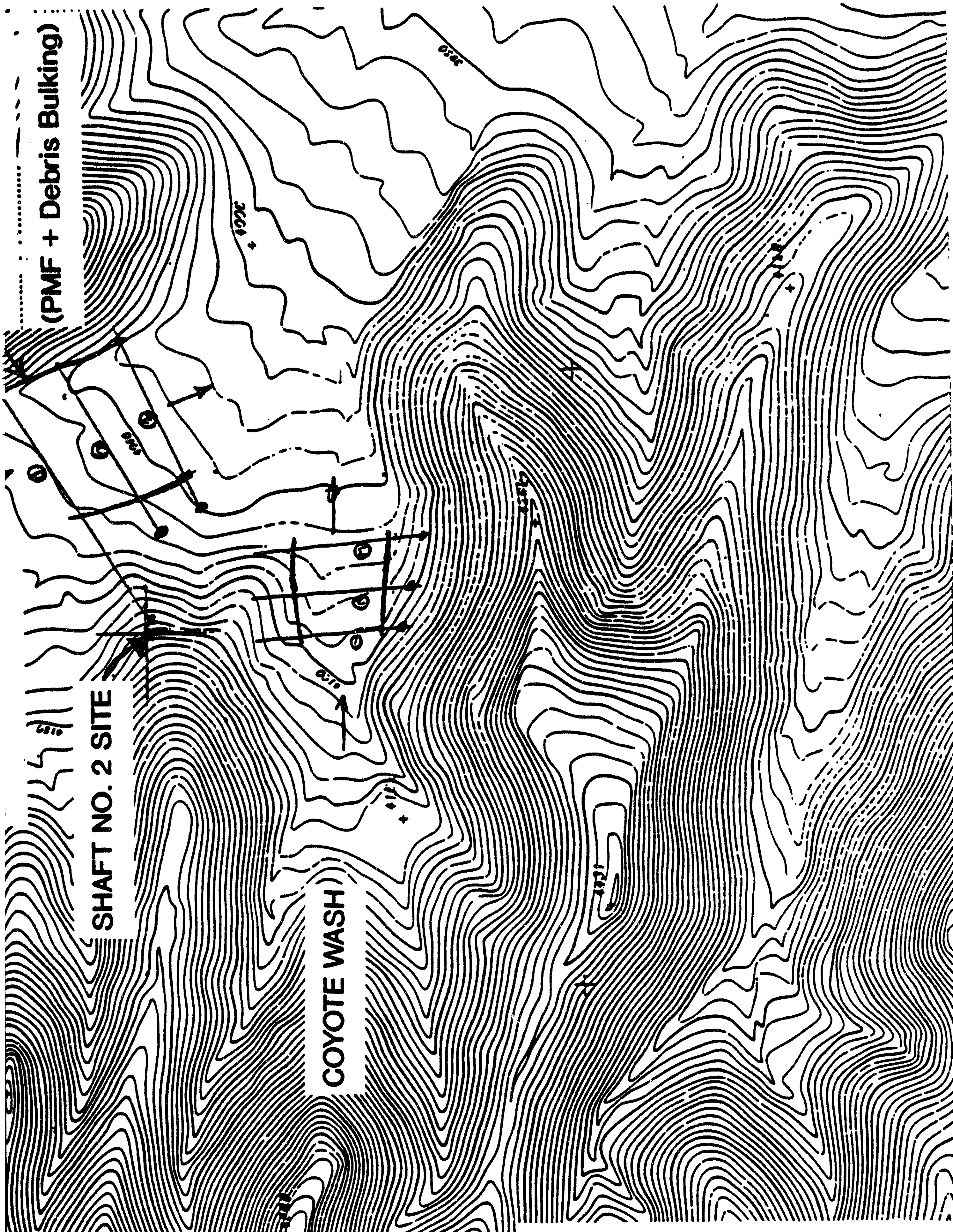


Figure 16 – Coyote Wash – Inundation Map

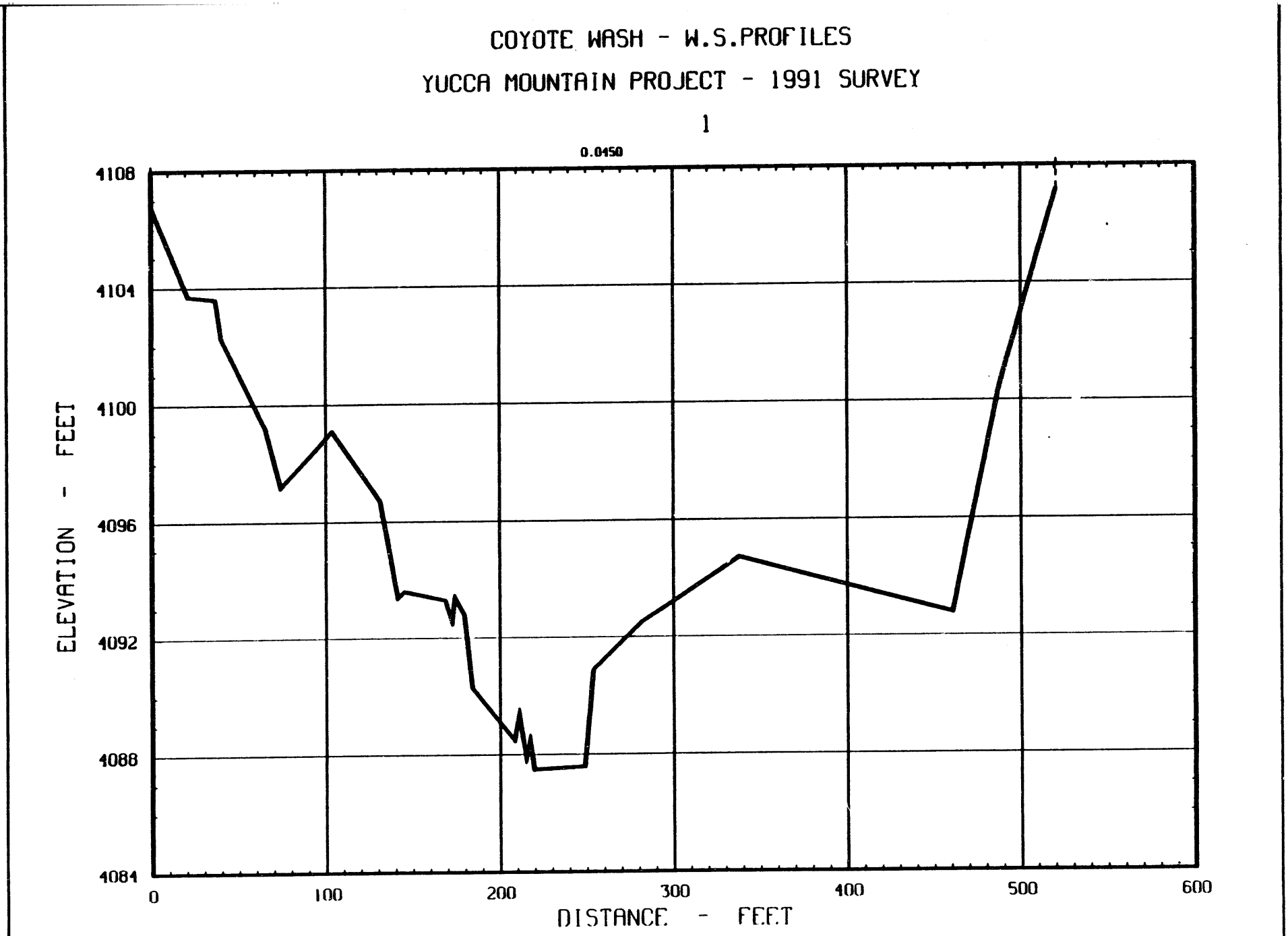


Figure 17 – Coyote Wash – Section

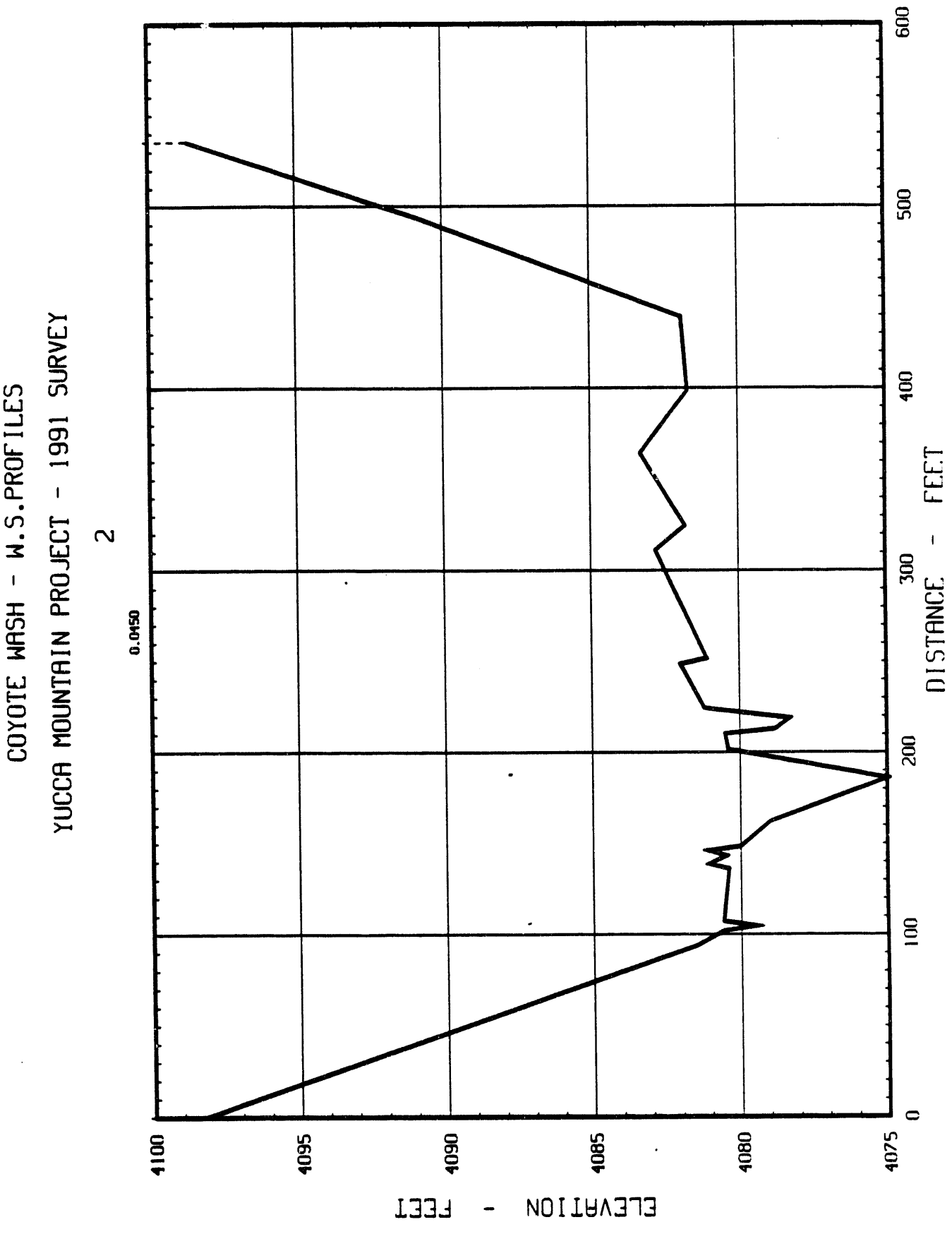


Figure 18 - Coyote Wash - Section 2

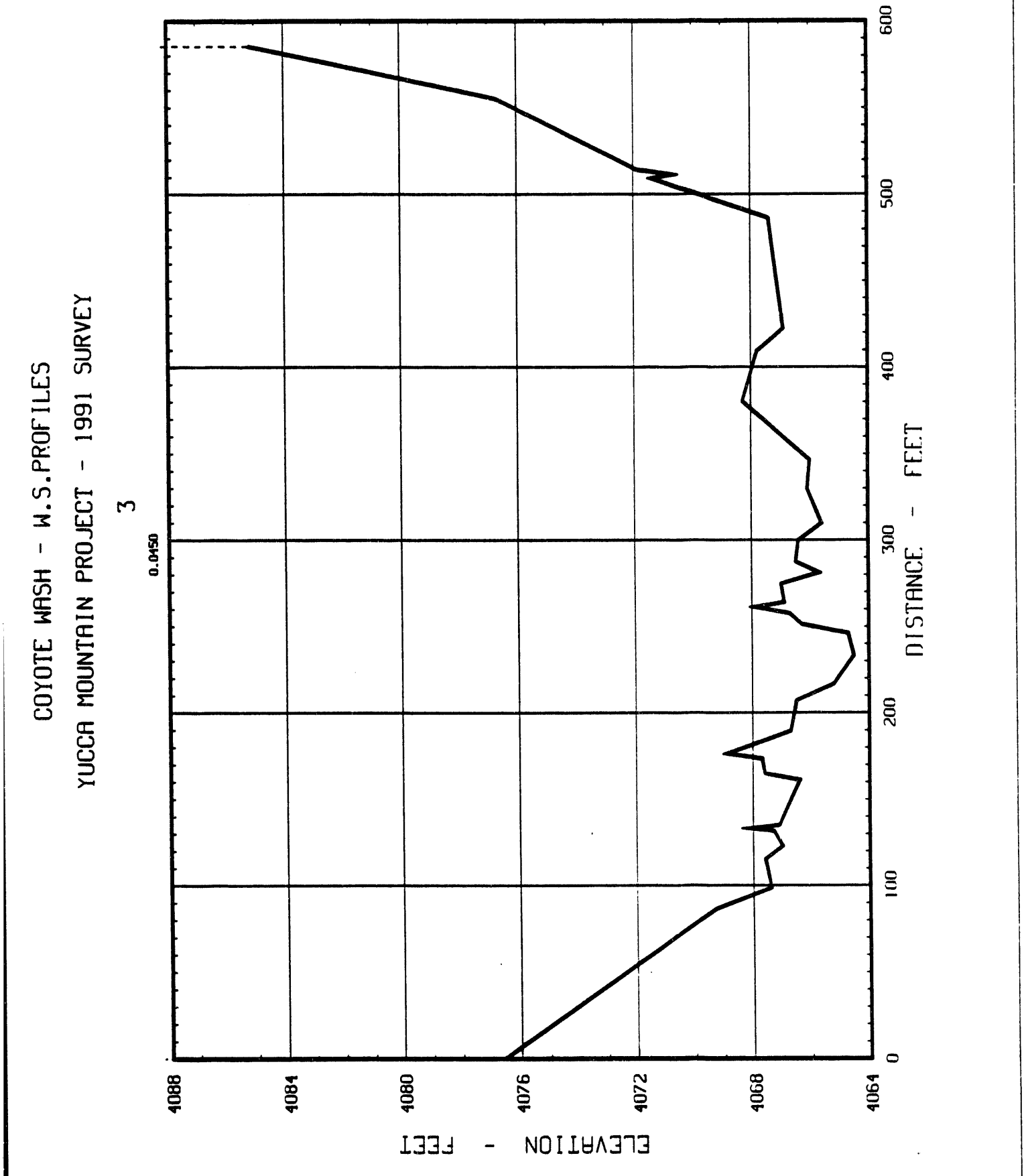
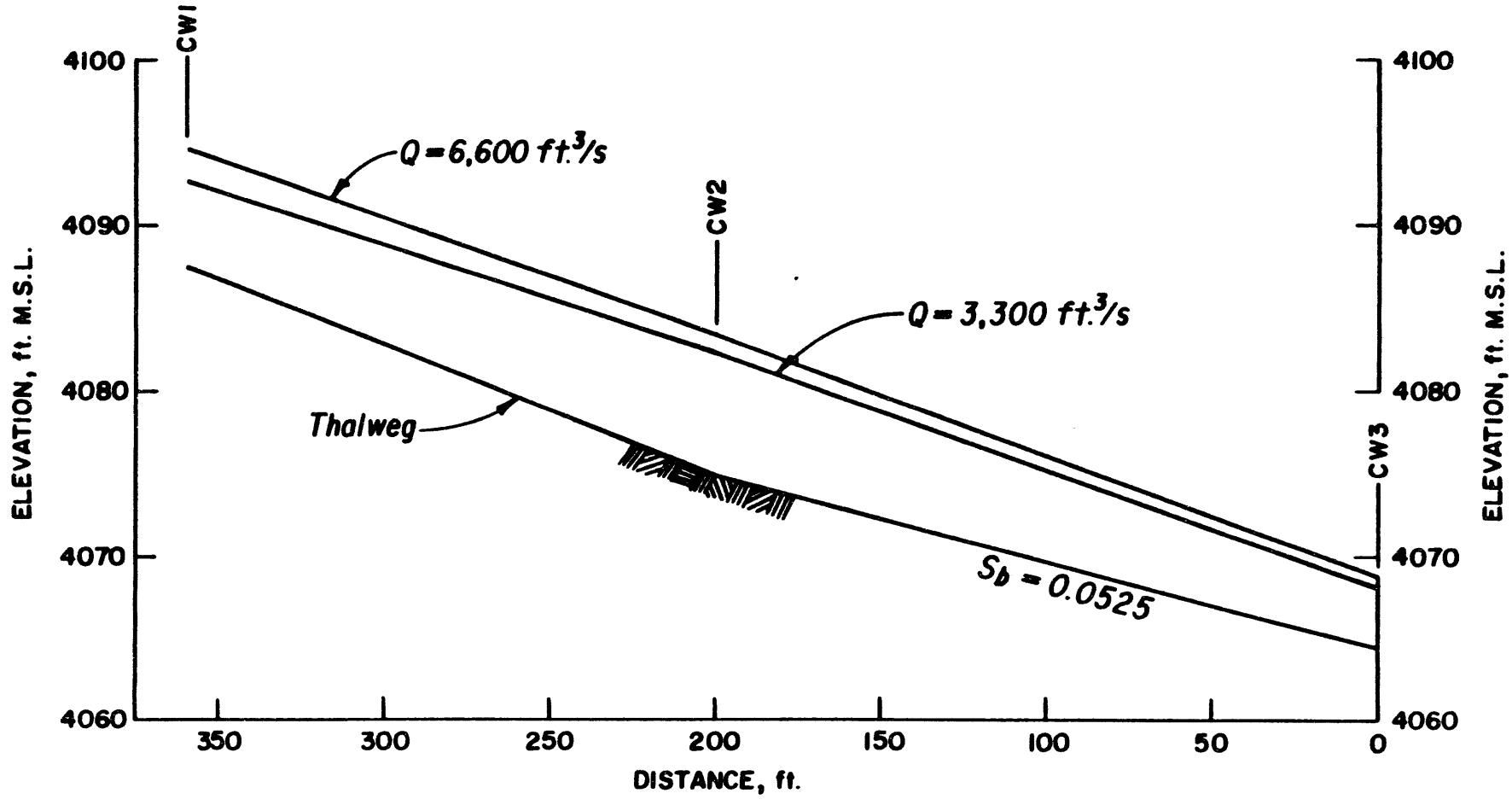


Figure 19 – Coyote Wash – Section 3



COYOTE WASH – WATER SURFACE PROFILES

Figure 20 – Coyote Wash – Water Surface Profiles

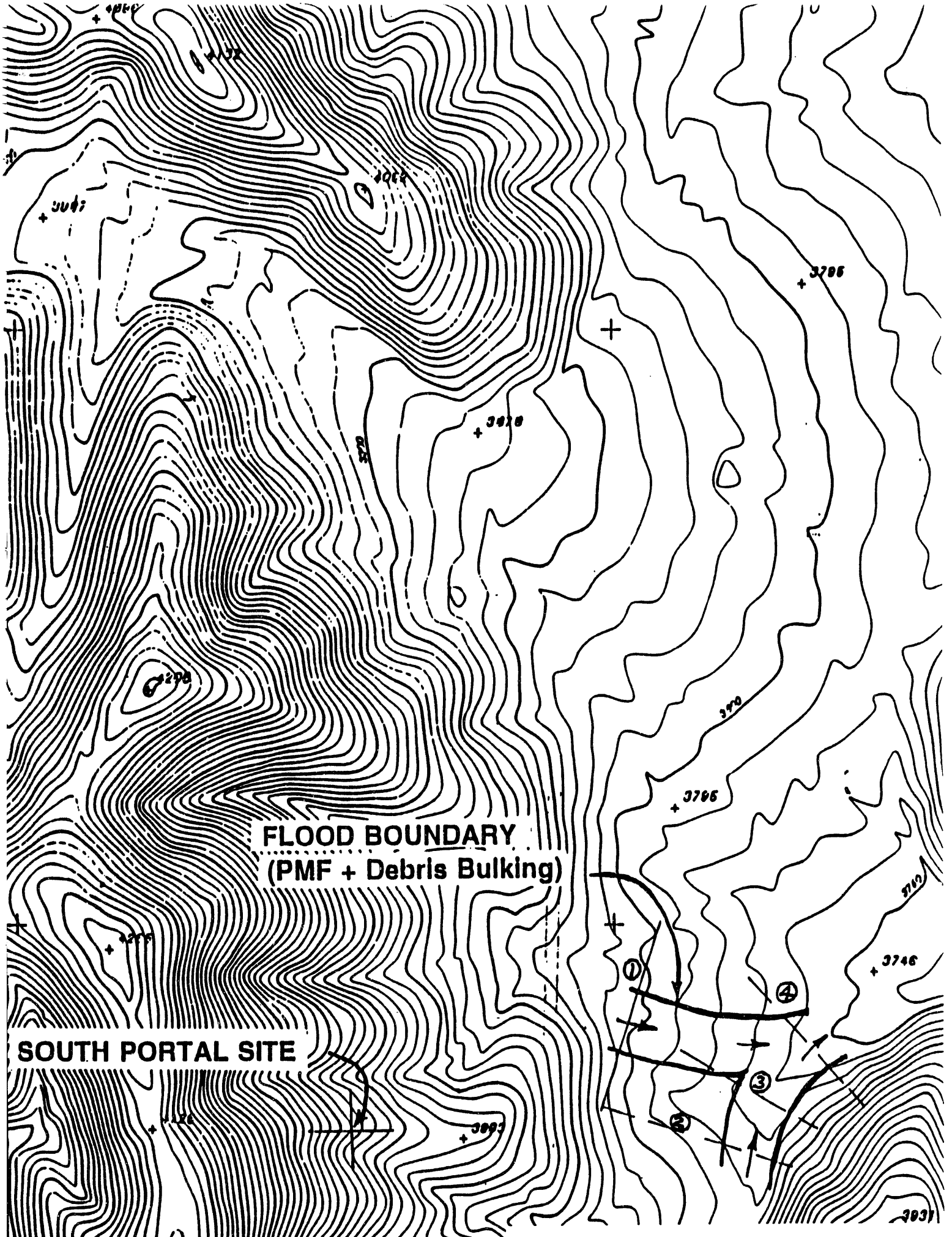


Figure 21 - South Portal - Inundation Map

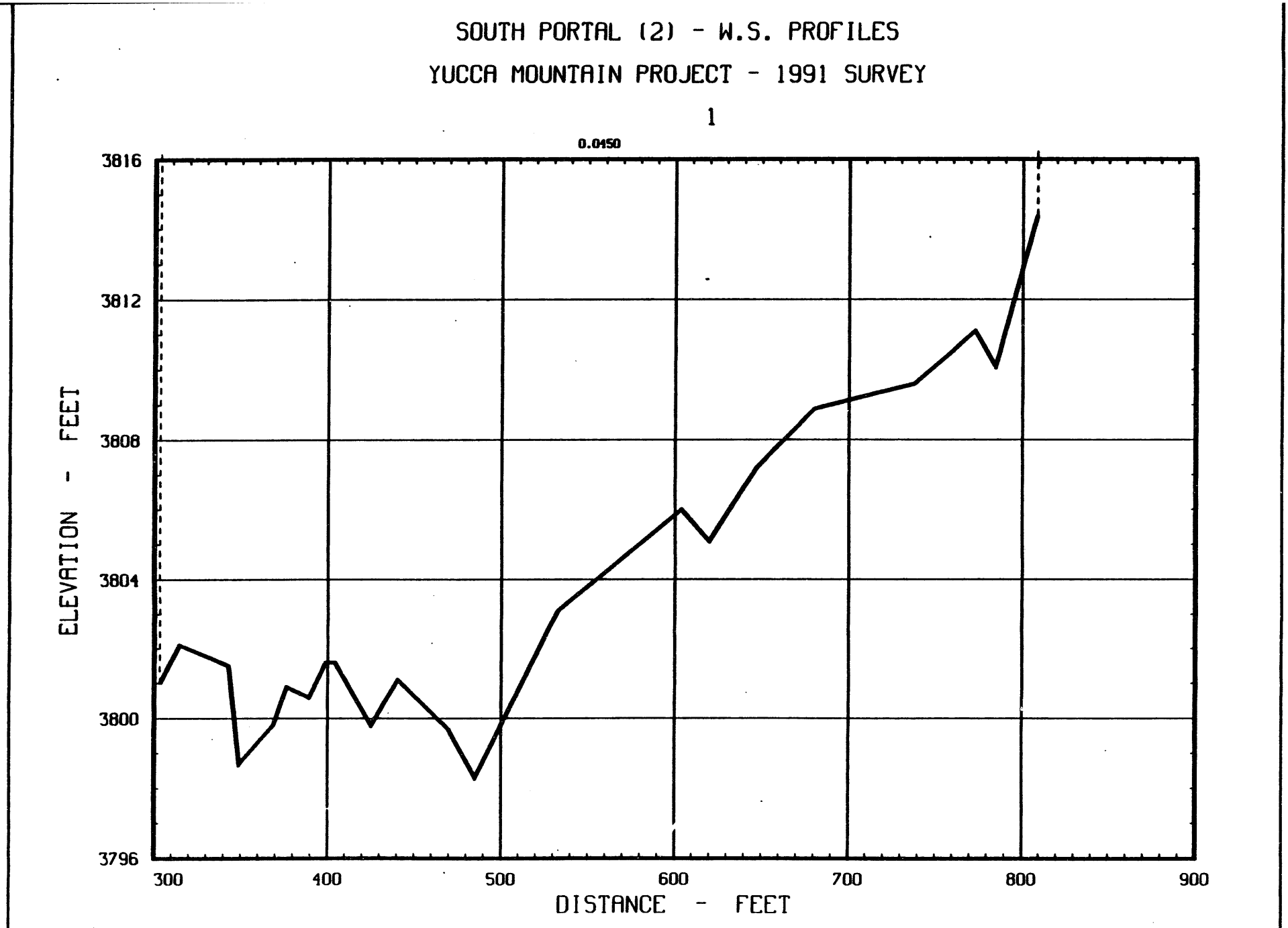


Figure 22 - South Portal - Section 1

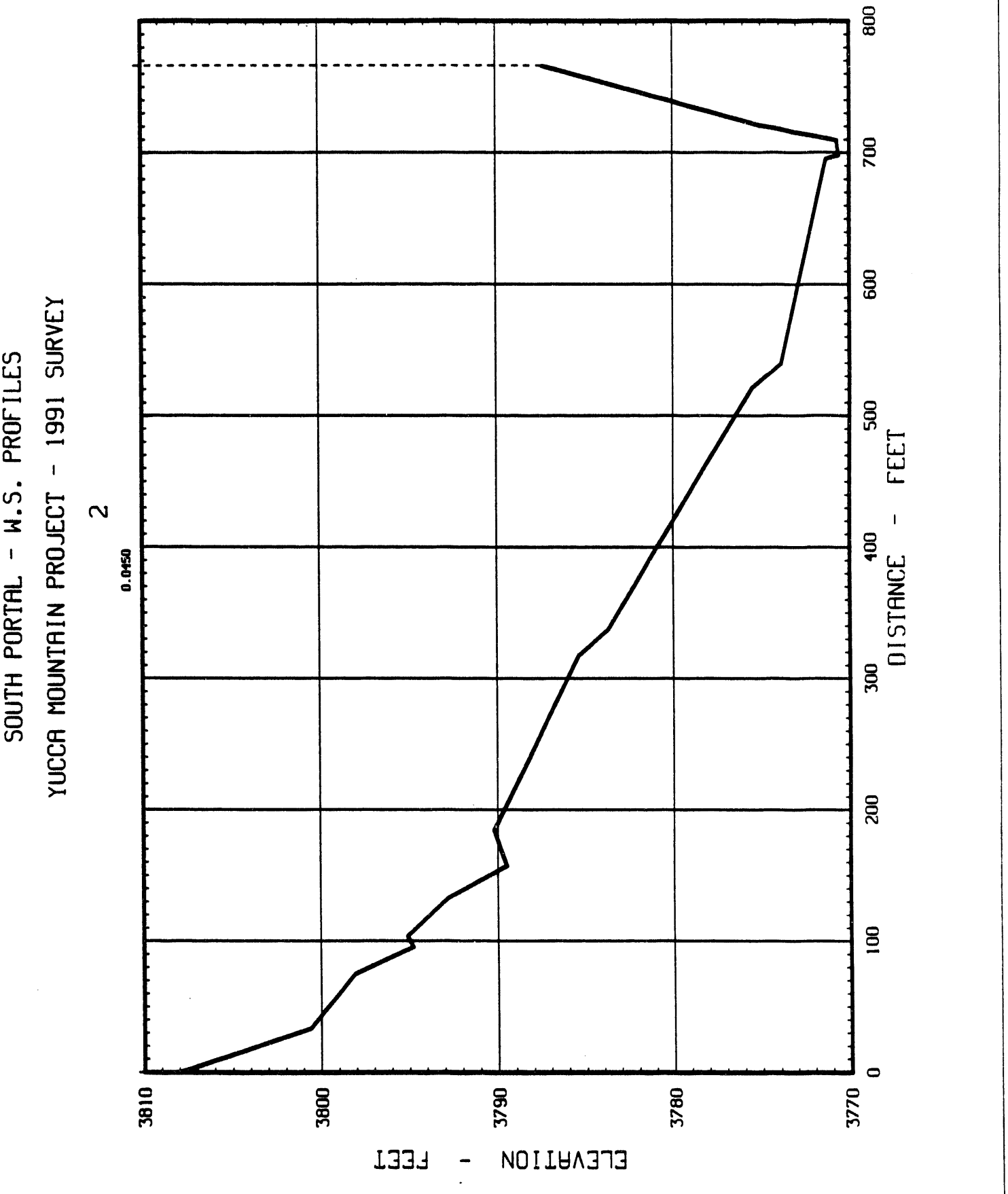


Figure 23 - South Portal - Section 2

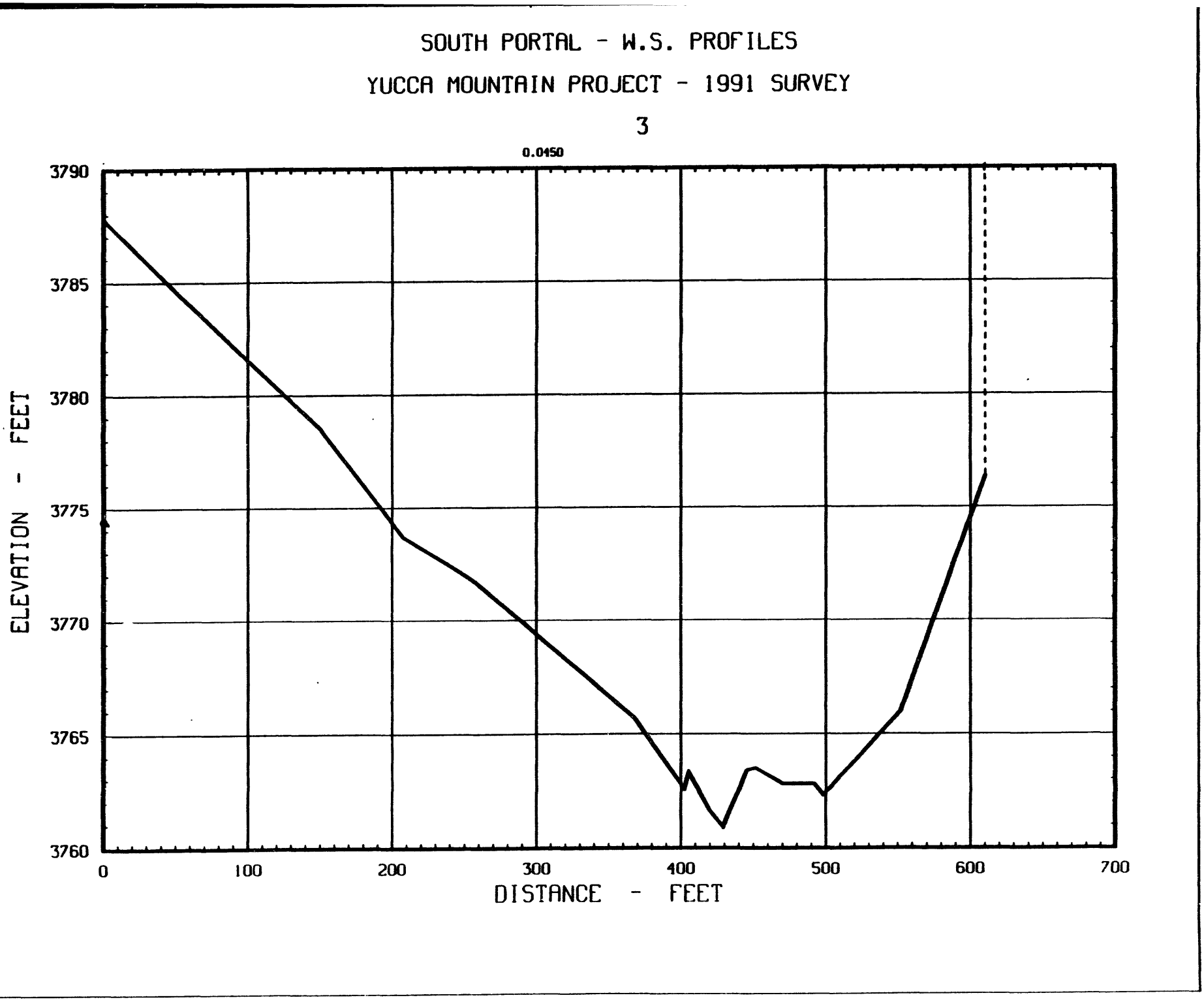


Figure 24 - South Portal - Section 3

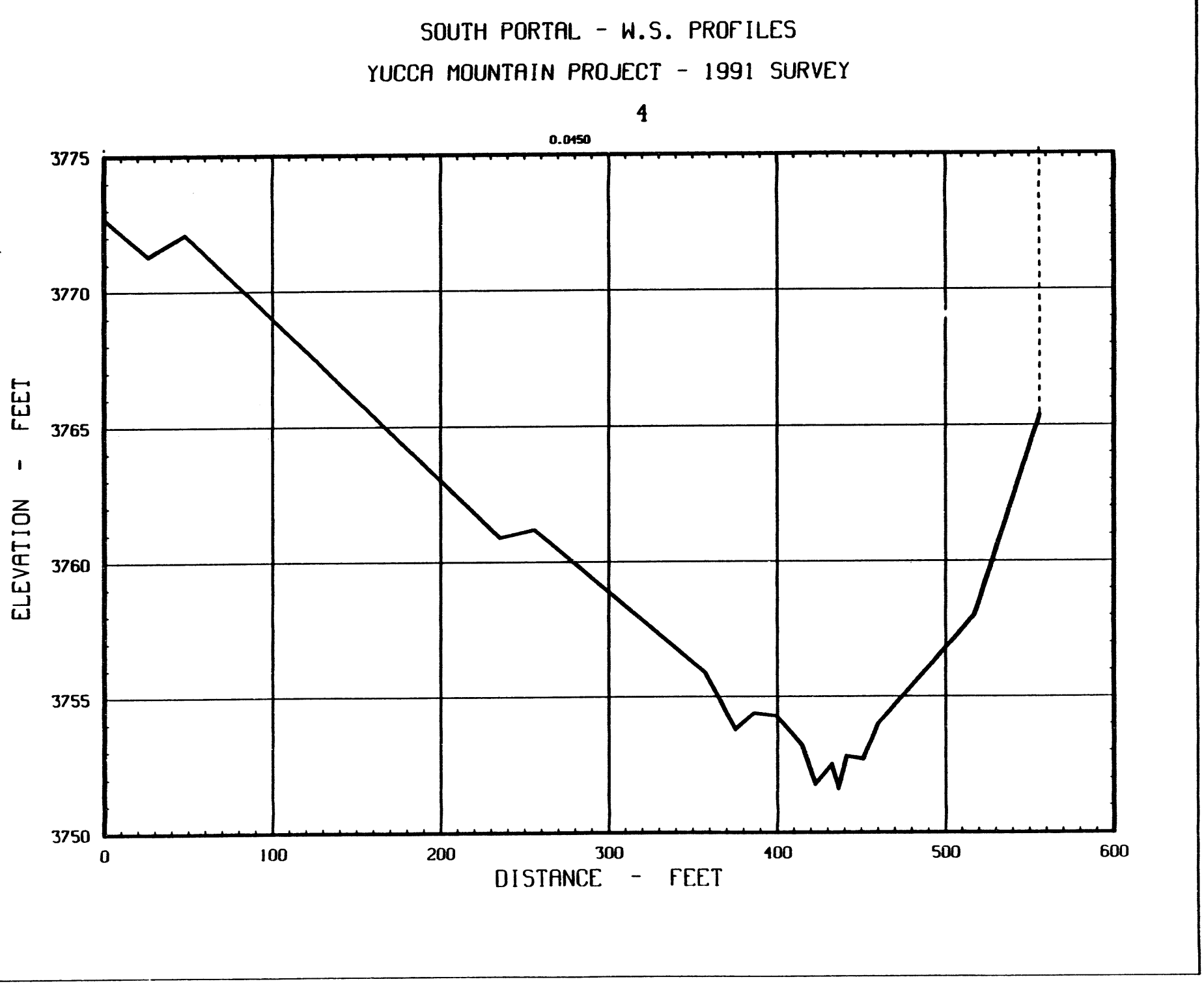
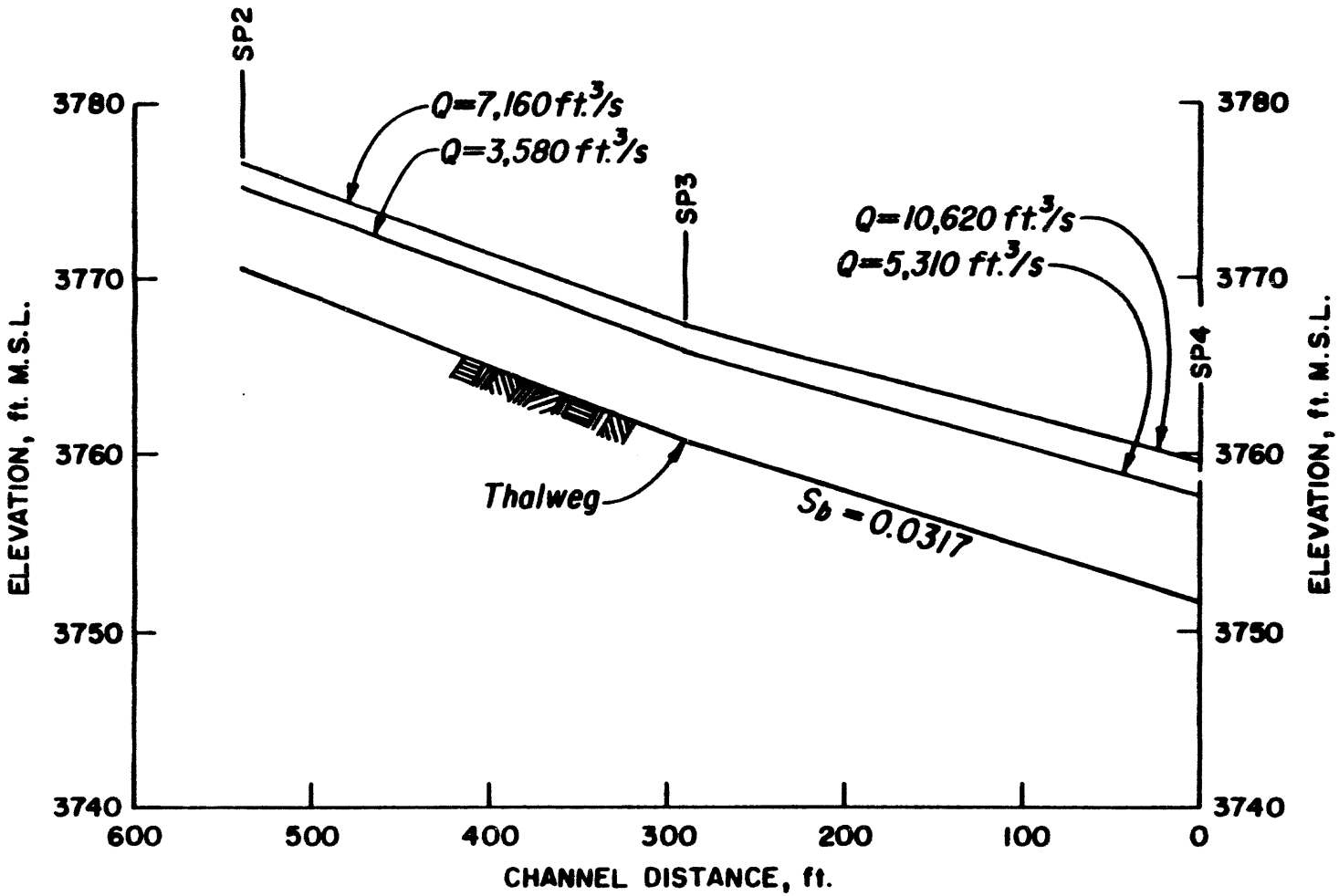
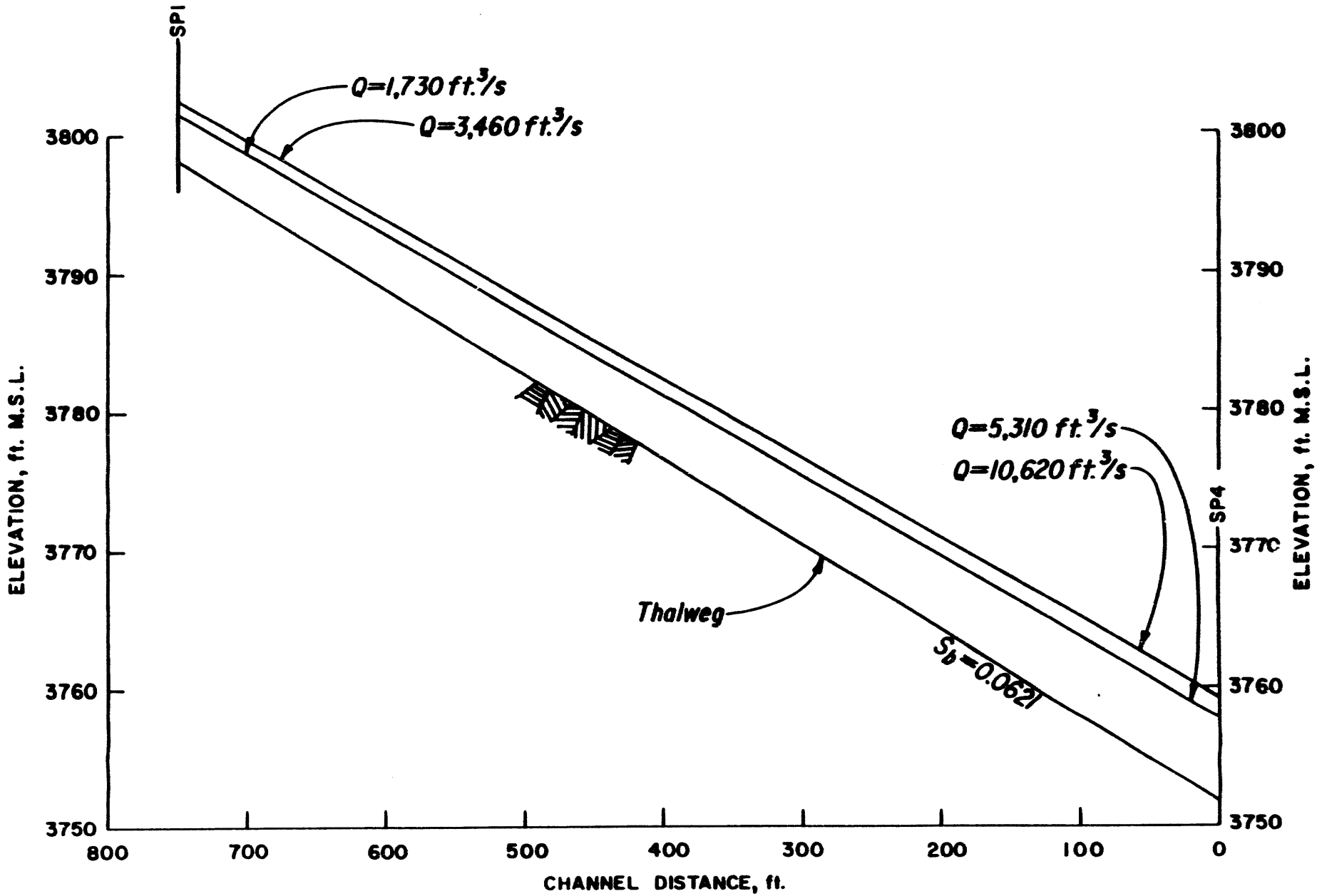


Figure 25 - South Portal - Section 4



SOUTH PORTAL AREA — WATER SURFACE PROFILES

Figure 26 – South Portal – Water Surface Profiles



SOUTH PORTAL AREA – WATER SURFACE PROFILES

Figure 27 – South Portal (2) – Water Surface Profile

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