APPENDIX 7-9

Right Fork of Lila Canyon Flow and Geomorphic Evaluation

Hydrologic Design

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INTRODUCTION:

On January 31, 2004 a stream evaluation was conducted of the Right Fork of Lila Canyon downstream of the proposed mine facilities toward the Price River. The purpose of the study was to determine the impact of a continuous discharge of 500 gpm from the mine would have on the downstream channel. A series of cross-section measurements were taken to characterize the channel configuration and the channel bed and bank materials. Photographs were taken of each cros-section location looking upstream and downstream to help visualize the conditions at the cross-section. Also, a photograph of the bed and bank materials was taken to aid in classifying the material type. The photographs are presented in Attachment #1 to this Appendix.

Figure 1 shows the location of the cross-section sites. The original plan was to collect cross-sections at one-half mile spacings along the channel alignment between the mine site and the Price River. However, at the third cross-section location, a recent diversion structure was found which diverted the normal flow of the Right Fork of Lila Canyon. Previously the flow from the Right Fork joined with the flows from Grassy Wash. However, with the diversion, the entire flow of the Right Fork is diverted to a diversion channel. The location of the diversion dam and alignment of the diversion channel is presented in Figure 1. Ultimately, the diversion channel will convey the flow to a stock pond located in the SW/4, SW/4 of Section 28, T. 16 S., R. 14 E.

This stock pond is a BLM pond. The agency had implemented a range improvement program in the area of the pond. As part of this program, the embankment had been improved and raised, the outlet riprapped, and the diversion structure moved upstream and improved to collect additional flows.

The result of this range improvement project is that the flows from the Right Fork of Lila Canyon will be diverted to the stock pond. If the pond fills, any excess water will be released back to Grassy Wash. Based on the size of the pond, it appears that the pond will hold about 5 to 7 acre-feet.

Results:

Channel sections

The Right Fork of Lila Canyon is an ephemeral channel which is incised into the pediment surface below the Book Cliffs. At cross-section location 1, the channel is incised about 25 to 30 feet and has a top width of approximately 75 to 100 feet. The channel has a low-flow component that consists of a general

trapezoidal shape with 1V:1.5 to 2H slopes, a bottom width of about 5 feet, and a low flow channel depth of almost 1.5 feet. Channel material consists of fine to coarse gravels and fine sands and few silts.

At cross section location 2, the channel is transitioning from the incised section to a broader section at the confluence of the Right Fork with Grassy Wash. In this reach, the channel is incised about 10 to 15 feet and has a top width of approximately 250 to 300 feet. The channel has a low-flow component that consists of a swale shape with gentle sideslopes, a bottom width of about 7.5 to 10 feet, and a low flow channel depth of almost 1.0 foot. Channel material consists of fine to coarse gravels and fine sands and silts.

Upstream of the confluence, Grassy Wash consists of a braided channel with several flow channels. The predominant channel has a top width of 10 to 12 feet with a bottom width of 8 or 9 feet and steep side slopes. The depth of this channel is approximately 2.5 feet deep. The overall channel is approximately 50 to 75 feet wide. Channel material consists of fine to coarse gravels and fine sands and silts.

Downstream of the confluence with the Right Fork, Grassy Wash is again an incised channel. The channel is approximately 10 to 15 feet wide with a depth of 5 to 6 feet. The channel bends to the west and flow is directed against the outer bank. This results in a steep slope on the outer bank and a gentler slope on the inner bank. Channel material consists of fine to coarse gravels and fine sands and silts.

Stream Transmission Loss Modeling

Based on the DOGM estimate for mine discharge, an estimate was prepared to determine if flow would reach the Price River. This estimate is based on the concepts presented in the U.S. Soil Conservation Service National Engineering Handbook Chapter 19 - Transmission Losses (1985). The actual method is based on regression equations derived from Arizona and New Mexico conditions. While the current site is similar, the conditions are different. Therefore, the current site was modeled using similar concepts.

The estimated mine discharge was assumed to be introduced to the channel. The soil designations of the channel area were determined from preliminary soils maps developed by the NRCS Price Office for the Emery County Soil Survey (personnel communication, Leland Sasser, 2004). The length of channel crossing each different soil type was determined. Permeability estimates of the soils were determined from the SCS soil survey engineering properties table. Estimates of channel width and depth, valley fill width and depth, along with the length of soil

sections and permeability data were input into the spreadsheet presented in Table 1. No evaporation was assumed to provide a conservative estimate. Based on the discharge to the channel and the estimates of infiltration and permeability loss over the flow length, an estimate of the distance that the flow would be conveyed was determined.

Given the soils in the area the 500 gpm flow from the mine would be expected to flow a distance of approximately 18,300 feet or 3.4 miles. The distance to the Price River from the mine is about 9.5 miles. Therefore, the flow from the mine will not reach the Price River.

With the presence of the diversion and the anticipated collection of the flows from the Right Fork of Lila Canyon in the stock pond, it is likely that the flow will not reach the 3.4 mile distance estimated.

Flow Characteristics

Based on regresssion equations for ephemeral streams in Utah developed by Thomas and Lindskov (1983), two watersheds on the Right Fork of Lila Canyon were evaluated to determine the peakflow and flow depth of the various return period storms. The first was the drainage from the mine site upstream. The second was the entire drainage upstream from the confluence with Grassy Wash. Calculations are presented in Attachment #2.

The results of the calculations show that the 500 gpm mine discharge (1.1 cfs) is significantly less than the 37 cfs for the 2 year flood flow expected just below the mine site. Given that the regression equations are limited in accuracy, even if the estimated peak is off by a factor of 2, the mine discharge would still be less than 6 percent of the expected peakflow of 18.5 cfs.

The 2 year flow was selected for comparison as this is generally considered to be the bankfull stage or capacity of the low flow channel. Many reseachers consider the bankfull flow to be the major channel forming flow, due to its probability of occurrence and its channel forming energy. Given the fact that the mine water flow is significantly below this flow, its is not likely that the flow will have any significant negative impact on the channel conditions.

It is likely that the constant low flow condition will result in the establishment of a vegetative community adjacent to the channel for the short distance that flow will exist above ground. Additionally, the development of such a community, would increase the evapotranspiration along the flow corridor and ultimately result in a shorter flow distance below the mine.

ATTACHMENT #1

PHOTOGRAPHS

X-section 1 Looking Upstream

X-Section 1 Looking Downstream

X-Section 1 Bed Materials

X-Section 2 - Looking Upstream

X-section 2 Bed Materials

X-section 3 Looking Upstream

X-section 4 Looking Upstream
Diversion Dam center and
Diversion Channel to Right

X-section 4 looking upstream
Diversion channel in center

Diversion Channel above stock pond

ATTACHMENT #2

CALCULATIONS

- EVALUATION OF PEAKFLOWS FOR RIGHT FORK OF LILA CANYON VS MINE DISCHARGE.

- RIGHT FORK OF LILA CANYON IS AN UNGAGED, UN-DEVELOPED WATERSHED. NO FLOW RECORDS EXIST.

- ESTIMATE FLOWS USING REGRESSION EQUATIONS OF THOMAS & LINDSKOV (1983).
  - BASED ON FIGURE 1 (ATTACHED), SITE IS LOCATED IN REGION E - LOW PLATEAUS.
  - INPUTS FOR PEAK DISCHARGE ARE:
    - WATERSHED AREA (SQ MI)
    - MEAN WS ELEVATION (1000'S OF FEET)

- TWO WATERSHED'S ARE TO BE EVALUATED:

A - JUST BELOW SEDIMENT POND

B - @ CONFLUENCE OF GRASSY WASH & RIGHT FORK OF LILA CANYON.

- AREAS

WS A - 12751280 FT^2 = 0.457 Sq MI

WS B - 24207230 FT^2 = 0.868 Sq. MI.

- MEAN WS ELEV. - DETERMINED FROM 20 GRIDDED POINTS OVER WS

WS A - 6910 FT → 6.9

WS B - 6324 FT → 6.3

- REGRESSION EQUATIONS ARE PRESENTED IN TABLE 6 (ATTACHED)

- TABLE 1 PRESENTS THE CALCULATION RESULTS

- BASED ON RESULTS THE 500 GPM ~ 1.1 CFS, IT IS LESS THAN THE 2YR EVENT FOR THE DRAINAGE CHANNEL WITH A FLOW DEPTH LESS THAN 0.9 FT.

- BASED ON STANDARD CHANNEL MORPHOLOGY, THE 2-YR EVENT IS GENERALLY CONSIDERED TO BE BANKFULL FOR A CHANNEL. THE BANKFULL FLOW IS THE FLOW THAT WILL AFFECT CHANNEL MORPHOLOGY THE MOST FREQUENTLY. THEREFORE, IT WILL HAVE THE MOST SIGNIFICANT AFFECT ON CHANNEL SHAPE & CONDITION.

- FOR THE MINE DISCHARGE, THE 500 GPM FLOW WILL EASILY BE CARRIED WITHIN THE LOW FLOW CHANNEL & WILL NOT AFFECT CHANNEL MORPHOLOGY.

EXPLANATION

FLOOD REGIONS

A. Northern Mountains High Elevation
B. Northern Mountains Low Elevation
C. Uinta Basin
D. High Plateaus
E. Low Plateaus
Great Basin—
F. High Elevation Subregion
G. Low Elevation Subregion

BOUNDARY OF FLOOD REGIONS—dashed where based on mean basin elevation.

DRAINAGE DIVIDE BETWEEN GREAT BASIN AND COLORADO RIVER BASIN.

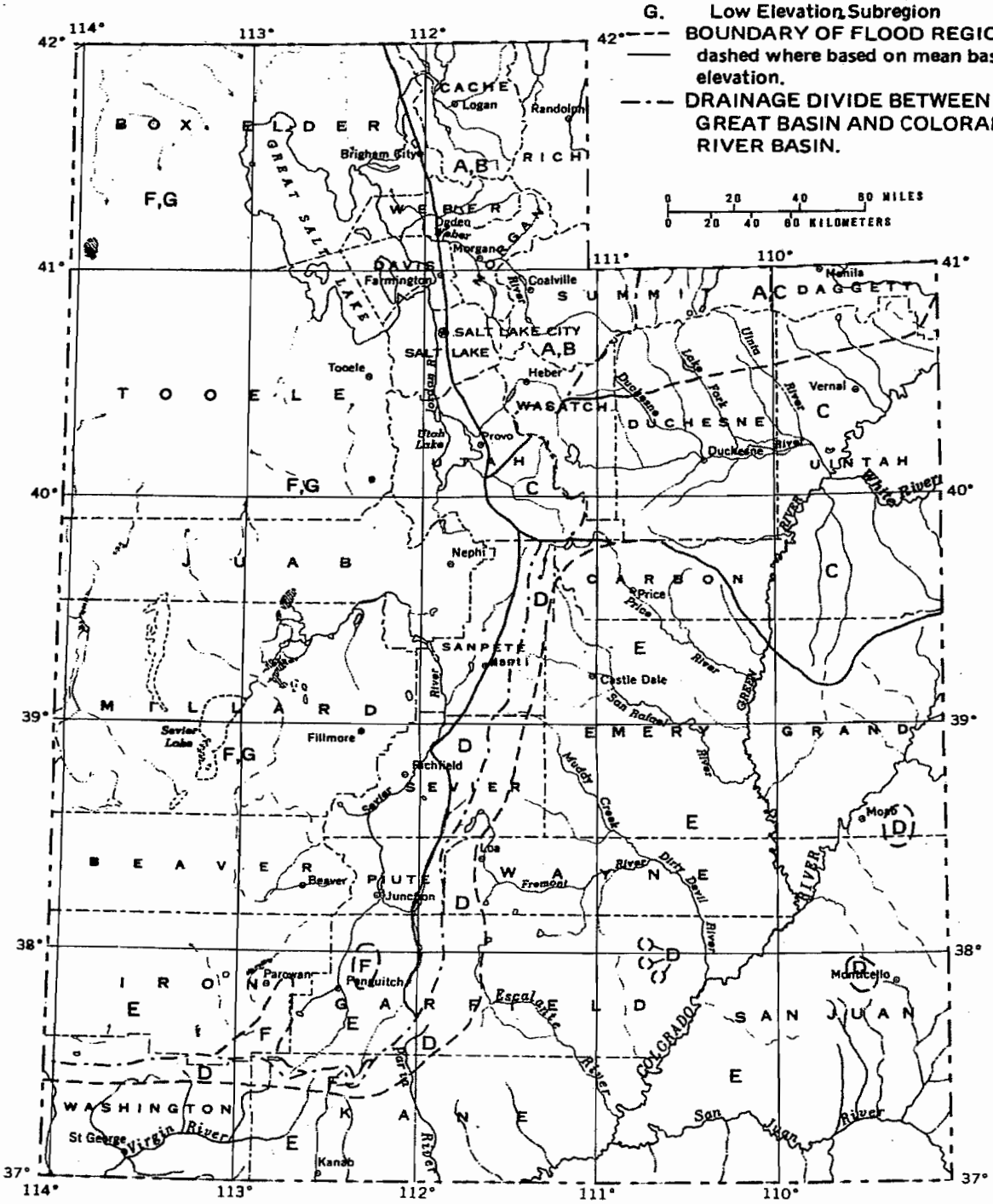

Figure 1.—Flood regions in Utah.

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Table 6.--Regression equations for peak discharges and flood depths of selected recurrence-interval floods for Low Plateaus Region

Equation: Q, peak discharge, in cubic feet per second; D, flood depth, in feet; A, drainage area, in square miles; and E, mean basin elevation, in thousands of feet.

Recurrence interval, in years	Equation	Number of stations used in analysis	Average standard error of estimate, in percent
	Peak Discharge		
2	$Q = 3{,}980\ A^{0.535}\ E^{-2.21}$	81	87
5	$Q = 13{,}300\ A^{0.467}\ E^{-2.23}$	81	72
10	$Q = 23{,}700\ A^{0.433}\ E^{-2.23}$	81	67
25	$Q = 42{,}500\ A^{0.398}\ E^{-2.21}$	81	65
50	$Q = 61{,}000\ A^{0.375}\ E^{-2.19}$	81	65
100	$Q = 83{,}100\ A^{0.356}\ E^{-2.17}$	81	66
	Flood Depth[1]		
2	$D = 11.3\ A^{0.230}\ E^{-1.23}$	46	35
5	$D = 22.7\ A^{0.180}\ E^{-1.25}$	46	35
10	$D = 29.3\ A^{0.157}\ E^{-1.21}$	46	37
25	$D = 32.0\ A^{0.141}\ E^{-1.10}$	46	38
50	$D = 35.8\ A^{0.128}\ E^{-1.06}$	45	37
100	$D = 17.9\ A^{0.143}\ E^{-0.680}$	43	33

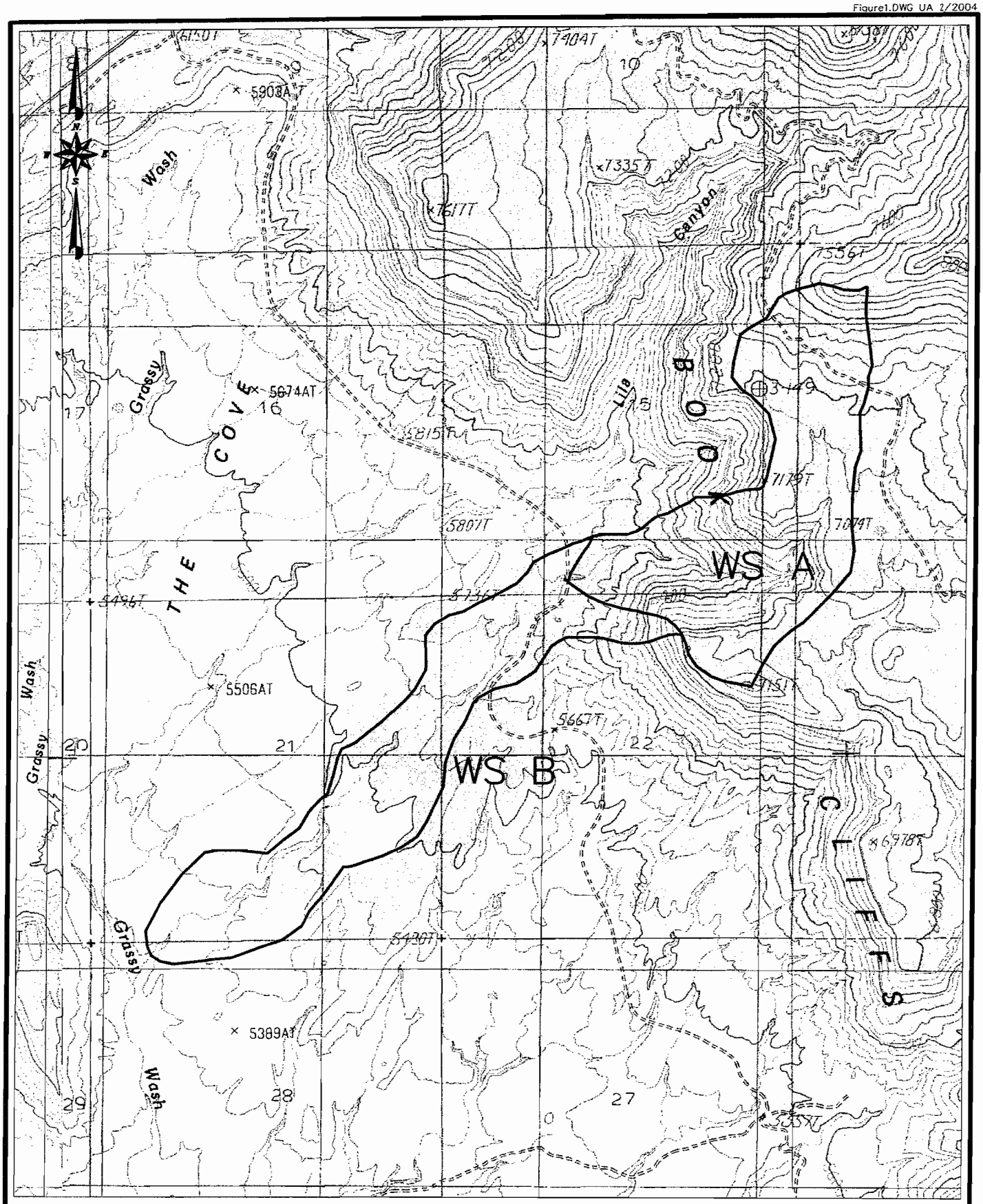
[1] The number of stations used in the flood-depth analysis varies because station rating curves were extended only as far as available information would permit.

Table 1

Regression Calculations for Peak Flow and Flow Depth
For Low Plateau Region - Thomas and Lindskov (1983)

Inputs:	WS A	WS B
Area:	0.457 Sq. mi.	0.868 Sq. mi.
Mean Elevation:	6.9 1000's of feet	6.3 1000's of feet
Peak Discharge Results:		
2yr	37 cfs	63 cfs
5yr	124 cfs	205 cfs
10yr	227 cfs	368 cfs
25yr	436 cfs	688 cfs
50yr	662 cfs	1027 cfs
100yr	951 cfs	1456 cfs
Flood Depth Results:		
2yr	0.9 ft	1.1 ft
5yr	1.8 ft	2.2 ft
10yr	2.5 ft	3.1 ft
25yr	3.4 ft	4.1 ft
50yr	4.2 ft	5.0 ft
100yr	4.3 ft	5.0 ft

Figure1.DWG UA 2/2004



ATTACHMENT 2–FIG 1. WATERSHED LOCATION MAP

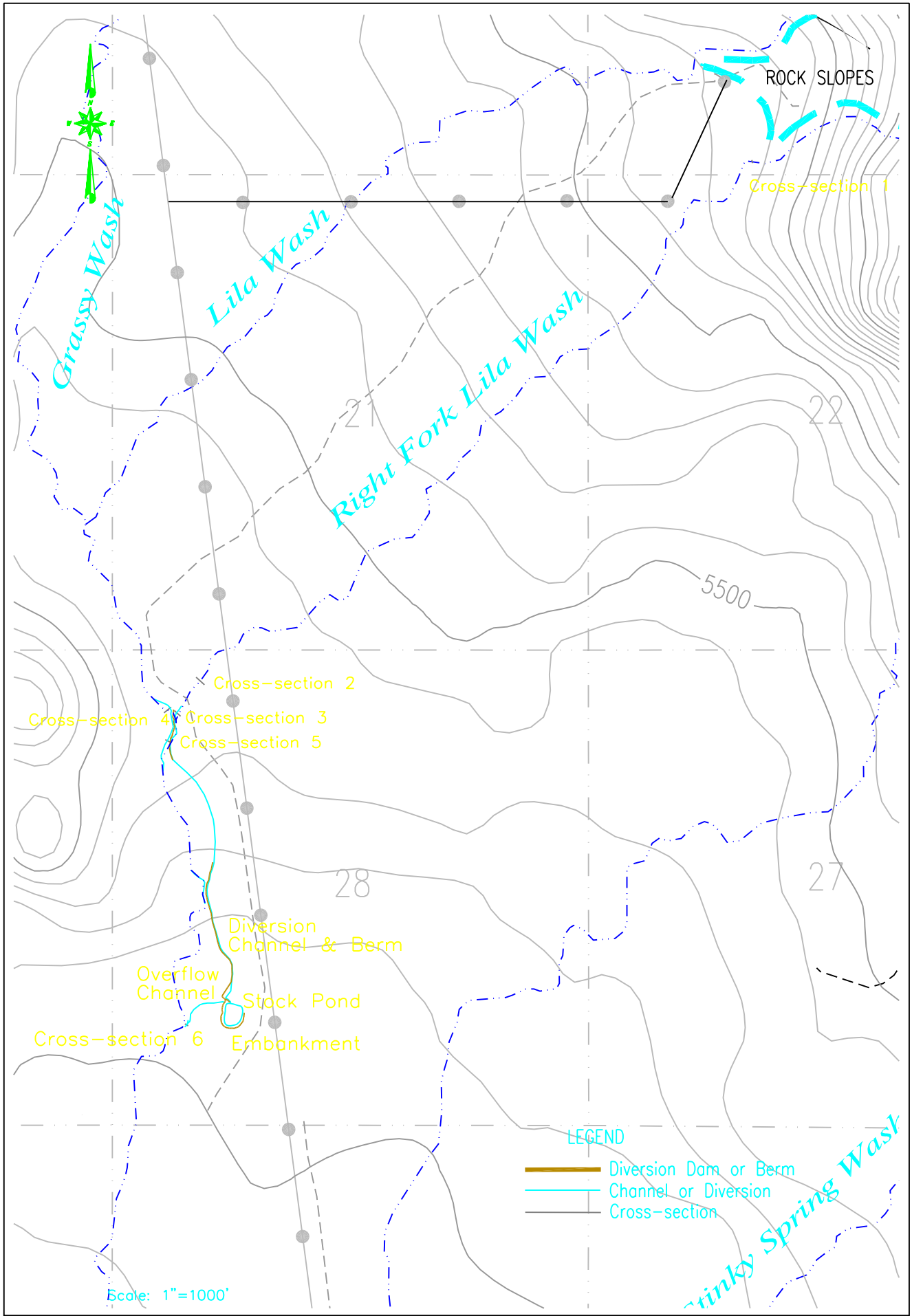


FIGURE 1. Cross-section Locations
Diversion Dam & Channel Alignment

UtahAmerican
Price, Utah

LILA CANYON MINE
Price, Utah

FIGURE1.DWG UA 2/2004