EXHIBIT 55B
STREAM CHANNEL PARAMETERS AND CHANGES DUE TO MINING-INDUCED SUBSIDENCE

PREPARED FOR:

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Revised December 2020
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EXHIBIT 55B
STREAM CHANNEL PARAMETERS AND CHANGES DUE TO LONGWALL MINING-INDUCED SUBSIDENCE

MOUNTAIN COAL COMPANY, LLC

WEST ELK MINE

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STREAM CHANNEL PARAMETERS AND CHANGES DUE TO LONGWALL MINING-INDUCED SUBSIDENCE

INTRODUCTION TO STUDY

Wright Water Engineers, Inc. (WWE) and Ernest Pemberton, P.E.[1] determined the extent to which projected subsidence due to longwall mining would impact stream channel stability and sediment transport at Mountain Coal Company, LLC's (MCC) West Elk Mine. Exhibit 55 was originally prepared for the B-seam longwall panels in the Apache Rocks and Box Canyon mining areas in May 1995, with revisions in November 1997 and November 1999. Exhibit 55A was prepared to address the E-seam longwall panels in the South of Divide mining area in April 2004, with a revision in November 2004. Subsequent to Exhibit 55A, MCC obtained the coal lease to the adjacent Dry Fork mining area. Tetra Tech prepared Exhibit 55B in September 2007, using Exhibit 55A as a base and incorporating the Dry Fork mining area. The December 2020 update was performed in order to reflect the most current information regarding the layout for the Sunset Trail longwall panels and panel E14 and the projected overburden thickness in these areas.

Figure 1 shows the drainage basins and stream channels in the vicinity of the Southern Panels (South of Divide and Dry Fork), Apache Rocks West, and Sunset Trail longwall panels study areas. Although Figure 1 also shows the layout of the development mining, this exhibit only addresses potential impacts due to longwall mining of the panels. Each basin has an identification number that will be used throughout this discussion of stream channel parameters and subsequent changes. As shown on Figure 1, Basins 3 through 6 and 26 through 35 are located in the Dry Fork of Minnesota Creek (Dry Fork) drainage; Basin 36, Lick Creek, is a tributary to the East Fork of Minnesota Creek. Minnesota Creek is a tributary to the North Fork of the Gunnison River (North Fork). Basin 37 is Deep Creek, a tributary to Raven Creek, which is a tributary to the North Fork. Basins 38 and 39 are within the South Prong watershed, tributary to the East Fork of Minnesota

[1] Prior to his passing, adjunct Scientist with WWE, Former Head of Sedimentation and River Hydraulics Section, Hydrology Department, Chief Engineer and Assistant Commissioner's Office, U.S. Bureau of Reclamation.

Creek. Basin 41 is Lion Gulch, a tributary to Minnesota Creek.

This report evaluates the extent of potential subsidence due to mining of the B-seam in longwall panels LWB26 through LWB29 within the Southern Panels mining area and the E-seam longwall panels LWE10 through LWE12 in the Apache Rocks West mining area. Finally, this report assesses potential subsidence over panels LWE14, and LWSS1 through LWSS4 in the Sunset Trail mining area. All panel layouts evaluated in this exhibit are shown in Figure 1.

As of December 2020, MCC had completed mining in E-seam longwall panels in LWE1 through LWE8. LWSS1 has been mostly mined. LWE14, LWSS2, LWSS3, and LWSS4 have not yet been mined. This exhibit assesses potential subsidence over portions of these unmined and partially mined panels, depending on the location of the study reach.

Table 1 identifies streams that may be impacted by the proposed mining. The mining area encompasses portions of 20 separate minor tributaries of the Dry Fork, Lick Creek, South Prong and Deep Creek in the study area. Table 1 lists the basins and whether or not they are potentially impacted by proposed mining. This study focuses on a detailed evaluation of the potential subsidence impacts to 7 representative basins overlying the existing and/or proposed longwall mining. A detailed discussion of the mine plan and projected subsidence for these areas is given in Exhibit 60E.

The first portion of this hydraulic and hydrologic evaluation establishes pre-mining, or baseline, conditions. The second portion of this evaluation describes the potential and likely impacts of mining operations on the surface drainage system and channel characteristics.

EXISTING STREAM CHANNEL CHARACTERISTICS

The existing stream channel characteristics have been defined for various parameters, including channel slopes, peak flow rates for a variety of frequencies of occurrence, flow velocities for each of the frequencies, sediment transport regime, stage-discharge relationships, channel profiles, and channel and over-bank stability.

The existing channel shapes were related to the dominant discharge (2-year frequency of occurrence). Sediment transport has been defined for each stream using the annual sediment load; however, sediment transport is a long-term value and represents the full range of flows including the 10-year and 100-year frequency peak discharges.

For each of the existing stream channels, many hydrologic and stream channel parameters were defined and evaluated, including:

1. Mean annual runoff
2. Peak discharges for the 2-year, 10-year, and 100-year frequency floods
3. Mean annual sediment yields
4. Average thalweg[2] slopes
5. Channel characteristics (consisting of width and depth relationships as well as other geomorphic properties)
6. The range of the channel slopes from near mouth to upper reach

Other factors that influence the long-term channel characteristics include the forested area and frequency of landslides.

[2] Line following lowest part of a valley, i.e., invert of channel.

BASIN HYDROLOGIC CHARACTERISTICS

WWE evaluated and studied each of the 8 basins and corresponding stream channels to define basic hydrologic characteristics related to the streams. This information is summarized in Table 2. While there are differences in soils and vegetation within the study areas, for the purpose of this conceptual analysis, conservative estimates of water yield and sediment yield have been adopted.

Average Annual Runoff

The mean annual runoff expressed in acre-feet (AF) per year per square mile is a fundamental parameter for determining annual average sediment yield. Total annual precipitation varies widely throughout the 526-square-mile basin of the North Fork Gunnison River (North Fork) at Somerset. In the higher elevations of the entire North Fork basin, precipitation can total up to 50 inches per year. Annual precipitation for the drainage basins near West Elk Mine typically ranges from 22 to 30 inches. Precipitation in excess of that portion lost to evapotranspiration and deep percolation (i.e., precipitation that ultimately becomes streamflow), also varies widely in the basin.

Woodward-Clyde conducted a water balance analysis for Horse Creek and Lick Creek for 1978 to 1980. The study, based on the Lick Creek stream gaging station, indicated an average annual runoff of 8.9 inches, representing 475 AF per square mile.

MCC's Exhibit 18 indicates an annual runoff approaching 1,000 AF for one square mile for a variety of North Fork watersheds. However, that finding is modified by their reference to much lowered water yields in South Prong and Horse Creek for the 1977 to 1978 period, which were lower than the driest-year yields of the regional basins.

The North Fork gage near Somerset provides the best long-term runoff data in the region, with 69 years of continuous gaging records. The 69-year period of record identifies a mean annual runoff of 630 AF per square mile; the runoff magnitude is significantly affected by the higher precipitation values at higher elevations in the drainage basin.

Analyses of water yield by WWE for the Division No. 4 Water Court approved water augmentation plan (Case No. 86CW38), indicated that typical annual water yields for tributaries of Dry Fork were approximately 200 AF per square mile. This value compares favorably with the yield estimate of 160 AF per square mile per year based on the U.S. Geological Survey (USGS) regional regression equations (USGS 1985).

The 1936 through 1947 and 1985 through 2002 periods of gaging flow on Minnesota Creek show an average annual yield for 41.3 square miles of 385 AF per square mile.

For the purpose of annual average sediment yields for the subject basins, WWE has concluded that an appropriate (i.e., conservative) mean annual runoff for the subject basins of 475 AF per square mile should be adopted, even though site-specific data for the basins would likely indicate a mean annual runoff of less than 475 AF per square mile. The adopted value represents a high mean annual runoff for use in conservative sediment and channel stability studies. For water rights purposes, the average year yield estimate of 200 AF per year is suitable, as approved by the Colorado Water Court in 1986.

The adopted mean annual runoff for the subject basins is used for sediment and channel stability purposes only. It is not proposed for use in water rights studies or for site-specific water budgets.

Peak Runoff Rates

Peak rates of storm runoff from rainfall and snowmelt events were defined for three return frequencies: 2-, 10-, and 100-year events.

These discharges are based on statistical evaluation of peak daily flow data collected by MCC in the permit area since 1978, study of the long-term published records for the North Fork at Somerset, and statistical evaluation of published streamflow data for basins in the vicinity of West Elk Mine. Special evaluations were made of the Lick Creek, Sylvester Gulch, and Horse Creek basins using the USGS peak rate of runoff computational procedure applicable to small basins in the Colorado mountainous area (USGS 1985).

Figure 2 provides a semi-logarithmic plot of the peak discharge rates. The semi-logarithmic plotting technique was adopted to analyze the small tributary basins under consideration. The results are consistent with the regional analyses for the North Fork.

Sediment Yield

The mean annual sediment yield for each of the streams is presented, for convenience, in terms of three units of measurement:

1. Tons per year
2. AF per year
3. Cubic yards per year

The mean annual sediment yields for each basin were estimated by utilizing a wide range of published and unpublished data combined with site-specific information and basin characteristics.

Sediment yield parameters for similar basins were evaluated using the USGS *Water Resources Investigation Report 87-4193* by John Elliott entitled *Regionalization of Mean Annual Suspended Sediment Loads in Streams, Central, Northwestern, and Southwestern Colorado* (1988). In addition, the rate of sediment production was evaluated using field observations of the basin characteristics, photographs, maps, aerial photos, and comparison with other mountainous regions with similar vegetative cover and similar characteristics for which sediment yield data were available. The typical suspended sediment concentrations of similar streams were taken into consideration for comparison and for “reasonableness” checks.

The adopted sediment yield rate of 0.03 AF per square mile per year for the subject basins, when coupled with annual water yield, results in an average annualized sediment concentration of approximately 70 mg/L. This is consistent with regional analyses for the North Fork.

STREAM CHANNEL HYDRAULIC CHARACTERISTICS

The stream channel regime and characteristics were defined using still photographs, videotapes, USGS topographic maps, detailed topographic maps prepared for the mine area, soil surveys, geological evaluations prepared by the late John Rold (former State Geologist and consultant to WWE), aerial photographs, and related evaluations. Channel profiles portraying the pre-mining slope and the range of slopes for each stream segment are presented in Figures 3 through 20. In previous versions of Exhibit 55B, USGS quads (40-foot contour interval) were used to develop the pre-mining channel profile. Pre-mining channel profiles in the December 2020 update have been developed based on topography provided by MCC with 20-foot contour intervals.

A summary of the stream channel hydraulic characteristics (width, depth, and velocity) for each of the 8 drainage basins is provided in Table 3. The channel dimensions are intended to generally represent each stream and provide a baseline, against which to compare potential changes due to longwall mining. The slope in the lower reach of the channel potentially impacted by mining is shown in addition to the average channel slope since only the lower reach will receive the full basin runoff.

The dominant discharge is the flow for the stream that tends to shape the stream channel and help establish the width and depth of the defined channel. The dominant discharge can vary based upon a number of watershed conditions, but correlates best with 1- to 2-year peak flow rates. For this analysis, the dominant discharge was assumed to be the 2-year return interval peak flow.

Erosion and sediment yield of a stream basin are normally a product of rainfall, ground cover, land use, topography, upland erosion, runoff, soil types, geology, sediment, and channel hydraulic characteristics. All of these factors were considered in this analysis.

The channel characteristics shown in Table 3 for the dominant discharge are for the stream near the mouth or at a point just downstream of each segment of stream channel potentially impacted by longwall mining. The width and depth values at the dominant discharge in Table 3 are approximate values based upon computed physical basin regime characteristics and identification of characteristics from photographs taken on selected stream channels in the area.

In 2020, WWE performed work relating to the South Prong stream channel through which we gained site-specific knowledge of the hydraulic characteristics. As a result, we have updated our channel geometry and refined our analyses of potential effect of longwall mining to incorporate this experience.

The width to depth ratio, floodplain connectivity, substrate material, and channel slope provide an understanding of the geomorphic context of the study stream systems. The hydraulic characteristics provided in Table 3 result in existing width-to-depth ratios of 12 and 4 for South Prong and Lion Gulch, respectively. As typically observed in headwater systems, the steep terrain surrounding each study reach sets both streams within a confined valley. A confined-valley type results in channels that are relatively entrenched, with little to no access to a broad floodplain. Similarly, the existing terrain results in steeper channel slopes and stream substrate that can withstand the higher velocities associated with the steep terrain. Together, these hydraulic and geomorphic characteristics indicate that both study reaches consist of cascading stream channels within the steeper sections and step-pool channel morphology where channel slopes are less than 4%.

IMPACTS OF SUBSIDENCE ON STREAM CHANNELS

The projected subsidence under each of the 8 studied stream channels in the study area was calculated using Surface Deformation Prediction System (SDPS), Version 6.2G (Department of Mining Engineering, University of Kentucky; Department of Mining and Minerals Engineering, Virginia Polytechnic Institute and State University), as calibrated using site-specific subsidence data. Exhibit 60E presents a detailed discussion of the subsidence evaluation.

All longwall panels were set at an elevation of zero, with the stream channel represented above based on overburden thickness. In utilizing SDPS, each stream channel reach was represented as a series of points (spaced 200 feet apart) with X, Y, and Z coordinates. The Z value for each point is the approximate overburden depth based on 10-foot overburden contours provided by MCC. Subsidence and changes to channel slope were determined along the profile.

Table 4 shows that the most significant changes will occur in the tributaries overlying a significant portion of both the B-seam and E-seam panels. The E-seam mining thickness is projected to be 14[3] feet at a maximum to the west, and 11 feet at a maximum to the east. The B-seam thickness is projected to be 9 feet in the most southerly panel, and 14 feet at a maximum to the north. The Sunset Trail panels mined in the E-seam are expected to have similar mining thickness values, with lower mining heights projected near the eastern end of the panels.

Basin Number 3 is the Horse Gulch basin, a tributary to Minnesota Reservoir. Because the B-seam has already been mined, this basin will only be affected by proposed E-seam mining. Basin 3 channel's slope will increase by a maximum 10.6% and will decrease by a maximum 2.9% due to E-seam mining. Because the pre-mining average slope of this channel is 11.1%, the slope changes due to subsidence do not create any reaches with negative or flat slopes. Maximum subsidence along the stream profile is approximately 8.3 feet. The pre- and post-mining profiles for Basin 3 are shown in Figure 21. This figure demonstrates that the overall channel slope is not

[3] Practically speaking, the maximum mining height with the current longwall is 13.5 feet; therefore, WWE used a height of 13.5 in the computer modeling.

projected to be significantly impacted by subsidence.

Basins 29 (Poison Gulch) and Basin 32 (Deer Creek) are tributary to Basin 35 (Dry Fork of Minnesota Creek). These three basins will be affected by both B-seam and E-seam mining. E-seam mining in the lower reaches of these drainage basins has already occurred without any noticeable adverse impacts. Within these three basins, the maximum changes in slope are an increase of 3.5% and a decrease of 5.1%. Because the pre-mining average slope of these channels ranged from 5.3% to 9.7%, the slope changes due to subsidence do not create any reaches with negative or flat slopes. Maximum subsidence along the stream profile of Basins 29, 32, and 35 is approximately 14.7 feet, 14.3 feet, and 15.2 feet, respectively. The pre- and post-mining profiles for Basins 29, 32, and 35, are shown in Figures 22, 23, and 24; these figures demonstrate that the overall channel slope is not projected to be significantly impacted by subsidence. There may be localized reaches within Deer Creek (Basin 32) where the post-mining slope flattens to roughly 1%.

Basin Number 36 is the Lick Creek basin, a tributary to East Fork Minnesota Creek. This basin will only be affected by E-seam mining. The Basin 36 channel's slope will increase by a maximum of 2.3% and will decrease by a maximum 4.4%. However, since the pre-mining average slope of this channel is 7.1%, the slope changes due to subsidence do not create any reaches with negative or flat slopes. Maximum subsidence along the stream profile is approximately 6.5 feet. The pre- and post-mining profiles for Basin 36 are shown in Figure 25. This figure demonstrates that the overall channel slope is not projected to be significantly impacted by subsidence.

Basin Number 37 is the Deep Creek basin, tributary to Raven Gulch. This basin will be affected by both B-seam and E-seam mining. The Basin 37 channel's slope will increase by a maximum 1.7% and will decrease by a maximum 3.0%. However, because the pre-mining average slope of this channel is 8.3%, the slope changes due to subsidence do not create any reaches with negative or flat slopes. Maximum subsidence along the stream profile is approximately 13.4 feet. The pre- and post-mining profiles for Basin 37 are shown in Figure 26. This figure demonstrates that the overall channel slope is not projected to be significantly impacted by subsidence.

Subsidence along the South Prong channel (Basin 39) ranges from zero to approximately nine feet. As shown in Table 3, the maximum decrease in slope is 3.7%, and the maximum increase is 1.5%. Given the average pre-mining slope of 18.1%, slope changes due to subsidence are not expected to create any reaches with negative or flat slopes. Figures 27A and 27B show subsidence along the full extent of South Prong and zoomed in to the western edge of LWSS4, respectively.

Subsidence along the Lion Gulch channel (Basin 41) ranges from zero to approximately nine feet. As shown in Table 3, the maximum decrease in slope is 3.0%, and the maximum increase is 1.8%. Given the average pre-mining slope of 24.2%, slope changes due to subsidence are not expected to create any reaches with negative or flat slopes. Figures 28A and 28B show subsidence along the full extent of Lion Gulch and zoomed in to the western edge of LWE14, respectively.

As shown in Figures 27B and 28B, the existing slope at the downstream limit of the subsidence was projected to decrease due to the projected subsidence. Reduction of the stream slope will likely result in an increased width to depth ratio, a reduction in channel velocity, increased floodplain connectivity, and increased potential for sediment deposition. South Prong will likely maintain a step-pool morphology where larger pools are developed, and riparian plants establish upon the gentler channel side slopes. Morphological changes to Lion Gulch are predicted to be less prominent due to the ephemeral nature of the drainage and relatively low flow rates.

The existing slope at the upstream limit of the subsidence is projected to increase. An increased stream slope generally results in a decreased width-to-depth ratio, an increased channel velocity, reduced floodplain connectivity, and increased potential for erosion. As the channel in the upper reaches currently maintains a cascade morphology, steepening of this reach will not fundamentally change the stream type. Furthermore, the observed outcroppings of bedrock in South Prong and larger material indicative of these steep streams will likely further mitigate against the potential for erosion where slopes have steepened beyond their existing condition. The Lion Gulch drainage will experience minimal change in its headwaters as the subsidence extends to the top of the watershed.

Although the changes in slope may impact the geomorphic characteristics of the channel, the potential for adverse impacts to stream function remain low. The dominant discharge will naturally shape a channel dimension that will be in dynamic equilibrium with the existing up- and downstream reaches that are not impacted by the subsidence.

CHANGES IN STREAM CHANNEL HYDRAULIC CHARACTERISTICS

The channel characteristics for each of the basins (as shown in Table 3) were analyzed using geomorphic and sedimentation engineering relationships and formulas to determine the extent and type of change to each channel segment. These relationships were then used to estimate the amount of sediment yield change.

Hydrologic review has determined that the following basin characteristics will not change significantly as a result of subsidence:

1. Mean annual runoff
2. Peak discharge
3. Dominant discharge
4. Forest cover

Mean annual runoff, peak discharge, and the dominant discharge are greatest for the lower end of each stream segment studied, priming these areas of the channel for maximum geomorphic change. Therefore, this analysis focuses primarily on the lower portion of each stream segment. Computations were performed for the lowest channel reach within the influence of the mining.

A principle of fluvial morphology, as confirmed by Manning's equation, is that the channel width and channel depth will respond to changes in slope as shown in the following table.

	Channel Width	**Channel Depth**
Slope Increase Due to Subsidence	Larger	Smaller
Slope Decrease Due to Subsidence	Smaller	Larger

The deformation of the ground surface due to subsidence results in a change in the existing channel slope. The magnitudes of changes were first computed based on the subsidence model output, then the changes were applied to the existing channel slope to determine the resultant post-mining channel slope. For purposes of determining changes in channel hydraulic characteristics, the channel slope near the lowest reach with predicted subsidence was used for calculations.

Utilizing geomorphic channel regime relationships, it was determined that the changes to channel geometry shown in Table 5 would typically occur over a period of approximately three to five years. There is potential for more rapid channel change in localized areas depending on factors such as forest cover, soil saturation, and channel composition. The changes in depth and width are the maximum computed values considering both a slope increase and slope decrease. However, it should be recognized that the maximum changes in channel width and depth would not occur over the same channel reach.

CHANGES IN SEDIMENT YIELD

The mean annual sediment yield for each basin is not expected to change except for minor channel cutting and filling over a period of three to five years or more. Overall, there will be a tendency for these changes in sediment production to balance out within the basins.

As shown in Table 2, the mean annual sediment yield for the subject basins ranges from approximately 30 to 90 cubic yards per year. These sediment yields are not expected to change (i.e., increase or decrease) by more than about 5 percent due to any change in hydraulic characteristics resulting from the increase in slope as identified in Table 4.

SUMMARY

Stream channel characteristics will change as a result of longwall panel subsidence. This analysis of stream channels was undertaken to determine the magnitude of subsidence along channel profiles and changes to channel slope due to longwall mining. The changes to stream channel parameters were analyzed using standard procedures of the sedimentation and geomorphic engineering professions based on the effects of thalweg slope changes (either increase or decrease) due to mining-induced subsidence. The results are summarized in Table 4.

Of those streams and longwall panels analyzed, the maximum estimated change in channel width is 9 feet, and the maximum change in channel depth is 0.8 feet (Table 5). Changes in stream channel width and depths generally are expected to occur over a period of three to five years. However, there is potential for more rapid localized change due to factors such as soil saturation, forest cover, and channel stability. The likely change in sediment yield is not expected to deviate by more than 5 percent from the values given in Table 1.

Subsidence in the studied basins can reach magnitudes of up to nine feet and extend along hundreds of feet of channel. Although the changes in slope may impact the geomorphic characteristics of the channel, the potential for adverse impacts to stream function remain low. The dominant discharge will naturally shape a channel dimension that will be in dynamic equilibrium with the existing up- and downstream reaches that are not impacted by the subsidence.

In general, channel geometry changes and channel profile lowering are expected to occur over a period of three to five years. However, localized factors may lead to more rapid change in which certain channel segments lower more quickly than others.

REFERENCES

U.S. Geological Survey. 1985. James Kircher. *Estimation of Natural Streamflow Characteristics in Western Colorado.* Water Resources Investigations Report 85-4086.

U.S. Geological Survey. 1988. John Elliot. *Regionalization of Mean Annual Suspended Sediment Loads in Streams, Central, Northwestern, and Southwestern Colorado*. Water Resources Investigations Report 87-4193.

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TABLES

TABLE 1
BASINS POTENTIALLY IMPACTED BY MINING

BASIN NO.	POTENTIALLY IMPACTED BY MINING	SELECTED FOR DETAILED STUDY
3	X	X
4	X	
5	X	
6	X	
26	X	
27	X	
28	X	
29	X	X
30	X	
31	X	
32	X	X
33	X	
34	X	
35	X	X
36	X	X
37	X	X
38	X	
39	X	X
41	X	X

TABLE 2
BASIN HYDROLOGIC CHARACTERISTICS

Basin Number [1]	Area		Mean Annual Runoff [2]	Peak Flood Flow (cfs) [3]			Mean Annual Sediment Yield [4]		
	(acres)	(sq-mi)	(ac-ft)	2-yr	10-yr	100-yr	(ac-ft)	(tons)	(cu-yd)
3	430	0.68	320	9.5	19	31	0.02	30	32
29	220	0.35	170	4.9	10	16	0.01	17	18
32	610	0.95	450	13.3	27	43	0.03	44	47
35	2,900	4.60	2,200	64.0	130	207	0.14	210	220
36	1,200	1.85	880	25.8	53	84	0.06	85	90
37	2,300	3.56	1,700	49.6	102	160	0.11	160	170
39	1,320	2.06	980	29.0	59	94	0.06	93	100
41	170	0.27	130	3.5	7	11	0.01	12	13

(1) Refer to Figure 1 for basin numbers and locations.

(2) Based on "Water Balance Analysis of Horse and Lick Creek" Table 24 by Woodward-Clyde Consultants.

(3) Flood frequency based on Figure 2, Regional Flood Frequency Curves.

(4) Sediment yields derived by Ernest Pemberton based on regional sediment yields of 0.03 ac-ft/sq mi.

TABLE 3
PRE-MINING CHANNEL HYDRAULIC CHARACTERISTICS

Basin Number	Channel Thalweg Slope (%)		Dominant Discharge (Q) Near Mouth			
	Average	Lower Reach [1]	Flow (cfs)	Width (ft)	Depth (ft)	Velocity (ft/sec)
3	11.1%	15.5%	9.5	8	0.3	3.1
29	9.7%	4.8%	4.9	6	0.3	2.9
32	8.5%	4.0%	13.3	10	0.4	3.2
35	5.3%	5.6%	64.0	22	0.7	3.8
36	7.1%	5.9%	25.8	14	0.5	3.5
37	8.3%	5.4%	49.6	19	0.7	3.7
39	15.9%	8.6%	29.0	10	0.8	3.5
41	30.0%	25.3%	3.5	2	0.5	3.5

[1] This refers to the lowest reach potentially impacted by mining.

TABLE 4
EFFECTS OF SUBSIDENCE ON STREAM CHANNELS

Basin Number	Pre-Mining Slope (%)		Maximum Subsidence (E-seam + B-seam)[2] (ft)	Change in Slope		Post-Mining Slope [3]	
	Average	Lower Reach [1]		Maximum Negative	Maximum Positive	Minimum	Maximum
3	11.1%	15.5%	8.3	-2.9%	10.6%	4.8%	18.3%
29	9.7%	4.8%	14.7	-5.1%	2.0%	2.8%	9.9%
32	8.5%	4.0%	14.3	-3.5%	2.4%	1.6%	7.5%
35	5.3%	5.6%	15.2	-2.1%	3.5%	2.1%	7.7%
36	7.1%	5.9%	6.5	-4.4%	2.3%	3.7%	10.3%
37	8.3%	5.4%	13.4	-3.0%	1.7%	3.7%	8.4%
39	15.9%	8.6%	9.2	-6.6%	1.5%	7.0%	15.2%
41	30.0%	25.3%	9.2	-3.0%	1.8%	23.5%	28.3%

(1) This refers to the lowest reach potentially impacted by mining.

(2) Basins 3, 36, 39, and 41 are only affected by E-seam mining.

(3) Slope range given for lowest reach potentially impacted by mining.

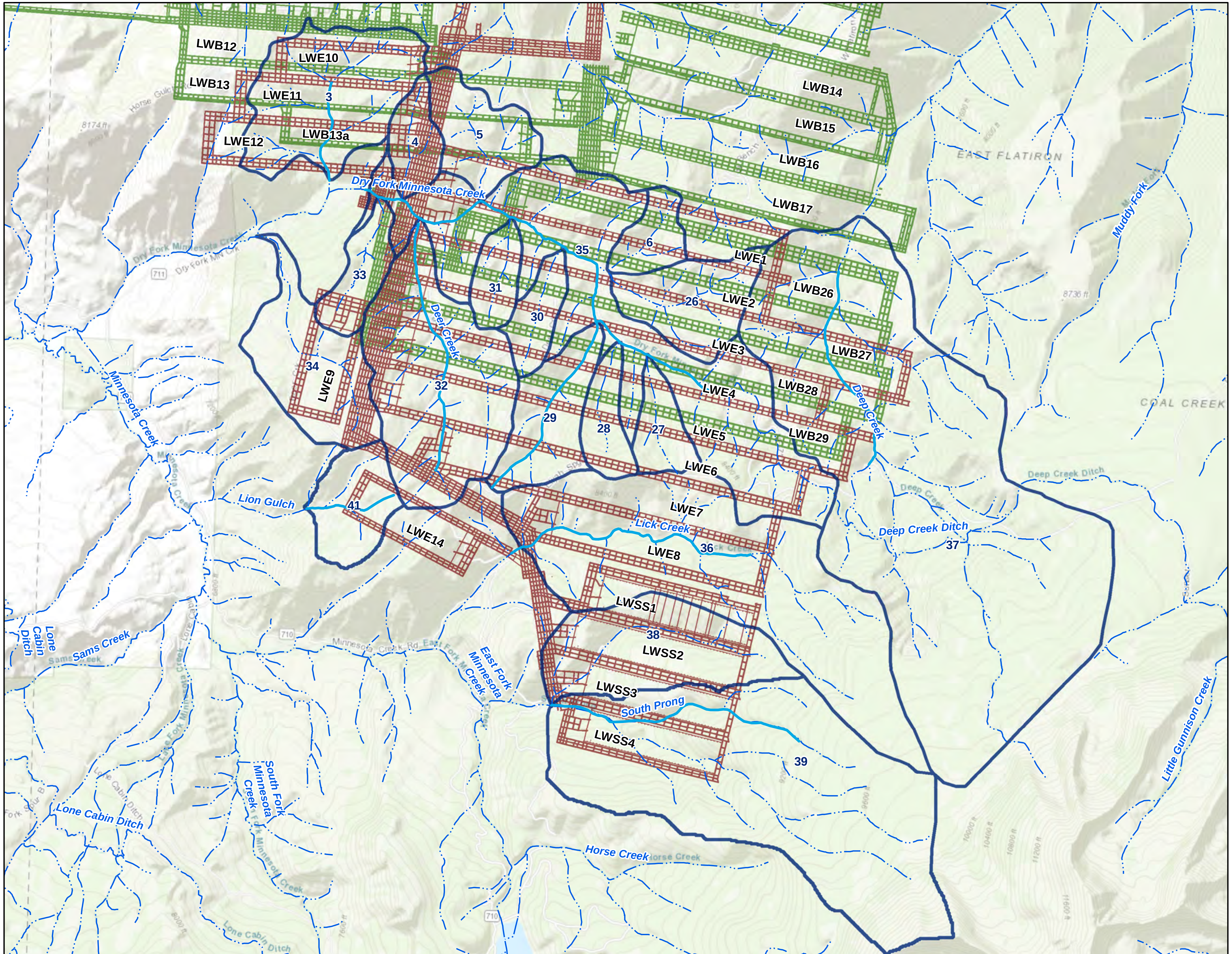
TABLE 5
POST-MINING STREAM CHANNEL HYDRAULIC CHARACTERISTICS

Basin Number	Flow (cfs)	Velocity (ft/sec)	Channel Size Near Mouth After Subsidence [1]		Max. Projected Channel Size Changes [2]	
			Width (ft)	Depth (ft)	Width (ft)	Depth (ft)
3	9.5	3.1	12	0.7	4	0.4
29	4.9	2.9	11	0.4	5	0.1
32	13.3	3.2	17	0.8	7	0.4
35	64.0	3.8	29	1.5	7	0.8
36	25.8	3.5	22	0.7	8	0.2
37	49.6	3.7	28	0.9	9	0.2
39	29.0	3.5	16	0.9	6	0.1
41	3.5	3.5	2	0.5	0	0.0

(1) Maximum values resulting from the maximum changes in slope due to subsidence.

(2) These values represent estimated maximum channel size changes for the subject basin.

FIGURES



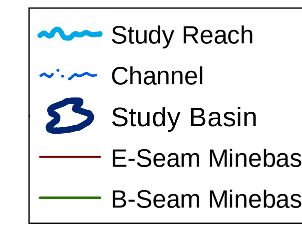


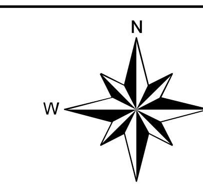
FIGURE 1

EXHIBIT 55B
STUDY BASINS

MOUNTAIN COAL COMPANY
WEST ELK MINE

DECEMBER 2020

SOURCES/NOTES:
1. E-Seam Minebase:
CAD drawing from MCC provided on 11/25/20.
2. Channel: NHD.
3. Study Reach, Study Basin: Drainages assessed for this iteration of Exhibit 55B.



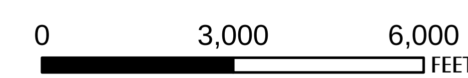


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FIGURE 2
REGIONAL FLOOD FREQUENCY CURVES

NORTH FORK OF THE GUNNISON RIVER BASIN
(Note: Strictly for Conceptual Planning Purposes)

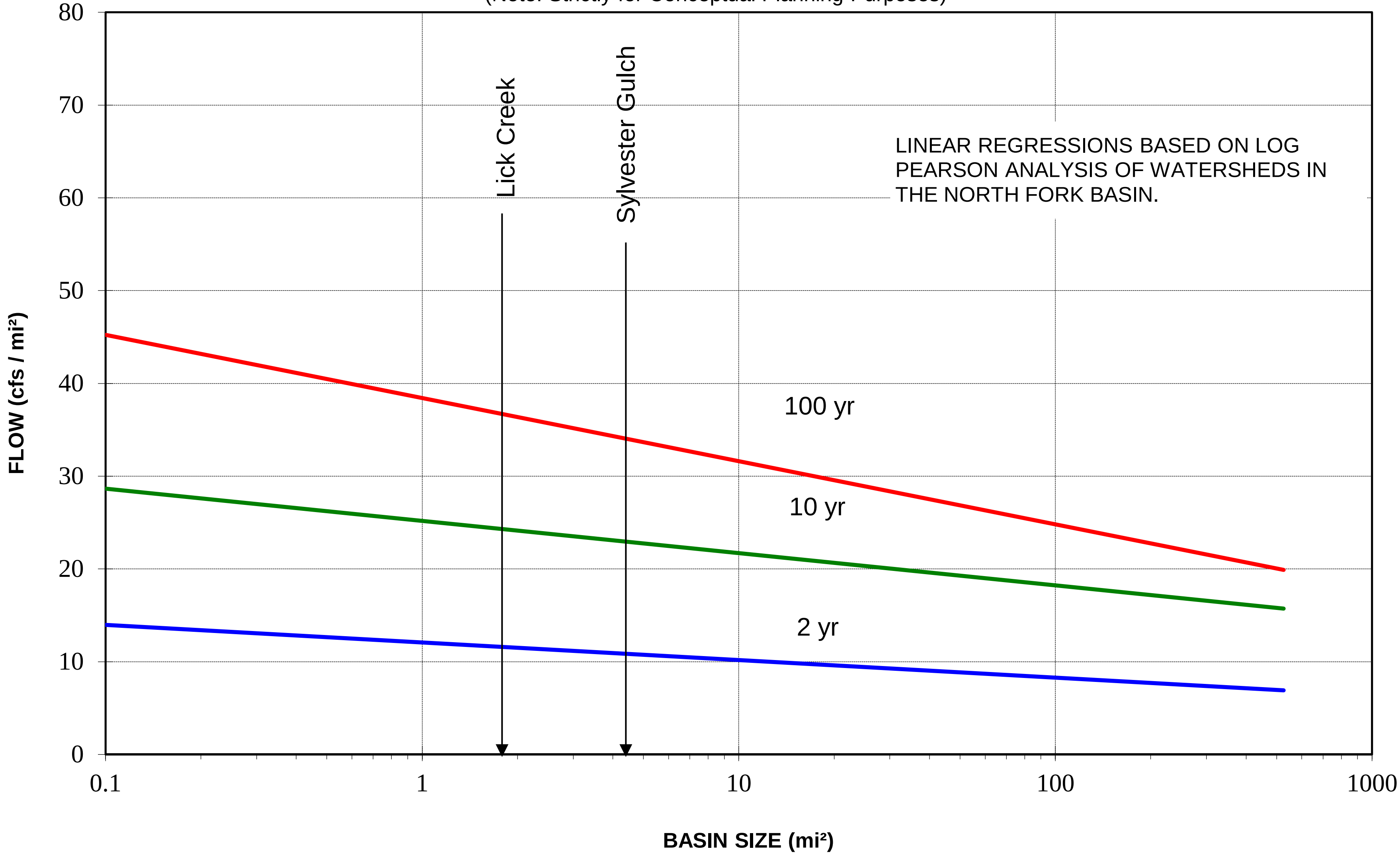
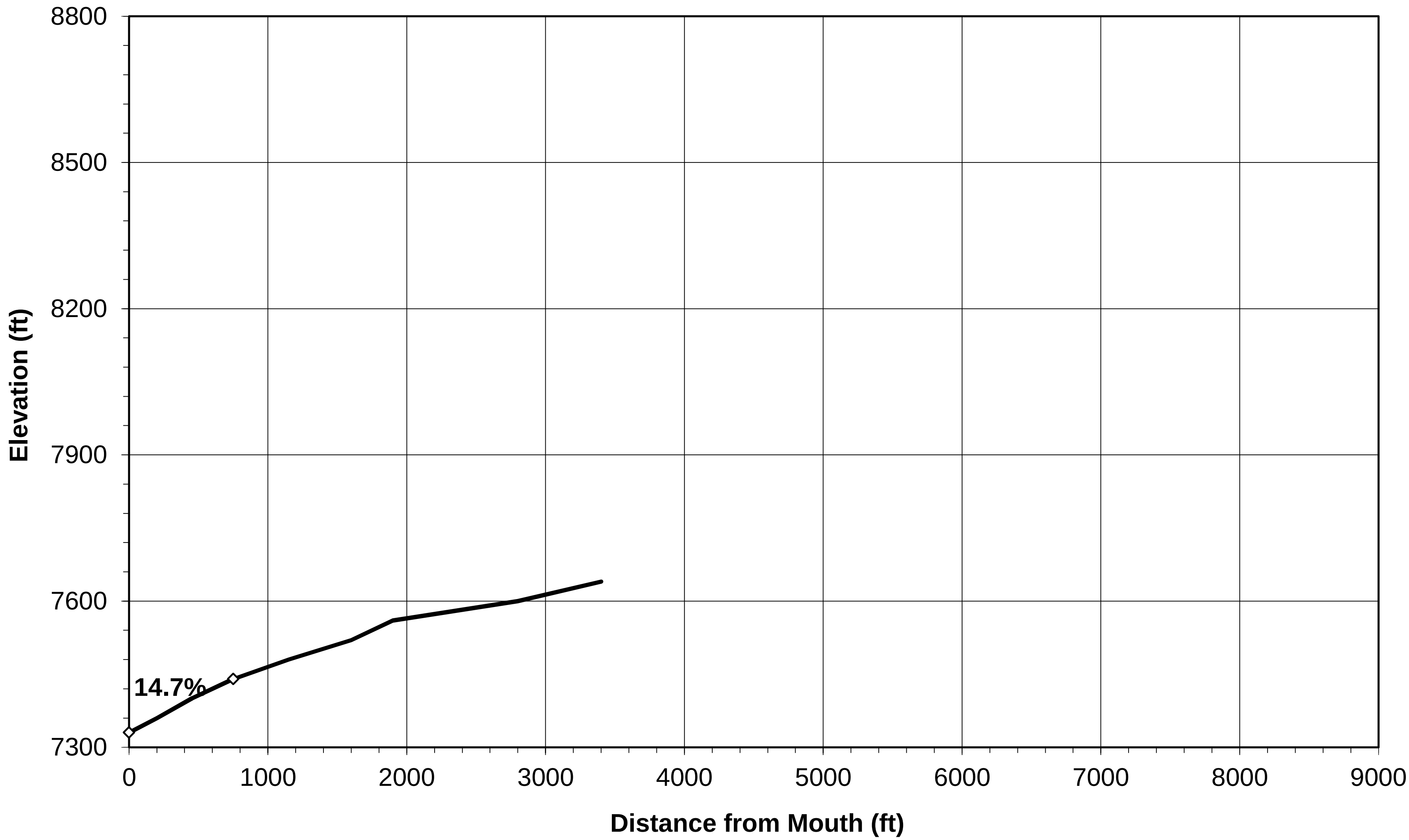
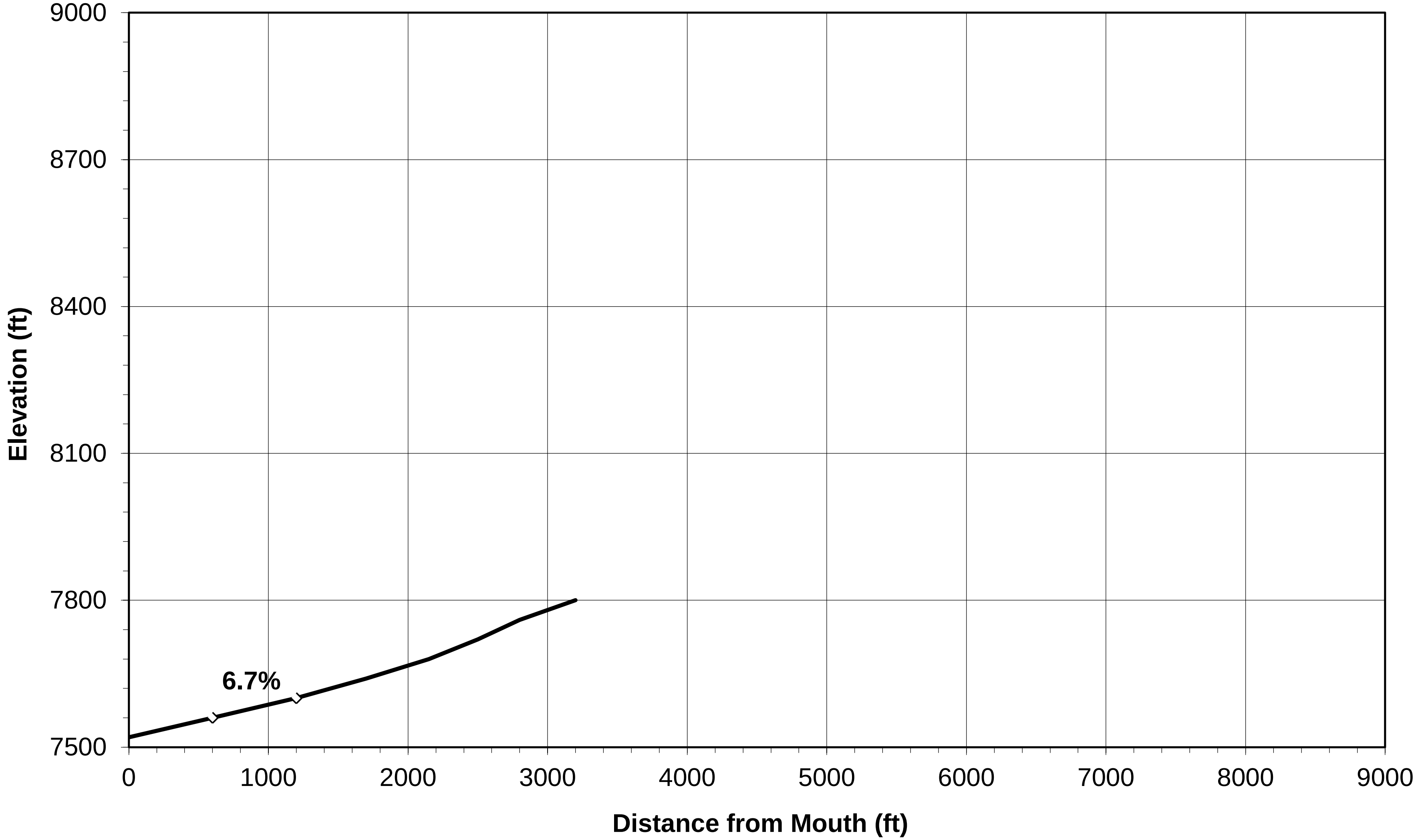


FIGURE 3
BASIN 3 CHANNEL PROFILE



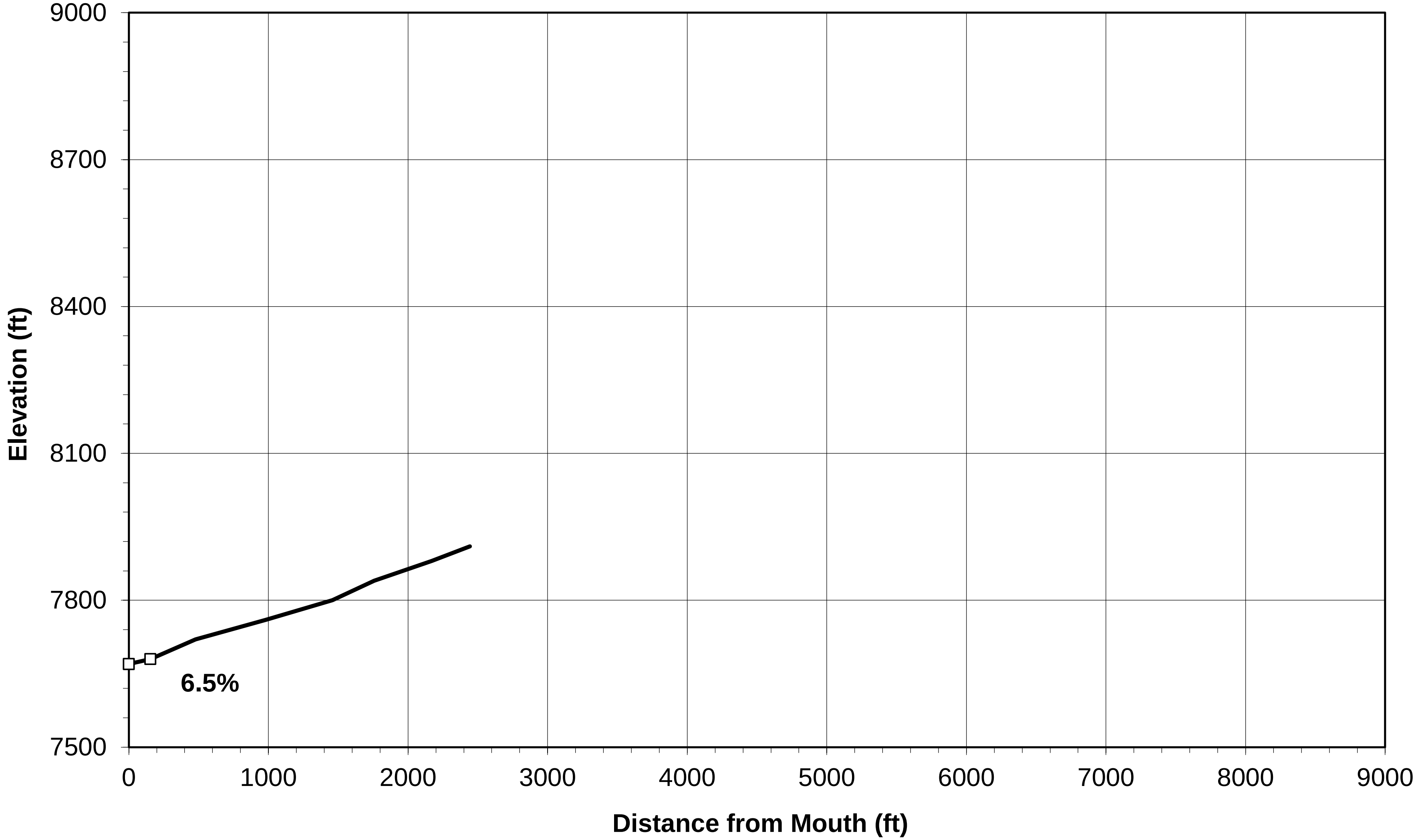
Notes: Slope indicated for lowest reach of channel potentially affected by subsidence.
Horizontal and vertical axes have been standardized to allow for graphical comparison of channel slopes.

FIGURE 4
BASIN 5 CHANNEL PROFILE



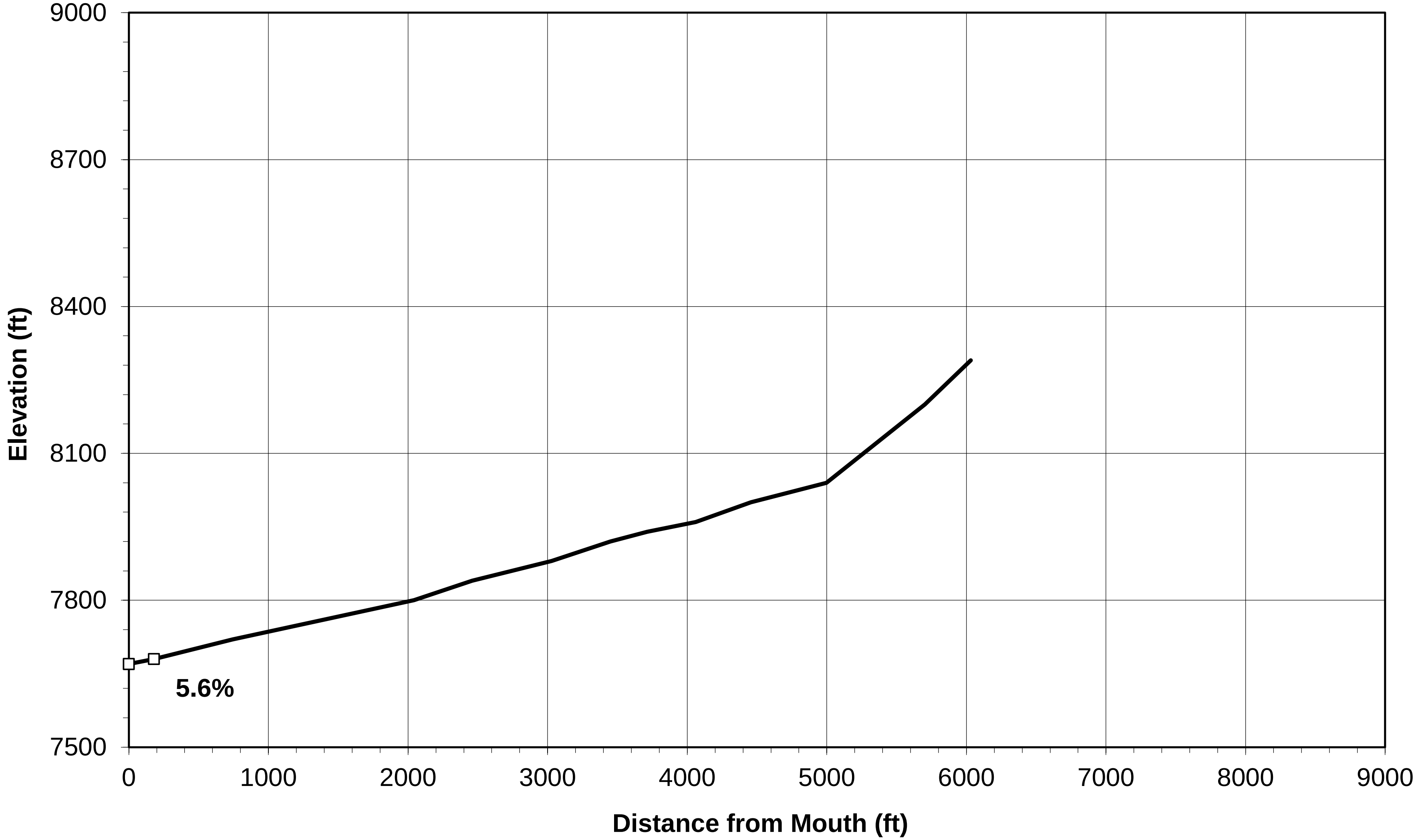
Notes: Slope indicated for lowest reach of channel potentially affected by subsidence.
Horizontal and vertical axes have been standardized to allow for graphical comparison of channel slopes.

FIGURE 5
BASIN 6 CHANNEL PROFILE



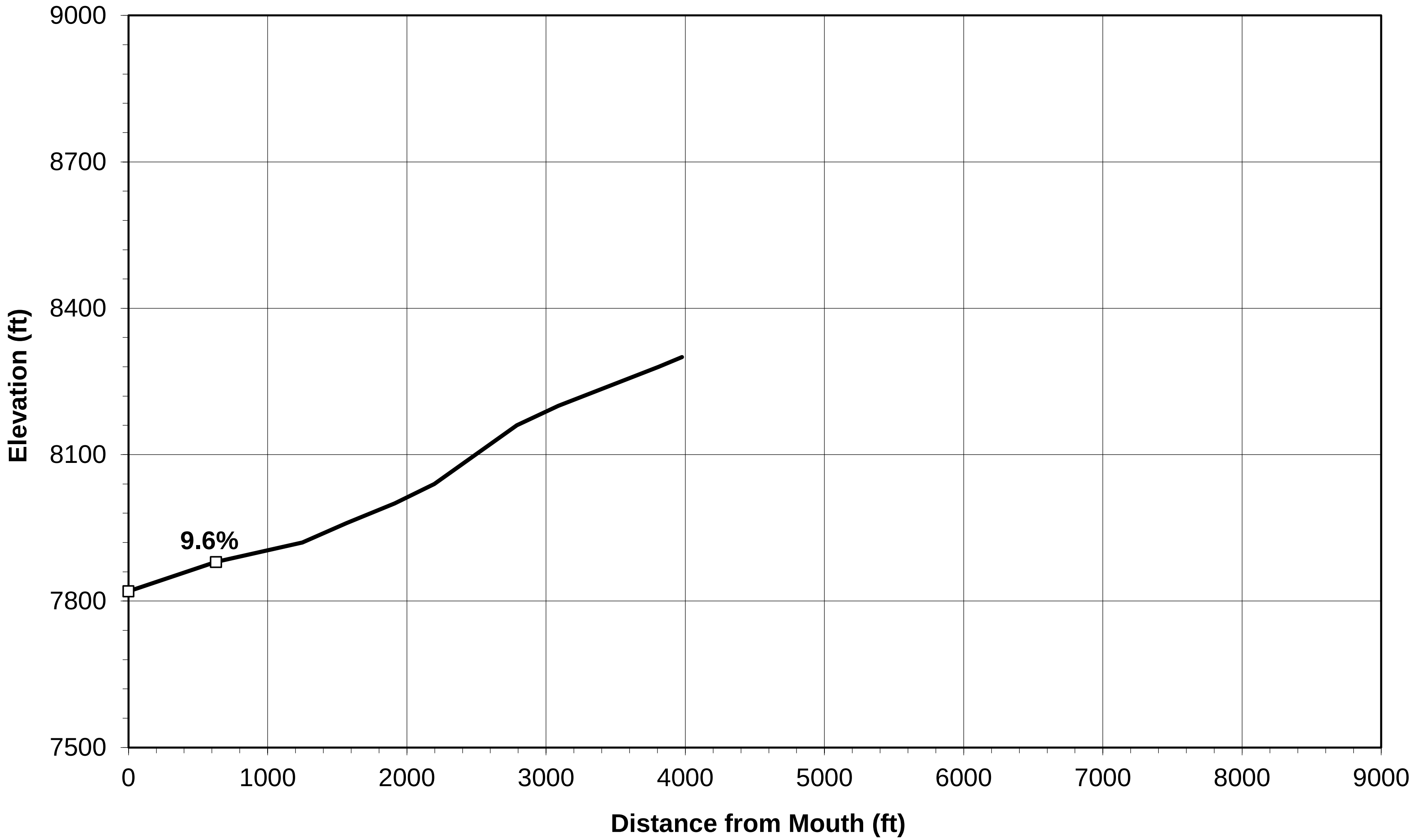
Notes: Slope indicated for lowest reach of channel potentially affected by subsidence.
Horizontal and vertical axes have been standardized to allow for graphical comparison of channel slopes.

FIGURE 6
BASIN 26 CHANNEL PROFILE



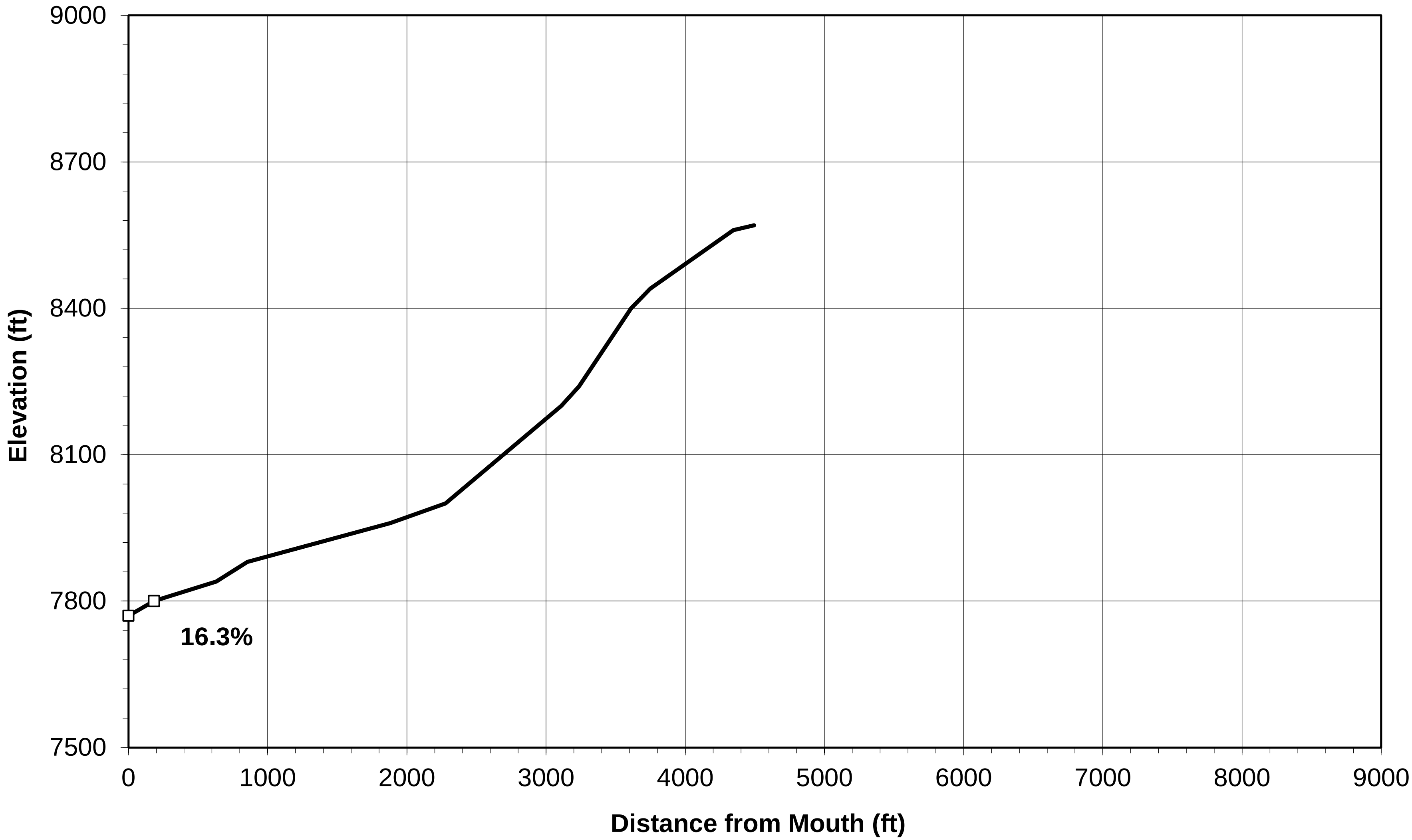
Notes: Slope indicated for lowest reach of channel potentially affected by subsidence.
Horizontal and vertical axes have been standardized to allow for graphical comparison of channel slopes.

FIGURE 7
BASIN 27 CHANNEL PROFILE



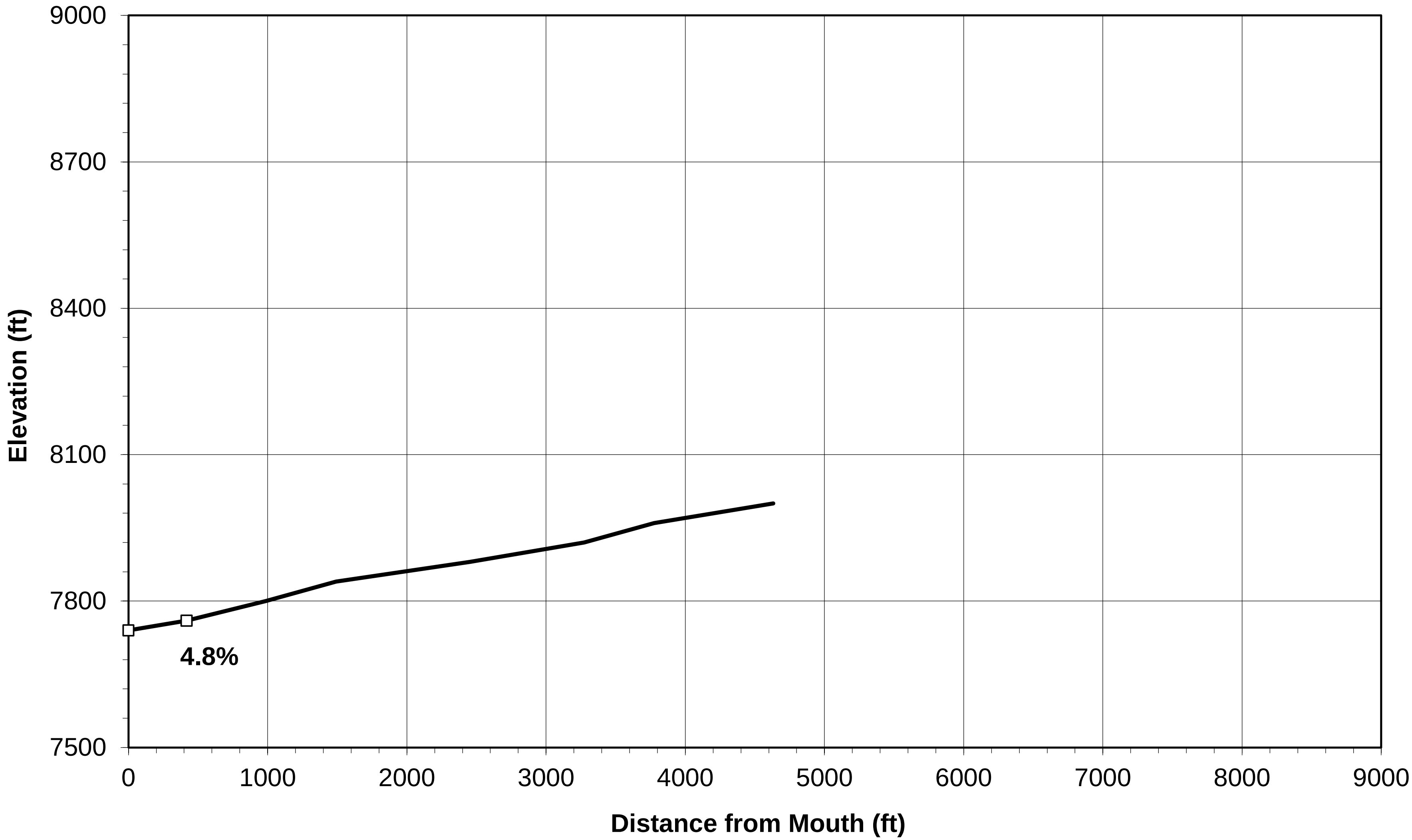
Notes: Slope indicated for lowest reach of channel potentially affected by subsidence.
Horizontal and vertical axes have been standardized to allow for graphical comparison of channel slopes.

FIGURE 8
BASIN 28 CHANNEL PROFILE



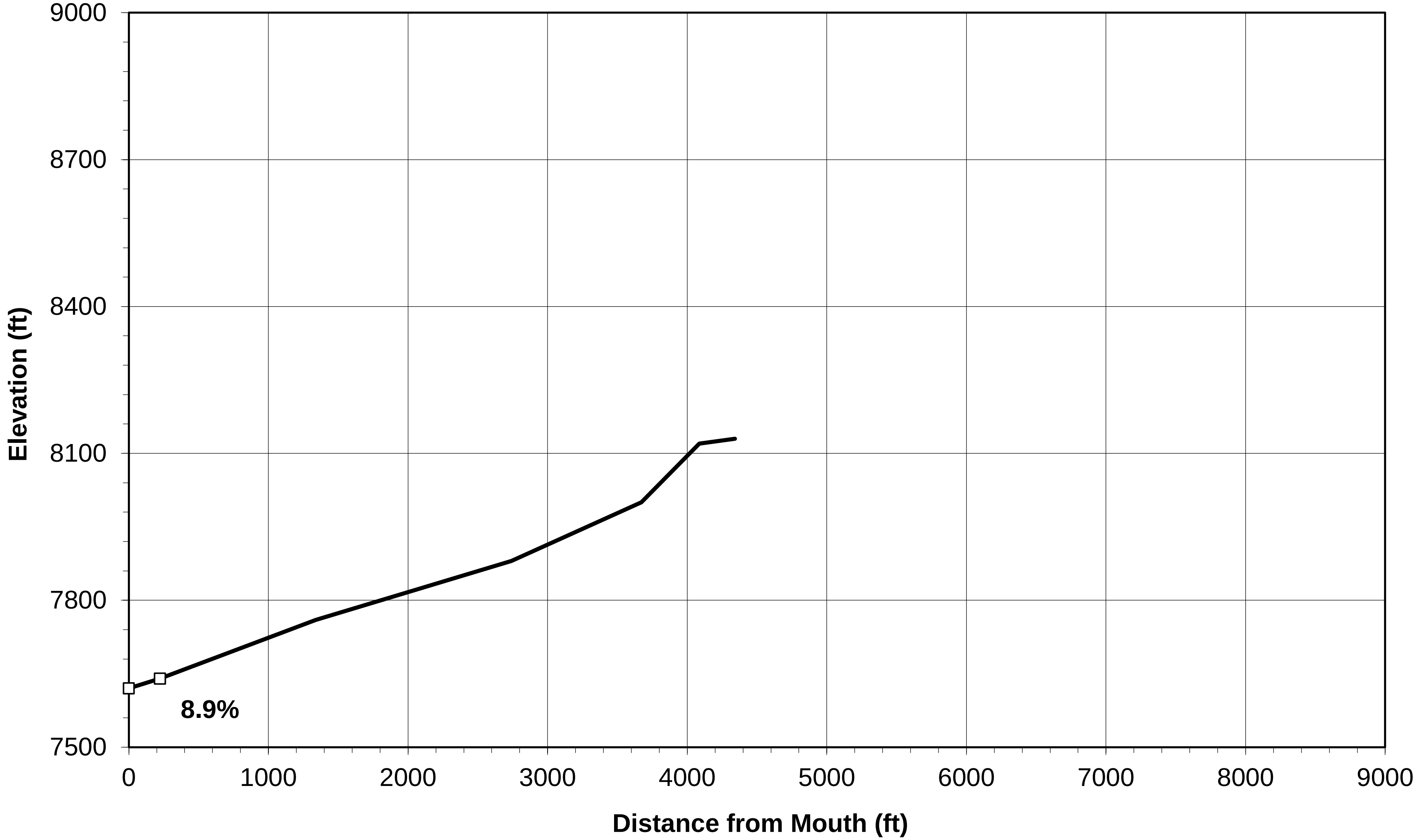
Notes: Slope indicated for lowest reach of channel potentially affected by subsidence.
Horizontal and vertical axes have been standardized to allow for graphical comparison of channel slopes.

FIGURE 9
BASIN 29 CHANNEL PROFILE



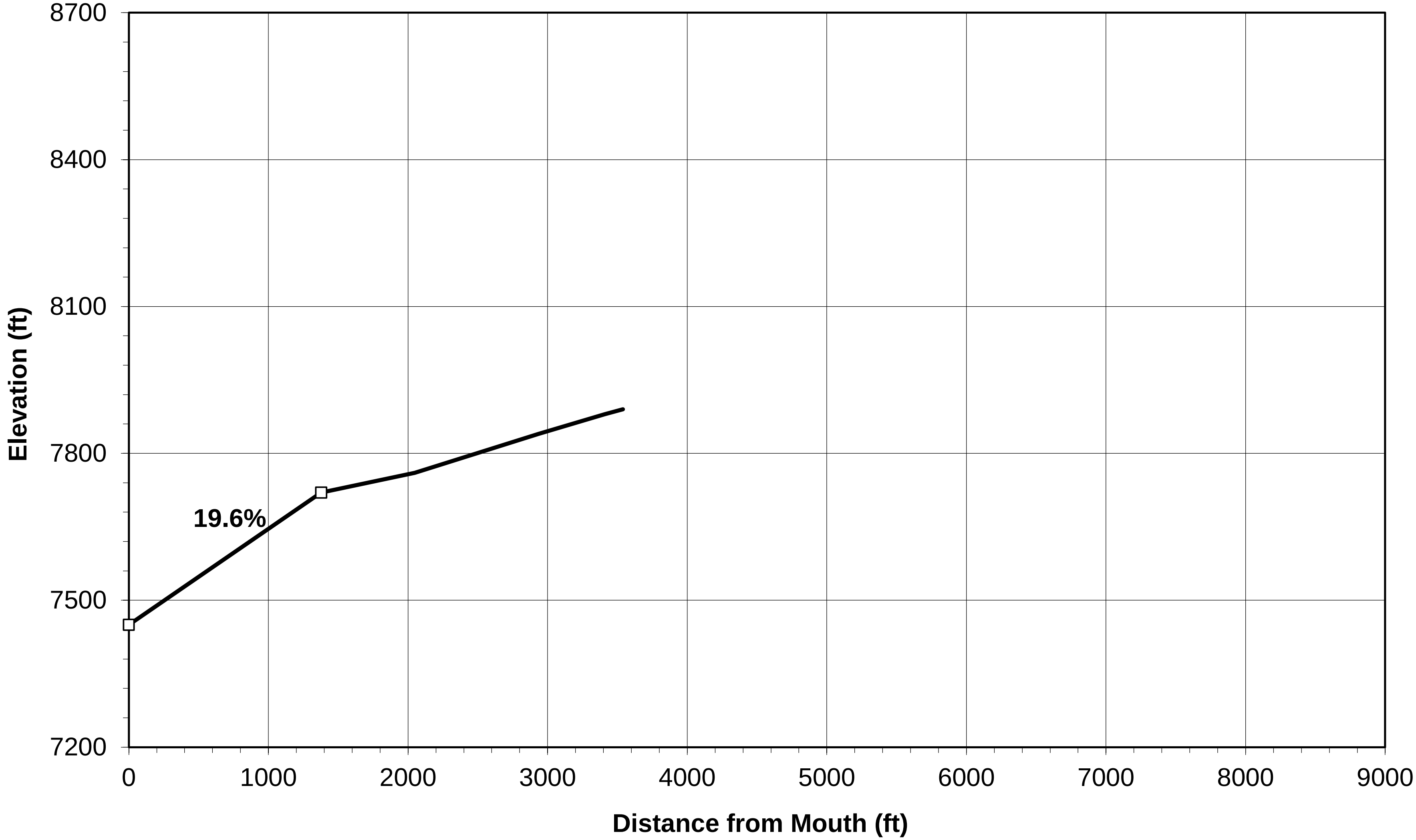
Notes: Slope indicated for lowest reach of channel potentially affected by subsidence.
Horizontal and vertical axes have been standardized to allow for graphical comparison of channel slopes.

FIGURE 10
BASIN 30 CHANNEL PROFILE



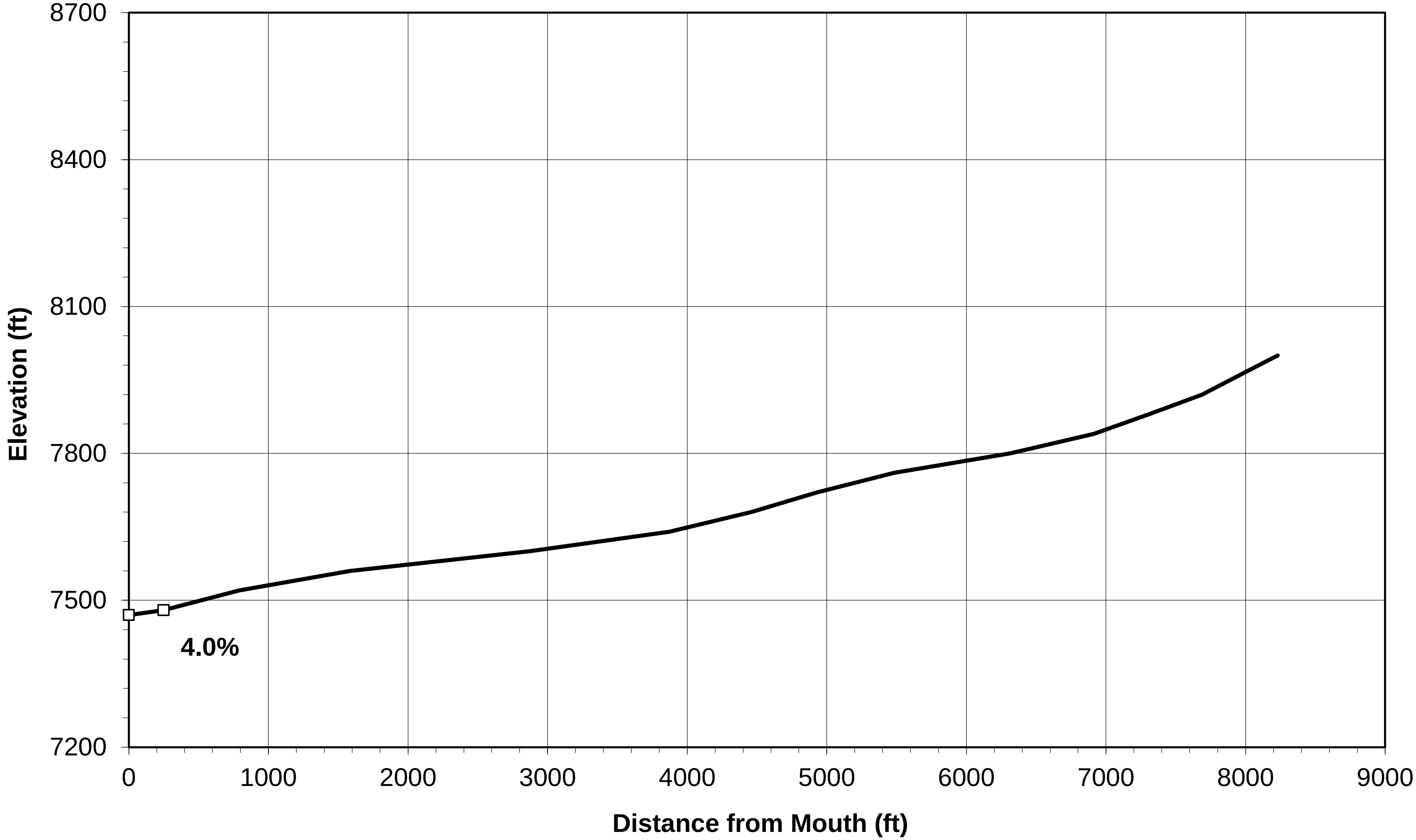
Notes: Slope indicated for lowest reach of channel potentially affected by subsidence.
Horizontal and vertical axes have been standardized to allow for graphical comparison of channel slopes.

FIGURE 11
BASIN 31 CHANNEL PROFILE



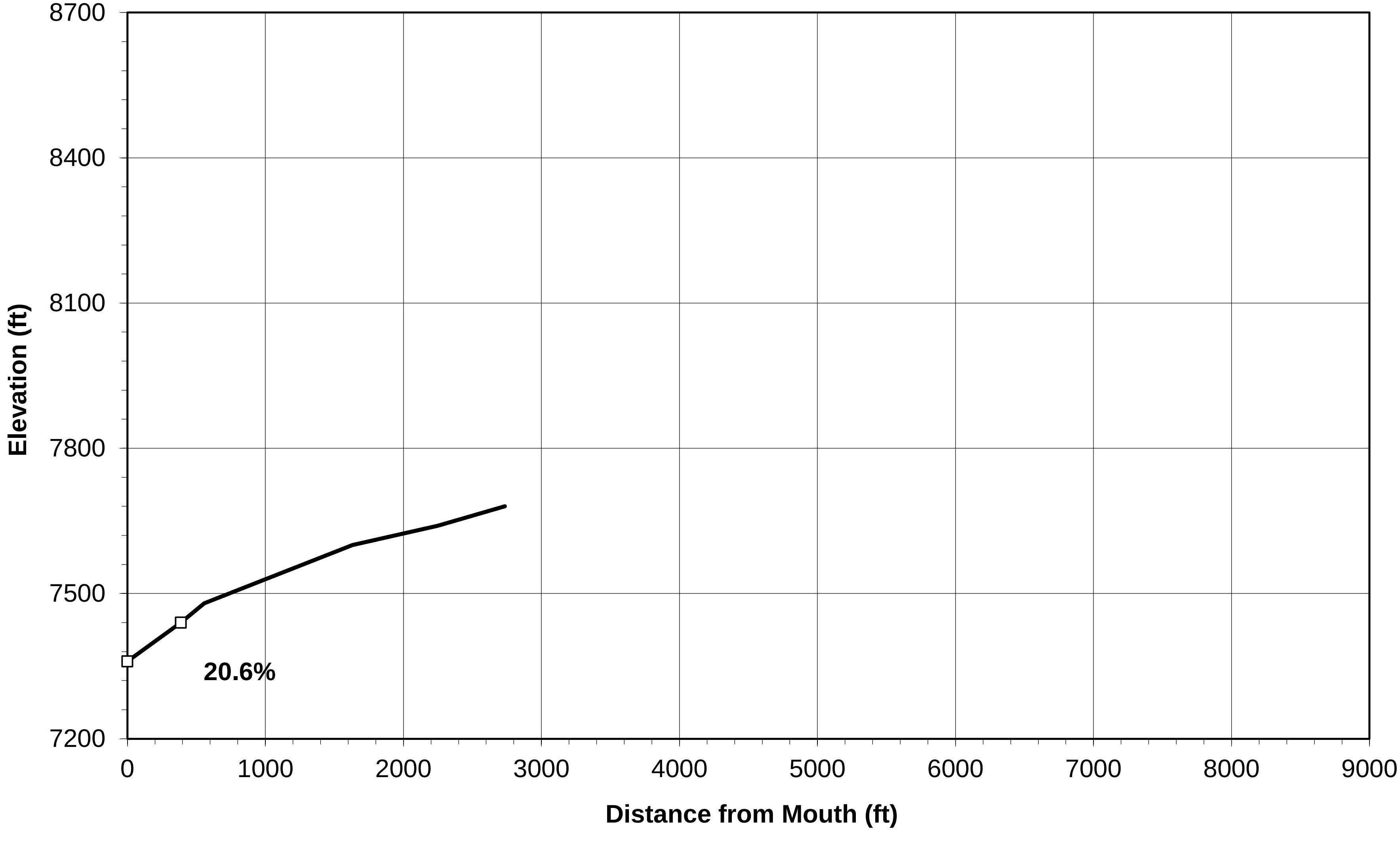
Notes: Slope indicated for lowest reach of channel potentially affected by subsidence.
Horizontal and vertical axes have been standardized to allow for graphical comparison of channel slopes.

FIGURE 12
BASIN 32 CHANNEL PROFILE



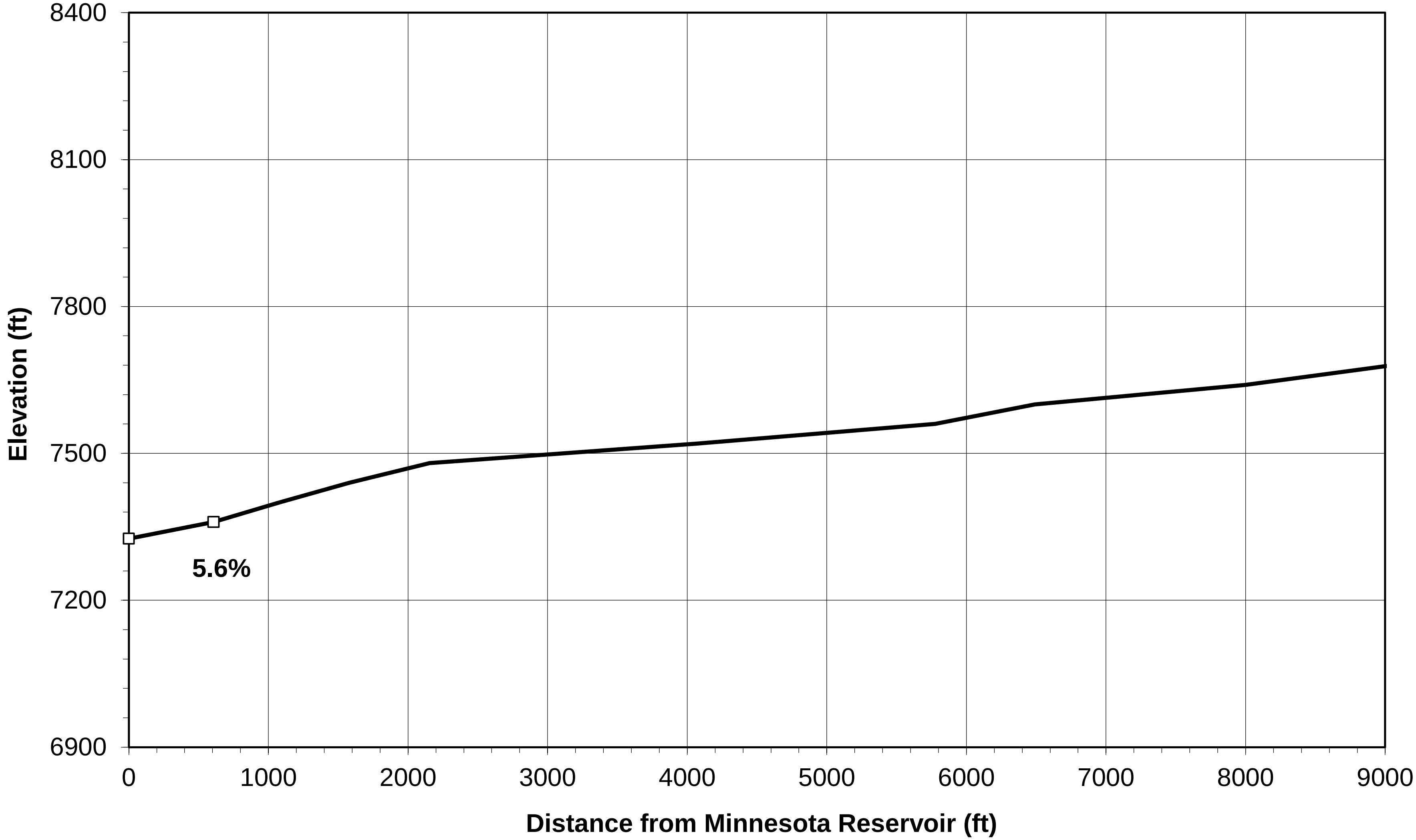
Notes: Slope indicated for lowest reach of channel potentially affected by subsidence.
Horizontal and vertical axes have been standardized to allow for graphical comparison of channel slopes.

FIGURE 13
BASIN 33 CHANNEL PROFILE



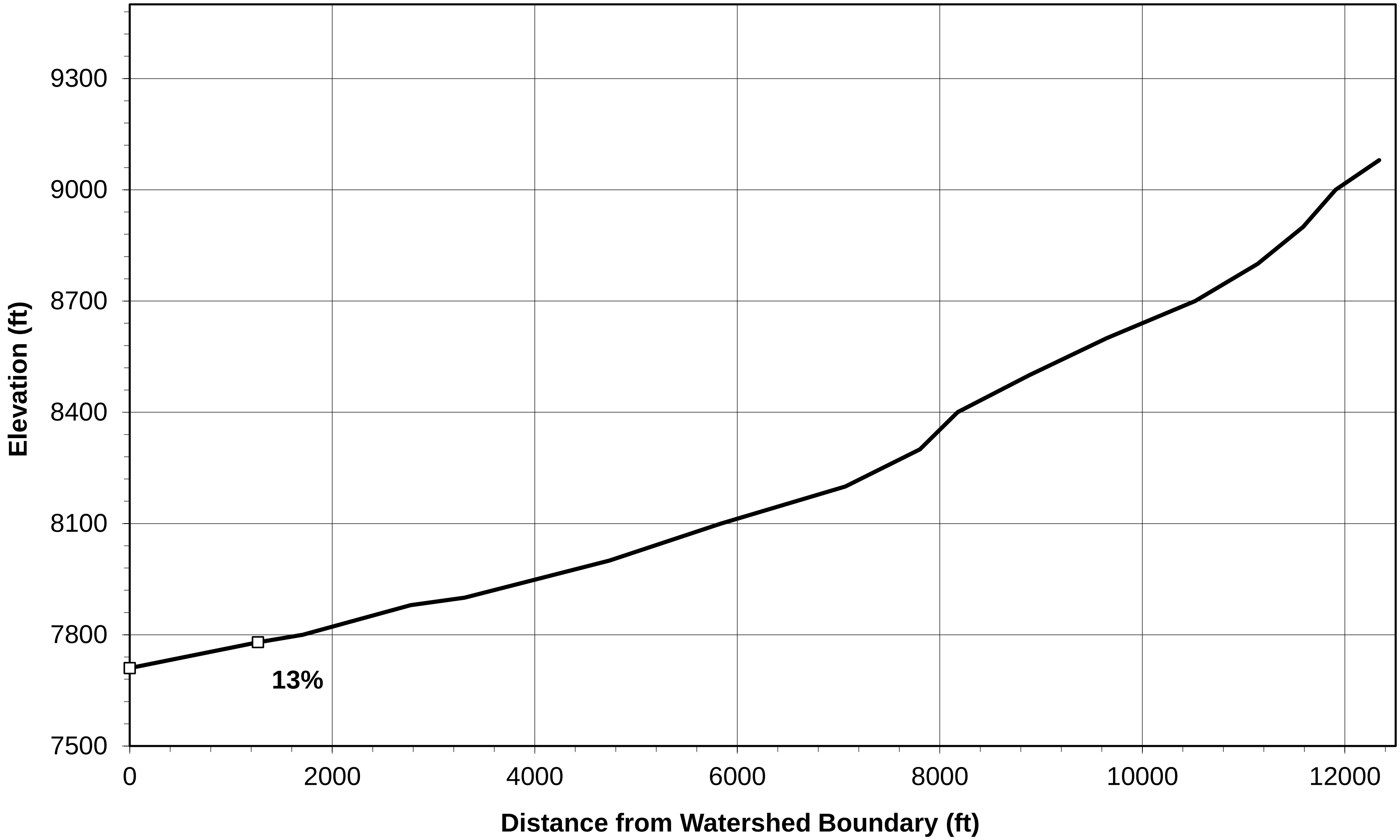
Notes: Slope indicated for lowest reach of channel potentially affected by subsidence.
Horizontal and vertical axes have been standardized to allow for graphical comparison of channel slopes.

FIGURE 14
BASIN 35 CHANNEL PROFILE (Lower Reach)



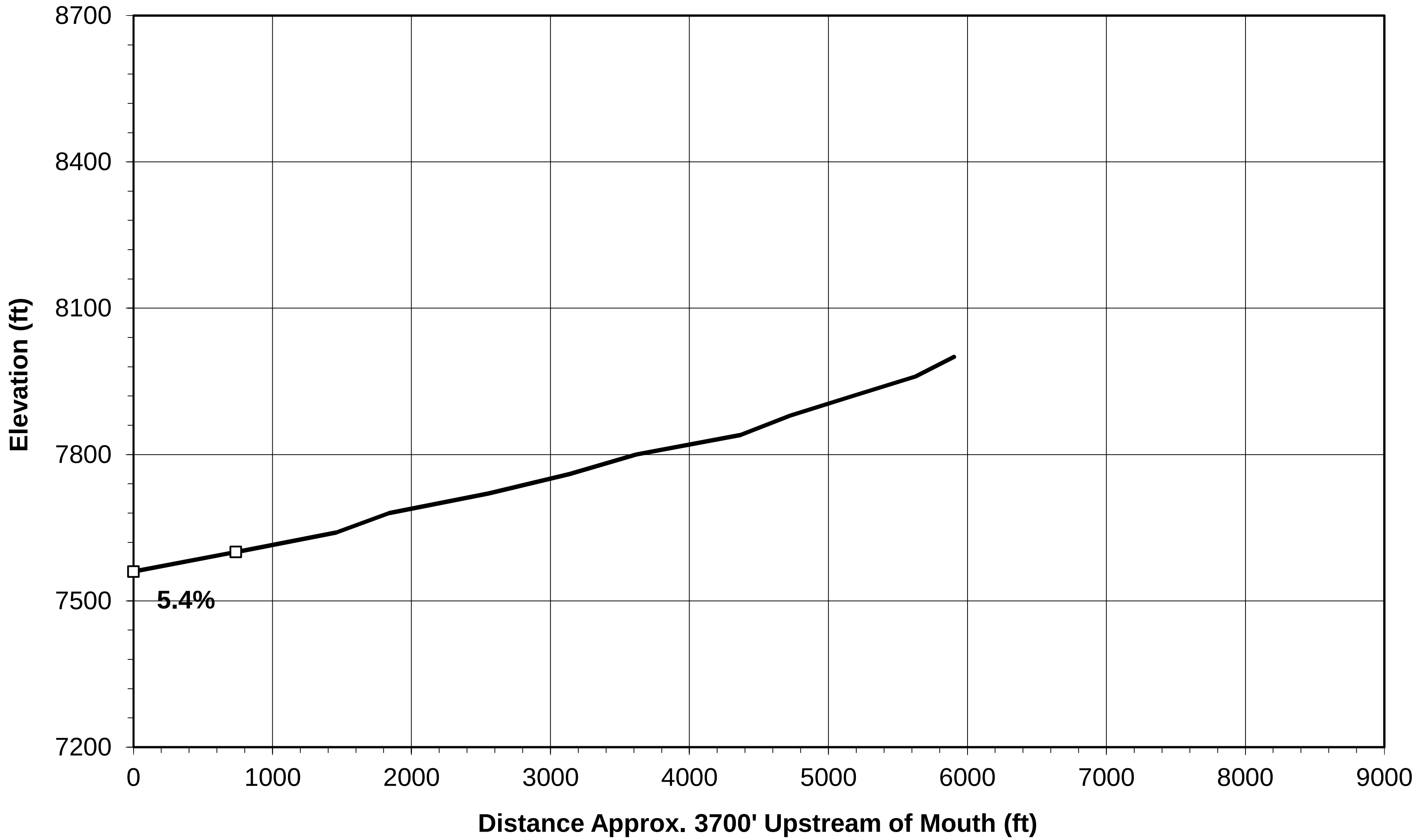
Notes: Slope indicated for lowest reach of channel potentially affected by subsidence.
Horizontal and vertical axes have been standardized to allow for graphical comparison of channel slopes.

FIGURE 15
BASIN 36 PROFILE



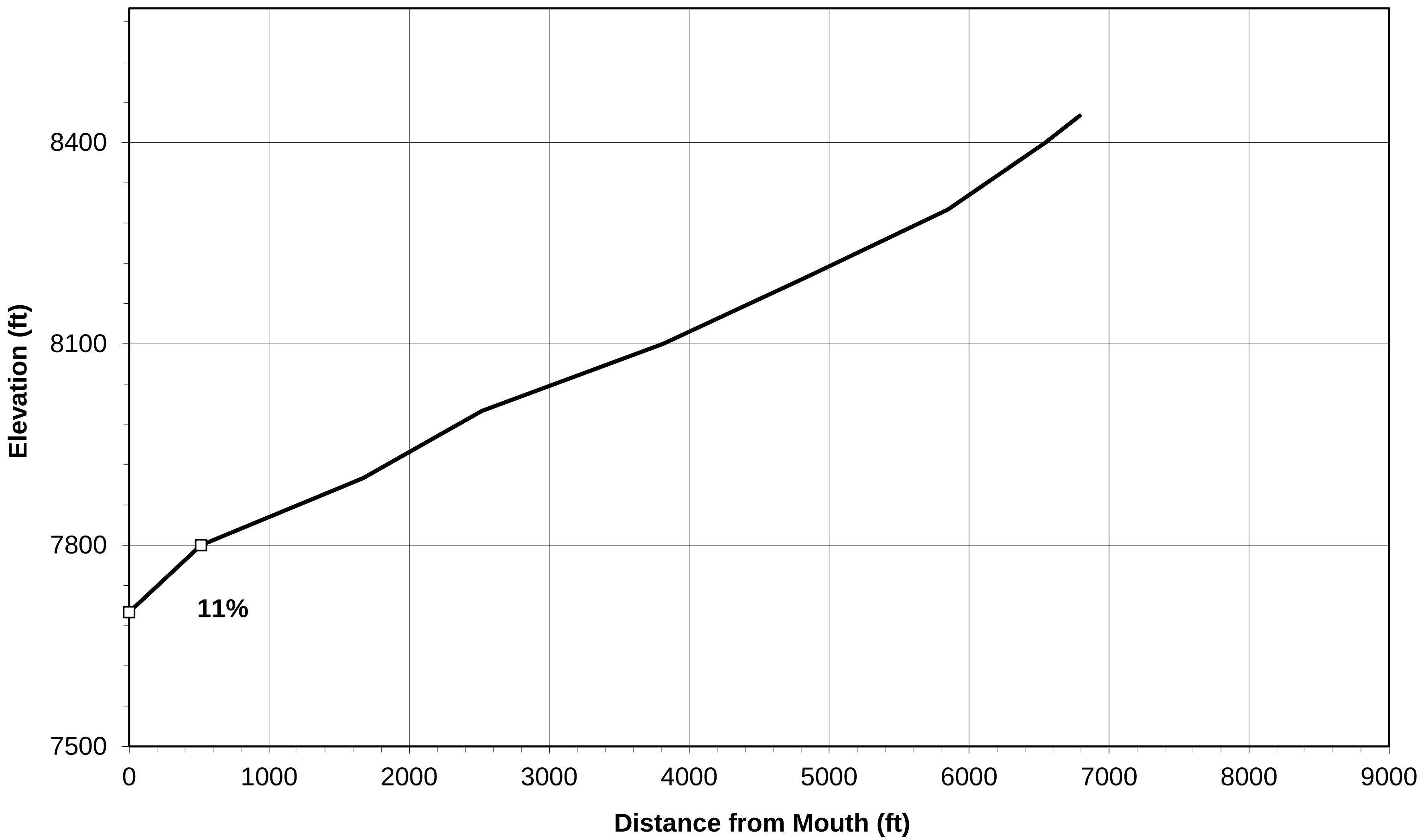
Notes: Slope indicated for lowest reach of channel potentially affected by subsidence.
Horizontal and vertical axes have been standardized to allow for graphical comparison of channel slopes.

FIGURE 16
BASIN 37 DEEP CREEK CHANNEL PROFILE



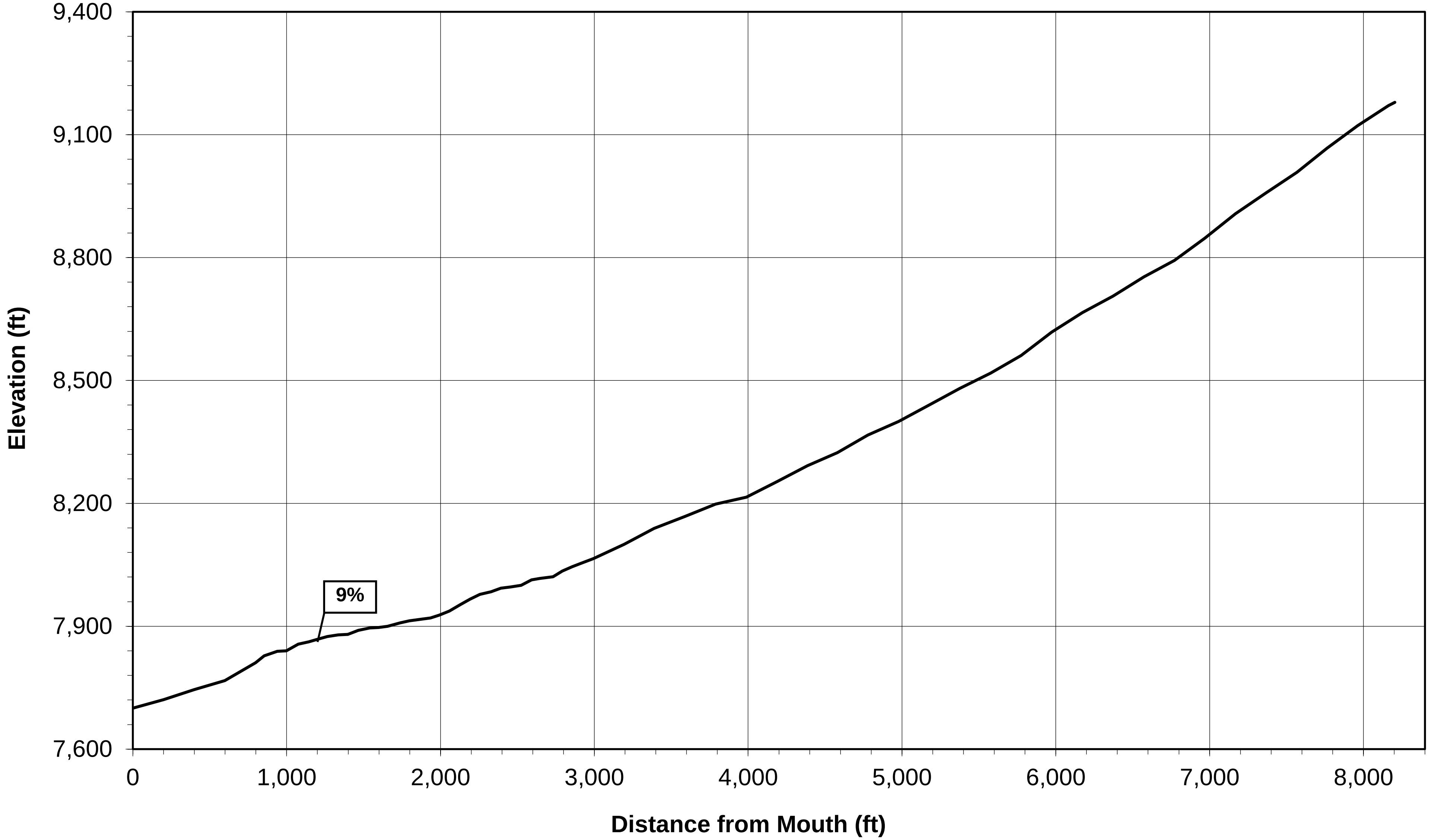
Notes: Slope indicated for lowest reach of channel potentially affected by subsidence.
Horizontal and vertical axes have been standardized to allow for graphical comparison of channel slopes.

FIGURE 17
BASIN 38 CHANNEL PROFILE



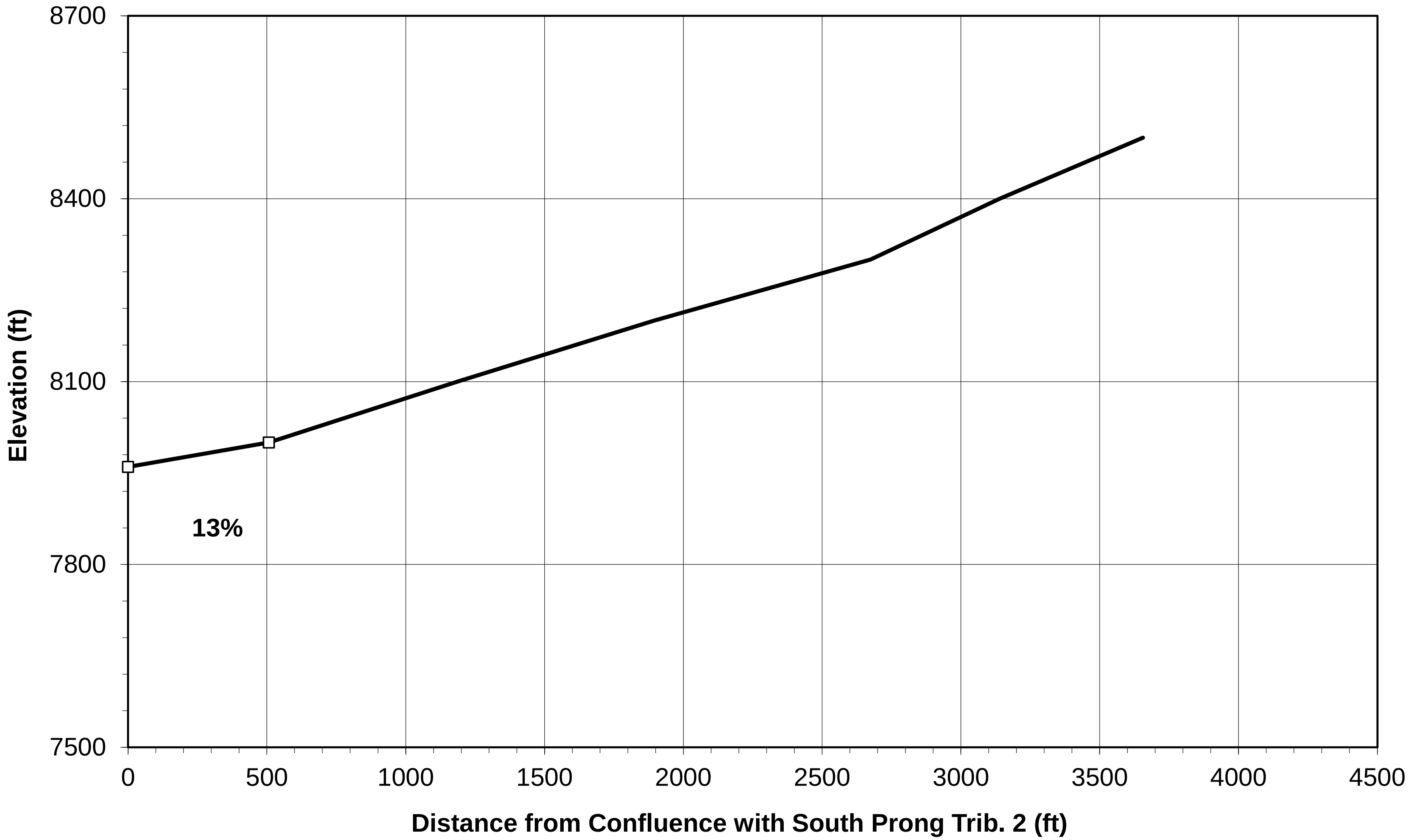
Notes: Slope indicated for lowest reach of channel potentially affected by subsidence.
Horizontal and vertical axes have been standardized to allow for graphical comparison of channel slopes.

FIGURE 18
BASIN 39 SOUTH PRONG CHANNEL PROFILE



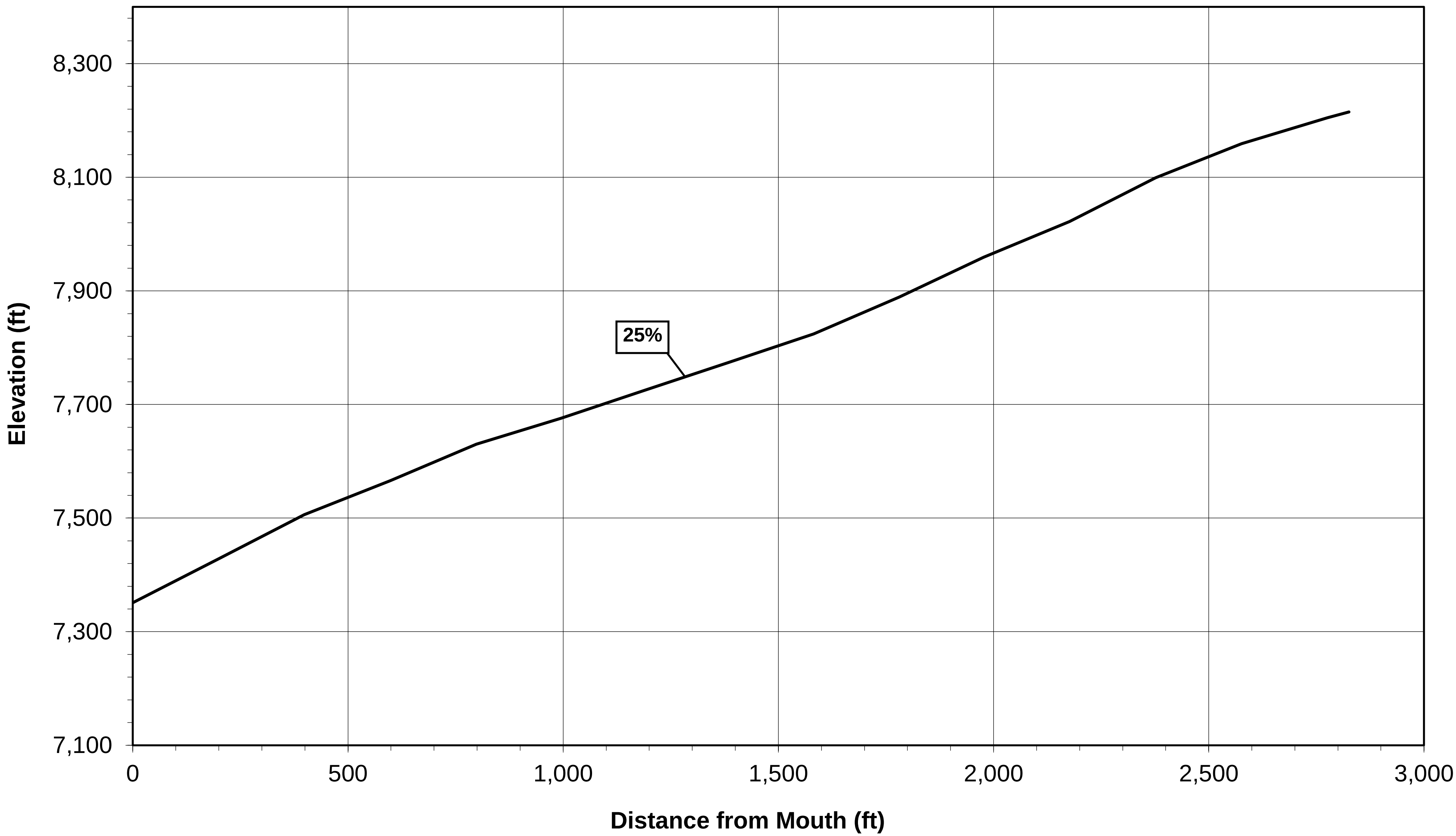
Notes: Slope indicated for lowest reach of channel potentially affected by subsidence.

FIGURE 19
BASIN 40 CHANNEL PROFILE



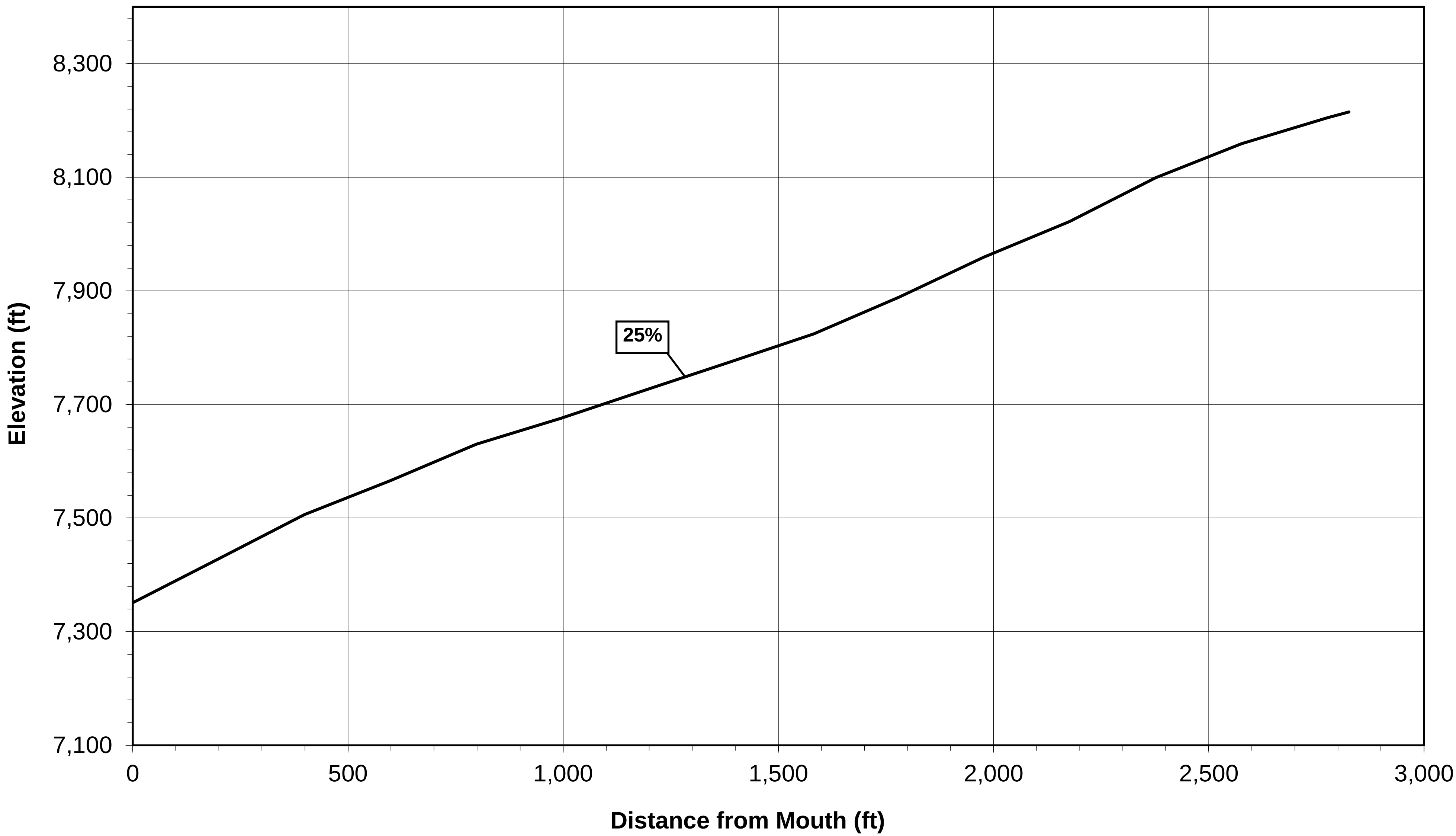
Notes: Slope indicated for lowest reach of channel potentially affected by subsidence.
Horizontal and vertical axes have been standardized to allow for graphical comparison of channel slopes.

FIGURE 20
BASIN 41 LION GULCH CHANNEL PROFILE



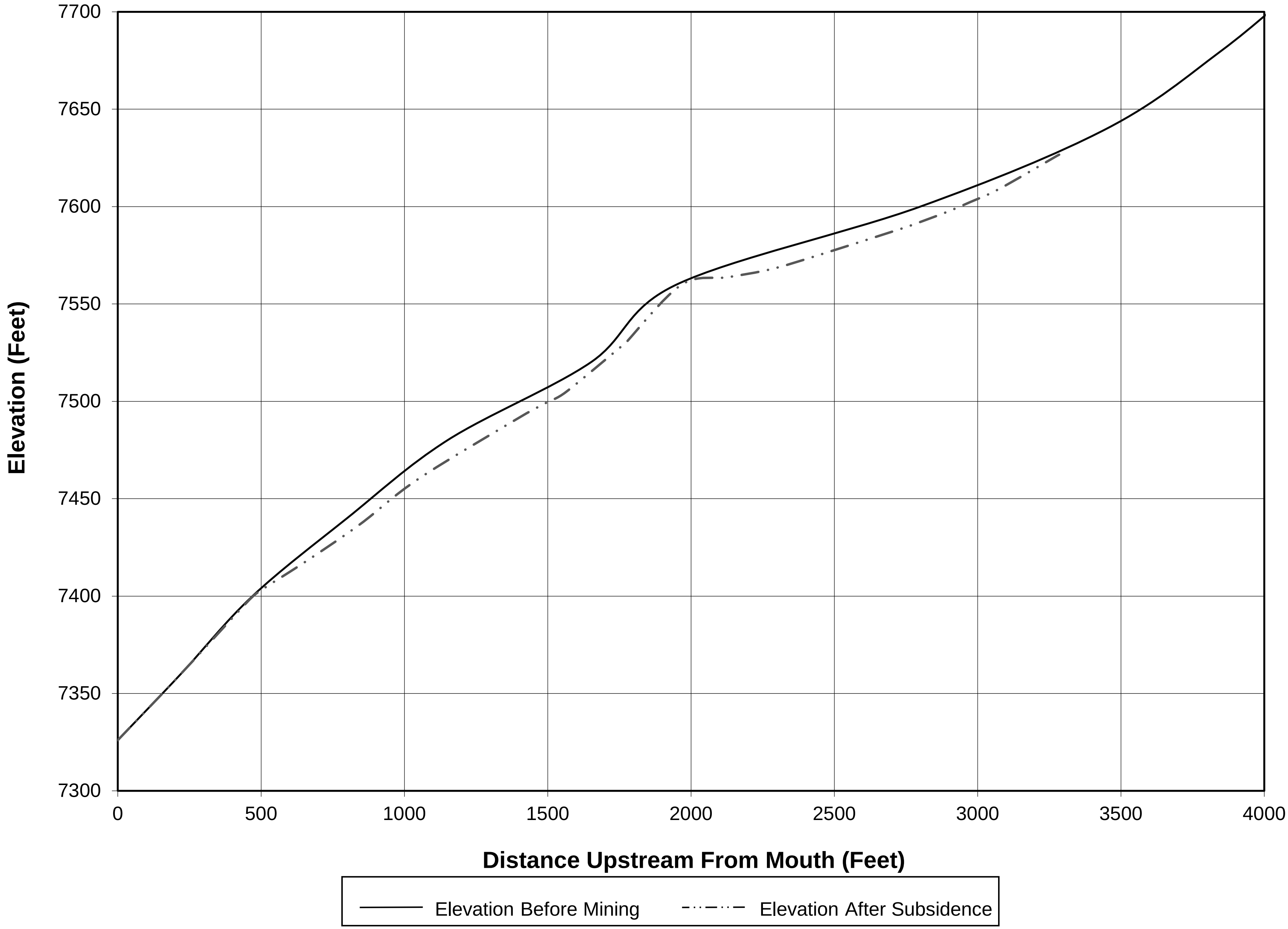
Notes: Slope indicated for lowest reach of channel potentially affected by subsidence.

FIGURE 20
BASIN 41 CHANNEL PROFILE



Notes: Slope indicated for lowest reach of channel potentially affected by subsidence.

Figure 21
Basin 3 - Horse Gulch Channel Profile Before and After Mining



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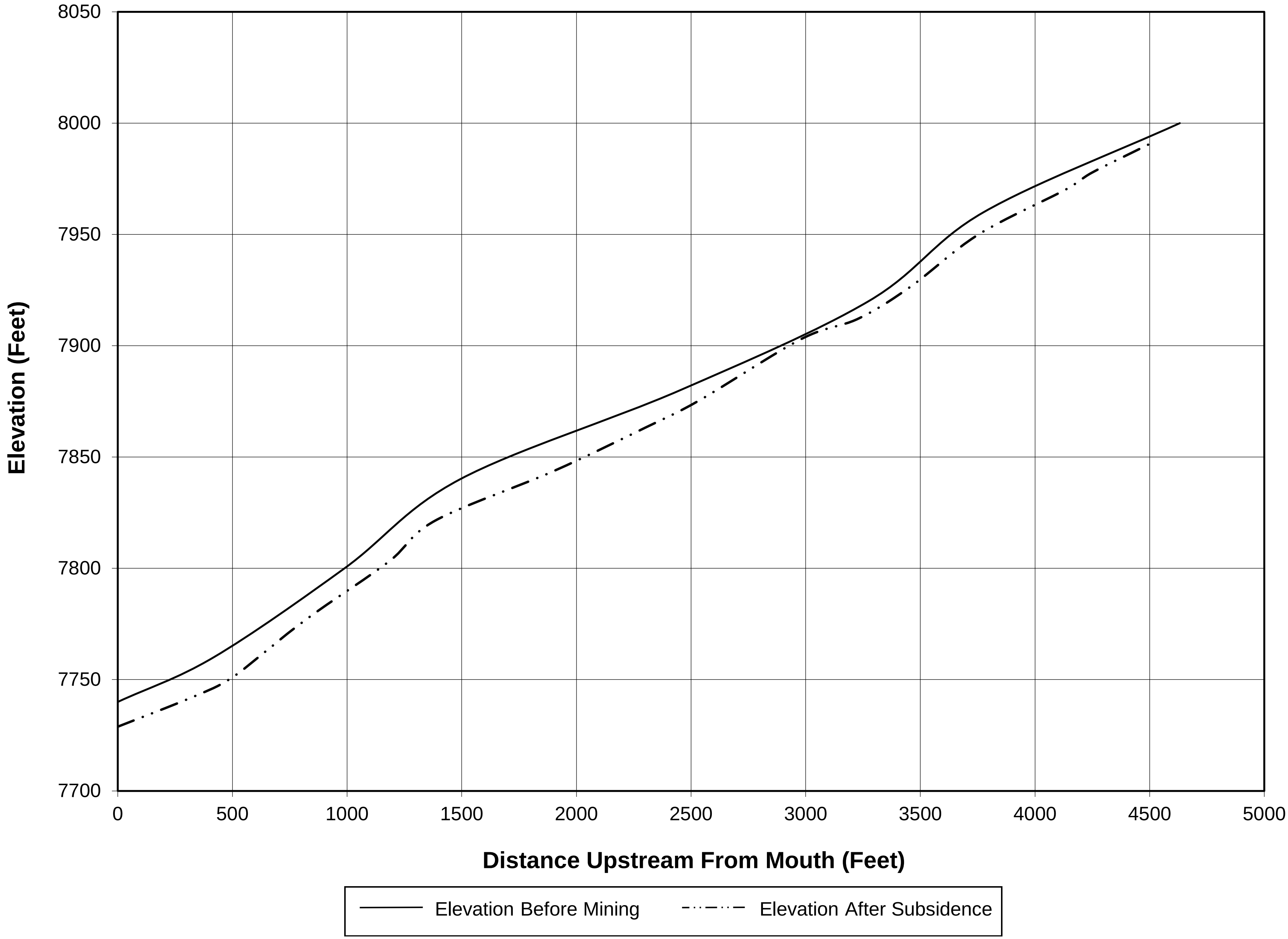
Basin 3.xlsx

Figure 22
Basin 29 - Poison Creek Channel Profile Before and After Mining



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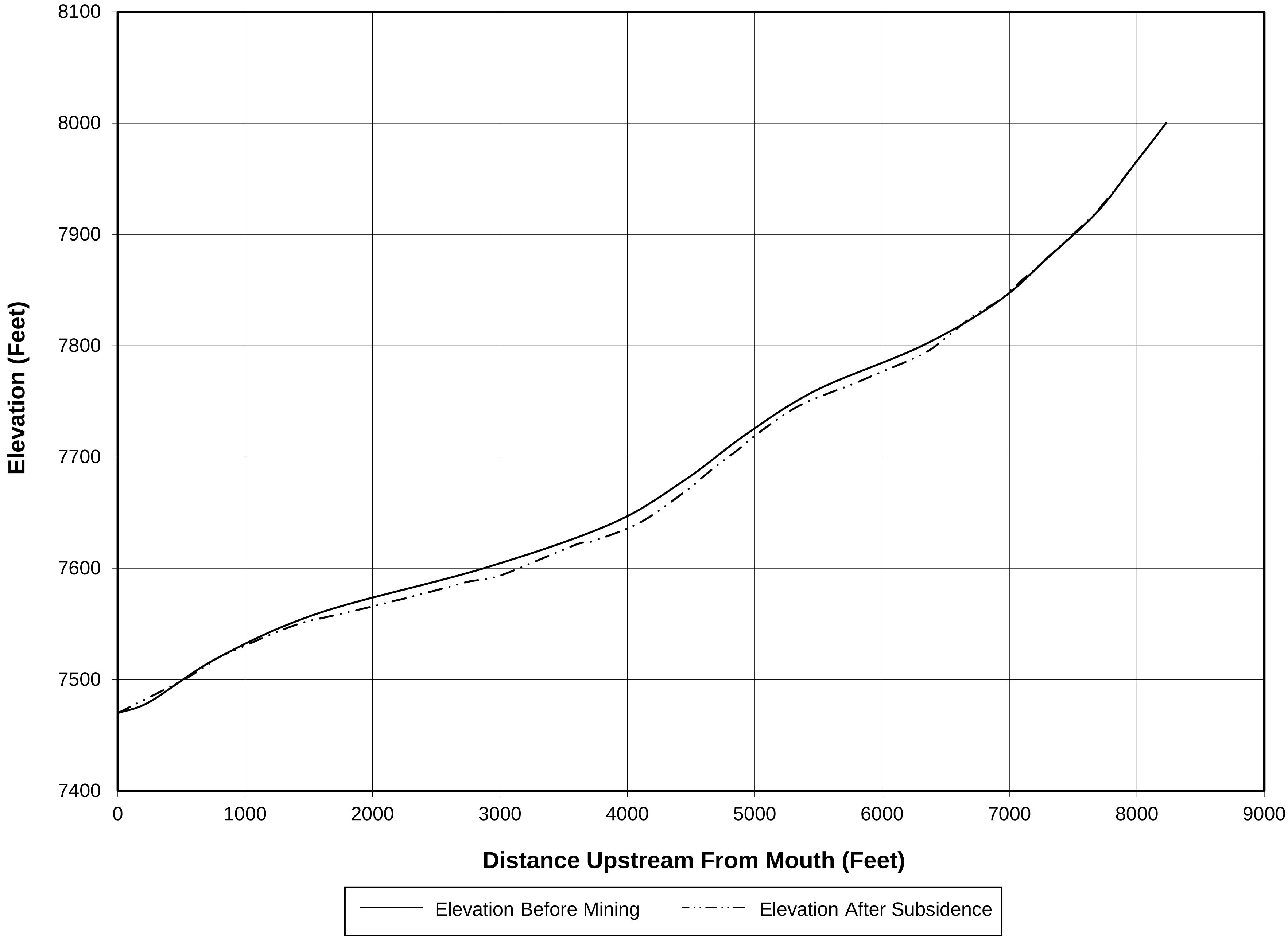
Basin 29.xlsx

Figure 23
Basin 32 - Deer Creek Channel Profile Before and After Mining



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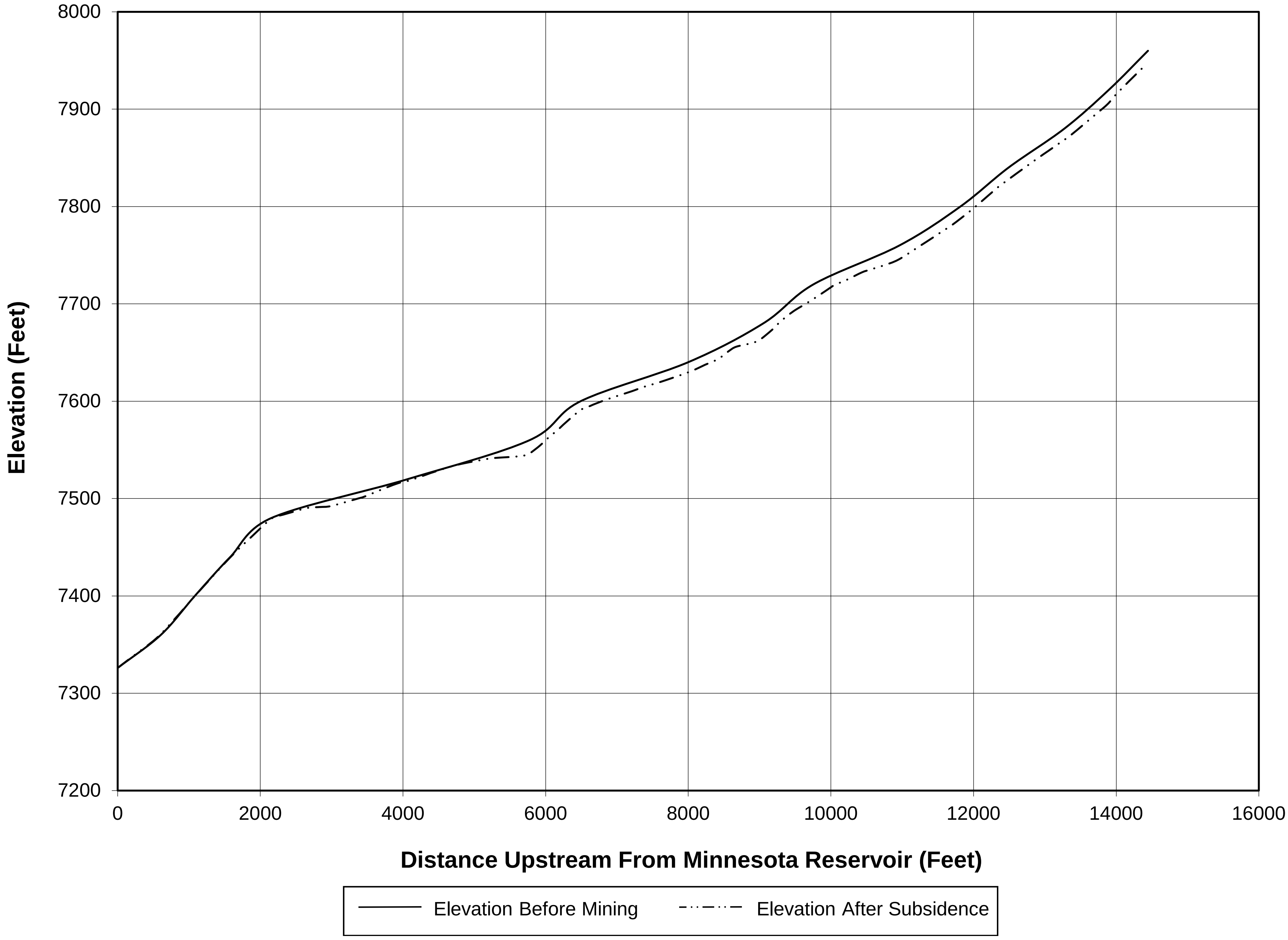
Basin 32.xlsx

Figure 24
Basin 35 - Dry Fork Channel Profile Before and After Mining



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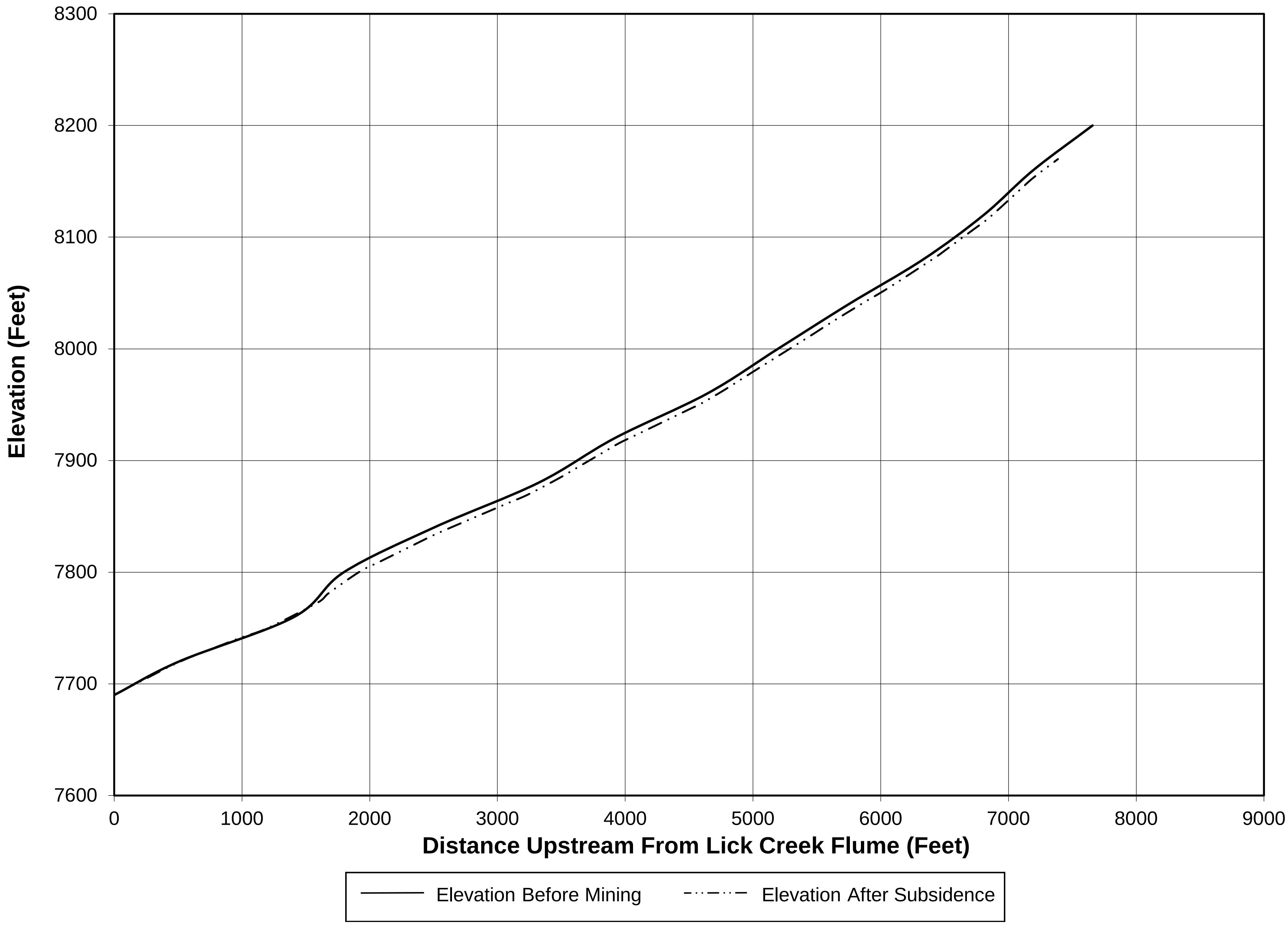
Basin 35.xlsx

Figure 25
Basin 36 - Lick Creek Channel Profile Before and After Mining



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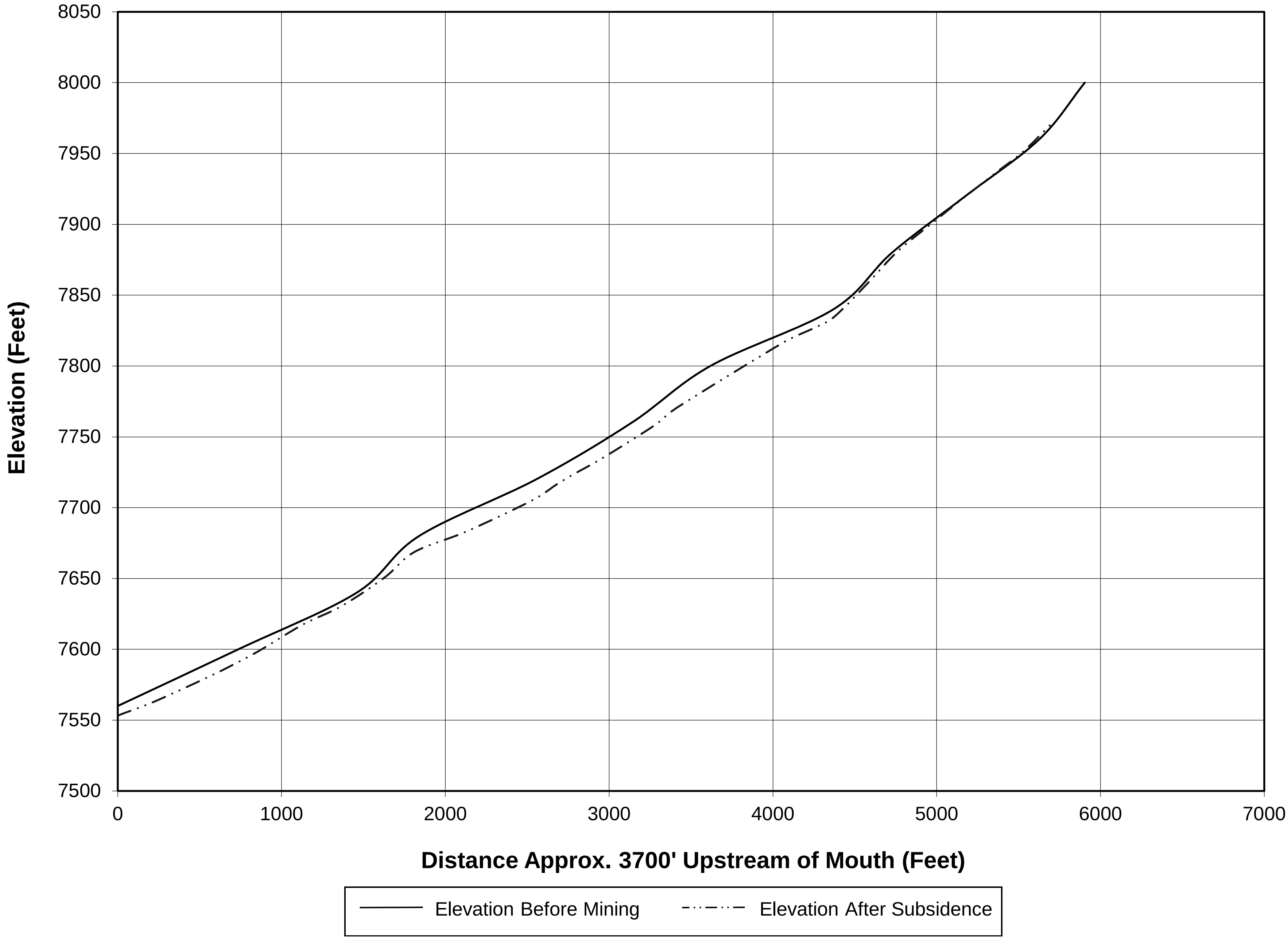
Basin 36.xlsx

Figure 26
Basin 37 - Deep Creek Channel Profile Before and After Mining



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Basin 37.xlsx

FIGURE 27A
Basin 39 - South Prong Channel Before and After Mining - Full Extent

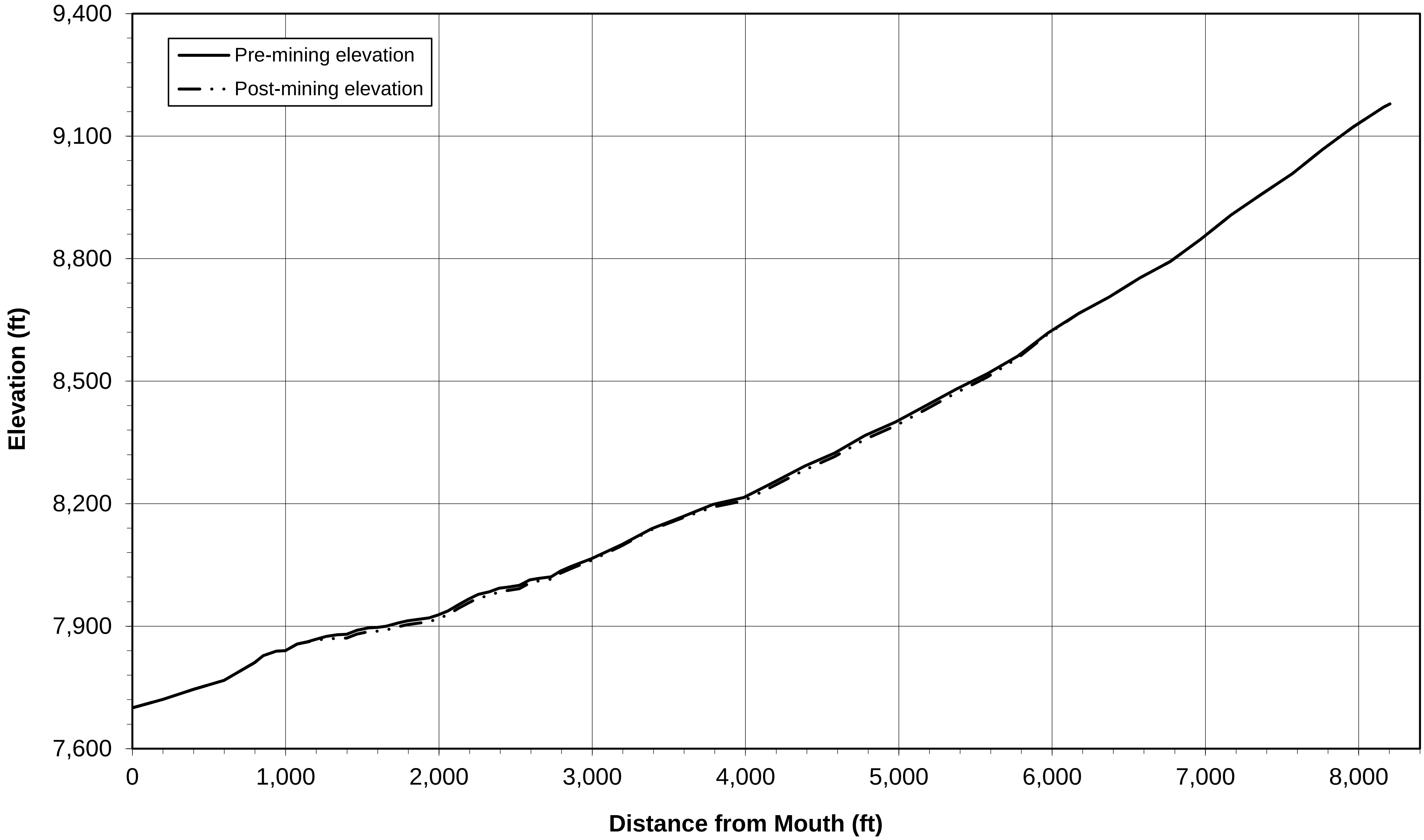


FIGURE 27B
Basin 39 - South Prong Channel Before and After Mining - Critical Reach

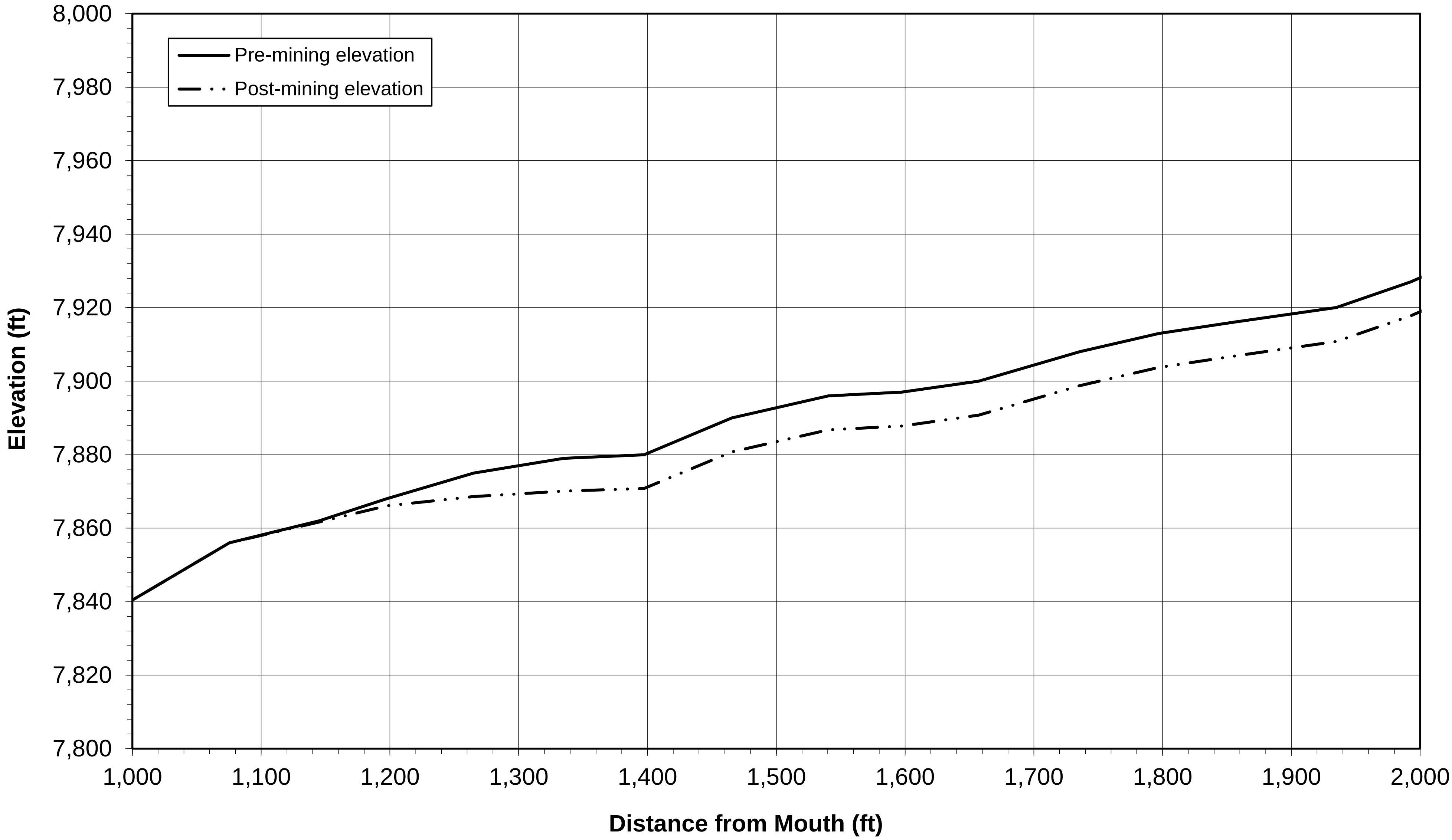
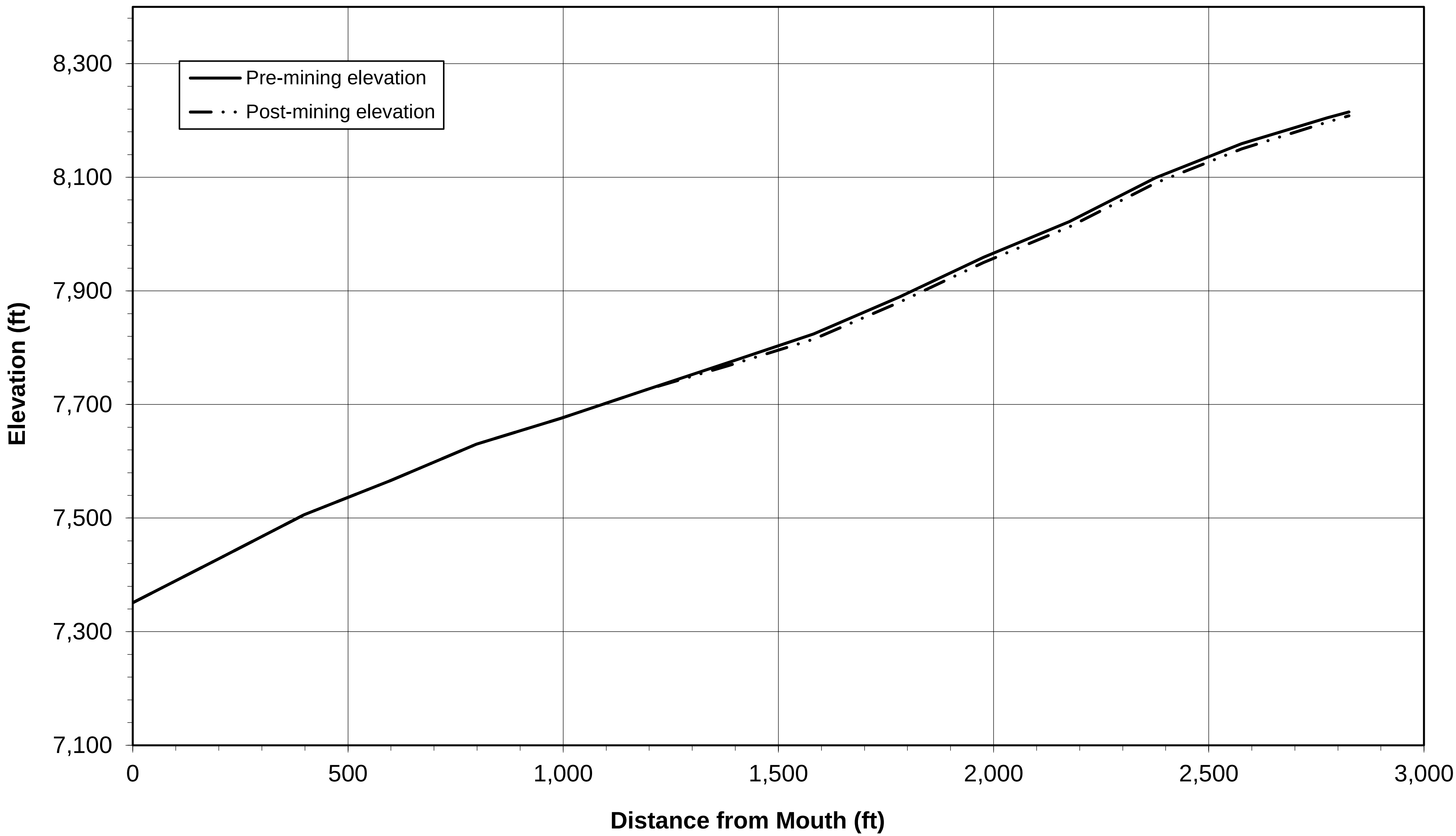
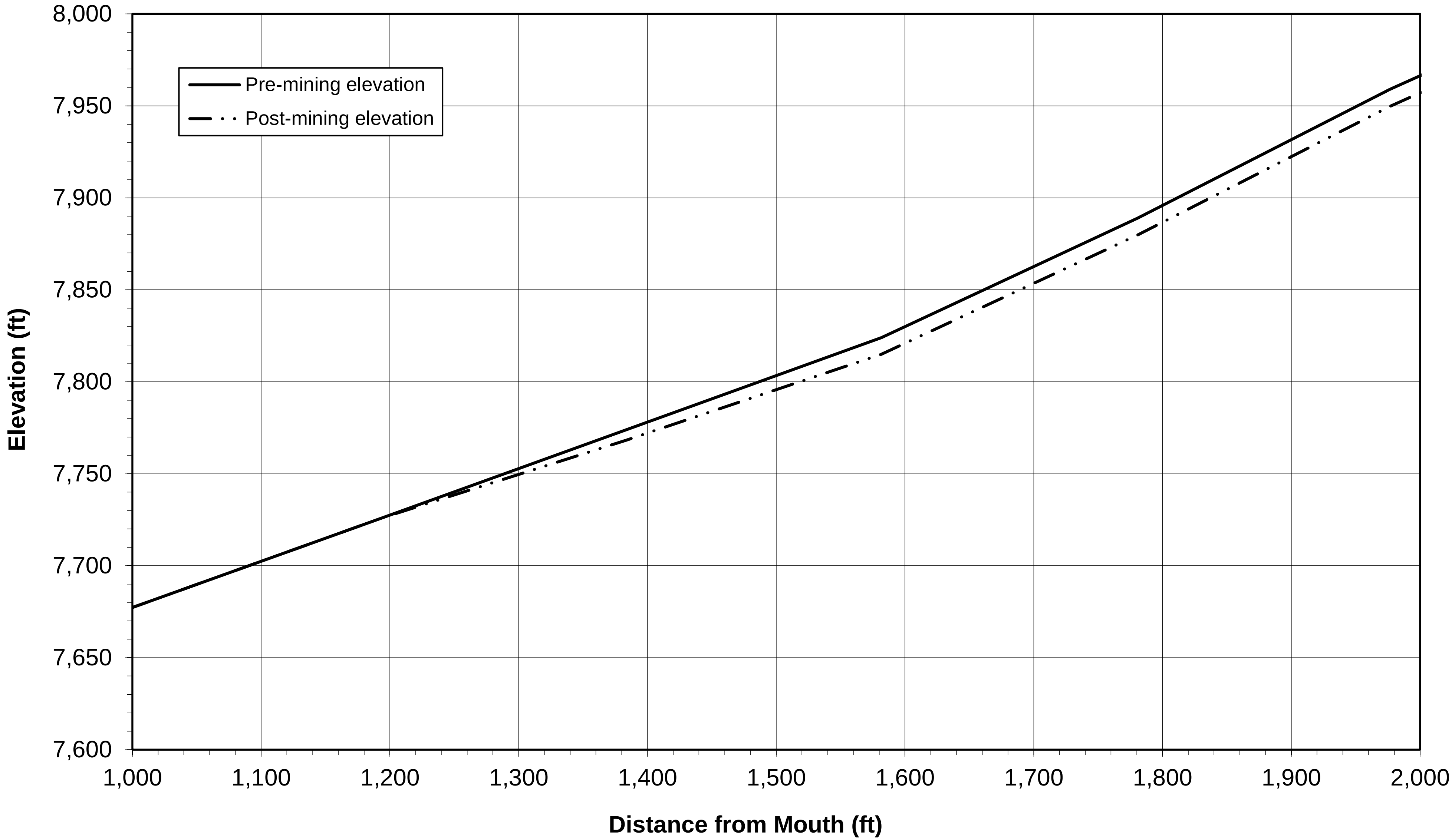


FIGURE 28A
Basin 41- Lion Gulch Channel Profile Before and After Mining - Full Extent



Notes: Slope indicated for lowest reach of channel potentially affected by subsidence.

FIGURE 28B
Basin 41- Lion Gulch Channel Profile Before and After Mining - Critical Reach



Notes: Slope indicated for lowest reach of channel potentially affected by subsidence.