SECTION E
STREAM CHANNEL CONDITION

INTRODUCTION

This report provides the results of an assessment of the stream channels of the Mendocino Redwood Company (MRC) ownership in the Albion River watershed analysis unit (WAU). The assessment was done following the methods described in the Watershed Analysis Manual (Version 4.0, Washington Forest Practices Board). The stream channel analysis is based on field observations, aerial photo interpretation and existing stream channel information.

The goals of the assessment were to determine the existing channel conditions and identify the sensitivity of the channels to wood and sediment. Stream channels are defined by the transport of water and sediment. A primary structural control of a channel in a forested environment, besides large rock substrate, is from woody debris. Channel morphology and condition therefore reflect the input of sediment, wood and water relative to the ability of the channel to either transport or store these inputs (Sullivan et. al., 1987)

Stream channel conditions represent the strongest link between forest practices and fisheries resources. Changes in channel condition typically reflect changes to fish habitat. Because of this the fish habitat and stream channel assessments were done in the same reaches. The results for the fish habitat parameters are presented in Section F - Fish Habitat Assessment.

METHODS

The methods of the stream channel assessment are designed to identify channel segments which are likely to respond similarly to changes in sediment or wood and group them into distinct geomorphic units. These geomorphic units enable an interpretation of habitat-forming processes dependent on similar geomorphic and channel morphology conditions. The channels are also evaluated for current channel condition to provide baseline information for the monitoring of channel conditions over the long term.

Stream Corridor Delineation

The stream channel network for the Albion WAU was partitioned into stream segments based on three classes of channel confinement and three classes of channel gradient. These classifications were based on channel classifications prepared from digital terrain data. Channel segments were delineated based on either a change in slope class or change in channel confinement. Channel slope class or confinement information from the digital terrain data was re-classified based on field observations. The stream segments are shown on Map E-1.

Field Measurements and Observations

Selection of field sites for stream channel observations was based on gathering a representative sample of response (0-3% gradient) and transport (3-20% gradient) channels from each planning

watershed of the WAU. Little attention was focused on the source reaches this was assumed to be covered in the mass wasting analysis.

For each channel segment the bankfull width, bankfull depth, approximate valley width, flood plain connectivity and channel slope were taken at several locations along the segment. Stream bed sediment characteristics were measured by pebble counts, observations of gravel bars, channel aggradation or degradation, and particle size of the stream bed material. The segment was further classified by its appropriate morphology type based on Montgomery and Buffington (1993) and Rosgen (1994). Large woody debris (LWD) in channel and potential recruitment trees were tallied. The abundance and type of pools were also observed. The field observations notes are in the appendix of this module. The field observations are summarized and defined in Table E-1.

Interpretations of Field Assessments

Interpretations related to sediment supply, transport capacity and LWD response were the basis for development of geomorphic unit classifications. These interpretations were based primarily on existing conditions observed in the channels and potential responses to changes to input factors as discussed in Montgomery and Buffington (1993).

Geomorphic Units

Channel segments were grouped into geomorphic units by similar attributes from the channel conditions discussed above, position in the drainage network, and gradient/confinement classes. The intent of the geomorphic units are to stratify channel segments of the WAU into units which respond similarly to the input factors of coarse and fine sediment, LWD, and catastrophic damage from mass wasting. These geomorphic units can then be interpreted to have similar habitat-forming or sediment routing processes.

Long-Term Stream Monitoring Sites

To monitor stream channel morphology conditions and stream sediment characteristics related to fish habitat, six long term stream channel monitoring segments were established in the Albion WAU. These segments were surveyed in 1998 and again in 2000. In 2001 staff from the North Coast Regional Water Quality Control Board surveyed one of the monitoring segments. Along these segments a thalweg profile, several cross sections and streambed D50 measurements were surveyed. Stream gravel bulk samples and permeability are also measured; the methods and results are presented in Section F - Fish Habitat Assessment of this report. The long term stream channel monitoring segment locations are shown on Map E-1 and the protocols described below.

Stream Thalweg Profile and Cross Section Protocal

The stream monitoring segment for thalweg profile and cross section surveys will start at known reference points along the channel and continue upstream until encountering another known reference point. The stream monitoring segment will be 20-30 bankfull channel widths in length. Cross section surveys will be taken approximately every 5-8 bankfull channel widths along the segment. Reference points that mark the upstream and downstream ends of the monitoring segment will be permanently monumented with rebar pins for future surveys.

Thalweg Profile

Working upstream, survey the thalweg depth (elevation) and distance along the stream. The distance should be measured by a tape stretched along the bank of the channel. The thalweg is the deepest point of the flowing channel, excluding any detached or "dead end" scours and/or side channels. Do not include these deep points in the thalweg profile or analyses of thalweg residuals. At any visually apparent change in thalweg location or depth, measure distance from previous thalweg depth location and shoot the elevation. In the absence of visually apparent changes, thalweg measurements should be taken every 15-20 feet up the center tape. Record each thalweg elevation to the nearest 1/100 of a foot and distance to the nearest 1/10 of a foot.

As specific landmarks are encountered along the reach, (e.g. tributary channels, particularly large pieces of woody debris, permanent survey stakes, armored bend, or other features of interest) the recorder should make note of their location and size. Where a channel splits into two components, the surveyor needs to decide which the main channel is and continue moving upstream (making measurements) along that channel. Generally, the main channel will be the one carrying the greatest flow. Measure every pool's maximum depth and the crest of the pool tail-out so that residual pool depths can be calculated.

Cross Sections and D50

Approximately every 5-8 bankfull channel widths along the thalweg profile, monument the location for a cross section survey, and record this location in the thalweg profile survey notes. The cross section should be located along a relatively straight reach. Cross sections will be surveyed from above the bankfull channel margins on both banks. Attempt to get 3-5 cross sections along the profile, 4 cross sections is preferred.

Establish cross section rebar pins at both ends of the cross section well above the bankfull channel margin to monument the cross section location. Use a clinometer, hand level or transect to ensure that a tape stretched between the two pins is level, if not adjust the pin location.

Secure the 0.0' end of the tape to the left bank pin and stretch the tape across the channel, securing it to the right bank pin. Take an azimuth, with a compass, along the cross section tape from the left bank pin. Record point locations of cross section pins and describe those locations in relation to other relatively permanent features (e.g. large trees, bedrock outcrops, or boulders). Record the elevation and the distance from the left bank pin at least every five feet or at any visually apparent topographic change along the cross section. Record each cross section elevation to the nearest 1/100 of a foot and distance to the nearest 1/10 of a foot. Provide a rough sketch of cross section as well. At each cross section conduct a pebble count, to determine the D50 of the cross section, by measuring 100 randomly selected pebbles along the transect.

RESULTS

Current Stream Channel Conditions

Field channel surveys were done on 20 stream segments, with a few observations on 3 more stream channel segments in the Albion WAU during the summer of 1998. Table E-1 provides a summary of the data collected. Further detail specific to in-channel habitat relationships is found in Section F - Fish Habitat Assessment. Large woody debris (LWD) data for stream channels is presented in Section F – Riparian Function.

Table E-1. Stream Segment Field Observations for Albion WAU (key to abbreviations follows table)

Stream Channel Dimensions										
Segment Name	ID #	Geomorphic Unit	Channel Confinement	Survey Length (ft)	Mapped Slope Category (%)	Observed Slope	Mean Bankfull Depth (ft)	Mean Bankfull Width (ft)	Width/Depth Ratio	Valley Width
Albion	43(Lower)	2	c	1265	0-1	0.7	5.7	44	7.7	104
Albion	43(Upper)	2	c	1219	1-2	1.2	6.2	45	7.3	70
Albion	3(Lower)	2	mc	1052	0-2	1.1	6	56	9.3	175
Albion	3(Upper)	2	c	1025	0-1	0.8	4	50	12.5	110
Albion	44	2	c	992	0-2	1.2	6	33	5.5	56
North Fork Albion	114	2	c	817	0-2	1.2	5.2	27	5.2	80
South Fork Albion	76	2	c	813	0-2	1.0	5.1	35	6.9	75
South Fork Albion	77	2	c	809	1-2	1.4	4.7	32	6.8	55
Railroad Gulch	4	3	uc	471	0-2	1.1	3.8	28	7.3	189
Railroad Gulch	5	3	uc	461	0-2	1.3	4.3	18	4.3	225
Tom Bell Creek	50	3	uc	360	0-2	1.9	3.8	17	4.5	
Pleasant Valley Creek	15	3	uc	418	1-2	1.3	2.8	13	4.6	190
Duck Pond Gulch	20	3	uc	375	0-2	1.2	3.5	10	2.9	80
South Fork Albion	78	3	uc	590	0-1	0.8	2.6	41	15.8	200
South Fork Albion	79	3	uc	410	0-1	0.7	3.5	20	5.7	175
Railroad Gulch	6	4	mc	415	1-2	1.2	3.3	16	4.8	68.0
East Railroad Gulch	45	4	c	716	1-4	2	4	16	4.0	37
East Railroad Gulch	46	4	c	obs.	2-4		2.5	12	4.8	
Little North Fork	91	4	c	453	0-2	0.8	2.8	21	7.5	41
Duck Pond Gulch	21	4	mc	319	2-4	2.4	3.4	9	2.6	50
South Fork Albion	80	4	c	800	1-2	1.1	4.3	15	3.5	160
Buckhorn	132	5	c	obs.	4-8	4.5	5	8	1.6	40
Morrison Gulch	64	5	c	obs.	2-4	3				

Table E-1 (continued). Stream Segment Field Observations for Albion WAU

Sediment/bedform Characteristics												
ID #	Montgomery/ Buffington Class	Rosgen Class	Floodplain Continuity	Aggredation/ Degradation in Past	Aggredation/ Degradation Current	Channel Roughness	Gravel Bar Abundance	Gravel Bar Type	Gravel Bar Proportion Class	Fine Sediment Abundance	Fine Sediment Type	D50 (mm)
43(Lower)	pb, p/r	c4, f4	n	n	y/a	f-r-c	a	a-p-m	3	s	p	33-45
43(Upper)	p/r, pb	f4, f1	n	n	n	r-c-b			1	s	p	46-64
3(Lower)	fp/r, pb	c4	c	n	y/a	f-bk-w	c	a-p-f	2	m-a	b	12-16
3(Upper)	p/r	c4	d	n	n	f-c	a	p-a-f	3	s	p	23-32
44	p/r, pb	f4, f3	n	n	n	b-c-f	f	p-m	1	s	m	23-32
114	p/r	f1, f3	n	n	n	r-b-v-c	c	a	2	s	p	33-45
76	p/r	c3	i-n	n	n	c-bk-f	c	p-a	2	s	p	46-64
77	p/r	f1,f2,f3	i-n	y/a	n	b-c-r-bk	f	m-f	1	s	p	33-45
4	p/r	e4	c	n	n	v-bk-f	f	p-a	1	m-a	p-a	9-11
5	p/r	c4	c	n	n	bk	f	p	1	m	m	12-16
50	p/r	f4	c	n	n	v-bk	f	f	1	m	m	n/a
15	pb, p/r	c4	c	n	y/a	c-bk-v	c	f-p	1	m	b	17-22
20	p/r	e4	c	y/a	n	v-bk-f	f	f-p	1	m	m	17-22
78	p/r	e6,e4	c	n	n	v-bk-f	f	f-p	1	a	b	n/a
79	p/r	e6,e4	c	n	n	v-f-bk	f	m	1	a	b	9-11
6	p/r	c4	c	n	n	f-bk	c	a-p-f	2	m	m	12-16
45	p/r, fp/r	g3	n	n	y/d	r-c-f-bk	f	p	1	s	p	12-16
46							c					
91	p/r	c4	c	y/a	n	bk-b-f	f	f-p	1	m	m	23-32
21	p/r, fp/r	g4	c	n	n	bk-v-f	f	p	1	m	m	12-16
80	p/r	f1,f3	d	y/a	y/d	r-bk-c	f	p-f	1	m	m	17-22
132	cas	a4, a5	n	y/a	y/a, y/d	bk						
64		g1,g3				r-f-b	f	p-f				

Table E-1 (continued). Stream Segment Field Observations for Albion WAU

	Pools								
ID #	Free	LWD Forced	Boulder Forced	Bank Forced	Total # Pools	Pool Spacing	Mean Residual Pool Depth (ft.)	Shade Canopy %	Comments
43(Lower)	4	1	0	5	10	2.9	1.9	75	willows at lower end, steep side slopes typically on one side
43(Upper)	7	1	3	0	11	2.5	2.7	84	1 side wlpz non-syp(open)
3(Lower)	4	8	0	0	12	1.6	2.7	71	lots of lwd on terraces acessed hi flows
3(Upper)	2	8	0	1	11	1.9	2.9	73	
44	2	5	2	4	13	2.3	2.8	67	segment adjacent Ukiah/Comptche rd.
114	8	3	0	0	11	2.8	2.0	84	
76	2	2	0	3	7	3.3	2.9	86	typically terrace one side, canyon wall other side. road adj.
77	4	2	2	2	10	2.5	2.8	87	confined "v" gorge
4	5	4	0	1	10	1.7	1.5	77	lower section wetland, upper section CMZ
5	5	5	0	0	10	2.5	1.9	81	CMZ
50	4	1	0	2	7	3.0	1.5	88	dry with patchy pools in summer
15	1	11	0	0	12	2.7	1.1	88	lower 1500 ft. CMZ
20	2	5	0	0	7	5.4	1.4	88	lower 500 ft. CMZ or Wetland
78	3	9	0	1	13	1.1	3.1	87	CMZ, fine material in terraces/channel
79	6	3	0	1	10	2.1	2.6	85	fine material in terrace/channel
6	1	7	0	0	8	3.3	1.7	82	
45	4	11	0	1	16	2.8	1.5	85	stream goes dry in upper portion of segment
46									defined channel, dry in summer, observations only
91	1	7	0	1	9	2.4	1.6	88	lower section dry, wet area fish present
21	0	5	0	1	6	5.9	1.2	86	
80	5	7	1	8	21	2.5	2	82	
132									observations, not surveyed
64									observations only. Intermittent dry/wet. V gorge

Key to Table E-1

Stream Channel Dimensions

Category	Description
ID #	the stream idenitification number (see Map E-1).
Geomorphic Unit	number of the geomorphic unit the channel segment is in.
Confinement	c = confined, mc = moderately confined as classified from USGS topography
Survey Length-	length of segment surveyed.
Mapped Slope Catogory	the slope category as defined from USGS topography.
Observed Slope	mean slope observed in field.
Mean Bankfull Depth	mean bankfull depth of surveyed segment, as observed in field.
Mean Bankfull Width -	mean bankfull width of surveyed segment, as observed in field.
Width/Depth Ratio	bankfull channel width to depth ratio.
Valley Width	valley bottom width, from the edges of the slope break of the channel inner gorge, estimated in field.

Sediment/Bedform Characteristics

Category	Description
Montgomery/ Buffington Class	the channel type: p/r = pool/riffle, fp/r = forced pool/riffle, stp = step pool, plnbed = plane bed, cas = cascade.
Rosgen Class	Rosgen channel classification, see Rosgen (1994).
Floodplain Continuity	description of floodplain/channel interaction: C = continuous, D = Discontinuous, I = inactive, N = no floodplain.
Aggredation/Degradation in Past	evidence of past aggregation or degradation of channel.
Aggredation/Degradation Current	currrent aggregation or degradation of channel.
Channel Roughness	B =boulders, C=cobbles, F=bedforms, V=live woody veg., W=large woody veg., R=bedrock, Bk=banks and roots
Gravel Bar Abundance	F=few, C=common, A=abundant
Gravel Bar Type	A=alternate, F=forced, P=point, M=medial
Gravel Bar Proportion Class	Proportion of streaqm segment in gravel bars: 1 = 0-25%, 2 = 25-50%, 3 = 50-75%, 4 - 75-100%.
Fine Sediment Abundance	S=sparse, M=medium, A=abundant
Fine Sediment Type	type of fine sediment accumulation: P=isolated pockets, B=bars
D50	the median gravel size of the stream bed

Key to Table E-1 continued.

Pool Characteristics

Category	Description
Free	number of free formed pools in segment.
LWD Forced	number of LWD forced pools in segment.
Boulder Forced	number of boulder forced pools in segment.
Bank Forced	number of bank forced pools in segment.
Total # Pools	total number of pools in segment.
Pool Spacing	number of pools per bankfull width.
Shade Canopy %	percentage of shade over the channel.
Comments	general comments.

Geomorphic Units

Individual channel segments were categorized into geomorphic units using the interpretation of channel networks described above, the topography the channel segments are found in, the position in the drainage network, and gradient/confinement classes. Six geomorphic units were established to represent the range of channel conditions and sensitivities to input factors of coarse and fine sediment and LWD. The spatial distribution of these six geomorphic units is shown on Map E-1.

Geomorphic Unit I. Low Gradient, Depositional Channels of the Albion River with Tidal Influence.

Includes Segments: Field observed - 2; lower sections 4, 25, 26, 32, 35
Extrapolated - 1

General Description: River channels within this unit flow through open, unconfined canyon bottoms in the lower section of the Albion River near the ocean. The channels are low gradient (0-1 percent) in this unit, with wide meadow and wetland areas adjacent to the channels. Ocean tides influence the stage of these channels with high tides raising the river level. Channels within this unit frequently access the floodplain at high flows. The water table in the canyon bottom adjacent to these channels is shallow, creating hydric soils, wet bog-like areas, and often standing water. The channel substrate is predominantly a consolidation of deposited silt and clay materials.

Associated Channel Types:
This unit primarily exhibits regime morphology. The Rosgen classification (Rosgen, 1994) for these channels are predominantly E6, with areas of E5 depending on the channel substrate.

Fish Habitat Associations:
Spawning habitat in this geomorphic unit is limited to availability and has poor site potential because of silt/clay substrate that is dominant in this unit. Low velocity and highly productive marsh boggy habitat is used by rearing salmonids for food and shelter. Meadow /wetland vegetation provide roughness to slow water flow providing overwintering habitat to juvenile salmonids.

Conditions and Response Potential

Coarse Sediment: Moderate Response Potential
Currently the channels do not show evidence of aggrading or degrading. However due to the low gradient of these channels, the stream power of these channels can be relatively low. With a low stream power, deposition of coarse sediments occurring from an increased coarse sediment supply could adversely affect this unit. This type of coarse sediment deposition could potentially raise channel beds or partially fill channel voids.

Fine Sediment: Low Response Potential
Fine sediment accumulations appear to have created the wide, flat terraces located in the canyon bottoms of this unit. High flows occurring in this unit typically access the floodplain allowing fine sediment to deposit along the channel margins and terraces. Grass and willow vegetation provide roughness to slow water flow on the floodplain providing increased potential for fine sediment deposition. This increased opportunity for fine sediment deposition away from the river channel provides a lower potential for impacts due to fine sediment in the channel of this unit.

Large Woody Debris(LWD): Low Response Potential
LWD is sparse in this unit due to the lack of trees directly adjacent to the channel banks. The regime morphology of this channel does not typically respond greatly to LWD inputs. Though some LWD recruitment can still provide potential fish habitat in this unit by providing cover or isolated areas of scour in the channel.

Geomorphic Unit II. Confined, Depositional Channel Segments of the Albion River

Includes Segments: Field observed - 3, 43, 44, 76, 77, 114, 115
Extrapolated -

General Description: River channels within this unit flow through confined canyon bottoms in the Albion River watershed. Typically the channel is confined between a steep adjacent side slope and a fill terrace. This fill terrace alternates from side to side throughout this unit. The channels in this unit are low gradient (0-2 percent), but sediment transport capacity is high due to the highly confined channel keeping water energy directed within the channel. There is typically no floodplain or channel migration capacity in this unit due to the highly confined channel. The channel bed varies from gravel to cobble to occasional boulder sized particles, with many areas bedrock dominated.

Associated Channel Types:
This unit primarily exhibits pool/riffle morphology, however plane bed and forced pool/riffle morphology is also present. The Rosgen classifications (Rosgen, 1994) for these channels are predominantly F4, F3, and F1, with areas of C4 depending on the channel substrate and bank configuration.

Fish Habitat Associations:
The confined channels in these units have a high sediment transport capacity during high flows, which flushes out fine sediment, creating cleaner, high quality gravel with low embeddedness for spawning. This same high-energy transport, in conjunction with a lack of large woody debris, creates free-formed pools in which the energy of the water creates the scour associated with the pool. These free-form pools provide rearing and overwintering habitat.

Conditions and Response Potential

Coarse Sediment: Moderate Response Potential
Coarse gravel accumulations are primarily in alternating point and medial gravel bars, with some LWD forced bars. The gravel bar abundance is common to abundant, with some areas with few gravel bars. As a whole the channels in the unit do not show evidence of either aggrading or degrading, except in the most downstream segments of this unit where some aggradation is observed. There is evidence of some past aggradation in isolated areas of this unit. The highly confined water flow of this unit creates high coarse sediment transport capacity. However, based on evidence of past aggradation, if the coarse sediment supply is high then the channels in the unit can aggrade lowering channel complexity and fish habitat quality.

Fine Sediment: Moderate Response Potential
High accumulations of fine sediment were not observed in this unit. Fine sediment is restricted to the top of gravel bars, accumulated in the bed of plane bed reaches, along pool margins, and in some pools. However, the fine sediment observations are of only sparse to moderate accumulations. The channels of this unit have high fine sediment transport capacity due to high flow capacity of the channel. However, when there is a high fine sediment supply in transport, accumulations of fine sediment can occur in this unit.

Large Woody Debris: Moderate Response Potential

Large woody debris is sparse to common in this unit. The LWD which is present is providing stream habitat development and cover. The high flows which are confined within channels of this unit require very large LWD pieces or debris jams to keep the LWD in place. Very large LWD is recruited into channels infrequently due to the long growing times of streamside trees. However, LWD in this unit is important because the channels in this unit would gain greater fish habitat diversity with increased LWD.

Geomorphic Unit III. Unconfined, Depositional Channel Segments of the Albion River

Includes Segments: Field observed - 4, 5, 15, 20, 50, 78, 79
Extrapolated - 25, 26, 28, 32, 35

General Description: Channels within this unit flow through unconfined canyon sections in the Albion River watershed. The channels in this unit are low gradient (0-2 percent), with a high degree of deposition and terrace development. Channels within this unit frequently access the floodplain and abandoned channels at high flows. The unconfined channels in combination with access of the floodplain and abandoned channels during high flows makes channel migration common in this unit. The channel substrate, and adjacent terraces is predominantly a consolidation of fine deposited materials of the silt and clay size classes.

Associated Channel Types:
This unit primarily exhibits pool/riffle morphology, however plane bed morphology is occasionally present. The Rosgen classifications (Rosgen, 1994) for these channels are predominantly E4 and E6, with areas of C4 and F4 depending on the bank configuration.

Fish Habitat Associations:
A high propensity for channel migration causes streams to spread out over floodplain rather than concentrating flows through a narrow channel. While this increased wetted area may enhance spawning habitat area, it also increases fine sediment deposition in areas of lesser flow. During drought conditions or low summer flows, it is not uncommon for side channel flow to go subsurface. In these situations, rearing habitat is limited to the main channel and deeper residual pools. The unconfined, low gradient nature of these streams combined with large amounts of woody debris result in an abundance of wood-forced pools. These segments are often lacking bedrock and the large cobble/boulder substrates associated with overwintering habitat. However, the LWD provides the roughness element to slow water velocities and provide key overwintering habitat to juvenile salmonids.

Conditions and Response Potential

Coarse Sediment: Moderate Response Potential
Coarse gravel accumulations are primarily in point and LWD forced gravel bars, with some medial bars. The gravel bar abundance is few, with some areas with gravel bars common. In a few isolated circumstances the channels do show evidence of either currently aggrading or having some aggradation in the past. The unconfined channels and migrating channel areas are not considered high sediment transport areas, but do provide a large amount of sediment storage opportunities buffering impacts from high coarse sediment loads. However, based on evidence of some past and current aggradation, if the coarse sediment supply is high then the channels could be adversely affected lowering channel complexity and fish habitat quality.

Fine Sediment: Low Response Potential
Moderate to high accumulations of fine sediment were observed in this unit. However, the substrate and terrace in this unit is composed of fine material. The unconfined and low gradient characteristics of this unit facilitates high fine sediment deposition. This deposition provides for the flat morphology of the stream channels, and thus the fine material composition of the channel banks, substrate and terraces. This process of fine sediment deposition appears to be the natural process in this unit. This unit is not anticipated to be adversely affected by future fine sediment deposition provided the channel migration and floodplain characteristics are not altered.

Large Woody Debris: High Response Potential

LWD is common to abundant in this unit with some areas with sparse accumulations. LWD is functional for stream habitat development or cover in this unit. The greatest portion of pool formation in this unit is LWD forced. The channel substrate and terraces in this unit are predominantly composed on fine particles (silt and clay), providing little in the way of roughness elements for stream habitat or channel diversity. LWD and streamside vegetation in this unit is the primary source of channel roughness for stream habitat development and quality. In the areas where channel migration is prevalent LWD recruitment across the entire canyon bottom is essential to ensure adequate LWD for channel roughness and habitat as the channel migrates.

Geomorphic Unit IV. Confined, Depositional Channel Segments of Tributaries of the Albion River.

Includes Segments: Field observed - 6, 21, 45, 46, 80, 91
Extrapolated - 16, 17, 18, 38, 53, 92, 101, 102, 103, 110, 111, 140

General Description:
Channels within this unit are confined to moderately confined within canyons with steep side slopes. Typically, channels in this unit are at the bottom of small sub-watershed tributaries of the river. Bankfull widths vary from about 10 to 20 feet in width, making these channels small depositional channels relative to the mainstem of the South Fork Albion River or Albion River. Channel gradients are low (0-4 percent). Sediment transport capacity is moderate to high due to moderately confined to confined channels directing water energy within the channel during high flows. Channel substrate is typically gravel to cobble sized particles, with some isolated bedrock dominated areas. These channels frequently go sub-surface (dry) during the Summer drought season.

Associated Channel Types:
This unit primarily exhibits pool/riffle and forced pool/riffle morphology. The Rosgen classifications (Rosgen, 1994) for these channels vary from C4, G3, G4, and F3, with areas of F1 depending on the bank configuration and channel substrate.

Fish Habitat Associations:
Spawning habitat and gravel are limited in this unit, but spawning gravel quality is good where present. These confined narrow channels have recruitment potential for LWD. The recruited LWD in turn facilitates pool development and offers shelter. Rearing habitat availability is drastically reduced because streams in this unit often go subsurface during the summer rearing period. Young fish typically have to migrate to other areas to survive through the summer months. Overwintering habitat is limited by a lack of large cobble/boulder and bedrock substrates. LWD in this unit provides overwintering habitat for juvenile salmonids.

Conditions and Response Potential

Coarse Sediment: Moderate Response Potential
Coarse gravel accumulations are primarily in point and LWD forced gravel bars. The gravel bar abundance is few, with some areas with gravel bars common. Some of the channels in this unit show evidence of past aggradation. Currently some channels in this unit are degrading, indicating the responsive of the channels in this unit to coarse sediment inputs.

Fine Sediment: Moderate Response Potential
Moderate accumulations of fine sediment were observed in this unit. These accumulations were observed in the gravel bars, along channel margins, and in some pools. The channels of this unit have high fine sediment transport capacity due to high flow capacity of the channel. However, when there is a high fine sediment supply in transport, accumulations of fine sediment can occur in this unit.

Large Woody Debris: High Response Potential
Large woody debris is common in this unit. LWD is functional for stream habitat development or cover where LWD loading is high. LWD in this unit was observed to force storage of coarse sediments creating a more complex channel morphology. The narrow channel enables LWD to lodge and debris jams to more easily form.

Geomorphic Unit V. Moderate Gradient Transport Segments of the Albion River.

Includes Segments: Field observed - 64, 88, 132
Extrapolated - 7, 10, 11, 14, 33, 37, 39, 41, 48, 49, 57, 58, 59, 61, 65, 70, 72, 74, 87, 89, 93, 97, 109, 117, 120, 124, 126, 132, 133, 134, 135, 136, 137, 138, 139, 142, 143

General Description:
Stream channel segments in this unit are confined to moderately confined within canyons. Typically valley widths are between 2 and 5 bankfull channel widths. This valley width is sufficient to allow some terrace formation and channel meandering. The channel segments in this unit are near the transition between deposition and transport channels. Due to the moderate gradient (2-8 percent) of the channels, they are responsive to aggradation and degradation from changes in the stream sediment supply. The stream bed of these channels varies from gravel to boulder sized particles. The gradient of the stream is high enough that stream segments in this unit easily downcut through the terrace deposits. These channels typically go sub-surface (dry) during the Summer drought season. The terraces in this unit appear to be created from large episodic sediment loads such as frequent mass wasting. The gradient of the stream is high enough that stream segments in this unit easily downcut through the terrace deposits.

Associated Channel Types:
This unit primarily exhibits step pool and cascade morphology, with some areas of pool/riffle morphology. The Rosgen classifications (Rosgen, 1994) for these channels vary from A4, A2, A3 with areas of G1, G2, and G3 depending on the bank configuration and channel substrate.

Fish Habitat Associations:
Spawning areas in this unit are infrequent, due to lack of accumulations of gravel sized particles. The steeper gradient segments of this unit typically form step-pool, cascade, and some pool-riffle habitat. The step-pools that are typically boulder formed, and offer substrate refugia, which provide both rearing and overwintering habitat.

Conditions and Response Potential

Coarse Sediment: Moderate Response Potential
Accumulations of coarse sediment are found in point and LWD forced gravel bars. The gravel bar abundance is few to common with some abundant accumulations. Currently many of the channels show evidence of down-cutting and occasional evidence of aggradation in response to coarse sediment fluctuations. There is evidence of past aggradation and degradation in this unit as well.

Fine Sediment: Moderate Response Potential
Accumulations of fine sediment are observed in this unit. Fine sediment accumulations varied from sparse to high primarily on the top of gravel bars, but also in isolated pockets in pools. The discontinuous floodplain and moderate slope gradient promotes high fine sediment transport due to concentrated stream power within channels. However, when there is a high fine sediment supply in transport, accumulations of fine sediment can occur in this unit.

Large Woody Debris: Moderate Response Potential
LWD in this unit was observed to force storage of coarse sediments slowing the outflow of coarse sediment material. LWD creates many scour and energy dissipation points providing for a more

complex channel morphology. In channels where down-cutting is present LWD was not observed improving the channel degradation. Often LWD recruited from riparian areas is recruited to streamside terraces and does not fall into the active channel, providing little stream structure or function.

Geomorphic Unit VI. High Gradient Transport Segments of the Albion River.

Includes Segments: 8, 9, 12, 13, 19, 22, 23, 24, 27, 29, 30, 31, 34, 36, 40, 42, 47, 51, 52, 54, 55, 56, 60, 62, 63, 66, 67, 68, 69, 71, 73, 75, 81, 82, 83, 84, 85, 86, 90, 92, 94, 95, 96, 98, 99, 100, 104, 105, 106, 107, 108, 112, 113, 116, 118, 119, 121, 122, 123, 125, 127, 128, 129, 141, 144, 145, 130, 131

General Description:
Channel segments in this unit are high gradient transport reaches from 8-20% with high sediment transport capacity. The channel segments in this unit typically flow through tightly confined, steep-sided, V-shaped canyons. These are typically zones of scour during high flows or debris flows. Stream substrate is typically from cobble to large boulders. Typically, there is no water flow in this unit in the Summer drought season.

Associated Channel Types:
This unit varies it morphology from step pool to cascades with some occasional waterfalls. The cascades and waterfalls occur in the steepest segments of this unit and only during winter storm events. The Rosgen (Rosgen, 1996) classification for these channels varies between A2, A3, and AA2, AA3 depending on channel gradient and substrate composition.

Fish Habitat Associations:
The high gradient channels of this unit prevent coho salmon from accessing these areas. Potential for steelhead trout utilization is low due to the high gradient; 12% to 20%. Rearing would be unlikely because of the streams subsurface flows in the summer months.

Conditions and Response Potential

Coarse Sediment: Low Response Potential
The unit has very few terraces, bars or storage sites. The roughness of the channels creates varied coarse sediment transport capacity. Large woody debris and large boulders can create some sediment storage.

Fine Sediment: Low Response Potential
Fine sediment accumulations in this unit range from sparse to moderate. Sediment transport capacity is high in these reaches allowing most fine sediment to be transported out of this unit.

Large Woody Debris: Low Response Potential
Large woody debris is sparse to abundant in this unit. Large woody debris provides some sediment storage and roughness elements in this unit. The cascade and step pool morphology is not highly affected by an increase or decrease in LWD.

Long Term Stream Monitoring

The six long term channel monitoring segments in the Albion WAU were surveyed for thalweg profiles, cross sections and pebble counts in 1998 and 2000. Those segments are segment 43 upper and lower, 45, 78, 3 upper and lower, and 76 (see Map E-1). In 2001 segment 3 upper thalweg and one cross section was surveyed by the North Coast Regional Water Quality Control Board as part of their assessment of the watershed. Also, in 2001 cross sections on 43 lower and 76 were surveyed by the North Coast Regional Water Quality Control Board. The plots of the surveys are included in the appendix of this module (Appendix E) for display. Stream gravel bulk samples and permeability were collected in several of these segments and are presented in Section F - Fish Habitat Assessment of this report.

Comparison of cross-section graphs between the 1998 and 2000 surveys show very little change in these areas of the Albion River WAU (see Appendix). Many of the curves are mirror images of each other. Some do show minor variations but considering that only two years of data exist, it is too early to draw any conclusions. D50 values are too similar to be able to draw any conclusions with only two observations. Residual water depths of thalweg profiles in the Albion River WAU are presented in the Appendix. Comparison of maximum and mean residual depths and standard deviation are shown in Table E-2. 1998 and 2000 values are fairly similar with the exception of segments 3(2) and 78. Mean residual depth and standard deviation of the residual depths have increased. This indicates deeper pools as well as more variable habitat in these channel segments. Although these differences do exist, there aren't enough years of data to be able to draw any conclusions.

Table E-2. Comparison of residual depth data for thalweg profiles in long-term channel monitoring segments in the Albion River WAU.

Segment ID	Stream	Year	Maximum Residual Depth (ft)	Mean Residual Depth (ft)	Standard Deviation
3 upper	Albion River	1998	4.72	1.29	1.2
3 upper	Albion River	2000	6.2	1.42	1.38
3 upper	Albion River	2001	7.91	1.77	1.8
43 lower	Albion River	1998	3.38	0.6	0.68
43 lower	Albion River	2000	3.11	0.63	0.64
43 upper	Albion River	1998	3.85	0.75	0.81
43 upper	Albion River	2000	4.21	0.83	0.89
45	Albion River	1998	2.56	0.43	0.54
45	Albion River	2000	2.29	0.51	0.53
76	South Fork Albion	1998	4.32	0.67	0.89
76	South Fork Albion	2000	4.95	0.73	0.87
78	South Fork Albion	1998	2.57	0.62	0.56
78	South Fork Albion	2000	2.74	0.97	0.76

LITERATURE CITED

Montgomery, D. and J. Montgomery. 1993. Channel classification, prediction of channel response, and assessment of channel condition. Washington State Timber/Fish/Wildlife report TFW-SH10-93-002. Washington.

Platts, W., W. Megahan, and G. W. Minshall. Methods for evaluating stream, riparian, and biotic conditions. USDA-Forest Service. Intermountain Forest and Range Experiment Station. Gen. Tech. Rep. INT-138. Ogden, UT. 70 p.

Rosgen, D. 1994. A classification of natural rivers. Catena 22, 169-199.

Washington Forest Practice Board. 1995. Standard methodology for conducting watershed analysis. Version 3.0. WA-DNR Seattle, WA.

Appendix E

Stream Channel Condition Module

Jan 22, 2001 - 10:39 a.m.
Report File: D:\ISAAC\STREAM~1\ALBION~1\SEGMEN~1\98ALB32S.TXT

Long Profile Data File: D:\ISAAC\STREAM~1\ALBION~1\SEGMEN~1\98ALB32.LPR
River Name:
Notes: Original Data file:
D:\ISAAC\STREAM~1\ALBION~1\SEGMEN~1\98ALB32.TXT
Measurement Units: U.S.

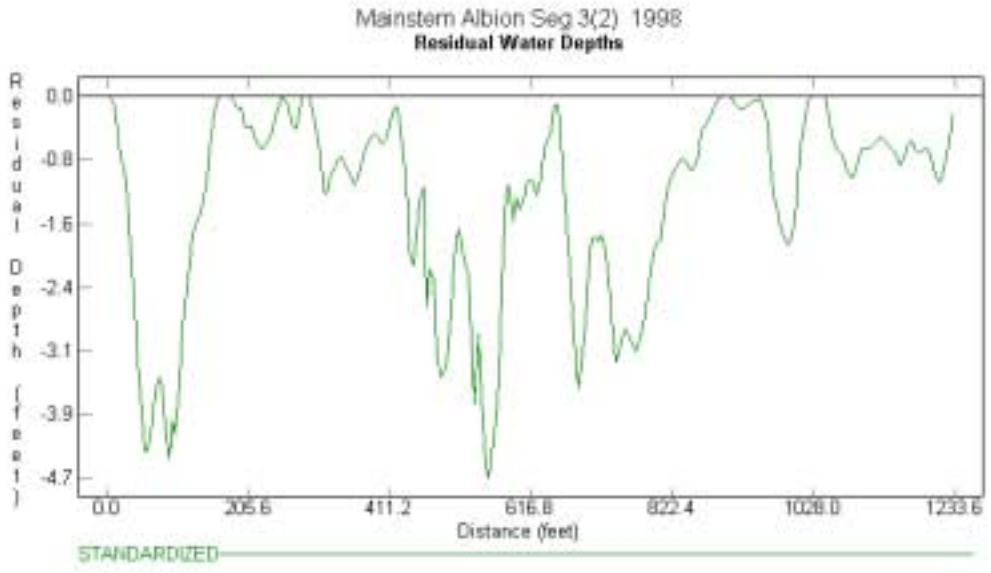
Top Elevation: -7.71
Bottom Elevation: -13.71
Reach Length: 1233.60

Standardized Statistics:
Number of data points in raw data: 162
Number of data points in Standardized data: 247

Reach Step Distance: 5.00

Max Residual Depth: 4.72
Mean Residual Depth: 1.29
Standard Deviation: 1.20

Number of non-zero Residual Depths: 229
Percent of Reach as pool: 92.71
Percent of Reach as riffle: 7.29



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River Name:
Notes: Original Data file: D:\ISAAC\STREAM~1\ALBION~1\SEGMEN~1\00ALB32.TXT
Measurement Units: U.S.

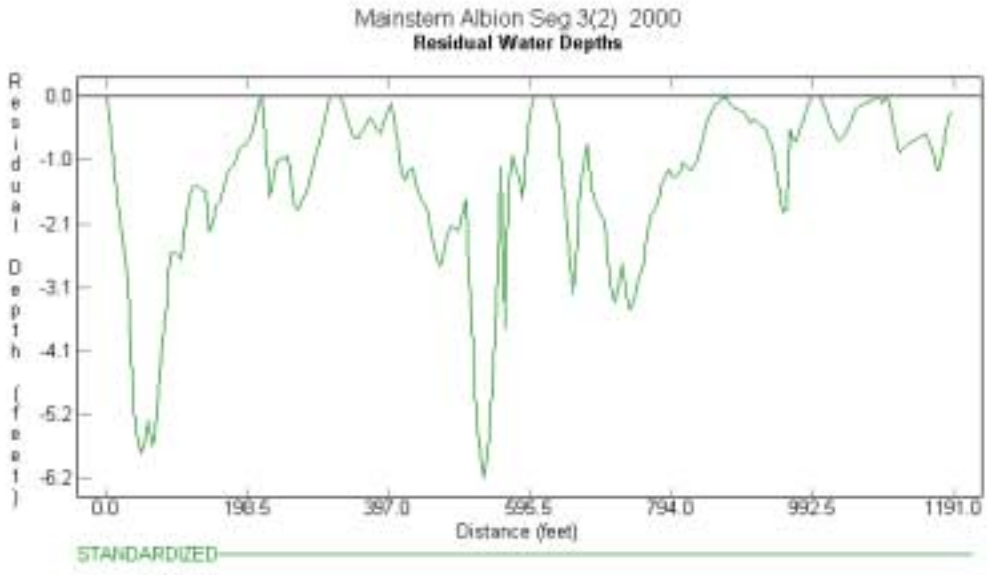
Top Elevation: -6.86
Bottom Elevation: -14.90
Reach Length: 1191.00

Standardized Statistics:
Number of data points in raw data: 147
Number of data points in Standardized data: 238

Reach Step Distance: 5.00

Max Residual Depth: 6.20
Mean Residual Depth: 1.42
Standard Deviation: 1.38

Number of non-zero Residual Depths: 222
Percent of Reach as pool: 93.28
Percent of Reach as riffle: 6.72



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River Name:
Notes: Original Data file:
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Measurement Units: U.S.

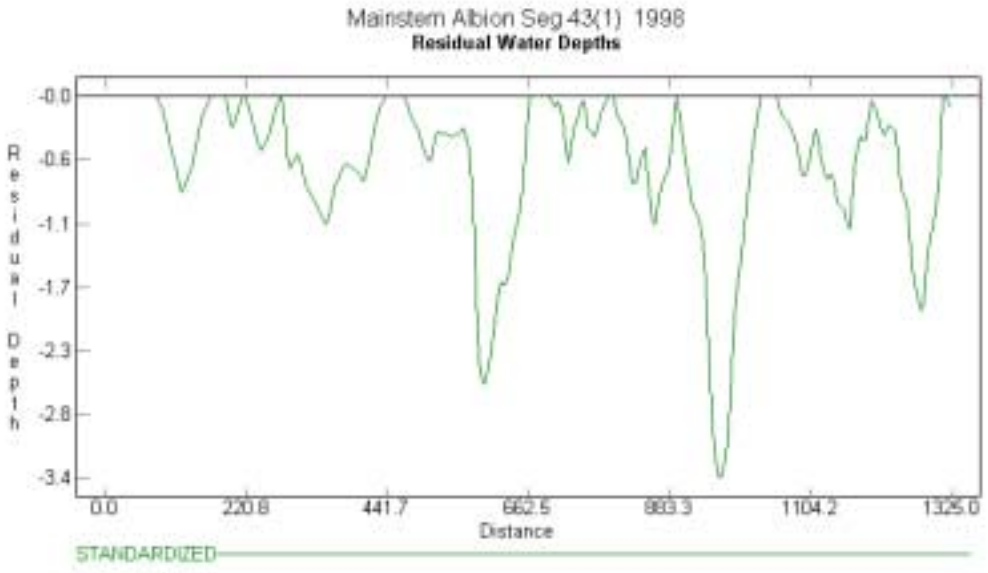
Top Elevation:	-3.80
Bottom Elevation:	-10.32
Reach Length:	1325.00

Standardized Statistics:
Number of data points in raw data: 120
Number of data points in Standardized data: 265

Reach Step Distance: 5.00

Max Residual Depth:	3.38
Mean Residual Depth:	0.60
Standard Deviation:	0.68

Number of non-zero Residual Depths: 216
Percent of Reach as pool: 81.51
Percent of Reach as riffle: 18.49



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Long Profile Data File:
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River Name:
Notes: Original Data file:
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Measurement Units: U.S.

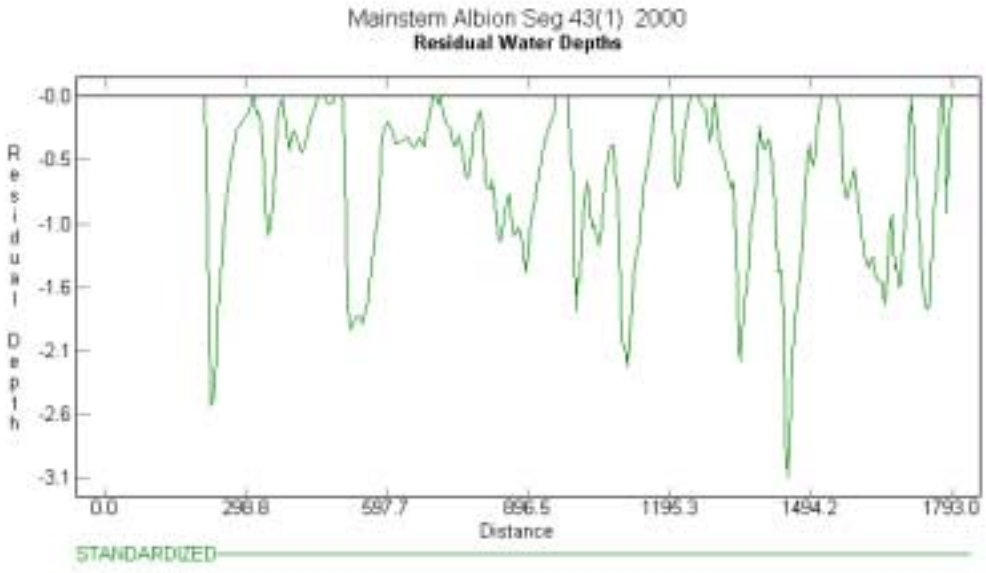
Top Elevation: -0.62
Bottom Elevation: -8.68
Reach Length: 1793.00

Standardized Statistics:
Number of data points in raw data: 228
Number of data points in Standardized data: 359

Reach Step Distance: 5.00

Max Residual Depth: 3.11
Mean Residual Depth: 0.63
Standard Deviation: 0.64

Number of non-zero Residual Depths: 285
Percent of Reach as pool: 79.39
Percent of Reach as riffle: 20.61



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River Name:
Notes: Original Data file:
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Measurement Units: U.S.

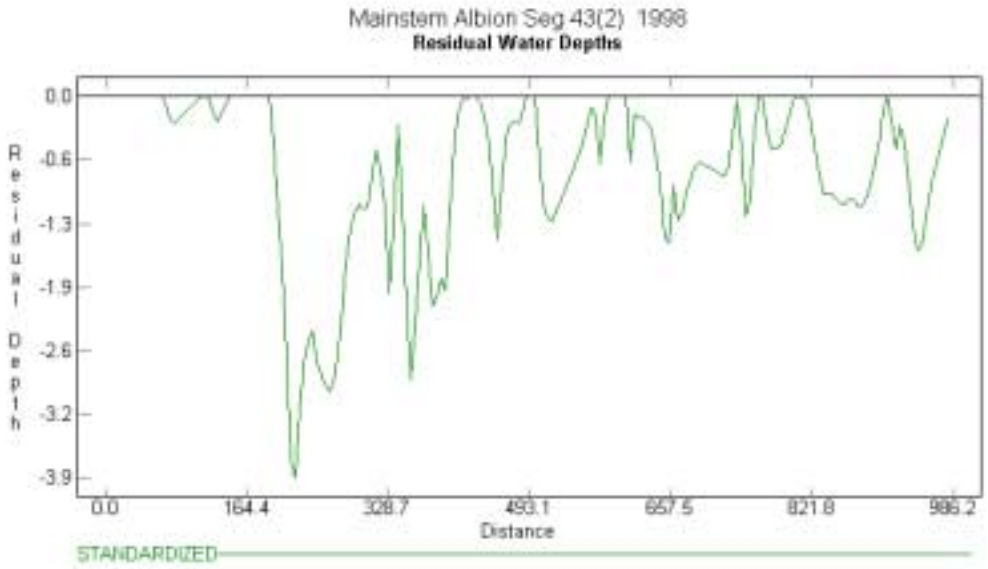
Top Elevation:	-8.16
Bottom Elevation:	-16.00
Reach Length:	986.20

Standardized Statistics:
Number of data points in raw data: 109
Number of data points in Standardized data: 197

Reach Step Distance: 5.00

Max Residual Depth:	3.85
Mean Residual Depth:	0.75
Standard Deviation:	0.81

Number of non-zero Residual Depths: 159
Percent of Reach as pool: 80.71
Percent of Reach as riffle: 19.29



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River Name:
Notes: Original Data file:
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Measurement Units: U.S.

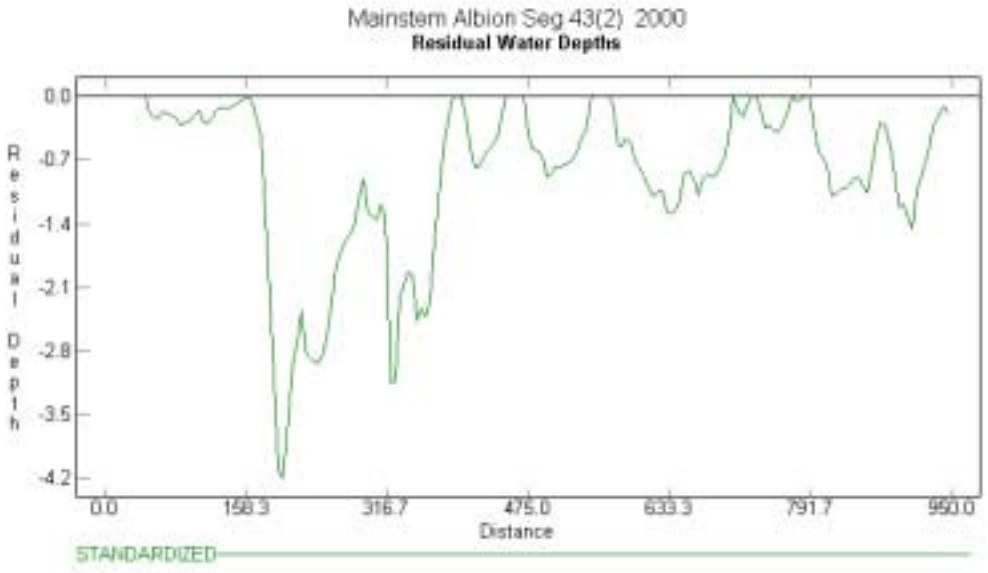
Top Elevation:	-8.45
Bottom Elevation:	-15.13
Reach Length:	950.00

Standardized Statistics:
Number of data points in raw data: 131
Number of data points in Standardized data: 190

Reach Step Distance: 5.00

Max Residual Depth:	4.21
Mean Residual Depth:	0.83
Standard Deviation:	0.89

Number of non-zero Residual Depths: 161
Percent of Reach as pool: 84.74



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River Name:
Notes: Original Data file:
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Measurement Units: U.S.

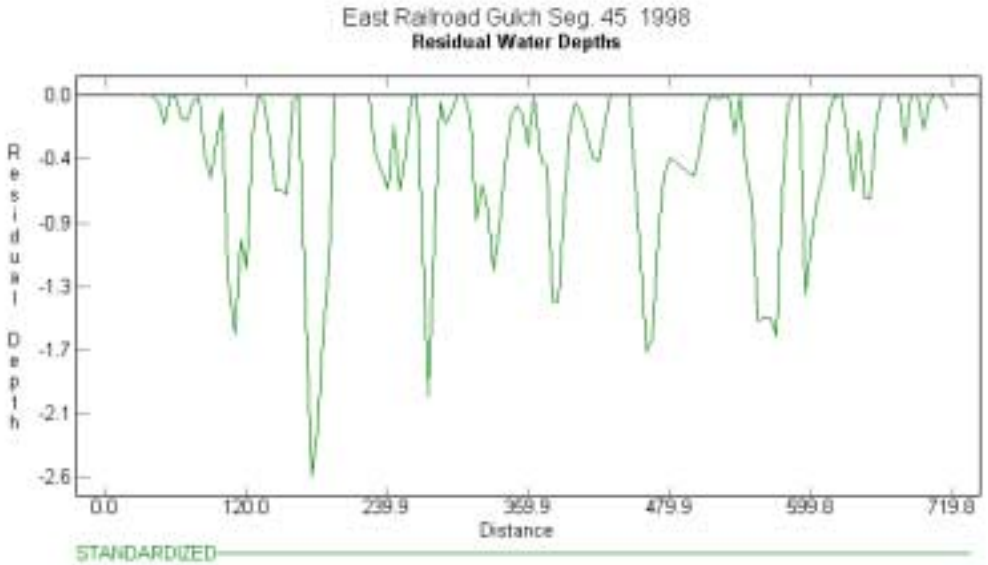
Top Elevation:	5.97
Bottom Elevation:	-10.82
Reach Length:	719.80

Standardized Statistics:
Number of data points in raw data: 153
Number of data points in Standardized data: 144

Reach Step Distance: 5.00

Max Residual Depth:	2.56
Mean Residual Depth:	0.43
Standard Deviation:	0.54

Number of non-zero Residual Depths: 104
Percent of Reach as pool: 72.22



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Long Profile Data File: D:\ISAAC\STREAM~1\ALBION~1\SEGMEN~4\00ALB45.LPR
River Name:
Notes: Original Data file:
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Measurement Units: U.S.

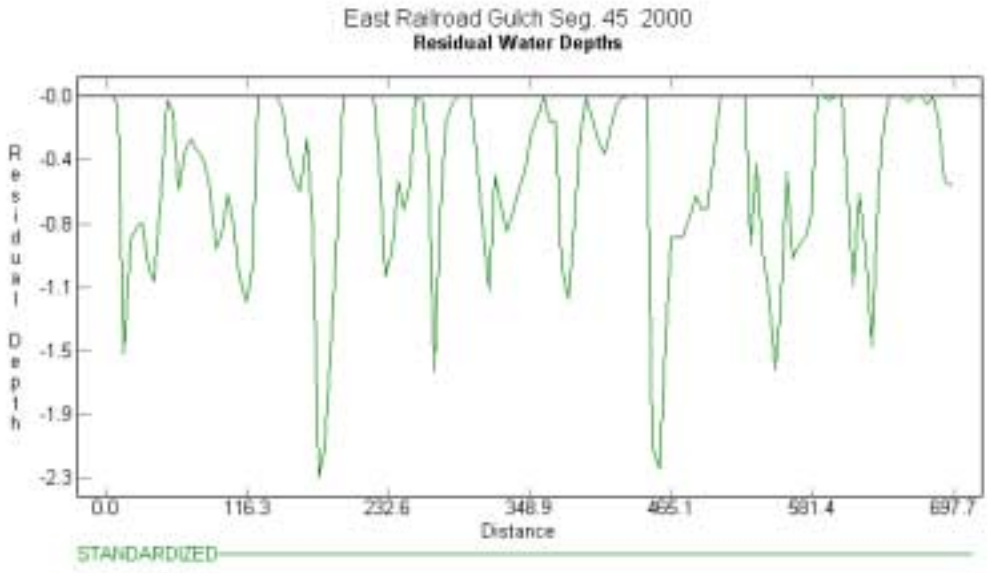
Top Elevation:	8.53
Bottom Elevation:	-11.02
Reach Length:	697.70

Standardized Statistics:
Number of data points in raw data: 135
Number of data points in Standardized data: 140

Reach Step Distance: 5.00

Max Residual Depth:	2.29
Mean Residual Depth:	0.51
Standard Deviation:	0.53

Number of non-zero Residual Depths: 105
Percent of Reach as pool: 75.00
Percent of Reach as riffle: 25.00



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River Name:
Notes: Original Data file:
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Measurement Units: U.S.

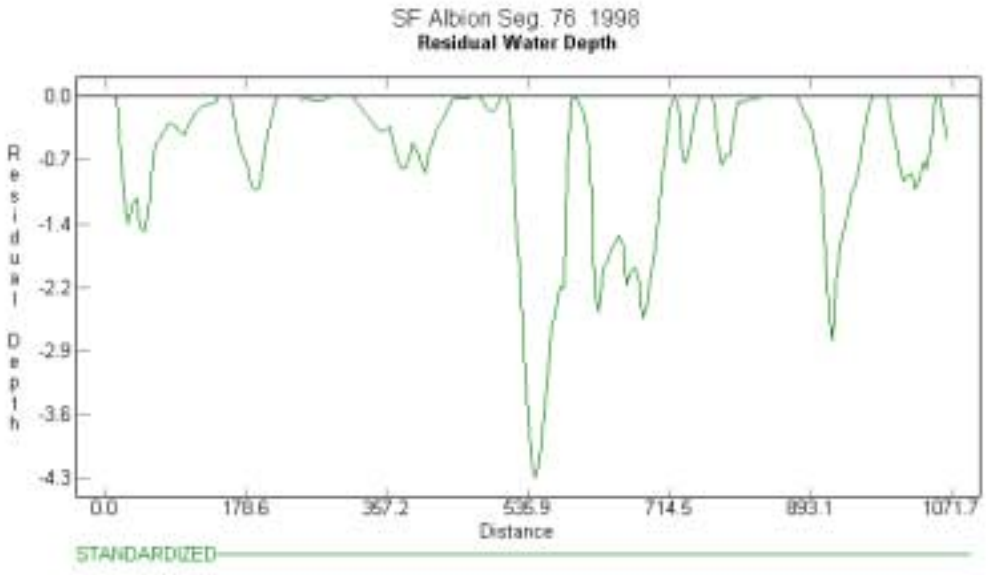
Top Elevation:	-1.61
Bottom Elevation:	-8.91
Reach Length:	1071.70

Standardized Statistics:
Number of data points in raw data: 183
Number of data points in Standardized data: 214

Reach Step Distance: 5.00

Max Residual Depth:	4.32
Mean Residual Depth:	0.67
Standard Deviation:	0.89

Number of non-zero Residual Depths: 174
Percent of Reach as pool: 81.31



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Long Profile Data File:
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River Name:
Notes: Original Data file:
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Measurement Units: U.S.

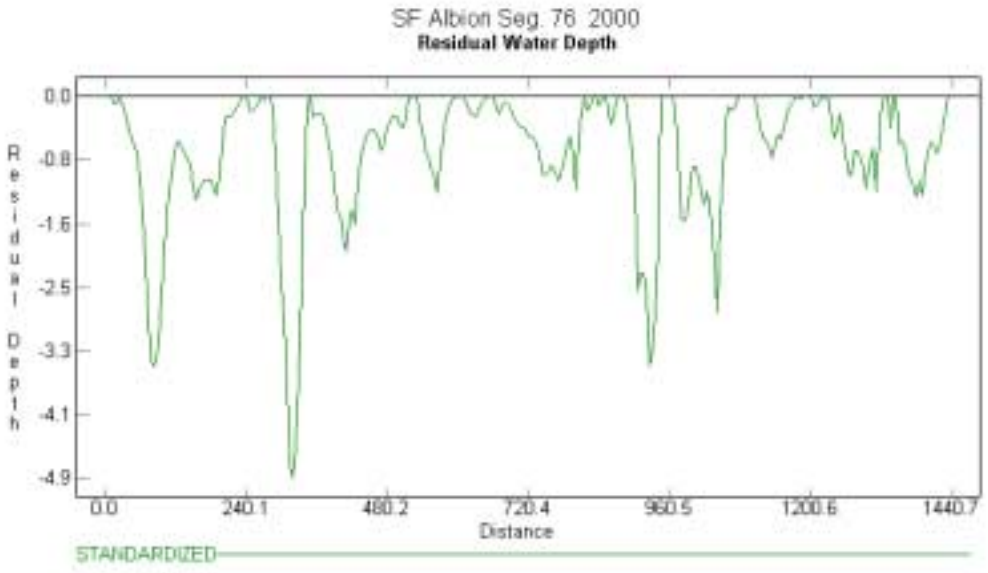
Top Elevation: -0.90
Bottom Elevation: -9.02
Reach Length: 1440.70

Standardized Statistics:
Number of data points in raw data: 235
Number of data points in Standardized data: 288

Reach Step Distance: 5.00

Max Residual Depth: 4.95
Mean Residual Depth: 0.73
Standard Deviation: 0.87

Number of non-zero Residual Depths: 248
Percent of Reach as pool: 86.11



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Long Profile Data File:
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River Name:
Notes: Original Data file:
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Measurement Units: U.S.

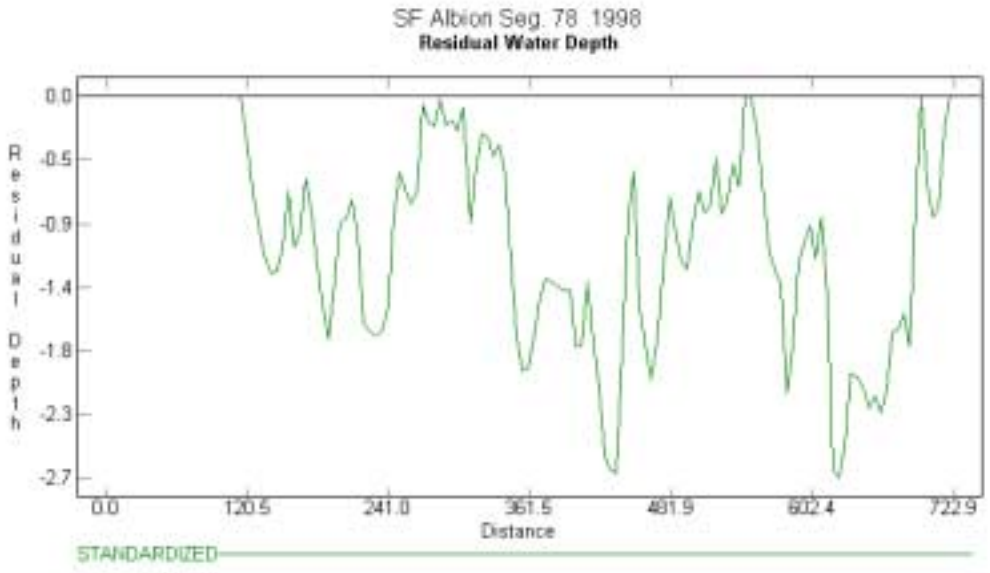
Top Elevation:	-4.37
Bottom Elevation:	-7.94
Reach Length:	717.10

Standardized Statistics:
Number of data points in raw data: 97
Number of data points in Standardized data: 143

Reach Step Distance: 5.00

Max Residual Depth:	2.57
Mean Residual Depth:	0.62
Standard Deviation:	0.56

Number of non-zero Residual Depths: 114
Percent of Reach as pool: 79.72
Percent of Reach as riffle: 20.28



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Long Profile Data File:
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River Name:
Notes: Original Data file:
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Measurement Units: U.S.

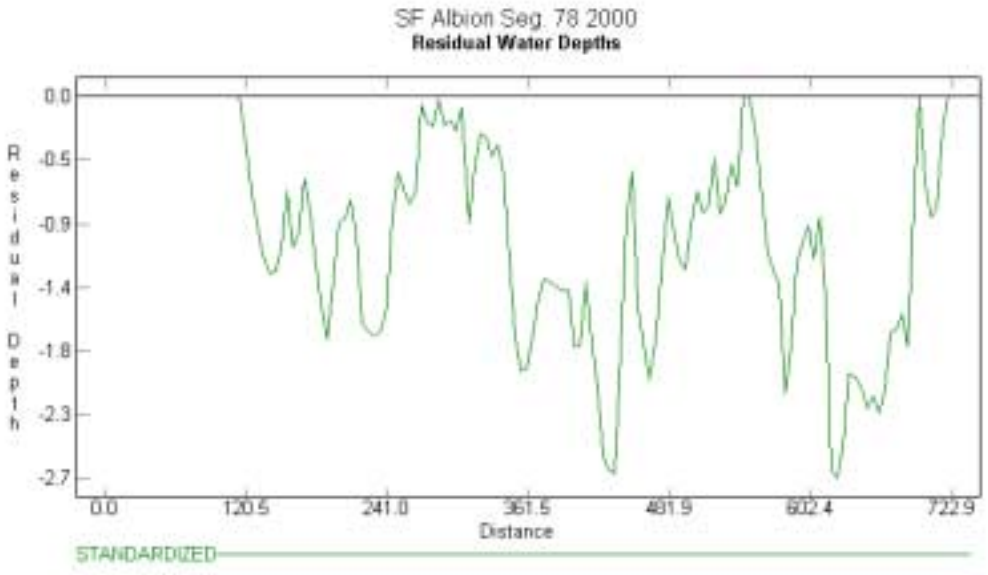
Top Elevation: -4.87
Bottom Elevation: -8.97
Reach Length: 722.90

Standardized Statistics:
Number of data points in raw data: 152
Number of data points in Standardized data: 145

Reach Step Distance: 5.00

Max Residual Depth: 2.74
Mean Residual Depth: 0.97
Standard Deviation: 0.76

Number of non-zero Residual Depths: 117
Percent of Reach as pool: 80.69

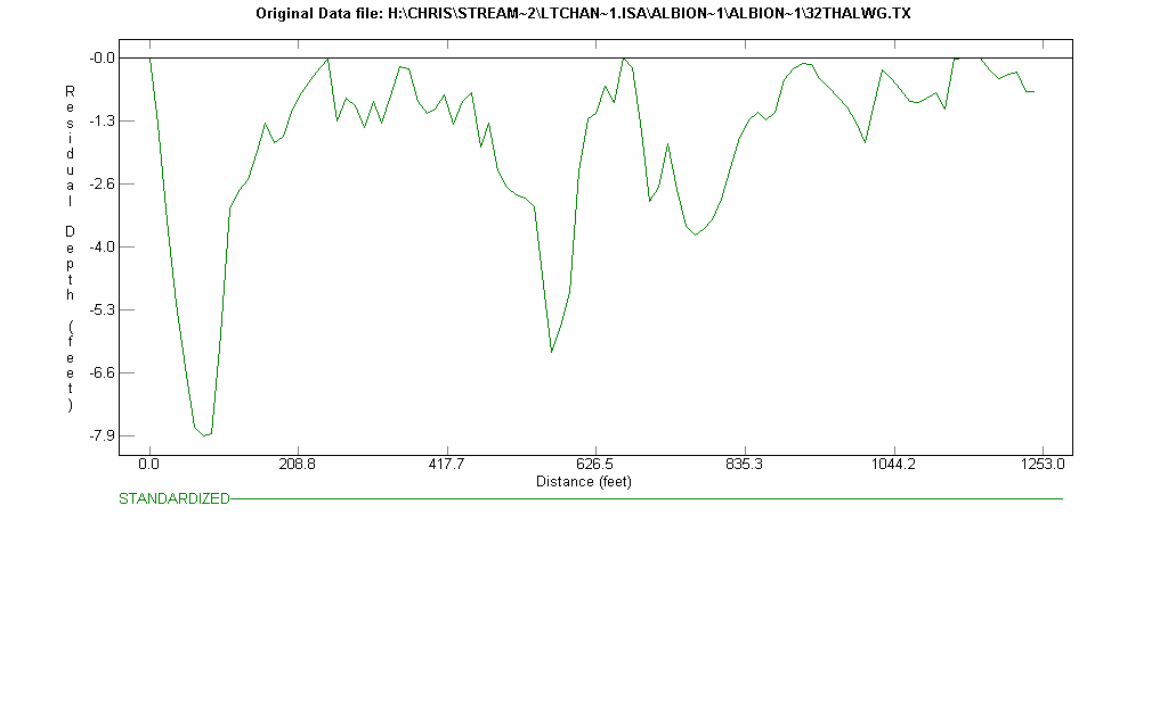


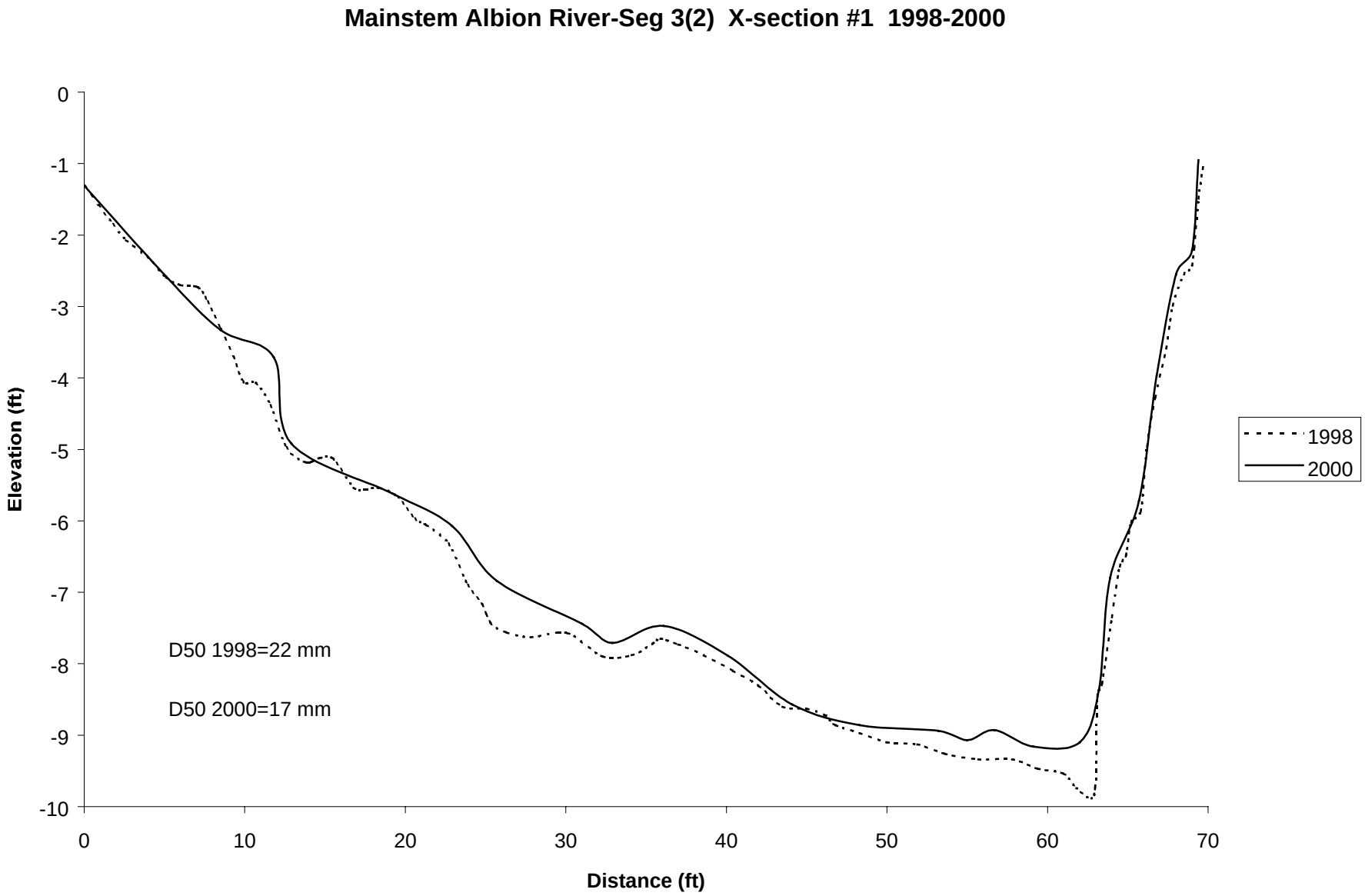
Segment 3(2) – 2001

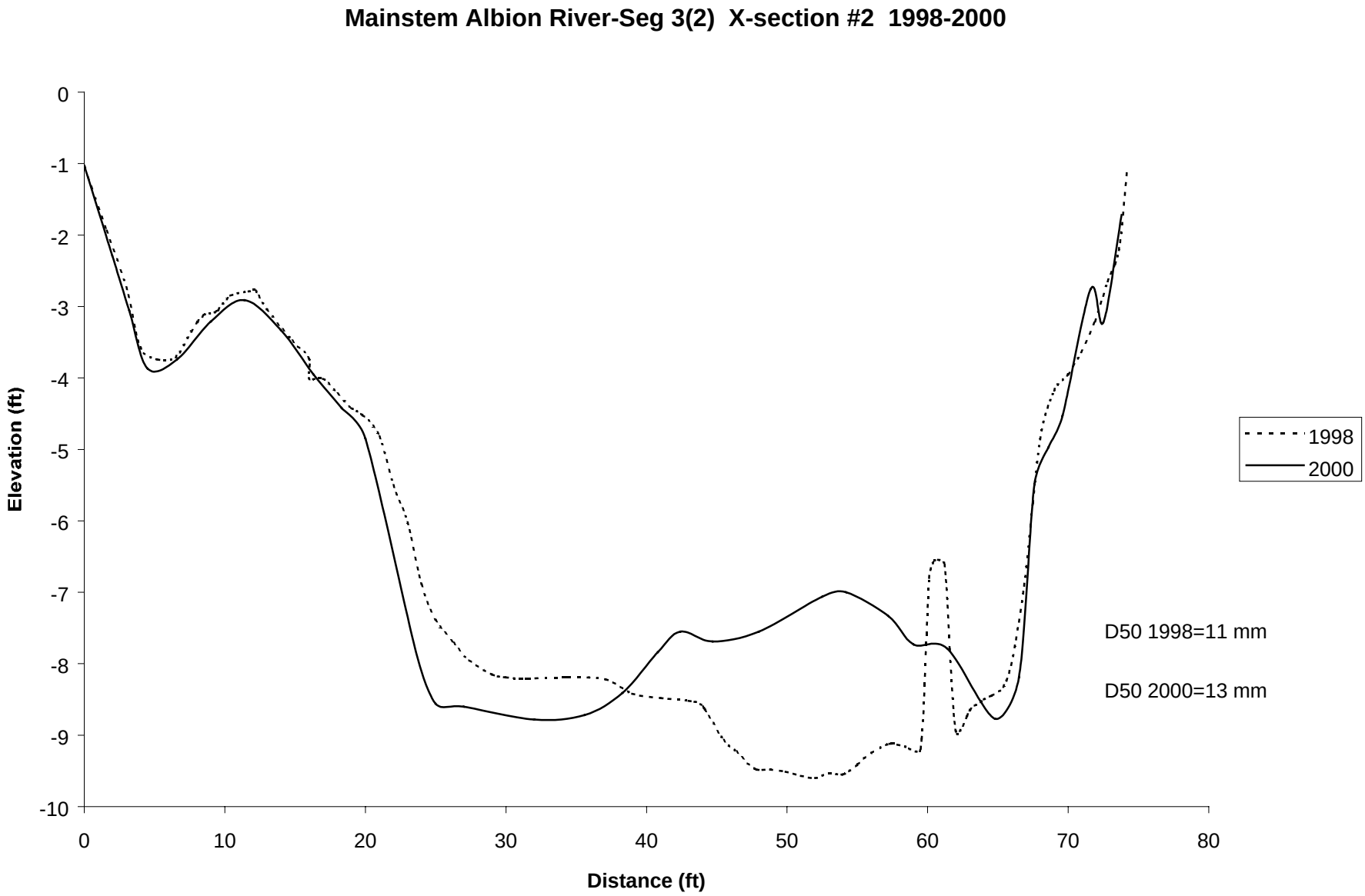
Top Elevation: 92.11
Bottom Elevation: 83.38
Reach Length: 1253.00

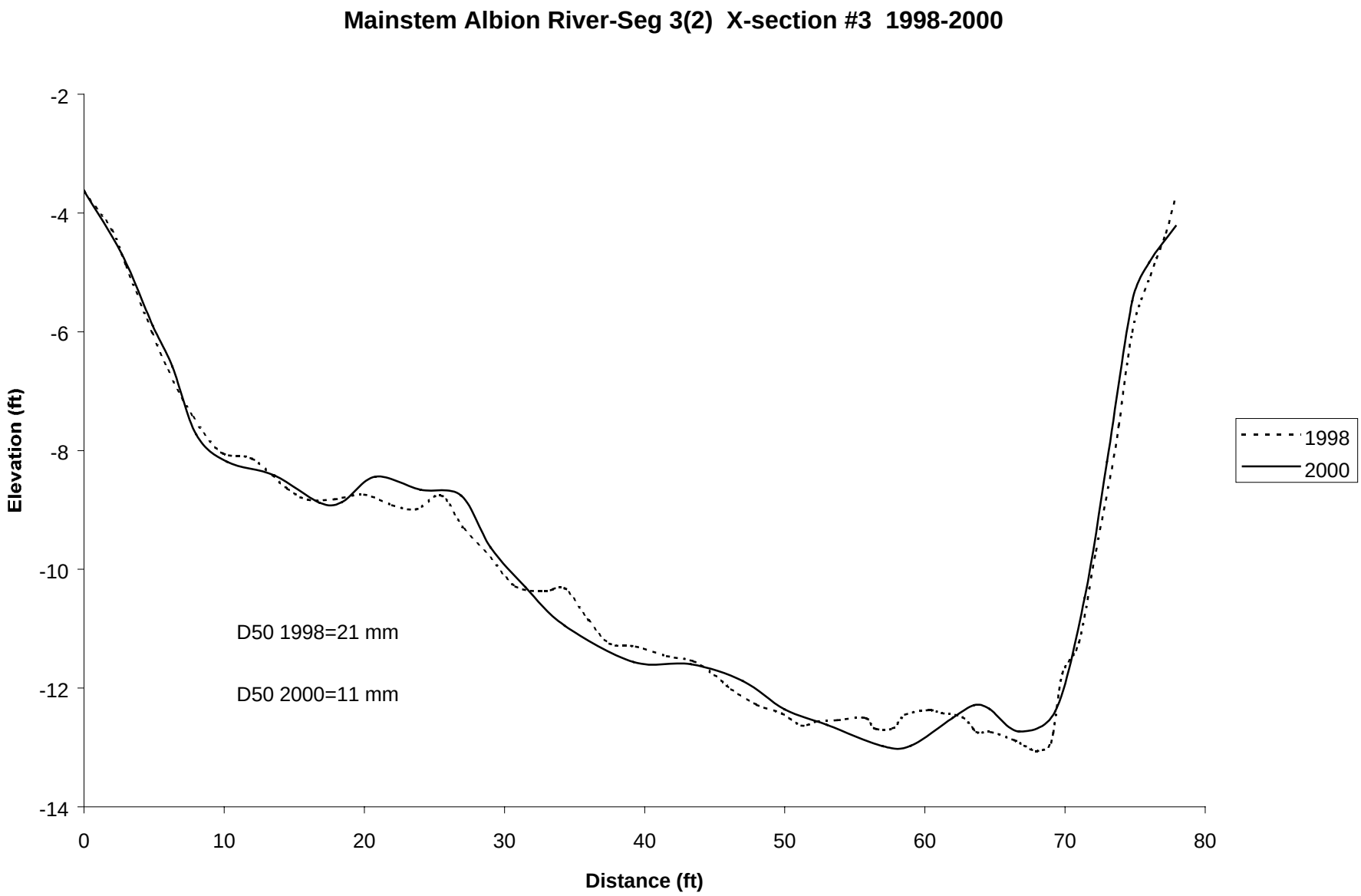
Max Residual Depth: 7.91
Mean Residual Depth: 1.77
Standard Deviation: 1.80

Number of non-zero Residual Depths: 95
Percent of Reach as pool: 95.00
Percent of Reach as riffle: 5.00

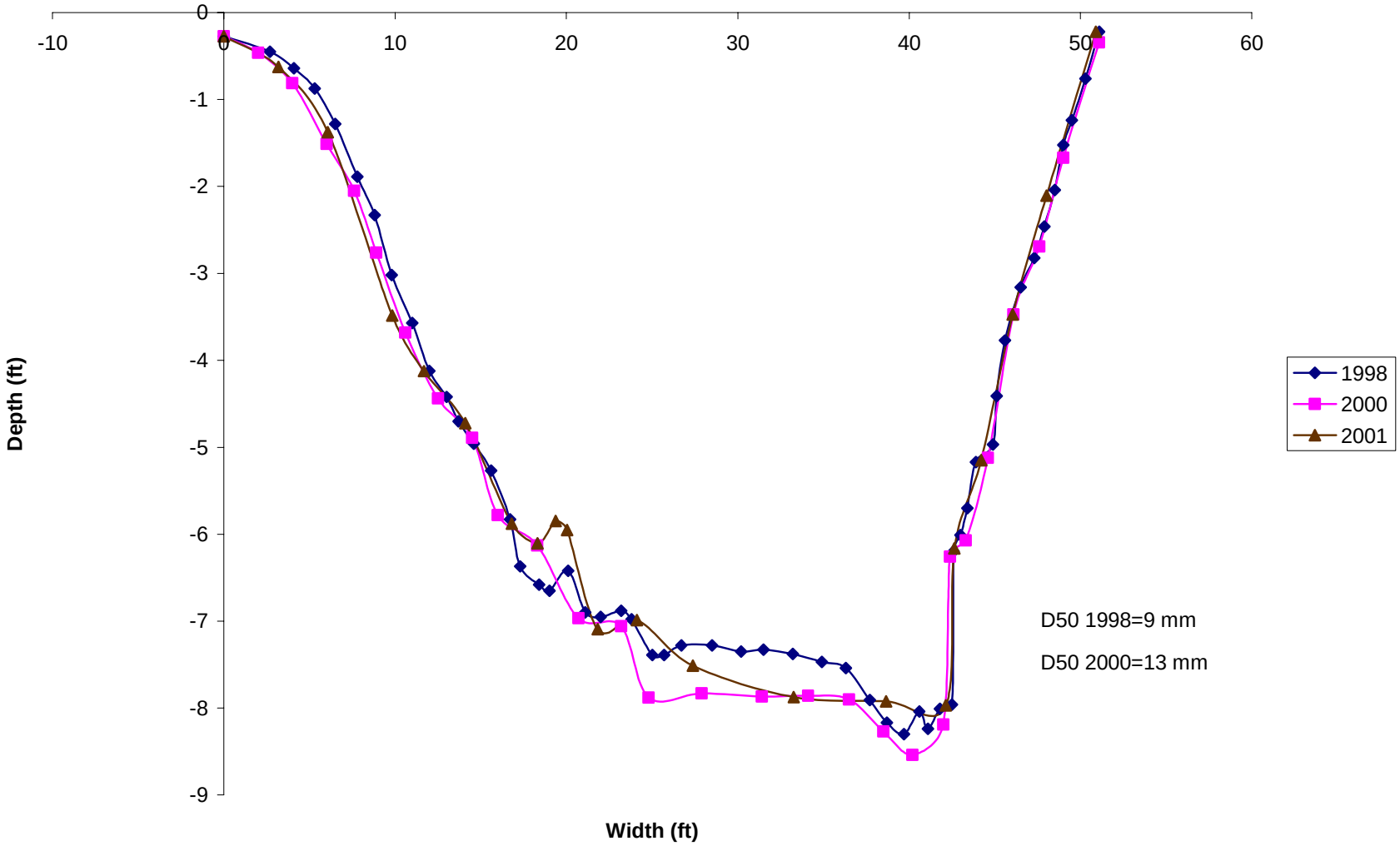


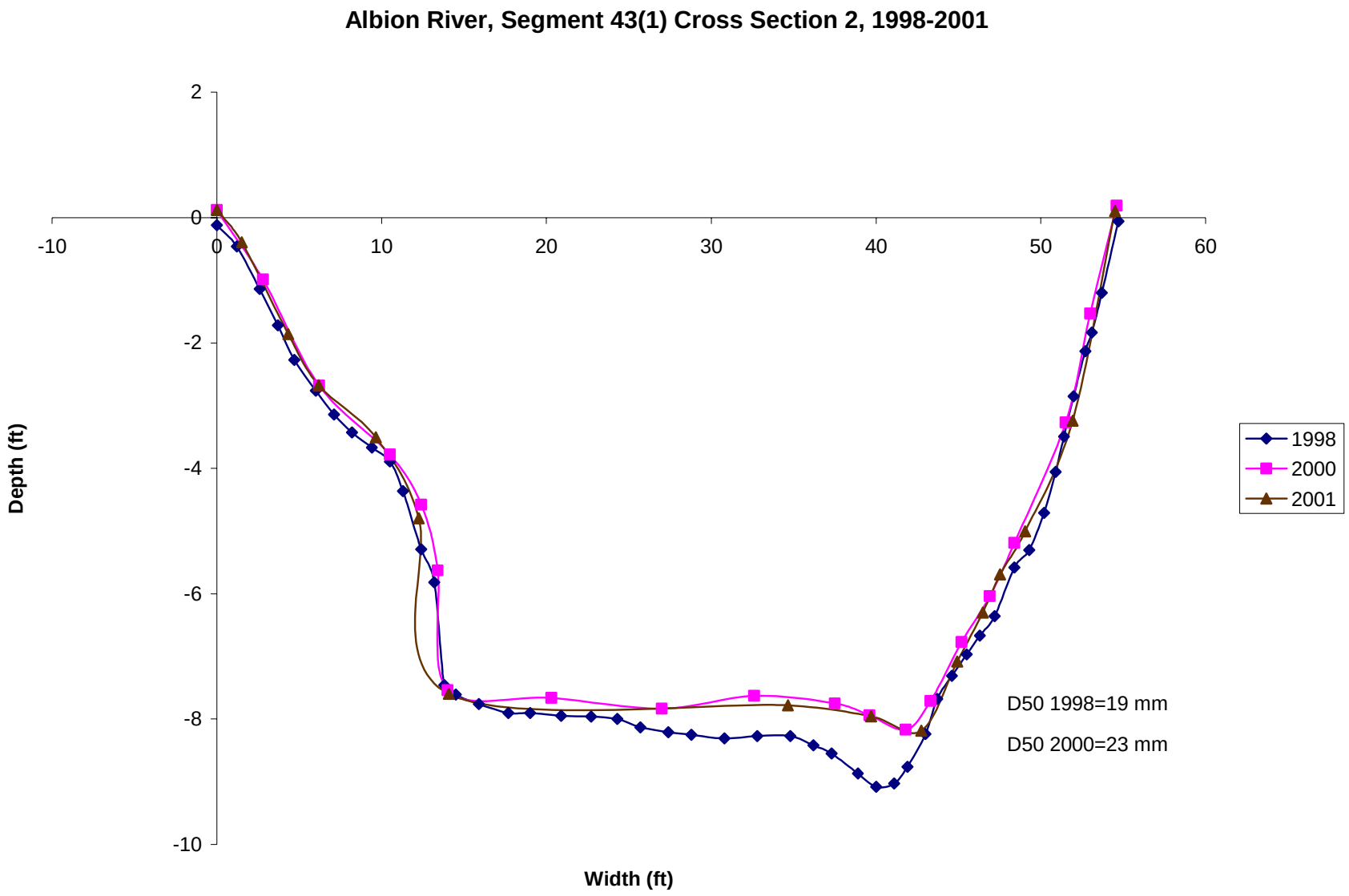

Mainstem Albion River-Seg 3(2) X-section #1 1998-2000
Elevation (ft)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
0
10
20
30
40
50
60
70
Distance (ft)
D50 1998=22 mm
D50 2000=17 mm
1998
2000


Mainstem Albion River-Seg 3(2) X-section #2 1998-2000
Elevation (ft)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
0
10
20
30
40
50
60
70
80
Distance (ft)
1998
2000
D50 1998=11 mm
D50 2000=13 mm

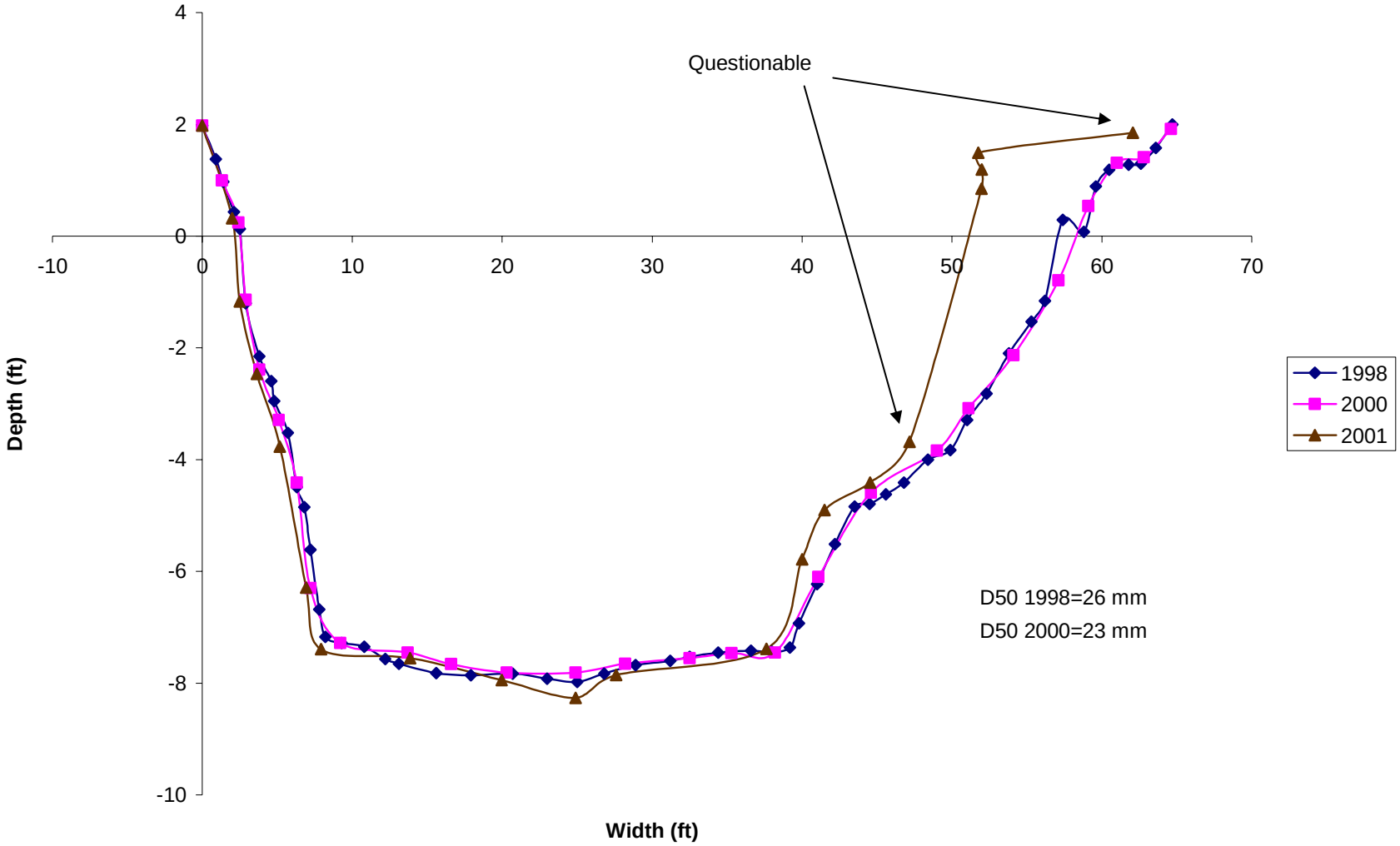

Mainstem Albion River-Seg 3(2) X-section #3 1998-2000
Elevation (ft)
-2
-4
-6
-8
-10
-12
-14
0
10
20
30
40
50
60
70
80
Distance (ft)
D50 1998=21 mm
D50 2000=11 mm
1998
2000

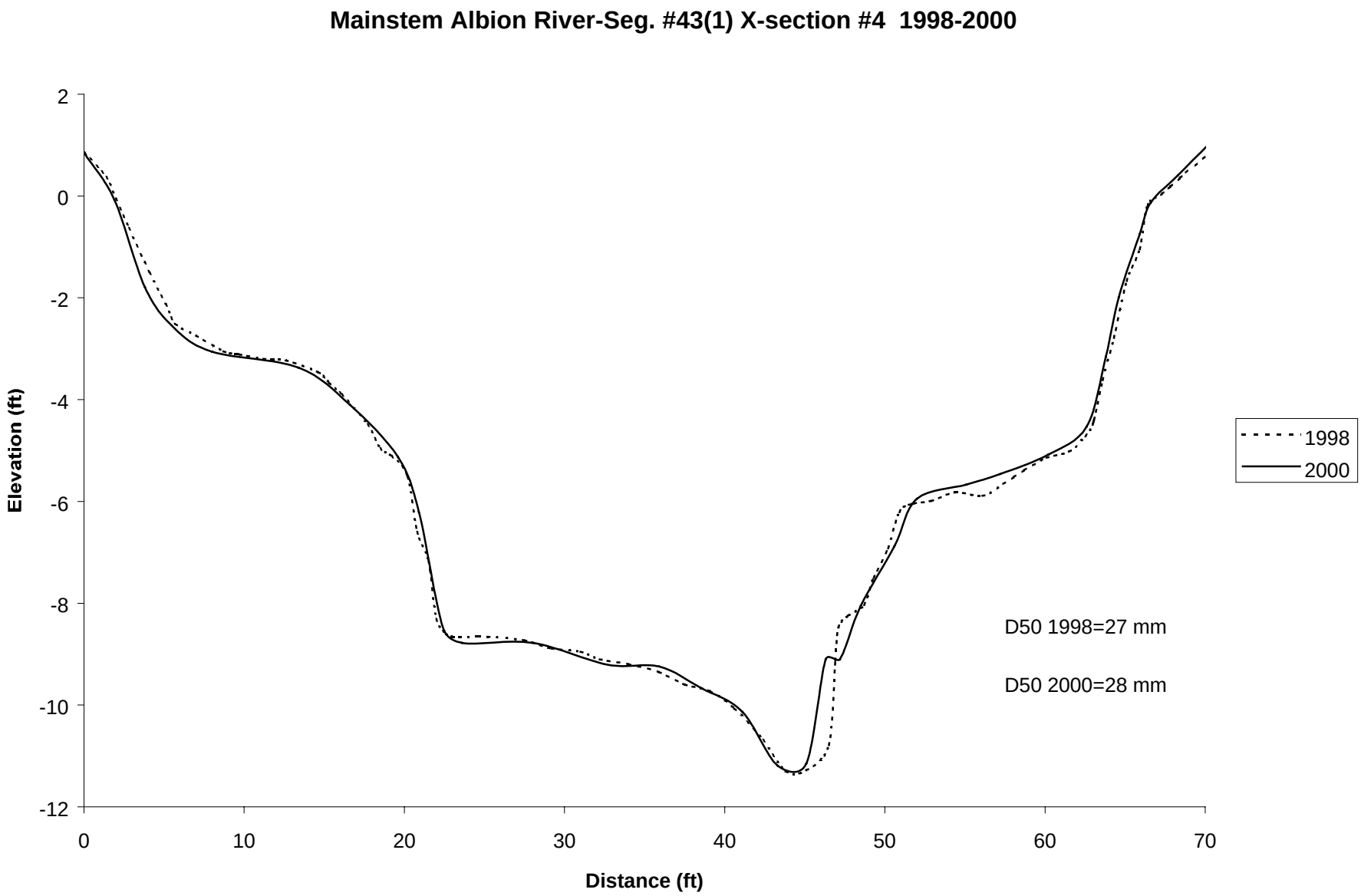
ALbion River, Segment 43(1) Cross Section 1, 1998-2001

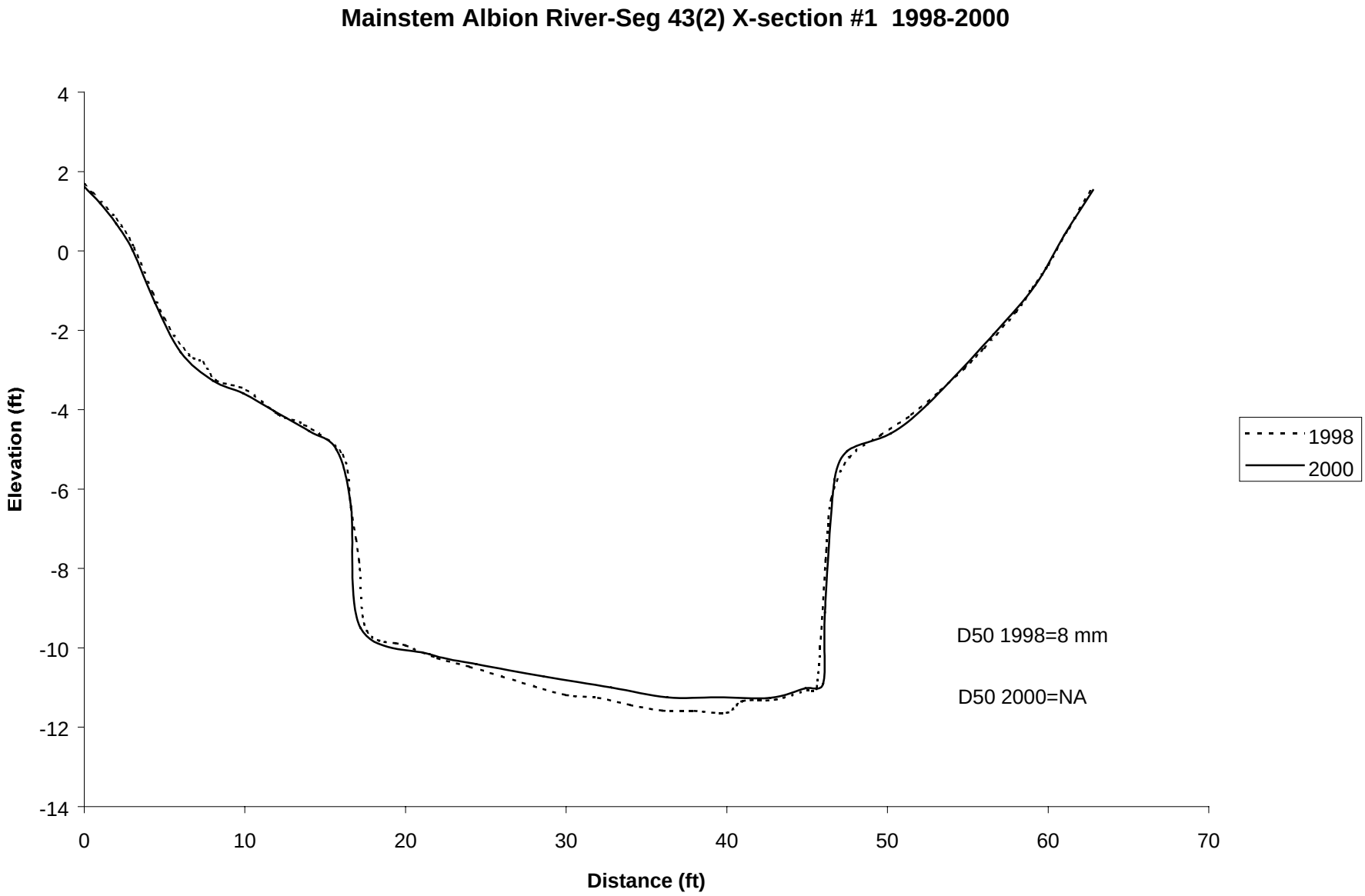


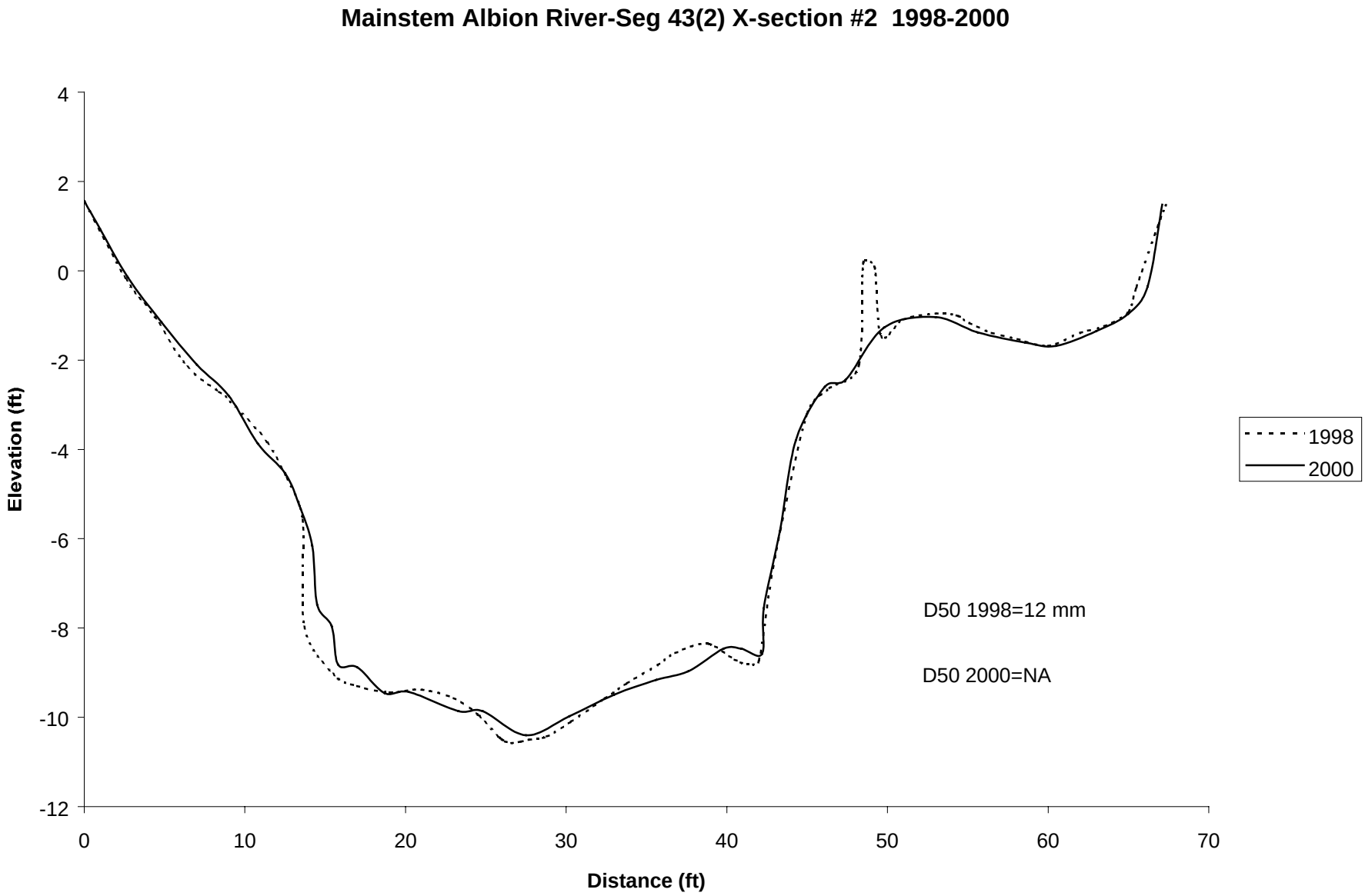

Albion River, Segment 43(1) Cross Section 2, 1998-2001
Depth (ft)
Width (ft)
2
0
-2
-4
-6
-8
-10
-10
0
10
20
30
40
50
60
1998
2000
2001
D50 1998=19 mm
D50 2000=23 mm

Albion River, Segment 43(1) Cross Section 3, 1998-2001

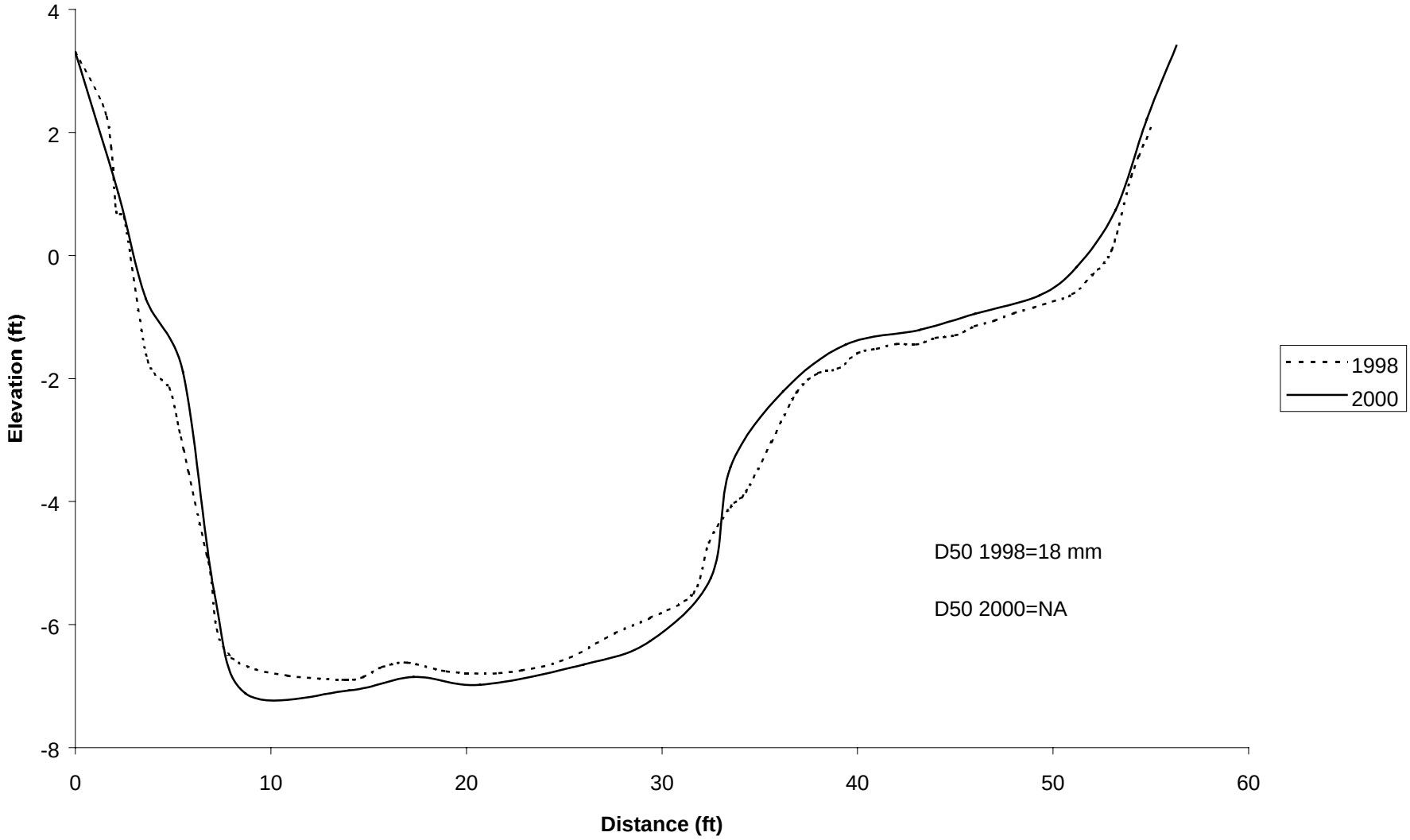


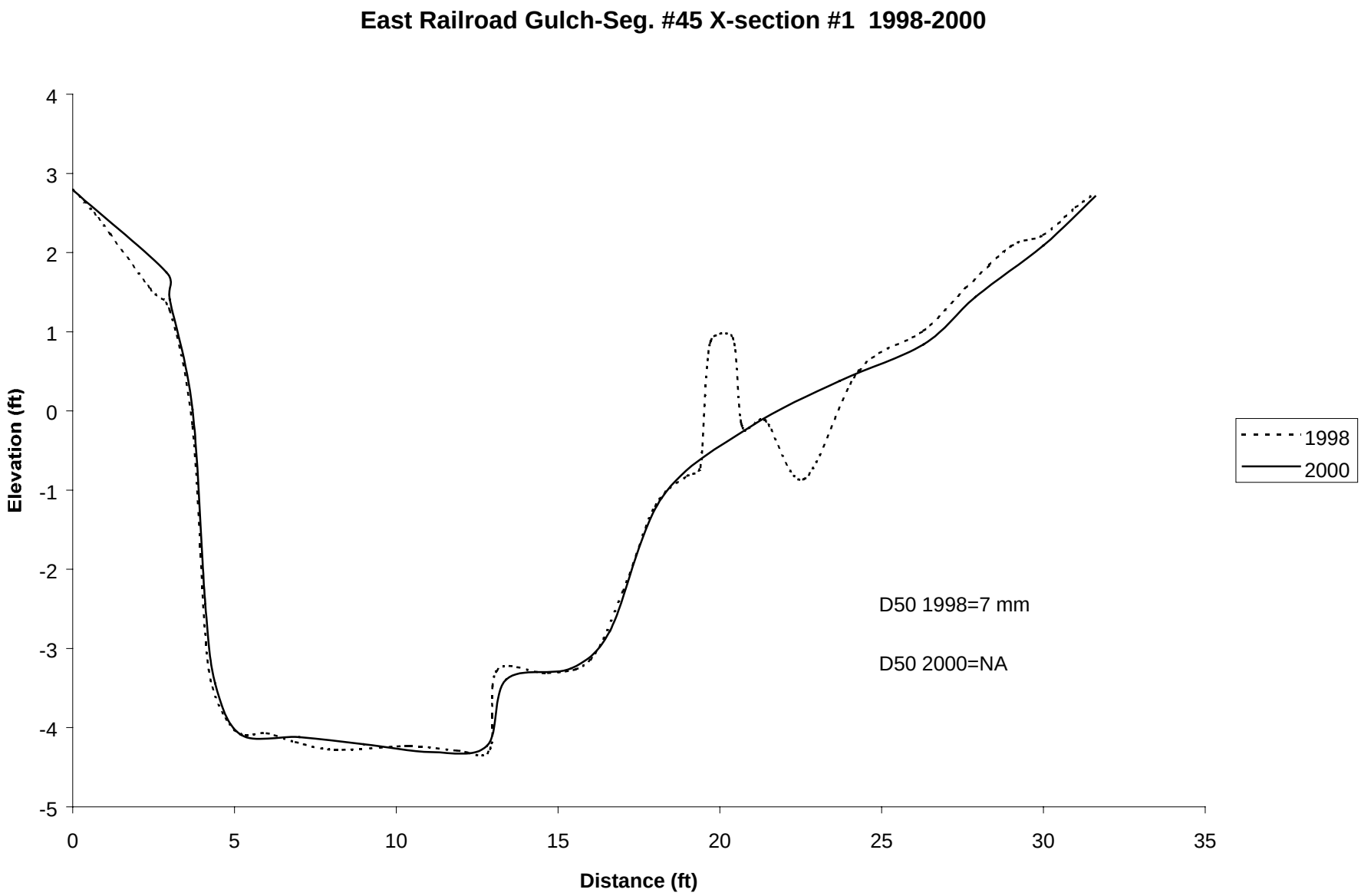

Mainstem Albion River-Seg. #43(1) X-section #4 1998-2000
Elevation (ft)
2
0
-2
-4
-6
-8
-10
-12
0
10
20
30
40
50
60
70
Distance (ft)
1998
2000
D50 1998=27 mm
D50 2000=28 mm

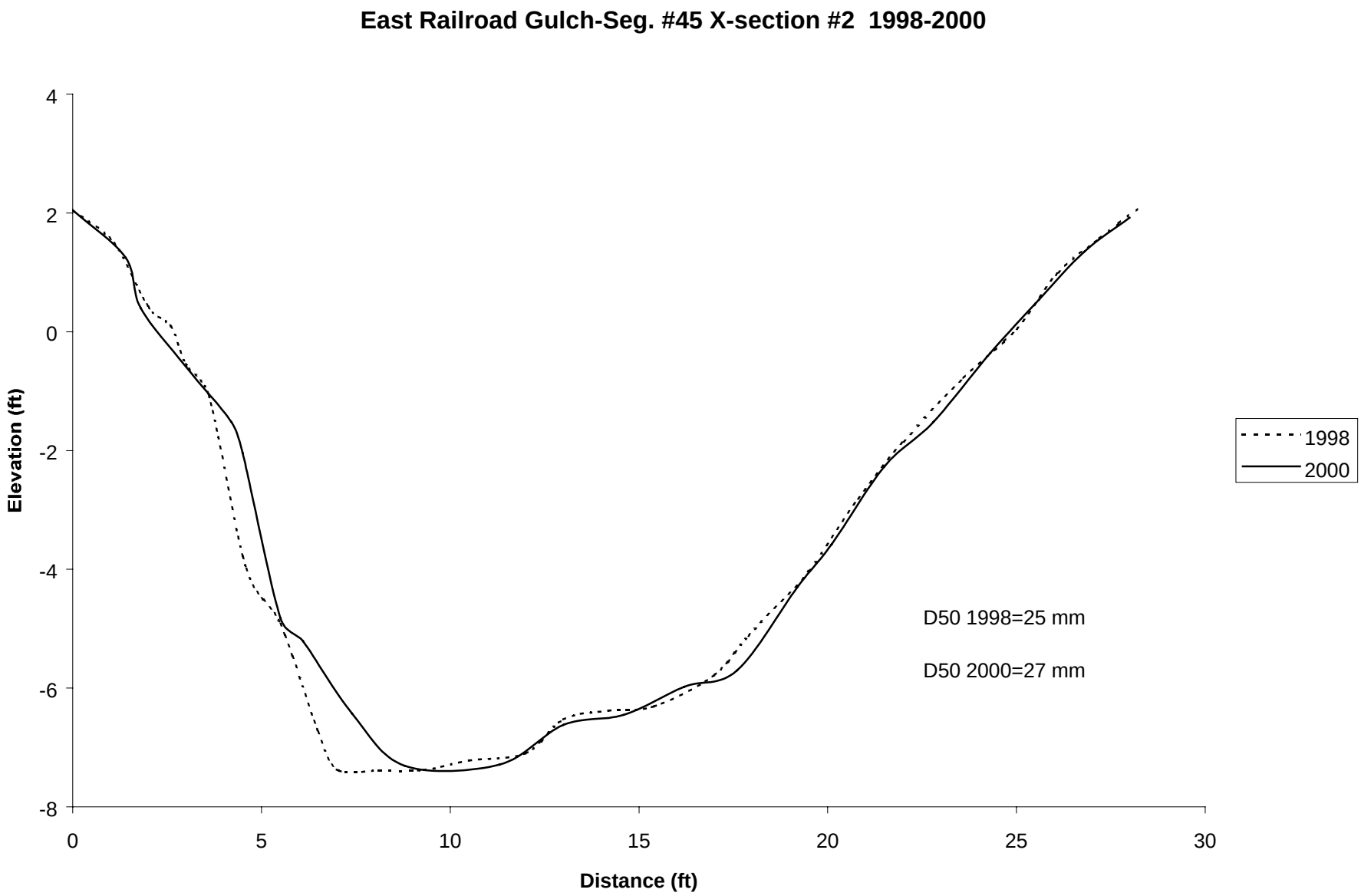

Mainstem Albion River-Seg 43(2) X-section #1 1998-2000
Elevation (ft)
4
2
0
-2
-4
-6
-8
-10
-12
-14
0
10
20
30
40
50
60
70
Distance (ft)
1998
2000
D50 1998=8 mm
D50 2000=NA

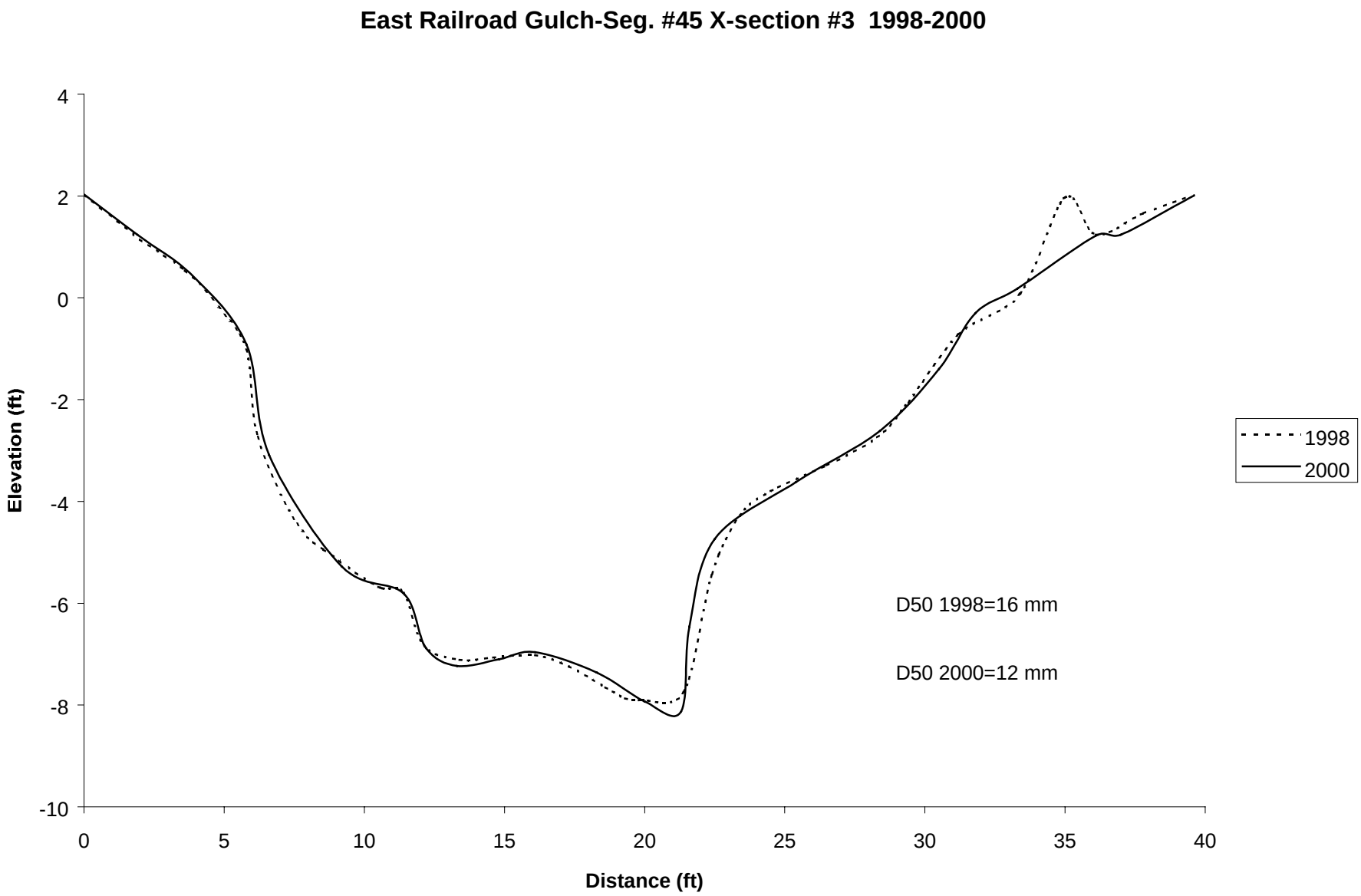

Mainstem Albion River-Seg 43(2) X-section #2 1998-2000
Elevation (ft)
4
2
0
-2
-4
-6
-8
-10
-12
0
10
20
30
40
50
60
70
Distance (ft)
1998
2000
D50 1998=12 mm
D50 2000=NA

Mainstem Albion River-Seg 43(2) X-section #3 1998-2000

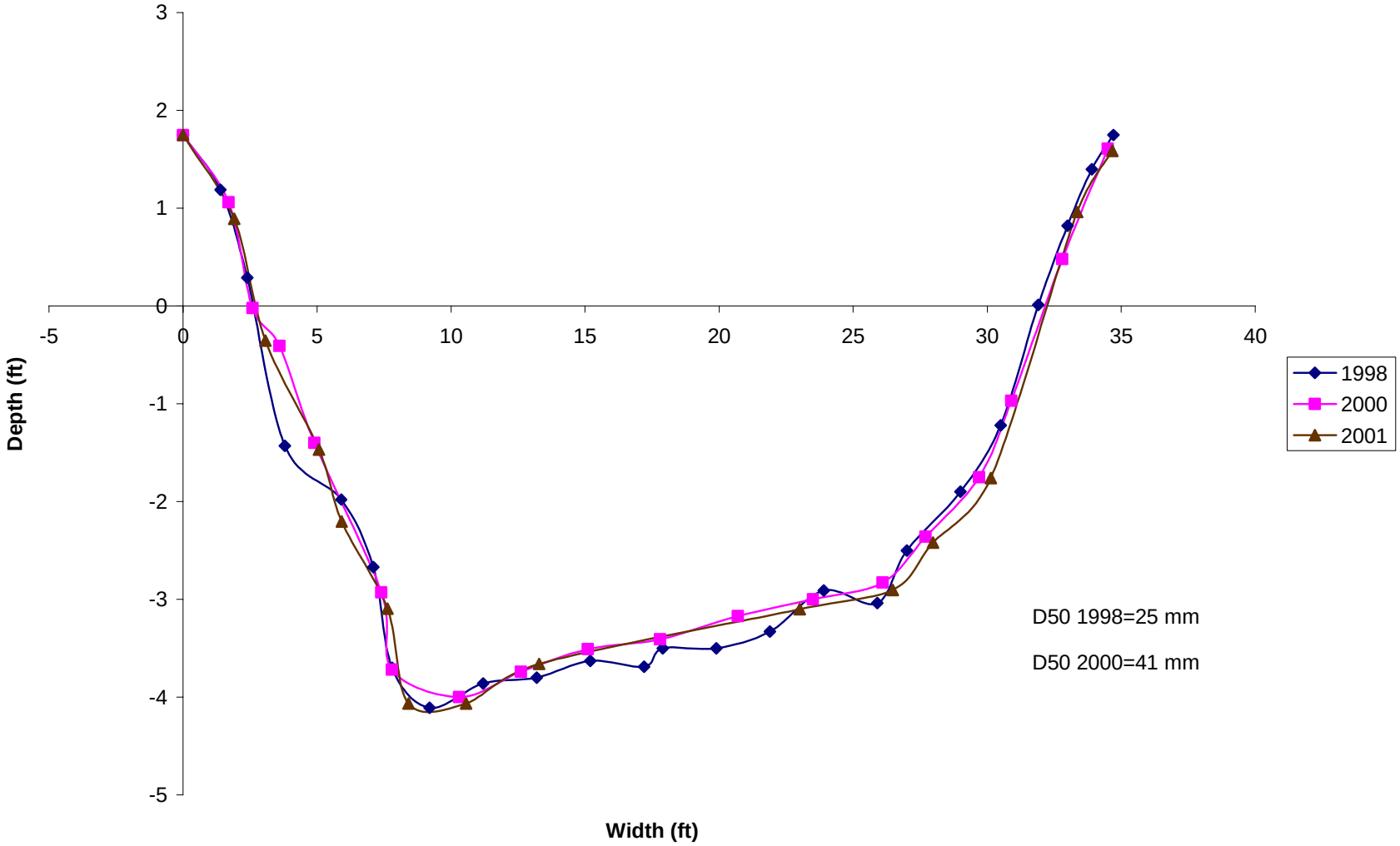



East Railroad Gulch-Seg. #45 X-section #1 1998-2000
Elevation (ft)
4
3
2
1
0
-1
-2
-3
-4
-5
0
5
10
15
20
25
30
35
Distance (ft)
1998
2000
D50 1998=7 mm
D50 2000=NA

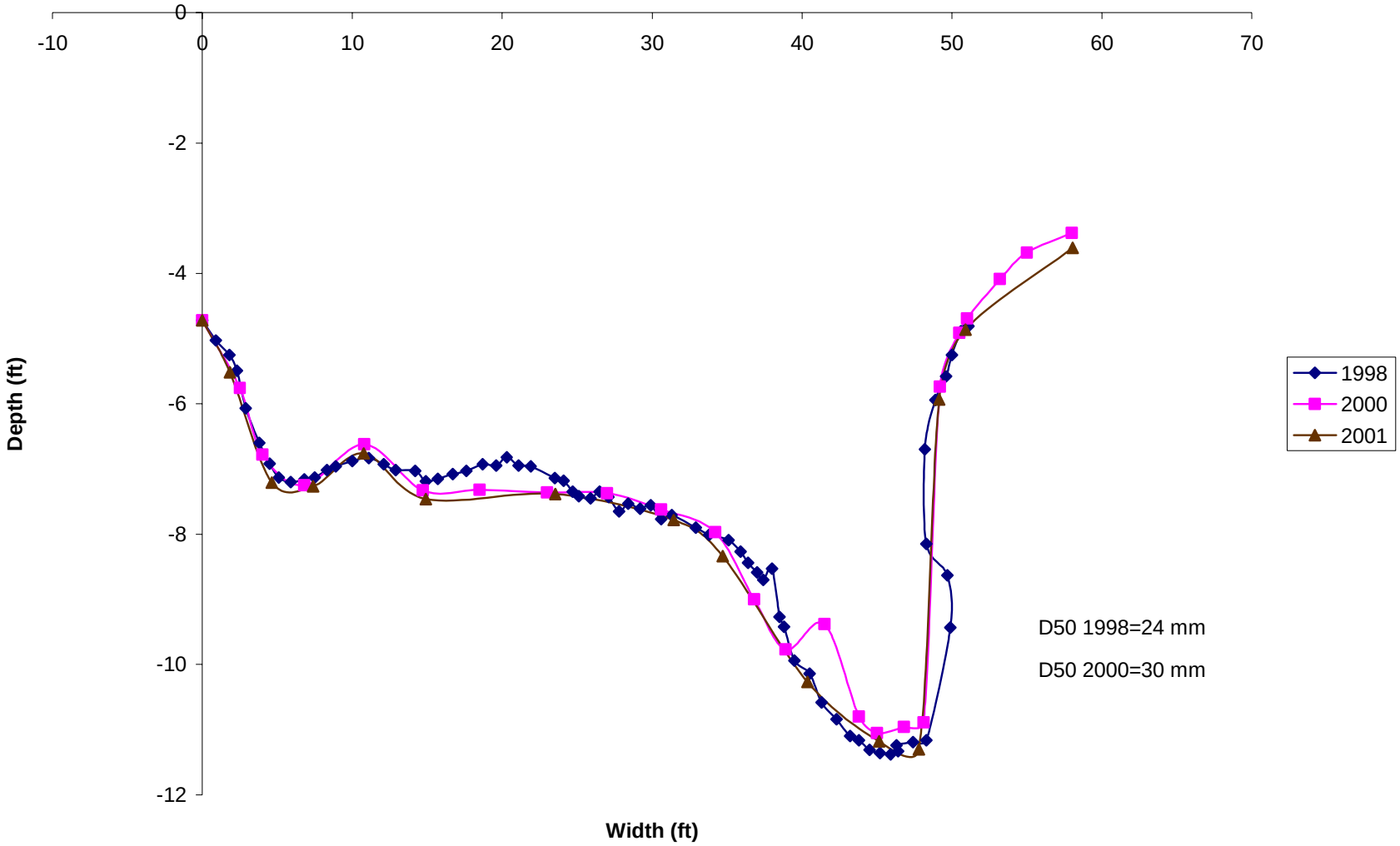

East Railroad Gulch-Seg. #45 X-section #2 1998-2000
Elevation (ft)
4
2
0
-2
-4
-6
-8
0
5
10
15
20
25
30
Distance (ft)
1998
2000
D50 1998=25 mm
D50 2000=27 mm


East Railroad Gulch-Seg. #45 X-section #3 1998-2000
Elevation (ft)
4
2
0
-2
-4
-6
-8
-10
0
5
10
15
20
25
30
35
40
Distance (ft)
1998
2000
D50 1998=16 mm
D50 2000=12 mm

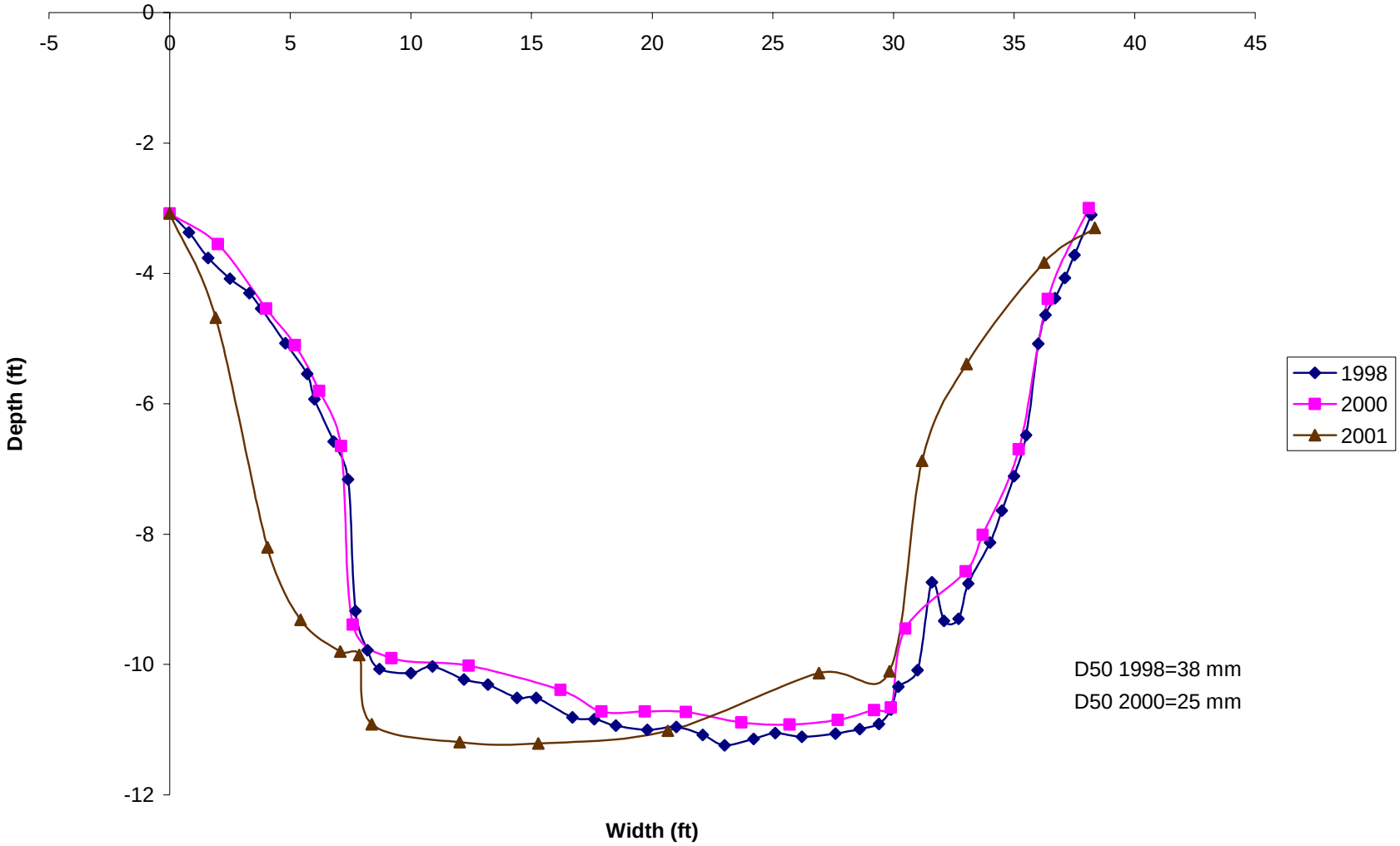
Albion River, Segment 76 Cross Section 1, 1998-2001



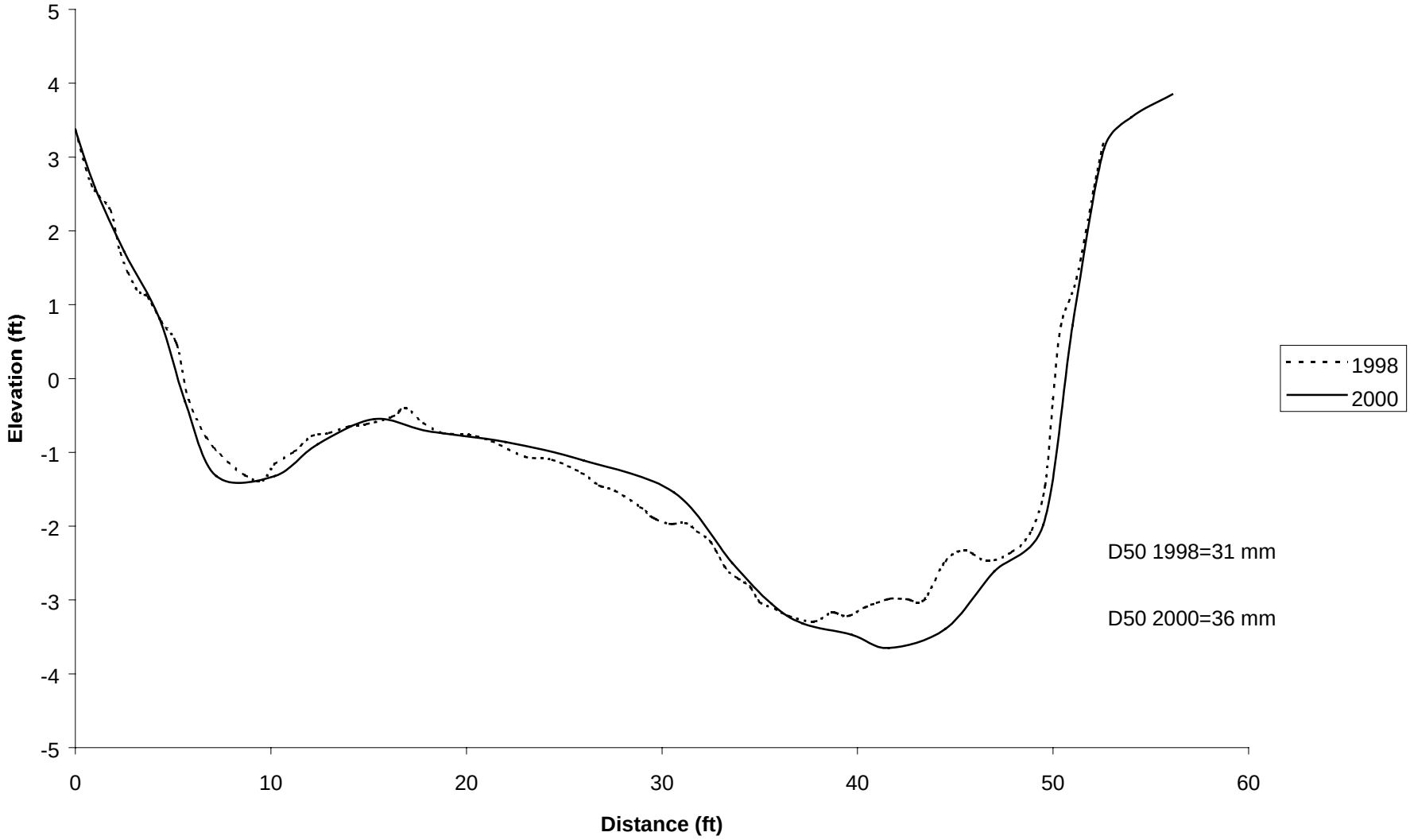
Segment 76, Cross Section 2, 1998-2001

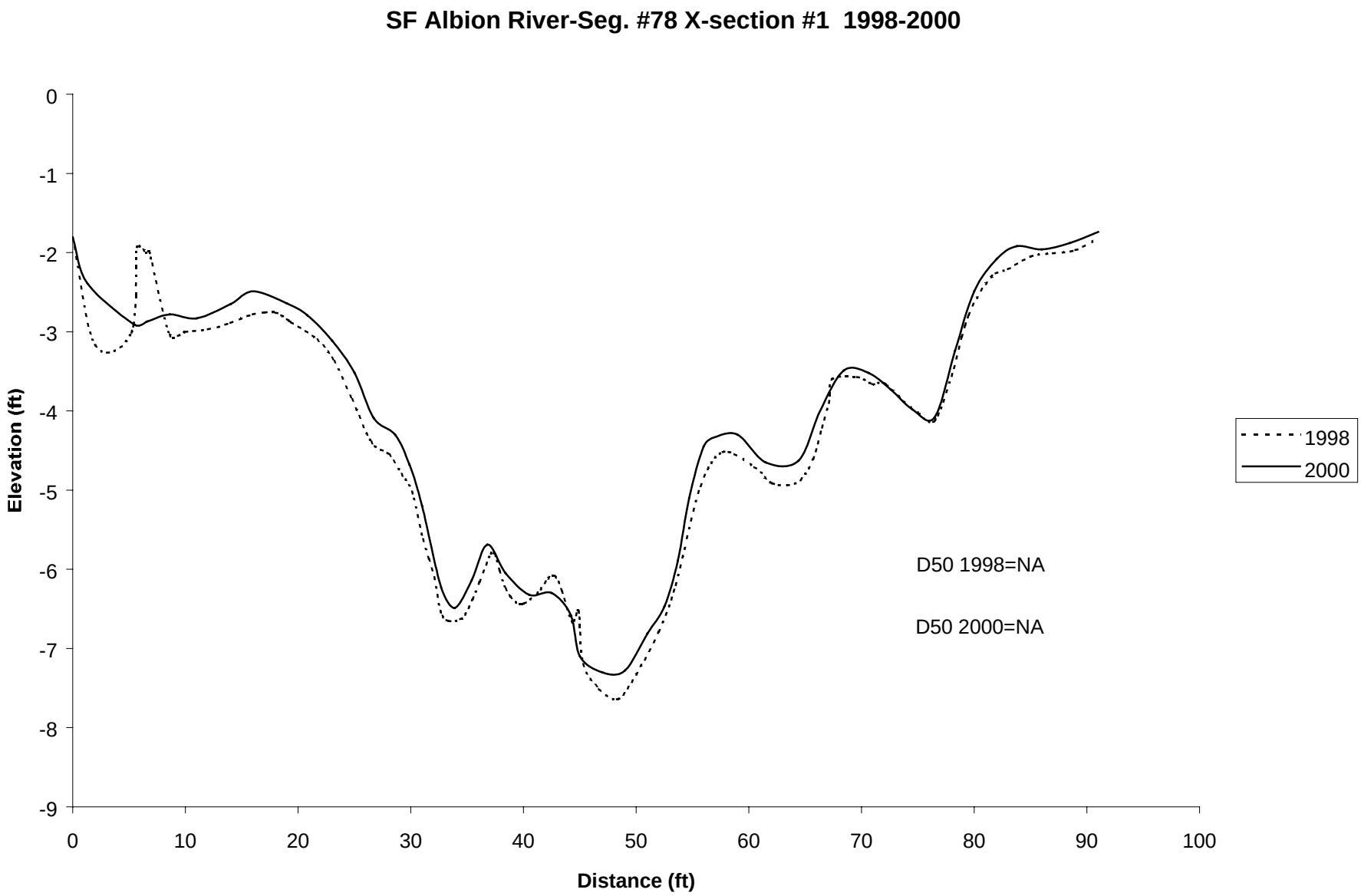


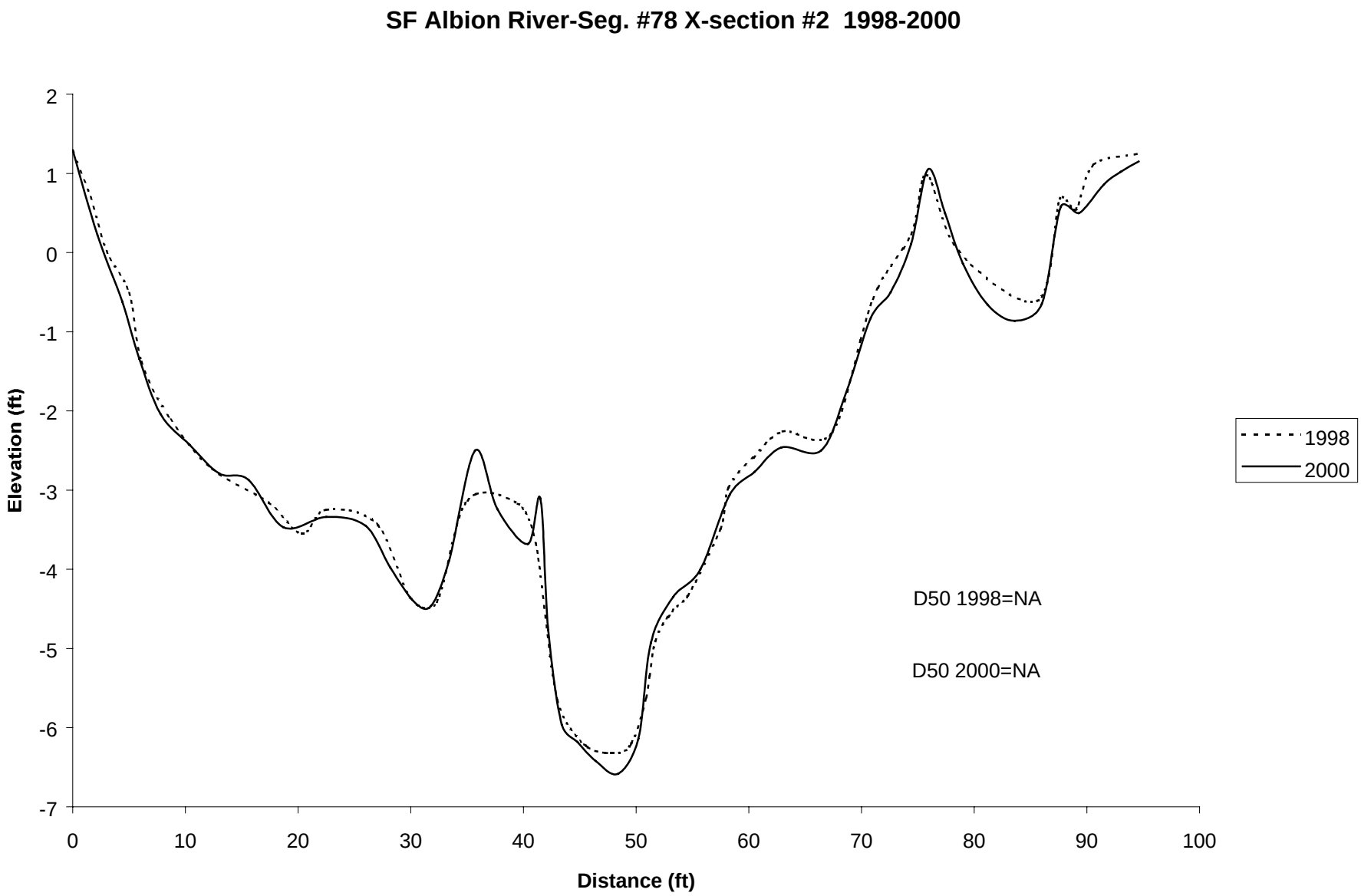
Albion River, Segment 76 Cross Section 3 1998-2001



SF Albion River-Seg. #76 X-section #4 1998-2000




SF Albion River-Seg. #78 X-section #1 1998-2000
Elevation (ft)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
0
10
20
30
40
50
60
70
80
90
100
Distance (ft)
1998
2000
D50 1998=NA
D50 2000=NA


SF Albion River-Seg. #78 X-section #2 1998-2000
Elevation (ft)
2
1
0
-1
-2
-3
-4
-5
-6
-7
0
10
20
30
40
50
60
70
80
90
100
Distance (ft)
1998
2000
D50 1998=NA
D50 2000=NA