Appendix A. GIS Metadata

Merced River Geomorphic Surfaces

Summary of Geospatial Metadata

Metadata Type	Description
Datum	NAD 83
Projection	State Plane Coordinate System, Zone 3326, Spheroid GRS 1980
Units	International Feet
Source media	Stereo aerial photography, available maps and literature
Capture method	Original maps were produced from orthorectified aerial photography
File size:	792 Kb., ArcInfo 447data records.
File format	ArcInfo coverage
Coverage type	Polygon

1 IDENTIFICATION INFORMATION

1.1 Citation

Title (Theme Name):	Merced River Geomorphic Surfaces
Resource Description (Theme Abbreviation):	floodplain
Originator:	Stillwater Sciences
Publication Date:	January 12, 2001

1.2 Description

Abstract

This database displays a morphologic map of the Quaternary valley floor and channel corridor of the Merced River, CA. Specifically described in the valley morphology map are the 1) currently active river channel (including gravel pits and reservoirs) of the Merced River, 2) historical fluvial landforms (terraces, recently abandoned floodplains, and dredger tailings), and 3) floodplains inundated at 6,000 cfs, the maximum allowable flood release under U.S. Army Corps of Engineers flood control rules.

Purpose

These data were created to estimate the extent of existing and potential geomorphic surfaces inundated by the maximum flood release (6,000 cfs) and to test hypotheses regarding vegetation community composition and position relative to the fluvial geomorphic surfaces.

1.3 Status: Final

1.4 Spatial Domain

North Bounding Coordinate (Latitude):	2016227.951
South Bounding Coordinate (Latitude):	1948011.375
West Bounding Coordinate (Longitude):	6423289.000
East Bounding Coordinate (Longitude):	6616669.432

1.5 Access Restrictions: None

1.6 Use Restrictions: None

1.7 Point of Contact (Data Steward):

Contact Person:	Jennifer Vick
Contact Position:	Project Manager
Contact Organization:	Stillwater Sciences
Contact Physical Address:	
Contact Mailing Address:	2532 Durant Avenue
Contact City:	Berkeley
Contact State:	California
Contact Zip code:	94704
Contact Voice Telephone:	510-848-8098

1.8 Native Data Set Environment

Software:	ArcInfo 7.2.1
Computer Operating System:	Unix

2 DATA QUALITY INFORMATION

2.1 Attribute Accuracy

Each step in the data entry process was checked by an independent reviewer. A second independent reviewer checked the corrections. This process was repeated until the reviewer identified no errors. Reviews and verifications were recorded onto QA/QC forms and archived.

2.2 Logical Consistency

All polygons close and features represented in this data set are consistent with those observed in the digital imagery.

2.3 Completeness of Report

All edits complete. No additional revisions are anticipated.

2.4 Positional Accuracy

Surface boundaries were derived from georeferenced imagery. They were not, however, field verified.

3 LINEAGE

3.1 Source Information

Mapping and classification of the valley floor geomorphic surfaces was developed using geologic literature and maps, topographic maps, aerial photographs, channel cross sections, and maps of valley inundation under several flow scenarios since 1967.

3.2 Data Sources

- Aerial photography 1937
- Aerial photography 1993
- Aerial photography 1998
- Bartow, J.A. 1988. The Cenozoic Evolution of the San Joaquin Valley, California.
- Blodgett, J.C. and G.L. Bertoldi. 1968. Determination of channel capacity of the Merced River downstream from Merced Falls Dam, Merced County, California. Prepared by U. S. Geological Survey, Water Resources Division in cooperation with California Reclamation Board, Menlo Park.
- USGS (U.S. Geological Survey). 1990. Geology map of the San Francisco-San Jose quadrangle, California. Compilation by D.L. Wagner, E.J. Bortugno, and R.D. McJunkin. Regional Geologic Map series, 1:250,000.
- Harden, J.W. 1987. Soils Developed in Granitic Alluvium near Merced, California. In *Soil Chronosequences in the Western United States*, J.W. Harden ed., U.S. Geological Survey Bulletin 1590-A.
- Huntington, G.L., E.L. Begg, J.W. Harden, and D.E. Marchand. 1977. Soil development, geomorphology, and Cenozoic history of the northeastern San Joaquin Valley and adjacent areas. In *California: A Guidebook for the Joint Field Session of the American Society of Agronomy, Soil Science Society of America and the Geological Society of America*, ed. M.J.Singer.
- Marchand, D.E. and A. Allwardt. 1981. Late Cenozoic stratigraphic units, northeastern San Joaquin Valley, California. U.S. Geological Survey Professional Paper 1470. 70 p.
- Merced River Planform Maps 1855 and 1911
- U.S. Army Corps of Engineers. 1997. Digital map of inundation boundary at a flow of approximately 8,080 cfs (measured at Snelling).

- Wahrhaftig, C. and J.H. Birman. 1966. The Quaternary of the Pacific Mountain system in California. In *Geology of Northern California,* ed. E. H. Bailey, California Division of Mines and Geology, USGS Bulletin No. 190.

3.3 Processing Steps

First, the Quaternary valley floor of the Merced River was inferred and delineated using available geologic and topographic information. Then, historic river planform maps, topographic and geologic maps, and aerial photographs were used to analyze the valley floor morphology and to infer and map the active channel (including in-channel alluvial features) of the Merced River and geomorphic valley floor surfaces. Geomorphic features were plotted onto orthorectified aerial photographs (1998, scale 1:6,000) and digitized in ArcInfo. The geomorphic surfaces were then classified in terms of relative age and inundation history using channel cross section data and inundation maps.

3.4 Data Resolution: Vector

3.5 Horizontal Coordinate System Definition

Map Projection Name:	State Plane
Units:	International Feet
Geodetic Model	
Horizontal Datum Name:	NAD83
Spheroid:	GRS1980
Zone:	3326

4 ENTITY AND ATTRIBUTE INFORMATION

4.1 Overview Description

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC	ALTERNATE NAME INDEXED?
1	AREA	8	18	F	5	-
9	PERIMETER	8	18	F	5	-
17	FLOODPLAIN12#	4	5	B	-	-
21	FLOODPLAIN12-ID	4	5	B	-	-
25	GEOM	8	8	C	-	-

4.2 Attribute Description

Area:	The area of each individual polygon in square international feet.
Perimeter:	The length of the perimeter of each polygon in linear international feet.
Floodplain12#:	A unique identification assigned by ArcInfo.
Floodplain12-ID:	A unique identification assigned by ArcInfo.
Geom:	Codes describing the geomorphic surfaces.

Attribute: Geom

Code	Name	Description
AC	Active Channel	The portion of the river channel that is actively scoured under the current flow conditions. This includes the low flow channel and unvegetated alluvial bars.
CF	Current Floodplain	Surfaces that are expected to be inundated by flows of approximately 6,000 cfs (the maximum releases allowable under U.S. Army Corps of Engineers flood control rules) in the absence of levees (some of these floodplain areas are now isolated from the river by levees). Historically, this geomorphic surface was likely contained within the bankfull channel.
CTFF	Current Terrace Former Floodplain	Surfaces that are not expected to be inundated by flows of approximately 6,000 cfs. Historically, floods exceeding the pre-dam bankfull flow inundated these geomorphic surfaces
DT	Dredger Tailings	Dredger Tailings
PIT	Pit	Gravel pits
POND	Pond	Ponds
TERR	Terrace	Abandoned alluvial surfaces within the valley that, historically, would have been inundated only by large, infrequent floods.

5 METADATA DATE: January 12, 2001

Merced River Levees

Summary of Geospatial Metadata

Metadata Type	Description
Datum	NAD 83
Projection	State Plane Coordinate System, Zone 3326, Spheroid GRS 1980
Units	International Feet
Source media	Aerial photography
Capture method	Original maps were produced from orthorectified aerial photography.
File size:	26.4KB., ArcInfo coverage, 36 data records.
File format	ArcInfo coverage
Coverage type	Line

1 IDENTIFICATION INFORMATION

1.1 Citation

Title (Theme Name): Merced River Levees
Resource Description (Theme Abbreviation): levees
Originator: Stillwater Sciences
Publication Date: January 12, 2001

1.2 Description

Abstract
This data set contains information regarding the location of levees adjacent to the Merced River, CA.

Purpose
These data were created to interpret and map levees along the Merced River, classify levees according to their geomorphic surface association, and identify 6,000 cfs geomorphic surfaces ("current floodplains") which are prevented from annual inundation by the levees.

1.3 Status: Final

1.4 Spatial Domain

North Bounding Coordinate (Latitude): 1993931.750
South Bounding Coordinate (Latitude): 1949583.375

West Bounding Coordinate (Longitude):	6429219.500
East Bounding Coordinate (Longitude):	6561342.500

1.5 Access Restrictions: None

1.6 Use Restrictions: None

1.7 Point of Contact (Data Steward):

Contact Person:	Jennifer Vick
Contact Position:	Project Manager
Contact Organization:	Stillwater Sciences
Contact Physical Address:	
Contact Mailing Address:	2532 Durant Ave.
Contact City:	Berkeley
Contact State:	California
Contact Zip Code:	94704
Contact Voice Telephone:	510-848-8098

1.8 Native Data Set Environment:

Software:	ArcInfo 7.2.1
Computer Operating System:	Unix

2 DATA QUALITY INFORMATION

2.1 Attribute Accuracy

Each step in the data entry process was checked by and independent reviewer. A second independent reviewer checked the corrections. This process was repeated until the reviewer identified no errors. Reviews and verifications were recorded onto QA/QC forms and archived.

2.2 Logical Consistency

Levee arcs do not overlap and are consistent with features observed in aerial photographs.

2.3 Completeness of Report

No further revisions are expected.

2.4 Positional Accuracy

This information was not completely field verified. Field verification was conducted at some locations in conjunction with other field work.

3 LINEAGE

3.1 Source Information

Mapping (including interpretation) of levees was developed using aerial photographs and California Department of Water Resources levee coverage.

3.2 Data Sources

- Aerial photography 1993
- Aerial photography 1998
- California Department of Water Resources 2000 unpublished data

3.3 Processing Steps

Stereo aerial photography (taken in 1993) was used to identify the location of all levees with respect to geomorphic surfaces (Step 1). The levees were then classified based on their association with geomorphic surfaces (Step 2). Most levees were located on a geomorphic surfaces classified as "current floodplain" (expected to be inundated by 6,000 cfs flows), "current terrace/former floodplain", or adjacent to "floodplain pits." Levees were originally drawn onto hardcopies of non-stereo, orthorectified aerial photographs (taken in 1998) (Step 3). This information was then digitized (on-screen) in ArcInfo (Step 4). The “current floodplain” levee coverage was checked against a levee coverage developed by the California Department of Water Resources using a query of their topographic data (which were developed from photogrammetry) (California Department of Water Resources unpublished data) (Step 5).

3.4 Data Resolution: Vector

3.5 Horizontal Coordinate System Definition

Map Projection Name:	State Plane
Units:	International Feet
Geodetic Model	
Horizontal Datum Name:	NAD83
Spheroid:	GRS1980
Zone:	3326

4 ENTITY AND ATTRIBUTE INFORMATION

4.1 Overview Description

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC	ALTERNATE NAME	INDEXED?
1	FNODE#	4	5	B	-	-	
5	TNODE#	4	5	B	-	-	
9	LPOLY#	4	5	B	-	-	
13	RPOLY#	4	5	B	-	-	
17	LENGTH	4	12	F	3	-	
21	LEVEES3#	4	5	B	-	-	
25	LEVEES3-ID	4	5	B	-	-	
29	LABEL	20	20	C	-	-	
49	BANK	4	5	C	-	-	
53	GEOM_SURF	8	8	C	-	-	

4.2 Attribute Description

FNODE#:	A unique identification number assigned by ArcInfo.
TNODE#:	A unique identification number assigned by ArcInfo.
LPOLY#:	A unique identification number assigned by ArcInfo.
RPOLY#:	A unique identification number assigned by ArcInfo.
LENGTH:	The length of the arc in international feet.
LEVEES3#:	A unique identification number assigned by ArcInfo.
LEVEES3-ID:	A unique identification number assigned by ArcInfo.
LABEL:	Name of the structure.
BANK:	The river bank location of the levee. R = right, L = left. Right and left are assigned from the perspective of a person looking downstream.
GEOM_SURF:	The geomorphic surface on which the levee resides.

5 METADATA DATE: January 12, 2001

Merced River Revetment and Bank Erosion

Summary of Geospatial Metadata

Metadata Type	Description
Datum	NAD 83
Projection	State Plane Coordinate System, Zone 3326, Spheroid GRS 1980
Units	International Feet
Source media	Aerial photography
Capture method	Original maps were produced from orthorectified aerial photography.
File size:	40.6KB., ArcInfo coverage, 193 data records.
File format	ArcInfo coverage
Coverage type	Line

1 IDENTIFICATION INFORMATION

1.1 Citation

Title (Theme Name): Merced River Revetment and Bank Erosion
Resource Description (Theme Abbreviation): revetment
Originator: Stillwater Sciences
Publication Date: January 12, 2001

1.2 Description

Abstract
This data set contains information regarding the location of bank revetment and bank erosion on the Merced River, CA.

Purpose
These data were created to interpret and map revetment and bank erosion along the Merced River.

1.3 Status Final

1.4 Spatial Domain

North Bounding Coordinate (Latitude): 1993931.750
South Bounding Coordinate (Latitude): 1949583.375
West Bounding Coordinate (Longitude): 6429219.500

East Bounding Coordinate (Longitude): 6561342.500

1.5 Access Restrictions: None

1.6 Use Restrictions: None

1.7 Point of Contact (Data Steward):

Contact Person:	Jennifer Vick
Contact Position:	Project Manager
Contact Organization:	Stillwater Sciences
Contact Physical Address:	
Contact Mailing Address:	2532 Durant Ave.
Contact City:	Berkeley
Contact State:	California
Contact Zip Code:	94704
Contact Voice Telephone:	510-848-8098

1.8 Native Data Set Environment:

Software:	ArcInfo 7.2.1
Computer Operating System:	Unix

2 DATA QUALITY INFORMATION

2.1 Attribute Accuracy

Each step in the data entry process was checked by and independent reviewer. A second independent reviewer checked the corrections. This process was repeated until the reviewer identified no errors. Reviews and verifications were recorded onto QA/QC forms and archived.

2.2 Logical Consistency

Arcs do not overlap and are consistent with features observed in aerial photographs.

2.3 Completeness of Report

No further revisions are expected.

2.4 Positional Accuracy

This information was completely field verified.

3 LINEAGE

3.1 Source Information

The locations of revetments and bank erosion were mapped in the field onto orthorectified aerial photographs (taken in 1998). Field work was conducted by boat in August 1999 (Crocker-Huffman Dam to Shaffer Bridge) and June 2000 (Shaffer Bridge to Hatfield State Park).

3.2 Data Sources

- Aerial photography 1993
- Aerial photography 1998

3.3 Processing Steps

Revetment and bank erosion locations were marked on maps during a field investigation. This information was digitized onscreen in ArcInfo.

3.4 Data Resolution: Vector

3.5 Horizontal Coordinate System Definition

Map Projection Name:	State Plane
Units:	International Feet
Geodetic Model	
Horizontal Datum Name:	NAD83
Spheroid:	GRS1980
Zone:	3326

4 ENTITY AND ATTRIBUTE INFORMATION

4.1 Overview Description

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC	ALTERNATE NAME	INDEXED?
1	FNODE#	4	5	B	-	-	
5	TNODE#	4	5	B	-	-	
9	LPOLY#	4	5	B	-	-	
13	RPOLY#	4	5	B	-	-	
17	LENGTH	4	12	F	3	-	
21	REVETMENT#	4	5	B	-	-	

25	REVETMENT-ID	4	5	B	-	-
29	LABEL	20	20	C	-	-
49	BANK	4	5	C	-	-

4.2 Attribute Description

FNODE#:	A unique identification number assigned by ArcInfo.
TNODE#:	A unique identification number assigned by ArcInfo.
LPOLY#:	A unique identification number assigned by ArcInfo.
RPOLY#:	A unique identification number assigned by ArcInfo.
LENGTH:	The length of the arc in international feet.
REVETMENT#:	A unique identification number assigned by ArcInfo.
LEVEES3-ID:	A unique identification number assigned by ArcInfo.
LABEL:	Name of the feature. RT = revetment, BE = bank erosion.
BANK:	The river bank location of the levee. R = right, L = left. Right and left are assigned from the perspective of a person looking downstream.
GEOM_SURF:	The geomorphic surface on which the levee resides.

5 METADATA DATE: January 12, 2001

Merced River Vegetation

Summary of Geospatial Metadata

Metadata Type	Description
Datum	NAD 83
Projection	State Plane Coordinate System, Zone 3326, Spheroid GRS 1980
Units	International Feet
Source media	Color infrared aerial photography
Capture method	Original maps were produced from orthorectified RF 1:24,000 color infrared scans saved in TIFF format and digitized in ArcView.
File size:	2.62 Mb., ArcInfo coverage, 3575 data records.
File format	ArcInfo coverage
Coverage type	Polygon for vegetation type

1 IDENTIFICATION INFORMATION

1.1 Citation

Title (Theme Name): Merced River Vegetation
Resource Description (Theme Abbreviation): vegclass
Originator: Stillwater Sciences and Geographic Information Center at California State University, Chico
Publication Date: December 8, 2000

1.2 Description

Abstract
This data set contains polygons representing the distribution of vegetation types adjacent to the Merced River.

Purpose
These data were created to inventory riparian vegetation resources and to test hypotheses regarding vegetation cover type and position relative to fluvial geomorphic surfaces.

1.3 Status: Final

1.4 Spatial Domain

North Bounding Coordinate (Latitude): 2016207.500

South Bounding Coordinate (Latitude):	1946777.875
West Bounding Coordinate (Longitude):	6419743.000
East Bounding Coordinate (Longitude):	6616736.500

1.5 Access Restrictions: None

1.6 Use Restrictions None

1.7 Point of Contact (Data Steward):

Contact Person:	Jennifer Vick
Contact Position:	Project Manager
Contact Organization:	Stillwater Sciences
Contact Physical Address:	
Contact Mailing Address:	2532 Durant Ave.
Contact City:	Berkeley
Contact State:	California
Contact Zip Code:	94704
Contact Voice Telephone:	510-848-8098

1.8 Native Data Set Environment:

Software:	ArcView 3.1
Computer Operating System:	Windows

2 DATA QUALITY INFORMATION

2.1 Attribute Accuracy

Map accuracy was assessed using the field verification, data entry, and quality control steps described in Section 3.2. Each step in the data entry process was checked by an independent reviewer. A second independent reviewer checked the corrections. This process was repeated until the reviewer identified no errors. Reviews and verifications were recorded onto QA/QC forms and archived.

Results of the accuracy assessment for the cover type attribute are summarized in the table below. Appendix E contains a more detailed discussion of map accuracy issues. Cover type descriptions are summarized below.

Summary of Vegetation Polygon Accuracy

Cover Type	Number of Polygons Mapped[1]	Polygons Field-Checked		Polygons Correctly Interpreted		Number of New Polygons Delineated During Field Checking
		Number	Percent	Number	Percent[2]	
Vegetation Cover Type						
Blackberry Scrub	108	3	3	1	33	0
Box Elder	38	17	45	12	71	6
Cottonwood Forest	360	61	17	38	62	9
Eucalyptus	55	19	35	7	37	8
Giant Reed	59	19	32	10	53	7
Herbaceous Cover	348	64	18	55	86	7
Marsh	74	0	0	N/A[3]	N/A[3]	1
Mixed Riparian Forest	479	176	37	120	68	11
Mixed Willow	526	142	27	69	49	10
Riparian Scrub	483	92	19	69	75	8
Tamarisk	2	0	0	N/A[3]	N/A[3]	0
Tree of Heaven	17	4	24	0	0	10
Valley Oak Forest	416	96	23	64	67	14
Total Vegetation	**2,965**	**693**	**23**	**445**	**64**	**91**
Land Use Cover Type						
Disturbed Riparian[4]	12	N/A	N/A	N/A	N/A	0
Dredger Tailings	31	0	0	N/A[3]	100[5]	0

[1] Patch totals represent the minimum polygon count for each cover type, in which adjacent polygons of the same type were merged during data editing. The digital GIS coverage retains the unmerged polygon configuration, which has higher polygon counts for some cover types (but the same total area for each type), because accuracy assessment data stored as polygon attributes in the GIS would have been lost during the merging process.

[2] Percent correct is calculated as the number of polygons correctly interpreted divided by the number of polygons checked for each cover type. New polygons delineated from field visits were not included in these counts.

[3] No polygons of this cover type were field-verified during the formal accuracy assessment, although occurrences of tamarisk, dredger tailings, and marsh were mapped during earlier reconnaissance surveys.

[4] The Disturbed Riparian classification was added in the field as a land use cover type to comprise revetted banks and other highly modified environments with sparse to no plant cover. Existing polygons of other cover types were recoded to this type, as appropriate.

[5] Dredger Tailing polygons were not formally checked as part of the field verification process, but assumed photointerpretation accuracy is 100 percent because of the distinct photographic signature and the large polygon size (mean polygon size = 138 acres) within this cover type.

2.2 Logical Consistency

All polygons close and no duplicate features exist within the data set. Polygon boundaries are consistent with objects observed in the digital imagery.

2.3 Completeness of Report

No further revisions are expected for this data at this time.

2.4 Positional Accuracy

Color infrared imagery (taken in 1999) was geo-referenced in the Albers projection system. The vegetation coverage was digitized over this imagery and subsequently re-projected in State Plane onto the Merced County 1998 black-and-white photomosaic. After reprojection, the vegetation polygon boundaries were adjusted to match the 1998 Merced County photomosaic.

3 LINEAGE

3.1 Source Information

This coverage is based on interpretation of aerial photographs taken in 1999 (scale 1:24,000) and 1993 (scale 1:6,000). A subsample of the polygons developed by photointerpretation was field verified, as described below.

3.2 Processing Steps

The Chico State University Geographic Information Center (GIC) mapped vegetation cover types from orthorectified color infrared aerial photography taken in May of 1999 (original scale 1:24,000). The 1999 photographs were not stereoscopic, therefore, color stereo photographs taken 1993 (original scale 1:6,000) were used to aid in interpretation of the 1999 photographs. Vegetation polygons were digitized on-screen. The vegetation classification developed and used by GIC is described in Section 4.2 below and was based on a similar system used to map riparian vegetation in the Sacramento River corridor.

Stillwater Sciences field-checked the polygons delineated by the GIC by spot visual observations from public and private access roads and by boat within the Merced River channel downstream of RM 34.5 (Shaffer Bridge). Choice of polygons to verify was based on ease of access and was not random. The Project Team checked 693 polygons out of a total of 3,008 polygons, representing an overall sampling rate of 23 percent (see Section 2.1).

After field-verification, vegetation maps were returned to the office for revisions. Field maps were copied for data entry and the originals archived. Correctly classified polygons were noted and misclassified polygons were corrected in the GIS database. Initial quality control checks were documented on paper maps; the final check was conducted on-screen and corrections confirmed on the paper maps. All QC map sets were archived.

The polygon totals cited in the map accuracy table (above) represent the number of patches for each cover type after adjacent patches of the same type were merged during data processing. The digital GIS coverage retains the unmerged polygon configuration, which has high polygon counts for some cover types (but the same total area for each type), because accuracy assessment data stored as polygon attributes in the GIS would have been lost during the merging process.

3.3 Data Resolution: Vector

3.4 Horizontal Coordinate System Definition

Map Projection Name:	State Plane
Units:	International Feet
Geodetic Model	
Horizontal Datum Name:	NAD83
Spheroid:	GRS1980
Zone:	3326

4 ENTITY AND ATTRIBUTE INFORMATION

4.1 Overview Description

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N. DEC	ALTERNATE NAME INDEXED?
1	AREA	4	12	F	3	-
5	PERIMETER	4	12	F	3	-
9	VEGCLASS#	4	5	B	-	-
13	VEGCLASS-ID	4	5	B	-	-
17	CLASS	4	4	C	-	-
21	ACRES	8	16	F	3	-
29	CHECK	2	2	B	-	-
31	CORRECT	4	4	C	-	-
35	RIGHT	2	2	B	-	-
37	WRONG	2	2	B	-	-
39	NEW	2	2	B	-	-
41	FINAL	4	4	C	-	-

4.2 Attribute Description

Area	The area of each individual polygon in square international feet.
Perimeter	The length of the perimeter of each polygon in linear international feet.
Vegclass#	A unique id assigned by ArcInfo.
Vegclass-ID	A unique id assigned by ArcInfo.
Class	The initial classification of functional vegetation groups or communities (see table below).

Attribute: Class (cover type classifications)

Code	Name	Description
BE	Box Elder	>50% crown canopy *Acer negundo*. Box elder, a component of the mixed riparian forest subcanopy, is often found in monospecific stands where there is no overstory.
BS	Blackberry Scrub	>50% crown canopy *Rubus discolor* (Himalaya berry) or *R. ursinus* (California blackberry).
CF	Cottonwood Forest	>50% crown canopy *Populus fremontii*. Contains various subcanopy species and combinations.
DR	Disturbed Riparian	Areas adjacent to the river with little native plant cover, such as revetted banks.
DT	Dredger Tailings	Dredger tailing areas, which include bare substrate and sparse non-native grasslands, cottonwood and willow riparian stands disconnected from the channel, and wetland and pond communities
EUC	Eucalyptus	>50% crown canopy *Eucalyptus* spp. Found in fairly monospecific stands on heavily modified banks.
G	Gravel	Depositional river bars
GR	Giant Reed	Clonal monospecific stands of *Arundo donax*, often on revetted or otherwise disturbed banks.
HL	Herbaceous Cover	Herbaceous communities, including grassland terraces, tailing transitional areas, and some seasonal wetlands.
M	Marsh	Areas with surface water supporting emergent plants. Found in some backwater channels and in some dredger tailing swales.
MF	Mixed Riparian Forest	Riparian hardwood forest with at least 3 species co-dominant. Composition varies along river, but often includes *Fraxinus latifolia, Alnus rhombifolia, Acer negundo, Quercus lobata, and Salix* spp.
MW	Mixed Willow	Areas almost exclusively willow, including *Salix exigua, S. gooddingii, S. lasiolepis*, and *S. laevigata*
OW	Open Water	Channel areas, backwaters, filled gravel mine pits
RS	Riparian Scrub	Early seral stage vegetation (shrubs and small trees) of various species that may indicate some form of regular disturbance or scour.
TAM	Tamarisk	Areas exclusively almost exclusively *Tamarix* spp., an invasive exotic plant.
TH	Tree of Heaven	>50% crown canopy *Ailanthus altissima*, an invasive exotic tree species.
VO	Valley Oak Forest	>50% crown canopy *Quercus lobata*. Occurs on terraces, and younger stands have established on former floodplains that are no longer frequently inundated.

Other Attributes (includes map verification and accuracy records):

Acres
The acreage of a given polygon.

Check
Field verified = 1, Not field verified = 0.

Correct
This item contains information regarding the accuracy of the image interpretation. 1 = Image classification is correct, 0 = Image classification incorrect.

Right
This item contains information regarding polygons that were correctly classified. The information was derived in the following manner. Class = 'X', Check = 1, Correct = 'X'. The codes for this item are as follows, 1 = right, 0 = not right or not checked.

Wrong
This item contains information regarding polygons that were incorrectly classified. The information was derived in the following manner. Class = 'X', Check = 1, Correct = 'Y'. The codes for this item are as follows, 1 = wrong, 0 = not wrong or not checked.

New
This item contains information regarding polygons that were created as a result of field verification. The information was derived in the following manner. Class = '', Check = 1, Correct = 'Y'. The codes for this item are as follows 1 = new, 0 = not new or not checked.

Final
The final classification of functional vegetation groups or communities. The codes are the same as the 'Class' item. The records in this item were in the following manner. If Check = 1 and Right =1 then Final = Class. If Check = 1 and Right = 0 then Final = Correct. If Check = 0 then Final = Class.

5 METADATA DATE: January 22, 2001

Appendix B. Snelling Site Cross Sections, Pebble Counts, and Rating Curves

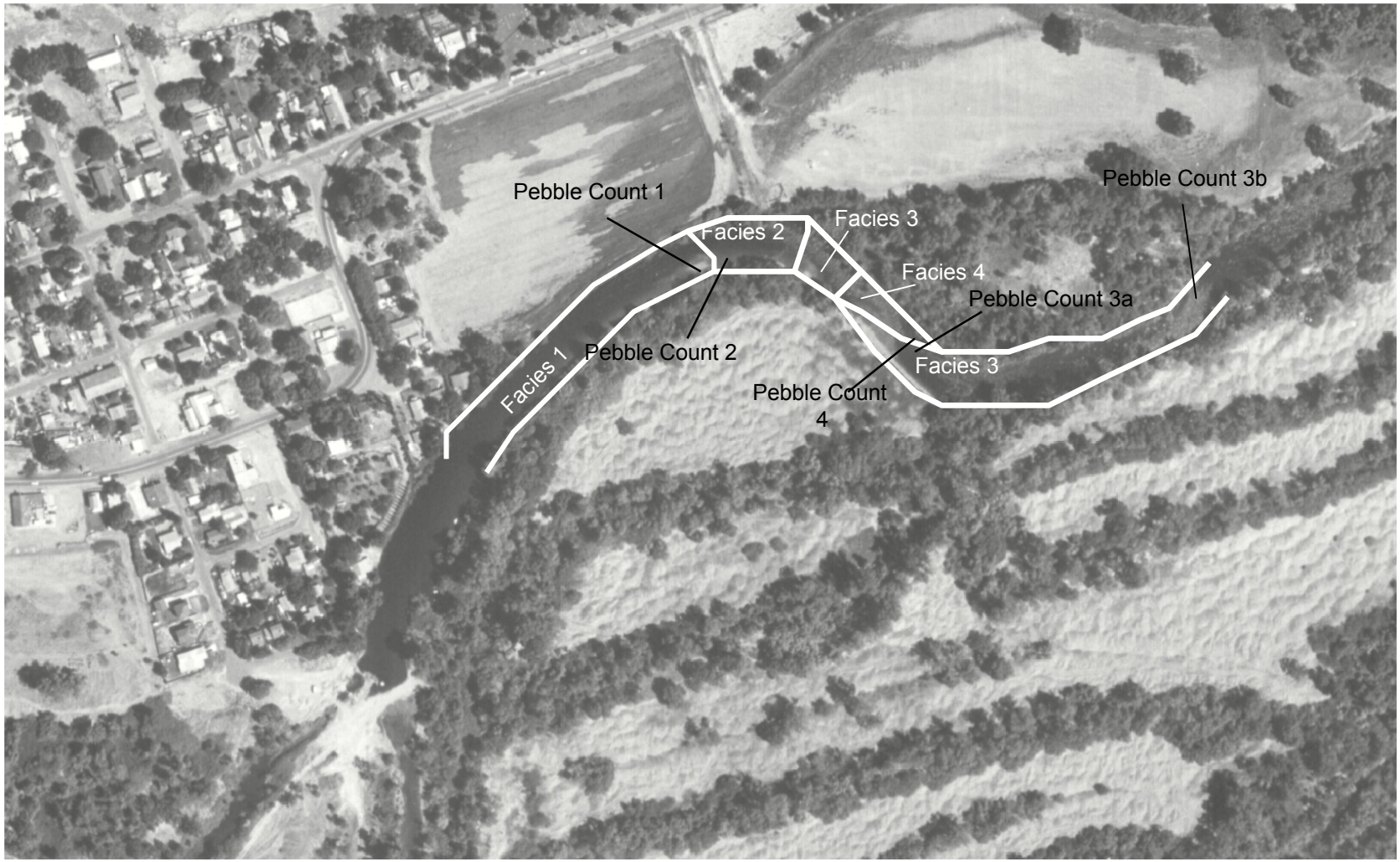


Figure B-1. Snelling model site facies map.
(photo: Merced County Planning and Community Development Department 1998)

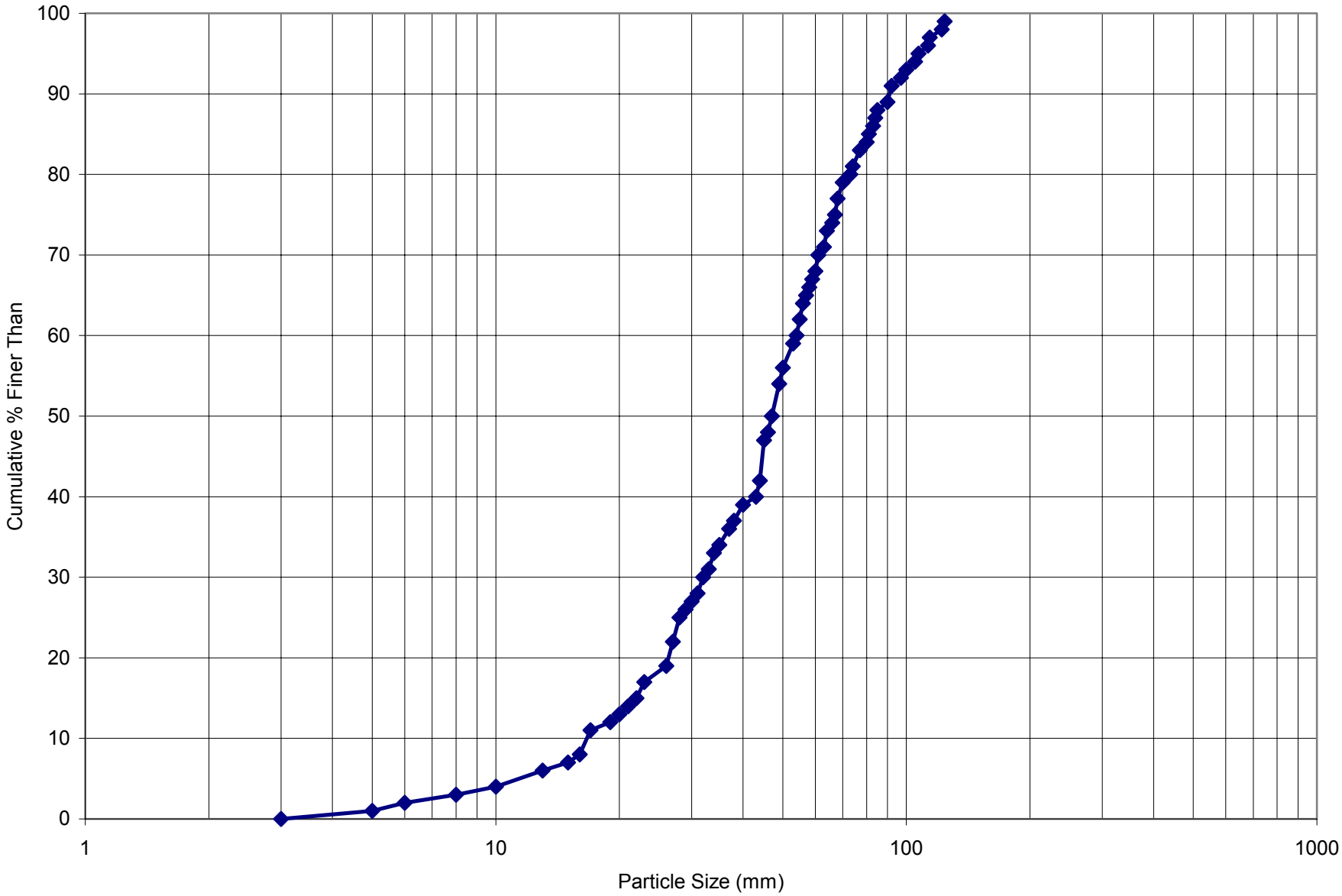


Figure B-2. Snelling site pebble count 1.

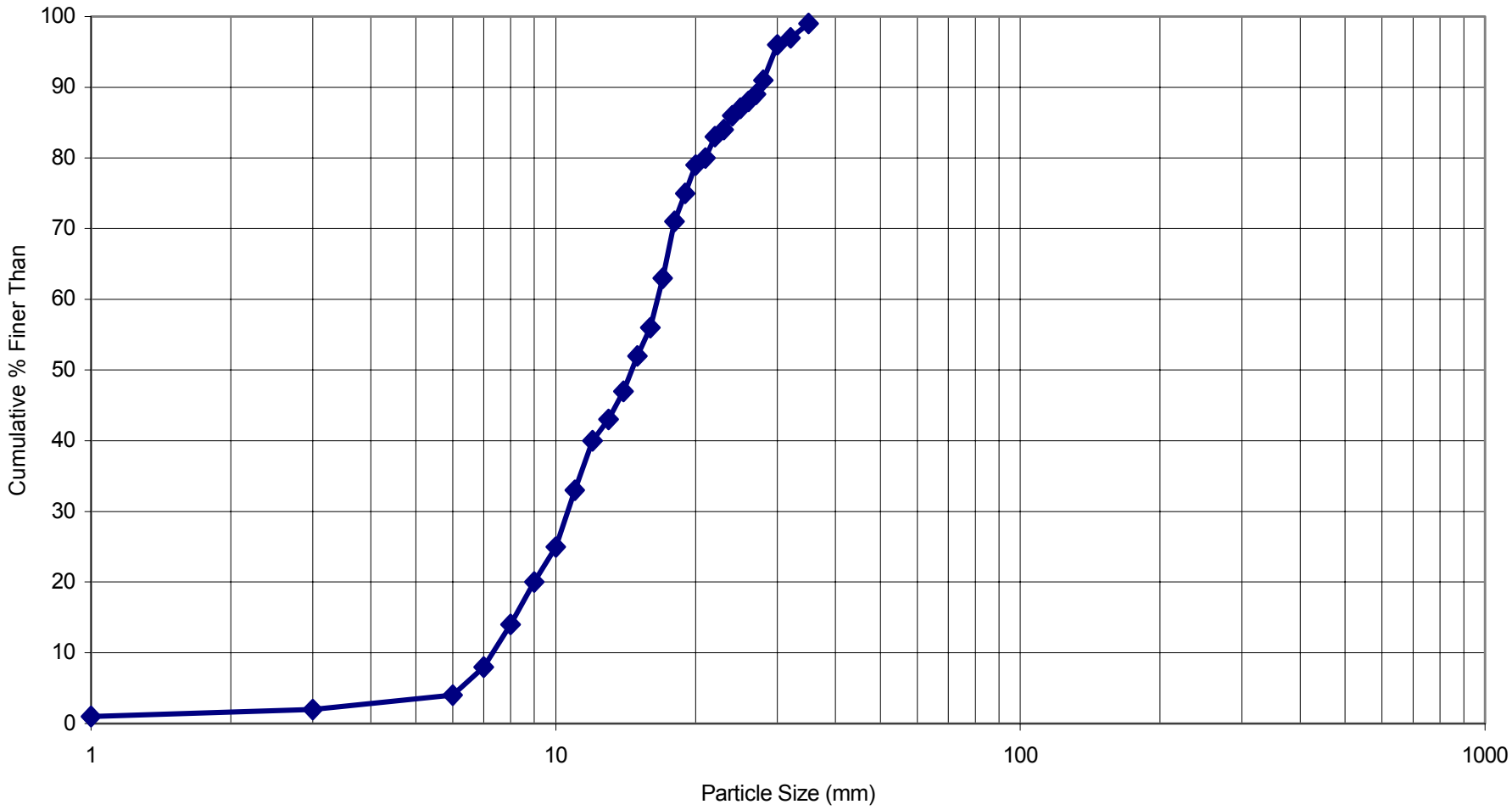


Figure B-3. Snelling site pebble count 2.

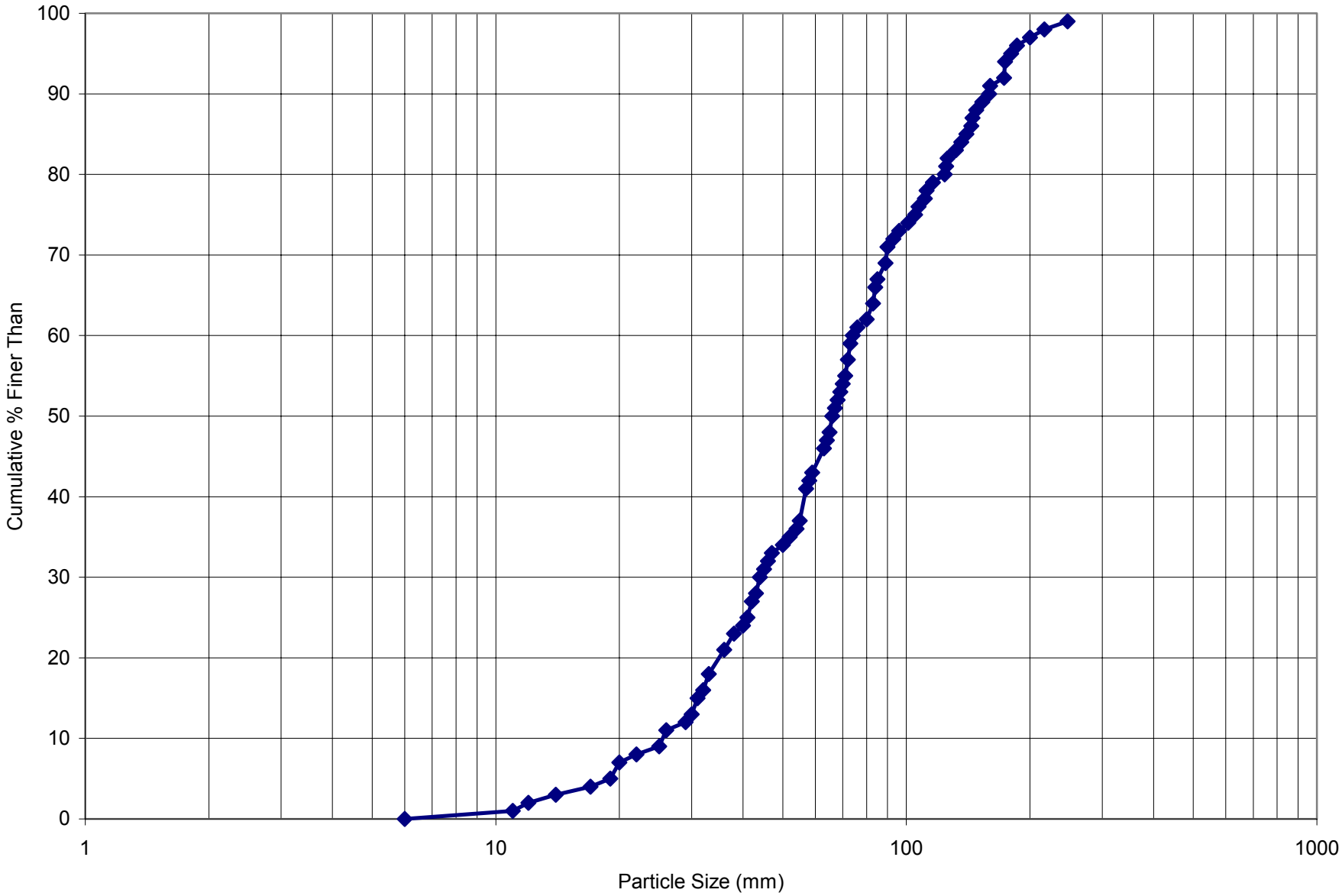


Figure B-4. Snelling site pebble count 3A.

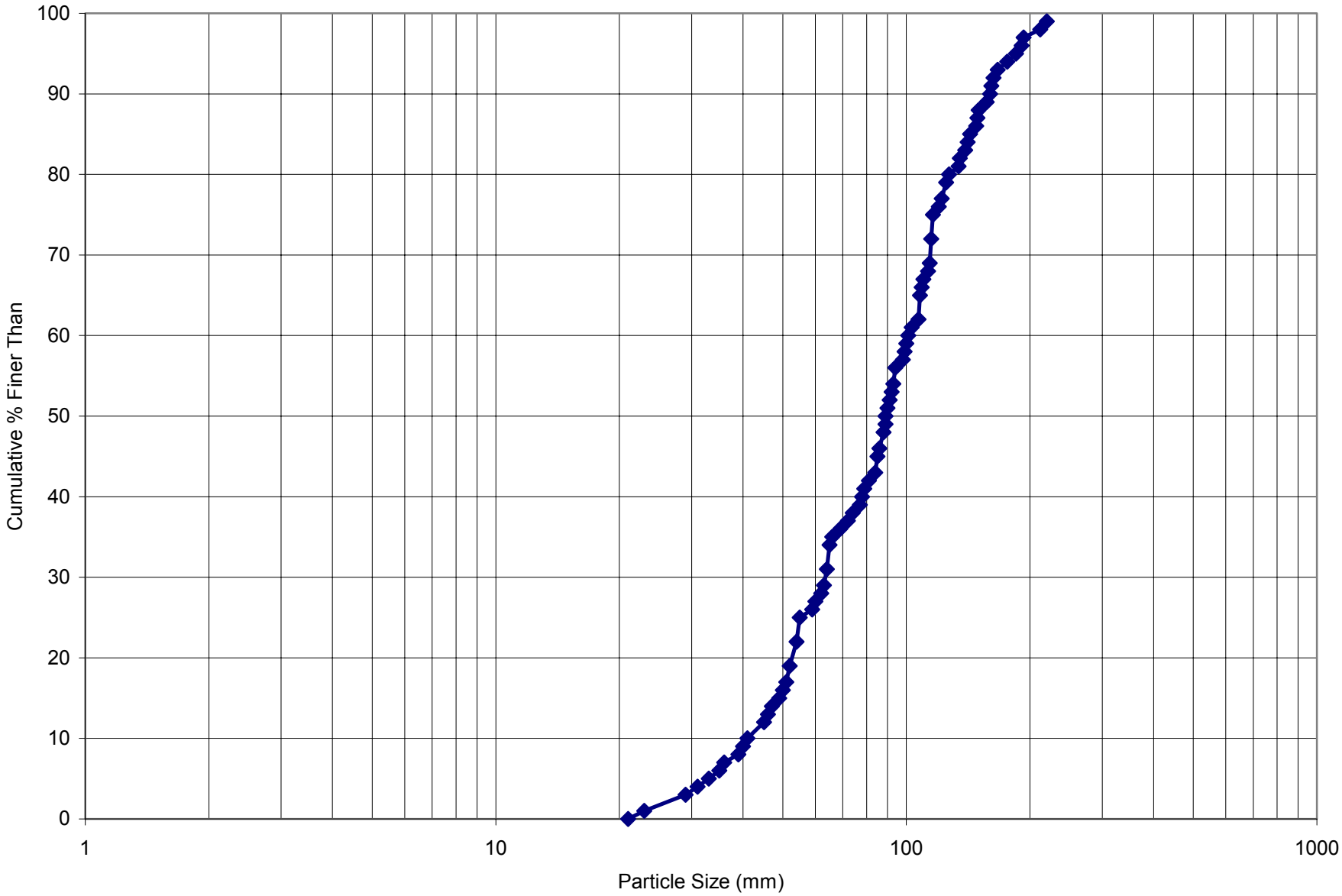


Figure B-5. Snelling site pebble count 3B.

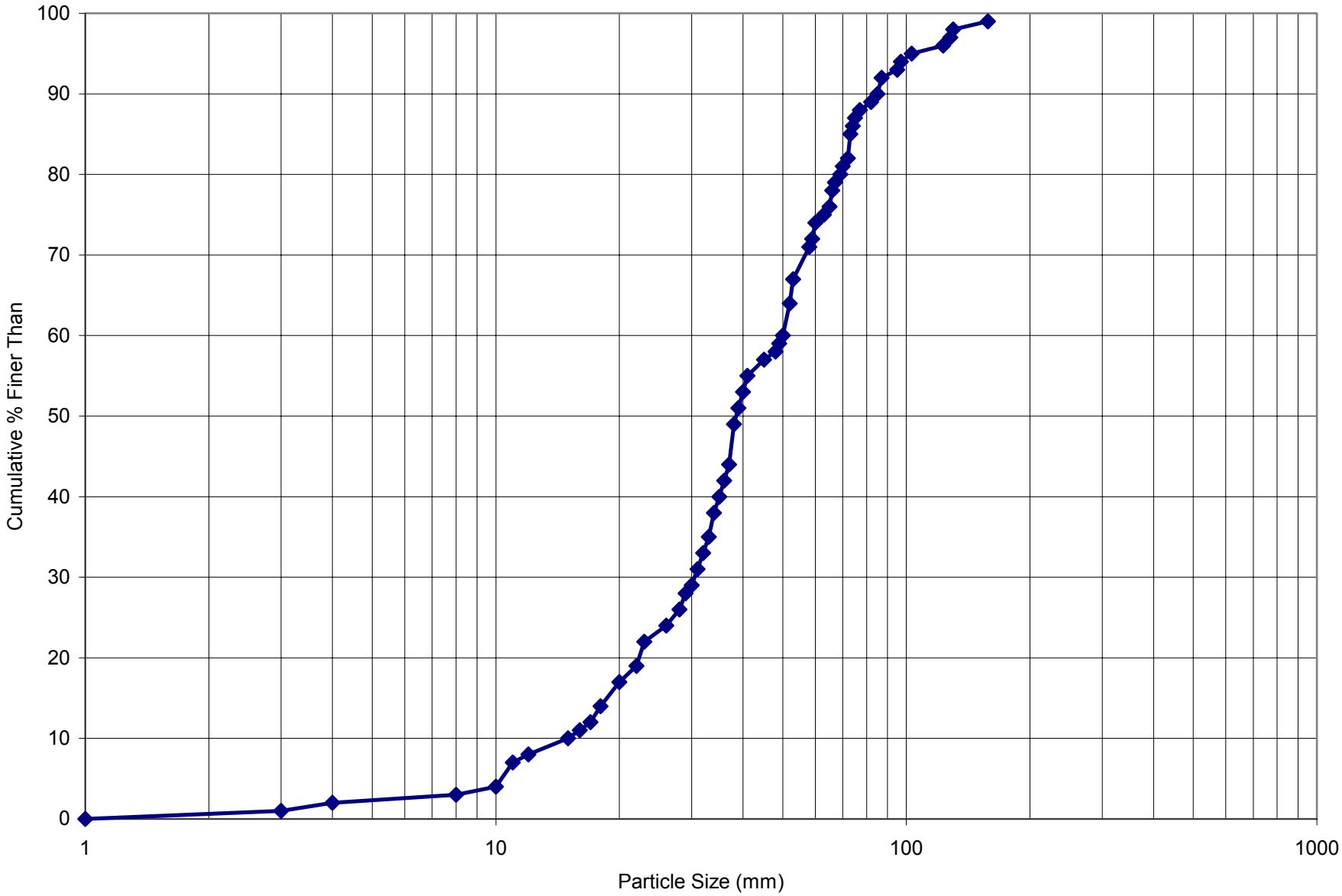


Figure B-6. Snelling site pebble count 4.

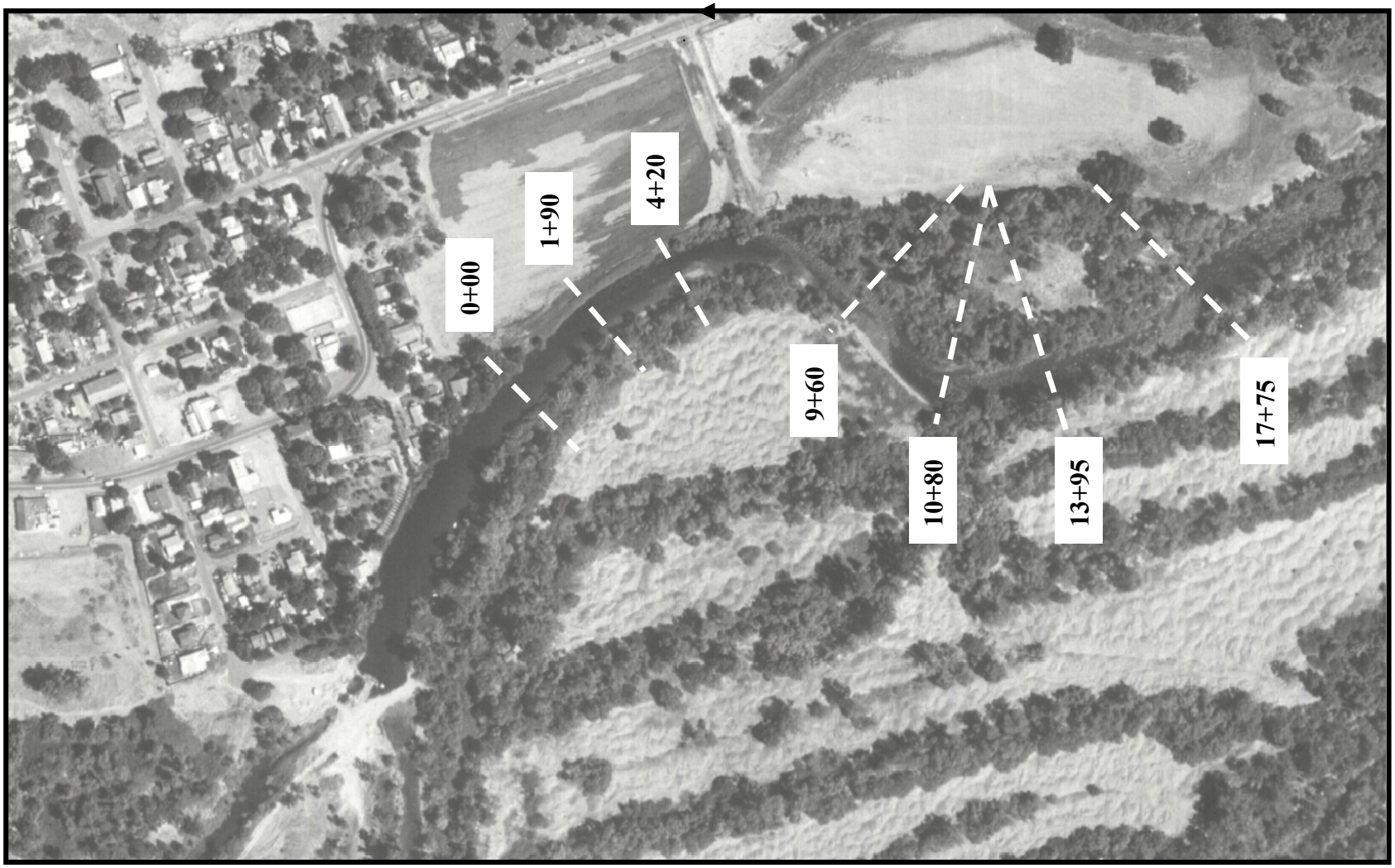


Figure B-7. Cross section survey locations at the Snelling model site.
(photo: Merced County Planning and Community Development Department 1998)

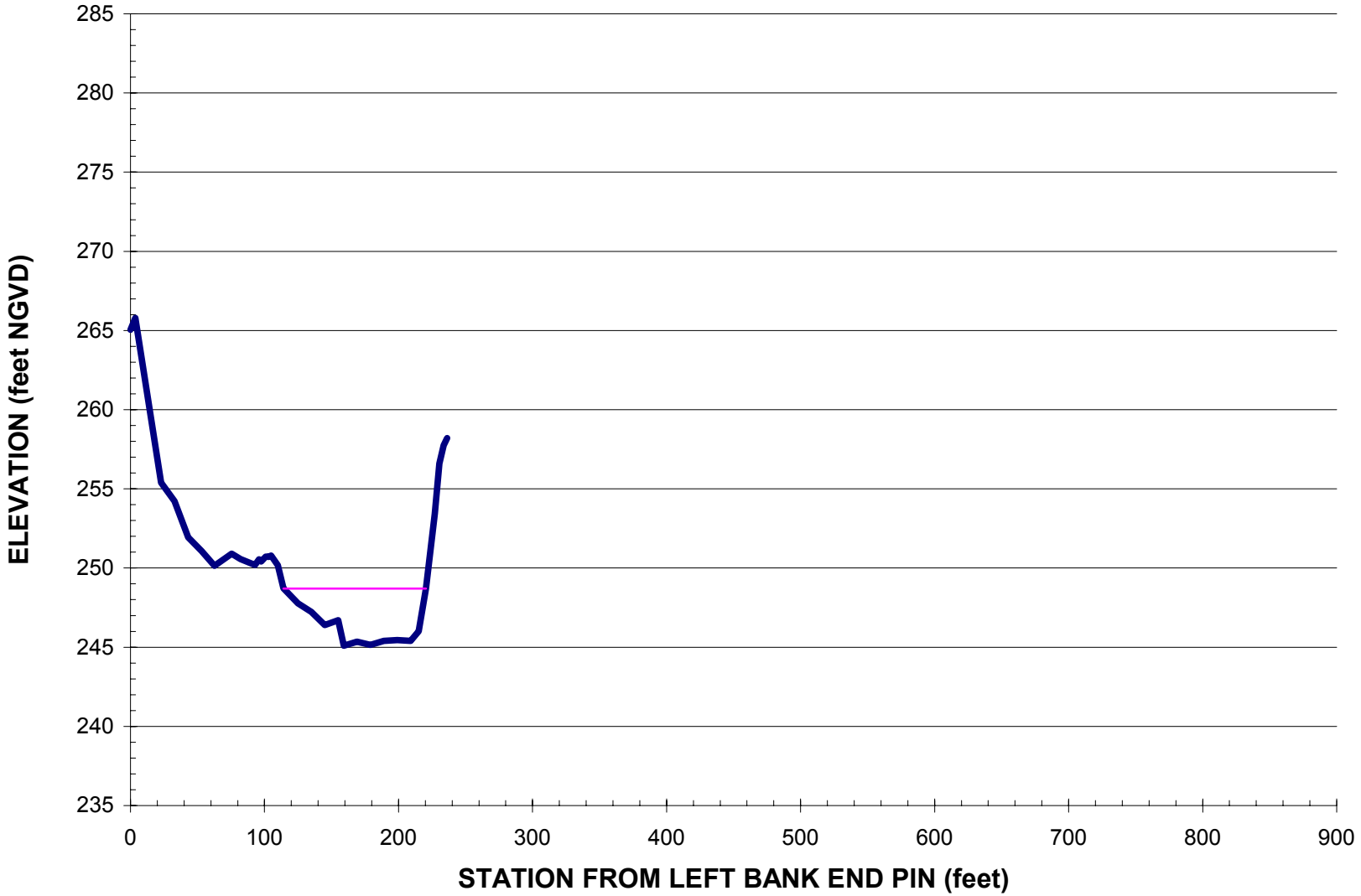


Figure B-8. Snelling Site topographic cross section 0+00.

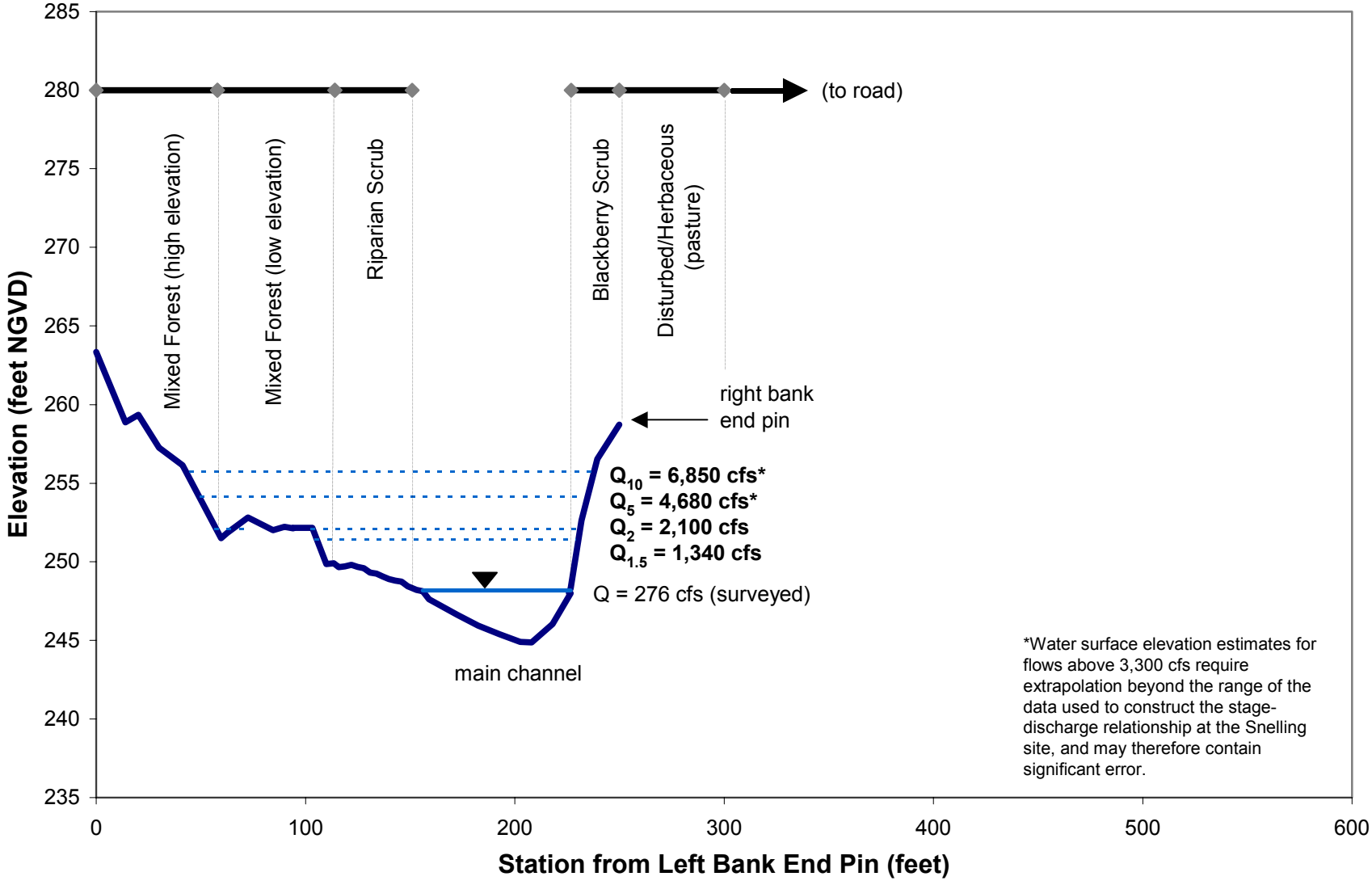


Figure B-9. Snelling Site vegetation cover and topographic cross section 1+90.

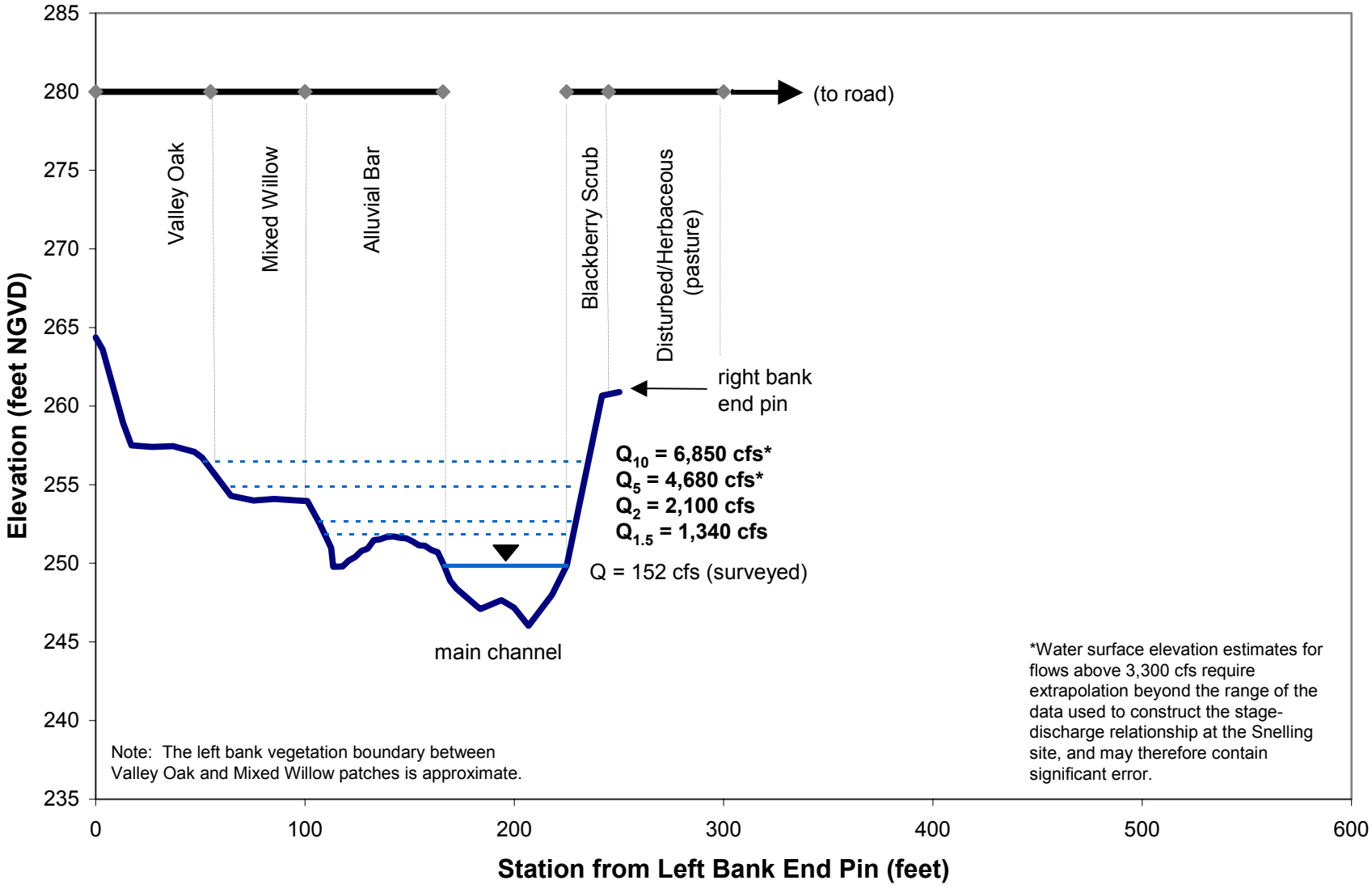


Figure B-10. Snelling Site vegetation cover and topographic cross section 4+20.

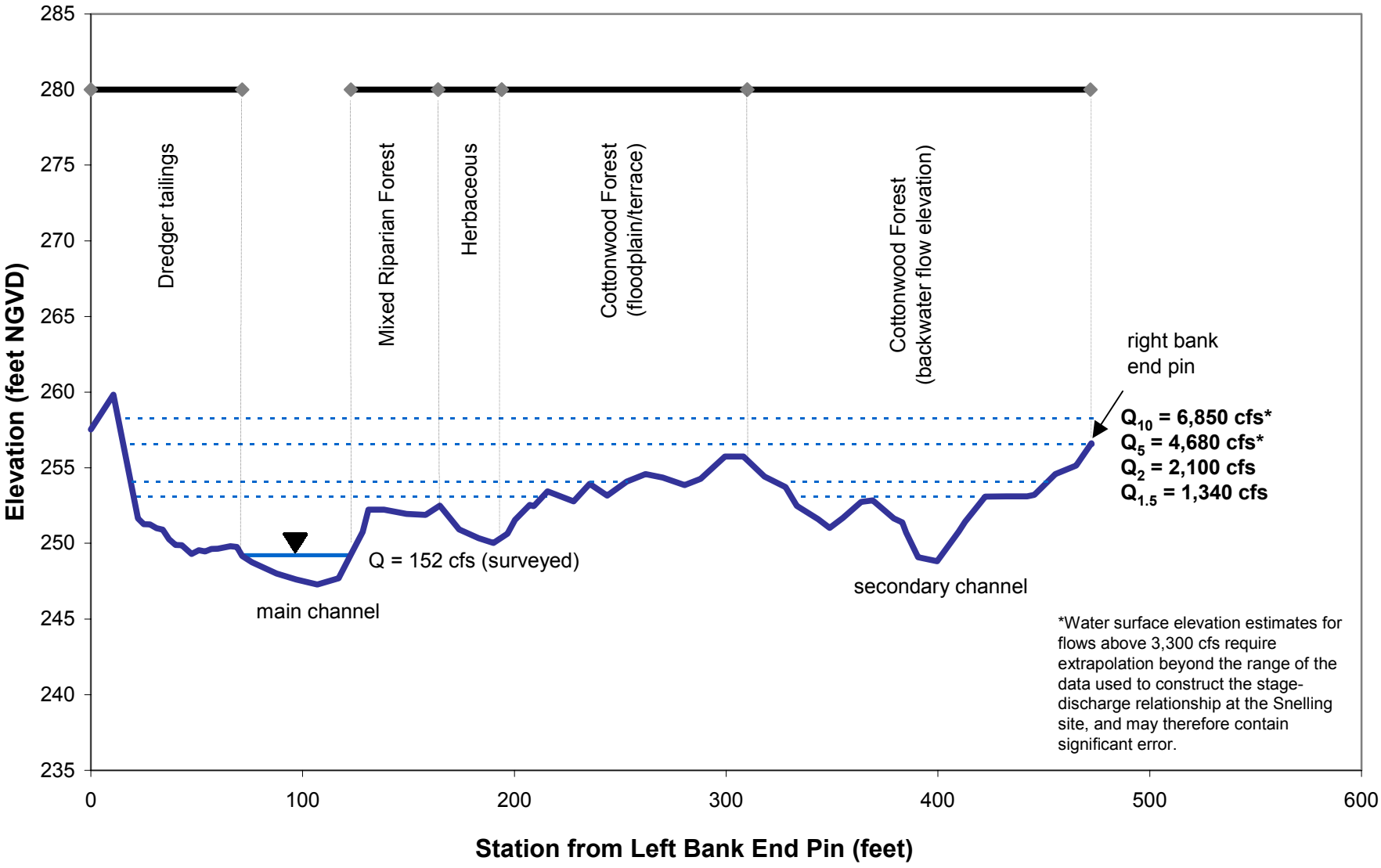


Figure B-11. Snelling Site vegetation cover and topographic cross section 9+60.

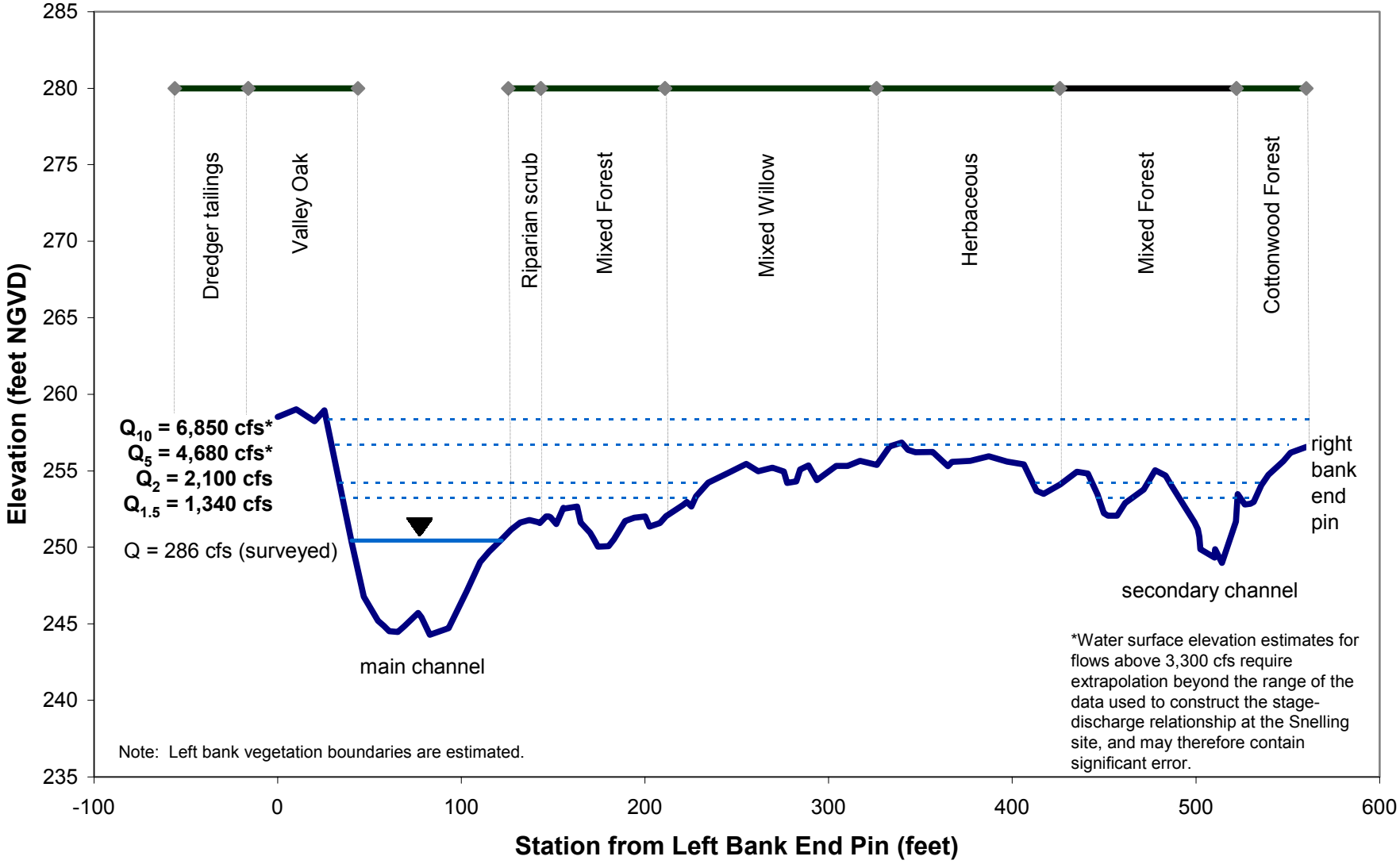
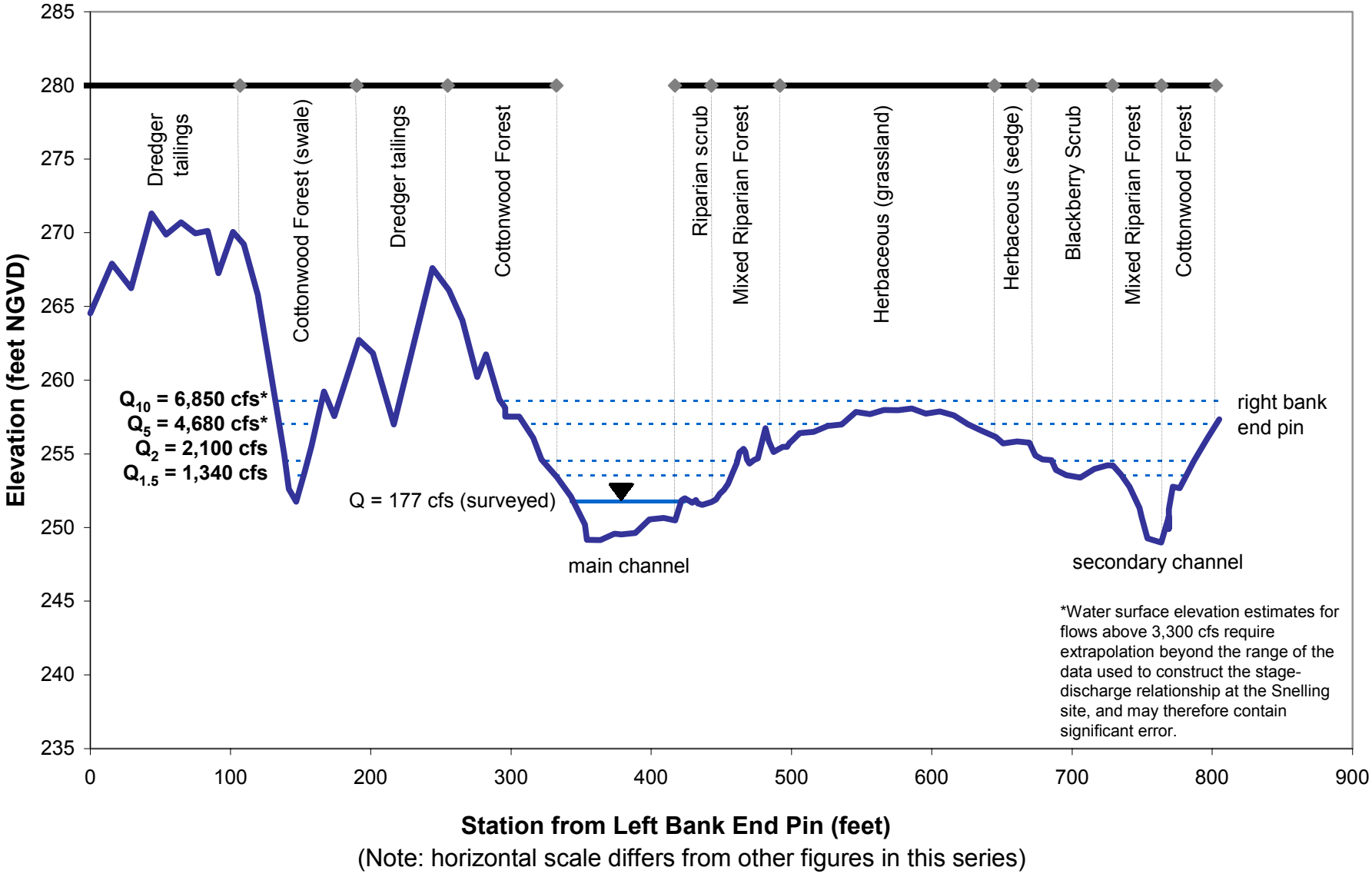


Figure B-12. Snelling Site vegetation cover and topographic cross section 10+80.



(Note: horizontal scale differs from other figures in this series)

Figure B-13. Snelling Site vegetation cover and topographic cross section 13+95.

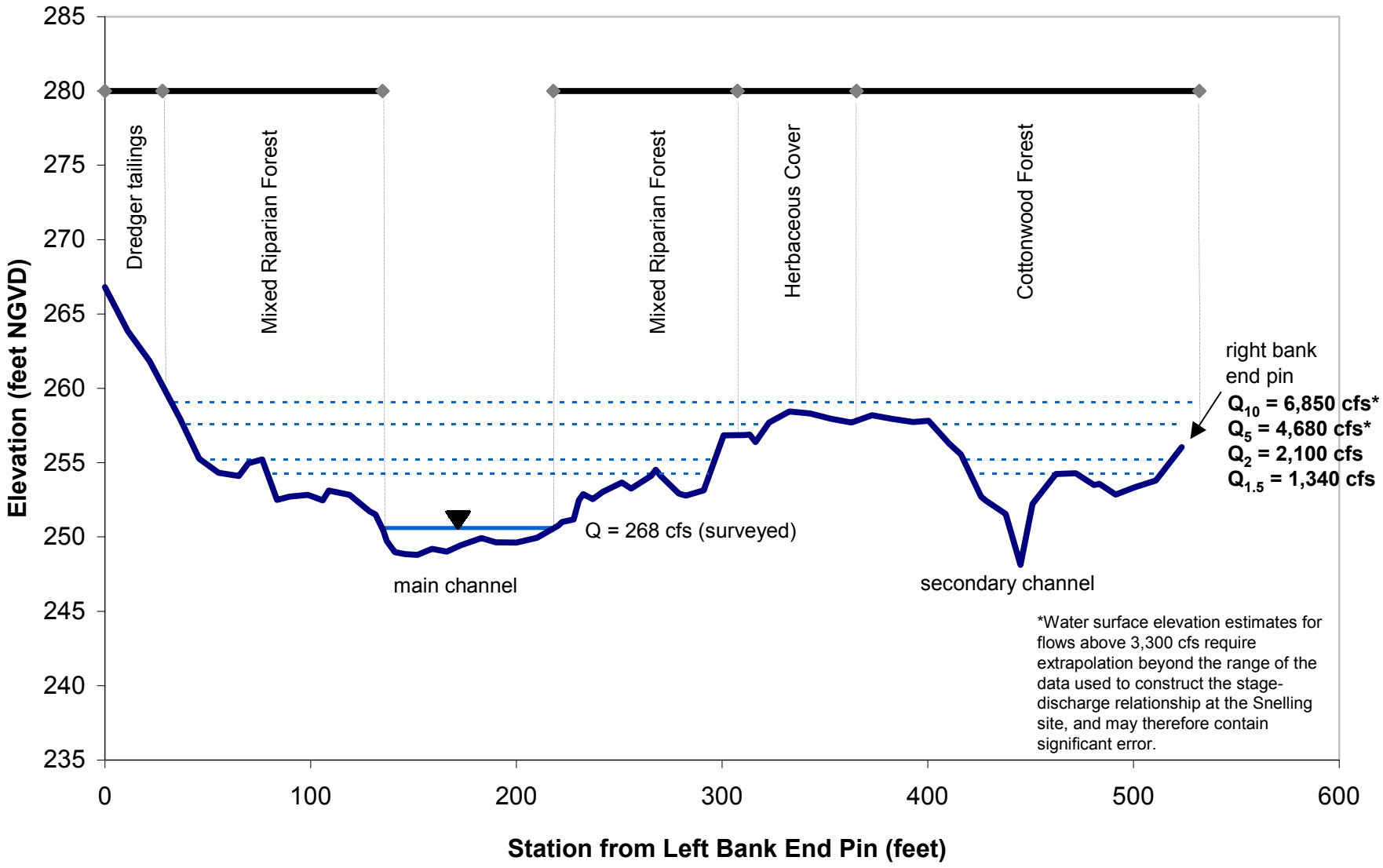


Figure B-14. Snelling Site vegetation cover and topographic cross section 17+75.

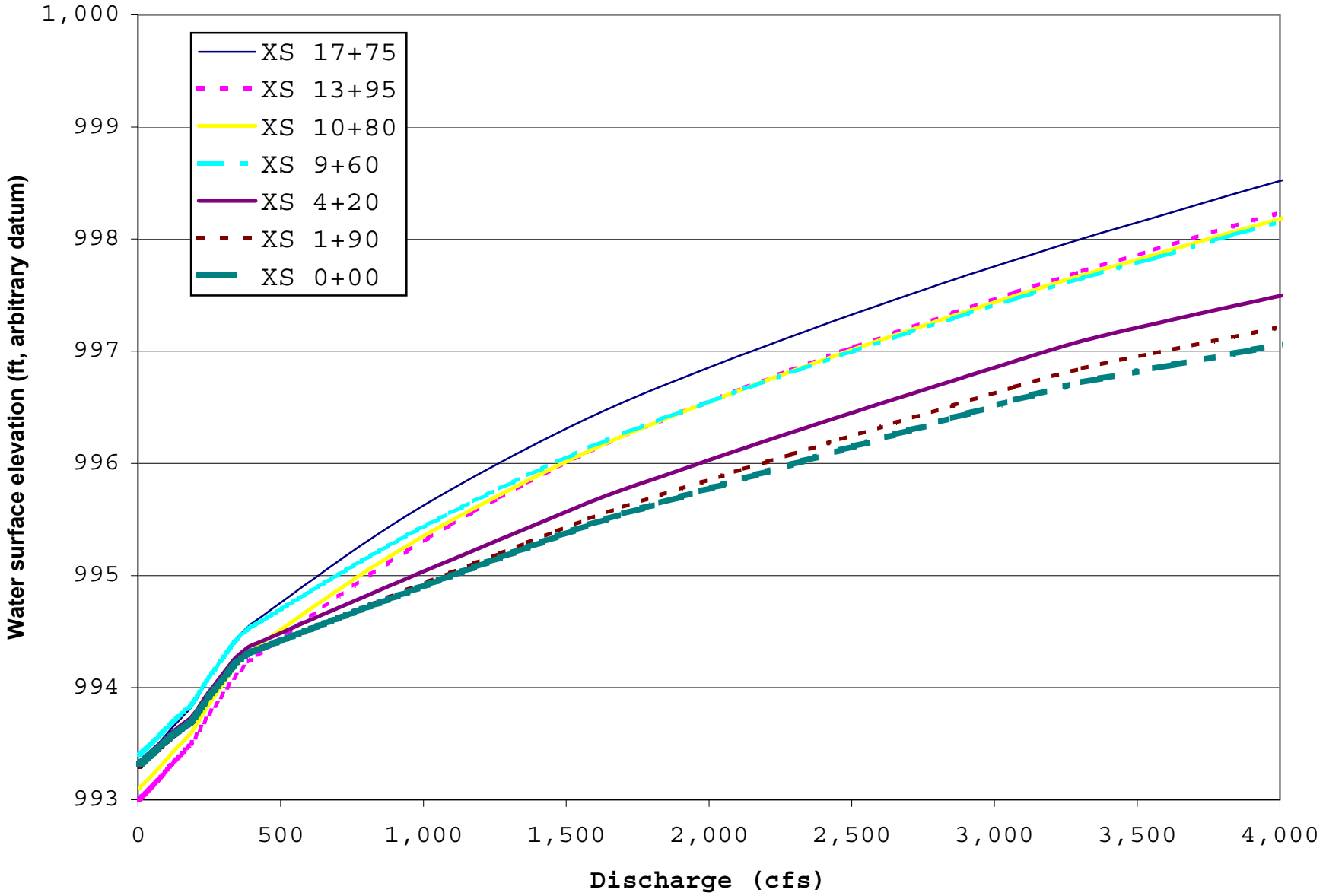


Figure B-15. Snelling model site rating curves.

Appendix C. Sediment Transport Modeling Description

The surface based bedload equation of Parker (1990a) was developed for wide rectangular channels for which channel geometry can be expressed as a channel width. Details of the surface based bedload equation of Parker can be found in the original references (Parker, 1990a,b). Here only the most essential part of the Parker equation is presented.

The surface based bedload equation of Parker (1990a) for a wide rectangular channel is as follows,

$$\frac{RgQ_G p_i}{Bu_*^3} = a F_i G\left(wf_{sgo}\left(\overline{D_i}/D_{sg}\right)^{-b}\right) \quad (1)$$

where R denotes the submerged specific gravity of gravel; g denotes the acceleration of gravity; Q_G denotes volumetric bedload transport rate; B denotes channel width; u_* denotes shear velocity; $\overline{D_i}$ denotes the mean grain size of the i-th subrange; p_i denotes the volumetric fraction of the i-th subrange in bedload; F_i denotes the volumetric fraction of the i-th subrange in the surface layer; D_{sg} denotes geometric mean grain size of the surface layer; ϕ_{sgo} is normalized Shields stress; ω is a function of the normalized Shields stress ϕ_{sgo} and the arithmetic standard deviation of the surface layer. Coefficients α and β are given as

$$a = 0.00218\,; \quad b = 0.0951 \quad (2a,b)$$

Grain size is described both in diameter and in ψ-scale (Parker, 1990b), which is the negative of the ϕ-scale,

$$y_i = -f_i = \ell og_2(D_i) \quad (3)$$

The grain size is divided into N subgroups bounded by N+1 grain sizes ψ_1 (D_1) to ψ_{N+1} (D_{N+1}). The mean grain size of the i-th subrange is then given as

$$\overline{y_i} = \frac{y_i + y_{i+1}}{2}, \quad \overline{D_i} = \sqrt{D_i D_{i+1}} \quad (4a,b)$$

The surface layer mean grain size $\overline{y_s}$ and standard deviation s_{sy} are as follows,

$$\overline{y_s} = \sum_{i=1}^{N} \overline{y_i} F_i\,, \quad s_{sy}^{\,2} = \sum \left(\overline{y_i} - \overline{y_s}\right)^2 F_i \quad (5a,b)$$

and the geometric mean grain size is given as

$$D_{sg} = 2^{\overline{y_s}} \quad (5c)$$

Note that only particles too coarse to be transported in suspension are included in the calculation. Parker suggested that the finest grain size (D_1) be set as 2 mm (Parker 1990a,b).

Parameter ω is a function of the normalized Shields stress ϕ_{sgo},

$$w = 1 + \frac{s_0}{s_{sy}}(w_0 - 1) \quad (6)$$

where σ_0 and ω_0 are functions of ϕ_{sgo} given in Figure 1 (Parker 1990a). Tabulated values of σ_0 and ω_0 are also given in Parker 1990b.

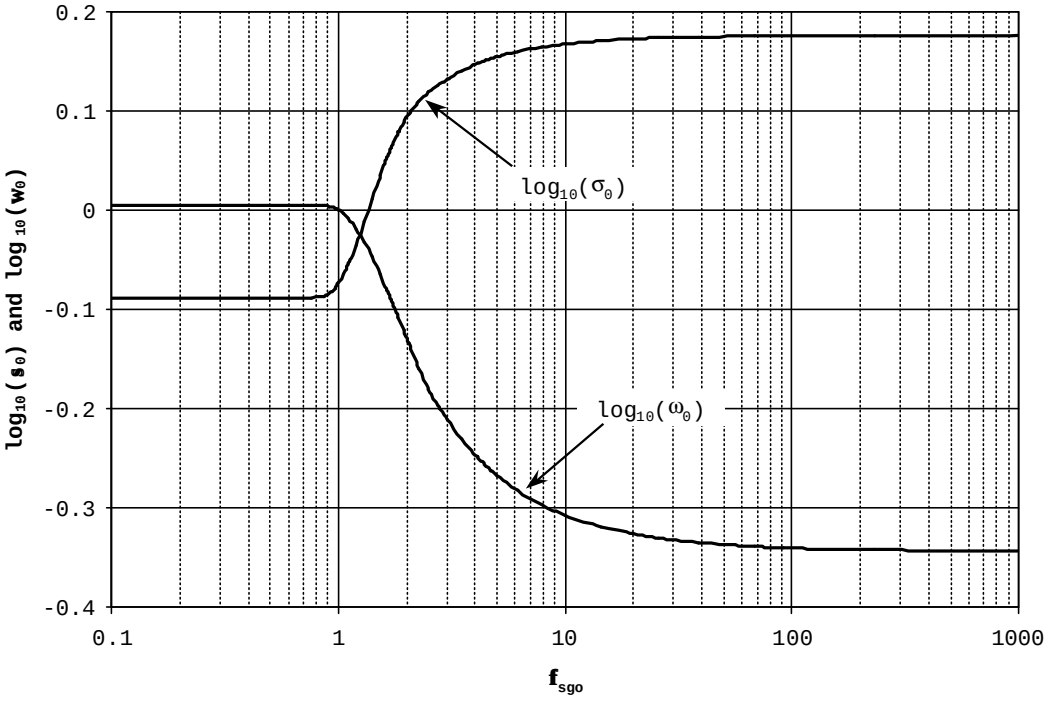


Figure 1. Parameters σ_0 and ω_0 as functions of ϕ_{sgo} in Parker equation

The normalized Shields stress ϕ_{sgo} is acquired by dividing the surface based Shields stress τ^*_{sg} by a reference stress τ^*_{rsgo},

$$f_{sgo} = \frac{\tau^*_{sg}}{\tau^*_{rsgo}} \tag{7}$$

where the reference Shields stress τ^*_{rsgo} is given by Parker (1990a) as 0.0386. The surface based Shields stress τ^*_{sg} is defined as

$$\tau^*_{sg} = \frac{u_*{}^2}{RgD_{sg}} \tag{8}$$

Shear velocity u^* is assumed to be the Keulegan resistance relation,

$$\frac{u}{u_*} = 2.5\ell n\left(11\frac{h}{k_s}\right) \tag{9}$$

in which u denotes flow velocity; h denotes water depth and k_s denotes roughness height. Roughness height is defined slightly differently from the original work of Parker (1990a,b) for simplicity,

$$k_s = 2D_{sg}\,\sigma_{sg}^{1.28} \tag{10}$$

where σ_{sg} denotes surface layer geometric standard deviation,

$$\sigma_{sg} = 2^{\sigma_{sy}} \tag{11}$$

Note that the roughness height given by Equation (10) is an approximation of the original value given by Parker (1990a,b), in which the roughness height was defined as twice of surface layer D_{90}.

In case of a normal flow, shear velocity u^* can be expressed as

$$u^* = \sqrt{ghS} \tag{12}$$

in which S is channel bed slope.

Function G is given by Parker (1990a,b) as

$$G(\phi) = \begin{cases} 5474\left(1-\dfrac{0.853}{\phi}\right)^{4.5} & \phi > 1.59 \\ \exp\left[14.2(\phi-1)-9.28(\phi-1)^2\right] & 1 \le \phi \le 1.59 \\ \phi^{14.2} & \phi < 1 \end{cases} \tag{13}$$

In case of an arbitrary cross section, the surface based bedload equation of Parker (Equation 1) and the Keulegan resistance relation (Equation 9) are modified as follows,

$$\frac{RQ_G p_i}{ASu_*} = \alpha F_i G\left(\omega\phi_{sgo}\left(\overline{D_i}/D_{sg}\right)^{-b}\right) \tag{14}$$

$$\frac{u}{u_*} = 2.5\ell n\left(11\frac{R_h}{k_s}\right) \tag{15}$$

where A denotes flow area; R_h denotes hydraulic radius of the flow,

$$R_h = \frac{A}{P} \tag{16}$$

and P denotes the wet perimeter of the channel.

References

Parker, G. 1990a. Surface-based bedload transport relation for gravel rivers. *Journal of Hydraulic Research*, IAHR, 28(4), 417-436.

Parker, G. 1990b. The "ACRONYM" series of PASCAL programs for computing bedload transport in gravel rivers. External Memorandum No. M-220, St. Anthony Falls Laboratory, University of Minnesota, Minneapolis, MN, February, 123p.

Appendix D. Marked Rock Recovery at the Snelling Site

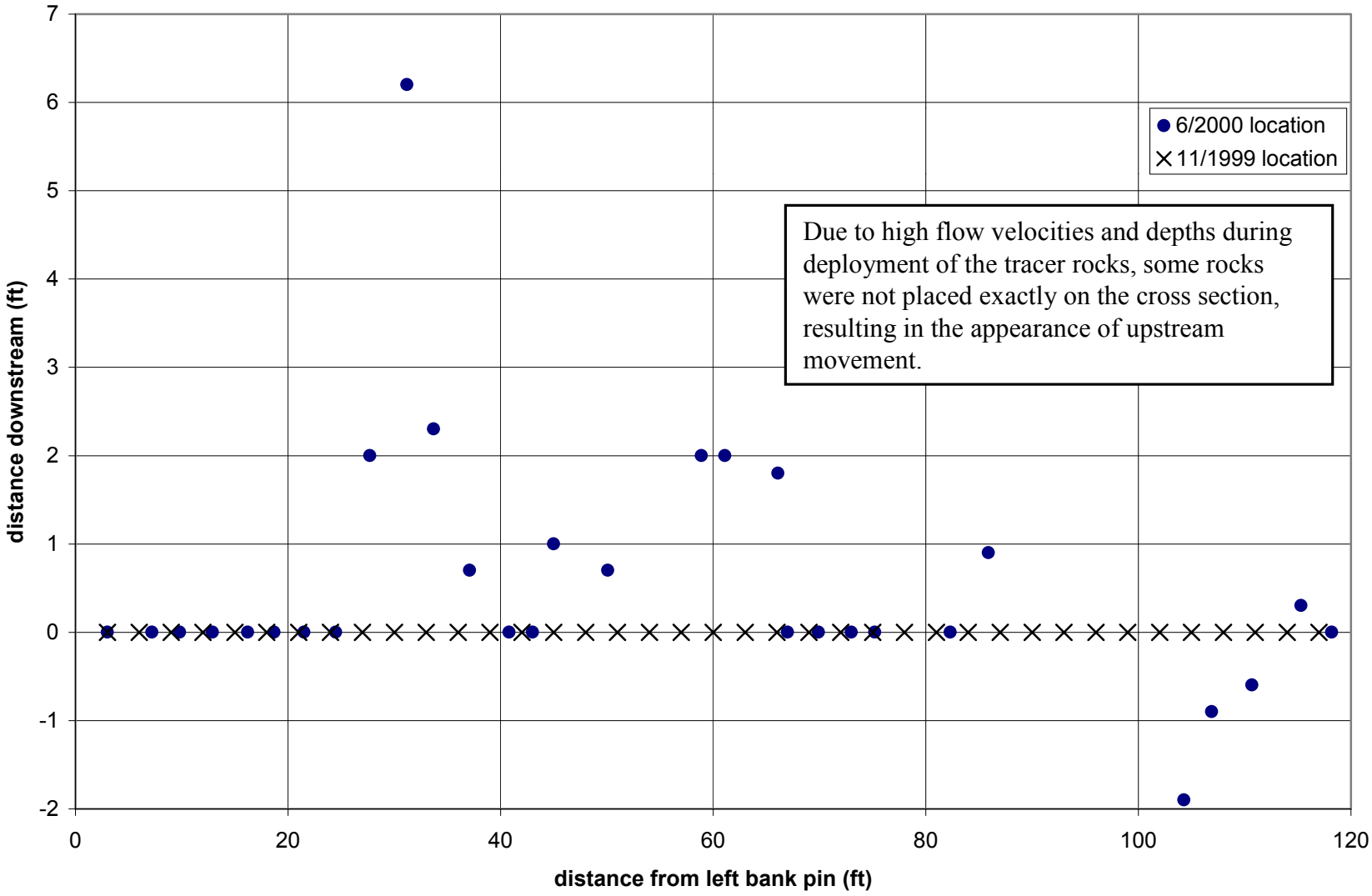


Figure D-1. Distance traveled downstream by marked rocks in Snelling Site cross section 1+90.

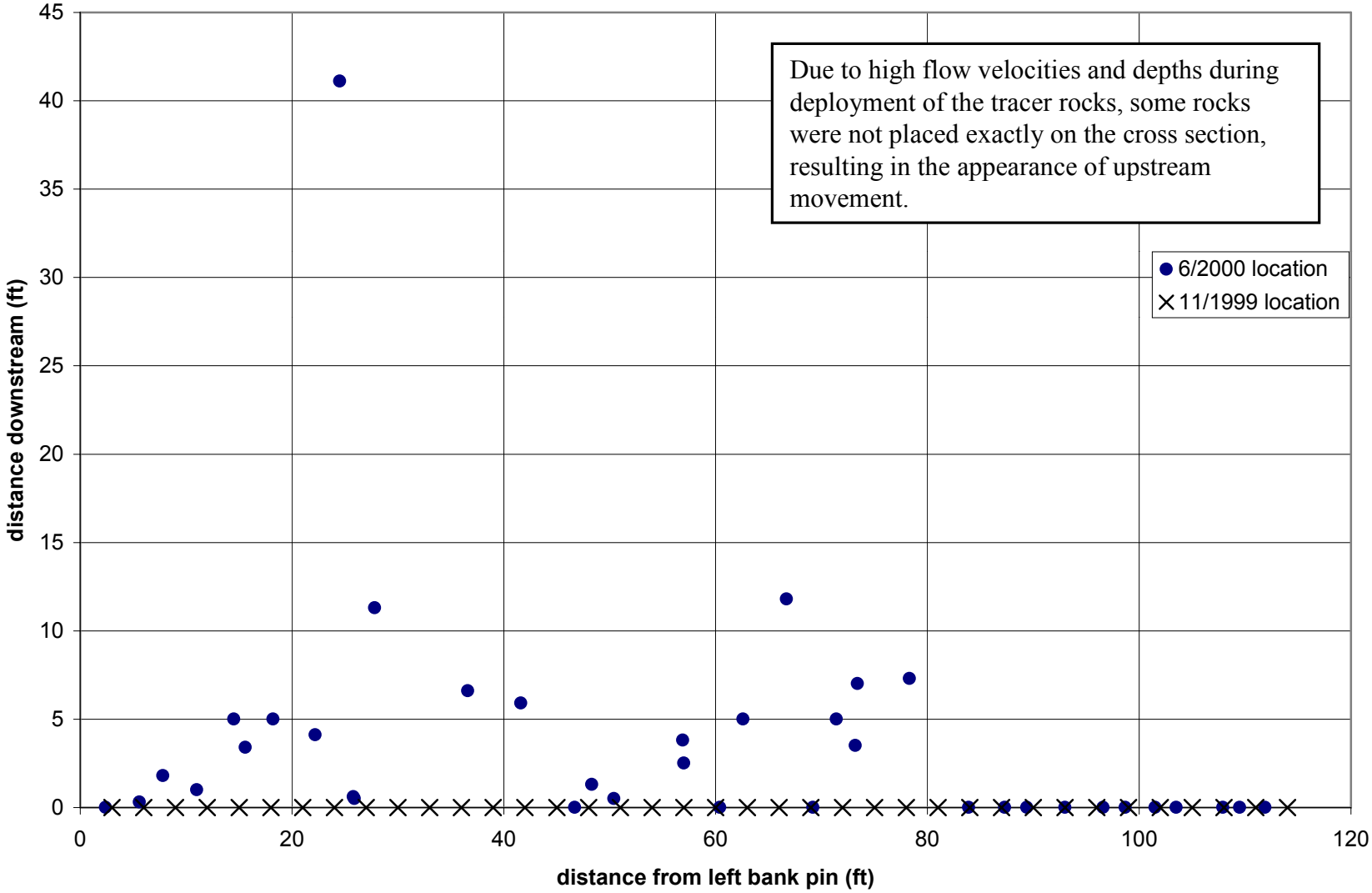


Figure D-2. Distance traveled downstream by marked rocks in Snelling Site cross section 4+20.

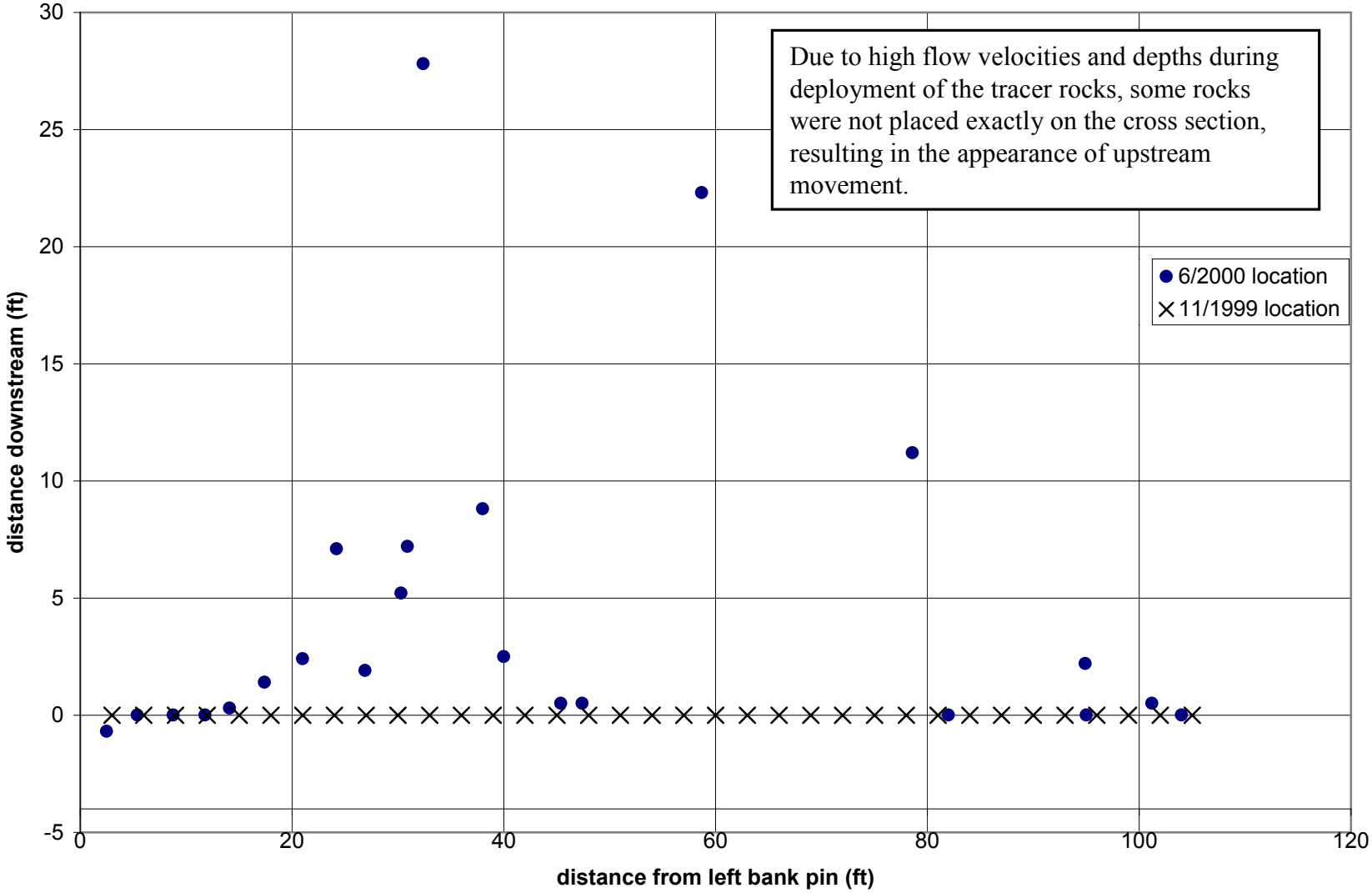


Figure D-3. Distance traveled downstream by marked rocks in Snelling Site cross section 9+60.

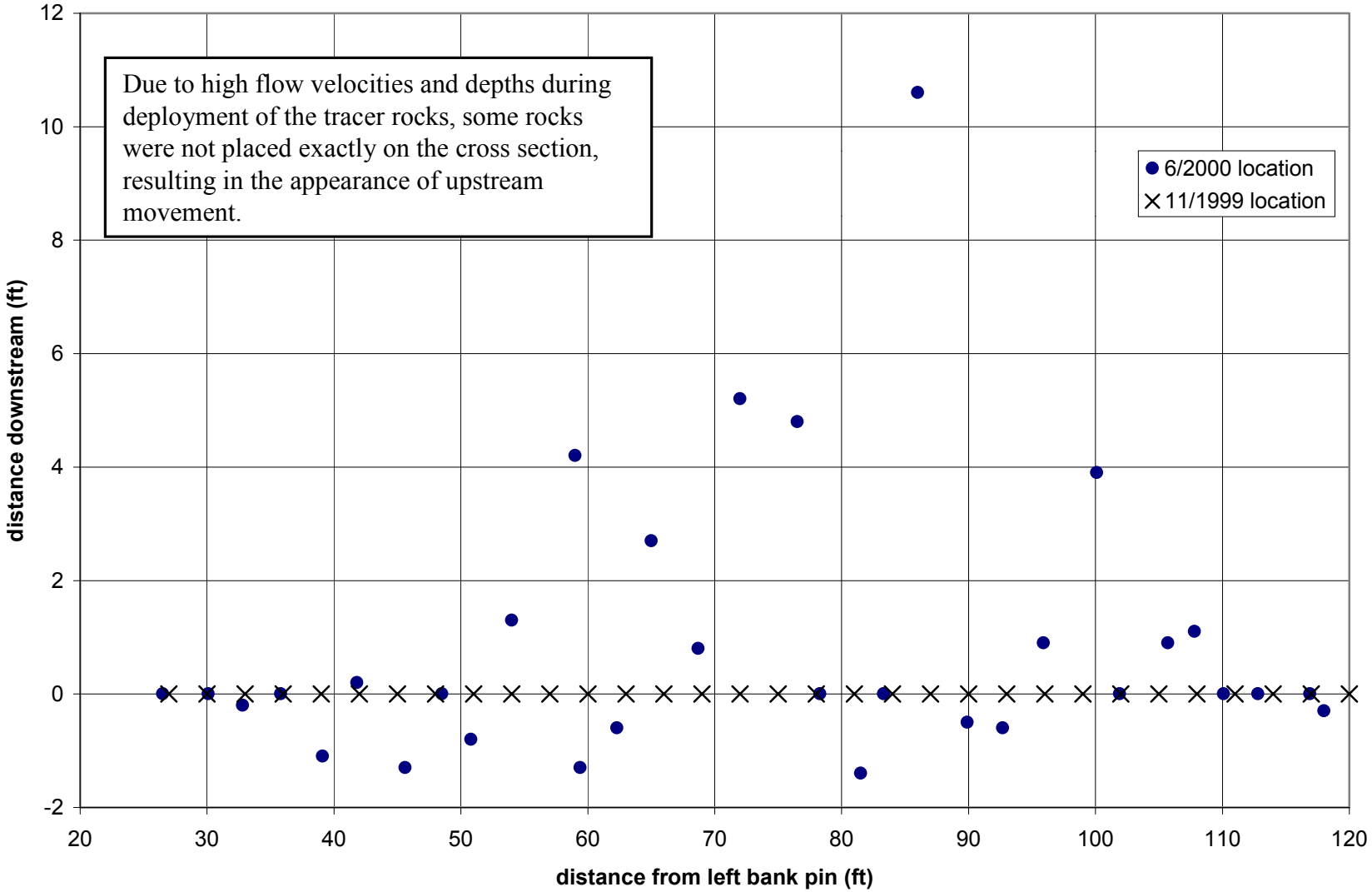


Figure D-4. Distance traveled downstream by marked rocks in Snelling Site cross section 13+95.

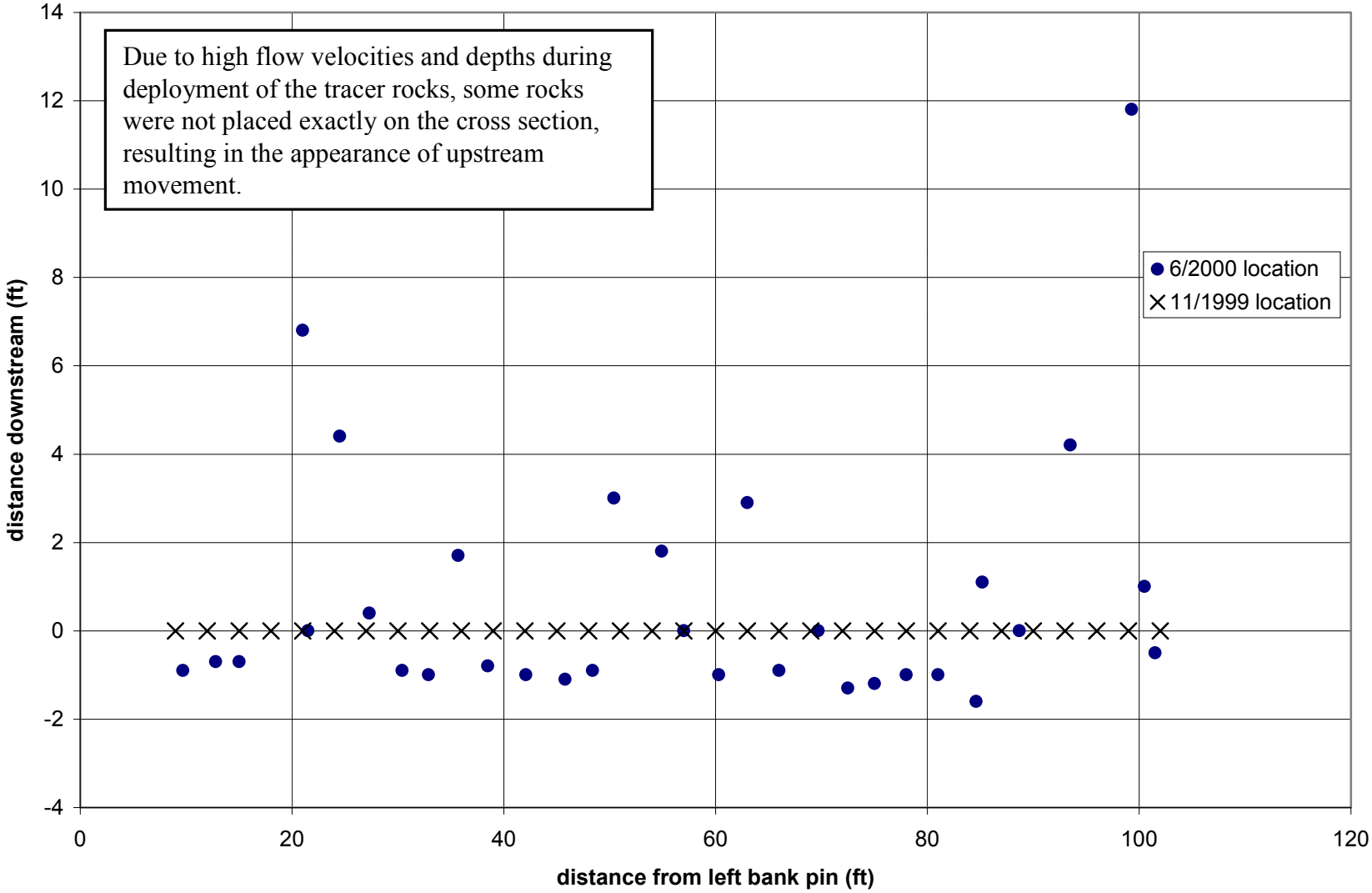


Figure D-5. Distance traveled downstream by marked rocks in Snelling Site cross section 17+75.

Appendix E. Vegetation Map Verification and Accuracy

This appendix summarizes the verification and accuracy issues encountered in developing the GIS riparian vegetation coverage for the Merced River. A description of the methods used and the resulting vegetation spatial analysis are presented in Section 6.1 of this report.

Map accuracy issues stem from the fact that it was not feasible to field-verify all vegetation polygons in the project GIS. Following interpretation and delineation of vegetation polygons from aerial photographs, a subset of polygons was field-checked by boat and land reconnaissance between Fall 1999 and Spring 2000. Because of time and logistic constraints, field verification by boat occurred only downstream of RM 34.5 (just upstream of Shaffer Bridge); consequently, vegetation maps were ground-truthed primarily in the lower half of the river corridor and most of the checked polygons were located adjacent or close to the river channels. Upstream portions of the river that were checked include public access points such as parks and bridges, and individual project study sites. A randomized polygon verification method was considered, but field logistic issues made that approach prohibitively difficult. Though the polygons verified were not distributed evenly throughout the corridor, the boat survey method that was adopted allowed a much higher number of polygons to be verified.

Accuracy and Cover Type

Of the 3,008 total polygons delineated for all fifteen cover classes, 693 were field-verified, representing an overall sampling rate of 23 percent (Table E–1). At least 15 percent of the total number of polygons for each vegetation cover type was verified, except for the Blackberry Scrub, Marsh, and Tamarisk cover types. Reasons for undersampling these cover types include low numbers of total polygons and lack of visibility during the boat surveys because of floodplain locations that were distant from the active channel. Dredger Tailing patches were not checked, and Disturbed Riparian patches were delineated in the field.

Photointerpretation accuracy for all classes except one ranged from 33 percent to 86 percent of all polygons checked, and averaged 64 percent across all vegetation cover types (Table E-1). During the field checking, 91 polygons were newly delineated to document small patches of non-native species or other vegetation. In calculating map accuracy, these polygons were classified separately from the originally delineated polygons because they were mapped at a finer resolution than intended for the original aerial photograph interpretation.

The greatest errors in cover type designations identified by the field-verification occurred for Mixed Willow and the non-native cover types. In the lower river (downstream of Shaffer Bridge), Mixed Willow patches were systematically misidentified as Cottonwood Forest because Fremont cottonwood and Goodding's black willow, a major component of mixed willow stands in the lower river had similar signatures. Spot observations upstream of Shaffer Bridge (where the boat surveys were not conducted) indicated that Goodding's black willow density is lower than in the downstream reaches, suggesting that the systematic cottonwood/willow photointerpretation error is not as great in the upper river. Also, Mixed Willow was difficult to distinguish in the field from Riparian Scrub due to significant overlap of species and similar canopy structure. In our vegetation classifications, the Mixed Willow cover type was assigned to patches that were exclusively willow, and Riparian Scrub was assigned to patches containing other species such as blue elderberry, mugwort, and non-willow riparian trees. In future mapping efforts, these two classifications should be merged because of the difficulty in distinguishing them in the field and from photographs.

Table E–1. Summary of Vegetation Polygon Accuracy

Cover Type	Number of Polygons Mapped[1]	Polygons Field-Checked		Polygons Correctly Interpreted		Number of New Polygons Delineated During Field Checking
		Number	Percent	Number	Percent [2]	
Vegetation Cover Type						
Blackberry Scrub	108	3	3	1	33	0
Box Elder	38	17	45	12	71	6
Cottonwood Forest	360	61	17	38	62	9
Eucalyptus	55	19	35	7	37	8
Giant Reed	59	19	32	10	53	7
Herbaceous Cover	348	64	18	55	86	7
Marsh	74	0	0	N/A[3]	N/A[3]	1
Mixed Riparian Forest	479	176	37	120	68	11
Mixed Willow	526	142	27	69	49	10
Riparian Scrub	483	92	19	69	75	8
Tamarisk	2	0	0	N/A[3]	N/A[3]	0
Tree of Heaven	17	4	24	0	0	10
Valley Oak Forest	416	96	23	64	67	14
Total Vegetation	**2,965**	**693**	**23**	**445**	**64**	**91**
Land Use Cover Type						
Disturbed Riparian[4]	12	N/A	N/A	N/A	N/A	0
Dredger Tailings	31	0	0	N/A[3]	100[5]	0

[1] Patch totals represent the minimum polygon count for each cover type, in which adjacent polygons of the same type were merged during data editing. The digital GIS coverage retains the unmerged polygon configuration, which has higher polygon counts for some cover types (but the same total area for each type), because accuracy assessment data stored as polygon attributes in the GIS would have been lost during the merging process.

[2] Percent correct is calculated as the number of polygons correctly interpreted divided by the number of polygons checked for each cover type. New polygons delineated from field visits were not included in these counts.

[3] No polygons of this cover type were field-verified during the formal accuracy assessment, although occurrences of tamarisk, dredger tailings, and marsh were mapped during earlier reconnaissance surveys.

[4] The Disturbed Riparian classification was added in the field as a land use cover type to comprise revetted banks and other highly modified environments with sparse to no plant cover. Existing polygons of other cover types were recoded to this type, as appropriate.

[5] Dredger Tailing polygons were not formally checked as part of the field verification process, but assumed photointerpretation accuracy is 100 percent because of the distinct photographic signature and the large polygon size (mean polygon size = 138 acres) within this cover type.

Of the four cover types dominated by non-native woody plants, Giant Reed was most successfully identified (53 percent) despite a very small average patch size (0.2 acres), because it had a distinctive infrared signature and grew in open areas. Eucalyptus was successfully identified in only 37 percent of cases and was often confused with Cottonwood Forest or Valley Oak Forest. None of the four field-checked Tree of Heaven stands were correctly identified.

This species had a patchy distribution and a similar infrared signature to other tall canopy species. Tamarisk polygons were rare (n=2), and only those patches identified in the field were mapped. The low accuracy of identifying these non-native vegetation types indicates that ground surveys are a better method than aerial photograph interpretation for mapping exotic species that occur in patchy and heterogeneous distributions, as found in the Merced River corridor.

Accuracy and Polygon Size

A major factor influencing map accuracy was the small size of many of the polygons delineated. Table E–2 shows mean, maximum, minimum patch size for each cover type. For two thirds of the cover types, average area was less than one acre, which is smaller than many comparable remote sensing efforts.

Table E–2. Merced River Vegetation Map Patch Summary

Cover Class	Cover Type Dominated by Native Species?	Number of Patches[1]	Total Area (acres)	Percent of Vegetation Total by Area	Mean Patch Size (acres)	Median Patch Size (acres)	Max Patch Size (acres)	Min Patch Size (acres)
Vegetation Cover Type								
Blackberry Scrub	Partly	108	48	1	0.4	0.3	4.9	< 0.1
Box Elder	Yes	38	19	<1	0.5	0.3	3.9	0.1
Cottonwood Forest	Yes	360	437	11	1.2	0.5	24.4	< 0.1
Eucalyptus	No	55	46	1	0.8	0.5	4.6	< 0.1
Giant Reed	No	59	12	<1	0.2	0.1	2.0	< 0.1
Herbaceous Cover	No	348	1,363	35	3.9	0.7	149.5	< 0.1
Marsh	Yes	74	65	2	0.9	0.5	5.8	< 0.1
Mixed Riparian Forest	Yes	479	880	22	1.8	0.7	84.2	< 0.1
Mixed Willow	Yes	526	404	10	0.8	0.4	10.4	< 0.1
Riparian Scrub	Yes	483	297	8	0.6	0.4	8.4	< 0.1
Tamarisk	No	2	0.4	0	0.2	0.2	0.3	< 0.1
Tree of Heaven	No	17	10	<1	0.6	0.3	1.8	< 0.1
Valley Oak Forest	Yes	416	342	9	0.8	0.3	27.3	< 0.1
Total		**2,965**	**3,923**	**100**				
Other Cover Type								
Disturbed Riparian	No	12	19		1.6	0.3	12.8	0.1
Dredger Tailings	No	31	4,308		138	4.3	665	< 0.1
Total		**43**	**4,327**					

[1] Patch totals represent the minimum polygon count for each cover type, in which adjacent polygons of the same type were merged during data editing. The digital GIS coverage retains the unmerged polygon configuration, which has higher polygon counts for some cover types (but the same total area for each type), because accuracy assessment data stored as polygon attributes in the GIS would have been lost during the merging process.

Mapping accuracy for the Merced River vegetation coverage was positively correlated with polygon size. Non-parametric statistical analyses[a] demonstrate that correctly interpreted polygons were significantly larger than misidentified ones ($p < 0.01$) and that polygon size threshold occurred for photointerpretation accuracy. For polygons 1.5 acres or larger, accuracy

[a] The field verification results were analyzed using non-parametric logistic regression. Size distributions for correctly versus incorrectly interpreted polygons were compared using a Kolmagorov-Smirnov goodness-of-fit test.

averaged at least 75 percent across all vegetation cover types; for polygons less than one acre, accuracy was 60 percent or less. Implications for map accuracy are that many smaller polygons may be misidentified, reducing the accuracy calculation on a per-polygon basis (averaging 64 percent for all cover types). On an area basis, however, accuracy of the Merced River coverage is expected to be higher because larger polygons were generally interpreted more accurately.

In many remote sensing efforts, a minimum mapping unit or lower size threshold for polygons is determined prior to mapping; this threshold is typically one acre or larger for upland areas. A minimum mapping unit was not set *a priori* for the Merced River vegetation coverage. Riparian zones are often more highly heterogeneous landscapes than upland areas, with steep environmental gradients that shape vegetation stand composition and structure. The resulting riparian mosaic is typically composed of many small, irregularly-shaped vegetation stands, often less than an acre in area. Furthermore, specific project objectives included mapping non-native plants and identifying vegetation cover types that were associated with geomorphic surfaces. These patches often comprised very small areas, and as a result many polygons smaller than one acre were delineated on the vegetation coverage.

Although there were some accuracy issues associated with particular cover types and polygon size, many of the problems were corrected in the final version or otherwise adjusted during field checking. The final vegetation maps are considered to be a reliable and appropriate tool for natural resource planning and management within the Merced River corridor.

Appendix F. Cover Type Descriptions

This appendix describes floristic, structural, and ecological characteristics of the 15 mapped vegetation cover types, 13 vegetation categories and two additional land use cover type (Disturbed Riparian and Dredger Tailings). The distribution of these vegetation cover types in the Merced River corridor is illustrated in Figures 6.1–1 A–D and discussed in Section 6.1 of the report.[a]

Box Elder

Box elder (*Acer negundo*), a common component of the subcanopy in Mixed Riparian Forest, also occurs in nearly monospecific forest stands lacking any significant contribution by other tree species. The canopy layer in these stands typically ranges from 25 to 40 ft in height. Blue elderberry (*Sambucus mexicana*) and California wild grape *(Vitis californica*) commonly occur in the shrub and vine layers, respectively. A similar Box Elder vegetation type has been observed and mapped on the Tuolumne River (McBain & Trush 2000). These box elder dominated stands share some characteristics with both the Great Valley Cottonwood Riparian Forest (element code 61410) and Great Valley Mixed Riparian Forest (element code 61420) plant communities described by Holland (1986).

The Box Elder vegetation type occurs in scattered locations along the Merced River corridor, becoming more common in the lower river (Encroached Reach and Confluence Reach) where it is typically interspersed with the more common Mixed Riparian Forest, Valley Oak Forest, and Herbaceous Cover vegetation types. The Box Elder type is uncommon, and represents less than one percent of the vegetation mapped. Thirty-eight patches (or stands) of Box Elder, covering a total of 19 acres, were mapped in the Merced River corridor. Patch sizes ranged from 0.1 to 3.9 acres, with an average size of 0.5 acres.

Box Elder stands were best delineated during field surveys. Our ability to accurately map this vegetation type from aerial photographs was limited by the relatively small size of most of these stands and the variation in the photographic signature of this type, which was caused largely by grape vines overgrowing box elder in many stands. In future landscape-level mapping efforts based on remote imagery it would probably be advisable to aggregate this vegetation type with Mixed Riparian Forest. It may be desirable, however, to identify and map Box Elder stands based on field surveys for site-specific restoration and management planning efforts.

Blackberry Scrub

This vegetation type includes any patch that has greater than 50 percent cover of blackberry species (*Rubus* spp.). Typically, patches mapped as Blackberry Scrub consist of dense, monospecific thickets of the non-native Himalaya berry (*R. discolor*). A sparse ground layer of non-native or native grasses and forbs is sometimes present. In some cases, the native California blackberry (*R. ursinus*) may be present as a co-dominant or minor component, but this species occurs more commonly as an understory species in undisturbed riparian forest stands, especially Mixed Riparian Forest. The Blackberry Scrub cover type has no clear affinity to any of the plant communities or vegetation series described by Holland (1986) or Sawyer and Keeler-Wolf (1995). Similar vegetation patches dominated by Himalaya berry have been documented on the Tuolumne River (McBain & Trush 1998).

[a] Patch totals cited in the cover type descriptions represent the minimum polygon count for each cover type, in which adjacent polygons of the same type were merged during data editing. The digital GIS coverage retains the unmerged polygon configuration, which has higher polygon counts for some cover types (but the same total area for each type), because accuracy assessment data stored as polygon attributes in the GIS would have been lost during the merging process.

This cover type occurs at various elevations from the channel edge to current terrace surfaces and patches dominated by Himalaya berry are associated more with human disturbance such as levees, roads and revetted banks rather than any specific hydrologic regime. One hundred eight patches of Blackberry Scrub, covering a total of 48 acres, were mapped in the Merced River corridor. Patch sizes ranged from less than 0.1 to 4.9 acres, with an average patch size of 0.4 acres. Control of the invasive, non-native Himalaya berry is an important management consideration; the species is listed as a widespread, aggressively invading pest plant of great ecological concern (list A-1) by the California Exotic Pest Plant Council (CalEPPC 1999). If unchecked, Himalaya berry can severely limit the growth of other plants, displace native species, and prevent river access by humans and wildlife (Bossard et a. 2000).

Cottonwood Forest

Cottonwood Forest is a multilayered riparian forest type. Fremont cottonwood is the dominant overstory forming species, commonly reaching heights of 75 feet or more. Goodding's black willow (*Salix gooddingii*) is often a co-dominant tree in the overstory canopy layer. The subcanopy layer may include various willow species, box elder, or Oregon ash (*Fraxinus latifolia*). The shrub layer typically includes various willows, California wild grape, and California wild rose (*Rosa californica*) while the ground layer varies from sparse to lush with a mixture of native and non-native grasses and forbs. This type best matches the Great Valley Cottonwood Riparian Forest (element code 61410) described by Holland (1986) and the Fremont cottonwood series described by Sawyer and Keeler-Wolf (1995).

Most existing stands of cottonwood in the study area are mature and available evidence suggests that new stands are not generally being created under existing conditions. Most of these mature stands occur on abandoned floodplain sites or in low-lying areas in dredger tailings, which they appear to have colonized soon after the original disturbance For example, examination of 1937 aerial photographs show fresh dredger tailings with little vegetation in the vicinity of Snelling Road adjacent to somewhat older tailings that been colonized by cottonwoods and willows; these same tailings now support mature stands of Fremont Cottonwood Forest with a fairly uniform age structure and little evidence of recent successful establishment of cottonwoods. Cottonwood seedlings are commonly observed in the spring and summer along alluvial bars, but most seedlings die from scour or inundation during the following winter (see Section 6.5). Successful establishment of cottonwoods past the seedling stage appears to be a very infrequent event, although it appears that high flow events in 1997 led to successful establishment of seedlings in some "safe sites" along the river where they were protected from subsequent scour.

Cottonwood Forest commonly intergrades with Mixed Willow at lower elevations near the active channel and with Valley Oak Forest at higher elevation sites. It may also intergrade with Mixed Riparian Forest. Cross section surveys at the Snelling site indicates that mature Cottonwood Forest stands tend to occur on higher elevation, less frequently inundated sites than adjacent Mixed Riparian Forest stands. Observations elsewhere along the Merced River, however, suggest that Mixed Riparian Forest stands may commonly occur at higher elevations than adjacent stands of Cottonwood Forest (which matches the elevational relationship between Great Valley Cottonwood Riparian Forest and Mixed Riparian Forest as described by Holland (1986)).

A total of 360 patches of Cottonwood Forest, covering 437 acres, were mapped in the Merced River corridor. Patch sizes ranged from less than 0.1 to 24.4 acres, with an average patch size of 1.2 acres. Cottonwood Forest was the fourth most common cover type mapped (after Dredger Tailings, Herbaceous Cover, and Mixed Riparian Forest). Historically, this vegetation type was

much more extensive and the historical average patch size likely exceeded the current maximum patch size of 24 acres.

Disturbed Riparian

Disturbed Riparian is a generalized land cover type used for convenience to represent areas adjacent to the river that have been heavily disturbed by human land use practices and currently support sparse vegetation. Revetted banks are a primary example of sites that were mapped as this cover type, but agricultural fields and orchards, gravel mines, dredger tailings, or other large-scale land uses are not included. Twelve patches of Disturbed Riparian vegetation, covering a total of 19 acres, were mapped in the Merced River corridor. Patch sizes ranged from 0.1 to 12.8 acres, with an average patch size of 1.6 acres.

Dredger Tailings

Dredger Tailings is a generalized land cover type used for convenience in mapping to represent the complex matrix of vegetation patches found in floodplain areas that were used for dredger mining. The dredger tailings consist of piles of cobbles and boulders that were excavated from the Merced River during gold mining earlier in the Twentieth Century. Sparse cover of weedy, non-native annual grasses and forbs grows on the dredger tailings in some areas, but the general lack of soil and available moisture on the tailings greatly limits the establishment of vegetation. Some native annuals, such as common madia (*Madia elegans* ssp. *densifolia*), may be relatively common on some tailings. The vegetation typically observed on the dredger tailings represents a sparse and generally depauperate form of the Non-Native Grassland (element code 42200) described by Holland (1986).

Low-lying areas within the tailings are often connected to a perennial or seasonal groundwater supply and support a variety of wetland vegetation types (primarily freshwater emergent marsh, seasonal wetland, open water/ponds, mixed willow, cottonwood forest). Most of the smaller and/or linear patches of riparian scrub and forest are dominated by Fremont cottonwood, Goodding's black willow, and arroyo willow (*Salix lasiolepis*). Narrow-leaved, and red willows (*Salix exigua* and *S. laevigata*), edible fig (*Ficus carica*), California buckeye (*Aesculus californica*), and California wild grape are common associated species. These patches of riparian vegetation found in the tailings grade between the Great Valley Cottonwood Forest (element code 61410) and Great Valley Willow Scrub (element code 63410) communities described by Holland (1986). In the deeper swales and wetter sites, this riparian scrub/forest occurs as a band around lower elevation emergent wetlands and/or ponds. The introduced edible fig is an occasional associated species in these patches of riparian scrub or forest vegetation.

Perennial ponds are also included within the Dredger Tailings cover type. These ponds typically support floating plants, such as various duckweeds (*Lemna* and *Wolfiella*) and water fern (*Azolla filiculoides*). The introduced water hyacinth (*Eichornia crassipes*) also occurs in some ponds. Many of the ponds also contain beds of submergent macrophytes, primarily Brazilian waterweed (*Egeria densa*). Two species of floating-leaved macrophytes, pondweed (*Potamogeton* sp.) and watershield (*Brasenia schreberi*), were also noted. Marsh pennywort (*Hydrocotyle* spp.) forms dense beds in some shallower ponds.

Data collected during a biological survey and wetland delineation (Stillwater Sciences 1999) of a 137-acre dredger tailings site near the State Route 59 bridge can be used to provide a general idea of the relative abundance of different vegetation and habitat types within the areas classified as Dredger Tailings. Most of this site was mined during the 1930s. Tailing piles with no vegetation or sparse annual vegetation of mainly non-native forbs and grasses cover approximately 80

percent of the site. Cottonwood Forest and Mixed Willow vegetation (with a few patches of Mixed Riparian Forest and Valley Oak Forest also included) cover roughly 15 percent of the study site. The remaining area contains Marsh vegetation and open water (pond) habitats.

Thirty-one Dredger Tailings patches, covering 4,308 acres, were mapped in the Merced River corridor. Patch sizes ranged from less than 0.1 to 665 acres, with an average patch size of 138 acres. This was the most common cover type mapped, accounting for 52 percent of the vegetation/land cover mapping area.

Eucalyptus

This non-native vegetation type includes stands in which introduced *Eucalyptus* species dominate the tree overstory layer. The Eucalyptus vegetation type is most common on Dry Creek and along the Merced River just upstream of the confluence with Dry Creek. Individual eucalyptus trees were observed both along the margins of the active channel and on former floodplains. Fifty-five Eucalyptus patches, covering a total of 46 acres, were mapped in the Merced River corridor. Patch sizes ranged from less than 0.1 to 4.6 acres, with an average patch size of 0.8 acres.

Eucalyptus trees are non-native species considered to be moderately invasive (Randall et al. 1998, Dudley and Collins 1995). Evidence from field surveys and aerial photograph analysis suggest that the extent of this non-native vegetation type has been expanding in recent years. Eradication or control of eucalyptus species is an important management consideration. *E.* globules, the most common species, is listed as a widespread, aggressively invading pest plant of great ecological concern (list A-1) by the California Exotic Pest Plant Council (CalEPPC 1999). Ecological problems related to eucalyptus invasion include loss of biological diversity due to displacement of native plant communities and corresponding wildlife habitat, the loss of understory species because of allelopathic (chemical) inhibition from litter, and high fire danger due to large, volatile fuel loads (Bossard et a. 2000).

Giant Reed

This vegetation type includes any vegetation stand or patch dominated by giant reed (*Arundo donax*). It occurs in relatively small patches scattered in disturbed sites throughout the Merced River corridor. Giant Reed was most commonly observed on revetted banks along Gravel Mining 2 Reach from RM 32.5 to 26.8, but small patches occurred in all reaches. A total of 59 polygons covering 12 acres were mapped in the corridor. The majority of these were small patches that were mapped from field observations taken during the accuracy assessment and other field survey efforts.

Although the current extent of this non-native species along the Merced River appears limited compared to many Central Valley rivers and streams (EPA/SFEI 1999), this species is generally considered to be highly invasive. Eradication or control of this species is an important management consideration; the species is listed as a widespread, aggressively invading pest plant of great ecological concern (list A-1) by the California Exotic Pest Plant Council (CalEPPC 1999). Where it becomes widely established, giant reed displaces native plants and associated wildlife, including special status species. It provides less in-stream shade, less forage for insect populations, and greater fire danger than native riparian species. In some ecosystems it is also suspected of altering hydrologic regimes and lowering groundwater availability because of its high transpiration rate (Bossard et a. 2000).

Herbaceous Cover

This type is most commonly found on sites with poorly developed and well-drained soils, such as abandoned bars with coarse substrate and some terraces. This type represents a classification of convenience for mapping and includes a variety of vegetation series and associations, which are primarily dominated by non-native grasses and forbs. Lower elevation sites near the river that experience seasonal inundation or saturated soils may be dominated by sedges and grasses, while drier, higher elevation terrace or abandoned floodplain sites in this category may be dominated by non-native forbs and grasses, including black mustard (*Brassica nigra*), poison hemlock (*Conium maculatum*), yellow starthistle (*Centaurea solstitialis*), and ripgut brome (*Bromus diandrus*).

A total of 348 Herbaceous Cover patches, covering a total of 1,363 acres, were mapped in the Merced River corridor. Patch sizes ranged from less than 0.1 to 150 acres, with an average patch size of 3.9 acres. This was the second most abundant cover type mapped (Dredger Tailings was the most common type).

Marsh

This vegetation type includes emergent freshwater marsh and associated seasonal wetland habitats. Persistent emergent wetlands dominated by cattails (*Typha latifolia* in wetter sites, and *T. angustifolia* in drier or more seasonal wetland sites) or tules (*Scirpus acutus*) are relatively common components of the larger persistent emergent wetland patches. An introduced yellow iris *(Iris pseudacorus*) also occurs in some persistent emergent wetland patches. This vegetation type generally matches Holland's Coastal and Valley Freshwater Marsh community (element code 52410). In the wettest sites, these persistent emergent wetlands occur around the margins of non-persistent emergent wetlands or open water perennial ponds. The non-persistent emergent wetlands are dominated by waterpepper (*Polygonum hydropiperoides*), bur-marigold (*Bidens laevis*), and water primrose (*Ludwigia repens*), with common cocklebur (*Xanthium strumarium*), nutsedge (*Cyperus eragrostis*), and rabbitsfoot grass (*Polypogon monspeliensis*) as common associated species. This vegetation type seems to be a variant of the Vernal Marsh community (element code 52500) described by Holland (1986). Small patches of open water ponds may also be included in the Marsh vegetation type (see description of pond habitats and associated plant species under the Dredger Tailings description).

Seventy-four Marsh patches, covering a total of 65 acres, were mapped in the Merced River corridor. Patch sizes ranged from less than 0.1 to 5.8 acres, with an average patch size of 0.9 acres. Additional patches of Marsh vegetation are included within the Dredger Tailings cover type.

Mixed Riparian Forest

Mixed Riparian Forest includes stands dominated by three or more hardwood species. Species composition varies, but common co-dominants include Oregon ash, white alder (*Alnus rhombifolia*), box elder, valley oak (*Quercus lobata*), and various willows. The canopy layer typically reaches 40 to 50 feet in height.

Mixed Riparian Forest typically occupies one of two positions along the standard toposequence. Patches typically dominated by white alder and Oregon ash, and often with California button willow (*Cephalanthus californica*) present in the understory occur at lower elevation sites where they typically intergrade with Riparian Scrub, Mixed Willow, and the active channel. Other patches (typically dominated by box elder and valley oak) occur at higher elevation sites where they intergrade primarily with Valley Oak Forest and Herbaceous Cover vegetation types. The Cottonwood Forest type typically occupies elevational positions intermediate between these two variants of the Mixed Riparian Forest type. California buckeye occurs in some of the higher

elevation patches in the upstream reaches. Non-native species that are commonly associated with the subcanopy or shrub layers of this vegetation type include London plane tree (*Platanus* x *acerifolia*), edible fig, tree of heaven, (*Ailanthus altissima*), pokeweed (*Phytolacca americana*), and mulberry (*Morus alba*).

A total of 479 patches (or stands) of Mixed Riparian Forest, covering 880 acres, were mapped in the Merced River corridor. Patch sizes ranged from less than 0.1 to 84 acres, with an average patch size of 1.8 acres. Mixed Riparian Forest was the third most common cover type mapped (after Dredger Tailings and Herbaceous Cover). Historically, more extensive stands of Mixed Riparian Forest were present in the Merced River corridor. In contrast, the current distribution is highly fragmented and greatly reduced.

Mixed Willow

Mixed Willow vegetation includes stands dominated almost entirely by willow species, particularly narrow-leaf willow, Goodding's black willow, and arroyo willow. The Mixed Willow vegetation type includes much variation in relative abundance and structure among patches. In general, Goodding's black willow and arroyo willow tend to dominate the overstory canopy, which reaches average heights of 20 to 35 feet. Narrow-leaf willow is often the most common component of the shrub layer, and it also contributes to the subcanopy or canopy layers in some patches. Red and dusky willows may occur as associated species in the Mixed Willow type. Nearly monospecific stands of narrow-leaf willow, located in low elevation sites adjacent to the channel that receive relatively frequent inundation and scour, are included within this type. The more common phase which is dominated by black or arroyo willows, tends to occur in somewhat higher elevation sites that are less hydraulically and geomorphically active.

A total of 526 patches of Mixed Willow vegetation, covering 404 acres, were mapped in the Merced River corridor. Patch sizes ranged from <0.05 to 10.4 acres, with an average patch size of 0.8 acres. Mixed Willow was the fifth most common cover type mapped (after Dredger Tailings, Herbaceous Cover, Mixed Riparian Forest, and Cottonwood Forest).

Riparian Scrub

Riparian Scrub is an early seral stage vegetation type dominated by shrubs, with California button-willow and narrow-leaf willow as the most characteristic species. Common associates in Riparian Scrub include seedlings or saplings of many other woody species, including as Fremont cottonwood, Goodding's black willow, Oregon ash, box elder, and white alder. Young valley oaks also occur in this vegetation type in some locations. Vegetation structure consistently includes both a ground layer (average height ranges from 0.5 to 4 feet) and a shrub layers (average height ranges from 6 to 15 feet). In some sites a subcanopy tree layer may also be present (average height, when present, ranges from 15 to 30 feet). Tree and vine layers are consistently absent in this vegetation type.

Riparian Scrub patches typically occur on alluvial bars or along the margins of the active channel, areas that are inundated and scoured frequently enough to prevent development of more mature vegetation. In the absence of scouring flows or other types of disturbance, Riparian Scrub is expected to be develop into riparian forest (Mixed Riparian Forest or Cottonwood Forest). Areas mapped as Riparian Scrub are among the most hydraulically and geomorphically active sites within the riparian corridor.

Riparian Scrub occurs throughout the Merced River corridor. A total of 483 patches, covering 297 acres, were mapped for this type. Patch sizes ranged from less than 0.1 to 8.4 acres, with an

average patch size of 0.6 acres. Riparian Scrub was the seventh most common cover type mapped (after Dredger Tailings, Herbaceous Cover, Mixed Riparian Forest, Cottonwood Forest, Mixed Willow, and Valley Oak Forest).

Tamarisk

Only two very small stands dominated by the non-native tamarisk (*Tamarix* spp.) were observed and mapped in the Merced River corridor (covering less than 0.4 acres total). Although tamarisk is considered to be a highly invasive non-native species that has replaced much of the native riparian vegetation along some Central Valley rivers and streams, it appears to represent only a moderate threat to existing native vegetation in the Merced River corridor. In spite of this, because of its highly invasive native as demonstrated in other river systems, eradication or control of this genus is an important management consideration; four tamarisk species are listed as widespread, aggressively invading pest plants of great ecological concern (list A-1) by the California Exotic Pest Plant Council (CalEPPC 1999). Ecological problems associated with widespread tamarisk invasion include dramatic changes in river geomorphology and plant community composition, increased soil salinity and fire frequency, and decreased groundwater availability and native wildlife diversity (Bossard et a. 2000).

Tree of Heaven

The Tree of Heaven vegetation type includes all stands with the non-native tree of heaven dominant in the overstory layers. Most stands observed along the Merced River corridor include a variety of age classes, indicating that existing stands are typically self-maintaining. The presence of seedlings and saplings at some distance from the nearest mature trees suggests that some stands are actively expanding. Examination of 1993 and 1999 aerial photographs confirmed that certain stands appear to have expanded noticeably since 1993.

Seventeen patches of the Tree of Heaven vegetation type, covering 10 acres total, were mapped in the Merced River corridor. Patch sizes ranged from less than 0.1 to 1.8 acres, with an average patch size of 0.6 acres. Tree of heaven also occurs as a component of the understory and subcanopy layers in some Mixed Riparian Forest stands. Tree of heaven is considered to be an invasive non-native species. Eradication or control of this species is an important management consideration, and the tree is listed as a wildland of lesser invasiveness (list B) by the California Exotic Pest Plant Council (CalEPPC 1999).

Tree of heaven is a shade tolerant, aggressive competitor that can establish large thickets through vigorous root sprouting, high growth rates, and release of allelopathic chemicals that inhibit understory plants (Bossard et a. 2000).

Valley Oak Forest

Valley Oak Forest includes stands in which the overstory canopy is dominated by valley oak. This vegetation type is typically best established on the highest parts of the floodplain and on terraces, where it is less subject to physical disturbance but still receives annual subsurface irrigation and periodic inputs of silty alluvium during larger flood events. The canopy layer ranges from 50 to 65 feet in average height. Canopy closure in Valley Oak Forest type varies from open (representing a savanna or woodland phase) to dense (true forest).

This type best matches the Great Valley valley oak riparian forest (element code 61430) of Holland (1986). This riparian forest type is established on alluvial terraces and on low hills throughout the Central Valley from Lake Shasta to northern Los Angeles County. Historically, valley oak woodlands were mostly restricted to deep alluvial soils at low elevations, forming belts

varying in width from a few hundred meters to a few kilometers (Holland and Keil 1995). As is common throughout the Central Valley, most of these native forests along the Merced River corridor have been lost due to human development (e.g., agriculture, dredger mining, firewood harvesting, and urban development in the floodplain). The historical extent of the original woodlands is difficult to determine because many stands were cut for firewood or cleared for agriculture before any accurate records were kept (Holland and Keil 1995).

A total of 416 Valley Oak Forest patches, covering 342 acres, were mapped in the Merced River corridor. Patch sizes ranged from less than 0.1 to 27.3 acres, with an average patch size of 0.8 acres. Valley Oak Forest was the sixth most common cover type mapped (after Dredger Tailings, Herbaceous Cover, Mixed Riparian Forest, Cottonwood Forest, and Mixed Willow).

Appendix G. Merced River Plant Species List

CATEGORY NOTES

Habit: G=grass, H=herb, T=tree, S=shrub, S/T=shrub to small tree, V=vine
Native/Exotic: E=exotic, I=invasive exotic, N=native
Data Source: Species presence based on field observations by Stillwater Sciences field crews unless otherwise noted.

Scientific Name	Common Name	Family	Habit	Native/ Exotic
Acer macrophyllum	big-leaf maple	Aceraceae	T	N
Acer negundo	box elder	Aceraceae	T	N
Acer saccharinum	silver maple	Aceraceae	T	E
Amaranthus sp.	amaranthus	Amaranthaceae	H	?
Conium maculatum	poison hemlock	Apiaceaea	H	E
Hydrocotyle sp.	marsh pennywort	Apiaceaea	H	N
Asclepias sp.	milkweed	Asclepiadaceae	H	N
Ambrosia psilostachya	western ragweed	Asteraceae	H	N
Anthemis cotula[1]	mayweed	Asteraceae	H	E
Artemisia douglasiana	mugwort	Asteraceae	H	N
Bidens cernua	bur-marigold	Asteraceae	H	N
Bidens frondosa	sticktight	Asteraceae	H	N
Carduus pycnocephalus	Italian thistle	Asteraceae	H	E
Centaurea solstitialis	yellow star-thistle	Asteraceae	H	I
Cichorium intybus	chicory	Asteraceae	H	E
Cirsium vulgare[1]	bull thistle	Asteraceae	H	E
Conyza canadensis	horseweed	Asteraceae	H	N
Gnaphalium luteo-album[1]	cudweed	Asteraceae	H	E
Gnaphalium palustre[1]	everlasting	Asteraceae	H	N
Gnaphalium stramineum[1]	cotton-batting plant	Asteraceae	H	N
Grindelia camporum[1]	gumplant	Asteraceae	H	N
Helianthus annuus[1]	sunflower	Asteraceae	H	N
Hemizonia kelloggii[1]	tarweed	Asteraceae	H	N
Heterotheca grandiflora[1]	telegraph weed	Asteraceae	H	N
Lactuca serriola	prickly lettuce	Asteraceae	H	E
Madia elegans ssp. *Densifolia*	common tarweed	Asteraceae	H	N
Picris echioides[1]	bristly ox-tongue	Asteraceae	H	E
Silybum marianum[1]	milk thistle	Asteraceae	H	E
Xanthium spinosum[1]	spiny cocklebur	Asteraceae	H	N
Xanthium strumarium	cocklebur	Asteraceae	H	N
Azolla filiculoides	mosquito fern	Azollaceae	F	N
Alnus rhombifolia	white alder	Betulaceae	T	N
Brassica nigra	black mustard	Brassicaceae	H	I
Lepidium latifolium	peppergrass	Brassicaceae	H	E
Raphanus raphanistrum[1]	jointed charlock	Brassicaceae	H	E
Brasenia schreberi	watershield	Cabombaceae	H	N
Sambucus mexicana	blue elderberry	Caprifoliaceae	S	N
Herniaria hirsuta ssp. *cinerea*[1]		Caryophyllaceae	H	N

Scientific Name	Common Name	Family	Habit	Native/ Exotic
Spergularia rubra	sand spurrey[1]	Caryophyllaceae	H	N
Atriplex patula	spear oracle	Chenopodiaceae	S	N
Chenopodium ambrosioides[1]	mexican tea	Chenopodiaceae	H	E
Carex sp.	sedge	Cyperaceae	H	N
Cyperus [esculentus?]	nutsedge	Cyperaceae	H	N?
Cyperus difformis[1]	annual nutsedge	Cyperaceae	H	E
Cyperus eragrostis[1]	umbrella sedge	Cyperaceae	H	N
Cyperus strigosus[1]	false nutsedge	Cyperaceae	H	N
Eleocharis macrostachya[1]	Spikerush	Cyperaceae	H	N
Lipocarpha micrantha[1]		Cyperaceae	H	N
Scirpus acutus var. *occidentalis*	tule, hardstem bulrush	Cyperaceae	H	N
Equisetum spp.	horsetail	Equisetaceae	F	N
Chamaesyce maculata[1]	spotted spurge	Euphorbiaceae	H	E
Eremocarpus setigerus[1]	doveweed	Euphorbiaceae	H	N
Euphorbia sp.	spurge	Euphorbiaceae	H	?
Lotus purshianus var. *purshianus*[1]		Fabaceae	H	N
Lupinus sp.[1]	bush lupine	Fabaceae	S	N
Melilotus alba	white sweetclover	Fabaceae	H	E
Quercus douglasii	blue oak	Fagaceae	T	N
Quercus lobata	valley oak	Fagaceae	T	N
Frankenia salina	alkali heath	Frankeniaceae	S	N
Centaurium muhlenbergii[1]	centaury	Gentianaceae	H	N
Erodium botry[1]	red-stemmed filaree	Geraniaceae	H	E
Myriophyllum aquaticum	parrot's feather	Haloragaceae	H	I
Aesculus californica	California buckeye	Hippocastanaceae	S/T	N
Egeria densa	Brazilian waterweed	Hydrocharitaceae	H	E
Hypericum anagalloides	tinker's penny	Hypericaceae	H	N
Hypericum perforatum[1]	Klamathweed	Hypericaceae	H	E
Iris pseudacorus	yellow iris	Iridaceae	H	E
Carya illinoiensis	pecan	Juglandaceae	T	E
Juglans californica var. *hindsii*	Northern California black walnut	Juglandaceae	T	NE
Juncus acuminatus[1]	taper-tip rush	Juncaceae	H	N
Juncus balticus[1]	baltic rush	Juncaceae	H	N
Juncus effusus	soft rush	Juncaceae	H	N
Juncus xiphioides[1]	Iris-leaf rush	Juncaceae	H	N
Lycopus americanus[1]	bugleweed	Lamiaceae	H	N
Marrubium vulgare	horehound	Lamiaceae	H	E
Mentha arvensis	mint	Lamiaceae	H	N
Lemna sp.	duckweed	Lemnaceae	H	N
Wolffia [globosa?]	water-meal	Lemnaceae	H	N
Ammania robusta[1]		Lythraceae	H	N
Lythrum hyssopifolium[1]	loosestrife	Lythraceae	H	E
Rotala ramosior[1]		Lythraceae	H	E

Scientific Name	Common Name	Family	Habit	Native/ Exotic
Mullugo verticillata[1]	carpet weed	Molluginaceae	H	E
Ficus carica	edible fig	Moraceae	S/T	E
Maclura pomifera	osage orange	Moraceae	T	E
Morus alba	white mulberry	Moraceae	T	E
Fraxinus latifolia	Oregon ash	Oleaceae	T	N
Fraxinus velutina[2]	velvet ash	Oleaceae	T	N
Epilobium ciliatum ssp. ciliatum[1]	willow herb	Onagraceae	H	N
Epilobium densiflorum[1]	fireweed	Onagraceae	H	N
Epilobium sp.	willow herb	Onagraceae	H	N
Ludwigia palustris[1]	false loosestrife	Onagraceae	H	N
Ludwigia peploides ssp. *peploides*[1]	water primrose	Onagraceae	H	N
Oenothera elata ssp. *hirsutissima*	yellow evening primrose	Onagraceae	H	N
Eschscholzia caespitosa[1]	poppy	Papaveraceae	H	N
Eschscholzia californica[1]	California poppy	Papaveraceae	H	N
Phytolacca americana	pokeweed	Phytolaccaceae	S/T	E
Plantago lanceolata	English plantain	Plantaginaceae	H	E
Platanus acerifolia	London plane tree	Platanaceae	T	E
Platanus racemosa	western sycamore	Platanaceae	T	N
Arundo donax	giant reed	Poaceae	G	I
Aven barbata	slender wild oat	Poaceae	G	E
Avena fatua	wild oat	Poaceae	G	E
Briza minor	little quaking grass	Poaceae	G	E
Bromus diandrus[1]	ripgut brome	Poaceae	G	E
Bromus madritensis ssp. *rubens*[1]	red brome	Poaceae	G	E
Bromus mollis[1]	soft chess	Poaceae	G	E
Cynodon dactylon[1]	Bermuda grass	Poaceae	G	E
Digitaria sanguinalis[1]		Poaceae	G	E
Distichlis spicata	Saltgrass	Poaceae	G	N
Echinochloa crus-galli[1]	barnyard grass	Poaceae	G	E
Leersia oryzoides	rice cutgrass	Poaceae	G	E
Leymus triticoides[1]	alkali rye	Poaceae	G	N
Lolium multiflorum[1]	Italian rye grass	Poaceae	G	E
Nassella sp.[1]	needlegrass	Poaceae	G	N
Paspalum dilatatum[1]	Dallis grass	Poaceae	G	E
Paspalum distichum	joint paspalum	Poaceae	G	N
Paspalum notatum[1]	paspalum	Poaceae	G	E
Phalaris arundinacea	reed canary grass	Poaceae	G	N
Poa annua[1]	annual blue grass	Poaceae	G	E
Polypogon monspeliensis	annual rabbit's-foot grass	Poaceae	G	E
Setaria viridis[1]		Poaceae	G	E
Sorghum halepense[1]	sorghum	Poaceae	G	E
Polygonum hydropiperoides	waterpepper	Polygonaceae	H	N
Polygonum lapathifolium[1]	Willow weed	Polygonaceae	H	N

Scientific Name	Common Name	Family	Habit	Native/ Exotic
Rumex crispus	curly dock	Polygonaceae	H	E
Eichhornia crassipes	water hyacinth	Pontederiaceae	H	I
Potamogeton crispus[1]	crispate-leaved pondweed	Potamogetonaceae	H	E
Potamogeton sp.	pondweed	Potamogetonaceae	H	N
Rhamnus californica	California coffeeberry	Rhamnaceae	S/T	N
Rhamnus tomentella ssp. *tomentella*[1]	hoary coffeeberry	Rhamnaceae	S/T	N
Rubus discolor	Himalaya berry	Rosaceae	V	I
Rubus ursinus	California blackberry	Rosaceae	V	N
Cephalanthus occidentalis var. *californicus*	California button willow, button bush	Rubiaceae	S	N
Galium sp.	bedstraw	Rubiaceae	H	N
Populus fremontii	Fremont cottonwood	Salicaceae	T	N
Salix exigua	narrow-leaved willow	Salicaceae	S	N
Salix goodingii	Goodding's black willow	Salicaceae	T	N
Salix laevigata	red willow	Salicaceae	T	N
Salix lasiolepis	arroyo willow	Salicaceae	S	N
Kickxia elatine[1]	fluellin	Scrophulariaceae	H	E
Lindernia dubia var. *anagallidea*[1]	false pimpernel	Scrophulariaceae	H	E
Mimulus cardinalis[1]	scarlet monkeyflower	Scrophulariaceae	H	N
Mimulus floribundus	slimy monkeyflower	Scrophulariaceae	H	N
Mimulus guttatus	common monkeyflower	Scrophulariaceae	H	N
Verbascum blattaria[1]	moth mullein	Scrophulariaceae	H	E
Verbascum thapsus	woolly mullein	Scrophulariaceae	H	E
Veronica catenata[1]	chain speedwell	Scrophulariaceae	H	E
Ailanthus altissima	tree of heaven	Simaroubaceae	T	E
Datura sp.	jimson weed	Solanaceae	H	E?
Nicotiana glauca	tree tobacco	Solanaceae	T	E
Physalis lancifolia[1]	ground cherry	Solanaceae	S	E
Solanum americanum[1]	nightshade	Solanaceae	H	N
Tamarix sp.	tamarisk	Tamaricaceae	T	I
Typha angustifolia	narrow-leaved cattail[1]	Typhaceae	H	N
Typha latifolia	broad-leaved cattail[1]	Typhaceae	H	N
Urtica dioica	giant nettle[1]	Urticaceae	H	N
Urtica dioica ss. *holosericea*	hoary nettle	Urticaceae	H	N
Phyla nodiflora var. *nodiflora*[1]		Verbenaceae	H	N
Verbena sp.[1]		Verbenaceae	H	?
Phoradendron macrophyllum	big leaf mistletoe	Viscaceae	P	N
Vitis californica	California wild grape	Vitaceae	V	N
Tirbulus terrestris	puncture vine	Zygophyllaceae	H	E

[1] Identified in CDWR, unpublished data
[2] Identified in McBain and Trush (2000)

References

McBain and Trush. 2000. Habitat restoration plan for the Lower Tuolumne River corridor, final report. Prepared for the Tuolumne River Technical Advisory Committee, with assistance from USFWS Anadromous Fish Restoration Program. McBain & Trush, Arcata, CA.

Appendix H. Snelling Site Vegetation Relevés

Merced River Patch Relevé
Snelling Site, Cross-Section 10+80 (right bank), Patch E (Mixed Forest)

Stratum	Scientific Name	Common Name	Cover Class
Ground	*Fraxinus latifolia*	Oregon ash	< 1%
	Quercus lobata	valley oak	< 1%
	SP-1[1]	herb	< 1%
	SP-4[1]	herb	< 1%
	Rumex sp.	dock	< 1%
Shrub	*Quercus lobata*	valley oak	1-5%
	Brassica nigra	black mustard	< 1%
	Salix goodingii	Gooding's black willow	1-5%
	Fraxinus latifolia	Oregon ash	1-5%
	Artemisia douglasiana	mugwort	< 1%
	Salix lasiolepis	arroyo willow	< 1%
	Cirsium sp.	thistle	< 1%
	Cercis occidentalis	Western redbud	< 1%
Tree (subcanopy)	*Salix lasiolepis*	arroyo willow	1-5%
	Quercus lobata	valley oak	5-15%
	Morus alba	mulberry	1-5%
	Fraxinus latifolia	Oregon ash	1-5%
	Acer saccharinum	silver maple	< 1%
	Alnus rhombifolia	white alder	1-5%
Tree (canopy)	*Quercus lobata*	valley oak	25-50%
Vine (<2 m)	*Rubus discolor*	Himalaya berry	50-75%

[1]"SP" designates an unknown species that occurred in the plot.

Merced River Patch Relevé
Snelling Site, Cross-Section 10+80 (right bank), Patch C (Mixed Willow)

Stratum	Scientific Name	Common Name	Cover Class
Ground	*Fraxinus latifolia*	Oregon ash	< 1%
	SP-7[1]	herb	< 1%
	SP-8[1]	herb	< 1%
	SP-9[1]	herb	< 1%
Shrub	*Conium maculatum*	Poison hemlock	1-5%
	SP-2[1]	herb	1-5%
	Salix lasiolepis	arroyo willow	1-5%
	Salix exigua	narrow-leaved willow	1-5%
	Artemisia douglasiana	mugwort	< 1%
	Quercus lobata	valley oak	< 1%
Tree (subcanopy)	*Salix lasiolepis*	arroyo willow	15-25%
	Quercus lobata	valley oak	1-5%
	Acer negundo	box elder	1-5%
Tree (canopy)	*Fraxinus latifolia*	Oregon ash	1-5%

Stratum	Scientific Name	Common Name	Cover Class
Vine (<2 m)	*Rubus ursinus*	California blackberry	5-15%
	Rubus discolor	Himalaya berry	< 1%
Vine (>2 m)	*Vitis californica*	California wild grape	5-15%

[1]"SP" designates an unknown species that occurred in the plot.

Merced River Patch Relevé
Snelling Site, Cross-Section 13+95 (right bank), Patch C (Herbaceous Cover)

Stratum	Scientific Name[1]	Common Name	Cover Class
Ground	*SP-21*[2] (Poaceae)	grass (dried)	>75%
	SP-22[2]	herb	15-25%
	Brassica nigra	black mustard	1-5%
	Eschscholzia californica	California poppy	1-5%
	Verbascum blattaria	moth mullein	< 1%
	Rubus ursinus	California blackberry	< 1%
Shrub	*Salix lasiolepis*	arroyo willow	1-5%
	Rhamnus californica	California coffeeberry	< 1%
Tree (subcanopy)	*Carya illinoiensis*	pecan	1-5%
Tree (canopy)	*Quercus lobata*	valley oak	5-15%

[1] Typical species that occur in this cover type and were not captured in this relevé include Oregon ash (*Fraxinus latifolia*), lupine (*Lupinus* spp.) and poison hemlock (*Conium maculatum*).
[2]"SP" designates an unknown species that occurred in the plot.

Merced River Patch Relevé
Snelling Site, Cross-Section 13+95 (right bank), Patch B (Mixed Forest)

Stratum	Scientific Name	Common Name	Cover Class
Ground	*Artemisia douglasiana*	mugwort	5-15%
	Acer saccharinum	silver maple	1-5%
	Phalaris arundinacea	reed canary grass	1-5%
	Verbascum blattaria	moth mullein	1-5%
	Quercus lobata	valley oak	< 1%
	Fraxinus latifolia	Oregon ash	< 1%
	Equisetum spp.	horsetail	< 1%
	SP-23[1](Fabaceae)	herb (legume family)	< 1%
	Acer negundo	box elder	< 1%
	Rumex sp.	dock	< 1%
	SP-11 (Solidago sp.*)*	goldenrod	< 1%
	SP-24 (Boraginaceae)	herb (borage family)	1-5%
Shrub	*Cephalanthus occidentalis* var. *californica*	California button willow	15-25%
	Fraxinus latifolia	Oregon ash	5-15%

Stratum	Scientific Name	Common Name	Cover Class
	Acer negundo	box elder	5-15%
	Salix lasiolepis	arroyo willow	5-15%
	Salix exigua	narrow-leaf willow	1-5%
	Alnus rhombifolia	white alder	1-5%
	Quercus lobata	valley oak	1-5%
Tree (subcanopy)	*Quercus lobata*	valley oak	15-25%
	Fraxinus latifolia	Oregon ash	5-15%
Tree (canopy)	*Fraxinus latifolia*	Oregon ash	15-25%
	Acer saccharinum	silver maple	5-15%
	Quercus lobata	valley oak	50-75%
Vine (<2 m)	*Rubus discolor*	Himalaya berry	15-25%
	Vitis californica	California wild grape	5-15%
	Rubus ursinus	California blackberry	1-5%
Vine (>2 m)	*Vitis californica*	California wild grape	5-15%

[1]"SP" designates an unknown species that occurred in the plot.

Merced River Patch Relevé
Snelling Site, Cross-Section 13+95 (left bank), Patch A (Cottonwood Forest)

Stratum	Scientific Name	Common Name	Cover Class
Ground	*SP-21*[1](Poaceae)	grass	15-25%
	Conium maculatum	poison hemlock	1-5%
	Artemisia douglasiana	mugwort	< 1%
Shrub	*Ficus carica*	edible fig	50-75%
	Salix lasiolepis	arroyo willow	5-15%
	Acer negundo	box elder	1-5%
	Maclura pomifera	Osage orange	1-5%
	Quercus lobata	valley oak	1-5%
	Cephalanthus occidentalis var. *californica*	California button willow	< 1%
Tree (subcanopy)	*Quercus lobata*	valley oak	15-25%
	Maclura pomifera	Osage orange	1-5%
Tree (canopy)	*Populus fremontii*	Fremont cottonwood	25-50%
	Quercus lobata	valley oak	5-15%
Vine (<2 m)	*Rubus ursinus*	California blackberry	5-15%
	Rubus discolor	Himalaya berry	5-15%

[1]"SP" designates an unknown species that occurred in the plot.

Merced River Patch Relevé
Snelling Site, Cross-Section 9+60 (left bank), Patch D (Cottonwood Forest, High-Flow Channel)

Stratum	Scientific Name[1]	Common Name	Cover Class
Ground	*Artemisia douglasiana*	mugwort	< 1%
Shrub	*Cephalanthus occidentalis* var. *californica*	California button willow	15-25%
	Fraxinus latifolia	Oregon ash	1-5%
Tree (subcanopy)	*Alnus rhombifolia*	white alder	5-15%
	Quercus lobata	valley oak	1-5%
	Cephalanthus occidentalis var. *californica*	California button willow	1-5%
	Fraxinus latifolia	Oregon ash	1-5%
	Salix goodingii	Gooding's black willow	< 1%
Tree (canopy)	*Populus fremontii*	Fremont cottonwood	5-15%
	Quercus lobata	valley oak	1-5%
Vine (<2 m)	*Rubus discolor*	Himalaya berry	15-25%
Vine (>2 m)	*Rubus ursinus*	California blackberry	< 1%
	Vitis californica	California wild grape	< 1%

[1]Other species occurring in this cover type and that were not captured in this relevé include box elder (*Acer negundo*) and less frequently, Osage orange (*Maclura pomifera*), and mulberry (*Morus alba*).

Merced River Patch Relevé
Snelling Site, Cross-Section 1+90 (left bank), Patch A (Mixed Forest)

Stratum	Scientific Name	Common Name	Cover Class
Ground	*Artemisia douglasiana*	mugwort	1-5%
	Aesculus californica	California buckeye	1-5%
	Quercus lobata	valley oak	< 1%
	Rosa californica	California wild rose	< 1%
	SP-12[1] (Poaceae)	grass (dried)	< 1%
	SP-13[1] (Poaceae)	grass	< 1%
	SP-14[1] (Poaceae)	grass	< 1%
Shrub	*Rubus ursinus*	California blackberry	25-50%
	Rubus discolor	Himalaya berry	5-15%
	Rosa californica	California wild rose	5-15%
	Salix exigua	narrow-leaved willow	1-5%
	Aesculus californica	California buckeye	1-5%
	Fraxinus latifolia	Oregon ash	1-5%
	Quercus lobata	valley oak	< 1%
	SP-11[1] (Asteraceae)	herb (yellow flower)	< 1%
Tree (subcanopy)	*Aesculus californica*	California buckeye	5-15%
	Salix lasiolepis	arroyo willow	1-5%
Tree (canopy)	*Quercus lobata*	valley oak	15-25%
	Fraxinus latifolia	Oregon ash	5-15%

Stratum	Scientific Name	Common Name	Cover Class
	Juglans californica var. *hindsii*	Northern California black walnut	1-5%

[1]"SP" designates an unknown species that occurred in the plot.

Merced River Patch Relevé
Snelling Site, Cross-Section 4+20 (left bank), Patch B (Valley Oak Forest)

Stratum	Scientific Name	Common Name	Cover Class
Ground	*SP-14*[1] (Poaceae)	grass	25-50%
	Artemisia douglasiana	mugwort	1-5%
	SP-6[1]		1-5%
	Madia sp.	tarweed	< 1%
Shrub	*Quercus lobata*	valley oak	1-5%
	Fraxinus latifolia	Oregon ash	1-5%
Tree (subcanopy)	*Quercus lobata*	valley oak	5-15%
	Fraxinus latifolia	Oregon ash	1-5%
Tree (canopy)	*Quercus lobata*	valley oak	15-25%
Vine (>2 m)	*Rubus discolor*	Himalaya berry	5-15%
	Vitis californica	California wild grape	5-15%
	Rubus ursinus	California blackberry	1-5%

[1]"SP" designates an unknown species that occurred in the plot.

Merced River Patch Relevé
Snelling Site, Cross-Section 9+60 (right bank), Patch B (Herbaceous Cover)

Stratum	Scientific Name	Common Name	Cover Class
Ground	*Phalaris arundinacea*	reed canary grass	>75%
	Cyperus sp.	nutsedge	5-15%
	Polygononum hydropiperoides	waterpepper	5-15%
	SP-16[1] (Lamiaceae)	herb (mint family)	5-15%
	Acer saccharinum	silver maple	1-5%
	Juncus sp.	rush	1-5%
	Eleocharis sp.	spikerush	1-5%
	SP-11[1] (possible *Solidago* sp.)	goldenrod	1-5%
	SP-19[1]		1-5%
	Carex barbarae	Santa Barbara sedge	< 1%
	Epilobium ciliatum var. *watsonii*	Epilobium	< 1%
	Hydrocotyle sp.	Hydrocotyle	< 1%
Shrub	*Acer saccharinum*	silver maple	5-15%
	Salix lasiolepis	arroyo willow	5-15%
	Cephalanthus occidentalis var. *californica*	California button willow	1-5%

Stratum	Scientific Name	Common Name	Cover Class
	Quercus lobata	valley oak	1-5%
	Fraxinus latifolia	Oregon ash	1-5%
	Carya illinoiensis	pecan	< 1%
Tree (subcanopy)	*Fraxinus latifolia*	Oregon ash	5-15%
	Quercus lobata	valley oak	1-5%
	Carya illinoiensis	pecan	1-5%
Tree (canopy)	*Populus fremontii*	Fremont cottonwood	1-5%
Vine (<2 m)	*Rubus discolor*	Himalaya berry	15-25%
	Rubus ursinus	California blackberry	5-15%
	Vitis californica	California wild grape	1-5%
Vine (>2 m)	*Vitis californica*	California wild grape	1-5%

[1]"SP" designates an unknown species that occurred in the plot.

Merced River Patch Relevé
Snelling Site, Cross-Section 9+60 (right bank), Patch C (Cottonwood Forest)

Stratum	Scientific Name	Common Name	Cover Class
Ground	*Conium maculatum*	Poison hemlock	15-25%
	Epilobium sp.	Epilobium	< 1%
	Verbascum blattaria	moth mullein	< 1%
	Rumex sp.	dock	< 1%
	Phalaris arundinacea	reed canary grass	< 1%
Shrub	*Ficus carica*	edible fig	< 1%
	Cephalanthus occidentalis var. *californica*	California button willow	1-5%
	Quercus lobata	valley oak	1-5%
	Fraxinus latifolia	Oregon ash	1-5%
	Artemisia douglasiana	mugwort	5-15%
Tree (subcanopy)	*Fraxinus latifolia*	Oregon ash	1-5%
Tree (canopy)	*Populus fremontii*	Fremont cottonwood	5-15%
	Quercus lobata	valley oak	25-50%
Vine (<2 m)	*Rubus ursinus*	California blackberry	15-25%
	Rubus discolor	Himalaya berry	50-75%
	Vitis californica	California wild grape	>75%
Vine (>2 m)	*Vitis californica*	California wild grape	15-25%

[1]"SP" designates an unknown species that occurred in the plot.

Merced River Patch Relevé
Snelling Site, Cross-Section 10+80 (right bank), Patch B (Mixed Forest)

Stratum[1]	Scientific Name	Common Name	Cover Class
Ground	*Platanus acerifolia*	London plane tree	< 1%
	Acer saccharinum	silver maple	< 1%
	Polygononum hydropiperoides	waterpepper	< 1%
	Setaria sp.	grass	< 1%
	Vitis californica	California wild grape	< 1%
	Phalaris arundinacea	reed canary grass	1-5%
Shrub	*Platanus acerifolia*	London plane tree	1-5%
	Morus alba	mulberry	1-5%
	Salix lasiolepis	arroyo willow	15-25%
	Salix esigua	narrow-leaved willow	15-25%
	Cephalanthus occidentalis var. *californica*	California button willow	25-50%
Tree (subcanopy)	*Platanus acerifolia*	London plane tree	5-15%
	Alnus rhomibifolia	white alder	25-50%
Tree (canopy)	*Populus fremontii*	Fremont cottonwood	5-15%
Vine (>2 m)	*Rubus discolor*	Himalaya berry	25-50%

[1]This relevé includes part of a perennially wet high-flow channel, covering 5-15% of the plot area.

Merced River Patch Relevé
Snelling Site, Cross-Section 17+75 (right bank), Patch A (Mixed Forest)

Stratum	Scientific Name[1]	Common Name	Cover Class
Ground	*Fraxinus latifolia*	Oregon ash	< 1%
Shrub	*Fraxinus latifolia*	Oregon ash	1-5%
	Alnus rhomibifolia	white alder	1-5%
	Cephalanthus occidentalis var. *californica*	California button willow	5-15%
Tree (subcanopy)	*Platanus acerifolia*	London plane tree	1-5%
	Alnus rhomibifolia	white alder	5-15%
	Fraxinus latifolia	Oregon ash	5-15%
	Quercus lobata	valley oak	5-15%
Tree (canopy)	*Acer saccharinum*	silver maple	1-5%
	Quercus lobata	valley oak	5-15%
Vine (<2 m)	*Rubus ursinus*	California blackberry	50-75%
	Rubus discolor	Himalaya berry	50-75%
Vine (<2 m)	*Vitis californica*	California wild grape	< 1%

[1]Narrow-leaf willow (*Salix exigua*) commonly occurred at the river channel edge and was not captured in this relevé plot.

Merced River Patch Relevé
Snelling Site, Cross-Section 17+75 (right bank), Patch C (Cottonwood Forest)

Stratum	Scientific Name	Common Name	Cover Class
Ground	*Phalaris arundinacea*	reed canary grass	<1%
Shrub	*Cephalanthus occidentalis* var. *californica*	California button willow	<1%
	Alnus rhomibifolia	white alder	1-5%
	Fraxinus latifolia	Oregon ash	1-5%
	Morus alba	mulberry	1-5%
Tree (subcanopy)	*Fraxinus latifolia*	Oregon ash	5-15%
	Alnus rhomibifolia	white alder	5-15%
	Maclura pomifera	Osage orange	15-25%
	Acer negundo[1]	box elder	1-5%
Tree (canopy)	*Alnus rhomibifolia*	white alder	50-75%
Vine (<2 m)	*Rubus ursinus*	California blackberry	5-15%
	Rubus discolor	Himalaya berry	5-15%

[1]Relevé did not adequately capture the presence of box elder (*Acer negundo)*, which was prominent at both edges of the patch.

Merced River Patch Relevé
Snelling Site, Cross-Section 13+95 (left bank), Patch C (Dredger Tailings, swale)

Stratum	Scientific Name	Common Name	Cover Class
Ground	*Fraxinus latifolia*	Oregon ash	<1%
	Cephalanthus occidentalis var. *californica*	California button willow	<1%
	Phalaris arundinacea	reed canary grass	<1%
	Artemisia douglasiana	mugwort	1-5%
	Sp-21[1] (Poeaceae)	grass (dried)	15-25%
Shrub	*Salix lasiolepis*	arroyo willow	25-50%
	Cephalanthus occidentalis var. *californica*	California button willow	50-75%
Tree (subcanopy)	*Salix lasiolepis*	arroyo willow	5-15%
	Salix goodingii	Gooding's black willow	5-15%
Tree (canopy)	*Populus fremontii*	Fremont cottonwood	1-5%
	Quercus lobata	valley oak	5-15%
	Fraxinus latifolia	Oregon ash	15-25%
Vine (<2 m)	*Rubus discolor*	Himalaya berry	1-5%
	Rubus ursinus	California blackberry	5-15%

[1]"SP" designates an unknown species that occurred in the plot.

Merced River Patch Relevé
Snelling Site, Cross-Section 17+75 (left bank), Patch A (Cottonwood Forest)

Stratum	Scientific Name	Common Name	Cover Class
Ground	*Maclura pomifera*	Osage orange	< 1%
	Phalaris arundinacea	reed canary grass	< 1%
	Rumex sp.	dock	< 1%
	Salix exigua	narrow-leaved willow	< 1%
	Verbascum sp.	mullein	< 1%
	Sp-23[1]		< 1%
	Artemisia douglasiana	mugwort	1-5%
	Carex sp.	sedge	1-5%
	Conium maculatum	Poison hemlock	1-5%
Shrub	*Carya illinoiensis*	pecan	<1%
	Cephalanthus occidentalis var. *californica*	California button willow	1-5%
	Salix goodingii	Gooding's black willow	1-5%
	Rhamnus californica	California coffeeberry	1-5%
	Salix exigua	narrow-leaved willow	5-15%
	Maclura pomifera	Osage orange	5-15%
	Salix laevigata	red willow	5-15%
	Fraxinus latifolia	Oregon ash	5-25%
	Salix lasiolepis	arroyo willow	15-25%
Tree (subcanopy)	*Quercus lobata*	valley oak	5-15%
	Fraxinus latifolia	Oregon ash	5-15%
	Carya illinoiensis	pecan	5-15%
Tree (canopy)	*Alnus rhomibifolia*	white alder	1-5%
	Acer saccharinum	silver maple	15-25%
	Populus fremontii	Fremont cottonwood	25-50%
Vine (<2 m)	*Rubus discolor*	Himalaya berry	1-5%
	Rubus ursinus	California blackberry	5-15%
Vine (>2 m)	*Vitis california*	California wild grape	1-5%

[1]"SP" designates an unknown species that occurred in the plot.

Merced River Patch Relevé
Snelling Site, Cross-Section 10+80 (right bank), Patch C (Mixed Willow)

Stratum	Scientific Name	Common Name	Cover Class
Ground	*Fraxinus latifolia*	Oregon ash	< 1%
	SP-7[1]	herb	< 1%
	SP-8[1]	herb	< 1%
	SP-9[1]	herb	< 1%
Shrub	*Conium maculatum*	Poison hemlock	1-5%
	SP-2[1]	herb	1-5%
	Salix lasiolepis	arroyo willow	1-5%

Stratum	Scientific Name	Common Name	Cover Class
	Salix exigua	narrow-leaved willow	1-5%
	Artemisia douglasiana	mugwort	< 1%
	Quercus lobata	valley oak	< 1%
Tree (subcanopy)	*Salix lasiolepis*	arroyo willow	15-25%
	Quercus lobata	valley oak	1-5%
	Acer negundo	box elder	1-5%
Tree (canopy)	*Fraxinus latifolia*	Oregon ash	1-5%
Vine (<2 m)	*Rubus ursinus*	California blackberry	5-15%
	Rubus discolor	Himalaya berry	< 1%
Vine (>2 m)	*Vitis californica*	California wild grape	5-15%

[1]"SP" designates an unknown species that occurred in the plot.

Merced River Patch Relevé
Snelling Site, Cross-Section 13+95 (right bank), Patch C (Herbaceous Cover)

Stratum	Scientific Name	Common Name	Cover Class
Ground	*SP-21*[1]	Poaceae (dried)	>75%
	SP-22[1]	herb	15-25%
	Brassira nigira	black mustard	1-5%
	Eschscholzia californica	California poppy	1-5%
	Verbascum thapsis	wooly mullein	< 1%
	Rubus ursinus	California blackberry	< 1%
Shrub	*Salix lasiolepis*	arroyo willow	1-5%
	Rhamnus californica	California coffeeberry	< 1%
Tree (subcanopy)	*Carya illinoiensis*	pecan	1-5%
Tree (canopy)	*Quercus lobata*	valley oak	5-15%

[1]"SP" designates an unknown species that occurred in the plot.

Merced River Patch Relevé
Snelling Site, Cross-Section 13+95 (right bank), Patch B (Mixed Forest)

Stratum	Scientific Name	Common Name	Cover Class
Ground	*Artemisia douglasiana*	mugwort	5-15%
	Acer saccharinum	silver maple	1-5%
	Phalaris arundinacea	reed canary grass	1-5%
	Verbascum thapsis	wooly mullein	1-5%
	Quercus lobata	valley oak	< 1%
	Fraxinus latifolia	Oregon ash	< 1%
	Equisetum spp.	horsetail	< 1%
	SP-23[1]	pea?	< 1%
	Acer negundo	box elder	< 1%

Stratum	Scientific Name	Common Name	Cover Class
Shrub	*Cephalanthus occidentalis var. californica*	California button willow	15-25%
	Fraxinus latifolia	Oregon ash	5-15%
	Acer negundo	box elder	5-15%
	Quercus lobata	valley oak	1-5%
Tree (subcanopy)	*Quercus lobata*	valley oak	15-25%
	Fraxinus latifolia	Oregon ash	5-15%
Tree (canopy)	*Fraxinus latifolia*	Oregon ash	15-25%
	Acer saccharinum	silver maple	5-15%
	Quercus lobata	valley oak	50-75%
Vine (<2 m)	*Rubus discolor*	Himalaya berry	15-25%
	Vitis californica	California wild grape	5-15%
	Rubus ursinus	California blackberry	1-5%
Vine (>2 m)	*Vitis californica*	California wild grape	5-15%

[1]"SP" designates an unknown species that occurred in the plot.

Merced River Patch Relevé
Snelling Site, Cross-Section 13+95 (left bank), Patch A (Cottonwood Forest)

Stratum	Scientific Name	Common Name	Cover Class
Ground	*SP-21*[1]	Poaceae	15-25%
	Conium maculatum	Poison hemlock	1-5%
	Artemisia douglasiana	mugwort	< 1%
Shrub	*Ficus carica*	edible fig	>75%
	Salix lasiolepis	arroyo willow	5-15%
	Acer negundo	box elder	1-5%
	Maclura pomifera	Osage orange	1-5%
	Quercus lobata	valley oak	1-5%
	Cephalanthus occidentalis var. californica	California button willow	< 1%
Tree (subcanopy)	*Quercus lobata*	valley oak	15-25%
	Maclura pomifera	Osage orange	1-5%
Tree (canopy)	*Populus fremont*	Fremont cottonwood	25-50%
	Quercus lobata	valley oak	5-15%
Vine (<2 m)	*Rubus ursinus*	California blackberry	5-15%
	Rubus discolor	Himalaya berry	5-15%

[1]"SP" designates an unknown species that occurred in the plot.

Merced River Patch Relevé
Snelling Site, Cross-Section 9+60 (left bank), Patch D (Cottonwood Forest, High-Flow Channel)

Stratum	Scientific Name	Common Name	Cover Class
Ground	*Artemisia douglasiana*	mugwort	< 1%
Shrub	*Cephalanthus occidentalis var. californica*	California button willow	15-25%
	Fraxinus latifolia	Oregon ash	1-5%
Tree (subcanopy)	*Alnus rhombifolia*	white alder	5-15%
	Quercus lobata	valley oak	1-5%
	Cephalanthus occidentalis var. californica	California button willow	1-5%
	Fraxinus latifolia	Oregon ash	1-5%
	Salix goodingii	Goodding's black willow	< 1%
Tree (canopy)	*Populus fremont*	Fremont cottonwood	5-15%
	Quercus lobata	valley oak	1-5%
Vine (<2 m)	*Rubus discolor*	Himalaya berry	15-25%
Vine (>2 m)	*Rubus ursinus*	California blackberry	< 1%
	Vitis californica	California wild grape	< 1%