2002 RIPARIAN REVEGETATION MONITORING REPORT

Lower Clear Creek Floodway Rehabilitation Project
Phases 2A, 2B North & 2B South

Redding, California

Prepared for

WESTERN SHASTA
RESOURCE CONSERVATION DISTRICT
6270 PARALLEL ROAD
ANDERSON, CA 96007

Prepared by

VESTRA
Environmental Services Division
962 Maraglia St.
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&

Terrestrial Connections
Botanical & Natural Resource
Survey Company
16045 Forest Ranch Road
Forest Ranch, CA 95942

APRIL 2003

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INTRODUCTION

This report has been prepared by VESTRA Resources, Inc., Environmental Services Division, and Terrestrial Connections (Terracon) for the Western Shasta Resource Conservation District (WSRCD) and the Lower Clear Creek Restoration Team (Restoration Team), to summarize the results of the 2002 annual monitoring of the riparian monitoring objectives outlined in the Ecological Monitoring Plan (Monitoring Plan) (North State Resources, 1999) for the Lower Clear Creek Floodway Rehabilitation Project. Described within this document are:

- Project background
- Site location
- A description of the monitoring methods
- Monitoring results
- Conclusions
- Recommendations for future action

BACKGROUND

The lower Clear Creek Floodway Rehabilitation Project is a multi-phased project that was designed to improve anadromous salmonid habitat by restoring natural stream channel and floodplain processes in areas that were severely impacted by gold mining, aggregate mining, and the effects of Whiskeytown Dam (McBain & Trush et al., 2000). Channel restoration in Clear Creek has been identified as a priority action in several federal, state, and local planning documents (USFWS, 1995) (DWR, 1986) (WSRCD, 1996) (WSRCD, 1998).

The project is being funded by the CALFED Ecosystem Restoration Program, the Central Valley Project Improvement Act (CVPIA) administered by the Bureau of Reclamation, and the Clean Water and Watershed Restoration Program administered by the Bureau of Land Management (BLM). The project is part of a larger watershed restoration program that includes erosion control, fuels reduction, spawning gravel augmentation, dam removal, and flow management projects.

The specific objectives of the lower Clear Creek Floodway Rehabilitation Project include:

- Reverse channel damage caused by historic gravel extraction at the Restoration Site by reconstructing a properly sized bankfull channel and floodplain

- Restore the ability of the channel to route coarse sediment downstream and deposit fine sediment on floodplain surfaces

- Restore native riparian vegetation on floodplain surfaces by focusing on species that provide a diverse canopy structure and removing competing exotic plant species

- Reduce salmonid stranding and mortality in floodplain gravel mining pits

- Provide improved habitat conditions for native fish and wildlife including priority salmonid species of central concern to CALFED and CVPIA restoration programs

- Create diverse off channel wetland habitats in marginal upland habitats that are currently degraded by dredger tailings and in other uplands locations as opportunities arise.

The Monitoring Plan established monitoring objectives for fisheries, geomorphology, and riparian vegetation. Since the preparation of the Monitoring Plan, avian monitoring has been added to the overall monitoring program. Two riparian monitoring objectives and associated hypotheses were listed in the Monitoring Plan:

- OBJECTIVE R1: Restore native riparian vegetation on newly created floodplain surfaces

    - Hypothesis R1: The revegetation phase of channel restoration activities will increase the quantity and diversity of native riparian vegetation on reconstructed floodplain surfaces

- OBJECTIVE R2: Create favorable physical conditions for regeneration of native riparian species on restored floodplains

    - Hypothesis R2: Implementation of channel and floodplain restoration activities, combined with favorable hydrologic conditions during seed dispersal period, will increase natural regeneration of native riparian species on constructed floodplain surfaces

This report summarizes the monitoring of these objectives and hypotheses. The results of the 2002 growing season outlined in this report represent the third year of riparian revegetation monitoring since the project began and serve as the annual status report to be submitted to CALFED as outlined in the Monitoring Plan. Two prior annual monitoring reports were prepared for the WSRCD by Dr. Tom Griggs for the 2000 and 2001 growing seasons (Griggs, 2001) (Griggs, 2002).

SITE LOCATION

The Lower Clear Creek Floodway Rehabilitation project is located west of Redding in Shasta County, California (Figure 1). Lower Clear Creek is the first major tributary to the Sacramento River below Shasta and Keswick Dams. Restoration activities have occurred at two sites on lower Clear Creek to date. The Restoration Site is a stream channel and floodplain restoration site located at River Mile 3 that was impacted by aggregate mining. The Reading Bar Borrow Site is a floodplain restoration site located at River Mile 8 that was impacted by dredge mining for gold.

Four riparian revegetation plantings have been implemented at both sites as part of three phases of the project as of the 2002 growing season (Figure 2). Phase 2A was planted in the spring of 2000, Phase 2B North was planted in the fall of 2001, and Phase 2B South was planted in the spring of 2002. The Phase 2A revegetation project included a 10.3 acre planting at the Restoration Site (Plug Site) and a 3.3 acre planting at the Reading Bar Borrow Site (2A Borrow). The Phase 2B North planting included 5.2 acres at the Restoration Site (2B North). The Phase 2B South planting included 17.1 acres at the Restoration Site (2B South). The planting plans for all four plantings are included in Appendix A. The 2002 growing season was the third growing season for the Plug Site and 2A Borrow and the first growing season for 2B North and 2B South.

MONITORING METHODS

Data Collection

Monitoring of the 2002 growing season was performed using the methods outlined in the 2000 season monitoring report (Griggs, 2001). Because of a concern about the potential impact of monitoring personnel turnover on the consistency of data collection methods, we have completely reiterated the data collection methods in this report and added several additional method details to ensure future consistency.

Monitoring data were collected between December 2002 and March 2003. Data were collected using two types of sampling plots, randomized circular plots, and fixed belt transects. A description of the methods used for both types of plots is provided below.

Circular Plots

The randomized circular plots were designed to measure the horticultural success of the plantings. The number of plots was selected using a goal of sampling 10% of the planted area of each site. Circular plots were randomized each year by using a random number generator to select numbered grid cells placed over a recent aerial photograph of the site. The center of each circular plot was placed in the center of the grid cell. When selected grid cells were located along the edge of a patch such that the plot did not lie completely in the planted area, the plot center was moved perpendicular to the patch edge until the plot edge matched the outside edge of the patch. This was done to ensure that the sampling effort was not skewed against sampling patch edges. Circular plots measuring 0.10 acres (11.5 meter radius) were generally used unless the patch was too narrow or small to accommodate it. For smaller and narrower patches, 0.05 acre plots (8.1 meter radius) or 0.03 acre plots (6.25 meter radius) were used. For patches that were too small or narrow to accommodate 0.03 acre plots, a complete census was used.

Plot boundaries were established by having one person hold one end of a measured rope in the center of the plot while the other person walked in a circle by holding the other end of the rope. Data were collected for all living plantings lying within the plot. Plants were considered within the plot circle if the rope contacted the plant at its base. Plantings that did not survive were recorded as dead and the species was noted. Where two cuttings were planted at a single location (Plug Site and 2A Borrow), both plants were sampled and counted as individual plantings. Valley oak planting locations were counted as a single planting, even though two acorns were planted because of the difficulty of differentiating individual plants. Data collected within the circular plots included:

- Height – Plant height was measured to the nearest 0.5 meter using the current living portion of the highest stem of the plant. Plants smaller than 0.25 meters were recorded as 0.1 meter. Some top heavy plantings have fallen over since the recent removal of plant protectors. These plants were not propped up when measuring height (ie. they were measured as they occurred in the field).

- Volunteer Seedlings – A total count of woody volunteer seedlings was conducted for each plot along with average height. In plots that had a very high number of volunteers, the number of volunteers was estimated by sampling a small representative plot and extrapolating for the total area.

- Herbaceous Plants – General observations were made regarding the most common herbaceous plant species growing in the plots.

Fixed Belt Transect Plots
Fixed belt transect plots were set up along transects across the floodplain as laid out in the Monitoring Plan for the project (Appendix B). The belt plots are 6 meters wide and are established by laying out a metric measuring tape along existing piezometers. The measuring tape is used as the centerline of the plot. Data collected within the belt plots included:

- Total Plant Count – A total count of plantings and woody recruits was conducted within the belt plots. In areas with heavy recruitment, small representative plots were sampled and extrapolated for the larger area. Blackberry shrubs were considered woody recruits and were counted. Each distinct blackberry shrub was counted as one individual plant regardless of the number of stems at the base.

- Diameter at Breast Height – Diameter at Breast Height (DBH) for each planting was measured with a caliper using only the tallest shoot. Where two cuttings were planted at a single location, (Plug Site and 2A Borrow) both plants were sampled and counted as individual plantings. DBH of recruits was not measured.

- Basal Diameter – Basal diameter for each planting was measured using a caliper to measure the diameter of the base nearest ground level. If the base had an oblong shape, the smallest and largest diameters were measured and averaged. Where two cuttings were planted at a single location, (Plug Site and 2A Borrow) both plants were sampled and counted as individual plantings. Valley oak planting locations were counted as a single planting, even though two acorns were planted because of the difficulty of differentiating individual plants. Basal diameter of recruits was not measured.

- Cover – Plant cover was measured for both the plantings and any woody plant recruits using a line intercept sampling technique. The length of aerial plant canopy that interceped the tape was measured to the nearest 0.1 meter using the current living portion of the plant. If the canopy of two plants of the same species overlapped, the overlap was not double measured. If the canopy of two plants of different species overlapped, the overlap was double measured. Blackberry shrubs were considered woody recruits and were measured.

Data Analysis

For the data analysis portion of this monitoring report, it is worth repeating the two project objectives. These objectives are: 1) to restore native riparian vegetation on newly created floodplain surfaces, and 2) to create favorable physical conditions for regeneration of native riparian species on restored floodplains. Although no specific objective success criteria were established in the Monitoring Plan, the monitoring design and previous reports by Griggs (2000 and 2001), provide the necessary data collection and analysis examples that are used for this report.

The bulk of the monitoring data, those being measures of horticultural success and productivity, will be summarized and presented separately for each of the four plantings. Belt tansect data for 2B North was not analyzed because of the extremely small amount of data. Most of the data is presented as charts, with supporting descriptive statistics such as sample size, standard deviation, standard error, and confidence intervals (95%) accompanying the charts in tabular form. Additional observations made during field data collection such as woody species recruits, herbivore impacts, dominant or significant herbaceous plant establishment, and floodplain dynamics are summarized and presented in tables or as photographs within the main document and appendices. A comparison of the Plug Site and 2A Borrow plantings is presented in the discussion section.

Table 1 COMMON AND SCIENTIFIC NAMES OF PLANTS MENTIONED IN THIS REPORT	
Common Name	**Scientific Name**
Arroyo Willow	*Salix lasiolepis*
Black Willow (Goodding's Black Willow)	*Salix gooddingii*
Red Willow	*Salix laevigata*
Shining Willow	*Salix lucida*
Narrow-leaved Willow	*Salix exigua*
Fremont Cottonwood	*Populus fremontii ssp. fremontii*
Mule Fat	*Baccharis salicifolia*
Valley Oak	*Quercus lobata*
Himalayan Blackberry (non-native)	*Rubus discolor*
California Blackberry	*Rubus ursinus*
California Wild Grape	*Vitus californica*
White Alder	*Alnus rhombifolia*
Foothill Pine	*Pinus sabiniana*
Buck Brush	*Ceanothus cuneatus*
Yerba Santa	*Eriodictyon californicum*
Black Locust (non-native)	*Robinia pseudoacacia*
Yellow Starthistle (non-native)	*Centaurea solstitialis*
Willow Herb	*Epilobium sp.*
Wooly Mullein (non-native)	*Verbascum thapsus*
Ripgut Brome (non-native)	*Bromus diandrus*
Sweet Clover (non-native)	*Melilotus alba*
Rose Clover (non-native)	*Trifolium hirtum*
Lupine	*Lupinus sp.*
Phacelia (non-native)	*Phacelia sp.*
Philaree (non-native)	*Erodium sp.*
Chickweed (non-native)	*Stellaria media*
Nutsedge	*Carex sp.*
Burclover (non-native)	*Medicago sp.*
Black Mustard (non-native)	*Brassica nigra*

MONITORING RESULTS

2A Borrow Planting

Circular Plot Data (2002):

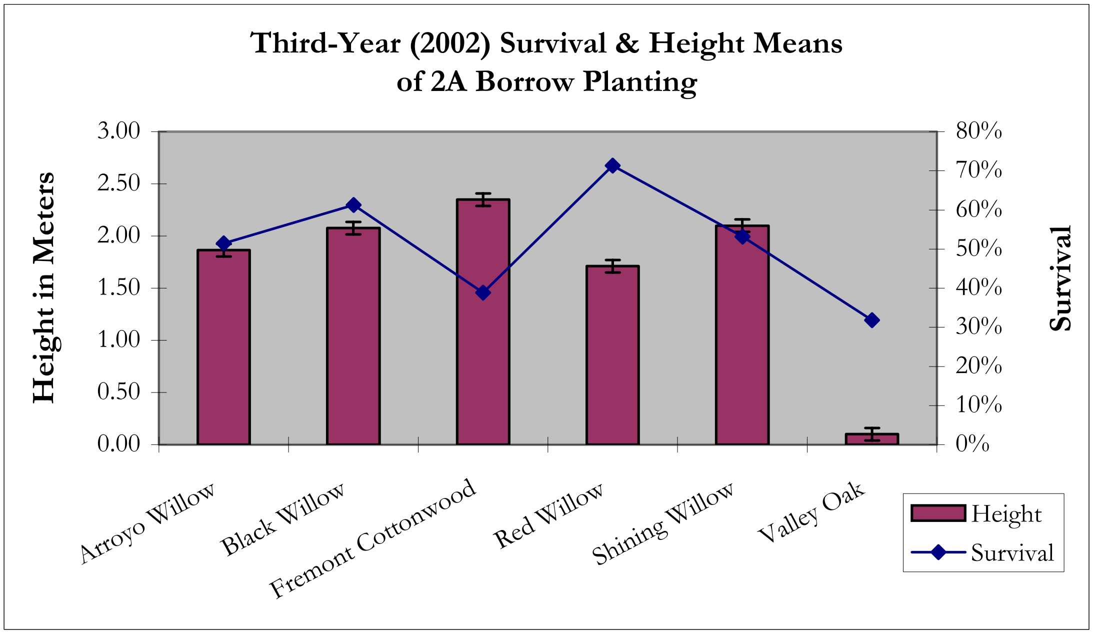

Figure 3. Mean survival and height data for all species at the 2A Borrow planting. Due to charting limitation, error bars are the mean confidence interval for all species (+/- 0.06). Extremely small standard error range allows use of mean error bars for presentation.

Table 2 DESCRIPTIVE DATA FOR FIGURE 3 ABOVE				
Species	**Plants Sampled †**	**Standard Deviation‡**	**Standard Error**	**Confidence Interval (95%)**
Arroyo Willow	207	0.58	0.04	0.08
Black Willow	141	0.72	0.06	0.12
Fremont Cottonwood	91	0.82	0.09	0.17
Red Willow	149	0.71	0.06	0.12
Shining Willow	84	0.63	0.07	0.14
Valley Oak	7	NA	NA	NA
Total/Average	**679**	**0.58**	**0.06**	**0.11**
† Live plants sampled for height analysis ‡ Meter units for SD, SE, and CI				

Three-year height growth data:

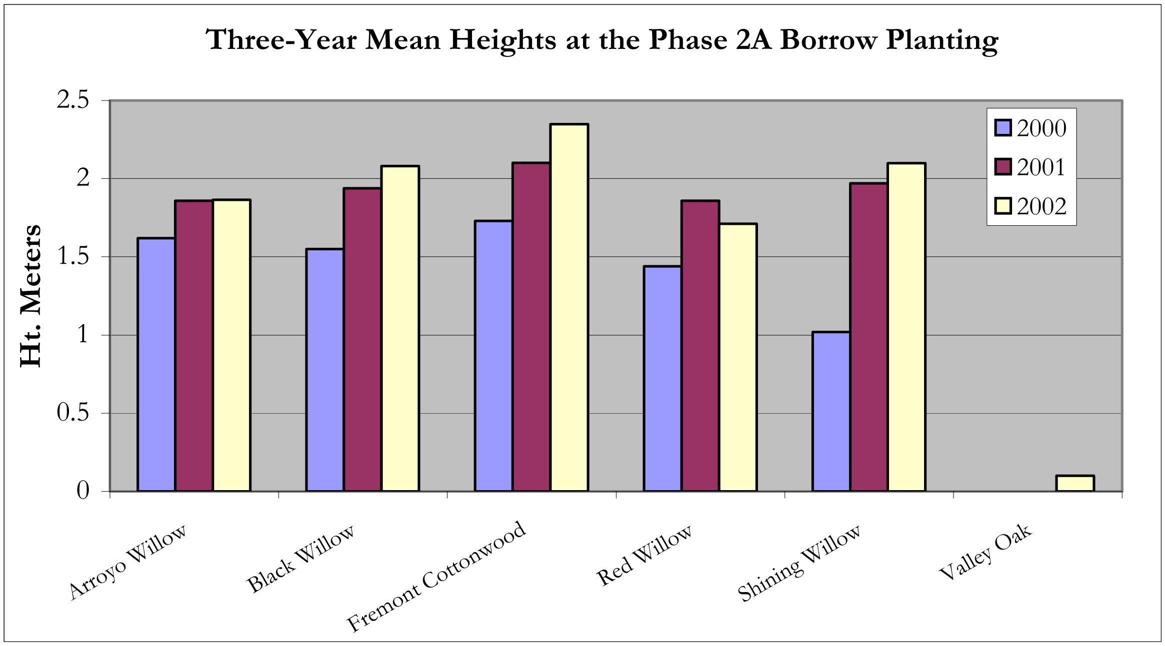

Figure 4. Three-year height growth of all species planted at the 2A Borrow planting.

Table 3
WOODY SPECIES RECRUITMENT AND HERBIVORY OF PLANTED SPECIES IN CIRCULAR PLOTS

Species	# of Recruits	Deer Impacts	Beaver Impacts
Blackberry (non-native)	13		
Yerba Santa	6		
Valley Oak	3		
California Blackberry	2		
White Alder	2		
Black Locust (non-native)	2		
Fremont Cottonwood	1		
	29		
Planted Species			
Arroyo Willow		3	
Black Willow		2	3
Red Willow		1	8
Shining Willow		1	
Fremont Cottonwood			3
Totals	**29**	**7**	**14**

Belt Transect Data, 2A Borrow

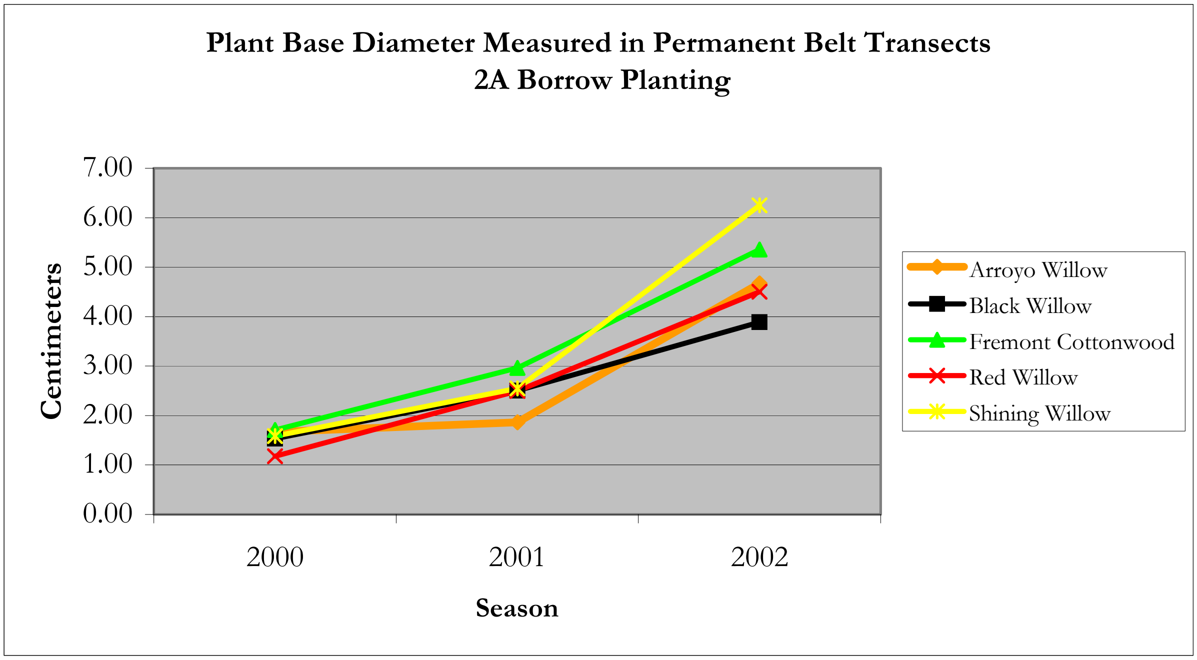

Figure 5. Three-year stem base diameter growth of all species planted at the 2A Borrow planting. Mean data from two transects.

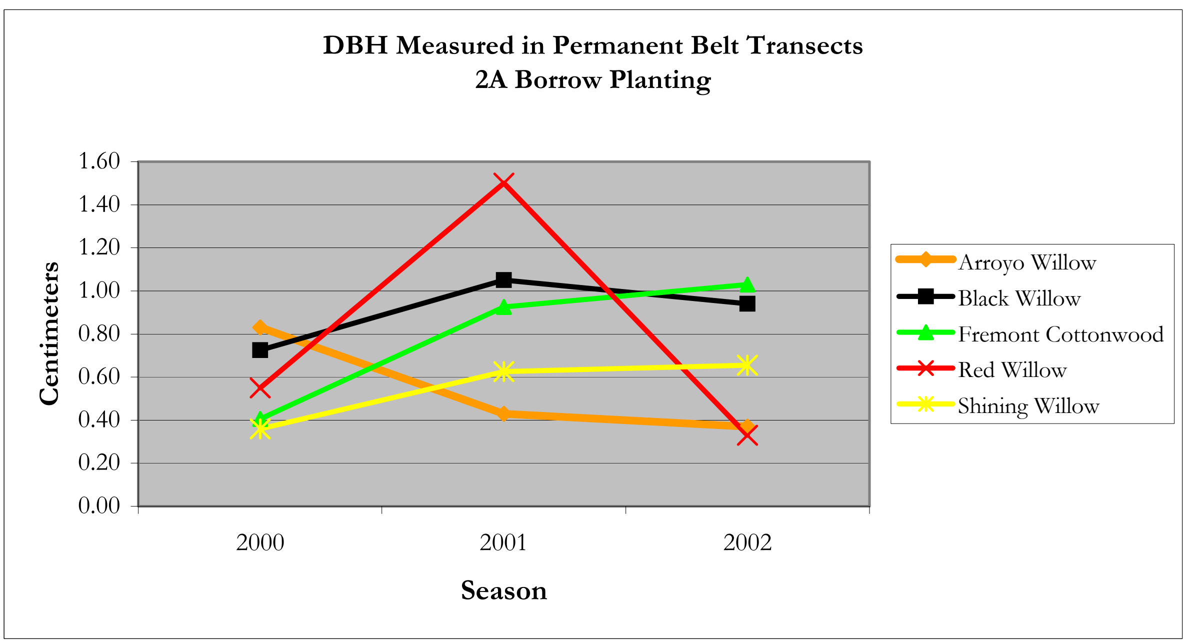

Figure 6. Three-year stem diameter growth at breast height for all species planted at the 2A Borrow planting. Mean data from two transects

Table 4 SUPPORTING DATA (2002) FOR FIGURES 5 AND 6						
Species	**Sample**	**Basal Diameter**			**Diameter Breast Height**	
		SD†	**SE ‡**		**SD**	**SE**
Arroyo Willow	6	1.03	0.42		0.50	0.20
Black Willow	46	1.36	0.32		0.86	0.20
Fremont Cottonwood	30	1.40	0.38		0.78	0.24
Red Willow	4	1.00	0.50		0.47	0.24
Shining Willow	15	2.33	1.03		0.57	0.23

† Standard Deviation
‡Standard Error

Table 5 RECRUITMENT AND COVER OF RECRUITS AND PLANTED SPECIES WITHIN BELT TRANSECTS OF 2A BORROW			
Species Planted	**Relative Cover (%)**	**Absolute Cover (%)**	**Number of Plants**
Black Willow	51.63	5.09	47
Fremont Cottonwood	32.09	3.17	30
Shining Willow	11.63	1.15	14
Red Willow	4.65	0.46	4
Arroyo Willow	0	0	6
Total	**100**	**9.86**	**101**
Species Recruiting in Patches	**Relative Cover (%)**	**Absolute Cover (%)**	**Number of Plants**
Himalayan Blackberry	68.18	2.75	6
Fremont Cottonwood	10.23	0.41	55
Valley Oak	7.95	0.32	1
White Alder	7.95	0.32	4
California Blackberry	4.55	0.18	2
Red Willow	1.14	0.05	8
Wild Grape	0	0	1
Buck Brush	0	0	1
Yerba Santa	0	0	39
Subtotals	**100**	**4.04**	**117**
Species Recruiting in Scour Channels	**Relative Cover (%)**	**Absolute Cover (%)**	**Number of Plants**
White Alder	77.27	36	60
Himalayan Blackberry	10	5	5
California Blackberry	10	5	4
Arroyo Willow	1.82	0.85	15
Shining Willow	0.91	0.43	17
Fremont Cottonwood	0	0	4
Narrow-leafed Willow	0	0	1
Subtotals	**100**	**46.81**	**104**
Recruit Totals			**221**

Plug Site Planting

<u>Circular Plot Data-2002</u>

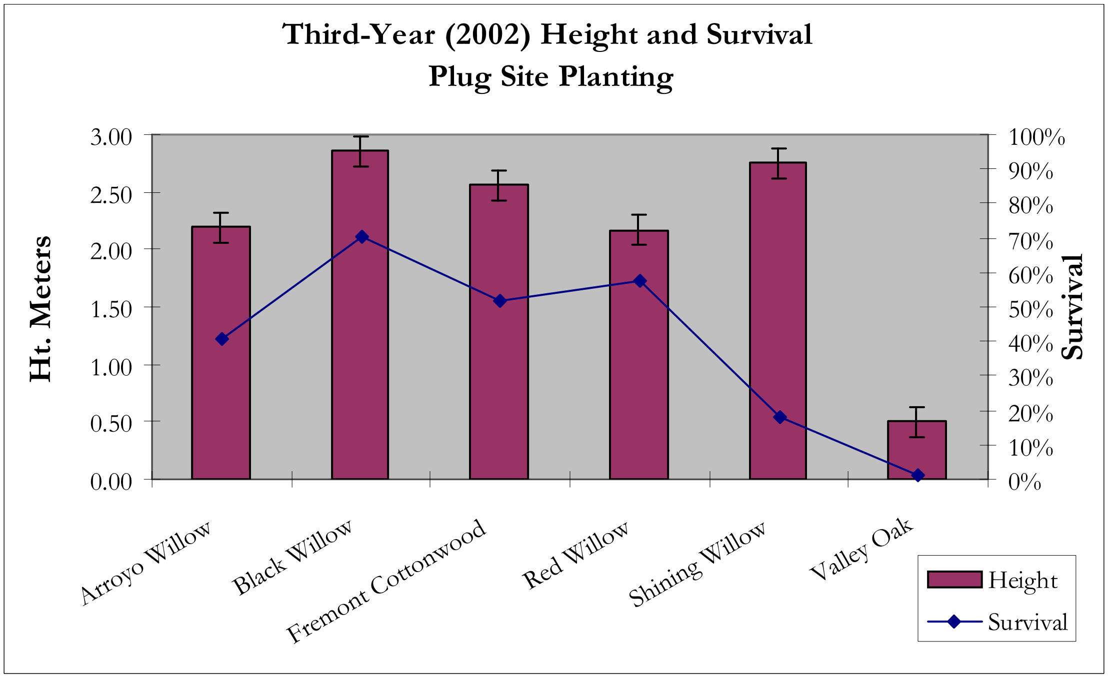

Figure 7. 2002 survival and height chart for all species planted in the Plug Site planting. Due to charting limitation, error bars are the mean confidence interval for all species (+/- 0.13 meters). Valley oak error bar should be disregarded, as only one plant survived.

Table 6
SUPPORTING DATA FOR FIGURE 7

Species	Plants Sampled	Standard Deviation	Standard Error	Confidence Interval (95%)
Arroyo Willow	13	0.38	0.11	0.23
Black Willow	282	0.37	0.08	0.16
Fremont Cottonwood	206	1.01	0.07	0.14
Red Willow	15	0.70	0.18	0.39
Shining Willow	20	0.94	0.21	0.44
Valley Oak	1	NA	NA	NA
Total/Average	**537**	**0.58**	**0.13**	**0.27**

Three-year height growth data:

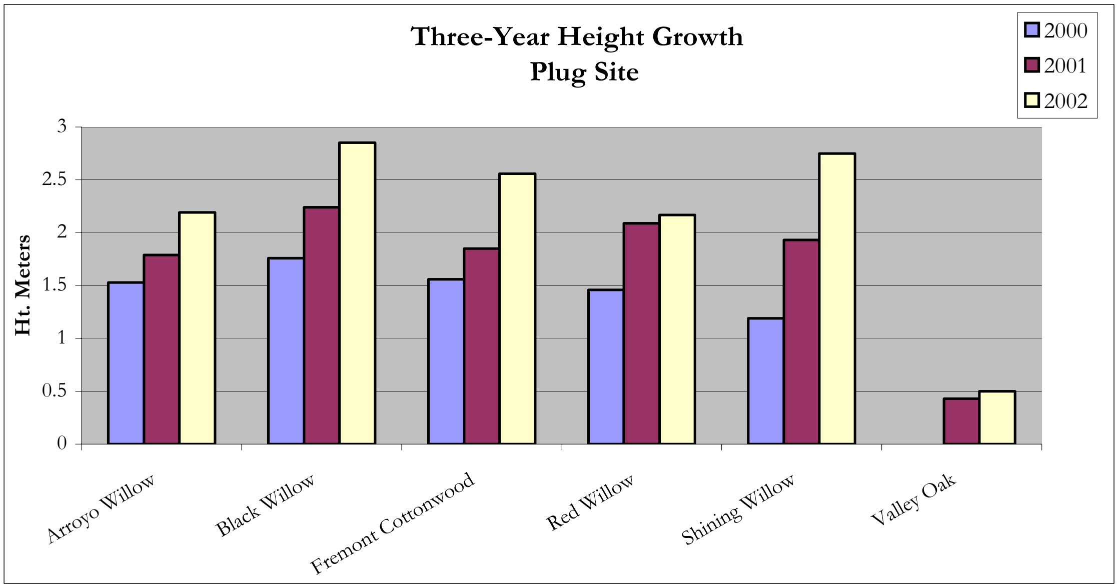

Figure 8. Three-year height growth of all species planted at the Plug Site.

Table 7
2002 WOODY SPECIES RECRUITMENT AND HERBIVORY OF PLANTED SPECIES
PLUG SITE CIRCULAR PLOTS

Species	# of Recruits		Deer Impacts	Beaver Impacts
Fremont Cottonwood & Salix sp. mix	375			
Fremont Cottonwood	244		1	6
Black Willow	30			3
Mule Fat	16			
Yerba Santa	8			
Blackberry (non-native)	1			
Red Willow				12
Shining Willow			1	
Totals	**674**		**2**	**21**

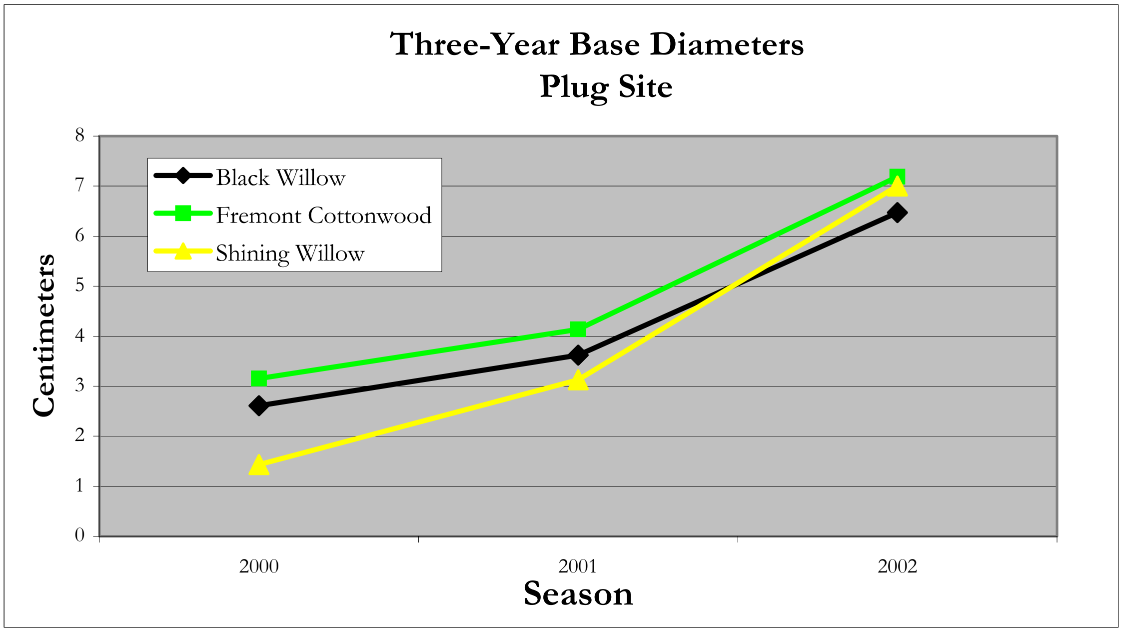

Figure 9. Three-year stem base diameter growth of all species planted at the Plug Site.

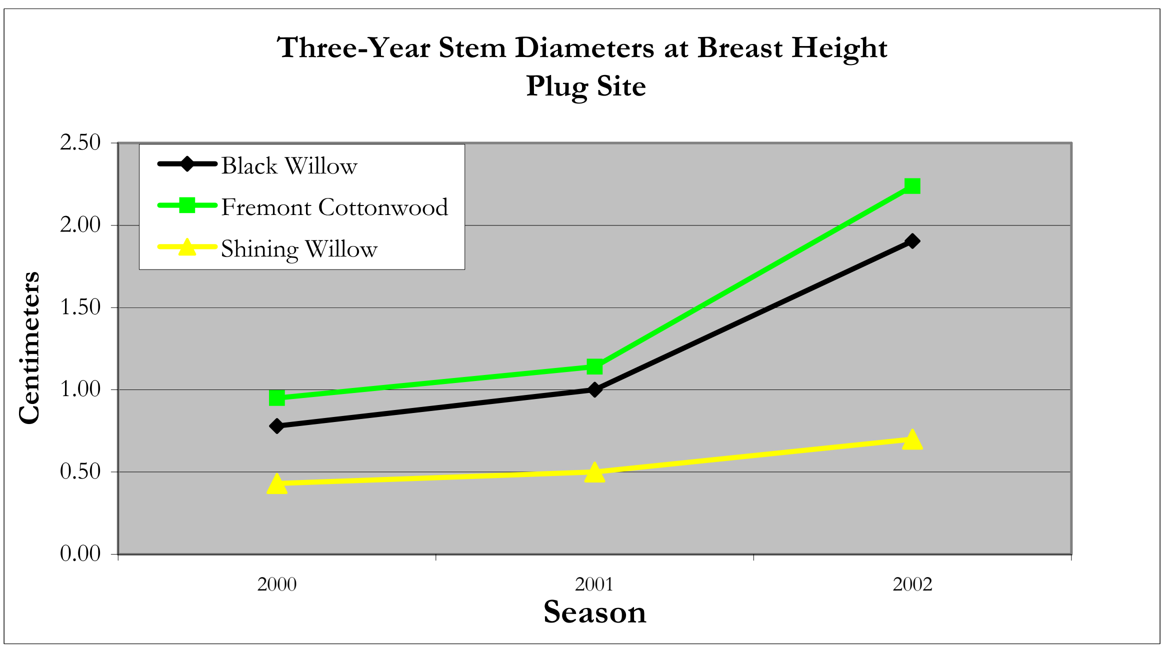

Figure 10. Three-year stem diameters at breast height for all species planted at the Plug Site.

Table 8 SUPPORTING DATA (2002) FOR FIGURES 9 & 10						
Species	**Sample**	**Basal Diameter**			**Diameter Breast Ht.**	
		SD[1]	**SE[2]**		**SD**	**SE**
Black Willow	19	3.26	0.75		0.86	0.20
Fremont Cottonwood	21	1.40	0.38		0.78	0.24
Shining Willow	3	2.33	1.03		0.57	0.23

[1]Standard Deviation
[2] Standard Error

Table 9 RECRUITMENT AND COVER OF RECRUITS AND PLANTINGS WITHIN BELT TRANSECT AT PHASE PLUG SITE			
Species Planted	**Relative Cover (%)**	**Absolute Cover (%)**	**Number of Plants**
Arroyo Willow	0	0	1
Black Willow	45	5	19
Fremont Cottonwood	40	5	21
Shining Willow	15	2	3
Valley Oak	0	0	1
Total	**100**	**12**	**45**
Species Recruited	**Relative Cover (%)**	**Absolute Cover (%)**	**Number of Plants**
Fremont Cottonwood	0	0	356
Black Willow	0	0	23
Arroyo Willow	0	0	11
Yerba Santa	87	10	8
Narrow-leaved Willow	0	0	5
Red Willow	13	2	2
California Blackberry	0	0	1
Mule Fat	0	0	1
Valley Oak	0	0	1
Wild Grape	0	0	1
Total	**100**	**12**	**409**

2B North

Circular Plot Data-2002

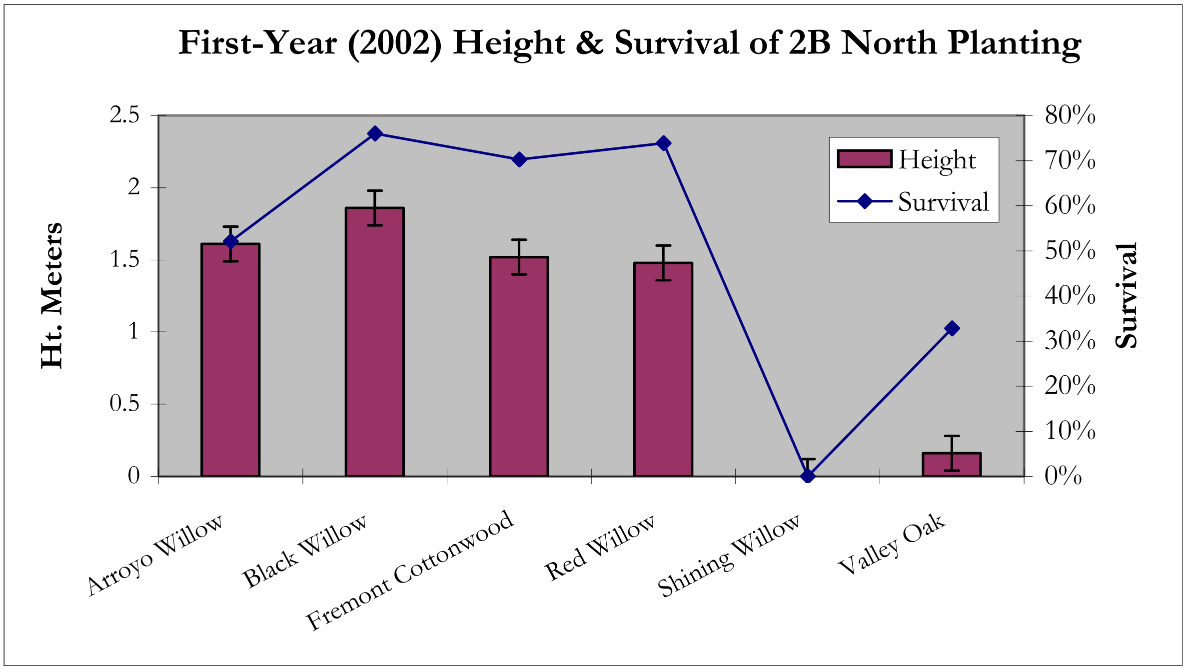

Figure 11. First-year (2002) mean height & survival of 2B North planting. As with previous charting, error bars are the mean confidence interval for all species (+/- 0.12). Valley oak error bars not relevant (see actual SE of valley oak data in Table 10 below. SE of graphed confidence interval is mean of arroyo, black, and red willow, and Fremont cottonwood only.

Table 10
FIGURE 11 SUPPORTING DATA

Species	Plants Sampled	Standard Deviation	Standard Error	Confidence Interval (95%)
Arroyo Willow	50	0.72	0.10	0.20
Black Willow	57	0.94	0.12	0.25
Fremont Cottonwood	59	0.87	0.11	0.23
Red Willow	34	0.94	0.16	0.33
Shining Willow	0	NA	NA	NA
Valley Oak	20	0.15	0.03	0.07
Total/Average	**220**	**0.72**	**0.12**	**0.22**

Table 11 2002 WOODY SPECIES RECRUITMENT AND HERBIVORY OF PLANTED SPECIES IN CIRCULAR PLOTS, 2B NORTH				
Species	**# of Recruits**		**Deer Impacts**	**Beaver Impacts**
Arroyo Willow	69			
Fremont Cottonwood	9		2	
Narrow-leaved Willow	7			
White Alder	7			
Blackberry (non-native)	6			
Yerba Santa	4			
Shining Willow	2			
Valley Oak	1			
Mule Fat	1			
Foothill Pine	1			
Totals	**100**		**2**	**0**

2B South

Circular Plot Data-2002

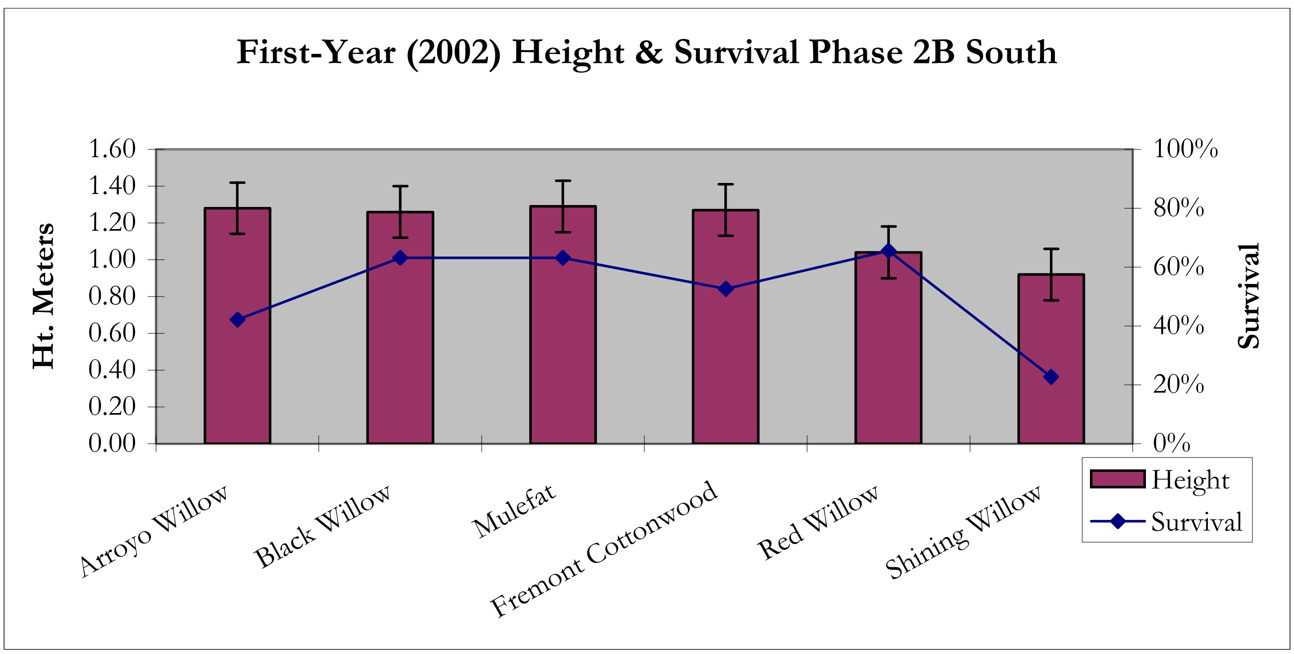

Figure 12. First-year (2002) mean height & survival of 2B South. See Table 12 below.

Table 12 SUPPORTING DATA FOR FIGURE 12				
Species	Plants Sampled	Standard Deviation	Standard Error	Confidence Interval (95%)
Arroyo Willow	99	0.68	0.07	0.14
Black Willow	103	0.71	0.07	0.14
Fremont Cottonwood	113	0.79	0.07	0.15
Mule Fat	30	0.76	0.14	0.28
Red Willow	59	0.68	0.09	0.18
Shining Willow	5	0.79	0.36	0.99
Total/Average	**409**	**0.71**	**0.14**	**0.33**

Table 13 2002 WOODY SPECIES RECRUITMENT AND HERBIVORY OF PLANTED SPECIES 2B SOUTH				
Species	Number of Recruits		Deer Impacts	Beaver Impacts
Arroyo Willow	15			
Fremont Cottonwood	15			
Narrow-leaved Willow	11			
Shining Willow	10			
Red Willow	7			
Black Willow	5			
Yerba Santa	1			
Total/Average	**64**		**0**	**0**

Belt Transect Data, 2B South-2002

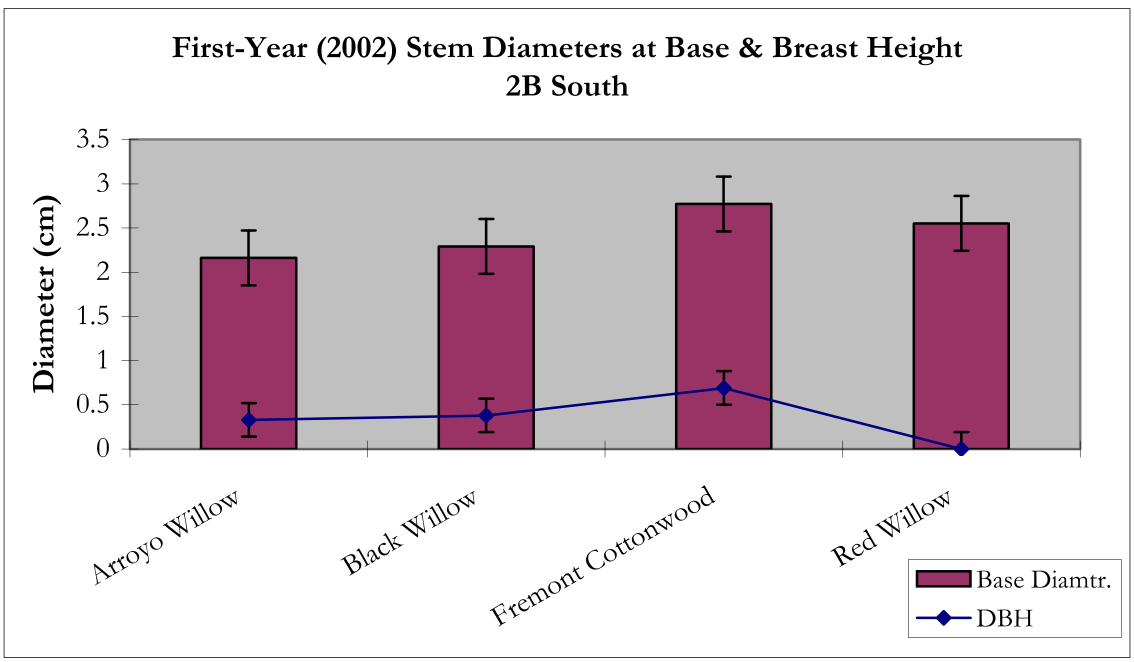

Figure 13. First-year (2002) stem diameter at base and breast height of 2B South plantings. SE means used for error bars, see Table 14 for tabular data.

Table 14 SUPPORTING DATA (2002) FOR FIGURE 13								
Species	**Sample**	**Basal Diameter**				**Diameter Breast Height**		
		SD†	**SE ‡**	**CI (95%)**		**SD**	**SE**	**CI(95%)**
Arroyo Willow	7	0.88	0.33	0.81		0.39	0.15	0.36
Black Willow	8	0.62	0.22	0.52		0.55	0.19	0.46
Fremont Cottonwood	10	0.52	0.17	0.37		0.75	0.24	0.54
Red Willow	6	1.30	0.53	1.36		NA	NA	NA
Total/Means	**31**	**0.83**	**0.31**	**0.77**		**0.56**	**0.19**	**0.45**

† Standard Deviation
‡ Standard Error

DISCUSSION

2A Borrow and Plug Site

After three years, growth for all species and all measures of productivity is greater at the Plug Site planting than at the 2A Borrow planting (Figures 14-15-16). These growth patterns may reflect differences in sites conditions as well as species adaptations to those conditions. There was a marked decrease in height growth and even a size reduction in DBH for several species at 2A Borrow in 2002 (Figure 6).

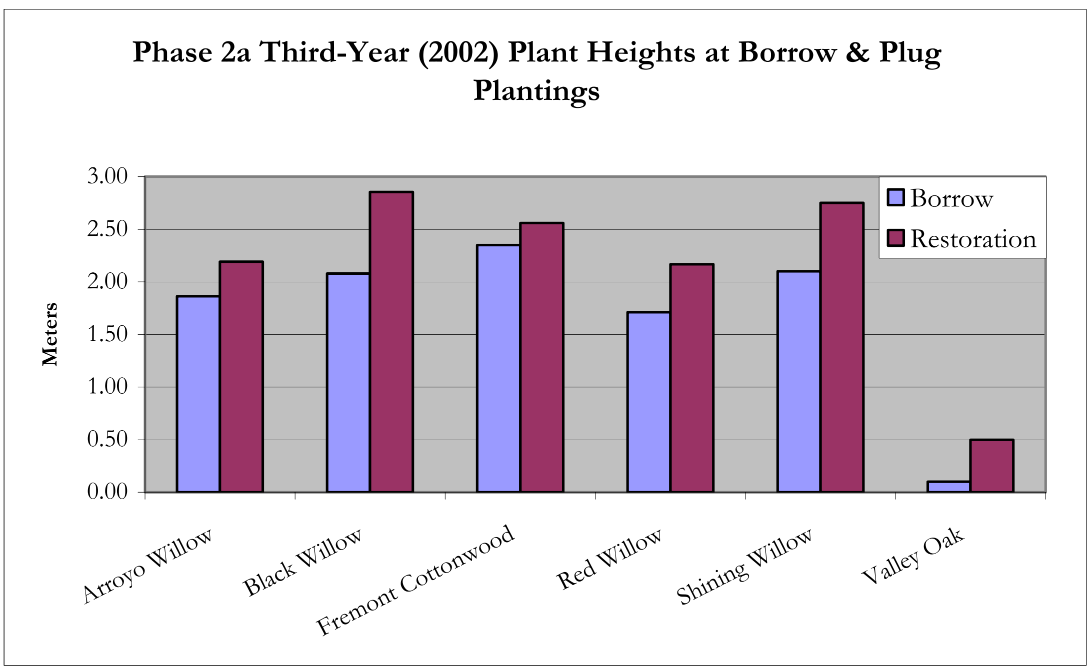

Figure 14. Height comparison of 2A Borrow and Plug Site (Restoration) plantings.

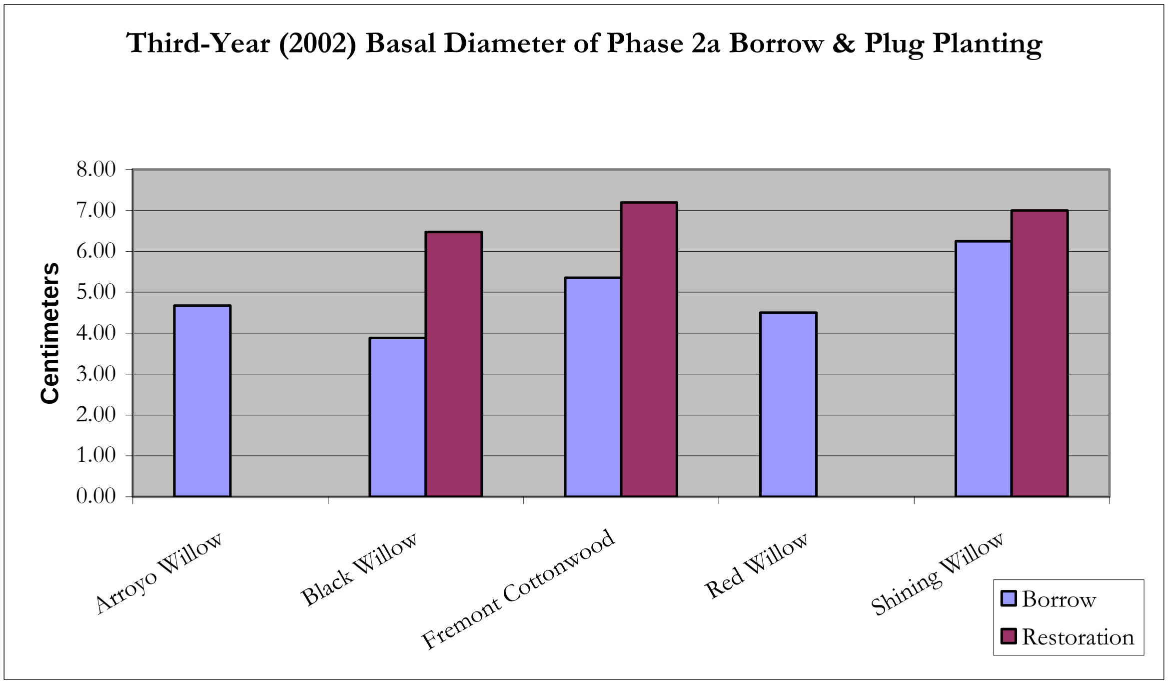

Figure 15. Base stem diameter comparison of 2A Borrow and Plug Site (Restoration) plantings

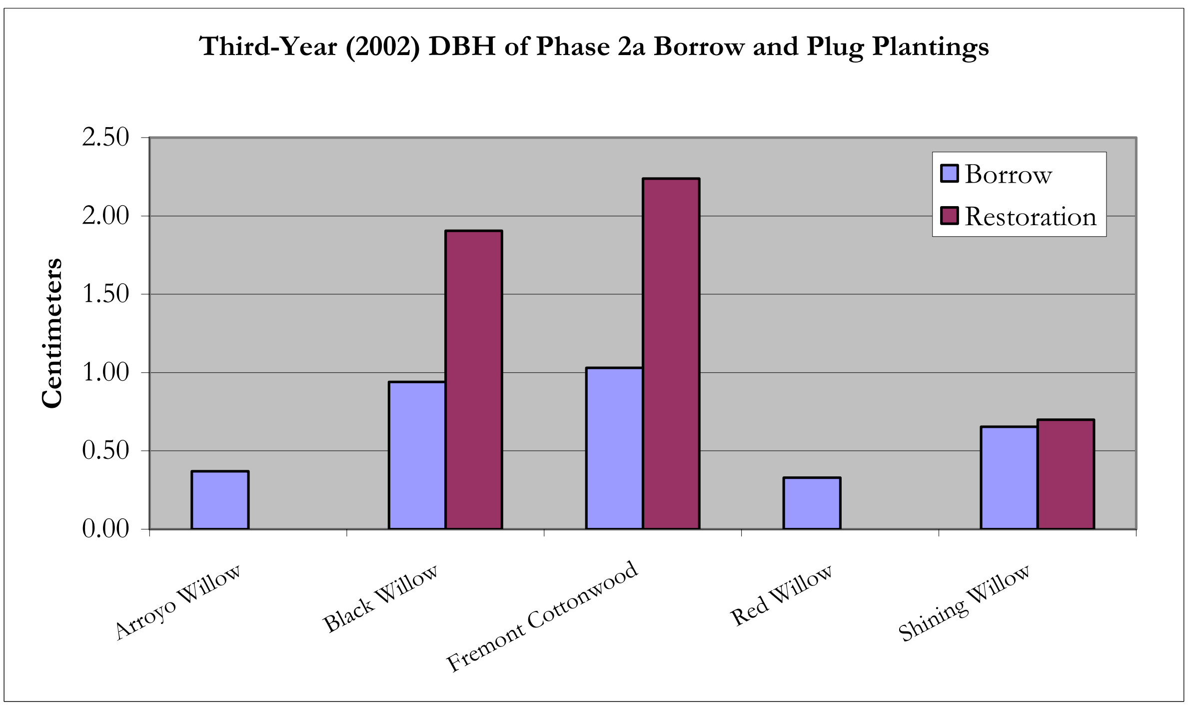

Figure 16. DBH comparison of 2A Borrow and Plug Site(Restoration) plantings.

During this same period, basal diameter still showed a gradual increase. This growth and form change may be a response to different soil moisture conditions for each planting during the summer and early fall. Early establishment and strong growth patterns of all species during the first two years of the project resulted from good soil moisture throughout the growing season and lower evapotranspiration of the smaller plants. By the third year, plants were much larger and required increasing amounts of water to maintain rapid vertical growth. The decreasing height growth and DBH at the 2A Borrow planting could have been caused by plant moisture stress. All of the planted riparian species will take the form of shrubs with multiple stems and much lower height when grown in xeric conditions or when experiencing periodic, severe drought conditions after adequate early season moisture status (the one exception is Fremont cottonwood, which has a stronger tendency to maintain a central leader, tree-like form). Vertical shoots extending above the establishing forest will desiccate and die back when plant moisture status is low. This tip dieback releases lateral buds from the apical dominance of the terminal shoot, leading to multiple shoots and a more shrub-like growth form. The greater growth of all species on the Plug Site during the same period, as compared to the 2A Borrow site, indicates these plants have not lost connection with good soil moisture. It must be emphasized that this apparent plant form shift is based on a very small sample size and only one year's data. Further monitoring will be needed to get a better understanding of growth patterns throughout the project areas.

Again referring to project objectives, the creation of favorable conditions for regeneration of native riparian species is one goal of the project. Favorable conditions for regeneration vary by species, so a diverse riparian zone was planned in order to accommodate recruitment and regeneration dynamics of a riparian system. Two measures of favorable regeneration conditions are: 1) the number, kind, and location of native species recruitment, and 2) within a newly created floodplain, the ability of the establishing plants to collect debris, sediment, and the accompanying soil microbia and nutrients. Project monitoring has measured recruitment within the belt transects and the circular plots. The data clearly shows successful species recruitment (Tables 5, 9, 11, 13). This is particularly evident in the eastern belt transect of the 2A Borrow planting. Within the two belt transects of this site, 221 woody plants have become established, 74 on the flood plain, and 137 within the deeper scour channels that are in close proximity to surface and ground water throughout the year. At the Plug Site, 409 recruits were counted within the single belt transect, with an additional 674 recruits in the circular plots. This recruitment data is an important measure of success at these sites. In addition to the naturally establishing recruits, Figure 17 shows the newly established plants "doing their job" in the restoration process. This photograph was taken at the 2A Borrow planting. Under the right conditions of water flows and depths, sand and plant material will continue to collect behind these established plants. This will act as a new site for further collection of the larger soil particles of sand, along with some smaller silt and organic material which may gradually develop and form new recruitment sites for other species, as well as improve growing conditions for the existing plants. This is the beginning of the restoration of a healthy riparian system.

Figure 17 Floodplain sediment deposition from plantings

2B North

2B North and 2B South plantings show similar differences in growing conditions, as evidenced by the first-year survival and growth data. First-year survival of the 2B North planting is above 60%, and height growth is near 1.5 meters. First-year survival at 2B South approaches 85% with an average height growth of 1.4 meters. Recruitment is spotty, but the flood plain is just beginning to develop at these sites.   Only on the western edge of 2B North are there a number of recruits. This western section is a protected area near existing riparian vegetation, and the water table is likely influenced by drainage from the northern edge of the river valley as well as a large pond approximately 150 meters north of the planting.

Common herbaceous plants that could be identified, at least to the genus, were noted (Table 1). Particular attention was paid to the potential for noxious weed recruitment, and to this point there does not seem to be any Category A listed noxious weeds, as defined by the California Department of Food and Agriculture. It should be noted that one winter-period observational survey of herbaceous vegetation is not an adequate intensity or frequency to monitor for noxious weeds.

CONCLUSIONS

After three years of establishment and growth at the Plug Site and 2A Borrow plantings, mean survival of all stem cuttings is over 50%. Mean height growth is greater than 2 meters, with plants averaging 2.5 meters in height on the Plug Site. Black willow mean height at the Plug Site is nearly 3 meters, and Fremont cottonwood and shining willow have grown over 2.5 meters in height.

First-year mean survival for 2B North is 60%, and 2B South is 55%. This is very similar to the first-year survival means for the 2A Borrow and Plug Site plantings (61 and 60% respectively). Mean height growth for all stem-planted species is over one meter at both 2B North and 2B South, which is slightly less than the average first-year height for 2A Borrow and the Plug Site.

Recruitment of native woody species is excellent, and planted areas are beginning to effect soil deposition and floodplain development. Ecological site differences are reflected in highly variable survival, growth, and growth forms. These differences are beginning to contribute to the structural diversity of vegetation within the project area.

These results clearly show that the riparian vegetation restoration objectives for this project are being met at the Plug Site and 2A Borrow plantings. Monitoring results indicate that after one year of development, survival and growth of the 2B North and South plantings are comparable to the early stages of the Plug Site and 2A Borrow plantings.

RECOMMENDATIONS

The following recommendations are provided based on the monitoring results presented in this report, observations by the authors and information obtained from individuals who had first-hand knowledge of the implementation, maintenance and monitoring of past revegetation activities. Three general areas of recommendations are provided.

The *Monitoring Methods Recommendations* section presents suggested changes to the previously established monitoring methods, or to the way in which data is currently being collected, in order to improve scientific accuracy and/or reduce monitoring costs. The *Revegetation Methods Recommendations* section presents suggested design changes to the current planting techniques or maintenance program in order to improve plant survival and growth. Finally, the *Research Recommendations* section presents potential experiments that could be incorporated into the design and monitoring programs in order to answer key adaptive management questions. A justification for all recommendations is provided.

Monitoring Methods Recommendations

1. **Future data collection should be conducted during the same month of each year.** The timing of data collection should be standardized to occur at roughly the same time each year. Data collection for the 2000 growing season occurred in November while data collection for the 2001 and 2002 seasons occurred between December and March. Differences in the degree of plant dormancy can affect the observer's accuracy of identifying plant species, determining survival/mortality, and estimating height, cover, and recruitment density. While thorough examination by the observer can minimize these inaccuracies, (eg. scraping the bark to confirm plant survival or the height of living tissue) it takes additional time, which increases the cost of the monitoring effort. It is even more critical that any data collected pertaining to herbaceous vegetation be collected at the same time of year because of the fact that dominant herbaceous vegetation will vary drastically throughout the growing season. If the Restoration Team decides to implement a more vigorous monitoring program for herbaceous vegetation, data collection should occur in the spring when plant identification is optimal.

2. **The randomized circular plots should be discontinued and replaced with additional fixed belt transects.** In order to analyze survival data for the circular plots, it is critical to be able to identify the species of plantings that did not survive. We were able to accurately identify plantings that did not survive by the end of the 2002 growing season in all but two patches where high mortality made reconstructing planting sequences impossible. However, it will get

increasingly difficult, and eventually impossible to identify plantings that did not survive unless a total mapping effort is completed of all of the planting sites. In addition, it is getting increasingly difficult to collect the circular plot data as the plants develop. The cost of continuing this method will likely increase significantly over time.

Belt transects can be used to collect the same information as the circular plots and will be more efficient because a complete mapping of the plantings in the plots can be accomplished at a much lower cost than for the entire planting sites. We recommend adding several additional belt transects to each planting so that each site has a minimum of three belt transects. The new belt transects should be oriented along planting rows and include 3 rows. The belts should be used to collect the same information that is currently being collected in the belt transects and circular plots. If this recommendation is adopted, the belt transects should be set up and the plantings should be mapped as soon as possible while remnants from plantings that did not survive can still be identified by species.

One of the important roles monitoring plays in the adaptive management process of restoration is to measure plant responses to specific site conditions over time. This information will help us make adjustments to improve the existing project management and to increase the success of future projects. Sample sizes of the belt transects being measured now are not large enough to provide us with definitive answers to management questions. Measuring changes in plant growth and survival of the same plants over time in fixed permanent belt transects laid across a floodplain (Griggs 2001), will provide statistically powerful and critical feedback information in an efficient manner. There will be a spatial component to the analysis that is not possible with annual randomly placed circular plots. The spatial components will include distance to seasonal and perennial surface water, direct correlation of productivity and survival with water table and soil moisture measurements (by placement of water table and soil moisture measuring devices within the transects), and relationships of individual species responses to known, measurable site conditions.

If the circular plots are not discontinued, we recommend a complete mapping of all of the revegetation plantings at all sites. If this option is selected, mapping should be done as soon as possible while remnants from plantings that did not survive can still be identified by species. A total mapping of plantings will take a considerable effort, but will be critical to ensure the accuracy of circular plot data and will greatly increase the efficiency of future data collection efforts.

3. **Take photos twice each year at fixed points to show vegetative changes and changes in soil deposition and surface organic layers.** Fixed photo points should be reoccupied twice each year. Photos should be taken in the late Summer to document plant growth and surface organic matter and in the late Winter, when deciduous plants are dormant, to document floodplain surface soil deposition.

4. **Discourage vehicle/equipment use in the areas that are being used as monitoring transects.** Vegetation recruitment may be negatively affected by vehicle traffic and could result in skewed monitoring data results. Areas that are not planted along the belt transects are valuable as reference areas to compare to the planted areas. Vehicle and construction equipment use naturally tends to occur in unplanted areas and in scour channels. Efforts should be made to discourage vehicle/equipment use within the belt transects.

5. **Discontinue collecting DBH/Basal Diameter and use height and cover as measures of productivity.** Basal diameter and DBH have become increasingly difficult to measure as the plantings have increased in size. Basal diameter measurements are becoming meaningless for

some of the tree and many of the shrub plantings as they develop multi-stem bases (Figure 18). DBH measurements are becoming inconsistent because most of the plantings have developed multiple stems (Figure 19). While DBH and basal diameter were good measurements of productivity for the first two growing seasons, their value as productivity indicators is diminishing. We recommend discontinuing these two measurements and using plant height and aerial cover as measures of productivity.

Figure 18. Photo of base of multi-stemmed planting

Figure 19 Photo of multi-stemmed planting

6. **Add herbaceous monitoring plots to belt transects.** The Calfed Adaptive Management Forum Report for Clear Creek recommends monitoring herbaceous vegetation. If this is desired by the Restoration Team, we recommend adding quadrats along belt transects and/or conducting a complete census to monitor species composition of herbaceous vegetation of the planting sites. The data should be analyzed to determine the composition of native vs. non-native herbaceous plant species that are establishing on the floodplains. Monitoring of herbaceous vegetation should occur once in the spring, at a minimum, and preferably once again in the early fall.

Revegetation Methods Recommendations

1. **Cut tops of pole plantings to achieve a 1/3 above ground 2/3 below ground ratio to provide an optimal root to shoot ratio.** Some of the plantings in 2B North and 2B South were planted with an above ground stem of up to 5 feet and an assumed maximum 4 foot planting depth. Plantings will generally develop initial root-to-shoot ratios in relation to the ratio of plant material that is installed below ground and above ground. Plantings can experience significant moisture stress, especially during the first growing season, if the top growth transpires more moisture than the roots can absorb. Discussions with WSRCD staff indicate that subsequent plantings are being cut to achieve a more desirable ratio.

2. **Improve irrigation scheduling response to soil moisture monitoring.** While overall, first year survival at 2B North and South appears to be similar to 2A Borrow and the Plug Site, it

appeared that 2B South experienced patchy mortality due to moisture stress. The large number of plantings likely made it difficult for maintenance crews to completely irrigate the entire site in a timely manner using the existing infrastructure and irrigation methods (tank irrigation). Annual planting numbers should be reduced in size such that the current infrastructure can be responsive to plant moisture stress monitoring data or the capacity of the infrastructure should be improved so that the entire site can be irrigated in a shorter period of time. Alternatively, other irrigation methods such as drip line irrigation could be considered.

3. **Install fertilizer tablets for valley oak plantings.** Valley oak plantings that germinated and survived in Phase 2A have not grown substantially since the first growing season. While initial site conditions are not optimal for valley oak (with the exception of portions of 2B North), changes in site conditions due to fine soil deposition, shading and organic matter build-up may make future conditions favorable. Future valley oak plantings would likely benefit from the addition of a slow-release fertilize tablet similar to those used for the pole plantings. Discussons with WSRCD staff indicates that fertilizer tablets are being installed in subsequent plantings.

4. **Ensure that cottonwood and willow pole cuttings are planted into the water table.** Discussions with the contractor that installed the plantings at 2B South and with WSRCD staff indicated that most of the plantings were not planted into the water table. A critical element of the original planting design concept was that pole plantings were to be installed into groundwater in the wet season so that developing roots could chase the receding water table during the initial growing season. The revegetation designs for 2B North and South used the same 4 foot planting depth specifications as were used for the Plug Site and 2A Borrow, although the water table was apparently significantly deeper. We recommend that piezometers be installed at future restoration sites and monitored for at least one full growing season prior to planting so that planting designs, and possibly geomorphic floodplain designs, can be tailored to hydrologic site conditions.

5. **Include additional floodplain plant species that can be planted as cuttings.** Several species that would enhance wildlife habitat on the restored floodplains and could be added to the species mix relatively easily include wild grape (*Vitis californica*) and native blackberry (*Rubus ursinus*). These species are not showing up in significant numbers as recruits after three years of monitoring. These and other species could also be planted as container stock in trials within the previously planted sites such as the Plug Site and 2A Borrow where site conditions may now be more favorable due to increased shade and leaf litter from past plantings.

Research Methods

1. **The fertilizer and mulch trials that were set up at 2A Borrow and the Plug Site should be reassessed at the end of the 2003 growing season.** The 2000 season monitoring report recommended that the trials be reevaluated at the end of the 2001 growing season. However, data has not been collected since the first growing season. Because additional mortality has occurred subsequent to the initial growing season, we recommend that these trials be reevaluated again in 2003 in order to gain information about the effect of the mulch and fertilizer on survival and productivity.

2. **Experiment with longer cuttings to see if there is a maximum length that will survive.** One of the potential ways to establish pole plantings in areas that have deeper groundwater tables is to use longer pole cuttings and install them deeper. One unknown variable is whether there is a maximum water depth at which cuttings can no longer translocate water to the upper vegetative shoots during the establishment period. We recommend conducting trials to determine if deeper plantings are feasible and, if so, to what depth.

3. **Conduct plant protector trials.** The installation and removal of plant protectors is a significant cost. Plant protectors were initially used in an attempt to increase survival and plant height because the survival of plantings in dredge tailings was relatively unknown. Now that it appears that acceptable survival rates are achievable, we recommend conducting trials to determine what effect protectors have on both survival and productivity for this unique restoration project so that the WSRCD and the Restoration Team can make future management decisions about the necessity of the protectors.

4. **Place additional piezometers and gypsum blocks in belt transects.** The Calfed Adaptive Management Forum Report for Clear Creek recommended that monitoring efforts should be designed to assess the effect of site hydrology on the survival and productivity of the riparian plantings and natural recruitment. Additional groundwater and soil moisture monitoring data will need to be collected in order to assess the affect of these parameters on vegetation survival and productivity. A hydrologist should provide recommendations regarding the number, locations and installation techniques for addition groundwater and soil moisture monitoring devices.

5. **Excavate soil pits in productive and unproductive areas of the Plug Site and 2A Borrow to understand differing site conditions.** Significant differences in plant production may be due to soil conditions, soil moisture differences, or both. Excavating soil pits will help us understand what differences in site conditions are driving plant responses. Soil pits should be excavated in the late summer when groundwater tables are at the deepest point. Soil conditions should be described along with soil moisture conditions, groundwater depth and riparian vegetation root establishment.

6. **Conduct herbaceous vegetation plantings trials.** The Point Reyes Bird Observatory (PRBO) has indicated that a tall, dense herbaceous plant layer would be beneficial for nesting success of several of the avian riparian focal species that are being monitored to measure the success of the Clear Creek revegetation program (Burnett and DeStaebler, 2002). We recommend conducting trials for several native herbaceous plant species that can establish dense thickets such as Santa Barbara sedge (*Carex barbarae*), creeping wild rye (*Leymus triticoides*), mugwort (*Artemisia douglasiana)*, etc.

REFERENCES

Burnett, R. D. and J. DeStaebler. 2002. *Songbird Monitoring in the Lower Clear Creek Floodway Restoration Project, 2001*. Prepared by the Point Reyes Bird Observatory for the Western Shasta Resource Conservation District.

California Department of Water Resources. 1986. Clear Creek Fishery Study. DWR, Northern District.

Elzinga, Caryl L., Daniel W. Salzer, and John W. Willoughby. 1998. *Measuring and Monitoring Plant Populations*. BLM Technical Reference 1730-1, Denver, CO: Pacific Northwest Research Station, Forest Service, U.S. Department of Agriculture.

Griggs, F. T. 2001. *Riparian Revegetation Monitoring Report for the Lower Clear Creek Floodway Rehabilitation Project for the 2000 Season*. Prepared for the Western Shasta Resource Conservation District.

Griggs, F. T. 2002. *Riparian Revegetation Monitoring Report for the Lower Clear Creek Floodway Rehabilitation Project for the 2001 Season*. Prepared for the Western Shasta Resource Conservation District.

McBain & Trush, Graham Matthews and North State Resources. 2000. *Lower Clear Creek Floodway Rehabilitation Project: Channel Reconstruction, Riparian Vegetation, and Wetland Creation Design Document.*

North State Resources. 2000. *Ecological Monitoring Plan for Lower Clear Creek Floodway Rehabilitation Project.* Prepared for the U. S. Bureau of Reclamation and the Western Shasta Resource Conservation District, Redding.

U. S. Fish and Wildlife Service. 1995. Working Paper on Restoration Needs: habitat restoration actions to double natural production of anadromous fish in the Central Valley of California. Volume 1. Prepared for the U. S. Fish and Wildlife Service under the direction of the Anadromous Fish Restoration Program Core Group. Stockton, CA.

Western Shasta Resource Conservation District. 1996. *Lower Clear Creek Watershed Analysis*. Prepared for the Bureau of Land Management, Redding.

Western Shasta Resource Conservation District. 1998. Lower Clear Creek Watershed Management Plan. Prepared for the Lower Clear Creek Coordinated Resource Management Planning Group.

Western Shasta Resource Conservation District, Bureau of Land Management and Bureau of Reclamation. 2001. *Addendum – Mitigated Negative Declaration/Finding of No Significant Impact for the Lower Clear Creek Floodway Rehabilitation Project.*

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Mr. Michael Harris, Project Manager
Western Shasta Resource Conservation District

Appendix A

Planting Plans

AW Patch
Row spacing – 10 ft on center O.C.
Plant spacing – 5 ft O.C.

PATCH#	AREA	PLANTING
AW–1	.2AC	150
TOTAL	.2AC	150

FC Patch
Row spacing – 10 ft O.C.
Plant spacing –10 ft O.C.

PATCH#	AREA	PLANTING
FC–1	.2AC	100
FC–2	1.4AC	650
FC–3	.5AC	200
TOTAL	2.1AC	950

MW Patch
Row spacing – 10 ft O.C.
Plant spacing – 10 ft O.C.

PATCH#	AREA	PLANTING
MW–1	.1AC	150
MW–2	.3AC	250
MW–3	.6AC	500
TOTAL	1.0AC	900

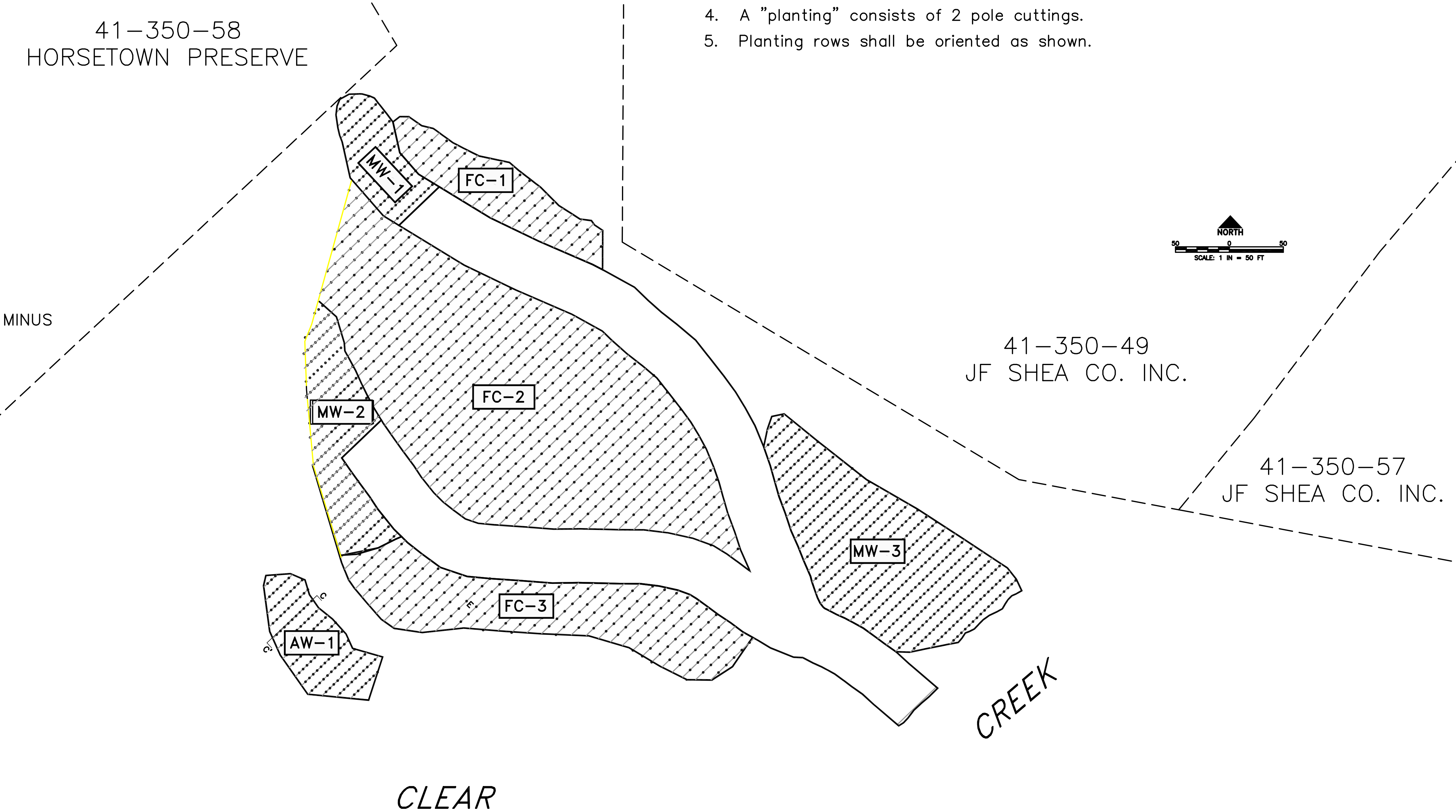
TOTAL 3.3AC 2000
ALL ACRES/PLANTINGS ARE PLUS OR MINUS

TOTAL ROW LENGTH 17500 PLUS OR MINUS

TOTAL PLANTINGS 2000 PLUS OR MINUS

NOTES:

1. Patch boundaries will be flagged by Contractor prior to commencement of work.
2. Contractor shall provide the total pole cutting and acorn counts to the District prior to the start of planting.
3. District will supply pole cuttings in bundles of 25 to Contractor based on Contractor's count.
4. A "planting" consists of 2 pole cuttings.
5. Planting rows shall be oriented as shown.



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LIST OF REVISIONS

REV.#	DATE	BY	COMMENT
1	3/8/00	GH/JS	

LEGEND
PROJECT CONSTRUCTION EXTENT
PATCH BOUNDARY
APPROXIMATE ROW CENTERLINE
PLANTING
SCOUR CHANNEL
PROPERTY BOUNDARY

DESIGNED: J.B.
DRAWN: R.M.
CHECKED: T.P./J.R.

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2651 W Guadalupe Rd., Suite A209
Mesa Arizona 85202

DATE: 2/29/2000

PHASE 2A REVEGETATION
LOWER CLEAR CREEK
FLOODWAY REHABILITATION PROJECT
SHASTA COUNTY, CALIFORNIA

Vegetation Patch and Planting Locations - Borrow Site

SCALE AS SHOWN

SHEET 4 OF 5 SHEETS

FC PATCH
ROW SPACING - 10FT o.c.
PLANTING SPACING - 10 FT ON CENTER (o.c.)

PATCH #	AREA	PLANTINGS
FC-1	±4.8AC	±2050
FC-2	±0.2AC	±100
FC-3	±1.0AC	±500
FC-5	±0.3AC	±150
FC-6	±2.1AC	±950
FC-7	±0.7AC	±300
TOTAL	±9.1AC	±4050

MW PATCH
ROW SPACING - 10 FT O.C.
PLANTING SPACING - 5 FT O.C.

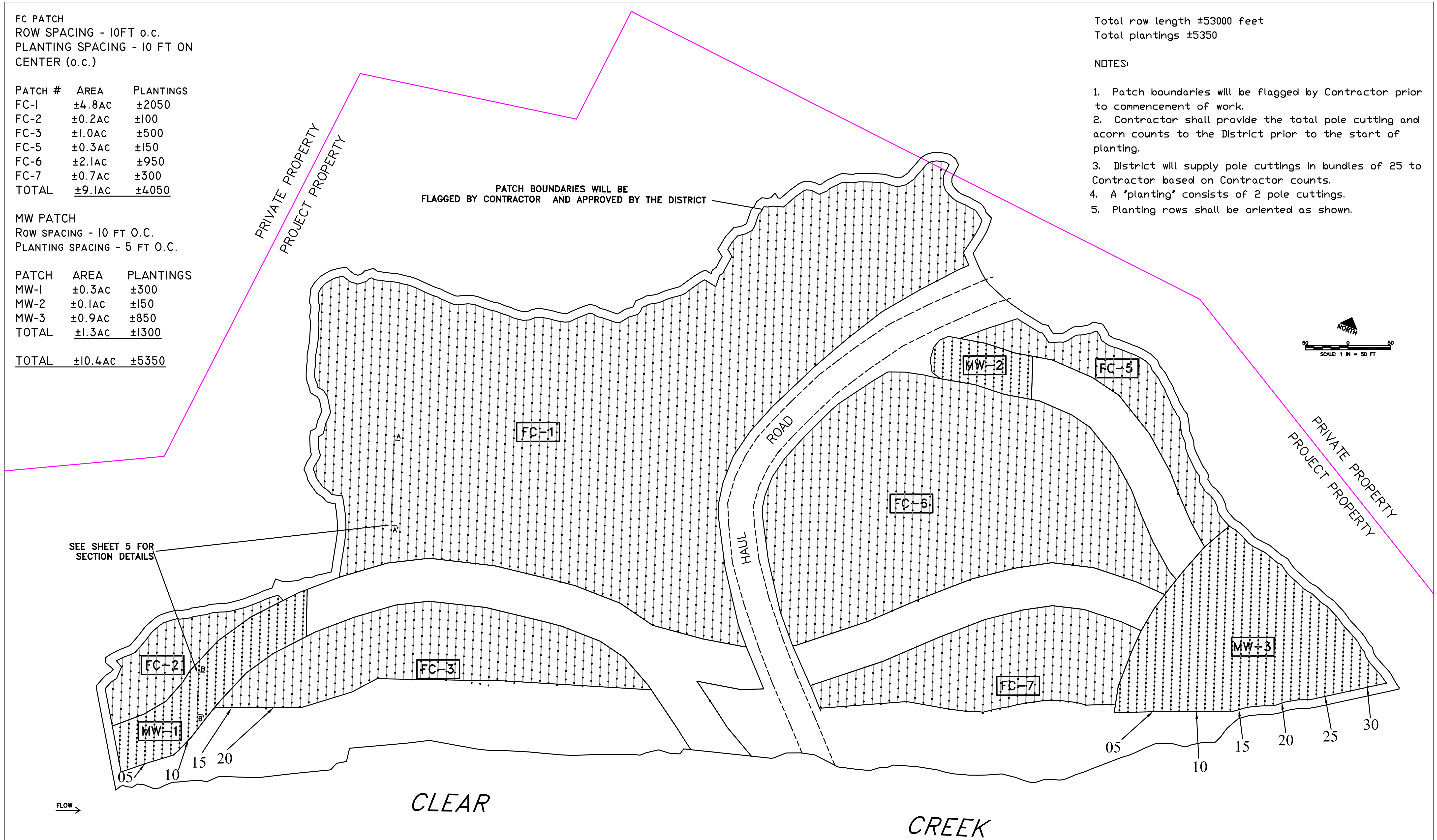
PATCH	AREA	PLANTINGS
MW-1	±0.3AC	±300
MW-2	±0.1AC	±150
MW-3	±0.9AC	±850
TOTAL	±1.3AC	±1300

TOTAL ±10.4AC ±5350

Total row length ±53000 feet
Total plantings ±5350

NOTES:

1. Patch boundaries will be flagged by Contractor prior to commencement of work.
2. Contractor shall provide the total pole cutting and acorn counts to the District prior to the start of planting.
3. District will supply pole cuttings in bundles of 25 to Contractor based on Contractor counts.
4. A "planting" consists of 2 pole cuttings.
5. Planting rows shall be oriented as shown.



LIST OF REVISIONS			
REV.#	DATE	BY	COMMENT
1	3/8/00	GH/JS	

LEGEND
PROJECT CONSTRUCTION EXTENT
PATCH BOUNDARY
APPROXIMATE ROW CENTERLINE
PLANTING
SCOUR CHANNEL
HAUL ROAD

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DESIGNED: J.B.
DRAWN: R.M.
CHECKED: T.P./J.R.

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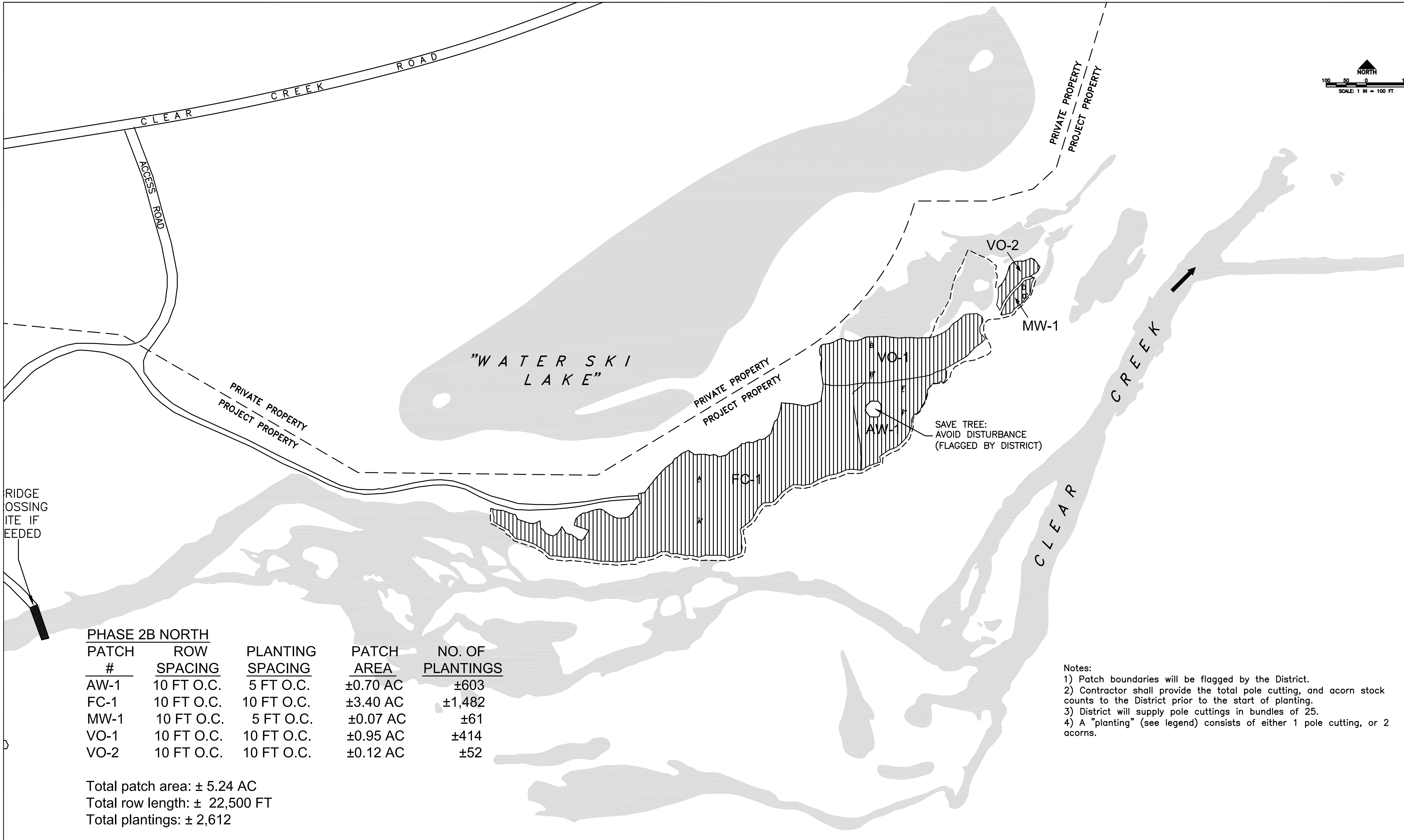
DATE: 2/29/2000

PHASE 2A REVEGETATION
LOWER CLEAR CREEK
FLOODWAY REHABILITATION PROJECT
SHASTA COUNTY, CALIFORNIA

Vegetation Patch and Planting Locations - Plug Site

SCALE AS SHOWN



PHASE 2B NORTH

PATCH #	ROW SPACING	PLANTING SPACING	PATCH AREA	NO. OF PLANTINGS
AW-1	10 FT O.C.	5 FT O.C.	±0.70 AC	±603
FC-1	10 FT O.C.	10 FT O.C.	±3.40 AC	±1,482
MW-1	10 FT O.C.	5 FT O.C.	±0.07 AC	±61
VO-1	10 FT O.C.	10 FT O.C.	±0.95 AC	±414
VO-2	10 FT O.C.	10 FT O.C.	±0.12 AC	±52

Total patch area: ± 5.24 AC
Total row length: ± 22,500 FT
Total plantings: ± 2,612

Notes:
1) Patch boundaries will be flagged by the District.
2) Contractor shall provide the total pole cutting, and acorn stock counts to the District prior to the start of planting.
3) District will supply pole cuttings in bundles of 25.
4) A "planting" (see legend) consists of either 1 pole cutting, or 2 acorns.

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DATE	22OCT01
REVISION	REV1
SCALE	AS SHOWN
DRAWN BY	RT
CHECKED BY	GH
DWG	L.CLEAR CREEK
JOB	PHASE 2B N

LEGEND

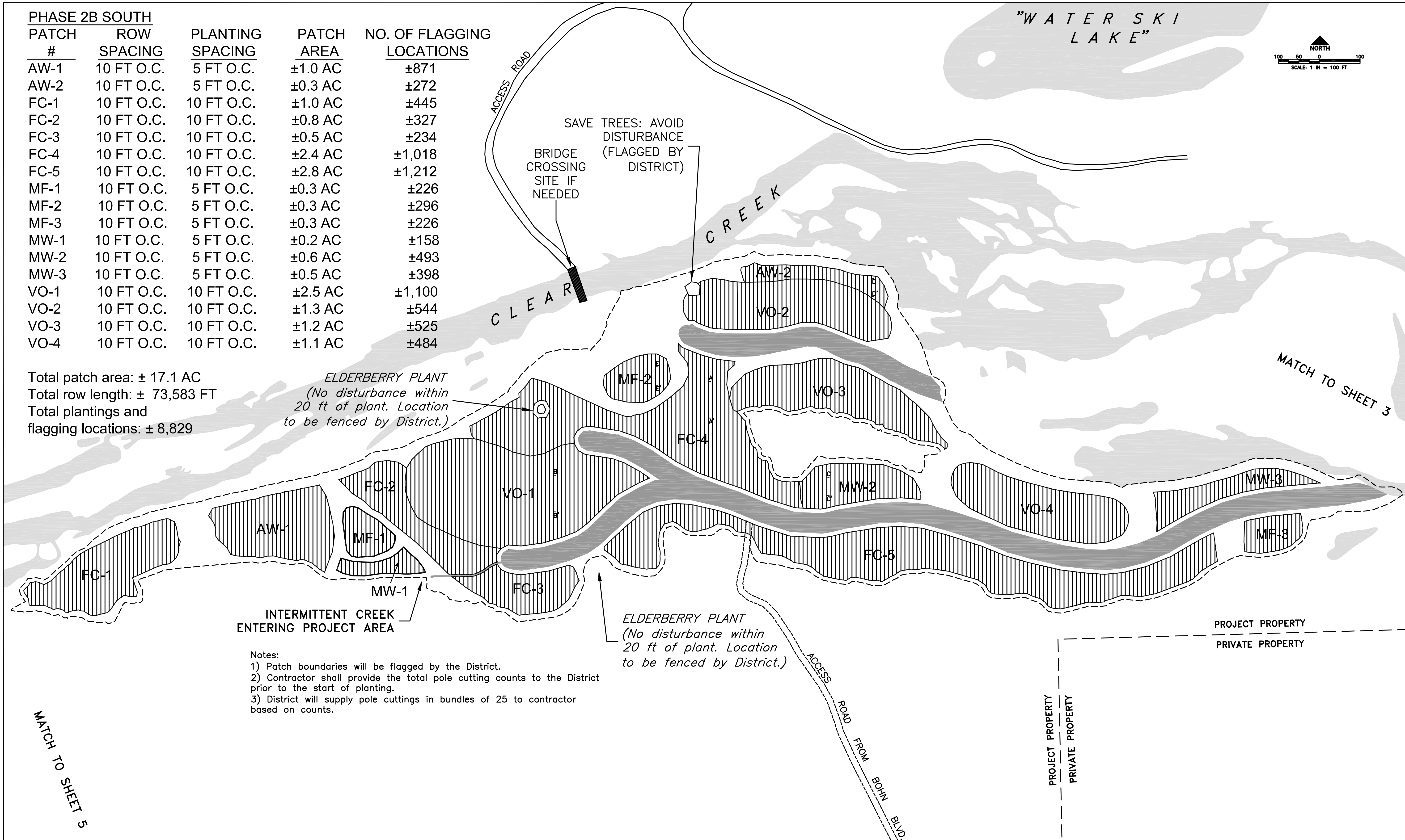
- EARTHWORKS CONSTRUCTION BOUNDARY
- EXISTING WATER SURFACE
- PATCH BOUNDARY
- PROPERTY BOUNDARY
- SCOUR CHANNEL

LOWER CLEAR CREEK FLOODWAY REHABILITATION PROJECT PHASE 2B NORTH VEGETATION PATCH AND ROW LOCATIONS

PHASE 2B SOUTH

PATCH #	ROW SPACING	PLANTING SPACING	PATCH AREA	NO. OF FLAGGING LOCATIONS
AW-1	10 FT O.C.	5 FT O.C.	±1.0 AC	±871
AW-2	10 FT O.C.	5 FT O.C.	±0.3 AC	±272
FC-1	10 FT O.C.	10 FT O.C.	±1.0 AC	±445
FC-2	10 FT O.C.	10 FT O.C.	±0.8 AC	±327
FC-3	10 FT O.C.	10 FT O.C.	±0.5 AC	±234
FC-4	10 FT O.C.	10 FT O.C.	±2.4 AC	±1,018
FC-5	10 FT O.C.	10 FT O.C.	±2.8 AC	±1,212
MF-1	10 FT O.C.	5 FT O.C.	±0.3 AC	±226
MF-2	10 FT O.C.	5 FT O.C.	±0.3 AC	±296
MF-3	10 FT O.C.	5 FT O.C.	±0.3 AC	±226
MW-1	10 FT O.C.	5 FT O.C.	±0.2 AC	±158
MW-2	10 FT O.C.	5 FT O.C.	±0.6 AC	±493
MW-3	10 FT O.C.	5 FT O.C.	±0.5 AC	±398
VO-1	10 FT O.C.	10 FT O.C.	±2.5 AC	±1,100
VO-2	10 FT O.C.	10 FT O.C.	±1.3 AC	±544
VO-3	10 FT O.C.	10 FT O.C.	±1.2 AC	±525
VO-4	10 FT O.C.	10 FT O.C.	±1.1 AC	±484

Total patch area: ± 17.1 AC
Total row length: ± 73,583 FT
Total plantings and flagging locations: ± 8,829



Notes:
1) Patch boundaries will be flagged by the District.
2) Contractor shall provide the total pole cutting counts to the District prior to the start of planting.
3) District will supply pole cuttings in bundles of 25 to contractor based on counts.

North State Resources
5000 Bechelli Lane, Ste 203
Redding, California 96002
(530)222-5347

McBain &Trush
P.O. BOX 663
ARCATA, CA 95518
(707)826-7794

GMA GRAHAM MATTHEWS & ASSOCIATES
P.O. Box 1516
Weaverville, CA 96093
(530)623-5327

DATE	FEBRUARY 02
REVISION	REV 1
SCALE	AS SHOWN
DRAWN BY	RT
CHECKED BY	GH
DWG	L. CLEAR CREEK
JOB	PHASE 2B SO.

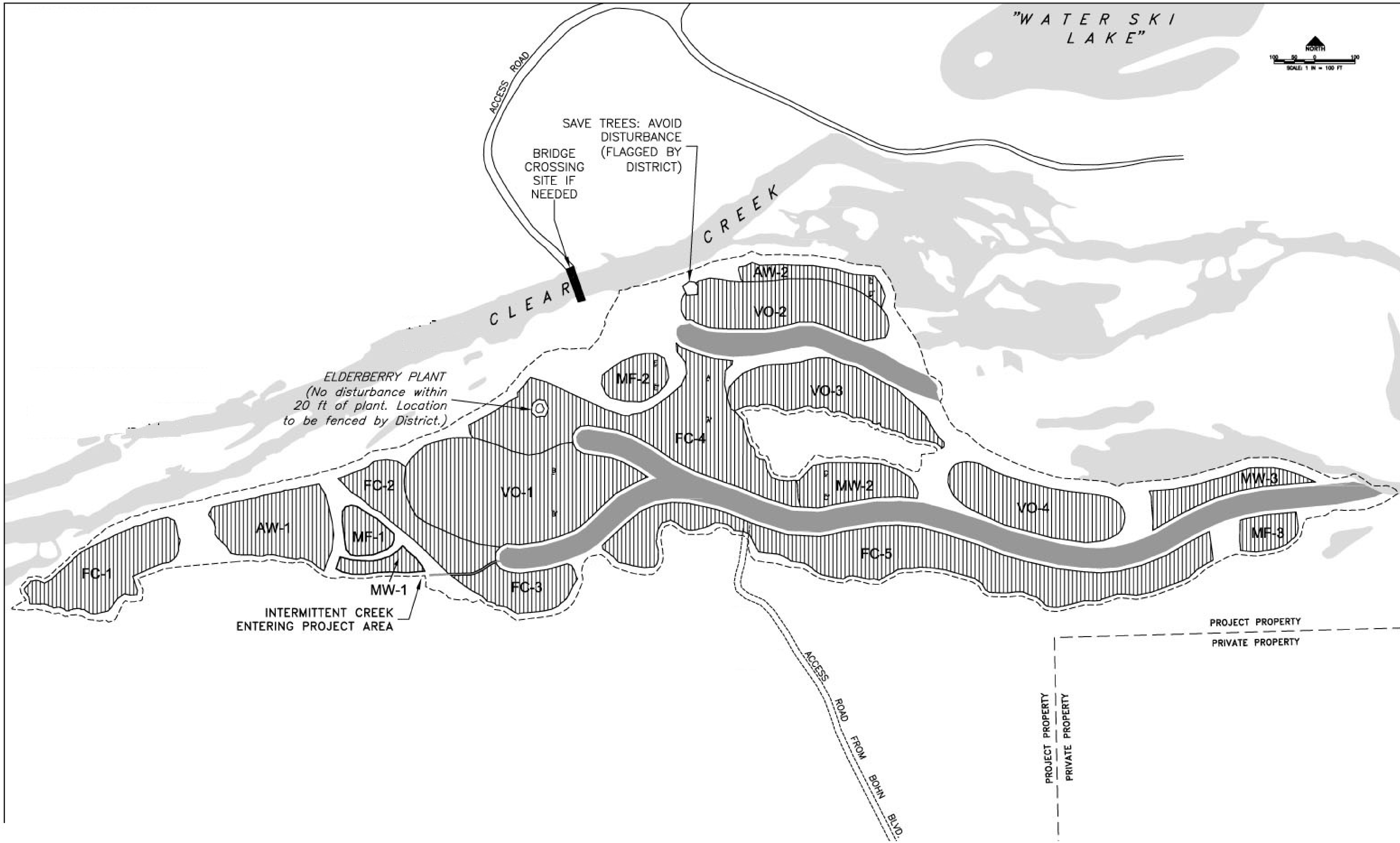
LEGEND

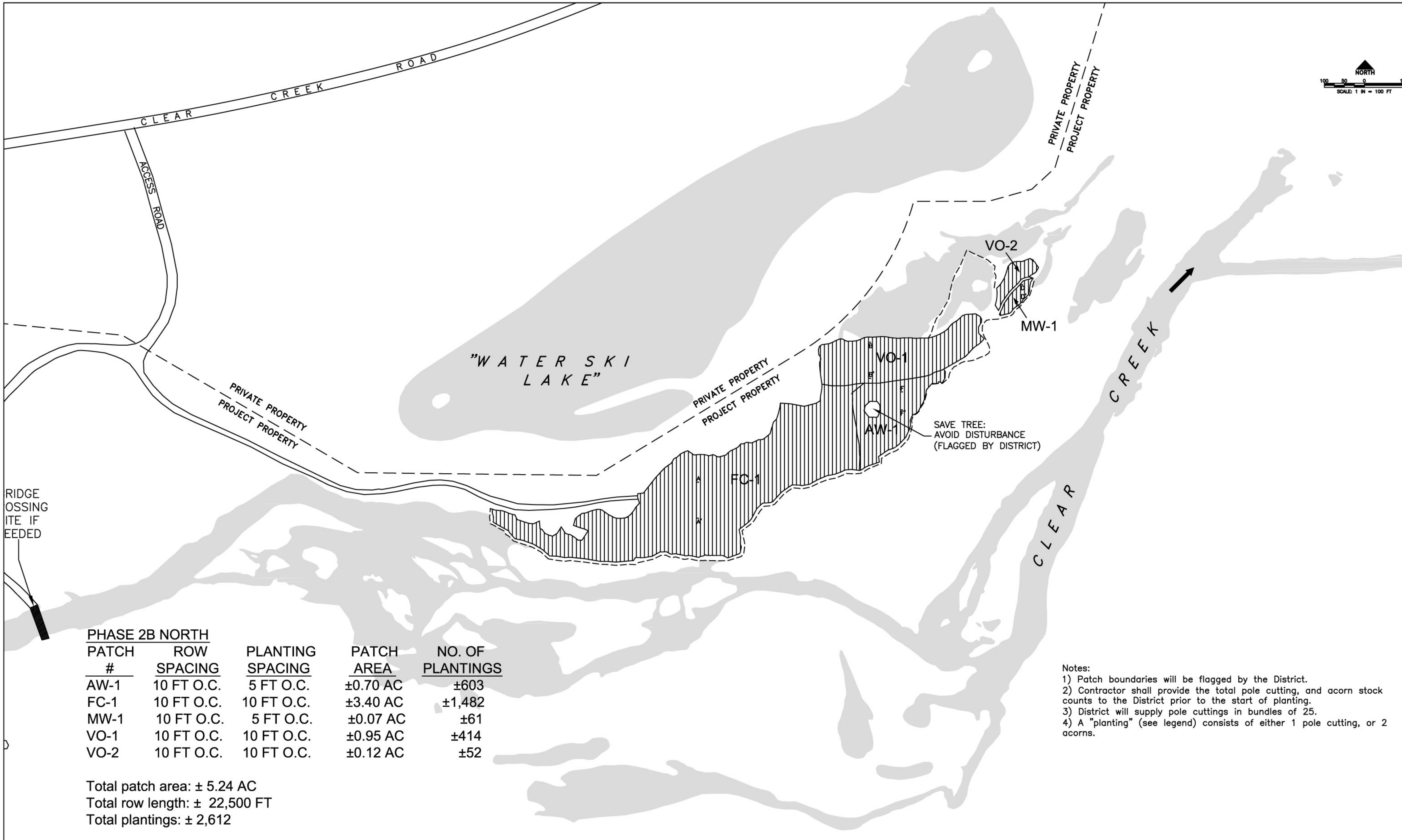
- EARTHWORKS CONSTRUCTION BOUNDARY
- EXISTING WATER SURFACE
- PATCH BOUNDARY
- PROPERTY BOUNDARY
- SCOUR CHANNEL

LOWER CLEAR CREEK FLOODWAY REHABILITATION PROJECT PHASE 2B SOUTH VEGETATION PATCH AND ROW LOCATION

Appendix B

Belt Transect Locations


"WATER SKI LAKE"
NORTH
SCALE: 1 IN = 100 FT
ACCESS ROAD
SAVE TREES: AVOID DISTURBANCE (FLAGGED BY DISTRICT)
BRIDGE CROSSING SITE IF NEEDED
CLEAR CREEK
ELDERBERRY PLANT (No disturbance within 20 ft of plant. Location to be fenced by District.)
AW-2
VO-2
MF-2
VO-3
FC-4
FC-2
VO-1
MW-2
VO-4
MW-3
AW-1
MF-1
MF-3
FC-1
MW-1
FC-3
FC-5
INTERMITTENT CREEK ENTERING PROJECT AREA
PROJECT PROPERTY
PRIVATE PROPERTY
ACCESS ROAD FROM BOHN BLVD.



PHASE 2B NORTH

PATCH #	ROW SPACING	PLANTING SPACING	PATCH AREA	NO. OF PLANTINGS
AW-1	10 FT O.C.	5 FT O.C.	±0.70 AC	±603
FC-1	10 FT O.C.	10 FT O.C.	±3.40 AC	±1,482
MW-1	10 FT O.C.	5 FT O.C.	±0.07 AC	±61
VO-1	10 FT O.C.	10 FT O.C.	±0.95 AC	±414
VO-2	10 FT O.C.	10 FT O.C.	±0.12 AC	±52

Total patch area: ± 5.24 AC
Total row length: ± 22,500 FT
Total plantings: ± 2,612

Notes:
1) Patch boundaries will be flagged by the District.
2) Contractor shall provide the total pole cutting, and acorn stock counts to the District prior to the start of planting.
3) District will supply pole cuttings in bundles of 25.
4) A "planting" (see legend) consists of either 1 pole cutting, or 2 acorns.

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Weaverville, CA 96093
(530)623-5327

DATE	22OCT01
REVISION	REV1
SCALE	AS SHOWN
DRAWN BY	RT
CHECKED BY	GH
DWG	L.CLEAR CREEK
JOB	PHASE 2B N

LEGEND
- EARTHWORKS CONSTRUCTION BOUNDARY
- EXISTING WATER SURFACE
- PATCH BOUNDARY
- PROPERTY BOUNDARY
- SCOUR CHANNEL

LOWER CLEAR CREEK
FLOODWAY REHABILITATION PROJECT
PHASE 2B NORTH
VEGETATION PATCH AND ROW LOCATIONS

SHEET 3 OF 4

Appendix C

2002 Aerial Photos

N

VESTRA

JOB NO. 702091

SOURCE: WSRCD, JUNE 2002

FIGURE

PHASE 2B SOUTH

LOWER CLEAR CREEK FLOODWAY

REHABILITATION

SHASTA COUNTY, CALIFORNIA

APRIL 2003

FIGURE
PLUG SITE
LOWER CLEAR CREEK FLOODWAY
REHABILITATION
SHASTA COUNTY, CALIFORNIA

VESTRA™

JOB NO. 702091

SOURCE: WSRCD, JUNE 2002

APRIL 2003

FIGURE
PHASE 2B NORTH
LOWER CLEAR CREEK FLOODWAY
REHABILITATION
SHASTA COUNTY, CALIFORNIA

VESTRA™

JOB NO. 702091

SOURCE: WSRCD, JUNE 2002

APRIL 2003

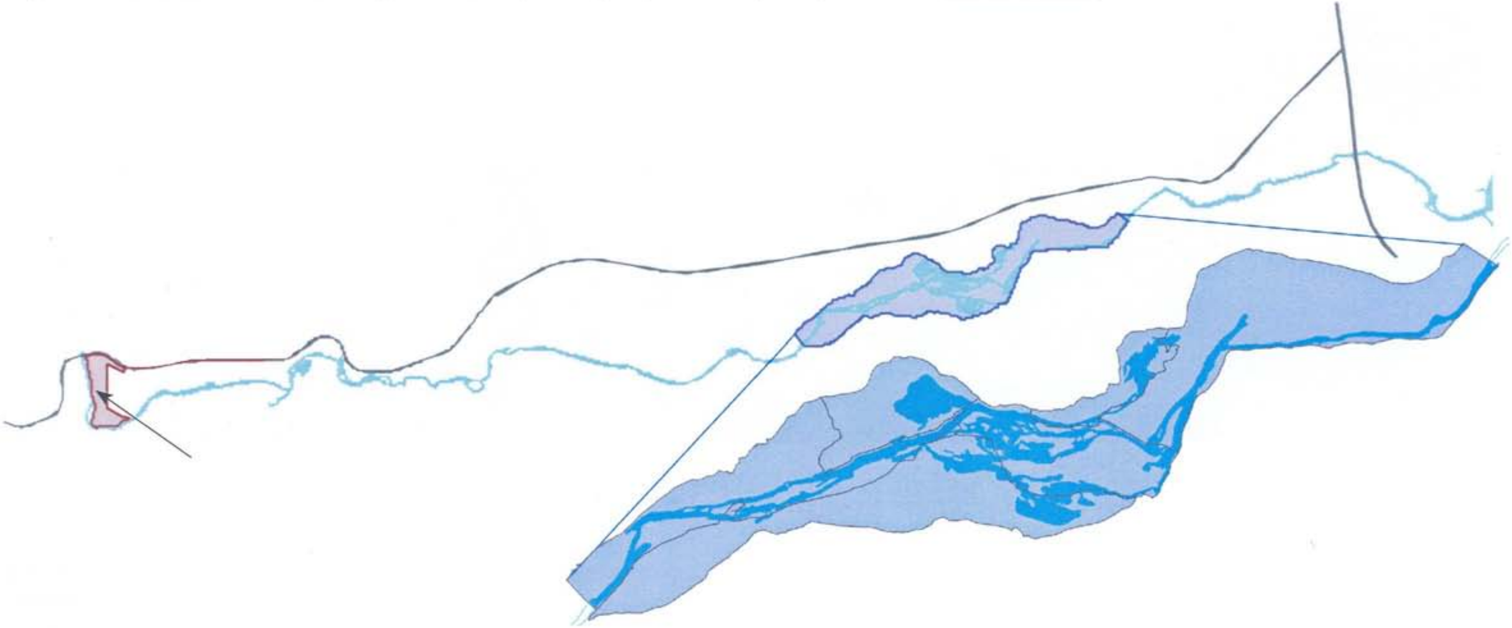
FIGURE
PHASE 2A BORROW
LOWER CLEAR CREEK FLOODWAY
REHABILITATION
SHASTA COUNTY, CALIFORNIA

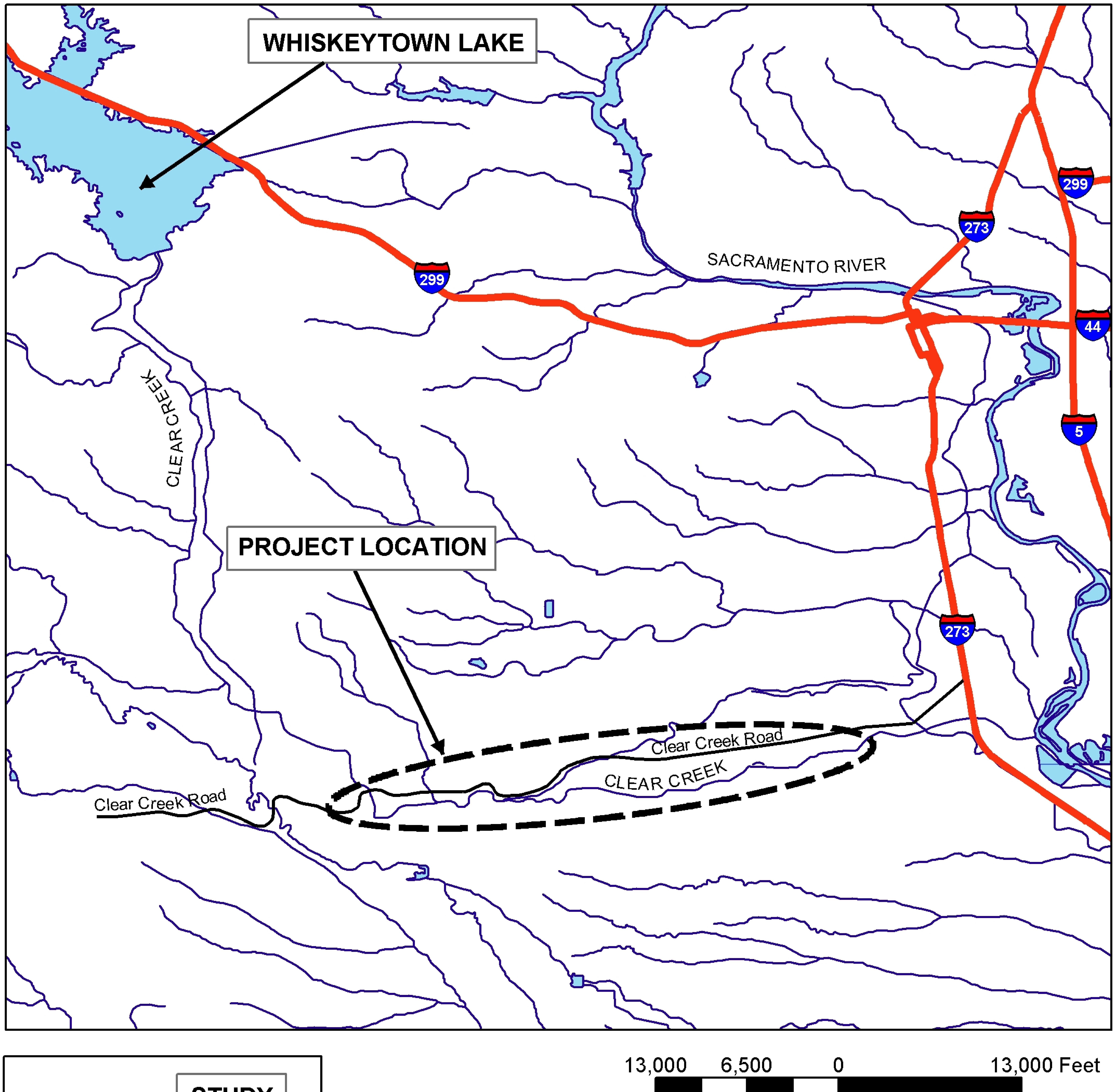
VESTRA™

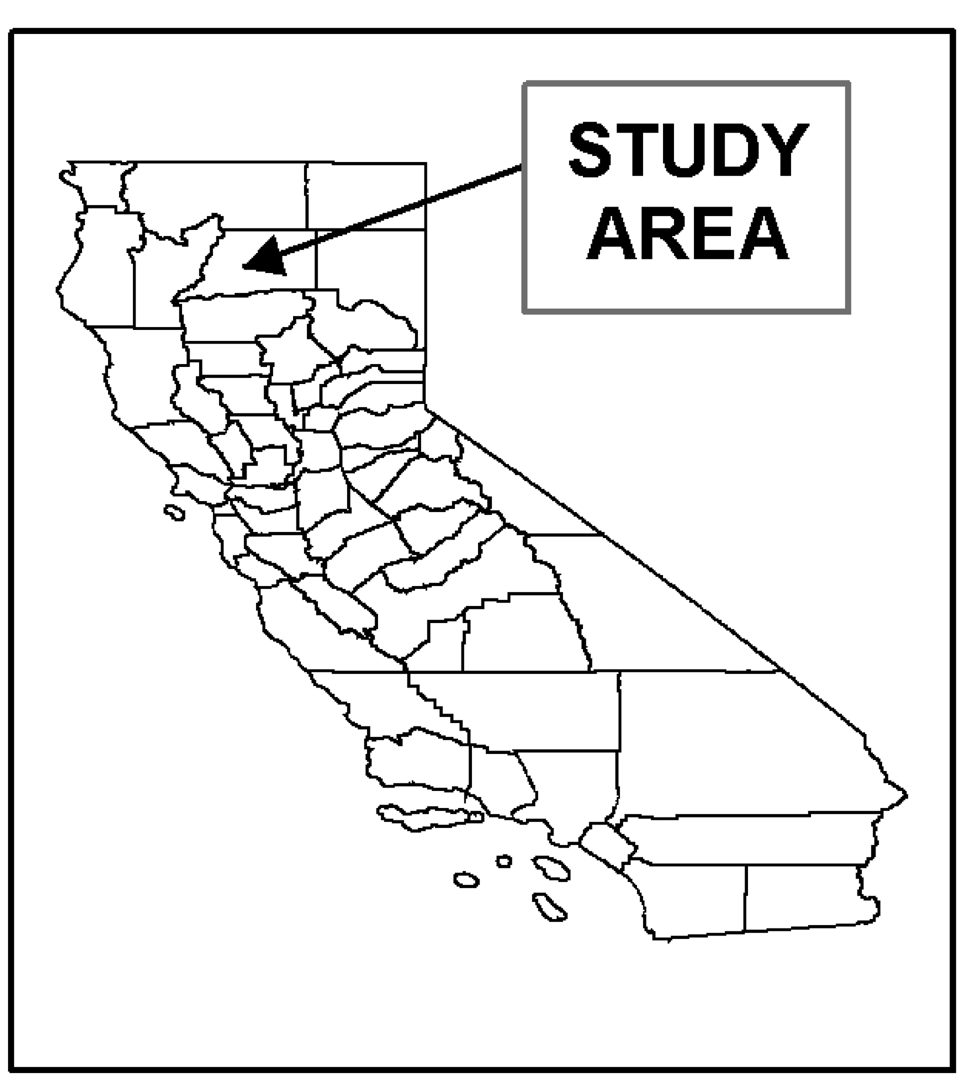
JOB NO. 702091

SOURCE: WSRCD, JUNE 2002

APRIL 2003







VESTRA

JOB NO. 702091

FIGURE 1
PROJECT LOCATION
LOWER CLEAR CREEK FLOODWAY REHABILITATION
SHASTA COUNTY, CALIFORNIA

APRIL 2003