PROJECT COMPLETION REPORT
End Creek-Rice Fish Habitat & Wetland Restoration Project

Oregon Watershed Enhancement Board Project No. 204-434

Grande Ronde Model Watershed/Bonneville Power Administration
Project PI 1992-026-01/Contract #00020546

Natural Resource Conservation Service
Rice-Wetland Reserve Program Project # 66-0436-3-040

January 2007

Document ID #P102705

End Creek Restoration Project Complex. Summer 2006 Construction viewing northeast from Grandview Campground atop Mount Emily

Prepared by:
Allen Childs
CTUIR Grande Ronde Subbasin Restoration Project Leader
Fish and Wildlife Biologist

Vance McGowan
ODFW Northeast Oregon Fish Habitat Enhancement Project Leader
Fish Biologist

PROJECT PARTNERS & COOPERATORS

Dr. Joel Rice (Landowner)
Oregon Department of Fish and Wildlife
Natural Resource Conservation Service
Confederated Tribes of the Umatilla Indian Reservation
Oregon Watershed Enhancement Board
Grande Ronde Model Watershed

Confederated Tribes of the Umatilla Indian Reservation
Administrative Summary

Project Headquarters:
Department of Natural Resources
Wildlife Program
Confederated Tribes of the Umatilla Indian Reservation
PO Box 638
Pendleton, OR 97801

Administrative Contact:
Julie Burke, Fish and Wildlife Administrative Manager
Phone: 541 966-2372
E-mail: julieburke@ctuir.com
Fax: 541 966-2397

Technical Contact:
Allen B. Childs
Fish & Wildlife Biologist/Project Leader
Phone: 541 966-2391
E-mail: allenchilds@ctuir.com
Fax: 541 966-2397

Suggested Citation:

Childs, Allen, B. McGowan, Vance. 2007. End Creek-Rice Fish Habitat and Wetland Restoration Project. Project Completion Report. Confederated Tribes of the Umatilla Indian Reservation.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION and BACKGROUND

The summer of 2006 culminated in the successful implementation of three consecutive phases of the End Creek Restoration Project located in the northwest Grande Ronde Valley within the Grande Ronde Subbasin of eastern Oregon. The project was developed and implemented by the landowners, Oregon Department of Fish and Wildlife (ODFW), Natural Resource Conservation Service (NRCS), Confederated Tribes of the Umatilla Indian Reservation (CTUIR), and several cooperating/funding agencies including the Grande Ronde Model Watershed (GRMW), Bonneville Power Administration (BPA), and Oregon Watershed Enhancement Board (OWEB). This report provides an overview of the project purpose, existing conditions and limiting factors, project goals and objectives, accomplishments, and expenditures for the project and fulfills reporting requirements for OWEB and GRMW/BPA.

The project was funded by multiple agencies through several grants and funding sources, including GRMW/BPA, NRCS - Wetland Reserve Program (WRP), ODFW, and CTUIR. The NRCS was the lead agency for administering the WRP with ODFW and CTUIR contributing to securing cost-share funding, planning and design, permitting, construction contract and field administration, maintenance, and monitoring/evaluation.

The End Creek Project complex encompasses approximately 776 acres within three contiguous private land parcels, 1.13 miles of End Creek, 1.06 miles of the South Fork Willow Creek, 0.65 miles of McDonald Creek, and several spring-fed tributaries in the Willow Creek Watershed. BPA and OWEB funding was utilized on the Rice portion of the project involving over 500 acre, lower End Creek, South Fork Willow Creek, several spring channels, floodplain ponds, and ditch and terrace reclamation. Project accomplishments included:

1. Construction of approximately 1.46 miles of new channel for End Creek, 1.64 miles for South Fork Willow Creek, and 5.33 miles of spring-fed tributary channels.
2. Reclamation of 2.92 miles of existing channelized stream reaches and ditches and 1.16 miles of terraces.
3. Construction and contouring 6 floodplain ponds (10.15 acres).
4. Construction of approximately 0.68 miles of low elevation, earthen terraces to protect adjacent private land from overland floodflow and/or to direct floodflow along End Creek restoration channel.
5. Instream placement of 20 rock grade control structures (cross vanes), 121 rootwad revetments (20 complexes), and 200 pieces of large woody debris along the South Fork Willow Creek restoration channel.
6. Removal of 5 existing culverts to improve channel conditions and fish passage and reinstallation of 2 culverts on access roads.
7. Initiation of native plant community restoration, including installation of 12,650 sedge/rush plugs, mechanical installation of 60 whole shrubs and approximately 5,180 square feet of sedge/rush matts (salvaged from the existing channelized End Creek reach) and installation of 7,800 pounds of native seed on approximately 430 acres.
8. Trap and haul (salvage) of fish, amphibians, and reptiles from existing streams reaches prior to channel diversions and restoration channel activation.
9. Installation of an irrigation system to facilitate vegetative recovery.

Project construction was initiated in late June with major construction on the Rice portion of the project area completed by October. During October through late November, an additional project phase involving construction of approximately 0.5 miles of the upper End Creek restoration channel, reclamation of channelized stream reaches, and construction of floodplain ponds was completed through a separate OWEB grant and NRCS WRP restoration fund on the Davidson property within the project complex. The final project component, located on the Dake property in the southern portion of the project complex, will be constructed during 2007 using NRCS WRP and GRMW/BPA funds. Planned actions for the project in 2007 include construction of additional stream channels along McDonald Creek, installation of two additional floodplain ponds, ditch reclamation, planting, weed control, irrigation system operation, other maintenance needs, and monitoring/evaluation.

2. PROJECT DESCRIPTION & EXISTING RESOURCE CONDITIONS

Project Area Description

The End Creek Restoration Project is located in the upper Willow Creek watershed in the Upper Grande Ronde River Subbasin (6th Field HUC 17060104803). The project is located in the northwest portion of the Grande Ronde Valley about 8 miles north of LaGrande, Oregon in Union County approximately 1 mile upstream from the confluence with Willow Creek in Township 1 South, Range 38 East, all or portions of Sections 22, 23, 26, and 27, Willamette Meridian. The project complex encompasses three contiguous private land parcels: Rice (568 acres); Davidson (108 acres); and Dake (100 acres). See Figure 1, Project Vicinity Map. In context of the Grande Ronde Subbasin Plan (NPCC, 2004), the project area is located in the Mid Grande Ronde Valley Geographic Priority Area (Lower Willow/mid Grande Ronde). Habitat limiting factors include sediment, flow, temperature, and key habitat quantity. Primary focal species include summer steelhead (spawning/rearing) and spring Chinook salmon (rearing habitat). Other species include resident trout and riparian/wetland dependent wildlife.

The End Creek watershed drains an area along the eastern foothills of the Blue Mountain Range, at the base of Mt. Emily. The drainage area includes approximately 4.9 square miles with a mean annual precipitation of 24 inches. Approximately 75% of the area is forested with 25% in agricultural production. End Creek is about 5 miles in length with headwaters originating at an elevation of 6,000 feet and a confluence elevation at the South Fork of Willow Creek of 2,700 feet. Based on USGS quadrangle maps, the forested headwater reaches are located on very steep slopes with average an gradient of 28%. The 1.5 mile middle transitional reach, consisting of a mixture of forest and agriculture use, has moderately steep terrain with an average 5.5% slope. The lower 1.5 miles, downstream of Hunter Road, are located along a relatively flat depositional and floodplain area with agricultural production being the primary activity. The reach averages 1.6% slope.

Figure 1 End Creek Project Vicinity

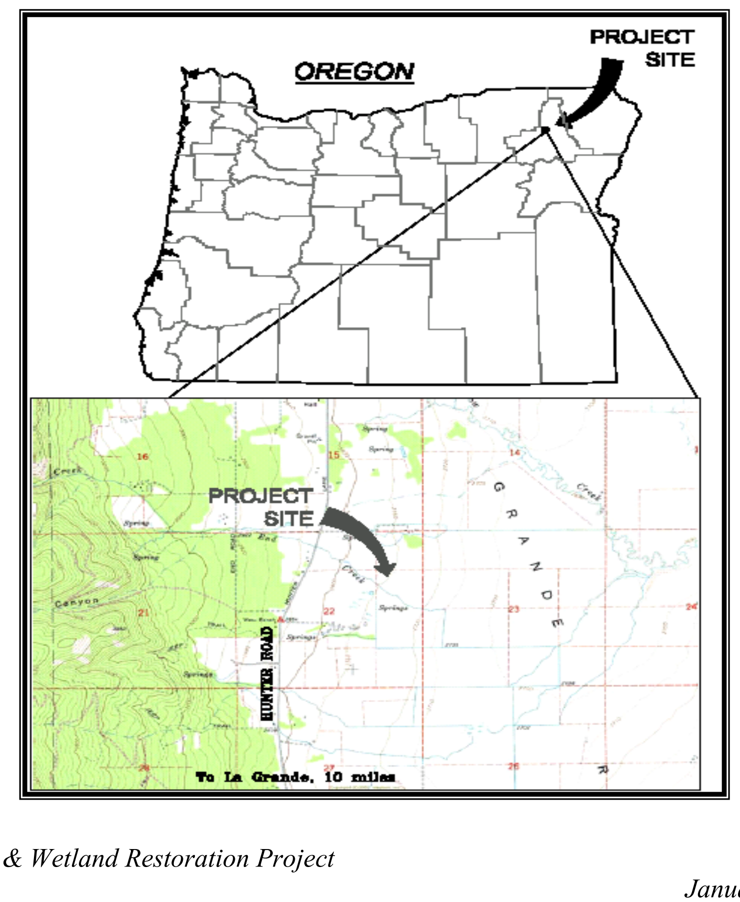


Figure 2 Restoration Project Overview

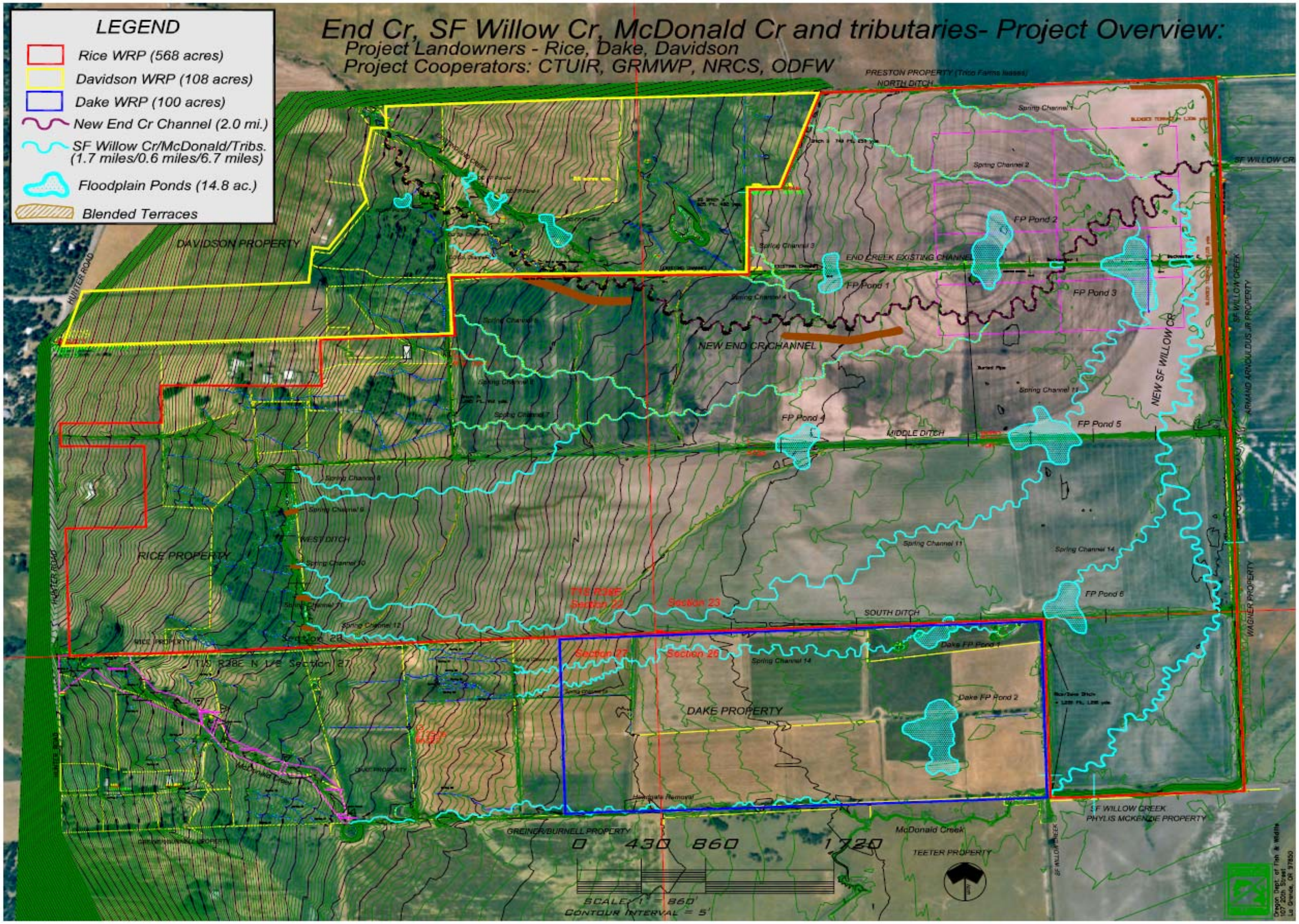


Figure 3 Project Area Tax Lot Map

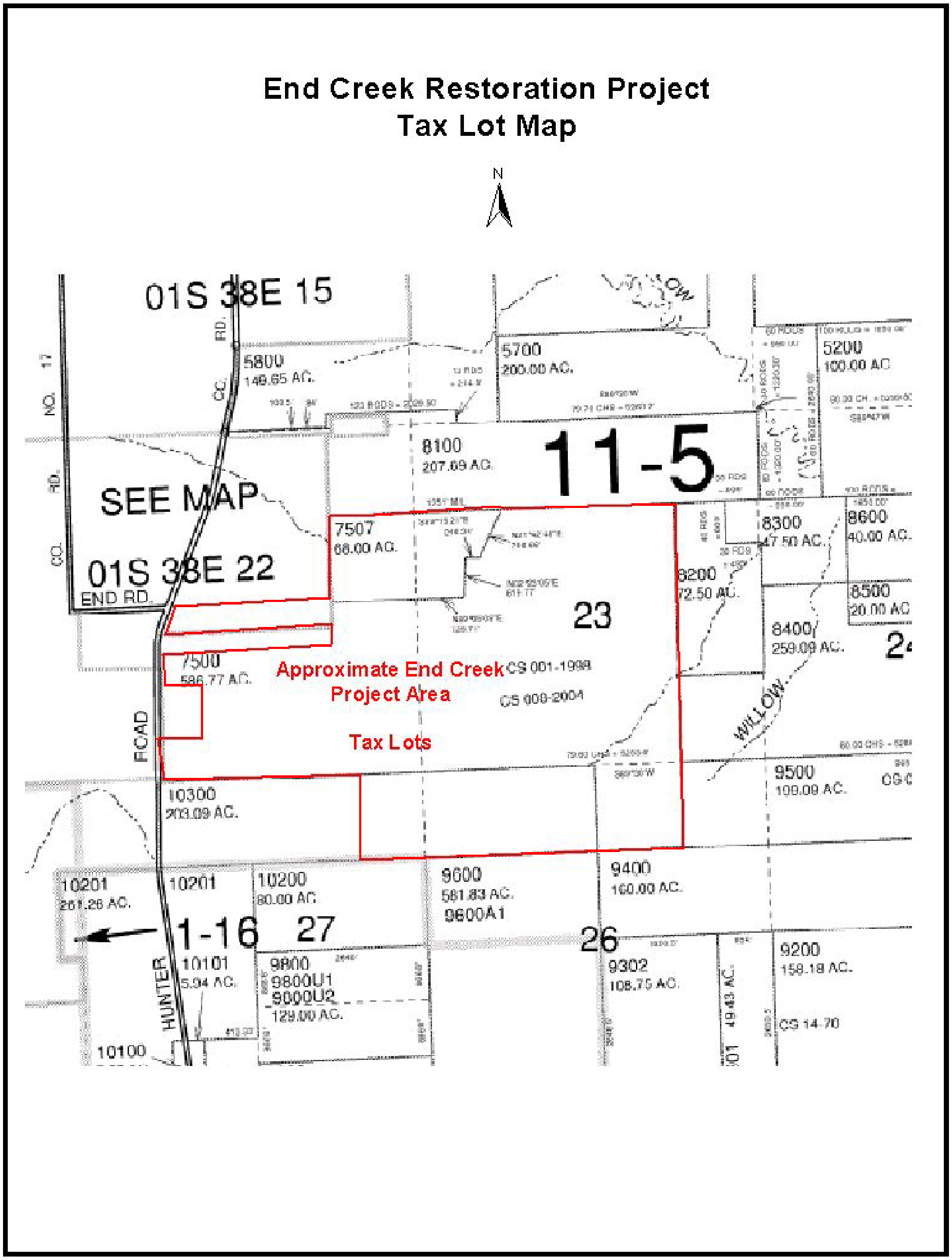


Figure 4 Construction Staging Areas & Culverts/Headgate Work Areas

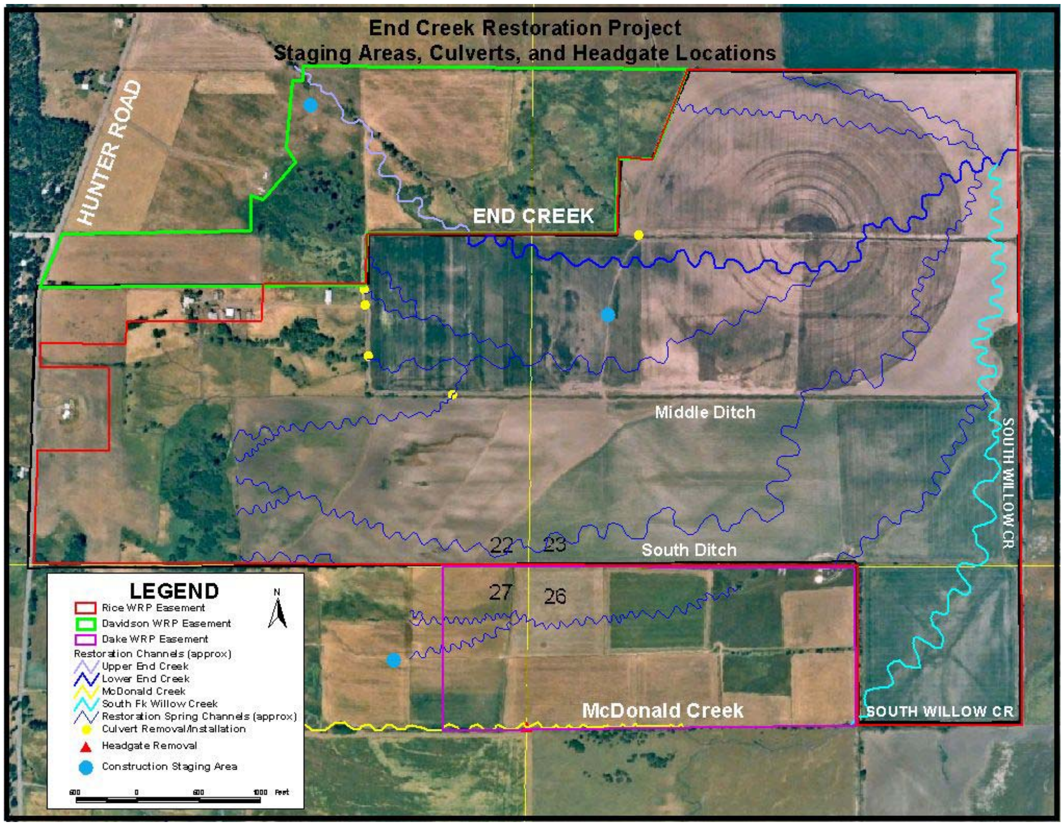
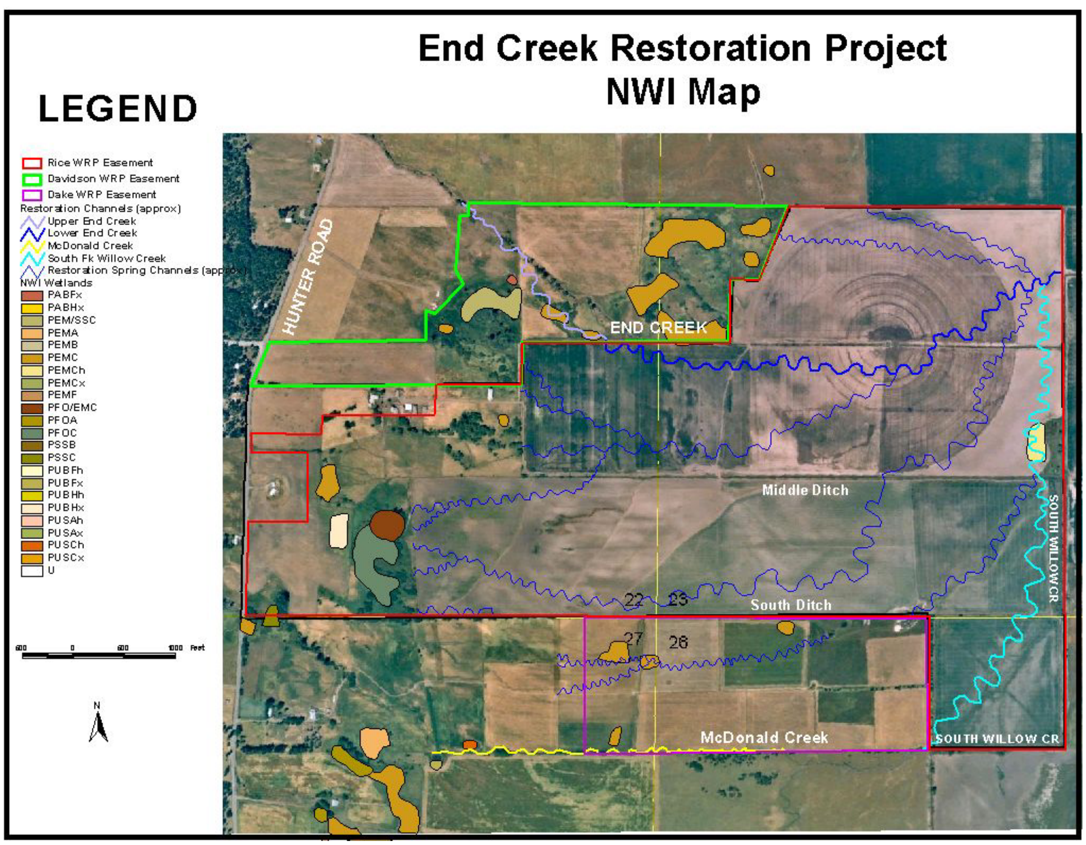


Figure 5 National Wetland Inventory Map



Existing Resource Conditions

Private lands in the project area have a long history of agricultural cultivation, channelization/ditching, and wetland conversion. The proposed action is to restore instream, riparian, and wetland habitat through active strategies involving restoration channel construction, floodplain improvements, and habitat protection through perpetual and term conservation easements. The project will facilitate restoration of wetlands and stable stream channel morphology with a network of meandering stream channels, palustrine emergent and shrub-scrub wetlands, and associated native upland habitats. Lack of cold water refuge and complex instream habitat currently limits productivity and summer distribution of salmonids to upper headwater reaches.

Historic land use practices have altered the hydrologic cycle, including the storage, movement, and character of water resources throughout the Subbasin (NPCC, 2001). Changes in the hydrologic cycle are demonstrated by excessive runoff, altered peak flow regimes, lack of ground water recharge, reduction in soil moisture, reduced storage capacity, and low late-season flow. Historic and current land use, in combination with hydrologic changes, have resulted in stream channel instability (channel incision, increased width:depth ratios, vertical cut banks, sedimentation, and loss of hydrophytic vegetation). Improperly managed land uses act to destabilize natural hydrologic processes and amplify the impacts of natural events such as floods. In an effort to enhance drainage for agricultural production, End Creek, South Fork Willow, McDonald Creek and several spring-fed tributaries were channelized in the early 1900's, resulting in a series of linear ditches currently lacking instream habitat complexity, riparian/wetland vegetation, and extensive vertical, eroding stream banks. Anthropogenic practices were extensively successful in draining wetlands and lowering local water tables, which allowed farming on much of the project area. In the existing condition, approximately 600 acres are annually tilled and planted to various crops. The balance of the project area is in pasture and Idaho fescue seed production.

The Willow Creek Watershed, including End Creek, South Fork Willow, and McDonald Creek are known to provide habitat for Federally listed Snake River summer steelhead. Willow Creek may provide rearing habitat for spring Chinook salmon and may have historically provided spawning habitat. End Creek was identified in the Willow Creek Coordinated Resource Management Plan (CRMP) (Union SWCD, 2002) and in the Union County Soil and Water Conservation District's water quality monitoring program as a high contributor of sediment to Willow Creek due to aggressive headcuts and streambank erosion. Channelization, channel incision, high width:depth ratios, confinement/poor floodplain connectivity, and limited riparian-wetland vegetation contributes to poor instream habitat diversity and water quality throughout the project area.

2003 Photos illustrate lower channelized End Creek. Extensive channelization in project area created unstable stream channels, excessive erosion, elevated water temperatures, loss of riparian and wetland vegetation, and poor fish habitat.

The following figure depicts a typical riffle cross section generated from survey data collected at Station 13+40 along lower End Creek. The cross section clearly illustrates the extent of channel incision and lack of floodplain connectivity. Flood conveyance capacity of the channel is significant which contributes to unstable stream banks shown in the above photos. Note that both the bankfull discharge and floodprone area are contained entirely within the existing channel, limiting connectivity to the floodplain.

Figure 6 Riffle Cross Section of Existing End Creek Reach

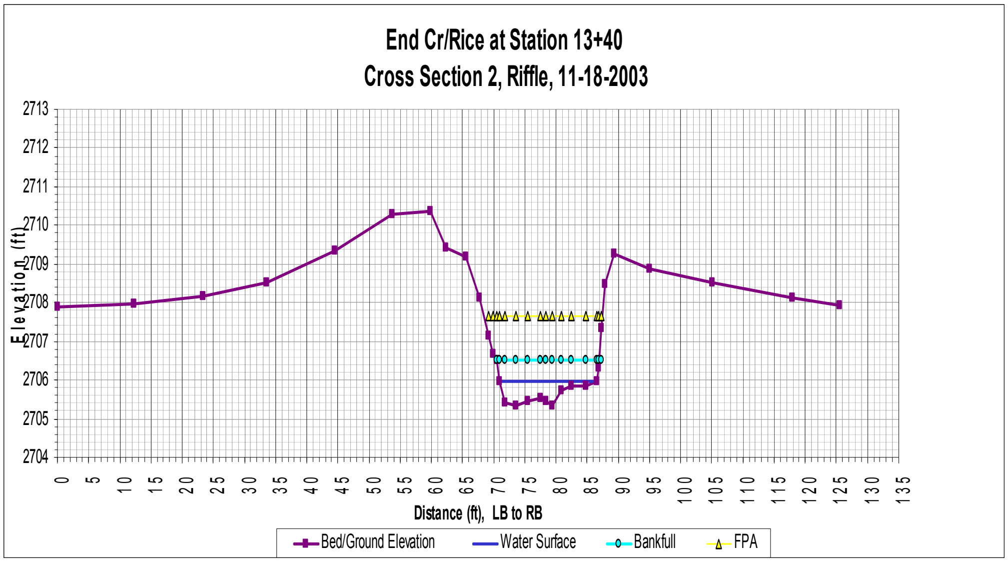
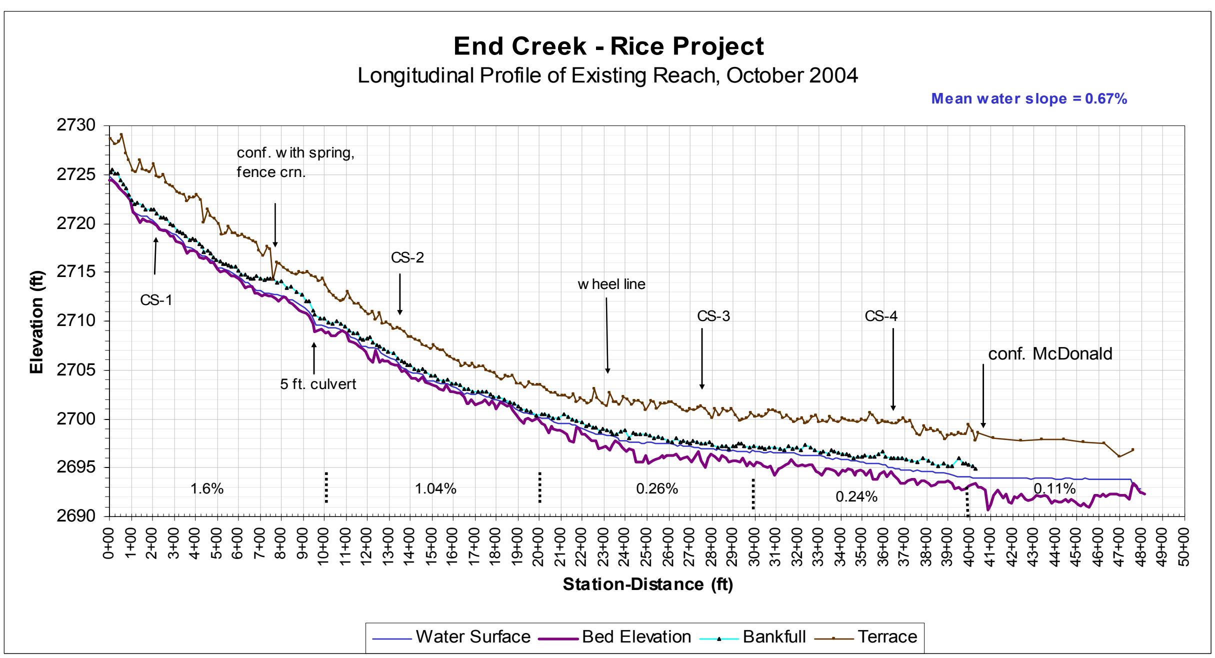


Figure 7 illustrates the profile of lower End Creek. Note the relation of the channel thalweg in comparison to adjacent terraces which illustrate extensive channel entrenchment, confinement, and high water slopes (mean of 0.67%). Also of note in the profile is the lack of large pool habitat. In the current condition, End Creek is severely unstable and lacks stable morphology necessary to develop high quality fish habitat.

Figure 7 Longitudinal Profile of Lower End Creek



During early August 2005, the CTUIR surveyed 15 randomized juvenile fish population index sites along End Creek, South Fork Willow, and McDonald Creek. Spring-fed tributaries within the project area were also sampled to determine fish presence/absence.

Fish species observed included summer steelhead/resident rainbow (O. Mykiss), sculpin, dace, red-sided shiner, sucker, northern pike minnow, pumpkinseed, and bluegill. Data indicates that summer distribution of O. Mykiss is limited to upper reaches of project area streams.

CTUIR fish crews conducting juvenile fish sampling at a sampling location along McDonald Creek.

Rearing O. Mykiss densities along End Creek ranged from 0.0 fish/square meter of habitat in the lower reaches (RM 0.0 to 0.5) to 0.93 fish/sq.m. in the upper project reaches at RM 1.2. Similar O. Mykiss rearing densities were observed in McDonald Creek, although a site at RM 1.05 was recorded at 1.8 fish/sq.m.

The South Fork Willow and lower reaches of both McDonald Creek and End Creek showed a distinct absence of salmonid presence due, presumably, to summer high water temperatures. Sites containing O. Mykiss also showed a distribution of age classes from age class 0 to age class 2 indicating local spawning and rearing of both anadromous and resident fish.

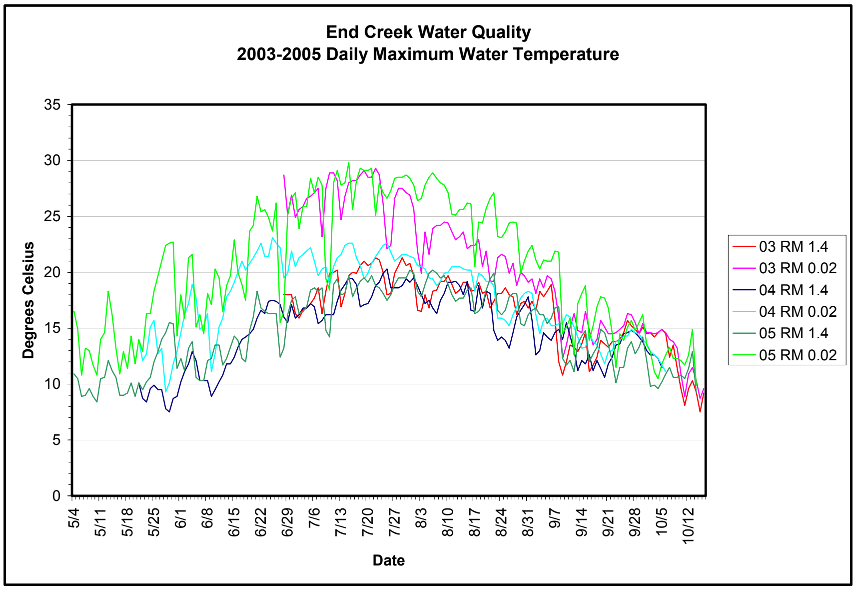
O. Mykiss catch at McDonald Creek sample site.

In addition, sampling also revealed a noted absence of native amphibians (particularly spotted frogs) and a general abundance of bull frog adults and juvenile tadpoles. The lower reaches of the South Fork Willow contained a substantial bull frog population with over 50 individual juveniles captured.

Water quality data is limited for the project area. Two Vemco temperature probes that record hourly water temperatures have been deployed in End Creek by the CTUIR since 2003. Monitoring sites are located at RM 2 approximately 0.1 miles upstream from the project area and RM 0.25 near the confluence with the South Fork Willow. Additional water quality monitoring was initiated in 2005 with ODFW installing Data Logger near RM 0.1 and RM 1.5 to collect year-round water temperature data.

Water temperatures recorded at the upper monitoring site have been observed to be consistently cooler than the lower site during 2003 through 2005 with a consistent heating trend detected through the lower channelized project reach. Observed maximum temperatures indicate that summer salmonid distribution in lower End Creek is limited by high summer water temperatures. Figure 8 illustrates data collected during 2003 through 2005.

Figure 8 End Creek Daily Maximum Water Temperatures 2003-2005



Other water quality monitoring on the project area is being conducted by Eastern Oregon University (EOU) through an agreement with the GRMW. Initiated in 2004, EOU is conducting annual water chemistry monitoring to evaluate chemical properties, including temperature, dissolved oxygen, phosphorous, nitrates, alkalinity, etc. Discussions are currently underway with EOU and the GRMW to expand this monitoring effort to other project area streams as well as other subbasin tributaries to provide baseline information on water quality that can be utilized for comparison over time. Water quality analysis will continue through project development to evaluate baseline and post-project water quality conditions.

ODFW is also monitoring groundwater elevations. Baseline data collection was initiated in 2005 with installation of a groundwater monitoring well network (15 wells total) along lower End Creek. Figure 9 illustrates well locations and Figure 10 presents an overview of pre-project, seasonal groundwater elevations.

Figure 9 End Creek Groundwater Monitoring Wells

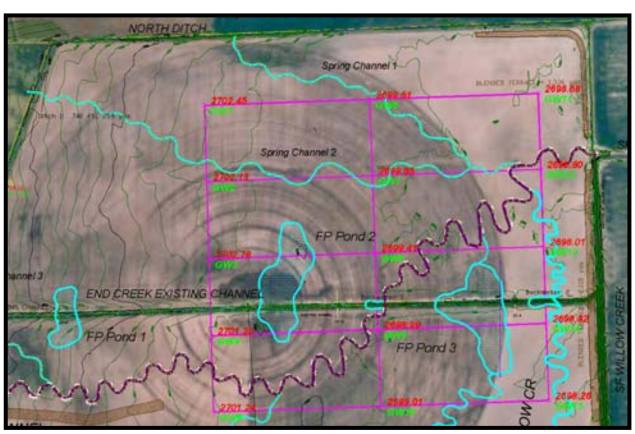
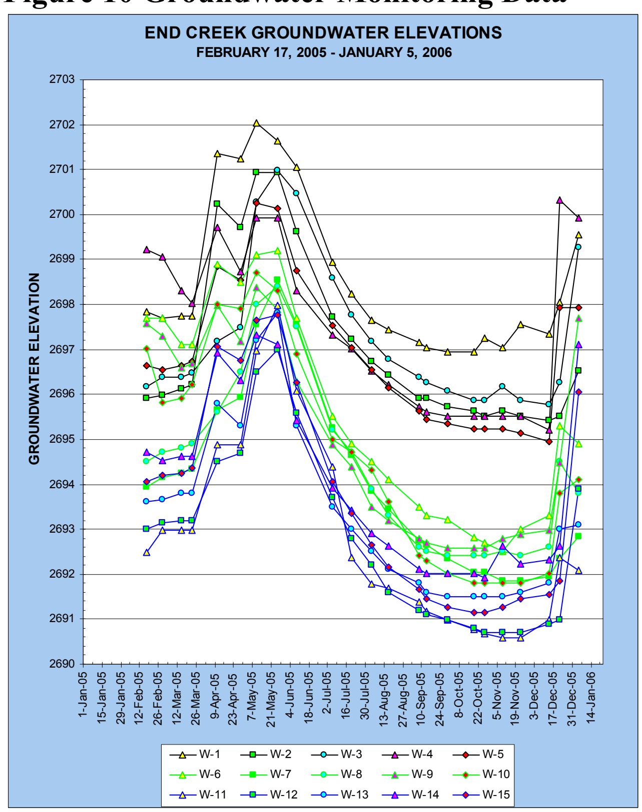


Figure 10 Groundwater Monitoring Data



3. PROJECT GOALS AND OBJECTIVES

The overall goal of the project is to restore the natural character and function of End Creek, South Fork Willow, McDonald Creek, and spring-fed tributaries with accompanying riparian and wetland vegetation, well connected floodplain, and stable, natural stream channels. Water quality, fish habitat, and wetland-riparian habitat restoration are key drivers for the project. The following project objectives have been identified for the End Creek Restoration Project complex:

- Improve channel dimension, pattern, and profile consistent with valley form, hydrology, and sediment.
- Restore emergent and shrub-scrub wetlands (camas)
- Reconnect floodplain and enhance groundwater/hyporheic exchange
- Increase cold water refuge and increase winter water temperatures
- Increase suitable steelhead spawning habitat
- Increase juvenile steelhead survival/productivity by increasing habitat quantity and quality
- Enhance diversity and abundance of macroinvertebrate communities

Regional Strategies/Objectives

This project is part of a region-wide effort to protect and restore anadromous fish habitat in the Grande Ronde Subbasin. The following reference documents and plans provide guidance for prioritizing habitat and watershed enhancement activities and provide context for the restoration project effort.

--Grande Ronde Subbasin Plan, NPCC. 2004
--Grande Ronde Subbasin Summary, NPCC 2001
--Willow Creek Watershed Assessment (GRMWP 2001)
--Willow Creek Coordinated Resource Management Plan (CRMP) (Union SWCD 2002)
--Grande Ronde River Subbasin- Salmon and Steelhead Production Plan, Columbia Basin System Planning, ODFW, CTUIR, NPT, WDF, WDW. 1990.
--CTUIR - Columbia Basin Salmon Policy, 1995.
--Stream and Riparian Conditions in the Grande Ronde Basin: A Report to the G.R. Model Watershed Board, Huntington, 1993.
--Upper Grande Ronde Subbasin Water Quality Management Plan (ODA 1990)
--Upper Grande Ronde TMDL (ODEQ 2000)
--Grande Ronde Model Watershed Action Plan (GRMWP 1994)

Watershed analysis through the EDT (NPCC, 2004a and Mobrand, 2003) and synthesis through the Management Plan development process, identified instream habitat condition, high water temperature, sediment loads, and flow modification as primary limiting factors for Chinook and steelhead (pg 11 NPCC 2004c, pg 3 NPCC 2004d). Primary habitat degradation includes:

Habitat Limiting Factors

- **Channel Habitat Conditions** – Channel instability associated with removal of streamside cover and channelization has resulted in channel incision/downcutting, increased gradient, reduced channel length, elevated erosion, increased width-to-depth ratios, and loss of channel complexity. The quality of instream habitat has correspondingly been altered throughout much of the Subbasin.
- **Sediment** – Loss of upland and streamside vegetative cover has increased the rates of erosion. Soils lost from upland areas has overwhelmed hydraulic processes resulting in decreased availability of large pool habitat, spawning areas, riffle food production, and hiding cover.
- **Riparian Function** – Riparian habitat degradation is the most serious habitat problem in the subbasin for fish (McIntosh 1994, ICBEMP 2000). Loss of flooplain connectivity by roads, dikes, and channel incision, and in many streams reduced habitat suitability for beaver has altered dynamically stable floodplain environments which has contributed to degradation and limited habitat recovery. This loss leads to secondary effects that are equally harmful and limiting, including increased water temperature, low summer flows, excessive winter runoff, and sedimentation.
- **Low Flow** – Water resources in many streams have been over over-appropriated resulting in limited summer and fall baseflow, development of fish passage barriers, and increased summer water temperatures.

The Willow Creek Watershed Assessment specifically identified lack of shade, large wood deficiencies, channelization, wetland drainage, high stream temperatures, and high nutrient levels as limiting factors in the Willow Creek watershed. Landowners identified a primary concern as lack of streamside vegetation. The Assessment identified the opportunity to restore channelized streams to natural, stable channels. The Willow Creek CRMP, developed by the GRMW, Union County SWCD, and participating landowners identified several goals for the watershed including: 1) make the stream more hospitable to fish (restore streamside vegetation, reestablish desirable cover, increase shade, reduce streambank erosion); and 2) improve fish habitat.

4. PROJECT ACCOMPLISHMENTS & ACTIVITIES

Table 1 illustrates project actions and metrics. Additional discussion follows the table to describe the various work related components involved in the development and implementation of the project.

Table 1 Summary of End Creek-Rice Restoration Project Accomplishments

PROJECT ACTION	PROJECT METRICS
Restoration Channel Construction **--End Creek** **--South Fork Willow Creek**	 7,708 feet 3.1 miles 8,659 feet
Spring Channel Construction	28,142 feet 5.33 miles total
Rock Cross Vanes	20 structures (vertical grade control in restoration channel)
Rootwad Revetments	121 structures (20 complexes along approx 960 feet of outside streambank meanders). Note: one structure is a footer log and rootwad with tree bole.
Woody Debris Additions	200 pieces large woody debris placement on Willow Creek restoration channel. Woody debris included 8-12 inch diameter, 10-20 foot length pieces placed in log jam configuration to enhance channel roughness and habitat complexity.
Channel/Ditch and Terrace Reclamation	21, 542 feet 4.08 miles
Floodplain Ponds/Backwater Habitat	6 ponds (10 acres) & 2 backwater habitats (End Creek & South Fork Willow Creek)
Blended Earthen Terraces	3,590 feet (0.68 miles) of low elevation terraces to control floodflow and protect adjacent private lands
Revegetation and Planting	Completed site preparation and seeding on 430 acres (ground-based and aerial application of 7,200 pounds native seed). Installed 12,650 sedge rush plugs. Mechanically installed 60 willow shrubs and approximately 5,180 square feet of sedge/rush matts. Additional planting and weed control planned for 07' and 08'.
Culvert Removal/Relocation	5 culverts removed, two reinstalled on access roads.

<u>Environmental Compliance/Regulatory Reviews</u>

CTUIR, ODFW, and NRCS staff worked cooperatively to address regulatory compliance requirement and secure necessary permits and clearances to implement the project. Project permitting was initiated concurrent with project design development and completed prior to initiating project construction. Tasks included developing a NEPA checklist through BPA's environmental compliance program, preparing biological assessments, coordinating formal and informal consultations with NMFS and USFWS through BPA, developing permit applications for ODSL and USCOE fill/removal permit processes, and coordinating archaeological surveys and consultation with Oregon SHPO. The environmental compliance process was conducted for the entire project complex to maximize planning and permitting efficiency. All environmental planning documents, permits, and concurrences are on file at CTUIR DNR Fish and Wildlife Program office.

<u>Construction Subcontracting, Administration/Inspection, Materials, & Project Layout</u>

The CTUIR provided construction subcontracting and administrative functions for the project, including management of project grant funds from GRMW-BPA, OWEB, and NRCS WRP, construction subcontracting, and materials purchasing. Tasks included preparation of subcontractor solicitations, conducting site tours and bidding processes, subcontractor selection, subcontracting document preparation and award, inspection, and payment. ODFW and NRCS technical representatives participated with all aspects of construction subcontract development and project implementation including development of statements of work, participating in site tours, and providing project inspection and oversight. ODFW provided a lead role in project construction oversight inspection and project layout. CTUIR also managed several materials purchasing needs, including acquisition of native seed, irrigation equipment, and supplies.

Restoration Channel Design and Construction

Project planning and design was accomplished over an approximate 2 year period and involved interagency and landowner meetings, coordination with adjacent private landowners, and development of funding proposals. ODFW staff provided a leading role in pre-design surveys and development of project designs (McGowan, 2005). Project planning was driven by landowner objectives, limiting factors, project goals, and biological objectives. Products of the planning effort and project design process were developed through an extensive watershed analysis conducted during 2003-04. The analysis was undertaken to evaluate past land use history and present conditions, identify habitat limiting factors, and develop a suite of actions to address the limiting factors. The analysis included:

- Determine the drainage area
- Review past & current land uses
- Examine 1930's aerial photographs
- Onsite inspections of various portions of the watershed by project biologists, engineers and geomorphologists
- Collect stream flow data at Hunter Road at bankfull stage
- Collect channel cross sections, longitudinal profiles and pebble counts
- Conduct a GPS survey of the entire work area and produce a topographic map at 1 ft. contours
- Install 15 groundwater wells and document soil profiles to depths of 10 ft.

Field data collected from four channel sections in the existing End Creek channelized reach indicated either an entrenched condition or a channel in the early stages of recovery (Rosgen G and F channels). The areas in recovery had begun to extend (erode) laterally against steep, vertical side-slopes of ditches that had been constructed with heavy equipment, dating back to the 1930's. Lack of maintenance of the ditch was allowing the stream to erode the banks and redeposit sediment, essentially forming a new floodplain. However, the severity of overall channel entrenchment, due to existing spoils piles created from ditch excavation, was such that the channel would take decades recover, in terms of channel aggradation, increased sinuosity, and reconnection to its former floodplain. Examination of aerial photographs from the 1930's illustrate that End Creek had already been straightened, with little evidence of historic channel meander scrolls evident. Analysis of local topography, however, indicated that the historic End Creek stream channel was likely located to the south of the pre-project location. The initial analysis indicated that an "active" restoration strategy would be necessary to facilitate recovery of stable stream channel morphology and associated benefits of enhanced instream structural complexity, floodplain connectivity, and restored hydrophytic plant communities and formed the basis from which to base more detailed analysis and project development.

Development of restoration stream channel design criteria was based on comparison of existing conditions measured at a selected reference site located along upper End Creek, analysis of hydrological conditions, and professional judgment. Table 2 summarizes reference conditions and channel design criteria developed through the analysis. Criteria presented in the table were utilized to design the End Creek restoration channel as well restoration channels for South Fork Willow Creek and McDonald Creek. All three tributaries approximate similar hydrology, watershed size and condition, valley form, and geomorphology.

Bankfull discharge (channel forming streamflow) was calculated using several methods, including: 1) collecting flow data at Hunter Road 2) Manning's N by channel type, 3) Relative roughness (R/d84) and resistance factor, 4) Manning's N from resistance factor, 5) Regional Curve and Continuity Equation, and 6) USGS Regression Analysis. NRCS staff conducted additional modeling using HEC-RAS to evaluate preliminary project designs. The analysis concluded that mean water velocities in the designed channel would be acceptable. The basic channel design template for End Creek, South Willow, and McDonald Creek was derived from reference conditions and is categorized as a Rosgen C channel (with a W/D ratio of 14). The long-term objective for channels under this design is to facilitate vegetative recovery and development of constructed "C" channels into "E" channels (W/D ratio <12).

Table 2 Morphological Characteristics for the Existing and Proposed Channels with Gage Station and Reference Reach Data (Rosgen, 1996)

VARIABLES	EXISTING CHANNEL*		PROPOSED REACH		REFERENCE REACH	
1. Stream Type	**B4c/G4c & F4***		**C4, C5, C6**		**E4c**	
2. Drainage Area (sq. miles)	**4.9 Mi.2**		**4.9 Mi.2**		**3.6 Mi.2**	
3. Bankfull Width (Wbkf)	**12.1** **7.7-16.5**	(Mean) (Range)	**11.0** **8-13**	(Mean) (Range)	**7.1**	(Mean) (Range)
4. Bankfull Mean Depth (dbkf)	**0.935** **0.86-1.01**	(Mean) (Range)	**0.79**	(Mean) (Range)	**0.9**	(Mean) (Range)
5. Width/Depth ratio (Wbkf/dbkf)	**13.4** **7.6-19.1**	(Mean) (Range)	**14.00**	(Mean) (Range)	**7.9**	(Mean) (Range)
6. Bankfull Cross-sectional Area (Abkf)	**10.95** **7.7-14.2**	(Mean) (Range)	**8.65**	(Mean) (Range)	**6.37**	(Mean) (Range)
7. Bankfull mean Velocity (Vbkf)	**4.45**		**4.62**		**5.9**	
8. Bankfull Discharge (cfs) (Qbkf)	**49**		**40**		**33**	
9. Bankfull Maximum depth (dmax)	**1.25**		**1.2**		**0.95**	
10. Max driff/dbkf ratio	**1.34**		**1.52**		**1.06**	
11. Low bank height to max. dbkf ratio	**3.03, 3.52**		**1.00**		**1.00**	
12. Width of Flood prone area (Wfpa)	**15.4**		**40**		**17.00**	
13. Entrenchment ratio(Wfpa/Wbkf)	**1.27**		**3.64**		**2.4**	
14. Meander Length (Lm)	**channelized**		**126.5**		**84**	
15. Ratio of Meander Length to bankfull Width (Lm/Wbkf)	**N/A**	(Mean) (Range)	**11.50** **9-14**	(Mean) (Range)	**11.83**	(Mean) (Range)
16. Radius of Curvature (Rc)	**N/A**	(Mean) (Range)	**30** **27-33**	(Mean) (Range)	**20**	(Mean) (Range)
17. Ratio of Radius of Curvature to Bankfull Width (Rc/Wbkf)	**N/A**	(Mean) (Range)	**2.75** **2.5-3.0**	(Mean) (Range)	**2.82**	(Mean) (Range)
18. Belt Width (Wblt)	**N/A**	(Mean) (Rang)	**55**	(Mean) (Range)	**55**	(Mean) (Range)
19. Meander Width Ratio (Wblt/Wbkf)	**N/A**	(Mean) (Rang)	**5.00**	(Mean) (Range)	**7.75**	(Mean) (Range)

VARIABLES	EXISTING CHANNEL*		PROPOSED REACH	REFERENCE REACH	
20. Sinousity (stream length/valley distance) (k)	**1.00**		**1.82**	**1.3**	
21. Valley Slope (ft/ft)	**0.0077**		**0.0091**	**0.0385**	
22. Average Slope (Savg) = (Svalley/k)	**0.0077**		**0.0050**	**0.0296**	
23. Pool Slope (Spool)	**varies**		**0.001**	**0.0134**	
24. Ratio of Pool slope to average slope (Spool/Sbkf)	**varies**		***0.2-0.3***	**0.4527**	
25. Maximum Pool Depth (dpool)	**1.70**		**2.2**	**1.63**	
26. Ratio of pool depth to average bankfull depth (dpool/dbkf)	**1.81**		**2.78**	**1.72**	
27. Pool Width (Wpool)	**12.45**		**15.0**	**7.8**	
28. Ratio of Pool Width to bankfull width (Wpool/Wbkf)	**1.03**		**1.36**	**1.10**	
29. Ratio of Pool Area to bankfull area	**1.35**		**1.79**	**1.17**	
30. Pool to Pool spacing (p-p)	**67**		**63**	**42**	
31. Ratio of p-p spacing to bankfull width (p-p/Wbkf)	**5.54**		**4.5-7**	**5.92**	
32. Riffle Slope (Sriff)	**0.0163**		**0.0088**	**0.0496**	
33. Ratio of Riffle Slope to average slope (Sriff/Sbkf)	**1.27**		**1.5-2**	**1.68**	
34. Maximum Riffle Depth (driff)	**1.34**		**1.2**	**0.95**	
35. Ratio of maximum riffle depth to average depth (driff/dbkf)	**1.43**		**1.52**	**1.06**	
MATERIALS:					
1. Particle Size distribution of	**upper**	**lower**		**upper**	**lower**
	mm	**mm**	**See Reference**	**mm**	**mm**
Channel Material D16	**0**	0	**Reach Data**	**17**	**12**
D35	**0.5**	0		**34**	**34**
D50	**9**	0		**43**	**46**
D84	**60**	**0.06**		**96**	**84**
D95	**90**	**0.5**		**120**	**115**
2. Particle Size distribution of	**See Reference**		**See Reference**	**mm**	**mm**
Bar Material D16	**Reach Data**		**Reach Data**	**25**	**5**
D35				**27**	**13**

VARIABLES	EXISTING CHANNEL*	PROPOSED REACH	REFERENCE REACH	
D50			**37**	**20**
D84			**60**	**48**
D95			**90**	**76**
3. Largest size particle at the toe (lower third) of the bar	**See Reference Data**	**See Reference Data**	**69**	**73**

NOTES: *Existing channel morphology are averages of 2 sample sites.

SEDIMENT TRANSPORT VALIDATION (Based on Bankfull Shear Stress)

Method	Existing	Proposed
Calculated value (mm) from curve	(Tc = 1.32) 180	(Tc = 0.73) 7
Value from Shield Diagram (lbs./ft2)	100	
Critical Dimensionless Shear Stress	0.053	0.05
Min. mean dbkf calculated using critical dimensionless Shear Stress equations	0.7	
Remarks: using bedload data adjusted shields relation.		

The following graphs illustrate typical stream channel cross sections and the restoration channel longitudinal profile. Channel cross sections are presented for each of the four habitat types (e.g., run, riffle, pool, and glide) and provide the "blueprint" for channel construction with details on channel dimension (cross sectional area) and streambank slopes. Following the channel cross section templates, a series of longitudinal profiles for the designed End Creek restoration channel are presented to illustrate channel profile. The design profile depicts the channel thalweg (bottom of stream channel), bankfull channel (channel forming flow) elevation, relation of bankfull channel to adjacent floodplain elevation (both before and after project) which illustrates floodplain connectivity and flood-prone area, and channel (water slope).

Construction specifications utilized during project implementation were generally maintained within (+/-) 1/10th of an inch whenever possible to ensure stream channel dimension, pattern, and profile was constructed per channel designs. Channel construction inspection was continuous with field staff providing field staking and elevation survey throughout the construction process. Elevation control was provided by elevation benchmarks established throughout the project area using Topcon lazer survey equipment and direct read and/or survey rods.

Construction efforts were initiated by delivery of rock and wood materials in late June with construction of the End Creek channel initiated by early July, beginning at the lowermost project reach and proceeding upstream to the Davidson property. Following completion of the restoration channel, rock cross vanes and rootwad revetments were installed and channel diversion completed. Prior to reclamation of the existing End Creek channel, all native plant materials (shrubs and sedges/rushes) were mechanically salvaged and installed along the restoration channel followed by installation of a temporary irrigation system. By late August, construction was initiated on the South Fork Willow restoration channel with continuation of channel/ditch reclamation, and pond construction. The Rice portion of the project was largely completed by mid-October, at which time, project managers initiated construction of the upper End Creek reach on the Davidson property and completed large wood placement on the newly constructed South Willow restoration channel.

Figure 10 Typical Run Cross Section for the End Creek Restoration Channel

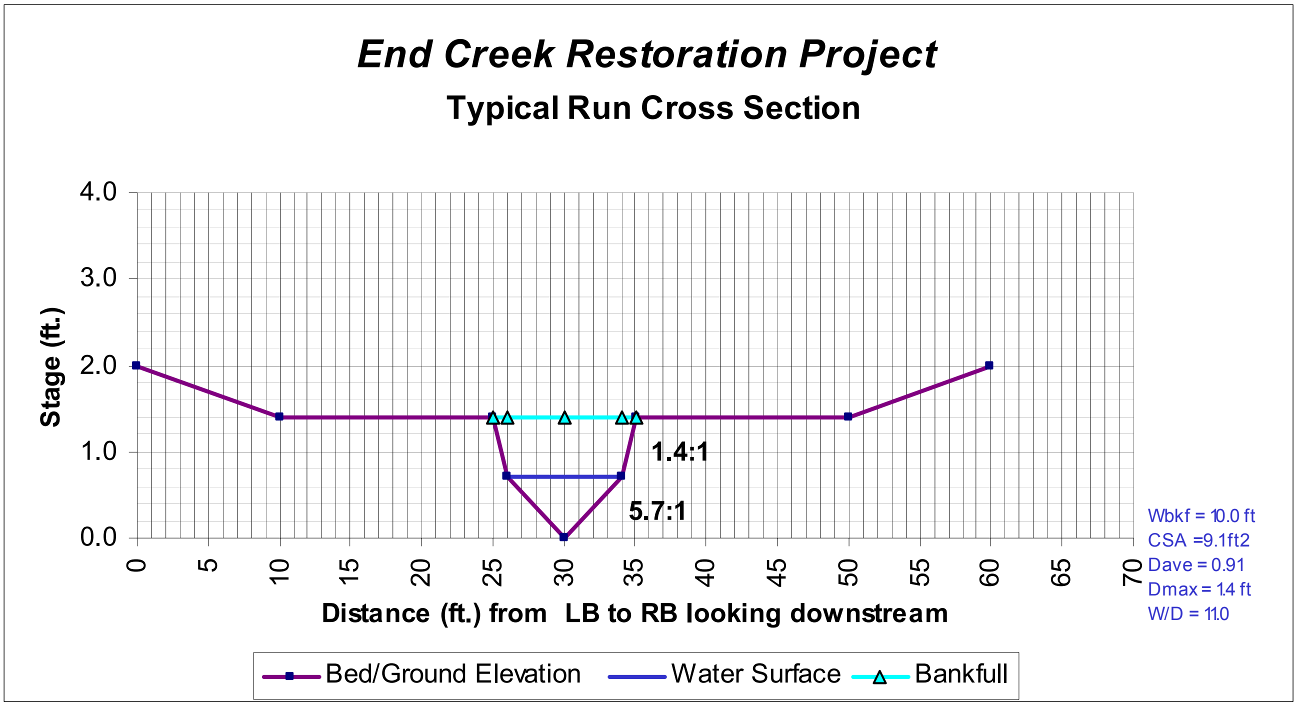


Figure 11 Typical Riffle Cross Section for the End Creek Restoration Channel

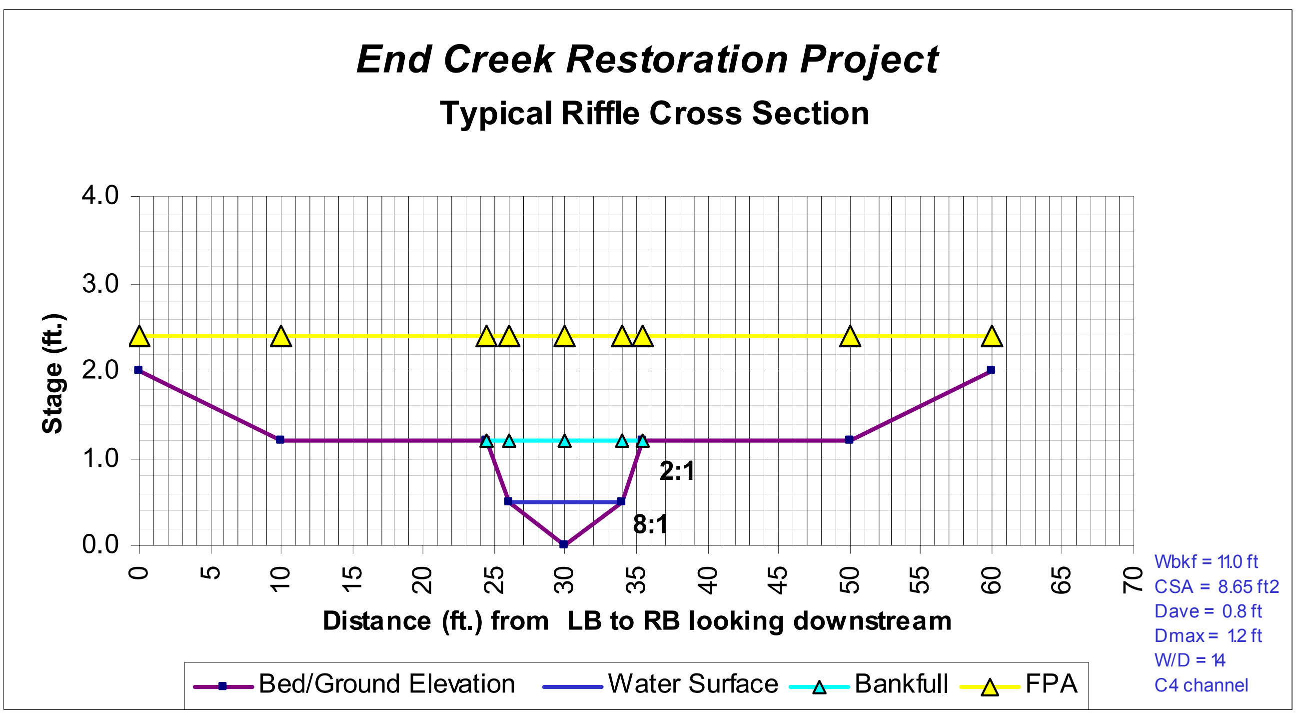


Figure 12 Typical Pool Cross Section for the End Creek Restoration Channel

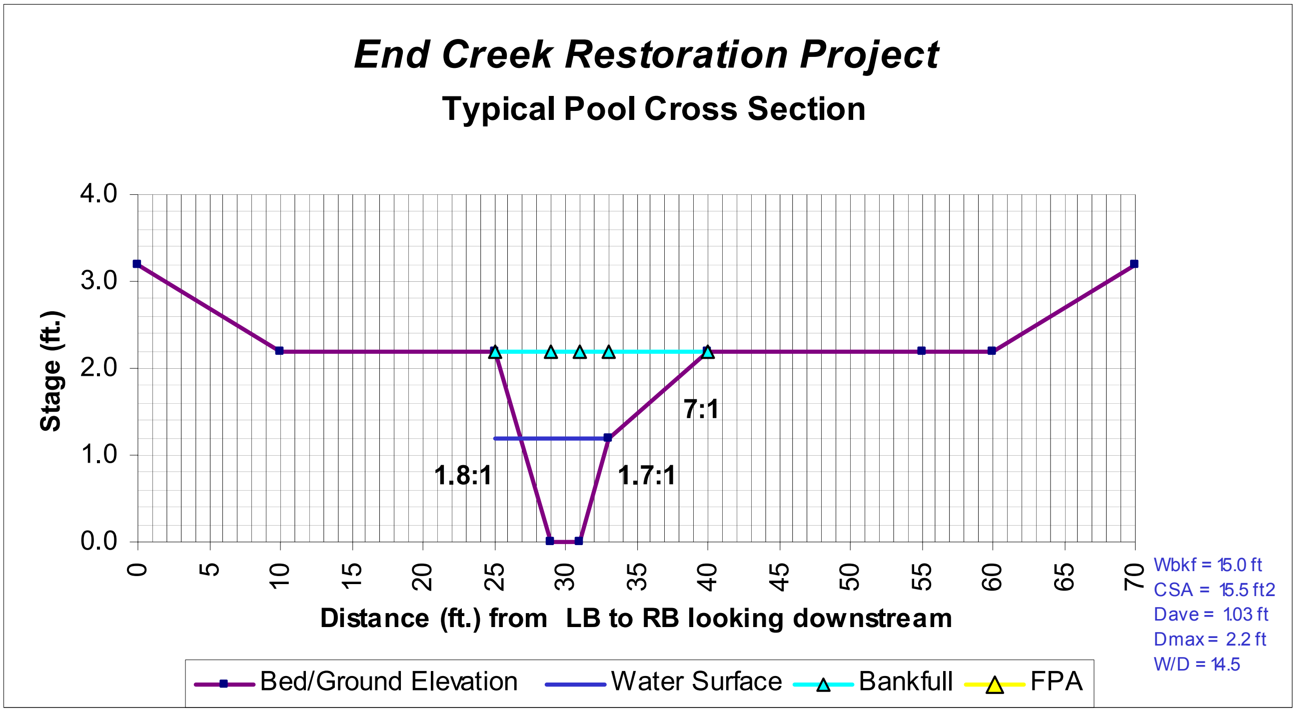


Figure 13 Typical Glide Cross Section for the End Creek Restoration Channel

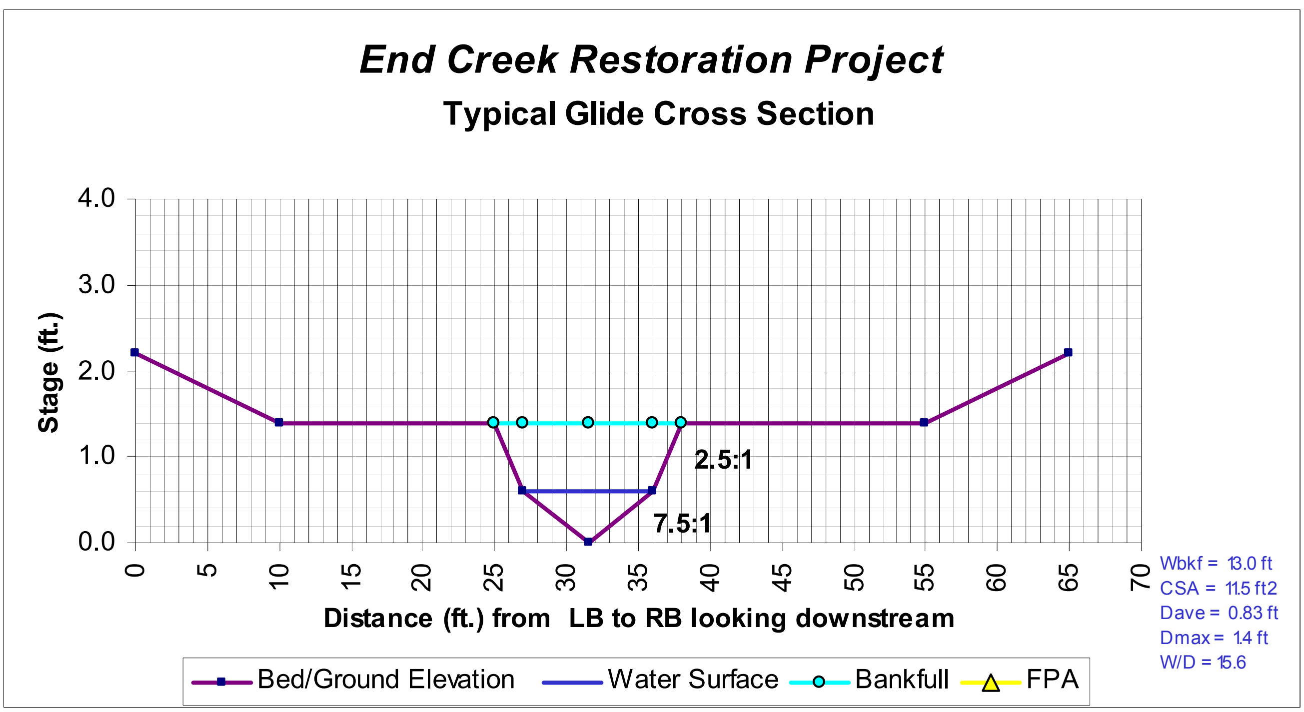


Figure 14 Longitudinal Profile of End Creek Restoration Channel

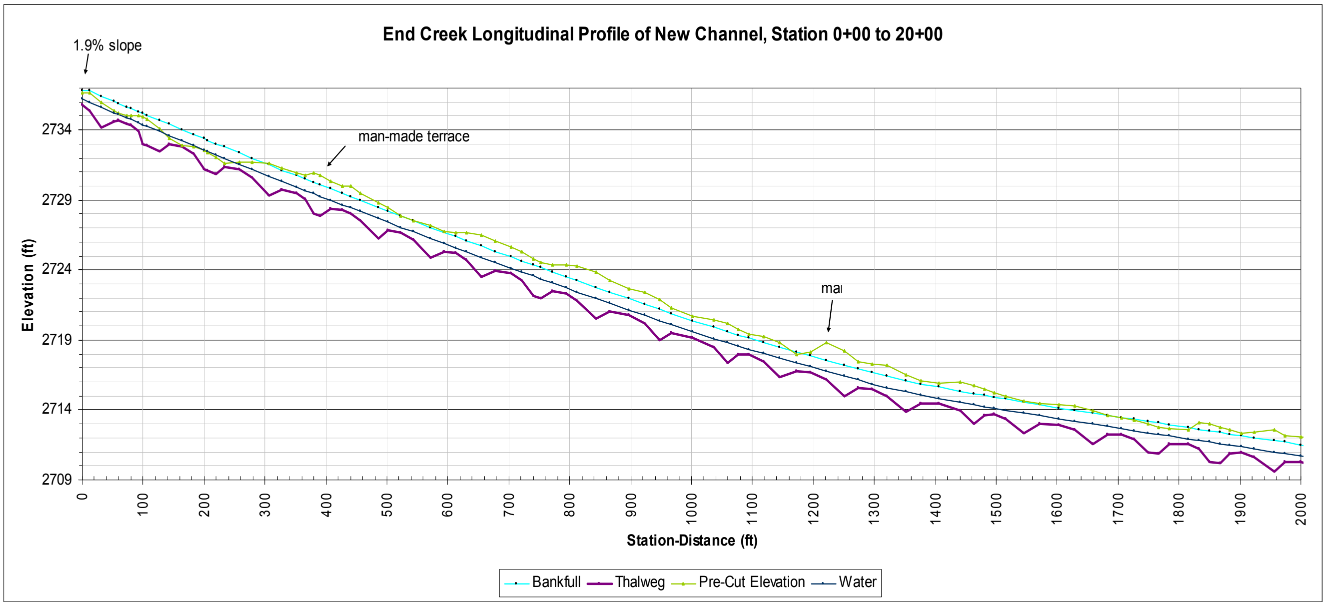


Figure 15 Longitudinal Profile of End Creek Restoration Channel (Cont.)

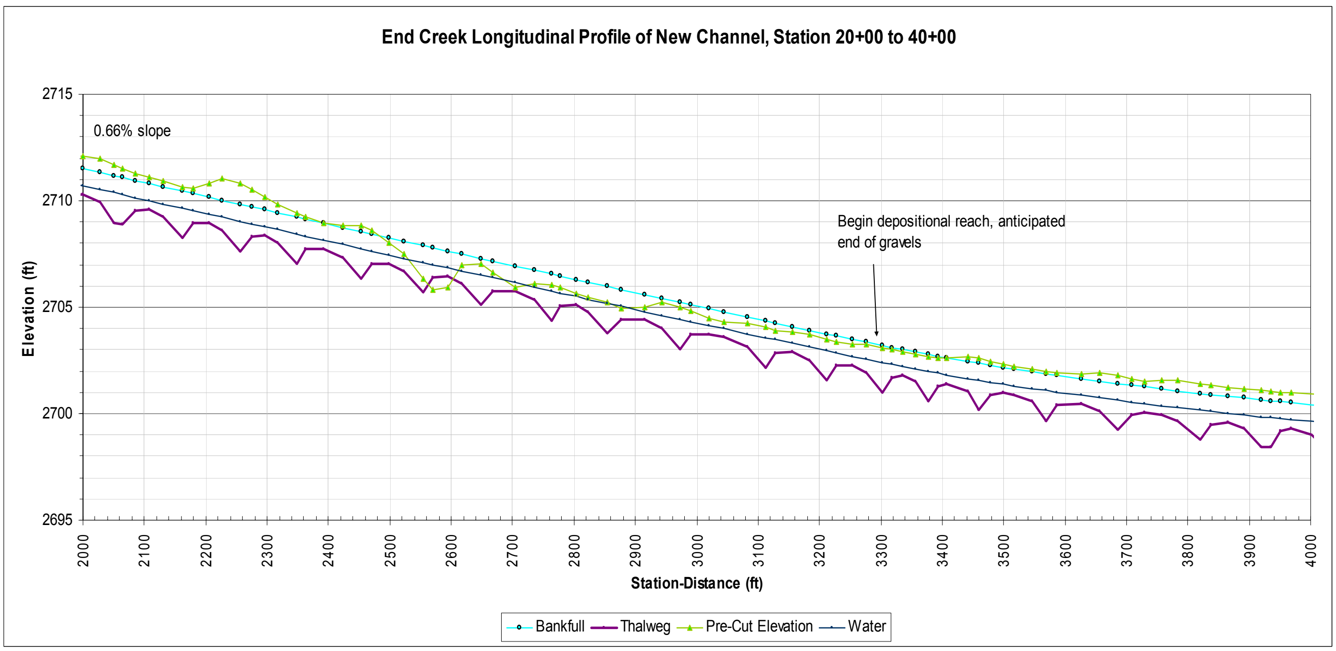


Figure 16 Longitudinal Profile of End Creek Restoration Channel (Cont.)

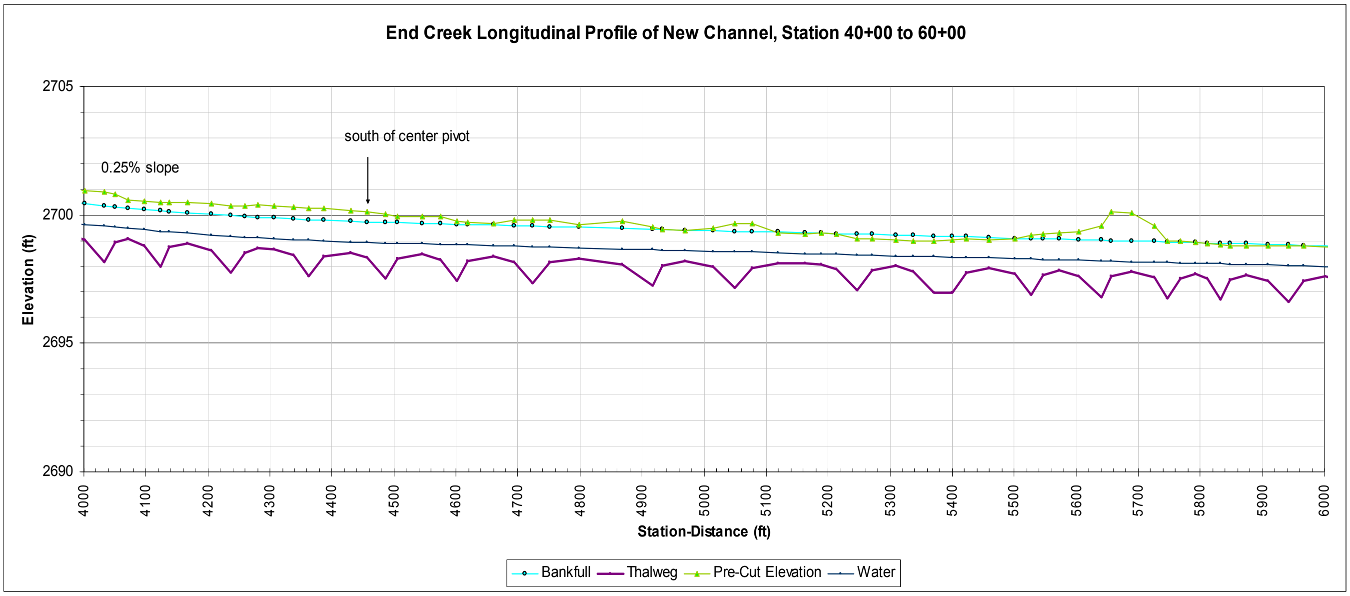
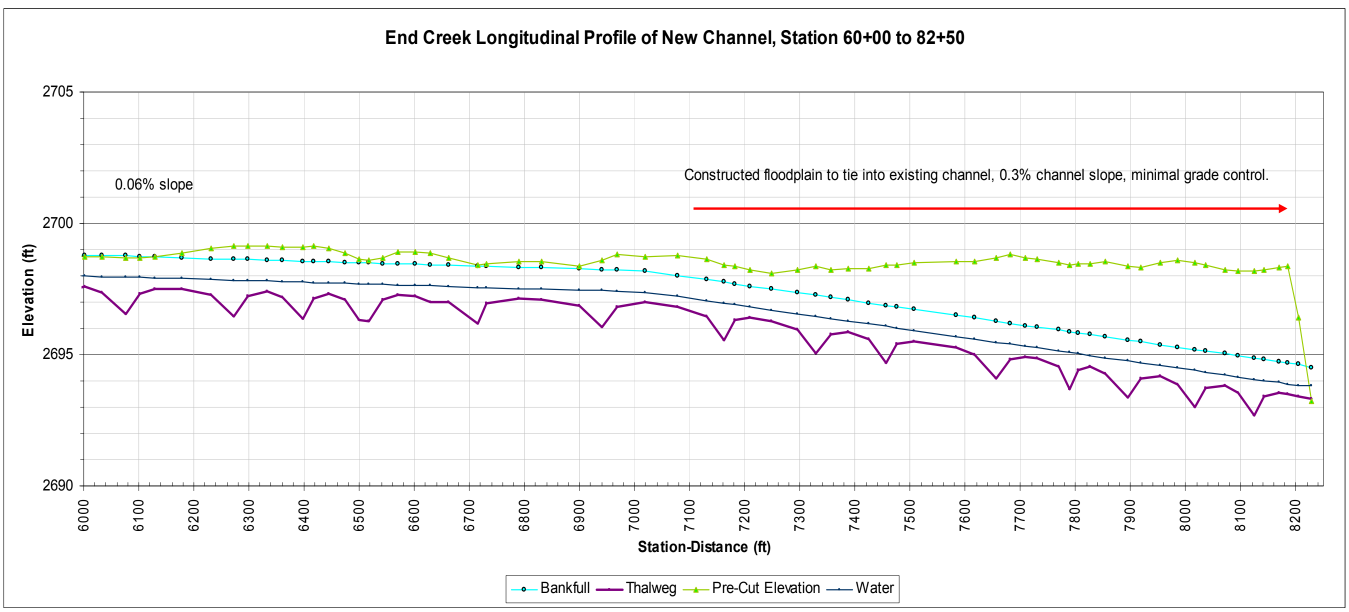


Figure 17 Longitudinal Profile of End Creek Restoration Channel (Cont.)



Initiation of End Creek restoration channel construction

Channel construction was performed using a 200 series track-mounted excavator, D5 dozer, and dump trucks. In stream channel segments requiring floodplain excavation (areas where the bankfull channel was deeper than existing ground surface), the floodplain was excavated first, followed by the bankfull channel and associated typical cross sections. Floodplain cuts involving extensive earth excavation were generally cut first using a dozer to bulk material which was then loaded by track-hoe onto dump trucks and hauled to designated locations (i.e., earthen terrace locations, backfill for channel reclamation, etc). In other channel segments that did not require floodplain construction, a track-hoe was utilized to sequentially excavate the channel per typical cross sectional dimensions in a downstream to upstream manner.

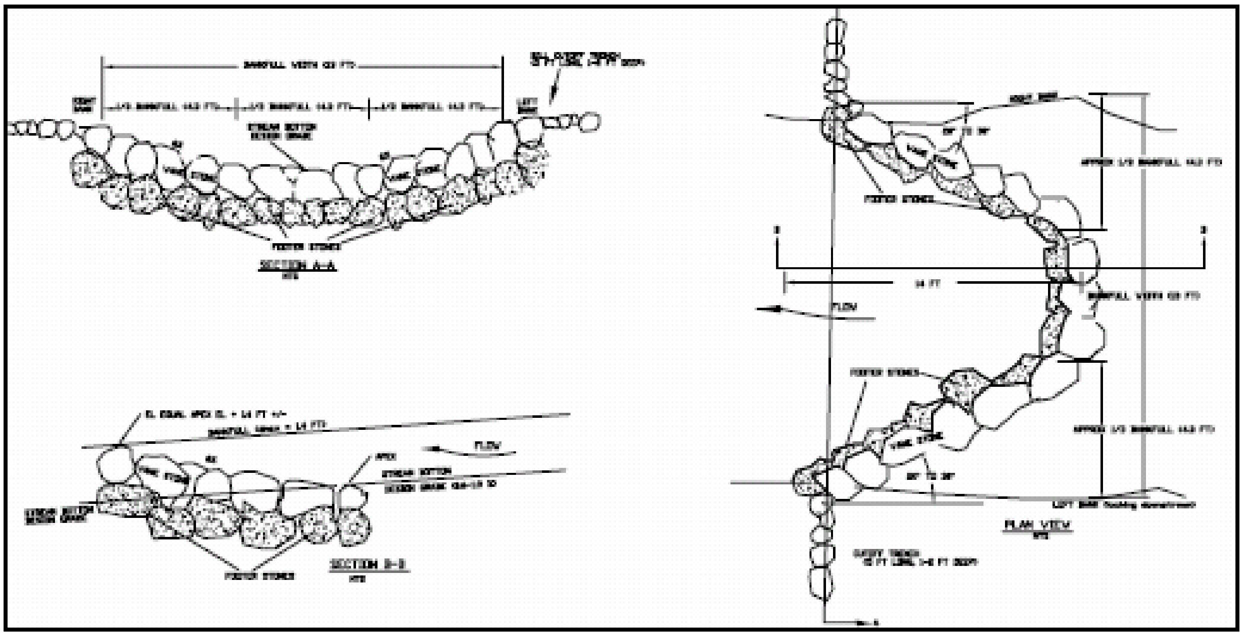
D5 Dozer grading material from floodplain in preparation for bankfull channel excavation by track-hoe

In addition to fish-bearing restoration stream channels constructed under this restoration effort, approximately 5.33 miles of small, spring fed restoration channels were constructed throughout the project area to replace existing ditches and facilitate wetland restoration. Typical spring channels were designed as small, meandering, v-shaped channels with maximum depths in the center of 1.0 to 1.5 feet. Spring channel were designed and constructed to maximize the use of existing topography and minimize earthwork requirements.

Rock Cross Vane Grade Control Structures

Typical rock cross vane designs are illustrated in Figure 18. These features are incorporated into channel designs to provide vertical grade control and minimize potential for channel incision. The structures were designed and installed at the junction of glides (downstream from pools) and riffles (natural grade control features). Rock within the cross vanes will be nearly indiscernible within the structure and will serve as a lithologic element that provides vertical channel stability. A total of 20 structures were installed in the Rice portion of the End Creek Restoration channel with the majority of placed in the upper sections to address higher channel slopes. Three structures were installed in the lower reaches to “step down” the channel entrance to the existing South Fork Willow Creek. Each structure consisted of approximately 15 cubic yards of angular basalt boulders with material ranging in size from 18-36 inches (average diameter (D50) of 28 inches (0.50 cubic yards each)).

Figure 18 Cross Vane Diagram



Photos below illustrate structure layout in the constructed restoration channel and an installed structure prior to backfill. Note that the elevation (invert) of the structure is the same as the bottom (thalweg) of the channel.

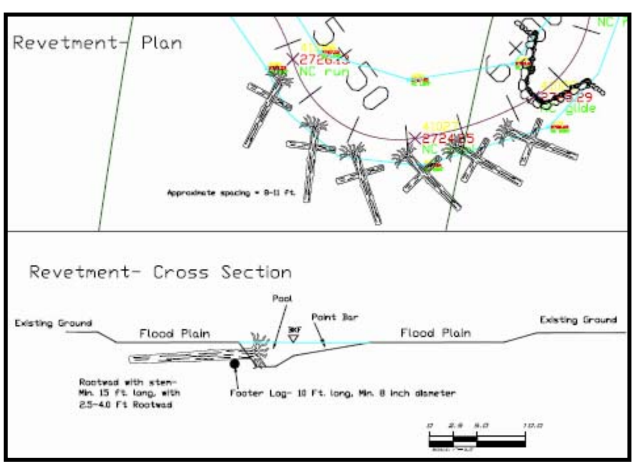
Rootwad Revetments & Large Wood Placement

Rootwad revetments were incorporated into the project design to provide streambank stability on outside meander streambanks until vegetation re-colonizes the site. Additionally, the rootwads provide structural diversity and contribute to complex pool habitat. Revetments consist of a tree bole with attached rootwad and a footer log which are keyed (excavated) into the streambed and streambank and backfilled.

Rootwad revetment installation. Photo illustrates installed footer log and keyway for rootwad and tree bole installation.

Revetments were installed in complexes along selected meanders with radius' of curvature (<30') in order to address concerns with potential for erosion associated with slightly greater water velocities and lack of vegetative stability. Figure 19 illustrates a planview of a typical revetment complex with a cross section of an individual revetment.

Figure 19 Rootwad Revetment Diagram



Tree boles were generally spaced 8-10 feet apart and the footers were installed at, or below, the streambed elevation in pools. Each tree bole/root wad had a footer log placed underneath and perpendicular to the root wad bole. Root wad and bole were angled upstream at approximately 45 degrees to face the channel thalweg.

Root wad diameters were 2.5 feet minimum and up to 4.0 feet maximum. Tree bole length minimum was 15 feet and footer logs were 10 feet in length and 8 inches minimum diameter on both ends. Approximately 960 linear feet of restoration channel streambank were stabilized with revetments. A total of 121 revetment logs 20 sites were installed on the Rice portion of the End Creek restoration channel.

Approximately 200 pieces of large wood was placed along the South Willow Creek channel to enhance floodplain roughness and instream habitat complexity.

Tree boles with intact rootwad and tops were generally placed on log debris jam configurations at strategic locations throughout the new channel reach. Additional wood placement is planned to complete the effort pending improved access conditions.

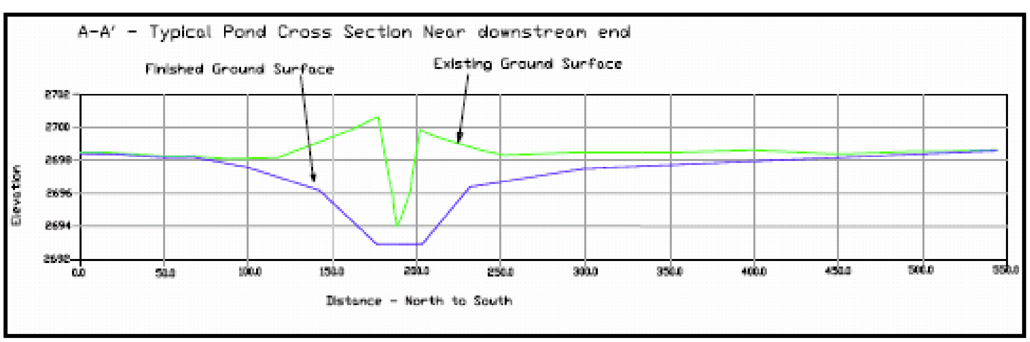
Channel/Ditch Reclamation, Floodplain Ponds, and Backwater Habitat

Following completion of channel diversion and removal of fish and other organisms from the channelized/abandoned stream reaches, reclamation activities along existing stream channels and ditches wera initiated along all channelized stream channels and ditches throughout the project area. The available quantity of excavated material from restoration channels (based on cut/fill calculations, design channel dimensions, and cross sectional measurement of channelized reaches) was found to be sufficient to backfill abandoned channels. Material in excess to that needed for channel reclamation was utilized to construct terraces along the eastern project area boundary and/or blended into floodplain adjacent to restoration channels. Reclamation work consisted of filling in and contouring soil and gravels along approximately 4 miles of existing channel. Fill material was blended into existing ground topography and contoured to provide a “natural” appearance.

Reclamation of channelized End Creek following activation of restoration channel.

Six floodplain ponds, totaling about 10 acres were constructed on the Rice portion of the project. Ponds were incorporated into the project design to provide open water habitat and develop associated wetland habitat. Ponds were located along channel and/or ditch segments planned for reclamation, taking advantage of entrenched channel segments to function as deep water habitat within the constructed pond. Constructed ponds vary in size from 0.7 to 2.4 acres with average depths of 1.0-1.5 feet deep and maximum depths of 6-7 feet. Existing steep side slopes along the channels were graded with a D6 dozer at 20:1 slope at the downstream portions of each pond. Fill material generated during pond excavation was utilized to fill upstream and downstream channel reclamation segments. Excess was utilized to construct feathered terraces and/or to fill man-made swells adjacent to the stream channel and floodplain pond network. The following figure illustrates a typical floodplain pond cross section.

Figure 20 Typical Floodplain Pond Cross Section



Ponds were shaped into various patterns (oxbow, meander) and contoured to develop diversity of macro topographic basins with both shallow and deep water habitat. Nearly all of the ponds filled with groundwater upon completion. Within two months of construction, all ponds were overflowing and activating spillways constructed to maintain connection between the pond and adjacent floodplain and/or spring channel. Waterfowl and shorebird use was observed shortly following construction, including long-necked stilts, avocets, mallard, American wigeon, blue winged teal, Canada goose, and Tundra swan.

***Floodplain pond construction*.**

Earthen Terraces

Earthen terraces were incorporated into project designs as floodplain features to minimize potential adverse effects from floodflow on adjacent private lands and/or to direct overland flow within the project area. Construction activities associated with these structures included hauling and spreading excess topsoil material generated from channel or pond construction activities. Blended terraces were constructed to a maximum height of 1.0 foot, with a 25-30 foot top width and 10:1 side slopes. Four blended terraces, totaling approximately 3,600 feet, were constructed on the Rice portion of the project area.

Earthen terrace constructed along eastern project boundary to minimize potential for flooding on adjacent private land

Culvert Removal and Reinstallation

Five existing culverts were removed and two reinstalled on access roads. Three culverts, including a large 60 inch culvert on the existing End Creek channel (Station 9+50) was not needed for project function. Two small, 20 inch culverts were reinstalled on an access road to service spring-fed tributaries. will be removed and/or relocated from project area ditches and streams to address resource needs.

Revegetation and Bioengineering

The long-term "vision" for the project area is a diverse assemblage of native plant communities that reflect site potential and contribute to the natural function, resiliency, and stability of a self-sustaining environment. In effect, project landowners and sponsors are trying to recreate, to the extent feasible, an environment similar to that which existed prior to European settlement and advent of agriculture, channelization, and draining of wetlands.

As part of the vision, a variety of plant communities and environments will be developed including emergent wetlands, shrub-scrub wetlands, riparian forest, and upland grassland and tree/shrub inclusions. In general, the upper, steeper portions of the project area will be more dominated by shrubs, trees, and upland grasses with the low gradient areas in the lower portions of the project dominated by emergent vegetation with sedges, rushes, and camas. Beaver colonization, as suitable habitat develops, will eventually contribute to the desired dynamic state of equilibrium.

Achieving the vision is perhaps one of the most challenging aspects of the project and demands attention to detail and persistence. Success in revegetation efforts will be dependant on a variety of factors including restoration of hydrology, selection of locally adapted species, and effective weed control. Planned techniques have been refined by project sponsors through evaluation of available research, practical application, trial and error, and persistence. Our planned approach utilizes a combination of techniques and includes installation and maintenance of temporary irrigation systems which has proven effective on similar projects in other portions of the basin.

Native grass seed mixes will generally consist of locally adapted Idaho fescue, bluebunch wheatgrass, basin wildrye, tufted hairgrass, and other appropriate and available species. Native seed mixes will be utilized throughout the project area with upland species such as Idaho fescue and blue bunch colonizing upland inclusions and basin wildrye dominating terraces and transition zones. Hydrophytic species such as tufted hairgrass, camas, and colonizing sedge and rush species will dominate low lying areas subject to annual moist soil conditions.

Shrub and tree planting will be accomplished adjacent to restoration channels and in upland inclusions distributed throughout the project area. Hydrophytic shrubs and trees planned for propagation include but are not limited to various willow species, red osier dogwood, black cottonwood, alder, and hawthorne while upland communities will include ponderosa pine, hawthorne, elderberry, rosehip, and snowberry. A combination of livewhips and containerized stock will be utilized on the project area beginning in spring 07'.

During the Fall of 2006, project sponsors initiated the first steps in moving towards the vision with completion of major project construction, site preparation, extensive seeding, and initial planting efforts. Following is an overview of the accomplishments to date.

Site Preparation – Ground disturbance created during construction efforts, accompanied by mowing and beating residual straw from the 06' wheat crop, provided a disturbed seed bed in preparation for seed installation. Mowing/beating was accomplished with a small tractor and mower on approximately 350 acres.

Native Seed Installation – Initial seeding efforts were completed along the End Creek restoration channel and floodplain ponds following construction using ATV mounted seed broadcaster and/or manual spreader.

Approximately 600 pounds of native tufted hairgrass and blue wildrye was applied on 30 acres and irrigated in late August to facilitate germination and growth along newly disturbed areas.

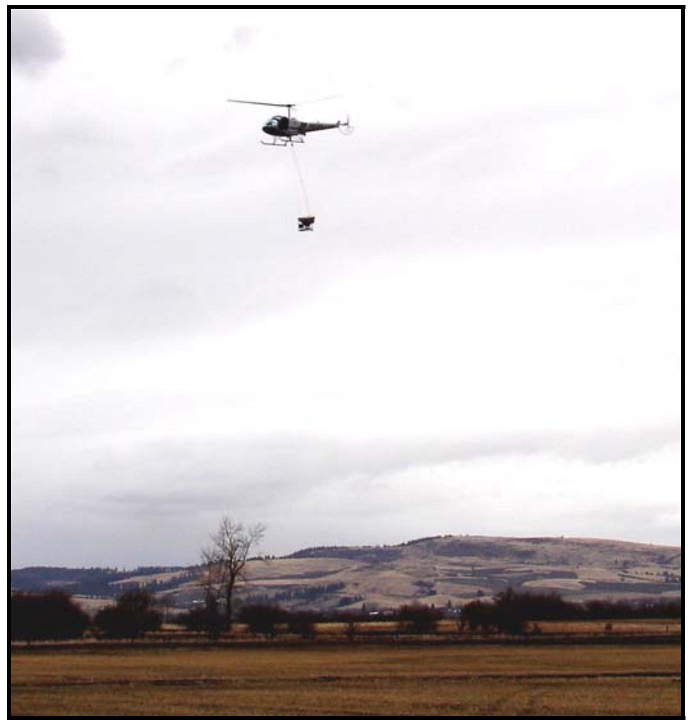
Project sponsors were planning on seeding the remainder of the project using a rangeland drill provided by ODFW, but delays associated with securing the drill due to post-fire rehabilitation efforts in other areas of the region and then heavy moisture by late November, limited our ability to complete project area seeding needs.

In mid December, the decision was made to secure the services of helicopter contract and proceed with an aerial seeding application, which was completed during December 11-12th. The operation consisted of CTUIR staff staging and loading seed into a 300 pound capacity seed hopper and aerially applying seed at an approximate rate of 18 pounds/acre.

The custom native seed mix included:

31.64% Idaho fescue
18.56% Grande Ronde Basin/Trailhead Wildrye
18.15% Blue wildrye
12.6% Bluebunch wheatgrass
9.18% Rosanna western wheatgrass
7.78% Sherman big bluegrass
2.09% Tufted hairgrass

Helicopter contract preparing for aerial seeding during December 2006



Aerial seeding was accomplished using an Enstrom helicopter.

The operation included installation of approximately 7,200 pounds of native seed on 430 acres, which covered all disturbed areas, including overseeding areas previously seeded during ground-based operations.

Plant Salvage and Installation –
Following diversion of End Creek into the restoration channel and prior to reclamation of the channelized reach, project sponsors directed a plant salvage effort from the existing End Creek alignment to provide plant materials for the restoration channel. The salvage effort included excavation of available shrubs (primarily salix spp.) and native sedge/rush matts using an excavator with hydraulic thumb and dump truck(s) to haul plant materials to designated locations.

The following photos illustrate the basic process which has been found to be highly efficient and effective in facilitating vegetative recovery following construction of restoration channels by project managers.

Dump truck hauling and stockpiling plant materials at selected locations along End Creek restoration channel.

Excavator prepares excavate and load sedge matt from the channelized End Creek alignment prior to reclamation (backfilling).

Salvage efforts were initiated in the lowermost channel reach, progressing upstream. Generally, salvage of whole shrubs with rootwad was conducted separately from sedge/rush matts in order to minimize damage to roots and stems of the willows.

Willow material was strategically staged for later mechanical installation in the upper, steeper regions of the restoration channel while sedge/rush matts were staged along nearly every outside channel meander.

Approximately 60 shrubs and 5,180 square feet of sedge/rush matts were salvage and reinstalled along the End Creek restoration channel. Shrubs were generally installed in small groups on point bars while sedge/rush matts were planted on streambanks along outside channel meanders in order to facilitate development of stable banks.

Excavator installing sedge/rush matts along outside stream meander on rootwad revetment

Because the salvage efforts were conducted during the summer growing season by necessity, special provisions are implemented to improve plant survival, including installation of irrigation systems to maintain moist soil conditions. Despite irrigation application, however, shrubs excavated outside of normal dormancy periods do not generally have high survival rates.

Sedge/Rush Plug Planting – Fall planting activities were focused on native sedge/rush plug installation along the End Creek and lower South Fork Willow Creek restoration channels. Local source sites were utilized to cut 3 inch diameter plugs using a simple plug cutting tool which were then hauled to planting locations and installed using a 4 inch power augur. Planting specifications required installation at one foot centers along entire length of channel, generally within the bankfull channel elevation in order to maximize access to moist soil conditions and improve survival. Between late September through mid-November, approximately 12,650 plugs were installed along approximately 10,708 feet of restoration channel. Additional sedge/rush planting is scheduled to get underway during spring 07' and encompass the remainder of the South Willow channel, spring channels, and floodplain ponds.

CTUIR habitat crew installing sedge/rush plugs along South Fork Willow Creek

Trap and Haul/Relocate Fish, Amphibians, and Reptiles Prior To Channel Diversion

An ODFW crew with assistance from CTUIR technicians conducted salvage operations along End Creek during August 23, 30, 31, September 5, and October 17-18. A total of 344 O. mykiss and 1,339 non-game species (sculpin, dace, shiner) were trapped and hauled from the End Creek channel prior diversion. Channel diversion was completed in phases, beginning with the lower sections and progessing upstream to the upper project reach. A total of 8 O. mykiss mortalities were recorded during the salvage operation.

Fish salvage operations were implemented under the following process, consistent with all Reasonable and Prudent Actions outlined in the Biological Opinion issued by NMFS:

1. The upper and lower reaches of the stream were block-netted to prevent movement of fish into the restoration reach.
2. Seine nets were be utilized first (where possible) to capture/remove fish.
3. A Smith-Root Model 12A POW electroshocker was utilized to capture remaining fish, using NMFS protocol ("Backpack Electrofishing Guidelines", NMFS June 2000 or later versions if available).
4. Fish transport was conducted using 6-wheeled, All Terrain Vehicles (ATVs) with integrated utility beds for secured storage of fish containers.

5. Fish were transported in large, aerated coolers and secured in ATV utility beds. Fish hold times were minimized by making multiple transport trips. Water temperatures were continuously monitored as work progressed to avoid thermal stress.
6. All encountered fish (salmonid and non-salmonid species), amphibians, and reptiles were salvaged from the channel prior to dewatering and relocated to upstream locations; and
7. Transported fish, amphibians, and reptiles were relocated to several designated sections above the restoration reach to avoid concentrating fish at designated release sites.

Riparian Conservation Easement Fence Construction

Approximately 776 acres were enrolled into the Federal Wetland Resource Program with about 676 acres permanent easements and 100 acres in a 30 year conservation easement on the Rice, Davidson, and Dake private parcels. As project development continues, a detailed management plan will be developed for each of the three parcels to ensure that resource objectives are being achieved over time. With the cost-share investment of BPA funds, both the CTUIR and ODFW are incorporated into the long-term agreements to assist in planning, implementation, and maintenance of the conservation easements. Approximately 2 miles of new fence boundary fence is planned for construction by the landowners.

5. PROJECT PHOTOGRAPHS

Upstream reach of End Creek (Rice) Restoration Channel, viewing east (downstream) towards South Fork Willow Creek confluence. Note reclaimed channelized reach in left corner of photo and floodplain ponds incorporated into reclamation plan

Upstream view of upper End Creek restoration channel

Middle reach of End Creek restoration channel viewing upstream.

Initiation of channel construction on lower End Creek.

Upper reach of South Fork Willow Creek restoration channel viewing downstream towards confluence with End Creek restoration channel. Note large woody debris placement in channel and floodplain.

Restoration spring channel paralleling End Creek Restoration Channel.

Lower End Creek Restoration Channel with floodplain pond in middle foreground.

Floodplain pond with spring channel outlet.

6. PROJECT EXPENDITURES

Work Item	Description	Detail	Bid/Cost Estimate	OWEB Rice ($38,880)	BPA-GRMW Rice ($197,792)	NRCS-WRP Rice ($157,853)	Total
Item 1	Mobilization	Unit Price	3,658	0	1,829	1,829	3,658
Item 2	Construct Lower End Cr Chann	8,229 feet, 13,170 yds	55,051	13,170	20,940	20,940	55,051
Item 3	Cross Vanes	27structures, 405 yds	12,801	0	12,801		12,801
Item 4	Revetments	20 units, 121 trees, approx 1,200 feet	37,620	0	18,810	18,810	37,620
Item 5	End Cr Channel Reclamation	3,730 feet, 6,248 yds	25,080	0	12,540	12,540	25,080
Item 6	Floodplain Ponds	8.98 acres, 15,054 yds	55,060	0	55,060		55,060
Item 7	Swale Construction	13,054 feet, 3,917 yds	12,279	5,875	0	6,404	12,279
Item 8	Ditch Reclamation	2 ditches, 2,025 ft, 1,171 yds	3,605	0	1,803	1,803	3,605
Item 9	Earthen Terraces	2 each, 2,382 feet/3,452 yds	10,822	0	0	10,822	10,822
Item 10	Planting	Mechanical salvage and installation	6,270	0	0	6,270	6,270
Item 11	Culverts	Removal (5), Installation (4)	3,135	0	3,135	0	3,135
TOTAL		CONSTRUCTION SUBTOTAL	225,380	19,045	126,918	79,417	225,380
Phase 3 (Rice) Summary (plus phase 1 elements)							
Item 1	Mobilization	Lump Sum	0	0	0	0	0
Item 2	Construct South Fk Willow Cr	8,648 ft. , 4325 yds	30,268	19,835	10,433	0	30,268
Item 3	Cross Vanes & Rock Crossings	2 CV structures (30 yds), 3 crossings (80 yds)	7,660	0	3,830	3,830	7,660
Item 4	Large Wood Placement	200 pieces, South Willow	35,840	0	17,920	17,920	35,840
Item 5	Floodplain Ponds	1 pond, 1.4 acres, 2,253 yds	7,886	0	7,251	635	7,886
Item 6	Spring Channel Construction	5 channels, 14,131 ft, 4239 yds	14,131	0	7,066	7,065	14,131
Item 7	Ditch & Terrace Reclamation	Ditch reclamation (middle, west, Duke/Rice, S Willow), (10,594 ft, 20,334 yds), 5 terraces (13,200 ft.)	31,885	0	0	31,885	31,885
		CONSTRUCTION SUB-TOTAL	127,670	19,835	46,499	61,336	127,670
	CONSTRUCTION TOTAL (PHASES 1 & 3)		353,050	38,880	173,417	140,753	353,050
	MISC Expenses						
Misc	Irrigation equipment	Irrigation pipe and pump	10,000		10,000		10,000
Misc	Site Preparation and Seeding	Wheat stubble beating, seed purchase, and installation	27,100		10,000	17,100	27,100
	Fence materials	purchase of materials for boundary fences	4,375		4,375		4,375
		MISC SUBTOTAL	41,475				41,475
Misc	TOTAL - CONSTRUCTION, MATERIALS, & MISC		394,525	38,880	197,792	157,853	394,525
Inkind	Project Design, Permitting, Layout, Contracting & Inspection (ODFW, CTUIR, & NRCS)						105,000

7. REFERENCES

Grande Ronde Model Watershed. 2001. Willow Creek Watershed Assessment

Meehan, William R., Editor, 1991. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats, American Fisheries Society Special Publication 19, Bethesda, Maryland, 1991.

McGowan, Vance. 2005. End Creek Restoration Project Design Report. Oregon Department of Fish and Wildlife, Northeast Oregon Regional Office.

Nehlsen, W., J. E. Williams, and J. A. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries Bulletin, American Fisheries Society, Bethesda, Maryland.

Northwest Power and Conservation Council. 2004. Grande Ronde Subbasin Plan.

Northwest Power and Conservation Council. 2001. Grande Ronde Subbasin Summary.

Oregon Department of Agriculture. 1990. Upper Grande Ronde Subbasin Water Quality Management.

Oregon Department of Environmental Quality. 2000. Upper Grande Ronde TMDL.

Oregon Department of Fish and Wildlife and National Marine Fisheries Service. 1990. Past and present abundance of Snake River sockeye, Snake River chinook, and lower Columbia River coho salmon. A report prepared for Senator Mark Hatfield, U. S. Senate.

Oregon Department of Fish and Wildlife and four other agencies. 1990. Grande Ronde River Subbasin, salmon and steelhead production plan. Northwest Power Planning Council, Portland, Oregon.

Oregon Department of Fish and Wildlife. 1991. Summaries of fish sampling during 1990, aquatic inventories project. Oregon Department of Fish and Wildlife, Portland, Oregon.

Rosgen, D., 1996 Applied river morphology. Wildland Hydrology, Pagosa Springs, Colorado.

Rosgen, D.L. 1998. The reference reach – a blueprint for natural channel design. Presented at the ASCE, Denver, CO.

Union County Soil and Water Conservation District. 2002. Willow Creek Coordinated Resource Management Plan.