Case Study 3 Little Elk River, Price County, Wisconsin

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Cover photo: Completed section of Little Elk River, Price County, Wisconsin

Advisory Note

Techniques and approaches contained in this handbook are not all-inclusive, nor universally applicable. Designing stream restorations requires appropriate training and experience, especially to identify conditions where various approaches, tools, and techniques are most applicable, as well as their limitations for design. Note also that product names are included only to show type and availability and do not constitute endorsement for their specific use.

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Abstract

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS); Wisconsin Department of Natural Resources (WDNR); Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP); U.S. Fish and Wildlife Service (USFWS); and the Price County Land Conservation Department (LCD) cooperated to improve a 1,000-foot section of trout stream that was degraded from a century of cattle access and an old rock dam crossing installed by the landowner. Rosgen's Stream Classification System (Rosgen 1996) was applied to the degraded section, as well as to an unimpacted section of river immediately upstream of the project site. Design was based on recommendations from the WDNR fish manager and recommended applications from Rosgen's book. The Rosgen approach to geomorphic channel design is provided in NEH 654.11. The design narrowed the degraded section of stream to imitate the class B4c unimpacted section of stream. Improvement to trout habitat was planned with random boulder placement in the riffles of the stream. Cross sections of the stream before construction, after construction, and the following spring were compared. The final cross sections show that the stream width of the degraded section was restored to class B4c to imitate the healthy section of stream.

Introduction

In 2002, 1,400 feet of the Little Elk River was restored. This portion of the river has a drainage area of 26 square miles. The watershed is predominantly wooded with some cropland. The stream bottom is rocky. The soils are mapped Stambaugh silt loam, a glacial outwash material. Most of the Little Elk River is a Class 3 trout stream; however, there is a 2.6-mile stretch of Class 1 trout stream located 0.8 miles downstream of the site (figs. CS3–1 and CS3–2 (WDNR 2002)).

Degradation of trout habitat is usually a result of human activities. Trout habitat is lost to activities that change water temperature or oxygen levels, reduce access to spawning areas, or eliminate trout hiding places. In northern Wisconsin, trout habitat has been degraded by logging, construction of dams (both manmade and beaver-built), draining of wetlands, uncontrolled cattle grazing, soil erosion, and loss of stream corridor vegetation. A section of the Little Elk

Figure CS3–1 Site of Little Elk River

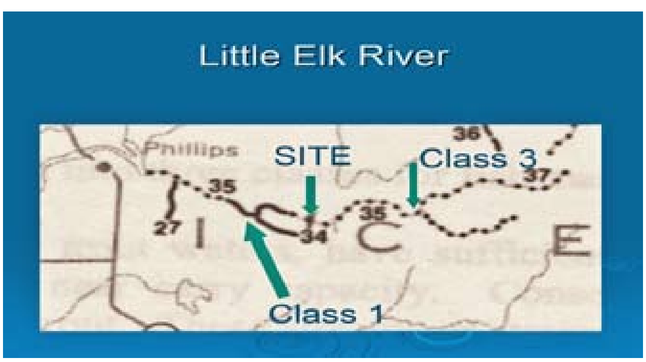
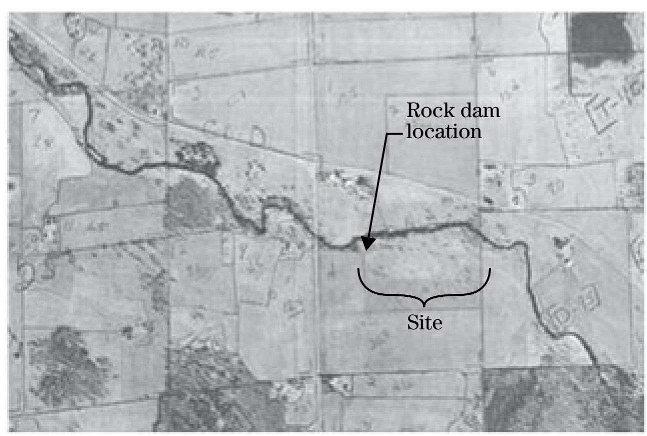


Figure CS3–2 1963 aerial photograph of Little Elk River



River in Price County, Wisconsin, was degraded by a rock dam crossing installed in the early 1990s, and uncontrolled cattle access led to loss of vegetation and widening of the stream (figs. CS3–3 and CS3–4). The crossing was located at the downstream end of the restoration project. Price County is located in the Wisconsin North Woods and supports 71 trout streams totaling 244 miles. Sixty miles are Class 1, 114 miles are Class 2, and 70 miles are Class 3. WDNR classifies trout streams as Class 1 if the high quality trout waters support natural reproduction to sustain populations of wild trout at or near carry capacity, Class 2 if there is some natural reproduction, and Class 3 when there is marginal trout habitat with no natural reproduction occurring. Classes 2 and 3 require annual stocking of trout.

Uncontrolled cattle grazing has eliminated woody vegetation along 700 feet of the 1,400-foot-long site and damaged the remainder (fig. CS3–4). Continuous hoof traffic has broken down the undercut streambanks where trout could hide and eroded the banks, so that the stream width has tripled in places. In the degraded section, the length between pools and riffles, as well as the drop over the riffles, has increased, compared to the more protected section upstream of the property.

The landowner initially contacted the NRCS to sign up for a riparian buffer in the continuous Cropland Reserve Program (CRP). The NRCS buffer program funded fencing along a 160-foot-wide corridor 1,400 feet long and tree planting for 1,050 feet.

NRCS sent the landowner to the Price County LCD for possible stream restoration cost-share assistance. The Wisconsin DATCP, Land and Water Resource Management (LWRM) funds, and the NRCS Access Road Conservation Practice Standard were used to design a rock crossing in place of the rock dam. Price County Shoreland Improvement funds and the USFWS contributed funding to restore 1,000 feet of the Little Elk River for better trout habitat. The LCD worked with the NRCS engineer and the local fish manager of the WDNR to provide a design and use this site as a demonstration project. The landowner contributed the rock riprap he had collected onsite over his years of farming. Assistance for tree planting was provided by local high school students as part of a classroom field trip.

Figure CS3–3 Little Elk River rock dam crossing

Figure CS3–4 Uncontrolled cattle grazing

Design

The design concept was to restore the degraded stream to a similar cross section and stream classification type of a nearby undergraded section. First, in 2001, the rock dam was removed (fig. CS3–5) and replaced with a cattle crossing to meet Wisconsin NRCS Conservation Practice Standard No. 560, Access Road.

The most critical information determined was the bankfull stage. Due to cattle traffic in the disturbed area, a typical bankfull elevation was not pronounced, so staining on rocks and elevations of woody vegetation were used to determine the bankfull elevation. The bankfull channel width was measured in the riffle segment of the selected reach. Cross sections were surveyed through a riffle area in the degraded site (fig. CS3–6) and upstream in an undisturbed area (fig. CS3–7). This information was used to determine the entrenchment ratio and width/depth ratio.

The following spring, the morphological description of each section was compared by applying the Rosgen Stream Classification System. Entrenchment ratio, width/depth ratio, sinuosity, stream slope, and channel material were calculated (Wolman pebble count method) (fig. CS3–8).

Figure CS3–5 Removal of rock dam crossing, Nov. 2001

Figure CS3–6 Cross section of disturbed site

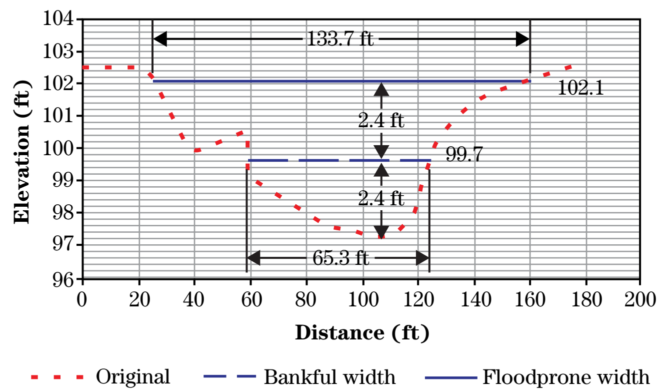


Figure CS3–7 Cross section of undisturbed site upstream

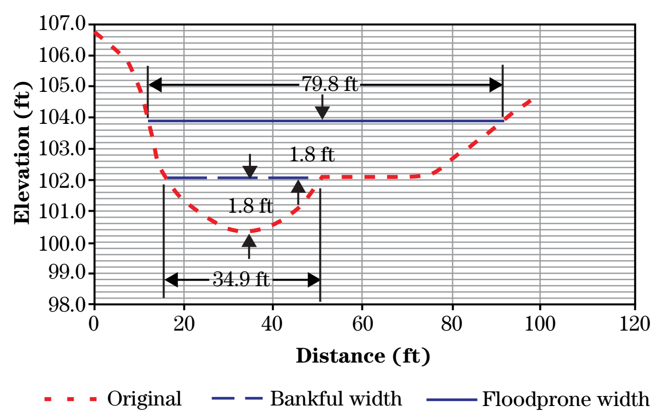


Figure CS3–8 Performing the Wolman pebble count

Entrenchment ratio is equal to the floodprone width divided by the bankfull width.

entrenchment ratio$_u$= 79.8 ft×34.9 ft = 2.29

entrenchment ratio$_d$ = 133.7 ft×65.3 ft = 2.0

Both are moderately entrenched.

Width/depth ratio is equal to the bankfull surface width divided by the mean depth of the bankfull channel.

width/depth ratio$_u$ = 34.9 ft×0.9 ft = 38.8

width/depth ratio$_d$ = 65.3 ft×1.2 ft = 54.4

Width/depth ratio is changing from a moderate toward high ratio.

Sinuosity was measured from an aerial photograph (fig. CS3–2).

sinuosity = 8,250 ft×6,435 ft = 1.28

moderate sinuosity

Moderate entrenchment, width/depth ratio, and sinuosity are characteristics of stream type B.

Water surface elevation was surveyed at two stations 660 feet apart. Both points were in a riffle.

slope = 2.24 ft/660 ft = 0.0034 ft/ft

<0.02 ft/ft, designates “c” in the classification

Median particle size, D_{50}, from the pebble count was 20 millimeters, which is a coarse gravel and designates a “4” in the classification (fig. CS3–9).

The Little Elk River classified as a B4c stream according to the Rosgen method. The width/depth ratio was changing from a moderate to high ratio in the degraded section.

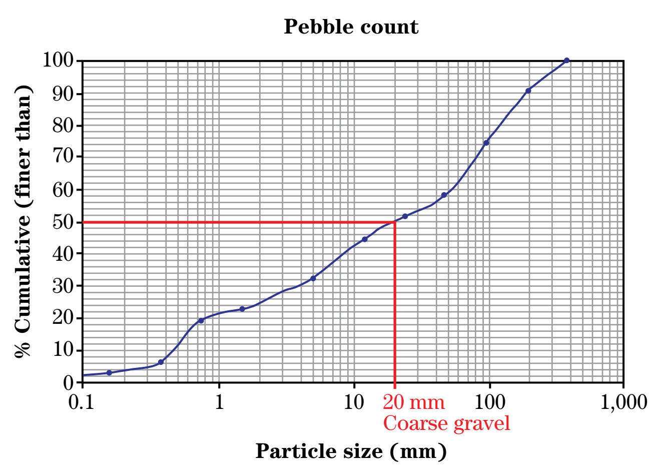
Applied River Morphology (Rosgen 1996) recommends suitable fish habitat improvement structures by stream classification. Channel type B4 is suitable for most structures. NRCS consulted the fish manager from WDNR to concur on the best structures for this site. Random boulder placement was chosen, as well as narrowing the stream to match the upstream undisturbed width.

The stream was narrowed to a 35- to 40-foot width at bankfull elevation, using rockfill. Rock piles were on site from many years of rock picking in the adjacent crop fields. The rock gradation was determined using the following criteria:

Percent passing by weight	Size in inches
100	2×D_{50}
60–85	1.5×D_{50}
25–50	D_{50}
5–20	0.5×D_{50}
0–5	0.2×D_{50}

The gradation of the rock piles measured as D_{50} = 5-inch diameter. This greatly exceeded the required rock size of 2-inch D_{50} based on the computed bankfull velocity of the stream using Manning’s equation and the 3.5-inch D_{50} rock size for a 10-year event. The velocity of the stream was computed to be 3.4 feet per second at the bankfull elevation and 5.1 feet per second in a 10-year, 24-hour storm event. Earthfill was placed over the top of the rockfill, seeded, and covered with erosion control mat. Due to budget constraints, only one strip of erosion control mat was used along both banks.

Figure CS3–9 Channel material D_{50}



The construction plan included a note for random boulder placement:

> ***Place approximately 30 boulders, in groups or singly, in a random fashion between stations 1+00 and 11+40. Boulder size shall be of 2-foot diameter or larger. Boulders shall be placed in riffles for added fish habitat cover. The placed boulder shall not divert water flow into the bank. The technician must be onsite during placement.***

Boulders were placed primarily in riffles to provide resting places for trout. Boulders were arranged in the field to direct flow away from the banks (figs. CS3–10 and CS3–11).

Construction		
Rock	1,465 yd^3×\$7.50/yd^3	= \$10,987.50
Earthfill	350 yd^3×\$5/yd^3	= \$ 1,750.00
Boulders	30 ea×\$20 ea	= \$ 600.00
Erosion control mat	10 rolls×\$76.70/roll	= \$ 767.00
Seed	Job	= \$ 110.00
Rock dam removal	Job	= \$ 875.00
Total cost		= \$15,089.50

Equipment used: JD–450, excavator, front end loader included in the cost of material.

Time to do the project: 3 days (about 26 hours).

Figure CS3–10 Boulders used for random placement in the stream

Figure CS3–11 Random boulder placement with DNR fish manager and NRCS engineer

Figure CS3–12 shows the project 1 month after construction; figure CS3–13 shows a cross-sectional comparison.

Figure CS3–12 1 month after construction

Conclusions

The rocky stream and soil conditions of this project supported narrowing the stream width with rockfill. The material was in existing stockpiles adjacent to the site, which helped make the project very cost effective. Working together with multiple agencies and disciplines early in the planning facilitated the permitting process and assured that both biological and engineering needs were met. The section of restored stream was tested with flooding just 2 days after installation, and the restoration features remained intact. A survey the following spring showed no significant change in the cross section geometry. The trout stream classification has not yet been reevaluated by the WDNR, but it is anticipated that the current Class 3 rating will improve to Class 2 or even Class 1 as found just 0.8 miles downstream.

Figure CS3–13 Cross-sectional comparison