BRAIDED CHANNEL CONSOLIDATION
IN AN OUTWASH AND GRAVEL-MINED AREA
OF CONFEDERATE GULCH, MONTANA

Part II of a Final Report

to

The Montana Department of Natural Resources and Conservation

on

Project No. RIT-87-8506:
Stream Restoration on Confederate Gulch and Deep Creek

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INTRODUCTION

Here, we present findings from a project to develop, evaluate and demonstrate channel restoration in a part of Confederate Gulch (creek) that has been structurally affected by various human activities: gravel outwash from placer mining several miles upstream from it, past gravel mining at the project site, and disruption of the natural streamflow discharge regime by water withdrawal for irrigation. We refer to the study area as "Lower Confederate Gulch" (LCG).

This study was concurrent with two other studies: one farther upstream in the canyon zone of Confederate Gulch or the "Upper Confederate Gulch" (UCG) study area; the other in nearby Deep Creek. The three studies were to investigate methods for restoring trout habitat from structural damage by placer mining, floods, and related influences. We present the findings from the UCG study separately in a Part I of this final report, and those from the Deep Creek study in Part III.

Phases I through IV of the work plan were previously reported to DNRC, and the tasks included in these phases are not reported upon here again except as they may pertain to the phases covered by the present report. The present report constitutes phase VI, the final report and recommendations, and covers phase V, the evaluation stage, as well.

Because the LCG project was more a construction project than research, the report will, after the following section on description of the project area, take the form recommended by DNRC for such reports.

PROJECT AREA DESCRIPTION

The study area lies in the northwest quarter of the southwest quarter of section 20, T9N-R2E, Broadwater County (Figure 1). The section of stream channel studied is on the property of Mr. and Mrs. Jay W. Sweetser and extends from a driveway and associated culverts near their south property line upstream to the north boundary fence of their property.

The main channel of the braided stream was about 450 m long at the outset of study. It was lengthened during the project, as reported below.

Drainage basin area above the downstream border is roughly 130 km^2 (about 50 mi^2) and rises from about elevation 1,215 m to 2,725 m (about 3,990-8,942 ft), the highest point being the summit of Boulder Baldy Mountain. Above the upstream end of the study area, the drainage basin is roughly 110 km^2 (42 mi^2). The difference in drainage area between the upper and lower boundaries is largely due to the tributary basin of Clear Creek, which enters from the east only about 30 m from the downstream boundary (and which, due to irrigation diversion, seldom flows at its mouth).

Most of the drainage is from a relatively low elevation saddle area of about 1,980-2,070 m (6,500-6,800 ft) at its ridge. Because little of the basin is at snowpack elevations, flood flows can be expected most often to come from intense rain storms rather than from snow melt (Ron Shields, USGS, Helena, personal communication, 1990).

Local residents reported that in previous years of "normal" precipitation, the stream had flowed year-round, but a series of drought years prevailed during the study. Thus, in each year of the study--and sometimes well into winter--Confederate Gulch's flow failed to exceed the amount of water diverted for irrigation, and the study area's channel became completely dewatered from spring through fall. Water usually flowed in the channel only during winter, but also sometimes briefly at other seasons when exceptionally high runoffs occurred.

In the canyon zone of the stream several miles upstream, base flows of about 120-230 L/sec (4-8 cfs) prevailed in summer and winter (White et al. 1992), and the 10-, 50- and 100-yr frequency high flows were estimated at 4.4, 11.0, and 14.2 m^2/sec (157, 390, and 502 cfs; Cunningham 1988).

NARRATIVE

I. Project description and the problem solved by the project

A. Problem description

To summarize the situation and problem in the LCG, in 1986 it was a section of largely braided channel, the main thread of which was about 450 m long. In this braided area, gravel that had washed from the placer-mined Confederate Gulch canyon was depositing. The study was initiated because the Montana Department of Fish, Wildlife and Parks (FWP) considered this part of the stream to represent a habitat problem because of poor channel form for migration passage and holding of adult trout. Other problems were lack of cover and other elements of rearing habitat for young trout and abrupt channel migration and encroachment of gravel and other sediments on pasture land.

The channel and riparian soils of the study area were predominantly gravel. This was apparently part of an outwash "fan" formed by gravel emanating from the canyon zone several kilometers away. Undoubtedly, gravel discharge from the canyon had increased greatly during the 1860s, when massive placer mining was done there, as well as during later mining, which was probably less intense.

Several decades ago, the study area was mined for gravel, which was probably used for building roads. On a past U.S. Geological Survey topographic map (Diamond City quadrangle), our study area appears to be almost completely occupied by a lake of rather uniformly round shoreline. This lake was undoubtedly the gravel mine pit. The pit has filled with more gravel to the degree that it is dry land with a braided stream channel, but some of the pit's edges are still evident as slight banks or benches.

Scattered groves of small cottonwood trees apparently developed before 1981 on the sediments that filled the gravel pit lake. Some of the groves had linear, hedge-like form, perhaps following former lake (gravel pit) shorelines or more recent streambank alignments.

A May 1981 flood created a tongue- or lobe-like deposit of gravel in the area (Figure 2), burying a meter or more of the trunks of many of these trees and radically changing the course of the stream. This lobe of sediment probably deposited not only because of decrease in valley slope, but also because the culverts under the driveway road at the lower end of the study area (point A, Figure 2) could not accommodate the flood water. The road embankment thus dammed the flood, exacerbating the inadequacy of water velocity in the study area to carry the gravel load. During the flood, water reportedly flowed over the road near point J of Figure 2 (J. Sweetser, personal communication).

When the gravel lobe formed, it forced a section of channel (GDC, Figure 2) to shift eastward along the edge of the new deposit, forming channel GFE. This new channel broke through one of the cottonwood rows or hedges at point F (Figure 2), where the tree roots still constrict flow and a deep pool exists. Much of this new channel was kept further shunted in that alignment by another of the cottonwood hedges from point E to H (Figure 2), although some of the flow often "leaked" back through the hedge, forming secondary channels that flowed toward the pre-1981 channel.

During subsequent high flows, the hedge-shunted part of the channel transported more gravel and, according to Mr. Sweetser, the landowner, kept shifting farther eastward, covering increasing amounts of his pasture land with gravel.

B. Project description

The project objective was to reroute the stream into a single, more stable, unbraided channel that would not cause the landowner problems and that would form a suitable route for migration, spawning and rearing of trout, were perennial flow ever restored to this part of the stream.

The overall plan was to make pre-design studies, plan the management accordingly, apply the management, then do post-management evaluatory studies, using information from pre-design studies for before-and-after comparison. Pre-planning studies and management design were done in 1986-88.

C. Work done

Pre-planning analyses indicated the situation described section in item A. Then in 1988, for more detailed analysis and planning, we measured the elevations, bearings and distances of points along the talweg of the main post-1981 channel and of some of the remnant and other secondary channels. The surveyed points were at apparent profile breaks, such as crests of riffles and deepest points of pools and lesser "dips," as well as intervening points deemed to help represent the stream bed--and at various benchmarks. An automatic-leveling surveyor's level with stadia hairs was used, measurements being made to the nearest 0.005 ft elevation and nearest foot horizontal distance.

From the survey data and low-level air photos, we drew plan-view maps of the channel and plotted talweg profiles. Using these, and under advisement of our engineer, we made further surveys to find a suitable path along which to reroute part of the channel. Much of this route consisted of reactivation of part of the pre-1981 channel (segment CD, Figure 2). In other words, we planned to direct the stream back into as much of its previous channel as could be easily done.

Our plan called for connecting the shifted channel with the old channel by excavating to deepen and enlarge secondary channels along segment DE and by blocking the post-1981 channel and several secondary channels of the braided system with rock berms, as shown in Figure 2. Also, parts of the reactivated pre-1981 channel that were obstructed by downed logs, other vegetation, and sediments would be cleared by excavation.

It had been envisaged at the outset of pre-planning study that we might install various special structures, such as current deflectors and streambank coverts, to further stabilize the channel and provide habitat for trout. But the lay of the land, the nature of the soils, and the above-described lack of perennial flow, which we discovered, made it advisable to simply dig enough new channel to enable the stream and vegetation do most of the work in forming a more suitable channel. A primary principle of stream habitat management is "let nature do it."

By not having to plan and build special habitat structures, the financial savings enabled us to add a third, larger culvert at the lower end of the study area.

Construction took place in April 1989. The designed channel was staked out and excavated with a backhoe along the course shown in Figure 2. The main blockage removed was the "hedged" grove of small trees at point E. Excavation extended from several hundred feet downstream from point C along the course CDE, a total of about 760 feet. Conditions found during excavation required that the entire distance be excavated to some extent, rather than just along the planned reaches that are shown in Figure 2. Some adjustment of the "hedge" gap at point F was also done. Two berms of large rock were built, as indicated on Figure 2. The added culvert was installed at Point A.

D. People involved in project

The project was directed by Ray J. White, Principal Investigator. Major project personnel were Graduate Research Assistants Walter V. McClure (1986-89), Steven J. Gerdes (1987), and Christopher W. Riley (1989-91).

Alfred B. Cunningham, MSU Department of Civil Engineering, served as consultant on hydrology and engineering. Stream hydrology and fluvial geomorphology consultants were Stephan G. Custer and William W. Locke, MSU Department of Earth Sciences. Daniel S. Long of the MSU Department of Plant and Soil Sciences took low-level aerial photos of the study area.

Fishery Biologist Bruce J. Rehwinkel of the Montana Department of Fish, Wildlife & Parks advised on study area selection and performed liaison for that agency. U.S. Soil Conservation Service personnel at Townsend, particularly Troy Helmlich and Michael Crowell, provided various services in site selection, planning, and liaison, as did Ted Flynn, Chairman of the Broadwater Conservation District. The landowners, Mr. and Mrs. Jay W. Sweetser, graciously cooperated regarding access and other matters. Construction contractor for the project was R. S. Construction of Bozeman (Richard W. Stolzfus, Owner), which did the structural work.

E. Project maps (next two pages)

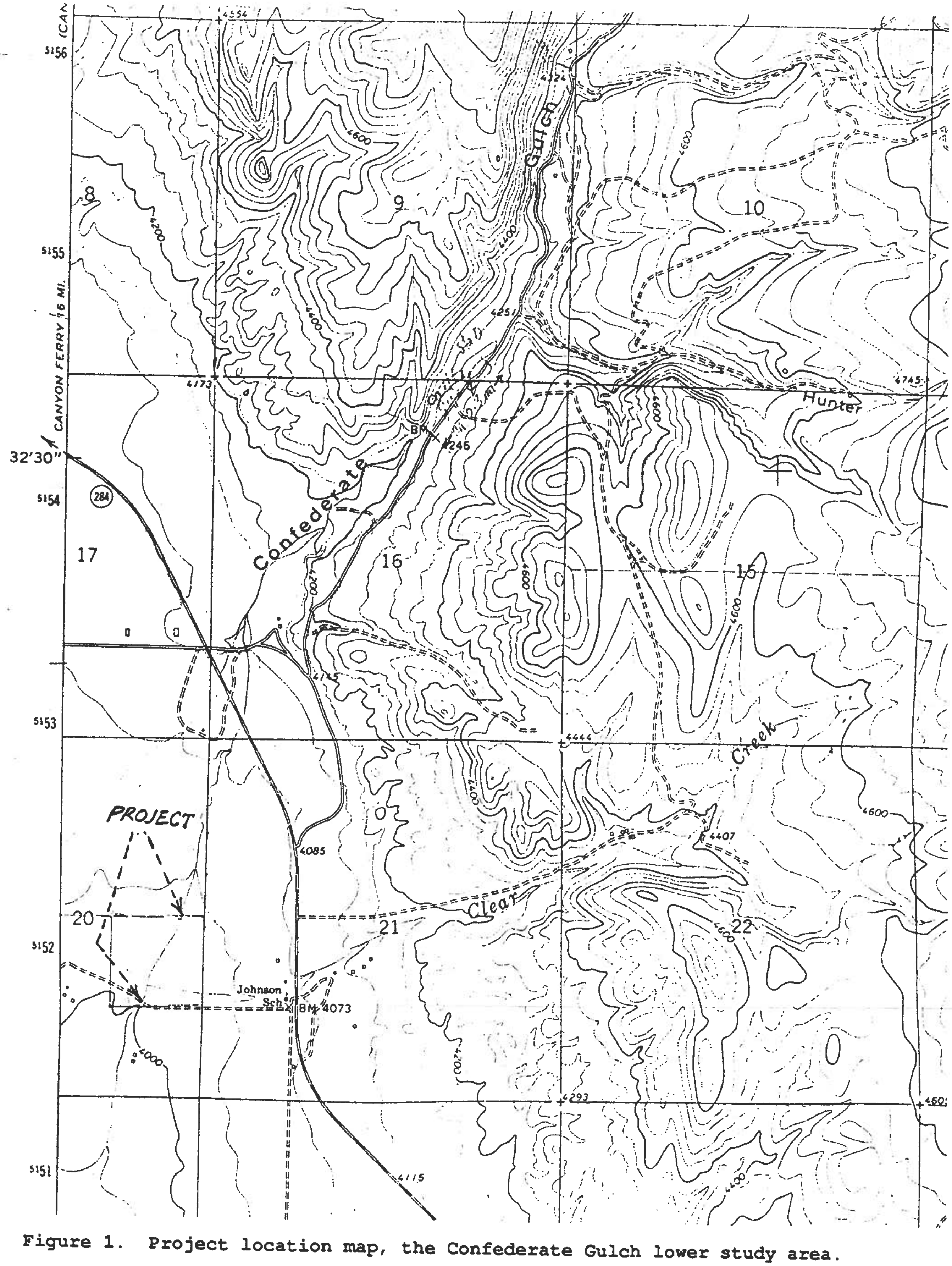

Figure 1. Project location map, the Confederate Gulch lower study area.

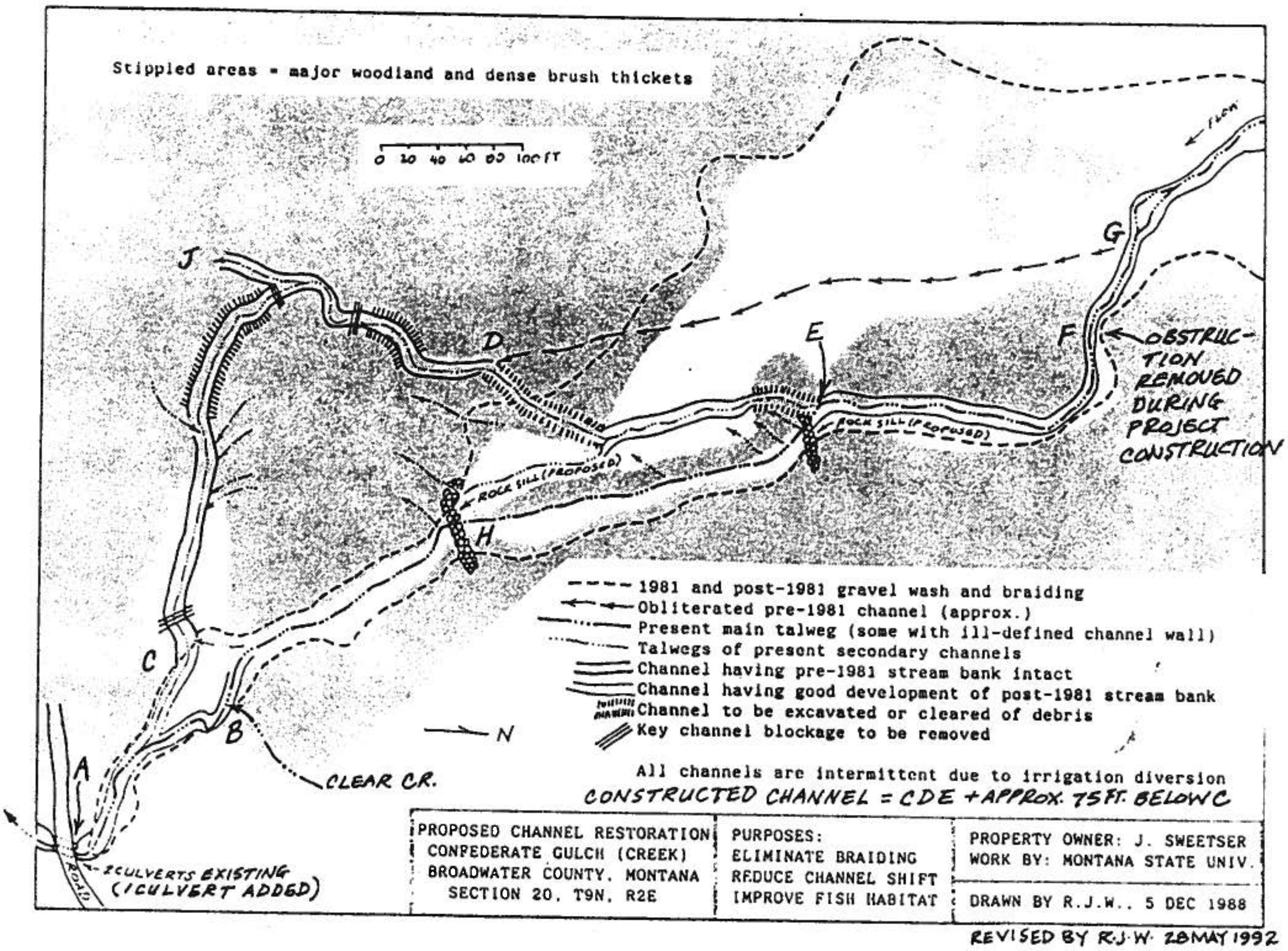

Figure 2. Project map, the Confederate Gulch lower study area.

II. Project product or results

A. How the results solved the problem

The channel we dug coalesced the stream's flow into a single course, as planned. Inspection several times each year since construction indicates that the new channel has persisted and has adjusted, as expected, speeding also the favorable development of the natural channel upstream from construction. Since obliteration by the 1981 flood, the stream there has been recovering to a deeper, better defined channel. Our removal of the blockages in the project area has helped this process.

B. How project success measured

Project success was determined mainly by direct observation during subsequent site visits. We also have the record of channel bed (talweg, or the path of deepest cross-sectional points in the channel) profile surveyed in 1988, before construction and in 1990, after construction and flows had adjusted the channel (Figure 3). In Figure 3, the 1988 profile is of the main thread of the braided channel. It had a shorter, steeper course than the new, single channel of 1990. In both profiles, 1988 and 1990, the lower end of the curve is point A of Figure 2 and the upper end is at the north line fence of the Sweetse property.

C. Project publicity and demonstration

The project is available for viewing. The MDFWP district fishery biologist has been given a tour and explanation of the project (1991). Photographs are available in this report.

D. Problems encountered in the project

Regrowth of the stumps of the previously "hedged" groves of small trees removed during excavation may again block flow, if they are not periodically cut back. If the stream flowed year-round, they probably would not be regrowing, and the problem would not exist, but the 1991 inspection revealed some constriction of the channel at certain points, especially at the critical point E (Figure 2).

An assoicated problem was that the small trees in the "hedge-rows" and other groves through which some of the new channel was excavated had their roots far below the level to which we planned (or could afford) to excavate. Their trunks had been buried in gravel to depths in excess of four feet, perhaps much more. This confirmed our pre-planning interpretation that a lobe of gravel had been washed into the area, probably by the 1981 flood. But it also made it impossible to eliminate all the trees, or even most of them, completely. See accompanying photos.

E. Copy of inspector's final project inspection sheet - Not applicable. DNRC did not institute such a system for this project.

F. As-builts - Not applicable. Not familiar with this term.

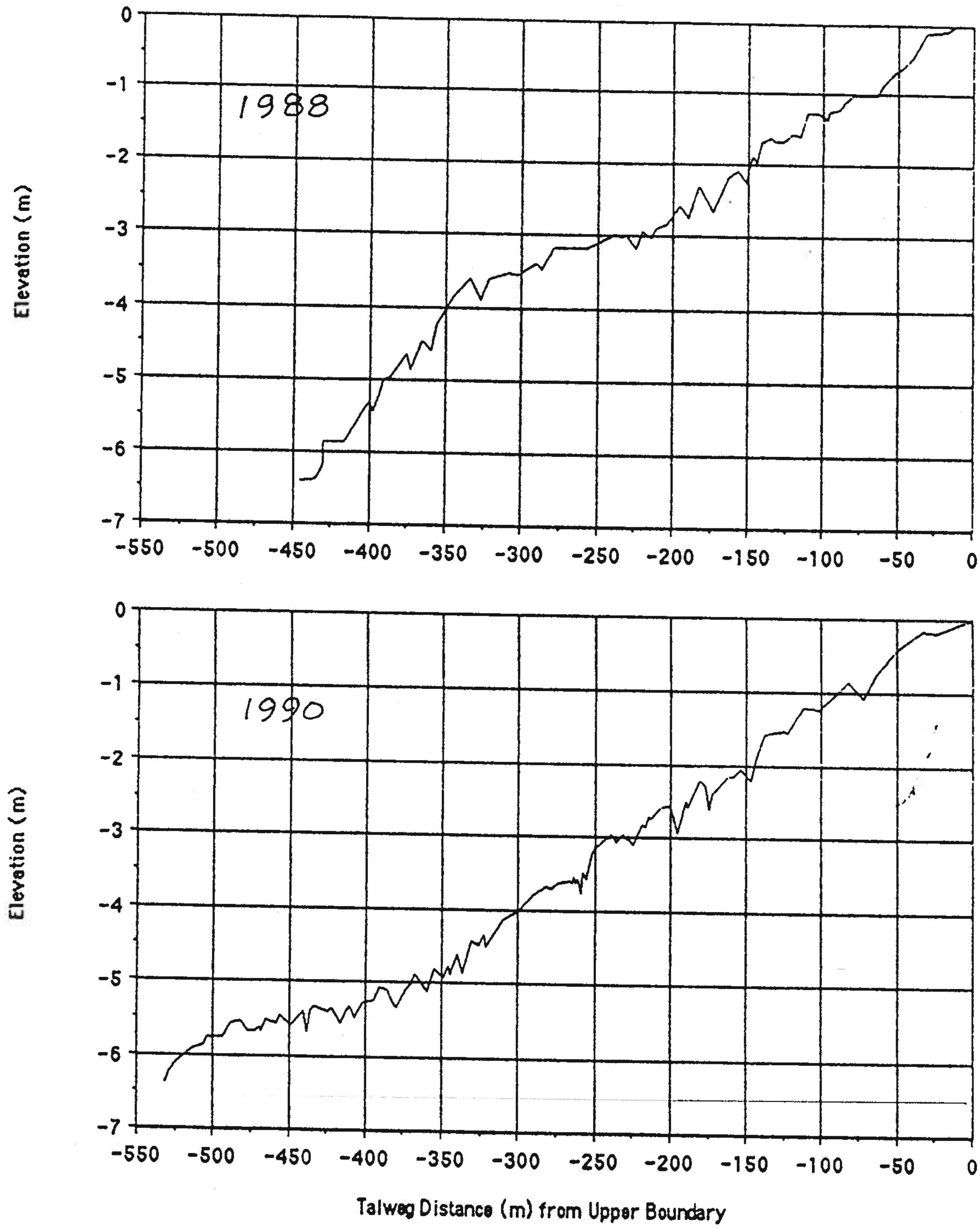

Figure 3. Streambed (talweg) profiles, Confederate Gulch lower study area, 1988 and 1990.

III. Project cost accounting

A. Compare cost estimated in contract with actual expenditures

Estimated cost equaled expenditures.

B. Other required funding

Other required funding was in connection with MSU salaries. These records would be available from MSU.

C. Method used for awarding construction contract

Bid opening. See appendix A.

D. Areas put out for bid

See Figure 2 and Appendix A.

IV. Pictures

The photos are numbered in an accompanying album folder sheet. The descriptions are as follows:

1. Looking upstream toward the upper boundary of the study area (J. Sweetser north line fence) in spring 1985. Note wide, shallow channel, lack of vegetation and other evidence of the 1981 flood.

2. The same area, viewed from the other bank and from farther downstream, 1991. Note a somewhat better defined channel (downcut, with more definite banks).

3. Excavation of the critical blockage point E (Figure 2), April 1989. Photo was taken from upstream, i.e., looking downstream. This was the upstream end of the main excavated new (largely reactivated) channel. Note that much of the stream still flows toward the left, a "perched" channel, diverted by the "hedge" of small trees in which the gap is being excavated. A few minutes later, all flow passed into the new channel that can be seen to the right of the backhoe.

4. The same point (E, Figure 2), viewed from about the same upstream point, September 1991. Note partial regrowth of the trees.

5. The same point, showing a close-up of the vegetational regrowth.

6. Excavation through another hedge-grove of small trees. Note that their trunks are merely "raked" off, leaving stubs, which had to be cut by hand.

7. The perched channel (CHE, Figure 2) at about point H, spring 1985.

8. The same channel from about the same point, September 1991. Flow has been diverted away from it and blocked by an upstream rock berm (barely visible). In foreground is the lower berm (Figure 2), which is to divert flow, if floods overtop the upper berm.

9. The lower part of the channel at about point C, spring 1985. At that time, over half the flow of the stream was entering point C not from the "historic main" channel, but the perched channel which enters from the right (behind vegetation at right) and is the same channel shown in photo 7. By 1988, the vegetation (probably aided by months of dewatering each year) had much further obstructed the channel at point C.

10. The same point (C) after excavation, spring 1988.

11. The new channel, looking upstream from about 50 ft above point C, September 1991. What had been a bed of mud during excavation is now entirely gravel, washed from upstream areas by high water. Were the stream not dewatered, this would be prime spawning grounds for trout.

12. The culverts under the private driveway at the downstream end of the study area. The large culvert at left was installed as part of the project. The other two had been inadequate to carry high flows.

REFERENCES CITED

White, R. J. 1989. Stream restoration on Grasshopper Creek: extended phase I preplanning investigation and discontinuation of project. Report to Montana DNRC Water Resources Div., Grant Agreement RIT-87-8506, Montana State Univ. Dept. of Biology, Bozeman. 10 pp.

White, R. J., W. V. McClure and C. W. Riley. 1991. Log sills to trap trout spawning gravel in Confederate Gulch, Montana. Part I of a Final Project Report to the Montana Department of Natural Resources and Conservation on Project No. RIT-87-8506. Dept. of Biology, Montana State University, Bozeman.

APPENDIX A

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Request for Quotation

(This is <u>not</u> an order.)

on a Contract to Excavate a Stream Channel Relocation and to Provide, Deliver, and Install Riprap Rock for Stabilization Berms in Confederate Gulch near Townsend, Montana

Issued by: Department of Biology
Montana State University
Bozeman, Montana 59717

14 April 1989

Contact Person: Dr. Ray J. White (at above address), phone 406-994-2492

1. Provide and deliver to the construction site 70 cubic yards of riprap-grade rock from the Continental Lime Company quarry, west of Townsend $ 1400.

2. Heavy equipment operation for channel excavation, spreading of spoil, clearing of vegetation, and installation of rock berms

   a. Mobilization cost (if any) to be charged for movement of equipment to and from Confederate Gulch $ 160.

   b. Per-hour price for operation of backhoe/loader $ 40./hr.

      Make and model of backhoe/loader: J.D. 300 B.

      Backhoe bucket size: 2' wide 1/3 cu. yd.

   c. Per-hour price for operation of rock-hauling truck $ 40./hr.

3. Date your firm commits to be available on site for starting construction, if awarded the contract: 4/24/89

4. Proof of insurance coverage or exemption must accompany this quotation, as indicated in the attached Description, Specifications and Work Statement

Name and address of bidder (print or type):
Richard Stoltzfus (R. S. Const.) 5740 Bridger Cyn. Rd.
Bozeman Mt. 59715

Signature: Richard L Stoltzfus Date: 4/19/89

Printed name: Richard Stoltzfus Title: owner

~~Submit~~ quotation to Ray J. White, MSU Biology Dept., Bozeman MT 59717

QUOTATIONS MUST BE RECEIVED <u>BY 11 A.M. (MDT) ON 21 APRIL 1989</u> IN A SEALED ENVELOPE MARKED "SEALED QUOTATION." These will be opened at that time.

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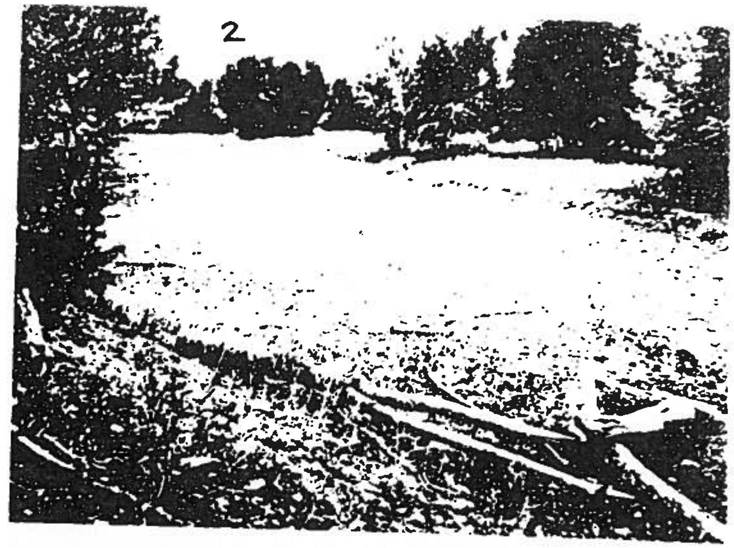

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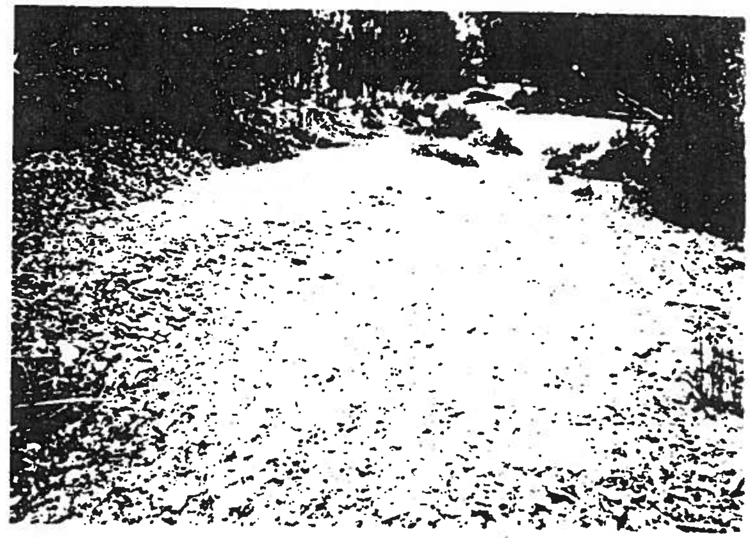

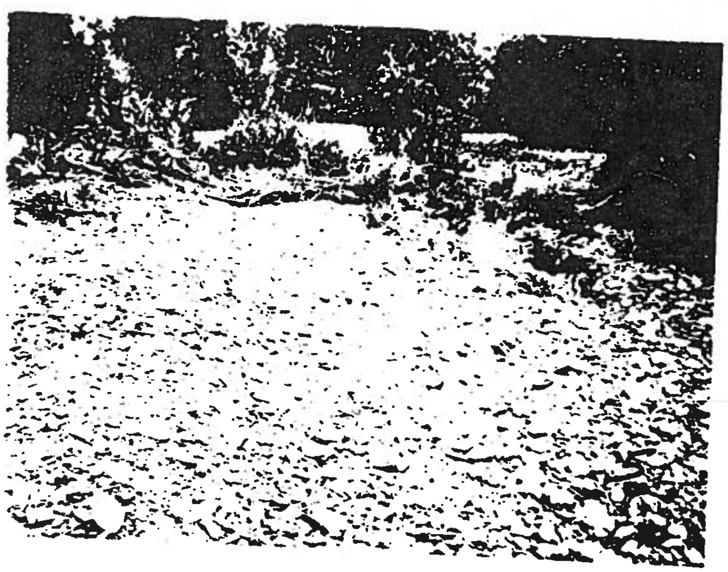

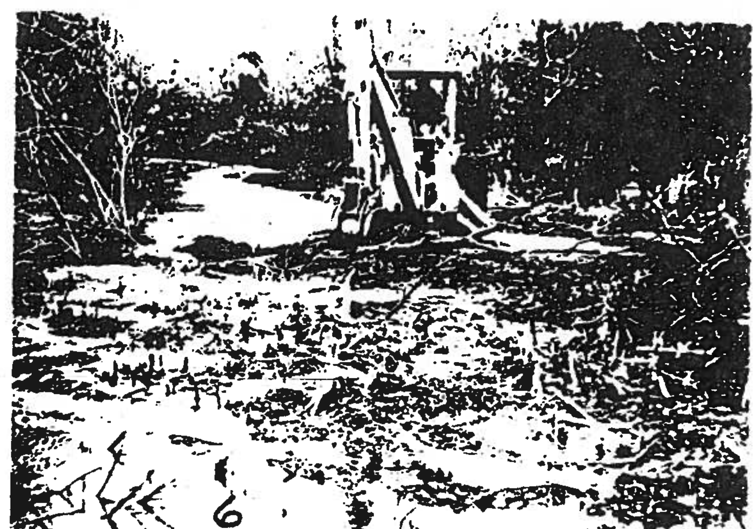

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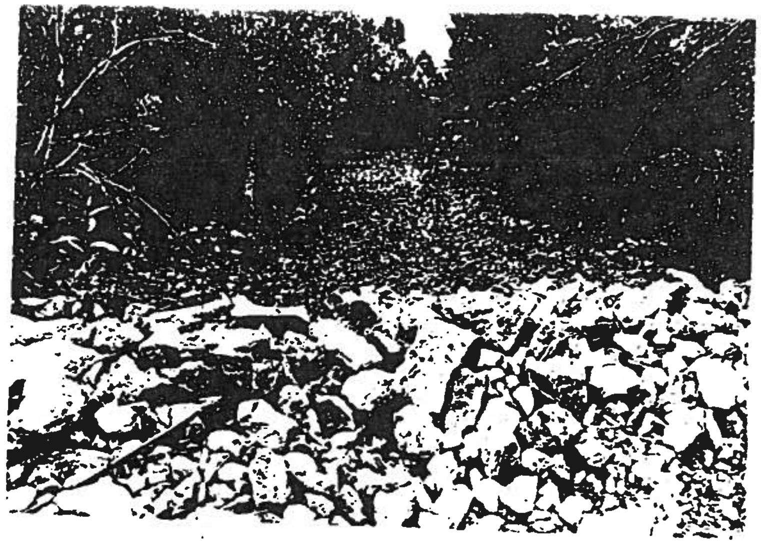

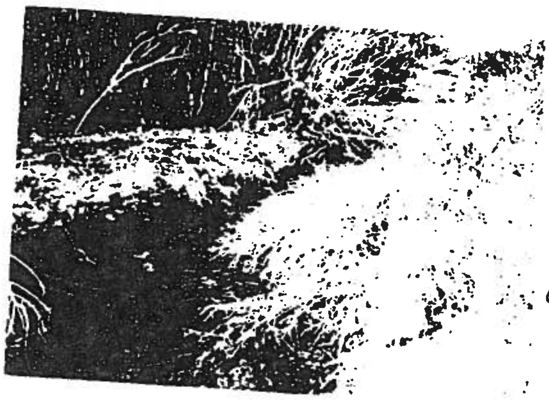

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