MILL CREEK RESTORATION PROJECT PHASE II: STREAMBANK STABILIZATION INTERIM PROJECT REPORT

January 1996

Prepared by

Brenda L. Landureth

and

Steven F. Jensen, M.P.A.

TABLE OF CONTENTS

Page

TABLE OF CONTENTS (Continued)

MILL CREEK RESTORATION PROJECT PHASE II: STREAMBANK STABILIZATION INTERIM PROJECT REPORT

INTRODUCTION

Mill Creek Canyon has been severely disturbed by grazing and even more recently by high intensity recreational activities. This recreational area is easily accessible for more than a half-million people and is heavily utilized during the growing season. Most recreationalists prefer being in or near the channel. This has eliminated cover on the upper and the lower banks and has caused high intensity erosion. In the past, resource managers have attempted to direct foot traffic by providing hardened picnic pads and trails to encourage recreationalists to stay on these protected surfaces. The Mill Creek Canyon Restoration Project Phase II has utilized innovative Best Management Practices to improve instream and streambank conditions relating to excessive recreational access, road construction and flood control activities.

PROJECT GOALS AND OBJECTIVES

The goal of Mill Creek Canyon Restoration Project Phase II: Stream bank Stabilization is to enhance water quality and fishery habitat conditions to improve existing and future beneficial uses. The impaired fishery (Class 3) and recreational uses (Class 2) in Mill Creek

Phase II site will be restored through improvement of instream and stream bank conditions by 1996. Approximately, half of the Maple Grove Picnic Area up to the last picnic pad was restored during 1995. (See project map in Appendix A and K.) Therefore, several Phase II objectives have been initiated or completed during the first half of this restoration project. These objectives primarily focus on improving instream and riparian conditions to enhance fishery production, recreational opportunities and aesthetic values. Phase II objectives and tasks address reducing uncontrolled recreational access and improving plant cover to reduce sediment production. The overall evaluation of the effectiveness of the Best Management Practices implemented in this project will require several years of monitoring physical, chemical and biological parameters (Harrelson, et. al., 1994).

PROJECT OVERVIEW

As of December 15, 1995 the Mill Creek Phase II has involved several multi-agency planning and design meetings, the collection of chemical, physical and biological baseline data and the evaluation and implementation Best Management Practices for stream restoration. This project has also included the implementation of several innovative instream, streambank and revegetation Best Management Practices to enhance riparian health, improve streambank stability and provide controlled recreational access. Together, these restoration measures will improve recreational potential, water quality and reduce the severity of recreational impacts in the future. This will also be accomplished through water quality, riparian and stream restoration education. Public awareness interpretive signs, pamphlets and activities will be utilized to educate users about responsible stewardship and how to maintain environmental quality along the Wasatch Front.

Salt Lake County and the Forest Service have identified this reach as a non-point source of sediment production. Phase II of this project has improved streambank conditions and overall stability. This has included maintaining flood channel capacity by creating floodplain areas, protecting and enhancing multiple use and recreational opportunities by controlling access and improving habitat conditions (Jensen, 1994).

STUDY AREA

The Mill Creek Restoration Site for Phase II: Streambank Stabilization is located between Maple Grove Picnic Area and Terraces. The proposed channel and streambank reconstruction began just above the Winter Gate on Mill Creek Road. The channel elevation ranges from 6044 feet to 6078 feet. The soils at this site are very high in organic matter and are highly erodible due to their fine texture, the lack of protective cover has resulted from high intensity recreational impacts and the increase in streambank slope gradient and length, which characterize this reach (Christenson, 1984). The upper banks are lacking good cover. Lower banks are bare, steep and eroding due to uncontrolled access. The overstory covers 90% of this site and consists of Big Tooth Maple, Box Elder, Cottonwood and Water Birch. (See Appendix F for the Species List.) The understory is scarce and unhealthy (Crowley, 1995). Re-establishment and resiliency potential of this site is unlikely under existing conditions.

PROJECT PLANNING

Project planning has included the following activities:

1. **Universal Soil Loss Determination**
2. **Stream Gradient Map**
3. **Best Management Practices Evaluation**
4. **Multi Agency and Interdisciplinary Meetings**
5. **Project Documentation**

Universal Soil Loss Determination

During early 1995, Salt Lake County completed a Universal Soil Loss Equation Determination for the proposed restoration site to identify low, medium and high intensity erosion along this reach. (See Appendix B.) The USLE predicts soil erosion from rainfall events on watershed slopes (Dissmeyer, 1994). The project reach was divided into similar regions and evaluated using the following parameters from the USLE formula **A = RKLSCP**:

A = Computed soil loss per unit area.
R = Rainfall and runoff factor.
K = Soil erodibility factor.
L = Slope length factor.
S = Slope steepness factor
C = Cover management factor.
P = Practice factor.

(Soil Conservation Service, 1977 and Dissmeyer, 1994)

The three erosion intensity levels were identified on the project map creating a Soil Loss Determination overlay to assist in formulating project design alternatives. (See Appendix B and K.) During on site planning meetings, the results of this USLE evaluation were field checked and discussed. The questionable adaptability and application of this model to forest situations was noted (Gray and Leiser, 1989).

Stream Gradient

A stream gradient map overlay was also completed utilizing the Mill Creek Project Survey Map completed by Salt Lake County during 1994. Stream gradient was also divided into high, medium and low categories to easily identify critical reaches of this channel to note during the planning, restoration and monitoring phases of this project. (See Appendix C.)

Best Management Practices Evaluation

This objective required researching Best Management Practices information related to stream and stream bank restoration. The following outside agencies were consulted:

State Division of Water Rights
U.S. Army Corp of Engineers
State Division of Environmental Quality
Utah Department of Transportation
Wyoming Game and Fish Department
Bureau of Land Management

Physical stabilization, vegetative and erosion control measures were evaluated.

Each BMP was evaluated by the following criteria:

Bank Stabilization Effectiveness
Cost
Future Maintenance
Feasibility: Meeting Project Goals and Objectives
Visual Impact

Then, these criteria were scored on a scale of zero to three to produce an overall score. The highest scores would be the Best Management Practices to consider during the planning and design phase of this project. A score of eleven or better would indicate the most appropriate BMP's to consider and implement based on these site specific conditions. This BMP evaluation was presented to the Jordan River Watershed Council for review.

This evaluation was an important part of the planning process and represents Salt Lake County's initiative to consider and evaluate all options prior to project implementation. However, it was difficult to quantitatively evaluate BMP's due to the lack of available information. (See Appendix D for the Best Management Practices Evaluation and the Bibliography for this evaluation.)

Multiagency and Interdisciplinary Team

This is perhaps the most valuable aspect of the entire planning process. Multiagency participation enhanced the planning process and improved problem solving effectiveness. (See Project Participation List in Appendix E.) According to the Salt Lake County and the USDA Forest Service Supervisors Office, the complexity and magnitude of

Phase II Mill Creek Restoration Project required the knowledge, skills and abilities of this interdisciplinary team to solve complex planning and design problems. This team of resource managers facilitated the effective transfer of information and made the various permitting, project planning and implementation more efficient (Roeber, 1995).

Throughout the planning process, several management plans and ongoing activities were presented to the Jordan River Watershed Council to encourage their participation in this project. Salt Lake County requested input on the BMP Evaluation, streambank stabilization and instream alterations plans and designs. This multiagency and interdisciplinary group is a invaluable resource in a project of this magnitude and complexity.

Project Documentation

A Mill Creek Restoration video has included 2.5 days of footage and a total of 35 hours of invested time to document this project. Planning, baseline data collection, project implementation including erosion control and revegetation measures have been documented. Footage during construction includes placement of boulders, rock vortex weirs, floodplain construction and notching or removal of log drop structures. This video has also included an education aspect during revegetation. During December, a list of interview candidates will be completed and in January the 1996 restoration schedule will be completed and forwarded to USDA to assist with 1996 documentation. It is estimated it will require approximately two weeks to complete 1996 video production (Wilbur, 1995).

BASELINE DATA COLLECTION

Baseline data will be used to measure the effectiveness and overall success of restoration projects such as Mill Creek Restoration Project Phase II: Streambank Stabilization. Therefore, to effectively evaluate and monitor the success of this project several pre-project inventories have been performed and include the following:

1. **Vegetation Inventory**
2. **Cover Assessment**
3. **Habitat Quality Index**
5. **Water Quality**
4. **Stream Survey**

Vegetation Inventory

A vegetation inventory and a cover south upper bank assessment has characterized the poor pre-project site conditions along this reach. The information collected and the conclusions drawn during the vegetation inventory and upper bank assessment assisted in revegetation planning, implementation and provided insight on site specific conditions and constraints that might impact good establishment. This data will also enable resource managers to anticipate changes in species and community type in the future.

Cover Assessment

The cover evaluation will provide valuable baseline data, which will be used to measure the overall effectiveness of revegetation techniques performed on the upper banks of the Maple Grove Picnic Area. Also, this evaluation is a quick, simple and low cost means to evaluate any improvements in percent cover on the south upper banks. Another important advantage of this cover evaluation is that it is easily repeatable due to the permanent markers chosen to delineate the three study areas. This basic inventory has been noted to be useful in other watershed management applications (Burton, et. al., 1992). In the future, improvements in cover and the constructed controlled recreational access points down to the channel will reduce recreational impacts along Mill Creek and it's upper banks.

Habitat Quality Index

A Habitat Quality Index survey was also completed to evaluate and inventory existing habitat, determine the potential for habitat improvements and attempt to predict trout carrying capacity or standing crops for this reach. Measuring improvements in each individual attribute of this HQI model will help measure the effectiveness of stream and streambank restoration within this reach (Binns, 1982).

Water Quality

The water quality samples Salt Lake County collected were a composite sample using the equal width integrated method. One set of water quality samples was taken above and below this restoration site. These samples were analyzed for total metals, nitrate/nitrates, total suspended sediment and fecal coliform.

Stream Survey

A stream survey was also completed to accurately describe physical attributes of this reach prior to restoration. Stream survey baseline data potential uses:

Monitor trends in fluvial and geomorphology characteristics over time.

Quantify or qualify environmental impact before and after project implementation.

Evaluate stream and watershed response to the implementation of management practices.

Provide instream flow and channel facts for water allocation and management decisions.

Provide background information for other resource inventories such as water quality, vegetation and habitat.

Identify and track cumulative effects for an entire watershed.

Allows for comparison based on stream type and similar management practices on the same stream.

Contribute to local, regional, national, and international databases (Harrelson, et. al., 1994).

The Mill Creek Phase II site conditions required the implementation of intense streambank and erosion control Best Management Practices. Therefore, this stream survey completed during September will provide insight into the effectiveness of these innovative stream and streambank restoration measures. This survey included a longitudinal profile, seven stream cross sections, flow data, substrate counts and several pre-project photographs at each cross section.

BASELINE DATA METHODS AND RESULTS

Vegetation Inventory Methods

Six segments along the north and south banks were visually analyzed for percent species coverage. Species were keyed and an inventory map was completed. Then, a correlation was made between communities mentioned in Riparian Community Type Classification of Utah and Southeastern Idaho (Padgett, Youngblood and Winward, 1989) and the Maple Grove site. Each segment on the map was color coded based on the Riparian Community Type Classification determination at this restoration site (Crowley, 1995). (See Appendix F.)

Vegetation Inventory Results

The vegetation inventory completed in July and August of 1995 includes a species list, a community type classification and several maps (Crowley, 1995). (See Appendix F.) Three communities were identified one segment was not community typed. The Maple Grove study area contained the following communities:

Boxelder/Dogwood

Cottonwood/Waterbirch

Cottonwood/Bigtooth Maple

Crowley stated, that grazing and recreational impacts may inhibit Cottonwood root suckers and seedlings from becoming established. It was also noted that fire suppression due to the proximity of a large urban area has impacted regeneration and succession of some species. The Narrowleaf Cottonwood is not reproducing effectively within the Phase II restoration site, however individuals are present and are either mature, unhealthy or dead. Several small conifers suggest a trend away from a Cottonwood dominated toward a conifer dominated site. Crowley, Padgett and others (1989) have described several conifer dominated sites within Mill Creek Canyon, however none of these appear to be an obvious successional stage for the Maple Grove site. These conclusions indicate that the disturbed nature of this riparian area has developed a very unique environment of coexisting species (Crowley, 1995).

Cover Assessment Methods

This study site is located across the foot bridge over to the south bank. It extends from the chain link fence marking the upstream end of the Maple Grove Picnic Area to the last picnic pad located downstream, if you follow the asphalt trail. This cover evaluation site is divided into three study areas A, B and C. (See Appendix G for the map.) These study areas were selected because they could easily be located and therefore improve the repeatability of this survey. All three study areas are located on the north side of the asphalt trail. The north upper bank was not included in this survey due to the location of Mill Creek Road and it's fill slope, the restroom and the parking lot, which have all severely impacted the north upper bank. Very little vegetation exists due to the foot traffic that accompanies these recreational facilities and the impacts even extend down to the stream.

This study utilized a line transect point sampling method to evaluate existing cover on the south upper bank in the Maple Grove Picnic Area (Meeuwig and Budy, 1981). Each sample set consisted of one-hundred paces. At every other pace a reading of cover/no cover will be recorded. Therefore, fifty readings were recorded for each sample set. Three study areas have been selected A, B and C and are easily identified at this restoration site to improve the repeatability of this survey. (See Appendix G for cover evaluation map, counts and site descriptions.) Each study area consisted of four samples.

Cover Assessment Results

The upper banks of this site have a shady Bigtooth Maple and Boxelder overstory and a shrubby understory. This shady overstory canopy extends over ninety percent of this site. The upper banks have very little understory and ground cover. Existing cover primarily consists of forbes and grasses. (See species inventory list in Appendix F).

However, most of this site is severly disturbed and lacking plant cover due to recreational impacts produced by intense riparian access (Crowley, 1995).

Study area A contained 23.5% cover and 76.5% bare ground. Study site B had 24% cover and 76% bare ground. Area C contained 27.5% cover and 72.5% bare ground. (See Appendix G2 for counts.) Overall, 25% percent cover and 75% bare ground was determined using a paced line transect method to evaluate cover for this analysis. Therefore, there was 75% bare ground along the upper south bank. An on site ocular estimate of percent bare ground ranged from 60-70%, which agrees well with the results of this evaluation (Crowley, 1995). Keith Clapier, the Forest Ecologist for the Salt Lake Ranger District stated, that bare ground in this particular community type would be approximately 10-15% under ideal conditions, based on his observations and surveys, which document the Mill Creek relic community (Clapier, 1995).

It is highly recommended to complete this cover/no cover evaluation prior to the yearly accumulation of leaf litter. Leaf litter was not considered cover in this evaluation due to the fact that this is a temporary event and the upper banks usually are bare and exposed to raindrop impact. This decision was made in the field because when this site evaluation was completed, leaf litter covered the majority of this site and therefore would not accurately represent the lack of good cover on the upper banks in the Maple Grove Picnic Area.

Habitat Quality Index Survey Methods

A HQI survey measures several important site characteristics and evaluates fish habitat quality. A study reach is generally several hundred feet long and is representative of the overall site conditions. The following attributes are measured and rated:

Channel and Thalweg Length
Flow Depth and Velocity Measurements
Water Quality (Nitrate Nitrogen)
Stream Macrophytes/Invertebrate (Diversity and Density)
Length of Eroding Banks Along the Channel
Type and Amount of Cover
Overhanging Vegetation
Instream Features (Boulders and Logs)
Substrate Counts
Stream Temperature

These attributes should be evaluated during the critical period for trout habitat in the Rocky Mountains due to reduced flow and warm water conditions, therefore September was an ideal time to perform this survey. Each study reach consists of ten equal length sections (Binns, 1982).

At the Mill Creek Maple Grove Streambank Stabilization Site, 742 feet reach was selected from the 1390 feet project to represent the pre-project conditions. This study reach consisted of fourteen equal length sections. Each section measured 53 feet long. This allowed for some flexibility with the data due to on site constraints and concerns. Three sections were selected above the proposed streambank reconstruction site to evaluate any potential headcutting or other upstream flow and habitat adjustments, which could occur within the next five to ten years. A foot bridge, that provides access to several picnic areas and trails has produced very sterile habitat conditions, therefore this section under the bridge will not be utilized in this HQI. (See HQI maps in Appendix H).

Several photographs were taken at each HQI cross section to identify their location. This will improve the repeatability of this HQI in the future. These photographs have been very useful during the report and the evaluation phase of this HQI. Each photograph has a short description and have been numbered for easy identification. The photographs will become a valuable visual tool to measure the effectiveness of this restoration project.

A map of each study area was also completed along with a site description of at each cross section. The photographs were very useful during this undertaking.

Flow data was also collected at each cross section and included measurements at 0.2, 0.4 and 0.6 depth of flow and at 0.25, 0.50 and 0.75 of the channel width. This data was used to calculate the average flow velocity for this reach.

Cover type and abundance was measured within each reach and included overhanging vegetation and instream cover. Overhanging vegetation was measured along the channel and a surrounding area of influence was considered under certain circumstances. Instream cover measurements included boulders, logs and log drop structures at this study site.

The length of eroding banks was also measured along the channel. After restoration, the length of eroding banks should significantly improve along this reach. This baseline data will be used to measure the effectiveness streambank stabilization and Best Management Practices implemented during this project.

Habitat Quality Index Survey Results

The data collected for each attribute is even a more valuable tool to assess habitat degradation and the effectiveness of stream and streambank restoration projects. A HQI is also used to determine and reinforce instream flow recommendations for habitat improvement and management (Binns, 1982). The results of this HQI are listed below and a Table of Results is located in (Appendix H).

1. Late Summer Stream Flow Attribute is 11.8 of the annual daily flow determined from ten years of flow data, which receives a rating of 1.

2. The Annual Stream Flow Variation is 83% of the annual flow was also determined from ten years of flow data, which receives a rating of 2.

3. The Maximum Summer Stream Temperature Attribute receives a rating of 3 based on the average temperature (52.5°) during this time period for this reach determined from existing data and field measurements.

4. Nitrate Nitrogen for Sample #10 was 0.097 mg/l and 0.022 mg/l for Sample #11 was determined in the Salt Lake City Public Utilities Laboratory Analysis Report completed on September 8, 1995. This attribute receives a rating of 1. (See Appendix I).

5. Fish Food Abundance was determined from existing data and receive a rating of 4. Results from samples taken at Terraces in August will be available in 1996. The limited amount of macrophytes and very high numbers of macroinvertebrates, over 1,757 per 0.1 m^2 was noted.

6. The Cover attribute received a rating of 2 based on measurements made in the field. Approximately 38.6% cover was noted within this reach.

7. The Eroding Streambanks Attribute received a rating of 0. This reach consisted of 182% eroding banks which is based on 964.5 feet of eroding banks for this 530 feet reach.

8. The Substrate attribute received a rating of 4 due to the low numbers of macrophytes and the high numbers of macroinvertebrates.

9. The average velocity of this reach is 1.46 ft./sec. which was determined from flow velocity measurements. This attribute received a rating of 3.

10. The average stream width based on cross section measurements was 19.82 feet and received a rating of 4.

The results of this HQI indicate the poor physical and biological conditions within this reach and the limited potential for instream fish habitat. This reach will support 29.83 pounds per acre, which is approximately thirty fish for this 530 feet reach. These results agree with the existing poor pre-project site conditions. In the future, significant improvements should be noted in the percent eroding banks and cover along this reach. Average stream width should decrease and an increase in depth and velocity should produce better fish habitat conditions. Habitat units will be provided in the final Mill Creek Stream Restoration Phase II: Streambank Stabilization. (Appendix H includes HQI Reach Maps, a Table of Results and flow data.)

Water Quality Methods

Water quality samples were collected above and below the Phase II Maple Grove streambank reconstruction site on August 23, 1995 and this data was used for this HQI analysis. The equal width integrated method was used to collect these grab samples. Laboratory analysis was performed by Salt Lake City Public Utilities Laboratory, which has EPA approved QA/QC documentation for the selected parameters. Protocol for sampling, chain-of-custody and laboratory analysis adopted by the Utah Department of Environmental Quality for Quality Assurance and Control was strictly followed. (See Appendix I for the water quality analysis report.)

Water Quality Analysis Results

Water quality parameters are well below drinking water standards, fishery and recreational limits. Therefore, the water quality is very suitable for improving fish and riparian habitat. The water quality analysis for samples #10 and #11 agree well with the exception of a slight difference in Total Suspended Sediment, which suggests channel aggredation within this reach (Loader, 1995). This is representative the aggredational characteristics noted along this reach. (See Appendix I for the Water Qualtiy Analysis Report completed by Salt Lake City Public Utilities Laboratory.)

Stream Survey Methods

The stream survey performed at the Phase II site included a longitudinal profile, seven cross sections, several substrate counts and photographs at each cross section. Salt Lake County has collected and is in the process of analyzing this data.

Longitudinal Profile Methods

The longitudinal profile included only thalweg and center of the channel elevation measurements due to the existing time and personnel constraints. The longitudinal profile provided the data required to correctly establish the correct placement of the rock vortex weirs during construction. (See Appendix J for the Longitudinal Profile Data and Plot.)

Cross Section Methods

Each cross section was permanently marked with rebar and anchored in place with concrete. In the field, a simple profile map and a short site description was completed at each cross section to locate during monitoring and compare to the computer generated plots.

It was difficult to choose representative cross sections of channel features and characteristics due to the disturbed nature of this channel. Typically, cross sections are selected to be representative the existing natural features over the entire study reach (Harrelson, et. al., 1994). However, Mill Creek has been heavily impacted by road construction, recreational and grazing activities and and these impacts have produced a wide shallow channel with steep eroding banks with few regular natural stream features.

This heavily impacted section has primarily adjusted to the log drop structures placed within this reach approximately fifteen years ago to control stream gradient. Sediment loads were deposited upstream from these log drop structures due to the change in the flow velocity and subsequent ponding. Below these drop structures deep scouring pools were created. The channel headcut until these log drop structures were several were six to twelve inches above the channel creating footbridges. The streambank was eroding around where these structures were anchored into the banks. This entire process has been controlling the flow and geomorphic characteristics of this channel. Therefore, fish and sediment passage has been severely restricted due to channel aggregation. Similar reports of drop structure failure were reported for several types of treatments (Rosgen and Fittante, 1986 and McLaughlin Water Engineers, 1986). Therefore, representative cross sections were selected that are representative of pre-project stream conditions and would indicate a dramatic change after stream and bank reconstruction. The following cross sections were selected:

Reach I: Riffle ten feet before a log drop structure.

Reach II: Cross-over between two meanders with a mid-channel vegetated gravel bar.

Reach III: The only deep narrow section of this study reach. This reach is suspected to have undergone fairly recent headcutting due to the undercutting of the log drop structure downstream.

Reach IV: Located between two log drop structures.

Reach V: A sediment laden area directly above a log drop structure. The streambanks have been impacted by road construction and recreational activities. The channel is wide and shallow.

Reach VI: Across a wide, shallow and slow run prior to the floodplain. A very steep, vertical and eroding left bank.

Reach VII: Near the lower bridge by Terraces Restoration Site. This is a wide floodplain area with some fine channel braiding.

Each cross section consisted of the following data collection and measurements (See Appendix J):

1. **Reference Photographs and Short Descriptions**
2. **Flow Data**
3. **Substrate Counts and Analysis**
4. **Cross Section Survey Data and Profile Maps**

Several photopoints were taken at each cross section and are numbered for easy identification (Summers, et. al., 1994). Flow data was also collected at each cross section and included 0.2, 0.4 and 0.6 depth of flow measurements. (See Flow Data in Appendix J.) The flow data was very difficult to collect at the same survey data points due to the height of the vertical banks. The measuring tape was always more than twenty-five feet above the stream and was very difficult to read even with binoculars. A twenty sample substrate count was taken at each stream survey cross section and this was used to create a composite sample for the entire reach. Three one hundred counts were completed for Cross Sections II, V and VII. (See substrate data and analysis in Appendix J.)

Stream Survey Results

It was noted that severe imbeddedness was present and it's origin is currently under speculation. This embedded substrate could be remnants of a pre-road construction floodplain or streambank or bedrock, however this is pure speculation (Condrat, 1995). Embedded substrate was noted at several cross sections, however Cross Section II contained nearly 20% embedded substrate. The d_{50} for the entire reach is 30 mm, which is consistent with substrate counts performed at the Terraces by the Division of Environmental Quality Stream Team during 1993. (See Appendix J for this data.) The d_{50} values determined for Terraces Project were 24.00 mm, 25.02 mm, 28.00 mm and 18.13 mm (Summers, 1994). The d_{84} for the reach is 90 mm compared to 70 mm which appeared at each cross section completed at Terraces during 1993. This discrepancy in the d_{84} was a result of different physical characteristics along this reach compared to Terraces. These characteristics include the following:

1. **Steep stream gradient.**
2. **Steep, bare and eroding banks due to recreational impacts.**
3. **Low sinuosity.**
4. **High flow velocity**

The percent fine sediment for this composite substrate count is 13.5%. (See Appendix J for the particle distribution plots.) Three one-hundred particle counts were completed at cross sections II, V and VII. The results are listed below:

TABLE OF RESULTS FOR SUBSTRATE COUNTS

Cross Section Identification	d_{50}	d_{84}	Percent Fines < 6 mm (%)
Composite (All Xsecs)	**30**	**90**	**13.5**
II	**50**	**103**	**15.0**
V	**40**	**83**	**12.5**
VII	**55**	**100**	**17.0**

Cross Section II was located on a cross over with a narrow thalweg adjacent to a steep eroding bank, a mid-channel sand and gravel bar and a riffle all represent this cross section. Therefore, the d_{50} and the d_{84} for this cross section is representative of these existing conditions. Severe imbeddedness was noted for 20% of the entire count and these results indicate, that there is a number of geomorphic variables to consider at this cross section. (See Cummulative Percent Finer vs Particle Size Plots in Appendix J.)

Cross Section V is a wide and very shallow aggredational area above a log drop structure. The d_{50} is approximately 40 mm and nearly 80% of this substrate count lies between 10 to 100mm, this is interesting because an ocular estemate of the particles across this cross section appeared to be very similar in size.

Cross Section VII is a wide floodplain area with a deep thalweg and small braiding channels across a several tiered sand and gravel bar. This explains the good mix of several different particle sizes found at this cross section. There was approximately 17% fines consisting of less than 6 mm at this cross section, which is the highest amount found in this substrate count analysis.

The results of these substrate counts are very representative of the existing conditions at each cross section. Therefore, this baseline data is reasonable and will provide future insight on the effectiveness of restoration on the quality of substrate and the instream habitat. Future substrate counts should indicate how effective instream measures will allow for sediment passage along this reach.

PROJECT DESIGN

The project design was completed by the USDA Forest Supervisors Office, however Salt Lake County completed a Best Management Practices Evaluation to assist in the design planning process. (See Appendix D.) This design included streambank stabilization Best Management Practices and instream alterations to meet project goals and objectives. (See Appendix K.)

PROJECT IMPLEMENTATION

Streambank Stabilization Measures

Phase II involved implementing streambank stabilization measures and instream channel alterations to reduce non-point source sediment production along this reach. Streambank stabilization measures included the following:

1. **Project Time Table**
2. **Limit Stream Construction Access Points**
3. **Construction Begins Upstream**
4. **Materials Acquisition**
5. **Riprap Terracing**
6. **Recreational Controlled Access Points**
7. **Topsoil and Floodplain Coarse Material Placement**
8. **Improve Streambank Stability**
9. **Revegetation Measures**
10. **Erosion Control Measures**

Project Time Table

The project and construction time table was an important component of this restoration project. Materials acquisition began during Fall of 1994. Baseline data collection began during mid-August 1995 and continued into early October for the lower part of the Phase II site. Construction began on September 5, 1995 and continued into early October. Salt Lake County and Tree Utah initiated revegetation measures during September immediately following construction. Construction began in the fall during low flows which allowed easier access to areas requiring restoration, minimized fishery impacts and reduced water quality impacts. Also, Mill Creek Canyon visitation slowly begins to dwindle as winter approaches and this made the restoration site easily accessible. Finally, a full growing season during 1996 will promote early establishment and ensure success of revegetation efforts initiated in fall of 1995.

Limited Stream Construction Access Points

A limited number of stream construction access points reduced excessive sediment production and streambank construction impacts during restoration. The heavy equipment operators, the project manager and the interdisciplinary team discussed and identified a limited number of entry points down into the channel prior to construction.

Construction Began Upstream

Construction activities were completed in a downstream direction. This streambank stabilization and channel alteration measure reduced construction impacts by preventing damage to surrounding and newly constructed areas.

Materials Acquisition

Materials acquisition prior to project implementation reduced project construction costs. A centrally located riprap storage area improved construction efficiency. Large angular granite riprap boulders were obtained from Brighton during the Fall of 1994. Topsoil and fifty percent of the talus material (pitrun) was obtained from Salt Lake Valley and was delivered as need by Cliff Johnson Company. The rest of the talus material was obtained near the restoration site.

Riprap Terracing

Riprap terracing was the primary streambank restoration Best Management Practice implemented during this restoration project. Riprap provides additional support along the channel, protects against erosion and also dissipates energy. Riprap is flexible with channel dynamics and geomorphic processes, is easily installed and provides effective bank protection (Gray and Leiser, 1989 and Levinski, 1982). Riprap terracing of the banks will improve streambank stability and reduce erosion by changing the steepness of the banks.

Controlled Recreational Access Points

Controlled stream recreational access points were discussed and identified prior to the implementation of streambank stabilization measures. Controlled stream recreational access points will reduce widespread impacts within this riparian area, therefore this Best Management Practice was essential to meet the goals and objectives of this project. The placement of controlled stream access points was based on medium and high intensity erosion areas. (See Appendix K.) These areas were identified using the USLE determination and interdisciplinary team field interpretations of highly utilized recreational areas along the stream and it's banks. This information determined where the riprap stairs were placed along the channel. The riprap controlled stream access points are conveniently located, aesthetically pleasing and blend well into the natural surroundings.

Topsoil and Floodplain Coarse Material Placement

Salt Lake Valley topsoil was used for fill material between and around the carefully placed riprap boulders. Fifty percent of the coarse talus material was readily available and acquired adjacent to Mill Creek Road. The other 50% was acquired from the Cliff Johnson Company in Salt Lake Valley. This talus material provided temporary cover for the fill material and for the created floodplain areas until vegetation becomes established. The particle sizes of this material ranged from gravel to cobble and was similar to particles located on the existing floodplain area near Cross Section I of the stream survey and above this restoration site.

Improving Streambank Stability

The riprap terracing and fill material placement improved the angle of repose of these slopes. This will reduce erosion and non-point source sediment production along this reach. Created floodplain areas will protect the banks from scouring and function as flood control overflow areas during high flows. (See Appendix K.) The establishment of deep rooted species within these floodplain areas will trap sediment and improve water quality.

Revegetation Measures

Revegetation measures included creating and broadcasting a native seed mix, planting seedlings and one-gallon size plants along this restoration site. Salt Lake County, Tree Utah and the USDA Salt Lake Ranger District combined resources to complete the revegetation of this reach.

The species included in the native seed mix were selected based on the vegetation inventory (Crowley, 1995). (See Appendix L for Salt Lake County and USDA Ranger District seed mix.) Salt Lake County seed mix broadcasting specifications were 20 lbs. per acre and 50-100 seeds per square foot. The USDA Salt Lake Ranger District seed mix broadcasting specifications were 12 pounds per acre.

Seedlings and one-gallon size plants included the following species:

Dogwood	**Waterbirch**	**Boxelder**
Woods Rose	**Red Current**	

One hundred Tree Utah volunteers provided 202 hours towards revegetation of this reach. According to Keith Clapier, Dogwood would be particularly effective in stabilizing the streambanks and catching sediment along this reach (Clapier, 1995). The selection of deep-rooted species are ideal for stabilizing soil and increasing resistance along a channel (Gray and Leiser, 1989).

Erosion Control Measures

Erosion control matting and wood chips were used to provide temporary cover until vegetation establishment occurs. Curlex high and low velocity erosion control matting was utilized depending on the erosion potential along this reach. High velocity matting consisted of a dense layer of Aspen shavings with 1/4 inch mesh netting. Low velocity matting consisted of a loose layer of Aspen shavings with five inch mesh netting on one side. Large eight inch staples were used to anchor the erosion control matting over the bare soil and around riprap boulders. All areas were broadcast seeded prior to the implementation of these measures. The utilization of erosion control matting with plastic netting will prevent erosion, reduce the intensity of raindrop impact, conserve moisture, protected young seedlings from excessive temperature variations and help control weeds (Gray and Leiser, 1989). Erosion control matting and wood chips used in high risk and heavily utilized areas will provide cover and prevent erosion. High risk areas and the selected treatments are listed below:

High Velocity Erosion Control Matting

1. Created floodplain areas.
2. The steep south bank near the foot bridge.

(10 rolls of high velocity--100 feet long by 48 inches wide)

Low Velocity Erosion Control Matting

1. High intensity recreation access points along the banks.

2. Limited areas on the upper banks.

(10 rolls of low velocity--60 feet long by 8 feet wide)

Silt Fence / Plastic Fence

Steep south upper bank near the foot bridge.

Wood Chips

Along the south upper bank between the foot bridge and the east end of this restoration project.

The silt fence and a plastic restrictive fence along the top of the asphalt trail near the foot bridge was necessary to prevent recreational impacts and subsequent erosion in recently restored areas. The application of wood chips will provide temporary protection until cover is established in areas not covered with erosion control matting.

Revegetation and erosion control measures were implemented together to ensure protection of recently restored streambanks. In the future, an increase in percent cover will improve available moisture and organic matter along this reach (Dunne, 1977, McGinty et al., 1979 and Blackburn, 1983).

Other physical aspects of project implementation include some surface contouring, installing drip irrigation or a sprinkling system and changing recreational access along the banks. Removing an eroding asphalt hardened trail leading to the edge of the upper bank, near the end of 1995 stream restoration project, will reduce recreational impacts along the south upper bank.

Instream Channel Alterations

Instream channel alterations were also necessary to meet project goals and objectives. The following instream alterations were implemented during the first half of Phase II:

1. **Floodplain Construction**
2. **Rock Vortex Weir Placement**
3. **Narrowing the Channel**
4. **Boulder Placement and Directing the Thalweg**
5. **Removing or Notching Log Drop Structures**

Floodplain Construction

Floodplain construction was an innovative streambank restoration BMP utilized during this restoration project. The creation of a large floodplain, approximately 50 feet by 15 feet upto the large mid-channel Cottonwood tree, directed flow away from the heavily impacted bare and eroding bank. (See Appendix H). This reach was wide and shallow and contained a large amount of woody debris. The streambank here was riprap terraced, revegetated and protected with low velocity erosion control matting. The follow procedures were used to create this floodplain feature (See Appendix K.):

1. **Anchoring riprap along the desired edge of water using the large Cottonwood tree as a reference marker for the pre-existing waters edge.**

2. **Fill and talus material was placed over a large log debris matrix.**

3. **Materials were compacted.**

4. **Broadcast seeded and covered with high velocity erosion control matting.**

The large amount of woody debris, approximately 447 $ft.^2$, provided a log support matrix for the fill and talus material and improved the stability of this feature. High velocity erosion control matting was utilized to protect this floodplain during high flows until vegetation becomes well established.

Rock Vortex Weir Placement

A Rock Vortex Weir design was utilized in this restoration project. (See Appendix K.) Mill Creek has a low width/depth ration and is considered a high bedload stream with sufficient sediment transport capacity. Other project evaluations have indicated that rock vortex weirs have worked well under these site conditions. According to Rosgen, Rock Vortex Weirs meet the following objectives:

1. Provide instream cover in the riffle reach.

2. Deepen the feeding areas in the riffle reach of the channel.

3. Provide a wider range of velocities for holding water at high flow without creating backwater and sediment deposition.

4. Act as a grade control structure without upstream lateral migration, bank erosion and aggravation, which is very characteristic of rock and log dams.

5. Maintain the low/width depth ratio which will reduce the likelihood of bar deposition and maintain the sediment transport capacity of the stream (Rosgen, 1991).

The Rock Vortex Weirs were placed at cross over features of the channel and appeared to be functioning effectively. This instream feature meets the goals and objectives of this restoration project, based on Rosgen's list of objectives (Rosgen, 1991).

Narrowing the Channel

Narrowing the channel will improve fish habitat potential by creating deeper water, which will provide the following fishery enhancements:

1. **Decrease stream temperature and improve oxygen availability.**
2. **Allow sediment passage.**
3. **Increase available cover.**
4. **Improve substrate characteristics.**
5. **Permit fish migration.**
6. **Increase flow velocity.** (Seehorn, 1985).

Narrowing the channel also provided the opportunity to slightly increase sinuosity. This instream alteration measure will help control stream gradient. Vortex Weir placement and narrowing the channel will improve fish habitat, sinuosity and recreational values of this mountain stream (Rosgen, 1988).

Boulder Placement and Directing the Thalweg

Boulder placement provides overhead cover and resting areas for fish. Large angular riprap boulders were placed mid-channel to direct the thalweg and enhance fish habitat potential. Clustering boulders along this reach will improve the effectiveness of this technique (Seehorn, 1992). Boulder placement, downstream from the created floodplain slightly resembled a cascading step pool sequence and helped direct the thalweg away from the banks. The pool riffle sequence spacing, the appropriate base elevation for this stream and the and desired meander wave length were discussed during restoration, however meander geometry was not completely analyzed during to existing time and personnel constraints (Inglis, 1947, Leopold and Wolman, 1957 and 1960, Leopold et. al.,1964 and Langbein and Leopold, 1966 and Rosgen, 1988). According to Rosgen's Stream Classification, Mill Creek is a B3 stream and most fish habitat improvement structures rate poor to fair for this stream type (Rosgen and Fittante, 1986).

Removing or Notching Log Drop Structures

Log drop structures were either notched or removed to permit fish and sediment passage (Cowley, 1995). Straight, diagnal and inverted v-weirs (labeled log drop structures in this report), created extensive aggregation above and deep scouring pools below. The log drop structure near the foot bridge was notched and the effectiveness of this approach will be evaluated prior to next Fall's construction. Rock Vortex Weirs replaced the other log drop structures and were placed at cross over features prior to their removal. This will improve instream habitat according to (Rosgen, 1991).

The instream alterations implemented in this restoration project were innovative, produced a natural stream appearance and are quite functional considering existing project constraints. The best stability test of these instream features will be next years (1996) high flows occurring during early to mid-summer.

PROJECT CONSTRAINTS

During project planning and implementation, two major constraints were identified by the multiagency and interdisciplinary team, which could limit restoration effectiveness.

Mill Creek Road and the amount of high intensity recreational use will continue to impact this reach.

Mill Creek Road is adjacent to the channel and will continue to impact this stream's chemical, biological and physical characteristics. The road limited the extent and controlled the potential of this restoration project. Protecting the road and fill slope was addressed by placing keyed in riprap at the base of these slopes.

The most important project constraint is the high intensity recreational use this canyon receives due to it's proximity to a large urban area. The project design and technical support from the multi agency and interdisciplinary team directly addressed this constraint by providing innovative, aesthetically pleasing and effective controlled recreational access points. However, recreational use will continue to have a significant impact on these resources and resource managers need to be aware of changes to reduce and manage recreational impacts in urban watersheds. Improving public awareness and educating users about recreational impacts will enhance restoration efforts and reduce damage to this recently restored ecosystem. Salt Lake County's collection of entrance fees also improves public awareness about the value and costs associated with managing Mill Creek Canyon and it's resources.

PROJECT COSTS

Project costs included in this report includes a breakdown of USDA Forest Supervisors Office and Salt Lake County participation. Inkind matching participation includes $46,538.00 and is a major component of this project.

MILL CREEK CANYON STREAM RESTORATION PROJECT PHASE II: STREAMBANK STABILIZATION COSTS

Salt Lake County

Steve Jensen	$ 1,620.00
Brenda Landureth-Intern	5,918.00
Jimmie Pryor-Intern	419.00
Rob Marostica-Intern	232.38
Surveyors (SU940244)	2,271.43
Engineering and Flood Control	232.00
Volunteer Participation	135.00
Milage	257.13
Native Seed Mix	216.00
Wood Chips	40.00
Miscellaneous Supplies	100.00
TOTAL	$11,440.56

INKIND MATCHING PARTICIPATION:

Forest Supervisors Office	$39,837.00
Salt Lake Ranger District Office	1,630.00
Department of Agriculture/Division of Development & Conservation	925.00
State Division of Wildlife Resources	870.00
Personnel	400.00
Equipment	550.00
State Division of Water Rights/Stream Alterations	40.00
State Division of Environmental Quality	960.00
Salt Lake City Corporation Department of Public Utilities	538.00
Tree Utah	1,738.00
TOTAL	$46,538.00

TOTAL PROJECT COST: **$57,978.56**

POST-PROJECT MONITORING

Measuring the effectiveness of these improvements will require a comprehensive monitoring plan. Monitoring will include repeating the following inventories and surveys to evaluate the extent of any chemical, biological and physical change:

Water Quality
Vegetation Inventory
Cover Assessment
Habitat Quality Index
Stream Survey

Quantifying erosion and sediment production along this reach will be a priority for project monitoring. Measuring vegetation density and improvements in health will improve cover and reduce erosion and sediment production. The HQI will evaluated post-project stream attributes and biological improvements, which will enhance fish and riparian habitat. Measuring physical changes will provide resource managers with valuable insight into the effectiveness of restoration along this reach.

The overall success of this project, depends on the effectiveness of instream and streambank stability Best Management Practices implemented during 1995. During and after 1996 Mill Creek high flows, the multiagency and interdisciplinary team will complete a on site evaluation to gauge the effectiveness of 1995 restoration measures. This information will be incorporated into 1996 restoration planning and project implementation.

PROJECT SUMMARY

The magnitude and the complexity of the Mill Creek Restoration Project Phase II: Streambank Stabilization required efficient multiagency and interdisciplinary team participation to effectively meet project goals and objectives. In order to complete Phase II and evaluate the overall effectiveness of this project, continued commitment of this multiagency and interdisciplinary team is essential. The highest priority project monitoring concerns sediment production and quantifying erosion along this reach. Repeating baseline data surveys will be necessary to measure the effectiveness of this restoration project. In order, for this evaluation to be useful resource managers must commit to several years of monitoring.

Restoration measures implemented in this project will accomplish the following objectives:

Improve Water Quality
Improve Vegetation Health and Density
Improve Streambank Stability
Manage Recreational Impacts by Providing Controlled Stream Access
Improve Fish Habitat
Reduce Sediment Production
Improve Recreational Opportunities
Improve Aesthetic Values

The overall success of this project, depends on the effectiveness of instream and streambank stability Best Management Practices implemented during and after 1996 Mill Creek high flows, the muliagency and interdisciplinary team will complete an on site evaluation to gauge the effectiveness of 1995 restoration measures. This information will be encorporated into 1996 restoration planning and project implementation.

LITERATURE CITED

Binns, N. A. 1982. Habitat Quality Index Procedures Manual, Wyoming Game and Fish Department, pp. 1-209.

Blackburn, W. H. 1983. Livestrock Grazing Impacts on Watersheds. Rangelands. 5: 123- 125.

Burton, T., N. Bare, G. Ketcheson, H. Hudak, W. Little, W. Grow, T. M. Collins, A. H. Winward, D. Duff and H. Forsgren. 1992. Integrated Riparian Evaluation Guide. USDA Forest Service, Intermountain Region, pp. 12-14.

Christenson, G. E. 1984. Sediment Source Study Little Cottonwood, Big Cottonwood and Mill Creeks, Salt Lake County, Utah. Utah Geological and Mineral Survey and Salt Lake County Division of Flood Control and Water Quality Report of Investigation. No. 189, pp. 1-22.

Clapier, K. B. 1995. Personal Communication. Mill Creek Vegetation and Community Inventory on November 30, 1995.

Condrat, C. 1995. Stream Survey Personal Communications on September 5, 1995. Forest Hydrologist USDA Forest Supervisors Office.

Condrat, C. 1995. Longitudinal Profile for Mill Creek Stream Restoration Project Phase II: Streambank Stabilization. Forest Landscape Architect, USDA Forest Supervisors Office.

Crowley, A. 1995. Maple Grove to Terraces Vegetation Inventory and Map. Salt Lake County Interim Progress Report, pp.1-35.

Dissmeyer, G. E. 1994. Evaluating the Effectiveness of Forestry Best Management Practices in Meeting Water Quality Goals or Standards. USDA Forest Service, Southern Region, pp. 72-76.

Dunne, T. 1977. Intensity and Control of Soil Erosion Kajiado District, Kenya, Reports of Kenya Wildlife Management Projects, Nairobe, Kenya, Ministry Tourism and Wildlife, U.N., F.A.O.

Gray, D. H. and A. T. Leiser. 1989. Biotechnical Slope Protection and Erosion Control. Robert E. Krieger Publishing Co., Inc.: Malabar, Florida, pp. 1-271.

Harrelson, C. C., C. L. Rawlins and J. P. Potyondy. 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Technique. USDA Forest Service General Technical Report RM-245, pp. 1-61.

Inglis, C. C. 1942. Rapid Westerly Movement of the Kosi River. Central Board of Irrigation, India (Technical), pp. 7-8.

Jensen, S. F. 1994. Submittal of Final 319 Project Implementation Plan for Phase II, Millcreek Stream Restoration Demonstration Project to Mr. Roy Gunnell, Salt Lake County Commissioners Office, pp. 1-8.

Langbein, W. B. and L. B. Leopold. 1966. River Meanders--Theory of Minimum Variance. U.S. Geologocial Survey Professional Paper No. 422-H. pp. 15.

Leopold, L. B., M. G. Wolman. 1957. River Channel Patterns: Braided, Meandering and Straight. U.S. Geological Survey Professional Paper 282-B.

Leopold, L. B., M. G. Wolman. 1960. River Meanders. Bulletin Geological Society American. 71:769-794.

Leopold, L. B., M. G. Wolman and J. P. Miller. 1964. Fluvial Processes in Geomorphology. Freeman, San Francisco, CA. pp. 522.

Levinski, C. L. 1982. Best Management Practices for Road Activities, Volume II: BMP Catalogue, pp. 1-193.

Loader, K. B. 1995. Personal Communication on December 18. Interpretation of Mill Creek Water Quality Samples. Laboratory Director, Salt Lake City Corporation Department of Public Utilites.

Oberlie, Dennis. 1995. Personal Communication. Habitat Quality Index Interview. November , 1995.

McGinty. W. A., F. E. Smeins and L. B. Merrill. 1979. Influence of Soil Vegetation and Grazing Management on Infiltration Rate and Sediment Production of Edwards Plateau Rangeland. Journal of Range Management. 32: 33-39.

McLaughlin Water Engineers, Ltd. 1986. Evaluation of and Design Recommendations for Drop Structures in the Denver Metropolitan Area. Prepared for Urban Drainage and Flood Control District. pp. V1-V18.

Meeuwig R. O. and J. D. Budy. 1981. Point and Line-Intersect Sampling in Pinyon-Juniper Woolands. U.S.D.A. Forest Service General Technical Report INT-104, Intermountain Forest and Range Experiment Station, USDA Forest Service, pp. 1-38.

Padgett, W. G., A. P. Youngblood and A. H. Winward. 1989. Riparian Community Type Classification of Utah and Southeastern Idaho. USDA Forest Service, Intermountain Region, R4-Ecol-89-01, p. 191.

Roeber, E. 1995. Mill Creek Interim Report Costs and Information or Phase II: FAX. From USDA Forest Service Supervisors Office on December 16, 1995.

Rosgen, D. L. and B. L. Fittante. 1986. Fish Habitat Structures: A Selection Using Stream Classification. Short Course on Stream Classification and Applications. Wildland Hydrology Consultants. pp. C100-C118.

Rosgen, D. L. 1988. Conversion of a Braided River Pattern to Meandering: A Landmark Restoration Project. California Riparian Systems Conference. September 22-24. Davis, CA. Wildland Hydrology. pp. E1-E13.

Rosgen, D. L. 1991. Personal Communication. From Implementation of the Vortex Rock Weir Design in Colorado, California and Maryland Streams. Short Course on Stream Classification and Applications. Wildland Hydrology Consultants, Pagosa Springs, Colorado. pp. E1-E28.

Seehorn, M. E. 1992. Stream Habitat Improvement Handbook. USDA Forest Service Southern Region. Atlanta, GA. Technical Publication R8-TP 16. pp. 1-29.

Summers, R. P. 1995. Personal Communications on November 30, December 6 and 11. Mill Creek Restoration Project Phase II: Streambank Stability-Stream Survey Technical Support.

Summers, R. P. 1995. Mill Creek Restoration Project Phase II: Streambank Stability. Stream Survey Cross Section Profile Plots and Substrate Count Plots. State of Utah Division of Environmental Quality. Division of WaterQuality.

Summers, R. P., M. Wilson, M. Peterson, W. D. Robinson and M. Alred. 1994. NPS Interagency Monitoring Workgroup: 1993 Field Evaluations and Progress Report. State of Utah, pp. 1-86.

USDA Forest Service. 1988. Forest Service Handbook 2509.22: Soil and Water Conservation Practices Handbook. Missoula, MT and Ogden, Ut. pp. 02-18.06.

USDA Soil Conservation Service. 1977. Procedure for Computing Sheet and Rill Erosion on Project Areas. Engineering Division and Ecological Sciences and Technology Divsion Technical Release No. 51. Rev. 2. pp. 1-17.

Wilbur, J. 1995. Mill Creek Restoration Video. September/October. USDA Division of Development & Conservation. Environmental Quality Section.

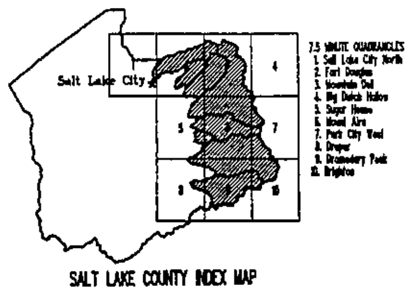
APPENDIX A

MILL CREEK PROJECT MAP

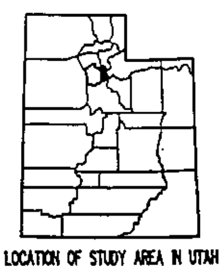
Salt Lake City
Watershed Management Plan
WATER BASIN BOUNDARIES

DIGITAL COMPILATION BY:
Utah Automated Geographic Reference
1271 State Office Building, Salt Lake City, Utah 84114.
January, 1987.

MAP SOURCE:
USGS 7.5 Minute Quadrangle Maps, 1:24,000.



SALT LAKE COUNTY INDEX MAP

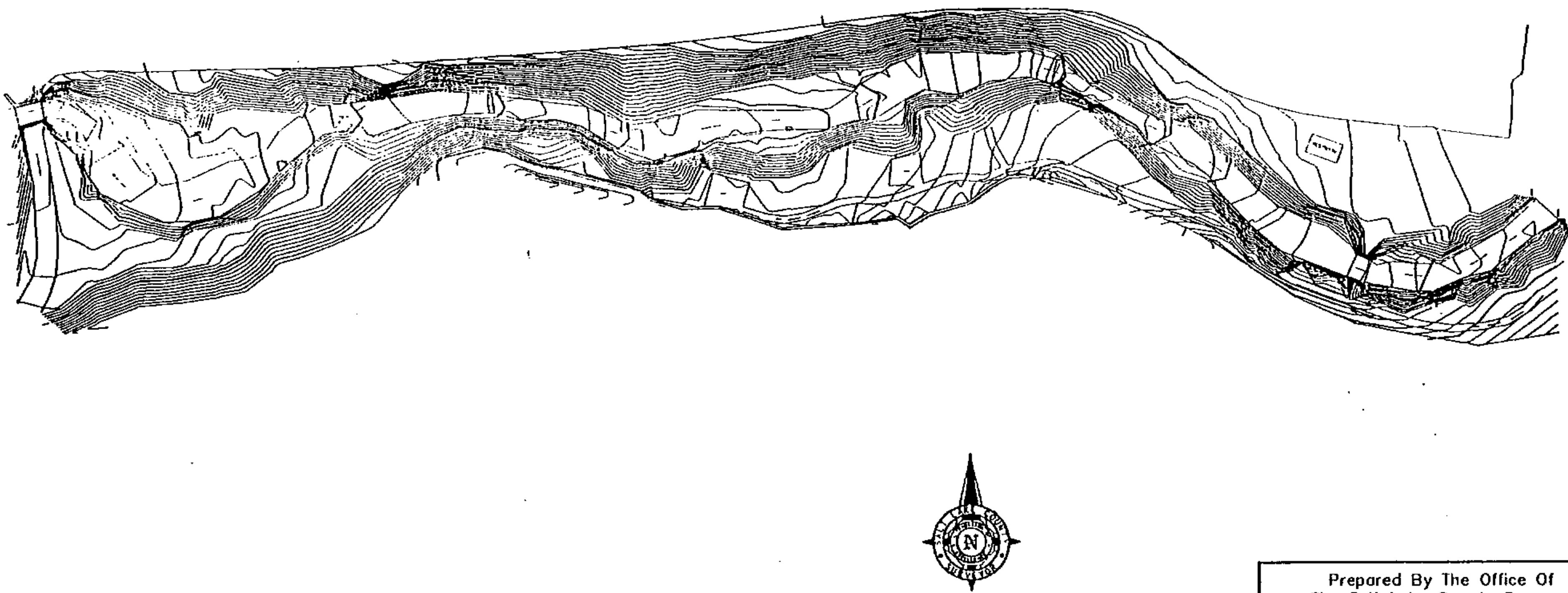


LOCATION OF STUDY AREA IN UTAH

APPENDIX B

UNIVERSAL SOIL LOSS DETERMINATION

Calculated Soil Loss for Specific Millcreek River Area
Soil Loss Graph (Tons/Area/Year)
Soil Loss (Tons/Acre/Year)
Millcreek Partitioned Soil Loss
USLE Determination Overlay
Erosion Intensity Overlay



Scale 1"–30'

MILL CREEK PROJECT MAP

Prepared By The Office Of
The Salt Lake County Surveyor
2001 S. State St. #N1500 Salt Lake City, Utah 84190-1350

Millcreek Canyon
near Terraces Picnic Grounds

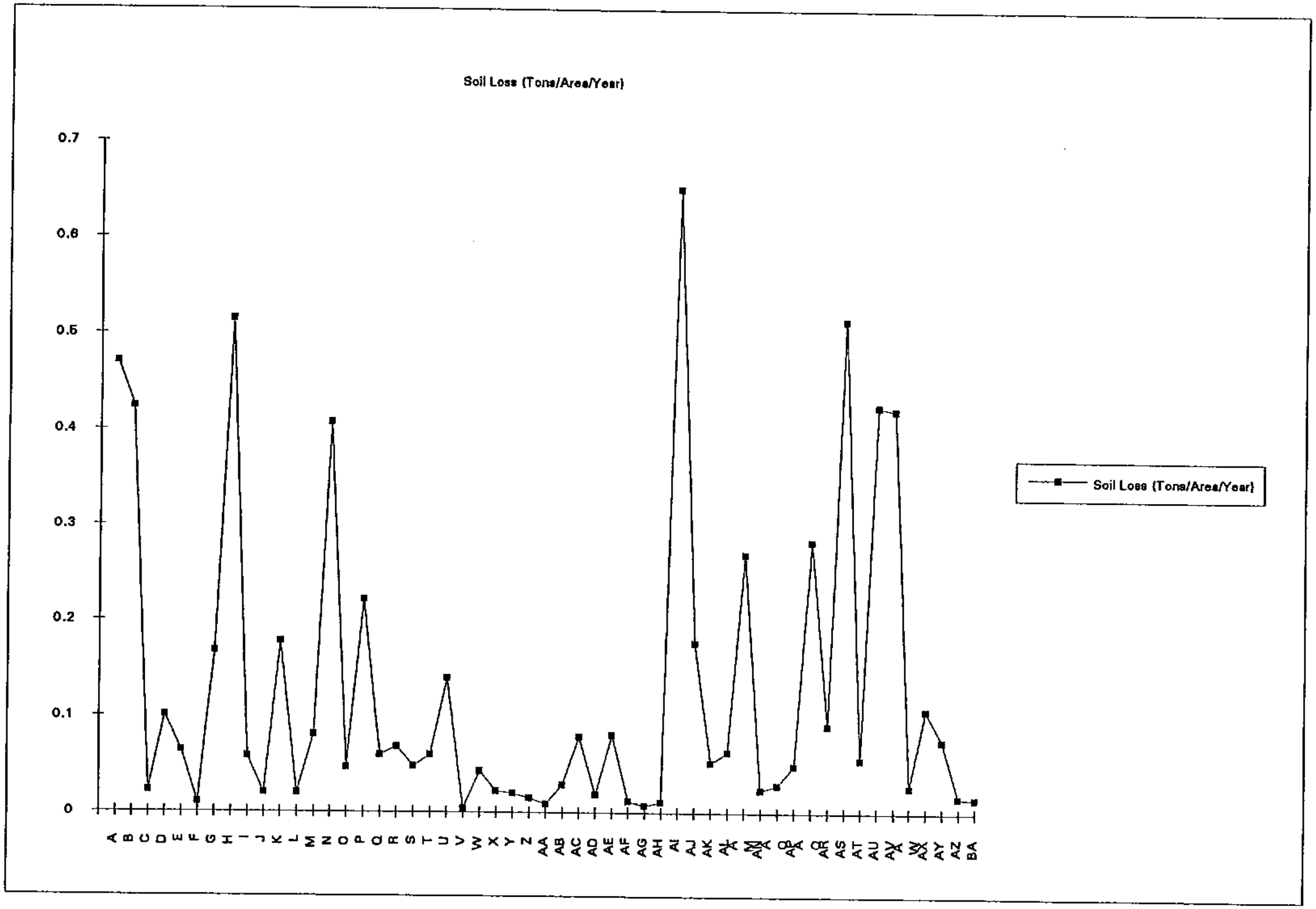
Prepared By: Larry Padilla
Surveyed By: Jim Pierce
Checked By: Melvin Duehlmeier, L.S.
Date: October 5, 1994
Work Order No.: SU 940211

M. Carl Larsen, L.S.
Surveyor

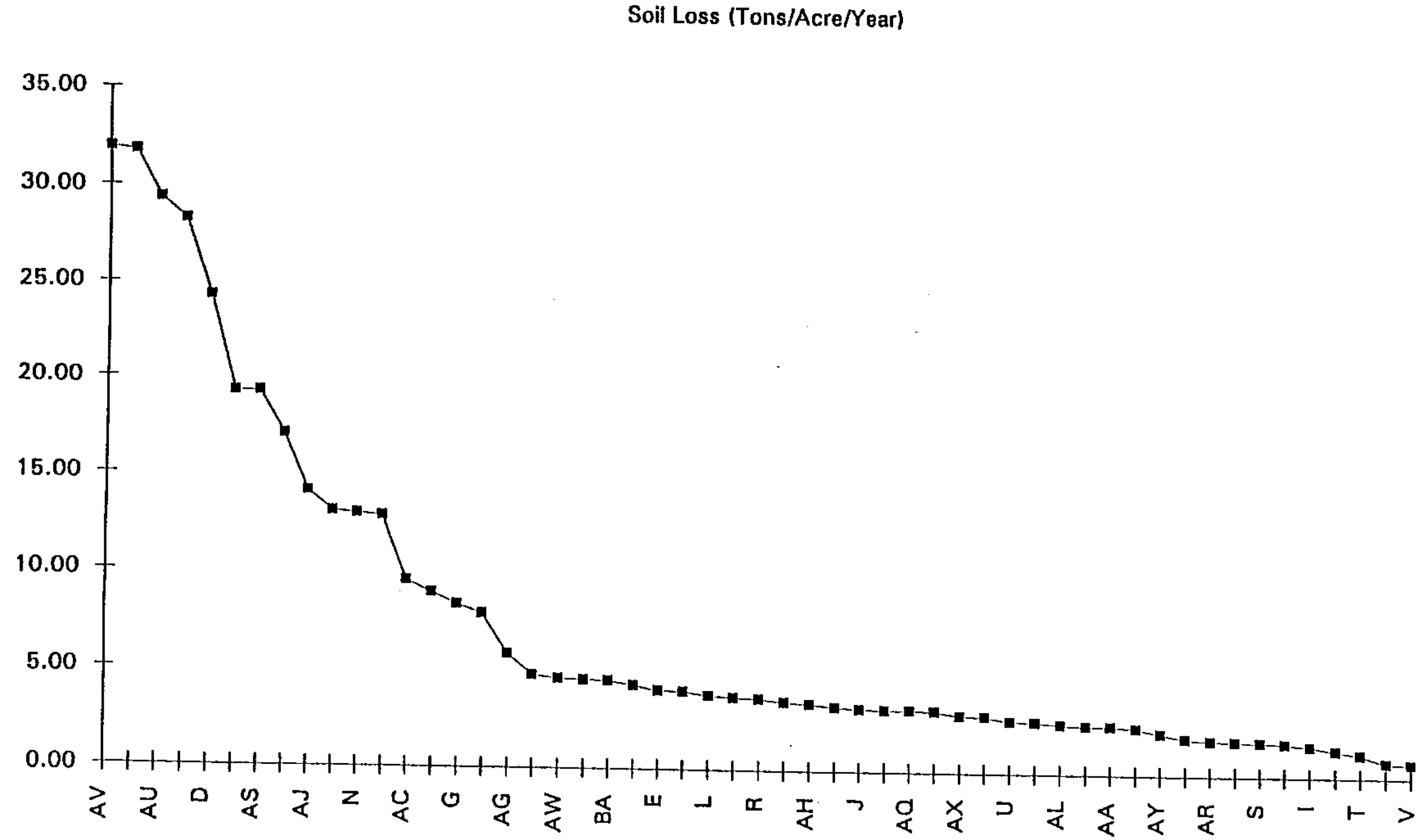
Calculated Soil Loss for Specific Millcreek River Area

Land Piece	Vertical Length	Vertical Elevation	Horizontal Length	Slope (Gradient)	Slope Length	LS Factor	Cropping	Rainfall	K Value	Land Piece Area	% of an Acre	Soil Loss (Tons/Acre/Year)	Soil Loss (Tons/Area/Year)
A	20	11	80	55.00%	22.83	7.54	0.85	20	0.10	1600	3.67%	12.81	0.471
B	10	11	58	110.00%	14.87	18.71	0.85	20	0.10	580	1.33%	31.81	0.424
C	6	7	35	116.67%	9.22	15.98	0.14	20	0.10	210	0.48%	4.48	0.022
D	14	12	13	85.71%	18.44	14.28	0.85	20	0.10	182	0.42%	24.28	0.101
E	14	12	50	85.71%	18.44	14.28	0.14	20	0.10	700	1.61%	4.00	0.064
F	21	9	15	42.86%	22.85	4.88	0.14	20	0.10	315	0.72%	1.37	0.010
G	21	9	42	42.86%	22.85	4.88	0.85	20	0.10	882	2.02%	8.30	0.168
H	11	11	72	100.00%	15.56	16.66	0.85	20	0.10	792	1.82%	28.32	0.515
I	25	11	65	44.00%	27.31	5.59	0.14	20	0.10	1625	3.73%	1.57	0.058
J	17	11	16	64.71%	20.25	9.39	0.17	20	0.10	272	0.62%	3.19	0.020
K	22	9	45	40.91%	23.77	4.59	0.85	20	0.10	990	2.27%	7.81	0.177
L	15	11	15	73.33%	18.60	11.11	0.17	20	0.10	225	0.52%	3.78	0.020
M	33	9	140	27.27%	34.21	2.74	0.14	20	0.10	4620	10.61%	0.77	0.081
N	25	13	55	52.00%	28.18	7.60	0.85	20	0.10	1375	3.16%	12.91	0.408
O	15	11	44	73.33%	18.60	11.11	0.14	20	0.10	660	1.52%	3.11	0.047
P	27	16	21	59.26%	31.38	10.05	0.85	20	0.10	567	1.30%	17.09	0.222
Q	25	17	30	68.00%	30.23	12.48	0.14	20	0.10	750	1.72%	3.49	0.060
R	28	17	29	60.71%	32.76	10.71	0.17	20	0.10	812	1.86%	3.64	0.068
S	45	16	27	35.56%	47.76	5.10	0.17	20	0.10	1215	2.79%	1.73	0.048
T	32	10	70	31.25%	33.53	3.42	0.17	20	0.10	2240	5.14%	1.16	0.060
U	22	12	105	54.55%	25.06	7.78	0.17	20	0.10	2310	5.30%	2.65	0.140
V	13	4	17	30.77%	13.60	2.12	0.17	20	0.10	221	0.51%	0.72	0.004
W	11	6	90	54.55%	12.53	5.50	0.17	20	0.10	990	2.27%	1.87	0.043
X	9	7	33	77.78%	11.40	9.59	0.17	20	0.10	297	0.68%	3.26	0.022
Y	12	6	44	50.00%	13.42	4.90	0.17	20	0.10	528	1.21%	1.66	0.020
Z	7	5	37	71.43%	8.60	7.23	0.17	20	0.10	259	0.59%	2.46	0.015
AA	7	5	22	71.43%	8.60	7.23	0.17	20	0.10	154	0.35%	2.46	0.009
AB	14	9	32	64.29%	16.64	8.42	0.17	20	0.10	448	1.03%	2.86	0.029
AC	19	9	19	47.37%	21.02	5.58	0.85	20	0.10	361	0.83%	9.48	0.079
AD	13	9	20	69.23%	15.81	9.30	0.17	20	0.10	260	0.60%	3.16	0.019
AE	20	9	20	45.00%	21.93	5.21	0.85	20	0.10	400	0.92%	8.86	0.081
AF	15	9	13	60.00%	17.49	7.67	0.17	20	0.10	195	0.45%	2.61	0.012
AG	8	10	7	125.00%	12.81	20.61	0.14	20	0.10	56	0.13%	5.77	0.007
AH	14	11	10	78.57%	17.80	12.19	0.14	20	0.10	140	0.32%	3.41	0.011
AI	15	9	145	60.00%	17.49	7.67	0.85	20	0.10	2175	4.99%	13.03	0.651
AJ	21	12	26	57.14%	24.19	8.29	0.85	20	0.10	546	1.25%	14.09	0.177
AK	37	14	35	37.84%	39.56	5.17	0.17	20	0.10	1295	2.97%	1.76	0.052
AL	27	15	41	55.56%	30.89	8.92	0.14	20	0.10	1107	2.54%	2.50	0.063
AM	29	18	21	62.07%	34.13	11.35	0.85	20	0.10	609	1.40%	19.29	0.270
AN	25	17	10	68.00%	30.23	12.48	0.17	20	0.10	250	0.57%	4.24	0.024
AO	26	18	13	69.23%	31.62	13.15	0.14	20	0.10	338	0.78%	3.68	0.029
AP	25	18	18	72.00%	30.81	13.87	0.17	20	0.10	450	1.03%	4.71	0.049
AQ	27	17	145	62.96%	31.91	11.24	0.14	20	0.10	3915	8.99%	3.15	0.283
AR	45	18	50	40.00%	48.47	6.31	0.14	20	0.10	2250	5.17%	1.77	0.091
AS	29	18	40	62.07%	34.13	11.35	0.85	20	0.10	1160	2.66%	19.29	0.514
AT	21	16	29	76.19%	26.40	14.11	0.14	20	0.10	609	1.40%	3.95	0.055
AU	18	16	35	88.89%	24.08	17.29	0.85	20	0.10	630	1.45%	29.40	0.425
AV	14	14	41	100.00%	19.80	18.80	0.85	20	0.10	574	1.32%	31.95	0.421
AW	20	15	13	75.00%	25.00	13.37	0.17	20	0.10	260	0.60%	4.55	0.027
AX	23	13	70	56.52%	26.42	8.50	0.17	20	0.10	1610	3.70%	2.89	0.107
AY	20	11	77	55.00%	22.83	7.54	0.14	20	0.10	1540	3.54%	2.11	0.075
AZ	14	9	21	64.29%	16.64	8.42	0.14	20	0.10	294	0.67%	2.36	0.016
BA	10	10	15	100.00%	14.14	15.89	0.14	20	0.10	150	0.34%	4.45	0.015

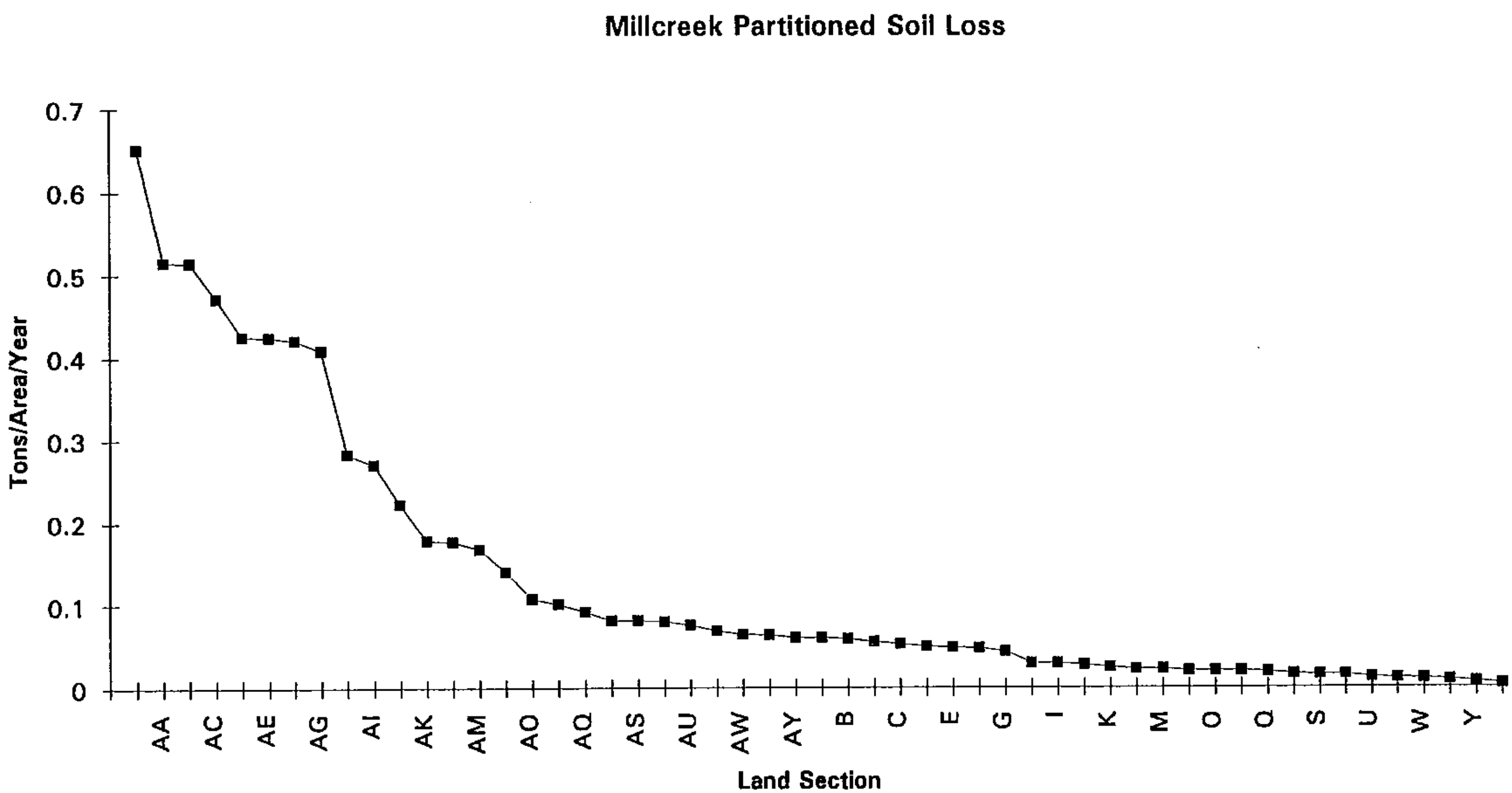
Land Piece	Soil Loss (Tons/Area/Year)
A	0.471
B	0.424
C	0.022
D	0.101
E	0.064
F	0.01
G	0.168
H	0.516
I	0.058
J	0.02
K	0.178
L	0.02
M	0.081
N	0.408
O	0.047
P	0.222
Q	0.06
R	0.068
S	0.048
T	0.06
U	0.14
V	0.004
W	0.043
X	0.022
Y	0.02
Z	0.016
AA	0.009
AB	0.029
AC	0.079
AD	0.019
AE	0.081
AF	0.012
AG	0.007
AH	0.011
AI	0.651
AJ	0.177
AK	0.052
AL	0.063
AM	0.27
AN	0.024
AO	0.028
AP	0.049
AQ	0.283
AR	0.091
AS	0.514
AT	0.055
AU	0.425
AV	0.421
AW	0.027
AX	0.107
AY	0.075
AZ	0.018
BA	0.016



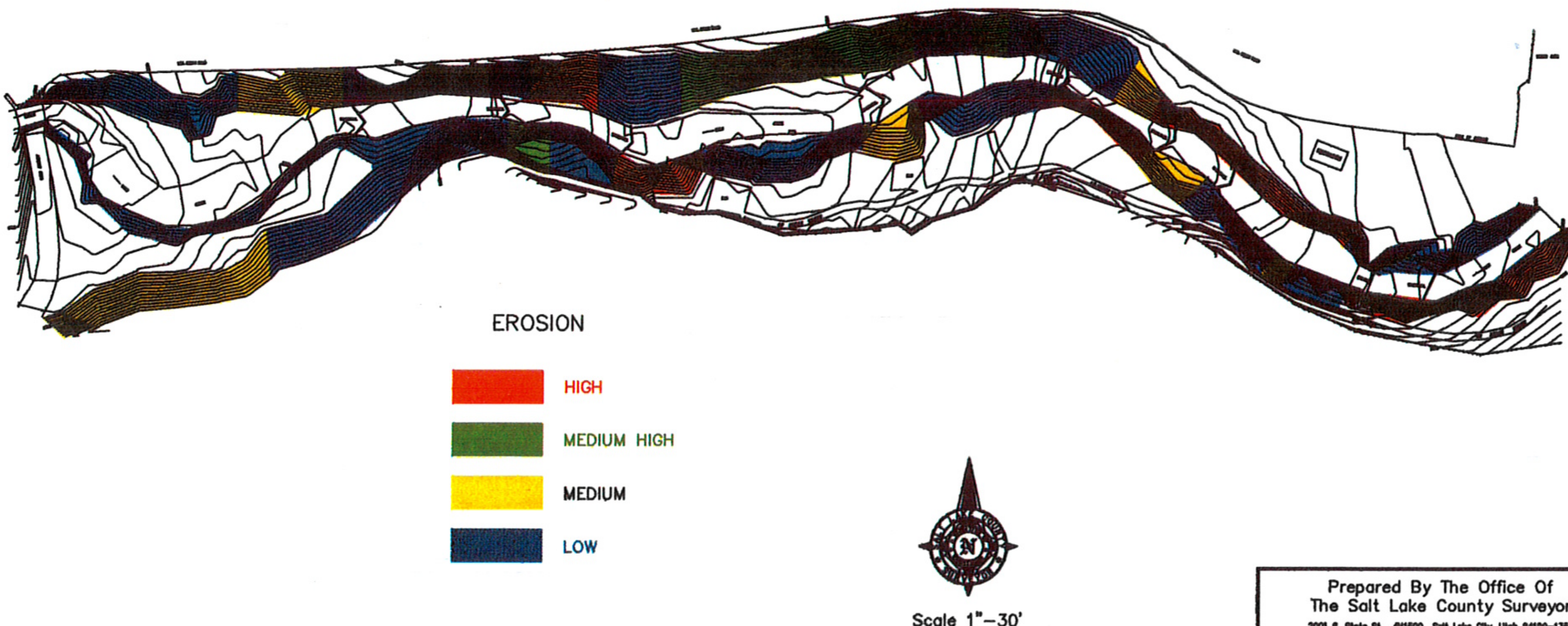
SOIL LOSS (TONS/AREA/YEAR)



SOIL LOSS (TONS/ACRE/YEAR)



PARTITIONED SOIL LOSS



Prepared By The Office Of
The Salt Lake County Surveyor
2001 S. State St. #N1500 Salt Lake City, Utah 84190-1350

Millcreek Canyon
near Terraces Picnic Grounds

Prepared By: Larry Padilla
Surveyed By: Jim Pierce
Checked By: Melvin Duehlmeier, L.S.
Date: October 5, 1994
Work Order No.: SU 940244

M. Carl Larsen, L.S.
Surveyor

USLE DETERMINATION OVERLAY

APPENDIX C

STREAM GRADIENT

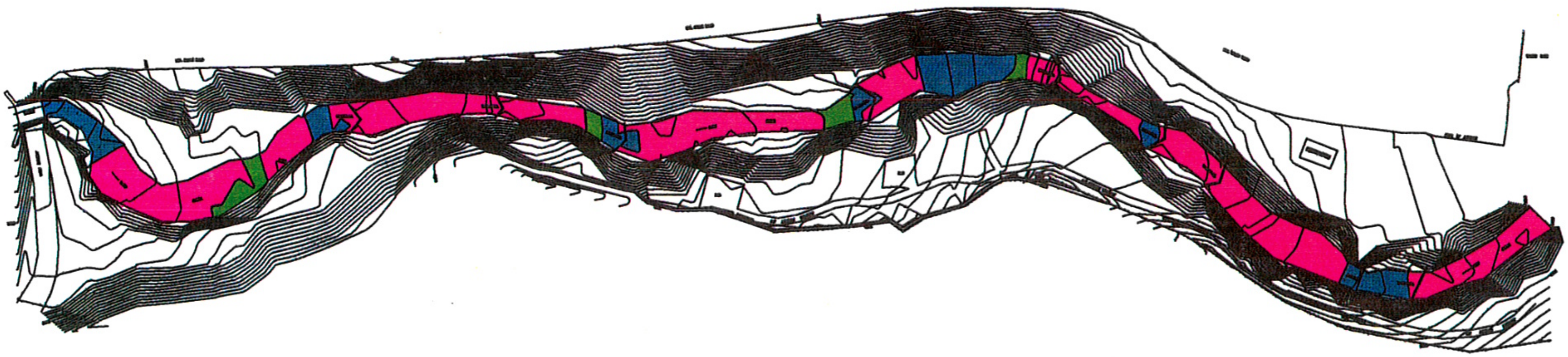
Stream Gradient
Stream Gradient Overlay

MILL CREEK

STREAM GRADIENT

Elevation (ft.)	Distance (in.)	True Distance (ft.)	Gradient
6078-6077	2.375	71.25	0.014
6077-6076	1.406	42.18	0.024
6076-6075	0.531	15.93	0.063
6075-6074	0.500	15.00	0.067
6074-6073	0.375	11.25	0.089
6073-6072	0.344	10.32	0.097
6072-6071	3.625	108.75	0.009
6071-6070	1.250	37.50	0.027
6070-6069	0.469	14.07	0.071
6069-6068**	2.500	75.00	0.013
6068-6067**	0.006	0.18	5.556
6067-6066	0.188	5.64	0.177
6066-6065	0.813	24.39	0.041
6065-6064	0.531	15.93	0.063
6064-6063	0.594	17.82	0.056
6063-6062**	1.000	30.00	0.033
6062-6061	0.563	16.89	0.059
6061-6060	0.030	0.90	1.111
6060-6059	1.500	45.00	0.022
6059-6058	2.250	67.50	0.015
6058-6057	0.813	24.39	0.041
6057-6056	0.031	0.93	1.075
6056-6055	0.938	28.14	0.036
6055-6054	1.625	49.88	0.020
6054-6053	1.406	42.18	0.024
6053-6052	1.406	42.18	0.024
6052-6051	0.469	14.07	0.071
6051-6050	1.250	37.50	0.027
6050-6049	0.344	10.32	0.097
6049-6048	1.500	45.00	0.022
6048-6047	0.875	26.25	0.038
6047-6046**	1.125	33.75	0.030
6046-6045**	0.625	18.75	0.053
6045-6044	0.813	24.39	0.041
6044-6043	0.066	19.69	0.051

** Unusual contours.



STREAM GRADIENT

Pink	0.00 – 0.04
Blue	0.04 – 0.08
Green	> 0.08

Scale 1"–30'

STREAM GRADIENT OVERLAY

Prepared By The Office Of
The Salt Lake County Surveyor
2001 S. State St. #N1500 Salt Lake City, Utah 84190-1350

Millcreek Canyon
near Terraces Picnic Grounds

Prepared By: Larry Padilla
Surveyed By: Jim Pierce
Checked By: Melvin Buchmeier, L.S.
Date: October 5, 1994
Work Order No.: SU 940244

M. Carl Larsen, L.S.
Surveyor

APPENDIX D

BEST MANAGEMENT PRACTICES EVALUATION

Best Management Practices Evaluation
Best Management Practices Bibliography

BEST MANAGEMENT PRACTICES MILL CREEK CANYON PHASE II : STREAMBANK STABILIZATION

		Bank Stabilization Effectiveness	Costs	Future Maintenance	Feasibility: Meeting Project Goals and Objectives	Visual Impacts	Overall Alternative Score
Physical Stabilization							
Riprap		3	3	2	3	3	14
Redwood Retaining							
Wall		3	1	3	1	1	9
Gabions		3	1	3	1	1	9
Concrete Block							
Reventment		3	0	3	1	1	8
Juniper Reventment		2	2	2	3	3	12
Terracing (Logs)		3	3	3	3	3	15
Vegetative Stabilization							
Willow Wattling		3	3	2	3	3	14
Tubelings		2	3	2	3	3	13
Sprigging		2	3	2	3	3	13
Native Seeding		3	2	3	3	3	14
Sediment and Erosion							
Control Measures							
Compaction		2	3	2	3	3	13
Geotextiles		3	2	2	2	2	11
Wood Chips		2	2	1	2	2	9
Straw Mulch		2	2	1	3	3	12
Hydromulch		2	2	2	3	3	12
Wood Excelsior							
Matting		1	2	2	2	3	10
Fiberglass Roving		3	1	2	2	2	10
Mulch Blanket		3	1	3	3	3	13
Jute Matting		2	2	2	3	3	12
Plastic Netting		3	2	3	3	3	14

BEST MANAGEMENT PRACTICES EVALUATION FOR STREAM RESTORATION

BIBLIOGRAPHY

Atchison, H. R. and E. N. Haase. 1978. Erosion Control Manual. Colorado Department of Highways and US Department of Transportation Federal Highway Administration. pp. 1-101.

Barton, J. R. and P. V. Winger. 1974. Stream Rehabilitation Concepts. Reserarch Report Submitted to Utah State Department of Highways. pp. 1-44.

Call, C. H. 1974. An Evaluation of In-Stream Structures Designed to Provide Fish Habitat. A Project Submitted to the Department of Civil Engineering Science. Brigham Young University, UT. pp. 1-108.

Camp, Dresser & McKee, Larry Walker Associates, Uribe & Associates and Resources Planning Associates. 1993. California Storm Water Best Management Practice Handbook. Construction Activity. Best Management Practice Handbook. Stormwater Quality Task Force. Sections 1-6.

Camp, Dresser & McKee, Larry Walker Associates, Uribe & Associates and Resources Planning Associates. 1993. California Storm Water Best Management Practice Handbook. Industrial/Commercial Best Management Practice Handbook. Stormwater Quality Task Force. Sections 3-4.

Camp, Dresser & McKee, Larry Walker Associates, Uribe & Associates and Resources Planning Associates. 1993. California Storm Water Best Management Practice Handbook. Municipal Best Management Practice Handbook. Stormwater Quality Task Force. Sections 4-5.

Dissmeyer, G. E. 1994. Evaluating the Effectiveness of Forestry Best Management Practices in Meeting Water Quality Goals or Standards. USDA Forest Service, Southern Region, pp. 72-76.

Gray, D. H. and A. T. Leiser. 1989. Biotechnical Slope Protection and Erosion Control. Robert E. Krieger Publishing Co., Inc.: Malabar, Florida, pp. 1-271.

Levinski, C. L. 1982. Best Management Practices for Road Activities, Volume II: BMP Catalogue, pp. 1-193.

McLaughlin Water Engineers, Ltd. 1986. Evaluation of and Design Recommendations for Drop Structures in the Denver Metropolitan Area. Prepared for Urban Drainage and Flood Control District. pp. V1-V18.

Rosgen, D. L. and B. L. Fittante. 1986. Fish Habitat Structures: A Selection Using Stream Classification. Short Course on Stream Classification and Applications. Wildland Hydrology Consultants. pp. C100-C118.

Rosgen, D. L. 1988. Conversion of a Braided River Pattern to Meandering: A Landmark Restoration Project. California Riparian Systems Conference. September 22-24. Davis, CA Wildland Hydrology. pp. E1-E13.

Rosgen, D. L. 1991. Peersonal Communication. From Implementation of the Vortex Rock Weir Design in Colorado, California and Maryland Streams. Short Course on Stream Classification and Applications. Wildland Hydrology Consultants, Pagosa Springs, Colorado. pp. E1-E28.

Salt Lake County Water Qualtiy & Pollution Control. 1981. Erosion-Sediment Control Handbook. Chapter V-VI. pp. 1-178.

Salt Lake County Public Works Department Engineering Division. 1995. Guidance Document Storm Water Management During Construction Activities. Chapter 4. pp.1-14.

Urban Drainage & Flood Control District. 1992. Urban Storm Drainage Criteria Manual. Volume III: Best Management Practices. Storm Water Quality. Third Printing. Salt Lake City, UT. Nonstructural Best Management Practices.

USDA Forest Service. 1986. Stream Habitat Improvement.. Wildlife and Fisheries Habitat Improvement Handbook. Chapter 1. Technical Editors: N. F. Payne and F. Copes, pp. 1-110.

USDA Forest Service. 1988. Forest Service Handbook 2509.22: Soil and Water Conservation Practices Handbook. Missoula, MT and Ogden, UT, pp. 02-18.06.

APPENDIX E

PROJECT PARTICIPATION LIST

MILL CREEK CANYON STREAM RESTORATION PHASE II: STREAMBANK STABILIZATION PROJECT SUPPORT

State Agencies Involved:

Bill Bradwisch, Aquatic Habitat Specialist
State Division of Wildlife Resources
Stream Survey and HQI Technical/Equipment Support
(801) 538-4866

Greg Mladenka, Stream Alteration Specialist
State of Utah Department of Natural Resources
Division of Water Rights
Stream Survey Assistance and Technical Support
(801) 538-7375

Rick P. Summers, P.H. Hydrologist
State of Utah Division of Environmental Quality
Division of Water Quality
Stream Survey Technical Support
(801) 538-6146

Dennis Oberlie, Aquatic Habitat Biologist
State of Wyoming Game and Fish Department
Lander WY
HQI Technical Support

U. S. Department of Agriculture Involved:

Erich Roeber, Forest Landscape Architect
Forest Supervisors Office
Wasatch-Cache National Forest
Project Design and Construction Manager
(801) 524-5109

Charlie Condrat, Forest Hydrologist
Forest Supervisors Office
Wasatch-Cache National Forest
Stream Survey Assistance and Technical Support
(801) 524-6061

Paul Flood, Forest Soil Scientist
Forest Supervisors Office
Wasatch-Cache National Forest
Technical Support
(801) 524-6061

Paul Cowley, Forest Fish Biologist
Forest Supervisors Office
Wasatch-Cache National Forest
Technical Support
(801) 524-6061

Jack Wilbur, Information Specialist
Division of Development & Conservation
Environmental Quality Section
Video Production and Technical Support
(801) 538-7098

Jack Vandenburg, Developed Sites Manager
Wasatch-Cache National Forest
Salt Lake Ranger District
(801) 943-1794

Jim White, Recreation Forester
Wasatch-Cache National Forest
Salt Lake Ranger District
Technical Support
(801) 943-1794

Keith Clapier, Plant Ecologist
Wasatch-Cache National Forest
Salt Lake Ranger District
Technical Support
(801) 943-2667

Fred Mangum, Aquatic Ecology Lab Director
U. S. Forest Service
Technical Support
(801) 378-4928

Salt Lake City Corporation Department of Public Utilities:

Florence Reynolds, Water Quality Administrator
Salt Lake City Corporation
Department of Public Utilities
Water Quality Support
(801) 483-6864

Kent B. Loader, Water Quality Laboratory Director
Salt Lake City Corporation
Department of Public Utilities
Water Quality Technical Support
(801) 799-4040

Casper Knies, Chemist 311
Salt Lake City Corporation Department of Public Utilities
Salt Lake City Public Utilities Laboratory
Water Quality Support
(801) 799-4043

Other Participating Agencies, Groups and Individuals Involved:

Anne Crowley, Botanist
Vegetation Species Inventory, Survey and Maps
Technical Support
(801) 363-5105

Tree Utah
Vaughn Lovejoy, Ecological Restoration and
Planting Project Coordinator
Revegetation Technical Support
(801) 487-9494

Salt Lake County Water Resource Planning:

Steven Jensen, M.P.A., Water Resource Planner
Brenda Landureth, Water Resource Planning Assistant
Jimmie Pryor, Water Resource Planning Assistant

Salt Lake County Technical Support:

Dave Lovell, Engineering Services Manager
Larry Padilla, Auto-Cad Technician, Surveyors Office
Terry Way, P.E., Hydrologic Engineer
Brent Beardall, P.E., Hydrologic Engineer
Steve Burgon, Hydrologic Technician
D. Chris Springer, Hydrologic Technician
Phil Lanouette, Construction Engineering Manager
Steve Mitckes, Technical Engineer
Lee Armstrong, Technical Engineer
Rick Olsen, Floodplain Coordinator
Rob Marostica, Salt Lake County Intern

Volunteers:

Scott Meeker Utah State Watershed Major
Rich Mallone

APPENDIX F

VEGETATION INVENTORY---ANNE CROWLEY

Maple Grove Community Type Classification Report
Species List
Community Type Maps

MAPLE GROVE
COMMUNITY TYPE CLASSIFICATION

MILLCREEK
MILLCREEK CANYON
SALT LAKE COUNTY
UTAH
NOVEMBER 24, 1995

PREPARED AT THE REQUEST OF
STEVEN F. JENSEN
WATER RESOURCE PLANNER
SALT LAKE COUNTY COMMISSION STAFF

PREPARED BY
ANNE F. CROWLEY
BOTANIST

CONTENTS

DISCUSSION

The Maple Grove mapped area begins just up stream of the Maple Grove Picnic Site at 6090 feet elevation and extends down stream for about 200 yards to the Terraces Bridge at 6060 feet elevation.

When looking at typifying the Maple Grove site, it seems necessary to consider that this is a disturbed, unnatural riparian reach. Steep road cuts, asphalt trails, picnic pads and foot trampled stream banks describe the area. The communities here seem to have found ways of coexisting within this unique environment.

For example, it has been noted by Padgett and others (1989) that moderate to heavy livestock grazing may inhibit Populus spp. root suckers and seedlings from becoming established. Could a correlation be made here to foot trampling and a marshmallow-roasting-stick grazing effect? Also, in Wyoming, the author describes fire as playing a role in maintaining Populus SPP. forests by inhibiting conifer regeneration. Due to the suburban location of the Maple Grove site, active fire control practices would be anticipated.

Populus angustifolia is not reproducing effectively anywhere within the mapped site, but individuals are present throughout as either mature, unhealthy or dead. Small conifers, however, were located in several areas along the stream terraces. This may suggest a trend away from a Populus dominated toward a conifer dominated site. Padgett and others (1989) does describe several conifer dominated sites, but none of them seemed to be an obvious succession to what is found at Maple Grove. Here again, the disturbed nature of the site must be considered.

METHOD

The percent species coverage data was visually analyzed for the north and south sides of the creek for each of the 6 segments. Then using the guidlines published by Padgett, Youngblood and Winward in Riparian Community Type Classification of Utah and Southeastern Idaho, 1989, a correlation was made between the communities the authors describe, and the communities at the Maple Grove site. The Maple Grove segments fit under the authors Tall Deciduous Tree-Dominated Groups: the entire mapped zone is dominated by an overstory of Acer negundo and Acer grandidentatum, which necessarily excludes those groups dominated by conifers and those groups dominated by shrubby overstories. Of the 8 groups they list, three apply in this study. These include Populus angustifolia/Betula occidentalis, Populus angustifolia/Acer grandidentatum and Acer negundo/Cornus sericea. The abbreviations that the authors use, and that will be used throughout the document, uses the first two letters of the genus name and the first two letters of the species name and will be shown in capital letters:

<u>Acer grandidentatum</u> = ACGR
<u>Acer negundo</u> = ACNE
<u>Betula occidentalis</u> = BEOC
<u>Cornus sericea</u> = COSE
<u>Populus angustifolia</u> = POAN

<u>Populus angustifolia</u> weighed heavily when considering classification types even though the majority of these trees were either unhealthy or dead, and never a dominant species. Some of the community type assignments may then seem artificial or contrived when based on an assumed relic community type. However, the repeated occurrences of other species strongly associated with POAN community types, supports the observation that these trees once likely held a dominate position in the system. In any case, the sites were assigned a Community Type Classification, and the following data attempts to give a brief supporting descriptive narrative as to why the sites were classified as they were.

SEGMENT #1

Although POAN is no longer regenerating or dominant, it's mature presence may represent a mid seral stage of one of the POAN community types. ACGR is the dominant overstory layer with ACNE to a lesser extent.

1 NORTH- The weak presence of BEOC (less than 1%) and several living POAN suggest a relic POAN/BEOC community type. However, ACGR has shown itself to be quite vigorous with a 60% overstory coverage and 15% understory coverage. The dominance of ACGR with ACNE as an understory codominant shrub layer supports a POAN/ACGR community type classification.

1 SOUTH- ACGR covers 60% of the overstory and is dominant. ACNE claims 10% and a few POAN are present. The sparse vegetation and 40% grassy coverage support a POAN/ACGR community type where POAN is not regenerating.

SEGMENT #2

ACNE and ACGR are codominant in both overstory and understory, with COSE playing an important secondary role.

2 NORTH- An old POAN/ACGR community type evidenced by a few POAN and a conspicuous ACGR presence seems to be tending toward an ACNE/COSE community type. ACNE/COSE is often associated with BEOC, and ACGR may codominate. By definition the percent coverage of COSE is generally greater than 25%, and this site is slightly deficient. However, given time the COSE could gain a stronger hold.

2 SOUTH– This area has been classified as a ACNE/COSE community type. It has 25% overstory coverage that is all ACNE. ACGR and ACNE share the understory dominance with 35 and 40% coverage respectively. COSE is present with 10% coverage. Except the fact that COSE should have a higher percent of coverage this could be a typical COSE community type.

SEGMENT #3

This segment is steep and grassy on the North bank with very little shrubby coverage and a strong ACNE overstory. The south bank has a dominant ACGR overstory with a dominant grass ground cover and a variety of shrubby species. Small conifers were noted scattered throughout the site.

3 NORTH– An ACNE/COSE community type best classifies this site. ACNE is the dominant overstory at 50% coverage and COSE is present (10%). Grasses are the primary understory vegetation at 70%. While the site would be a stronger ACNE/COSE type if there were a higher percent of COSE, there are no strong indicator against this classification.

3 SOUTH– ACGR is the dominant overstory. POAN/ACGR community type best describes this site even though POAN is extinct. Here again the small conifers are invading the terrace. And shrubs such as Mahonia repens and Pachystima myrsinites are present and Poa pratensis cover is high, which further substantiates placing this site in the POAN/ACGR community type.

SEGMENT #4

ACGR overstory is common to both sides of the stream with ACNE codominating on the north side. The overstory coverage is fairly light at approx. 30%. There is dense streamside shrub coverage on both sides.

4 NORTH– ACNE and ACGR codominate the overstory with a 30% total coverage, while COSE is the dominant understory at 40%. Poa pratensis and other grasses are present, and POAN regeneration is absent or minor. With the presence of high percentages of both COSE and ACNE, this plot has been identified as a ACNE/COSE community type.

4 SOUTH– ACNE is absent in the overstory, but is 40% of the shrubby understory. COSE makes up 15% of the understory. There is no POAN, and ACGR (30%) is dominating the overstory. Padgett does not describe an ACGR community type that excludes POAN, but this area may be an intermediate successional stage leading from a relic POAN/ACGR to a ACNE/COSE community type.

SEGMENT #5

Once again POAN are present. On both sides there is over 50% barren ground, and shrubs are sparse.

5 NORTH- ACGR and ACNE share the overstory dominance. There are remnants of a POAN community type, and Poa pratensis and other grasses cover 40% of the site. These characteristics are typical of a POAN/ACGR community type.

5 SOUTH- The south bank is also a POAN/ACGR community type. POAN and conifers are present. As is typical of this community type, ACGR dominates the overstory and ACGR and ACNE make up the shrubby layer.

SEGMENT #6

Conifers occur in this segment that lies just east of Terraces Bridge. ACNE is the dominant overstory, and the shrubby layer is a mix of ACGR, ACNE and COSE.

6 NORTH- A 65% ACNE overstory and a 10% COSE understory suggest that this is an ACNE/COSE community type. As is typical of this description, ACGR codominates as a shrub and Poa pratensis and Smilicina stellata are present.

6 SOUTH- ACNE dominates the overstory with 40% coverage and ACGR has 10%. ACGR and ACNE codominate the shrubby layer (25% each), and grasses and forbs were noted at 10 and 15% respectively. The conifers that are on the site are very large, and no COSE was reported. There is no regeneration of conifers or POAN. So, there is no COSE to support an ACNE/COSE community type. There is no regeneration of conifers to suggest a successional trend away from a deciduous dominated forest. And, there is no POAN to substantiate one of the POAN community types. This site will remain unclassified.

REFERENCES

Arnow, L.; Albee, B.; Wyckoff A. Flora of the Central Wasatch Front, Utah. Salt Lake City, Utah: University Printing Service, 2 ed. 663 p.

Clapier, K. 1991. Facsimile of the Riparian Complex Data Sheet for the site beginning at Maple Grove Campground. U.S. Department of Agriculture, U.S. Forest Service, R4-F19-D01, Salt Lake City Utah. Unpublished. 3 p.

Clapier, K. 1995. Personal Communication. U.S. Department of Agriculture, U.S. Forest Service, R4-F19-D01, Salt Lake City, Utah.

Hitchcock, C.L.; Cronquist, A. 1981. Flora of the Pacific Northwest. Seattle: University of Washington Press. 730 p.

Jensen, S.F. 1995. Personal Communication. Water Resource Planner, Salt Lake County Commission Staff, Salt Lake City, Utah.

Padgett, W.G.; Youngblood, A.P.; Winward, A.H. 1989. Riparian Community Type Classification of Utah and Southeasten Idaho. U.S. Department of Agriculture, Forest Service, Intermountain Region, R4-Ecol-89-01. 191 p.

Welsh, S.L.; Atwood, N.D.; Higgins, L.C.; Goodrich, S. 1987. A Utah Flora: Great Basin Naturalist Memoir No.9 1987. Brigham Young University. ISBN 0-8425-2260-3. 894 p.

APPENDIX A: MAPLE GROVE SPECIES LIST

The following list includes dominant overstory and understory vegetation, as well as other species observed while mapping the site. The inventory was taken on August 10, 1995.

SCIENTIFIC NAME	COMMON NAME
<u>GRASSES</u>	
Agropyron cristatum	Crested Wheatgrass
Agropyron intermedium	Intermediate Wheatgrass
Agropyron trachycaulum	Slender Wheatgrass
Bromus inermis	Smooth Brome
Dactylis glomerata	Orchard Grass
Phleum sp.	Timothy
Poa pratensis	Kentucky Bluegrass
Stipa lettermannii	Needlegrass
<u>FORBS</u>	
Achillea millefolium	Yarrow
Agastache urticifolium	Giant Hyssop
Aster engelmannii	Engelmann's Aster
Aster sp.	Aster
Capsella bursa-pastoris	Shepherd's Purse
Circaea alpina	Enchanter's Nightshade
Chrysanthemum parthemium	Feverfew
Cynoglossum officinale	Hound's Tongue
Fragaria vesca	Wild Strawberry
Galium triflorum	Bedstraw
Grindelia squarrosa	Curlycup Gumweed
Heracleum sphondylium	Cow Parsnip
Iliamna rivularis	Mountain Hollyhock
Lactuca sp.	Prickly Lettuce
Lapsana communis	Nipplewort
Lepidium sp.	Pepperweed
Melilotus sp.	Yellow Sweetclover
Nepeta cataria	Catnip
Plantaga major	Broadleaf Plantain
Polygonum sp.	Knotweed
Potentilla sp.	Cinquefoil
Smilacina stellata	False Salomonseal
Taraxacum officinale	Dandilion
Viola sp.	Violets
Verbascum sp.	Mullein
<u>SHRUBS</u>	
Amalanchier alnifolia	Serviceberry

Apocynum androsaemifolium	Spreading Dogbane
Betula occidentalis	WesternWaterbirch
Cornus stolonifera	Red-Osier Dogwood
Mahonia repens	Oregon Grape
Pachystima myrsinites	Pachystima
Physocarpus malvaceus	Ninebark
Prunus virginianus	Chokecherry
Ribies sp.	Currant
Rosa woodsii	Wood's Rose
Sambucus caerulea	Blue Elderberry
Symphoricarpos oreophilus	Snowberry

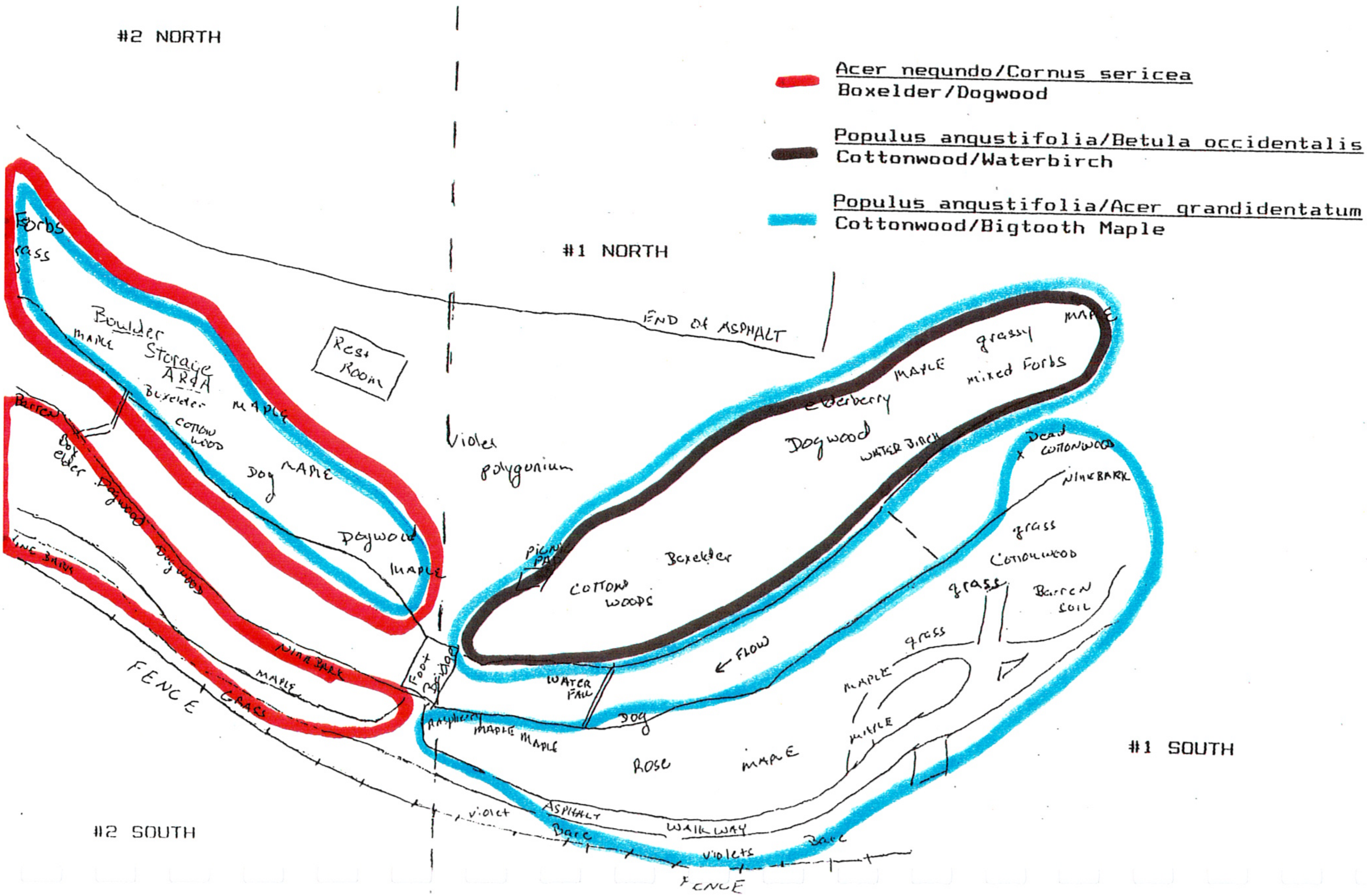
<u>TREES</u>

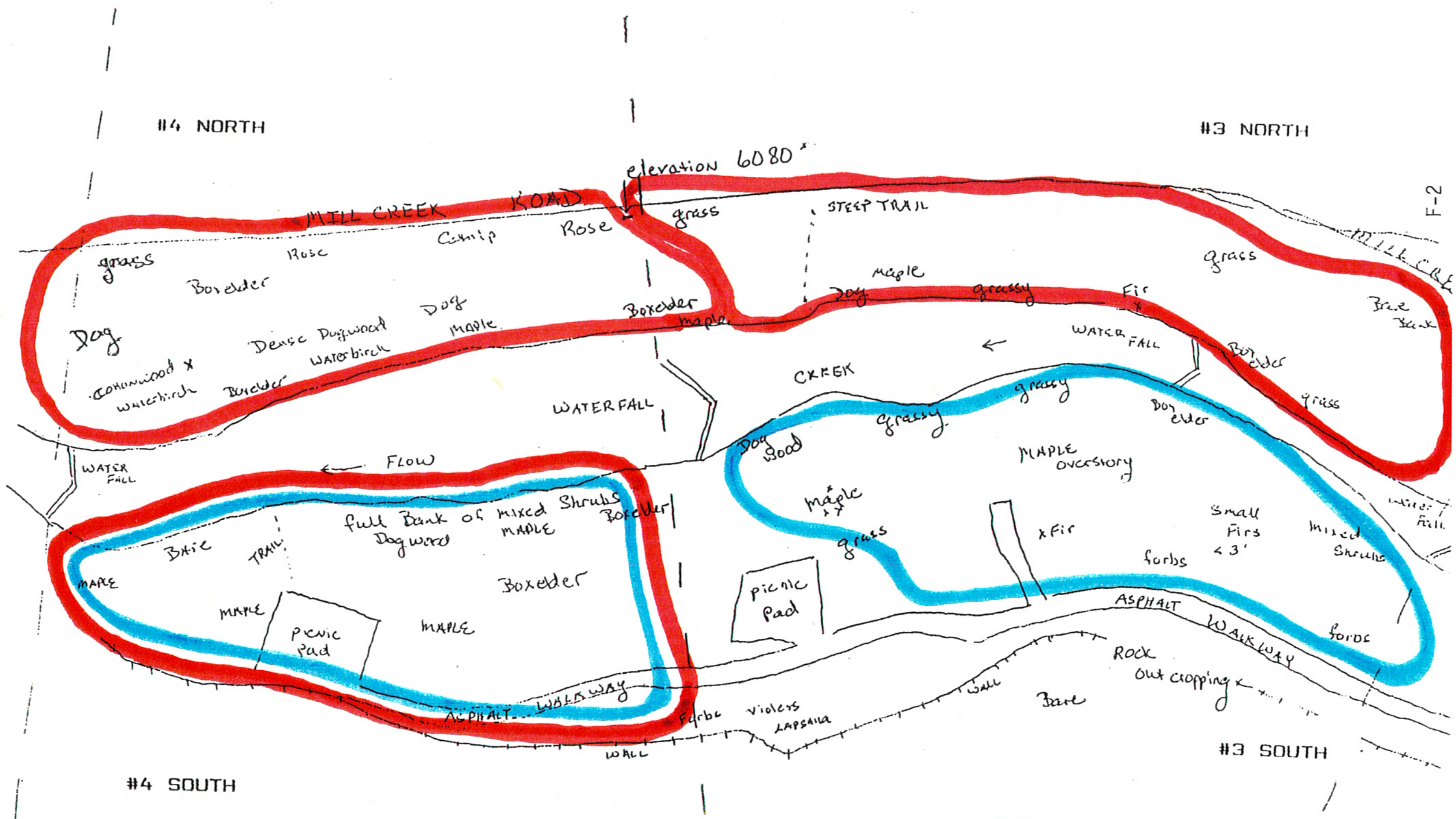
Acer grandidentatum	Bigtooth Maple
Acer negundo	Boxelder
Abies concolor	White Fir
Populus angustifolia	Narrowleaf Cottonwood

APPENDIX B: OVERLAYS OF COMMUNITY TYPES

The following overlays show the community type areas that were discussed in the preceeding document. The maps have been divided into 3 pages and are continuous with each other: #1 begins at the east side and #6 ends at the west end. A red ( ) boundary represents an ACNE/COSE community. A Black ( ) boundary line represents a POAN/BEOC community. A Blue ( ) boundary represents a POAN/ACGR community and the Green ( ) boundary is an community that was not typed.

MAPLE GROVE RIPARIAN COMMUNITY TYPE CLASSIFICATION



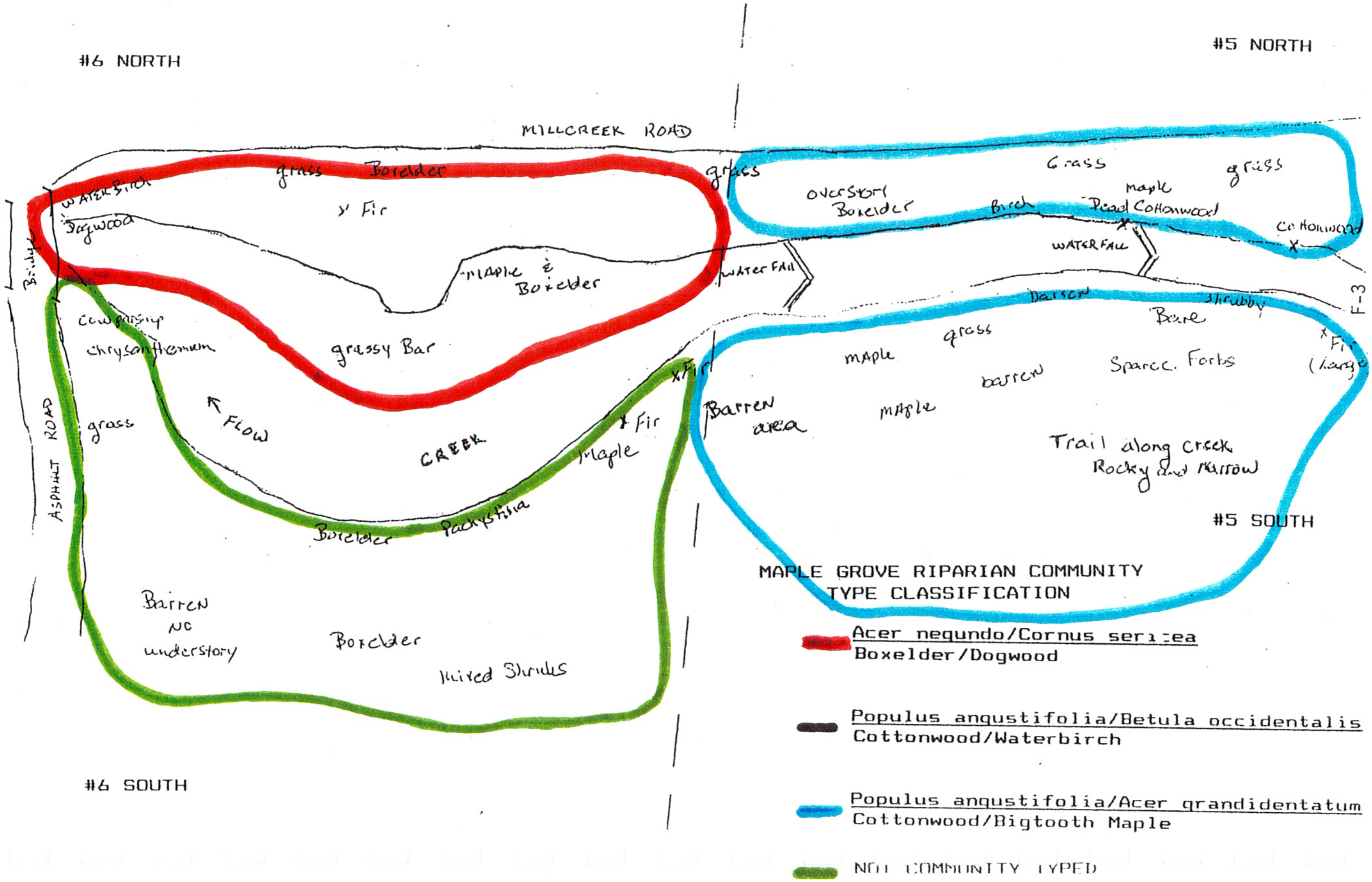


MAPLE GROVE RIPARIAN COMMUNITY
TYPE CLASSIFICATION

Acer negundo/Cornus sericea
Boxelder/Dogwood

Populus angustifolia/Betula occidentalis
Cottonwood/Waterbirch

Populus angustifolia/Acer grandidentatum
Cottonwood/Bigtooth Maple

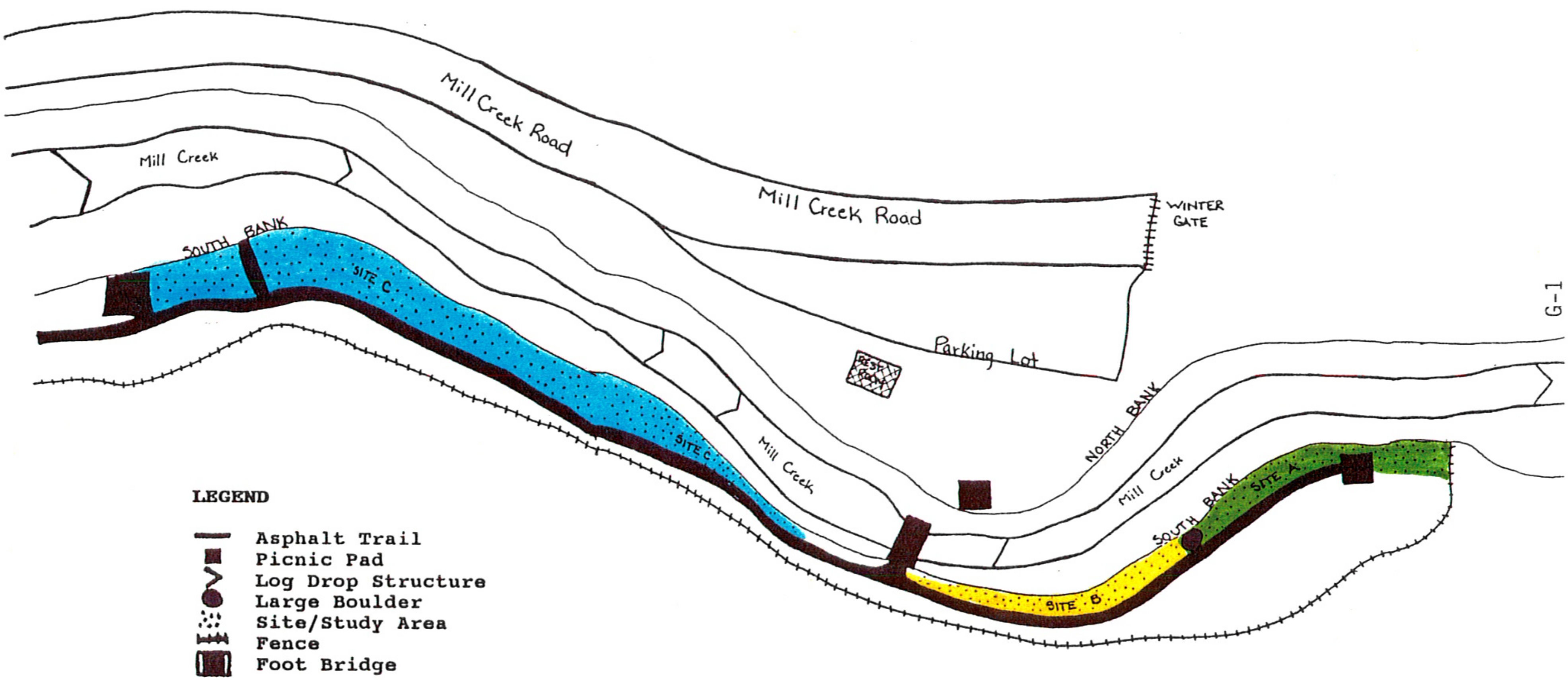

#6 NORTH
#5 NORTH
MILLCREEK ROAD
grass
Boxelder
Fir
Dogwood
Bridge
MAPLE & Boxelder
WATER FALL
Grass
grass
overstory Boxelder
Birch
maple
Dead Cottonwood
Cottonwood
WATER FALL
Barren
Shrubby
Bare
F-3
chrysanthemum
grassy Bar
FLOW
CREEK
grass
ASPHALT ROAD
Fir
Maple
Pachystima
Boxelder
Barren area
maple
grass
barren
Sparce Forbs
Fir
Trail along creek
Rocky and narrow
#5 SOUTH
MAPLE GROVE RIPARIAN COMMUNITY
TYPE CLASSIFICATION
Barren
NO
understory
Boxelder
Mixed Shrubs
Acer negundo/Cornus sericea
Boxelder/Dogwood
Populus angustifolia/Betula occidentalis
Cottonwood/Waterbirch
Populus angustifolia/Acer grandidentatum
Cottonwood/Bigtooth Maple
#6 SOUTH
NOT COMMUNITY TYPED

APPENDIX G

SOUTH UPPER BANK COVER ASSESSMENT

South Upper Bank Cover Assessment Map
Brief Site Descriptions and Cover Assessment Counts

SOUTH UPPER BANK COVER ASSESSMENT



Mill Creek Canyon Restoration Project Phase II: Streambank Stabilization
South Upper Bank Cover Evaluation

October 1995: Brenda Landureth

SITE A: Is located between picnic pad #1, which is near the large constructed floodplain. This study are is between the fence upstream from the chain link fence and the rebar marker for Stream Survey Cross Section II, which is on the downstream side of the very large boulder found on the right upper bank.

	SAMPLE NUMBER	COVER	NO COVER
	1	10	40
	2	11	39
	3	12	38
	4	14	36
Totals		47	153

SITE B: Is located between the Stream Survey Cross Section marker and the foot bridge.

	SAMPLE NUMBER	COVER	NO COVER
	1	17	33
	2	6	44
	3	13	37
	4	12	38
Totals		48	152

SITE C: Is located between the foot bridge and the lower extent of the 1995 completed restoration and last picnic pad along the asphalt trail.

	SAMPLE NUMBER	COVER	NO COVER
	1	15	35
	2	8	42
	3	15	35
	4	17	33
Totals		55	145

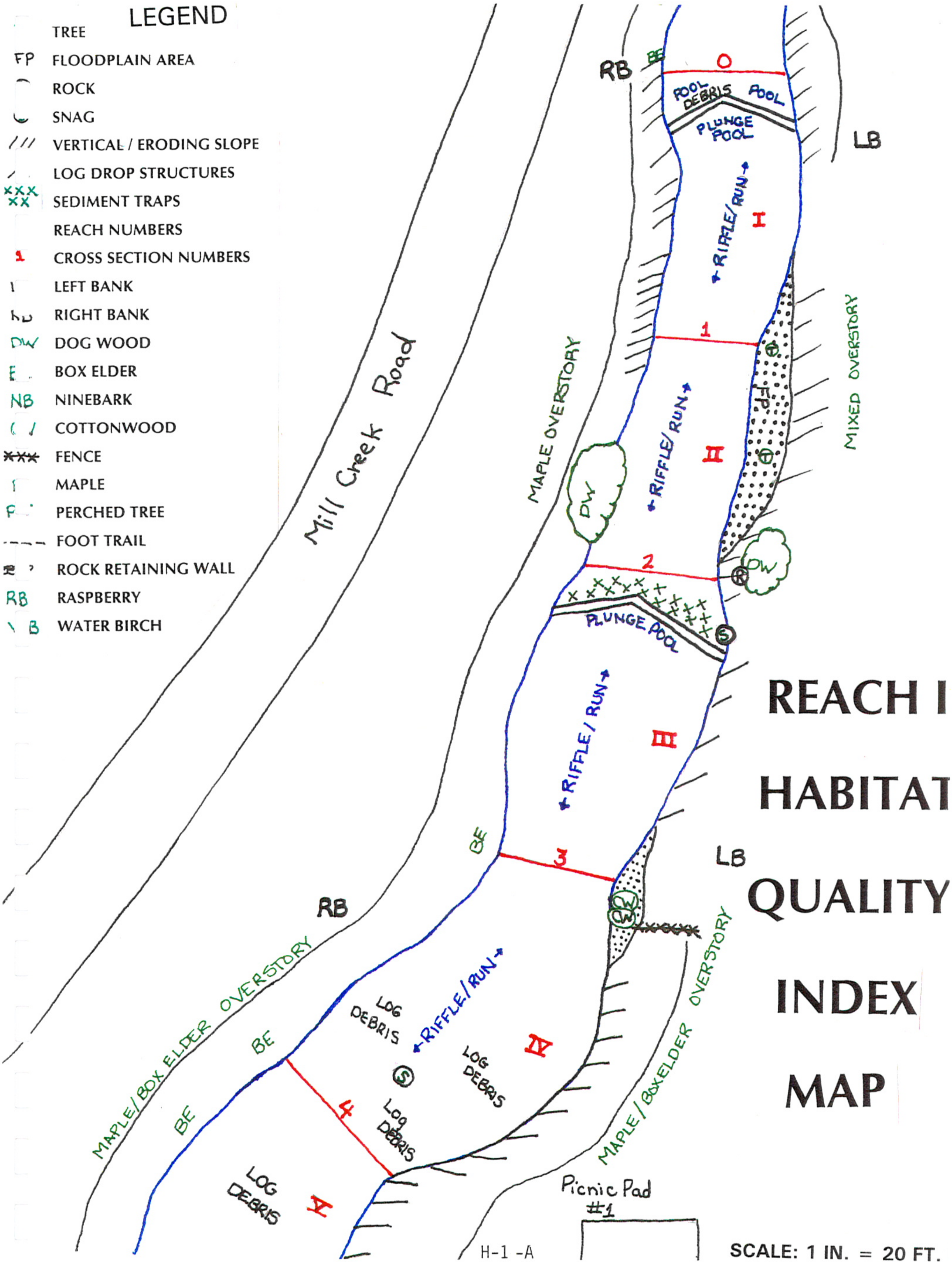
APPENDIX H

HABITAT QUALITY INDEX

Habitat Quality Index Maps
Reach I and II

Habitat Quality Index Table of Results
Flow Data

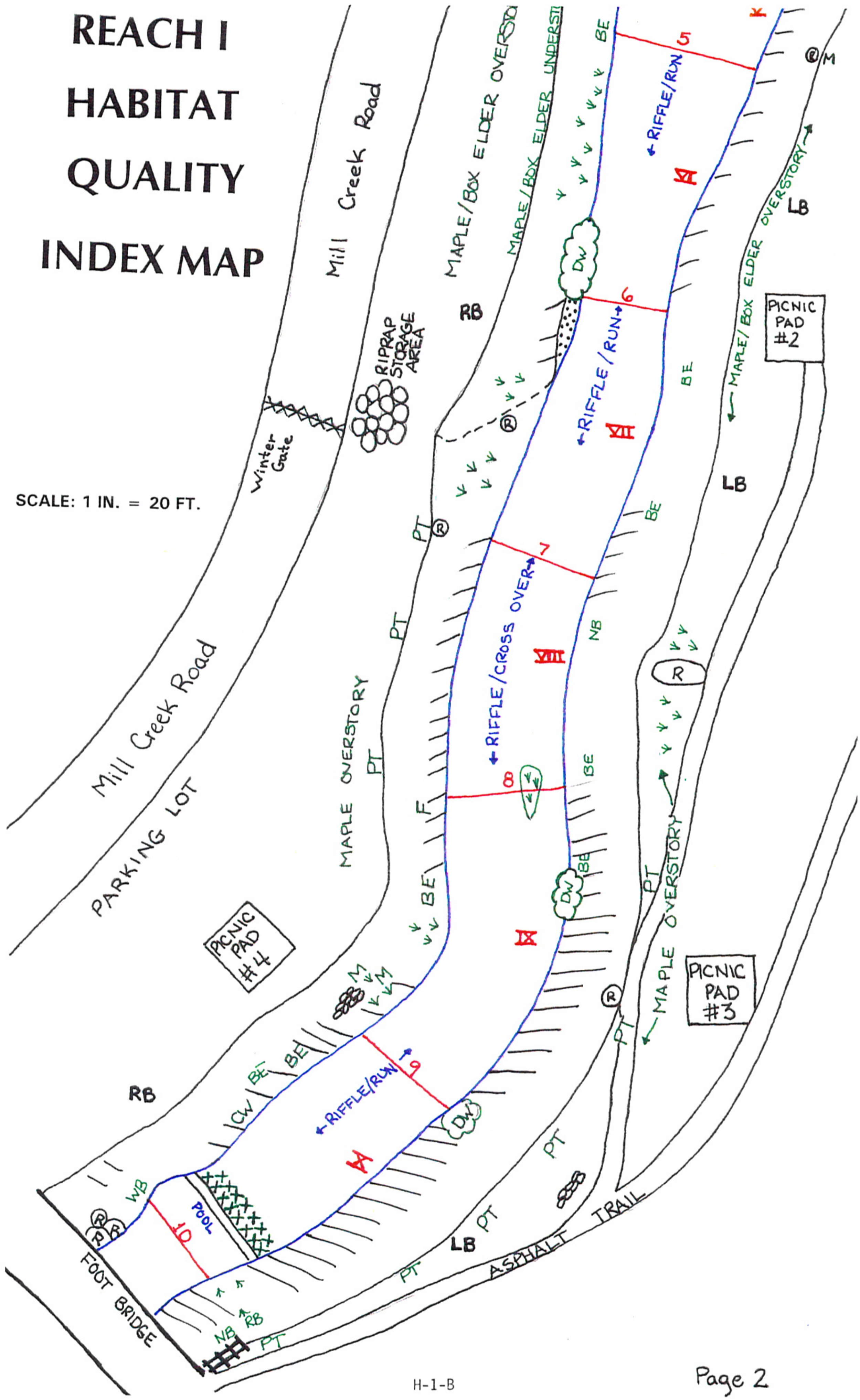
REACH I HABITAT QUALITY INDEX MAP

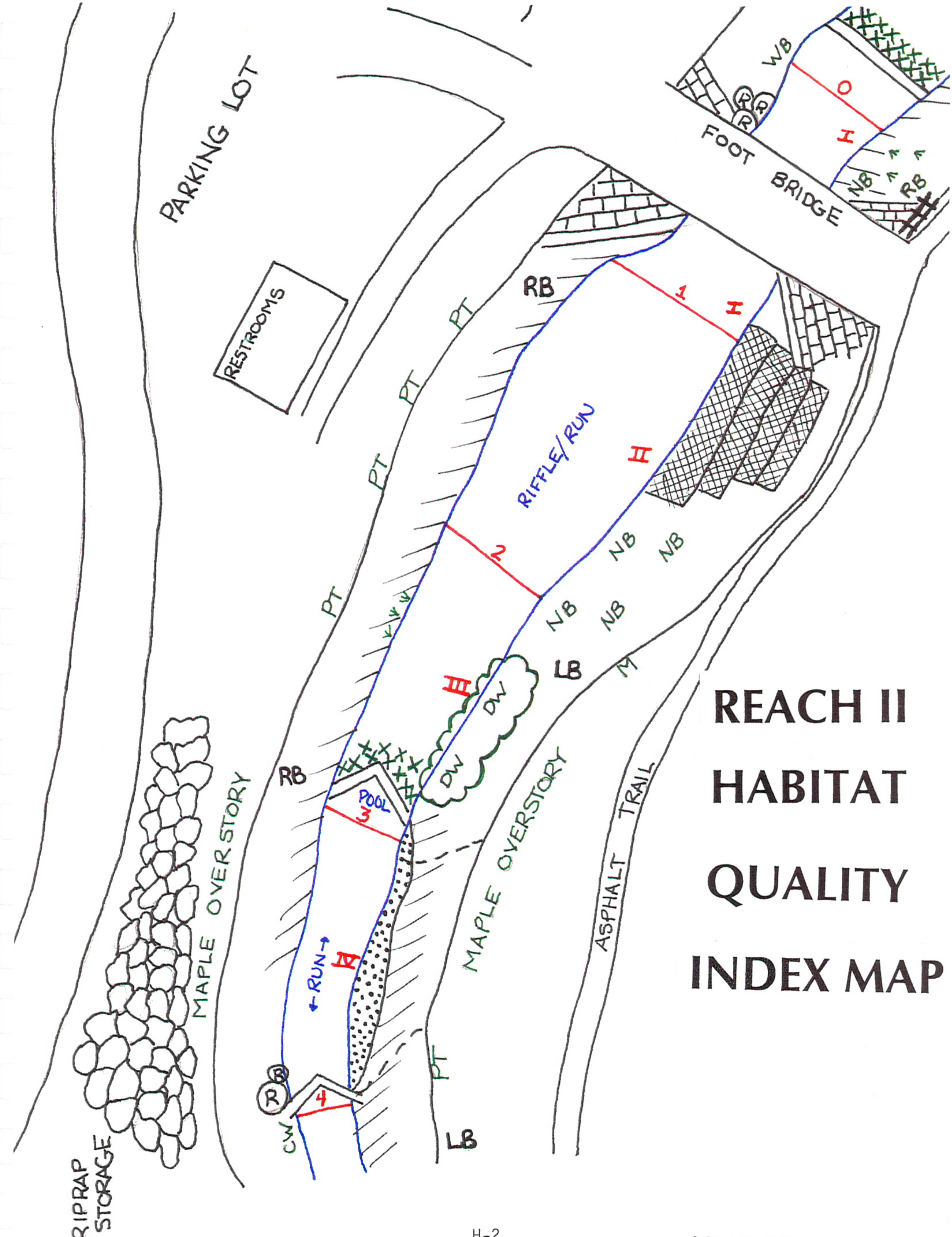


SCALE: 1 IN. = 20 FT.

REACH I HABITAT QUALITY INDEX MAP

SCALE: 1 IN. = 20 FT.





REACH II HABITAT QUALITY INDEX MAP

SCALE: 1 IN. = 20 FT.

Table 1. Habitat Quality Index Evaluation, Mill Creek Phase II

Salt Lake County, Utah, September 1995

Attribute	Data Summary	Rating
Late Summer Streamflow	Discharge data, 1981-1991, critical period flow was 11.8 of the annual daily flow	1
Annual Streamflow Variation	Discharge data, 1981-1991, annual peak flow was, on average, 83% the annual low flow	2
Maximum Summer Stream Temperature	1989-1993 STORET and Sept. 1995 field data, 12 C.	3
Nitrate Nitrogen	1989-1993 STORET and Sept. 1995 field data, 0.022	1
Cover	Sept. 1995 field data 3,974 ft., 38.6%	2
Eroding Streambanks	Sept. 1995 field data, 964.5 ft. , 172%	0
Water Velocity	Sept. 1995 field data, 1.46 ft./sec.	3
Fish Food Abundance		4
Stream Width	Sept. 1995 field data, 19.82 ft.	4
Habitat Units		
Lbs./acre, Predicted		29.83

MILLCREEK CANYON
FLOW VELOCITY MEASUREMENTS FOR THE HQI SURVEY

Velocity Measurement Depth 0.20	0.40	0.60	Total Depth	Cross Section
0.12	0.28	0.40	1.10	t = 0
0.52	0.59	0.57	1.18	
0.81	1.42	1.50	1.50	
1.19	1.49	1.53	0.60	t = 1
0.65	1.27	1.17	0.50	
2.33	2.80	2.92	0.50	
0.24	0.13	0.16	0.50	t = 2
0.48	0.67	1.06	0.61	
0.99	2.06	2.32	0.35	
0.09	1.80	1.76	0.50	t = 3
1.79	2.11	2.60	0.40	
1.31	2.14	2.09	0.40	
2.32	2.98	3.38	0.50	t = 4
2.85	3.25	4.81	0.50	
0.48	0.45	0.18	0.33	
0.32	0.92	1.81	0.90	t = 5
0.00	0.00	0.00	0.42	
0.06	0.19	0.15	0.50	
1.07	0.00	0.00	0.20	t = 6
1.27	1.06	2.08	0.80	
1.43	0.00	0.00	0.20	
0.04	0.38	0.13	0.50	t = 7
1.06	1.46	2.31	0.51	
1.40	2.00	2.33	0.75	
0.61	1.63	2.30	0.52	t = 8
0.28	1.58	2.19	0.52	
0.42	0.70	0.84	0.28	
0.37	0.91	1.35	0.50	t = 9
1.27	0.00	0.00	0.05	
1.48	2.12	2.44	0.40	
0.47	1.46	2.08	0.38	t = 10
0.32	1.38	2.34	0.56	
0.54	0.93	1.32	0.57	
0.39	0.62	0.72	0.62	t = 11
0.18	0.24	0.31	1.14	
0.02	0.60	1.24	0.54	

08–Nov–95

APPENDIX I

WATER QUALITY ANALYSIS

LEROY W. HOOTON, JR.
DIRECTOR

SALT LAKE CITY CORPORATION

DEPARTMENT OF PUBLIC UTILITIES
WATER SUPPLY AND WATERWORKS
WATER RECLAMATION AND STORMWATER

DEEDEE CORRADINI
MAYOR

Salt Lake City Public Utilities Laboratory
Sample Analysis Report

Report Date: September 8,1995

Sample Location: Mill Creek Canyon
Station #1 Sample #10
Station #2 Sample #11
Date Sample taken: 8/23/95 Sampled by: Brenda Landureth

SAMPLE RESULTS

	Sample #10	Sample #11
Fluoride	0.071 mg/l	0.071 mg/l
Chloride	4.30 mg/l	4.34 mg/l
Nitrite	<0.02 mg/l	<0.02 mg/l
Bromide	<0.02 mg/l	<0.02 mg/l
Nitrate	0.097 mg/l	<0.02 mg/l
Phosphate	<0.05 mg/l	<0.05 mg/l
Sulfate	154 mg/l	155 mg/l
TSS	5 mg/l	4 mg/l
T-Lead	<0.003 mg/l	0.009 mg/l
T-Zinc	0.071 mg/l	<0.020 mg/l

Results: colonies/100 ml.		
Total Coliform	100	40
Fecal Coliform	2	0
HPC	TNTC	TNTC

Questions: Please contact Kent Loader 799-4040

1530 SOUTH WEST TEMPLE, SALT LAKE CITY, UTAH 84115
TELEPHONE: 801-483-6768 FAX: 801-483-6818

RECYCLED PAPER

APPENDIX J

STREAM SURVEY

Longitudinal Profile Data and Plot
Cross Section Survey Data and Plots
Flow Data
Substrate Count Data
Particle Distribution Plots
Stream Survey Map

MILL CREEK MAPLE GROVE STREAM SURVEY: LONGITUDINAL PROFILE
SEPTEMBER 6, 1995: CHARLIE CONDRAT, ROB MAROSTICA

DISTANCE (ft.)	THALWEG ELEVATION (ft.)	MID-CHANNEL ELEVATION (ft.)	COMMENTS **Thalweg is located in the middle of the channel.
0	14.65	14.06	New instrument set-up mid-channel (at 0 ft.).
5	5.22	5.85	Stream Survey Cross-Section #1. H.I. is 3.97 ft..
10	5.31	5.31	
15	5.31	5.31	
20	5.55	5.24	
25	5.45	5.20	Tip of log drop structure is at 27 ft..
30	7.40	7.40	Depth of pool under drop structure is 2.3 ft..
35	6.40	6.40	
40	6.60	6.50	
45	6.85	6.50	
50	6.80	6.90	
55	7.10	7.05	
60	7.40	7.25	
65	7.60	7.45	
70	7.50	7.20	
75	7.80	7.20	
80	7.90	7.45	
85	8.30	7.80	New set-up reading 7.4 ft.. Elevation is 2.7 ft..
90	5.80	5.40	
95	6.10	5.70	
100	6.20	6.00	
105	6.35	6.35	**
110	6.40	6.40	**
115	6.60	6.60	**
120	6.50	6.50	**
125	6.70	6.70	
130	7.10	6.70	
135	7.80	7.10	
140	8.00	7.00	
145	8.10	7.10	
150	8.40	7.40	
155	8.45	7.60	
160	8.50	7.40	
165	8.25	7.50	
170	8.25	7.90	
175	8.40	8.15	
180	8.80	8.20	Large Cottonwood tree in the middle of channel.
185	8.80	8.35	
190	9.20	8.40	
195	9.30	9.20	
200	9.65	9.40	

MILL CREEK MAPLE GROVE STREAM SURVEY: LONGITUDINAL PROFILE 6-Sept. 95

DISTANCE (ft.)	ELEVATION (ft.)	MID-CHANNEL ELEVATION (ft.)	COMMENTS: **Thalweg is located in the middle of the channel.
205	2.70	2.70	** New set-up 9.9 ft..
210	2.60	2.60	**
215	2.80	2.80	**
220	3.10	3.10	**
225	3.20	2.85	
230	3.30	3.00	
235	3.40	3.20	
240	3.80	3.40	
245	3.80	3.60	
250	4.10	4.10	**
255	4.30	4.30	**
260	4.30	4.30	**
265	4.30	4.20	
270	4.40	4.35	
275	4.60	4.40	
280	4.65	4.70	
285	4.70	4.70	
290	4.85	4.85	
295	5.10	5.10	**
300	5.40	5.40	**
305	5.70	5.70	**
310	5.65	5.65	**
315	5.90	6.20	
320	6.10	5.90	
325	7.30	5.60	
330	6.80	6.30	
335	6.70	6.40	Stream Survey Cross-Section #2.
340	7.20	6.60	
345	7.35	6.80	
350	7.60	7.00	
355	7.80	7.10	
360	8.10	7.40	
365	8.20	7.50	
370	8.40	7.55	
375	8.50	7.90	
380	8.25	8.10	
385	8.60	8.60	**
390	8.75	8.75	**
395	8.60	8.60	**
400	8.80	8.80	**
405	8.85	8.85	**
410	8.90	8.90	**

MILL CREEK MAPLE GROVE STREAM SURVEY: LONGITUDINAL PROFILE 6-Sept. 95

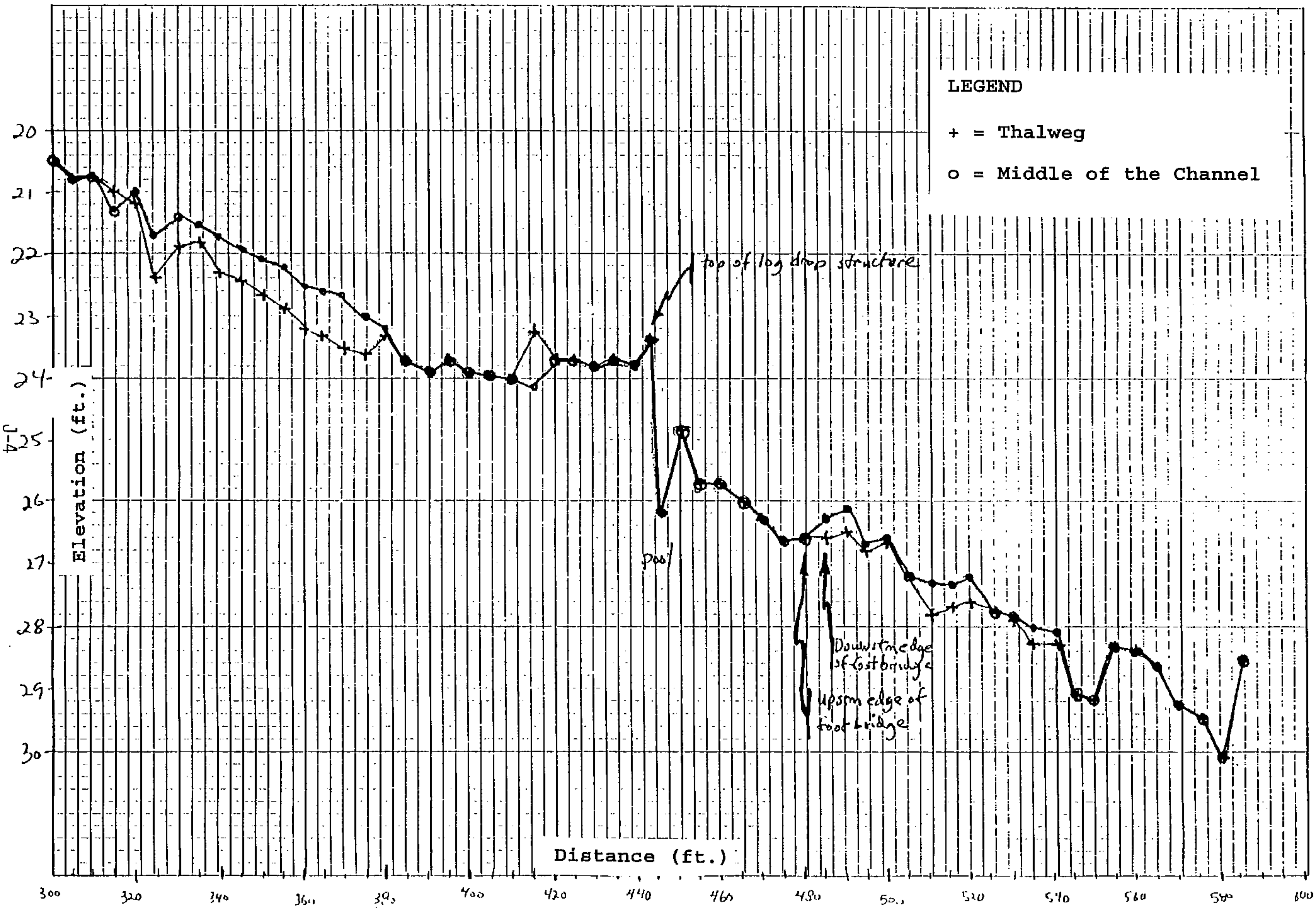
DISTANCE (ft.)	THALWEG ELEVATION (ft.)	MID-CHANNEL ELEVATION (ft.)	COMMENTS : **Thalweg is located in the middle of the channel.
415	9.15	9.00	New set-up 8.4 ft. B.S. 3.2 ft..
420	3.40	3.40	**
425	3.40	3.40	**
430	3.50	3.50	**
435	3.40	3.40	**
440	3.50	3.50	**
444	3.10	3.10	** Middle of log drop structure.
445	5.90	5.90	** Depth of pool 1.8 ft..
450	4.55	4.55	** Lower end of the pool.
455	5.40	5.40	**
460	5.40	5.40	**
465	5.70	5.70	**
470	6.05	6.05	**
475	6.30	6.30	**
480	6.30	6.30	** Upstream edge of the footbridge.
485	6.30	6.00	Downstream edge of the footbridge.
490	6.20	5.80	
495	6.50	6.40	
500	6.40	6.30	
505	6.90	6.90	
510	7.50	7.00	
515	7.40	7.00	
520	7.30	6.90	
525	7.45	7.50	
530	7.55	7.50	
535	8.00	7.70	
540	8.00	7.80	
545	8.80	8.80	**
550	8.90	8.90	**
555	8.00	8.00	**
560	8.10	8.10	**
565	8.35	8.35	**
570	8.95	8.95	**
575	9.15	9.15	**
580	9.80	9.80	**
583	8.25	8.25	Top of tip of the log structure. End of the survey.

Set elevation of the picnic area pads to use a reference elevations. Survey begins at Cross-Section #1. Approximately, 350 ft. abouve the Winter Gate. H.I. above rebar is 4.65 ft. sight 6.02 to point #1. H.I. 4.92 above point. #1. Point #1 to the NE corner (on top) of cement fireplace on the picnic pad, just W of the picnic table 10.78 ft..

— + Thalweg
— ● Middle of Channel

Mill Creek at Maple Grove Picnic Area-Longitudinal Profile

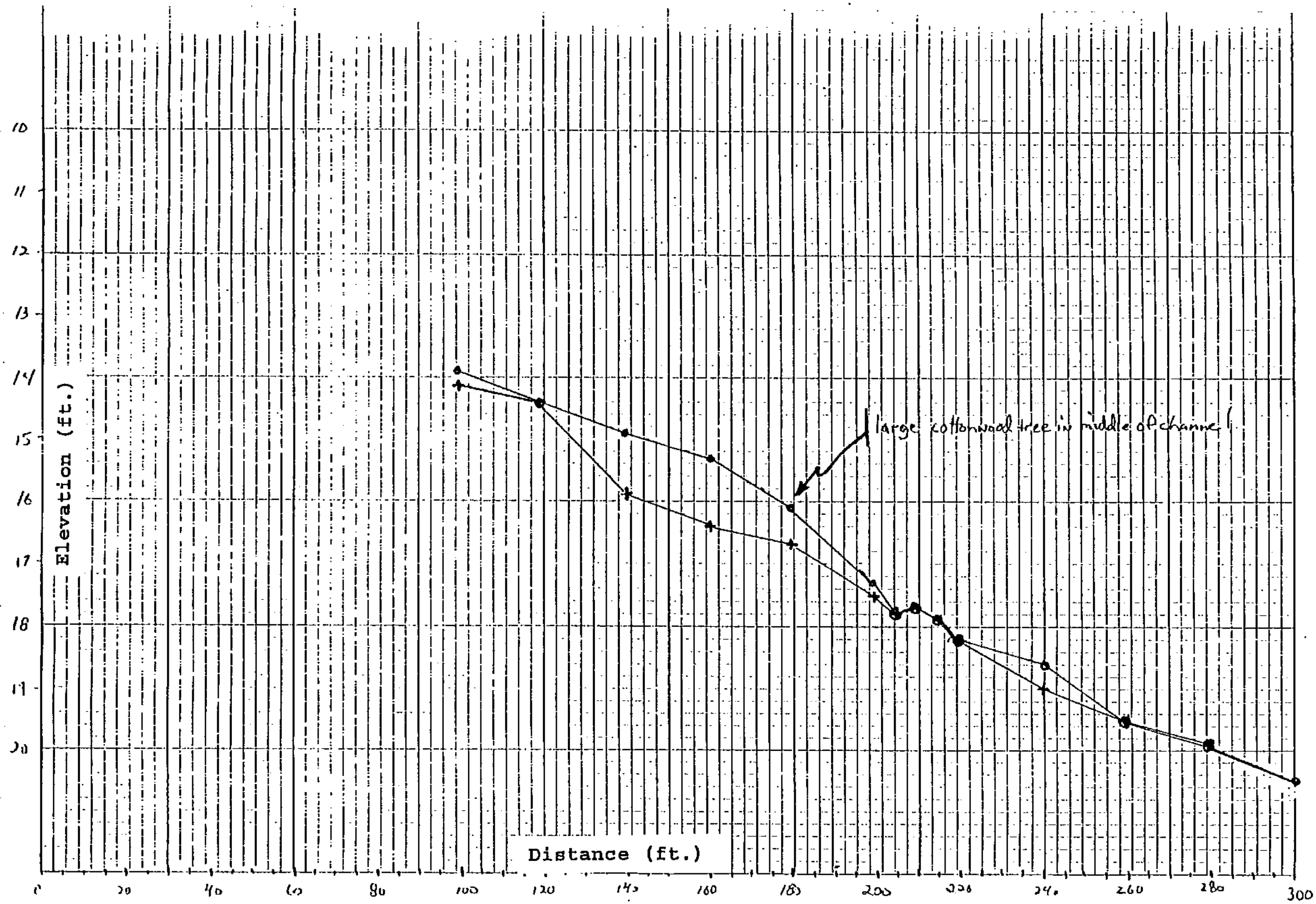
09/06/95



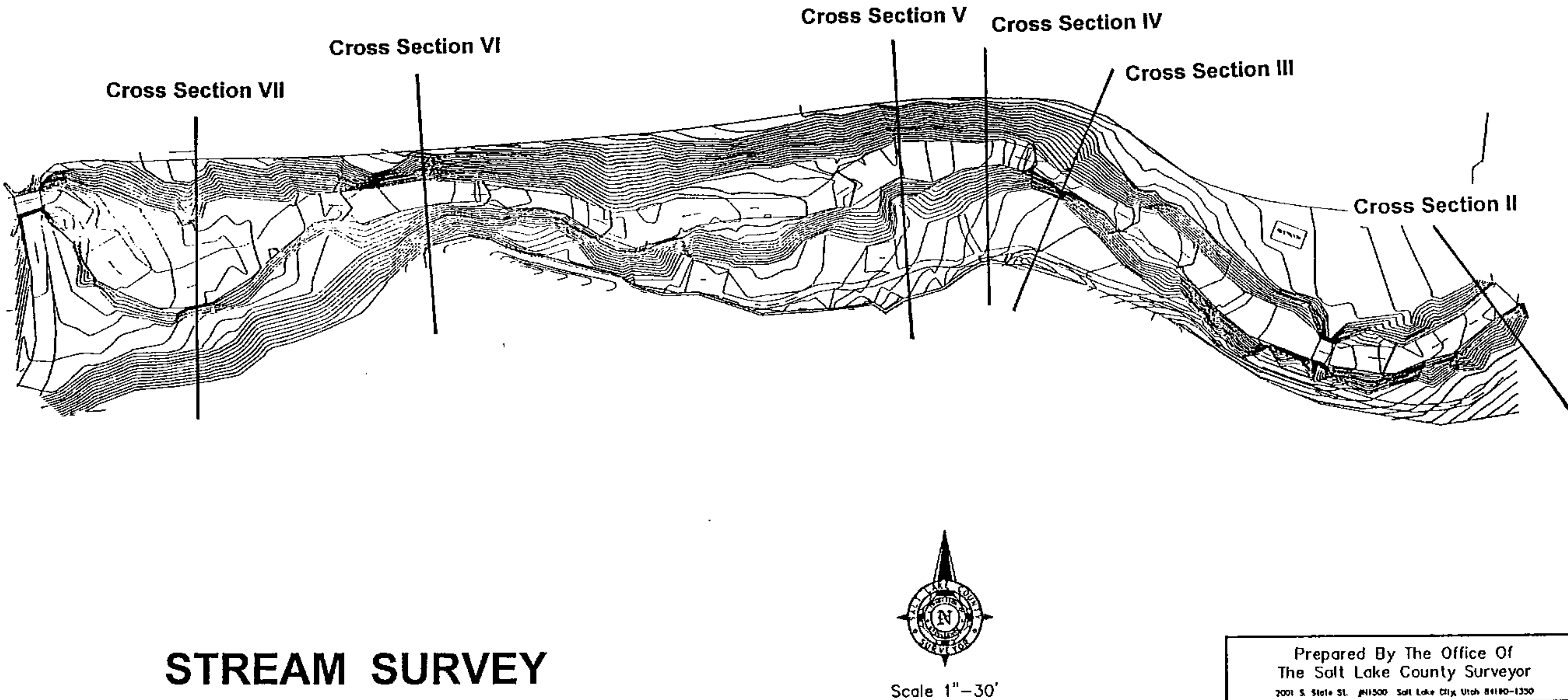
J-4

Mill Creek at Maple Grove Picnic Area Longitudinal Profile

Mill Creek at Maple Grove Picnic Area-Longitudinal Profile 09/06/95



Mill Creek at Maple Grove Picnic Area Longitudinal Profile



STREAM SURVEY

CROSS SECTION LOCATION OVERLAY

Prepared By The Office Of
The Salt Lake County Surveyor
2001 S. State St. #N1500 Salt Lake City, Utah 84190-1350

Millcreek Canyon
near Terraces Picnic Grounds

Prepared By:	Larry Padilla
Surveyed By:	Jim Pierce
Checked By:	Melvin Overmeier, L.S.
Date:	October 5, 1994
Work Order No.:	SU 940244

M. Carl Larsen, L.S.
Surveyor

MILL CREEK MAPLE GROVE STREAM SURVEY: CROSS SECTION DATA
SEPT. 9,1995: BRENDA LANDURETH AND SCOTT MEEKER

CROSS SECTION I

DISTANCE (m)	ELEVATION (ft.)	COMMENTS:
1.00	6.45	H.I 3.5 ft.. Distance across from rebar to rebar 15.4 m. LB
1.89	8.22	Rebar is located above the large boulder embedded into the RB.
2.48	11.14	Below the large boulder.
2.81	11.75	Break in slope.
2.94	12.19	Break in slope.
3.10	12.68	RB edge of water.
5.15	12.96	Cobble and gravel bar.
6.33	13.08	Edge of the thalweg.
7.18	13.43	Mid-thalweg.
8.10	13.30	Edge of the thalweg.
9.25	12.92	Coarse sand bar and instream debris.
10.43	12.70	RB edge of water.
11.67	12.21	Break in slope.
12.31	11.24	Break in slope.
13.50	8.15	Steep and eroding bank.

CROSS SECTION II

DISTANCE (m)	ELEVATION (ft.)	COMMENTS:
1.50	1.45	H.I. is 3.65 FT.. Distance across is 16.17 m. LB
2.59	2.98	Top of LB.
3.58	6.10	Break in slope.
4.74	8.68	Break in slope.
5.10	12.34	RB edge of water.
6.68	12.66	Edge of the gravel bar and remnants of the paved old streambank.
8.26	12.70	Small vegetated island consisting of cobble and gravel bar.
10.16	13.23	Edge of the cobble and gravel bar.
11.10	13.42	Edge of the thalweg.
12.08	13.68	Center of the thalweg.
13.20	12.96	RB edge of the water.
13.21	11.74	Break in slope.
13.87	9.60	Break in slope.
14.99	6.78	Break in slope.

MILL CREEK MAPLE GROVE STREAM SURVEY: CROSS SECTION DATA
SEPT. 12, 1995: BRENDA LANDURETH, BILL BRADWISCH AND GREG MLADENKA

CROSS SECTION III

DISTANCE (m)	ELEVATION (ft.)	COMMENTS:
0.20	4.02	H.I. 4.05 ft.. Top of RB. Distance across is 12.17 m. LB
1.35	10.10	Break in slope.
2.10	11.14	Top of a break in slope.
2.65	15.98	LB edge of water.
4.45	16.56	Mid-channel.
6.10	16.29	LB edge of water. Vertical slope.
6.20	16.54	Top of the vertical slope adjacent to the waters edge.
5.91	14.12	Break in slope.
8.63	11.51	Bottom of a small rock retaining wall.
8.88	10.36	Top of the retaining wall.
9.89	9.02	Bare and vertical and eroding slope.

CROSS SECTION IV

DISTANCE (ft.)	ELEVATION (ft.)	COMMENTS:
0.00	2.92	H.I. 3.05 ft. 5.60 ft. from the rebar. Distance across 55 ft.RB
1.75	4.46	Reading above taken on top of the rebar. Vertical slope.
4.30	8.32	Vertical slope.
6.75	11.14	Base of the vertical rise.
9.80	13.22	Bottom of the slope.
12.20	13.50	Upper edge of a large boulder.
14.00	12.20	Top of the large boulder.
16.10	14.24	LB bankfull is located at the base of the large boulder.
17.60	14.63	LB edge of water.
20.60	15.15	
23.45	15.37	Center of the channel.
26.30	15.22	Thalweg.
29.75	14.69	
32.65	14.68	RB edge of water.
33.10	14.52	RB bankfull.
34.00	14.06	Small floodplain area.
36.10	13.62	Small foodplain area.
40.00	11.50	Bottom of boulder embedded in the bank.
42.00	9.80	Top of the boulder.
44.85	8.46	Break in slope.
47.25	7.25	Foot trail located on a break in slope.
48.00	6.62	Break in slope.
50.00	5.48	On a slope below a break.

MILL CREEK MAPLE GROVE STREAM SURVEY: CROSS SECTION DATA
SEPT. 12, 1995: BRENDA LANDURETH, BILL BRADWISCH AND GREG MLADENKA

CROSS SECTION V

DISTANCE (ft.)	ELEVATION (ft.)	COMMENTS:
10.75	6.52	H.I. 3.14 ft.. Instrument is located 28.3 ft. away from the LB rebar.
19.30	8.71	Break in slope. Distance across the channel is 71.6 ft..
19.50	10.12	Break in slope.
20.10	10.96	Break in slope.
22.60	12.20	Break in slope.
25.00	12.76	Break in slope.
25.10	13.78	LB bankfull.
27.85	14.58	LB edge of water.
30.80	13.89	Thalweg.
33.95	13.44	Channel cobble and gravel bar.
37.70	13.60	Channel cobble and gravel bar.
40.90	13.63	Center of the channel.
44.50	13.98	
48.65	13.50	RB edge of water.
49.60	12.48	Bottom of a root wad.
51.70	11.18	Top of a root wad.
53.00	11.47	On the root wad.
54.00	12.04	Base of the root wad.
56.50	11.99	Edge of a foot trail.
61.20	10.58	Mid-slope trail.
65.45	8.19	Base of vertical perched trees.
68.50	2.49	Edge of the vertical bank near a set of perched trees.
71.60	2.22	Base of the rebar.

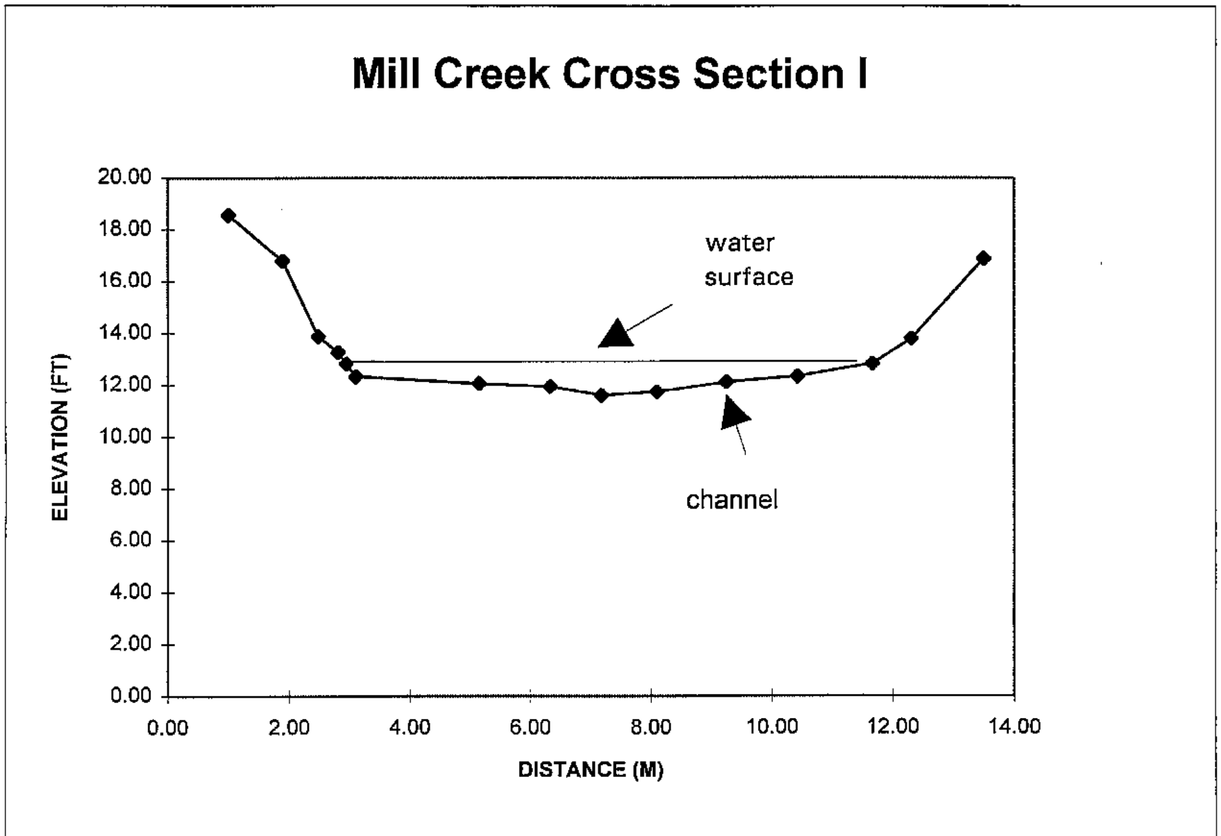
MILL CREEK MAPLE GROVE STREAM SURVEY: CROSS SECTION DATA

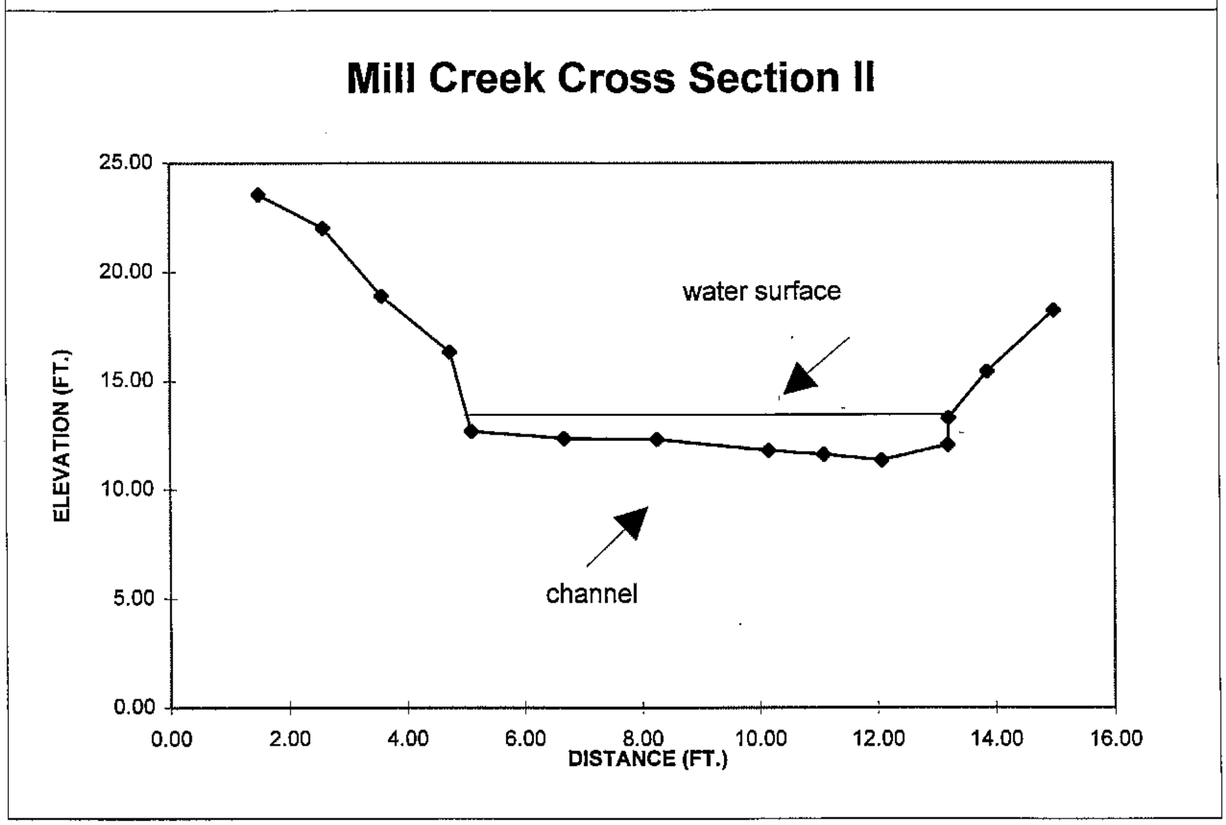
CROSS SECTION VI

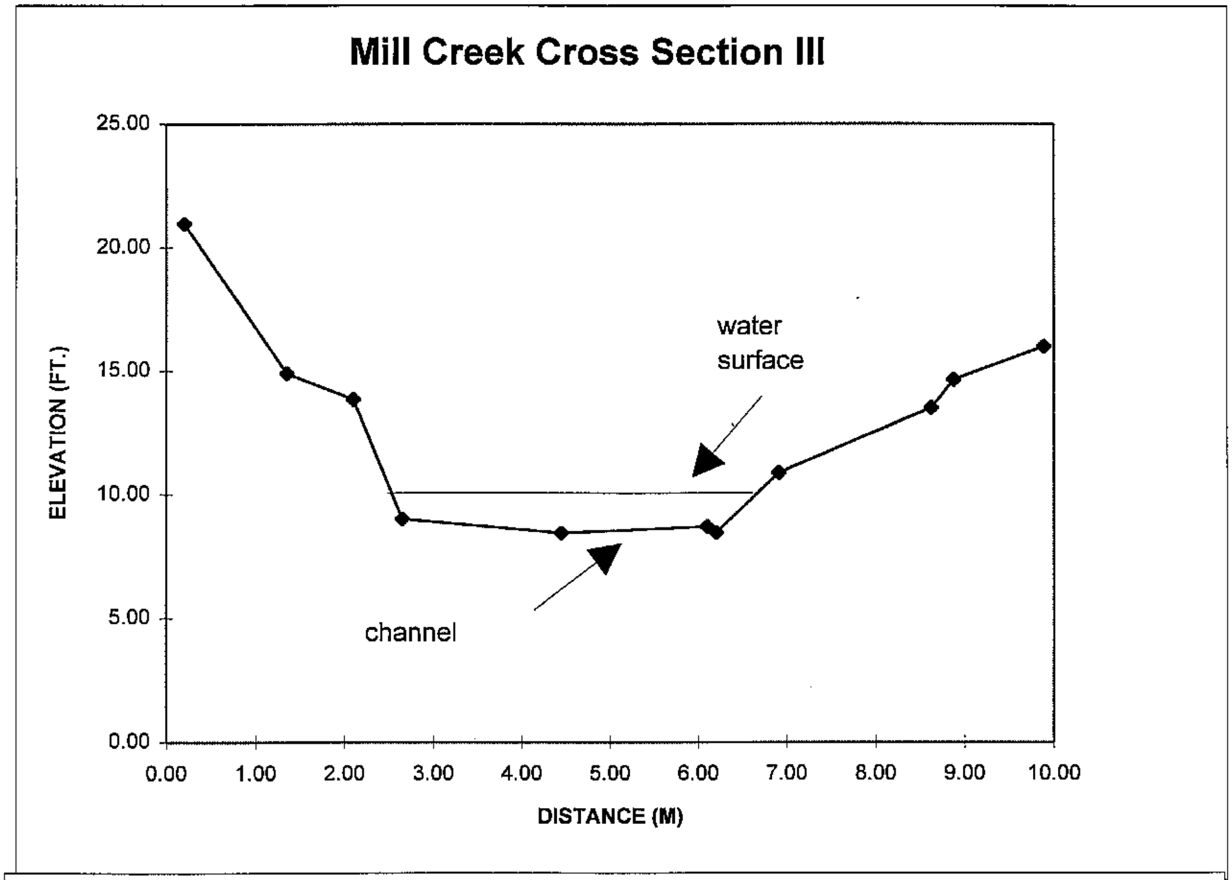
DISTANCE (ft.)	ELEVATION (ft.)	COMMENTS:
4.10	4.24	H.I. is 2.3 ft.. Distance across the channel is approximately 80 ft.?
7.00	7.49	
8.20	8.38	
11.80	12.29	Vertical slope.
19.46	16.45	LB edge of water.
23.15	16.72	
29.87	17.04	Center of the channel and thalweg.
20.81	16.99	
44.63	16.43	RB edge of water.
55.03	12.95	
57.05	11.71	
61.07	10.35	Ontop of a pile of debris on the RB.
65.77	7.66	
67.11	6.59	Log buried or embedded on RB.
77.18	2.29	

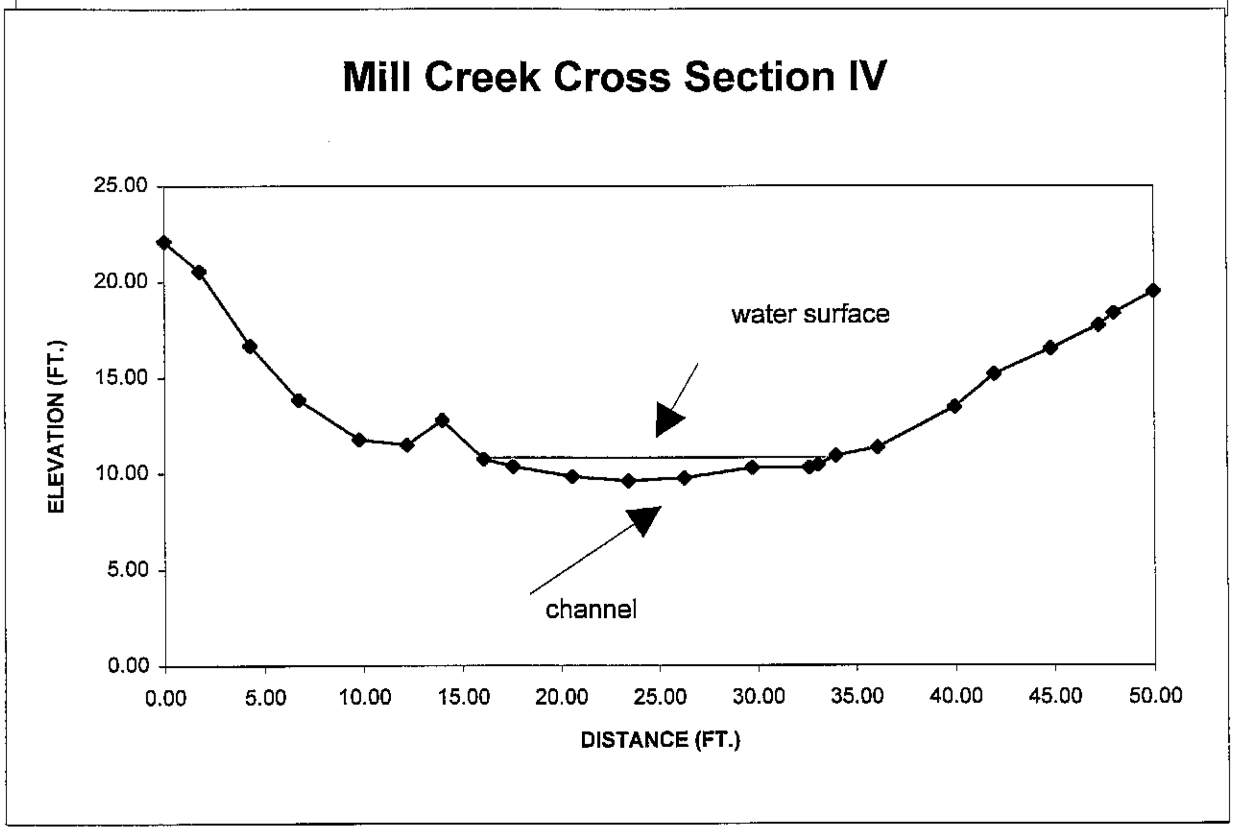
CROSS SECTION VII

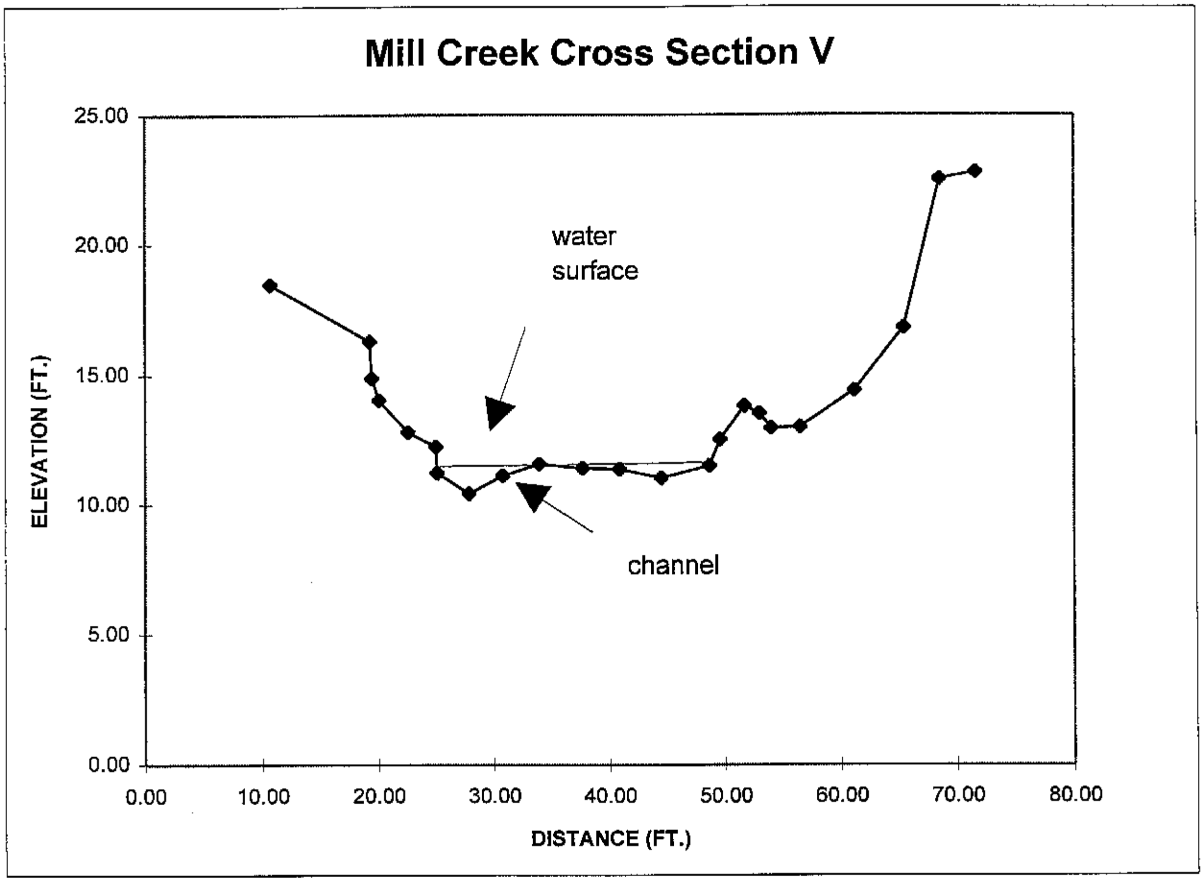
DISTANCE (ft.)	ELEVATION (ft.)	COMMENTS:
0.00	4.10	H.I. 3.3 ft.. Rebar is next to the root wad on the upper bank. LB
2.00	5.26	Top of the break in slope.
5.00	7.26	Bottom of the break in slope.
7.30	7.72	Infront of a stump.
8.80	10.42	Top of the stump.
15.45	10.74	LB edge of water.
17.40	10.54	In water edge of a cobble and gravel bar.
19.90	11.28	Off of the top edge of the bar.
24.90	10.70	Center of the channel and thalweg.
29.20	10.12	Climbing the edge of the gravel bar.
32.50	9.91	Bottom of a vegetated and taller cobble/gravel bar.
35.00	9.02	Top of this cobble/gravel bar.
36.50	9.28	Edge of a small braided side channel across the middle of this bar.
40.00	9.28	Middle of the bar-flowing water.
44.30	9.48	Small break in slope on this bar.
51.00	9.58	Small break in slope on this bar with a grassy mound.
56.00	9.57	RB edge of water.
59.50	9.02	Edge of the lower bank approximately 1 ft. from the edge of water.
65.50	9.01	Edge of the floodplain .
70.00	8.80	Below a large fir tree.
75.50	6.30	Next to the fir tree.
80.00	3.90	Steep bank and heavily vegetated.

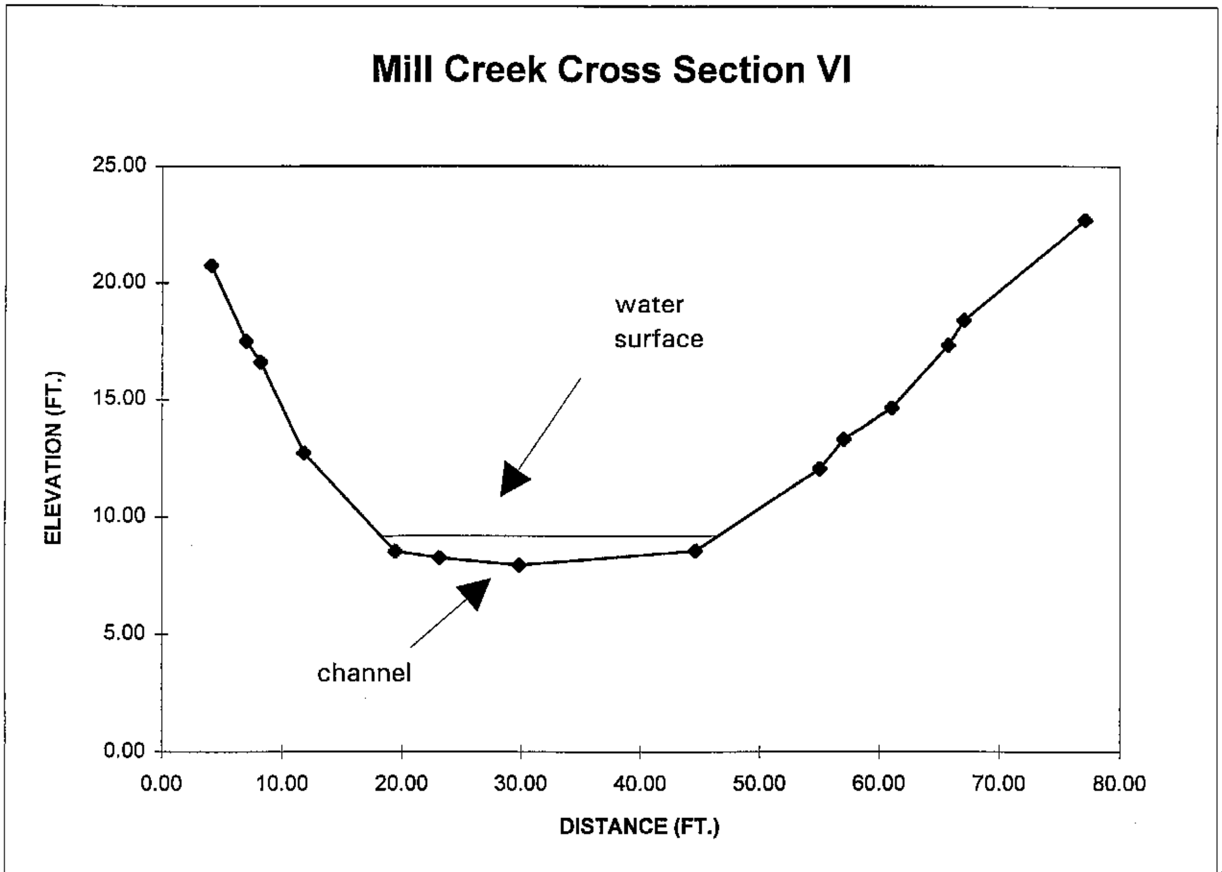

Mill Creek Cross Section I
water surface
channel
ELEVATION (FT)
DISTANCE (M)
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00

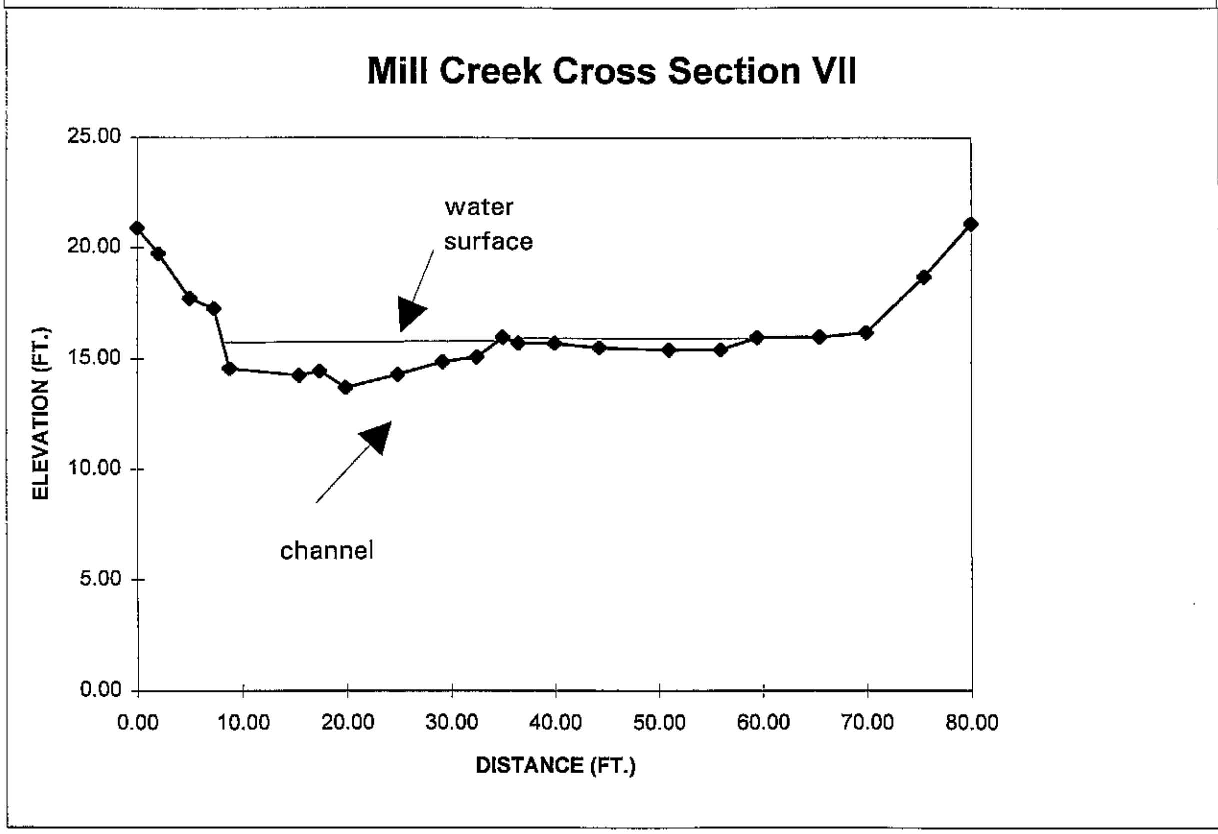

Mill Creek Cross Section II
water surface
channel
ELEVATION (FT.)
DISTANCE (FT.)
25.00
20.00
15.00
10.00
5.00
0.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00


Mill Creek Cross Section III
25.00
20.00
15.00
10.00
5.00
0.00
ELEVATION (FT.)
water
surface
channel
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
DISTANCE (M)


Mill Creek Cross Section IV
25.00
20.00
15.00
10.00
5.00
0.00
ELEVATION (FT.)
water surface
channel
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
DISTANCE (FT.)


Mill Creek Cross Section V
water
surface
channel
ELEVATION (FT.)
25.00
20.00
15.00
10.00
5.00
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
DISTANCE (FT.)


Mill Creek Cross Section VI
25.00
20.00
15.00
10.00
5.00
0.00
ELEVATION (FT.)
water
surface
channel
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
DISTANCE (FT.)


Mill Creek Cross Section VII
25.00
20.00
15.00
10.00
5.00
0.00
ELEVATION (FT.)
water
surface
channel
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
DISTANCE (FT.)

MILL CREEK CANYON RESTORATION PROJECT: STREAMBANK STABILIZATION

SEPT. 1995: BRENDA LANDURETH

CROSS SECTION I

DISTANCE (m)	VELOCITY 0.2 DEPTH OF FLOW (ft./sec.)	0.4 DEPTH OF FLOW (ft./sec.)	0.6 DEPTH OF FLOW (ft./sec.)	0.8 DEPTH OF FLOW (ft./sec.)	TOTAL DEPTH (ft./sec.)
5.15	0.54	0.81			0.30
6.33	1.28	1.87	2.81		0.40
7.18	0.54	1.47	1.59	1.76	0.80
13.30	1.34	1.61	1.63	1.84	0.60

CROSS SECTION II

DISTANCE (m)	VELOCITY 0.2 DEPTH OF FLOW (ft./sec.)	0.4 DEPTH OF FLOW (ft./sec.)	0.6 DEPTH OF FLOW (ft./sec.)	0.8 DEPTH OF FLOW (ft./sec.)	TOTAL DEPTH (ft./sec.)
6.68	1.36	2.19			0.30
8.26					0.00
10.16	1.91	2.08			0.20
11.10	2.65	3.49			0.20
12.08	1.74	1.61	2.21	2.54	0.60
12.60	1.42	2.18	2.71	3.02	0.90

CROSS SECTION III

DISTANCE (m)	VELOCITY 0.2 DEPTH OF FLOW (ft./sec.)	0.4 DEPTH OF FLOW (ft./sec.)	0.6 DEPTH OF FLOW (ft./sec.)	0.8 DEPTH OF FLOW (ft./sec.)	TOTAL DEPTH (ft./sec.)
2.85	0.42	0.90	0.54	0.65	0.65
4.45	0.26	0.62	1.26	1.59	0.80
5.80	1.02	1.57	2.21	2.45	0.50

CROSS SECTION IV

DISTANCE (m)	VELOCITY 0.2 DEPTH OF FLOW (ft./sec.)	0.4 DEPTH OF FLOW (ft./sec.)	0.6 DEPTH OF FLOW (ft./sec.)	0.8 DEPTH OF FLOW (ft./sec.)	TOTAL DEPTH (ft./sec.)
19.50	0.18	0.38	0.52		0.57
20.60	0.03	0.35	0.60		0.40
23.45	1.15	1.69	1.90		0.50
26.30	2.07	2.26	2.80		0.70
29.75	0.02				0.10

MILL CREEK CANYON RESTORATION PROJECT:
STREAMBANK STABILIZATION
SEPT. 1995: BRENDA LANDURETH

CROSS SECTION V					
DISTANCE			**VELOCITY**		
	0.2 DEPTH OF FLOW	0.4 DEPTH OF FLOW	0.6 DEPTH OF FLOW	0.8 DEPTH OF FLOW	TOTAL DEPTH
(ft.)	(ft./sec.)	(ft./sec.)	(ft./sec.)	(ft./sec.)	(ft./sec.)
26.00	0.07	0.11	0.03		0.62
27.85	0.28	0.91	2.30		0.75
30.80	0.50				0.05
33.95	0.82				0.05
37.70	1.01	1.30			0.20
40.90	1.05	2.26			0.30
44.50	2.12	2.19	2.27		0.45
46.40	1.66	1.96	2.77		0.45
47.00	0.01				0.17

CROSS SECTION VI					
DISTANCE			**VELOCITY**		
	0.2 DEPTH	0.4 DEPTH	0.6 DEPTH	0.8 DEPTH	TOTAL
	OF FLOW	OF FLOW	OF FLOW	OF FLOW	DEPTH
(ft.)	(ft./sec.)	(ft./sec.)	(ft./sec.)	(ft./sec.)	(ft./sec.)
17.00	0.00	0.03	0.02		0.36
20.00	0.27	0.44			0.25
23.00	0.00	0.16	0.26		0.32
27.00	0.26	0.50	0.73		0.59
29.00	0.00	0.18	0.87		0.52
37.00	0.20	0.42	0.58		0.51

CROSS SECTION VII					
DISTANCE			**VELOCITY**		
	0.2 DEPTH OF FLOW	0.4 DEPTH OF FLOW	0.6 DEPTH OF FLOW	0.8 DEPTH OF FLOW	TOTAL DEPTH
(ft.)	(ft./sec.)	(ft./sec.)	(ft./sec.)	(ft./sec.)	(ft./sec.)
9.5	0.92	1.24	1.70		3.50
18.00	0.02	0.02	0.04		0.70
19.90	0.00	0.19	0.54		0.92
24.90	0.00	0.09	0.37		0.42
29.20	0.42				0.05
32.50					
35.00					
36.00					
37.90	0.80				0.08
46.00	1.42				0.20

Mill Creek Stream Restoration Project Phase II: Streambank Stabilization
Stream Survey Substrate Counts

Sept. 1995: Brenda Landureth, Scott Meeker and Jimmie Pryor

Cross All	(cm)	Cross II	(cm)	Cross V	(cm)	Cross VII	(cm)
1	0.05	1	0.05	1	0.05	1	0.05
2	0.05	2	0.05	2	0.05	2	0.05
3	0.05	3	0.05	3	0.05	3	0.05
4	0.05	4	0.05	4	0.05	4	0.05
5	0.05	5	0.05	5	0.05	5	0.05
6	0.05	6	0.05	6	0.05	6	0.05
7	0.05	7	0.05	7	0.06	7	0.05
8	0.05	8	0.05	8	0.08	8	0.05
9	0.05	9	0.05	9	0.09	9	0.05
10	0.05	10	0.05	10	0.09	10	0.05
11	0.05	11	0.05	11	0.09	11	0.05
12	0.05	12	0.06	12	0.70	12	0.05
13	0.05	13	0.50	13	1.00	13	0.05
14	0.05	14	0.90	14	1.10	14	0.05
15	0.05	15	1.10	15	1.10	15	0.06
16	0.05	16	1.20	16	1.20	16	1.00
17	0.07	17	1.30	17	1.30	17	1.05
18	0.09	18	1.30	18	1.40	18	1.05
19	0.60	19	1.50	19	1.50	19	1.20
20	0.80	20	1.50	20	1.50	20	1.20
21	0.80	21	1.90	21	1.70	21	1.40
22	0.90	22	2.00	22	1.70	22	1.50
23	1.10	23	2.00	23	1.70	23	1.80
24	1.10	24	2.10	24	1.80	24	1.90
25	1.30	25	2.20	25	1.90	25	2.10
26	1.30	26	2.20	26	2.00	26	2.20
27	1.40	27	2.30	27	2.00	27	2.30
28	1.50	28	2.50	28	2.70	28	2.30
29	1.50	29	2.50	29	2.20	29	2.50
30	1.50	30	2.70	30	2.20	30	2.60
31	1.50	31	2.70	31	2.30	31	2.90
32	1.70	32	3.00	32	2.40	32	3.00
33	1.70	33	3.00	33	2.40	33	3.20
34	1.80	34	3.00	34	2.40	34	3.50
35	1.80	35	3.00	35	2.50	35	3.60
36	1.80	36	3.30	36	2.50	36	3.70
37	1.90	37	3.40	37	2.50	37	3.80
38	1.90	38	3.50	38	2.60	38	3.90
39	2.00	39	3.60	39	2.70	39	3.90
40	2.10	40	3.80	40	2.80	40	4.20
41	2.20	41	3.80	41	2.90	41	4.20
42	2.20	42	3.80	42	3.30	42	4.30
43	2.30	43	4.00	43	3.30	43	4.60
44	2.30	44	4.50	44	3.30	44	4.70
45	2.30	45	4.50	45	3.40	45	5.20
46	2.50	46	4.50	46	3.60	46	5.20
47	2.60	47	4.80	47	3.70	47	5.20
48	2.60	48	5.00	48	4.00	48	5.30
49	2.70	49	5.00	49	4.00	49	5.40

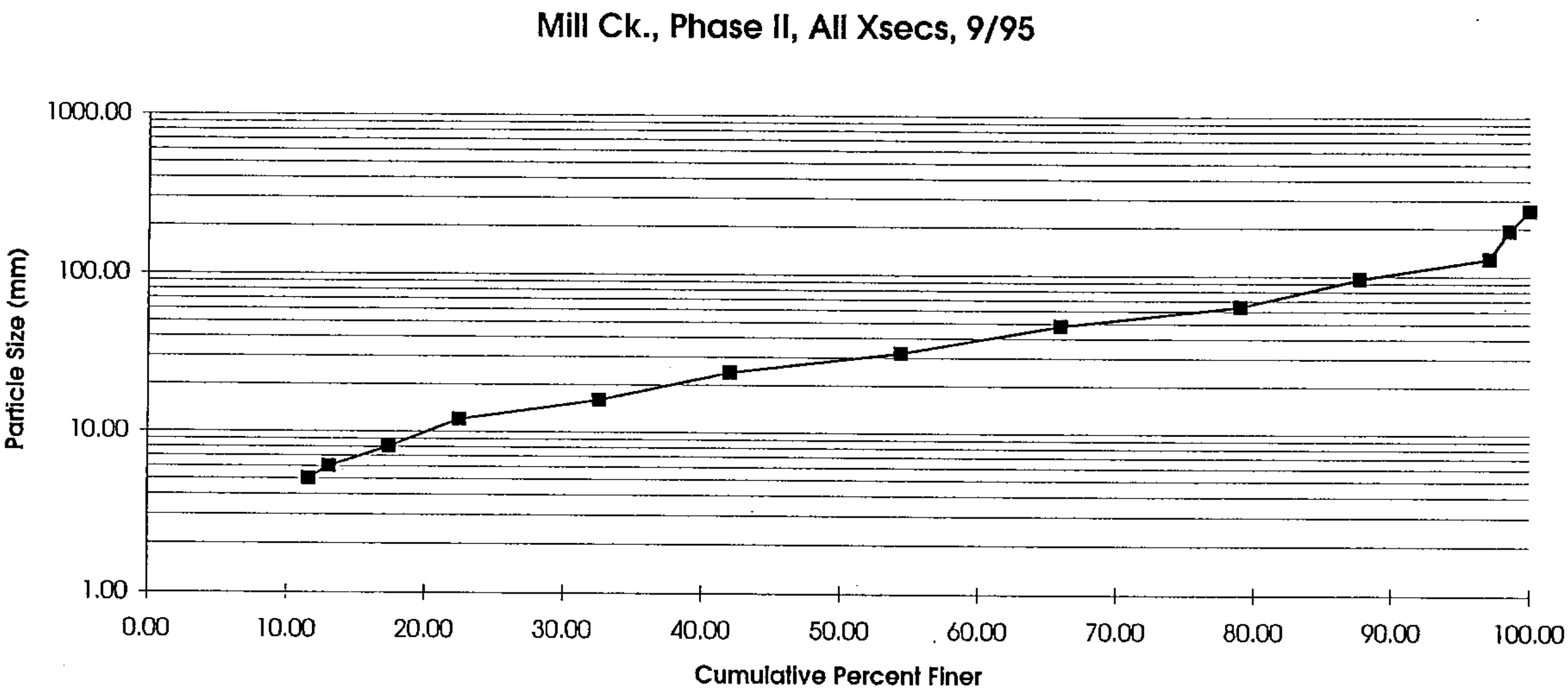
Mill Creek Canyon Stream Restoration Project Phase II: Streambank Stabilization
Stream Survey Substrate Counts

Cross All	(cm)	Cross II	(cm)	Cross V	(cm)	Cross VII	(cm)
50	2.80	50	5.00	50	4.30	50	5.40
51	2.80	51	5.00	51	4.30	51	5.50
52	3.00	52	5.50	52	4.40	52	5.70
53	3.00	53	5.50	53	4.50	53	5.90
54	3.00	54	5.60	54	4.50	54	6.10
55	3.00	55	5.70	55	4.50	55	6.10
56	3.00	56	5.80	56	4.60	56	6.30
57	3.00	57	6.00	57	4.70	57	6.30
58	3.10	58	6.00	58	4.70	58	6.40
59	3.30	59	6.00	59	4.80	59	6.40
60	3.30	60	6.80	60	4.80	60	6.70
61	3.50	61	7.00	61	4.90	61	6.80
62	3.50	62	7.50	62	5.00	62	6.90
63	3.50	63	7.50	63	5.10	63	6.90
64	3.50	64	7.50	64	5.20	64	7.00
65	3.60	65	7.50	65	5.20	65	7.10
66	3.60	66	7.50	66	5.30	66	7.20
67	3.80	67	7.80	67	5.40	67	7.20
68	4.00	68	7.80	68	5.70	68	7.20
69	4.00	69	7.90	69	5.80	69	7.30
70	4.20	70	8.00	70	5.90	70	7.40
71	4.30	71	8.00	71	6.30	71	7.50
72	4.30	72	8.00	72	6.30	72	7.70
73	4.40	73	8.00	73	6.50	73	7.90
74	4.50	74	8.20	74	6.70	74	7.90
75	4.70	75	9.00	75	6.70	75	8.00
76	4.80	76	9.00	76	7.00	76	8.30
77	4.80	77	9.00	77	7.10	77	8.50
78	5.00	78	9.40	78	7.30	78	8.50
79	5.00	79	9.50	79	7.40	79	8.70
80	5.00	80	10.00	80	7.40	80	8.70
81	5.00	81	10.50	81	7.50	81	8.80
82	5.20	82	10.50	82	7.60	82	8.80
83	5.30	83	11.00	83	7.60	83	9.50
84	5.30	84	11.00	84	7.90	84	9.70
85	5.50	85	12.00	85	8.00	85	9.80
86	5.80	86	12.00	86	8.30	86	10.00
87	6.00	87	12.50	87	8.30	87	10.50
88	6.00	88	12.70	88	9.00	88	10.96
89	6.20	89	13.00	89	9.30	89	11.00
90	6.20	90	13.50	90	9.40	90	11.10
91	6.30	91	13.50	91	9.40	91	11.50
92	6.40	92	13.50	92	10.00	92	11.80
93	6.70	93	14.00	93	10.20	93	12.00
94	6.90	94	14.50	94	10.50	94	12.30
95	7.20	95	15.00	95	11.00	95	12.50
96	7.50	96	15.00	96	11.50	96	13.80
97	7.50	97	15.00	97	11.60	97	15.90
98	7.90	98	17.50	98	12.00	98	16.50
99	8.00	99	18.00	99	13.80	99	17.00
100	8.10	100	28.00	100	17.70	100	23.00

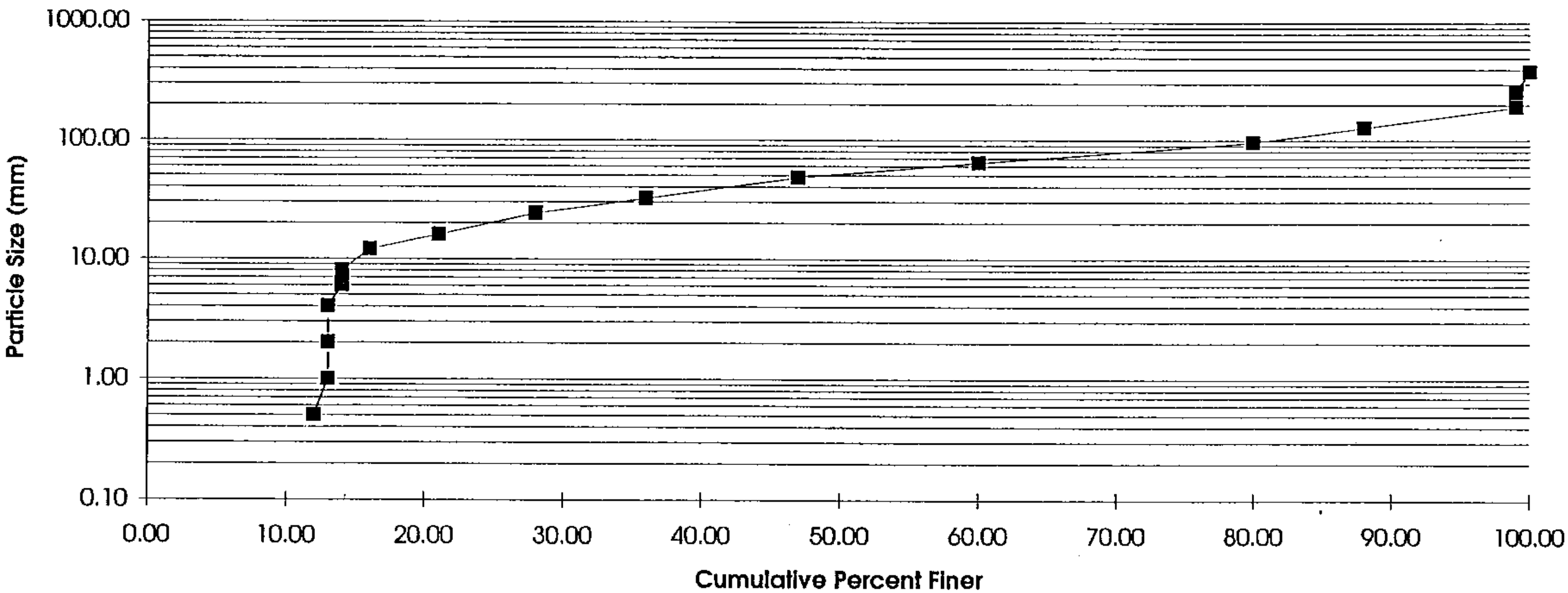
	Cross All (cm)
101	8.10
102	8.30
103	8.40
104	8.50
105	8.50
106	8.70
107	9.40
108	9.40
109	9.50
110	10.50
111	10.50
112	10.50
113	10.50
114	10.60
115	11.10
116	11.80
117	11.90
118	12.00
119	12.00
120	12.50
121	12.50
122	13.80
123	13.80
124	14.50
125	16.50
126	16.50
127	16.50
128	16.50
129	17.00
130	17.00
131	17.40
132	17.70
133	18.00
134	19.00
135	20.00
136	20.00

Substrate Analysis : All Cross Sections

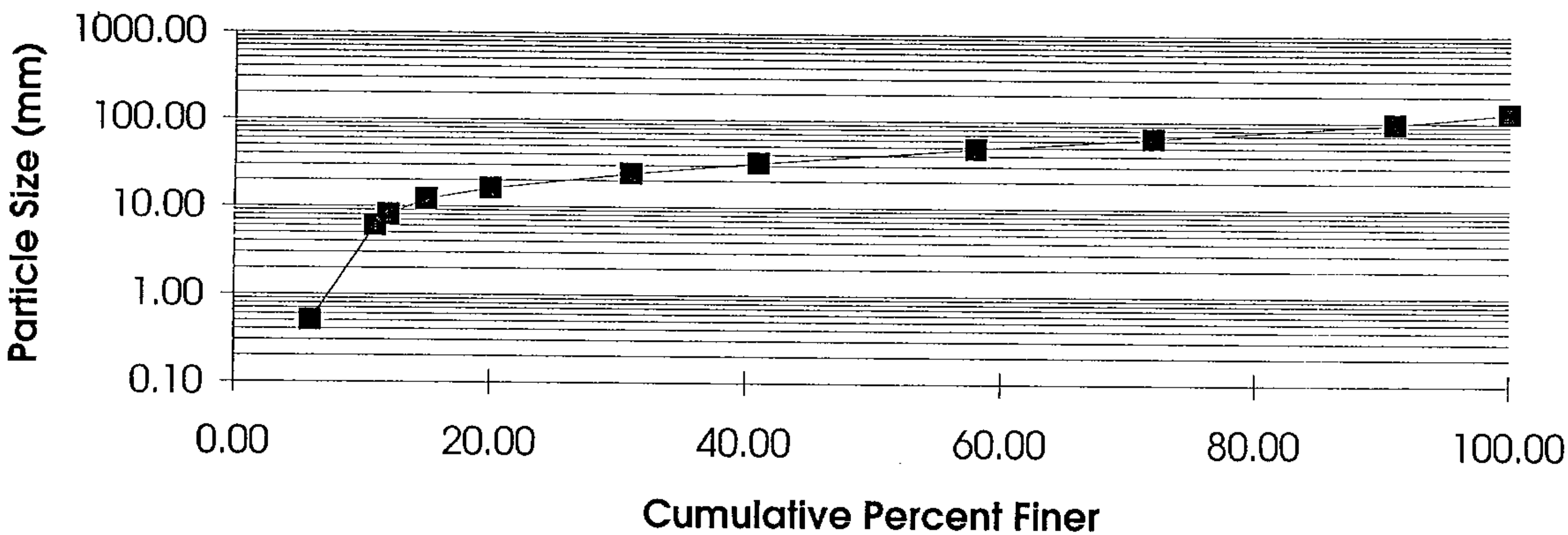
Particle Range (mm)		Count (#)	% (ct./tot ct.)	Sum thru interval	Cum thru interval	Cum. %	Plot Pos. (upper lmt)
4096.00	2048.00	0.00	0.00	0.00	138.00	100.00	4096.00
2048.00	1024.00	0.00	0.00	0.00	138.00	100.00	2048.00
1024.00	512.00	0.00	0.00	0.00	138.00	100.00	1024.00
512.00	384.00	0.00	0.00	0.00	138.00	100.00	512.00
384.00	256.00	0.00	0.00	0.00	138.00	100.00	384.00
256.00	192.00	2.00	1.45	2.00	138.00	100.00	256.00
192.00	128.00	2.00	1.45	4.00	136.00	98.55	192.00
128.00	96.00	13.00	9.42	17.00	134.00	97.10	128.00
96.00	64.00	12.00	8.70	29.00	121.00	87.68	96.00
64.00	48.00	18.00	13.04	47.00	109.00	78.99	64.00
48.00	32.00	16.00	11.59	63.00	91.00	65.94	48.00
32.00	24.00	17.00	12.32	80.00	75.00	54.35	32.00
24.00	16.00	13.00	9.42	93.00	58.00	42.03	24.00
16.00	12.00	14.00	10.14	107.00	45.00	32.61	16.00
12.00	8.00	7.00	5.07	114.00	31.00	22.46	12.00
8.00	6.00	6.00	4.35	120.00	24.00	17.39	8.00
6.00	4.00	2.00	1.45	122.00	18.00	13.04	6.00
5.00	2.00	16.00	11.59	138.00	16.00	11.59	5.00
	TOTALS	**138.00**	**100.00**				

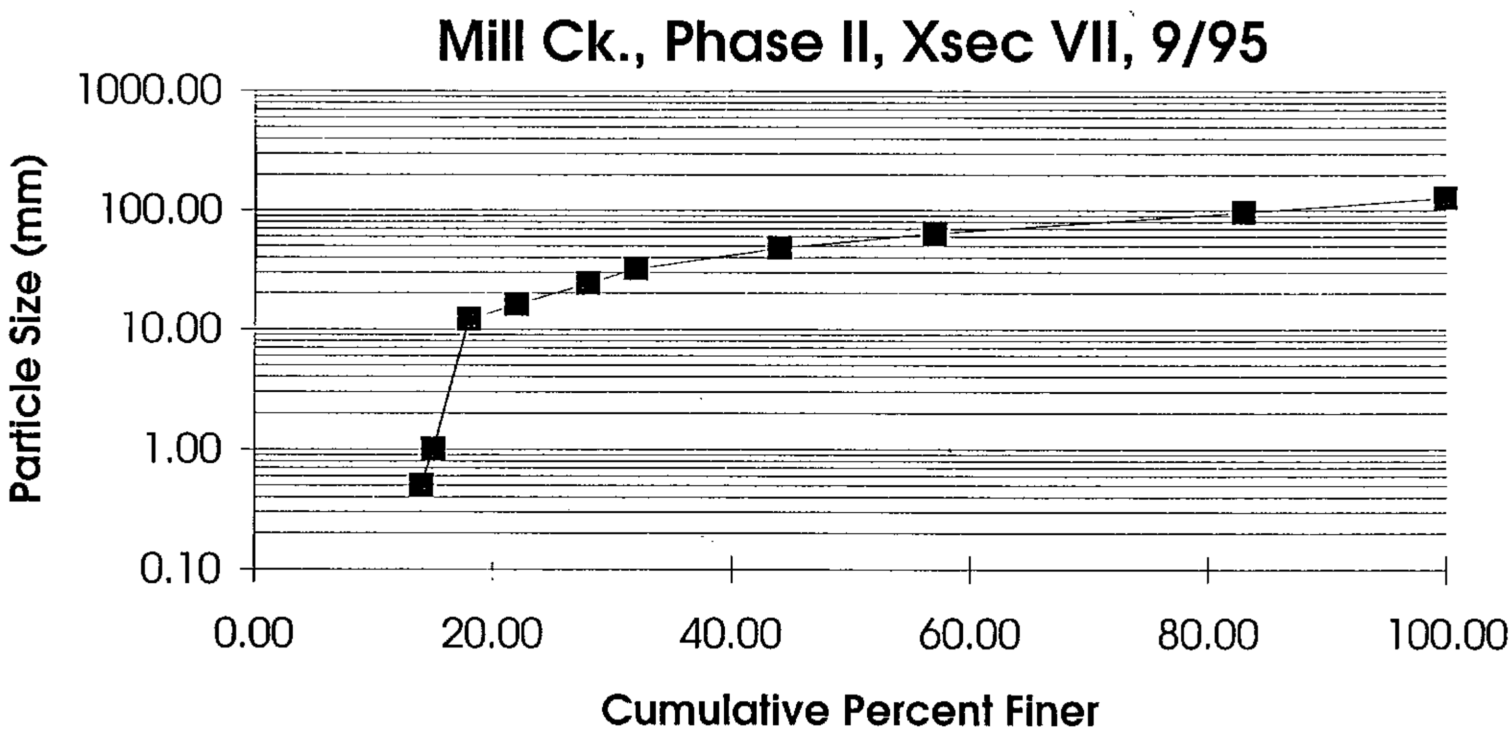

Mill Ck., Phase II, All Xsecs, 9/95
1000.00
100.00
10.00
1.00
Particle Size (mm)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
Cumulative Percent Finer

Mill Ck., Phase II, Xsec II, 9/95



Mill Ck., Phase II, Xsec V, 9/95




Mill Ck., Phase II, Xsec VII, 9/95
Particle Size (mm)
1000.00
100.00
10.00
1.00
0.10
0.00
20.00
40.00
60.00
80.00
100.00
Cumulative Percent Finer

APPENDIX K

PROJECT DESIGN

USDA FOREST SUPERVISORS OFFICE RESTORATION PLAN
INSTREAM STRUCTURES
CONTROLLED RECREATIONAL ACCESS
STREAMBANK STABILIZATION STRUCTURES

USDA FOREST SERVICE INTERMOUNTAIN REGION

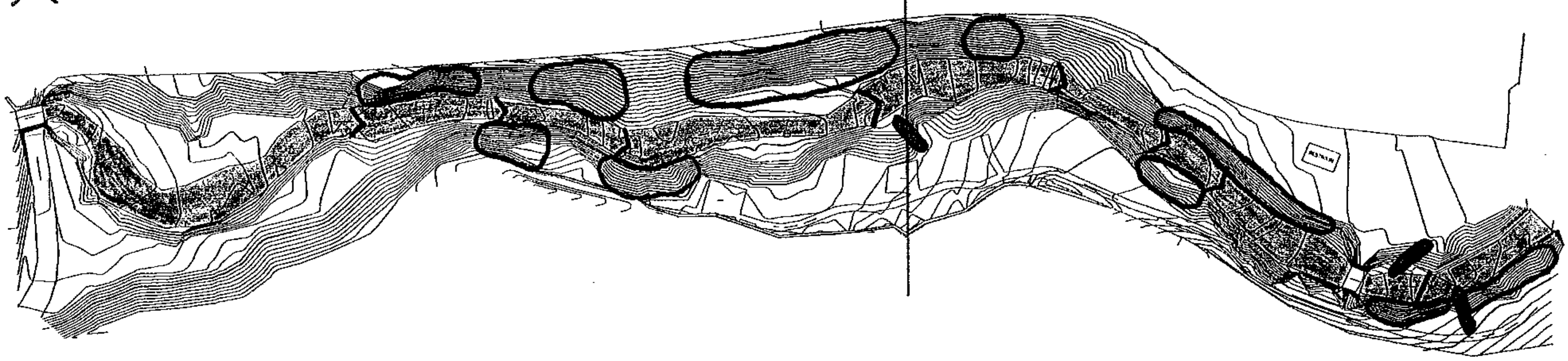
LEGEND

AREAS WITH MEDIUM TO HIGH EROSION RATES

CONTROLLED RECREATIONAL ACCESS POINTS

NOTCH OR REMOVE LOG DROP STRUCTURES

RESTORATION COMPLETED DURING 1995



Scale 1"--30'

MILL CREEK RESTORATION PLAN

Prepared By The Office Of
The Salt Lake County Surveyor
2001 S. State St. #N1500 Salt Lake City, Utah 84190-1350

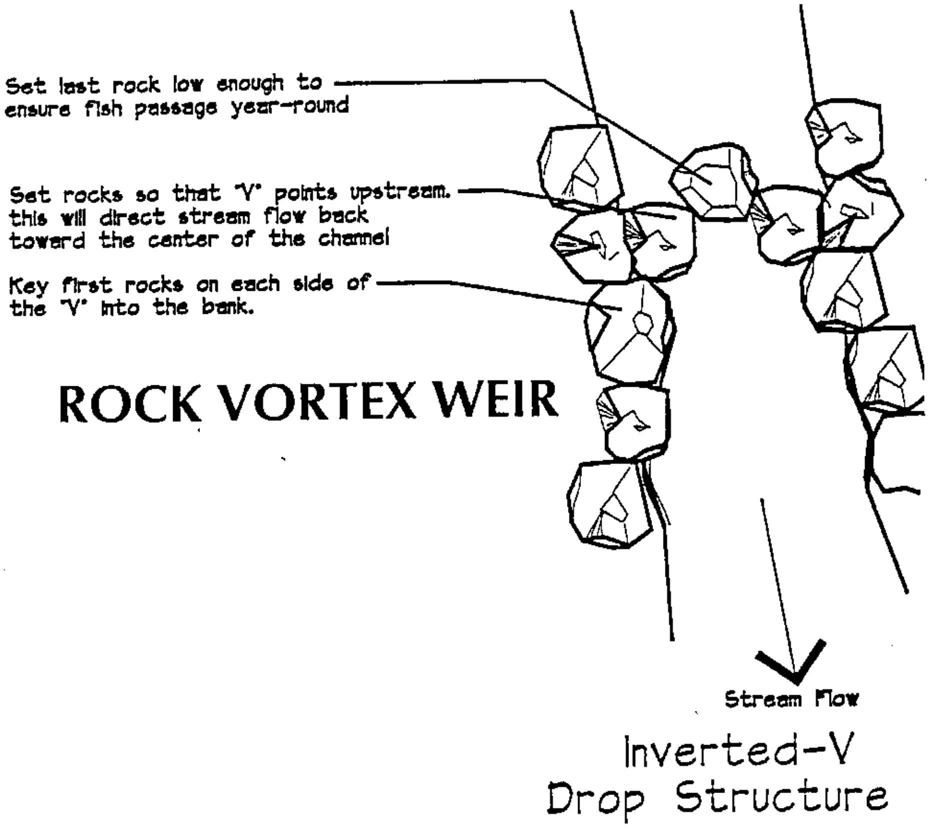
Millcreek Canyon
near Terraces Picnic Grounds

Prepared By: Larry Padilla
Surveyed By: Jim Pierce
Checked By: Melvin Duehlmeier, L.S.
Date: October 5, 1994
Work Order No.: SU 940244

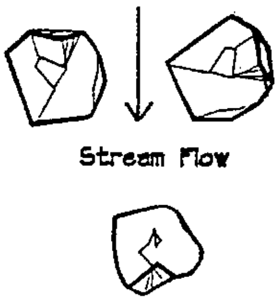
M. Carl Larsen, L.S.
Surveyor

INSTREAM STRUCTURES

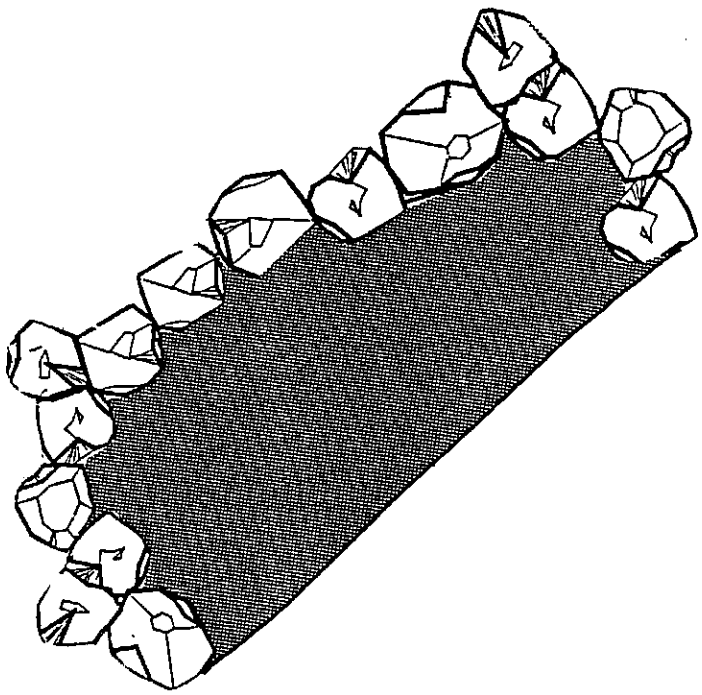
ROCK VORTEX WEIR



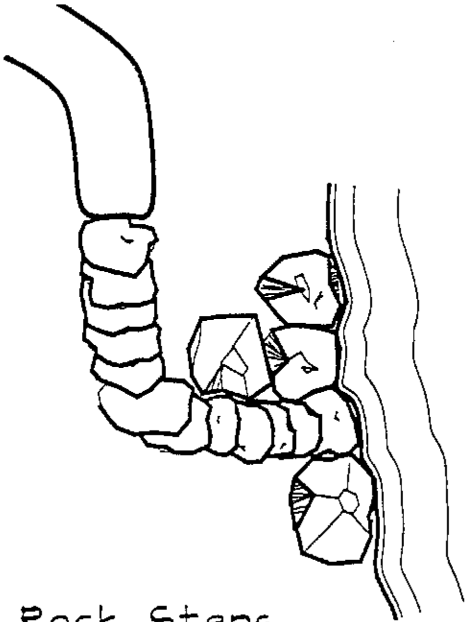
BOULDER PLACEMENT

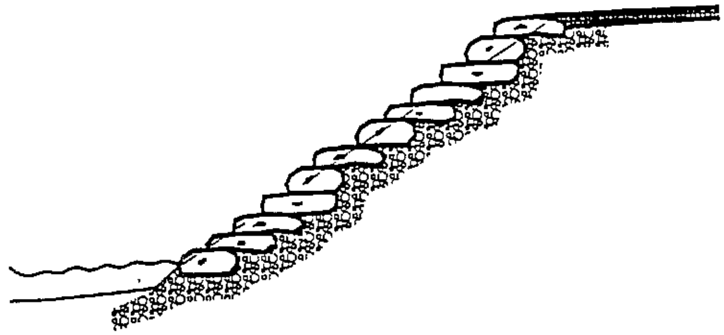


CONSTRUCTED FLOODPLAIN



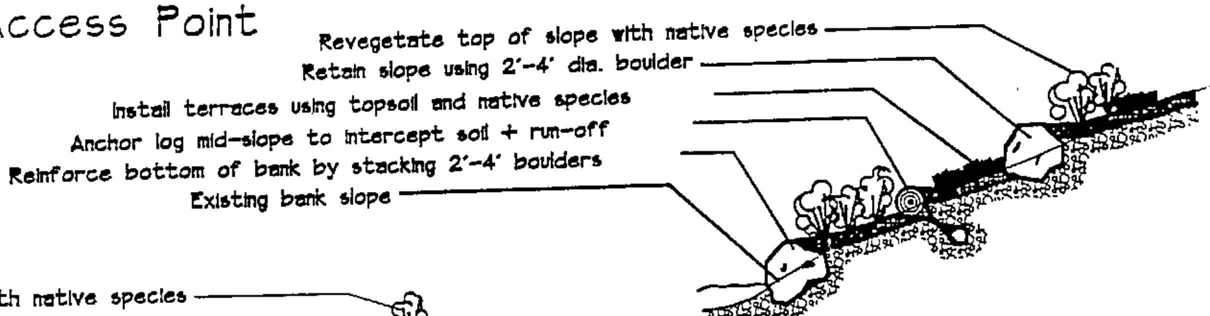
CONTROLLED RECREATIONAL ACCESS

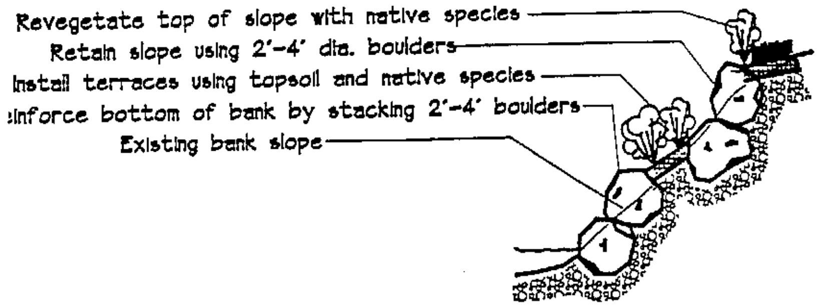




Rock Steps
Recreation Access Point
(Section View)

Rock Steps
Recreation Access Point
(Plan View)





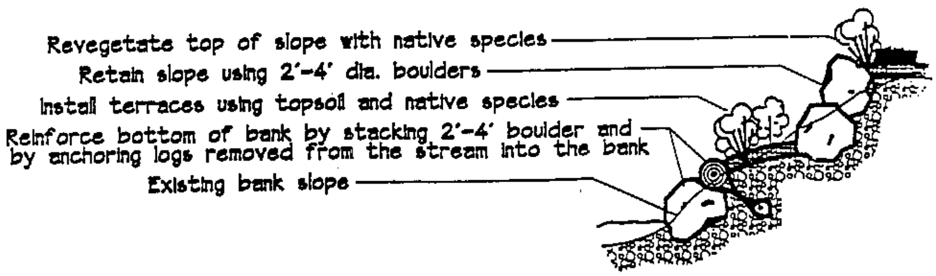
Bank Stabilization Treatment
for Slopes with Medium to
Low Soil Loss

Bank Stabilization Treatment
for Slopes with High to
Medium High Soil Loss

STREAMBANK

STABILIZATION

STRUCTURES



Bank Stabilization Treatment
for Slopes with High to
Medium High Soil Loss

APPENDIX L

NATIVE SEED MIX

Mill Creek Native Seed Mix Composition

Salt Lake County Seed Mix

Species	Percent of Mix
Intermediate Wheatgrass	25.93
Slender Wheatgrass	11.11
Engelmann's Aster	3.70
Smooth Bromegrass	25.93
Orchard Grass	11.11
Yellow Sweetclover	1.85
Climax Timothy	11.11
Chokecherry	1.85
Wax Current	3.70
Woods Rose	3.70

Total Amount Broadcasted 27 lbs.

Purchased from Granite Seed Company: June 9, 1995

Salt Lake Ranger District Seed Mix

Species	Percent of Mix
Red Top	10.00
Western Wheatgrass	10.00
Smooth Bromegrass	10.00
Orchard Grass	20.00
Blue Wildrye	10.00
Mountain Brome	20.00
Kentucky Bluegrass	10.00
Woods Rose	10.00

Total Amount Broadcasted 12 lbs.

Purchased from Granite Seed Company: September 11, 1995

APPENDIX M

USDA FOREST SERVICE PROJECT EXPENSES

Mill Creek Interim Report - Project Costs and Information for Phase I

I. Project Costs

A. Personnel

1. Planning/Coordination/Design

Salt Lake Ranger District (Jim White, Jack Vanderberg)	$1630
Landscape Architect (Erich Roeber)	1297
Hydrologist (Charlie Condrat)	585
Soil Scientist (Paul Flood)	100
Equipment/Materials Ordering	435
Sub total:	**$4047**

2. Implementation

Construction Supervision (Erich Roeber)	$2433
Construction Inspection (Bob Dunn)	1440
Plant Material Installation	1105
Erosion Control Mat Installation	1105
Track Hoe, Loader, Dump Trucks (incl. operators)(Skyview)	20,518
Dump Trucks (incl. drivers)(Cliff Johnson Co.)	3175
Sub total:	**$29,776**

3. Anticipated Monitoring Costs — unknown

4. Anticipated Project Completion Schedule (Phase I) — complete

B. Materials

1. Erosion Control Matting	$ 800
2. Plants (TreeUtah and Lone Peak Nursery)	1119
3. Roadbase (Cliff Johnson Co.)	393
4. Topsoil (Cliff Johnson Co.)	4134
5. Pitrun (Cliff Johnson Co.)	1198
Sub total:	**$7644**
Total:	**$41,467**

C. Project Costs by Objective and Task (Refer to S.L. County Interim Report for definitions)

1. Objective 1 - $13,249
   - Task 1 - $ 950
   - Task 2 - $ 1080
   - Task 3 - $11,219
2. Objective 3 - $28,218
   - Task 1 - $ 1030
   - Task 2 - $ 1050
   - Task 3 - $26,138