Clean Water Act
Section 319 Nonpoint Source Pollution Control Program
Watershed Project Final Report

East Canyon Creek Stream Rehabilitation and Flow Feasibility Studies, Summit and Morgan Counties, Utah

Project Sponsors
Kamas Valley Conservation District
Mountainland Association of Governments
Snyderville Basin Water Reclamation District

Prepared by
Kari Lundeen, Project Coordinator
Watershed Scientist, Utah Division of Water Quality

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List of Abbreviations and Acronyms

ANOVA	ANALYSIS OF VARIANCE (A STATISTICAL ANALYSIS METHOD)
BMP	BEST MANAGEMENT PRACTICES
CFS	CUBIC FEET PER SECOND
DO	DISSOLVED OXYGEN
DWQ	(UTAH) DIVISION OF WATER QUALITY
ECWC	EAST CANYON WATERSHED COMMITTEE
ECWRF	EAST CANYON WATER RECLAMATION FACILITY
EPT	EPHEMEROPTERA, PLECOPTERA, AND TRICHOPTERA (A BIOLOGICAL INDEX)
EQIP	ENVIRONMENTAL QUALITY INCENTIVES PROGRAM
GIS	GEOGRAPHIC INFORMATION SYSTEM
HBI	HILSENHOFF BIOTIC INDEX (A BIOLOGICAL INDEX)
JRGC	JEREMY RANCH GOLF COURSE
MAG	MOUNTAINLAND ASSOCIATION OF GOVERNMENTS
NPS	NON-POINT SOURCE
NRCS	NATIONAL RESOURCES CONSERVATION SERVICE
PCMC	PARK CITY MUNICIPAL CORPORATION
PCMR	PARK CITY MOUNTAIN RESORT
SBWRD	SNYDERVILLE BASIN WATER RECLAMATION DISTRICT
STORET	STORAGE AND RETRIEVAL DATABASE (EPA WATER QUALITY DATABASE)
SVAP	STREAM VISUAL ASSESSMENT PROTOCOL
TMDL	TOTAL MAXIMUM DAILY LOAD
TP	TOTAL PHOSPHORUS
UAFRRI	UTAH ANIMAL FEEDLOT RUNOFF RISK INDEX WORKSHEET
UCASE	UTAH COMPREHENSIVE ASSESSMENT OF STREAM ECOSYSTEMS
WRAP	WATERSHED RESTORATION ACTION PLAN

1.0 Executive Summary

1.1. PROJECT TITLE: East Canyon Creek Stream Rehabilitation and Flow Feasibility Studies

PROJECT START DATE: 11/01/2001 PROJECT COMPLETION DATE: 09/30/2009

FUNDING (SEE SECTIONS 3 – 7 FOR DETAILED BUDGET TABLES)	
TOTAL BUDGET FY2001	$91,000.00
TOTAL EXPENDITURE OF EPA FUNDS	$54,600.00
TOTAL SECTION 319 MATCH ACCRUED	$36,400.00
TOTAL EXPENDITURES	$91,000.00
TOTAL BUDGET FY2002	$260,000.00
TOTAL EXPENDITURE OF EPA FUNDS	$156,000.00
TOTAL SECTION 319 MATCH ACCRUED	$104,000.00
TOTAL EXPENDITURES	$260,000.00
TOTAL BUDGET FY2003	$416,667.00
TOTAL EXPENDITURE OF EPA FUNDS	$250,000.00
TOTAL SECTION 319 MATCH ACCRUED	$166,667.00
TOTAL EXPENDITURES	$416,667.00
TOTAL 319	**$460,600**
TOTAL MATCH	**$307,067**
TOTAL PROJECT REVENUE	**$767,667**

SUMMARY ACCOMPLISHMENTS:

Since completion of the 2000 total maximum daily loads (TMDL) for East Canyon Creek and Reservoir (Whitehead, 2000), the environmental goals for the watershed have included (1) restoring the impaired beneficial use by achieving water quality standards for DO, and (2) gaining public acceptance and support of nonpoint source (NPS) activities and goals by informing and educating the public.

To meet these ends, several projects have been implemented in the watershed using Section 319 funding. Project deliverables include: a stream visual assessment protocol (SVAP), studies into

feasibility of augmenting stream flow, geologic mapping of high-phosphorus content bedrock, streambank stabilization and re-vegetation, sediment detention basins, fencing, educational programs, informational websites, stream restoration demonstration projects and agricultural practices improvement projects. Funding sources expended include approximately $768,000 Section 319 funds and match.

2.0 Introduction

2.1. Water Quality Priority

East Canyon Creek, from the East Canyon Reservoir to the headwaters, has been on Utah's 303(d) list of impaired waters since 1992 due to excessive total phosphorus (TP). An additional listing based on low dissolved oxygen (DO) concentrations was added for the creek in 1998. The impaired beneficial use is the Class 3A cold water fishery.

East Canyon Creek was formerly a productive cold water fishery that supported several varieties of trout, including a self-sustaining population of Kokanee salmon that came up the creek from the reservoir to spawn. Due to declining streamflow and degraded water quality, the cold water fishery has declined markedly. The Kokanee salmon are completely gone. Current summer time conditions are not conducive to maintaining a healthy cold water fishery, and trout populations are stressed due to high temperatures and low DO values.

Diel DO studies completed during July, August, and September from 2000 to 2007 at seven locations along the creek confirm that water quality is improving: minimums were above 4.0 mg/L from 2005 through 2007, means were above 6.5 mg/L from 2005 through 2007, and in one location the daily DO fluctuations decreased by 1.4 mg/L between 2001 and 2007. Even with these documented improvements in water quality, water quality standards are still not being consistently achieved for DO in all areas of the creek.

Much of the upper half of the watershed has been experiencing explosive growth over the past 20 years. Summit County's population grew 91.6% from 1990 to 2000, and Park City's population has nearly doubled from 4,468 residents in 1990 to 7,497 in 2005. Because of this growth, active construction and the resultant NPS pollution continue to contribute to the water quality impairment of the creek.

A TMDL analysis was completed for East Canyon Creek in April 2000 and revised in 2009. The 2000 TMDL called for implementation in two main categories: (1) contributions of the sole point source discharger, East Canyon Water Reclamation Facility (ECWRF), were addressed through upgrades to the treatment facilities, and (2) a locally led watershed committee, working in conjunction with the Utah Division of Water Quality (DWQ), began a long-range effort to address NPS issues.

2.2. Waterbody Description

East Canyon Creek is a 2nd order stream that is a tributary to the Weber River. The creek is located in Hydrologic Unit Code 16020102 and spans portions of Summit and Morgan Counties. The annual flow characteristics for the creek reflect a snow-melt driven spring peak flow of up to 80 cfs, followed by base flows that are largely dependent on ground water contributions (ranging around 6 cfs during the summer season below Jeremy Ranch Golf Course [JRGC]). Using a Rosgen classification system (Figure 1), the upper portions of the

watershed are typically E3 and E4 stream types.

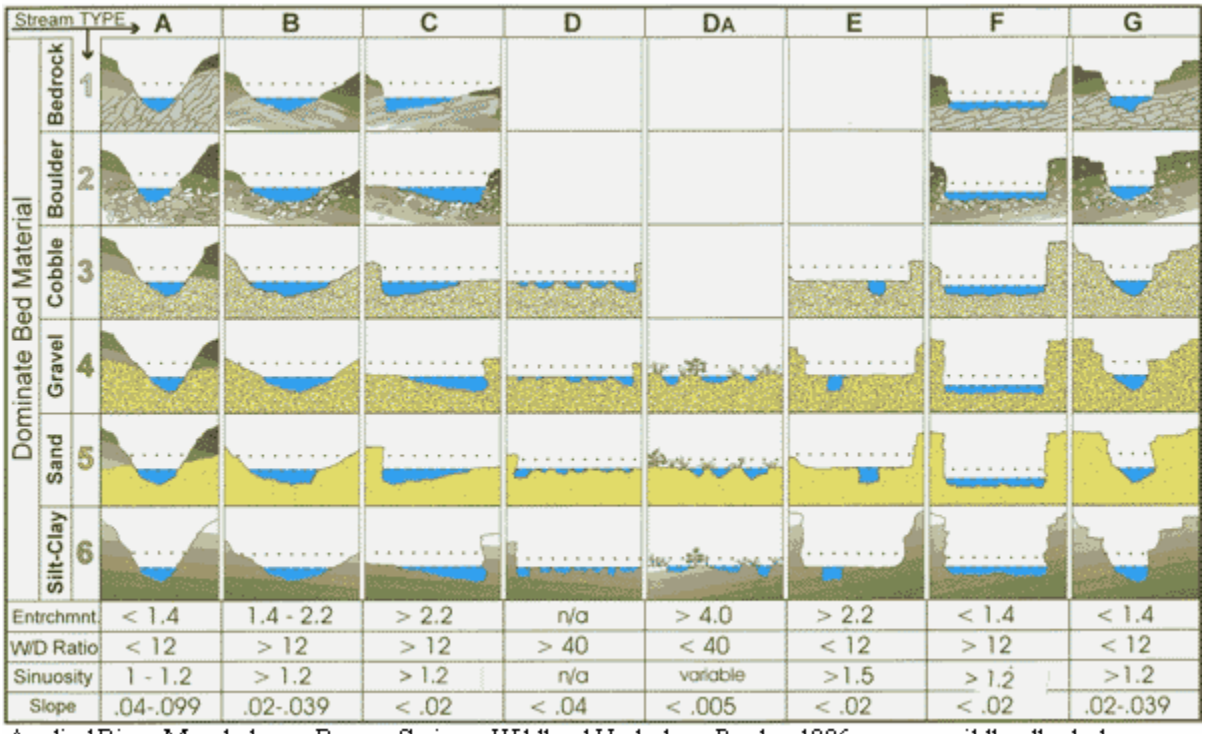

Figure 1. Rosgen stream classification system (Rosgen, 1996).

The stream types typical of the lower part of the watershed are C3 and C4. According to the Bio/West Study on East Canyon (Olsen and Stamp, 2000) and an SVAP conducted in 2002 (Green, 2002), over 50% of the entire stream length is impaired and exhibits poor channel and riparian conditions. Channel widening, active bank erosion, channel entrenchment, sedimentation, and poor riparian conditions are common problems along the main stem of East Canyon Creek.

2.3. Location and Map Information

Figures 2 and 3 depict location information and features of the watershed.

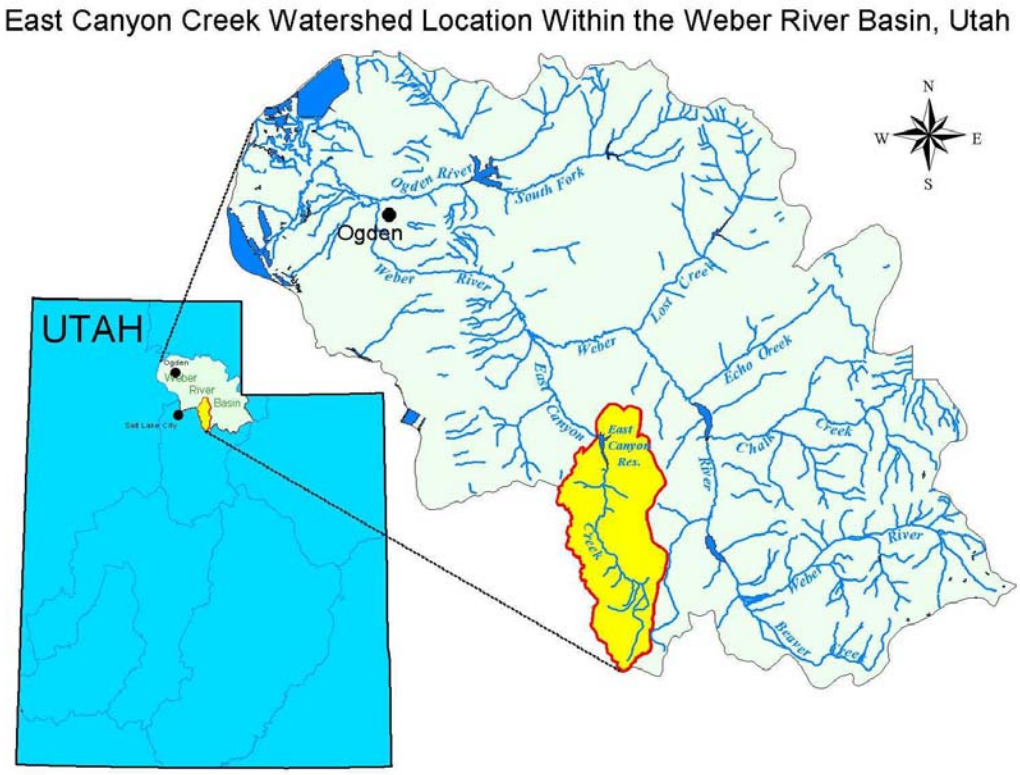

Figure 2. The East Canyon watershed.

2.4. General Watershed Information

The upper East Canyon watershed is located in north central Utah approximately 20 miles east of Salt Lake City. The watershed drains 144 square miles of mountainous terrain on the eastern slope of the Wasatch Mountains. The elevation of the watershed ranges from over 10,000 feet in the southern end to approximately 5,600 feet at the reservoir. East Canyon Creek is the principal drainage flowing to the north into the East Canyon Reservoir. The principal drainage channel of the upper part of the watershed (Park City area) is McLeod Creek, which becomes Kimball Creek and subsequently joins East Canyon Creek north of the intersection of Interstate 80 and Kimball Creek.

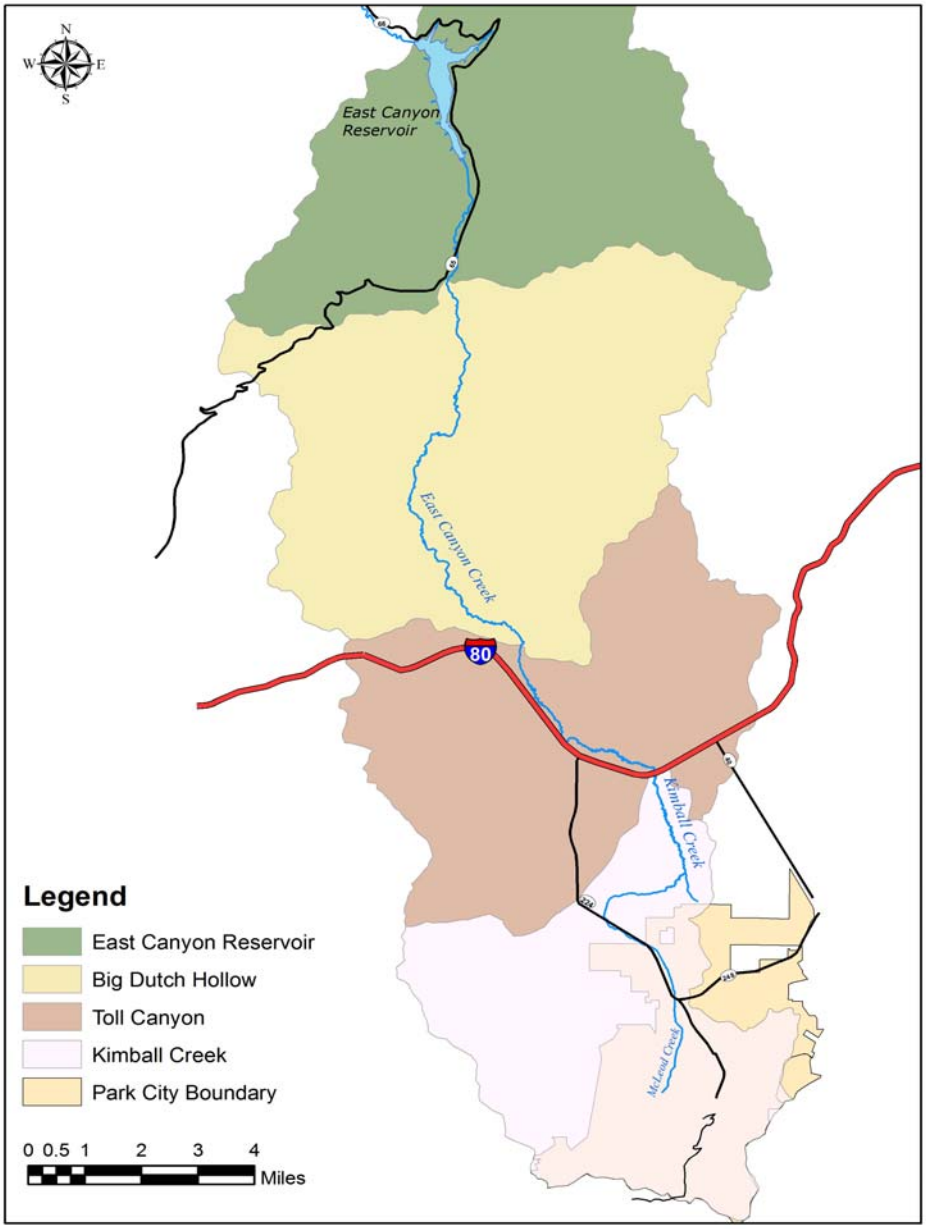

Figure 3. East Canyon sub-watersheds (see legend), pertinent tributaries, and location relative to Park City boundaries.

2.4.1. Climate & Streamflow

Average annual precipitation in the watershed ranges from 44 inches in the southern highest elevations to approximately 19 inches in the lowest elevations adjacent to the reservoir (Brooks et al., 1998). Approximately 65 to 75% of the annual precipitation

occurs during the winter months principally in the form of snow. Stream flows generally peak during the snow melt between March and June. Summer stream flows are mostly derived from ground water discharges, irrigation return flows, and ECWRF effluent.

2.4.2. Land Use and Ownership

According to the 2009 revised TMDL (SWCA), the watershed is 93% forest and shrub/scrub habitat. Only 2% of the watershed is utilized in active agriculture and this is principally grazing.

In the upper portion of the watershed nearly half of the land comprises residential, recreational, or commercial land use. Land ownership in the East Canyon Watershed is 96% private with just a few federal and state parcels.

2.4.3. Water Quality Issues

The 2000 East Canyon Creek and Reservoir TMDLs cited elevated TP and high sediment loads from nonpoint and point sources, elevated water temperatures, and low DO as the primary causes of water quality impairments in the watershed. The 2000 TMDLs recommended NPS reduction programs and required Snyderville Basin Water Reclamation District (SBWRD) to treat effluent from the ECWRF for phosphorus. As such, ECWRF upgraded their system to enhance their biological and add chemical phosphorus treatment. Since the upgrades were finalized in 2003/2004, the average TP concentrations downstream of ECWRF have dropped from 2.79 mg/L (before enhanced TP treatment) to 0.19 mg/L. In terms of loading, loads were reduced from 9.49 kg/day to 1.12 kg/day. As such, the upgrade reduced the average TP concentration by 93% and the average daily loading by 88%.

3.0 FY2001- Phase I Stream Rehabilitation

3.1. Project Goals, Objectives, and Tasks

Goal 1: Restore beneficial uses of water quality currently impaired for East Canyon Creek and Reservoir by achieving water quality standards for DO and the water quality indicator for TP.

Objective 1: Complete an assessment of degraded channel segments and stream channel restoration measures needed for East Canyon Creek and tributaries to minimize contributions of sediment and associated phosphorus. Develop recommendations, best management practices (BMPs), and designs to implement stream channel restoration in a future phase of this project.

The assessment procedure used is called the SVAP. It was developed by the United States Department of Agriculture Natural Resources Conservation Service (NRCS) National Water and Climate Center. A copy of the protocol can be retrieved at: http://www.ftw.nrcs.usda.gov/pdf/svapfnl.pdf

SVAP is a qualitative assessment of the water resource integrity of the stream, incorporating assessments of the habitat (aquatic and terrestrial), biotic factors, energy sources, and flow regimes. It is not a monitoring tool. This assessment protocol provides a basic level of stream health evaluation. It can be successfully applied by conservationists with little biological or hydrological training. It is intended to be conducted with the

landowner and incorporates talking points for the conservationist to use during the assessment. This protocol is the first level in a four-part hierarchy of assessment protocols. Tier 2 is the NRCS Water Quality Indicators Guide, Tier 3 is the NRCS Stream Ecological Assessment Field Handbook, and Tier 4 is the intensive bio-assessment protocol used by the State water quality agency. This protocol provides an assessment based primarily on physical conditions within the assessment area. It may not detect some resource problems caused by factors located beyond the area being assessed. The use of higher tier methods is required to more fully assess the ecological condition and to detect problems originating elsewhere in the watershed. However, most landowners are mainly interested in evaluating conditions on their land, and the SVAP protocol is well suited to supporting that objective.

SVAP is a tool that requires on the ground field work with a team of resource professionals who evaluate each reach of stream. Members of the East Canyon Water Quality Steering Committee assisted in the inventory. The SVAP assessment resulted in the identification of problems in the field, the assessment of the severity of the problems, and a tool to use for prioritization based on geographic location and/or type of water quality impairment. The entire length of East Canyon Creek was walked. The length and depth of each eroding bank was measured, photographed, and GPS coordinates recorded.

Task 1: Document stretches of East Canyon Creek and tributaries that are currently unstable and contributing sediment and associated phosphorus to the stream. Compile detailed stream channel inventory of East Canyon Creek and significant tributaries (McLeod Creek, Kimball Creek, Willow Draw, Spring Creek, Three Mile Creek, Two Mile Creek, and Toll Creek) to identify areas that need to implement restoration measures in order to reduce contributions of sediment and associated phosphorus.

Task 2: Develop restoration recommendations and BMPs for each stretch of stream that is unstable and contributing undesirable levels of sediment and associated nutrients. BMPs will be in accordance with those that have been standardized in the NRCS Field Office Technical Guide. This task was completed in August 2002 with the SVAP and in June 2004 with an assessment of the major tributaries in the East Canyon Watershed.

Products (Tasks 1 and 2): SVAP report with maps and priority sources that delineate segments of East Canyon Creek and tributaries that require stream channel restoration measures, and written recommendations and BMPs for each segment of identified stream channel to restore water quality.
http://www.eastcanyoncreek.org/resources/documents

Task 3: Compile list of landowners (names, addresses, and phone numbers) for each segment of stream that needs restoration.

Products: A written list of landowner information was compiled.

Task 4: Contact landowners of stream segments needing work and develop implementation plans that are acceptable to the landowner and accomplish the restoration measures identified. Obtain landowner commitment to undertake project and provide needed matching resources to meet 319 NPS program requirements.

Products: Landowners along the stream were contacted and the majority of the landowners were interested in participating in the voluntary incentive based approach to restoring the stream. Implementation plans were developed for 8 landowners.

Task 5: Assist Park City Municipal Corporation (PCMC) with funding for a sediment detention basin dredging project. PCMC will be removing accumulated sediment from the 18th pond on the Park City Public Golf course. This maintenance will result in improved storage capacity of the pond.

Products: 10,000 cubic yards of sediment were removed; a new detention basin was installed upstream from the existing pond; installation of a new stand pipe in the existing structure. http://www.eastcanyoncreek.org/projects/4-park-city-golf-course-pond-dredging-project

Task 6: Restore and stabilize the runoff channel in the Treasure Hollow drainage at Park City Mountain Resort (PCMR). This will result in a reduction in erosion and consequential sediment and phosphorus loading in the Upper East Canyon watershed.

Products: A stable runoff channel was installed and re-vegetated on the Treasure Hollow ski run. Water bars were installed to direct runoff into the new channel. http://www.eastcanyoncreek.org/projects/6-park-city-mt-resort-erosion-control-and-gully-repair-project

Objective 2: Complete an inventory of roadway segments that are contributing sediment and associated phosphorus to East Canyon Creek and tributaries. Develop recommendations, BMPs, and designs for control measures to minimize contributions of sediment and associated phosphorus in a future phase of this project.

Task 7: Compile inventory of roadways adjacent to East Canyon Creek and tributaries to identify segments that are contributing significant amounts of sediment and associated nutrients.

Task 8: Develop recommendations and BMPs for each road segment to minimize contributions of sediment and associated nutrients. BMPs will be from the NRCS Field Office Technical Guide.

Task 9: Compile list of owners (names/contacts, addresses, phone numbers) for each segment of roadway that needs implementation of BMPs.

Products: Chapter 2 of the Snyderville Basin Recreation and Construction Industry Water Quality Improvements Project (Stantec et al., 2003) is the final report addressing Tasks 7, 8, and 9. The document is available at the following web address: http://www.eastcanyoncreek.org/images/stories/Downloadable_publications/wq_improvement_project.pdf

This includes a written report with maps that delineate roadway segments that require drainage control improvements; written recommendations and BMPs for each road segment to minimize sediment and nutrient contributions; and a written list of owners/management agency for identified segments of roadways.

Task 10: Contact road owners/management agencies and develop implementation plans to install BMPs that will minimize contributions of sediment and associated phosphorus from roadways to East Canyon Creek and tributaries. Obtain owner commitment to undertake project and provide needed matching resources to meet 319 NPS program requirements.

Products: Implementation plans and BMPs were developed for the roadway and are listed in the Snyderville Basin Recreation and Construction Industry Water Quality Improvements Project final report. However, a pipeline from East Canyon Reservoir back up to the Snyderville Basin was approved after development of the BMPs. Because this pipeline will have major impacts to the dirt road along Easy Canyon Creek and will negate any improvements implemented, the task was not completed. Some improvements to the road system were made by Summit County during the summer of 2003. These improvements are associated with tasks in Phase II of this project.

Goal 2: Gain public acceptance and support of NPS activities and goals by informing and educating the public about NPS pollution and solutions in the East Canyon Watershed and Rees Creek Watersheds.

Objective 3: Increase public awareness and support for stream channel restoration and road drainage improvement efforts; highlighting successes and project areas that the public can visit and view.

Task 11: Watershed tours were conducted to visit channel restoration and road drainage improvement projects which have been completed at Jeremy Ranch and Big Spring. In addition, a tour was conducted at the ECWRF while it was under construction to remove phosphorus from its effluent.

Products: Two Watershed Tours

Task 12: Issue two press releases for newspaper articles and radio interviews that promote the stream channel and road drainage improvement projects in the watershed.

Product: Two press releases

Task 13: Develop Web Page Coverage that provides photographs and information for the East Canyon Watershed stream channel and road drainage improvement projects.

Products: Web Page photos and narrative www.eastcanyoncreek.org

Task 14: Complete two stream restoration demonstration projects on degraded segments of East Canyon Creek to inform the public and provide an example of what can be done to restore degraded stream segments.

Products: This task has been completed. In addition to the two stream restoration demonstration projects, a restoration project was implemented on the PCMR, Upper and Lower Treasure Hollow. http://www.eastcanyoncreek.org/projects/6-park-city-mt-resort-erosion-control-and-gully-repair-project

The Treasure Hollow drainage is in the headwaters of the East Canyon Watershed. In October 2005, PCMR re-graded 2,100 feet of existing gully and constructed a stabilized runoff channel using channel reinforcement mat and slope stabilization fabric. The runoff channel discharges to an existing rock lined channel in the lower reaches of Treasure Hollow run. The entire ski run area adjacent to the new channel was smoothed and re-vegetated. Water bars were installed and directed to the new stabilized channel.

Task 15: Complete the second stream restoration demonstration project on Rees Creek to retain, and settle suspended sediment loads. NRCS was not able to provide engineering assistance on non Farm Bill project work. As such, the design for the Rees Creek Phase II sediment detention project was contracted to a private engineering firm to expedite completion of the project.

Products: Design of 4 sediment detention basins as well as construction consultation and inspection. A final report titled "Rees Creek 319 Demonstration Project, Summit County, Utah" was submitted to EPA in August of 2008.

3.2. Planned and Actual Milestones and Completion Dates

Task (*responsible party*)	Output	Completion Date
Objective 1 Task 1 Compile stream channel inventory of East Canyon Creek and Tributaries; document segments that are unstable and contributing sediment to the stream (*MAG*)	Report with maps that delineate segments of East Canyon Creek and tributaries that require stream channel restoration measures.	June 2002
Task 2 Develop Restoration Recommendations and BMPs (*MAG*)	Written recommendations and BMPs for each stream segment.	August 2002
Task 3 Compile landowner list (*East Canyon Watershed Committee [ECWC]*)	Written list of landowners of affected stream segments	March 2002
Task 4 Obtain landowner commitments to undertake projects (*ECWC*)	Written landowner commitments	September 2002
Task 5 PCMC sediment detention basin dredging project (*PCMC*)	Removal of 10,000 cubic yards of sediment	November 2006
Task 6 Restore and stabilize the runoff channel in the Treasure Hollow drainage at PCMR *(PCMR*)	Stabilized runoff channel with water bars and vegetation	August 2006
Task 8 Develop recommendation for road drainage improvements (*MAG*)	Written recommendations	August 2002
Task 9 Compile list of road owners (*ECWC*)	Written list of road owners	March 2002
Task 10 Obtain road owner commitments to undertake projects (*ECWC*)	Not complete – see Section 3.1.	Not complete

Task (*responsible party*)	Output	Completion Date
Task 12 Issue two press releases for newspaper articles and radio interviews (*ECWC*)	Two Press Releases – in the Park City newspaper – the Park Record	May - September 2003
Task 13 Develop Web Page Coverage for East Canyon Watershed stream channel and road drainage improvement projects (*MAG*)	Web Page photos and narrative	November 2002 - May 2003
Task 14 Complete Stream Channel Restoration Demonstration Projects (*MAG*)	On the ground demonstration projects to inform and educate the public what can be done to address degraded stream segments	October 2002
Task 15 Complete the second stream restoration demonstration project on Rees Creek to catch, retain, and settle suspended sediment loads (*Upper Weber Watershed Coordinator*)	Engineering design of 4 sediment detention basins; construction consultation and inspection	August 2007

3.3. Evaluation of Goal Achievement

All tasks have been successfully completed except for task 10 (see Section 3.1). The completion of tasks 1 and 2 has resulted in the identifying of degraded and impacted sections of East Canyon Creek and the tributaries. Recommendations have been made for improving these sections. $26,000 was initially budgeted to complete the two tasks. Most of this funding was not needed to complete these tasks because of the help from NRCS and others. The project implementation plan for this grant was amended to include additional project work. Remaining funds from this grant have been used on three projects, including the Upper Treasure Hollow Erosion Control and Gully Repair Project, the Rees Creek Phase II Sediment Detention Project, and the PCMC Pond Dredging Project.

The project tours and press releases have brought awareness of water quality and watershed issues to the local residents, legislators, and stakeholders. The success of these tasks, along with the development of the web site, is reflected in the attendance and pro-activeness of the East Canyon Watershed Committee (ECWC). This committee meets quarterly and all restoration and education efforts for the watershed are facilitated through this committee.

The East Canyon Creek Streambank Rehabilitation Demonstration Project has had a number of positive effects for the watershed. It has reduced streambank erosion and established healthy streamside vegetation. It has also prevented unauthorized dumping of waste material in the project area. This project has been and will continue to be used to demonstrate how coordinated restoration activities can be implemented and accomplished and as a showcase for healthy streambanks.

3.4. Detailed Budget

Gray shaded areas represent tasks for which no match was submitted – no match was required due to the extra match provided by PCMC for Task 5.

Table 1. Budget table for FY2001 – Phase I Stream Rehabilitation.

Description	EPA Funds (Budget version 5/2007)	Match	Type
Goal 1			
Objective 1 (SVAP)			
Task 1 Document unstable reaches - ECC & Tribs	$ -		
Task 2 Restoration & BMP recommendations	$ -		
Task 3 Compile owner list	$ -		
Task 4 Contact landowners, develop implementation plans	$ 1,200.00		
Task 5 PCMunicipal - sediment detention dredging project	$ 6,300.00	$ 29,503.00	cash - PCMC
Task 6 Treasure Hollow Erosion Control project	$ 5,616.00	$ 6,240.00	cash - PCMR
Objective 1 Total:	**$ 13,116.00**		
Objective 2 (Inventory road segments causing sediment loading)			
Task 7 Inventory road segments - ECC & Tribs	$ 4,800.00		
Task 8 Recommendations & BMPs for road drainage improvements	$ 14,124.00	$ 657.00	cash - Stantec
Task 9 Compile list of road owners	$ 600.00		
Task 10 Contact road owners, develop implementation plans	$ 1,200.00		
Objective 2 Total:	**$ 20,724.00**		
Goal 2			
Objective 3 (Information & Education)			
Task 11 Conduct 2 watershed tours	$ 600.00		
Task 12 Prepare 2 press releases - 1 newspaper, 1 radio	$ 600.00		
Task 13 Develop web page	$ 600.00		
Task 14 2 stream restoration demonstration projects	$ 12,000.00		
Task 15 Rees Creek stream restoration demonstration project	$ 6,960.00		
Objective 3 Total:	**$ 20,760.00**		
Project Total	*$ 54,600.00*	*$ 36,400.00*	

4.0 FY2002 - Phase II Stream Rehabilitation

4.1. Project Goals, Objectives, and Activities

Goal 1: Restore beneficial uses of water quality currently impaired for East Canyon Creek by achieving water quality standards for DO and the water quality indicator for TP.

Objective 1: To minimize contributions of sediment and associated phosphorus from degraded streambanks and stream segments by stabilizing and protecting eroding stream banks and stream segments utilizing Best Management Practices (BMPs).

Task 1: Stabilize 9 miles of stream bank. Work with landowners along the East Canyon Creek riparian corridor to implement stream restoration BMPs for unstable and or eroding stream segments of East Canyon Creek and tributaries. Unstable and eroding streambanks were inventoried using the NRCS SVAP protocol (See Section 3.1). Design of BMPs will be based on criteria established by NRCS in their Field Office Technical Guide. The most critical areas identified in the SVAP will be given first priority. BMPs will include but are not limited to willow plantings, rock barbs, vortex weirs, installation of root wads, tree revetment, jetties, and sloping of vertical banks.

Products: The land owners between East Canyon Reservoir and the headwaters of East Canyon Creek were contacted to determine their interest in participating in a voluntary incentive-based approach to restore East Canyon Creek. Fortunately, the majority of land owners along the stream showed interest in participating in the restoration efforts.

Five plans were written and implemented. Swaner Nature Preserve coordinated with other property owners adjacent to the preserve to restore about 5 miles of East Canyon Creek above the ECWRF. Additional management/restoration plans were written for these landowners.

Task 2: Install permanent fencing along trails in the East Canyon Creek riparian corridor at Swaner Nature Preserve. Unauthorized off-trail access to the restoration area by trail users has been identified as a significant source of soil and streambank erosion. Current restoration efforts have been hampered by the trampling of native vegetation and the spread of noxious weeds.

Products: Swaner Nature Preserve installed permanent fencing along many of its trails along the East Canyon Creek corridor. The fencing will help control the unauthorized access to the habitat rehabilitation area along East Canyon Creek. This unauthorized access has hampered restoration efforts and resulted in increased soil and streambank erosion. Approximately 5,100 linear feet of permanent fencing was installed during the late fall of 2007.

Task 3: Implement site-specific landowner management plans and agricultural producer nutrient management plans in order to reduce nutrient loading to East Canyon Creek and tributaries. BMPs may include fencing of the riparian area, rotational grazing, creation of vegetative buffer zones, nutrient management, water and sediment control basins, implementation of the Summit County Storm Water program for construction activities along the stream, and protection of BMPs implemented in Task 1.

Products: A conservation management plan has been developed for the PV Ranch. The ranch encompasses about 7800 acres in the East Canyon Watershed and has several miles of East Canyon Creek on the property. The plan includes stream bank fencing totaling 12,773 feet, prescribed grazing on 371.5 acres, wildlife fencing totaling 9,820 feet, riparian forest buffer totaling 41.5 acres, use exclusion for 21.5 acres and streambank and shoreline protection for 500 feet on East Canyon Creek. Except for the streambank protection and wildlife fencing portions, the plan has been successfully completed. A tour of the project area was conducted to highlight the success of fencing off the stream and allowing the natural vegetation to re-establish itself. http://www.eastcanyoncreek.org/images/stories/Downloadable_publications/2004_newsletter.pdf

DD, a dairy farm along East Canyon Creek in Morgan, constructed a feedlot and composting facility with off channel watering for livestock. The facility enabled the producer to permanently prevent 200 cows from accessing East Canyon Creek, impacting water quality, and damaging the riparian area. The overall project goal was to develop a Comprehensive Nutrient Management Plan, Animal Waste Management System, and conservation plans with a suite of BMPs as a demonstration of the role that manure composting can play in NPS pollution reduction. The composting facility not only allowed the producer to effectively contain and manage the waste from all his cattle but also provided him with a value-added product to market. This has enabled him to make adjustments in other areas and aspects of his operation, thereby improving water quality. The Utah Animal Feedlot Runoff Risk Index Worksheet (UAFRRI) model was used to calculate load reductions to East Canyon Creek. A reduction of

1,370 lbs of phosphorus, 2,853 lbs of nitrogen, and 12,517 lbs of BOD_5 was calculated after project implementation was completed. This Task was modified from the original PIP.

Biological monitoring conducted at this site along East Canyon Creek in 2008 showed that the stream is meeting its beneficial uses.

Objective 2: Improve the riparian vegetative community to restore shading, lower water temperatures, and restore cold-water fishery habitat.

Task 4: Re-vegetate 4 miles of stream with willows and other woody vegetation. Assist land owners to re-establish woody vegetative species along streambank and riparian zone of East Canyon Creek and tributaries to enhance streambank stability, lower water temperatures, and increase shading for improved cold water fishery habitat.

Products: Approximately 760 trees and shrubs were planted along East Canyon Creek within the Swaner Nature Preserve. 2,800 willow cutting transplants were also planted in this area. 400 riparian shrubs were planted along McLeod Creek. Swaner Nature Preserve has continued implementation of their streambank stabilization and revegetation project. During August of 2007, an additional 710 feet of brush revetment was installed along the banks of East Canyon Creek. Positive results were observed after 2 spring run-offs had passed through the project areas. Sediment deposition and vegetation growth are occurring behind the older revetment structures. Permanent cross sections have been installed to track resulting geomorphic changes to the stream channel. http://www.eastcanyoncreek.org/projects/5-swaner-nature-preserve-east-canyon-creek-restoration-project

Task 5: Implement a stream restoration project along McLeod Creek, a tributary to East Canyon Creek. PCMC will be installing brush revetment, planting native shrubs, and broadcasting native grass seed along the McLeod Creek riparian corridor.

Products: PCMC conducted various stream restoration activities along McLeod Creek during May of 2007. Restoration activities included planting 400 riparian shrubs, repairing and installing approximately 90 feet of brush revetment, and seeding approximately 23 acres with native grasses. This project was completed in an effort to stabilize actively eroding stream banks, restore riparian vegetation, and reduce NPS pollution within the East Canyon Creek Watershed. Results of this effort are detailed in the Park City Municipal Corporation Storm Water Management Plan 2007 Annual Report, page 18.
http://www.eastcanyoncreek.org/images/stories/AnnualReport2007BFINAL.pdf

Task 6: Implement a re-vegetation plan on Swaner Nature Preserve to complement an existing noxious weed eradication plan. Areas of noxious weed infestation have been treated and needed to be re-seeded with native grasses in order to prevent the re-colonization of disturbed areas.

Products: Swaner Nature Preserve initiated an aggressive weed management plan in response to extensive weed infestations present throughout the preserve. Swaner provided significant funding towards the mechanical and chemical treatment of infested areas. Funds from the Phase II grant were used to implement a revegetation plan in the previously treated areas. This revegetation plan consists of preparation of the seed bed followed by no-till drill and hydro-seeding application of native seed mix. The

revegetation component of this project was completed in the fall of 2008. Approximately 70 acres of wetland and riparian areas were re-vegetated using native seeds. Depending on site conditions, the areas were hydro-seeded or planted using a no-till drill. Compacted soils were loosened prior to seeding.

Objective 3: Coordinate with Summit County to implement road drainage BMPs to minimize contributions of sediment and associated phosphorus from roadway segments adjacent to East Canyon Creek and tributaries that are contributing sediment and associated phosphorus to surface water.

Task 7: Reduce road drainage erosion for the portion of Jeremy Road that lies within Summit County. This segment contributes significant amounts of sediment and associated nutrients. Original plans called for road drainage improvements from JRGC to State Highway 65. That portion of the project will not be completed due to an impending pipeline project.

Products: Summit County has made progress in improving the road drainage system and thus reducing road drainage erosion on the dirt road from the JRGC to State Route 65. Improving this road drainage system was one of the implementation items in the East Canyon Creek TMDL. Summit County hardened the surface of their portion of the dirt road. This amounts to about 3 miles and equals just under 50% of the total length of the road. The hardening of the road surface has minimized the dust coming from the road and entering the stream. In the past, the dust was an issue because it is a sediment source for the creek and thus facilitates the transport of nutrients, such as phosphorus, the pollutant of concern. Summit County further improved the road drainage by installing small berms along certain sections to inhibit the flow of water from the road into the stream.

Objective 4: Implement specific water quality improvement projects as listed in the Stantec Snyderville Basin Recreation and Construction Industry Water Quality Improvement Project Report (http://www.eastcanyoncreek.org/images/stories/Downloadable_publications/wq_improvement_project.pdf) along with other projects identified as having a direct water quality improvement benefit.

Task 8: Work with landowners and land mangers such as Ski Hills, Golf Courses, Home Owners Associations and public and private businesses to reduce sediment and nutrient loading to East Canyon Creek and tributaries. Project work will include, but not be limited to, mechanical removal of sediment, macrophytes and their associated nutrients to increase sediment detention and increase diurnal DO values; improving water control structures for better water management and installation of sediment detention basins.

Products: Starting in November 2005 the Silver Springs Homeowners Association began implementation of an Invasive Species Eradication and Water Quality Improvement Plan developed by the Silver Springs Lake Committee. The plan was developed in response to water quality in the lake being 4 to 5 times above the state standard for phosphorus. The lake is a pass though for Silver Spring Creek, which is a perennial tributary to East Canyon Creek. The lake was drained and over 12,000 lbs of invasive goldfish, sediment, and macrophytes were removed from the lake. An aeration system was installed into the lake to circulate water coming in from streams and

increase nutrient turnover. Section 319 funding was used to assist with the removal of sediment and macrophytes. The task was completed in October 2006.

Task 9: Restore and stabilize the runoff channel in the Treasure Hollow drainage at PCMR. This will result in a reduction in erosion and consequential sediment and phosphorus loading in the Upper East Canyon watershed.

Products: A stabilized runoff channel was installed and re-vegetated on the Treasure Hollow ski run. Water bars were installed to direct runoff into the new channel. http://www.eastcanyoncreek.org/projects/6-park-city-mt-resort-erosion-control-and-gully-repair-project

To complete the project begun in 2005, two existing drop structures and basins, constructed as part of the Lower Treasure Hollow project, have been rehabilitated. The previous outlets of the basins were damaged from runoff and the basin side slopes were eroding into the basin, greatly reducing their effectiveness. Rehabilitation consisted of placement of erosion control fabric and reseeding of the basin side slopes and reconstruction of the outlet weirs. This was completed in 2006.

Based upon the project channel construction strategy, a Revised Universal Soil Loss Equation calculation was performed. The calculated soil loss from existing conditions is 780 tons per year. The soil loss after construction is calculated to be 460 tons per year, an approximate reduction of 41% (320 tons/year).

Task 10: PCMC will develop a web based environmental geographic information system (GIS) that will provide the public with access to currently existing environmental GIS data. This GIS application will identify environmental data within the city limits and relate it to specific land parcels. Data sources will include, but not be limited to, streams, wetlands, floodplains, storm water drains, and soils ordinance testing results. Other environmental information such as homeowner BMPs and NPS pollution reduction techniques will be housed on the website.

Products: PCMC developed a web based environmental GIS. This GIS allows citizens to map out parcels within the city and overlay various layers from PCMC's GIS server. Functionality includes stream and wetland buffer mapping, soils ordinance mapping, soils and water quality testing data, storm drain location, etc. The web module can be viewed at http://mapserv.utah.gov/ParkCityGIS/

4.2. Planned and Actual Milestones and Completion Dates

Task	Output	Qty.	Completion Date
Objective 1 Task 1: Work with land owners along the East Canyon Creek riparian corridor to implement stream restoration BMPs for unstable and or eroding stream segments of East Canyon Creek and tributaries (*MAG*).	Restored and stabilized segments along East Canyon Creek and tributaries.	Nine miles of stream channel restoration on the priority segments identified by SVAP.	October 2008
Task 2: Install permanent fencing along trails in the riparian corridor at Swaner Nature Preserve (*Swaner Nature Preserve*).	Riparian zone protected from trampling of native vegetation and the spread of noxious weeds.	5,100 linear feet of permanent fencing.	October 2008
Task 3: Implement site specific private land owner management practices and agricultural producer nutrient management plans. Protect BMPs implemented in Task 1 (*MAG*).	Written management plans for each participating private landowner. Installation of BMPs as designed in individual management plans.	Fencing and buffer zones on segments of East Canyon Creek and tributaries.	October 2006
Objective 2 Task 4: Assist land owners to re-establish woody vegetative species along streambanks and riparian zones to enhance streambank stability, lower water temperatures, and increase shading to improve the cold water fishery (*MAG*).	Woody species plantings along degraded zones of East Canyon Creek and tributaries.	Re-establish woody species along 4 miles of main stem channel.	October 2008
Task 5: Implement a stream restoration project along McLeod Creek. (*PCMC*)	Installation of brush revetment, planting native shrubs, broadcasting native grass seed along riparian corridor.	90 feet of brush revetment. 400 riparian shrubs. 23 acres seeded with native grass seed.	July 2007

Task	Output	Qty.	Completion Date
Objective 4 Task 8: Work with landowners, Ski Hills, Golf Courses, Home Owners Associations and public and private businesses to reduce sediment and nutrient loading. Project work may include mechanical removal of sediment, and associated nutrients and macrophytes to increase sediment detention, thereby improving water control structures (*MAG*).	Reduce negative impacts to water quality through the reduction, removal and increased detention of sediment and association nutrients.	Installation of 2 sediment detention basins and removal of 5000 cubic yards of sediment and associated nutrients and macrophytes from existing sediment detention basins.	October 2006
Task 9: Restore and stabilize the runoff channel in the Treasure Hollow drainage at PCMR (PCMR).	Reduced erosion and consequential sediment and phosphorus loading. Reduction of 320 tons/yr sediment estimate using RUSL equation.	Water bars and 2100 feet of stabilized and vegetated runoff channel on the Treasure Hollow ski run.	July 2007
Task 10: Develop a web based environmental GIS that will provide the public with access to currently existing environmental GIS data (PCMC).	GIS application identifies environmental data within the city limits and relates it to specific land parcels. Information will include streams, wetlands, floodplains, storm water drains, soils ordinance testing results, homeowner BMPs and NPS pollution reduction techniques.	ArcGIS Server application available to the public through the PCMC website.	October 2008

4.3. Evaluation of Goal Achievement

The SVAP document provided a comprehensive list of areas of concern for the watershed with an inventory of unstable and eroding streambanks and a priority list for addressing them. Fencing, bank stabilization, and other erosion control BMPs at ski areas, agricultural operations, and on roadways have reduced phosphorus loading. Shading and revegetation projects have helped reduce temperatures and improve habitat. The Environmental GIS is online and available to the public in the watershed.

Since the beginning of this project a Watershed Restoration Action Plan (WRAP) has been written for the East Canyon Watershed. The WRAP will provide a cohesive strategy for implementing water quality improvements within the watershed and maintaining water quality standards.
http://www.eastcanyoncreek.org/images/stories/Downloadable_publications/east_canyon_wrap_final_2004_09_01.pdf

4.4. Detailed Budget

Table 2. Budget table for FY2002 - Phase II Stream Rehabilitation.

Description		EPA Funds	Match	Type
Goal 1				
Objective 1	*(Stabilizing and protecting eroding streambanks using BMPs)*			
Task 1	Working with private landowners, stabilize 9 miles of stream bank	$ 30,852.00	$ 20,568.00	cash - landowners
Task 2	Install permanent fencing along trails on Swaner Nature Preserve	$ 28,800.00	$ 19,200.00	cash, in-kind - Swaner
Task 3	Develop and implement management plans for individual owners	$ 25,008.00	$ 16,672.00	in-kind - landowners
	Objective 1 Total:	**$ 84,660.00**	**$ 56,440.00**	
Objective 2	*(Improve riparian vegetation)*			
Task 4	Re-vegetate & fence 4 miles w/ willows, cottonwoods (individual land owners)	$ 4,014.00	$ 2,676.00	cash - landowners
Task 5	Implement a stream restoration project along McLeod Creek (PCMC)	$ 540.00	$ 360.00	cash, in-kind - PCMC
Task 6	Implement a re-vegetation plan on Swaner Nature Preserve	$ 12,396.00	$ 8,264.00	cash, in-kind - Swaner
	Objective 2 Total:	**$ 16,950.00**	**$ 11,300.00**	
Objective 3	*(Implement road drainage BMPs)*			
Task 7	Reduce drainage erosion	not completed		
	Objective 3 Total:			
Objective 4	*(Implement improvement projects based on Stantec report)*			
Task 8	Work with land owners etc., to construct & maintain sed. Detention basins	$ 40,740.00	$ 27,160.00	cash - landowners
Task 9	Treasure Hollow runoff channel	$ 4,188.00	$ 2,792.00	cash - PCMR
Task 10	GIS application	$ 9,462.00	$ 6,308.00	cash - PCMC
	Objective 4 Total:	**$ 54,390.00**	**$ 36,260.00**	
	Project Total	*$ 156,000.00*	*$ 104,000.00*	

5.0 FY2003 - Flow Feasibility and Alternatives Study

5.1. Project Goals, Objectives, and Activities

Goal 1: Restore beneficial uses of water quality currently impaired for East Canyon Creek by achieving water quality standards for DO and the water quality indicator for TP.

Objective 1: Complete a detailed analysis of the feasibility of flow augmentation for East Canyon Creek and identify alternatives to maintain minimum in-stream flows and allow achievement of beneficial uses designated for the creek.

Task 1: Complete a detailed analysis of historical stream flows, precipitation records and water right diversions for East Canyon Creek to determine historical critical summer flows from July through September. Correlate summer flows with precipitation records to distinguish flow reductions that are a result of climatic conditions versus reductions induced by up-stream water uses.

Task 2: Determine mechanisms, options, availability and cost to augment and maintain summer season flows in East Canyon Creek. Inventory existing water rights in the Snyderville Basin to determine feasibility of acquiring senior water rights that will insure summer season flows are maintained in East Canyon Creek. This analysis will include investigation of all reasonable means to acquire flow augmentation including purchase, lease, loans, donation, and other means.

Task 3: Provide a final report to include analysis and results from tasks 1 & 2 including a prioritized listing of options and costs of all mechanisms to augment summer flows in East Canyon Creek based on investigations and analysis completed under Task 1 and 2.

Products: Tasks 1 through 3 are detailed in the final report, titled *East Canyon Creek Flow Augmentation Feasibility Study, Summit and Morgan Counties, Utah* (Kleinfelder Inc., 2005). The study lists 12 alternatives that might individually or in combination have the potential to meet the stream flow augmentation goals. The goals of the study are to maintain minimum flows of 3.5 cfs in Upper McLeod Creek, 5.0 cfs in Lower McLeod Creek and 6.0 cfs in East Canyon Creek. East Canyon Creek has not met this goal since before 2001. During low flow conditions the stream is often below 2.0 cfs.

http://www.eastcanyoncreek.org/images/stories/Downloadable_publications/fafs.pdf

Task 4: Continue stream rehabilitation work currently in progress under the FY2002 East Canyon Watershed Stream Restoration Phase II PIP. This will include stabilizing an additional 1.9 miles of stream bank utilizing the findings of the SVAP report.

Products: Funding for this Task was approved in November 2004 in a separate allocation. As such, this task was included in the "Phase III" work plan (Section 7.0 of this report).

Task 5: Map natural phosphoric deposits. There are 2 natural phosphoric deposits located within The Canyons and PCMR areas of operations. These areas will be mapped using standard geologic mapping techniques including aerial survey information, ground-truthing, and soil testing. Mapping the phosphoric deposit locations will provide precise location of these sensitive soils and allow operators to avoid/minimize disturbances in these areas. Utilizing qualitative methods, estimates of the nature and extent of contribution to East Canyon Creek will be prepared.

Funding for this Task was approved in November 2004 in a separate allocation. As such, this task was included in the "Phase III" work plan (Section 6.0 of this report).

5.2. Planned and Actual Milestones and Completion Dates

Task/ (Responsible Party)	Output	Completion Date
Task 1: Determine critical summer flows from July to September. Isolate climate related flow from water use (*SBWRD*).	Detailed analysis of historical stream flows, precipitation records, water right diversions correlated with precipitation records.	February 2005
Task 2: Determine feasibility of augmenting/maintaining stream flow in East Canyon Creek (*SBWRD*).	Analysis including investigation of all reasonable means to acquire flow augmentation including purchase, lease, loans, donation, and other means to maintain summer flows in East Canyon Creek.	February 2005
Task 3: Provide final report (*SBWRD*).	Final report including analysis and results from tasks 1 & 2; a prioritized listing of options and costs of all mechanisms to augment summer flows.	February 2005
Task 4: Continue stream rehabilitation work from Phase II PIP (*SBWRD*)	Funding for this Task was approved in November 2004 in a separate allocation. As such, this task was included in the "Phase III" work plan (Section 7.0 of this report).	
Task 5: Map natural phosphoric deposits (*SBWRD*)	Funding for this Task was approved in November 2004 in a separate allocation. As such, this task was included in the "Phase III" work plan (Section 6.0 of this report).	

5.3. Evaluation of Goal Achievement

The report of flow was completed by Kleinfelder in 2005. Since then the ECWC and stakeholders have been using the report as a basis for securing in-stream flow rights and pursuing other means of providing additional flow to the creek. In 2008 a local family donated approximately 3 cfs to the Utah Division of Wildlife Resources to provide in-stream flow. The water right extends from Thaynes Canyon (2.5 miles northwest of Park City) to East Canyon Creek northwest of Jeremy Ranch Golf Course and will target a problem area. The Utah State Engineer approved the donation in 2009. Funding for tasks 4 and 5 was provided at a later date and is included as a separate work plan (see sections 6 and 7 of this report).

5.4. Detailed Budget Table

Table 3. FY2003 - Flow Feasibility and Alternatives Study.

	Description	EPA Funds	Match	Type
Goal 1				
Objective 1				
Task 1	Determine critical summer flows from July to September and isolate climate related flow from water use	$ 39,000.00	$ 26,000.00	cash, in-kind - PCMC and other stakeholders
Task 2	Determine feasibility of augmenting/maintaining stream flow in East Canyon Creek	$ 33,000.00	$ 22,000.00	
Task 3	Provide final report	$ 3,000.00	$ 2,000.00	
	Objective 1 Total:	**$ 75,000.00**	**$ 50,000.00**	
	Project Total	*$ 75,000.00*	*$ 50,000.00*	

6.0 FY2003 - Geologic Mapping

6.1. Project Goals, Objectives, and Activities

Goal 1: Minimize the amount of phosphorus-bearing sediment entering the stream from The Canyons and PCMR. This will be accomplished by using BMPs to manage the phosphorus bearing shale and its associated soil complexes.

Objective 1: Locate the phosphate bearing rocks and associated soils and create GIS maps that can be used to develop and implement BMPs.

Task 1: Literature review.

Task 2: Develop a soil sampling plan.

Task 3: Field mapping of bedrock and soil utilizing survey equipment and including soil testing (if necessary).

Task 4: Develop Geographic Information System (GIS) coverages that can provide the precise location of phosphate bearing rocks and soils. This information will be used by planners/managers to avoid or minimize disturbance of sensitive areas or to otherwise determine how best to apply BMPs.

Objective 2: Provide an estimation of sediment loading that can be used to develop and prioritize BMP implementation.

Task 5: Utilize a general method (such as the Universal Soil Loss Equation) to provide a general estimate of the nature and extent of sediment loading to East Canyon Creek.

Products (Tasks 1 – 5): A geologic/soils map and descriptions in GIS format. A map depicting erosion rates. A report containing the results of sampling conducted and estimates of the sediment contribution to East Canyon Creek. The report is available on the East Canyon Watershed website:

http://www.eastcanyoncreek.org/images/stories/ECPhosMapDocument.pdf

6.2. Planned and Actual Milestones and Completion Dates

Task/ (Responsible Party)	Output	Completion Date
Task 1: Literature review (*MAG: Stantec*)	A report containing sampling results and analysis, estimates of sediment contribution and a map depicting erosion rates, and a geologic/soils map with descriptions in GIS format. http://www.eastcanyoncreek.org/images/stories/ECPhosMapDocument.pdf	January 2008
Task 2: Develop a soil sampling plan (*MAG: Stantec*)		
Task 3: Field mapping of bedrock and soils (*MAG: Stantec*)		
Task 4: Develop GIS coverages (*MAG: Stantec*)		
Task 5: Provide a general estimate of nature and extent of sediment loading (*MAG: Stantec*)		

6.3. Evaluation of Goal Achievement

The GIS was provided to the ski resorts. They have used the information provided to develop BMPs and slope stabilization projects using their own resources.

6.4. Detailed Budget

Table 4. FY2003 - Geologic Mapping.

	Description	EPA Funds	Match	Type
Goal 1				
Objective 1	*Locate phosphatic rocks & soils, develop GIS*			
Task 1	Literature review	$12,650.00	$ 8,433.33	cash, in-kind - PCMC and other stakeholders
Task 2	Develop a soil sampling plan	$800.00	$ 533.33	
Task 3	Field mapping and soil testing	$6,400.00	$ 4,266.67	
Task 4	Develop GIS	$4,000.00	$ 2,666.67	
	Objective 1 Total:	**$ 23,850.00**	**$ 15,900.00**	
Objective 2	*Provide estimate of sed loading*			
Task 5	Provide a general estimate of the nature & extent of sed. loading	$ 750.00	$ 500.00	
	Objective 2 Total:	**$ 750.00**	**$ 500.00**	
	Project Total	*$ 24,600.00*	*$ 16,400.00*	

7.0 FY2003 - Phase III Stream Rehabilitation

7.1. Project Goals, Objectives, and Activities

Goal 1: Restore beneficial uses of water quality currently impaired for East Canyon Creek by achieving water quality standards for DO and the water quality indicator for TP.

Objective 1: To minimize contributions of sediment and associated phosphorus from degraded streambanks and stream segments by stabilizing and protecting eroding stream banks and stream segments utilizing BMPs.

Task 1: Work with landowners within the East Canyon watershed to implement stream restoration BMPs for unstable and or eroding stream segments of East Canyon Creek and its tributaries. Unstable and eroding streambanks have been inventoried using the NRCS SVAP protocol and the most critical areas identified were given first priority. Design of BMPs will be based on criteria established by NRCS in their Field Office Technical Guide. These included but were not limited to willow plantings, rock barbs, vortex weirs, installation of root wads, tree revetment, jetties, sloping of vertical banks, and fencing of riparian corridors.

The sediment reductions for this task were calculated using the STEPL streambank BMP effectiveness calculator assuming an average bank height of 4 feet, a lateral recession rate of 0.5' per year, and a BMP effectiveness rating of 0.95.

Products: Restored, stabilized, and non-eroding streambanks along East Canyon Creek and its tributaries. 2,500 linear of feet of severely eroding streambanks were treated on East Canyon Creek throughout Summit and Morgan Counties. This resulted in a load reduction ranging from 166-261 tons of sediment per year. Swaner EcoCenter installed 1900 feet of log post riparian fencing. PCMC installed 500 riparian shrubs, 90 ft of brush revetment, and approximately 23 acres of native grass seeding.

SWCA Environmental Consultants worked with landowners along Kimball Creek to install revetments and plant willows and other native vegetation. Their report is available here:
http://www.eastcanyoncreek.org/images/stories/Annual_Progress_Report_2010_319Funded1.pdf

Objective 2: Improve the riparian vegetative community to restore shading, lower water temperatures, and restore cold-water fishery habitat.

Task 2: Continue a re-vegetation plan on Swaner Nature Preserve to complement an existing noxious weed eradication plan. Areas of noxious weed infestation have been treated and need to be re-seeded with native grasses in order to prevent the re-colonization of disturbed areas.

Products: 62 acres of wetland and riparian areas were re-vegetated using native seeds and 1000 native shrubs. Depending on site conditions, the areas were hydro-seeded or planted using a no-till drill. Compacted soils were loosened prior to any seeding. Areas re-vegetated/restored in 2007 and 2008 were maintained and monitored through a weed management program.

Objective 3: Reduce nutrient loading in East Canyon Creek and its tributaries by improving manure storage facilities within the watershed.

Task 3: Provide cost share assistance on an existing Environmental Quality Incentives Program (EQIP) project which involves construction of solid waste bunkers, liquid waste storage ponds, livestock fencing, and pipeline construction.

Products: The project will ultimately improve manure storage facilities. So far a pumping plant, sprinkler system, and weep walls have been installed. An interim UAFRRI model shows that 38 lbs/year of nitrogen and 7 lbs/year of phosphorus have been removed from East Canyon Creek. Once the remainder of the project is complete, UAFRRI model outputs estimate that it will result in the removal of approximately 161 lbs/year of nitrogen and 32 lbs/year of phosphorus.

Goal 2: Restore beneficial uses of water quality currently impaired in Silver Creek by achieving water quality standards for cadmium and zinc.

Objective 4: Minimize contributions of cadmium and zinc to Silver Creek from the Prospector Drain by installing an anaerobic bio-cell and constructed wetland.

Task 4: Assist PCMC in the construction of an anaerobic bio-cell and wetland below the Prospector neighborhood. This complex will treat contaminated groundwater that is migrating through mine tailings in the middle Silver Creek watershed. PCMC, in accordance with the Silver Creek TMDL, wishes to decrease the heavy metal load entering Silver Creek by constructing an anaerobic treatment bio-cell to treat the water coming from the Prospector Drain. This bio-cell has reduced the concentrations of heavy metals entering Silver Creek from the Prospector Square groundwater by approximately 70 to 80%.

Products: Partial payment on the construction of an anaerobic bio-cell and wetland. A more detailed report on the wetland project is available here: http://www.eastcanyoncreek.org/projects/62-park-city-prospector-park-treatment-wetland

Goal 3: Provide administrative services to project sponsors documenting matching contributions, tracking individual project progress, coordinating team efforts, and generating reports and data in a timely manner.

Objective 5: Provide administrative services.

Task 5: Track match and prepare reports. The Upper Weber Watershed Coordinator will coordinate this effort and prepare the necessary reports. SBWRD will provide financial oversight/documentation and provide quarterly financial reports to the local steering committee.

Products: Documented match records, ongoing for duration of project. Semi-annual, Annual and Final reports.

7.2. Planned and Actual Milestones and Completion Dates

Task/ (Responsible Party)	Output	Qty.	Completion Date
Objective 1 Task 1: Work with land owners along the East Canyon Creek riparian corridor to implement stream restoration BMPs for unstable and or eroding stream segments of East Canyon Creek and tributaries (*SBWRD*).	Restored, stabilized, and non-eroding streambanks along East Canyon Creek and its tributaries. Reduced phosphorus and sediment loading to East Canyon Creek and East Canyon Reservoir.	2,500 linear of feet of severely eroding streambanks were treated on East Canyon Creek throughout Summit and Morgan Counties.	September 2009
Objective 2 Task 2: Implement a re-vegetation plan on Swaner Nature Preserve to complement an existing noxious weed eradication plan. Areas of noxious weed infestation have been treated and need to be re-seeded with native grasses in order to prevent the re-colonization of disturbed areas.	Wetland and riparian corridor stabilized with native vegetation.	69.5 acres of wetland and riparian areas were re-vegetated using native seeds.	December 2008
Objective 3 Task 3: Provide cost share assistance on an existing an existing EQIP project which involves construction of solid waste bunkers, liquid waste storage ponds, livestock fencing, and pipeline construction.	Improved manure storage facilities with reduced nutrient loading.	1 waste management facility resulting in the removal of approximately 161 lbs/yr nitrogen and 32 lbs/yr phosphorus.	September 2009
Objective 4 Task 4: Assist PCMC in the construction of an anaerobic bio-cell and wetland to treat contaminated groundwater.	Anaerobic bio-cell and wetland that decreases heavy metal loading to Silver Creek.	70 % to 80% reduction in cadmium and zinc loads to Silver Creek from groundwater at Prospector Square.	November 2008
Objective 5 Task 5: Track match and prepare reports.	Documented match records, ongoing for duration of project. Semi-annual, Annual and Final reports.	As necessary through the duration of the project.	As necessary through the duration of the project.

7.3. Evaluation of Goal Achievement

Approximately 2,500 linear feet of eroding streambank were treated using plantings, bank re-shaping, and revetment. On a site visit in May 2010 the revetments were coated with sediment, indicating that they are functioning to remove sediment from the creek by slowing the water velocity. The plantings were also growing with high survival rates. Revegetation at Swaner Preserve has been equally successful. The manure management project is not yet

complete, but the construction of the manure bunker has eliminated manure as a source of TP to the stream. The biocell is functioning well, even in winter, and has achieved removal rates up to 80% for both cadmium and zinc.

7.4. Detailed Budget

Gray shaded areas represent tasks for which no match was submitted – no match was required due to the extra match provided by PCMC for Task 4.

Table 5. FY2003 - Phase III Stream Rehabilitation.

	Description	EPA Funds	Match	Type
Goal 1				
Objective 1	*Stabilize eroding stream banks using BMPs*			
Task 1	Work with land owners along East Canyon Creek	$ 77,025.00	$ 1,053.00	cash, in-kind - landowners
Objective 2	*Improve riparian vegetation to restore shading, lower temp, and restore habitat*			
Task 2	Implement a re-vegetation plan on Swaner Nature	$ 37,855.00	$ 33,461.00	in-kind - Swaner
Objective 3	*Reduce nutrient loading by improving manure storage facilities within the watershed*			
Task 3	Provide cost share assistance on an existing EQIP	$ 20,000.00	$ 14,169.00	cash - landowners
Goal 2				
Objective 4	*Minimize contributions of Cd and Zn to Silver Creek from the Prospector Drain*			
Task 4	Assist PCMC in construction of an anaerobic biocell	$ 8,000.00	$ 51,584.00	cash - PCMC
Goal 3				
Objective 5	*Provide administrative services*			
Task 5	Track match and prepare reports	$ 7,520.00	$ -	
	Project Total	*$ 150,400.00*	*$ 100,267.00*	

8.0 Monitoring Results

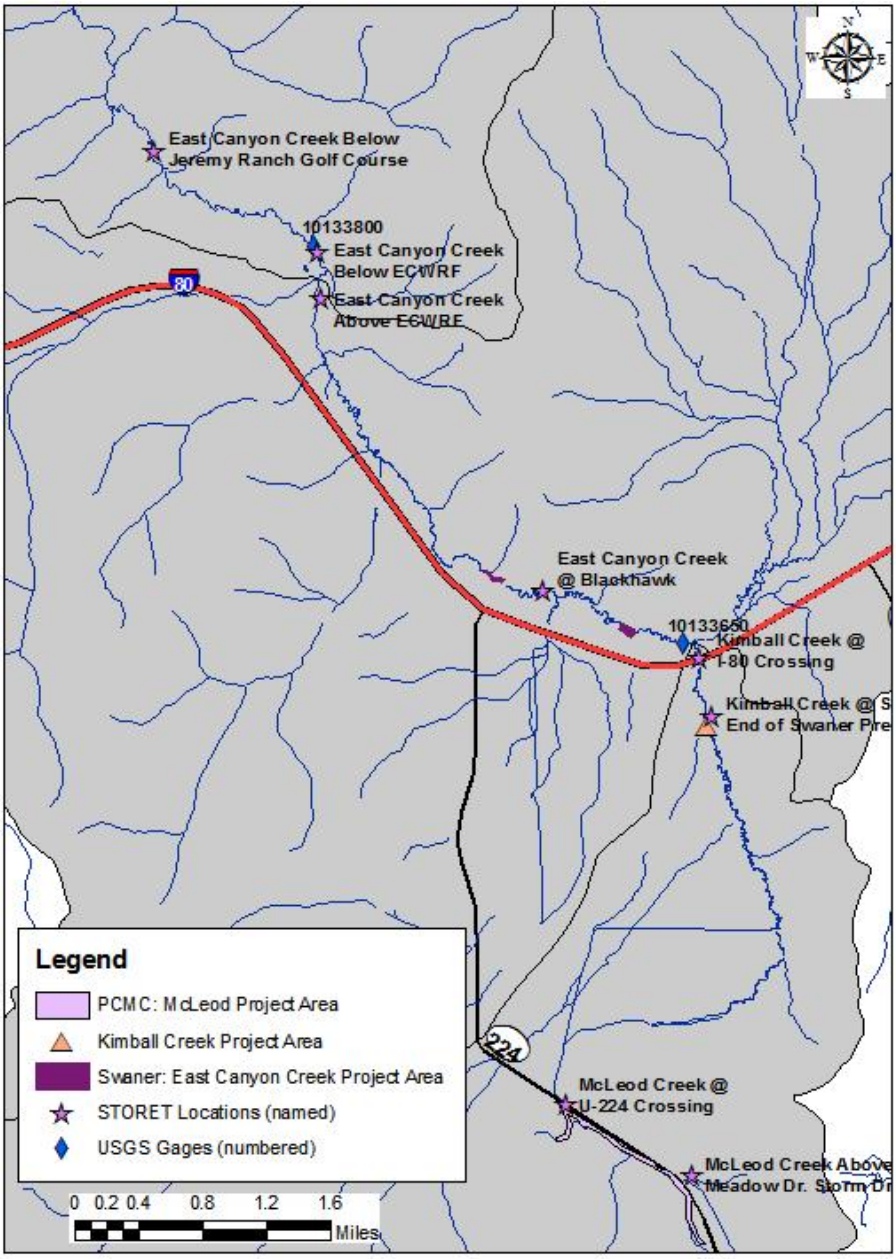

Figure 4. Sampling and project locations.

8.1. Data Availability

Figure 3 maps several of the sampling locations throughout East Canyon Watershed. Because there is such an extensive data set, locations were chosen that had robust and comparable data sets. The most extensive chemical and biological data sets come from East Canyon Creek above ECWRF, below ECWRF, and below JRGC. Additional chemical and biological data are available for the Kimball Creek location, and chemical data only is available for McLeod Creek.

Diel DO data has been routinely collected at the STORET locations depicted in Figure 3 during the summer seasons each year from 2000 through 2009. The data was collected using InSitu Troll 9000 data loggers, which monitor DO, percent saturation, specific conductivity, and temperature each hour for the duration of deployment (from 1 week to 3 months).

8.2. Streamflow and DO considerations

East Canyon Creek has experienced declining stream flows as growth has occurred in the basin. In order to compare data sets to determine whether water quality improvements have occurred, an analysis was completed to assess which data sets represent comparable flow conditions. Figure 4 shows mean summer streamflow below ECWRF (and above JRGC) for the years 2002 through 2009. The data was collected using USGS Gage 10133800, which continuously monitors flow and dissolved oxygen.

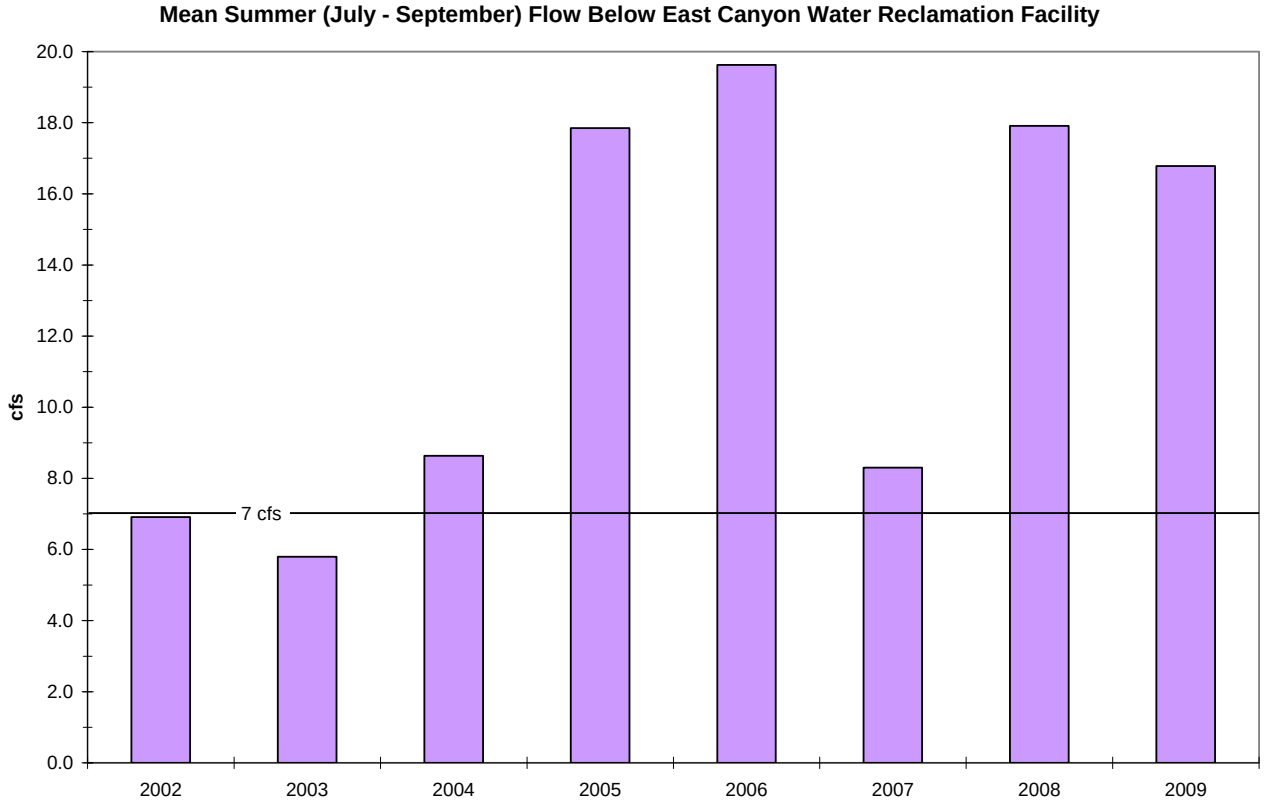

Figure 5. Mean summer streamflow (cfs) below ECWRF. Data source: USGS continuous monitoring gage 10133800.

Stream flow was correlated to dissolved oxygen using a Pearson Correlation (Table 1). Based on this analysis, there is a correlation between summer (July through September) streamflow and DO during low flow years: when summer streamflow averages less than approximately 7.0 cfs, the DO concentrations are also low. As such, data from years 2002 and 2003 was left out of the comparisons. Data sets from 2005 and 2007 were selected to

represent stream conditions post-project work (projects were initiated in 2002 or later) because flow during those years was above 7.0 cfs and there was a robust data set.

Table 6. Pearson correlation - streamflow and dissolved oxygen during the summer season (July - September).

Pearson Correlation 2002	*Flow*	*Pearson Correlation 2006*	*Flow*
DO	0.6	DO	-0.1
Mean Summer Flow	6.9	Mean Summer Flow	19.6
Pearson Correlation 2003	*Flow*	*Pearson Correlation 2007*	*Flow*
DO	0.7	DO	0.0
Mean Summer Flow	5.8	Mean Summer Flow	8.3
Pearson Correlation 2004	*Flow*	*Pearson Correlation 2008*	*Flow*
DO	-0.3	DO	-0.1
Mean Summer Flow	8.6	Mean Summer Flow	17.9
Pearson Correlation 2005	*Flow*	*Pearson Correlation 2009*	*Flow*
DO	-0.3	DO	-0.1
Mean Summer Flow	17.8	Mean Summer Flow	16.8

Key	
Very weak to negligible correlation	0.0 to 0.2
Weak correlation	0.2 to 0.4
Moderate correlation	0.4 to 0.6
Strong, high correlation	0.7 to 0.9
Very strong correlation	0.9 to 1.0

Data from 2001 was selected to represent pre-project work. While no streamflow data exists for the summer of 2001, the precipitation totaled 37.3 inches that water year (Thaynes Canyon SNOTEL Station S814). This was higher than the precipitation totals for either the 2002 or 2003 water years that demonstrated a flow/DO correlation.

8.3. Surface Water Improvements

8.3.1. Point Source Considerations

As described in the 2009 TMDL, "SBWRD completed an upgrade and expansion project of their ECWRF in September 2002 as part of the implementation of the East Canyon Reservoir TMDL from 2001, adding a chemical phosphorus reduction process to the plant which became effective in July 2003. The process mixes secondary effluent with alum (aluminum sulfate) and a polymer in solids-contact clarifiers, and then filters the liquid through a constant-backwash sand filter. The heart of the process is the use of alum to both pull orthophosphorus out of solution and to bind the phosphorus molecule to the alum. The polymer is designed to join the resultant molecules in a long chain for easier filtering. Effluent then passes though a UV disinfection process" (SWCA, 2009).

"The plant had previously utilized only a biological phosphorus reduction process (since 1996). The incorporation of chemical phosphorus reduction methods resulted in a substantial reduction in the effluent's phosphorus concentration once the process became fully effective in July 2003. Other constituents (such as TSS, BOD, NH_3) were not significantly reduced by this process, which is very specific to TP (although there was some reduction in TSS). There have been considerable reductions in phosphorus concentrations below the ECWRF. Average TP concentrations have been reduced from

2.79 mg/L for data collected from 1993 to 1996 to 0.99 mg/L for data collected from 1997 to 2003 prior to the ECWRF expansion taking effect. Following the upgrade and expansion of the ECWRF in July 2003, average TP concentrations dropped to 0.19 mg/L (data collected from August 2003 to August 2007). Total phosphorus loading from the ECWRF has also been dramatically reduced from an average of 9.49 kg/day in 1997–1999, to 2.18 kg/day for data collected from 2002 to 2003 prior to the ECWRF expansion, then decreased to 1.12 kg/day following the ECWRF upgrade and expansion (data collected August 2003 through December 2007)"(SWCA, 2009).

Much of the initial improvement at the below ECWRF and below JRGC locations is likely due to ECWRFs load reductions. The stream is effluent dominated at this point: summer flows have comprised up to 75% effluent. However, the improvements to locations upstream of ECWRF and the continuing improvements below ECWRF and below JRGC are likely related to NPS project work.

8.3.2. Chemical: Dissolved Oxygen

Figures 6 and 7 depict the diel DO data plotted against time during August, which is typically the driest part of the summer. This illustrates the minimum and maximum concentrations reached at each location as well as the amplitude of change between daily and nightly values. Extremely low values and extreme differences between highs and lows are detrimental to aquatic species.

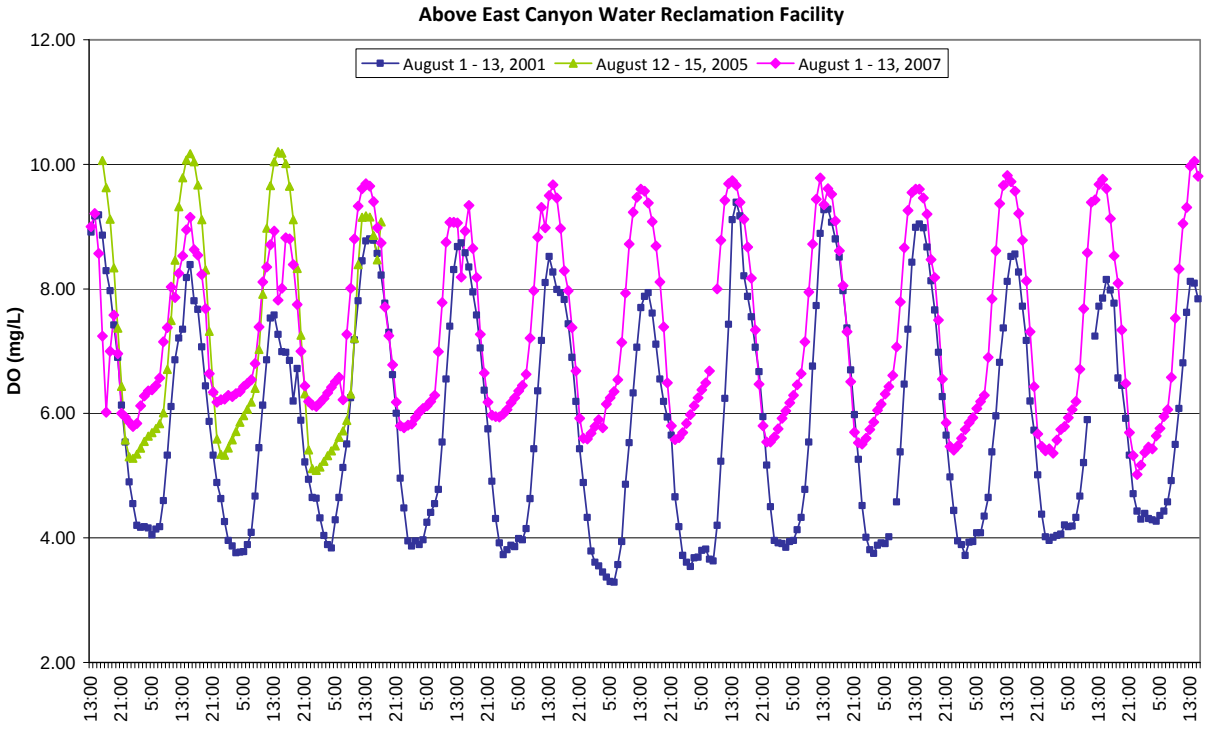

Figure 6. Diel DO data collected in East Canyon Creek above ECWRF during August, 2001, 2005, and 2007.

The data at the above and below ECWRF locations show that DO concentrations

typically reached minimums below 4.0 mg/L during 2001 (before any project work). In 2005 and 2007, the minimums were consistently above 5 mg/L. Additionally, the difference between high and low concentrations (diel amplitude) decreased.

An analysis of variance (ANOVA) (Appendix 14.2, table 3) for the mean DO concentrations pre- and post-project work above ECWRF (6.22 mg/L and 7.33 mg/L, respectively) demonstrated that the difference between the means was statistically significant. Thus, it is reasonable to conclude that these data represent an improvement to water quality.

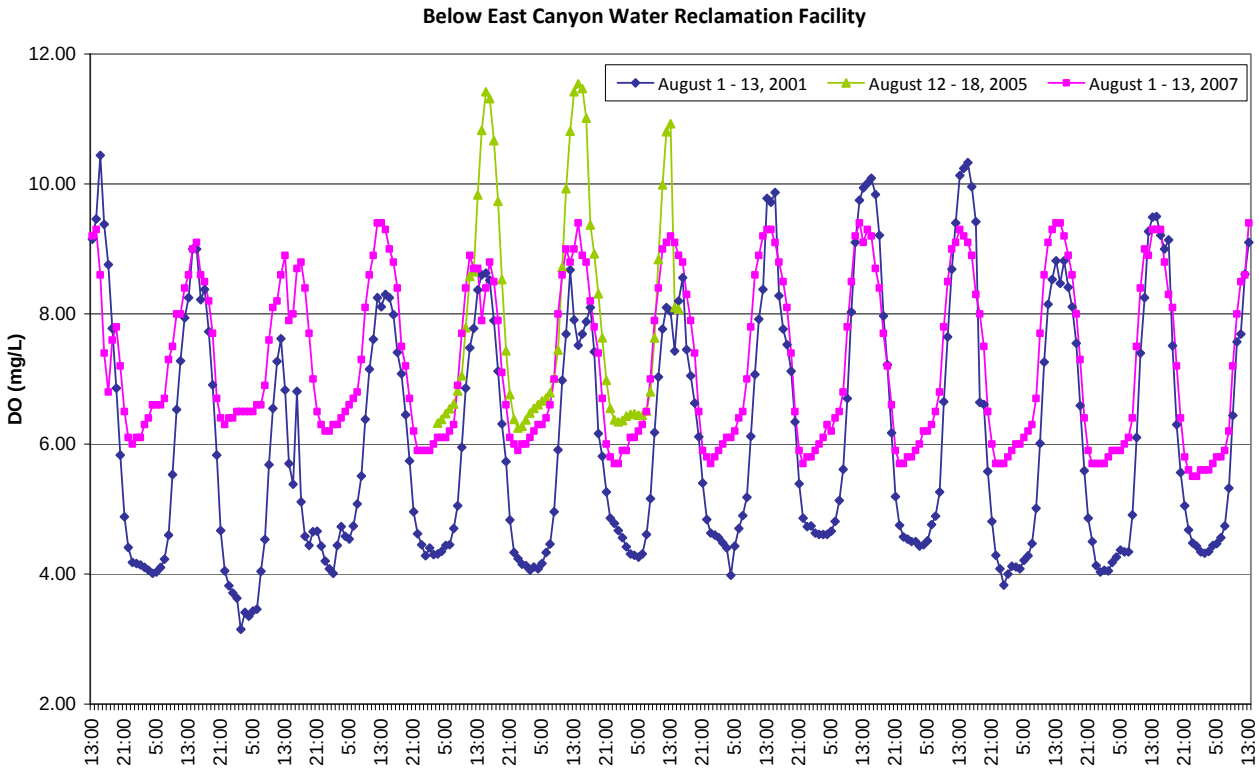

Figure 7. Diel DO data collected in East Canyon Creek below ECWRF during August, 2001, 2005, and 2007.

An ANOVA for the mean DO concentrations pre- and post-project work below ECWRF (Appendix 14.2, 2a) demonstrated that the difference between the means was also statistically significant at that location. This was true for the both the August (6.07 mg/L pre-project, 7.22 mg/L post-project) and the August – September (6.61 mg/L pre-project, 7.75 mg/L post-project) datasets. An ANOVA was also performed on the mean DO concentration for 2005 and 2007 (post-project). The means, 7.52 mg/L and 7.42 mg/L, were not different statistically. This indicates that an improvement occurred between 2000 and 2005 and has been maintained.

Table 7 summarizes the annual and summer DO concentration minimums, means, maximums, and amplitude using data from the USGS gage below ECWRF.

Table 7. Summer and annual DO data from USGS gage 10133800 below ECWRF.

Year	Summer DO				Diel amplitude (max - min)	*n*
	Min	Mean	Max	St. Dev		
2002	4.7	6.3	7.8	0.8	3.1	92
2003	5.5	6.7	8.2	0.6	2.7	91
2004	6.7	7.9	9.9	0.6	3.2	92
2005	6.7	7.5	8.9	0.6	2.2	91
2006	6.2	7.7	9.1	0.6	2.9	92
2007	6.6	7.4	8.6	0.4	2.0	90
2008	6.7	7.4	8.4	0.4	1.7	92
2009	6.8	7.6	8.5	0.4	1.7	90
Year	Annual DO				Diel amplitude (max - min)	*n*
	Min	Mean	Max	St. Dev		
2002	4.7	8.6	11.4	1.7	6.7	359
2003	5.5	8.5	11.2	1.5	5.7	363
2004	6.7	9.7	12.8	1.6	6.1	344
2005	6.7	8.9	11.3	1.2	4.6	357
2006	6.2	9.2	12.0	1.5	5.8	362
2007	6.6	8.6	10.6	1.0	4.0	339
2008	6.7	9.1	12.1	1.3	5.4	340
2009	6.8	9.3	11.1	1.2	4.3	363

Figures 8 and 9 graphically represent the data compiled in Table 2.

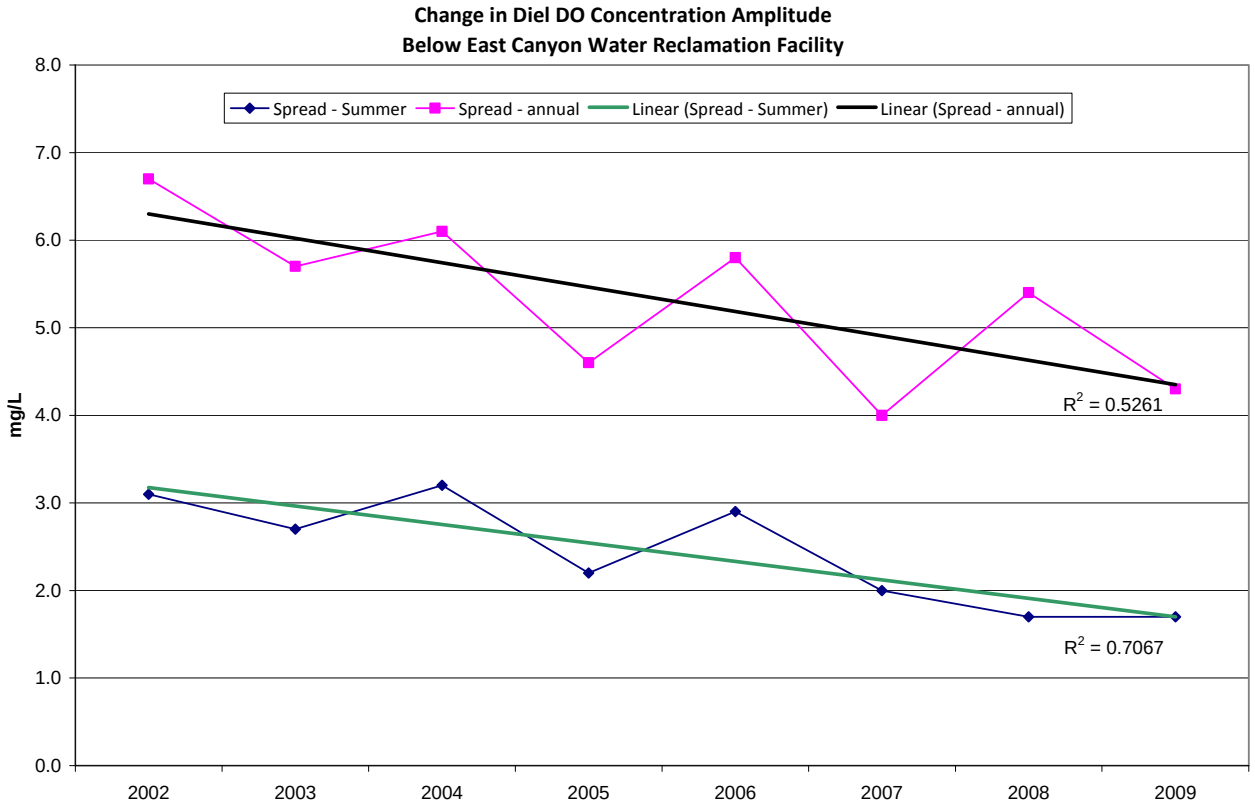

Figure 8. Change in diel DO amplitude from the USGS Gage below ECWRF. Continuous DO data was available for 2002 through 2009.

The decrease in diel amplitude (Figure 7), particularly in the summer, represents a measurable change in stream condition.

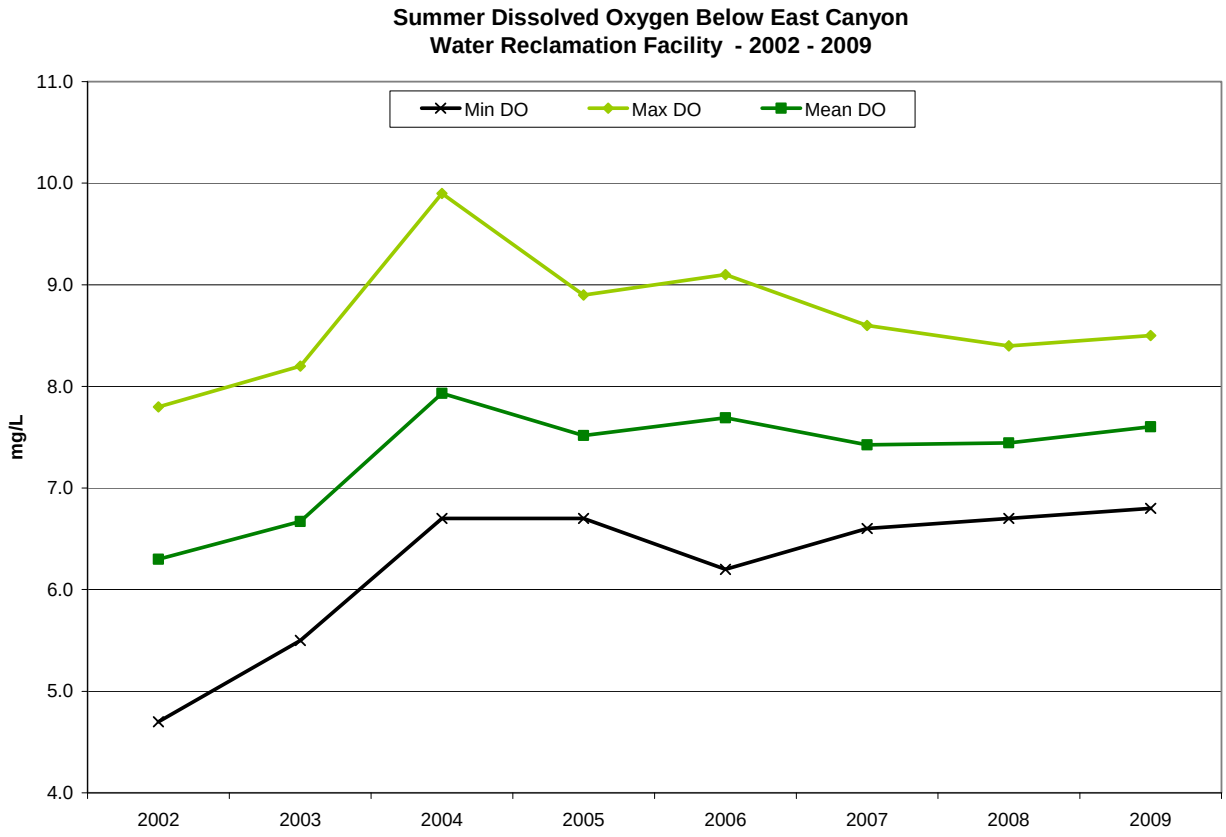

Figure 9. Change in minimum, maximum, and mean DO concentrations below ECWRF.

Figure 9 shows the change in summer minimum, maximum, and mean DO concentrations below ECWRF. As discussed above, this location is immediately downstream of ECWRF. The increase of minimum, maximum, and mean DO in 2004 is likely due to the removal of water column phosphorus beginning in 2003. Since 2004, the minimums, maximums, and mean have leveled out, while the diel amplitude has continued to decrease.

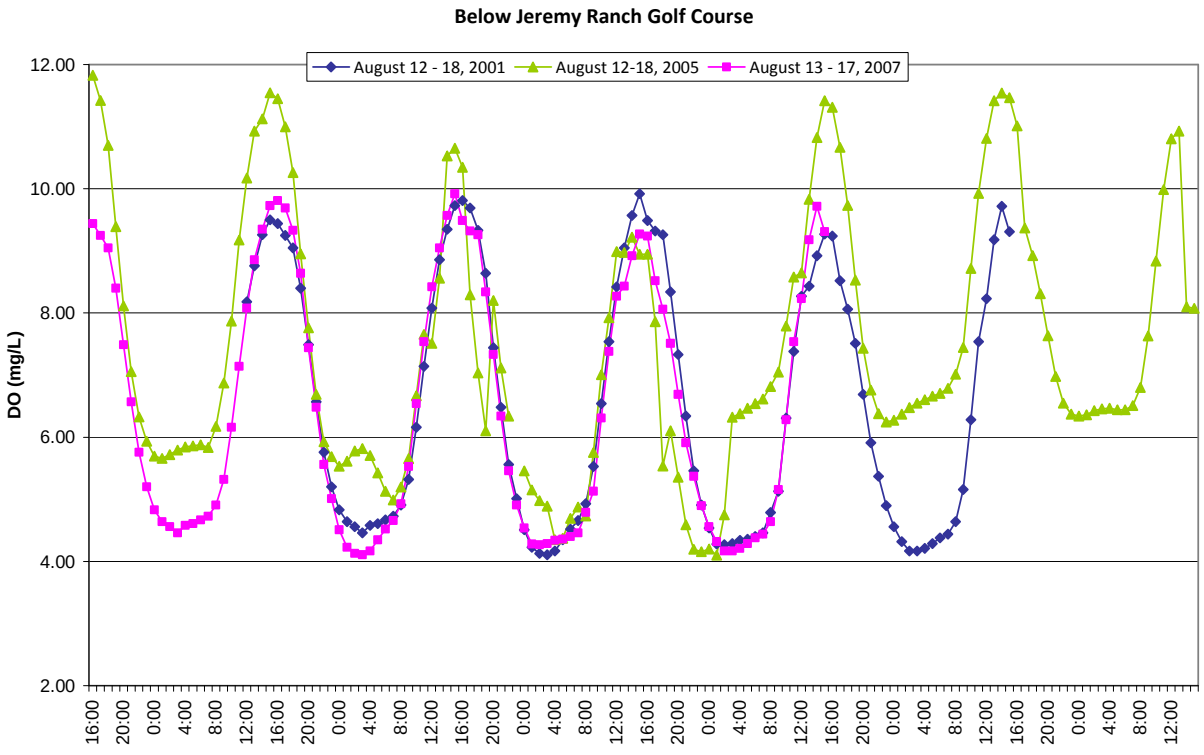

Figure 10. Diel DO data collected in East Canyon Creek below JRGC during August, 2001, 2005, and 2007.

Diel DO data collected below JRGC (Figure 10) does not show as clear a trend as the upstream samples. However, the ANOVA comparison of the mean DO concentrations for the summer before project work and the summers after project work (6.85 mg/L and 7.45 mg/L) showed that the change was statistically significant.

DO data was also available from STORET for McLeod Creek, just below the riparian project completed by PCMC. DO for the summers of 2000 and 2001 (pre-project) averaged 8.19 mg/L. DO for the summers of 2004 through 2009 (post-project) averaged 9.52 mg/L. According to the ANOVA for this data the change in the means is statistically significant.

8.3.3. Nutrients: TP

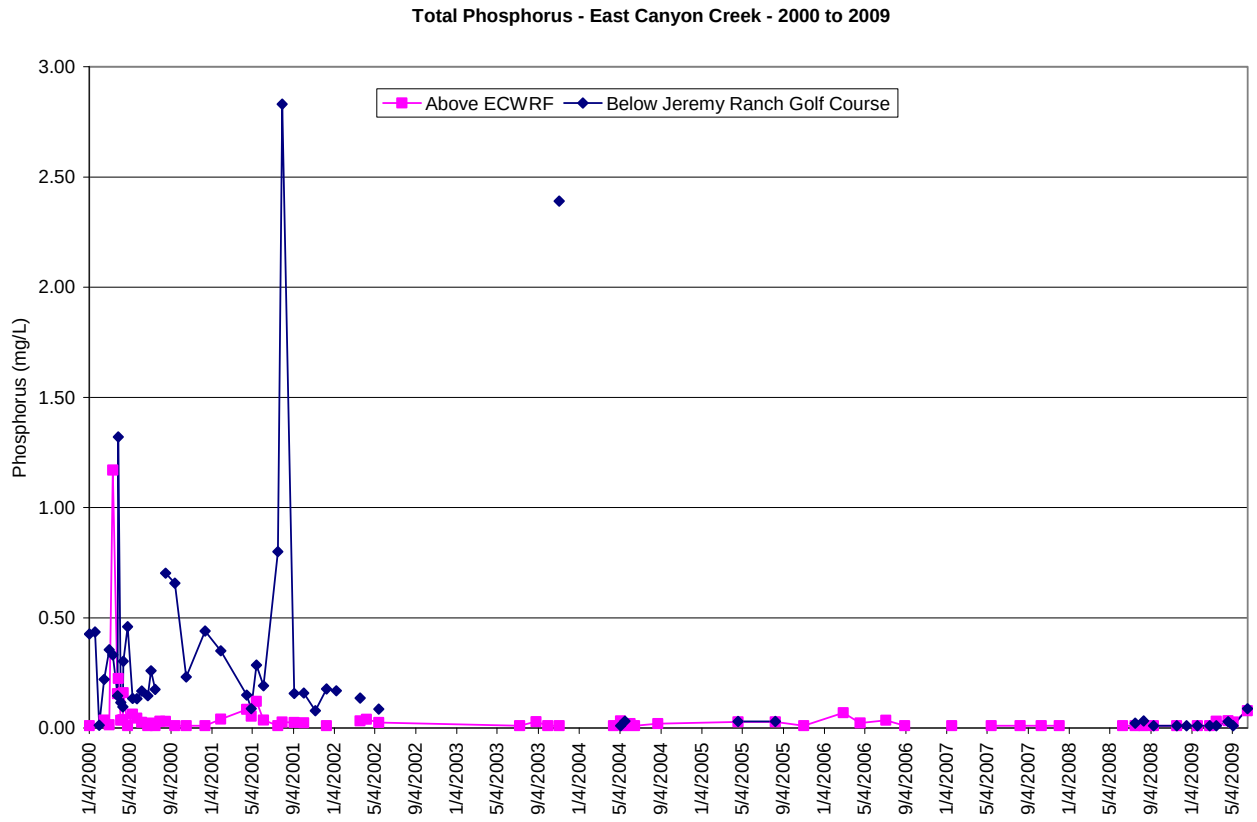

Figure 11. TP data for East Canyon Creek above ECWRF and below JRGC (2000 – 2009).

Figure 11 illustrates the decrease in TP concentrations over time above ECWRF and below JRGC. Based on the graph, TP concentrations have decreased since projects began in 2002. Below JRGC the change in TP concentrations may be linked to ECWRF beginning phosphorus removal in 2003. However, the decrease in TP above ECWRF suggests that the reductions are due in part to NPS load reductions.

An ANOVA for mean phosphorus concentrations pre- and post- project work above ECWRF (Appendix 14.3, table 3) indicates that the means are equal – no statistically significant changes occurred. This result may be due to the variability in the dataset, such as the timing of sample collection and the number of data points. Additional data will be collected as part of routine monitoring efforts and may help determine whether improvements have actually occurred.

The ANOVA for mean TP concentrations below JRGC (Appendix 14.3, table 4) indicated that there is a statistically significant difference between the datasets collected before and after project work (0.35 mg/L and 0.02 mg/L, respectively).

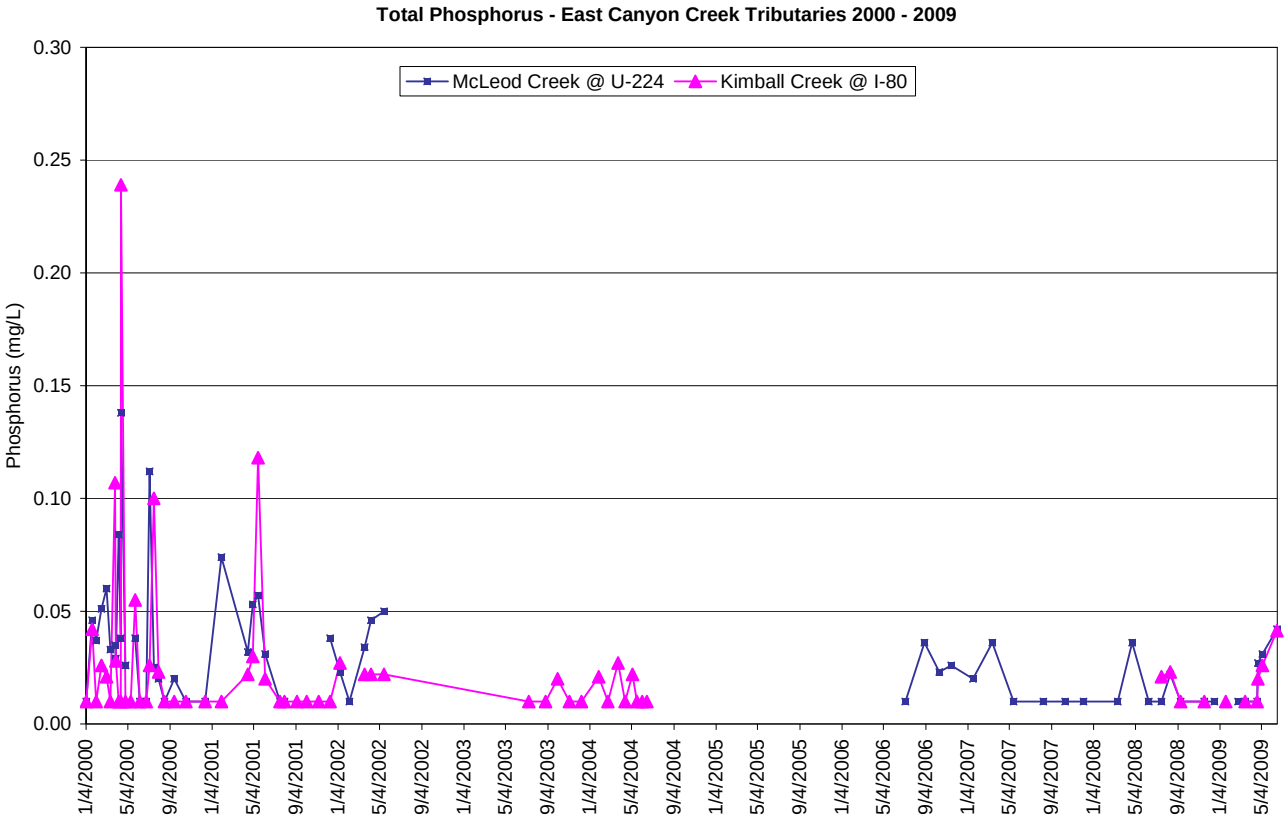

Figure 12. TP for McLeod Creek and Kimball Creek (2000 – 2009) – tributaries to East Canyon Creek.

Figure 12 depicts TP concentrations in tributaries to East Canyon Creek. PCMC began project work on McLeod Creek in 2002. TP samples collected from the location immediately downstream of the project area (McLeod Creek @ U-224 Crossing – see Figure 3) decreased from concentrations that sometimes exceeded 1.0 mg/L during 2000 and 2001 to concentrations consistently below 0.05 mg/L from 2006 to 2009. The mean concentrations changed from 0.038 mg/L to 0.018 mg/L. According to the ANOVA the difference is statistically significant (Appendix 14.3, table 1).

Based on the graph, TP concentrations in Kimball Creek appear to have decreased post project work. However, an ANOVA for mean phosphorus concentrations pre- and post-project work at Kimball Creek (Appendix 14.3, table 2) indicates that the means are equal – no statistically significant changes occurred. This result may be due to the small dataset and may not be accurate. Additional data will be collected as part of routine monitoring efforts to determine whether improvements have occurred.

8.3.4. Biological: EPT and HBI Scores

Biological measures are useful because they integrate longer time frames to provide a broader picture of overall stream health.

Table 3 summarizes the macroinvertebrate data collected by Dr. Lawrence Gray above ECWRF and below JRGC (Gray, 2010). Two indices were calculated using the data: Percent EPT and HBI. (The full report is available here: http://www.eastcanyoncreek.org/images/stories/LGray_Weber_Trib_Macroinvertebrates_2010_Report_for_2009_sampling.pdf)

Table 8. Macroinvertebrate data (Gray, 2010).

EPT/HBI and Streamflow Data for East Canyon Creek		2004	2005	2006	2007	2008	2009
EPT	ECG - East Canyon Below JRGC	29%	32%	42%	40%	36%	40%
	ECW - East Canyon Above ECWRF	33%	40%	47%	35%	36%	33%
HBI	ECG - East Canyon Below JRGC	7.2	5.5	4.6	5.85	6.55	3.9
		poor	fair	good	fair	fairly poor	very good
	ECW - East Canyon Above ECWRF	5.36	4.52	4.6	4.18	5.23	3.67
		fair	good	good	very good	good	excellent
Mean Annual Streamflow (cfs)		25.0	48.6	55.1	22.0	40.0	40.5

Data Source: Macroinvertebrate Sampling and Analysis Studies in the Weber River Drainage Basin
Prepared for the Utah Department of Environmental Quality, Division of Water Quality, TMDL Program
Prepared by Dr. Lawrence J. Gray, Senior Ecologist (ESA) January 1, 2010

Percent EPT is an index that is frequently used to assess the overall condition of streams. It is the percentage of individuals in a sample that are in the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). In general, species within these Orders are more sensitive to anthropogenic stressors than species from other Orders of macroinvertebrates.

The Modified Hilsenhoff Biotic Index (HBI) is an index that summarizes the relative tolerance of an assemblage to human-caused nutrient enrichment. The higher the HBI value the greater the enrichment and the poorer the water quality.

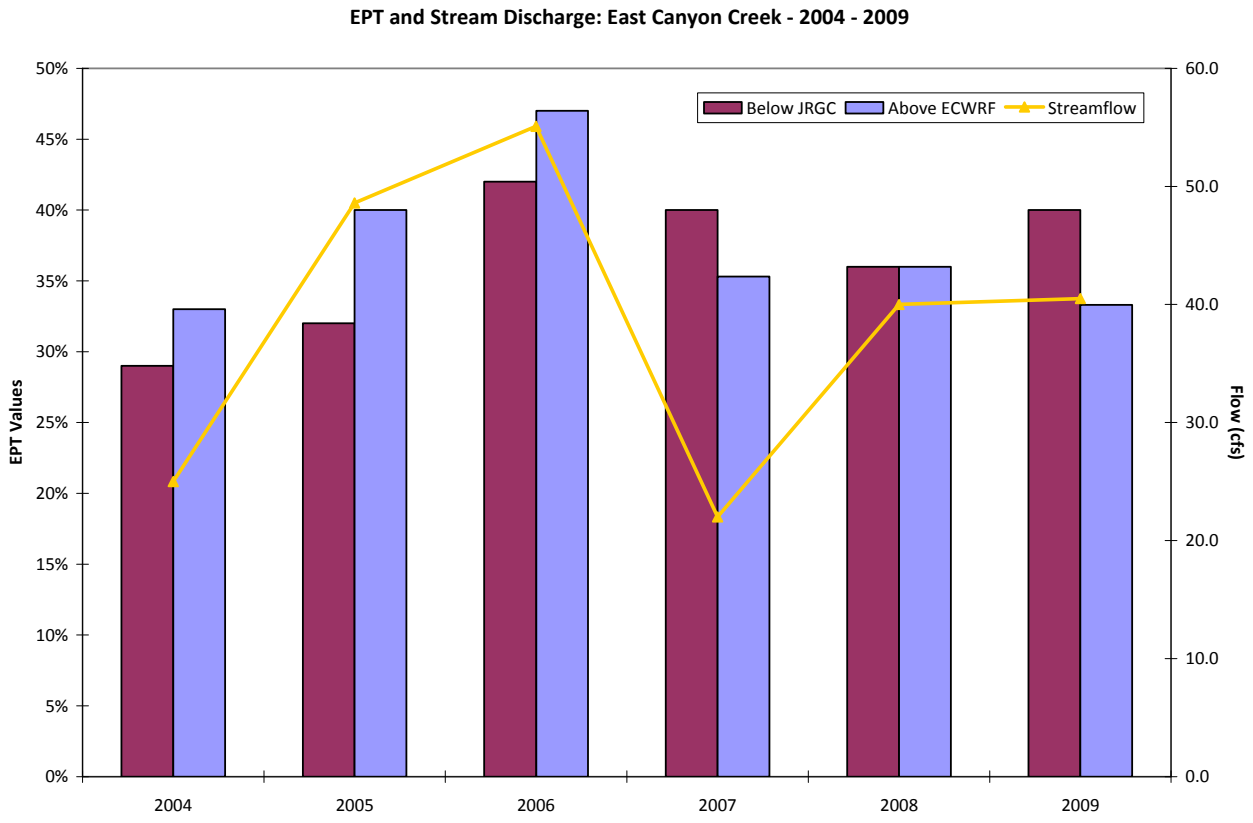

Figure 13. EPT and streamflow 2004 – 2009 (data from Gray, 2010).

Figure 13 compares EPT and streamflow above ECWRF and below JRGC. EPT appears to increase with increasing streamflow and shows a moderate response to the decrease in flow. From 2004 to 2006 more EPT species were observed above ECWRF. From 2007 to 2009 the percent EPT was the same or greater below JRGC.

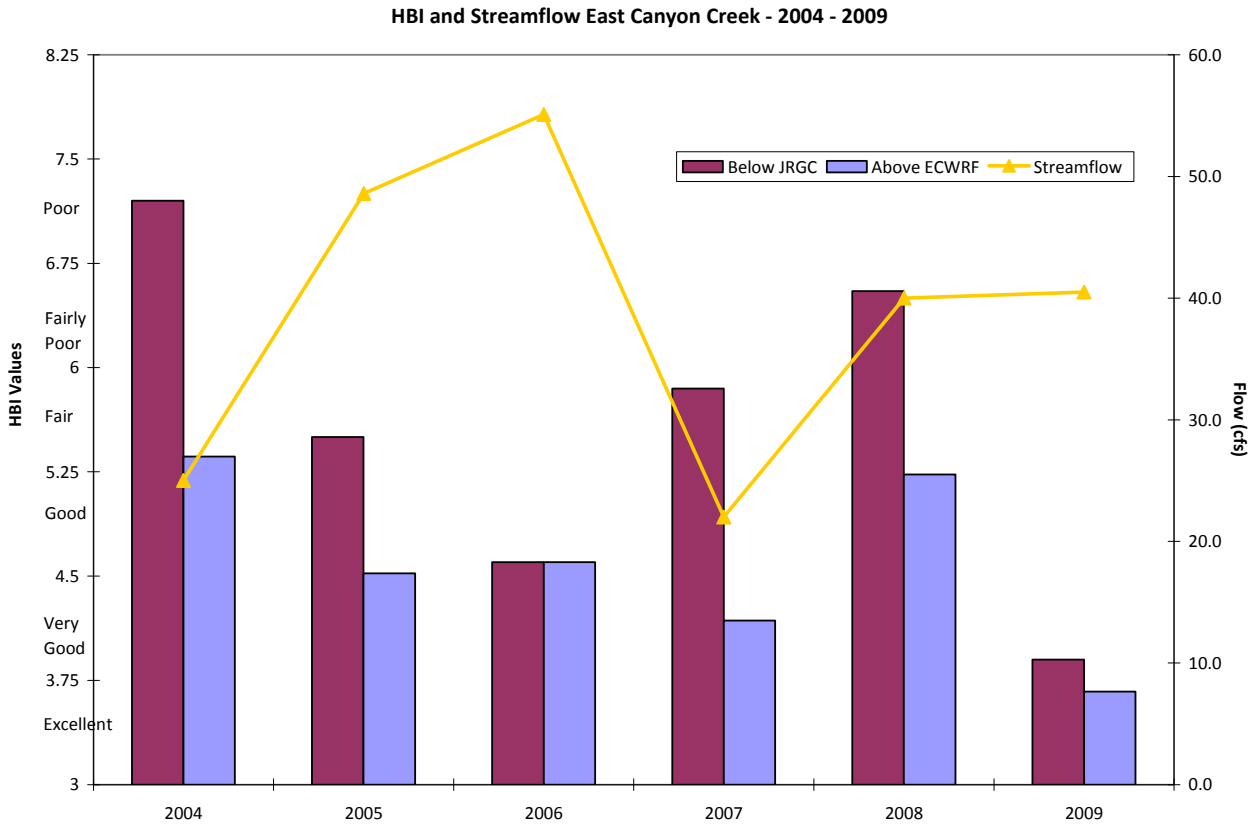

Figure 14. HBI values and streamflow 2004 – 2009 (data from Gray, 2010).

Figure 14 compares HBI values and streamflow above ECWRF and below JRGC. HBI values are generally lower above ECWRF, and they went from fair in 2004 to excellent in 2009. There is no correlation between HBI and streamflow above ECWRF. This may be due to the overall better condition of the stream in this location.

Below JRGC values have improved but not as consistently as the above ECWRF location. They went from poor in 2004 to very good in 2009. There is a moderate correlation to streamflow below JRGC - HBI decreases as streamflow increases, indicating healthier benthic populations. This may be due to higher flows flushing sediment from the system, thus removing the source of nutrients and organics and resulting in a more diverse macroinvertebrate assemblage.

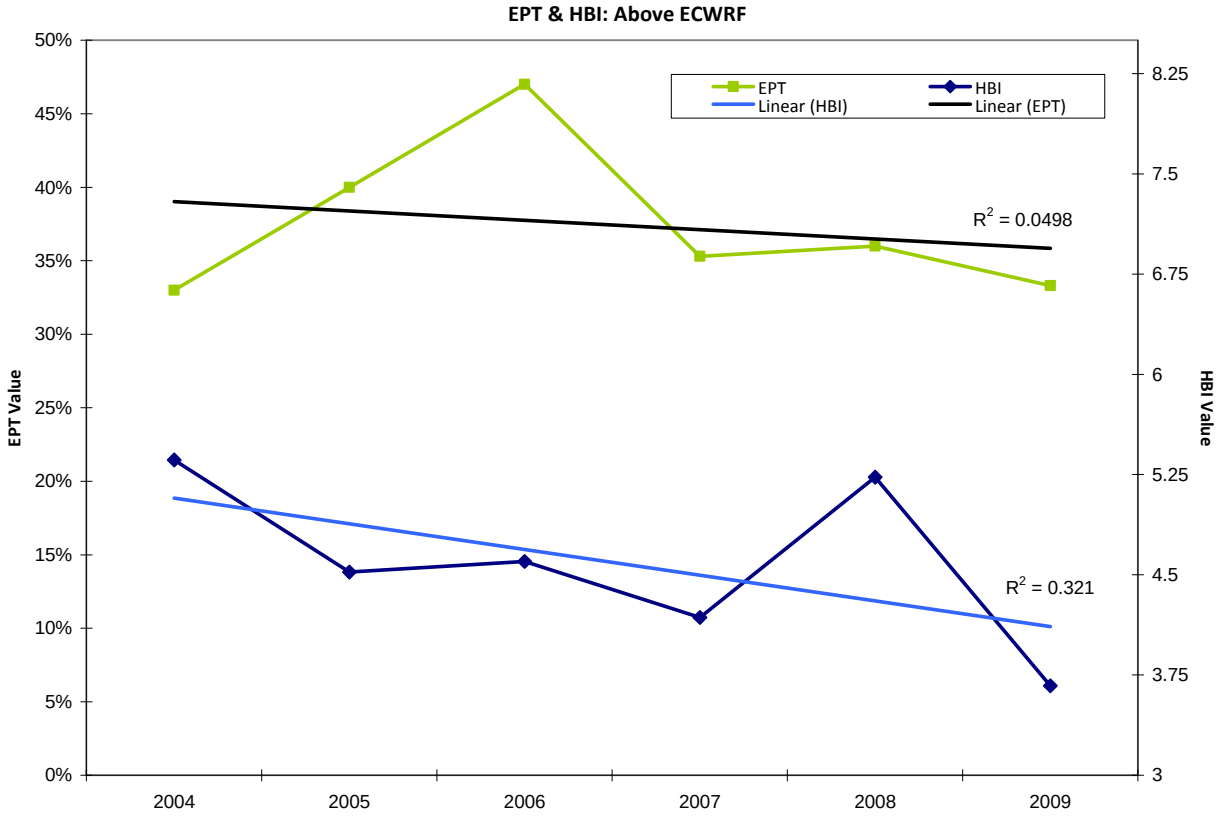

Figure 15. Change in EPT and HBI values above ECWRF 2004 – 2009 (data from Gray, 2010).

In Figure 15, EPT does not show a clear trend above ECWRF. HBI has slightly decreased over time at this location, indicating that water quality may be improving. Given the DO and HBI data, it would appear that water quality is fairly good at this location such that EPT is less responsive to the changes in flow.

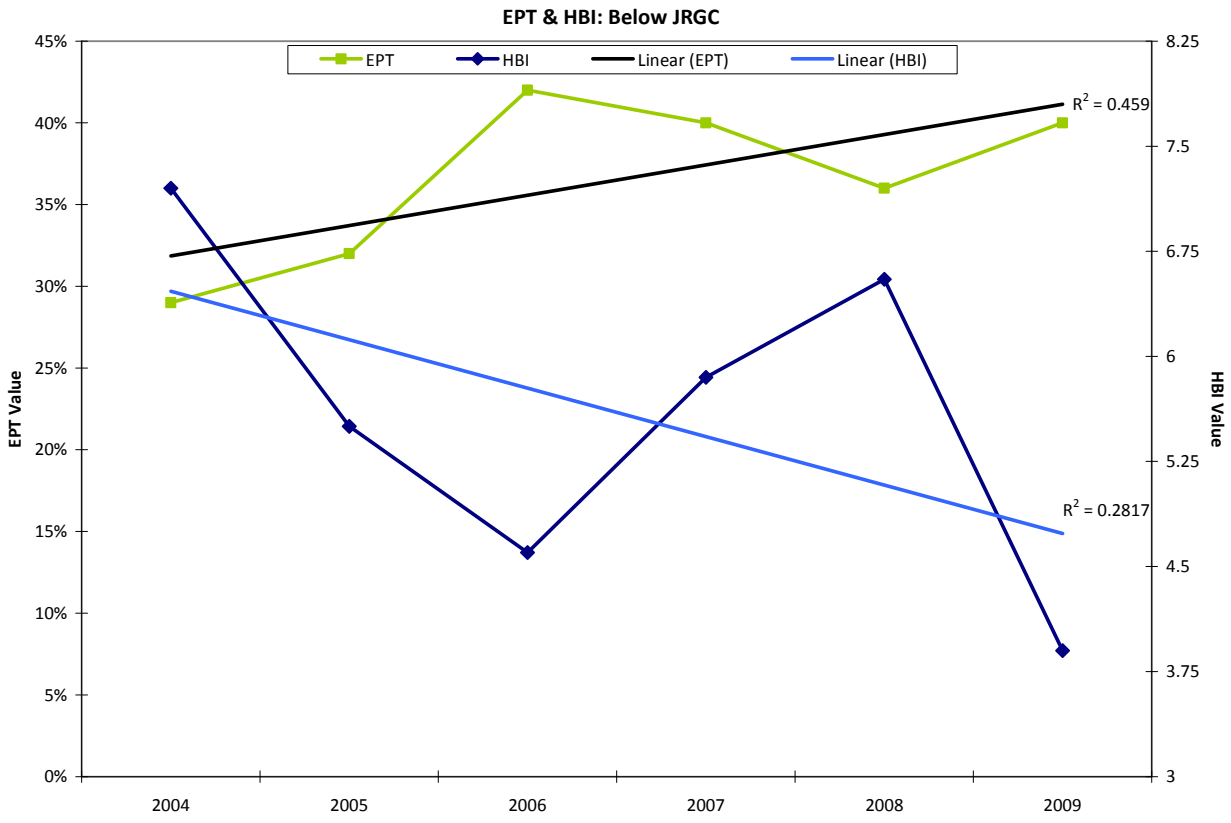

Figure 16. EPT and HBI values below JRGC (data from Gray, 2010).

Figure 16 illustrates that EPT has increased and HBI has slightly decreased below JRGC, perhaps indicating improved stream health.

The EPT and HBI data show improvements above ECWRF and below JRGC. However, there are some ambiguities in the data, particularly as it pertains to streamflow. These two locations are designated as long-term biological monitoring sites, so additional years of study may remove some of the ambiguity.

8.3.5. Biological: O/E Scores

DWQ collected macroinvertebrate data using Utah Comprehensive Assessment of Stream Ecosystems (UCASE) protocols. The UCASE survey involves collection of: (1) general water chemistry (e.g., pH, TSS, TDS, bicarbonate, carbonate, carbon dioxide, hydroxide, sulfate, alkalinity, specific conductance, and turbidity), (2) metals (e.g., aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, selenium, silver, and zinc), (3) nutrients (e.g., ammonia, phosphorus, nitrate, and nitrite), (4) physical habitat (e.g., channel dimensions, gradient, substrate characteristics, habitat and cover complexity, riparian vegetation cover and structure, anthropogenic disturbance, and floodplain connectivity), (5) periphyton, and (6) macroinvertebrate samples.

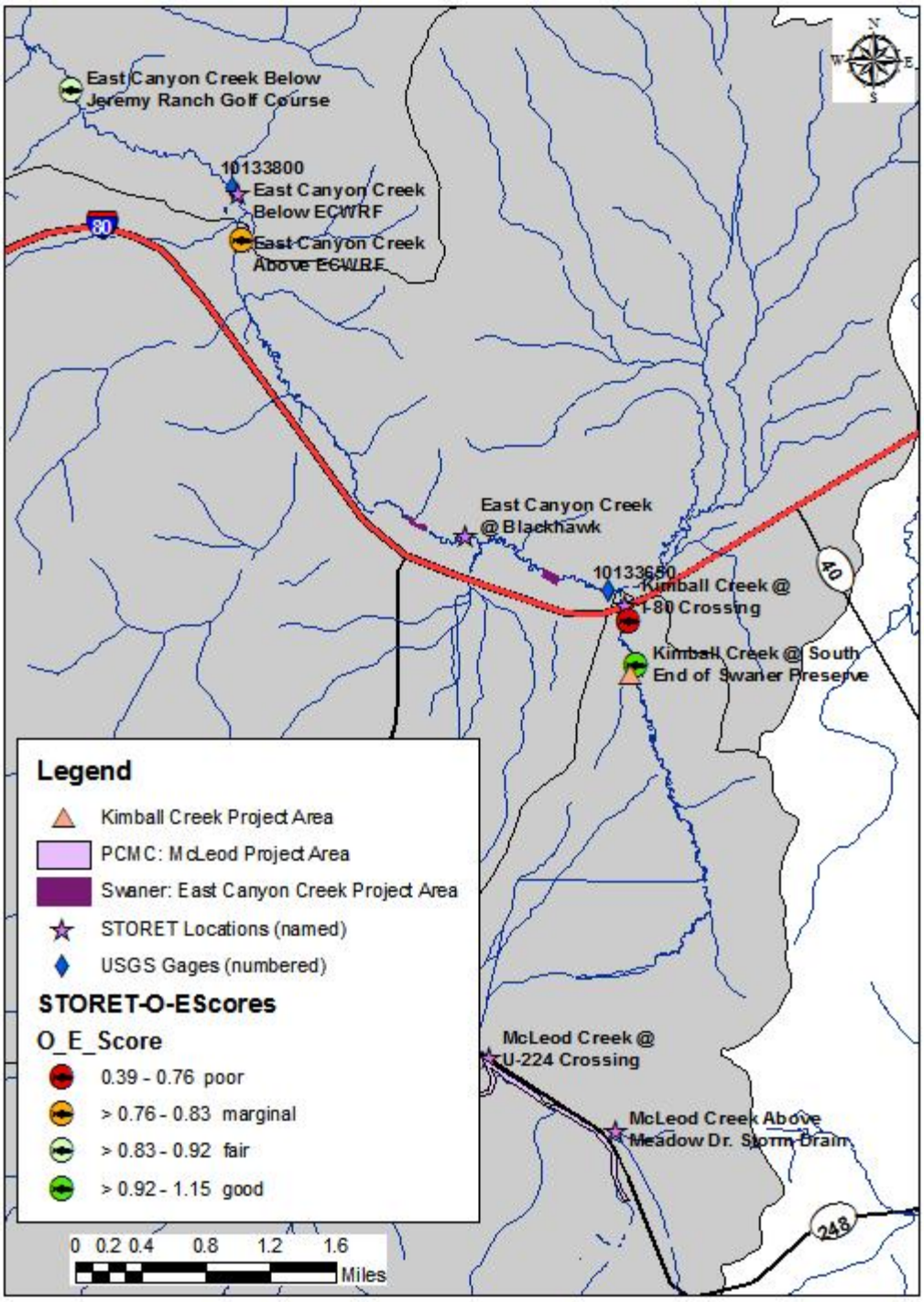

Figure 17. O/E Scores – data collected by DWQ from 2006 – 2008.

O/E is another measure of biological integrity that is derived from RIVPACS-type empirical models (Wright, 1984). These models use geographical and physical watershed characteristics from reference sites to predict the number of taxa that are expected to occur in the absence of human-caused disturbance (E). These predictions are then compared with those taxa observed at a site that the model predicted to occur (O). An O/E score of 0.75 indicates that only 75% of the expected species are present.

Figure 17 shows locations with O/E data. The color coding represents whether the location is meeting water quality standards based on O/E score. For the purposes of this report the scores have been broken into 4 categories: red = poor (39% to 76.0%), orange = marginal (>76%, <= 83%), light green = fair (>83% to 92%), and dark green = good (>92%). Scores in the fair and good categories meet water quality standards.

These scores suggest that Kimball Creek upstream of Swaner is in good condition, but Kimball Creek at the I-80 crossing, which is also Swaner Preserve, is in poor condition. East Canyon Creek above ECWRF had a marginal O/E score and East Canyon Creek below JRGC had a good O/E score.

Not all of the O/E data correspond well with other sources of data collected. However, individual sites can be variable. Additional data will be collected using the UCASE protocols.

8.4. Improvement Summary Table and Conclusions

Table 9. Comparison of monitoring results.

Location	Improvement: yes/no/unclear				O/E score
	DO	TP	EPT	HBI	
McLeod Creek @ U-224	yes	yes			
Kimball Creek @ south end of Swaner Preserve					95%
Kimball Creek @ I-80		unclear			48%
East Canyon Creek above ECWRF	yes	unclear	unclear	yes	79%
East Canyon Creek below ECWRF	yes				
East Canyon Creek below JRGC	unclear	yes	yes	yes	92%
yellow squares indicate that no data was available					

Table 9 compares the results of the different types of monitoring discussed in this report. This matrix shows that there are some measurable water quality improvements, particularly in McLeod Creek and in East Canyon Creek below ECWRF and below JRGC.

There is also some ambiguity between the different data sets. This could be explained by variations in shading, sediment deposition/legacy sediment, channel morphology, and stream flow. This is consistent with the findings of the 2009 TMDL revision, which documented water quality improvements but determined that there are still impairments that are due to factors other than water column chemistry (see Section 12.0).

8.5. Quality Assurance Reporting

Data collection was conducted under standard protocols established by the State of Utah DWQ. Results from the monitoring activities are routinely scrutinized in a timely manner against the data quality objectives established for 319 projects. The DWQ Watershed/TMDL coordinator is responsible for determining whether the objectives of the NPS monitoring effort have been attained and whether to reestablish new data quality objectives based upon the data collected from the projects.

9.0 Coordination Efforts

9.1. Federal Agencies

Natural Resources Conservation Service
United States Geological Survey
United States Department of the Interior/Bureau of Reclamation

9.2. State Agencies

Utah Department of Environmental Quality/Division of Water Quality
Utah Department of Natural Resources/ Division of Wildlife Resources
Utah Department of Natural Resources/ Division of Parks and Recreation
Utah Department of Natural Resources/ Division of Water Rights

9.3. County and Local Agencies

Kamas Valley Conservation District
Park City Municipal Corporation
Park City Municipal Golf Course
Snyderville Basin Water Reclamation District
Summit County
Summit County Engineering Department
Summit County Health Department
Morgan County Commission
Weber Basin Water Conservancy District
Mountainland Association of Governments

9.4. Local Stakeholders

East Canyon Water Quality Advisory Committee
Park City Mountain Resort
The Canyons
Jeremy Golf and Country Club
East Canyon Resort
Summit Water Distribution Company
Trout Unlimited
Utah Association of Conservation Districts

9.5. USDA Programs

WIPP
EQIP

9.6. Other Sources of Funds

NRCS Congressional Earmark

10.0 Summary of Public Participation

The public in the East Canyon Watershed are well educated and generally environmentally aware. Much of the local public has moved to this area because of its aesthetic beauty and environmental setting. There is strong support to assure that the stream and reservoir are restored and maintained.

The East Canyon Water Quality Advisory Committee holds quarterly meetings that are well attended by a broad spectrum of interested organizations and individuals, including local, state, and federal governmental agencies. The meetings focus on the water quality concerns and issues of East Canyon Creek and Reservoir. As the initial TMDLs were developed in late 1999 and early 2000, significant interest was noted both in committee meetings and at public meetings. The general consensus from the public at these meetings was concern that something had not been done earlier to address the water quality problems that have existed in the creek and reservoir for several years. Since the 2000 TMDLs, the public, stakeholders, and state and federal agencies have actively participated in implementation.

11.0 Aspects of the Project that Did Not Work Well

This project work has been very successful in the watershed. It has encouraged stakeholder involvement to leverage additional funding and conduct additional project work. There have been documented water quality improvements. Future project work could be improved by developing a project tracking database specific to the East Canyon Watershed that would be available to stakeholders and the public. The revised TMDL (SWCA, 2009) has recommended developing such a database to be hosted on the East Canyon Creek Watershed website. This would help not only project tracking and reporting, but also encouraging continued involvement of the community.

12.0 Future Activity Recommendations

The 2000 TMDLs for East Canyon Creek and Reservoir were revised in 2009 (SWCA, 2009). The TMDL study found that sediment nutrients and NPS TP and TSS drive DO concentrations and macrophyte levels in East Canyon Creek. Extensive macrophyte and algal populations in the stream cause increased sediment oxygen demand and low DO concentrations. The revised TMDL recommended riparian shading, increased streamflow, and change in channel geometry to reduce macrophyte productivity. As such, it is recommended that streambank stabilization, revegetation, and channel re-shaping where necessary be continued in order to restore the beneficial use.

13.0 Literature Cited

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14.0 List of Appendices

14.1. Appendix: Web Links to Supporting Documents

Links are listed in the order they appear in the text.

East Canyon Creek SVAP: http://www.eastcanyoncreek.org/resources/documents
PCMC dredging project: http://www.eastcanyoncreek.org/projects/4-park-city-golf-course-pond-dredging-project
Treasure Hollow Erosion control project: http://www.eastcanyoncreek.org/projects/6-park-city-mt-resort-erosion-control-and-gully-repair-project
Snyderville Basin Recreation and Construction Industry Water Quality Improvements Project:
http://www.eastcanyoncreek.org/images/stories/Downloadable_publications/wq_improvement_project.pdf
East Canyon Watershed Website: http://www.eastcanyoncreek.org
East Canyon Watershed 2004 Newsletter:
http://www.eastcanyoncreek.org/images/stories/Downloadable_publications/2004_newsletter.pdf
Swaner Nature Preserve revegetation project: http://www.eastcanyoncreek.org/projects/5-swaner-nature-preserve-east-canyon-creek-restoration-project
PCMC McLeod Creek restoration:
http://www.eastcanyoncreek.org/images/stories/AnnualReport2007BFINAL.pdf
PCMC web-based environmental GIS: http://mapserv.utah.gov/ParkCityGIS/
East Canyon WRAP:
http://www.eastcanyoncreek.org/images/stories/Downloadable_publications/east_canyon_wrap_final_2004_09_01.pdf
East Canyon Creek Flow Augmentation Feasibility Study, Summit and Morgan Counties, Utah (Kleinfelder, February 2005):
http://www.eastcanyoncreek.org/images/stories/Downloadable_publications/fafs.pdf
East Canyon Watershed Phosphorus Deposit Mapping (Stantec Consulting Inc., January 2008): http://www.eastcanyoncreek.org/images/stories/ECPhosMapDocument.pdf
East Canyon Creek Streambank Enhancement Project – Annual Report (SWCA Environmental Consultants, December 2009):
http://www.eastcanyoncreek.org/images/stories/Annual_Progress_Report_2010_319Funded1.pdf

14.2. Appendix: ANOVA Tables – Dissolved Oxygen

1. Single Factor ANOVA Comparison of Mean Dissolved Oxygen Concentrations
McLeod Creek @U224: Pre and Post Project Work, Summer

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
DO Summer 2000 - 2001	12	98.3	8.19	1.17
DO Summer 2004-2009	6	57.1	9.52	0.71

Single Factor ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	7	1	7.06	6.8664	0.0186	4.4940
Within Groups	16	16	1.03			
Means are equal	no					
Total	24	17				

2a. Single Factor ANOVA Comparison of Mean Dissolved Oxygen Concentrations Below
East Canyon Water Reclamation Facility: Pre and Post Project Work, August 2001, 2005, 2007

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Pre (August 2001)	488	2964.2	6.07	3.09
Post (August 2005, 2007)	791	5713.8	7.22	2.16

Single Factor ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	399	1	398.66	158.6525	2.25E-34	3.8488
Within Groups	3209	1277	2.51			
Means are equal	no					
Total	3608	1278				

2b. Single Factor ANOVA Comparison of Mean Dissolved Oxygen Concentrations
Below East Canyon Water Reclamation Facility: Pre and Post Project Work, August-September

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Pre (August - September 2001)	785	5187.7	6.61	2.48
Post (August-September 2007)	1450	11234.3	7.75	2.50

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	661	1	661.08	265.3794	1.83E-56	3.8456
Within Groups	5563	2233	2.49			
Means are equal	no					
Total	6224	2234				

2c. Single Factor ANOVA Comparison of Mean Dissolved Oxygen Concentrations Below East Canyon Water Reclamation Facility: Post Project Work, August

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
DO 2005	91	684.0	7.52	0.34
DO 2007	90	668.2	7.42	0.15

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0	1	0.38	1.5618	0.2130	3.8939
Within Groups	44	179	0.25			
Means are equal	yes					
Total	44	180				

3. Single Factor ANOVA Comparison of Mean Dissolved Oxygen Concentrations Above East Canyon Water Reclamation Facility: Pre and Post Project Work, August 2001, 2007

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Pre (August 2001)	340	2113.5	6.22	2.61
Post (August 2007)	730	5348.0	7.33	2.67

Single Factor ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	286	1	285.72	107.8205	3.96E-24	3.8502
Within Groups	2830	1068	2.65			
Means are equal	no					
Total	3116	1069				

4a. Single Factor ANOVA Comparison of Mean Dissolved Oxygen Concentrations Below Jeremy Ranch Golf Course: Pre and Post Project Work, August

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
pre (August: 2001)	534	3535.2	6.62	9.17
post (August: 2005, 2007)	243	1723.9	7.09	4.41

Single Factor ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	37	1	37.49	4.8778	0.0275	3.8535
Within Groups	5957	775	7.69			
Means are equal	no					
Total	5995	776				

4b. Single Factor ANOVA Comparison of Mean Dissolved Oxygen Concentrations Below Jeremy Ranch Golf Course: Pre and Post Project Work, Summer

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Pre (Summer 2001)	703	4818.3	6.85	7.71
Post (Summer 2005, 2007)	434	3232.5	7.45	4.57

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	95	1	94.79	14.5553	0.0001	3.8497
Within Groups	7392	1135	6.51			
Means are equal	no					
Total	7486	1136				

14.3. Appendix: ANOVA Tables – Total Phosphorus

1. Single Factor ANOVA Comparison of Mean Total Phosphorus Concentrations Pre and Post Project Work
MCLEOD CREEK AT U-224 CROSSING

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Pre (00-02)	35	1.32	0.03771	0.00085
Post (06-09)	24	0.439	0.01829	0.00012

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.01	1	0.0054	9.6708	0.0029	4.0099
Within Groups	0.03	57	0.00056			
Means are equal	no					
Total	0.04	58				

2. Single Factor ANOVA Comparison of Mean Total Phosphorus Concentrations Pre and Post Project Work
KIMBALL CREEK AT I-80 CROSSING

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Pre (00-02)	38	1.15	0.0303	0.0019
Post (04,08,09)	23	0.3614	0.0157	6.98E-05

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.00	1	0.0030	2.4487	0.1230	4.0040
Within Groups	0.07	59	0.0012			
Means are equal	yes					
Total	0.08	60				

3. Single Factor ANOVA Comparison of Mean Total Phosphorus Concentrations Pre and Post Project Work

EAST CANYON CREEK ABOVE EAST CANYON WATER RECLAMATION FACILITY

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Pre (00-02)	34	2.644	0.07776	0.03969
Post (03-09)	33	0.653	0.01979	0.00027

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.06	1	0.0563	2.7750	0.1006	3.9886
Within Groups	1.32	65	0.0203			
Means are equal	yes					
Total	1.37	66				

4. Single Factor ANOVA Comparison of Mean Total Phosphorus Concentrations Pre and Post Project Work

EAST CANYON CREEK BELOW JEREMY RANCH GOLF COURSE

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Pre (00-02)	35	12.496	0.357029	0.250543
Post (04-09)	14	0.332	0.023714	0.000437

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.11	1	1.1110	6.1257	0.0170	4.0471
Within Groups	8.52	47	0.1814			
Means are equal	no					
Total	9.64	48				