2000 Water Quality

Implementation Report

Deer Creek and Jordanelle Reservoirs
Water Quality Management Plan
for 1999

2000 Water Quality
Implementation Report

Deer Creek and Jordanelle Reservoirs
Water Quality Management Plan
for 1999

Prepared for:
The Wasatch County Commission

In Association with:
Jordanelle Reservoir Water Quality
Technical Advisory

September, 2000
FINAL

Prepared by:
PSOMAS
2825 East Cottonwood Parkway, Suite 120
Salt Lake City, Utah 84121
(801)-270-5777
http:\\www.psomas.com

We would like to acknowledge the support and cooperation of each of the following entities who all contributed to help fund the JTAC Workplan:

Central Utah Water Conservancy District (CUWCD)

Metropolitan Water District of Orem (MWDO)

Metropolitan Water District of Provo (MWDP)

Metropolitan Water District of Salt Lake City (MWDSLC)

Jordan Valley Water Conservancy District (JVWCD)

United States Bureau of Reclamation (USBR)

We would like to acknowledge the support and cooperation of each of the following entities for their valuable participation in JTAC:

Deer Valley Resort

Heber Valley Special Service District

Jordanelle Special Service District

Mayflower Resort

Mountainland Association of Governments (MAG)

Provo River Water Users Association (PRWUA)

Salt Lake City Public Utilities

Summit County

United States Environmental Protection Agency (EPA)

United States Department of Agriculture (USDA)

United States Geological Survey (USGS)

Utah Department of Transportation (UDOT)

Utah State Department of Environmental Quality
Division of Drinking Water Quality
Division of Water Quality (DWQ)

Utah State Department of Natural Resources
Division of Water Resources
Division of Wildlife Resources (DWR)
Division of Parks and Recreation

Wasatch-Cache National Forest

Wasatch County

Wasatch County Service Area #1

Natural Resources Conservation Service (NRCS)
Wasatch Soil Conservation District

Prepared By:

PSOMAS
2825 East Cottonwood Parkway, Suite 120
Salt Lake City, Utah 84121
(801) 270-5777
htttp:\\www.psomas.com

Project Team:

Dave Eckhoff, Team Leader
Alane Boyd, Project Director
Charles Gillette, Staff Engineer
Roger Peters, Staff Engineer
Brian Harward, Intern Engineer

Prepared For:

WASATCH COUNTY COMMISSION

T. LaRen Provost, Chairman

Ralph Duke

Michael L. Kohler

WASATCH COUNTY PLANNING COMMISSION

Roy Remund, Chairman

Mike Davis

George Holmes

John W. Lloyd

Bill McNaughten

Ralph Duke

John H. Price

John Burns

Julie Owens

Table of Contents

List of Tables

List of Figures

List of Abbreviations

ac-ft	acre-feet
BMPs	Best Management Practices
cfs	cubic feet per second
CUPCA	Central Utah Project Completion Act
CUWCD	Central Utah Water Conservancy District
DNR	Utah Department of Natural Resources
DO	Dissolved Oxygen
DTP	Dissolved Total Phosphorus
DWQ	Utah State Division of Water Quality
DWR	Utah State Division of Wildlife Resources
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Improvement Program
HVSSD	Heber Valley Special Service District
JSSD	Jordanelle Special Service District
JTAC	Jordanelle Reservoir Water Quality Technical Advisory Committee
kg/yr	kilograms per year
MAG	Mountainland Association of Governments
mg/l	milligrams per liter
MtBE	Methyl tertiary-butyl ether
MWDO	Metropolitan Water District of Orem
MWDP	Metropolitan Water District of Provo
MWDSLC	Metropolitan Water District of Salt Lake City
NH_3	Ammonia
NOV	Notice of Violation
NRCS	Natural Resources Conservation Service
PRRP	Provo River Reclamation Project
PRWUA	Provo River Water Users Association
QA/QC	Quality Assurance / Quality Control
RMP	Deer Creek Resource Management Plan
SLCWCD	Salt Lake City Water Conservancy District
SLOC	Salt Lake Olympic Committee
SLOW	Selective Level Outlet Works
SRF	Clean Water State Revolving Fund
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TP	Total Phosphorus
TSI	Carlson Trophic State Index
TSS	Total Suspended Solids
UDOT	Utah Department of Transportation
UPDES	Utah Pollutant Discharge Elimination System
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WCWEP	Wasatch County Water Efficiency Project
µg/l	micrograms per liter

Executive Summary

INTRODUCTION

Water plays a vital role in the development of the West. Productivity and economy are closely tied to maintaining access to abundant high quality sources of water. One of Utah's best water resources, the Provo River, provides water for use by over a million Utah residences for purposes such as drinking, agricultural, industrial, and recreational. Equally important, the Provo River supports a delicate ecosystem of invaluable living organisms.

Along the Provo River, Deer Creek and Jordanelle Reservoirs water management plans have helped make this water available for public and private use. These reservoirs are vital to the surrounding communities. One of the main challenges facing those in charge of managing the reservoirs is the control of eutrophication. Eutrophication is a natural process that occurs in lakes and reservoirs when there is an abundance of nutrients. It simply means that there are enough of the right nutrients present to incur algae growth. Excessive algae growth can seriously deteriorate water quality causing taste and odor problems which in turn increase treatment costs.

Formation of JTAC

In 1981, because of eutrophication evidences in the Deer Creek Reservoir, Utah Governor Scott Matheson established the Jordanelle Reservoir Water Quality Technical Advisory Committee (JTAC) for the purpose of developing a reservoir management plan for Deer Creek Reservoir and the then future Jordanelle Reservoir. Thus, JTAC was created with the representation of over twenty federal, state, local agencies, and private companies.

The Water Quality Management Plan for Deer Creek and Jordanelle Reservoirs was implemented by JTAC in 1984. This plan directs JTAC to conduct a water-sampling program that monitors the condition of water quality throughout the year. It also requires that an annual report be released that analyzes and presents the resulting data. This plan was updated in 1998.

Phosphorus: Limiting Nutrient

The JTAC water-sampling program identifies many water quality parameters, some of these include physical and chemical properties, metals and nutrients present in the water. The most critical water quality constituent for this analysis, however, is phosphorus. In general, phosphorus is the limiting nutrient that controls the growth of algae. By decreasing the phosphorus loads into the reservoirs algae growth will also decrease.

In the Provo River Watershed, a variety of natural sources contribute to the formation of phosphorus, but human factors also are a substantial contributor. The goal of JTAC is to reduce pollution from these sources by encouraging the implementation of projects, efficient management practices, and smart planning.

Another constituent, Total Suspended Solids (TSS), is an important factor in water quality. This is an extremely important parameter in the analysis of stream water. It is used to evaluate the amount of inorganic salts and other materials suspended in water. Also, the degree of treatment needed to ready the water for consumption may be determined if accurate results are obtained.

CURRENT ACTIVITIES

Land use and various activities within the watershed affect the water quality in streams, rivers and reservoirs, which ultimately affects the water users. Several of these activities are extremely important to future water quality in the watershed. Described below are some of these activities.

JTAC "Keep Your Water Clean" Logo

A public information subcommittee of JTAC has developed a logo to convey the message that Deer Creek and Jordanelle Reservoirs are primarily storage reservoirs for drinking water and should therefore be protected from unnecessary pollution.

Provo Canyon Scenic Byway / Watershed Management Plan

Through federal grants, the Mountainland Association of Governments has commissioned a study to be performed in the Provo Canyon area. The study is two-fold, the first part being a scenic highway plan, which would help to preserve and promote the many intrinsic characteristics of the canyon road.

The second part of the plan is a watershed management plan with calculations for Total Maximum Daily Loads (TMDLs), which will identify water quality concerns in the canyon. Most of the water treatment agencies that are members of JTAC divert water directly from this portion of the Provo River. They are actively participating in the Watershed Management Plan.

Tri-Valley Watershed Project

The installation of sprinkler systems in the Heber Valley is the highest priority project in the Tri-Valley Watershed Plan. During 1999 the Natural Resources Conservation Service (NRCS) continued the planning and contracting efforts with 87 more landowners. At the present time NRCS has helped a total of 150 landowners with $951,107 in contracts for federal cost-share assistance, which will pay for part of the cost of installing a sprinkler system. NRCS anticipates that most of these systems will be installed during the summer and fall of 2000. In order to participate with the cost-share program, a Resource Management Plan must be developed by the landowner. NRCS can assist with this plan. Those interested may contact Ralph Mickelson of NRCS at (435) 654-0242, or e-mail at: Ralph.Mickelson@utheber.fsc.usda.gov.

Jordanelle Basin Master Plan and Developments

Wasatch County has adopted the Jordanelle Basin Master Plan and the Jordanelle Basin Overlay Zone ordinances, which will supplement existing county zoning regulations for lands within the Overlay Zone. These regulations are to guide development within the Basin and provide the vision for what is to come.

Sewer, water lines, and a water treatment plant are currently being constructed within the Jordanelle Special Service District to service developments within the Jordanelle Basin. Approximately 10,000 equivalent residential units have been approved in the master plans. A fire station has also been constructed and being operated with a full-time staff. And construction of some roads will begin this summer. It is anticipated that the Basin will grow rapidly within the next five years.

Wasatch County Water Efficiency Project

Design of the Wasatch County Water Efficiency Project has been completed and Central Utah Water Conservancy District (CUWCD) advertised for construction bids. The project was awarded to Barnard Construction Company, Inc and received a Notice to Proceed on October 8, 1998. The three-year construction project is in its second year of construction. The project will allow 1600 acres of land in the Heber Valley to be irrigated with sprinklers rather than the flood irrigation methods currently used. The result of this will reduce nutrient rich return flows that contribute to some of the water quality problems in Deer Creek Reservoir.

Provo River Restoration Project

The goal of the Provo River Restoration Project (PRRP) is to restore the Provo River in Heber Valley from below Jordanelle Dam to Deer Creek Reservoir. In many areas the river has been straightened for construction of flood control levees. The Utah Reclamation Mitigation and Conservation Commission is implementing the PRRP to restore the river pattern and ecological function to a more natural condition.

Restoration will be achieved by constructing a multiple-thread meandering channel, reconnecting the river to existing remnants of historic secondary channels and constructing small side channels to recreate aquatic features. Existing levees will be set back to create a near natural flood plain that will allow the river to change course naturally.

The first phase of the project began in April 1999 and was completed in December 1999. It covered approximately 1.45 miles of the Provo River, from 1.6 miles downstream of Jordanelle Dam to 0.9 miles south and west of Highway 40.

Upper Provo River Water Quality Management Plan

The Upper Provo River Water Quality Management Plan is an update to the management plan that was released 15 years ago in 1984. The basin characteristics and problems were identified and analyzed. Accordingly, Total Maximum Daily Loads (TMDLs) for problematic stream segments in the basin were set. These TMDLs were developed from procedures given by EPA to comply with the requirements under section 303(d) of the Clean Water Act.

Heber Valley Storm Water Management Plan

In response to recommendations from previous years' implementation reports Wasatch County has completed the Storm Water Study in Heber Valley. Wasatch County continues to experience increased urbanization that tends to increase natural storm runoff conditions. The study has identified potential sites for construction of new sedimentation basins and/or wet ponds intended to reduce eroded sediments in surface waters prior to entering Deer Creek Reservoir. By removing sediments, many pollutants including phosphorus will also be removed.

Heber Valley Special Service District

Heber Valley Special Service District (HVSSD) adopted a new facility plan in the summer of 1999. The plan recommends that the most cost effective and efficient manner to treat wastewater from the users is to expand the current facility of aerated lagoons with land application. (HVSSD is a non-discharge facility).

The construction year of 1999 saw almost 470 connections, which represents 11% of the designed capacity for connections. With the expectation that growth will continue at a brisk pace, HVSSD is moving forward with plans to design and build an additional treatment/storage lagoon that will add 1500+ connections. The new treatment/storage lagoon is expected to be on-line by the fall of 2001 in order to meet the needs of continued growth and most of the wastewater impacts of the 2002 Winter Olympics.

MONITORING PROGRAM

The JTAC monitoring program uses a method of systematically taking samples from streams and reservoirs in the watershed. In 1999, JTAC took over 500 samples from 45 locations for the purpose of water quality analysis. The sampling locations were selected with the purpose of analyzing the progress towards the goals set in 1984. There are 17 stream, 23 reservoir, 3 point source, and 2 QA/QC sampling locations.

JTAC Water Quality Standards

The JTAC water quality standards are mostly adopted from standards set by the state with one exception. Since phosphorus is the pollutant of concern, JTAC has adopted a slightly more stringent pollution indicator concentration than the state. Rather than use the state pollution indicator value of 0.05 mg/l Total Phosphorus (TP), JTAC has used 0.04 mg/l TP.

CURRENT CONDITIONS

Good water quality prevailed during 1999 in the Provo River Watershed. Significant improvements were recorded and overall, the water quality showed either average conditions or slightly better than average conditions. Despite the improvements, many water quality problems still exist. In the following sections, the water quality of individual areas of the watershed is discussed starting at the top of the watershed and moving downstream.

Synopsis of Water Quality Problems

Seven items of water quality concern were observed in the preparation of this report. These are listed as follows:

1. Heber Valley—There continues to be a high phosphorous loading into the Deer Creek Reservoir from the Heber Valley.
2. Fish Hatcheries—These point sources are generating high phosphorous loads and an effort may be required to discuss their operation and maintenance procedures.
3. Mine Sites—Hazardous levels of metals, particularly arsenic and lead are a concern for mine waste and tailing sites which are scattered throughout the Jordanelle Basin.
4. Jordanelle Reservoir—One instance of anoxic conditions occurred at the lower levels of the reservoir, this may be starting a new cycle of events for the young reservoir as it settles into a mature cyclical state.
5. Agricultural—Agricultural sources appear to be a significant non-point pollution source of phosphorous, especially in the Heber and Round Valley.
6. Provo Canyon—Most culinary water providers divert water from this canyon; thus the monitoring plan through this stretch should be more oriented towards drinking water concerns.
7. Deer Creek Reservoir—The 1999 monitoring results indicate high phosphorus loading, deep anoxic conditions, and a high TSI value in the reservoir. This may be a precursor to taste and odor problems in the near future.

Upper Provo River

Figure ES.1 that follows, presents the Total Suspended Solids (TSS), Total Phosphorus (TP), and Dissolved Total Phosphorus (DTP) loadings in the upper Provo River basin area. Loadings were calculated at the Provo River at Woodland, Weber Provo Canal, the Provo River at Hailstone, and the Provo River below the Jordanelle. In Table ES.1, these loads are compared to historical loadings from the previous five years.

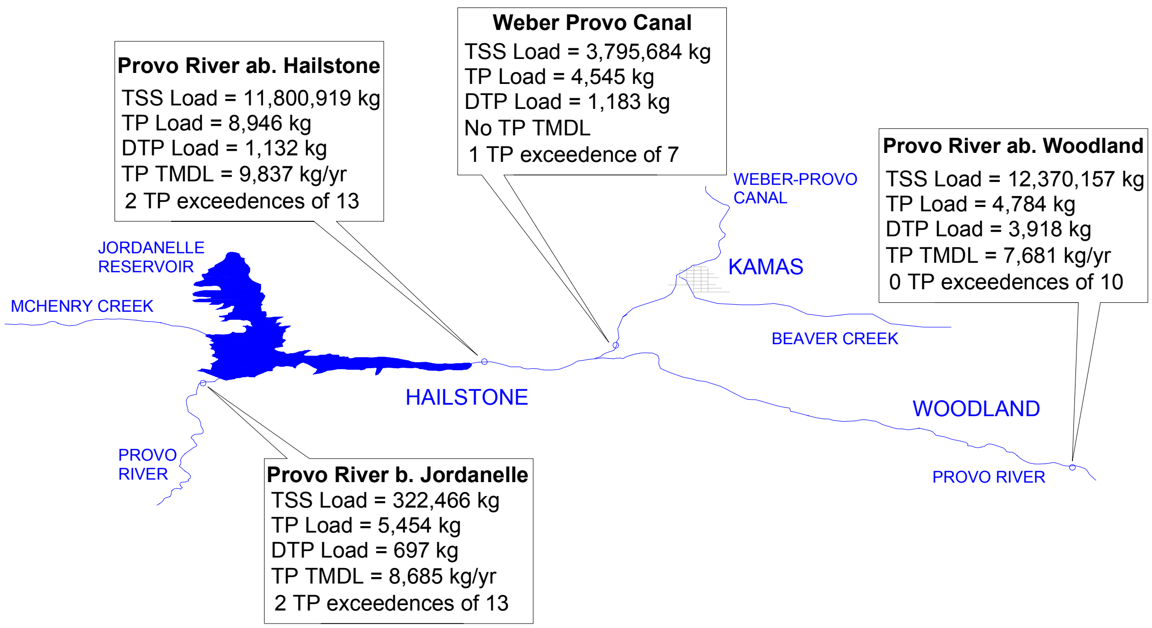


Figure ES. 1 Upper Provo River 1999 River Loadings

Table ES. 1 Upper Provo River Historical River Loadings

	1993	1994	1995	1996	1997	1998	1999	Averages
Provo River at Woodland, storet 499840								
Average Flow (cfs)	339	134	303	242	220	296	**323**	265
TP Annual Load (kg/yr)	6,094	2,008	7,053	1,995	-	4,762	**4,784**	4,449
DTP Annual Load (kg/yr)	-	-	2,499	1,995	-	201	**3,918**	2,153
TSS Annual Load (kg/yr)	7,692,847	1,704,960	10,334,714	2,486,544	1,517,482	2,825,034	**12,370,157**	5,561,677
Weber Provo Canal, STORET 499814								
Average Flow (cfs)	110	52	57	82	21	57	**192**	82
TP Annual Load (kg/yr)	8,079	1,923	2,432	1,594	-	731	**4,545**	3,217
DTP Annual Load (kg/yr)	-	-	733	526	-	-	**1,183**	814
TSS Annual Load (kg/yr)	4,417,245	2,039,486	1,937,566	2,287,441	76,622	366,015	**3,795,684**	2,131,437
Provo River at Hailstone, STORET 499813								
Average Flow (cfs)	474	224	385	284	308	288	**338**	329
Total Phosphorus Load (kg/yr)	22,992	7,721	14,267	5,825	-	5,159	**8,946**	10,818
D. Phosphorus Load (kg/yr)	-	-	1926	2528	-	1,725	**1,132**	1,828
TSS Load (kg/yr)	15,252,858	8,245,837	14,552,043	5,571,686	7,076,823	2,132,646	**11,800,919**	9,233,259
Provo River TP Increase Ratio	3.8	3.8	2.0	2.9	-	1.1	**1.9**	-
Provo River below Jordanelle, STORET 499733								
Average Flow (cfs)	317	139	238	270	324	350	**348**	284
Total Phosphorus Load (kg/yr)	10,271	2,722	4,272	3,496	-	2,969	**5,454**	4,864
D. Phosphorus Load (kg/yr)	-	-	4367	2876	-	194	**697**	2,034
TSS Load (kg/yr)	3,286,183	648,241	-	19,957	-	-	**322,466**	1,069,212
Jordanelle Reservoir TP Retention	55%	65%	70%	40%	-	42%	**39%**	-

TMDLs (Total Maximum Daily Loads) for TP have been established by the 1999 Upper Provo River Water Quality Management Plan in accordance with EPA requirements. Figure ES.1 above gives these TMDLs.

At Woodland, the Provo River had an average TP loading while high DTP and TSS loadings were recorded. The high loading for TSS occurred because of an extremely high TSS sample measurement recorded during May, a high flow month. Other than this high reading it is necessary to note that the readings were relatively stable and at normal levels. They vary between 2 and 4 and average approximately 2.6. In 1999, this ratio was reported as 1.9. In the past, increases in Total Phosphorous have been attributed to high sediment tributaries and agricultural non-point sources.

Jordanelle Reservoir

Continuing down the watershed, the Jordanelle Reservoir has served as an excellent tool to reduce phosphorus loading into Deer Creek Reservoir. The TSS, TP and DTP loadings into and out of the Jordanelle Reservoir have been previously shown in Figure ES.1. The retention of each constituent is evident. The figure shows that in 1999 the Jordanelle Reservoir retained approximately 39% of TP loading, 38% of DTP, and 97% of TSS. It released 5,454 kg of TP, this value is significantly below the TMDL of 8,685 kg.

With only 8,946 kg entering the reservoir, the SLOW (Selective Level Outlet Works) tower did an excellent job in 1999 of retaining 39% of TP. Although the average retention, as shown in Table ES.1, is 58%, the average amount of annual loading from the Provo River is generally more than 11,000 kg/yr of TP. The SLOW tower's capability is better tested when higher phosphorus loading occurs.

Within Jordanelle, the reservoir also showed low concentrations of phosphorus. Of the 94 reservoir samples that were taken, there were 12 exceedences of the 0.025 mg/l TP pollution indicator, slightly less than 13%.

Dissolved Oxygen Monitoring

Dissolved Oxygen (DO) levels as well as TP concentrations are an important part of water quality monitoring. Figure ES.2 shows the 1999 results of DO monitoring at three locations on the reservoir. Each of the three reservoir monitoring locations was sampled seven times in 1999.

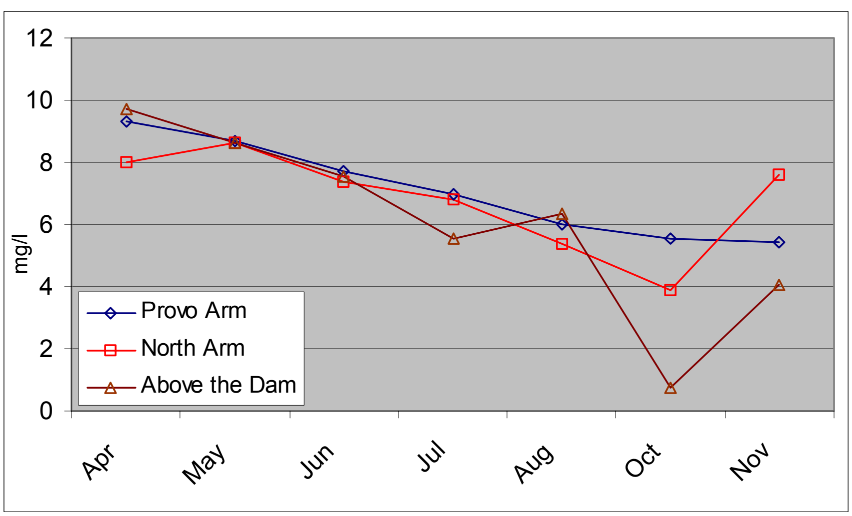


Figure ES. 2 Jordanelle Reservoir 1999 DO Concentrations Bottom Layer

In 1999 the Jordanelle Reservoir DO conditions were normal except for the monitoring location above the dam during the month of October. During this month the reservoir recorded DO levels below the indicator value of 2.0 mg/l. Figure F-18 of Appendix F indicates that the low DO levels occurred at very low depths. These results are responsible for the drop of DO shown in the above figure. This is not historically typical to this portion of the reservoir, but may continue in the future.

Jordanelle Reservoir Trophic State Index

The Carlson Trophic State Index (TSI) has been used by the State of Utah to rank and compare the trophic status of lakes and reservoirs within the state. TSI ranks the reservoirs into one of three categories: eutrophic or an overabundance of nutrients; mesotrophic, a healthy level of nutrients; and oligotrophic, a lack of nutrients. Figure ES.3 shows the 1999 calculated value of TSI in the Jordanelle Reservoir as compared to historical TSI values for the Jordanelle Reservoir.

The TSI was calculated to be 41.4, which classifies the reservoir as mesotrophic, indicating a healthy balance of nutrients. The ecosystem of the reservoir has not quite established itself, however it appears to be stabilizing as mesotrophic.

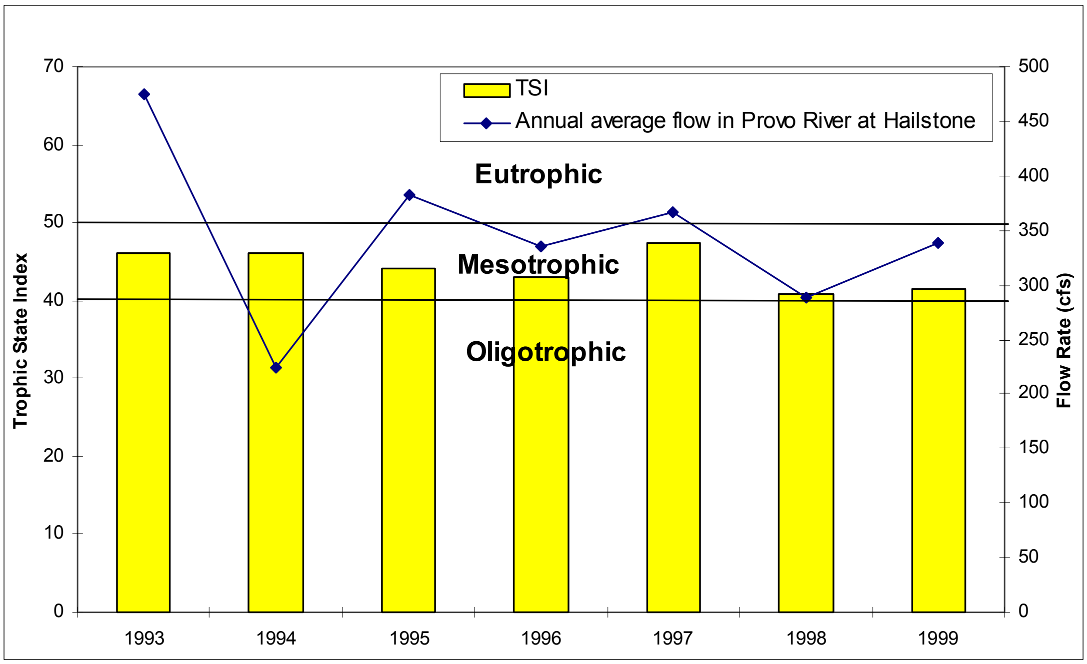


Figure ES. 3 Jordanelle Reservoir TSI 1993-1999

Heber Valley/Round Valley Streams

Streams flowing through the Heber Valley, mainly Snake Creek, Provo River and Daniels Creek, contribute the majority of the water to Deer Creek Reservoir. Main Creek flows into Deer Creek Reservoir from Round Valley to the east. These four streams are the most important tributaries of Deer Creek Reservoir. The 1999 stream loading results from water quality monitoring of these streams are shown in Figure ES.4.

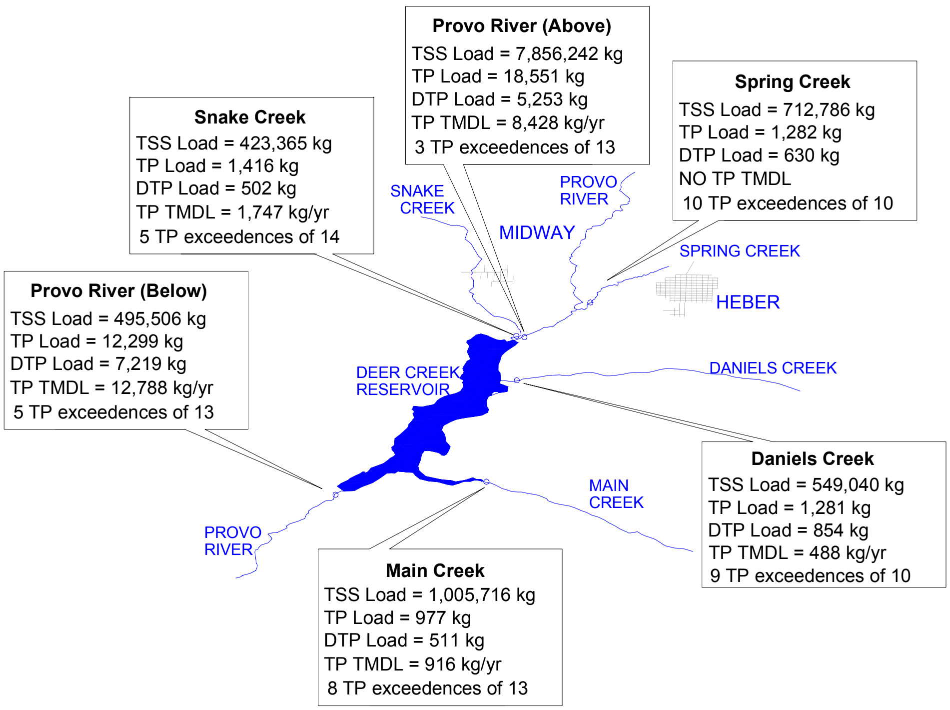


Figure ES. 4 Heber Valley/Round Valley 1999 Stream Loading

Table ES. 2 Heber Valley/Round Valley 1993-1999 Stream Loadings

	1993	1994	1995	1996	1997	1998	1999	Averages
Provo River above Deer Creek								
Weighted Average Flow (cfs)	314	138	198	262	303	332	319	267
TP Annual Load (kg/yr)	21,671	4,975	10,472	10,866	-	7,681	18,551	12,369
DTP Annual Load (kg/yr)	-	-	4,478	5,773	-	2,591	5,253	4,524
TSS Annual Load (kg/yr)	6,778,611	944,936	4,774,856	269,371	5,025,665	2,586,511	7,856,242	4,033,742
Snake Creek above Deer Creek								
Weighted Average Flow (cfs)	45	38	50	54	48	57	43	48
TP Annual Load (kg/yr)	2,259	1,934	2,690	1,860	-	873	1,416	1,839
DTP Annual Load (kg/yr)	-	-	1,270	1,134	-	476	502	846
TSS Annual Load (kg/yr)	213,742	369,582	616,915	421,925	431,283	507,661	423,365	426,353
Daniels Creek above Deer Creek								
Weighted Average Flow (cfs)	24	8	18	14	22	19	22	18
TP Annual Load (kg/yr)	6,517	702	1,685	1,047	-	1,160	1,281	2,065
DTP Annual Load (kg/yr)	-	-	732	625	-	513	854	681
TSS Annual Load (kg/yr)	5,257,412	247,102	1,390,923	801,933	1,801,933	651,235	549,040	1,528,511
Main Creek above Deer Creek								
Weighted Average Flow (cfs)	23	11	28	65	30	23	16	28
TP Annual Load (kg/yr)	2,570	437	3,452	7,154	-	1,183	977	2,629
DTP Annual Load (kg/yr)	-	-	964	5,669	-	605	511	1,937
TSS Annual Load (kg/yr)	2,136,137	243,025	2,750,898	1,146,639	3,727,492	926,538	1,005,716	1,705,206
Provo River below Deer Creek								
Weighted Average Flow (cfs)	343	201	240	358	406	462	371	340
TP Annual Load (kg/yr)	12,999	10,331	8,887	8,099	-	10,171	12,299	10,464
DTP Annual Load (kg/yr)	-	-	7,432	6,711	-	5,603	7,219	6,741
TSS Annual Load (kg/yr)	1,640,831	515,278	365,927	164,330	324,265	443,813	495,506	564,279

The TMDLs calculated in the 1999 Wasatch County Water Quality Management Plan are shown together with the 1999 loading in Figure ES.4. Table ES.2 shows how these loading values compare to the previous six years.

Deer Creek Reservoir

Deer Creek Reservoir has, throughout the years, suffered from the effects of eutrophication due to high nutrient loading. One of these effects is low DO during summer months. In the following chart, Figure ES.5 shows the tracking of DO levels at different locations of Deer Creek Reservoir during 1999.

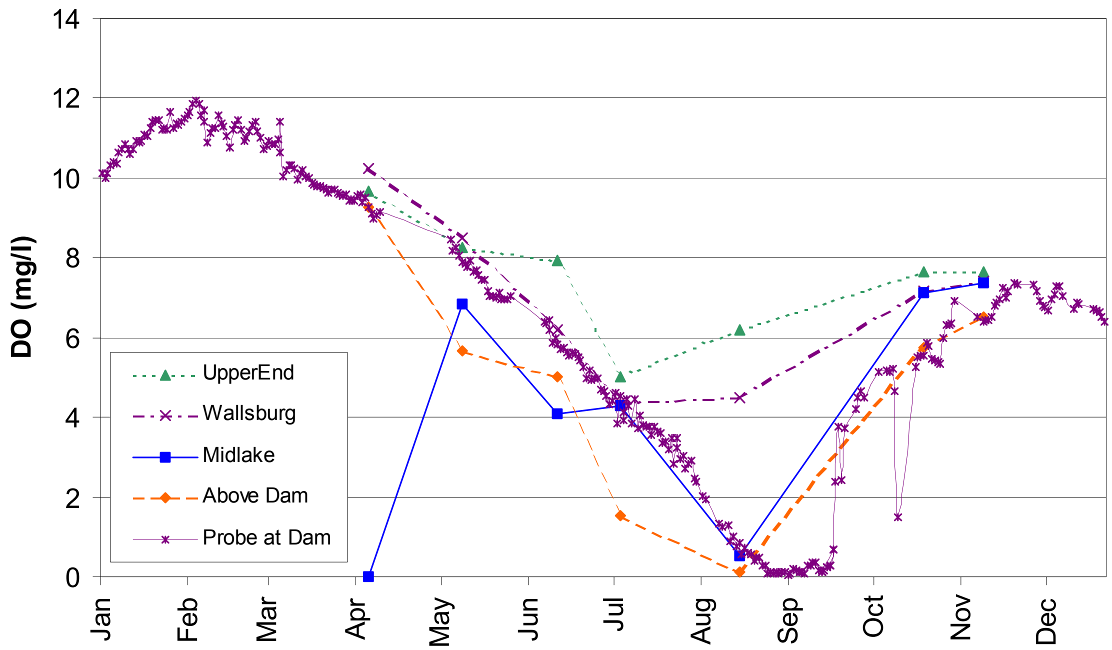


Figure ES. 5 Deer Creek Reservoir 1999 DO Concentrations Bottom Layer

As shown in the figure above, anoxic conditions existed in Deer Creek Reservoir, Above the Dam and at Midlake during August and September.

The next figure shows the anoxic conditions that have existed in the late summer months, July, August and September from 1986 to 1999. This figure tracks the DO conditions in the reservoir. The deep anoxic condition in August 1999 combined with expected low flows in 2000 may be precursors to taste and odor problems in the future.

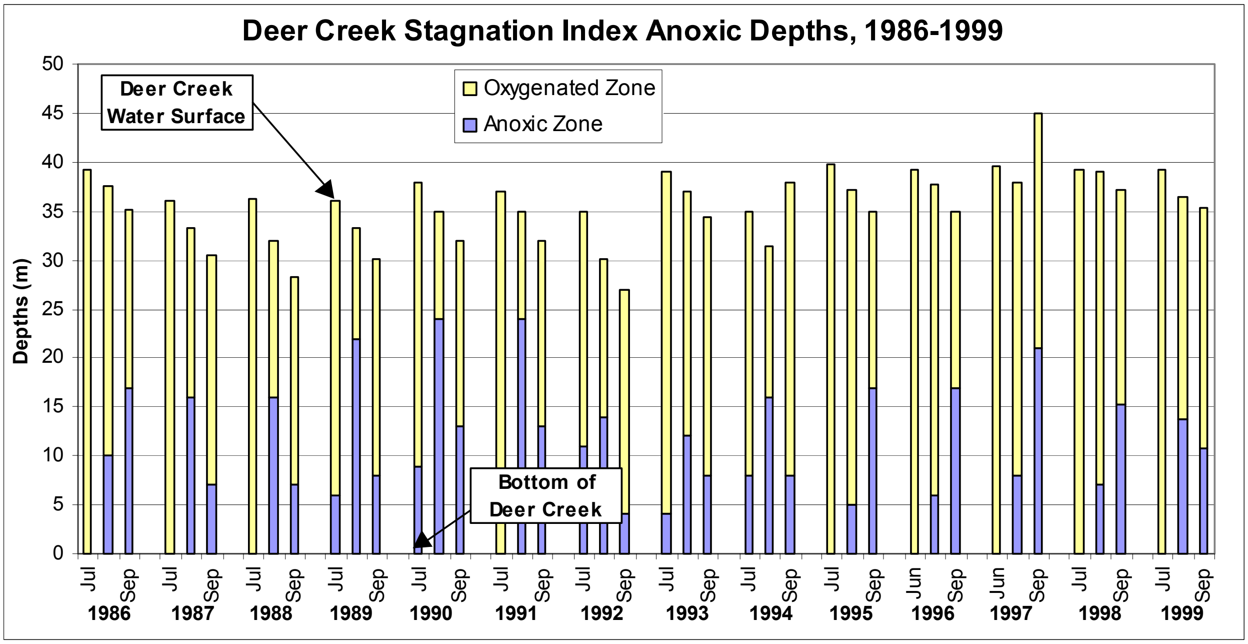


Figure ES. 6 Deer Creek Reservoir Stagnation Index above Dam 1986-1999

This figure shows that the worst DO conditions occurred in 1989-1991 when there were numerous taste and odor problems with raw water at the treatment plant intakes. In 1999 D.O. conditions were similar to the 1989 D.O. conditions. This, combined with lower than average flows into the Deer Creek Reservoir may indicate that taste and odor problems may occur again in the near future.

In the next graph, Figure ES.7, the TSI from 1981 to 1999 is shown which tracks the trophic status of the Deer Creek Reservoir.

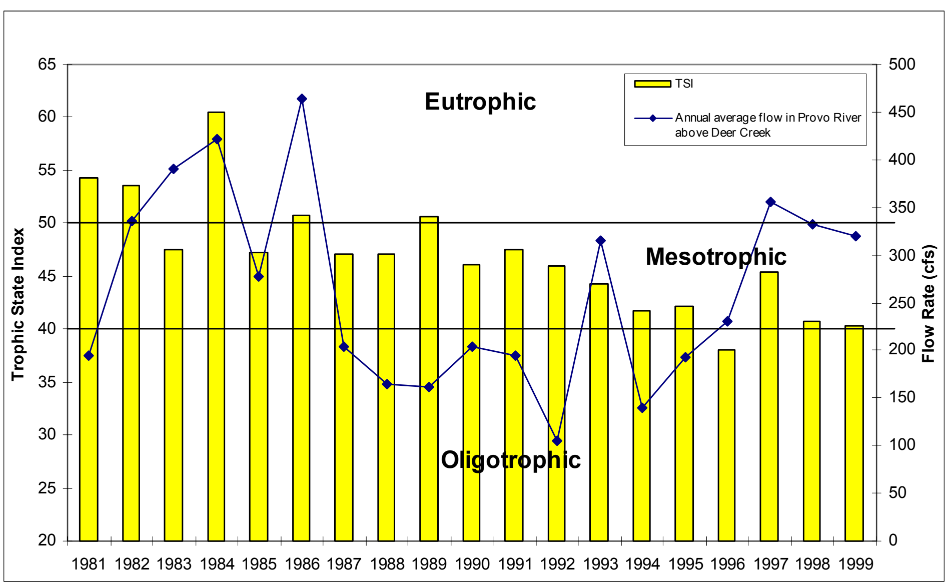


Figure ES. 7 Deer Creek Reservoir TSI 1981-1999

In 1999, the TSI was calculated to be 40.2. This indicates lower water quality than we have seen in the last 10 years. This was due to the high amounts of phosphorous that entered into the lake during the summer months. Figure ES.7 indicates that the trophic state is near eutrophic, which could be a concern.

PROBLEM AREAS

Despite great improvements in many areas, the 1999 monitoring program detected several water quality problems in the watershed. As a summary, the problems detected are as follows:

Table ES. 3 1999 Water Quality Problem Areas

Location	Problem	Exceedence Rate*
McHenry Creek below Mayflower	High Phosphorus Concentration	40%
Spring Creek at the Entrance to Provo River	High Phosphorus Concentration	100%
County Flood Control Channel at Provo River	High Phosphorus Concentration	80%
Midway Fish Hatchery Effluent	High Phosphorus Concentration	43%
Midway Fish Hatchery Effluent	High Ammonia Concentration	43%
Kamas Fish Hatchery	High Phosphorus Concentration	80%
Provo River above Deer Creek	High Phosphorus Load	23%
Snake Creek above Deer Creek	High Phosphorus Concentration	36%
Daniels Creek 100 Feet below LLC	High Phosphorus Concentration	90%
Main Creek at Bridge on U.S. 189	High Phosphorus Concentration	62%
Deer Creek Reservoir (Midlake)	Low Dissolved Oxygen	39%
Deer Creek Reservoir (Wallsburg Bay)	High Temperature	67%
Deer Creek Reservoir (Above Dam)	Low Dissolved Oxygen	50%
Provo River below Deer Creek Dam	High Phosphorus Concentration	39%

* Refer to Chapter 2 for values used in determination of exceedence.

RECOMMENDATIONS

This report recommends the following eleven items as suggestions for JTAC to continue to improve on water quality management and reduce the problems shown in Table ES.3.

1. Heber Valley Storm Water Controls

In response to recommendations from previous years' implementation reports Wasatch County, through a contract with Psomas, has completed the third year of a three year Storm Water Study in Heber Valley. The study has identified potential sites for the construction of new sedimentation basins with the capability of removing pollutants. The project has several potential obstacles the largest of which is funding. Other obstacles are items such as management, maintenance, and property availability. Also, there may be an opportunity to combine the management plan with Heber City's Storm Water Master Plan which identifies the construction of a 40 acre-foot treatment pond for storm water discharges in the Spring Creek and Sagebrush Canal. The key to the success of this project will be through the diligent work of County officials.

Wasatch County should aggressively pursue federal and state funding that are available. Also, **Wasatch County** should identify opportunities to incorporate management plan with Heber City Storm Water Master Plan. **JTAC** should fully support County officials in this effort which may require that JTAC members write letters to funding committees and local officials.

Of the problem areas identified in Table 8.1, the following will be addressed by implementation of this recommendation:

- Spring Creek, High Total Phosphorus
- Flood Control Channel, High Total Phosphorus
- Snake Creek, High Total Phosphorus
- Daniels Creek, High Total Phosphorus

2. Increase Monitoring to Identify Pollution Sources in Heber Valley

The Jordanelle Reservoir removes approximately half of the phosphorus load from the Provo River before it released below the dam. In the 10-mile stretch of Provo River between Jordanelle and Deer Creek, the total phosphorus load increases by a factor of 2.6 on average, even though the flow is comparable. The source of such a phosphorus increase is unknown. It is known that Spring Creek and the Flood Control Channel contribute but additional sources must be present to account for the entire increase.

JTAC should conduct a one-year intensive monitoring period along the Provo River in the Heber Valley increasing the number of stations monitored and frequencies. It is recommended that this occur during the sampling period of the calendar year 2001. Review of this data will enable locating the general area of significant pollution increases. Once the source(s) of pollution are located, the future monitoring program should be adjusted to measure the annual loading from these sources.

Of the problem areas identified in Table 8.1, the following will be addressed by implementation of this recommendation:

- Provo River above Deer Creek, High Total Phosphorus

3. Update Water Quality Management Plan

The Upper Provo River Water Quality Management Plan is one of the first reports in Utah to pursue definition of Total Maximum Daily Loads (TMDLs) for the watershed. The EPA has not accepted the plan to this date and new TMDL requirements have since come into effect. Also, new data on the watershed is available for better analysis of existing conditions.

Utah Division of Water Quality should update the plan to reflect additional EPA requirements and new data that is now available.

Of the problem areas identified in Table 8.1, the following will be addressed by implementation of this recommendation:

- All Waterbodies

4. Agricultural Nonpoint Source Pollution

Agriculture appears to continue to have an impact on water quality. There are many ongoing programs that will help to reduce these impacts such as the Tri-Valley Watershed Project, Wasatch County Water Efficiency Project (WCWEP), and the Deer Creek Reservoir Resource Management Plan. In addition the NRCS is working with farmers on an individual basis to help them manage lands with Best Management Practices (BMPs) which will also favorably impact water quality. Better management practices in the Heber Valley will reduce non-point source phosphorus loading resulting in improved water quality.

JTAC should continue to support projects that will reduce pollutant contributions from non-point sources and support the education of local farmers and ranchers in BMPs. **NRCS** should quantify and document the beneficial impacts of the Tri-Valley Watershed Project. **Central Utah Project Completion Act (CUPCA)** should quantify and document the beneficial impacts of the WCWEP.

Of the problem areas identified in Table 8.1, the following will be addressed by implementation of this recommendation:

- Spring Creek, High Total Phosphorus
- Flood Control Channel, High Total Phosphorus
- Daniels Creek, High Total Phosphorus
- Snake Creek, High Total Phosphorus
- Main Creek, High Total Phosphorus
- Provo River, High Total Phosphorus

5. Public Information Campaign

Public education is a very beneficial method to protect water quality since many people in the community are unaware of the impacts of poor stewardship of water quality. JTAC has already made a concerted effort to inform and educate the public on the need to protect drinking water sources through the posting of signage, advertisements, and distribution of logo. A public information committee in JTAC has been formed to pursue education and information opportunities.

The Public Information Sub-Committee of JTAC should continue its efforts and increase distribution of signage around the critical waterbodies that support high recreational use. Also, signage could be facilitated by the Adopt-a-Waterbody program, which is instituted by the **DWQ**.

Of the problem areas identified in Table 8.1, the following will be addressed by implementation of this recommendation:

- All Waterbodies

6. Expand JTAC Membership

JTAC has been an effective cooperative effort among state, federal, local, and private agencies to improve the Provo River Watershed. However, JTAC is missing representation by local communities in Heber Valley such as Heber City and Midway. These municipalities could provide valuable knowledge and insight to pollution sources and management strategies to the problems of urbanization.

JTAC should encourage participation from representatives of local communities.

Of the problem areas identified in Table 8.1, the following will be addressed by implementation of this recommendation:

- All Waterbodies

7. Source Water Assessment and Protection Plan for Provo River Watershed

The Federal Safe Drinking Water Act Amendments of 1996 require states to establish Source Water Assessment for all water sources. Previously Source Water Assessments were only required for groundwater sources. Beginning this year, the state will require that Public Water Systems (PWS) prepare assessments and protection plans for surface waters as well. The Provo River Watershed is a surface water source to multiple PWSs in Salt Lake, Utah and Wasatch County. The efforts and costs to prepare these documents could be shared by those PWSs.

Metropolitan Water District of Salt Lake City, Jordan Valley Water Conservancy District, Central Utah Water Conservancy District, Metropolitan Water District of Orem and Metropolitan Water District of Provo should cooperate to complete a Source Water Assessment and Protection Plan for the Provo River.

Of the problem areas identified in Table 8.1, the following will be addressed by implementation of this recommendation:

- Provo River above Deer Creek, High Total Phosphorus
- Provo River below Deer Creek, High Total Phosphorus

8. Additional Monitoring of Provo Canyon

Many of the Provo River culinary water diversions are in the Provo Canyon. Increased monitoring in this area for drinking water specific constituents would help identify some of the problems more specific to drinking water. Drinking water treatment plants generally are concerned with phosphorus, algae, dissolved oxygen, total organic carbon, UV254 and metals.

JTAC should consider increased efforts to monitor many of these constituents within the Provo Canyon. Also JTAC should also support the efforts of the **Utah Water Quality Alliance**, which is monitoring for *Cryptosporidium, Giardia, E. Coli*, and other bacteria in the basin. These biological contaminants are a major concern for water quality controls and are important to the basin monitoring.

Of the problem areas identified in Table 8.1, the following will be addressed by implementation of this recommendation:

- Provo River below Deer Creek

9. Jordanelle Reservoir – Management of Releases

The Jordanelle Reservoir has helped improve the water quality in the Provo River by retaining phosphorus rich sediments, regulating temperature of outlet water, and controlling dissolved phosphorus levels in outlet water. Many of these benefits are due to the Selective Level Outlet Works (SLOW) which is operated by the Central Utah Water Conservancy District and the Bureau of Reclamation (USBR). The USBR is in the process of revising the Standard Operating Procedures of the SLOW to maximize its benefit.

The 1999 data shows that anoxic conditions occurred near the SLOW at the lower levels. The low DO water should not be exported through the SLOW to avoid water quality problems in the Provo River below. The Standard Operating Procedures should identify this hazard and be adjusted appropriately.

JTAC should continue to work with the USBR to ensure that the operation of Jordanelle Reservoir will not only accommodate the distribution of water rights, but also favorably impact the water quality and fishery resource of the Provo River.

Of the problem areas identified in Table 8.1, the following will be addressed by implementation of this recommendation:

- Provo River above Deer Creek, High Total Phosphorus

United States Bureau of Reclamation is responsible for the implementation of this recommendation.

10. Fish Hatcheries – Point Sources

The Kamas Fish Hatchery has recently expanded its operation to almost double fish production. The expansion plans incorporated features such as settling ponds and concrete linings, which should greatly aid in reducing TSS and TP in the effluent. These features will help water quality as the fish operation expands. The TP loading from the hatchery was 548 kg as compared to the TMDL of 173 kg. Also, the Midway Fish Hatchery is discharging high concentrations of phosphorus and ammonia into Snake Creek.

It is recommended that **JTAC** work with the **Division of Wildlife Resources** to investigate if there are operational or maintenance practices that could be used to reduce the phosphorus and ammonia problems in the two hatcheries.

Of the problem areas identified in Table 8.1, the following will be addressed by implementation of this recommendation:

- Midway Fish Hatchery, High Total Phosphorus
- Midway Fish Hatchery, High Ammonia
- Kamas Fish Hatchery, High Total Phosphorus
- Snake Creek, High Total Phosphorus

11. EPA Assessment of Jordanelle Basin Mine Sites

The mining industry once thrived in the Park City area of Summit County. Some of the mining activities spilled into Wasatch County, especially on the west side of Jordanelle Reservoir. The mine waste that remains contains hazardous levels of certain metals particularly arsenic and lead. Due to the potential hazards of these materials and plans for residential developments, the Utah Division of Environmental Response and Remediation requested that EPA, Region VIII, reevaluate the Mayflower Mountain Tailings Pond and evaluate other nearby mining-related sites which may pose risks to human health and the environment. EPA's reevaluation of these sites is expected to commence in the near future.

JTAC should support mitigation of these potential water quality hazards. **JTAC** should also closely monitor these sites for discharges of contaminated water that may pose a risk to drinking water sources such as the Jordanelle Reservoir. **Wasatch County** should likewise support mitigation and review property owner monitoring.

Table ES. 4 Summary Table of Recommendations and Responsibilities

Recommendations	Party Responsible	Problem Area Addressed
1. Heber Valley Storm Water Controls • Aggressively pursue federal and state funding sources for sediment/ wet ponds. • Coordinate with Heber City Storm Water Management Plan. • Continue to support the plan fully which may include writing letters to funding committees or other officials.	Wasatch Co. Wasatch Co. JTAC	High TP Loads in: • Spring Creek • Flood Control Channel • Snake Creek • Daniels Creek
2. Increase Monitoring to Identify Pollution Sources in Heber Valley • One-year intensive monitoring of Provo River and known inputs in Heber Valley. • Review monitoring and locate pollution increases in Heber Valley. • Modify future monitoring to quantify discovered sources.	JTAC JTAC JTAC	High TP Loads in: • Provo River above Deer Creek
3. Update Water Quality Management Plan • Update water quality management plan to include computer analysis and new data for TMDL implementation.	DWQ	All waterbodies
4. Agricultural Nonpoint Source Pollution • Quantify and document pollutant loading reductions from Tri-Valley Watershed Project • Quantify and document pollutant loading reductions from Wasatch County Water Efficiency Project • Continue to support projects that reduce nonpoint source pollution from agricultural sources. • Continue to support education of agricultural produces of resource management and BMPs.	NRCS CUPCA JTAC JTAC	High TP Loads in: • Spring Creek • Flood Control Channel • Snake Creek • Daniels Creek • Main Creek • Provo River
5. Public Information Campaign • Increase distribution of signage. • Incorporate with Adopt-a-Waterbody program.	JTAC Public Information Committee	All waterbodies
6. Expand JTAC Membership • Encourage participation from community representatives in local communities such as Heber City and Midway.	JTAC	All waterbodies
7. Source Water Assessments and Protection Plan for Provo River Watershed • Cooperate among public water providers to complete the source water assessment and protection plan for Provo River Watershed.	CUWCD, JVWCD, MDWSLC, MWDP, MWDO	High TP Loads in • Provo River above Deer Creek • Provo River below Deer Creek
8. Additional Water Quality Monitoring in Provo Canyon • Increase efforts to monitor for constituents that affect drinking water quality such as TOC, UV254, DO, TP, algae, and metals. • Continue bacteriological monitoring for constituents such as E. Coli, Giardia, Cryptosporidium and bacteria that may be public health concerns	JTAC Utah Water Quality Alliance	Provo River below Deer Creek
9. Jordanelle Reservoir Management of Releases • Provide releases per water right allocations • Protect water quality by avoiding export of high algae content, high phosphorus content and anoxic waters through management of SLOW.	USBR USBR	High TP Loads in: • Provo River above Deer Creek DO, TP and Algae problems in Deer Creek
10. Fish Hatcheries – Point Sources • Evaluate operational and maintenance procedures to identify potential improvements. • Evaluate impact of Kamas Fish Hatchery on Provo River watershed.	DWR JTAC	High TP Loads in: • Snake Creek • Hatcheries High NH3 Load in: • Midway Hatchery
11. EPA Assessment of Jordanelle Basin Mine Sites • Support mitigation of potential water quality hazards. • Closely monitor these sites. • Review property owner monitoring of sites.	JTAC/Was. Co. JTAC Wasatch Co.	All waterbodies downstream from Jordanelle Basin

CHAPTER 1

Introduction

BACKGROUND

Water plays a vital role in the development of the West. Productivity and economy are closely tied to maintaining access to abundant high quality sources of water. One of Utah's best water resources, the Provo River, provides water for use by over a million Utah residences for purposes such as drinking, agricultural, industrial, and recreational. Equally important, the Provo River supports a delicate ecosystem of invaluable living organisms.

Along the Provo River, Deer Creek and Jordanelle Reservoirs water management plans have helped make this water available for public and private use. These reservoirs are vital to the surrounding communities. One of the main challenges facing those in charge of managing the reservoirs is the control of eutrophication. Eutrophication is a natural process that occurs in lakes and reservoirs when there is an abundance of nutrients. It simply means that there are enough of the right nutrients present to incur algae growth. Excessive algae growth can seriously deteriorate water quality causing taste and odor problems which in turn increase treatment costs.

Formation of JTAC

In 1981, because of eutrophication evidences in the Deer Creek Reservoir, Utah Governor Scott Matheson established the Jordanelle Reservoir Water Quality Technical Advisory Committee (JTAC) for the purpose of developing a reservoir management plan for Deer Creek Reservoir and the then future Jordanelle Reservoir. Thus, JTAC was created with the representation of over twenty federal, state, local agencies, and private companies.

The Water Quality Management Plan for Deer Creek and Jordanelle Reservoirs was implemented by JTAC in 1984. This plan directs JTAC to conduct a water-sampling program that monitors the condition of water quality throughout the year. It also requires that an annual report be released that analyzes and presents the resulting data. This report was updated in 1998.

Phosphorus: Limiting Nutrient

The JTAC water-sampling program identifies many water quality parameters, some of these include physical and chemical properties, metals and nutrients present in the water. The most critical water quality constituent for this analysis, however, is phosphorus. In general, phosphorus is the limiting nutrient that controls the growth of algae. By decreasing the phosphorus loads into the reservoirs algae growth will also decrease.

In the Provo River Watershed, a variety of natural sources contribute to the formation of phosphorus, but human factors also are a substantial contributor. The goal of JTAC is to reduce pollution from these sources by encouraging the implementation of projects, efficient management practices, and smart planning.

Another constituent, Total Suspended Solids (TSS), is an important factor in water quality. This is an extremely important parameter in the analysis of stream water. It is used to evaluate the amount of inorganic salts and other materials suspended in water. Also, the degree of treatment needed to ready the water for consumption may be determined if accurate results are obtained.

PURPOSE AND SCOPE

The 2000 Wasatch County Water Quality Implementation Report is released to fulfill the requirement by the 1984 Water Quality Management Plan for the Deer Creek and Jordanelle Reservoirs. As directed by the plan, this report will:

- present the results of 1999 water quality sampling,
- identify exceedences of JTAC water quality parameter standards,
- identify trends in the water quality,
- analyze the effectiveness of current management practices, and
- recommend action for further progress towards water quality improvement.

AUTHORIZATION

Psomas has been contracted by the Wasatch County Commission to fulfill the requirements of the 1984 Water Quality Management Plan for the Deer Creek and Jordanelle Reservoirs by compiling information and preparing the 2000 Annual Water Quality Implementation Report.

SOURCE OF DATA

The monitoring data has been gathered through the coordination of various agencies participating in JTAC. JTAC through the Utah State Division of Water Quality has provided Psomas with most of the water quality monitoring data and other pertinent information.

Other agencies have provided additional information for the completion of this report. The United States Geological Survey (USGS) provided data for stream flows at various USGS stream gage locations within the area of study. The Provo River Water Users Association (PRWUA) provided flow data for the Weber-Provo Canal. The United States Bureau of Reclamation (USBR) provided flow data for the water released from the Jordanelle Dam. The Utah Division of Water Rights supplied data on the diversion of water from the Provo River into the Timpanogus Canal. And, the Salt Lake City

Metropolitan Water District (MWDSLC) provided flow data for the diversion of water from Deer Creek Reservoir through the Salt Lake Aqueduct. Some of the agencies listed above are part of JTAC and have contributed in other ways as well. We appreciate all agencies that have assisted in providing information.

CHAPTER 2

Current Activities

INTRODUCTION

Land use and various activities within the watershed affect the water quality in streams, rivers and reservoirs, which ultimately affects the water users. Several of these activities are extremely important to future water quality in the watershed. This chapter will briefly discuss the individual activities in this watershed that may have positive or negative affects upon the water quality.

CURRENT WATER USERS

Water users that are currently dependent on the Provo River can be separated into three categories: Municipal, Agricultural, and Recreational. Each category is described as follows:

Municipal

Municipal water users are the water districts located in Salt Lake, Utah, Wasatch and Summit Counties. These agencies provide safe drinking water to residents and industries through the region. The Central Utah Water Conservancy District (CUWCD), the Jordan Valley Water Conservancy District (JVWCD), the Metropolitan Water District of Salt Lake City (MWDSLC), Metropolitan Water District of Orem City (MWDO), and the Metropolitan Water District of Provo City (MWDP) treat and distribute water from the Provo River. Good water quality is especially important to these water districts in order for them to control the expensive costs of water treatment and to provide the highest quality drinking water.

Agricultural

The Provo River is also a source of irrigation water for agricultural purposes. In Heber Valley there are fourteen irrigation companies that have water rights to the Provo River. The Provo River Water Users Association (PRWUA) and several irrigation companies in Utah and Salt Lake Valley also have water rights to water contained in the Deer Creek Reservoir. Water quality is important to maintain healthy crops and livestock.

Recreational

Jordanelle and Deer Creek Reservoirs, along with the Provo River and its tributaries, are sources of recreation for many people. State Parks are located on both the Jordanelle and

Deer Creek Reservoirs. These provide basic services for thousands of recreationists that visit the two reservoirs. They also provide water skiing, swimming, boating and many more activities. These reservoirs and rivers provide excellent fishing for anglers. Water quality is important in regards to safe recreational activities and the preservation of wildlife such as birds, fish and the hosts of additional animal life common to the area.

CURRENT ACTIVITIES

JTAC "Keep Your Water Clean" Logo

A public information subcommittee of JTAC has developed a logo to convey the message that Deer Creek and Jordanelle Reservoirs are primarily storage reservoirs for drinking water and should therefore be protected from unnecessary pollution.

The logo and concept was distributed during 1998 to the public through free litter bags given at State Parks, posted signs around the reservoirs, and published advertisements in literature distributed by the division of Wildlife Resources.

In 1999, a local Boy Scout, Travis Pitcher of Troop 444 coordinated with other Boy Scouts to place signs along the Provo River between Deer Creek Dam and the Olmstead Diversion as part of an Eagle Project. The signs were installed at several popular fishing locations along this stretch of river, which is considered to be one of the best fisheries in Utah.

Activities such as these are encouraged to others that are looking for public service opportunities. JTAC has more signs that are ready to be placed. It is JTACs goal that the signage be increased by in-kind or voluntary services. The Adopt-a-Waterbody Program may be utilized in the efforts to increase public education on water quality issues as well. The efforts to

Provo Canyon Scenic Byway / Watershed Management Plan

Through federal grants, the Mountainland Association of Governments has commissioned a study to be performed in the Provo Canyon area. The study is two-fold, the first part being a scenic highway plan, which would help to preserve and promote the many intrinsic characteristics of the canyon road.

The second part of the plan is a watershed management plan with calculations for Total Maximum Daily Loads (TMDLs), which will identify water quality concerns in the canyon. Most of the water treatment agencies that are members of JTAC divert water directly from this portion of the Provo River. They are actively participating in the Watershed Management Plan.

The watershed plan will provide a calculation of Total Maximum Daily Loads (TMDLs) for Phosphorous and total suspended solids. It will also identify best management practices that should be implemented to improve water quality.

A team of consultants has been selected for this project and will complete the study by October 2000.

Tri-Valley Watershed Project

The installation of sprinkler systems in the Heber Valley is the highest priority project in the Tri-Valley Watershed Plan. During 1999 the Natural Resources Conservation Service (NRCS) continued the planning and contracting efforts with 87 more landowners. At the present time NRCS has helped a total of 150 landowners with $951,107 in contracts for federal cost-share assistance, which will pay for part of the cost of installing a sprinkler system. NRCS anticipates that most of these systems will be installed during the summer and fall of 2000. In order to participate with the cost-share program, a Resource Management Plan must be developed by the landowner. NRCS can assist with this plan. Those interested may contact Ralph Mickelson of NRCS at (435) 654-0242, or e-mail at: Ralph.Mickelson@utheber.fsc.usda.gov.

Jordanelle Basin Master Plan and Developments

Wasatch County has adopted the Jordanelle Basin Master Plan and the Jordanelle Basin Overlay Zone ordinances, which will supplement existing county zoning regulations for lands within the Overlay Zone. These regulations are to guide development within the Basin and provide the vision for what is to come.

Sewer, water lines, and a water treatment plant are currently being constructed within the Jordanelle Special Service District to service developments within the Jordanelle Basin. Approximately 10,000 equivalent residential units have been approved in the master plans. A fire station has also been constructed and being operated with a full-time staff. And construction of some roads will begin this summer. It is anticipated that the Basin will grow rapidly within the next five years.

Deer Crest, located just west of the Mayflower Junction on U.S. 40, has already begun construction, and is operating ski lifts and ski runs in conjunction with Deer Valley. Infrastructure for this development is nearing completion. Wasatch County has issued fifteen building permits for single family dwellings at Deer Crest. Future phases may include commercial and multi-family structures.

Hailstone village (now known as Still Water) has received final approval of Phase 1 which will consist of about 250 condo-hotels units, some conference center facilities and a restaurant. They intend to break ground this spring. Future phases are planned for a retail commercial village near the hotel. Jordanelle View has been approved for 72 lots and intends to break ground this summer. Deer Mountain on the Northeast side of the lake has received final approval for 2 phases, which consist of 184 apartments and about 150 condominiums/duplexes. They are cutting the roads in at this time and will begin construction this spring. Many other developments are submitting concept plans for approval later this year.

The Eastern portion of the Basin has been divided into two more Master Planning Areas. One, being the Indian Hollow Master Plan and the other being Jordanelle East Master Plan. Indian Hollow has received a recommendation for a base density of over 3,000 units with a potential for about another 1,000 and a golf course, if approved. The Jordanelle Master Plan is being studied at this time. Water tanks and sewer lines for these areas are expected to begin this year.

Jordanelle State Park

Camping, fishing, boating, hiking and other recreational activities are available at the two developed recreation sites of Jordanelle State Park. A third potential recreation site at the end of the North Arm, "Ross Creek" is still awaiting development funding.

The Rock Cliff Recreation Site is located at the east end of the reservoir and has accommodations which include a nature center, elevated boardwalk systems, modern restrooms with showers, group-use pavilions, 50 walk-in camping sites, and limited non-motorized trails.

The Hailstone Recreation Site and Jordanelle Reservoir opened its park gates and launch ramps at the end of June 1995. The 400 acre tract of land located on the west shore of the reservoir provides facilities for 180 camping units, individual powerboat and personal watercraft launching sites, 30 individual day use cabanas, beach house facility, 3 large group use pavilions, playgrounds, laundromats, visitor center and a convenience store / restaurant.

The perimeter trail system opened in conjunction with the Hailstone facilities. The park now offers 13 miles of trails available for hiking, jogging, mountain biking, equestrian use, and cross-country skiing. A ten-mile segment is planned for future development.

The Ross Creek site will be located on the east shore of the north arm of the reservoir. No permanent facilities are being designed at present because of its limited use due to reservoir fluctuation, and because full development cannot proceed until a sewer system is developed and extended to this location.

Currently meetings are being held in regards to landowners gaining private access to the reservoir. Final decisions will be made available in the month of March.

Jordanelle Recreation Access Management Committee

As private development is beginning to flourish around Jordanelle Reservoir, many inquiries have been made concerning the restricted access policy that is currently in place. The Jordanelle Recreation Access Management Committee was formed in 1999 to evaluate and address the issues of reservoir access.

Currently, there are four official access points, which are designated as Hailstone, Ross Creek, Rock Cliff, and Crandall Point. Of these official access points, only Hailstone and Rock Cliff have been developed with recreation facilities. The other points are identified for future development.

The committee prepared a draft access policy, which is being considered to become the official policy of Jordanelle State Park. The major points of the draft policy are as follows:

- Access will only be allowed at officially designated points.
- Private exclusive access to Jordanelle will not be allowed.
- Review and approval of access applications is dependent on the standards set by NEPA environmental statements and the Jordanelle State Park Master Plan.
- Costs associated with reviewing and processing applications, including the appropriate level of NEPA compliance, will be borne by the applicant.
- Unapproved use and access will be investigated and eliminated.

On March 14, 2000, a public hearing was held to discuss the draft policy and invite comments. Approximately twenty persons attended, about half of which were adjacent property owners. No suggestions of changes to the policy were given during the meeting although two written comments were received. The policy was adopted by the State Parks Board during its April meeting.

Jordanelle Special Service District

The Jordanelle Special Service District (JSSD) has been created to provide water and sewer services to the imminent developments around the Jordanelle Reservoir. The district is in the process of building an infrastructure with the Keetley Water Treatment Plant at the mouth of the Ontario Drain Tunnel #2, and many waterlines, pump stations water storage tanks, sewerlines, and sewer lift stations.

The Deer Crest area is nearly complete with infrastructure and new tanks were built last year to service other developments in Area A such as Stillwater and East Park. JSSD will soon be servicing developments in the Ross Creek area on the north arm of the Jordanelle Reservoir. During the summer of 2000, water transmission lines and main sewer lines will be constructed to the Ross Creek Area. Water storage tanks will be constructed on the Butte Property and Deer Mountain.

The Keetley Water Treatment Plant will be completed this fall and will be ready to deliver water to these prospective developments in the Jordanelle Basin.

Mayflower Resort

Mayflower Mountain Resort has been monitoring stream flows and water quality parameters in the McHenry Canyon drainage area since 1984, and reporting the results in an annual report to Wasatch County.

The Utah Division of Water Quality (DWQ) had issued a Ground Water Quality Discharge Permit for the stabilization of the three tailing ponds located adjacent to US Highway 40. This 5-year permit expired in 1998, but because of failure by Mayflower to address a Notice of Violation (NOV) issued in 1996, DWQ did not renew the permit. One of the issues in the NOV was that the tailing ponds had not yet been stabilized as promised. The Utah Division of Environmental Remediation and Response (DERR) then began to reevaluate the site for the EPA's Superfund Program.

Mayflower has since then decided to stabilize the ponds through a cooperative agreement with the state. The DWQ has been called upon to be the regulative agency in this agreement, thus the division is in the process of reviewing Mayflower's stabilization plans to cap the tailings ponds.

In the meantime, Mayflower has implemented interim storm water controls around the tailing ponds to control the migration of tailing material. The interim storm water controls consist of diversion channels and detention basins, which are inspected, with DWQ oversight, twice a year and maintained as necessary. Biannual inspection reports are prepared and submitted to the DWQ identifying inspection observations and recommendations, and summarizing any maintenance performed on the interim storm water controls.

Soldier Hollow: 2002 Winter Olympics

In anticipation of the 2002 Winter Olympics, the SLOC selected Soldier Hollow as the site for all Cross-country, Biathlon, and Nordic combined events. The site is located on the southern end of Wasatch Mountain State Park and directly west of the northern tip of Deer Creek Reservoir. In order to facilitate hosting of these Olympic events it will be necessary to construct 23 kilometers of trails, a shooting range for small caliber rifles, a stadium area and a Competition Management facility. The venue is currently under design.

Drainage culverts were installed at drainage crossings and erosion control measures were incorporated to prevent erosion of the newly bladed areas into the existing waterways and streams. The trail areas will be re-seeded using a native seed mixture approved by the Division of Natural Resources (DNR).

In 1999, the trail system construction was completed along with the installation of a snow making system; installation of water, sewer, gas, electrical and telecommunications lines; and the construction of a shooting range and a Competition Management building.

The majority of water flows through the venue site have traditionally come from irrigation canals. There are currently two irrigation ditches bringing flows to the site. The West Bench Ditch and the Epperson Ditch carry flows from the Midway Irrigation Company to service farm lands on the west side of the Heber Valley. Midway Irrigation Company will construct a new, winterized water line that will provide 8 ft^3/sec of secondary water for snowmaking at the Olympic site and irrigation water for the future golf course. Midway Irrigation Company has constructed an 18-inch diameter waterline to deliver water to the venue.

As part of the snow making system, a small holding pond will be constructed at the end of the Midway Irrigation Company pipeline. This pond will serve as a cooling pond for snowmaking and as a holding pond for irrigation of the proposed future golf course located just north of the Olympic venue.

With the completion of the Midway Irrigation piping, the West Bench Ditch will be abandoned and will serve only as a storm drainage collection ditch. The ditch has been breached just north of the main drainage channel running through the venue to prevent flows north of the drainage from contributing to the erosion potential along the newly constructed trails south of the drainage.

Overflows from the Midway Irrigation Piping will be allowed to flow through the Epperson to the main drainage just east of the stadium area, where they will join with natural flows running through an existing detention basin before flowing into Deer Creek Reservoir.

UPDES Permits

Three entities in the watershed have surface water discharge permits which are part of the Utah Pollutant Discharge Elimination System (UPDES) Permit program administered by the Division of Water Quality (DWQ). These are the Midway Fish Hatchery, Kamas Fish Hatchery, and United Park City Mines.

Midway Fish Hatchery

The UPDES permit was effective on March 1, 1995 and expires February 28, 2000. It specifically limits the total suspended solids (TSS) maximum concentration to 25 mg/l, TSS maximum daily loading to 1398 lbs/day, pH to a range of 6.5 to 9.0, and net increase of total phosphorus to 626 kg/yr. The permit requires the hatchery to monitor the influent springs and the effluent springs for the determination of net increase of total phosphorus.

Kamas Fish Hatchery

The Kamas Fish Hatchery, although smaller than the one at Midway, has expanded its facilities and increased its fish production from 80,000 to 140,000 pounds per year. The new facilities include concrete lining of the ponds and a string of settling ponds to reduce suspended solids in the effluent. Their current UPDES permit became effective March 1, 1995 and expires February 28, 2000. Because of expansion, it was amended in August

1997 to allow for higher daily loads of TSS. The original limitations for TSS were a maximum 25 mg/l and 882 lbs/day. The new amended permit holds the maximum concentration of TSS at 25 mg/l, but allows the daily loading limit of TSS to increase to 1,741 lbs/day.

The UPDES permit does not require phosphorus monitoring. To offset the potential for increased phosphorus and TSS discharges, however, the DWR has included settling ponds in the expanded facilities that will contribute to reducing the amount of phosphorus loads that otherwise would have been discharged. The settling ponds at the Midway Fish Hatchery appear to have helped greatly to meet phosphorus limitations.

United Park City Mines

On the west side of Jordanelle Reservoir, the United Park City Mines discharges water from their treatment facilities at Keetley Station. This water originates from old Park City mines that are drained through the Ontario #2 Drain Tunnel. The UPDES permit sets specific limitations on daily maximum concentrations of TSS, aluminum, copper, lead, mercury, zinc, oil and grease. Limitations are also placed on 30-day average concentrations of TSS, lead and mercury. The drain tunnel is not a significant source of phosphorus and phosphorus is not limited in the permit although JTAC monitors the effluent. The current permit was effective on August 1, 1997 and expires June 30, 2002.

Wasatch County Water Efficiency Project

Components of the Wasatch County Water Efficiency Project were separated in early 2000 and bids awarded to several contractors. Work on all phases of the 44-mile pipeline, irrigation canal rehabilitation, pond development, and administration building project neared completion at the end of 2000. Final testing will be conducted during 2001, with full operation expected to begin in 2002.

WCWEP will allow 1600 acres of land in the Heber Valley to be irrigated with sprinklers rather than the flood irrigation methods currently used, thus potentially conserving 23,000 acre feet of water per year. This will reduce nutrient-rich return flows that contribute to some of the water quality problems in Deer Creek Reservoir. Water conserved by the improved irrigation systems will also be used to supplement the flows of Spring Creek, lower Lake Creek, London Ditch, and Creamery Ditch in Heber Valley.

In addition, the project will allow the delivery of water to Daniel Irrigation Company to replace a Strawberry River Basin water supply terminated by CUP Completion Act mandate. Restoring the water to the Strawberry River Basin will improve fish and wildlife habitat there and contribute additional water to Strawberry Reservoir.

Provo River Restoration Project

The goal of the Provo River Restoration Project (PRRP) is to restore the Provo River in Heber Valley from below Jordanelle Dam to Deer Creek Reservoir. In many areas the river has been straightened for construction of flood control levees. In1999, the Utah Reclamation Mitigation and Conservation Commission began the Provo River Restoration Project (PRRP) between Jordanelle Dam and Deer Creek Reservoir to restore the river's pattern and ecological function to a more natural condition.

The PRRP consists of constructing a multiple-thread meandering channel, reconnecting the river to existing remnants of historic secondary channels and constructing small side channels to recreate aquatic features. Existing levees are set back to create a near natural flood plain that allows the river to change course naturally. Planting and fostering streamside vegetation will provide necessary environment for healthy fisheries. Side channels and ponds will improve fish habitat and create habitat for wetland dependent wildlife.

Utah Division of Wildlife Resources and U.S. Bureau of Reclamation construction crews helped initiate the project by carving new meanders, side channels and wetland ponds in and around the Provo River from about 1.6 miles downstream of Jordanelle Dam to Highway 40. The area was revegetated and an angler access site along this reach was also improved. This work was coordinated with the Central Utah Water Conservancy District, which rebuilt diversion facilities as part of the Wasatch County Water Efficiency Project.

In the Fall, 2000, an additional 1.3 miles of the river was restored between Highway 40 and the bridge crossing on River Road in Midway. Similar to the work upstream, this river reach was taken out of a straightened, diked channel and carved into new meanders, accompanied by side channels and wetland ponds. The project along this reach is mostly complete. Remaining tasks, such as: revegetating disturbed areas, constructing additional wetland ponds, constructing two additional side-channels, and completing a new angler access site to include a restroom, resurfaced driveway and parking area, will be completed in the Spring, 2001.

Deer Creek Resource Management Plan

The Deer Creek Resource Management Plan (RMP) insures water integrity as a principle source of water supply for the Wasatch Front area. It protects and maintains the purposes for which the Provo River Project was authorized by congress, as well as provides long term management direction information for prospective users as well as interested public.

A Recreation and Land Management Review was held at Deer Creek Reservoir on May 17, 2000. The purposes of the Recreation and Land Management Review were:

- To audit the implementation of the Resource Management Plan (RMP), and
- To audit the completion of monitoring plans required by the RMP. Monitoring Plans predict resource conditions necessary to achieve desired RMP future conditions.

Implementation of the RMP

Reservoir Management Reviews are the monitoring vehicles to track progress toward achieving RMP goals and objectives. Results of these reviews are categorized under these sections: Partnerships, Water Resources, Recreational Resources, Natural and Cultural Resources, and Land Management Resources.

Implementation results are also divided into three categories: completed actions, ongoing actions, and action required. The following are items recommended for immediate action.

Partnerships - Partnerships with state and local entities to provide enhanced management of Deer Creek are generally working well.

The RMP commitment to eliminate grazing (except east of US-189) has been accomplished. Several commitments, including the recruiting of volunteer efforts, and the development of interpretive and educational programs, are ongoing efforts. A fire protection plan and a new recreation management agreement with State Parks are priorities for FY2001 efforts.

Water Resources - Overall water quality in the reservoir is good. It is unknown if sampling for oil and grease is being implemented. The Provo River Technical Committee reports low dissolved oxygen levels in the river, below the dam. Turbine aeration is expensive and inefficient and has not been pursued. There are no plans, at present, to investigate this issue. The Utah Division of Wildlife Resources has placed four restrooms along the lower Provo River in an attempt to eliminate human caused waste.

Recent recreation facility renovations by the Bureau of Reclamation and State Parks are in compliance with the RMP direction and commitment to construct facilities and sewer drain fields a minimum of 300 feet from the reservoir high water line. Current management of fishing and recreation is within the RMP guidelines. Efforts to coordinate with the Utah Department of Transportation to minimize impacts from road and highway construction continue.

Some prohibited travel below the high water line at Charleston Bay has been observed. Signs and traffic control measures need to be considered to augment law enforcement efforts. Refueling of watercraft below the high water line, and on the water, is prohibited.
While fueling operations are generally in compliance, the PRWUA believe additional education of the public is needed. Pack and saddle animals are not allowed on project lands and additional signing and posting of the Wallsburg Management Area is necessary.

Recreational Resources - Recreation facility renovation is expected to be complete this year. At present, State Parks, UDOT, and Reclamation are completing the acceleration lane at Rainbow Bay on US-189. The State Park is assembling picnic tables and erecting pavilions to complete final work associated with the project. Island Bay and Sail Boat Beach are complete and open to the public. Completed work is popular with the public and the concessionaire at Island Bay. As the result of renovation, weekday use at Island Bay has become heavy in addition to elevated weekend use.

Restrictions on the number of watercraft and wakeless areas are working well. Appropriate facilities have been constructed and are being managed in compliance with the RMP commitments.

Natural and Cultural Resources - Management is in compliance with UDWR efforts to provide for a two-storied fishery that provides year-round recreation to anglers. Coordinated pest management between affected entities is occurring. The Wallsburg Area and the area between Snow's and Rainbow Bay are being managed for wildlife values. Charleston Bay is being managed for the protection of birds and wetlands.

Whirling disease is a concern at the reservoir. Efforts to construct surface boat ramps should be pursued as funds are made available. A wildlife implementation document for the Wallsburg Area and a natural area implementation plan for Charleston Bay need to be developed. The PRWUA believes Charleston Bay needs more intense wakeless management.

Land Management Resources - Fences should be constructed after recommendations are made in a wildlife implementation document. Wholesale boundary location is needed for management purposes. Additional signage and enforcement is needed to protect facilities and educate the public on project purposes. The Little Deer Creek Area is temporarily blocked from public access pending an off-highway vehicle access study.

Access to Little Deer Creek, an agreement for State Parks to house law enforcement officials in the homes, and the proper management of the wooden bridge at the Lower Provo River need attention.

Evaluation of Monitoring Plans

Monitoring plans allow resource managers to predict and quantify progress in accomplishing the future desired results established by the RMP. Resources are categorized into four major areas: Water Quality, Recreation, Natural and Cultural Resources, and Land Resources. The monitoring plans for Water Quality and Recreation have been developed and are in place.

Recommended Actions

Partnerships

- A fire prevention plan needs to be developed to define the roles and responsibilities of the partners. (USBR Lands)

Water Resources

- Currently the Wallsburg Wildlife Area is receiving recreational equestrian use. Signing and posting is needed to prohibit the use of pack and saddle animals on project lands. (PRWUA)

Recreational Resources

- Develop a new Memorandum of Understanding for recreation management (USBR Recreation)
- Monitor Little Deer Creek and develop restroom, waste and picnic facilities as needed. (USBR Recreation)

Natural and Cultural Resources

- Develop a wildlife implementation document for the Wallsburg Wildlife Management Area. (USBR Environmental)
- Develop a natural area implementation document for the Charleston Bay Area. (USBR Environmental)
- Manage Charleston Bay as wakeless. (State Parks)
- Complete Monitoring Plans identified in Appendix C. (USBR Environmental)

Land Management Resources

- An agreement for State Parks to use the homes below the dam needs to be revisited. PRWUA would also like direct access to State Parks law enforcement. (USBR Lands)
- Determine the status of the wooden bridge over the Provo River, below the dam. (USBR Lands)
- Prepare rights-of-way descriptions for recent recreation renovation activities. (USBR Lands)
- Complete Monitoring Plans identified in Appendix C. (USBR Lands)

Deer Creek State Park Renovations

Visitation:

Visitation increased once again to 253,523 in 2000 compared to 200,912 and 180,367 in 1999 and 1998 respectively. Much of this visitation is attributed to the development of the Wallsburg Overnight Group Use area, Main Park Campground, the and Rainbow Day Use area. The Island Beach, Main Park, Charleston Day, and Rainbow Bay areas reached visitation capacity on most weekends and holidays from Memorial Day through Labor Day. The park is closed during capacity for one hour at a time. If enough visitors leave, the park is opened again until capacity is reached and the park is then closed again for one hour. If visitation is not relieved, the park remains closed for still another hour.

Boat Capacity Limits:

Since 1996, Deer Creek has limited the boating use to a capacity of 300. This is a safety recommendation set by the USBR and State Parks counting one boat for every 10 surface acres. This capacity limit is enforced almost every weekend in the summer. Rainbow Bay will be closed to boat trailers because of the capacity limit.

Law Enforcement and Resource Management Plan Compliance:

Deer Creek rangers issued a total of 368 citations and 5,520 oral warnings in 2000. In compliance with the Resource Management Plan and State Park law, the following citations and warnings were given:

Dog Violations: A total of 20 citations and 105 oral warnings were issued for dogs being off a leach in shoreline areas, in the water, or in any day use area. Every major area is posted and we strictly enforced. The only area where dogs are allowed is in the Main Park Campgrounds. There they are confined to be on a leash and attended.

As of right now, there is no State Park law restricting dogs from being on boats. The Resource Management Plan calls for no dogs on boats and the Park Manager has submitted a request to the State Park Board of Directors to implement this law. It is expected to pass as the State Park Board of Directors approved the Resource Management Plan.

Vehicle violations: A total of 20 citations and 53 oral warnings were issued for vehicles being on the shoreline. Vehicles are restricted from any shoreline area with physical barriers and signs.

Trespassing violations: A total of 11 citations were issued for trespassing on the Provo Water User's property around the Dam, Spillway, and Power Plant. No Warnings were given.

Renovations

For the past three years, Deer Creek State Park has been under renovation construction. Island Beach, Sailboat Beach, Rainbow Bay, Wallsburg Bay, the Main Park Campground, a ranger home, and a new Park office have all been developed and/or renovated. This totaled approximately $5.5 million. Fifty percent of the money was Federal and fifty percent was State money. All of the picnic tables in the Main Campground and Rainbow Bay still need to be covered with pavilions and Rainbow Bay's water system needs to be installed. With 40 fire pits installed in the new campground, the renovation project will be complete.

Deer Creek Dam Foundation Tests

The Bureau of Reclamation (USBR) is conducting tests on Deer Creek Dam to determine if the foundation is stable. There is concern that the foundation may have problems and need rehabilitation. If the foundation is unstable, in the case of an earthquake, liquefaction may occur which may result in dam failure.

Deer Creek Dam was built in 1941 and spans the Provo River canyon in the Wasatch Range with a high earthen embankment. For several years, the Utah Department of Transportation has been meeting with the Bureau of Reclamation, the dam owner, and the Provo River Water Users Association, the dam operator, to gain permission to over lay the downstream embankment slope with a large road way embankment. The overlay would give the State a comparatively low-cost way of widening and straightening State Highway 189, which presently crosses the embankment crest with two lanes that approach the dam from sharp turns off the abutment hillsides.

Neither Reclamation nor the Water Users Association has expressed objections to the proposal, provided the definite plan meet the following requirements: The plan cannot diminish the design functionality of the project. The plan cannot reduce the required level of dam safety; furthermore safety enhancements should be considered during planning to counterbalance any unintended, unwanted consequences that the roadway might cause. If the highway work would make some reasonably anticipated treatment difficult to accomplish in the future, then the treatment should be made before the road is constructed, while flexibility still exists.

The state expects to start road construction in the summer of 2003 and has not completed a definite plan. Reclamation has been conducting ongoing investigations on the foundation of Deer Creek as part of Reclamation's Safety Evaluation of Existing Dams process since 1998. In an effort to meet UDOT's schedule, Reclamation intended on finalizing investigations and analysis which would be compiled as a Report of Findings (ROF) by the end of 2000.

During the field season of 2000, the field exploration request included an additional cross-hole shear wave triplet. Samples and Standard Penetration Testing (SPT) data were collected from each of these three holes. Two other SPT holes were drilled. Six Becker Hammer holes were also drilled consisting of two sample holes and four penetration holes. Shear wave velocity tests were conducted in the new triplet of holes. Also, in the year 2000 a seismic refractions survey was conducted upstream of the dam centerline.

Currently the ROF is in draft format and is being peer reviewed. Upon completion of the peer review, an independent consultant board consisting of three members will meet and provide comment. The consultant board is scheduled to meet March 22-23, 2001. A final ROF can be expected by April 30, 2001.

Upper Provo River Water Quality Management Plan

The Upper Provo River Water Quality Management Plan is an update to the management plan that was released 15 years ago in 1984. The basin characteristics and problems were identified and analyzed. Accordingly, Total Maximum Daily Loads (TMDLs) for problematic stream segments in the basin were set. These TMDLs were developed from procedures given by EPAto comply with the requirements under section 303(d) of the Clean Water Act.

The yearly TMDLs for phosphorus are listed below in Table 2.1:

Table 2. 1 Upper Provo River Annual TMDLs for TP Loadings

WATERSHED NAME	ANNUAL TMDL'S TP – kg/yr
Provo @ Woodland	7,681
Kamas Fish Hatchery	173
Provo @ Hailstone	9,837
Provo @ Jordanelle	8,685
Provo @ Charleston	8,428
Provo @ Deer Creek	12,788
Snake Creek	1,747
Daniels Creek	488
Main Creek	916

The Upper Provo River Water Quality Management Plan was delivered in draft form to members of JTAC in June 1997. Comments were solicited at that time from members of the Committee as well as the EPA, DNR and other interested parties. These comments were received and responses to these comments drafted. Based on the comments received, changes and revisions to the Draft Plan were made and a final version of the Plan was given March 1999. The Wasatch County Commission and the Executive Committee of Mountainland Association of Governments have approved the plan.

Heber Valley Storm Water Management Plan

In response to recommendations from previous years' implementation reports, Wasatch County has completed the Storm Water Study in Heber Valley. Wasatch County continues to experience increased urbanization that tends to increase natural storm runoff conditions. The study has identified potential sites for construction of new sedimentation basins and/or wet ponds intended to reduce eroded sediments in surface waters prior to entering Deer Creek Reservoir. By removing sediments, many pollutants including phosphorus will also be removed.

The plan lists two alternatives for building sediment basins. The first alternative suggests a basin wide plan that identifies ten sediment basin locations around the valley to be managed by the County. This plan could be used to reduce flood discharge as well as remove pollutants.

The second alternative is less costly than the first but only addresses the water quality benefit and not flood control benefits. It identifies four basin locations each at the mouth of major tributaries to the Provo River, which are: the Flood Channel, Spring Creek, Snake Creek and Daniels Creek.

Currently, efforts are being directed toward identifying sources of funds that can be used for this project. The following funding sources are being evaluated:

- Clean Water State Revolving Funds (SRF): Low interest loans through the state.
- Nonpoint Source Implementation Grants (319 Program): Federal grant money.
- Reallocation of $1 Million Charleston Sewer Grant: Federal grant money.
- Wetland Banking by Private Developers: Private developers could purchase for wetland mitigation problems on properties.

Heber Valley Special Service District

Heber Valley Special Service District (HVSSD) adopted a new facility plan in the summer of 1999. The plan recommends that the most cost effective and efficient manner to treat wastewater from the users is to expand the current facility of aerated lagoons with land application. (HVSSD is a non-discharge facility).

The construction year of 1999 saw almost 470 connections, which represents 11% of the designed capacity for connections. With the expectation that growth will continue at a brisk pace, HVSSD is moving forward with plans to design and build an additional treatment/storage lagoon that will add 1500+ connections. The new treatment/storage lagoon is expected to be on-line by the fall of 2001 in order to meet the needs of continued growth and most of the wastewater impacts of the 2002 Winter Olympics.

HVSSD will also be working closely with Jordanelle Special Service District to determine growth and most of the wastewater treatment in the Jordanelle Basin.

US-40 Highway Construction

The section of US-40 between the River Road/SR-32 intersection and Heber City is a two-lane facility with marginal shoulders. It was scheduled for reconstruction to a five-lane road in 1996 but funding was transferred to a higher priority project.

The existing road received an overlay in 1997 to preserve it until funding was again available. This section of US-40 is once again on-track for reconstruction and rehabilitation in 2000. The money will come from the Olympic funding. To realize the value of the overlay and reduce costs of the project, the concept has changed from total reconstruction to reconstruction and rehabilitation. The widening will be on the west side of US-40 and then an additional overlay over the existing road.

The completed project will be a five lane facility, two lanes in each direction, a permissive left turn lane and ten foot shoulders on both sides of the road. The project will include new drainage and irrigation culverts, some intersection improvements, and enhancement of a wetland mitigation site purchased for the 1996 project.

The concept change has required that the plans are redrawn and the contract package is prepared again. The construction has commenced and will be completed this year.

1999 Water Quality Monitoring Program

CHAPTER 3

INTRODUCTION

This chapter describes the JTAC program that has been established to monitor water quality in the Provo River Watershed. Also, this chapter provides the methodology and assumptions used for presentation, calculations, and analyses of the water quality data.

JTAC MONITORING PROGRAM

The JTAC monitoring program uses a method of systematically taking samples from streams and reservoirs in the watershed. In 1999, JTAC took over 500 samples from 45 locations for the purpose of water quality analysis. The sampling locations were selected with the purpose of analyzing the progress towards the goals set in 1984. Each is identified by a six-digit STORET number for the State's system of identification. Tables 3.1 and 3.2 on the following pages lists the 45 sites with their STORET number and descriptions. These locations are graphically shown on Maps 1-4 located at the end of this chapter.

Stream Monitoring

There are 16 locations along Provo River and the basin's tributary streams where stream samples were taken. Most stream locations were sampled approximately on a monthly basis. Field data is gathered that describes many physical properties. Further analyses are then conducted at the State Laboratory for nutrients and dissolved metals, refer to Tables 3.1 and 3.2.

Reservoir Monitoring

There are four locations on Deer Creek Reservoir and three on Jordanelle Reservoir where reservoir sampling occurred. The samples have been typically taken at four different depths where possible. Accounting for the varying depths, there are a total of 23 reservoir sampling points. Field data is gathered, along with Turbidity measurements for the determination of water clarity of the reservoir. Further analyses are then conducted at the State Laboratory for nutrients and dissolved metals refer to Tables 3.1 and 3.2.

Insert Table 3.1 JTAC Monitoring Plan Fiscal Year 1998-1999

Table 3. 1 JTAC Monitoring Plan Fiscal Year 1998-1999

Table 3.2 JTAC Monitoring Plan Fiscal Year 1999-2000

Table 3. 2 JTAC Monitoring Plan Fiscal Year 1999-2000

Reservoir Profiles

In addition to the reservoir sampling as described above, temperature, dissolved oxygen, specific conductance, redox potential, and pH data were gathered at 4 sites at various depths to produce a profile of the reservoir for these parameters. The most critical parameter is dissolved oxygen (DO) concentration with reference to the thermocline determined from the temperature readings. Low DO concentrations are an indication of poor water quality and these conditions can be the cause of anaerobic activity, loss of aquatic wildlife and undesired taste and odors. For lakes and reservoirs the algae growth is responsible for DO depletion. This is due to dying algae that consequently sinks to the bottom of the reservoir and aerobically decays in the hypolimnion consuming the DO. In severe conditions, which occur seasonally in Deer Creek Reservoir, the decay of algae will entirely consume the DO, thus creating an anaerobic environment. The profiles provided in this report help monitor the oxygen conditions in the reservoir throughout the year.

Other Monitoring

The remaining five sampling locations account for three point source effluents (Midway Fish Hatchery, Kamas Fish Hatchery, and United Park City Mines), and two Quality Assurance/Quality Control (QA/QC) locations. The QA/QC locations are described later in this chapter. JTAC has also included the funding needed for monitoring groundwater in existing wells in Heber Valley.

REPORT ORGANIZATION

For the purpose of report organization, the watershed has been divided into four major sub-basins. Each sub-basin is analyzed in its own separate chapter. The sub-basins and their corresponding chapters are listed below:

- **Chapter 4**. The Upper Provo River and Jordanelle Reservoir Basin
- **Chapter 5**. The Provo River through the Heber Valley
- **Chapter 6.** The Deer Creek Reservoir Basin
- **Chapter 7.** The Provo River below Deer Creek

Note: Appendix A presents the water quality data in the order given by the segmented sub-basins above.

QA/QC PROGRAM

The DWQ has established the method of duplicate sampling for Quality Assurance /Quality Control (QA/QC). The method consists of taking duplicate samples that are labeled with a separate STORET number and a dummy description is given for unbiased comparisons. The laboratory results of the duplicate sample are compared with the actual site sample. Any discrepancy found in the samples is weighed against a 95% confidence interval generated through a statistical methodology.

There were two sites from which duplicate samples were taken. One was located on the Provo River below Deer Creek Reservoir with a dummy description of Provo River at Utah County Line. The other was located on Deer Creek Reservoir near the dam with a dummy description of Deer Creek Reservoir 100 meters west of outhouse.

1999 QA/QC Results

The following excerpt is from a memorandum from Arne Hultquist, Division of Water Quality, reporting on the 1999 QA/QC results. The entire memo, which includes attached QA/QC data, may be referred to in Appendix D.

> The results of the data given by JTAC's Quality Assurance Analysis show that none of the samples tested have significant deviations from each other. For all analysis most of the reported values that lie outside of the confidence intervals might be attributed to the normal errors associated with sampling and laboratory analysis. For all analysis 4.1% of the test that were taken fall outside of the 95% confidence level.

The QA/QC program has determined that the water quality data received from the State Laboratory is relatively reliable. Specifically encouraging, are the phosphorus analyses, which appear to have been fixed from the problems that eliminated the previous year's phosphorus data.

SURFACE WATER CLASSIFICATIONS AND STANDARDS

Each stream and reservoir in the State of Utah is classified according to its beneficial uses. The classifications are used to determine the required standards for water quality parameters. The following classifications have been assigned to the surface waters pertinent to this report:

Description	Classification
Provo River and tributaries	1C, 2B, 3A, 4
Deer Creek Reservoir	1C, 2A, 2B, 3A, 4
Jordanelle Reservoir	1C, 2A, 3A, 4

The classifications are defined as:

Class 1C:	Protected for domestic purposes with prior treatment processes as required by Utah Department of Health.
Class 2A:	Protected for primary contact recreation such as swimming.
Class 2B:	Protected for secondary contact recreation such as boating, wading and similar uses.

Class 3A:	Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in the food chain.
Class 4:	Protected for agricultural uses including stock watering and irrigation of crops.

This information can be found in detail in Utah Administrative Code R317-2 Standards of Quality for Waters of the State.

Water Quality Standards

The State of Utah has established water quality standards that are based upon the beneficial uses as determined by previously described classifications.

State Bacterial Standards

The State of Utah has set bacteria standards for surface waters that are classified for domestic or recreational uses (Classes 1 & 2). The standards set for Class 1 domestic use water is 5000 maximum total coliforms per 100 mL and 2000 total maximum fecal coliforms per 100 mL. The standards set for Class 2 recreational use water is 1000 maximum total coliforms per 100 mL and 200 maximum total fecal coliforms per 100 mL. The results of the bacteriological laboratory tests on the samples can be found in the complete data in Appendix E.

State Physical Properties Standards

According to state standards, the pH for waters of all classifications must remain in the range from 6.5 to 9.0. For cold water species of fish (Class 3A) the maximum water temperature is 20 degrees Celsius. Maximum water temperature and minimum dissolved oxygen (DO) levels have been set for aquatic life. Minimum DO levels have been determined based upon the presence of early stages of life. When present, 8.0 mg/L is the minimum limit, otherwise it is 4.0 mg/L.

The DWQ, rather than perform an investigation at each location for early stages of life, has established the practice of using 6.5 mg/L as an indicator of a low DO level. For deep lakes and reservoirs, lower DO levels are anticipated and accepted. JTAC, for this report, has established the value of 2.0 mg/L to be used as the minimum DO limit in Deer Creek and Jordanelle Reservoirs.

State Phosphorus Standards

The State's standards regarding phosphorus are limited for recreational, and aquatic wildlife uses (Classes 2 & 3). The State maximum limit for phosphorus as P is 0.05 mg/L for streams and 0.025 mg/L for reservoirs. The 1984 Watershed Management Report by JTAC recommended that the phosphorus concentration target be reduced to 0.04 mg/L for the Provo River Watershed because of problems relating to eutrophication.

JTAC General Standards

Table 3.3 that follows is a summary of the JTAC standards that were used to analyze the water quality data and identify potential problems.

Table 3. 3 JTAC Water Quality Standards

Parameter	Value
Minimum Dissolved Oxygen (mg/L)	6.5/2.0*
pH Range	6.5-9.0
Maximum Temperature (deg C)	20
Total Suspended Solids (mg/L)	35
Total Phosphorus as P (mg/L)	.04/.025*
Dissolved Phosphorus as P (mg/L)	.04/.025*

* First value is used for streams and rivers, second value is used for reservoirs

State Ammonia Standards

For protection of aquatic life, the State has set standards for allowable ammonia concentrations. The toxicity of ammonia varies according to pH and temperature. The State has established charts for the determination of ammonia standards. The chart used for this report is for Class 3A waters as given below in Table 3.4.

Table 3. 4 1-Hour average allowable concentrations (mg/L) of ammonia as N for Class 3A waters.

	TEMPERATURE (C)						
pH	**0**	**5**	**10**	**15**	**20**	**25**	**30**
6.5	0.008	0.011	0.015	0.021	0.03	0.03	0.03
7.0	0.019	0.027	0.038	0.054	0.076	0.076	0.076
7.5	0.037	0.053	0.075	0.105	0.149	0.149	0.149
8.0	0.054	0.076	0.107	0.151	0.214	0.214	0.214
8.5	0.054	0.076	0.107	0.151	0.214	0.214	0.214
9.0	0.054	0.076	0.107	0.151	0.214	0.214	0.214

The State standard for ammonia has also been adopted by JTAC to monitor water quality conditions.

State Dissolved Metal Standards

Part of the JTAC monitoring plan analyzes dissolved metal concentrations for select locations. The standards used for dissolved metals are from state restrictions for domestic, aquatic life, and irrigation uses. Recreational and aesthetic uses, however, have very few set standards on dissolved metal concentrations. Table 3.5 below summarizes the limits for each use based on 1-hr averages of measurements. The bold numbers indicate the most stringent of the standards that were used for identifying problem locations.

Table 3. 5 Dissolved Metals Allowable Concentrations for 1-hr average measurements

	Allowable Concentration (μg/l)		
Dissolved Metal	**Class 1C**	**Class 3A**	**Class 4**
Aluminum		**750**	
Arsenic	**50**	360	100
Barium	**1000**		
Cadmium	10	**3.9**	10
Chromium	50	**16**	100
Copper		**18**	200
Iron		**1000**	
Lead	**50**	82	100
Mercury	**2**	2.4	
Selenium	**10**	20	50
Silver	50	**4**	
Zinc		**120**	

Total Organic Carbon

Organic contaminants (natural organic substances, insecticides, herbicides, and other agricultural chemicals) enter waterways in rainfall runoff. Domestic and industrial wastewaters also contribute organic contaminants in various amounts. As a result of accidental spills or leaks, industrial organic wastes may enter streams. Some of the contaminants may not be completely removed by treatment processes; therefore, they could become a problem for drinking water sources. It is important to know the organic content in a waterway.

Total organic carbon (TOC) provides a speedy and convenient way of determining the degree of organic contamination. By using TOC measurements, the number of carbon-containing compounds in a source can be determined. This is important because knowing the amount of carbon in a freshwater stream is an indicator of the organic character of the stream. The larger the carbon or organic content, the more oxygen is consumed. A high organic content means an increase in the growth of microorganisms which contribute to the depletion of oxygen supplies.

LOADING CALCULATIONS AND ASSUMPTIONS

Loading calculations are based on the water quality data gathered by JTAC and average daily flow measurements, typically taken from a USGS gage station. Loading is determined at each location for three important water quality parameters, total suspended solids (TSS), total phosphorus (TP), and dissolved total phosphorus (DTP). All samples with constituent concentrations below the detectable limit were assumed to have no concentration of that constituent.

Loads were calculated by multiplying the mass concentration of the substance (mg/l) by the daily flow rate (cfs) in the stream to determine the daily mass loading rate. TSS daily loading was determined in units of tons/day; total phosphorus and total dissolved phosphorus was determined in lbs/day.

Each daily mass loading rate was then averaged with the mass loading rate of the previous sampling date and multiplied by the number of days between samples to obtain the total mass load for that period. Loading for the period between January 1st and the first sampling date was calculated using the daily loading rate for the first sampling date and multiplying it by the number of days between January 1st and the first sampling date. Likewise, the loading for the period between the year's last sampling date and December 31st was calculated in the same manner.

The annual mass loading rate was determined by summing the load for each period. This methodology assumes that mass loading rates are steady and that fluctuations are relatively gradual. This calculation method is in accordance with the statistical report published in the 1992 implementation report.

Insert Map 1

Figure 3. 1 Map 1 of Provo River Watershed Area

Insert Map 2

Figure 3. 2 Map 2 of Provo River Watershed Area

Insert Map 3

Figure 3. 3 Map 3 of Provo River Watershed Area

Insert Map 4

Figure 3. 4 Map 4 of Provo River Watershed Area

Upper Provo River and Jordanelle Reservoir

CHAPTER 4

INTRODUCTION

This chapter will present and analyze the water quality monitoring for the Upper Provo River and Jordanelle Reservoir Basin.

STREAM MONITORING RESULTS

In the area of the Upper Provo River and Jordanelle Reservoir Basins, JTAC monitored five stream sampling locations and two point source discharge locations during the year of 1999. The monitoring locations are as follows:

STORET No.	Location Description
• 499840	Provo River above Woodland at USGS gage
• 492900	Kamas Fish Hatchery effluent
• 499814	Weber Provo Canal Diversion at US 189
• 499813	Provo River above Hailstone
• 499804	Ontario #2 Drain Tunnel (Park City Ventures)
• 499767	McHenry Creek below Mayflower

Each stream monitoring location is discussed individually in the sections that follow. A summary table of the water quality monitoring results is presented, which lists maximums, minimums, averages, and number of exceedences for temperature, dissolved oxygen, pH, TSS, ammonia, dissolved phosphorus and total dissolved phosphorus. A more complete analysis of the data is included in Appendix A.

The Provo River above Woodland, STORET # 499840

This monitoring location represents water coming from the headwaters of the Provo River in the Uinta Mountains. It is located on the Provo River approximately 4 miles upstream of Woodland near USGS flow gage #10154200. A summary of the water quality data for this location is shown in Table 4.1.

Table 4. 1 Provo River above Woodland, 499840 – Water Quality Summary

Date	*Temp* ° C	*pH*	*D.O.* mg/l	*T.S.S.* mg/l	*Ammonia N* mg/l	*T. Phos.* mg/l	*D-T Phos.* mg/l
Minimum	2	7.4	8.4	0	0	0	0
Maximum	13.4	8.2	11.2	76	0	0.033	0.023
Median	3.9	7.95	10.15	0	0	0.01	0
Mean	6.6	7.9	9.8	8.7	0.00	0.012	0.007
Number	10	10	10	10	10	10	10
Exceedences	0	0	0	1	0	0	0

Note: Highlighted information exceeds stream water quality standards or guidelines.

The location was sampled ten times during 1999. The TSS data shows that one sample, collected on May 25th exceeded the JTAC indicator value of 35 mg/l. No other exceedences were recorded. Historically, few exceedences are recorded at this location indicating the excellent water quality at this location. The 1999 data is relatively average compared to historical data.

Kamas Fish Hatchery Effluent, STORET # 492900

The Kamas Fish Hatchery discharges into Beaver Creek, approximately 3 miles east of Kamas, which is historically a tributary to the Weber River. During high spring runoff flows, a portion of the water is diverted into the Weber-Provo Canal, which brings it into the Provo River Basin. Also, during the agricultural growing season, much water is diverted from Beaver Creek for irrigation and the return flows are discharged into the Provo River Basin. For this reason, the Kamas Fish Hatchery is considered a point source of phosphorus loading for the Provo River. The current UPDES permit does not require phosphorus monitoring despite efforts by Wasatch County to persuade the DWQ to establish phosphorus limits. A summary of the water quality data for the effluent is shown below in Table 4.2.

Table 4. 2 Kamas Fish Hatchery Effluent, 492900 – Water Quality Summary

Date	*Temp* ° C	*pH*	*D.O.* mg/l	*T.S.S.* mg/l	*Ammonia N* mg/l	*T. Phos.* mg/l	*D-T Phos.* mg/l
Minimum	9.9	7.2	6.9	0	0	0	0
Maximum	13.4	7.7	9.27	0	0	0.205	0.164
Median	10.33	7.505	7.4	0	0	0.15	0
Mean	10.9	7.5	7.7	0.0	0.0	0.1	0.0
Number	5	4	5	5	5	5	5
Exceedences	0	0	0	0	0	4	1

The location was sampled five times during 1999. These five samples showed relatively normal levels. There were 4 Total Phosphorous exceedences of the 5 samples taken. Of the 5 samples 5 were tested in the lab. The ammonia levels were considerably lower than that of years past.

Weber Provo Canal Diversion, STORET # 499814

This monitoring site is located where the Weber-Provo Canal flows into the Provo River at a point approximately 3 miles south of Kamas. The Weber-Provo Canal diverts water from the Weber River through Kamas into the Provo River. A summary of the data is shown below in Table 4.3.

Table 4. 3 Weber Provo Canal Diversion at U.S. 189, 499814 – Water Quality Summary

Date	Temp ° C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	0.2	7.8	8.9	0	0	0	0
Maximum	17.4	8.2	12.1	66.8	0	0.042	0.027
Median	5.7	8	10.5	0	0	0.022	0
Mean	6.2	8.0	10.7	11.8	0.00	0.022	0.011
Number	7	7	7	7	7	7	7
Exceedences	0	0	0	1	0	1	0

This location was monitored seven times during 1999. Only one sample, collected on May 25th, recorded an exceedence in phosphorus concentration. This sample also exceeded the maximum allowable value of TSS

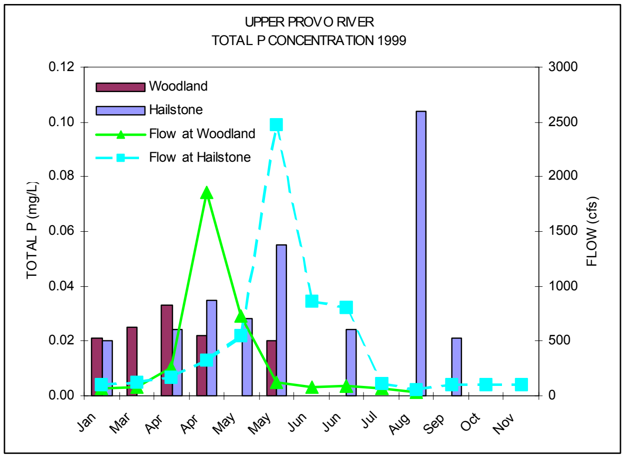
Provo River above Hailstone, STORET # 499813

This monitoring site is located in the Provo River just upstream of the Jordanelle Reservoir near USGS flow gage #10155000. This location represents the water that flows into Jordanelle Reservoir from the Provo River. A summary of the data is shown below in Table 4.4.

Table 4. 4 Provo River above Hailstone, 499813 – Water Quality Summary

Date	Temp ° C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	0.2	7.6	8.1	0	0	0	0
Maximum	17.2	8.8	12.5	100.8	0.057	0.104	0.031
Median	4.2	8.2	10.6	0	0	0.021	0
Mean	7.3	8.2	10.2	10.9	0.0	0.0	0.0
Number	13	13	13	13	13	13	13
Exceedences	0	0	0	0	0	2	0

This location was monitored thirteen times during 1999. Two samples collected on May 25th and August 19th exceeded the phosphorus concentration indicator, also one sample on May 25th exceeded TSS The location showed phosphorus concentrations slightly lower than historical data. The following charts, Figures 4.1 and 4.2 compare the total suspended solid and total phosphorus concentrations at Hailstone to those upstream 10 miles at the Woodland monitoring location.



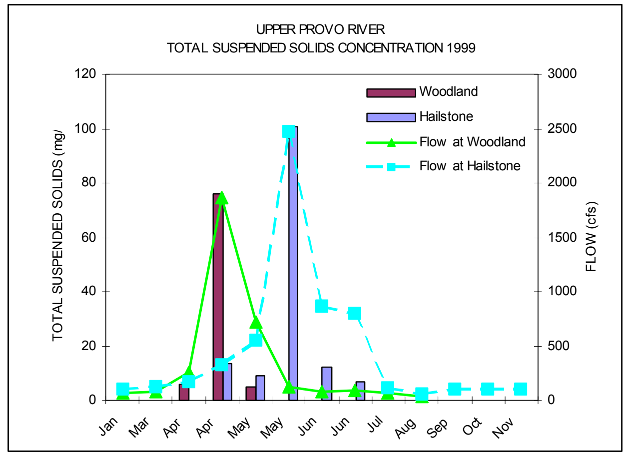


Figure 4. 1 Upper Provo River 1999 TP Concentrations
Figure 4. 2 Upper Provo River 1999 TSS Concentrations

The charts show that some increases in TP and TSS concentrations occur between the two locations. This is indicative of the non-point source loading throughout this 10-mile stretch from agricultural lands and small tributaries. Notable is the fact that high TSS concentrations were present in May, yet strangely high TP concentrations did not coincide with this high level of TSS. Rather, high TP concentrations occurred in June when TSS concentrations were lower.

Ontario #2 Drain Tunnel (Park City Ventures), STORET # 499804

This monitoring site is located on the west side of Jordanelle Reservoir where the United Park City Mines discharges from treatment facilities at the Keetley Station. A summary of the water quality data is provided below in Table 4.5.

Table 4. 5 Ontario #2 Drain Tunnel, 499804, Water Quality Summary

Date	Temp ° C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	8.4	8.3	8.7	0	0	0	0
Maximum	12.8	8.9	13.72	12	0	0.022	0
Median	10.3	8.68	9.6	8	0	0	0
Mean	10.2	7.5	10.0	6.5	0.0	0.0	0.0
Number	7	7	7	7	7	7	7
Exceedences	0	0	0	0	0	0	0

This location was monitored seven times during 1999. Historically the drain tunnel has had no problems with phosphorus concentrations, but has had problems with high pH. This year the maximum pH was just under 9.0.

McHenry Creek below Mayflower, STORET # 499767

This monitoring site is located on the west side of Jordanelle Reservoir where McHenry Creek flows into the reservoir. This creek lies in the same drainage as the Mayflower mine and tailings ponds that pose a risk of contamination. Also further up in the drainage lies development activities by Deer Valley Ski Resort. A summary of the water quality data is provided below in Table 4.6.

Table 4. 6 McHenry Creek below Mayflower, 499767 – Water Quality Summary

Date	Temp ° C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	3.1	7.5	9.2	6	0	0.022	0
Maximum	12.6	8.3	11.2	51.3	0	0.059	0.04
Median	6.4	7.8	10.4	11.2	0	0.032	0.028
Mean	7.2	7.9	10.1	18.7	0.0	0.037	0.020
Number	5	5	5	5	5	5	5
Exceedences	0	0	0	1	0	2	0

The location was monitored five times during 1999. Phosphorus exceedences were detected in two of the samples. Historically the location has a few exceedences in phosphorus concentrations. This year appears to be typical as compared to past years. There was one exceedence on May 25th for TSS

STREAM LOADINGS & TMDLS IN UPPER PROVO RIVER

The data from stream samples that were collected are used with flow data to calculate river loadings of three important constituents: TSS, TP, DTP. In the Upper Provo River area these loads are calculated in three stream locations: Provo River near Woodland, Weber-Provo Canal Diversion, Provo River near Hailstone; and one point source location being the Kamas Fish Hatchery Effluent. The spreadsheets of these calculations can be found in Appendix C. Figure 4.3, as follows, illustrates the results.

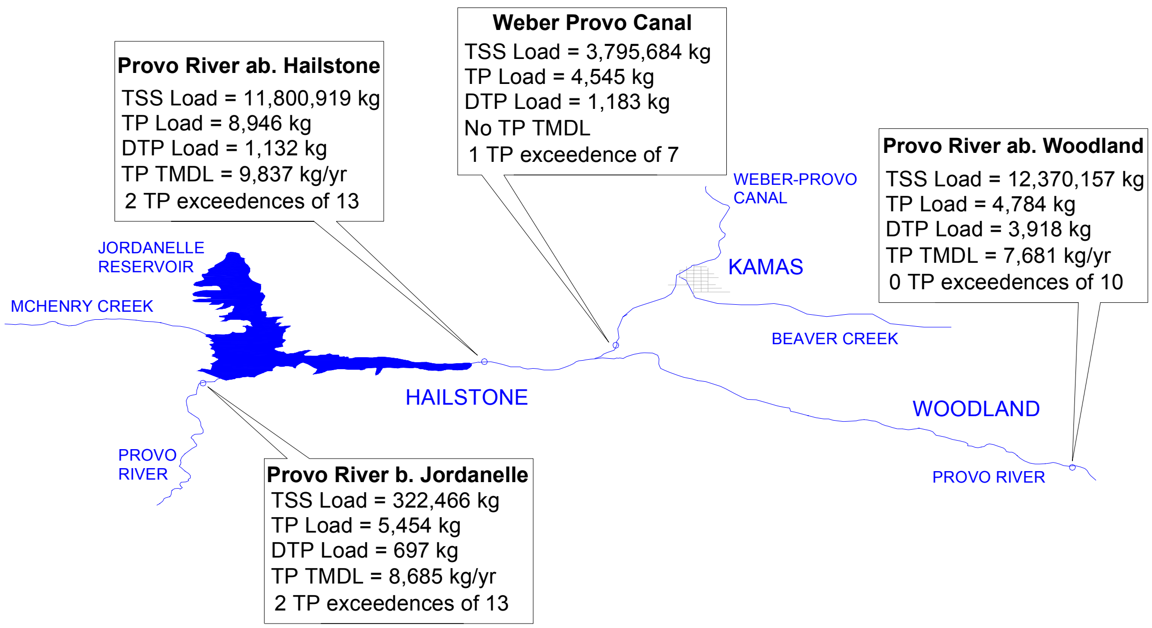


Figure 4. 3 Upper Provo River TSS/TP/DTP Loading Overview

As shown in the map, the Provo River near Woodland showed fairly high loading values for TSS The location near Hailstone, however, has nominal loadings of TP and TSS. These observations are apparent in Table 4.7, which compares the 1999 loading results to the previous six years.

Table 4. 7 Upper Provo River Loading Summary

	1993	1994	1995	1996	1997	1998	1999
Provo River at Woodland, STORET 499840							
Weighted Average Flow (cfs)	339	134	303	242	220	296	323
TP Weighted Average (mg/l)	0.020	0.016	0.026	0.009	-	0.018	0.017
TP Annual Load (kg/yr)	6,094	2,008	7,053	1,995	-	4,762	4,784
DTP Weighted Average (mg/l)	-	-	0.009	0.004	-	0.001	0.014
DTP Annual Load (kg/yr)	-	-	2,499	1,995	-	201	3,918
TSS Weighted Average (mg/l)	25.4	14.5	38.2	11.5	7.7	10.7	42.9
TSS Annual Load (kg/yr)	7,692,847	1,704,960	10,334,714	2,486,544	1,517,482	2,825,034	12,370,157
Kamas Fish Hatchery, STORET 492900							
Weighted Average Flow (cfs)	5.2	4.9	6.2	5.8	6.2	6.5	4.4
TP Weighted Average (mg/l)	0.008	0.078	0.060	0.046	-	0.023	0.141
TP Annual Load (kg/yr)	388	337	327	237	-	135	548
DTP Weighted Average (mg/l)	-	-	0.039	0.025	-	0.016	0.066
DTP Annual Load (kg/yr)	-	-	214	130	-	91	255
TSS Weighted Average (mg/l)	2.5	1.4	1.5	0	4.1	0	0
TSS Annual Load (kg/yr)	11,516	6,008	8,122	0	22,816	0	0
Weber Provo Canal, STORET 499814							
Weighted Average Flow (cfs)	110	52	57	82	21	57	192
TP Weighted Average (mg/l)	0.082	0.042	0.048	0.022	-	0.014	0.027
TP Annual Load (kg/yr)	8,079	1,923	2,432	1,594	-	731	4,545
DTP Weighted Average (mg/l)	-	-	0.014	0.007	-	0	0.007
DTP Annual Load (kg/yr)	-	-	733	526	-	0	1,183
TSS Weighted Average (mg/l)	44.9	44	37.8	31.1	4.2	7.2	22.2
TSS Annual Load (kg/yr)	4,417,245	2,039,486	1,937,566	2,287,441	76,622	366,015	3,795,684
Provo River at Hailstone, STORET 499813							
Weighted Average Flow (cfs)	474	225	385	284	308	288	338
TP Weighted Average (mg/l)	0.054	0.039	0.042	0.023	-	0.02	0.03
TP Annual Load (kg/yr)	22,992	7,721	14,267	5,825	-	5,159	8,946
DTP Weighted Average (mg/l)	-	-	0.006	0.010	-	0.007	0.004
D. Phosphorus Load (kg/yr)	-	-	1,926	2,528	-	1,725	1,132
TSS Weighted Average (mg/l)	36.1	41.1	42.4	22.0	25.8	8.3	39.1
TSS Annual Load (kg/yr)	15,252,858	8,245,837	14,552,043	5,571,686	7,076,823	2,132,646	11,800,919
Provo River below Jordanelle, STORET 499733							
Weighted Average Flow (cfs)	317	139	238	270	324	350	348
TP Weighted Average (mg/l)	0.036	0.022	0.020	0.015	-	0.010	0.018
TP Annual Load (kg/yr)	10,271	2,722	4,272	3,496	-	2,969	5,454
DTP Weighted Average (mg/l)	-	-	0.021	0.012	-	0.001	0.002
DTP Annual Load (kg/yr)	-	-	4,367	2,876	-	194	697
TSS Weighted Average (mg/l)	11.6	5.2	0.0	0.1	0.0	0.0	1
TSS Annual Load (kg/yr)	3,286,183	648,241	0	19,957	0	0	322,466
Provo River TP Increase Ratio	3.8	3.8	2.0	2.9	-	1.1	1.9

Typically increases in TP and TSS occur through this 10-mile stretch between the two locations; TP loadings usually increase on the order of a ratio varying from 2.0 to 3.8. In the past, these increases have been attributed to the erodibility of soil through this area and also agricultural activities that increase loadings.

Comparisons to TMDLs

TMDLs were calculated in the Wasatch County Water Quality Management Plan 1999. In the Upper Provo River they were calculated for the Provo River at Woodland, Kamas Fish Hatchery, and Provo River at Hailstone. Table 4.8 shows the comparisons of 1999 loadings to the annual TMDLs. As shown in the table, none of the 1999 loads exceed the annual TMDLs.

Table 4. 8 Upper Provo River TMDLs for Total Phosphorous

Location	TMDL (kg/yr)	1999 Phos. Load (kg)
Provo River at Woodland	7,681	4,784
Kamas Fish Hatchery	173	548
Provo River at Hailstone	9,837	8,946

JORDANELLE RESERVOIR MONITORING

On the Jordanelle Reservoir, JTAC monitored three locations during the year of 1999. Reservoir monitoring included samples taken at various depths in each location as well as profiles of physical characteristics at multiple depths to generate a profile of the water characteristics, the most important characteristic being dissolved oxygen (DO). The three monitoring locations listed are as follows:

STORET No.	Location Description
• 591404	Jordanelle Reservoir – Provo River arm
• 591403	Jordanelle Reservoir – north arm
• 591401	Jordanelle Reservoir – above dam

Each location is discussed individually in the sections that follow. A summary table of the water quality monitoring results is presented, which lists maximums, minimums, averages, and number of exceedences for temperature, dissolved oxygen, pH, TSS, ammonia, dissolved phosphorus and total dissolved phosphorus.

Provo Arm, STORET #591404

The Provo River Arm of Jordanelle Reservoir was sampled eight times during 1999. All nine included a sample taken from the reservoir surface and a sample taken from the bottom of the reservoir at a depth of approximately 39 meters. A combined summary of the water quality data for the surface and bottom is shown below in Table 4.9.

Table 4. 9 Jordanelle Reservoir-Provo Arm, 591404 – Water Quality Summary

Date	*Temp* ° C	*pH*	*D.O.* mg/l	*T.S.S.* mg/l	*Ammonia N* mg/l	*T. Phos.* mg/l	*D-T Phos.* mg/l
Minimum	4	6.9	5.5	0	0	0	0
Maximum	21.2	8.3	10.5	0	0.0601	0.026	0.047
Median	6.4	7.75	7.65	0	0	0.017	0
Mean	9.8	7.7	7.7	0.0	0.0	0.0	0.0
Number	16	16	16	16	16	16	16
Exceedences	2	0	3	0	1	0	1

High water temperatures on the surface of the reservoir are not uncommon, as there were two exceedences. On April 15th, there was an incident of DTP concentrations exceeding the JTAC indicator value of 0.025 mg/l in the surface sample and the bottom sample. Despite the DTP exceedences, none of the samples recorded TP concentrations that exceeded JTAC indicator value. Obviously, this is due to laboratory error. There was one exceedence in ammonia and it appears that only one sample was tested for ammonia levels.

North Arm, STORET #591403

The north arm of Jordanelle Reservoir was also sampled on eight occasions during 1999. Samples were taken at the surface of the reservoir and the reservoir bottom approximately 42 meters deep. A combined summary of the water quality data for the surface and bottom is shown below in Table 4.10.

Table 4. 10 Jordanelle Reservoir-North Arm, 591403 – Water Quality Summary

Date	*Temp* ° C	*pH*	*D.O.* mg/l	*T.S.S.* mg/l	*Ammonia N* mg/l	*T. Phos.* mg/l	*D-T Phos.* mg/l
Minimum	4.1	6.8	3.8	0	0	0	0
Maximum	21.2	8.4	10.5	0	0.0531	0.068	0.035
Median	6.5	7.75	7.25	0	0	0.021	0
Mean	9.8	7.7	7.3	0.0	0.0	0.0	0.0
Number	16	16	16	16	16	16	16
Exceedences	2	0	4	0	1	1	0

Similar to the Provo Arm of the reservoir there two exceedences of maximum temperature. Also there was one exceedence in phosphorus levels. Also, there were four times when the D.O. levels dropped below normal. There was one exceedence in ammonia and it appears that only one sample was tested for ammonia levels.

Above Dam, STORET #591401

Above the dam of Jordanelle Reservoir, there were samples taken on eight occasions during 1999. There were a total of 62 samples taken from varying depths at this site. A combined summary of the water quality data at all depths is provided below in Table 4.11.

Table 4. 11 Jordanelle Reservoir-Above Dam, 591401 – Water Quality Summary

Date	*Temp* ° C	*pH*	*D.O.* mg/l	*T.S.S.* mg/l	*Ammonia N* mg/l	*T. Phos.* mg/l	*D-T Phos.* mg/l
Minimum	4.2	7	1.3	0	0	0	0
Maximum	20.4	8.3	9.7	4.8	0.061	0.045	0.028
Median	6.75	7.7	7.6	0	0	0	0
Mean	8.3	7.6	7.3	0.1	0.0	0.0	0.0
Number	62	62	62	62	62	62	62
Exceedences	2	0	20	0	1	1	0

As expected there were exceedences in temperature from the surface samples. One phosphorus exceedence was detected as well as insufficient level of D.O at several instances. There was one exceedence in ammonia and it appears that only one sample was tested for ammonia levels.

Jordanelle DO Monitoring

At the three reservoir monitoring sites on the Jordanelle, JTAC took measurements of temperature, pH, and dissolved oxygen (DO) at varying depths for the generation of water parameter profiles. Graphs of these profiles, located in Appendix F, plot the temperature and dissolved oxygen concentration with respect to depth for the purpose of analysis of stratification in the reservoir. The profiles graphically show the thermocline in the reservoir and the depth at which dissolved oxygen levels decrease. If anoxic conditions exist in the reservoir, it will be apparent in the generated profiles.

During 1999, Profile data was gathered 7-8 times at the three monitoring locations. They were gathered between months of April and December. Figure 4.4 below tracks the DO concentration throughout 1999 at the lowest depth of each profile.

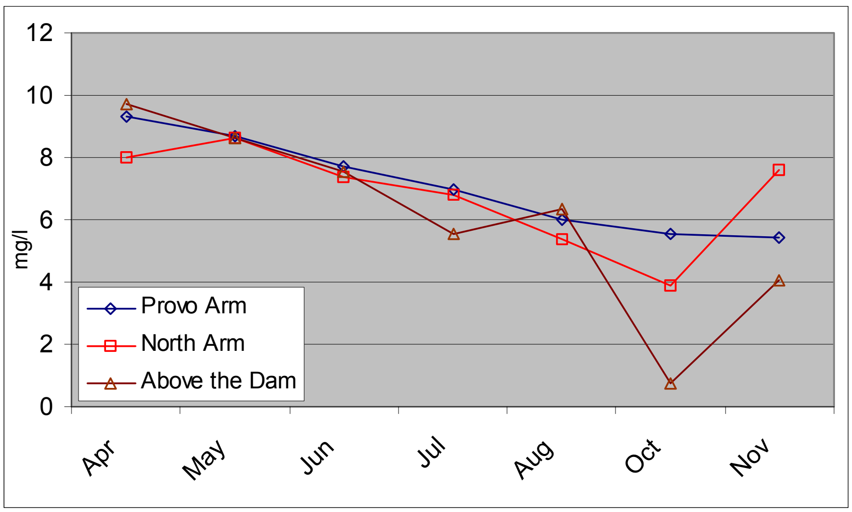


Figure 4. 4 Jordanelle 1999 DO Concentrations at Bottom Depth

The figure shows how the reservoir goes through annual cycle of stratification. Stratification begins when the warm summer air begins to warm the surface of the reservoir. Then, as the temperatures decrease in the late fall, the reservoir begins to turnover from convection currents, destratification is the result. Presentation of the profiles in a calander year shows the complete cycle of mixed to stratified back to mixed.

Jordanelle SLOW and Reservoir Phosphorus Retention

At the dam of the Jordanelle Reservoir, water is released into the Provo River through a SLOW (Selective Level Outlet Works) Tower. This feature of the dam allows for certain parameters of the released water to be controlled, based on the depth from which water enters the intake. Temperature and phosphorus concentrations are some of the major concerns that may be controlled.

It is important that the Jordanelle Reservoir retain phosphorus in the reservoir to reduce phosphorus loadings and thus further improve water quality in Deer Creek Reservoir. Retention will occur naturally because suspended sediments that have attached phosphorus settle in the reservoir. But, dissolved portions will remain. The SLOW tower must selectively change depth to release water with lower concentrations of phosphorus. The Wasatch County Water Quality Management Plan of 1999, has set the goal that Jordanelle Reservoir retain an additional 2,800 kg/yr using 1996 as a baseline. Table 4.12 shows the retention of TP in the reservoir since 1993.

Table 4. 12 Jordanelle Reservoir Retention 1993-1999

Jordanelle Reservoir TP Retention	1993	1994	1995	1996	1997	1998	1999
Provo River Input (kg/yr)	22,992	7,721	14,267	5,825	-	5,159	8,946
Provo River Release (kg/yr)	10,271	2,722	4,272	3,496	-	2,969	5,454
Retention (kg/yr)	12,721	4,999	9,995	2,329	-	2,190	3,492
% Retained	55.3%	64.7%	70.1%	40.0%	-	42.5%	39.0%

The table shows that in 1999 the Jordanelle Reservoir retained approximately 39% of TP load. It released 5,454 kg of TP, this value is significantly below the TMDL of 8,685 kg. Although the water quality management plan calls for additional retention, it would be difficult to export any less than 2,000 kg of TP. With only 8,946 kg entering the reservoir, the tower has done an excellent job in 1999 of retaining phosphorus. The true test of the tower, however, will be retention during years of higher loadings such as one similar to 1995 when 14,000 kg entered the reservoir.

JORDANELLE TROPHIC STATE INDEX

The Carlson Trophic State Index (TSI) has been used by the State of Utah to rank and compare the trophic status of lakes and reservoirs within the state. This index uses data from May to September of two parameters: total phosphorus, and Chlorophyll A. A TSI value can be calculated individually from each of these parameters. In this report, we have taken an average of the TSIs calculated from each. Table 4.13 shows the calculation results for Jordanelle Reservoir. And Figure 4.5 compares the calculated TSI value to historical values that have been calculated since 1993 when the reservoir first began to fill.

Table 4. 13 Carlson Trophic State Index (TSI) calculation for Jordanelle Reservoir

Sample	North Arm			Provo Arm			Above Dam		
Date	Transp.	Chlor-A	TP	Transp.	Chlor-A	TP	Transp.	Chlor-A	TP
	m	μg/l	mg/l	m	μg/l	μg/l	m	μg/l	μg/l
18-May-99	3.9	5.2	0.021	1.7	6	0	5.1	5	0.041
21-Jun-99	2.2	4.3	0.021	1.9	4.9	0	2.8	3.2	0
14-Jul-99	1.9	7.7	0	2.1	6.9	0.025	2.1	6	0.025
25-Aug-99	3.3	2.7	0	3.7	3.2	0	4.8	2.3	0
22-Sep-99	5.4	2	0	4.6	2.9	0.015	5.6	2	0
Average	3.34	4.4	0.008	2.8	4.8	0.008	4.08	3.7	0.013
TSI	**42.6**	**45.1**	**34.8**	**45.2**	**45.9**	**34.1**	**39.7**	**43.4**	**41.4**
TSI Average		**40.9**			**41.7**			**41.5**	
		Average TSI for Reservoir		→	**41.4**				

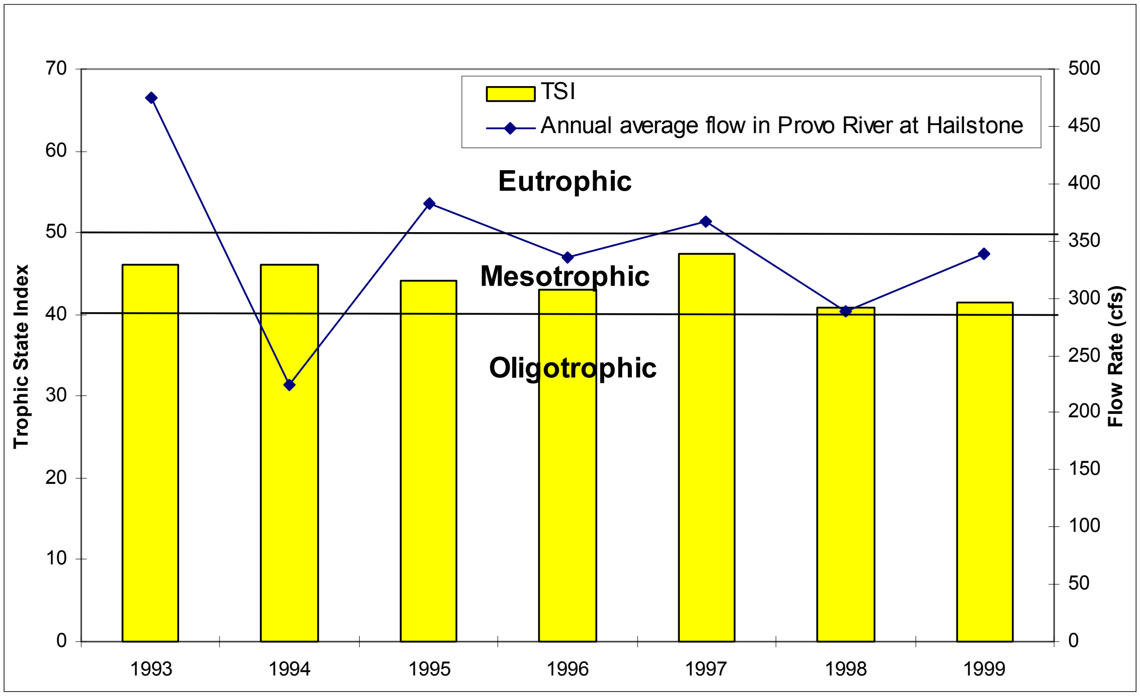


Figure 4. 5 Jordanelle Reservoir TSI and Provo River Average Flow 1993-1999

The TSI was calculated to be 41.4, which classifies the reservoir as mesotrophic indicating a healthy balance of nutrients. This value is close to the value calculated in 1998. The reservoir is close to the borderline of an oligotrophic state, which would indicate a lack of nutrients. The ecosystem of the reservoir has not quite established itself, however it appears to be heading towards a stable mesotrophic status.

PHYTOPLANKTON FLORAS FROM JORDANELLE RESERVOIR

Dr. Samuel R. Rushforth, professor of Botany at Brigham Young University, conducts an annual study on the phytoplankton floras of Jordanelle Reservoir as well as Deer Creek. The abstract to this year's report is as follows:

> A study of the algal plankton flora of Jordanelle Reservoir, Wasatch County, Utah was performed through the calendar year of 1999. Quantitative net plankton and total plankton samples were collected and studied. A total of 32 taxa was identified in the plankton flora. In addition, the two categories, centric diatoms and pennate diatoms, each contained many additional taxa.
>
> The most important algae in all Jordanelle plankton samples (combined net and total plankton samples) for 1999 as determined by frequency of occurance and biomass were the diatoms and diatom categories, **Fragilaria crotonensis** (ISI=28.18), **Stephanodiscus niagarae** (ISI=3.31), pennate diatoms (ISI=3.04),

Asterionella formosa (ISI=1.90) and **Melosira granulata** var. **angustissima** (ISI=0.86); the chrysophyte **Dinobryon divergens** (ISI=2.01); the cyanophyte **Microcystis incerta** (ISI=1.64), chlorophytes **Ankistrodesmus falcatus** (ISI=0.81), **Staurstrum gracile** (ISI=2.63) and **Oocystis borgei** (ISI=0.11) and the dinoflagellate **Ceratium hirundinella** (ISI=0.63). These eleven taxa and two categories comprised more than 99% of the sum importance value for all taxa in the reservoir during 1999. The ISI determination is an assessment of algal standing crop and distribution through the year as reflected in our samples.

The flora of Jordanelle Reservoir continued to be dominated by diatoms during 1999. The flora was comprised of approximately 82% diatoms, 9% Chlorophyta, 4% Chrysophyta, 1% Pyrrhophyta and 3% Cyanophyta.

Similar to earlier studies, biomass and species richness of Jordanelle Reservoir were quite low for the study period. The importance of noxious cyanophytes remained low for the 1999 collection season. Diatom dominance decreased a bit, but still characterized this reservoir system. (Rushforth, 1999)

DISSOLVED METALS ANALYSIS

The dissolved metal concentrations were analyzed in the laboratory for some of the water samples that were taken. JTAC did not test the samples from the Fish Hatchery effluent for dissolved metals, but the other locations were tested 1 to 6 times during 1999. In Table 4.14 below, a summary of the monitoring results is provided.

Table 4. 14 Upper Provo River and Jordanelle Reservoir Dissolved Metals Summary

Date	Al µg/l	As µg/l	Ba µg/l	Cd µg/l	Cr µg/l	Cu µg/l	Fe µg/l	Pb µg/l	Hg µg/l	Mn µg/l	Se µg/l	Ag µg/l	Zn µg/l
Storet 499840, Provo River above Woodland A USGS gage													
25-May-99	440	<5.0	48	<1.0	<5.0	<12.0	229	<3.0	<0.2	7.9	<1.0	<2.0	<30.0
19-Aug-99	<30.0	<5.0	51	<1.0	<5.0	<12.0	59.3	<3.0	<0.2	6.1	<1.0	<2.0	<30.0
21-Oct-99	<30.0	<5.0	52	<1.0	<5.0	<12.0	44	<3.0	<0.2	7.1	<1.0	<2.0	<30.0
Storet 591404, Jordanelle Resevoir - Provo Arm													
18-May-99	<30.0	<5.0	48	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
25-Aug-99	<30.0	<5.0	46	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
22-Sep-99	<30.0	<5.0	49	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
27-Oct-99	<30.0	<5.0	46	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
Storet 591403, Jordanelle Reservoir - North Arm													
18-May-99	<30.0	<5.0	46	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
25-Aug-99	<30.0	<5.0	45	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
22-Sep-99	<30.0	<5.0	46	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
27-Oct-99	<30.0	<5.0	43	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
Storet 591401, Jordanelle Reservoir - Above Dam													
18-May-99	<30.0	<5.0	48	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
25-Aug-99	<30.0	<5.0	46	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
22-Sep-99	<30.0	<5.0	49	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
27-Oct-99	<30.0	<5.0	46	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0

MONITORING BY MAYFLOWER RESORT

Mayflower Mountain Resort has been responsible for a monitoring program since 1984. The program has been governed by agreements with Wasatch County since 1985. Mayflower provides analysis of water quality in an annual report to Wasatch County.

The two sites monitored by Mayflower Mountain Resort are both on McHenry Creek. Site A is located at the outlet works of the Utah Department of Transportation (UDOT) and Mayflower Mountain Resort's Detention Basin, located east of U.S. 40. Site 1 is located on the west side of U.S. 40 on McHenry Creek.

This year there was no data available at the time this draft was written. If the data is available the results will be included in the final report.

MONITORING BY DEER VALLEY RESORT

In 1980, Deer Valley Ski Resort constructed ski runs and lifts in the McHenry and Mayflower drainage basins. Erosion controls and revegetation have followed to reduce the impact on the water quality. As part of an agreement with Wasatch County each year during the spring runoff (approximately April to June) Deer Valley monitors the water effluents of their detention basins in each drainage. The monitoring program analyzes flow rate, TKN (Total Kjeldahl Nitrogen), total phosphate, orthophosphate, TSS, and pH. Flow rate is measured continually while water samples are taken weekly for constituent analyses.

Deer Valley's Water Quality and Sediment Control Report for the 1999 Runoff Season was completed in July 1999 and includes the following statements in the executive summary. For further information, refer directly to the report.

- Deer Valley recorded 170 inches or 93% of its 18-year average snowfall during the 1998/1999 season.
- The peak flow and total runoff in 1999 were slightly above average.
- The TKN concentrations were at normal levels.
- Both basins exhibited continuing stabilized performance trends regarding downstream concentrations of constituents.
- Deer Valley should continue with their current maintenance program.
- Yearly site inspections should be performed.
- Deer Valley personnel should visit each site at least twice weekly to ensure operation of gauges, but samples should still be taken weekly. The staff gauge depth should be indicated on the charts every time the charts are reset.

Deer Valley water monitoring results for 1999 Runoff Season are summarized below in Table 4.15.

Table 4. 15 Deer Valley Water Quality Monitoring Results for 1999 Runoff Season

	McHenry Basin			Mayflower Basin		
	Total	Peak	Average	Total	Peak	Average
Runoff	172 ac-ft	4.58 cfs	1.42 cfs	54 ac-ft	1.24 cfs	0.52 cfs
TKN	169.59 kg	0.8 mg/l	0.8 mg/l	53.71 kg	0.8 mg/l	0.8 mg/l
Total P	10.60 kg	0.07 mg/l	0.05 mg/l	1.88 kg	0.06 mg/l	0.028 mg/l
Ortho P	7.00 kg	0.04 mg/l	0.03 mg/l	1.07 kg	0.03 mg/l	0.016 mg/l
TSS	741.95 kg	8 mg/l	3 mg/l	107.41 kg	3 mg/l	1.6 mg/l

Deer Valley also showed phosphorus measurements above the 0.04 mg/l indicator limit.

TOTAL ORGANIC CARBON

Total Organic Carbon (TOC) is used to track the overall organic content of water. This is an important measure for surface water because it correlates with the production of disinfection by-products during chlorination. Measuring for TOC is more cost effective than measuring for individual compounds. This value is useful in general comparisons of water supplies, in identifying pollution sources, and in helping to determine when additional, more specific analyses might be required. The TOC measure has become very common such that values from source and finished supplies throughout the United States can be compared on this basis. The typical range for surface water TOC is 0.1 to 2.0 mg/L (AWWA, 1999).

The only data points reported were ones that were in exceedence of 2.0 mg/L. Regardless of this the TOC concentrations from the Jordanelle Reservoir were in exceedence for the entire year. This could be a result of the high phosphorous levels that were reported. This is a parameter that should be monitored in the future.

Table 4. 16 Total Organic Carbon Exceedences

Storet Number	Location	Date	ID No.	mg/l
499767	McHenry Creek below Maflower	25-May-99	C9904122	2.10
499813	Provo River above Hailstone Junction	25-May-99	C9904118	6.29
499814	Weber Provo Canal Diversion at US 189	25-May-99	C9904119	5.27
499840	Provo River above Woodland at USGS gage	25-May-99	C9904120	6.80
591401	Jordanelle Reservoir - Above Dam	15-Apr-99	C9902733	2.88
		21-Jun-99	C9905247	3.66
		14-Jul-99	C9906202	3.47
		25-Aug-99	C9908074	3.28
		22-Sep-99	C9909044	2.84
		27-Oct-99	C9910187	3.17
		17-Nov-99	C9910748	2.91
591403	Jordanelle Reservoir - North Arm	15-Apr-99	C9902741	3.00
		21-Jun-99	C9905255	3.51
		14-Jul-99	C9906210	3.49
		25-Aug-99	C9908082	3.20
		25-Aug-99	C9908083	2.49
		22-Sep-99	C9909052	2.91
		27-Oct-99	C9910195	3.09
		17-Nov-99	C9910756	2.88
591404	Jordanelle Reservoir - Above Dam	15-Apr-99	C9902743	2.81
		21-Jun-99	C9905257	3.98
		14-Jul-99	C9906212	2.81
		24-Aug-99	C9908084	2.75
		25-Aug-99	C9908085	2.33
		22-Sep-99	C9909054	2.73
		27-Oct-99	C9910197	3.13
		17-Nov-99	C9910758	2.74

Middle Provo River through Heber Valley

CHAPTER 5

INTRODUCTION

This chapter will present and analyze the water quality monitoring for Snake Creek, Spring Creek, and the Provo River through the Heber Valley.

STREAM MONITORING RESULTS

In the area of the Heber Valley Basin, JTAC monitored four stream sampling locations and one point source location during the year of 1999 as follows:

STORET No.	Location Description
• 499733	Provo River below Jordanelle Dam
• 499725	Spring Creek entrance to Provo River
• 591112	County Flood Control Channel at Provo River
• 591363	Provo River at McKeller Bridge above Deer Creek
• 499713	Midway Fish Hatchery effluent
• 591016	Snake Creek above Deer Creek at RR Crossing

Each monitoring location is discussed individually in the sections that follow. A summary table of the water quality monitoring results is presented, which lists maximums, minimums, averages, and number of exceedences for temperature, dissolved oxygen, pH, TSS, ammonia, dissolved phosphorus and total dissolved phosphorus. A more complete analysis of the data is included in Appendix A.

Provo River below Jordanelle Dam, STORET #499733

This station is located below the outlet works of Jordanelle Dam and samples the water that is released from Jordanelle Reservoir. A summary of the water quality data for this location is shown in Table 5.1.

Table 5. 1 Provo River below Jordanelle Dam, 499733 – Water Quality Summary

Date	Temp ° C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	2.8	7.5	8.5	0	0	0	0
Maximum	13.7	8.8	11.5	4.4	0	0.139	0.03
Median	7.7	8	10	0	0	0.023	0
Mean	8.1	8.0	9.9	0.6	0.0	0.0	0.0
Number	13	13	13	13	13	13	13
Exceedences	0	0	0	0	0	2	0

Summary Note: Highlighted information exceeds stream water quality standards or guidelines.

The location was monitored thirteen times during 1999. Testing did not detect phosphorus in most of the samples. But, there were two exceedences in DTP. Since operation of the dam in 1992, this location has had low levels of phosphorus and very few exceedences. None of the samples had detectable concentrations of TSS, which is evidence of sediment settling in the reservoir and is comparable to previous years. Figure 5.1 compares the TP and TSS average concentrations to previous years.

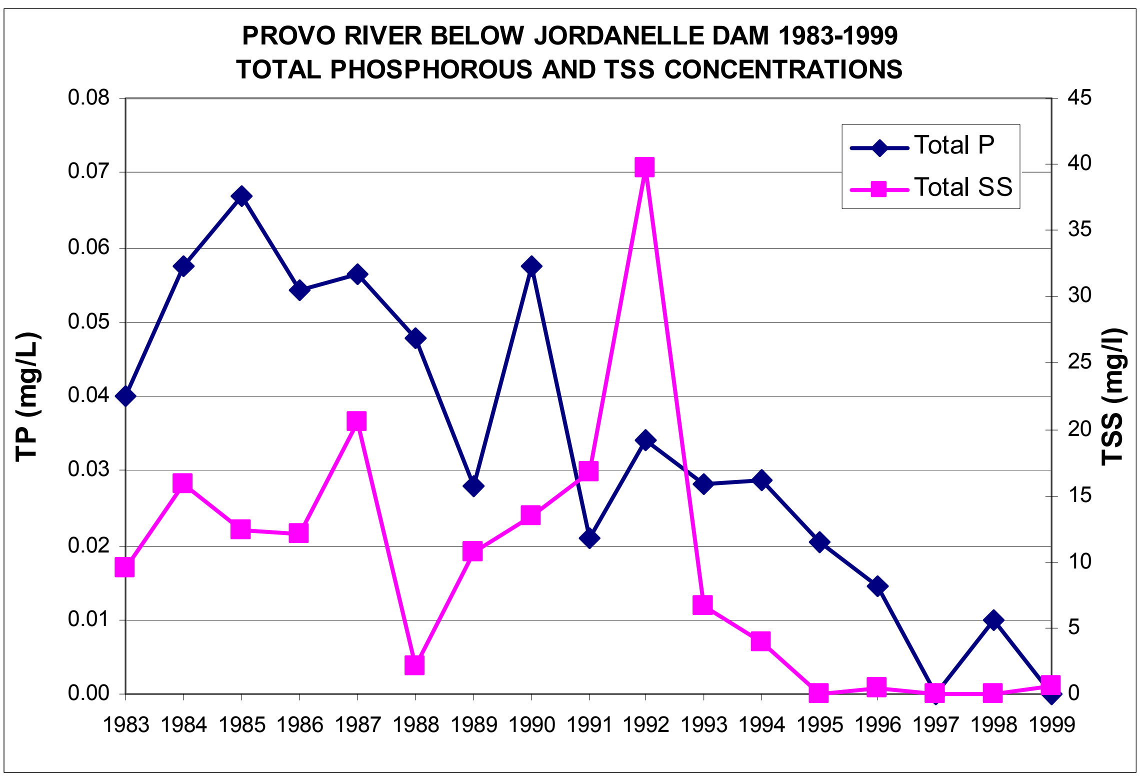


Figure 5. 1 Provo River below Jordanelle TP & TSS Concentrations 1980-1999

The graph illustrates the significant reduction in TP and TSS since operation of Jordanelle Reservoir in 1992.

Spring Creek at Entrance to Provo River East of WWTP, STORET #499725

This monitoring site is located on Spring Creek where it enters into the Provo River at a point approximately 2 miles north of Deer Creek Reservoir and 2 miles west of Heber City. Spring Creek drains most of the northeastern portion of Heber Valley. A summary of the water quality data for this location is shown below in Table 5.2.

Table 5. 2 Spring Creek at entrance to Provo River, 499725 – Water Quality Summary

Date	Temp ° C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	4.3	7.8	8.1	0	0	0.04	0.026
Maximum	18.1	8.6	11.8	175.3	0.0811	0.172	0.072
Median	9.05	8	10.55	15.4	0	0.081	0.051
Mean	10.3	8.1	10.2	31.1	0.0	0.1	0.1
Number	10	10	10	10	10	10	10
Exceedences	0	0	0	1	0	10	8

This location was monitored ten times during 1999. All ten samples exceeded the JTAC pollution indicator value of 0.04 mg/l. There was one exceedence in TSS. This location has historically contained large phosphorus concentrations. This creek is an area where improvements to water quality are still needed.

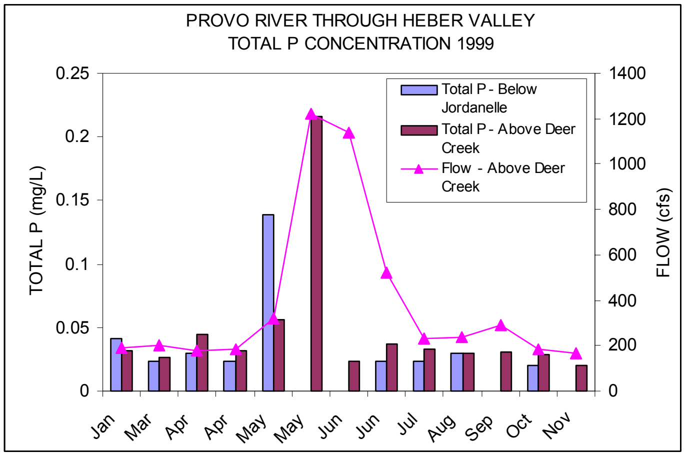
Provo River at McKeller Bridge above Deer Creek, STORET #591363

This monitoring site is located on the Provo River near USGS flow gage #10155500 approximately one half mile upstream from Deer Creek Reservoir. The sampling represents the loadings into Deer Creek Reservoir from the Provo River. A summary of the water quality data for this location is shown below in Table 5.3.

Table 5. 3 Provo River at McKeller Bridge above Deer Creek, 591363 – Water Quality Summary

Date	Temp ° C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	3.5	7.6	8.1	0	0	0.02	0
Maximum	17.6	8.7	12	116	0.0539	0.216	0.031
Median	8.8	8.3	10.7	5.2	0	0.032	0.023
Mean	9.1	8.2	10.3	15.8	0.00	0.047	0.019
Number	13	13	13	13	13	13	13
Exceedences	0	0	0	2	0	3	0

The location was monitored thirteen times during 1999. The tested samples had three instances in which phosphorus exceedences were detected. Also, there were two exceedences in TSS Normally this location has numerous phosphorus exceedences. There has been a great improvement at this location in comparison to previous years. Figures 5.2 and 5.3, as follows, compare the sample concentrations of TP and TSS at the two locations on the Provo River between Jordanelle and Deer Creek Reservoirs. And Figure 5.4 compares the 1999 average concentration of TSS and TP to historical data.



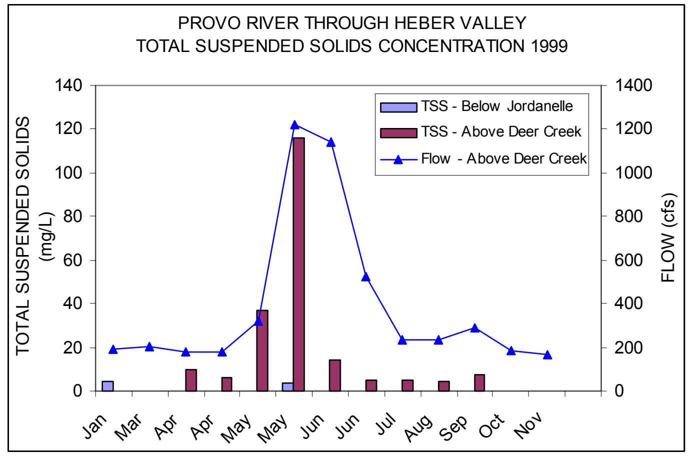


Figure 5. 2 Middle Provo River 1999 TP Concentrations
Figure 5. 3 Middle Provo River 1999 TSS Concentrations

Generally these graphs illustrate the accumulation of TP and TSS as the Provo River winds through the Heber Valley. In Figure 5.2, the TSS gain is very evident since none of the samples taken from below the Jordanelle had detectable levels of TSS. Also, these graphs illustrate the relationship between concentrations and flow. Generally, highest concentrations occur during highest level of flow. The next figure, Figure 5.4 shows the comparison of 1999 to historical data.

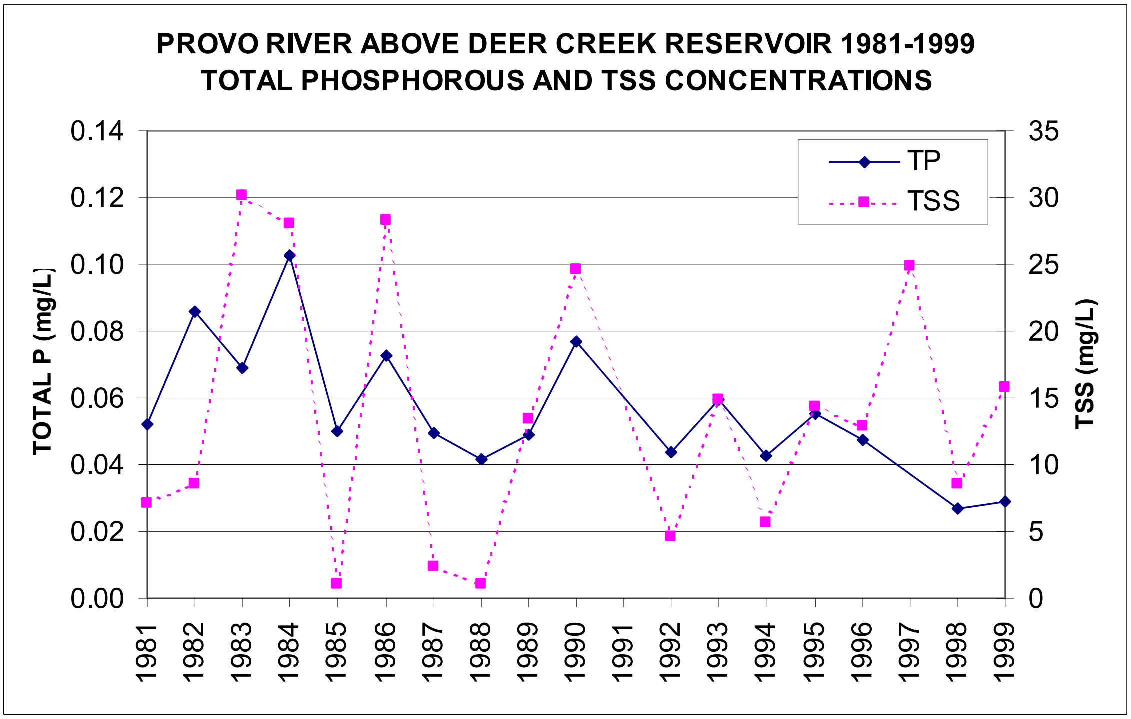


Figure 5. 4 Provo River above Deer Creek TP & TSS Average Conc. 1981-1999

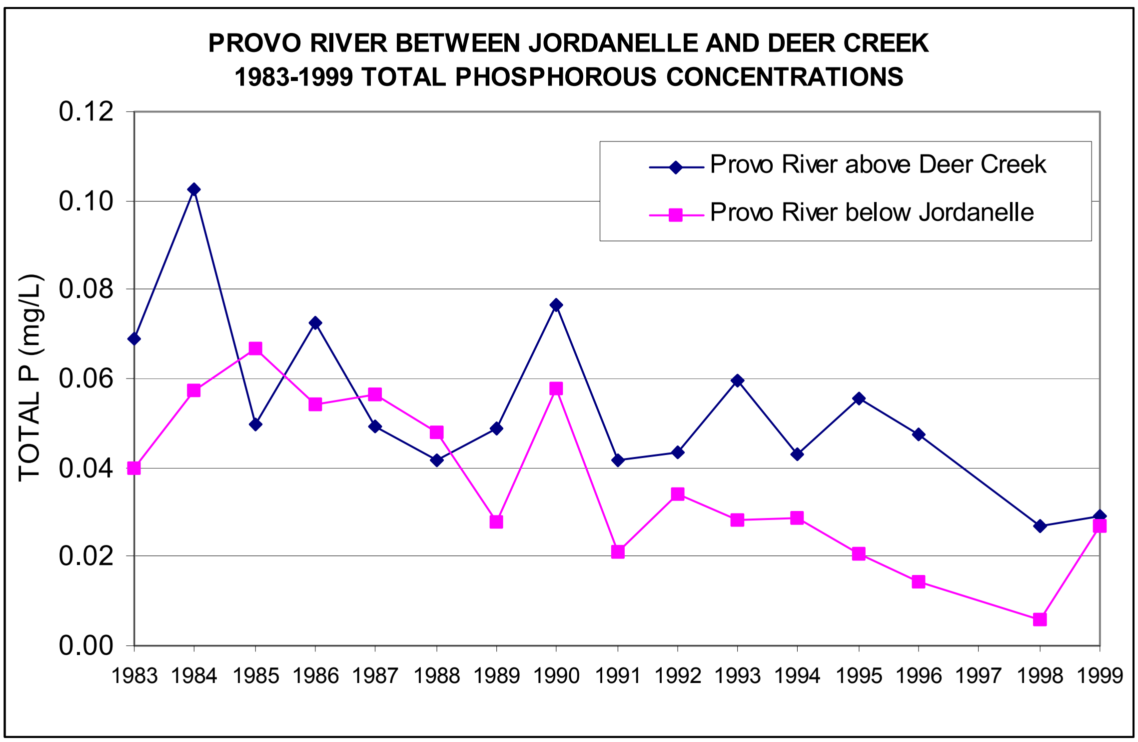


Figure 5. 5 Middle Provo River TP Average Concentrations 1983-1999

Figure 5.5 shows that this year's phosphorus concentrations are lower than ever. It appears again, that the Jordanelle Reservoir has had a great effect at reducing phosphorus concentrations after 1993. Hopefully, the trend that is shown will continue past 1999 to further improve the water quality.

Midway Fish Hatchery Effluent, STORET #499713

As Utah's largest fish hatchery, Midway produces 180,000 pounds of fish per year, mainly rainbow trout. The effluent water from the Midway Fish Hatchery discharges from two 24-inch pipes into Snake Creek after passing through a series of settling ponds approximately 1 mile from the mouth of the creek at Deer Creek Reservoir. The facility receives the water from several nearby springs. The Hatchery has a UPDES permit that requires the hatchery to monitor the influent springs and the effluent springs for the determination of net increase of total phosphorus not to exceed 626 kg/yr. A summary of the water quality data from JTAC monitoring for this location is shown below in Table 5.4.

Table 5. 4 Midway Fish Hatchery Effluent, 499713 – Water Quality Summary

Date	Temp ° C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	8.8	7.1	6.8	0	0	0	0
Maximum	17.8	7.89	10.78	15.6	0.209	0.066	0.041
Median	13.5	7.4	9.25	0	0.11	0.03	0.0255
Mean	13.2	7.4	8.9	1.5	0.1	0.0	0.0
Number	11	17	8	19	7	19	6
Exceedences	0	0	0	0	3	8	1

This location was sampled nineteen times during 1999. TP concentration was measured in each sample but DTP concentration was only measured 6 times while the Ammonia levels were measured 7 times. TP concentrations exceeded the JTAC standard 8 of the 19 samples. Also three of the ammonia concentrations exceeded state standards. This year is fairly consistent with historical conditions of the point source.

Snake Creek above Deer Creek at RR Crossing, STORET #591016

This monitoring site is located on Snake Creek slightly upstream from its confluence with Provo River above Deer Creek Reservoir. Snake Creek winds in a southerly direction through the west side of Heber. The Midway Fish Hatchery discharges into Snake Creek approximately one mile above this monitoring site. A summary of the water quality data for this location is shown below in Table 5.5.

Table 5. 5 Snake Creek above Deer Creek, 591016 – Water Quality Summary

Date	*Temp* ° C	*pH*	*D.O.* mg/l	*T.S.S.* mg/l	*Ammonia N* mg/l	*T. Phos.* mg/l	*D-T Phos.* mg/l
Minimum	7.7	7.4	8.2	0	0	0	0
Maximum	17.2	8.7	10.9	18	0.07	0.041	0.048
Median	11.1	7.7	9.8	7.6	0	0.029	0.01
Mean	12.1	7.7	9.7	8.6	0.0	0.0	0.0
Number	14	14	14	14	14	14	14
Exceedences	0	0	0	0	0	5	1

This location was monitored on fourteen occasions during 1999. 5 phosphorus exceedences occurred as well as 1 DTP exceedence. The phosphorus concentrations were significantly lower than historical data.

STREAM LOADING IN THE HEBER VALLEY

The data from stream samples that were collected are used with flow data to calculate river loadings of three important constituents: TSS, TP, DTP. In the Upper Provo River area these loads are calculated in four stream locations: Provo River below Jordanelle, Spring Creek at Provo River, Provo River above Deer Creek, Snake Creek above Deer Creek; and one point source location being the Midway Fish Hatchery Effluent. The spreadsheets of these calculations can be found in Appendix C. Figure 5.6, as follows, graphically as well as geographically illustrates the results of stream loading calculations.

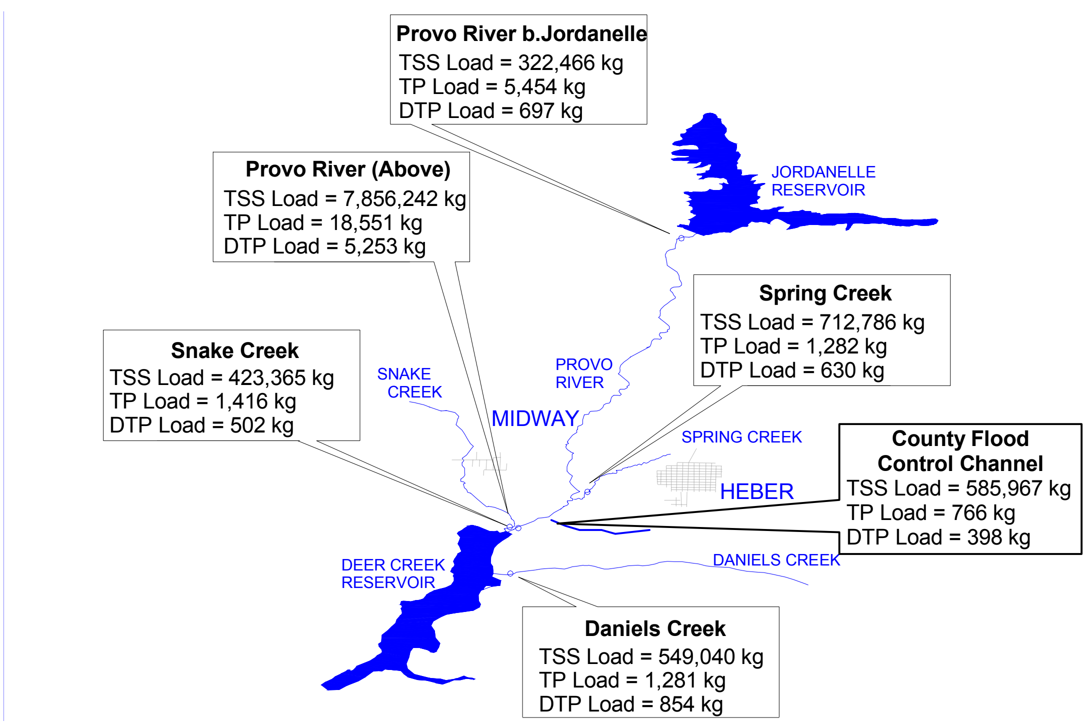


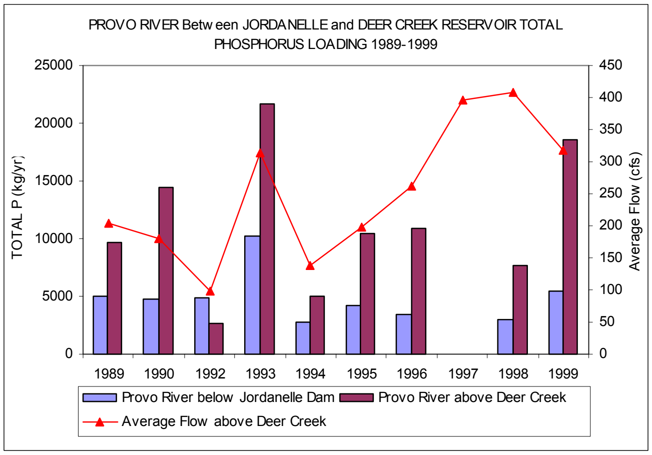
Figure 5. 6 Heber Valley TSS/TP/DTP Loading Overview

As shown in the map, there was some gain in phosphorus along the Provo River through the Heber Valley as TP loading increased by 13,057 kg from below the Jordanelle Reservoir to above the Deer Creek Reservoir. Approximately 7% of this increase can be attributed to Spring Creek, as its TP loading was 1,282 kg in 1999. At the Provo River below Jordanelle none of the samples had detectable levels of TSS hence the loading was calculated to be 322,466 kg. The comparison of loading to the previous six years is shown in Table 5.6.

Table 5. 6 Heber Valley Stream Loading Summary

	1993	1994	1995	1996	1997	1998	1999
Provo River below Jordanelle, STORET 499733							
Weighted Average Flow (cfs)	317	139	238	270	324	350	348
TP Weighted Average (mg/l)	0.036	0.022	0.020	0.015	-	0.010	0.018
TP Annual Load (kg/yr)	10,271	2,722	4,272	3,496	-	2,969	5,454
DTP Weighted Average (mg/l)	-	-	0.021	0.012	-	0.001	0.002
DTP Annual Load (kg/yr)	-	-	4,367	2,876	-	194	697
TSS Weighted Average (mg/l)	11.6	5.2	0.0	0.1	0.0	0.0	1
TSS Annual Load (kg/yr)	3,286,183	648,241	0	19,957	0	0	322,466
Spring Creek at Provo River, STORET 499725							
Weighted Average Flow (cfs)	-	-	-	-	25	35	13
TP Weighted Average (mg/l)	-	-	-	-	-	0.054	0.113
TP Annual Load (kg/yr)	-	-	-	-	-	1,671	1,282
DTP Weighted Average (mg/l)	-	-	-	-	-	0.031	0.055
DTP Annual Load (kg/yr)	-	-	-	-	-	969	630
TSS Weighted Average (mg/l)	-	-	-	-	28.3	15.9	62.5
TSS Annual Load (kg/yr)	-	-	-	-	634,393	496,794	712,786
Wasatch County Flood Control Channel at Provo River, STORET 591112							
Weighted Average Flow (cfs)	-	-	-	-	-	-	12
TP Weighted Average (mg/l)	-	-	-	-	-	-	0.072
TP Annual Load (kg/yr)	-	-	-	-	-	-	766
DTP Weighted Average (mg/l)	-	-	-	-	-	-	0.037
DTP Annual Load (kg/yr)	-	-	-	-	-	-	398
TSS Weighted Average (mg/l)	-	-	-	-	-	-	55.0
TSS Annual Load (kg/yr)	-	-	-	-	-	-	585,967
Provo River above Deer Creek, STORET 591363							
Weighted Average Flow (cfs)	314	138	198	262	303	332	319
TP Weighted Average (mg/l)	0.077	0.040	0.060	0.047	-	0.026	0.030
TP Annual Load (kg/yr)	21,671	4,975	10,472	10,866	-	7,681	18,551
DTP Weighted Average (mg/l)	-	-	0.025	0.025	-	0.009	0.009
DTP Annual Load (kg/yr)	-	-	4,478	5,773	-	2,591	5,253
TSS Weighted Average (mg/l)	24.2	7.7	27.1	11.2	18.6	8.7	27.6
TSS Annual Load (kg/yr)	6,778,611	944,936	4,774,856	2,629,371	5,025,665	2,586,511	7,856,242
Midway Fish Hatchery, STORET 499713							
Weighted Average Flow (cfs)	23.5	21.0	18.8	18.3	16.3	18.8	22.6
TP Weighted Average (mg/l)	0.059	0.063	0.044	0.050	-	0.035	0.033
TP Annual Load (kg/yr)	1,349	1,176	740	820	-	591	670
DTP Weighted Average (mg/l)	-	-	0.046	0.031	-	0.013	0.014
DTP Annual Load (kg/yr)	-	-	769	515	-	213	278
TSS Weighted Average (mg/l)	0.8	2.5	0.5	1.9	1.1	0.7	1.4
TSS Annual Load (kg/yr)	17,615	47,099	8,472	31,398	15,305	11,455	29,078
Snake Creek above Deer Creek, STORET 591016							
Weighted Average Flow (cfs)	45	38	50	54	48	57	43
TP Weighted Average (mg/l)	0.057	0.058	0.061	0.038	-	0.017	0.024
TP Annual Load (kg/yr)	2,259	1,934	2,690	1,860	-	873	1,416
DTP Weighted Average (mg/l)	-	-	0.029	0.023	-	0.009	0.011
DTP Annual Load (kg/yr)	-	-	1,270	1,134	-	476	502
TSS Weighted Average (mg/l)	5.4	11.0	14.0	8.7	10.1	10.1	13.1
TSS Annual Load (kg/yr)	213,742	369,582	616,915	421,925	431,283	507,661	423,365
Provo River TP Increase Ratio	2.1	1.8	2.5	3.1	-	2.6	3.4

The table shows that the 1999 loadings are generally lower than were the six previous years. The following graphs also illustrate the improvements in loadings.



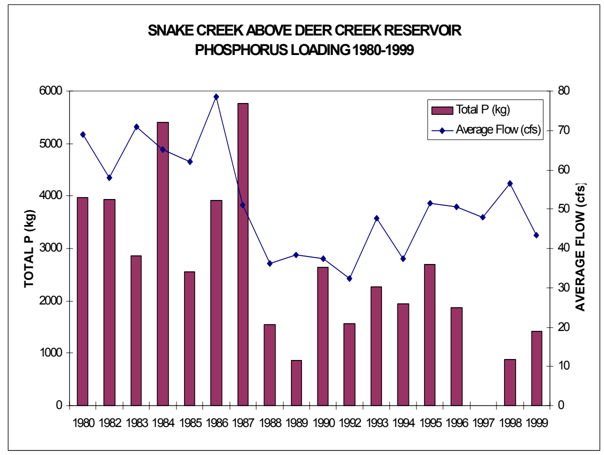


Figure 5. 7 Provo River TP Loadings in the Heber Valley 1989-1999
Figure 5. 8 Snake Creek TP Loading 1980-1999

In Figure 5.7 the 1999 TP loadings in the Provo River are compared to the previous years. A very noteworthy observance is that despite having high flows comparable to 1993, the loadings were substantially decreased.

In Figure 5.8, Snake Creek historical TP loadings demonstrate that the 1999 loading very near to the lowest in the period of record that occurred in 1989. But 1999 is more noteworthy than 1989 because of the higher flows that occurred yet still maintained a relatively low load.

Comparisons to TMDLs

TMDLs were calculated in the Wasatch County Water Quality Management Plan 1999. In the Heber Valley they were calculated for the Provo River below Jordanelle, Provo River above Deer Creek, and Snake Creek above Deer Creek. Table 5.7 shows the comparisons of 1999 loadings to the annual TMDLs. As shown in the table, none of the 1999 loads exceed the annual TMDLs.

Table 5. 7 Provo River through Heber Valley and Snake Creek TMDLs

Location	TMDL (kg/yr)	1999 Load (kg)
Provo River below Jordanelle	8,685	5,454
Provo River above Deer Creek	8,428	18,551
Snake Creek above Deer Creek	1,747	1,416

DISSOLVED METAL ANALYSIS

The dissolved metal concentrations were analyzed in the laboratory for some of the water samples that were taken. JTAC did not test the samples from the Fish Hatchery effluent, but the other locations were tested 3 to 4 times during 1999. In Table 5.8 below, a summary of the monitoring results is provided.

Table 5. 8 Heber Valley Dissolved Metals Summary

Date	Al µg/l	As µg/l	Ba µg/l	Cd µg/l	Cr µg/l	Cu µg/l	Fe µg/l	Pb µg/l	Hg µg/l	Mn µg/l	Se µg/l	Ag µg/l	Zn µg/l
Storet #499733, Provo River below Jordanelle Dam													
19-Aug-99	<30.0	<5.0	130	<1.0	<5.0	<12.0	36.6	<3.0	<0.2	23	<1.0	<2.0	<30.0
21-Oct-99	<30.0	<5.0	160	<1.0	<5.0	<12.0	30.6	<3.0	<0.2	21	<1.0	<2.0	<30.0
Storet #499725, Spring Creek at entrance to Provo River east of WWTP													
12-Jan-99	<30.0	<5.0	44	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
9-Mar-99	<30.0	<5.0	54	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
19-Aug-99	33	<5.0	41	<1.0	<5.0	<12.0	37.9	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
21-Oct-99	<30.0	<5.0	47	<1.0	<5.0	<12.0	35.3	<3.0	<0.2	14	<1.0	<2.0	<30.0
Storet #591363, Provo River at McKeller Bridge above Deer Creek Reservoir													
19-Aug-99	<30.0	17	40	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	8.5	<1.0	<2.0	<30.0
21-Oct-99	<30.0	16	42	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	6.8	<1.0	<2.0	<30.0
Storet #591016, Snake Creek above Deer Creek Reservoir at RR crossing													
25-May-99	<30.0	<5.0	66	<1.0	<5.0	<12.0	25.4	<3.0	<0.2	22	<1.0	<2.0	<30.0
19-Aug-99	<30.0	<5.0	62	<1.0	<5.0	<12.0	45.7	<3.0	<0.2	12	<1.0	<2.0	<30.0
21-Oct-99	<30.0	<5.0	67	<1.0	<5.0	<12.0	32.9	<3.0	<0.2	8.2	<1.0	<2.0	<30.0

The results of the tests conducted show that for dissolved metals the levels were relatively normal. Table 3.5 shows the values of allowable concentrations.

GROUNDWATER STUDY

In 1995, the aquifer in the Heber Valley was classified as Class 1A pristine by the State Water Quality Board. From recommendations made in previous implementation reports, JTAC has been working with Wasatch County and the USGS to develop a groundwater monitoring plan. During 1999, JTACs monitoring schedule included cost-share funding for USGS to collect and analyze one sample from each of ten selected existing observation wells in the valley. Figure 5.9 shows the location of each well in the Heber Valley. Also, Table 5.9 shows an abbreviated table of the laboratory results, showing 3 of the 18 constituents measured: TDS, Dissolved Nitrates, and TDP. The entire table can be found in Appendix E.

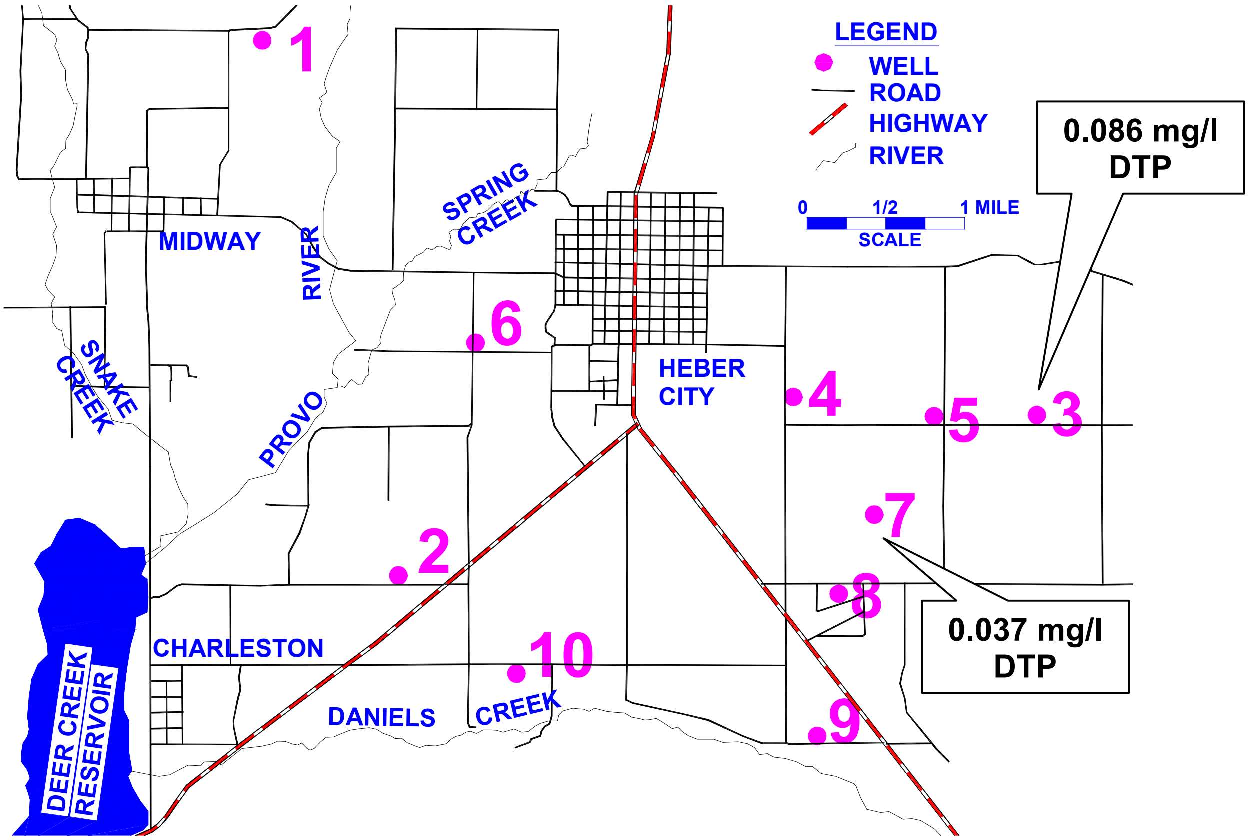


Figure 5. 9 Heber Valley Well Monitoring Program Map

Table 5. 9 Heber Valley Well Monitoring Water Quality Summary 1998-1999

Well	USGS Station Number	Owner	TDS (mg/L)		D_Nitrates (mg/L)		DTP (mg/L)	
			1998	**1999**	1998	**1999**	1998	**1999**
1	403146111272701	L. Kohler	485	**-**	2.60	**-**	<0.010	**-**
2	402842111263101	HVSSD	233	**239**	1.51	**1.41**	<0.010	**<0.050**
3	402937111214901	B. Baird	307	**289**	5.12	**4.72**	0.050	**0.086**
4	402946111233901	D. Giles	233	**222**	2.83	**-**	0.059	**-**
5	402842111223601	T. McDonald Mair	231	**163**	1.77	**-**	0.037	**-**
6	403003111255801	E. Moulton	237	**257**	1.64	**1**	<0.010	**<0.050**
7	402904111225801	E. Blodgett	277	**257**	1.65	**1.21**	0.032	**0.037**
8	402840111232201	R. Wade	367	**367**	2.82	**2.84**	<0.010	**<0.050**
9	402750111232701	B. Webster	248	**249**	0.63	**0.81**	<0.010	**<0.050**
10	402813111253701	-	309	**306**	2.81	**2.06**	<0.010	**<0.050**

The map in Figure 5.9 shows the locations of each well and the Dissolved Total Phosphorous (DTP) values for the locations shown. In Table 5.9, only two of the wells had detectable levels of phosphorus, one of which exceeded the JTAC indicator of 0.04 mg/l while there were no reported values for 3 of the 10 wells.

On average, the concentration of phosphorus was 0.018 mg/l. This is much lower than the 0.05 mg/l that was assumed for groundwater phosphorus loading calculations into the Deer Creek Reservoir, this was based on the 1991 USGS report "Hydrology of Heber and Round Valleys, Wasatch County, Utah with Emphasis on Groundwater". It should be noted that 3 of the 10 wells did not have recorded values.

Even more surprising is that the phosphorus was detected only in wells that are located in the northeastern side of the Heber Valley, more than four miles from the Deer Creek Reservoir. Wells 6, 2 and 10, which are significantly closer to Deer Creek and down gradient from the phosphorus polluted wells, did not detect any phosphorus. This may indicate that estimates of phosphorus loading into Deer Creek Reservoir are significantly overestimated.

Despite the results shown here, in the next chapter, the Deer Creek Reservoir phosphorus loading is calculated still using 0.05 mg/l as the estimated groundwater concentration. This equates to a 2,725-kg/year TP loading. It is necessary to stay consistent with previous years of phosphorus loading and with only one year of groundwater quality data additional information must be gathered before altering this method. If future groundwater quality monitoring shows that phosphorus loading has been overestimated, then reevaluation of the loading calculation for the period of record may be necessary.

TOTAL ORGANIC CARBON

Total Organic Carbon (TOC) is used to track the overall organic content of water. This is an important measure for surface water because it correlates with the production of disinfection by-products during chlorination. Measuring for TOC is more cost effective than measuring for individual compounds. This value is useful in general comparisons of water supplies, in identifying pollution sources, and in helping to determine when additional, more specific analyses might be required. The TOC measure has become very common such that values from source and finished supplies throughout the United States can be compared on this basis. The typical range for surface water TOC is 0.1 to 2.0 mg/L (AWWA, 1999).

Table 5. 10 Total Organic Carbon Exceedences

Storet Number	Location	Date	ID No.	mg/l
499725	Spring Creek Entrance to Provo River	25-May-99	C9904121	3.96
499733	Provo River below Jordanelle Dam	25-May-99	C9904117	2.57
591016	Snake Creek Above Deer Creek at RR Crossing	25-May-99	C9904108	2.02
591363	Provo River at McKeller Bridge Above Deer Creek	12-Jan-99	C9900244	2.49
		25-May-99	C9904109	2.36

Deer Creek Reservoir Basin

CHAPTER 6

INTRODUCTION

This chapter will present and analyze the water quality monitoring for Deer Creek Reservoir and the major tributaries not analyzed in previous chapters, Daniels Creek and Main Creek.

STREAM MONITORING RESULTS

In the basin of the Deer Creek Reservoir, JTAC monitored five stream sampling locations and one point source discharge locations during the year of 1999. The stream monitoring locations are as follows:

STORET No.	Location Description
• 591352	Daniels Creek below confluence w/ LCC
• 591346	Main Creek at Bridge above Deer Creek

Each stream monitoring location is discussed individually in the sections that follow. A summary table of the water quality monitoring results is presented, which lists maximums, minimums, averages, and number of exceedences for temperature, dissolved oxygen, pH, TSS, ammonia, dissolved phosphorus and total dissolved phosphorus. A more complete analysis of the data analyzing more constituents, however, is included in Appendix A.

Daniels Creek 100 feet below LCC, STORET #591352

This monitoring site is located on Daniels Creek just before it flows into Deer Creek Reservoir near USGS gage #10157500. After spring snowmelt is completed, in Daniels Canyon, much of the water in Daniels Creek originates from return flows of agricultural lands of the east side of Heber Valley. A summary of the water quality data is given below in Table 6.1.

Table 6. 1 Daniels Creek 100 feet below LCC, 591352 – Water Quality Summary

Date	Temp ° C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	5.5	7.9	8.4	5.6	0	0.039	0.022
Maximum	15.5	8.8	11.9	110	0	0.128	0.08
Median	11.7	8.3	9.35	13.6	0	0.068	0.0515
Mean	10.7	8.3	9.8	28.3	0.00	0.070	0.047
Number	10	10	10	10	10	10	10
Exceedences	0	0	0	3	0	9	6

Daniels Creek was sampled ten times in 1999. In nine of the samples, high levels of phosphorus concentrations were detected. In comparison to historical data, the TP concentrations were actually slightly lower than previous years indicating that some progress in water quality improvement has been made. These improvements, however, still do not meet the goals set by JTAC. Additionally, TSS standards were exceeded on three occasions.

Main Creek at Bridge above Reservoir, STORET #591346

This monitoring site is located on Main Creek just before it discharges into Wallsburg Bay of Deer Creek Reservoir. Main Creek drains a large area to the southeast of Deer Creek including Round Valley. A summary of the water quality data is shown below in Table 6.2.

Table 6. 2 Main Creek at Bridge above Deer Creek, 591346 – Water Quality Summary

Date	Temp ° C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	4.7	7.9	7.9	0	0	0.024	0
Maximum	16.9	8.5	11.5	136.8	0.0604	0.12	0.046
Median	8.4	8	9.9	19.6	0	0.043	0.027
Mean	10.3	8.1	9.9	38.9	0.0	0.1	0.0
Number	13	13	13	13	13	13	13
Exceedences	0	0	0	4	0	8	3

Main Creek was sampled thirteen times during 1999. Slightly more than half, eight of the fourteen samples, exceeded the JTAC phosphorus standards for Total Phosphorous. Main Creek along with Daniels Creek, although slightly lower than previous years, continue to be unable to meet JTAC standards for phosphorus. Increased management efforts in these sub-watersheds may be necessary to control problems.

STREAM LOADINGS INTO DEER CREEK RESERVOIR

The data from stream samples that were collected are used with flow data to calculate river loadings of three important constituents: TSS, TP, DTP. For the streams of focus in this chapter these loads are calculated for two stream locations: Daniels Creek above

Deer Creek and Main Creek above Deer Creek. Two other important stream loadings, which were previously discussed in Chapter 5, are also included here so as to enable discussion of the entire 1999 loadings into the Deer Creek Reservoir. The spreadsheets of these calculations can be found in Appendix C. Figure 6.1, as follows, illustrates the calculation results.

Figure 6. 1 Deer Creek Reservoir TSS/TP/DTP Loading Overview

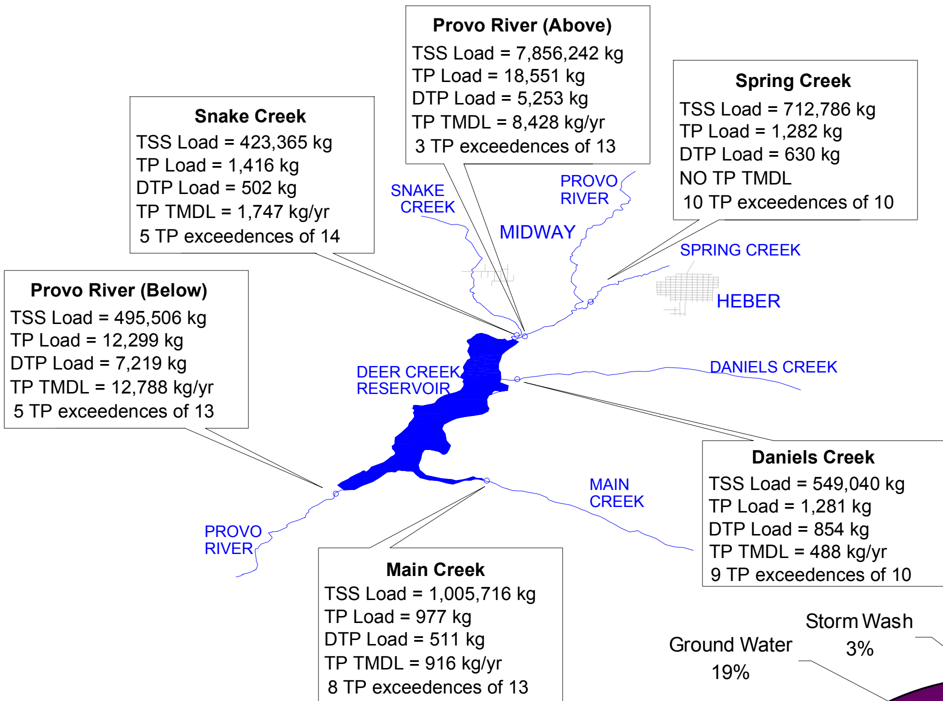
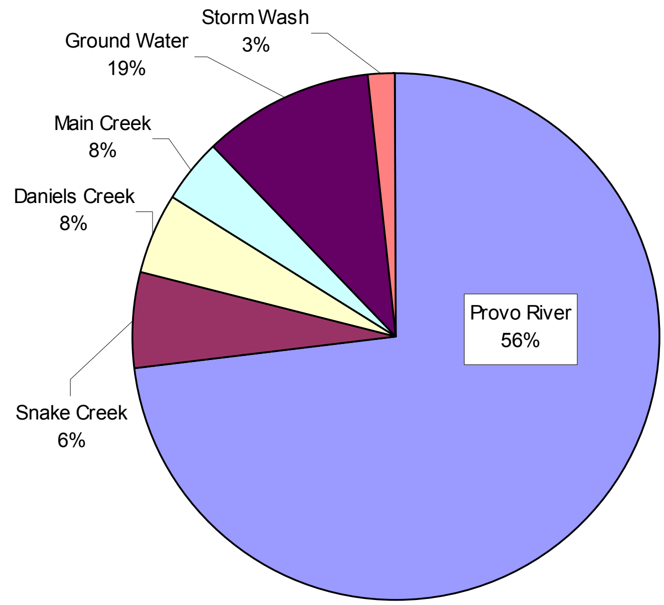


Table 6. 3 Deer Creek Reservoir TP Loading Summary

	TMDL	1999 Load	%
Input Source	kg/yr	kg/yr TP	of total
Provo River	8,428	18,551	73%
Snake Creek	1,747	1,416	6%
Daniels Creek	488	1,281	5%
Main Creek	916	977	4%
Ground Water*	n/a	2,725	11%
Storm Wash**	n/a	400	2%
Total Input		**25,350**	



***Based on 61 cfs inflow of groundwater at 0.05mg/l- USGS report "Hydrology of Heber and Round Valleys, Wasatch County, Utah, with Emphasis on Groundwater"**

**** Based on an average calculated value of Storm Flush from previous implementation reports which ranged from 250 to 550 kg.yr**

The loading that occurred in 1999 was lower than were those in previous years. Table 6.5 shows how these TP loads compare to TMDLs (Total Maximum Daily Loads) set by the 1999 Wasatch County Water Quality Management Plan. The TMDLs demonstrate the improvements that have been achieved in Provo River and Snake Creek, which had loadings significantly less than the TMDLs. Daniels Creek and Main Creek, however, did not meet their respective TMDL. Daniels Creek more than doubled its TMDL. And Main Creek exceeded its TMDL by 61 kg. The following figure shows the distribution of phosphorus loading per month.

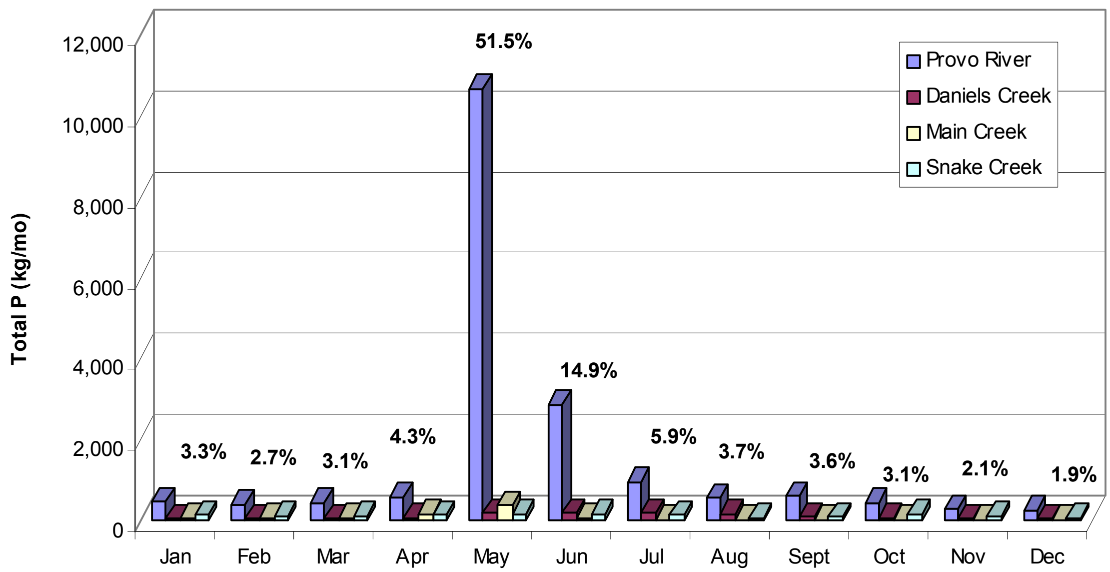


Figure 6. 2 Monthly Distribution of 1999 TP Loading

The majority of phosphorus loading occurred during the spring runoff months April, May, June which accounted for 70.7% of the total loading for the year. The Provo River above Deer Creek peak monthly load occurred in May with 10,685 kg/mo. This load, however did surpass the monthly TMDL of 2143 kg/mo by an extreme amount of 8,542 kg/mo. Snake Creek did not surpass the monthly TMDLs for any month except January, while in contrast, Daniels Creek exceeded the monthly TMDL each month except May of 1999.

Table 6.6 that follows compares the 1999 loading in Deer Creek to the previous six years. The table illustrates the loading improvements that occurred in 1999.

Table 6. 4 Deer Creek Reservoir Stream Loadings 1993-1999

	1993	1994	1995	1996	1997	1998	1999
Provo River above Deer Creek, STORET 591363							
Weighted Average Flow (cfs)	314	138	198	262	303	332	319
TP Weighted Average (mg/l)	0.077	0.040	0.060	0.047	-	0.026	0.065
TP Annual Load (kg/yr)	21,671	4,975	10,472	10,866	-	7,681	18,551
DTP Weighted Average (mg/l)	-	-	0.025	0.025	-	0.009	0.018
DTP Annual Load (kg/yr)	-	-	4,478	5,773	-	2,591	5,253
TSS Weighted Average (mg/l)	24.2	7.7	27.1	11.2	18.6	8.7	27.6
TSS Annual Load (kg/yr)	6,778,611	944,936	4,774,856	2,629,371	5,025,665	2,586,511	7,856,242
Snake Creek above Deer Creek, STORET 591016							
Weighted Average Flow (cfs)	45	38	50	54	48	57	43
TP Weighted Average (mg/l)	0.057	0.058	0.061	0.038	-	0.017	0.037
TP Annual Load (kg/yr)	2,259	1,934	2,690	1,860	-	873	1,416
DTP Weighted Average (mg/l)	-	-	0.029	0.023	-	0.009	0.013
DTP Annual Load (kg/yr)	-	-	1,270	1,134	-	476	502
TSS Weighted Average (mg/l)	5.4	11.0	14.0	8.7	10.1	10.1	10.9
TSS Annual Load (kg/yr)	213,742	369,582	616,915	421,925	431,283	507,661	423,365
Daniels Creek above Deer Creek, STORET 591352							
Weighted Average Flow (cfs)	24	8	18	14	22	19	22
TP Weighted Average (mg/l)	0.300	0.104	0.103	0.082	-	0.067	0.066
TP Annual Load (kg/yr)	6,517	702	1,645	1,047	-	1,160	1,281
DTP Weighted Average (mg/l)	-	-	0.046	0.049	-	0.030	0.044
DTP Annual Load (kg/yr)	-	-	732	625	-	513	854
TSS Weighted Average (mg/l)	241.7	36.4	86.7	62.9	90.3	37.8	28.1
TSS Annual Load (kg/yr)	5,257,412	247,102	1,390,923	801,933	1,801,933	651,235	549,040
Main Creek above Deer Creek, STORET 591346							
Weighted Average Flow (cfs)	23	11	28	65	30	23	16
TP Weighted Average (mg/l)	0.128	0.046	0.137	0.125	-	0.058	0.067
TP Annual Load (kg/yr)	2,570	437	3,452	7,154	-	1,183	977
DTP Weighted Average (mg/l)	-	-	0.038	0.099	-	0.030	0.035
DTP Annual Load (kg/yr)	-	-	964	5,669	-	605	511
TSS Weighted Average (mg/l)	106.1	25.7	108.7	19.9	139.5	45.4	68.8
TSS Annual Load (kg/yr)	2,136,137	243,025	2,750,898	1,146,639	3,727,492	926,538	1,005,716

DEER CREEK RESERVOIR MONITORING

On the Deer Creek Reservoir, JTAC monitored four locations during the year of 1999. Reservoir monitoring included samples taken at various depths in each location as well as profiles of physical characteristics at multiple depths to generate a profile of the water characteristics, the most important characteristic being dissolved oxygen (DO). The four monitoring locations listed are as follows:

STORET No.	Location Description
• 591324	Deer Creek Reservoir – Upper End
• 591323	Deer Creek Reservoir – Midlake
• 591345	Deer Creek Reservoir – Wallsburg Bay
• 591322	Deer Creek Reservoir – Above Dam

Each location is discussed individually in the sections that follow. A summary table of the water quality monitoring results is presented, which lists maximums, minimums, averages, and number of exceedences for temperature, dissolved oxygen, pH, TSS, ammonia, dissolved phosphorus and total dissolved phosphorus.

Upper End, STORET #591324

The north end of Deer Creek Reservoir near the inlet of the Provo River and Snake Creek is relatively shallow with an approximate depth of 8 meters. Samples were collected from the surface and the bottom. A combined summary of the water quality data for the surface and bottom is shown below in Table 6.5.

Table 6. 5 Deer Creek Reservoir Upper End, 591324 – Water Quality Summary

Date	Temp ° C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	6.9	7.6	5.1	0	0	0	0
Maximum	23	8.7	11.8	11.6	0.062	0.075	0.026
Median	13.25	8.15	7.9	0	0	0.026	0
Mean	14.4	8.1	8.0	1.5	0.01	0.025	0.007
Number	20	20	20	18	20	20	20
Exceedences	3	0	3	0	0	4	0

Midlake, STORET #591323

The midlake monitoring site was approximately 24 meters deep. Samples were collected at as many as five separate depths; (“surface”, “above thermocline”, “mid-depth”, “below thermocline” and “bottom”) depending on the strength of the stratification. The location was sampled on 23 occasions during 1999. A combined summary of the water quality data is provided below in Table 6.6.

Table 6. 6 Deer Creek Reservoir Midlake, 591323 – Water Quality Summary

Date	Temp ° C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	7.2	7.1	0.4	0	0	0	0
Maximum	22.6	8.7	9.1	8.4	0.167	0.059	0.037
Median	15.9	8	6.8	0	0	0.025	0
Mean	15.1	8.0	6.2	1.0	0.0	0.0	0.0
Number	23	23	23	21	23	23	23
Exceedences	5	0	9	0	3	4	0

Wallsburg Bay, STORET #591345

On the east side of Deer Creek Reservoir where Main Creek discharges into the reservoir is Wallsburg Bay. This monitoring site is approximately 11 meters deep. Samples were only collected from the surface and only field data was gathered. A summary of the water quality data is provided below in Table 6.7.

Table 6. 7 Deer Creek Reservoir Wallsburg Bay, 591345 – Water Quality Summary

Date	Temp ° C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	5	0	6.226087				
Maximum	23	23	23				
Median	15.073913	7.9913043	9				
Mean	14.4	10.3	12.7				
Number	3	3	3				
Exceedences	2	0	0				

Note: There was no data available for the TSS, Ammonia, TP and DTP readings.

Above Dam, STORET #591322

The water was approximately 37 meters deep at the monitoring station just above the dam in Deer Creek Reservoir. Samples were collected at five separate depths ("surface", "above thermocline", "mid-depth", "below thermocline" and "bottom"). The location was sampled on 33 occasions during 1999. A combined summary of the water quality data is provided below in Table 6.8.

Table 6. 8 Deer Creek Reservoir above Dam, 591322 – Water Quality Summary

Date	Temp ° C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	5.5	6.9	0.1	0	0	0	0
Maximum	37	8.7	11.4	9.6	0.201	0.539	0.046
Median	14.1	7.9	6.55	0	0	0.023	0.007
Mean	14.6	7.9	5.8	1.2	0.0	0.0	0.0
Number	32	32	32	27	33	33	33
Exceedences	5	0	16	0	5	6	3

Deer Creek Reservoir DO Analysis

At the four reservoir monitoring sites on Deer Creek Reservoir, JTAC took measurements of temperature, pH, and dissolved oxygen (DO) at varying depths for the generation of water parameter profiles. Graphs of these profiles, located in Appendix F, plot the temperature and dissolved oxygen concentration with respect to depth for the purpose of analysis of stratification in the reservoir. The profiles graphically show the thermocline in the reservoir and the depth at which dissolved oxygen levels decrease. If anoxic conditions exist in the reservoir, it will be apparent in the generated profiles.

During 1999, Profile data was gathered 7-9 times at the four monitoring locations. They were gathered between months of March and December. Figure 6.3 below tracks the DO concentration throughout 1999 at the lowest depth of each profile.

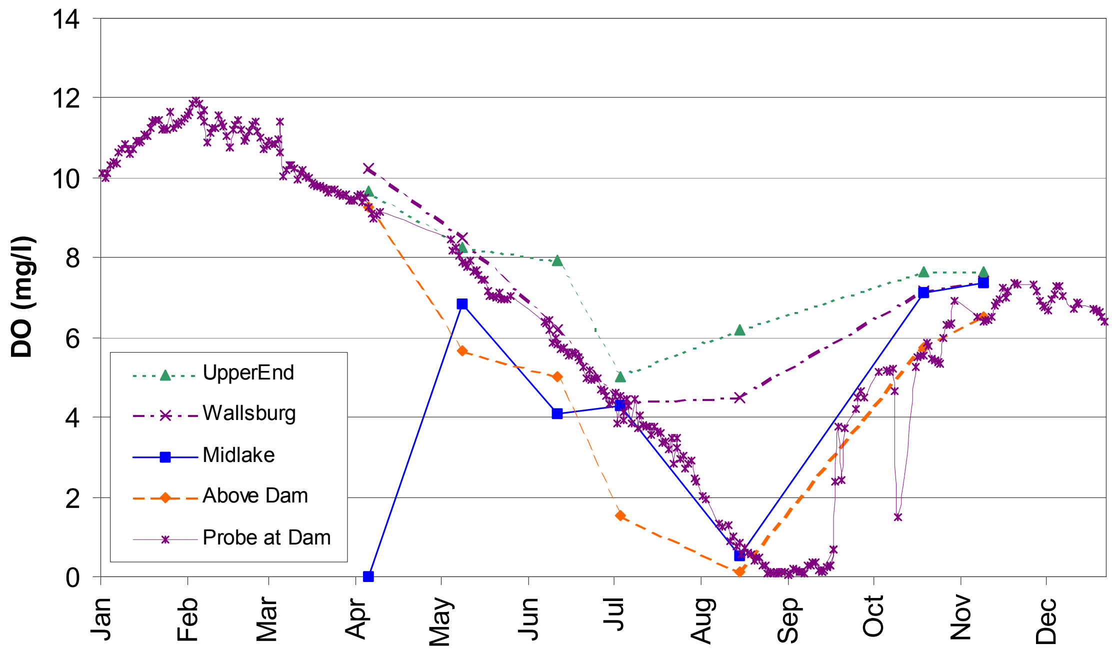


Figure 6. 3 Deer Creek Reservoir 1999 DO Concentrations at Bottom Depth

The figure shows how the reservoir goes through annual cycle of stratification. Stratification begins when the warm summer air begins to warm the surface of the reservoir. Then, as the temperatures decrease in the late fall, the reservoir begins to turnover from convection currents, destratification is the result. Presentation of the profiles in a calander year shows the complete cycle of mixed to stratified back to mixed.

Heavy stratification occurred during August through September and DO levels dropped to nearly zero as anoxic conditions prevailed. Mostly, these problems occurred only in the deeper locations of the reservoir (Midlake and Above Dam) while the other locations showed only minor evidences of stratification. The relationship of the DO levels to TP concentration in the reservoir is shown in Figure 6.4.

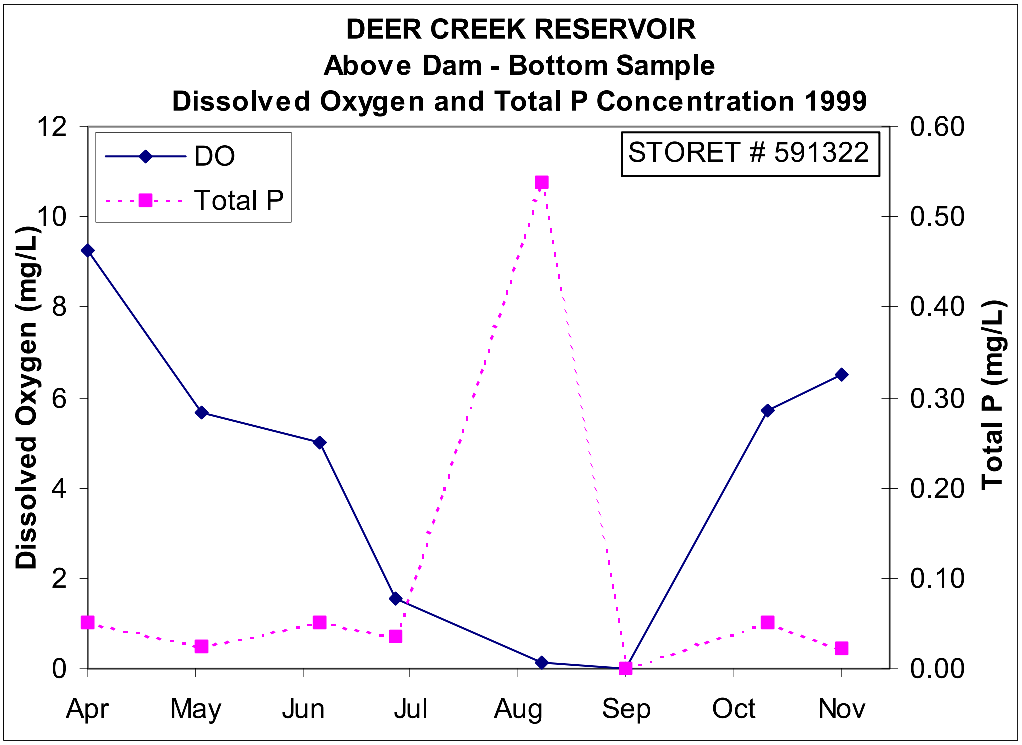


Figure 6. 4 Deer Creek Reservoir 1999 DO & TP Concentration above Dam

In Figure 6.5 the stagnation index shows the extent of anoxic conditions during the summer months from 1986 to present.

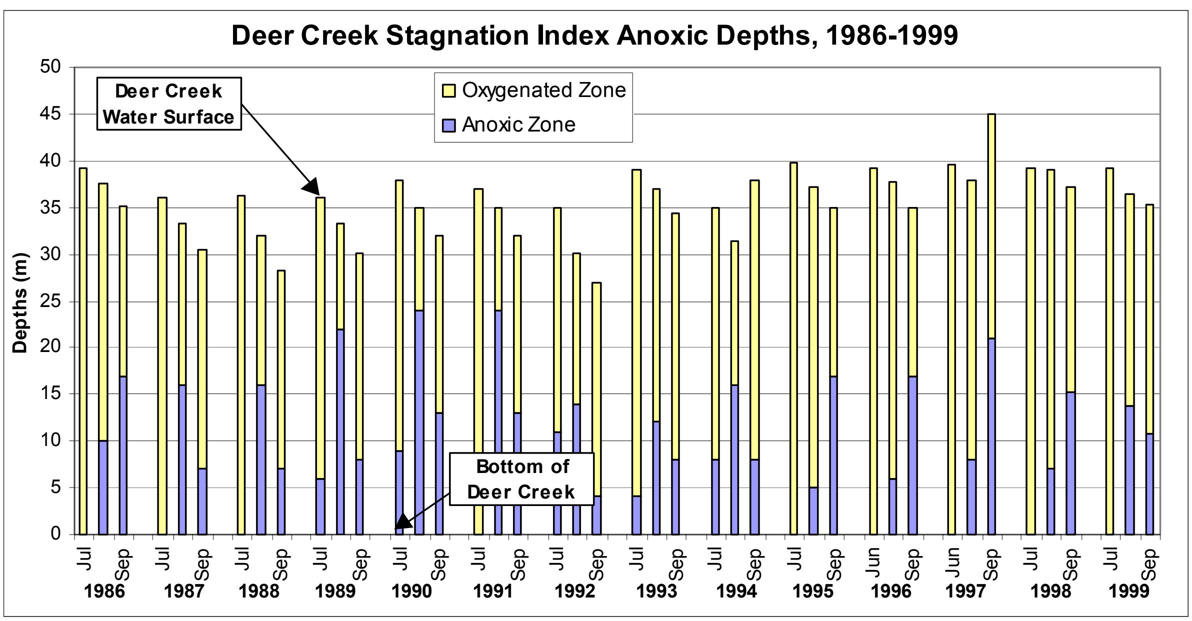


Figure 6. 5 Deer Creek Stagnation Index of Anoxic Depths, 1986-1999

Despite the encouraging results of decreasing phosphorus and algae levels in Deer Creek Reservoir, low DO concentrations are still an ongoing problem that has not yet been corrected. As shown in Figure 6.5 some improvements have been achieved in the last few years in comparison to stagnation levels from 1989-1991, especially for the earlier summer months July and August.

DEER CREEK MONITORING PROBE

A monitoring probe has been located in Deer Creek dam since March 1992 and makes daily readings of field parameters of the water released from Deer Creek. Figure 6.5 below shows the data recorded from March of 1992 to December 1999. The graph shows the annual cycles in the reservoir with respect to temperature, dissolved oxygen and pH. 1999 shows no significant changes in these parameters as compared with previous years.

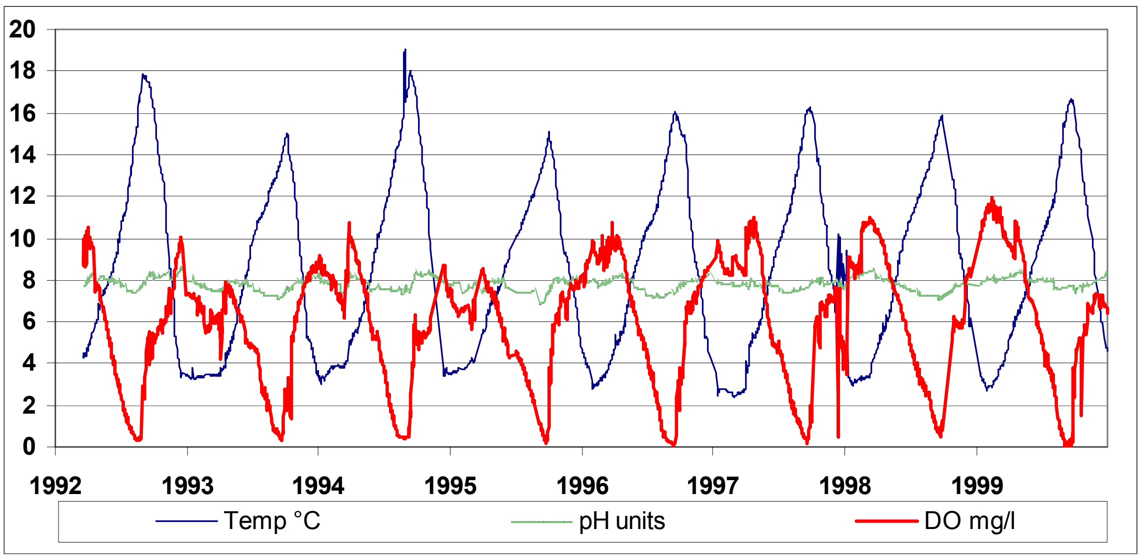


Figure 6. 6 Deer Creek Dam Monitoring Probe Measurements 1992 - 1999

PHYTOPLANKTON FLORAS FROM DEER CREEK

Dr. Samuel R. Rushforth, professor of Botany at Brigham Young University, conducts an annual study on the phytoplankton floras of Jordanelle Reservoir as well as Deer Creek. The abstract to this year's report is as follows:

> The algal plankton flora of Deer Creek Reservoir, Wasatch County, Utah was studied through the 1999 calendar year. Quantitative net plankton and total plankton samples were examined. A total of 44 taxa was identified in the plankton flora. In addition, the two common categories, centric diatoms and pennate diatoms, each contained many additional taxa.
>
> Diatoms continued to dominate the algal flora of the Deer Creek Reservoir during 1999. The most important plankters as determined by calculating Important Species Indices (ISIs) from all Deer Creek Reservoir combined net and total plankton samples collected during 1999 were **Fragilaria crotonensis** (ISI =

18.87), **Stephanodiscus niagarae** (ISI = 13.41), **Melosira granulata** (ISI=3.71), **Asterionella formosa** (ISI=1.57), **Melosira granatula** var. **angustissima** (ISI=1.19) and the category pennate diatoms (ISI = 1.07); the green algae **Sphaerocystis schroeteri** (ISI=3.71) and **Cosmarium** species (ISI=1.91); and the cyanophyte **Microcystis incerta** (ISI = 1.70) (Table 2). These taxa (and the category pennate diatoms) all had ISIs greater than or equal to 1.0. These eight taxa and one category comprised about 92% of the phytoplankton flors (as determined by summing importance values) of Deer Creek Reservoir for the 1999 year. The ISI measurement is an assessment of algal standing crop and distribution through the year as reflected in our samples.

The three top three plankters in the reservoir were diatoms and comprised just more than 70% of sum ISIs of all plankton in the reservoir for 1999. When ISIs for all diatoms in Deer Creek for 1999 are summed, they comprise about 80% of the flora.

During 1999, green algae comprised about 13% of the Deer Creek flora. This percentage sustains the drop from about 30% of the flora noted during 1997.

Cyanophytes in 1997 comprised about 27% of the sum ISI values in the reservoir. Furthermore, during 1997, two of the top six taxa were cyanophytes. During 1998, the percentage of cyanophytes in the reservoir (as measured by sum ISI values) decreased substantially to about 11% which was essentially entirely **Ahanizomenon flos-aquae**. During 1999 **A.flos-aquae** decreased substantially and **Anabaena** was again not important in the reservoir flora. The single cyanophyte on importance in the reservoir system was **Microcystis incerta** with an ISI of 1.70. This trend suggests a continuing improvement in biological water quality.

DEER CREEK TROPHIC STATE INDEX

The Carlson Trophic State Index (TSI) has been used by the State of Utah to rank and compare the trophic status of lakes and reservoirs within the state. This index uses data from May to September of three parameters: Secchi depth (transparency), total phosphorus and Chlorophyll A. A TSI value can be calculated individually from each of these parameters. In this report, we have taken an average of the TSIs calculated from each. Table 6.9 shows the calculation results for Deer Creek Reservoir. And Figure 6.7 compares the calculated TSI value to historical values that have been calculated since 1981.

Table 6. 9 Carlson Trophic State Index (TSI) calculation for Deer Creek Reservoir

Sample	Upper End			Midlake			Above Dam		
Date	Transp.	Chlor-A	TP	Transp.	Chlor-A	TP	Transp.	Chlor-A	TP
	m	μg/l	mg/l	m	μg/l	mg/l	m	μg/l	mg/l
18-May-99	3.4	4.5	0.022	4.4	4.8	0.033	4.4	4.2	0.036
27-May-99	3.9	0.6	0	4.8	1.8	0	5.6	2.3	0.022
21-Jun-99	3.2	5.2	0	3.2	4.5	0.02	3	4.3	0
13-Jul-99	2.3	4.6	0.023	2.8	2.5	0.025	2.6	4.5	0
06-Aug-99	3.9	-	0.02	5	1.6	0	4.3	1.4	0
24-Aug-99	3.3	4.7	0	4.1	1.8	0	3.5	3.3	0
22-Sep-99	4.2	4	0	5.6	3.4	0	5.2	2.1	0.021
Average	3.45714	3.9	0.009	4.27	2.9	0.011	4.08571	3.2	0.011
TSI	**42.1**	**44.0**	**36.3**	**39.1**	**41.1**	**38.9**	**39.7**	**41.9**	**39.1**
TSI Average		**40.8**			**39.7**			**40.2**	
		Average TSI for Reservoir			→	**40.2**			

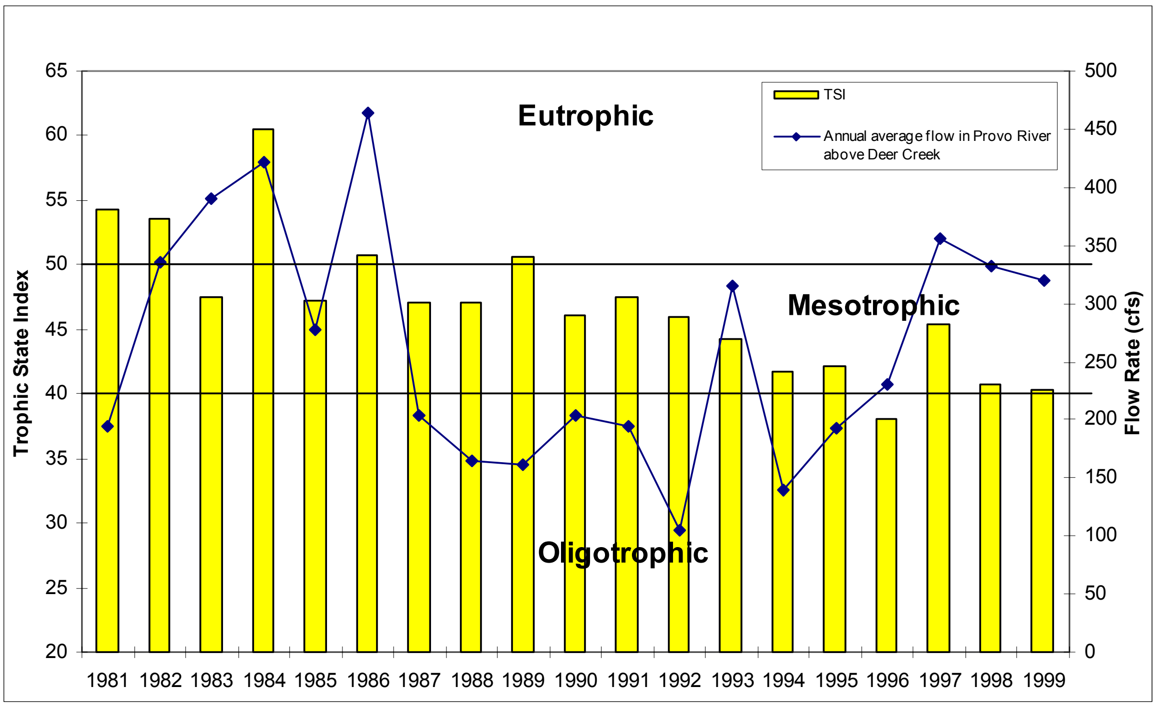


Figure 6. 7 Deer Creek Reservoir TSI and Provo River Average Flow 1981-1999

The TSI was calculated to 40.2, which shows increased improvement of the water quality in Deer Creek Reservoir water quality. Figure 6.7 shows how the reservoir has improved from a completely eutrophic reservoir in the early 1980's to currently a borderline mesotrophic-oligotrophic reservoir. As a water quality goal, the trophic state should be maintained in this TSI range. However, looking at the stagnation index in Figure 6.5 additional improvements could be achieved.

DISSOLVED METAL ANALYSIS

The dissolved metal concentrations were analyzed in the laboratory for some of the water samples that were taken. Dissolved metals were analyzed at all sites in this basin except for Deer Creek at Wallsburg Bay. The other locations had samples that were tested two to three times during 1999. Very few dissolved metals were detectable and the ones that were detected occurred in very small concentrations. There were no exceedences of the standards outlined in Table 3.5. The following table, Table 6.12, summarizers the results of the monitoring.

Table 6. 10 Deer Creek Reservoir Dissolved Metals Summary

Date	Al µg/l	As µg/l	Ba µg/l	Cd µg/l	Cr µg/l	Cu µg/l	Fe µg/l	Pb µg/l	Hg µg/l	Mn µg/l	Se µg/l	Ag µg/l	Zn µg/l
Storet #591322, Deer Creek Reservoir above the dam													
18-May-99	<30.0	<5.0	68	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	26	<1.0	<2.0	<30.0
06-Aug-99	<30.0	<5.0	61	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	240	<1.0	<2.0	<30.0
24-Aug-99	<30.0	<5.0	61	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	98	<1.0	<2.0	<30.0
22-Sep-99	<30.0	<5.0	73	<1.0	<5.0	<12.0	21.3	<3.0	<0.2	200	<1.0	<2.0	<30.0
28-Oct-99	<30.0	<5.0	71	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	14	<1.0	<2.0	<30.0
Storet #591323, Deer Creek Reservoir at Midlake													
18-May-99	<30.0	<5.0	70	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	17	<1.0	<2.0	<30.0
24-Aug-99	<30.0	<5.0	61	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	46	<1.0	<2.0	<30.0
22-Sep-99	<30.0	<5.0	72	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
28-Oct-99	<30.0	<5.0	69	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
Storet #591324, Deer Creek Reservoir at upper end													
18-May-99	<30.0	<5.0	70	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	13	<1.0	<2.0	<30.0
24-Aug-99	<30.0	<5.0	67	<1.0	<5.0	<12.0	21.7	<3.0	<0.2	6.8	<1.0	<2.0	<30.0
22-Sep-99	<30.0	<5.0	75	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
28-Oct-99	<30.0	<5.0	70	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
Storet #591346, Main Creek at bridge on US 189 above reservoir													
19-Aug-99	<30.0	<5.0	120	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	19	<1.0	<2.0	<30.0
21-Oct-99	<30.0	<5.0	120	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	24	<1.0	<2.0	<30.0
Storet #591352, Daniels Creek 100 feet below confluence with the LCC													
19-Aug-99	<30.0	<5.0	140	<1.0	<5.0	<12.0	35.1	<3.0	<0.2	7	<1.0	<2.0	<30.0
21-Oct-99	<30.0	<5.0	160	<1.0	<5.0	<12.0	24.9	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0

TOTAL ORGANIC CARBON

Total Organic Carbon (TOC) is used to track the overall organic content of water. This is an important measure for surface water because it correlates with the production of disinfection by-products during chlorination. Measuring for TOC is more cost effective than measuring for individual compounds. This value is useful in general comparisons of water supplies, in identifying pollution sources, and in helping to determine when additional, more specific analyses might be required. The TOC measure has become very common such that values from source and finished supplies throughout the United States can be compared on this basis. The typical range for surface water TOC is 0.1 to 2.0 mg/L (AWWA, 1999).

The Deer Creek Reservoir reported high concentrations of TOC much like the Jordanelle Reservoir. The high TOC values are used as an indicator of high organic levels in the water and does not necessarily mean that there are problems with the natural balance of the Reservoir.

Table 6. 11 Total Organic Carbon Exceedences

Storet Number	Location	Date	ID No.	mg/l
591322	Deer Creek Reservoir - Above Dam	15-Apr-99	C9902728	2.66
		18-May-99	C9903957	2.65
		21-Jun-99	C9905238	2.81
		13-Jul-99	C9906190	3.16
		24-Aug-99	C9908063	3.21
		22-Sep-99	C9909034	2.58
		28-Oct-99	C9910179	2.40
		18-Nov-99	C9910740	2.38
591323	Deer Creek Reservoir - MidLake	18-May-99	C9903960	2.59
		21-Jun-99	C9905242	2.89
		13-Jul-99	C9906194	2.98
		24-Aug-99	C9908067	3.14
		22-Sep-99	C9909038	2.41
		28-Oct-99	C9910181	2.62
		18-Nov-99	C9910742	2.44
591324	Deer Creek Reservoir - Upper End	15-Apr-99	C9902730	2.56
		18-May-99	C9903962	2.59
		21-Jun-99	C9905244	2.86
		13-Jul-99	C9906198	3.00
		24-Aug-99	C9908071	2.82
		22-Sep-99	C9909041	2.38
		28-Oct-99	C9910183	2.56
		18-Nov-99	C9910744	2.32
591346	Main Creek at Bridge Above Deer Creek	25-May-99	C9904106	4.30
591352	Daniels Creek Below Confluence w/ LCC	25-May-99	C9904107	4.15

MTBE Study on Deer Creek Reservoir

Methyl tertiary-butyl ether (MtBE) is a volatile organic chemical compound typically added to oxygenated fuel, reformulated gasoline and premium grades of unleaded gasoline. This additive increases the oxygen content of fuels thus reducing carbon monoxide and ozone emissions from combustion engines, which can help reduce air pollution in metropolitan areas.

The Clean Air Act of 1990 mandates the use of oxygenated gasoline in cities with poor air quality and smog. The Utah State Administrative Code (R307-8) has implemented the Oxygenated Gasoline Program, which has required since November 1, 1992 that gasoline sold in Utah County be oxygenated. MtBE is the most common additive to produce oxygenated gasoline.

MtBE has become a health concern as a pollutant of water sources as use of oxygenated gasoline has increased. Contamination can occur from leaking storage tanks and pipes, spills, and emissions from marine engines into lakes and reservoirs. The EPA does not mandate a maximum contaminant limit (MCL) on MtBE, but in 1997 released a Drinking Water Advisory that suggested that concentrations be maintained below 40 μg/l for taste and odor problems. The actual health risks associated with MtBE are unknown since not enough research data is available yet. The carcinogenicity assessment of the pollutant has classified it as a "possible" human carcinogen. Ethanol (ethyl alcohol) is a potential substitute for MtBE in the production of oxygenated gasoline; however, its health effects may be equally harmful.

JTAC has recently become concerned with the MtBE contamination on Deer Creek Reservoir, especially with the increasing use of personal watercrafts and the high potential of direct gasoline spills into the reservoir. JTAC's concern is that MtBE will build up on the surface during the summer and then mix completely when the reservoir begins turnover where MtBE could enter water intakes to municipal water systems. JTAC took two samples at the dock of Deer Creek State Park where on-lake gasoline refueling occurs during July and August. Then when the reservoir becomes mixed another sample was taken at the dam outlet in January 2000. The results of the sampling are given below:

Table 6. 12 Results of MtBE water sampling on Deer Creek Reservoir

Date	MtBE Concentration (μg/l)
Deer Creek State Park Dock Samples	
July 13, 1999	1.7
August 24, 1999	1.4
Dam Outlet Sample	
January 26, 2000	Undetected (<1.0)

These results indicate the presence of MtBE in Deer Creek Reservoir, but at relatively low levels, well below the 40 μg/l taste and odor threshold given by the EPA. Currently, MtBE appears not to be a concern; however, this should not discourage continued monitoring in Deer Creek Reservoir. The EPA is documenting increasingly frequent cases of contamination in water sources. JTAC should continue to monitor MtBE to make sure problems do not increase in Deer Creek Reservoir.

Lower Provo River below Deer Creek Reservoir

CHAPTER 7

INTRODUCTION

This chapter will present and analyze the water quality monitoring for the six-mile stretch of the Provo River and its tributaries starting below Deer Creek Reservoir to the Murdock Diversion.

STREAM MONITORING RESULTS

This year's monitoring plan included six sites in this area. Below is listed the description of each site with its STORET number.

STORET No.	Location Description
591321	Provo River below Deer Creek Dam
499687	Little Deer Creek above confluence with Provo River
499685	Lower North Fork of Provo River at Wildwood
499683	Lower South Fork Provo River at Vivian Park
499681	Provo River at Olmsted Diversion
499678	Provo River at Murdock Diversion

Each site is described in the following sections with a summary table of the water quality monitoring. For more complete tables showing actual data from the 1999 water quality monitoring, refer to Appendix A.

Provo River below Deer Creek Dam, STORET #591321

This monitoring site is immediately below Deer Creek dam near to the USGS gage station # 10159500. The water released from the reservoir is sampled here for analysis. A summary of the data is shown below in Table 7.1

Table 7. 1 Provo River below Deer Creek Dam, STORET # 591321 – Water Quality Summary

Date	*Temp* ° C	*pH*	*D.O.* mg/l	*T.S.S.* mg/l	*Ammonia N* mg/l	*T. Phos.* mg/l	*D-T Phos.* mg/l
Minimum	3.6	7.3	2	0	0	0	0
Maximum	15.7	8.5	11.4	9.2	0.127	0.064	0.051
Median	10.3	8.1	8.7	0	0	0.038	0.024
Mean	9.9	8.0	8.5	1.4	0.0	0.0	0.0
Number	13	13	13	13	13	13	13
Exceedences	0	0	2	0	2	5	1

The location was sampled on thirteen occasions during 1999. The location showed five exceedences in total phosphorus. Historically this location has had three or four exceedences of phosphorus each year. The TSS concentrations are comparable to past years. Also, there were two exceedences in DO concentration, which the same as last year. Figure 7.1 compares the total phosphorus and total suspended solids concentrations to previous years.

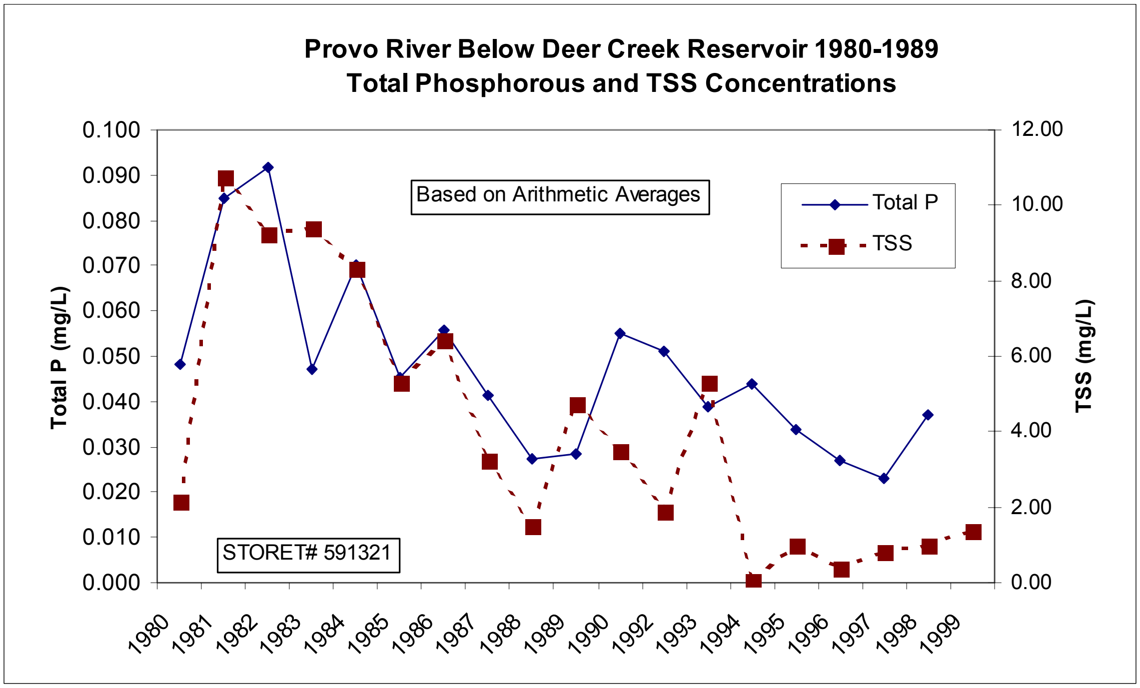


Figure 7. 1 Provo River Below Deer Creek Reservoir, TP & TSS Concentrations 1980-1999

The graph illustrates the significant reduction in total phosphorus below the Deer Creek Reservoir. The TSS has increased in concentration compared to the previous four years but is still a great improvement compared to the 1980's.

Little Deer Creek above Confluence with Provo River, STORET #499687

This monitoring site is located on Little Deer Creek near its confluence with the Provo River just below Deer Creek Dam. This creek drains a large mountainous area nestled in the Wasatch Mountains directly to the north. A summary of the data is shown below in Table 7.2.

Table 7. 2 Deer Creek above Provo River, STORET # 499687 – Water Quality Summary

Date	Temp ° C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	3.4	8	8	0	0	0	0
Maximum	15.4	8.6	11.1	31.6	0.0667	0.058	0.071
Median	7.95	8.3	9.7	9.6	0	0	0
Mean	8.9	8.3	9.6	11.2	0.01	0.016	0.015
Number	10	10	10	10	10	10	10
Exceedences	0	0	0	0	0	1	1

This location was monitored on ten occasions during 1999. One out of the ten samples taken at this location had levels of total phosphorous in exceedence of JTAC standards. Historically, this location is known to have few phosphorus problems. The sample's TSS concentrations were slightly higher than previous years and had only one exceedence.

Lower North Fork of Provo River at Wildwood, STORET #499685

This site monitors the North Fork of the Provo River at the point of confluence with the Provo River near Wildwood. The North Fork drains the northern mountainous area surrounding Sundance Ski Resort and Aspen Grove. A summary of the monitoring data is shown below in Table 7.3.

Table 7. 3 Lower North Fork of Provo River, STORET # 499685 – Water Quality Summary

Date	Temp ° C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	4.2	8.1	8.7	0	0	0	0
Maximum	12	8.9	11.3	29.2	0	0.042	0.051
Median	6.9	8.35	10.35	0	0	0	0
Mean	7.5	8.4	10.2	3.8	0.0	0.0	0.0
Number	10	10	10	10	10	10	10
Exceedences	0	0	0	0	0	1	1

This location was monitored ten times during 1999. This location had one exceedence of phosphorus. Historically, this area has rarely had occasions of phosphorus exceedences.

Lower South Fork Provo River at Vivian Park, STORET #499683

This monitoring site is located in Provo Canyon on the Lower South Fork of the Provo River near its confluence with the Provo River by Vivian Park. This creek drains a large mountainous area to the south, which includes some residential/cabin areas and regular recreational activities. A summary of the monitoring data is shown below in Table 7.4.

Table 7. 4 Lower South Fork Provo River, STORET # 499683 – Water Quality Summary

Date	Temp ° C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	4.4	8	8.6	0	0	0	0
Maximum	12.7	8.4	10.7	18	0	0.027	0.034
Median	7.95	8.3	9.65	5.3	0	0.0105	0
Mean	8.1	8.3	9.7	5.6	0.00	0.012	0.006
Number	10	10	10	10	10	10	10
Exceedences	0	0	0	0	0	0	0

This location was monitored ten times during 1999. This location's water monitoring results indicated that the water was of high quality. Historically, it has not been common to have more than one exceedence per year recorded at this location. The TSS concentrations are comparable to past years. No other exceedences were recorded at this location in 1999.

Provo River at Olmsted Diversion, STORET #499681

The site monitored the water quality in the Provo River at the location of the Olmsted Diversion about one mile downstream from the South Fork at Vivian Park. This water quality data represents the combination of the Lower Provo River with its major tributaries. A summary of the monitoring data is shown below in Table 7.5.

Table 7. 5 Provo River at Olmsted Diversion, STORET # 499681 – Water Quality Summary

Date	Temp ° C	pH	D.O. mg/l	T.S.S. mg/l	Ammonia N mg/l	T. Phos. mg/l	D-T Phos. mg/l
Minimum	3.3	7.6	7.1	0	0	0.021	0
Maximum	13.9	8.5	11.7	10.4	0.0898	0.059	0.041
Median	10	8.05	9.4	0	0	0.0325	0.023
Mean	9.3	8.1	9.7	3.2	0.01	0.034	0.019
Number	10	10	10	10	10	10	10
Exceedences	0	0	0	0	0	2	1

This site was monitored ten times for TSS, ammonia N, total phosphorous and dissolved total phosphorous. Two exceedences of total phosphorous were registered in 1999. Historically, this location on the Provo River has shown to have approximately half of its phosphorous measurements in exceedence. The TSS concentrations for this site are consistent with past years.

Provo River at Murdock Diversion, STORET #499678

This site monitored the water quality in the Provo River at the Murdock Diversion located approximately one mile from the mouth of Provo Canyon. This represents the water in the Provo River leaving Provo Canyon entering into Utah Valley. A summary of the monitoring data is shown below in Table 7.6.

Table 7. 6 Provo River at Murdock Diversion, STORET # 499678 – Water Quality Summary

Date	*Temp* ° C	*pH*	*D.O.* mg/l	*T.S.S.* mg/l	*Ammonia N* mg/l	*T. Phos.* mg/l	*D-T Phos.* mg/l
Minimum	4.5	7.7	8.5	0	0	0	0
Maximum	14.7	8.7	12	20	0.0776	0.043	0.043
Median	9.6	8.45	10.2	2.2	0	0.025	0
Mean	9.4	8.4	10.1	4.5	0.0	0.0	0.0
Number	10	10	10	10	10	10	10
Exceedences	0	0	0	0	0	1	1

This location was monitored ten occasions during 1999. Total phosphorous was in exceedence of JTAC standards one time. Historically this site has 1 or 2 exceedences each year. TSS concentrations were at levels comparable to past years.

Figures 7.2 & 7.3 compares the total phosphorus concentration and the TSS concentration at below Deer Creek, Olmstead, and Murdock. Great improvement in both the phosphorus and TSS are indicated in the three locations. Figure 7.2 indicates that the three locations maintained phosphorus concentrations below JTAC standard for most of the time, except for three months.

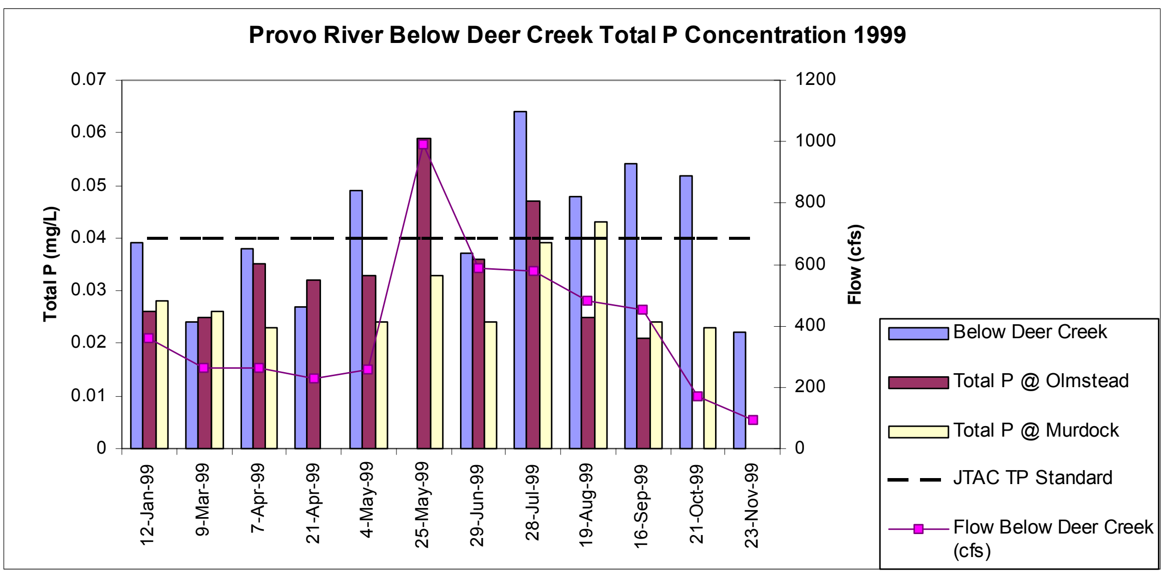


Figure 7. 2 Below Deer Creek, 1999 Total Phosphorus Concentrations

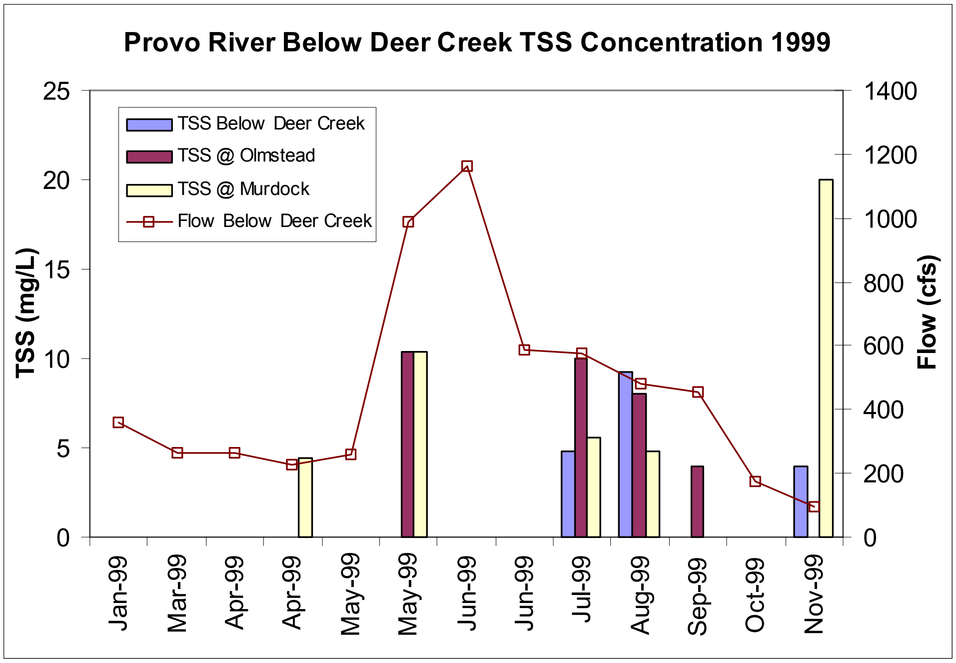


Figure 7. 3 Below Deer Creek TSS Concentration 1999

LOADINGS IN THE LOWER PROVO RIVER

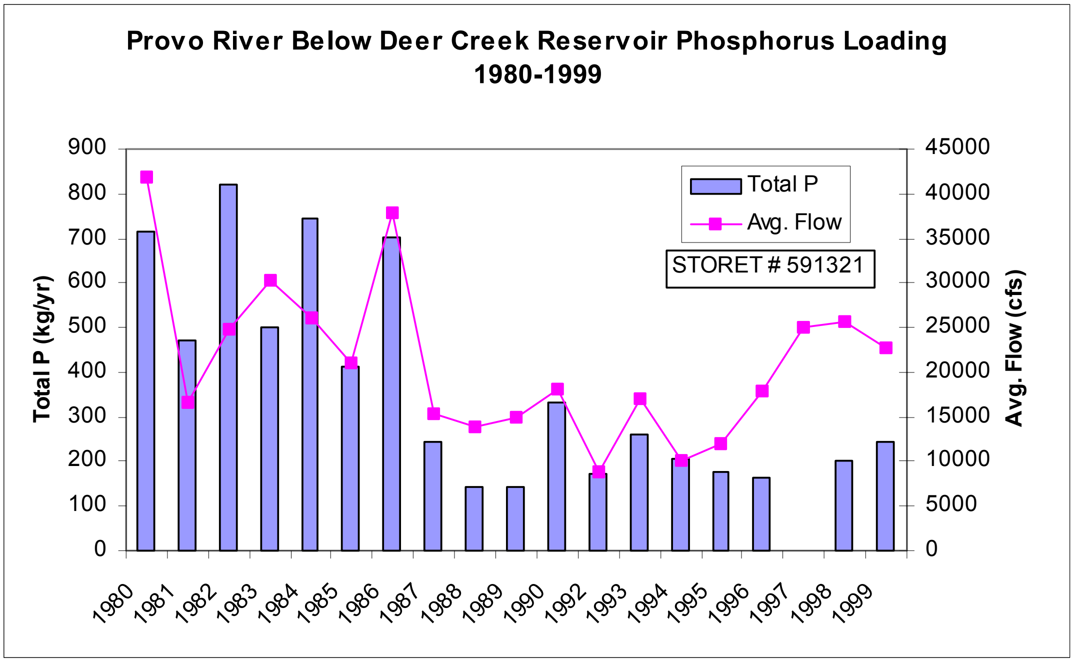


Figure 7. 4 Historical Phosphorus Loading Below Deer Creek Reservoir

The phosphorous loads were calculated at only one JTAC monitoring location in this area of the watershed. The location is directly below the Deer Creek dam on the Provo River. Figure 7.4 indicates the historical phosphorous loading and the phosphorous loading for 1999 (see Appendix C for complete calculations for phosphorous loading). The phosphorus data for 1997 was corrupt and therefore was disregarded. Table 7.7 indicates the loads for total phosphorus, dissolved total phosphorus, TSS, and the average flow in comparison to the previous six years.

Table 7. 7 Historic Water Quality Data (1993-1999)

	1993	1994	1995	1996	1997	1998	1999
Provo River below Deer Creek, STORET 499733							
Weighted Average Flow (cfs)	343	201	240	358	406	462	371
TP Weighted Average (mg/l)	0.043	0.058	0.042	0.025	-	0.025	0.037
TP Annual Load (kg/yr)	12,999	10,331	8,887	8,099	-	10,171	12,299
DTP Weighted Average (mg/l)	-	-	0.035	0.021	-	0.014	0.022
DTP Annual Load (kg/yr)	-	-	7,432	6,711	-	5,603	7,219
TSS Weighted Average (mg/l)	5.4	2.9	1.7	0.5	0.9	1.1	1.5
TSS Annual Load (kg/yr)	1,640,831	515,278	365,927	164,330	324,265	443,813	495,506

DISSOLVED METALS ANALYSIS

The dissolved metal concentrations were analyzed in the laboratory for some of the water samples that were taken. Dissolved metals were analyzed at all sampling sites in this area four times each during 1999. Very few dissolved metals were detectable and those detected were in very small concentrations. There were no exceedences of the standards set in Table 3.5. The following table, Table 7.8, summarizes the results of the monitoring.

Table 7. 8 Dissolved Metals Summary for Provo River below Deer Creek Sampling Sites

Date	Al µg/l	As µg/l	Ba µg/l	Cd µg/l	Cr µg/l	Cu µg/l	Fe µg/l	Pb µg/l	Hg µg/l	Mn µg/l	Se µg/l	Ag µg/l	Zn µg/l
Storet #591321, Provo River below Deer Creek Reservoir													
12-Jan-99	<30.0	<5.0	70	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	11	<1.0	<2.0	<30.0
9-Mar-99	<30.0	<5.0	74	<1.0	5.5	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
25-May-99	<30.0	<5.0	71	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	7.7	<1.0	<2.0	<30.0
19-Aug-99	<30.0	<5.0	75	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	130	<1.0	<2.0	<30.0
21-Oct-99	<30.0	<5.0	80	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
Storet #499687, Little Deer Creek above confluence with the Provo River													
19-Aug-99	<30.0	<5.0	66	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
21-Oct-99	<30.0	<5.0	63	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
Storet #499685, Lower North Fork of Provo River at Wildwood													
19-Aug-99	<30.0	<5.0	32	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
21-Oct-99	<30.0	<5.0	36	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
Storet #499683, Lower South Fork Provo River at Vivian Park													
19-Aug-99	<30.0	<5.0	62	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
21-Oct-99	<30.0	<5.0	55	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0
Storet #499681, Provo River at Olmstead Diversion													
12-Jan-99	<30.0	<5.0	67	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	7	<1.0	<2.0	<30.0
9-Mar-99	<30.0	<5.0	70	<1.0	5.1	<12.0	<20.0	<3.0	<0.2	8.1	<1.0	<2.0	<30.0
25-May-99	<30.0	<5.0	70	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	8.8	<1.0	<2.0	<30.0
19-Aug-99	<30.0	<5.0	63	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	48	<1.0	<2.0	<30.0
21-Oct-99	<30.0	<5.0	66	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	14	<1.0	<2.0	<30.0
Storet #499678, Provo River at Murdock Diversion													
6-Oct-99	<30.0	<5.0	110	<1.0	9.7	<12.0	<20.0	<3.0	<0.2	<5.0	24	<2.0	<30.0
25-May-99	<30.0	<5.0	67	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	6.9	<1.0	<2.0	<30.0
29-Jun-99	<30.0	<5.0	57	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	5.9	<1.0	<2.0	<30.0
19-Aug-99	<30.0	<5.0	61	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	8.5	<1.0	<2.0	<30.0
21-Oct-99	<30.0	<5.0	56	<1.0	<5.0	<12.0	<20.0	<3.0	<0.2	<5.0	<1.0	<2.0	<30.0

TOTAL ORGANIC CARBON

Total Organic Carbon (TOC) is used to track the overall organic content of water. This is an important measure for surface water because it correlates with the production of disinfection by-products during chlorination. Measuring for TOC is more cost effective than measuring for individual compounds. This value is useful in general comparisons of water supplies, in identifying pollution sources, and in helping to determine when additional, more specific analyses might be required. The TOC measure has become very common such that values from source and finished supplies throughout the United States can be compared on this basis. The typical range for surface water TOC is 0.1 to 2.0 mg/L (AWWA, 1999).

The Lower Provo River appears to have the lowest TOC values that were recorded. While there were higher values reported for the Provo River these values were not as high as the values that were recorded for the Jordanelle and Deer Creek Reservoirs.

Table 7. 9 Total Organic Carbon Exceedences

Storet Number	Location	Date	ID No.	mg/l
499678	Provo River at Murdock Diversion	12-Jan-99	C9900246	1.49
		25-May-99	C9904111	2.38
499683	Lower South Fork Provo River at Vivian Park	25-May-99	C9904113	0.99
499685	Lower North Fork of Provo River at Wildwood	25-May-99	C9904114	1.18
499687	Little Deer Creek Above Confluence w/ Provo River	25-May-99	C9904115	1.11
499681	Provo River at Olmsted Diversion	12-Jan-99	C9900247	2.22
		21-Apr-99	C9902951	2.02
		25-May-99	C9904112	2.19
		29-Jun-99	C9905616	2.19
591321	Provo River Below Deer Creek Dam	12-Jan-99	C9900245	2.24
		9-Mar-99	C9901771	2.18
		7-Apr-99	C9902443	2.21
		21-Apr-99	C9902949	2.30
		4-May-99	C9903398	2.84
		25-May-99	C9904110	2.53
		8-Jun-99	C9904697	4.21
		29-Jun-99	C9905614	2.35

PROVO RIVER WATER QUALITY

Dr. Samuel R. Rushforth, professor of Botany at Brigham Young University, conducted a study on the biological water quality of the Provo River as determined by the analysis of Periphyton Communities. The results of this report is given in the following excerpt:

> Algal floras present from July 1998 to June 1999 continue to indicate relatively high biological water quality. Algal floras were quite diverse and healthy. The pennate diatom flora was especially well developed and diverse. The non-diatom algal flora was dominated by the chlotophytes **Cladogonium glomerate** and several species of **Ulothrix**. In addition, **Oedogonium** species and several species of **Spirogyra** often dominated the flora at several sites.

A total of 38 algal taxa were observed in the samples collected during the period July 1998 – June 1999. In addition, many additional taxa included in the categories pennate and centric diatoms were present in the samples but most were not identified to the specific level. Thus, the count of taxa reported herein for the July 1998 – June 1999 periods is lower than actual occurred in the river system.

Conclusions and Recommendations

CHAPTER 8

INTRODUCTION

The Provo River System is a great resource that provides benefits to many people throughout the area. The resolutions made to improve the ecology in the Provo River are helping to sustain the good water quality. This final chapter summarizes the water quality problems that were detected in the basin and gives recommendations to help towards improving water quality for the problem areas as well as the watershed as a whole.

PROBLEM AREAS

Despite great improvements in many areas, the 1999 monitoring program detected several water quality problems in the watershed. As a summary, the problems detected are as follows:

Table 8. 1 1999 Water Quality Problem Areas

Location	Problem	Exceedence Rate*
McHenry Creek below Mayflower	High Phosphorus Concentration	40%
Spring Creek at the Entrance to Provo River	High Phosphorus Concentration	100%
County Flood Control Channel at Provo River	High Phosphorus Concentration	80%
Midway Fish Hatchery Effluent	High Phosphorus Concentration	43%
Midway Fish Hatchery Effluent	High Ammonia Concentration	43%
Kamas Fish Hatchery	High Phosphorus Concentration	80%
Provo River above Deer Creek	High Phosphorus Load	23%
Snake Creek above Deer Creek	High Phosphorus Concentration	36%
Daniels Creek 100 Feet below LLC	High Phosphorus Concentration	90%
Main Creek at Bridge on U.S. 189	High Phosphorus Concentration	62%
Deer Creek Reservoir (Midlake)	Low Dissolved Oxygen	39%
Deer Creek Reservoir (Wallsburg Bay)	High Temperature	67%
Deer Creek Reservoir (Above Dam)	Low Dissolved Oxygen	50%
Provo River below Deer Creek Dam	High Phosphorus Concentration	39%

* Refer to Chapter 2 for values used in determination of exceedence.

RECOMMENDATIONS

This report recommends the following eleven items as suggestions for JTAC to continue to improve on water quality management and reduce the problems shown in Table ES.3.

1. Heber Valley Storm Water Controls

In response to recommendations from previous years' implementation reports Wasatch County, through a contract with Psomas, has completed the third year of a three year Storm Water Study in Heber Valley. The study has identified potential sites for the construction of new sedimentation basins with the capability of removing pollutants. The project has several potential obstacles the largest of which is funding. Other obstacles are items such as management, maintenance, and property availability. Also, there may be an opportunity to combine the management plan with Heber City's Storm Water Master Plan which identifies the construction of a 40 acre-foot treatment pond for storm water discharges in the Spring Creek and Sagebrush Canal. The key to the success of this project will be through the diligent work of County officials.

Wasatch County should aggressively pursue federal and state funding that are available. Also, **Wasatch County** should identify opportunities to incorporate management plan with Heber City Storm Water Master Plan. **JTAC** should fully support County officials in this effort which may require that JTAC members write letters to funding committees and local officials.

Of the problem areas identified in Table 8.1, the following will be addressed by implementation of this recommendation:

- Spring Creek, High Total Phosphorus
- Flood Control Channel, High Total Phosphorus
- Snake Creek, High Total Phosphorus
- Daniels Creek, High Total Phosphorus

2. Increase Monitoring to Identify Pollution Sources in Heber Valley

The Jordanelle Reservoir removes approximately half of the phosphorus load from the Provo River before it released below the dam. In the 10-mile stretch of Provo River between Jordanelle and Deer Creek, the total phosphorus load increases by a factor of 2.6 on average, even though the flow is comparable. The source of such a phosphorus increase is unknown. It is known that Spring Creek and the Flood Control Channel contribute but additional sources must be present to account for the entire increase.

JTAC should conduct a one-year intensive monitoring period along the Provo River in the Heber Valley increasing the number of stations monitored and frequencies. It is recommended that this occur during the sampling period of the calendar year 2001. Review of this data will enable locating the general area of significant pollution increases. Once the source(s) of pollution are located, the future monitoring program should be adjusted to measure the annual loading from these sources.

Of the problem areas identified in Table 8.1, the following will be addressed by implementation of this recommendation:

- Provo River above Deer Creek, High Total Phosphorus

3. Update Water Quality Management Plan

The Upper Provo River Water Quality Management Plan is one of the first reports in Utah to pursue definition of Total Maximum Daily Loads (TMDLs) for the watershed. The EPA has not accepted the plan to this date and new TMDL requirements have since come into effect. Also, new data on the watershed is available for better analysis of existing conditions.

Utah Division of Water Quality should update the plan to reflect additional EPA requirements and new data that is now available.

Of the problem areas identified in Table 8.1, the following will be addressed by implementation of this recommendation:

- All Waterbodies

4. Agricultural Nonpoint Source Pollution

Agriculture appears to continue to have an impact on water quality. There are many ongoing programs that will help to reduce these impacts such as the Tri-Valley Watershed Project, Wasatch County Water Efficiency Project (WCWEP), and the Deer Creek Reservoir Resource Management Plan. In addition the NRCS is working with farmers on an individual basis to help them manage lands with Best Management Practices (BMPs) which will also favorably impact water quality. Better management practices in the Heber Valley will reduce non-point source phosphorus loading resulting in improved water quality.

JTAC should continue to support projects that will reduce pollutant contributions from non-point sources and support the education of local farmers and ranchers in BMPs. **NRCS** should quantify and document the beneficial impacts of the Tri-Valley Watershed Project. **Central Utah Project Completion Act (CUPCA)** should quantify and document the beneficial impacts of the WCWEP.

Of the problem areas identified in Table 8.1, the following will be addressed by implementation of this recommendation:

- Spring Creek, High Total Phosphorus
- Flood Control Channel, High Total Phosphorus
- Daniels Creek, High Total Phosphorus
- Snake Creek, High Total Phosphorus
- Main Creek, High Total Phosphorus
- Provo River, High Total Phosphorus

5. Public Information Campaign

Public education is a very beneficial method to protect water quality since many people in the community are unaware of the impacts of poor stewardship of water quality. JTAC has already made a concerted effort to inform and educate the public on the need to protect drinking water sources through the posting of signage, advertisements, and distribution of logo. A public information committee in JTAC has been formed to pursue education and information opportunities.

The Public Information Sub-Committee of JTAC should continue its efforts and increase distribution of signage around the critical waterbodies that support high recreational use. Also, signage could be facilitated by the Adopt-a-Waterbody program, which is instituted by the **DWQ**.

Of the problem areas identified in Table 8.1, the following will be addressed by implementation of this recommendation:

- All Waterbodies

6. Expand JTAC Membership

JTAC has been an effective cooperative effort among state, federal, local, and private agencies to improve the Provo River Watershed. However, JTAC is missing representation by local communities in Heber Valley such as Heber City and Midway. These municipalities could provide valuable knowledge and insight to pollution sources and management strategies to the problems of urbanization.

JTAC should encourage participation from representatives of local communities.

Of the problem areas identified in Table 8.1, the following will be addressed by implementation of this recommendation:

- All Waterbodies

7. Source Water Assessment and Protection Plan for Provo River Watershed

The Federal Safe Drinking Water Act Amendments of 1996 require states to establish Source Water Assessment for all water sources. Previously Source Water Assessments were only required for groundwater sources. Beginning this year, the state will require that Public Water Systems (PWS) prepare assessments and protection plans for surface waters as well. The Provo River Watershed is a surface water source to multiple PWSs in Salt Lake, Utah and Wasatch County. The efforts and costs to prepare these documents could be shared by those PWSs.

Metropolitan Water District of Salt Lake City, Jordan Valley Water Conservancy District, Central Utah Water Conservancy District, Metropolitan Water District of Orem and Metropolitan Water District of Provo should cooperate to complete a Source Water Assessment and Protection Plan for the Provo River.

Of the problem areas identified in Table 8.1, the following will be addressed by implementation of this recommendation:

- Provo River above Deer Creek, High Total Phosphorus

- Provo River below Deer Creek, High Total Phosphorus

8. Additional Monitoring of Provo Canyon

Many of the Provo River culinary water diversions are in the Provo Canyon. Increased monitoring in this area for drinking water specific constituents would help identify some of the problems more specific to drinking water. Drinking water treatment plants generally are concerned with phosphorus, algae, dissolved oxygen, total organic carbon, UV254 and metals.

JTAC should consider increased efforts to monitor many of these constituents within the Provo Canyon. Also JTAC should also support the efforts of the **Utah Water Quality Alliance**, which is monitoring for *Cryptosporidium, Giardia, E. Coli*, and other bacteria in the basin. These biological contaminants are a major concern for water quality controls and are important to the basin monitoring.

Of the problem areas identified in Table 8.1, the following will be addressed by implementation of this recommendation:

- Provo River below Deer Creek

9. Jordanelle Reservoir – Management of Releases

The Jordanelle Reservoir has helped improve the water quality in the Provo River by retaining phosphorus rich sediments, regulating temperature of outlet water, and controlling dissolved phosphorus levels in outlet water. Many of these benefits are due to the Selective Level Outlet Works (SLOW) which is operated by the Central Utah Water Conservancy District and the Bureau of Reclamation (USBR). The USBR is in the process of revising the Standard Operating Procedures of the SLOW to maximize its benefit.

The 1999 data shows that anoxic conditions occurred near the SLOW at the lower levels. The low DO water should not be exported through the SLOW to avoid water quality problems in the Provo River below. The Standard Operating Procedures should identify this hazard and be adjusted appropriately.

JTAC should continue to work with the USBR to ensure that the operation of Jordanelle Reservoir will not only accommodate the distribution of water rights, but also favorably impact the water quality and fishery resource of the Provo River.

Of the problem areas identified in Table 8.1, the following will be addressed by implementation of this recommendation:

- Provo River above Deer Creek, High Total Phosphorus

United States Bureau of Reclamation is responsible for the implementation of this recommendation.

10. Fish Hatcheries – Point Sources

The Kamas Fish Hatchery has recently expanded its operation to almost double fish production. The expansion plans incorporated features such as settling ponds and concrete linings, which should greatly aid in reducing TSS and TP in the effluent. These features will help water quality as the fish operation expands. The TP loading from the hatchery was 548 kg as compared to the TMDL of 173 kg. Also, the Midway Fish Hatchery is discharging high concentrations of phosphorus and ammonia into Snake Creek.

It is recommended that **JTAC** work with the **Division of Wildlife Resources** to investigate if there are operational or maintenance practices that could be used to reduce the phosphorus and ammonia problems in the two hatcheries.

Of the problem areas identified in Table 8.1, the following will be addressed by implementation of this recommendation:

- Midway Fish Hatchery, High Total Phosphorus
- Midway Fish Hatchery, High Ammonia
- Kamas Fish Hatchery, High Total Phosphorus
- Snake Creek, High Total Phosphorus

11. EPA Assessment of Jordanelle Basin Mine Sites

The mining industry once thrived in the Park City area of Summit County. Some of the mining activities spilled into Wasatch County, especially on the west side of Jordanelle Reservoir. The mine waste that remains contains hazardous levels of certain metals particularly arsenic and lead. Due to the potential hazards of these materials and plans for residential developments, the Utah Division of Environmental Response and Remediation requested that EPA, Region VIII, reevaluate the Mayflower Mountain Tailings Pond and evaluate other nearby mining-related sites which may pose risks to human health and the environment. EPA's reevaluation of these sites is expected to commence in the near future.

JTAC should support mitigation of these potential water quality hazards. **JTAC** should also closely monitor these sites for discharges of contaminated water that may pose a risk to drinking water sources such as the Jordanelle Reservoir. **Wasatch County** should likewise support mitigation and review property owner monitoring.

Table 8. 2 Summary Table of Recommendations and Responsibilities

Recommendations	Party Responsible	Problem Area Addressed
12. Heber Valley Storm Water Controls • Aggressively pursue federal and state funding sources for sediment/ wet ponds. • Coordinate with Heber City Storm Water Management Plan. • Continue to support the plan fully which may include writing letters to funding committees or other officials.	Wasatch Co. Wasatch Co. JTAC	High TP Loads in: • Spring Creek • Flood Control Channel • Snake Creek • Daniels Creek
13. Increase Monitoring to Identify Pollution Sources in Heber Valley • One-year intensive monitoring of Provo River and known inputs in Heber Valley. • Review monitoring and locate pollution increases in Heber Valley. • Modify future monitoring to quantify discovered sources.	JTAC JTAC JTAC	High TP Loads in: • Provo River above Deer Creek
14. Update Water Quality Management Plan • Update water quality management plan to include computer analysis and new data for TMDL implementation.	DWQ	All waterbodies
15. Agricultural Nonpoint Source Pollution • Quantify and document pollutant loading reductions from Tri-Valley Watershed Project • Quantify and document pollutant loading reductions from Wasatch County Water Efficiency Project • Continue to support projects that reduce nonpoint source pollution from agricultural sources. • Continue to support education of agricultural produces of resource management and BMPs.	NRCS CUPCA JTAC JTAC	High TP Loads in: • Spring Creek • Flood Control Channel • Snake Creek • Daniels Creek • Main Creek • Provo River
16. Public Information Campaign • Increase distribution of signage. • Incorporate with Adopt-a-Waterbody program.	JTAC Public Information Committee	All waterbodies
17. Expand JTAC Membership • Encourage participation from community representatives in local communities such as Heber City and Midway.	JTAC	All waterbodies
18. Source Water Assessments and Protection Plan for Provo River Watershed • Cooperate among public water providers to complete the source water assessment and protection plan for Provo River Watershed.	CUWCD, JVWCD, MDWSLC, MWDP, MWDO	High TP Loads in • Provo River above Deer Creek • Provo River below Deer Creek
19. Additional Water Quality Monitoring in Provo Canyon • Increase efforts to monitor for constituents that affect drinking water quality such as TOC, UV254, DO, TP, algae, and metals. • Continue bacteriological monitoring for constituents such as E. Coli, Giardia, Cryptosporidium and bacteria that may be public health concerns	JTAC Utah Water Quality Alliance	Provo River below Deer Creek
20. Jordanelle Reservoir Management of Releases • Provide releases per water right allocations • Protect water quality by avoiding export of high algae content, high phosphorus content and anoxic waters through management of SLOW.	USBR USBR	High TP Loads in: • Provo River above Deer Creek DO, TP and Algae problems in Deer Creek
21. Fish Hatcheries – Point Sources • Evaluate operational and maintenance procedures to identify potential improvements. • Evaluate impact of Kamas Fish Hatchery on Provo River watershed.	DWR JTAC	High TP Loads in: • Snake Creek • Hatcheries High NH3 Load in: • Midway Hatchery
22. EPA Assessment of Jordanelle Basin Mine Sites • Support mitigation of potential water quality hazards. • Closely monitor these sites. • Review property owner monitoring of sites.	JTAC/Was. Co. JTAC Wasatch Co.	All waterbodies downstream from Jordanelle Basin

Bibliography

American Water Works Association. 1999. "Water Quality & Treatment" McGraw-Hill, Inc.

Denton, Richard L.; Cox, Myron I.; Merritt, LaVere B.; Sowby and Berg Consultants; Utah Department of Health, Division of Environmental Health & Bureau of Water Pollution Control. 1984. "Deer Creek Reservoir, Phase 1: 314 Clean Lakes Study."

Eckhoff, Watson and Preator Engineering. 1997. "1997 Water Quality Implementation Report: Deer Creek and Jordanelle Reservoirs Water Quality Management Plan for the 1996 Water Year." Salt Lake City Utah.

Eckhoff, Watson and Preator Engineering. 1996. "1996 Water Quality Implementation Report: Deer Creek and Jordanelle Reservoirs Water Quality Management Plan for the 1995 Water Year." Salt Lake City Utah.

Eckhoff, Watson and Preator Engineering. 1995. "1995 Water Quality Implementation Report: Deer Creek and Jordanelle Reservoirs Water Quality Management Plan for the 1995 Water Year." Salt Lake City Utah.

Eckhoff, Watson and Preator Engineering. 1994. "1994 Water Quality Implementation Report: Deer Creek and Jordanelle Reservoirs Water Quality Management Plan for the 1993 Water Year." Salt Lake City Utah.

Eckhoff, Watson and Preator Engineering. 1993. "1993 Water Quality Implementation Report: Deer Creek and Jordanelle Reservoirs Water Quality Management Plan for the 1992 Water Year." Salt Lake City Utah.

Eckhoff, Watson and Preator Engineering. 1992. "1992 Water Quality Implementation Report: Deer Creek and Jordanelle Reservoirs Water Quality Management Plan for the 1991 Water Year." Salt Lake City Utah.

Eckhoff, Watson and Preator Engineering. 1991. "1991 Water Quality Implementation Report: Deer Creek and Jordanelle Reservoirs Water Quality Management Plan for the 1989 & 1990 Water Years." Salt Lake City Utah.

Psomas and Associates. 1998. "1998 Water Quality Implementation Report: Deer Creek and Jordanelle Reservoirs Water Quality Management Plan for 1997 Calander Year." Salt Lake City. Utah.

Rushforth, Samuel R. 2000. "Phytoplankton Floras from Deer Creek Reservoir, Wasatch County, Utah 1999." Brigham Young University, Provo, Utah.

Rushforth, Samuel R. 2000. "Phytoplankton Floras from Jordanelle Reservoir, Wasatch County, Utah 1999." Brigham Young University, Provo, Utah.

Rushforth, Samuel R. 2000. "Biological Water Quality of the Provo River as Determined by Analysis of Periphyton Communities, July 1998-June1999." Brigham Young University, Provo, Utah.

Sowby and Berg Consultants. 1984. "Deer Creek Reservoir and Proposed Jordanelle Reservoir Water Quality Management Plan." Heber, Utah.

Sowby and Berg Consultants. 1989. "1989 Water Quality Implementation Report: Deer Creek Reservoir and Jordanelle Reservoir." Heber, Utah.

Wasatch County & Eckhoff, Watson, and Preator Engineering. 1996. "A Guide for Erosion and Sediment Control." Salt Lake City, Utah.