Mill Creek
TMDL
Grand County, Utah

Prepared by

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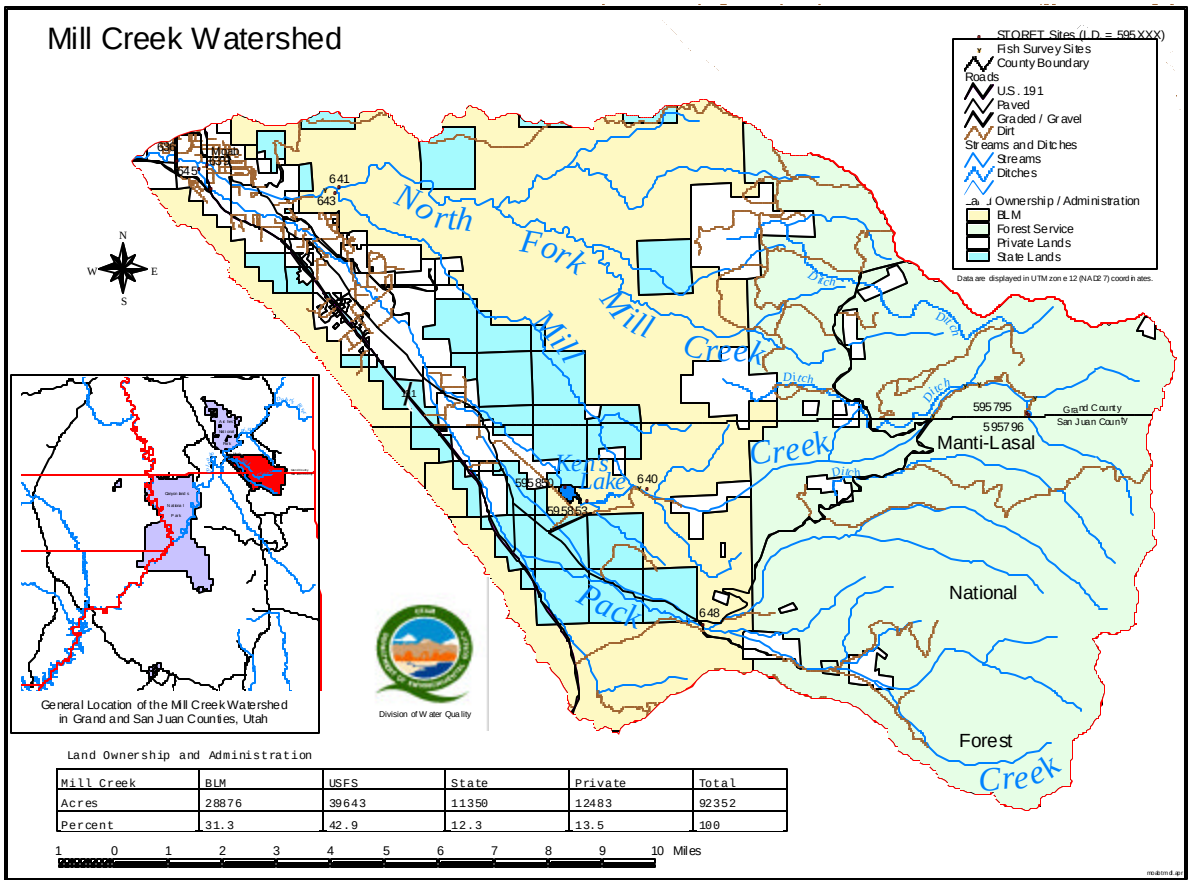
Mill Creek TMDL

Waterbody ID	**Mill Creek**
Location	**Grand County, Utah HUC# 14030005**
TMDL Pollutants of Concern	**Temperature** **Total Dissolved Solids (TDS)**
Impaired Beneficial Uses	**Class 3A: Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.** **Class 4: Protected for agricultural uses including irrigation of crops and stock watering.**
Loading Assessment	**Temperature exceeds 20° standard during summer months as a result of solar heating, low flows and degraded riparian condition.** **Current TDS in Mill Creek meets state standards. Pack Creek a tributary to Mill Creek exceeds state standards as a result of groundwater inputs and irrigation return flow.**
Water Quality Targets/Endpoints **Temperature** **TDS**	 **Temperature not to exceed state standard relative to assessment criteria.** **TDS not to exceed state standard for agricultural use. Footnote 4 states TDS limits may be adjusted if such adjustment does not impair the designated beneficial use of the receiving water.**
Implementation Strategy **Temperature** **TDS**	 **To attain a temperature reduction in Mill Creek this TMDL recommends maintaining the 3 cfs (or total creek flow) below the Sheley diversion as required by the BLM and improving riparian condition in areas identified as degraded riparian condition.** **Delist based on assessment that there is no current impact on the agricultural defined beneficial use.**
This document is identified as a TMDL for Mill Creek and is officially submitted to the U.S. EPA to act upon and approve as a TMDL.	

I. INTRODUCTION

Mill Creek is a tributary of the Colorado River, located in southeastern Utah HUC #14030005. Exceedence of Utah water quality standards for temperature and total dissolved solids were documented at one or more of the following state monitoring sites 495639, 495640, & 495646. Monitoring occurred during the intensive monitoring cycle from July 1997- June 1998. As a result of this monitoring effort, exceedences of Utah water quality standards for temperature and total dissolved solids were documented. This TMDL document addresses these exceedences.

A Watershed Restoration Action Strategy (WRAS) for all activities to be established in the watershed is not included with this document. The Utah Division of Water Quality will work with stakeholders to further develop the details of a WRAS. Implementation of recommendations in this document will be done with full participation of all interested and affected parties. During implementation, additional water quality data will be collected. As a result, targets will be re-examined. This document is considered to be a component of the WRAS. In the event that new data indicate that the targets used in this analysis are not appropriate or if new standards are adopted, the load capacity will be adjusted accordingly.



Mill Creek	BLM	USFS	State	Private	Total
Acres	28876	39643	11350	12483	92352
Percent	31.3	42.9	12.3	13.5	100

Figure 1 – Mill Creek Watershed

Mill Creek flows through the town of Moab. Surrounded by desert terrain, Moab has an elevation of about 4,000 feet above sea level. The LaSal Mountains, just 18 miles to the east, reach elevations of over 12,000 feet. The mountain valleys provide contrast to the panoramic view of the deserts and

canyons below. This varied topography offers recreational opportunities throughout the year. During the last few years, the drainage basin has become world famous for mountain biking. The unique slick rock trails, including the famous Slickrock Bike Trail, attract hundreds of thousands of bikers from across the nation and around the world.

The Mill Creek Watershed is in a cold desert ecosystem with hot summers, cold winters and moderate spring and fall seasons. Mill Creek is a popular year-round recreation area. While the stream corridor is largely restricted to vehicle access, there are several county roads, 4x4 vehicle routes, hiking, mountain biking, and other recreational activities and events located within the stream corridor and other parts of the watershed.

II. WATER QUALITY STANDARDS

Based on historical water quality data, water quality of Mill Creek does not meet the standards set by the State of Utah for its 3A & 4 designated beneficial use classifications. Mill Creek was originally listed as impaired on the 1998 303d list. The Utah Division of Water Quality (UDWQ) has adopted numeric water quality standards for total dissolved solids to protect the designated use of agricultural waters. It has likewise adopted numeric water quality standards for temperature to protect the designated use of a cold-water fishery.

Table 1 – From Utah's 2002 list of stream and river waterbodies needing TMDL analyses.

Water Quality Management Unit	Waterbody Name	HUC	Waterbody Size (Miles)	Beneficial Use Impaired	Pollutant or Stressor Of Concern	Priority For TMDL	Targeted For TMDL 2000-2002
Southeast Colorado	Mill Creek	14030005-005	41.14	3A	Temperature	Low	No
Southeast Colorado	Mill Creek	14030005-005	41.14	4	Total Dissolved Solids	Low	No

Table 2 – Beneficial use class and pollutants causing impairment

Waterbody	Beneficial Use Classes (Impaired class shown in **bold**)	Impairment
Mill Creek	1C, 2B, **3A**, **4**	Total Dissolved Solids Temperature

Table 3 – Explanation of beneficial use classifications for Mill Creek

Class 1 - Protected for use as a raw water source for domestic water systems
Class 1C - Protected for domestic purposes with prior treatment by treatment processes as required by the Utah Division of Drinking Water.
Class 2 - Protected for recreational use and aesthetics.
Class 2B - Protected for secondary contact recreation such as boating, wading, or similar uses.
Class 3 - Protected for use by aquatic wildlife.
Class 3A - Protected for cold-water species of game fish and other cold-water aquatic life, including the necessary aquatic organisms in their food chain.
Class 4 - Protected for agricultural uses including irrigation of crops and stockwatering.

Tables 1 through 3 show the TMDL status, pollutants of concern and the beneficial use classification of Mill Creek. Water quality standards have been set at a level to protect and support the beneficial use. The primary standards leading to an assessment of use impairment is the numeric criteria for total dissolved solids of 1200 mg/l and temperature of 20°C (68°F).

Public Law 92-500, the Federal Water Pollution Control Act (commonly referred to as the Clean Water Act), enacted by Congress in 1972 and amended in 1977 and 1981, provides a national framework for water quality protection. The Clean Water Act recognizes that it is the primary responsibility of the States to prevent, reduce and eliminate water pollution; to determine appropriate uses for their waters and to set water quality criteria to protect those uses. Section 303(d) of the Clean Water Act requires that each state reviews and, if necessary, revises its Water Quality Standards at least once every three years. This serves to ensure that the requirements of state and federal law are met and that water quality criteria are adequate to protect designated water uses.

III. WATER QUALITY TARGETS/ENDPOINTS

The desired goal for the TMDL is to meet state water quality standards for the designated beneficial uses of the waterbody. The target endpoint for temperature is to obtain a 3A beneficial use classification standard of < 20° as defined by the assessment criteria. The target endpoint for total dissolved solids is to obtain an instream concentration of < 1200 mg/l as defined by the assessment criteria. However an exemption to the 1200 mg/l standard is allowed if such adjustment does not impair the designated beneficial use of the receiving water. Endpoints identified to achieve the TMDL coincide with the goals and objectives associated with the WRAS.

Endpoint Identification

1. TDS < 1200 mg/l
2. Temperature < 20° Celsius
3. Riparian Restoration approximately 6 miles
4. Minimum 3 cfs flow below Sheley Diversion

IV. TECHNICAL ANALYSIS & SIGNIFICANT SOURCES

Temperature

Factors affecting temperature in Mill Creek include:

- Reduced summertime flow (both natural and human-caused)
- Diversion of water at the Sheley Diversion above the amount needed to maintain a 3.0 cfs below the diversion
- High width to depth ratio (due to bedrock formation between the confluence of North Fork and the Sheley Diversion)
- Limited riparian habitat (due to bedrock formations, exotic vegetation, beaver depradation and recreational impacts)

Table 4 – Moab, Utah (425733) 1971-2000 Monthly Climate Summary													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	44.2	52.7	64.0	72.9	83.2	94.1	99.8	97.4	88.6	74.9	56.1	46.0	73.0
Average Min. Temperature (F)	19.9	26.1	34.8	41.9	49.9	57.6	63.7	63.0	53.2	40.5	28.7	21.4	41.9
Average Total Precipitation (in.)	0.66	0.57	0.87	0.95	0.80	0.43	0.79	0.89	0.86	1.12	0.83	0.66	9.42

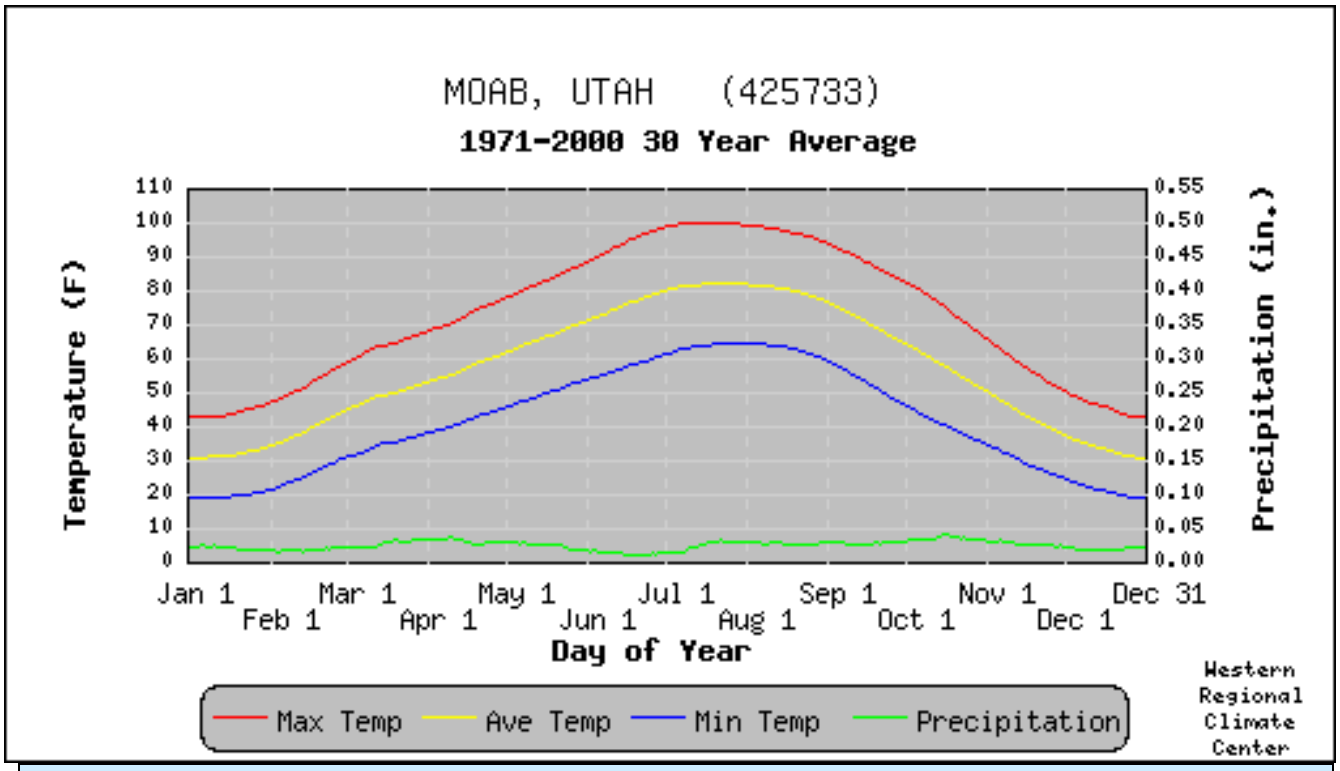


Figure 2 - Moab, Utah (425733) 1971-2000 Monthly Climate Summary

The following application of a simplified approach in predicting the effect of shading on stream temperatures shows that a 36% (11% more than current conditions) reduction in solar radiation will permit the stream to meet its temperature criteria for cold water fisheries.

To determine the effect of restored riparian vegetation on stream temperatures, a simple model published in EPA's *Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water – Part 1* (1985) was used. The model predicts a stream equilibrium temperature based upon average dewpoint temperature for the critical time period (July & August), mean daily windspeed and the net incoming solar radiation. The estimated reduction in solar radiation due to stream shading was derived from guidelines set forth by Pluhowski (1968).

T_d (average dewpoint temperature for August) = 40°F
U (mean daily windspeed) = 9.2 mph
H_{sn} (net incoming shortwave radiation) = 2188 btu/ft^2/day

Equilibrium temperature (E_i) under unshaded conditions

a. $f(U) = 70+0.7(U^2)$
b. $T=(E_i+T_d)/2$
c. $B=0.255-0.0085(T)+0.000204(T^2)$
d. $K=15.7+(B+0.26)(f(U))$
e. $E_{i+1}=T_d+H_{sn}/K$

Table 5 – Solar & Climate data for Mill Creek

Month	Solar Radiation KWh/m^2/day	Solar Radiation BTU/ft^2/day	Average Dewpoint Temperature (°F)	Mean Wind Speed (mph)
July	7.3	2314.65	40	9.4
August	6.5	2060.99	40	9.1

The wind speed function f(U) is computed once and the dewpoint temperature (T_d) is initially used in place of the equilibrium temperature (E_i). If E_i and E_{i+1} differ by more than 1° than E_{i+1} is used in equation b and the procedure is repeated until convergence is attained. After three iterations of the model the equilibrium temperature of Mill Creek under unshaded conditions was found to be 29°C. As can be seen in Figure 3 temperature rarely rises above 22°C indicating that a 25% reduction currently exists as a result of riparian cover already in place.

After applying an additional 11% reduction over current conditions in incoming solar radiation (H_{sn}=1860 btu/ft^2/day) the new equilibrium temperature was found to be 19.74°C, which meets the state criteria for cold-water fisheries.

Based on the above information it is clear that without implementation of some practices to reduce solar radiation or increase the flow of cooler water the temperature in Mill Creek will continue to exceed the state's 20 degree Celsius standard during the summer months.

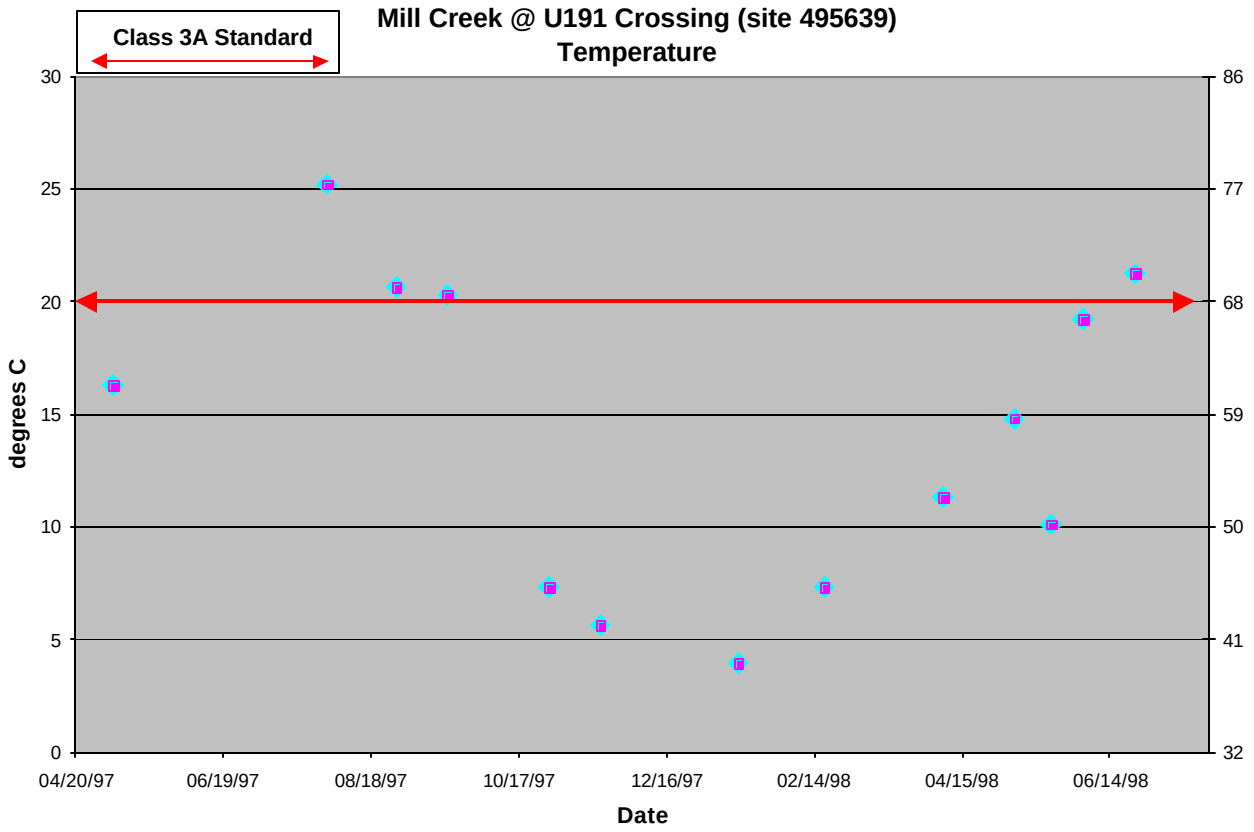


Figure 3 – Mill Creek temperature from Intensive Monitoring 1997-1998.

A Proper Functioning Condition (PFC) assessment of the riparian area in Mill Creek canyon was conducted between 1995 and 1998 (see figure 4) by the Bureau of Land Management. This assessment identified areas in the canyon that were classified as functional at risk. Riparian plantings and streambank improvement practices will have a positive affect on the temperature in Mill Creek.

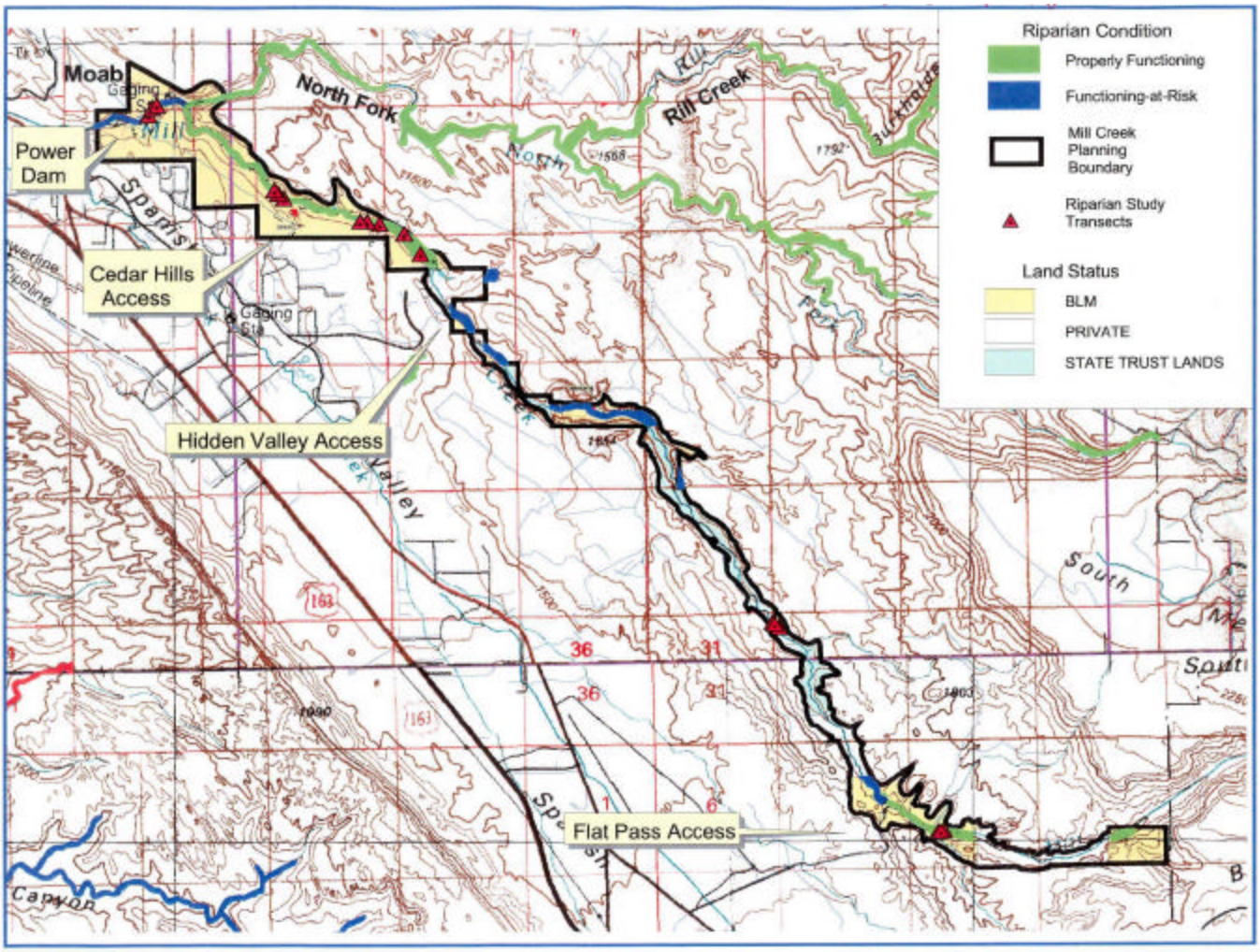


Figure 4 – Mill Creek Canyon PFC assessment *(Information from Bureau of Land Management)*.

Total Dissolved Solids

Total dissolved solids in Mill Creek do not exceed state standards as can be seen in Figure 5. The lowest site monitored on Mill Creek (495639) has a TDS well below the standard. As depicted in figure 5 at station 495646 the TDS exceedence occurs only in Pack Creek, a tributary to Mill Creek. The average value for TDS in Pack Creek at site 495646 figure 5 & table 6 is 1111 mg/l. The low degree of exceedence seen would indicate that it is probably within the statistical variability of 1200 mg/l.

Flow in Pack Creek is minimal during the irrigation season from May through September. Flow during this period is attributed to ground water inflow and irrigation return flow. TDS in both the groundwater and the irrigation return flow are the only identified potential sources of TDS in Pack Creek. Observing that TDS exceedence occurs primarily during the non-irrigation season suggests a high likelihood of natural sources. In accordance with state water quality standards allowances can be made to adjust the numeric TDS criteria if the defined beneficial use is not impaired. The primary source of water used for

irrigation in this basin is from Ken's Lake, Mill Creek below the Sheley diversion and Pack Creek; none exhibit a high TDS concentration. Water at the mouth of Pack Creek where water quality is monitored is representative of return flows and groundwater. It is not the water used for agriculture in the basin and is diluted by Mill Creek where no exceedence occurs.

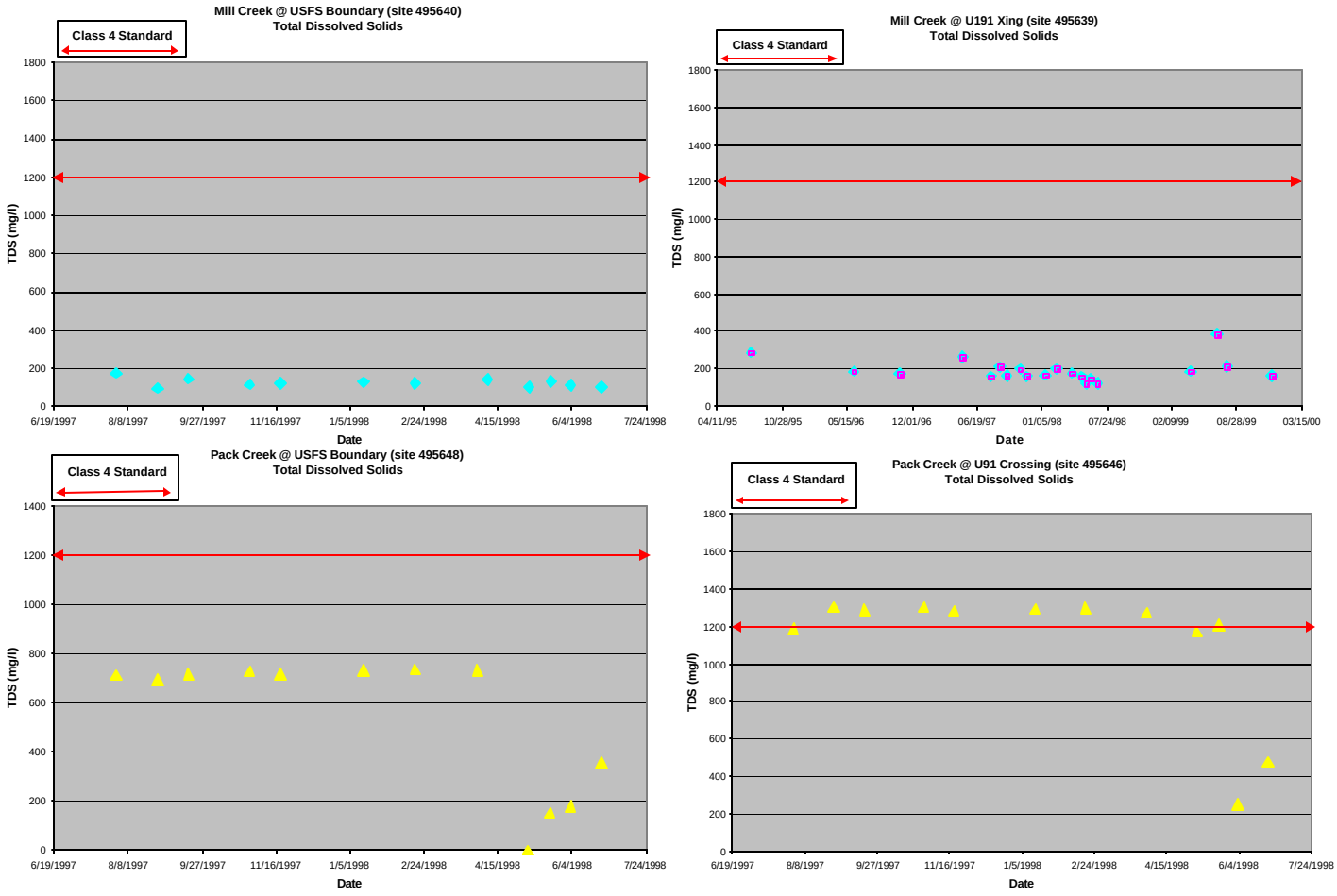


Figure 5 – Total dissolved solids in Mill Creek & Pack Creek

Table 6 – TDS data for Pack Creek at U191 crossing site 495646

Date	Flow cfs	TDS mg/l		Date	Flow cfs	TDS mg/l
7/31/1997	2	1188		2/18/1998	3.5	1298
8/28/1997	3	1304		4/1/1998	5	1270
9/18/1997	8	1288		5/6/1998	2	1174
10/29/1997	3	1302		5/21/1998	5	1206
11/19/1997	6.3	1284		6/3/1998	5.5	252
1/14/1998	4	1292		6/24/1998	6	474

V. MARGIN OF SAFETY AND SEASONALITY (MOS)

Temperature

Temperature exceedence only occurs during the summer months as can be seen in figure 3. Improvement in riparian condition should result in increased shading and a significant reduction in solar radiation inputs. Maintaining the minimum 3 cfs (or total creek flow) below the Sheley diversion (summer temperature measured at 19° C above diversion) during the summer months will further reduce the temperature in Mill Creek to comply with state standards. The MOS will also include future monitoring to evaluate the effectiveness of restoring the riparian corridor through application of these BMP's.

TDS

The MOS will include future monitoring and tracking to assure water quality standards are met for the agricultural defined beneficial use.

VI. ALLOCATION OF LOAD REDUCTIONS OR MANAGEMENT PRACTICES

Temperature

Temperature reductions will be attained by:

- Maintaining a 3 cfs or total creek flow below the Sheley diversion
- Riparian plantings and streambank BMP's

The following practices have been identified that would reduce Mill Creek water temperatures to bring conditions into compliance with the standard for Class 3A waters:

1. Provide higher stream flows during summer. At a minimum this should include maintaining the BLM required 3 cfs flow immediately below the diversion to Ken's Lake.
2. Increase water depth by narrowing the stream channel with restoration techniques involving use of heavy equipment (bottom 14 miles).
3. Plant and protect riparian vegetation to increase shading a minimum of 11% (control tamarisk, restore natives in the bottom 14 miles) to attain water quality standard.

Channel alterations will not be considered unless other efforts to achieve endpoints are not successful.

VII. PUBLIC PARTICIPATION

Information concerning the Mill Creek TMDL has been distributed throughout Moab. A brochure was developed to help people understand TMDL's. A public meeting and open house were held to explain the assessment and recommendations to those interested. The main land manager in the basin is the BLM. The local BLM office is represented on the Technical Advisory Committee for the watershed, as are other major stakeholders. The TMDL report was posted to the Division of Water Quality's web site on the internet and a comment period of 30 days was offered.

A Technical Advisory Committee was established for the development of the TMDL. Table 7 shows the committee membership and the interests' they represent.

Table 7 - Technical Advisory Committee members

NAME	REPRESENTING	EMAIL	PHONE #
Mike Allred	Div. Water Quality	mallred@deq.state.ut.us	801-538-6316
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Ann Marie Aubry	BLM	Ann_Marie_Aubry@ut.blm.gov	435-259-2173
Louis Berg	Div. Wildlife Resources	nrdwr.lberg@state.ut.us	435 636-0268
George Carter	Moab SCD, Irr Co.	geoann@citlink.net	435-259-1413
Kathrine Foster	Forest Service	kfoster01@fs.fed.us	435-636-3503
Michael Johnson	Extension	michaelj@ext.usu.edu	435-259-7558
Dale Pierson	Spanish Valley WCD	dpierson@lasal.net	435-259-8121
Todd Stonely	Div. Water Resources	TSTONELY.NRWRES@state.ut.us	801 538-7277
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