Utah Department of Environmental Quality
Division of Water Quality
TMDL Section

Spring Creek TMDL

Summary Page

Waterbody ID	**Spring Creek**
Hydrologic Unit Code	16010203
Location	Cache County, Utah
Pollutants of Concern	Total Phosphorus (TP) Dissolved Oxygen (DO) Ammonia Temperature Fecal Coliforms
Impaired Beneficial Uses	Class 3A: Protected for cold water species of game fish and other cold water aquatic life. Class 2B: Protected for secondary contact recreation such as boating, wading, or similar uses.
Water Quality Assessment	• Current Total Phosphorus (TP) load is 27,131 kg/year at drainage outlet. • TP Avg Concentration: 0.70 mg/l • Exceedence Rates at Drainage Outlet: o Dissolved Oxygen: 40% o Temperature: 3% (delist) o Ammonia: 11% o Fecal Coliforms: 39%
Defined Targets/Endpoints	• 0.05 mg/l Total Phosphorus at Drainage Outlet (Approximately 1,950 kg/year). • Dissolved Oxygen, Ammonia, and Fecal Coliformas to meet State Standards.
Implementation Strategy	1. Reduce Point Source Phosphorus and Ammonia Loads. 2. Implement Nonpoint Source BMPs

I. Introduction

Spring Creek begins as a groundwater spring in the middle of Cache Valley of Northern Utah. The spring is located just west of Highway 89, as shown in Figure 1, approximately one mile north of the College Ward community. Spring Creek meanders northwesterly through mainly agricultural lands towards the Little Bear River for approximately five miles eventually discharging into Cutler Reservoir, a reservoir on the Bear River and a significant water resource for the State of Utah. The major tributaries to Spring Creek are Hyrum Slough and the Spring Creek South Fork. Many irrigation canals crisscross the watershed bringing water from Blacksmith Fork and the North Fork of the Little Bear River. These canals support the agricultural industry that predominates the watershed.

The Spring Creek watershed and area of study is defined, as shown in Figure 1, starting at the discharge of Spring Creek into Cutler Reservoir, extending to the southeast towards the foothills of Hyrum City. The basin covers an area of approximately 29.3 square miles (18,700 acres). The actual drainage area may be considered to be somewhat smaller, however, (26.2 square miles or 16,800 acres) because the Highline Canal crosses the southeast end of the basin and may cut off all runoff. Most of Hyrum City and parts of the City of Nibley are located within the drainage. The remaining areas are unincorporated and governed by Cache County. Spring Creek water comes from a variety of sources, including rainfall, groundwater, and canal diversions from the Blacksmith Fork and Little Bear Rivers.

Spring Creek was identified by the Utah Department of Environmental Quality - Division of Water Quality (DWQ) as not supporting its beneficial use requirements for the numerical criteria associated with fecal coliform, total phosphorus, temperature, dissolved oxygen, and ammonia. Spring creek is listed as low priority for TMDL and was not targeted for TMDL for 2000-2002. Since Spring Creek eventually empties into Little Bear River which discharges into Cutler Reservior, DWQ contracted with Psomas to prepare a TMDL plan comply with Federal Regulations as stipulated in the Clean Water Act. The goals of this report are to:

- Assess the water quality impairment of the beneficial uses.
- Identify the sources of pollution contributing to the impairment.
- Identify the TMDL targets and endpoints which will ensure a restoration of beneficial uses.
- Determine the allocation of load reductions from all significant sources of pollution.
- Research potential best management practices (BMPs) and best available technologies (BATs) and recommend those that should help significant sources meet load reduction allocations.

- Recommend an implementation schedule for the implementation of BMPs and BATs.
- Determine the impacts of future sources.
- Recommend a future monitoring program.

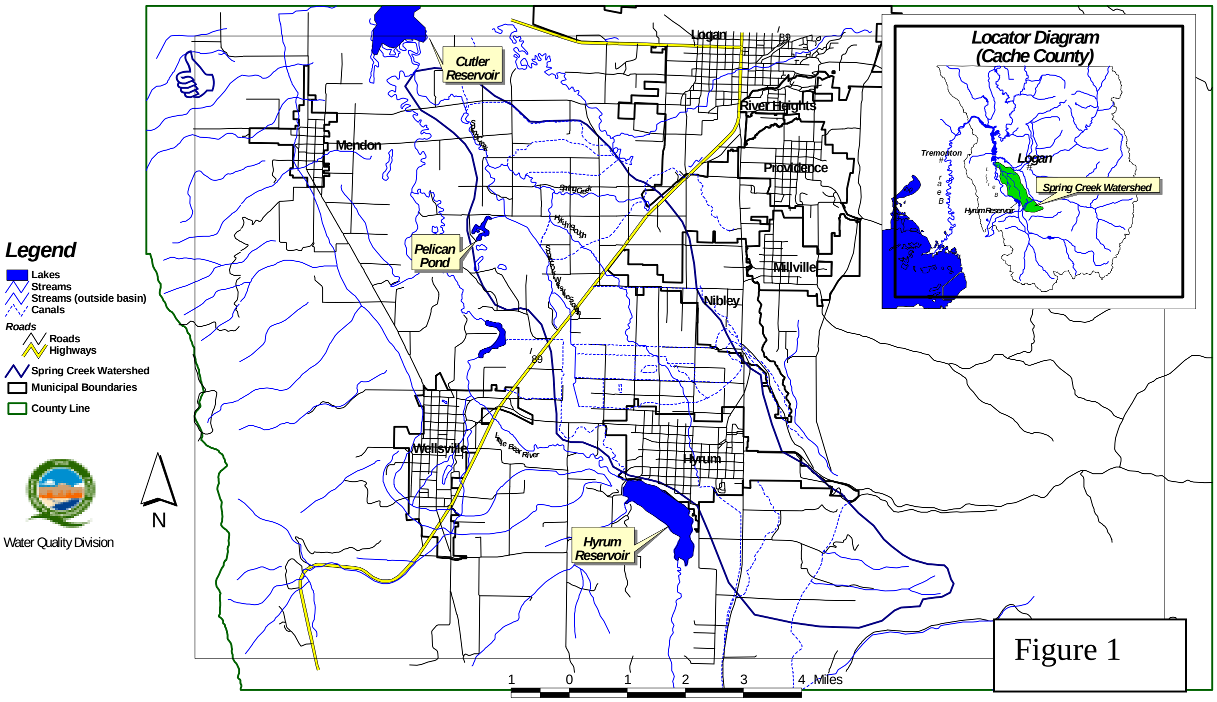

Figure 1. Spring Creek Drainage Study Area

II. Water Quality Standards

In an effort to quantify the acceptability of water quality parameters, standards have been developed by the State of Utah. The purpose of these standards is to limit various constituents, which have been found to negatively impact the designated beneficial use of a water body. The beneficial uses for Spring Creek, as determined by the state are:

- **2B:** Protected for secondary contact recreation such as boating, wading, or similar uses
- **3A:** Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain
- **3D**: Protected for waterfowl, shore birds and other water-oriented wildlife not included in Classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain

- **4**: Protected for agricultural uses including irrigation of crops and stock watering

Prior to this investigation, it had been determined that certain constituents may be having a negative effect on the above-mentioned beneficial uses for streams within Spring Creek watershed, determining which parameters needed to be reviewed. This investigation focuses on the following parameters: dissolved oxygen, water temperature, ammonia, total phosphorus, and fecal coliforms. This section discusses these parameters and the standards, which the state has provided. Table 1 summarizes these water quality standards.

Table 1: Water Quality Standards Summary

Constituent	State Standard
Dissolved Oxygen	8 mg/l (1-day avg) 6.5 mg/l (30-day avg)
Water Temperature	20° C
Ammonia	Varies. See Table 2 and 3.
Total Phosphorus	0.05 mg/l
Fecal Coliforms	200 Clf/100 ml

Table 2 State Standards for Maximum 1-Hour Average Concentration of Total Ammonia as N (mg/l) for Class 3A waters.

	TEMPERATURE (C)						
pH	***0***	***5***	***10***	***15***	***20***	***25***	***30***
6.5	28.7	26.8	25.4	24.4	23.8	16.6	11.8
7.0	23.1	21.6	20.5	19.7	19.2	13.4	9.52
7.5	14.3	13.4	12.7	12.3	12	8.42	5.99
8.0	6.55	6.14	5.86	5.68	5.59	3.97	2.87
8.5	2.11	1.99	1.93	1.9	1.92	1.4	1.05
9.0	0.7	0.68	0.68	0.7	0.75	0.59	0.48

Table 3 State Standards for Maximum 4-day Average Concentration of Total Ammonia as N (mg/l) for Class 3A waters.

	TEMPERATURE (C)						
pH	***0***	***5***	***10***	***15***	***20***	***25***	***30***
6.5	2.49	2.33	2.21	2.12	1.46	1.02	0.72
7.0	2.49	2.33	2.21	2.13	1.47	1.03	0.73
7.5	2.5	2.34	2.22	2.14	1.48	1.04	0.74
8.0	1.49	1.4	1.33	1.29	0.9	0.64	0.46
8.5	0.48	0.45	0.44	0.43	0.31	0.23	0.17
9.0	0.16	0.16	0.16	0.16	0.12	0.1	0.08

Calculations for minimum, maximum, and mean values as wells as the total number of samples and the standard deviation are given for each constituent. The time period for these calculations is from 1992 to 1999. Samples which exceed the standard established by the state are highlighted. A summary of the results of the statistics analysis is provided in Table 4 which shows the six most critical monitoring locations with the seven most critical parameters: temperature, total phosphorus, dissolved total phosphorus, dissolved oxygen, ammonia, dissolved nitrite and nitrate, and fecal coliforms.

Loading calculations were completed for the Spring Creek watershed based on data obtained from the Division of Water Quality. Calculations were made for ammonia, total phosphorus, and TSS at each of the sampling locations within the watershed. The time period for these calculations corresponds with the intensive monitoring period starting July 1998 and ending June 1999. A summary of the results of the loading calculations is shown in Table 5 which shows the loads for the six critical stream monitoring locations and the two point source effluents from July 1992 to June 1999 for total phosphorus (TP), ammonia (NH3) and dissolved nitrite and nitrate (NO2+NO3).

Table 4 Spring Creek Water Quality Statistics

	Temperature deg C	Total Phosphorus mg/l TP	D. T. Phosphorus mg/l DTP	Dissolved Oxygen mg/l DO	Ammonia mg/l as N	NO2+NO3 mg/l as N	Fecal Coliforms clf/100ml
Spring Creek at Mendon Road, STORET 490490							
Minimum*	0.6	0.005	0.005	4.900	0.025	0.749	20
Maximum	21.4	9.729	2.778	12.100	10.992	10.734	4140
Average	11.3	0.814	0.619	8.613	0.662	3.910	693
% Exceedence**	3%	98%	99%	40%	11%	n/a	29%
Standard Deviation	5.1	1.107	0.459	1.650	1.496	2.371	969
South Fork East of Pelican Pond, STORET 490492							
Minimum*	0.4	0.005	0.005	4.700	0.025	0.070	4
Maximum	25.4	8.129	8.848	12.500	15.759	12.500	17700
Average	11.6	0.942	0.959	8.494	0.286	8.494	1085
% Exceedence**	10%	98%	99%	39%	2%	n/a	51%
Standard Deviation	6.6	1.246	1.449	1.722	1.593	1.722	3,039
Hyrum Slough at Island Road, STORET 490395							
Minimum*	17.7	0.295	0.043	5.200	0.025	0.010	n/a
Maximum	1.2	2.980	2.748	10.230	7.340	16.400	n/a
Average	9.9	1.287	1.166	8.435	0.859	7.523	n/a
% Exceedence**	0%	100%	n/a	33%	11%	n/a	n/a
Standard Deviation	4.6	0.780	0.757	1.241	1.664	4.425	n/a
Upper Spring Creek in College Ward, STORET 490499							
Minimum*	5.0	0.005	0.005	5.500	0.025	0.130	1
Maximum	18.3	4.582	0.743	14.900	0.347	5.833	500
Average	11.7	0.137	0.038	9.647	0.050	1.133	72
% Exceedence**	0%	31%	11%	15%	0%	n/a	9%
Standard Deviation	3.6	0.573	0.085	1.851	0.051	0.608	94
Upper Hyrum Slough at Nibley Road, STORET 490487							
Minimum*	0.0	0.005	0.005	2.200	0.025	0.395	20
Maximum	22.0	3.784	2.734	14.760	10.354	20.164	47600
Average	9.8	0.442	0.362	9.481	0.573	2.637	4595
% Exceedence**	1%	93%	93%	12%	11%	n/a	88%
Standard Deviation	5.4	0.590	0.430	1.796	1.497	2.583	8,940
South Fork at US 89, STORET 490494							
Minimum*	0.3	0.005	0.029	1.700	0.025	0.010	5
Maximum	26.0	31.230	20.670	13.300	96.345	106.160	51400
Average	12.0	5.527	5.151	7.547	4.061	29.168	5026
% Exceedence**	6%	99%	99%	41%	38%	n/a	86%
Standard Deviation	5.6	5.010	4.040	1.918	10.959	22.798	9,073

* For samples that resulted in undetectable quantities of the constituent, one half of the detection limit was used.

** % Exceedence is based on the following criteria: Temperatures > 20 deg C, Total Phosphorus >0.05 mg/l, Dissolved Total Phosphorus > 0.05mg/l, Ammonia > 4-day standard (Table 3-4), Fecal Coliforms > 200 clf/100ml.

Table 5 Spring Creek Loadings

	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999	Average
Spring Creek at Mendon Road, STORET 490490								
Weighted Average Flow (cfs)	34.2	41.9	35.1	45.9	35.6	67.4	43.6	**43.4**
TP Weighted Average (mg/l)	1.09	0.84	1.26	0.77	0.56	0.58	0.70	**0.79**
TP Annual Load (kg/yr)	33,219	31,425	39,442	31,468	17,769	34,703	27,131	**30,737**
NH3 Weighted Average (mg/l)	1.48	0.92	0.31	0.86	0.43	0.36	0.93	**0.72**
NH3 Annual Load (kg/yr)	45,132	34,139	9,522	35,364	13,724	21,817	36,271	**27,996**
NO2+NO3 Weighted Average (mg/l)	5.87	3.17	4.06	4.00	4.38	4.02	4.94	**4.28**
NO2+NO3 Annual Load (kg/yr)	178,710	117,977	126,589	163,972	138,597	241,180	191,603	**165,518**
South Fork East of Pelican Pond, STORET 490492								
Weighted Average Flow (cfs)	1.8	1.2	2.9	5.4	3.5	4.6	3.5	**3.2**
TP Weighted Average (mg/l)	2.96	1.44	1.16	1.46	0.69	0.41	1.00	**1.13**
TP Annual Load (kg/yr)	4,643	1,473	2,955	6,968	2,121	1,674	3,121	**3,279**
NH3 Weighted Average (mg/l)	3.95	0.09	0.12	0.11	0.10	0.10	0.24	**0.43**
NH3 Annual Load (kg/yr)	6,200	87	297	549	306	412	744	**1,228**
NO2+NO3 Weighted Average (mg/l)	11.72	1.48	5.86	5.19	9.85	2.32	2.57	**5.31**
NO2+NO3 Annual Load (kg/yr)	18,380	1,511	14,882	24,831	30,469	9,387	8,026	**15,355**
Hyrum Slough at Island Road, STORET 490395								
Weighted Average Flow (cfs)					25.1	32.5	23.9	**27.2**
TP Weighted Average (mg/l)					1.30	0.89	1.24	**1.12**
TP Annual Load (kg/yr)					29,035	25,719	26,430	**27,061**
NH3 Weighted Average (mg/l)					1.39	0.73	0.25	**0.75**
NH3 Annual Load (kg/yr)					31,065	21.025.95	5,396	**18,230**
NO2+NO3 Weighted Average (mg/l)					8.17	6.10	9.40	**7.68**
NO2+NO3 Annual Load (kg/yr)					182,847	176,353	200,186	**186,462**
Upper Spring Creek in College Ward, STORET 490499								
Weighted Average Flow (cfs)	13.7	10.0	12.4	13.2	14.0	22.6	17.2	**14.7**
TP Weighted Average (mg/l)	0.05	0.04	0.03	0.03	0.06	0.06	0.36	**0.10**
TP Annual Load (kg/yr)	658	376	364	294	694	1,288	5,455	**1,304**
NH3 Weighted Average (mg/l)	0.03	0.03	0.03	0.07	0.09	0.03	0.08	**0.05**
NH3 Annual Load (kg/yr)	313	245	338	847	1,171	654	1,212	**683**
NO2+NO3 Weighted Average (mg/l)	1.19	1.02	0.95	0.97	1.15	1.02	1.54	**1.13**
NO2+NO3 Annual Load (kg/yr)	14,444	9,079	10,490	11,386	14,368	20,522	23,503	**14,827**
Upper Hyrum Slough at Nibley Road, STORET 490487								
Weighted Average Flow (cfs)	4.5	5.8	10.4	12.0	14.1	18.7	11.1	**10.9**
TP Weighted Average (mg/l)	1.10	0.22	0.47	0.25	0.24	0.20	0.18	**0.30**
TP Annual Load (kg/yr)	4,374	1,142	4,302	2,650	3,035	3,383	1,775	**2,951**
NH3 Weighted Average (mg/l)	1.98	0.25	0.60	0.20	0.14	0.23	0.19	**0.35**
NH3 Annual Load (kg/yr)	7,906	1,268	5,539	2,092	1,768	3,747	1,927	**3,464**
NO2+NO3 Weighted Average (mg/l)	2.83	1.50	1.51	1.84	1.81	2.16	4.07	**2.22**
NO2+NO3 Annual Load (kg/yr)	11,270	7,742	13,899	19,710	22,825	35,989	40,305	**21,677**
South Fork at US 89, STORET 490494								
Weighted Average Flow (cfs)	8.5	8.2	6.6	7.0	9.7	9.6	7.5	**8.2**
TP Weighted Average (mg/l)	12.39	6.16	5.94	3.92	4.49	3.00	3.71	**5.64**
TP Annual Load (kg/yr)	93,784	44,835	34,863	24,566	38,971	25,557	24,643	**41,031**
NH3 Weighted Average (mg/l)	8.77	12.01	3.23	2.03	3.73	1.25	1.47	**4.68**
NH3 Annual Load (kg/yr)	66,344	87,400	18,939	12,718	32,343	10,689	9,761	**34,028**
NO2+NO3 Weighted Average (mg/l)	37.03	22.26	36.15	28.08	23.41	26.93	29.43	**28.97**
NO2+NO3 Annual Load (kg/yr)	280,315	162,022	212,033	175,841	220,307	229,627	195,638	**210,826**
Hyrum City WWTP Discharge, STORET 490552								
Weighted Average Flow (cfs)	1.1	1.0	1.3	1.0	0.8	1.2	1.4	**1.13**
TP Weighted Average (mg/l)	6.58	6.14		3.90	2.86	2.64	2.85	**4.04**
TP Annual Load (kg/yr)	6,693	5,657		3,515	2,104	2,856	3,631	**4,076**
NH3 Weighted Average (mg/l)	0.79	0.46	6.36	0.08	0.15	0.06	0.07	**1.24**
NH3 Annual Load (kg/yr)	802	425	7,163	74	110	70	84	**1,247**
NO2+NO3 Weighted Average (mg/l)	17.27	12.21		15.70	19.18	18.56	18.61	**16.66**
NO2+NO3 Annual Load (kg/yr)	17,573	11,253		14,153	14,119	20,072	23,687	**16,809**
ConAgra WWTP Discharge, STORET 490554								
Weighted Average Flow (cfs)	1.9	2.7	1.8	1.5	2.6	1.3	1.4	**1.89**
TP Weighted Average (mg/l)	19.61	11.61		20.97	21.38	13.18	26.60	**18.10**
TP Annual Load (kg/yr)	33,335	28,191		27,733	49,883	14,883	29,423	**30,575**
NH3 Weighted Average (mg/l)	3.47	58.07	6.87	23.60	6.53	7.63	10.94	**19.19**
NH3 Annual Load (kg/yr)	5,906	140,947	11,021	31,213	15,238	8,617	13,977	**32,417**
NO2+NO3 Weighted Average (mg/l)	133.62	63.04		117.19	135.33	124.58	121.06	**100.69**
NO2+NO3 Annual Load (kg/yr)	227,168	153,020		154,973	315,739	14,883	154,686	**170,078**

Temperature Assessment

High temperatures stress the cold water fishery and are therefore monitored by the State which has standards which limit temperature to maximum of 20 ^{o}F. Figure 2 shows the temperatures during 1992-1999 at the outlet monitoring location (490490) and the three tributary monitoring locations (490499 Upper Spring Creek, 490395 Hyrum Slough, 490492 South Fork).

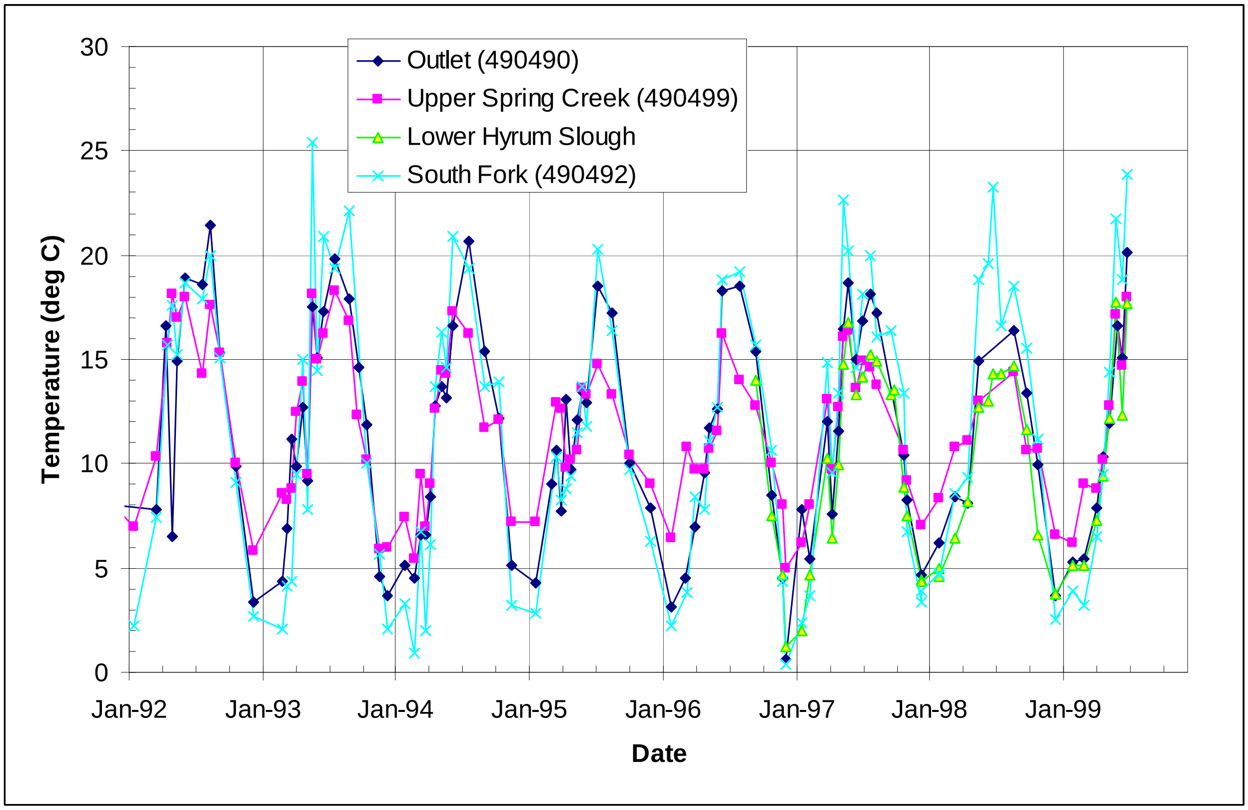

Figure 2. Temperatures in Spring Creek drainage system 1992-1999

The temperatures at these critical locations show that the only location with multiple exceedences is the South Fork monitoring location. This location receives a constant discharge from Pelican Pond, which is a natural pond and wetland system fed by groundwater sources. The pond appears to be heavily influencing the elevated temperatures at this monitoring location because the impounded water will increase in temperature during the summer as is common with open standing water.

Based on linear regressions of the temperature data, temperatures at the outlet (490490) and Upper Spring Creek (490499) appear to be trending lower while the Hyrum Slough and the South Fork appear to be trending higher. These trends are minor and do not appear to be significant concerns and should be attributes natural swings in the climate.

The analysis of the temperature data shows minimal evidence of temperature impairment. Considering the effects of Pelican Pond on the South Fork are natural occurring events and not influenced by human interventions and does not appear to correlate to high temperatures in the Spring Creek channel, it is recommended that Spring Creek be de-listed from the 303(d) list for temperature.

DISSOLVED OXYGEN ASSESSMENT

Dissolved oxygen is required to support the aquatic biology. The State standard for one-day average (acute) dissolved oxygen concentration is 4.0 mg/l for all water bodies or 8.0 mg/l if early stages of life are present. The 30-day average (chronic) standard specified for dissolved oxygen is 6.5 mg/l. The State uses the 6.5 mg/l value for its assessment of streams and rivers. However, since the acute standard governs, 8.0 mg/l is considered to be the standard that should be maintained in the stream system.

Figure 3 shows the dissolved oxygen during 1992-1999 at the outlet monitoring location (490490) and the three tributary monitoring locations (490499 Upper Spring Creek, 490395 Hyrum Slough, 490492 South Fork).

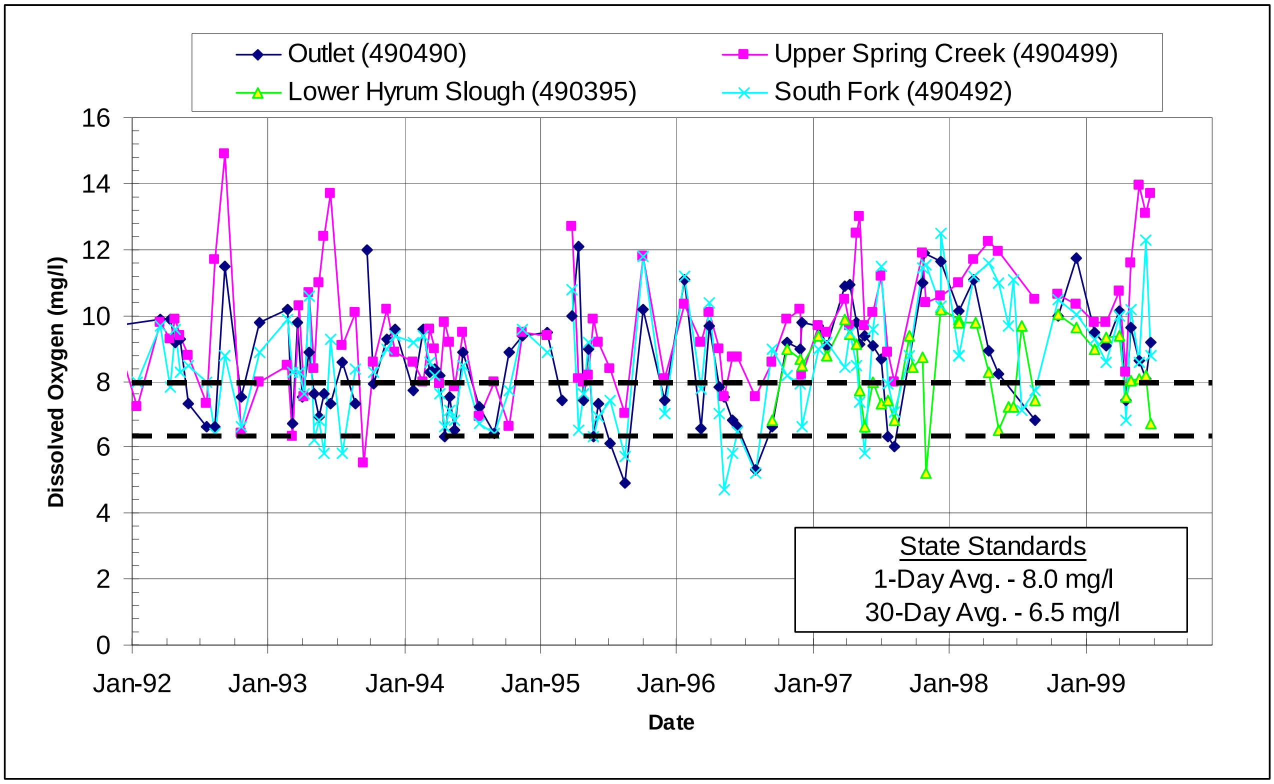

Figure 3 Dissolved Oxygen Concentrations in Spring Creek Drainage 1992-1999.

The above graph shows that the 6.5 mg/l standard is occasionally exceeded, but the 8.0 mg/l standard is exceeded often. Table 4 shows that the 8.0 mg/l standard is exceeded at a rate of approximately 40% at the Spring Creek drainage outlet (490490), upper and lower South Fork (490492 and 490494), and lower Hyrum Slough (490395). The upper Spring Creek (490499) and upper Hyrum Slough (490487) locations exceeded dissolved oxygen standards at a much lower rate of 15 and 12%, respectively.

The dissolved oxygen trends tend to indicate that concentrations have been increasing since 1992. There have been less exceedences of the 8.0 mg/l standard from 1997 to 1999 indicating slightly improved conditions. This trend may be attributable to the local agricultural community's efforts to control pollution from animal feeding operations in the drainage.

The seasonality of dissolved oxygen is shown in Figure 4. Average monthly concentrations are plotted for each of the six critical monitoring locations. This analysis shows that low dissolved oxygen levels are most common during the summer months while during the rest of the year dissolved oxygen levels appear to be healthy. This may be attributable to the high productivity in the stream during the summer when high levels of nutrients that increase eutrophication and high levels of organic solids that demand oxygen for decomposition.

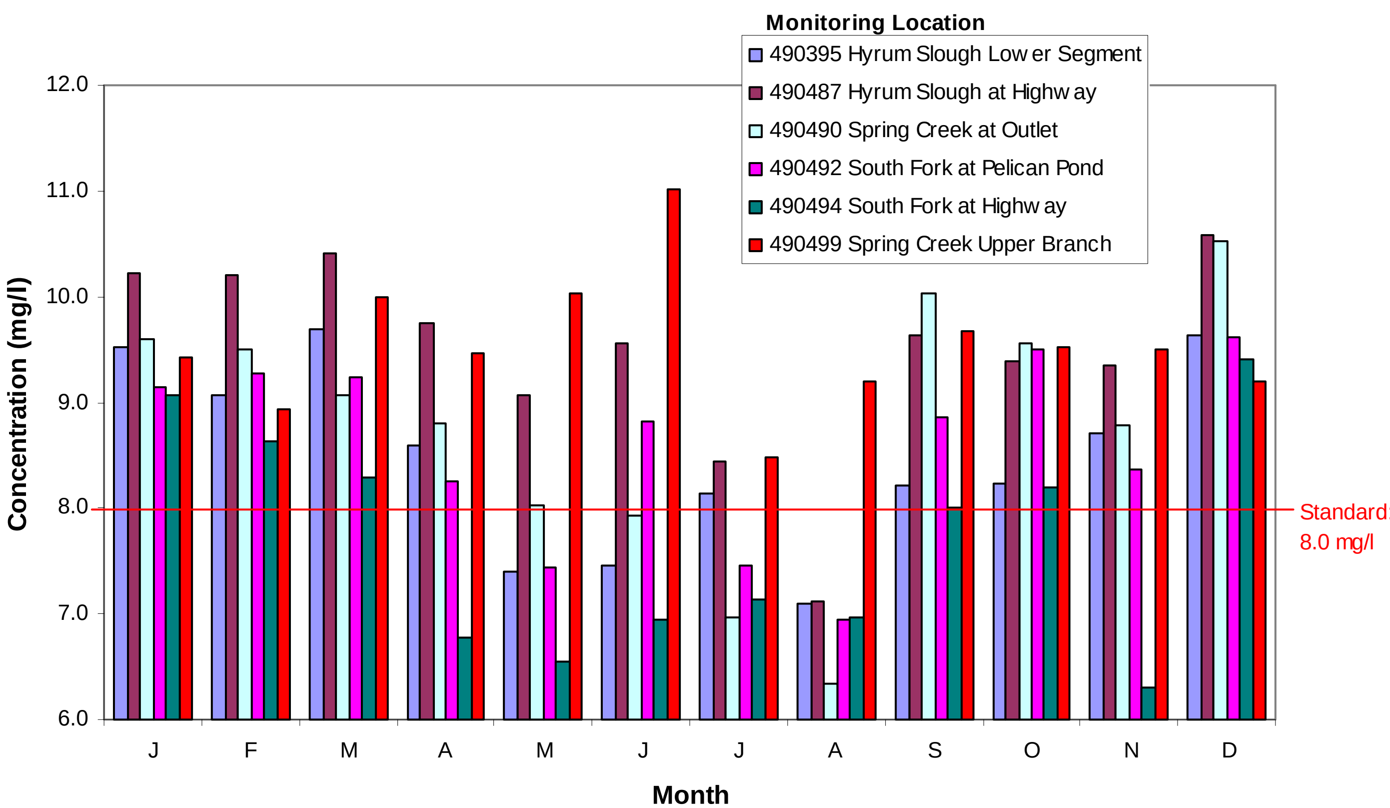

Figure 4. Average (1992-1999) Monthly Dissolved Oxygen Concentrations

PHOSPHORUS ASSESSMENT

As identified previously, the State pollution indicator value for total phosphorus is 0.05 mg/l. The Spring Creek drainage is heavily concentrated with concentrations of total phosphorus (TP) at the drainage outlet (490490) averaging at 0.814 mg/l and dissolved total phosphorus (DTP) averaging 0.619 mg/l. The phosphorus in the system appears to be mostly dissolved with average DTP:TP ratios ranging between 27% (upper Spring Creek) to 100% (South Fork at Pelican Pond) and an average ratio of approximately 78% dissolved. The dissolved portion is generally considered to be more bio-available and contribute more to the nuisance of algae growth. Particulate phosphorus, on the other hand, is important because it can be converted to a bio-available dissolved form but generally is less of a problem.

Figure 5 shows the phosphorus concentrations at the Spring Creek drainage outlet (490490). The graph shows that phosphorus levels rarely drop below the state indicator value of 0.05 mg/l and values as high as 9.7 mg/l have been recorded. The graph also indicates phosphorus improvements that have occurred where phosphorus has not exceeded 1.0 mg/l since mid-1996. This may be attributable to the improvements that have been made with animal feeding operations.

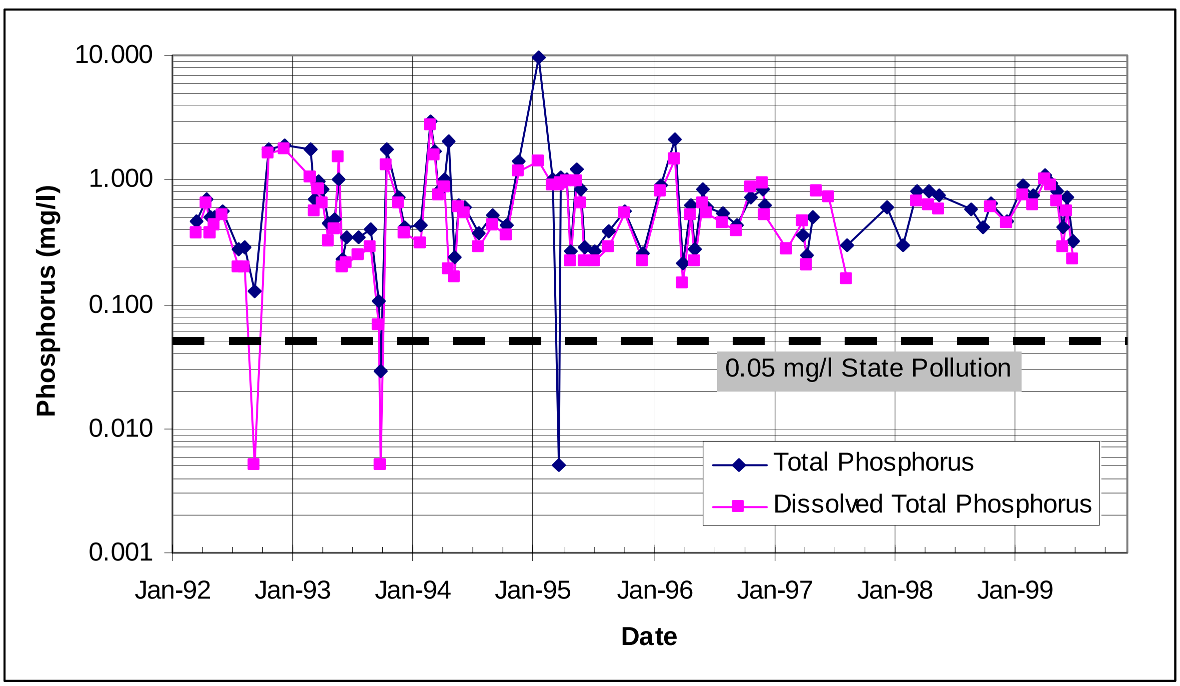

Figure 5. Total Phosphorus and Dissolved Total Phosphorus concentrations at Spring Creek drainage outlet (490490).

The seasonality of phosphorus is minimal, as shown in Figure 6, with fairly constant concentrations throughout the year. Phosphorus concentrations tend to be slightly higher in the winter months of October through February. The seasonal fluctuations do not appear to be correlated to the flows.

Phosphorus loadings are shown in Table 5. The loadings are massive with the Spring Creek drainage outlet annual load ranging between 17,770 to 39,440 kg/yr TP (during the period 1992-1999) with an average annual load of 30,740 kg/yr TP. To meet the State phosphorus indicator value of 0.05 mg/l, annual loads should not exceed 1,950 kg/yr. The loadings can be traced to the Hyrum Slough and the South Fork, the point sources appear to be contributing the most significant phosphorus loads with average annual discharges of 30,580 and 4,100 kg/yr TP for Con-Agra Meat Packaging and Hyrum City Waste Water Treatment Plant, respectively.

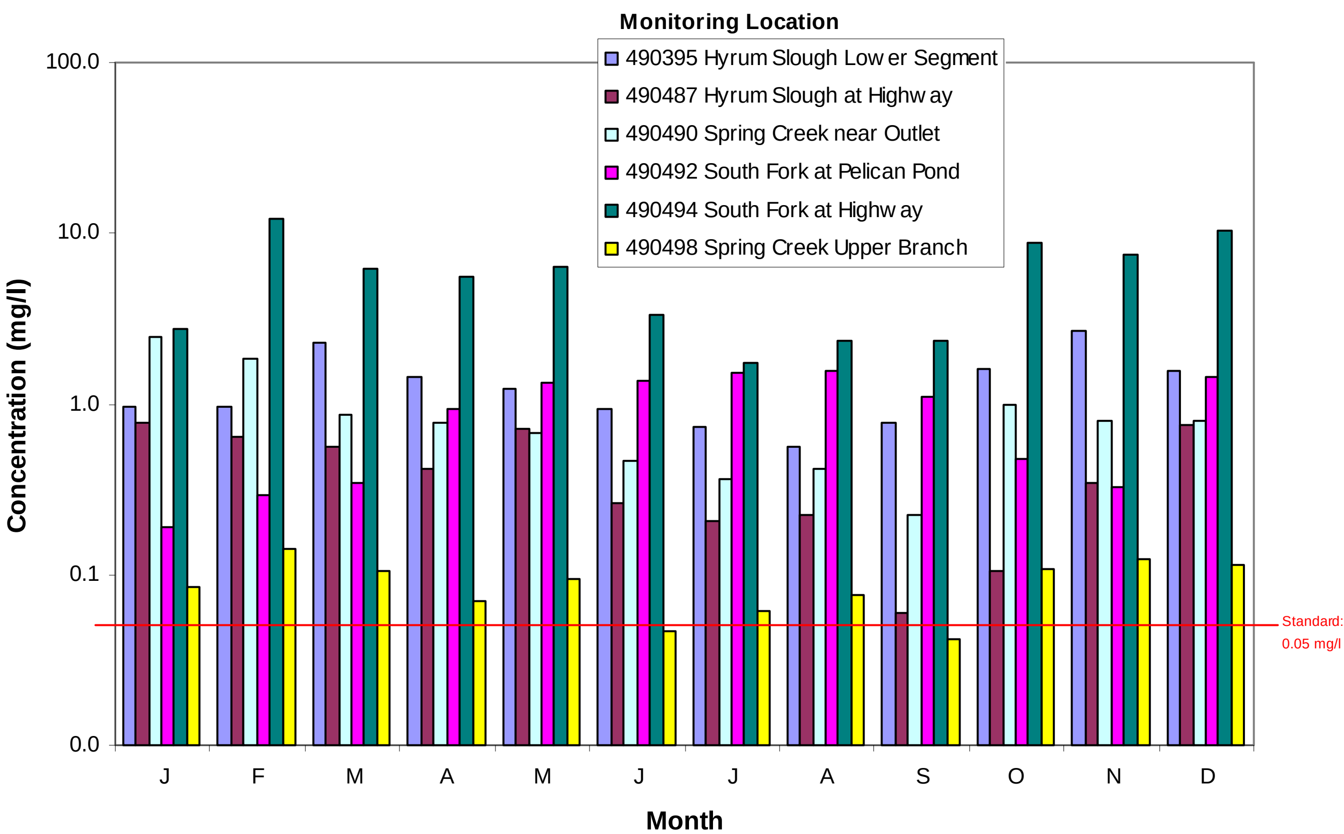

Figure 6. Average (1992-1999) Monthly Total Phosphorus Concentrations

Nonpoint sources appear to also be contributing large phosphorus loads based on the calculated loads at the upper branch of Spring Creek (490499) and the upper segment of Hyrum Slough (490487), which contribute an average annual load of 1,300 and 2,950 kg/yr TP, respectively.

AMMONIA/NITROGEN ASSESSMENT

The Spring Creek system has a highly variable nitrogen to phosphorus (N:P) ratio. Average N:P ratios are between approximately 6.0 to 8.0, indicating that stream eutrophication in Spring Creek is sometimes nitrogen limiting and sometimes phosphorus limiting. Phosphorus is still considered the main parameter of concern for stream eutrophication because of its controllability.

However, ammonia is also a parameter of concern because of toxicity problems when high levels of unionized ammonia are present. Higher pH in the stream causes a shift of ammonia to its unionized form which causes more risk to toxicity. The figure also shows how ammonia generally dissipates in natural streams due to nitrification and volatilization. Nitrification, however, can contribute to increases in nitrates, which can be a problem as it becomes available for algae production.

The standard provided by the state to avoid ammonia toxicity varies with the pH and temperature of the water as shown previously in Table 2 and 3. The rate of exceedence of these State standards for each critical stream monitoring location is shown in Table 6.

Table 6 Spring Creek Total Ammonia Exceedences

	Exceedence of 4-day standard	Exceedence of 1-hour standard
Spring Creek at Mendon Road, STORET 490490	11%	3%
South Fork East of Pelican Pond, STORET 490492	2%	1%
Hyrum Slough at Island Road, STORET 490395	11%	5%
Upper Spring Creek in College Ward, STORET 490499	0%	0%
Upper Hyrum Slough at Nibley Road, STORET 490487	11%	4%
South Fork at US 89, STORET 490494	38%	11%

These locations do not exceed the ammonia standard on a regular basis except for the upper branch of the South Fork which exceeds the 4-day standard at a rate of 38%. Table 5 shows the stream loadings of ammonia to the stream system. The high level of exceedence appears to be a result of Con-Agra ammonia discharges which have averaged to be 12,600 kg/yr (Total NH_3) from 1996-1999. Con-Agra, before 1996, had discharged larger loads, but has since improved its operation. Non-point sources appear to also contribute ammonia, since heavier loads are apparent in lower Spring Creek.

Figure 7 shows the seasonal variations of Ammonia during the year. The graph shows how ammonia concentrations generally increase during the winter months and decrease during the warm summer months. This may be caused by decreased nitrification and ammonia volatilization from decreased temperatures.

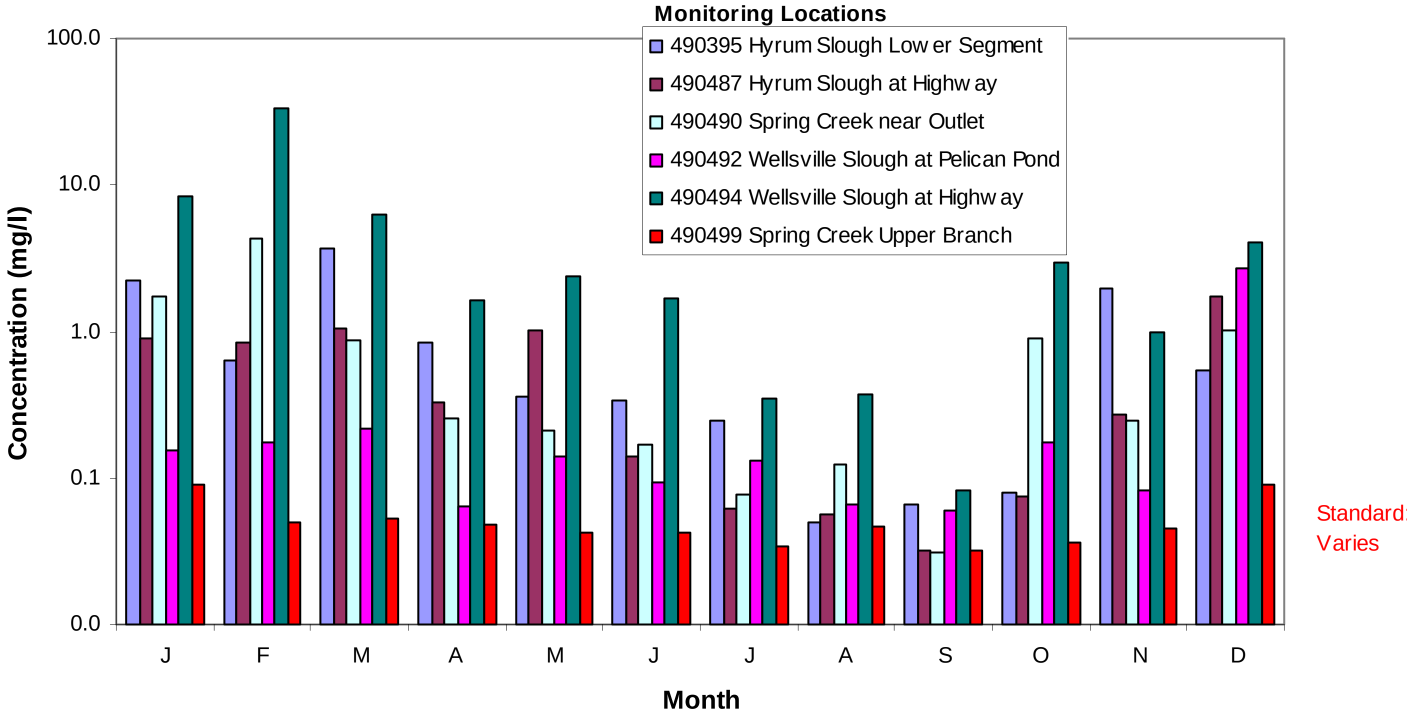

Figure 7. Average (1992-1999) Monthly Total Ammonia (mg/l as N) Concentrations

COLIFORMS ASSESSMENT

Coliforms are called "indicator organisms" that, when present, indicate the potential presence of pathogens. Coliforms are abundant in human and animal waste and also indicate the presence of fecal material. Fecal coliforms (FC) are the most important indicator since they do not include soil organisms. The State standards for fecal coliforms in a Class 2B water body is 200 clf/100ml.

The ratio of fecal coliforms to fecal streptococci (FS) can be used to interpret whether the coliform sources originate from animal or human. FC/FS ratios less than one can be assumed to mean that animals are the major source of contamination. FC/FS ratios greater than four generally mean that humans are the major source. (Chapra, 1997) Spring Creek FC/FS ratios are nearly always less than one indicating the heavy influence from the animal industry.

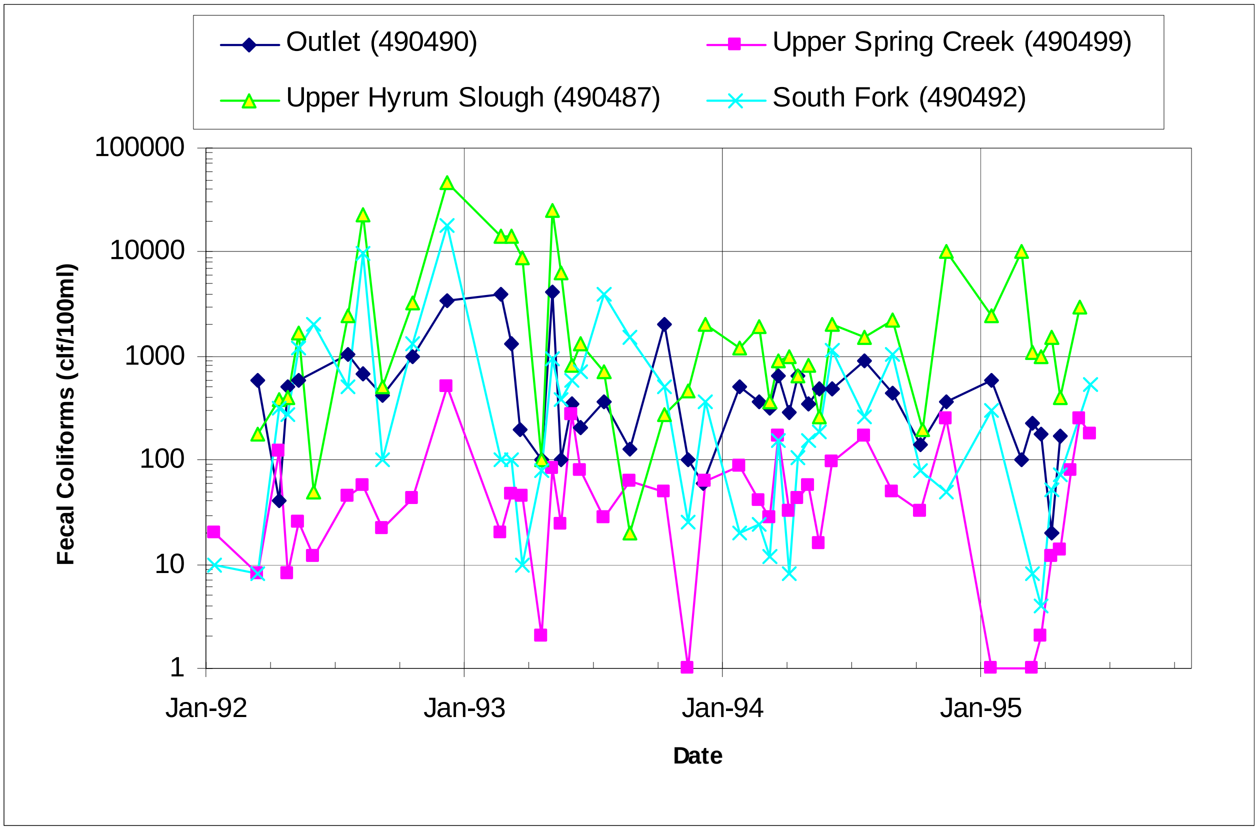

Figure 8. Fecal Coliform Concentrations in Spring Creek Drainage 1992-1995.

Figure 8 above shows the fecal coliforms in Spring Creek and the main branches of the drainage from 1992 to 1995 (coliforms were not measured from 1996 to present). The chart shows the high variability in fecal coliforms with values that range between 1 to 50,000 coliforms per 100 ml. The Hyrum Slough and the South Fork appear to have the highest counts while the upper Spring Creek branch appears to have levels in compliance with State standards. The Hyrum Slough appears to be contaminated from nonpoint sources while the south fork appears to be contaminated by point sources and nonpoint sources. Fecal coliforms do not appear to have any seasonal trends and is variable throughout the year.

WATER QUALITY CONCLUSIONS

The overall water quality of Spring Creek appears to be in poor condition. The stream system is characterized by extremely high concentrations of phosphorus and ammonia, low dissolved oxygen, and high fecal coliforms. The high fecal coliform counts indicate that the stream system poses a potential health hazard. It is apparent that the system does not support a healthy aquatic ecosystem since the fishery cannot be supported. Algae production is high and stream eutrophication is apparent. The restoration of the stream system will require a concerted effort from both nonpoint sources and point sources.

III. Water Quality Targets/Endpoints

One of the requirements of the TMDL is to identify water quality targets and endpoints, which indicate that the water quality improvements have been achieved. The targets are meant to be quantifiable, must restore the beneficial use, and meet and maintain water quality standards. These targets are used to identify the load reductions and improvement projects that can be implemented to restore the beneficial use.

Compliance to the targets and endpoints is expected to be obtained in the stream segments highlighted in Figure 9. These highlighted segments include the main channel of Spring Creek from the headwaters to the drainage discharge, South Fork from the confluence with Spring Creek to the 4400 South Street, and Hyrum Slough from the confluence with Spring Creek to the south end of Hyrum City. These segments represent either historical stream segments or relocated historical stream segments. While reduced pollutants will be required in agricultural ditches and streams in order to improve the identified stream segments, assessments of drainage system health will only be based on these segments.

The Class 3A cold water fishery is listed by the state as impaired due to the levels total phosphorus (TP), ammonia, dissolved oxygen (DO) and temperature. Temperature, however, after further analysis presented in Chapter 3, is recommended to be removed from the listing. Additionally, the stream system is listed for Fecal Coliforms levels which impact Class 2B secondary contact recreation. Endpoints for each of these parameters and also any other potential indicators are discussed in following sections.

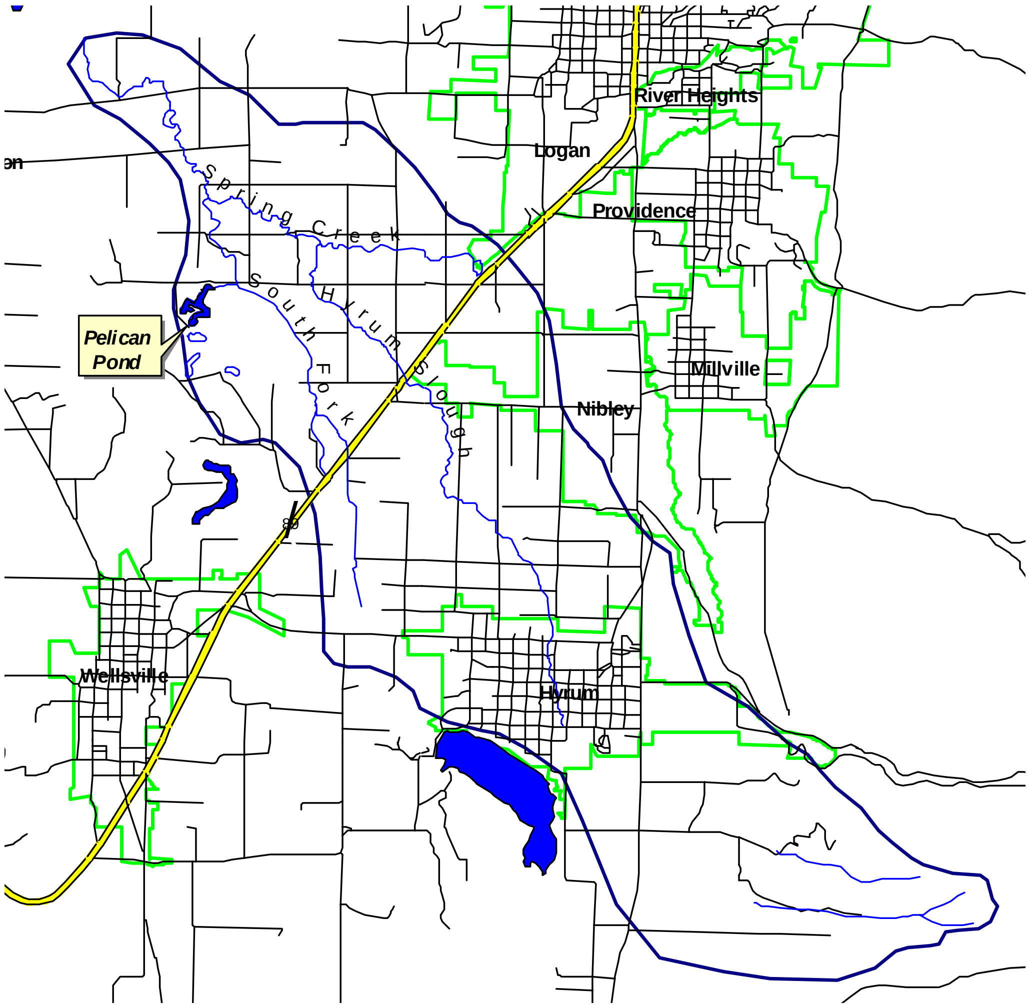

Figure 9: Compliance Stream Segments (Shown in Blue)

PHOSPHORUS ENDPOINTS

Currently, the state uses 0.05 mg/l TP as an indicator of high phosphorus concentrations in a river or stream. For those streams that exceed this indicator, further evaluation is required to determine a healthy level that is stream system specific. Our analysis of the available data indicates that there is not sufficient evidence to warrant a change in the current state indicator value. From the research performed for this report, no historical biological assessments have been performed on Spring Creek that could help identify the nutrient concentrations, which would support a healthy cold water fishery.

EPA's 1986 water quality criterion document (USEPA, 1986) indicated that total phosphates as phosphorus should not exceed 0.10 mg/l in any stream or other flowing water or exceed 0.05 mg/l in any stream at the point where it enters a lake or reservoir. Laboratory research on other TMDLs seems to validate these values (ODEQ, 2001).

It is recommended that Spring Creek, being a tributary to Cutler Reservoir, have a primary target and endpoint of an average concentration of 0.05 mg/l TP at the drainage discharge monitoring station (STORET 490490). Additionally, since it is plausible that the cold water fishery in the Spring Creek system could be supported with a concentration of 0.10 mg/l TP, it is proposed that this concentration be used as secondary targets for the remaining monitoring locations. The primary target of 0.05 mg/l TP at the outlet, however, will remain the governing target. It is unlikely that the secondary goals of 0.10 mg/l TP at all other monitoring locations will be exceeded once the primary goal is achieved. However, the primary and secondary goals must be achieved for the full endpoint conditions.

When 0.10 mg/l is achieved in the drainage system, it is recommended that a biological study be performed to determine the stream system health. If necessary, endpoints may be adjusted per any new information that may be discovered in these studies.

AMMONIA ENDPOINTS

Ammonia toxicity is a concern for the fishery. Ammonia toxicity is based on water temperature and pH. The current state standards for ammonia are given below in Table 3 and 4. The proposed target for Spring Creek is to maintain the state standards such that no more than one sample exceeds the acute standard and no more than three consecutive samples at any location exceed the chronic standard.

DISSOLVED OXYGEN ENDPOINTS

The state standards for dissolved oxygen in a Class 3A cold water fishery are given as follows:

Table 7. State Dissolved Oxygen Standards for Class 3A Cold Water Fishery

Minimum Dissolved Oxygen	
	mg/l
30 Day Average	6.5
7 Day Average	9.5*/5.0
1 Day Average	8.0*/4.0

*First number represents when early stages of life are present.

It is assumed that early stages of life are either present or will become present once the beneficial use is restored, therefore, the more stringent values are used to determine targets for the stream segments. The stream will be considered to be healthy when the 1 Day Average is not exceeded more than once per year, the 7 Day Average is not exceeded more than twice consecutively, and the 30 Day Average is not exceeded more than three times consecutively.

FECAL COLIFORMS ENDPOINTS

The state standard for fecal coliforms in a Class 2B secondary recreational contact beneficial use is a maximum count of 200 coliforms per 100 ml. This state standard will be used as the water quality target for all stream segments.

BIOLOGICAL ENDPOINTS

Biological data has not been collected for the drainage system, therefore, it is difficult to determine what level of biological activity would indicate a healthy system. It is recommended that this endpoint be based on further biological analyses.

IV. TMDL

The TMDLs are generally expressed in terms of kg per day as indicated by the term of daily load. From the endpoints discussed in the previous section the TMDLs have been identified for Phosphorus. It is assumed that an achievement of phosphorus reductions will result in the nonpoint source reduction of coliforms, ammonia, and oxygen demanding organic matter. Thus, the Spring Creek TMDL revolves around the phosphorus reductions in terms of nonpoint source management. Point source management, on the other hand, will require specific limitations on fecal coliforms and ammonia as well as phosphorus for the incorporation of an UPDES permit. Ammonia and coliforms are more dynamic than phosphorus in terms of decay rates, nitrification and denitirification. QUAL2E was used to model the stream system as described previously in this chapter. This model became the basis for determining the constituent limitations for these parameters.

PHOSPHORUS TMDL

Growth of algae in the Spring Creek system is at times and in certain locations limited by phosphorus and other times and other locations it is limited by nitrogen. However, in determining a management approach, phosphorus is the main parameter of concern since it is the most controllable nutrient. The analyses performed on Spring Creek along with literature reviews have indicated that reductions of TP will help to restore the beneficial use to the system.

The most reliable indicator of the stream system health is TP concentration. However, loads must still be assigned to meet TMDL requirements and assist in determining the required load reductions. As was discussed in the endpoint section, average TP concentration should be reduced to an average of 0.05 mg/l at the drainage outlet. Based on average flows (1992-1999) at the outlet this corresponds to 1,950 kg/yr TP or 5.3 kg/day TP. Average outlet flows during the period of 1992-1999, however, have varied from 34.2 (92-93) to 67.4 (97-98) corresponding to acceptable TMDL loads of 1525 kg/yr TP to 3010 kg/yr TP. Nevertheless, the average TP load is used for the allocating load reductions to the point and nonpoint sources. This is justified since nonpoint source loads have been show to be proportional to the system hydrology. Additionally, the margin of safety should act as a buffer to help prevent water quality impacts due to swings in hydrological patterns.

Since all upstream stream segments will be allowed average concentrations as high as 0.10 mg/l TP in the TMDL, the allocation of loading reductions requires less attention to the particular subbasin of each source. Instead, the allocations can be made for a basin wide approach but then checked to ensure that subbasin TMDLs are not exceeded. This approach is appropriate for Spring Creek especially since subbasins change depending on the direction of flow in canals. Table 8 shows the maximum annual load based on average flows for the major stream monitoring stations and the corresponding subbasins.

Table 8. Total Phosphorus TMDLs per Subbasin

Subbasin	STORET	Sampling Location	Avg. Flow cfs	TP TMDL mg/l	TP TMDL kg/yr
Drainage Outlet	490490	Spring Creek at Drainage Outlet	43.4	0.05	1,950
Spring Creek (Upper)	490499	Spring Creek in College Ward	14.7	0.10	1,310
South Fork (Lower)	490492	South Fork East of Pelican Pond	3.2	0.10	290
South Fork (Upper)	490494	South Fork at US Hwy 89	8.2	0.10	730
Hyrum Slough (Lower)	490395	Hyrum Slough at Island Road	27.2	0.10	2,430
Hyrum Slough (Upper)	490487	Hyrum Slough at Nibley Road	10.9	0.10	970

V. Significant Sources

The TMDL process identifies how much pollution is coming from nonpoint sources, point sources, and natural sources. Once this is identified, officials can begin to target the responsible parties and determine where the reductions need to occur in order to meet applicable water quality standards. Part of this process requires determining the assimilative capacity of the watershed, then specific reductions from each source can be determined. This section of the report identifies those nonpoint sources within Spring Creek watershed that have been found to contribute a significant portion of the identified pollutants that have caused water quality degradation.

NONPOINT SOURCES

Nonpoint sources of pollution within the Spring Creek watershed have been found to include urban areas, agriculture, and groundwater sources. In 1993 it was estimated that nonpoint sources of pollution contributed on average over 83 kg/day (approximately 30%) of the total phosphorus loads and almost 43 kg/day (approximately 25%) of total dissolved phosphorus loads in the South Fork Spring Creek drainage (ERI, 1995b). This drainage incorporates the northwest portion of the Spring Creek watershed. Table 9 summarizes this information. Table 10 illustrates the nonpoint sources by land type, revealing that a majority of the nonpoint source pollutants are coming from unidentified sources. The Lower Bear River Water Quality Management Plan (ERI, 1995b) did not specifically identify what these unidentified sources were. One objective of this TMDL study is to determine how much of the pollutant loads within the Spring Creek watershed originate from nonpoint sources and to specifically identify these sources where possible. The most recent water quality data was collected during July 1998 through June 1999. Table 10 also summarizes total phosphorus loads from nonpoint sources for the entire watershed during this time period. Based on these results, nonpoint sources continue to contribute on average over 30 percent of the total phosphorus loads in the watershed.

Table 9. Allocation of total phosphorus and total dissolved phosphorus loads to different sources in the upper South Fork Spring Creek drainage (1993 data)

SOURCE	AREA (acres)	TOTAL PHOSPHORUS LOADS (KG/DAY)		
		RATE OF LOADING		
		MEDIUM	RANGE (Low - High)	PERCENT (Average)
POINT SOURCES:				
EA Miller		101		39.4%
Hyrum WWTP		18		7%
Miller Bros. Feedlot		54		21.1%
Arambel Dairy		*		*
Total Point Sources:		173		67.5%
NON-POINT SOURCES:				
Irrigated agriculture	756	1.8	0.8 – 4.5	.7%
Non-irrigated agriculture	0	0	0	0
Open/unknown	84	0.08	0.01 – 0.25	0.03%
Urban	187	0.23	0.02 – 0.56	0.10%
Public lands	0	0	0	0
Feedlots	0.5	0.14	0.09 – 0.24	0.05%
Unidentified nonpoint		81	36 – 134	31.6%
Total Nonpoint Sources:		83.25	37 – 140	31.6%
TOTAL 1993 LOAD:		256	256	100%
SOURCE	AREA (Acres)	DISSOLVED TOTAL PHOSPHORUS LOADS (KG/DAY)		
		V.1.1.1 RATE OF LOADING		
		MEDIUM	RANGE (Low – High)	PERCENT (Average)
POINT SOURCES:				
EA Miller		86		51%
Hyrum WWTP		16		9.5%
Miller Brothers Feedlot		24		14.2%
Arambel Dairy		*		*
Total Point Sources:		126		74.6%
NONPOINT SOURCES:				
Irrigated agriculture	756	0.44	0.18 – 1.1	0.26%
Nonirrigated agriculture	0	0	0	0
Open/unknown	84	0.05	0.01-0.16	~0
Urban	187	0.15	0.01-0.36	0.10%
Public lands	0	0	0	0
Feedlots	.5	0.06	0.04-0.11	~0
Unidentified nonpoint		42	22-66	25%
Total Nonpoint Sources:		42.7	22.24 – 67.73	25.4%
TOTAL 1993 LOAD:		169	169	100%
Source: Lower Bear River Water Quality Management Plan, 1995.				

* The Arambel Dairy was not identified individually as a point source in the1993 source evaluation since it did not become identified as a CAFO with a UPDES permit until 2001.

Table 10. Estimated total phosphorus contributions from nonpoint sources* (July 1, 1998 – June 30, 1999)				
		Low	Medium	High
Nonpoint Source	Estimated Acreage***	kg/day**		
Irrigated Ag.	8,693	8.69	21.12	51.11
Nonirrigated Ag.	490	0.05	0.41	0.87
Open/unknown	1,347	0.14	1.20	3.96
Urban	1,224	0.13	1.49	3.66
TOTAL	11,754	9.03	24.22	59.60
Percent of Total		12%	33%	80%
* Based on Total Phosphorus loadings taken from STORET site 490490.				
** Based on coefficients from Reckhow et al. 1980.				
*** Total acres in basin for STORET site 490490 is 12,244. Acreage by landuse was estimated based on the assumption that the percentage of land by landuse for the total watershed would be the same for the 12,244 acres.				

POINT SOURCES

Effluent discharge to waters of the State of Utah is controlled by the Utah Pollutant Discharge Elimination System (UPDES) permitting process, as described under the Utah Water Quality Act, Title 19, Chapter 5, Utah Code Annotated (UCA) 1953, as amended. This legislation sets forth specific limitations for effluent discharge and self-monitoring activities that must be adhered to by the permittee. It also contains a narrative standard that places qualitative limits on effluent discharge as establishing standards for environmental conditions downstream from the point of discharge. Depending upon what parameters are included in the UPDES permit, a compliance schedule may be included in the permit, detailing a course of action for the permittee to follow, should they desire to apply for a change in discharge limitations. All UPDES permits include strict guidelines for noncompliance reporting and fines that will be implemented should violations of the permit occur.

There are currently two UPDES permitted dischargers located within the Spring Creek watershed, Hyrum Wastewater Treatment Plant (HWWTP) and Con-Agra Agra Blue Ribbon Beef. The first permittee is a Publicly Owned Treatment Works (POTW) that treats effluent discharge from Hyrum City. The second permittee is a slaughter and meat packaging facility with an associated wastewater treatment operation which treats process water used during operation of the facility.

In addition to the two UPDES permittees, there are two permitted CAFOs and 46 AFOs or potentials CAFOs. The largest CAFO is Miller Brothers Feedlot and maintains approximately 3,000 head of cattle. The other CAFO is Arambel Dairy and maintains approximately 1,500 head of dairy cows (including milking and dry cows). The remaining facilities are AFOs maintaining less than 1000 animal units and may be in the process of controlling unacceptable conditions, if present.

Although point source pollution is relatively easy to define in comparison to nonpoint source pollution, a clear understanding of normal operating procedures and history of each potential contributor is necessary in order to develop accurate individual Wasteload Allocations (WLAs). The sum total of individual WLAs will be included in the TMDL analysis and will eventually help to determine the attainment of water quality standards. The remainder of this chapter will discuss in detail the contributions made by point source pollution in the Spring Creek watershed.

VI. Technical Analysis

The BPMs recommended for the reduction of phosphorous will reduce fecal materials entering the creek; therefore, it is assumed that an achievement of phosphorus reductions will result in the nonpoint source reduction of coliforms, ammonia, and oxygen demanding organic matter. Ammonia and coliforms are more dynamic than phosphorus in terms of decay rates, nitrification and denitirification. QUAL2E was used to model the stream system as described previously. This model became the basis for determining the constituent limitations for these parameters. The fecal coliform loads were found to be proportionately related to the phosphorus reductions. Based on the expected reduction of the phosphorus load through the BMPs and BATs, the anticipated reduction of Fecacal Coliforms is 85%.

Phosphorus loads were analyzed during high and low flow scenarios to determine relationships between pollutant sources and water quality response at the watershed outlet (STORET 490490) using QUAL2E. This information provided support to the level of nutrient loading reduction that is required to achieve desired water quality targets. The model showed that although pollutant loads in the Spring Creek watershed are primarily dominated by point source pollution, reductions in dissolved phosphorus concentrations must occur from nearly all identified pollutant sources in order to achieve desired water quality goals. Although pollutant loads contained in groundwater do not appear to make significant contributions during the high flow scenario, reductions in modeled dissolved phosphorus under the low flow scenario produce more substantial changes. Non-point source pollutant loads also contribute to water quality impairment at upstream measuring sites. The analysis determined that reduction of dissolved phosphorus concentrations from non point sources located upstream from these sites must occur in order to achieve desired water quality targets.

VII. Margin of Safety and Seasonality

MARGIN OF SAFETY

As required by TMDL regulations, a margin of safety must be employed to ensure that loading reductions result in the achievement of water quality goals. The margin of safety is implicit and explicit. The implicit margin of safety is based on this study's finding that not all phosphorus sources are reaching the drainage outlet, implying that sources are either being retained in the drainage due to field irrigation or exported from the drainage through cross basin irrigation canals. In addition, a 10 percent explicit margin of safety has been added as well.

SEASONALITY

The seasonality component of the TMDL should maintain water quality during critical periods of the year. The critical period could be defined as the period when the drainage is most sensitive to pollutant loads which is commonly the period of lowest flow. The Spring Creek drainage has a sporadic hydrology because it is so heavily influenced by canal diversions and irrigation patterns. A large groundwater influence ensures that a fairly constant base flow. Spring Creek as measured at Mendon Road rarely has flows less than 20 cfs. Lower flows generally occur during the irrigation months of July to August. This is considered to be the critical period. On average the flow is reduced 60% from the average flow during these months.

The annual loading TMDL of 1950 kg/yr is monthly average of 160 kg/month. The loading during the critical period, however should be reduced 60%, therefore the monthly TMDL for July to August should not exceed 100 kg/month.

VIII. Allocation of Load Reductions and Management Practices

The above mentioned TMDL requires a TP loading reduction 36,600 kg/yr based on the TP loading estimates for 1998-1999. To facilitate the TP loading reduction, waste load allocations (WLAs) have been made to the point sources and load allocations (LAs) have been made to nonpoint sources based on the assumed effectiveness of best management practices (BMPs) and treatment technologies. Table 11 summarizes the TP load allocations.

Table 11. Basin-Wide Allocation of Load Reductions

Sources	Current 98-99 kg/yr	Load Allocations kg/yr	Reduction kg/yr	Recommended BMPs and BATs
ConAgra	29,420	170	29,250	Chemical Precipitation Phosphorus Removal
Hyrum WWTP	3,630	140	3,490	Chemical Precipitation Phosphorus Removal
Miller Brothers Feedlot	400	0	400	Eliminate all discharges (as permitted by UPDES permit)
Arambel Dairy	200	0	200	Eliminate all discharges (as permitted by UPDES permit)
AFO/CAFO	1390	325	1,065	CNMP compliance, prevent direct access of animals to streams and canals, improve on-site composting or centralize.
Other Ag	1,990	325	1,665	Nutrient Management
Urban	190	85	105	Hyrum City Storm Water Management
Groundwater	530	130	400	College-Young Ward Sewer System
Background	580	580		
10% MOS		195		
	Total	**1,950**	**36,600**	

WASTE LOAD ALLOCATIONS

The four point sources in the watershed are the Hyrum Wastewater Treatment Plant (WWTP), ConAgra's Treatment Facility, Miller's Brothers Feedlot, and Arambel Dairy. Current annual TP loads (98-99) are 3,630 kg/yr and 29,420 kg/yr, respectively which are very close to the average loads from 1992-1999. Point sources of phosphorus in the watershed represent approximately 85% of the total phosphorus loads into the surface waters. In order to restore water quality in the watershed it is necessary that phosphorus limitations be placed on the two treatment facilities. It has been determined that a feasible level of treatment from chemical precipitation could reduce phosphorus levels to 0.10 mg/l.

The Hyrum WWTP has a treatment capacity of 1.0 MGD and is currently operating at an average flow rate of 0.9 MGD. The WLA for Hyrum City has been calculated to be 140 kg/yr TP based on the capacity of the plant (1.5 cfs) and an average total phosphorus concentration of 0.10 mg/l.

The Con-Agra treatment facility has had an average flow rate (1992-1999) of 1.9 cfs and appears to be fairly consistent. The WLA for Con-Agra has been calculated to be 190 kg/yr TP based on this average flow rate and an average total phosphorus concentration of 0.10 mg/l.

LOAD ALLOCATIONS

In order to meet the TMDL target of 1950 kg/yr it was necessary to reduce nonpoint sources load contributions from animal feeding operations (AFOs and CAFOs), other agriculture activities, groundwater sources, and residential-commercial runoff. The reductions are based on the approximated load reductions from anticipated watershed projects as identified in Table 5-5.

The largest nonpoint source of TP is estimated to be related to the heavy agricultural land uses; therefore, nonpoint source reductions should begin with improved agricultural operations. AFOs are recommended to reduce nutrient loads through continuing the preparation of Comprehensive Nutrient Management Plans (CNMP). Many AFOs have already prepared CNMPs though the assistance of the NRCS, but field investigations have revealed that AFOs operating with a CNMP still need to further reduce pollution risks. Field investigations revealed that many animals are allowed to water in streams and canals damaging stream banks and increasing pollutant loads. Animals should be fenced from water sources and should receive water from off stream sites.

All other agricultural lands (alfalfa, corn, grains, etc.) also need to reduce nutrient contributions through improved application of fertilizers and manure. Field investigations have revealed that many fields are over-applied with manure. Farm operators should use soil testing as tool to optimize manure applications. Also winter manure applications have been reported as being common in the drainage (ERI and BRRC&D, 1995). Manure should be stored during the winter for spring applications. Winter applications can lead to increased phosphorus loads during snow melt.

The next largest nonpoint source is estimated to be related to the septic tank systems that are common in the College-Young Ward areas in the north portion of the drainage. The first recommended action is that Cache County officials increase restrictions on septic tank approvals. It is known that high groundwater causes many septic systems in the College-Young Ward area to fail annually. More septic systems should not be allowed in these areas. Also, illicit discharges were located during field investigations. The County should investigate these discharges and issue notices of violation with intent to fine individuals if no action is taken. Ultimately, a sewer system is needed in College-Young to reduce groundwater contributions per the LA indicated in Table 5-5.

Urban storm water from Hyrum City is the last nonpoint source for which load reductions are recommended. Storm water management is recommended with associated storm water BMPs such as detention basins to capture sediments and nutrients.

RECOMMENDED MANAGEMENT PRACTICES

In order to achieve the necessary load reductions, multiple restoration projects will be required that incorporate Best Management Practices (BMPs) and Best Available Technologies (BATs). The following projects are recommended in order of priority:

1. *Point Source Phosphorus Reductions*
   Treatment facilities from Con-Agra and Hyrum City have been determined to be a significant source of phosphorus in the drainage accounting for approximately 76% and 9%, respectively, of the total load in the drainage. The current UPDES permits do not limit phosphorus discharges, however, per this TMDL study, phosphorus limitation should be implemented. It is recommended that treatment processes be added which reduce phosphorus concentrations from current levels to an average concentration of 0.1 mg/l TP. This will require Con-Agra to reduce phosphorus discharges approximately 99.4% and Hyrum City to reduce discharges by 96.5%. The current BAT to remove phosphorus is chemical precipitation, which is recommended.

2. *Con-Agra Ammonia Reductions*
   Con-Agra has been operating the treatment plant without UPDES limitation on ammonia discharges. Since 1997, DWQ has recorded ammonia discharge levels from Con-Agra which average at approximately 1.3 mg/l and have reached as high as 11.1 mg/l (January 16, 1997), which appears to be one of the major causes of poor health in the fishery. It is recommended that Con-Agra's UPDES permit require the plant to reduce ammonia discharges a level below 2.0 mg/l for 7-day average and below 1.0 mg/l for 30-day average. These levels may be achievable with improved maintenance rather than additional treatment facilities since only 15% of the samples taken during the period of July 1997 to June 1999 exceeded 1.0 mg/l.

3. *Animal Feedlot Cleanup Program*
   Animal feeding operations (AFOs) are contributing a significant amount of pollution to the watershed. Of the 40 AFOs which have been identified in the drainage, 21 have been working with the NRCS to reduce nonpoint source pollution through Comprehensive Nutrient Management Plans (CNMPs). The CNMP must address BMPs such as the proper handling of manure, storm water, and other liquid wastes. The current Utah AFO/CAFO strategy (Utah AFO/CAFO Committee, 2001) is to have all AFOs and CAFOs to operate under a prepared CNMP. Assessments have been made of the AFOs in the drainage and it has been determined that all AFOs need to be working with the NRCS to prepare CNMPs and those which are currently operating with a CNMP should be monitored by the NRCS to help those which have a CNMP but are not maintaining BMPs. One important BMP that appears to be an issue in the drainage is the fencing of streams and canals to prevent animals

from direct contact with the surface waters. Watering of animals should occur off-stream.

4. *General Agricultural BMPs*
A large portion of the agricultural lands are heavily manured with minimal efforts to effectively manage nutrient applications. Additionally, winter manure applications are common (ERI, 1995) in the drainage. Better nutrient management should be implemented by performing soil testing before manure applications. Additionally, many crop fields are farmed up to the edge of banks of streams, effectively providing no buffer for storm water runoff. Buffer zones of preferably 50 feet should be implemented through either voluntary action of land owners through encouragement by the NRCS or actual land purchases using government funding and assigning perpetual conservation easements. A riparian corridor could be used for future recreational opportunities for possibly trail development or fisherman access.

5. *College-Young Ward Sewer*
Septic Systems in College-Young Ward and Nibley have been determined to be a significant source of pollution. The City of Nibley is in the process of constructing a sewer system to be completed by the end of 2001, which will reduce septic system pollution potential by approximately 35%. However, septic systems in the unincorporated County areas known as College-Young Ward will still be considered a significant source. A sewer system should be installed to service these homes and reduce the potential for pollution.

6. *Urban Storm Water Management*
Storm water impacts from residential areas in the City of Hyrum, the City of Nibley and unincorporated County areas are a significant source of pollution. Storm Water Management plans should be prepared for these areas to address pollution concerns.

Table 12. Summary of Stream Restoration Costs.

Project	Responsibility	Estimated Construction Costs	Estimated Annual O&M Costs	Estimated TP Reduction kg/yr
Chemical Precipitation Phosphorus Treatment	Con-Agra	$ 2,800,000	350,000	29,250
Ammonia Stripping Treatment	Con-Agra	1,500,000	200,000	n/a
Chemical Precipitation Phosphorus Treatment	Hyrum City	1,200,000	200,000	3,490
AFO/CAFO Cleanup	NRCS	600,000	n/a	1,665
Agricultural BMPs	NRCS/ Cache County	600,000	n/a	1,665
College-Young Sewer	Cache County	N/A	N/A	400
Urban Storm Water Management	Hyrum, Nibley, Cache County	250,000	10,000	105
	Total	$ 6,950,000		

IX. Public Participation

One of the EPA requirements of the TMDL process is public involvement. The public has been involved through several methods including a public out-reach program with students of Spring Creek Junior High, open houses, meetings, and a TMDL web site.

After the analysis of the Spring Creek watershed in July of 2000, a model was developed to analyze the water quality data. The DWQ decided to incorporate the model into a public "out-reach " program, which involved the students of the local Spring Creek Junior High. As a class project, junior high students have been collecting and analyzing water quality samples in Spring Creek for several years. The project has helped them to understand the dynamics of water quality, the requirements for analysis, and the impact of pollution. Their data has been incorporated into this model as a second data set to be compared to the data collected by the state. DWQ's intention of this program is to generate interest among the youth in water quality that will hopefully spread to their parents, spurring them be interested in the TMDL process occurring in their community.

In addition, the results of monitoring findings were presented at an open house at the Hyrum City Civic Center on January 11, 2001. The open house was advertised in the Harold Journal on January 6th and 10th, 2001. Approximately twenty people attended the open house.

The Draft TMDLs were made available for public comment on the TMDL website www.deq.state.ut.us/eqwq/TMDL/TMDL_info.htm. The comment period was from February 4, 2002 to March 8, 2002. This comment period was advertised in the Harold Journal on February 4, 2002.

On February 27, 2002, a public meeting was held at the Hyrum City Civic Center. The meeting was advertised in the Harold Journal on February 26, 2002.

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