NMED/SWQ-08/1

WATER QUALITY ASSESSMENTS FOR SELECTED NEW MEXICO LAKES

2006

Monitoring and Assessment Section
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LAKE WATER QUALITY MONITORING, TROPHIC STATE EVALUATION, AND STANDARDS ASSESSMENTS FOR:

Conchas Reservoir, Ute Reservoir, Upper and Lower Charette Lakes, Springer Lake, Lake Maloya, Lake Alice, Laguna Madre, Stubblefield Lake, Maxwell 12, 13, and 14, Lower and Upper Shuree Ponds in New Mexico

2006

EXECUTIVE SUMMARY

During 2006, the Monitoring and Assessment Section of the Surface Water Quality Bureau of the New Mexico Environment Department conducted water quality and biological assessment surveys of fourteen lacustrine systems within the upper Canadian River watershed. These surveys were partially funded by EPA grants and were completed as the survey component of an Environmental Protection Agency funded 104(b)(3) lakes nutrient criteria development grant, and in fulfillment of work-plan commitments of the *FY 2004-2006 section 106 Work Program for Water Quality Management.*

Lake surveys occurred concurrently with an intensive Total Maximum Daily Load (TMDL) stream study conducted within the watershed. The joint lake and stream surveys helps to ensure a timely return to the lake system as watersheds are revisited and adds to the understanding of surface waters within the overall watershed. Water quality sampling methods used during these surveys were in accordance with the "Quality Assurance Project Plan for Water Quality Management Programs" (NMED 2006).

Lake Alice, April 2006.

Lakes surveyed ranged from two large mainstem reservoirs to relatively small ponds. Specific sites included:

- Conchas and Ute Reservoirs both large impoundments located on the Canadian River in East Central New Mexico
- The Charette Lakes located on a remote, predominantly volcanic mesa near Ocate, NM
- Lake Maloya and Lake Alice located within Sugarite Canyon State Park and which are a significant part of the municipal water supply for the City of Raton, NM

- Laguna Madre, Stubblefield Lake and Maxwell #12, #13, and #14 located adjacent to or within the Maxwell National Wildlife Refuge near Maxwell, NM
- The Shuree Ponds, two small impoundments located within the Valle Vidal Unit of the Carson National Forest and which are popular, stocked fishing lakes

The following assessments provide information pertaining to water quality, biological integrity, trophic state, limiting nutrients, water quality criteria exceedences and water quality standards specific to designated and existing uses in the State of New Mexico Standards for Interstate and Intrastate Surface Waters (NMAC 2007).


North Shuree Pond and South Shuree Pond

Physical, chemical and biological sampling at lake stations include total and dissolved nutrients, total and dissolved metals, major ions including total dissolved solids, total suspended solids, hardness and alkalinity, radionuclides, volatile and semi-volatile organic compounds, cyanide, and microbiological collections. Samples were also collected for phytoplankton and benthic diatom analysis.

Because of the large amount of data collected, only a pertinent subset of these data are included in this report. All data are available upon request. The following summaries detail those results specifically related to the general physical nature, trophic state, limiting nutrient or criteria exceedences and consequent attainment status for designated or existing uses specific to the particular lake system.

Though significant differences in size, location, accessibility, water supply and adjacent land uses exist for the fourteen lakes included in this study, some pronounced similarities do exist that are generally applicable to most, if not all New Mexico lake and reservoir systems. First, NMED found all lakes to be in full support of their designated use, with the exception of a number of impairments due to elevated mercury concentrations in fish tissue. Mercury is an atmospheric contaminant, released through burning of fossil fuels, which deposits on lakes across all of New Mexico and the United States. This mercury then bioaccumulates as it moves up the food chain leading to high concentrations in fish tissue. Second, the vast majority of lakes surveyed are impoundments that have huge watershed to lake size ratios suggesting that these waterbodies may be subject to eutrophication simply by way of the organic matter contributed by the watershed. This is exacerbated by upstream agricultural and grazing practices that add excessive nutrient loads and downstream irrigation demands that substantially reduce pool size. While the lakes in this survey only showed limited signs of eutrophication, it is advisable for both land and water management agencies to reduce nutrient input to river systems by using practices that reduce water use, such as implementing efficient irrigation and fertilization technologies and planting fewer water-demanding crops.

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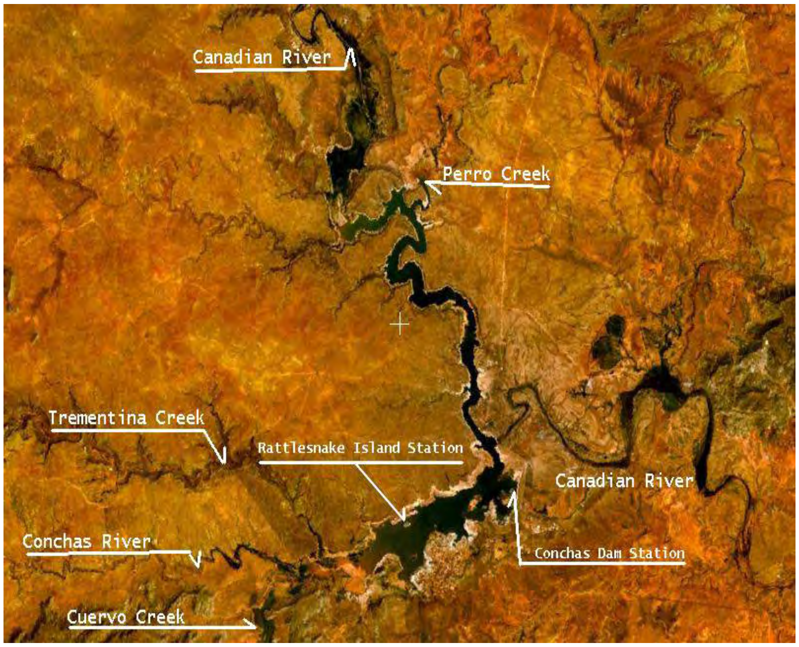
LAKE SURVEYS

Water Quality and Biological Assessment Survey of Conchas Reservoir, San Miguel County, April 24, 2002, March 29, June 21, and September 26, 2006. Danny R. Davis, Principal Investigator

Conchas Reservoir is an impoundment created by the damming of the Canadian and Conchas Rivers. The dam, completed in September 1939, consists of a concrete gravity main section that is 381 meters (1,250 feet) long with a maximum height of 61 meters (200 feet) above streambed. Earthen dikes extend from each side of the dam resulting in an overall length of about 5.95 km (3.7 miles). Maximum storage capacity is 389 x 10^6 meters cubed (m^3) (315,700-acre-feet) with an inactive storage or conservation pool of 2.46 x 10^6 m^3 (70,490 acre-feet). The U.S. Army Corp of Engineers maintains the dam and provides reservoir releases responding to calls for irrigation water.



The elevation of the lake is about 1,280 meters (4,200 ft.) above mean sea level and is located within the Southwestern Tablelands ecoregion contained in Aggregate Ecoregion IV (the Great Plains Grass and Shrublands) (Omernik and Griffith, 2006). Based on a forty year record, precipitation averages 33 cm (13 in.) per year with pan evaporation historically averaging 124.2 cm (48.9 in) per year resulting in a deficit of 91.1 cm (35.85 in) per year (Gabin and Lesperance 1977). The reservoir captures water from the 19,189 square kilometers (7,409 square mile) watershed (USGS 2003). The primary water supply to the reservoir is from the Canadian and Conchas Rivers, with lesser quantities supplied from Trementina Creek, Cuervo Creek and Perro Creek.

The lake is managed for irrigation, flood control and recreation, and as such, Conchas Reservoir is classified under segment 20.6.4.304 NMAC in New Mexico Water Quality Standards for Interstate and Intrastate Surface Waters (NMAC 2007), with designated uses of irrigation storage, livestock watering, wildlife habitat, primary contact and warmwater aquatic life being recognized. The New Mexico State Parks Division manages the recreational activities within the Conchas Lake State Park. Camping and picnicking areas, boat ramps, marina, concessions, and visitor's center are provided. Conchas Lake provides fishing for warmwater species, which include bluegill, channel catfish, crappie, large mouth bass and walleye.

Water quality studies have been performed prior to this investigation. In 1975, the Office of Research and Development of the U.S. Environmental Protection Agency included Conchas Reservoir in a nation-wide study to determine the rate of increased eutrophication in U.S. lakes (USEPA 1977a). In 1988, the author conducted a single season, two-station study on Conchas Reservoir (Potter and Davis, 1989).

For this study, sampling of Conchas Reservoir officially started during the spring of 2002, however budgetary and laboratory limitations postponed the study until 2006. Three seasonal visits at two lake stations were successfully completed in 2006. The two stations included Conchas Reservoir at Rattlesnake Island and Conchas Reservoir at the Dam. The data from 2002 have been included with the 2006 data in the overall assessment for Conchas Reservoir (Table 1A).

Table 1A. Physical Characteristics for Conchas Reservoir, 2002 & 2006.

Physical Characteristics		Deep Station	Shallow Station
Secchi (m)	**Sp 2002**	2.25	1.0
	Sp	2.6	1.3
	Su	2.2	1.6
	Fall	1.8	1.25
Forel Ule Color	**Sp 2002**	9	11
	Sp	10	11
	Su	9	12
	Fall	11	12
Maximum Depth (m)	**Sp 2002**	8.5	7.25
	Sp	24.5	12.0
	Su	20.4	4.8
	Fall	22.1	9.75
Euphotic Zone (m)	**Sp 2002**	7.0	3.5
	Sp	9.0	5.0
	Su	7.0	>4.8
	Fall	7.0	4.0
Surface Area in km^2 (Acres)	**Sp 2002**	MDP	MDP
	Sp	21.96 (5,421)	21.96 (5,421)
	Su	18.31 (4,521)	18.31 (4,521)
	Fall	21.77 (5,375)	21.77 (5,375)
Storage Capacity in m^3 (Ac. Ft.)	**Sp 2002**	124.7×10^6 (101,110)	124.7×10^6 (101,110)
	Sp	195.7×10^6 (158,690)	195.7×10^6 (158,690)
	Su	157.2×10^6 (127,467)	157.2×10^6 (127,467)
	Fall	193.6×10^6 (156,962)	193.6×10^6 (156,962)
Chlorophyll *a* (µg/L)	**Sp 2002**	1.43	1.59
	Sp	MDP	MDP
	Su	1.40	2.99
	Fall	4.24	4.95
Anoxic Hypolimnion (Y/N)	**Sp 2002**	No	No
	Sp	No	No
	Su	No	No
	Fall	No	No

Physical Characteristics		Deep Station	Shallow Station
Stratified (Y/N) @ depth (m)	**Sp 2002**	No	No
	Sp	No	No
	Su	Yes (9-10)	No
	Fall	Yes (4-5)	No
pH (s.u.)	**Sp 2002**	8.2	8.6
	Sp	8.24	8.20
	Su	8.1	8.17
	Fall	8.0	8.1
Conductivity (μS)	**Sp 2002**	990	990
	Sp	830	837
	Su	845	856
	Fall	720	720
Turbidity (NTUs)	**Sp 2002**	3.6	10.9
	Sp	2.67	7.09
	Su	5.29	6.31
	Fall	3.39	7.95
Integrated Sample surface to (m)	**Sp 2002**	7.0	3.5
	Sp	9.0	5.0
	Su	19.0	4.0
	Fall	7.0	5.0
Dissolved Oxygen Surface (mg/L)	**Sp 2002**	7.58	7.66
	Sp	8.11	7.99
	Su	6.55	6.65
	Fall	6.19	6.50
Dissolved Oxygen Bottom (mg/L)	**Sp 2002**	7.31	7.39
	Sp	7.51	7.94
	Su	1.35	6.66
	Fall	5.23	5.88
Temperature Surface (°C)	**Sp 2002**	15.15	14.83
	Sp	9.27	9.04
	Su	22.61	22.47
	Fall	21.12	19.62
Temperature Bottom (°C)	**Sp 2002**	14.51	13.89
	Sp	8.05	8.79
	Su	15.74	21.37
	Fall	18.75	18.75

Sp = Spring; Su = Summer; MDP = missing data point; (Q) = questionable result.

Table 2A. Trophic State (Carlson 1977)

		Deep Station	Shallow Station
Secchi depth	**Sp 2002**	Mesotrophic	Eutrophic
	Sp	Mesotrophic	Eutrophic
	Su	Mesotrophic	Eutrophic
	Fall	Eutrophic	Eutrophic
Chlorophyll *a*	**Sp 2002**	Oligomeso	Oligomeso
	Sp	MDP	MDP
	Su	Oligomeso	Mesotrophic
	Fall	Mesotrophic	Mesotrophic
Total Phosphorus	**Sp 2002**	Mesotrophic	Mesotrophic
	Sp	Eutrophic	Eutrophic
	Su	Hypereutrophic	Eutrophic
	Fall	Mesotrophic	Mesotrophic
Total Nitrogen	**Sp 2002**	Mesotrophic	Mesotrophic
	Sp	Mesotrophic	Mesotrophic
	Su	Oligomeso	Mesotrophic
	Fall	Mesotrophic	Mesotrophic
Overall Trophic Condition		**Mesotrophic**	

Table 3A. Limiting Nutrient

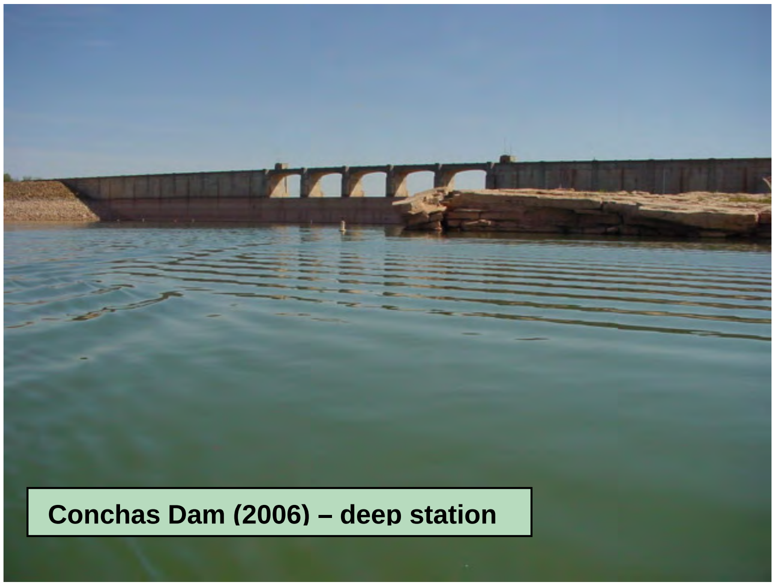
		Deep Station	Shallow Station
Limiting Nutrient	**Sp 2002**	P	P
	Sp	N/P	N/P
	Su	P	N/P
	Fall	P	P

Table 4A. Summary of attainment status for all designated uses

Designated or Existing Use	Criteria Exceedence	Attainment Status
Warmwater Aquatic Life	Mercury in Fish Tissue	Not Supporting
Irrigation	None	Fully Supporting
Primary Contact	None	Fully Supporting
Livestock Watering	None	Fully Supporting
Wildlife Habitat	None	Fully Supporting

Water Quality Assessment

Physical measurements collected at Conchas Reservoir included temperature, specific conductance, dissolved oxygen, pH and turbidity (Table 1A). Lake chemistry sampling consisted of total, dissolved and calculated nutrients, anions and cations, total and dissolved heavy metals, synthetic organics, radionuclides, bacteria, and cyanide, which cover all water quality criteria pertinent to the protection of all designated or existing uses. Only criteria exceedences are discussed below, however all data are available upon request.



Conchas Dam (2006) – deep station

Currently, development of lake and reservoir nutrient criteria specific to this ecoregion are being developed for total nitrogen and total phosphorous for use as a multiparametric nutrient assessment tool. Until this assessment tool is complete, nutrient assessments are provided using methods and indicators consistent with past assessment.

Conchas Reservoir may be classified as mesotrophic according to Carlson's (1977) indices for secchi depth, chlorophyll *a*, total phosphorus, total nitrogen, and algal community composition (Likens 1975). This is in agreement with assessments by Potter and Davis in 1989 and the USEPA National Eutrophication Study of 1975 (Table 2A). Phosphorus was the limiting nutrient for algal productivity in 3 out of 6 samples collected in 2006 whereas phosphorus and nitrogen were co-limiting in the other 3 samples (Table 3A). These results are fairly consistent with the 1989 study even though conditions during the earlier study were conducted during relatively high lake levels.

Conchas Reservoir near Rattlesnake Island -- shallow station

Phytoplankton community composition was dominated by the diatom genera *Cyclotella* during the June and September sampling visits. During the June sampling effort, the blue-green algae *Microcystis* comprised twenty-three percent of the community and the green alga *Oocystis* was the third most common phytoplankton. During the September visit, *Microcystis* and

Oocystis were reversed, but remained within the top three most common algae identified. No algal scums, macrophyte blooms or fish kills were observed or reported during the study.

Diatom community composition was dominated by *Achnanthes minutissima* Kützing, *Diatoma moniliformis* Kützing, *Fragilaria tenera* (Smith) Lange-Bertalot, and *Mastogloia smithii* Thwaites. These four species comprised over 45 percent of the total community composition. Forty-six species representing 20 genera were identified in the five-hundred-valve count.

Physical, chemical and biological indicators show that Conchas Reservoir is in relatively favorable condition from a nutrient standpoint considering the large 19,166 km^2 (7,400 mi^2) watershed that supplies its water. The majority of sampling was done during a prolonged drought, which resulted in low pool size and potentially increased nutrient concentrations. However, even under the added stress of lower water levels, the observed conditions indicate no impairment due to nutrient load, therefore it is reasonable to delist Conchas Reservoir for nutrient impairment.

Table 4A shows that the warmwater aquatic life use remains listed for mercury in fish tissue. There continues to be a fish advisory for mercury, thus mercury will remain as a cause of non-support until such time as new findings show that this cause no longer exists. The uses of irrigation, primary contact, wildlife habitat, and livestock watering were fully supported during this study.

Water Quality and Biological Assessment Survey of Ute Reservoir, Quay County, April 23, 2002, March 29, June 21, and September 26, 2006.
Danny R. Davis, Principal Investigator

Ute Reservoir is located in the east-central part of New Mexico approximately 40 km (25 mi) northeast of Tucumcari, New Mexico near the town of Logan. The lake is formed by a 625 meter (2,050 ft) long earthfill dam with a maximum height of 40 meter (132 ft) above streambed. Construction of the dam was completed in May of 1963 though storage began in December of 1962. The lake holds water supplied from the 28,775 km^2 (11,110 mi^2) Canadian River Watershed and has a design storage capacity of 336 x 10^6 m^3 (272,770 acre-feet) (USGS 2003). The elevation of the lake is about 1,160 meters (3,806 ft.) above mean sea level and is located within the Southwestern Tablelands ecoregion contained in Aggregate Ecoregion IV (the Great Plains Grass and Shrublands) (Omernik and Griffith 2006). Based on a thirty-four year record, precipitation averages 39.5 cm (15.5 in.) per year with pan evaporation historically averaging 120 cm (47.4 in) per year resulting in a deficit of 81 cm (31.9 in) per year (Gabin and Lesperance 1977).

The lake is managed for municipal and industrial water supply, recreation, and flood and sediment control, and as such, Ute Reservoir is classified under segment 20.6.4.302 NMAC in the New Mexico Water Quality Standards for Interstate and Intrastate Surface Waters (NMAC 2007), with designated uses of livestock watering, wildlife habitat, municipal and industrial water supply, primary contact, and warmwater aquatic life being recognized. The New Mexico State Parks Division manages the recreational activities within Ute Lake State Park. Camping and picnicking areas, boat ramps, marina, concessions, and visitor's center are provided. Ute Reservoir provides fishing for warmwater species, which include largemouth and smallmouth bass, crappie, walleye, channel catfish and white bass.

Water quality studies were performed prior to this investigation. In 1975, the Office of Research and Development of the U.S. Environmental Protection Agency included Ute Reservoir in a nation-wide study to determine the rate of increased eutrophication in U.S. lakes (USEPA, 1977). In 1988, the author conducted a single season, three-station study on Ute Reservoir (Potter and Davis, 1989).

For this study, sampling of Ute Reservoir officially started during the spring of 2002, however budgetary and laboratory limitations postponed the study until 2006. Three seasonal visits at three lake stations were successfully completed in 2006. The three stations included Ute Lake near the dam, Ute Lake near the mouth of Ute Creek and Ute Lake near

Horseshoe Bend. The data from 2002 have been included with the 2006 data in the overall assessment for Ute Reservoir (Table 1B).

Table 1B. Physical Characteristics for Ute Reservoir, 2002 & 2006.

Physical Characteristics		Deep Station	Ute Creek	Horseshoe
Secchi (m)	**Sp 2002**	3.5	2.5	1.25
	Sp	2.7	1.8	1.8
	Su	2.6	0.75	1.3
	Fall	3.6	0.8	1.75
Forel Ule Color	**Sp 2002**	7	7	13
	Sp	7	7	7
	Su	12	12	11
	Fall	11	12	12
Maximum Depth (m)	**Sp 2002**	7.0	15.5	7.0
	Sp	23.2	6.5	5.5
	Su	20.9	6.1	7.6
	Fall	24.7	7.2	6.4
Euphotic Zone (m)	**Sp 2002**	>7.0	9.0	5.0
	Sp	9.0	6.0	>5.5
	Su	9.0	2.8	4.2
	Fall	8.5	3.0	5.6
Surface Area in km^2 (Acres)	**Sp 2002**	≅25.74 (6,355)	≅25.74 (6,355)	≅25.74 (6,355)
	Sp	26.6 (6,570)	26.6 (6,570)	26.6 (6,570)
	Su	25.8 (6,364)	25.8 (6,364)	25.8 (6,364)
	Fall	28.59 (7,059)	28.59 (7,059)	28.59 (7,059)
Storage Capacity in m^3 (Ac. Ft.)	**Sp 2002**	217.1×10^6 (176,000)	217.1×10^6 (176,000)	217.1×10^6 (176,000)
	Sp	227.6×10^6 (184,562)	227.6×10^6 (184,562)	227.6×10^6 (184,562)
	Su	217.3×10^6 (176,191)	217.3×10^6 (176,191)	217.3×10^6 (176,191)
	Fall	253.7×10^6 (205,716)	253.7×10^6 (205,716)	253.7×10^6 (205,716)
Chlorophyll *a* (μg/L)	**Sp 2002**	0.748	1.308	1.31
	Sp	MDP	1.68	1.12
	Su	1.31	2.62	1.62
	Fall	1.62	2.71	3.18
Anoxic Hypolimnion (Y/N)	**Sp 2002**	No	No	No
	Sp	No	No	No
	Su	No	No	No
	Fall	No	No	No

Physical Characteristics		Deep Station	Ute Creek	Horseshoe
Stratified (Y/N) @ depth (m)	**Sp 2002**	No	No	No
	Sp	No	No	No
	Su	Yes @ 13 m	No	No
	Fall	No	No	No
pH (s.u.)	**Sp 2002**	7.1	7.88	7.58
	Sp	8.43	8.44	7.79
	Su	8.37	8.29	8.32
	Fall	8.16	8.15	8.18
Conductivity (μS)	**Sp 2002**	1,128	1,139	1,136
	Sp	1,186	1,198	1,186
	Su	1,241	1,259	1,243
	Fall	1,160	1,065	1,119
Turbidity (NTUs)	**Sp 2002**	3.10	2.98	6.23
	Sp	2.75	4.85	4.52
	Su	4.78	18.6	7.98
	Fall	1.68	10.4	6.37
Integrated Sample surface to (m)	**Sp 2002**	6.5	9.0	5.0
	Sp	9.0	6.0	4.0
	Su	20	6.0	6.0
	Fall	8.5	6.0	6.0
Dissolved Oxygen Surface (mg/L)	**Sp 2002**	7.98	7.78	8.08
	Sp	8.71	8.66	8.67
	Su	7.63	7.42	7.28
	Fall	5.87	5.92	6.41
Dissolved Oxygen Bottom (mg/L)	**Sp 2002**	7.78	7.0	7.75
	Sp	8.34	8.40	8.59
	Su	3.48	6.47	6.68
	Fall	1.84	5.48	6.05
Temperature Surface (°C)	**Sp 2002**	16.35	15.69	15.33
	Sp	9.19	11.03	9.32
	Su	23.37	24.5	22.44
	Fall	20.42	20.57	20.42
Temperature Bottom (°C)	**Sp 2002**	14.77	13.61	14.03
	Sp	8.50	9.67	8.70
	Su	16.27	23.36	21.56
	Fall	18.94	18.88	19.73

Sp = Spring; Su = Summer; MDP = missing data point; (Q) = questionable result.

Table 2B. Trophic State (Carlson 1977)

		Deep Station	Ute Creek	Horseshoe
Secchi depth	**Sp 2002**	Mesotrophic	Mesotrophic	Eutrophic
	Sp	Mesotrophic	Eutrophic	Eutrophic
	Su	Mesotrophic	Eutrophic	Eutrophic
	Fall	Mesotrophic	Eutrophic	Eutrophic
Chlorophyll *a*	**Sp 2002**	Oligotrophic	Oligomeso	Mesotrophic
	Sp	MDP	Oligomeso	Oligomeso
	Su	Oligomeso	Mesotrophic	Oligomeso
	Fall	Oligomeso	Mesotrophic	Mesotrophic
Total Phosphorus	**Sp 2002**	Oligotrophic	Oligotrophic	Oligotrophic
	Sp	Eutrophic	Eutrophic	Eutrophic
	Su	Eutrophic	Mesotrophic	Mesotrophic
	Fall	Mesotrophic	Mesotrophic	Mesotrophic
Total Nitrogen	**Sp 2002**	Mesotrophic	Mesotrophic	Mesotrophic
	Sp	Mesotrophic	Mesotrophic	Mesotrophic
	Su	Eutrophic	Mesotrophic	Mesotrophic
	Fall	Mesotrophic	Mesotrophic	Mesotrophic
Overall Trophic Condition		**Mesotrophic**		

Sp = Spring; Su = Summer; MDP = missing data point

Table 3B. Limiting Nutrient

		Deep Station	Ute Creek	Horseshoe
Limiting Nutrient	**Sp 2002**	P	P	P
	Sp	P	P	P
	Su	P	P	P
	Fall	P	P	P

Table 4B. Summary of attainment status for all designated uses

Designated or Existing Use	Criteria Exceedence	Attainment Status
Warmwater Aquatic Life	**Mercury in Fish Tissue, Aluminum (chronic)**	Not Supporting
Municipal and Industrial Water Supply	No criteria applicable	Fully Supporting
Primary Contact	None	Fully Supporting
Livestock Watering	None	Fully Supporting
Wildlife Habitat	None	Fully Supporting

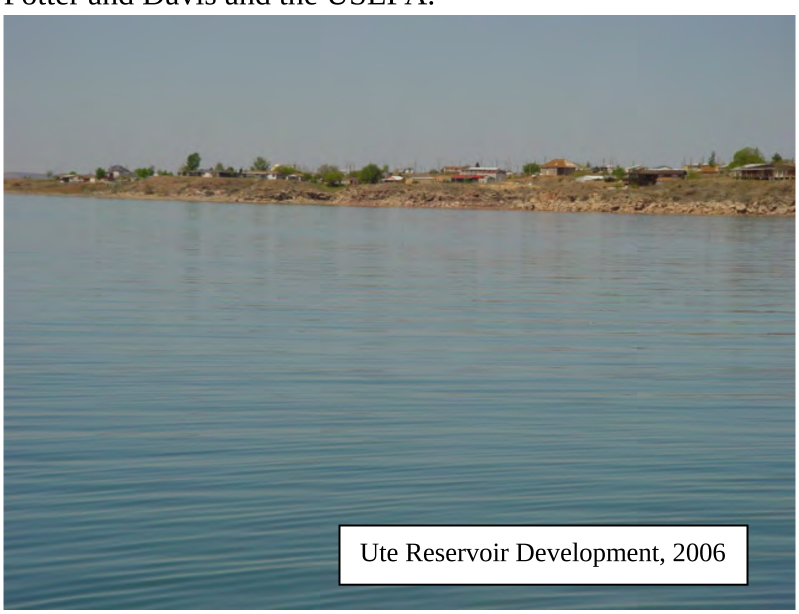
Water Quality Assessment


Ute Reservoir Dam, 2006.

Physical measurements collected at Ute Reservoir included temperature, specific conductance, dissolved oxygen, pH and turbidity (Table 1B). Lake chemistry sampling consisted of total, dissolved and calculated nutrients, anions and cations, total and dissolved heavy metals, synthetic organics, radionuclides, bacteria, and cyanide, which cover all standards criteria pertinent to the protection of all designated or exisiting uses. Criteria exceedences are discussed below, however additional data are available upon request.

Currently, development of lake and reservoir nutrient criteria specific to this ecoregion are being developed for total nitrogen and total phosphorous for use as a multiparametric nutrient assessment tool. Until this assessment tool is complete, nutrient assessments are provided using methods and indicators consistent with past assessment.

Ute Reservoir may be classified as mesotrophic (Table 2B) according to Carlson's (1977) indices for secchi depth, chlorophyll *a*, total phosphorus, total nitrogen, and algal community composition (Likens 1975). This is in agreement with assessments made by Potter and Davis in 1989, which demonstrated oligomesotrophic conditions, and the USEPA National Eutrophication Study of 1975, which verified mesotrophic conditions in Ute Reservoir. The nitrogen to phosphorous ratio indicated that phosphorous was the limiting nutrient during all seasons and all sampling visits (Table 3B). Again, this is consistent with earlier findings by Potter and Davis and the USEPA.


Ute Reservoir Development, 2006

Phytoplankton community composition was determined from two samples collected during the summer and fall sampling visits. During the summer visit, *Microcystis* dominated the algal population with over 36 percent of the total population. *Oocystis* was the second most common algal species comprising over eight percent of the community. *Chlamydomonas* was the most common during the fall sampling visit with the blue-green algae *Microcystis* the second most common. A total of 25 species were identified from the summer sample while 19 were present in the fall community.

Over fifty percent of the diatom community composition was dominated by *Diatoma moniliformis* Kützing, followed by *Synedra acus* Kützing. A total of twenty-three species were identified in the five-hundred-valve count.

Physical, chemical and biological indicators show that Ute Reservoir is in good condition from a nutrient standpoint especially when taking into consideration the rather large 28,852 km^2 (11,140 mi^2) watershed that supplies water to this impoundment. The majority of sampling was done during a prolonged drought, which resulted in low pool size and potentially increased nutrient concentrations; however, even under the added stress of lower water levels, no algal scum's, macrophyte blooms, nor fish kills were observed or reported. In other words, no conditions were observed that would suggest use impairment due to increased nutrient loading.

Ute Reservoir State Park, East Boatramp, 2006.

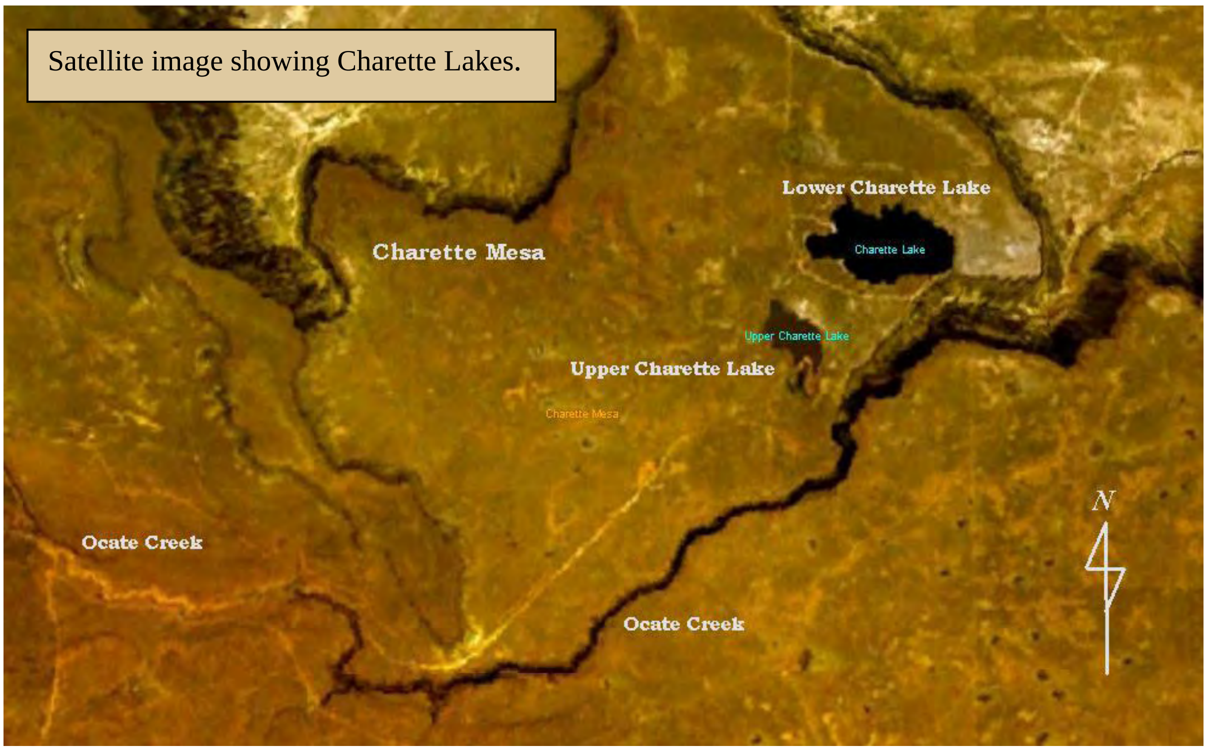
Furthermore, Ute Reservoir was designed for sediment control, but sedimentation/siltation is still included on the 2006-2008 Integrated List as a probable cause of impairment. (NMED/SWQB 2006). No ill effects from suspended sediment were observed at any time nor at any station during the course of this study. As a result, the sedimentation/siltation listing was removed from the 2008-2010 Integrated List as a probable cause of impairment because there were no data nor applicable assessment protocols available to make this determination.

Table 4B shows that the warmwater aquatic life use remains listed for chronic aluminum and mercury in fish tissue. There were 2 of 12 exceedences of the chronic aquatic life criterion, confirming the previous aluminum listing, therefore Ute Reservoir will remain listed for aluminum. There continues to be a fish advisory for mercury, thus mercury will remain as a cause of non-support until such time as new findings show that this cause no longer exists. The uses of secondary contact, wildlife habitat and livestock watering were fully supported during this study.

Water Quality and Biological Assessment Survey of Lower and Upper Charette Lakes, Mora County, April 4 and July 18, 2006.

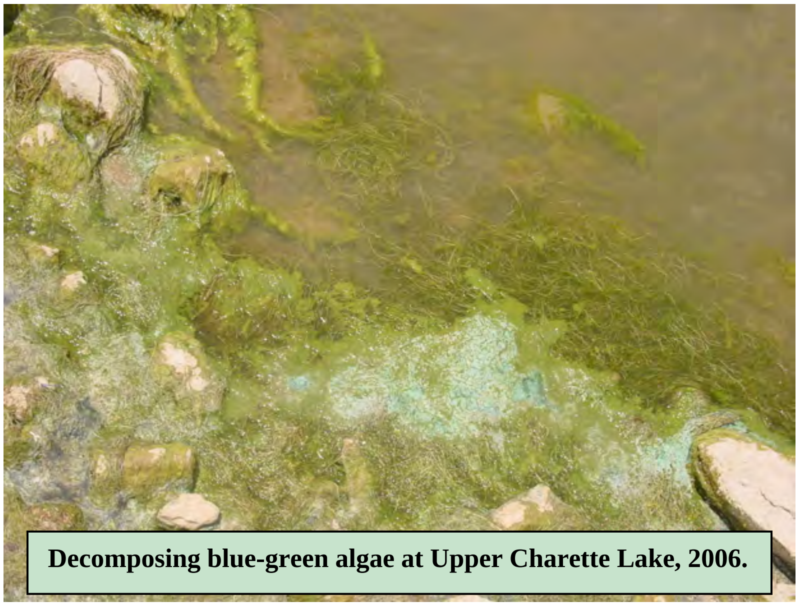
Danny R. Davis, Principal Investigator

Lower and Upper Charette Lakes are located in Mora County about twenty-two miles (35 km) southwest of Springer. The Charette Lakes are natural lakes perched on top of a mesa at an elevation of 2,023 meters (6,640 ft.) above mean sea level. Both lakes are located within the generally characterized Southwestern Tablelands ecoregion contained within Aggregate Ecoregion IV (the Great Plains Grass and Shrublands) (Omernik and Griffith, 2006). Data from three historic weather stations within the general region of Charette Lakes resulted in an average of 43 cm (16.9 in.) of precipitation per year with pan evaporation historically averaging 83 cm (32.7 in) per year resulting in a deficit of 41 cm (16 in) per year (Gabin and Lesperance 1977).



Both Upper and Lower Charette Lakes are located within the 2,000 acre Charette State Fishing and Waterfowl Area, which is managed by the New Mexico Department of Game and Fish for both recreation and fishing opportunities. Fish species common to the lakes include rainbow trout, yellow perch, white sucker, yellow bullhead, introduced grass carp and an occasional brown trout thought to migrate from Ocate Creek; however, the shallow nature of the upper lake subjects the lake to increased heating and nutrient concentrations, which will limit this fishery during drought conditions.

Lower Charette Lake is the larger of the two, and has a total surface area of about 300 acres at full pool, whereas Upper Charette Lake has a total surface area of about 110 acres at full pool. When adequate water is available in Ocate Creek, a portion of the creek is diverted through a canal to the upper lake. Once the upper lake is full, the overflow drains to the lower lake which then drains through a standpipe and out the cliff-side to rejoin Ocate Creek below.



Decomposing blue-green algae at Upper Charette Lake, 2006.

The lakes receive the majority of their water from Ocate Creek and the associated watershed. The upper lake is fed from a 556 km^2 (215 mi^2) watershed resulting in a 1,251:1 watershed to lake size ratio, whereas the lower lake is fed from a 216.2 mi^2 (138,380 acre) watershed resulting in a 461:1 watershed to lake size ratio. This large watershed would suggest that the lakes might be at risk of suffering from increased nutrient loading, however, the upper lake intercepts the source water before it continues downgradient to the lower lake. It is reasonable to suspect that the upper lake serves as a filter intercepting the nutrient load and sequestering it in algal and aquatic vegetation. This interpretation was reflected during the 2006 survey by a significantly more eutrophic condition encountered in the upper lake as compared to the lower lake.

The Charette Lakes are covered by water quality segment 20.6.4.308 NMAC of the New Mexico Water Quality Standards For Interstate and Intrastate Surface Waters (NMAC 2007), with designated uses of coldwater aquatic life, warmwater aquatic life, secondary contact, livestock watering, and wildlife habitat being recognized. Both lakes were studied at single stations during spring and summer seasons such that contrasting weather, longer day length, and other seasonal variables would be encountered.

Lower Charette Lake, April, 2006.

Table 1C. Physical characteristics for Lower and Upper Charette Lakes, 2006.

Physical Characteristics	Lower Charette Lake		Upper Charette Lake	
	Spring	Summer	Spring	Summer
Secchi Depth (m)	2.9	3.5	0.40	0.25
Forel Ule Color	9	8	12	15
Maximum Depth (m)	14.9	14.2	1.7	1.0
Euphotic Zone (m)	9	12	1.3	0.75
Surface Area in km^2 (Acres)	1.2 (300)	1.2 (300)	0.45 (110)	0.45 (110)
Anoxic Hypolimnion (Y/N)	No	No	No	No
Stratified (Y/N) @ (m)	No	No	No	No
pH (s.u.) Surface	6.88	8.16	7.83	8.50
Conductivity (µS) (Surface)	592	597	607	714
Turbidity (NTUs)	3.01	2.72	6.1	39.6
Integrated sample surface to (m)	9	13	1.5	0.1
Dissolved Oxygen Surface (mg/L)	8.29	6.95	8.03	9.17
Dissolved Oxygen Bottom (mg/L)	8.18	5.85	7.77	MDP
Temperature Surface (°C)	6.28	22.13	8.77	23.23
Temperature Bottom (°C)	8.18	18.64	8.71	MDP
Chlorophyll *a* (µg/L)	MDP	2.74	3.30	41.12

MDP = missing data point; (Q) = questionable result.

Table 2C. Trophic State (Carlson 1977)

	Lower Charette Lake		Upper Charette Lake	
	Spring	Summer	Spring	Summer
Secchi depth	Mesotrophic	Mesotrophic	Hypereutrophic	Hypereutrophic
Chlorophyll *a*	MDP	Mesotrophic	Mesotrophic	Eutrophic
Total Phosphorus	Oligotrophic	Oligotrophic	Eutrophic	Eutrophic
Total Nitrogen	Eutrophic	Eutrophic	Eutrophic	Eutrophic
Overall Trophic Condition	Mesotrophic		Eutrophic	

Table 3C. Limiting Nutrient

	Lower Charette Lake		Upper Charette Lake	
	Spring	Summer	Spring	Summer
Limiting Nutrient	P	P	P	P

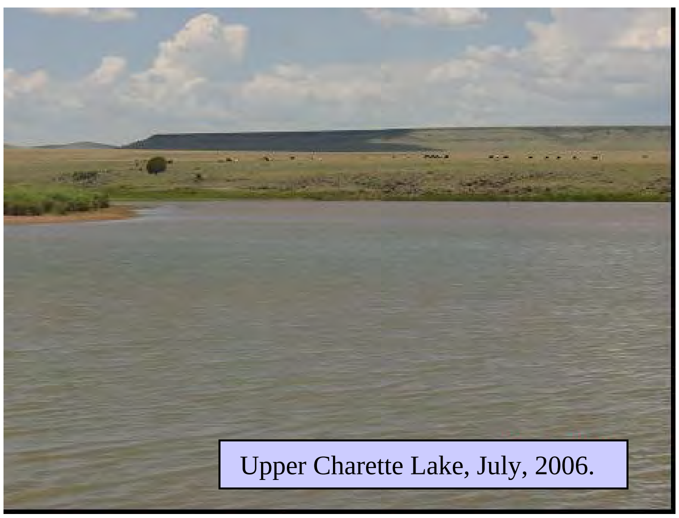
Table 4C. Summary of attainment status for all designated uses

Designated or Existing Use	Lower Charette Lake		Upper Charette Lake	
	Criteria Exceedence	Attainment Status	Criteria Exceedence	Attainment Status
Coldwater Aquatic Life	Mercury in Fish Tissue	Not Supporting	Mercury in Fish Tissue	Not Supporting
Warmwater Aquatic Life	Mercury in Fish Tissue	Not Supporting	Mercury in Fish Tissue	Not Supporting
Secondary Contact	None	Fully Supporting	None	Fully Supporting
Wildlife Habitat	None	Fully Supporting	None	Fully Supporting
Livestock Watering	None	Fully Supporting	None	Fully Supporting

Water Quality Assessment

Physical measurements collected at the Charette Lakes included temperature, specific conductance, dissolved oxygen, pH and turbidity (Table 1C). Lake chemistry sampling consisted of total and dissolved nutrients, anions and cations, total and dissolved heavy metals, volatile and semi-volatile synthetic organic compounds, radionuclides, cyanide and bacteriological, which covers all standards criteria pertinent to the protection of all designated or existing uses. Phytoplankton, diatom and chlorophyll analyses were also performed. Only criteria exceedences are discussed below, however all data are available upon request.

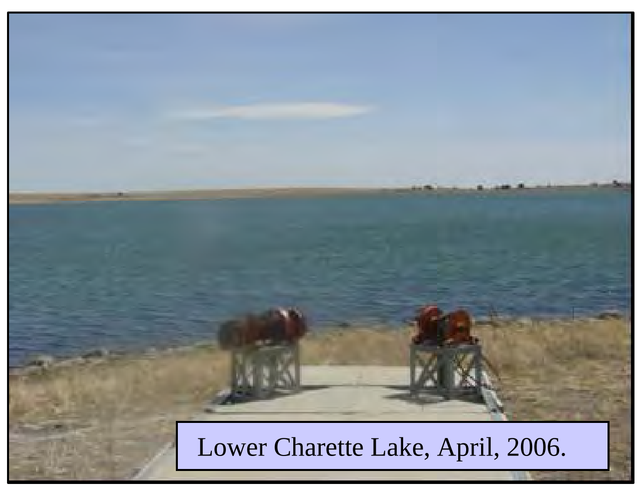
Currently, development of lake and reservoir nutrient criteria specific to ecoregion is being developed for total nitrogen and total phosphorous for use in a multiparametric nutrient assessment tool. Until this assessment tool is complete, nutrient assessments are provided using methods and indicators consistent with past assessment.



Upper Charette Lake, July, 2006.

Lower Charette Lake may be classified as mesotrophic and Upper Charette Lake as eutrophic according to Carlson's (1977) indices and algal community composition (Likens 1975). Table 2C shows trophic variation observed during the spring and summer visits for secchi depth, chlorophyll *a*, total phosphorus, and total nitrogen. The N/P ratio indicated that phosphorous was the limiting nutrient for both of these lakes during this study (Table 3C).

Diatom community composition in Lower Charette Lake consisted of 43 species in which *Cocconeis pediculus* Ehrenberg, *Cocconeis placentula* var. *lineata* (Ehrenberg) Van Heurck, and *Fragilaria crotonensis* Kitton comprised almost fifty percent of the total diatom community. Phytoplankton community composition consisted of the chrysophyta and chlorophyta during the spring visit and a mix of these plus the blue-green algae, *Microcystis* and *Gloeocapsa* having less numbers. This phytoplankton community and seasonal variability reflect the overall mesotrophic condition encountered during the survey (Likens 1975). Diatom community composition in Upper Charette Lake consisted of 30 species in which *Rhoicosphenia* abbreviata (Agardh) Lange-Bertalot was the most common species representing 27 percent of the total community. *Cocconeis* placentula var. *euglypta* (Ehrenberg) Grunow and *Gomphonema minutum* (Agardh) Agardh followed totaling about 27 percent between the two species.



Lower Charette Lake, April, 2006.

Phytoplankton community composition was determined for both spring and summer visits to Upper Charette Lake. At the time of the spring visit, the Chlorophyta were the dominant algae component of the community composition represented by *Ankistrodesmus* followed by the blue-green species *Microcystis*. The green algae comprised about forty-eight percent of the total community composition. Significant changes were seen in the community during the summer visit where the Cyanophyta or blue-green component jumped to ninety-six percent of the total community, which is consistent with the increased nutrient and higher chlorophyll found during the summer visit. As might be expected, diversity according to Shannon-Weaver (1949) dropped significantly during the summer visit compared to the spring sampling run. This phytoplankton community and seasonal variability reflect the overall eutrophic condition encountered during the survey (Likens 1975).

Table 4C shows that both coldwater and warmwater aquatic life uses remain listed for mercury in fish tissue. Mercury will remain as a cause of non-support until such time as new findings show that this cause no longer exists. The uses of secondary contact, wildlife habitat, and livestock watering were fully supported during this study.

Though no exceedences affecting support for the coldwater aquatic life designation were observed during the two sampling visits, the shallow and nutrient enriched nature of Upper Charette Lake renders it a poor candidate as a coldwater fishery. During some years where water level is high and some flushing occurs, it is reasonable to conclude that a marginal coldwater fishery would be supportable. This would recognize the Upper Charette Lake as a seasonal put-and-take trout fishery like many similar lakes in New Mexico where seasonality and favorable conditions dictate the fishery possibility.

Upper Charette Lake, July, 2006.

Water Quality and Biological Assessment Survey of Springer Lake, Colfax County, April 4 and July 18, 2006.

Danny R. Davis, Principal Investigator

Springer Lake is a 1.8 km^2 (450 acre) impoundment located in Colfax County about 6.5 km (4 miles) northwest of Springer, via State road 468. The lake is located at an elevation of 1,808 meters (5,932 ft.) above mean sea level. The earthen dam impounding Springer Lake was completed in 1920 providing more reliable irrigation waters to farmers and ranchers in the area. Water is diverted primarily from the Cimarron River through an extensive system of canals and ditches, though some water can be diverted from Ponil Creek should the need arise. Watershed to lake size ratio is undeterminable due to the extensive system of canals and ditches. In these situations where water has been transported great distances to create an irrigation storage reservoir such as Springer Lake, little relevance exists between the lake and watershed areas related to nutrient concentrations and subsequent trophic conditions. Land use immediately surrounding Springer Lake consists primarily of ranching with associated cattle grazing. The open-range conditions that exist allow cattle access to the lake shore in some areas.


Cattle grazing on northern shore of Springer Lake, 2006.

Springer Lake is located within the Southwestern Tablelands ecoregion contained within Aggregate Ecoregion IV (the Great Plains Grass and Shrublands) (Omernik and Griffith, 2006). Sixty-nine years of meteorological data from the Springer area has a preciptation average of 37.6 cm/year (14.8 in) of with pan evaporation historically averaging 91.2 cm/year (35.9 in),resulting in a deficit of 53.9 cm (21.2 in) per year (Gabin and Lesperance 1977).

Springer Lake is leased by the New Mexico Department of Game and Fish who manage the recreational facilities including a small concrete boat ramp and portable toilets. Persons fishing may encounter largemouth bass, black bullhead, yellow perch, northern pike, sun fish, channel catfish, white suckers, fathead minnows and plains killifish. Other activities that are common at Springer Lake are swimming and, if water levels are sufficient, water skiing. The New Mexico State record northern pike was captured from Springer Lake in 1974 weighing 36 pounds and measuring 53 inches long. This record has not been broken to date.

Prior to 2005, Springer Lake was included in water quality segment 20.6.4.306 (“306”), but because water is diverted to fill the lake it is not considered to be “in-line” with water quality segment “306”, therefore it was temporarily placed under water quality segment 20.6.4.99 (“99”). Segment “99” is designed to protect all perennial unclassified waters of the State. Springer Lake will remain under 20.6.4.99 until a new water quality segment specific to Springer Lake can be created or until a new default segment specific to lakes, in general, is developed. Existing uses that are not covered under the designated uses described in segment “99”, such as primary contact, irrigation, or warmwater aquatic life, are noted in SWQB’s Assessment Database (ADB) and are taken into consideration during assessment. By using the information and data collected from this survey, it is SWQB’s intent to propose a lake-specific water quality segment for Springer Lake (or default classification) that includes all the existing *and attainable* uses of the lake in order to provide the lake with suitable and appropriate protection.

Springer Lake, 2006

Table 1D. Physical characteristics for Springer Lake, 2006.

Physical Characteristics	Spring	Summer
Secchi Depth (m)	0.50	0.30
Forel Ule Color	11	15
Maximum Depth (m)	2.8	2.3
Euphotic Zone (m)	2.0	1.0
Surface Area in km^2 (Acres)	1.8 (450)	1.8 (450)
Anoxic Hypolimnion (Y/N)	No	No
Stratified (Y/N) @ (m)	No	No
pH (s.u.) Surface	7.83	8.18
Conductivity (μS) (Surface)	805	838
Turbidity (NTUs)	MDP	58.2
Integrated sample surface to (m)	2.0	0.1
Dissolved Oxygen Surface (mg/L)	7.28	6.46
Dissolved Oxygen Bottom (mg/L)	7.30	6.33
Temperature Surface (°C)	9.80	24.24
Temperature Bottom (°C)	9.76	24.19
Chlorophyll *a* (μg/L)	6.92	30.44

Table 2D. Trophic State (Carlson, 1977)

Springer Lake (2006)	Spring	Summer
Secchi depth	Eutrophic	Hypereutrophic
Chlorophyll *a*	Mesotrophic	Eutrophic
Total Phosphorus	Eutrophic	Eutrophic
Total Nitrogen	Mesotrophic	Eutrophic
Overall Trophic Condition	**Eutrophic**	

Table 3D. Limiting Nutrient

	Spring	Summer
Limiting Nutrient	P	P

Table 4D. Summary of attainment status for all designated uses

Designated or Existing Use	Criteria Exceedence	Attainment Status
****Primary Contact**	None	Fully Supporting
Secondary Contact	None	Fully Supporting
****Warmwater Aquatic Life**	Mercury in Fish Tissue	Not Supporting
Wildlife Habitat	None	Fully Supporting
Livestock Watering	None	Fully Supporting
****Irrigation**	None	Fully Supporting

** These uses do exist and should be supported within an appropriate Water Quality Segment.

Water Quality Assessment

Physical measurements collected at Springer Lake included temperature, specific conductance, dissolved oxygen, pH and turbidity (Table 1D). Lake chemistry sampling consisted of total and dissolved nutrients, anions and cations, total and dissolved heavy metals, volatile and semi-volatile synthetic organic compounds, radionuclides, cyanide and bacteriological, which covers all standards criteria pertinent to the protection of all designated or existing uses. Phytoplankton, diatom and chlorophyll analyses were also performed. Only criteria exceedences are discussed below, however all data are available upon request.

Currently, development of lake and reservoir nutrient criteria specific to this ecoregion are being developed for total nitrogen and total phosphorous for use as a multiparametric nutrient assessment tool. Until this assessment tool is complete, nutrient assessments are provided using methods and indicators consistent with past assessment.

Primary contact recreation at Springer Lake, 2006.

Springer Lake may be classified as eutrophic according to Carlson's (1977) indices, and algal community composition (Likens 1975). Table 2D shows trophic variation observed during the spring and summer visits for secchi depth, chlorophyll *a*, total phosphorus, and total nitrogen. The N/P ratio indicated that phosphorous was the limiting nutrient during this study (Table 3D).

Diatom community composition consisted of sixty-three species of which the most common were of the genus *Navicula*. Species richness and diversity were very high and no single species dominated the community composition.

Phytoplankton community composition was dominated by the blue-green algae, *Microcystis* during the spring visit, which comprised about two-thirds of the cells counted. The centric diatom *Melosira* was most dominant during the summer sampling visit comprising twenty-eight percent of the community, however, almost fifty percent of the community consisted of blue-green cyanobacteria notably *Nostoc, Microcystis* and *Anabaena* species. One species of Euglena, also common in nutrient-rich conditions, was also common in the summer sample. Both Cyanophyta and Euglenophyta are common in waters of high nutrient concentration (Likens 1975).

The warmwater aquatic life use associated with Springer Lake remains listed due to mercury in fish tissue. This listing will remain as a cause of non-support until new findings show this impairment no longer exists (Table 4D). All other physical, chemical and biological findings confirm support of a healthy fish community. The uses of primary and secondary contact recreation, irrigation, livestock watering, and wildlife habitat were fully supported during the study period.

Water Quality and Biological Assessment Survey of Lake Maloya, Colfax County, April 11, July 25 and October 3, 2006 and Lake Alice, Colfax County, April 12 and July 25, 2006.
Danny R. Davis, Principal Investigator

Lake Maloya is a 120-acre reservoir located in Sugarite Canyon State Park on the New Mexico-Colorado border, with approximately three acres located within Colorado. Lake Maloya is formed by a earthfill dam, which was completed in 1907 resulting in an original storage capacity of 59 acre-feet. However, the lake was enlarged in 1916 resulting in a capacity of 1,130 acre-ft., and yet again in 1948 resulting in the current capacity of 3,690 acre-ft. (USGS 2003). Lake Alice is a six acre impoundment located about three miles (4.8 km) below Lake Maloya. Lake Alice is an off-channel lake fed by water released from Lake Maloya via Chicorica Creek and stores approximately 65-70 acre-feet of water behind an earthen dam. The lakes are located at an elevation of approximately 2,200 meters (7,260 ft) above mean sea level.


Lake Maloya

Sugarite Canyon State Park is located within what is generally characterized Southern Rockies ecoregion, part of the Western Forested Mountains Aggregate Ecoregion II (Omernik and Griffith, 2006). These lakes receive an average of 56.7 cm (22.34 in.) of precipitation per year with pan evaporation historically averaging 65.5 cm (25.8 in) per year resulting in a deficit of 18.2 cm (7.16 in) per year (Gabin and Lesperance 1977).

The lakes are primarily used as municipal water supply for the City of Raton, New Mexico and releases are managed by the Vermejo Conservancy District. Sugarite Canyon State Park manages the recreational activities which include fishing and camping. Small boats are permitted on Lake Maloya but gasoline motors are prohibited. Access to Lake Alice is by foot path only, though State Road 526 and roadside parking close to the lake. Wildlife is abundant in the area and the lake attracts migratory waterfowl and seasonal neotropical migrants.

Lake Maloya and Lake Alice are classified under segment 20.6.4.305 NMAC in New Mexico Water Quality Standards for Interstate and Intrastate Surface Waters (NMAC 2007), with designated uses of irrigation, marginal warmwater aquatic life, livestock watering, wildlife habitat, and secondary contact being recognized. Existing uses not included in segment 20.6.4.305 include municipal and industrial water supply, coldwater aquatic life for Lake Maloya, and marginal coldwater aquatic life for Lake Alice.

The principal fish supported and stocked by the New Mexico Department of Game and Fish (NMDGF) is rainbow trout, though white sucker, yellow perch and occasionally splake, a cross between a lake and brook trout, are captured by anglers. In 2008, the Friends of Sugarite Canyon State Park received approval from the NMDGF to introduce brown trout in both Lake Maloya and Lake Alice. The nature of this fish community adds credence to the coldwater and marginal coldwater conditions that exist in these lakes and further support the necessity for adoption of appropriate criteria to protect these existing uses.

Table 1E. Physical Characteristics for Lake Maloya and Lake Alice, 2006.

Physical Characteristics		Lake Maloya		Lake Alice
		Deep Station	Shallow Station	
Secchi Depth (m)	Sp	1.5	1.5	2.0
	Su	3.75	2.6	2.0
	Fall	1.5	1.5	MDP
Forel Ule Color	Sp	12	12	9
	Su	11	12	14
	Fall	14	14	MDP
Maximum Depth (m)	Sp	16.9	5.0	7.0
	Su	15.2	5.6	7.1
	Fall	20.6	5.7	MDP

Physical Characteristics		Lake Maloya		Lake Alice
		Deep Station	Shallow Station	
Euphotic Zone (m)	**Sp**	5.0	5.0	6.0
	Su	12	>5.6	6.5
	Fall	3.5	3.5	MDP
Surface Area in km^2 (Acres)	**Sp**	0.49 (120)	0.49 120	6
	Su	0.49 (120)	0.49 (120)	6
	Fall	0.49 (120)	0.49 (120)	MDP
Storage Capacity in m^3 (Ac. Ft.)	**Sp**	4.5×10^6 (3,690)	4.5×10^6 (3,690)	MDP
	Su	4.5×10^6 (3,690)	4.5×10^6 (3,690)	MDP
	Fall	4.5×10^6 (3,690)	4.5×10^6 (3,690)	MDP
Anoxic Hypolimnion (Y/N)	**Sp**	No	No	No
	Su	Yes	No	Yes
	Fall	Yes	No	MDP
Stratified (Y/N) @ depth (m)	**Sp**	No	No	Yes (3-4)
	Su	Yes (5-6)	Yes (1-2)	Yes (2-3)
	Fall	Yes (12-13)	No	MDP
pH (s.u.)	**Sp**	6.68	7.41	7.3
	Su	8.5	8.47	8.2
	Fall	8.21	8.64	MDP
Conductivity (μS)	**Sp**	166	167	291
	Su	168	168	284
	Fall	170	170	MDP
Turbidity (NTUs)	**Sp**	3.37	4.23	3.66
	Su	2.10	2.32	5.41
	Fall	3.32	4.24	MDP
Integrated Sample surface to (m)	**Sp**	5.0	4.0	6.0
	Su	14	5.0	6.5
	Fall	20	5.0	MDP
Dissolved Oxygen Surface (mg/L)	**Sp**	8.88	8.94	8.01
	Su	6.47	6.55	6.63
	Fall	7.57	8.00	MDP
Dissolved Oxygen Bottom (mg/L)	**Sp**	8.52	4.55	6.83
	Su	0.08	5.74	0.15
	Fall	0.22	7.55	MDP
Temperature Surface (°C)	**Sp**	7.10	8.22	10.07
	Su	21.84	22.52	21.48
	Fall	14.5	14.79	MDP

Physical Characteristics		Lake Maloya		Lake Alice
		Deep Station	Shallow Station	
Temperature Bottom (°C)	Sp	6.14	7.80	7.56
	Su	9.35	20.83	12.68
	Fall	8.89	14.22	MDP
Chlorophyll *a* (µg/L)	Sp	6.63	4.49	2.06
	Su	1.92	2.74	27.85
	Fall	3.23	8.04	MDP

Sp = Spring; Su = Summer; MDP = missing data point; (Q) = questionable result.

Table 2E. Trophic State (Carlson 1977)

		Lake Maloya (2006)		Lake Alice (2006)
		Deep Station	Shallow Station	
Secchi depth	Sp	Eutrophic	Eutrophic	Eutrophic
	Su	Mesotrophic	Mesotrophic	Eutrophic
	Fall	Eutrophic	Eutrophic	--
Chlorophyll *a*	Sp	Mesotrophic	Mesotrophic	Oligomesotrophic
	Su	Oligomeso	Mesotrophic	Eutrophic
	Fall	Eutrophic	Mesotrophic	--
Total Phosphorus	Sp	Mesotrophic	Mesotrophic	Eutrophic
	Su	Eutrophic	Mesotrophic	Hypereutrophic
	Fall	Hypereutrophic	Mesotrophic	--
Total Nitrogen	Sp	Mesotrophic	Mesotrophic	Mesotrophic
	Su	Eutrophic	Mesotrophic	Eutrophic
	Fall	Mesotrophic	Mesotrophic	--
Overall Trophic Condition		**Mesoeutrophic**		**Eutrophic**

Table 3E. Limiting Nutrient

		Lake Maloya		Lake Alice
		Deep Station	Shallow Station	
Limiting Nutrient	Sp	P	N/P	N
	Su	P	P	N
	Fall	N	P	--

Table 4E. Summary of attainment status for all designated uses

Designated or Existing Use	Lake Maloya		Lake Alice	
	Criteria Exceedence	Attainment Status	Criteria Exceedence	Attainment Status
****Coldwater Aquatic Life**	Mercury in fish tissue and Temperature	Not Supporting	N/A	N/A
****Marginal Coldwater Aquatic Life**	N/A	N/A	None	Fully Supporting
Marginal Warmwater Aquatic Life	Mercury in fish tissue	Not Supporting	None	Fully Supporting
Irrigation	None	Fully Supporting	None	Fully Supporting
Livestock Watering	None	Fully Supporting	None	Fully Supporting
Wildlife Habitat	None	Fully Supporting	None	Fully Supporting
Secondary Contact	None	Fully Supporting	None	Fully Supporting
****Municipal and Industrial Water Supply**	None	Fully Supporting	None	Fully Supporting

** Existing use not designated by water quality segment 20.6.4.305.

Water Quality Assessment

Physical measurements collected at Lake Maloya and Lake Alice included temperature, specific conductance, dissolved oxygen, pH and turbidity (Table 1E). Lake chemistry sampling consisted of total, dissolved and calculated nutrients, anions and cations, total and dissolved heavy metals, synthetic organics, radionuclides, bacteria, cyanide, and physical parameters, which cover all standards criteria pertinent to the protection of all designated or existing uses. Phytoplankton, diatom and chlorophyll analyses were also performed. Only criteria exceedences are discussed below, however all data are available upon request.

Lake Maloya

Currently, lake and reservoir nutrient criteria specific to the ecoregion are being developed for total nitrogen and total phosphorous for use as a multiparametric nutrient assessment tool. Until this assessment tool is complete, nutrient assessments are provided using methods and indicators consistent with past assessment.

Lake Maloya may be classified as mesoeutrophic according to Carlson's (1977) indices, and algal community composition (Likens 1975). Table 2E shows the variation observed seasonally and between stations for secchi depth, chlorophyll *a*, total phosphorus, and total nitrogen. The nitrogen and phosphorus ratio showed that phosphorus was the limiting nutrient during four of the six visits, co-limiting and nitrogen limiting for one sample each (Table 3E).

Lake Maloya has about 120 surface acres but captures and stores water from a watershed having an area of 75 km^2 (28.8 mi^2) or 13,355 acres. This large watershed to lake size ratio suggests that this lake would eventually succumb to nutrient loading from the large drainage area. Results from a study by Potter and Davis in 1987 showed that eutrophic conditions existed in Lake Maloya. However, the New Mexico State Parks Division and the City of Raton Water Authority have implemented several projects designed to improve bank stabilization and protect riparian areas associated with the lake. The results from the current water quality study suggest that these efforts have provided substantial benefits to lake water quality and surrounding habitat. Notable improvement in water clarity, chlorophyll *a*, secchi depth, and nutrient concentrations speak to the benefits of good management practices.

Lake Alice may be classified as eutrophic according to Carlson's (1977) indices, and algal community composition (Likens 1975). Table 2F shows trophic variation observed during the spring and summer visits for secchi depth, chlorophyll *a*, total phosphorus and total nitrogen. The N/P ratio indicated that nitrogen was the limiting nutrient during this study (Table 3F).

The watershed draining to Lake Alice is 75 km^2 (28.84 mi^2) resulting in a watershed to lake size ratio of 3,076:1. This huge watershed to lake size ratio suggests that Lake Alice is subject to increased nutrient loading and the consequent responses, such as excessive algal growth, decreased light transparency, and considerable shifts in pH and dissolved oxygen. Discussions with Robert Dye, park manager at Sugarite Canyon State Park, and Dan Campbell, City of Raton water division, both pointed out that 2006 was a dry water year compared to other years. During spring runoff following winters with significant snow accumulation, Lake Maloya will spill as much as 10,000 acre feet of runoff. This allows flow to be diverted through Lake Alice allowing significant flushing of nutrients. During the spring and throughout the summer of 2006, there was no discharge from Lake Maloya and consequently, no flushing of Lake Alice. These conditions help to explain the predominance of higher nutrient concentrations with associated algal community composition.
Phytoplankton community composition in Lake Maloya was dominated by the diatom genera *Fragilaria* and *Tabellaria* during the spring sampling effort, *Cyclotella* and *Microcystis*, the latter a blue-green algae, was most common during the summer visit, and heavily dominated by *Microcystis* and *Anabaena*, both blue-green algae, in the fall. No algal scum, macrophyte blooms or fish kills were observed or reported during the survey. Periphyton diatom community composition consisted of forty-nine species where *Achnanthes minutissima* Kützing, *Fragilaria crotonensis* Kitton, and *Staurosira construens* var. *binodis* (Ehrenburg) Hamilton, comprised 47 percent of the community composition.

Phytoplankton community composition in Lake Alice consisted of twelve species during the spring sampling effort and eighteen members during the summer sampling effort. The Chlorophyta represented over one-third of the total community during both spring and summer visits. The Chrysophyta totaled 37 percent of the community during the spring run, but were much less common during the summer sampling visit. The Cyanophyta or blue-green algae totaled 27 percent of the community during the summer visit and *Euglena* increased by 10 percent compared to the spring sampling visit. Both the increase in the Cyanophyta and Euglenophyta coincide with the increase nutrient concentration observed during the summer visit (Likens 1975). Diatom community composition was derived from a single sample collected from multiple substrates during the summer sampling visit and consisted of forty-four species with *Achnanthes minutissima* Kützing, comprising almost thirty percent of the community. This diatom is a very tolerant species able to adapt to wide ranges of nutrient, chemical and physical conditions. *Epithemia sorex* Kützing, and *Staurosira construens* var. *binodis* (Ehrenburg) Hamilton, were the next most abundant diatom species representing twelve and seven percent, respectively, of the total 500 cells counted.

In Lake Maloya, elevated temperatures were encountered within the epilimnion during the summer sampling visit at both deep and shallow stations (21.8 ºC and 22.5 ºC, respectively). Applying a coldwater aquatic life use temperature criterion of 20 °C resulted in a temperature impairment for Lake Maloya. One exceedence of the cyanide criterion was observed, however this single exceedence did not result in a use impairment. A fish consumption advisory remains in effect for mercury concentrations in white suckers, which are common in Lake Maloya, however trout are not listed in the consumption advisory. The coldwater and marginal warmwater aquatic life uses associated with Lake Maloya will continue to be listed due to mercury in fish tissue until new findings show this concern no longer exists. The uses of secondary contact, irrigation, livestock watering, wildlife habitat, and municipal and industrial water supply were fully supported during the study period (Table 4E).

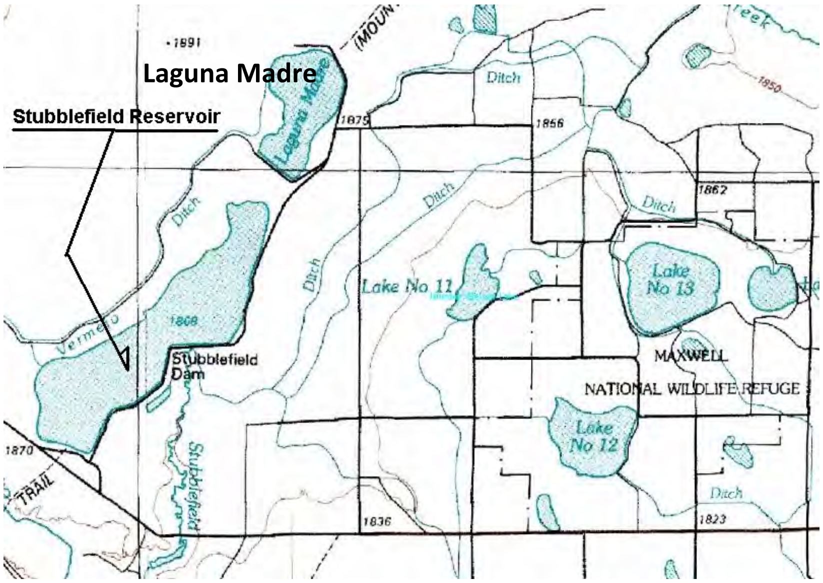
Lake Alice had one exceedence of the arsenic criterion, though this single occurrence did not result in an impairment listing. Similarly, temperature measurements during the summer visit showed an exceedence of the 20º C temperature criterion for coldwater aquatic life use, but this single exceedence also did not result in an impairment listing. Unlike Lake Maloya, Lake Alice is not listed in the current fish consumption advisory for mercury in fish tissue, therefore, both marginal warmwater and the proposed marginal coldwater aquatic life uses were fully supporting. The irrigation, livestock watering, wildlife habitat, and secondary contact uses also were fully supported (Table 4F).

Lake Maloya and Lake Alice, like many smaller impoundments in New Mexico, was historically placed within a water quality segment that was associated with its source streams. Problems have become apparent when a water quality standard associated with a lotic (running water) system is applied to a lentic (standing water) waterbody. For example, it may be impractical for Lake Alice, a small and relatively shallow lake that often lacks reliable flow, to meet the 20 ºC coldwater temperature criterion during extreme summer conditions. As such, SWQB would recommend adopting an acute upper limit of 25ºC specifically for Lake Alice or to apply a marginal coldwater aquatic life use to this lake, which applies a 25ºC temperature criterion. The put-and-take trout fishery maintained by the New Mexico Department of Game and Fish would continue to be supported if one of these strategies were adopted. By using the information and data collected from this survey, it is SWQB's intent to propose a lake-specific water quality segment for Sugarite Canyon State Park (or default classification) that includes all the existing *and attainable* uses of the park's lakes in order to provide them with suitable and appropriate protection.

Water Quality and Biological Assessment Survey of
Laguna Madre & Stubblefield Lake,
Colfax County, April 18 and August 8, 2006.

<u>Danny R. Davis, Principal Investigator</u>

Laguna Madre (1.58 km^2 (390 acre) and Stubblefield Lake 5.28 km^2 (1,305 acre) are earthen dam impounded playa lakes located adjacent to the Maxwell National Wildlife Refuge near Maxwell, New Mexico. The lakes are fed by water diverted from the Vermejo River via a series of irrigation canals and stores irrigation water managed by the Vermejo Conservancy District. The U.S. Bureau of Reclamation constructed the various irrigation storage lakes in the 1950's, and the U.S. Fish and Wildlife Service established the refuge in 1966 beginning its management of 3,200 acres of grassland, agricultural land and three waterbodies of the Vermejo Conservancy District. In 1987, a multiple lake characterization study was conducted by Potter and Davis that included the same Maxwell lakes studied during this 2006 study effort. Some reference will be made to this earlier lake study for comparative purposes and to establish if substantive changes in water quality and habitat conditions are evident. Storage capacity of Laguna Madre at maximum pool is reported to be 3,134 acre-feet, whereas storage capacity for Stubblefield Lake is 16,721 acre-feet at maximum pool.



The elevation of the Laguna Lake is roughly 1,875 meters (6,148 ft) above mean sea level and Stubblefield Lake sits approximately 1,868 meters (6,129 ft) above mean sea level. Both lakes are located within the most characteristic component of the Southwestern Tablelands ecoregion contained in Aggregate Ecoregion IV (the Great Plains Grass and Shrublands) (Omernik and Griffith, 2006). These lakes receive an average of 35.8 cm (14.1 in) of precipitation per year with pan evaporation historically averaging 83.3 cm (32.8 in) per year resulting in a deficit of 47.4 cm (18.65 in) per year (Gabin and Lesperance 1977).

American White Pelicans, Laguna Madre, 2006

Discussions with Erik Frey of the New Mexico Department of Game and Fish confirmed that a warm water aquatic life use is appropriate for Laguna Madre where walleye, largemouth bass, smallmouth bass, white crappie, green sunfish, yellow perch, channel catfish, yellow and black bullheads and white suckers comprise the fish community.

Prior to 2005, Laguna Madre and Stubblefield Lake were unclassified, in other words they were not specifically included within a water quality standards segment. In 2005, they were temporarily placed under water quality segment 20.6.4.99 ("99"). Segment "99" is designed to protect all perennial unclassified waters of the State. Laguna Madre and Stubblefiled Lake will remain under 20.6.4.99 until a new water quality segment specific to these lakes can be created or until a new default segment specific to lakes is developed. Existing uses that are not covered under the designated uses described in segment "99", such as irrigation or warmwater aquatic life, are noted in SWQB's Assessment Database (ADB) and are taken into consideration during assessment. By using the information and data collected from this survey, it is SWQB's intent to propose a lake-specific water quality segment for Laguna Madre and Stubblefiled Lake (or default classification) that includes all the existing *and attainable* uses of these lakes in order to provide them with suitable and appropriate protection.

Laguna Madre, April 2006

Stubblefield Lake, 2006

Table 1G. Physical characteristics for Laguna Madre & Stubblefield Lake, 2006.

Physical Characteristics	Laguna Madre		Stubblefield Lake	
	Spring	Summer	Spring	Summer
Secchi Depth (m)	0.5	1.5	1.75	1.1
Forel Ule Color	8	14	9	15
Maximum Depth (m)	Est. 2-3	Est. 2-3	3.5	4.5
Euphotic Zone (m)	1.0	1.0	> 3.5	3.2
Surface Area in km^2 (Acres)	1.58 (390)	1.58 (390)	5.28 (1,305)	5.28 (1,305)
Anoxic Hypolimnion (Y/N)	No	No	No	No
Stratified (Y/N) @ (m)	No	No	No	No
pH (s.u.) Surface	7.08	9.04	8.04	9.21
Conductivity (µS) (Surface)	710	616	589	516
Turbidity (NTUs)	20.4	1.84	3.65	9.54
Integrated sample surface to (m)	1.0	0.25	3.0	4.0
Dissolved Oxygen Surface (mg/L)	7.04	10.08	8.16	10.72
Dissolved Oxygen Bottom (mg/L)	MDP	10.72	8.08	3.39
Temperature Surface (°C)	14.1	25.26	13.16	23.72
Temperature Bottom (°C)	MDP	24.31	12.96	21.94
Chlorophyll *a* (µg/L)	1.68	2.71	1.96	30.09

Table 2G. Trophic State (Carlson 1977)

	Laguna Madre		Stubblefield Lake	
	Spring	**Summer**	**Spring**	**Summer**
Secchi depth	Eutrophic	Eutrophic	Eutrophic	Eutrophic
Chlorophyll *a*	Oligomesotrophic	Mesotrophic	Oligomesotrophic	Eutrophic
Total Phosphorus	Eutrophic	Eutrophic	Eutrophic	Eutrophic
Total Nitrogen	Eutrophic	Eutrophic	Eutrophic	Eutrophic
Overall Trophic Condition	**Eutrophic**		**Eutrophic**	

Table 3G. Limiting Nutrient

	Laguna Madre		Stubblefield Lake	
	Spring	**Summer**	**Spring**	**Summer**
Limiting Nutrient	P	P	P	P

Table 4G. Summary of attainment status for all designated uses

Designated or Existing Use	Laguna Madre		Stubblefield Lake	
	Criteria Exceedence	**Attainment Status**	**Criteria Exceedence**	**Attainment Status**
****Warmwater Aquatic Life**	None	Fully Supporting	Mercury in Fish Tissue	Not Supporting
****Irrigation**	None	Fully Supporting	None	Fully Supporting
Wildlife Habitat	None	Fully Supporting	None	Fully Supporting
Livestock Watering	None	Fully Supporting	None	Fully Supporting
Secondary Contact	None	Fully Supporting	None	Fully Supporting
****Primary Contact**	None	Fully Supporting	None	Fully Supporting

** These uses exist and should be supported within an appropriate Water Quality Segment.

Water Quality Assessment

Physical measurements collected at Laguna Madre and Stubblefield Lake included temperature, specific conductance, dissolved oxygen, pH, and turbidity (Table 1G). Lake chemistry sampling consisted of total and dissolved nutrients, anions and cations, total and dissolved heavy metals, volatile and semi-volatile synthetic organic compounds, radionuclides and cyanide and E. coli bacteria, which covers all standards criteria pertinent to the protection of all designated or existing uses. Phytoplankton, diatom and chlorophyll analyses were also performed. Only criteria exceedences are discussed below, however all data are available upon request.

Raft of White Pelicans on Laguna Madre, 2006.

Laguna Madre, April, 2006.

Currently, development of lake and reservoir nutrient criteria specific to this ecoregion are being developed for total nitrogen and total phosphorous for use as a multiparametric nutrient assessment tool. Until this assessment tool is complete, nutrient assessments are provided using methods and indicators consistent with past assessment.

Laguna Madre and Stubblefield Lake may be classified as eutrophic according to Carlson's (1977) indices, and algal community composition (Likens 1975). Table 2G shows trophic variation observed during the spring and summer visits for secchi depth, chlorophyll *a*, total phosphorus and total nitrogen. The N/P ratio indicated that phosphorus was the limiting nutrient for both lakes during this study (Table 3G).

Phytoplankton community composition in Laguna Madre was dominated by the blue-green algae Microcystis during the spring and summer visits where their numbers totaled seventy-eight and eighty-four percent of the total community composition respectively. Lesser numbers of other Cyanophyta and Euglenophyta were present supporting the overall eutrophic determination (Likens, 1975). Diatom community composition was not determined due to sample damage.

Phytoplankton community composition in Stubblefield Lake was dominated by the diatom *Fragilaria* during the spring visit with *Euglena* and the blue-green, *Microcystis* making up the majority of the remaining phytoplankton population. The summer visit showed a predominance of blue-green species where *Anabaena* and *Microcystis* comprised about seventy-five percent of the total community with lesser amounts of Euglenophyta and green algal species. These Cyanophyta and Euglenophyta are common to waters high in nutrient input and reflect the eutrophic conditions that existed during this survey (Likens, 1975). Diatom community composition from Stubblefield Lake consisted of 40 species, where *Navicula veneta* Kützing, *Nitzschia frustulum* (Kützing) Grunow, *Achnanthidium minutissimum* (Kützing) Czarnecki and *Achnanthes delicatula* (Kützing) Grunow comprised over 50 percent of the community.

Water quality results from the water quality survey conducted by Potter and Davis in September, 1987 on Laguna Madre showed comparable results with the current study for total nitrogen, total phosphorus, Forel-Ule color and physical parameters. The only exception being two pH results, which exceeded the pH warmwater aquatic life criterion.

Water quality results from the 1987 water quality survey on Stubblefield Lake showed lower nitrogen and phosphorus concentrations which may be explained by the larger pool size that existed during that survey. Secondary nutrient indicators such as chlorophyll *a*, secchi depth, Forel Ule color and pH were also lower during the previous study. However, pool size as well as the six week difference in seasonal sampling must be factored into the overall evaluation of these types of irrigation reservoirs in which seasonal variations in addition to water delivery demands may result in considerable variability of water quality conditions.

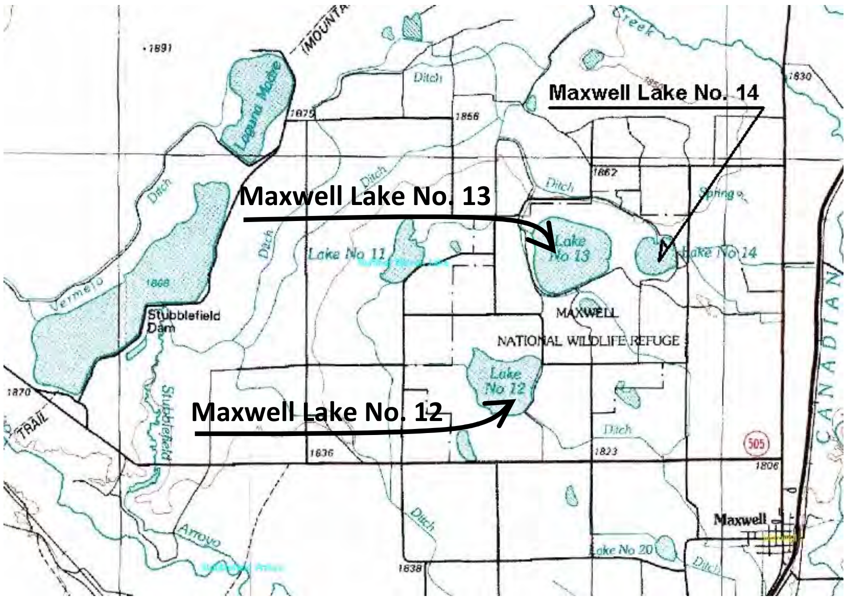

Stubblefield Lake, April, 2006

All physical, chemical and biological findings support and confirm a healthy and viable warmwater aquatic life use in Laguna Madre. However, the warmwater aquatic life use associated with Stubblefield Lake remains listed due to mercury in fish tissue (Table 4G). This listing will remain as a cause of non-support until new findings show this concern no longer exists. Although Laguna Madre is not listed within the New Mexico Fish Consumption Guidelines due to mercury contamination, the close proximity of Stubblefield Lake and the common water source supplying both lakes suggest that anglers may want to refer to this advisory before consuming fish taken from Laguna Madre. All other physical, chemical and biological findings in Stubblefield Lake support and confirm a healthy fish community. In addition, the uses of primary and secondary contact recreation, irrigation, livestock watering, and wildlife habitat were fully supported in both lakes during the study period (Table 4G).

Water Quality and Biological Assessment Survey of Maxwell Lake No. 12, No. 13, and No. 14 Colfax County, April 19 and August 9, 2006.

<u>Danny R. Davis, Principal Investigator</u>

Maxwell Lakes No. 12, No. 13, and No. 14 are playa lakes located within the Maxwell National Wildlife Refuge near Maxwell, New Mexico, where water is stored for wildlife habitat and irrigation storage and angling for both cold and warm water fish species. Current estimates of storage capacity for the three lakes are 910 acre-feet for No. 12, 4,480 acre-feet for No. 13, and 680 acre-feet for No. 14.



The lakes are fed by water diverted from Chicorica Creek via a series of canals, and stores irrigation water managed by the Vermejo Conservancy District. The U.S. Bureau of Reclamation constructed the various irrigation storage lakes in the 1950's, and the U.S. Fish and Wildlife Service established the refuge in 1966 beginning its management of 3,200 acres of grassland, agricultural land and water storage impoundments of the Vermejo Conservancy District.


Maxwell Lake No. 12

The elevation of the Maxwell Lake No. 12 is roughly 1,830 meters (6,004 ft), No. 13 is approximately 1,843 meters (6,046 ft), and No. 14 is around 1,841 meters (6,040 ft) above mean sea level. The Maxwell Lakes are located within the most characteristic component of the Southwestern Tablelands Ecoregion contained within Aggregate Ecoregion IV (the Great Plains Grass and Shrublands) (Omernik and Griffith,2006). These lakes receive an average of 35.8 cm (14.1 in) of precipitation per year with pan evaporation historically averaging 83.3 cm (32.8 in) per year resulting in a deficit of 47.4 cm (18.65 in) per year (Gabin and Lesperance 1977).

Erik Frey of the New Mexico Department of Game and Fish confirmed that the Maxwell Lakes will typically support black bullhead, yellow perch, white sucker, channel catfish, walleye, and large mouth bass, all warmwater fishes. Thus, it can be concluded that when conditions are favorable, a warmwater aquatic life use and associated fishery exists. Additionally, rainbow trout continue to be a popular game species in Maxwell Lake No. 13, which reflects the existing marginal coldwater designation. Due to the interconnectedness of the refuge and adjacent waterbodies by canals, it is reasonable to assume that some migration between lakes may occur over time aiding in the reestablishment of a fish community. However, temperatures commonly exceed the 20 ºC coldwater criterion and drought can cause the lakes to dry up, clearly impairing and severely limiting the ability of the lakes to sustain a viable fishery on an annual basis.

Maxwell Lake No. 13

Prior to 2005, the Maxwell Lakes were unclassified, in other words they were not specifically included within a water quality standards segment. In 2005, they were temporarily placed under water quality segment 20.6.4.99 (“99”). Segment “99” is designed to protect all perennial unclassified waters of the State. The Maxwell Lakes will remain under 20.6.4.99 until a new water quality segment specific to these lakes can be created or until a new default segement specific to lakes, in general, is developed. Existing uses that are not covered under the designated uses described in segment “99”, such as irrigation or warmwater aquatic life, are noted in SWQB’s Assessment Database (ADB) and are taken into consideration during assessment. By using the information and data collected from this survey, it is SWQB’s intent to propose a lake-specific water quality segment for the Maxwell Lakes (or default classification) that includes all the existing *and attainable* uses of these lakes in order to provide them with suitable and appropriate protection.

Maxwell Lake No. 14

Water quality sampling occurred on two occasions, April 19, and August 9, 2006. In 1987, a multiple lake characterization study was conducted by Potter and Davis that included the same Maxwell Lakes studied during the 2006 study effort. Some reference will be made to this earlier lake study for comparative purposes and to establish if substantive changes in water quality and habitat conditions are evident.

Table 1H. Physical characteristics for the Maxwell Lakes, 2006.

Physical Characteristics		No. 12	No. 13	No. 14
Secchi Depth (m)	**Sp**	1.75	Est. 0.5	Est. > 1.0
	Su	1.5	2.2	> 1.5
Forel Ule Color	**Sp**	10	10	9
	Su	12	15	14
Maximum Depth (m)	**Sp**	1.0	Shore (0.25)	Est. 1.5
	Su	1.5	3.9	1.5
Euphotic Zone (m)	**Sp**	> 1.0	MDP	MDP
	Su	> 1.5	>3.9 (est.7)	> 1.5
Surface Area in km^2 (Acres)	**Sp**	1.36 (335)	1.32 (326)	0.49 (120)
	Su	1.36 (335)	1.32 (326)	0.49 (120)
Anoxic Hypolimnion (Y/N)	**Sp**	No	No	No
	Su	No	No	No
Stratified (Y/N) @ Depth (m)	**Sp**	No	No	No
	Su	No	No	Yes (1m)
pH (s.u.) @ Surface	**Sp**	8.14	8.44	7.88
	Su	9.43	9.44	9.29
Conductivity (μS)	**Sp**	1,717	1,180	1,670
	Su	1,820	1,013	900
Turbidity (NTUs)	**Sp**	6.29	14.9	4.04
	Su	5.67	4.40	1.55
Integrated Sample Surface to (m)	**Sp**	0.25	0.25	0.25
	Su	0.25	3.0	1.0
Dissolved Oxygen @ Surface (mg/L)	**Sp**	8.47	9.0	7.18
	Su	7.80	9.98	9.66
Dissolved Oxygen @ Bottom (mg/L)	**Sp**	N/A	N/A	N/A
	Su	N/A	7.92	10.57
Temperature @ Surface (°C)	**Sp**	12.62	15.56	11.18
	Su	23.40	23.95	24.5
Temperature @ Bottom (°C)	**Sp**	N/A	N/A	N/A
	Su	N/A	22.59	23.22
Chlorophyll *a*	**Sp**	1.03	1.12	0.75
	Su	2.06	13.27	1.87

Sp = Spring; Su = Summer; MDP = missing data point

Table 2H. Trophic State (Carlson, 1977) – Maxwell Lakes, 2006

		No. 12	No. 13	No. 14
Secchi Depth	**Sp**	Eutrophic	Eutrophic	Eutrophic
	Su	Eutrophic	Mesotrophic	Eutrophic
Chlorophyll *a*	**Sp**	Oligomesotrophic	Oligomesotrophic	Oligotrophic
	Su	Oligomesotrophic	Eutrophic	Oligomesotrophic
Total Phosphorus	**Sp**	Eutrophic	Eutrophic	Eutrophic
	Su	Eutrophic	Eutrophic	Eutrophic
Total Nitrogen	**Sp**	Eutrophic	Eutrophic	Eutrophic
	Su	Eutrophic	Eutrophic	Mesotrophic
Overall Trophic Condition		**Mesoeutrophic**	**Eutrophic**	**Mesoeutrophic**

Table 3H. Limiting Nutrient – Maxwell Lakes, 2006

	No. 12		No. 13		No. 14	
	Spring	**Summer**	**Spring**	**Summer**	**Spring**	**Summer**
Limiting Nutrient	P	P	N/P	N/P	P	P

Table 4H. Summary of attainment status for all designated uses – Maxwell Lakes, 2006

Designated or Existing Use	No. 12		No. 13		No. 14	
	Criteria Exceedence	Attainment Status	Criteria Exceedence	Attainment Status	Criteria Exceedence	Attainment Status
****Warmwater Aquatic Life**	None	FS	None	FS	None	FS
****Marginal Coldwater Aquatic Life**	N/A	N/A	None	FS	N/A	N/A
****Irrigation**	None	FS	None	FS	None	FS
Wildlife Habitat	None	FS	None	FS	None	FS
Livestock Watering	None	FS	None	FS	None	FS
Secondary Contact	None	FS	None	FS	None	FS
****Primary Contact**	None	FS	None	FS	None	FS

** These uses do exist and should be supported within an appropriate Water Quality Segment.
FS = Fully Supporting; N/A = designated use not applicable to this lake

Water Quality Assessment

Physical measurements collected at the Maxwell Lakes included temperature, specific conductance, dissolved oxygen, pH, and turbidity (Table 1H). Lake chemistry sampling consisted of total and dissolved nutrients, anions and cations, total and dissolved heavy metals, volatile and semi-volatile synthetic organic compounds, radionuclides, cyanide, and E. coli bacteria, which cover all standards criteria pertinent to the protection of all designated or existing uses. Phytoplankton, diatom and chlorophyll analyses were also performed. Only criteria exceedences are discussed below, however all data are available upon request.

Currently, development of lake and reservoir nutrient criteria specific to this ecoregion are being developed for total nitrogen and total phosphorous for use as a multiparametric nutrient assessment tool. Until this assessment tool is complete, nutrient assessments are provided using methods and indicators consistent with past assessment.

Table 2H shows trophic variation observed during the spring and summer visits for secchi depth, chlorophyll *a*, total phosphorus, and total nitrogen. **Maxwell Lake No. 12 and No. 14** may be classified as mesoeutrophic according to Carlson's (1977) indices and algal community composition (Likens 1975), whereas **Maxwell Lake No. 13** may be classified as eutrophic. During this study, the N/P ratio indicated that phosphorus was the limiting nutrient for **Maxwell Lakes No. 12 and 14** and that nitrogen and phosphorus were co-limiting in **Maxwell Lake No. 13** (Table 3H).

The spring phytoplankton community composition in **Maxwell Lake No. 12** was dominated by the blue-green algae *Microcystis* which comprised about 41 percent of the community of twenty-three species. Twelve percent of the spring community was *Euglena* resulting in about fifty-three percent of the community dominated by these two genera. Summer phytoplankton community also consisted of twenty-three species where the two spring dominants were reversed. *Euglena* represented about thirty-four percent while *Microcystis* dropped to thirteen percent of the total population. The Cyanophyta and Euglenophyta are commonly dominant in waters with high nutrient load. This adds support to the determination that mesoeutrophic conditions existed during the survey visits (Likens 1975). Diatom community composition consisted of 40 species, where *Navicula veneta* Kützing, and *Nitzschia frustulum* (Kützing) Grunow comprised over 60 percent of the community.

The spring phytoplankton community composition in **Maxwell Lake No. 13** was dominated by the green algae *Spirogyra* and *Zygnema,* which comprised about 56 percent of the community of twenty-one species. Summer phytoplankton community had only nine species identified with *Anabaena* and *Microcystis,* both cyanobacteria, dominating the community with about seventy-nine percent of the total composition. The Cyanophyta are commonly dominant in waters with high nutrient load. This adds support to the overall eutrophic determination that existed during the survey visits (Likens 1975). Diatom community composition consisted of thirty-one species, where *Navicula veneta* Kützing, and *Amphora veneta* Kützing comprised almost 32 percent of the population. Sixteen members of the genus *Nitzschia* were identified representing over 50 percent of the total community composition.

The spring phytoplankton community composition in **Maxwell Lake No. 14** was dominated by the Euglenophyta, which comprised 39 percent of the total community where twenty species were identified. The second dominant taxon was *Chlamydomonas,* a green algae,


Maxwell Lake No. 12

closely followed by the genera *Cryptomonas.* The summer algal community consisted of the blue-green algae *Microcystis,* which comprised about 41 percent of the community of twenty-three species. *Euglena* followed totaling over twelve percent of the summer phytoplankton community. The Cyanophyta and Euglenophyta are commonly dominant in waters with high nutrient load. This adds support to the determination that mesoeutrophic conditions existed during the survey visits (Likens 1975). Diatom community composition consisted of twenty-one species where *Navicula veneta* Kützing, and *Rhoicosphenia abbreviata* (Agardh) Lange-Bertalot comprised over thirty-three percent of the community. *Epithemia sorex* Kützing was also very common representing over ten percent of the phytoplankton community.


Maxwell Lake No. 13

Water quality results from the water quality survey conducted by Potter and Davis in September, 1987 on **Maxwell Lake No. 12** showed similar results with the current study for total nitrogen, total phosphorus, Forel-Ule color and physical parameters. The only exception was a slight decrease in chlorophyll *a*, when compared to the earlier study. It appears that the overall water quality and trophic conditions present during the 1987 study are comparable to more recent conditions.

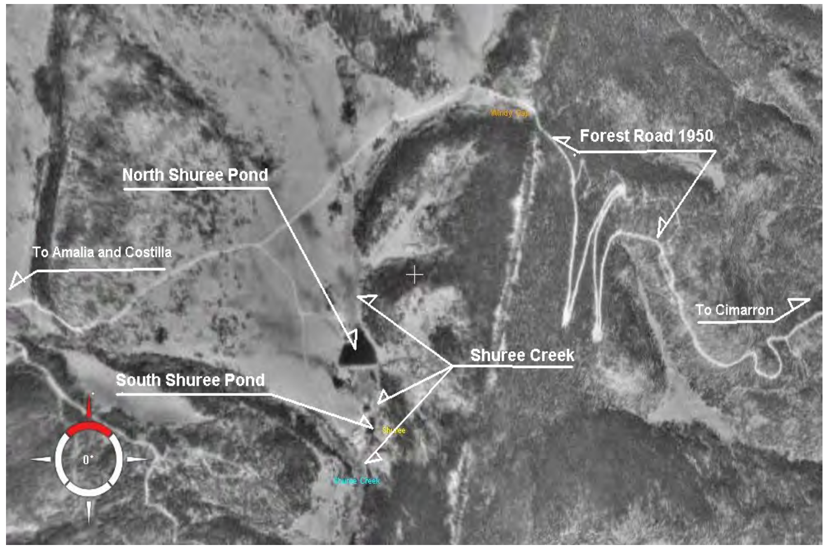
Maximum depth of **Maxwell Lake No. 13** during the 1987 sampling effort was approximately two meters deeper than in 2006, which may explain the overall lower readings for specific conductance, temperature, and pH. Dissolved oxygen saturation was very high reaching 157% during the 2006 summer sampling effort, but this may have been due to the afternoon timing compared to a early morning sampling time in 1987. Euphotic depth reached three meters in 1987 with a corresponding Secchi depth of 0.80 meters. Nitrogen and phosphorus concentrations were almost identical to those measured in 1987. One exceedence of the pH criterion was recorded during the August sampling visit, though this single exceedence did not result in an impairment determination.

Maximum depth of **Maxwell Lake No. 14** during the 1987 sampling effort was, at most, 0.25 meters deeper than in 2006, which is insignificant for a shallow playa lake. In 1987, the single sampling visit took place in late September, approximately five weeks later than the summer visit in 2006. This may explain the cooler water temperatures, high dissolved oxygen concentrations, and lower secondary response variables such as Forel-Ule color. Specific conductance was about half of what was measured in 2006. Nitrogen and phosphorus concentrations were relatively similar between the 1987 and 2006 sample results. Similar to Maxwell Lake No. 13, one exceedence of pH criterion was recorded during the August sampling visit, but this single exceedence did not trigger an impairment determination.

All physical, chemical and biological findings support and confirm that the marginal coldwater, warmwater, and marginal warmwater aquatic life uses are fully supported in the Maxwell National Wildlife Refuge assuming adequate water levels are maintained. Wildlife habitat, livestock watering, secondary contact, irrigation, and primary contact were also fully supported in these lakes during this survey (Table 4H).

**Water Quality and Biological Assessment Survey of
South and North Shuree Pond,
Colfax County, April 13 and May 16, 2006.**

Danny R. Davis, Principal Investigator



South Shuree Pond is a one-half acre lake and North Shuree Pond is a three-acre lake located within the Valle Vidal Unit of the Carson National Forest. These lakes are in a series of small ponds that impound water flowing from Shuree Creek, a very small tributary to the Middle Ponil Creek.

The Valle Vidal Unit of the Carson National Forest became public land in 1982 when the Pennzoil Company donated 101,794 acres to the people of America. The ponds are managed by the New Mexico Department of Game and Fish, which owns the old lodge building adjacent to South Shuree Pond. The Department of Game and Fish provide and maintain an excellent trout fishery, regularly stocking 12-20 inch rainbow trout. The National Forest maintains two camping areas in close proximity to the Shuree Ponds that include family and group camping sites, picnic tables, and restrooms.

The Shuree Ponds are located within the most characteristic component of the Southern Rockies Ecoregion contained within Aggregate Ecoregion II (the Western Forested Mountains) (Omernik and Griffith, 2006). These lakes receive an average of 51.7 cm (20.4 in) of precipitation per year with pan evaporation historically averaging 54.2 cm (21.3 in) per year resulting in a deficit of 15.6 cm (6.2 in) per year based upon the closest long-term station of similar elevation at Red River, New Mexico (Gabin and Lesperance 1977).

The Shuree Ponds are classified under segment 20.6.4.309 NMAC in New Mexico Water Quality Standards for Interstate and Intrastate Surface Waters (NMAC 2007), with designated uses of domestic water supply, irrigation, high quality coldwater aquatic life, livestock watering, wildlife habitat, municipal and industrial water supply, and secondary contact being recognized. The purpose of this study was to assemble baseline water quality data for the Shuree Ponds and to collect water quality data specific to the needs for numeric nutrient criteria development. The Shuree Ponds were visited on two occasions, however, the April, 2006 visit was done from the shore and lacked many of the formal lake sampling and characterization attributes normally applied to lake studies. The May visit included such evaluative measurements as secchi depth, full depth profiles, Forel Ule water color and so forth. The studies of the Shuree Ponds provided first-time information of the health and condition of these surface waters.


South Shuree Pond


North Shuree Pond

Table 1I. Major Physical Characteristics of South & North Shuree Ponds – 2006.

Physical Characteristics	South Shuree Pond		North Shuree Pond	
	April	May	April	May
Secchi Depth (m)	MDP	2.6	MDP	2.7
Forel Ule Color	MDP	8	MDP	7
Maximum Depth (m)	MDP	3.6	MDP	5.6
Euphotic Zone (m)	MDP	>3.6	MDP	>5.6
Surface Area in km^2 (Acres)	0.001 (0.25)	0.001 (0.25)	0.01 (3)	0.01 (3)
Anoxic Hypolimnion (Y/N)	MDP	No	MDP	No
Stratified (Y/N) @ (m)	MDP	No	MDP	No
pH units (SUs) Surface	8.93	7.58	8.88	8.8
Conductivity (µS) (Surface)	163	265	222	165
Turbidity (NTUs)	2.2	1.44	1.7	1.86
Integrated sample surface to (m)	Surface	2.5	Surface	0.25
Dissolved Oxygen Surface (mg/L)	9.76	4.7	9.55	6.81
Dissolved Oxygen Bottom (mg/L)	MDP	4.5	MDP	6.93
Temperature Surface (°C)	8.56	13.08	9.74	12.42
Temperature Bottom (°C)	MDP	12.06	MDP	11.9
Chlorophyll *a* (µg/L)	MDP	0.87	MDP	0.31

Table 2I. Trophic State (Carlson 1977)

	South Shuree Pond		North Shuree Pond	
	April	**May**	**April**	**May**
Secchi depth	MDP	Mesotrophic	MDP	Mesotrophic
Chlorophyll *a*	MDP	Oligotrophic	MDP	Oligotrophic
Total Phosphorus	Eutrophic	Mesotrophic	Oligomesotrophic	Eutrophic
Total Nitrogen	Mesotrophic	Mesotrophic	Mesotrophic	Mesotrophic
Overall Trophic Condition	**Mesotrophic**		**Mesotrophic**	

Table 3I. Limiting Nutrient

	South Shuree Pond		North Shuree Pond	
	April	**May**	**April**	**May**
Limiting Nutrient	N/P	P	N/P	P

Table 4I. Summary of attainment status for all designated uses

Designated or Existing Use	South Shuree Pond		North Shuree Pond	
	Criteria Exceedence	**Attainment Status**	**Criteria Exceedence**	**Attainment Status**
High Quality Coldwater Aquatic Life	None	Fully Supporting	None	Fully Supporting
Livestock Watering	None	Fully Supporting	None	Fully Supporting
Secondary Contact	None	Fully Supporting	None	Fully Supporting
Wildlife Habitat	None	Fully Supporting	None	Fully Supporting
Domestic Water Supply	None	Fully Supporting	None	Fully Supporting
Municipal and Industrial Water Supply	None	Fully Supporting	None	Fully Supporting
Irrigation	None	Fully Supporting	None	Fully Supporting

Water Quality Assessment

Physical measurements collected at the Shuree Ponds included temperature, specific conductance, dissolved oxygen, pH, and turbidity (Table 1I). Lake chemistry sampling consisted of total and dissolved nutrients, anions and cations, total and dissolved heavy metals, volatile and semi-volatile synthetic organic compounds, radionuclides, cyanide, and E. coli bacteria, which cover all standards criteria pertinent to the protection of all designated or existing uses. Phytoplankton, diatom and chlorophyll analyses were also performed. Only criteria exceedences are discussed below, however all data are available upon request.

Currently, development of lake and reservoir nutrient criteria specific to this ecoregion are being developed for total nitrogen and total phosphorous for use as a multiparametric nutrient assessment tool. Until this assessment tool is complete, nutrient assessments are provided using methods and indicators consistent with past assessment.

Table 2I shows trophic variation observed during the spring and summer visits for secchi depth, chlorophyll *a*, total phosphorus, and total nitrogen. According to Carlson's (1977) indices and algal community composition (Likens 1975), the overall trophic condition of both South and North Shuree Ponds during the survey was mesotrophic (Table 2I). Phosphorus and nitrogen were determined to be co-limiting in the Shuree Ponds during April, whereas phosphorus was the limiting nutrient in May (Table 3I).

Phytoplankton community composition in South Shuree Pond consisted of seventeen species during the May sampling visit. The Cyanophyta were most dominant with fifty-seven percent of the community consisting of *Microcystis.* The green algae, *Oocystis* comprised slightly less than ten percent of the community and *Euglena* were present with roughly nine percent of the total community. It is interesting to see the Blue-green algae dominating the phytoplankton community in such a remote, high elevation location during the spring season. However, Shuree Creek is a very low flow source stream, which suggests that the overall flushing rate for this little pond is low. Both the Cyanophyta and Euglenophyta are commonly associated with waters that have elevated nutrient concentrations (Likens 1975).

South Shuree Pond

Diatom community composition in South Shuree Pond was derived from a single sample collected from multiple substrates during the sampling visit and consisted of thirty-seven species with *Encyonopsis microcephala* (Grunow) Krammer, comprising almost thirty percent of the community. *Achnanthes minutissima*, Kützing comprised almost twenty-five percent of the total community and *Gomphonema parvulum* (Kützing) Kützing represented over nine percent of the total, 500 cell count.

Phytoplankton community composition was not determined for North Shuree Pond, however diatom community composition in North Shuree Pond was derived from a single sample collected from multiple substrates during the sampling visit and consisted of forty-seven species with *Staurosira construens* var. *venter* (Ehrenberg) Hamilton comprising over 33 percent of the community. *Staurosirella pinnata* (Ehrenberg) Williams et Round was the second most common diatom with over 17 percent of the community mix. *Hippodonta capitata* (Ehrenberg) Lange-Bertalot, Metzeltin et Witkowski, formerly *Navicula capitata* Ehrenb., was the third most common and represented about seven percent of the total 500 cell count.

The elevated nutrient concentration in South Shuree Pond likely resulted in the dissolved oxygen concentration being below the criterion during one of the two visits. Though this does not result in a determination of non-support, it may prompt future questions regarding aquatic life use potential especially for this smaller pond. Similarly, pH was slightly in excess of the pH criterion during the April visit. All other chemical and physical parameters were well within acceptable limits and all applicable uses were fully supported.

Fifteen to twenty inch rainbow trout are stocked in the Shuree Ponds numerous times each year. Depths encountered during the sampling visit suggest that remaining trout could survive winter and possibly reproduce, which would further qualify these waters as High Quality Coldwater Aquatic Life habitats. One concern regarding the South Shuree Pond is the small size and shallower depth compared to the larger and deeper North Shuree Pond. Though all applicable uses are currently fully supported, there may be future concern for eventual challenges stemming from the relatively small lake size and limited perennial flow with a large watershed to lake size ratio.

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