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WATER QUALITY ASSESSMENTS FOR SELECTED NEW MEXICO LAKES

1998

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LAKE WATER QUALITY MONITORING, TROPHIC STATE EVALUATION, AND STANDARDS ASSESSMENT'S FOR:

Eagle Nest Reservoir, Seva J. Joseph
El Vado Reservoir, Danny R. Davis
Bottomless Lakes, D. R. Davis
Fenton Lake, S. J. Joseph

1998

EXECUTIVE SUMMARY

Water quality surveys and assessments were completed in fulfillment of work-plan commitments of the *FY 98-99 Section 106 Work Program for Water Quality Management.* This program was partially funded by a grant from the U.S. Environmental Protection Agency.

During 1998 the Surveillance and Standards Section of the Surface Water Quality Bureau of the New Mexico Environment Department conducted water quality and biological assessment surveys of three lacustrine systems. Eagle Nest Reservoir, El Vado Reservoir and Fenton Lake were studied concurrently with an intensive Total Maximum Daily Load (TMDL) stream study's conducted within the respective watersheds. Studying lakes in this way helps to insure a timely return to the lake system as watersheds are revisited, and also adds to the understanding of surface waters within the drainage basin. Water quality sampling methods were in accordance with the "Quality Assurance Project Plan for Water Quality Management Programs" (NMED 1998).

A special study was conducted at the Bottomless Lakes State Park, where karst geology has resulted in very unique collapse basins, sinkholes or cenote as the Spanish and Mayan called them. These surface water features contact groundwater resulting in perennial pools, unique biotic communities and water quality characteristics. This study marked the first intensive sampling effort at Bottomless Lakes State Park.

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 existing, attainable or designated uses in the State of New Mexico Standards for Interstate and Intrastate Surface Waters, 1995.

Water chemistry sampling at lake stations included total and dissolved nutrient's, total and dissolved metal's, major ion's, total dissolved solids (TDS), hardness, alkalinity, radionuclides, organic scans, cyanide, and microbiological collections. Phytoplankton and benthic diatom samples were also collected for analysis. The following assessments do not include only results specifically related to a criteria exceedance and consequent standard violation. Complete data are available upon request.

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Eagle Nest Reservoir, Colfax County, April 23, July 15 and October 21, 1998.
Seva J. Joseph, Primary Investigator

Eagle Nest Reservoir, in Colfax County, New Mexico, began impounding water in 1918. Maximum storage capacity is 79,450 acre-feet, though the storage pool varied from 56,795 to 66,750 acre-feet during the study. The reservoir is fed by Cieneguilla, Six Mile and Moreno creeks, and is the source for the Cimmarron River. The Reservoir is in the Southern Rockies ecoregion (Omernik, 1987) and receives an average of 33.2 centimeters of precipitation per year. Elevation at the lake is about 2500 meters (8200 ft.). Eagle Nest Lake is unclassified, however attainable uses include domestic water supply, irrigation, high quality coldwater fishery, livestock watering, wildlife habitat, municipal and industrial water supply and secondary contact.

Table 1. Seasonal variation of physical characteristics of Eagle Nest Reservoir.

Physical Characteristics	Deep Station		Shallow Station	
Secchi (M)	Sp	2.40	Sp	1.70
	Su	3.25	Su	>1.20
	Fall	1.90	Fall	0.80
Forel Ule Color	Sp	3	Sp	4
	Su	4	Su	4
	Fall	5	Fall	-
Maximum Depth (M)	Sp	25.8	Sp	1.75
	Su	24.1	Su	1.20
	Fall	24.5	Fall	1.70
Euphotic Zone (M)	Sp	6.0	Sp	>1.75
	Su	8.5	Su	>1.2
	Fall	3.5	Fall	1.7
Surface Area (Acres)	Sp	Mdp	Sp	Mdp
	Su	Mdp	Su	Mdp
	Fall	Mdp	Fall	Mdp
Storage Capacity (Ac. Ft.)	Sp	66,750	Sp	66,750
	Su	66,114	Su	66,114
	Fall	56,795	Fall	56,795

Table 1. Con't.

Physical Characteristics		Deep Station		Shallow Station
Anoxic Hypolimnion (Y/N)	Sp	Mdp	Sp	Mdp
	Su	Yes	Su	No
	Fall	No	Fall	No
Stratified (Y/N) @ depth (M)	Sp	No	Sp	No
	Su	Yes @ 7 meters	Su	No
	Fall	No	Fall	No
pH	Sp	8.49	Sp	8.42
	Su	8.58	Su	8.70
	Fall	8.20	Fall	8.46
Conductivity (umhos/cm)	Sp	320	Sp	321
	Su	321	Su	322
	Fall	322	Fall	322
Turbidity (ntu)	Sp	1.87	Sp	2.63
	Su	5.47	Su	3.49
	Fall	8.31	Fall	7.68
Integrated Sample surface to (M)	Sp	6.0	Sp	1.0
	Su	24	Su	1.0
	Fall	4.0	Fall	Surface
Dissolved Oxygen Surface (mg/L)	Sp	Equip. Failure	Sp	Equip. Failure
	Su	7.20	Su	6.9
	Fall	7.70	Fall	8.20
Dissolved Oxygen Bottom (mg/L)	Sp	Equip. Failure	Sp	Equip. Failure
	Su	0.3	Su	7.8
	Fall	4.4	Fall	8.3
Temperature Surface C	Sp	4.6	Sp	6.2
	Su	20.4	Su	22.8
	Fall	10.8	Fall	10.0
Temperature Bottom C	Sp	3.8	Sp	5.8
	Su	14.9	Su	22.1
	Fall	10.6	Fall	10.1
Chlorophyll *a* (corrected)	Sp	3.18	Sp	2.80
	Su	2.06	Su	2.15
	Fall	Mdp	Fall	Mdp

Mdp = missing data point.

Table 2. Trophic State (Carlson's, 1977)

Trophic State Indices		Deep Station		Shallow Station
Secchi depth	Sp	Eutrophic	Sp	Eutrophic
	Su	Mesotrophic	Su	Eutrophic
	Fall	Eutrophic	Fall	Eutrophic
Chlorophyll *a*	Sp	Oligotrophic	Sp	Oligotrophic
	Su	Oligotrophic	Su	Oligotrophic
	Fall	Mdp	Fall	Mdp
Total Phosphorus	Sp	Mdp	Sp	Mdp
	Su	Eutrophic	Su	Oligotrophic
	Fall	Eutrophic	Fall	Eutrophic

Overall Trophic Condition	Mesotrophic

Table 3. Nitrogen/Phosphorus Ratio

		Deep Station		Shallow Station
Limiting Nutrient	Sp	N	Sp	N
	Su	N	Su	P
	Fall	N or P	Fall	N or P

Table 4. Use Attainment

Designated or Attainable Use	Criteria Exceedence	Attainment Status
Domestic Water Supply	None	Fully Supporting
Irrigation	None	Fully Supporting
High Quality Coldwater Fishery	None	Fully Supporting
Livestock Watering	None	Fully Supporting
Wildlife Habitat	None	Fully Supporting
Muni. And Ind. Water Supply	None	Fully Supporting
Secondary Contact	Fecal Coliform	Fully Supporting, Impacts Observed

Water Quality Assessment

Lake chemistry sampling consists of total and dissolved nutrients, anions and cations, total and dissolved heavy metals, organics, radionuclides, and cyanide, which cover all standards criteria pertinent to the protection of all designated uses. These data are available upon request, though any criteria exceedences will be discussed in the following narrative.

Eagle Nest Lake may be classified as mesotrophic according to Carlson's (1977) indices, and algal community composition (Likens 1975). Table 2 shows the variation observed seasonally and between stations for secchi depth, chlorophyll *a*, and total phosphorus. Phytoplankton community composition consisted mostly of members of the Cryptophyceae resulting in relatively low diversity. Benthic diatom community

composition consisted of 22 species, and a high diversity according to Shannon-Weaver (1949). The diatom community consisted of common members, many of which preferred waters of moderate to high nutrient enrichment.

Though Eagle Nest Lake fit generally within the mesotrophic or moderately enriched category, development within the Moreno Valley, close proximity to Angel Fire Ski resort, the presence of the town of Eagle Nest adjacent to the lake with waste water lagoons at the lake shore, and cattle grazing within the valley, suggest that gradual eutrophication of this high elevation lake is likely.

Eagle Nest Reservoir was not stratified during either spring or fall sampling runs, however a pronounced thermocline was present between seven and eight meters during the summer visit. Below this depth, dissolved oxygen fell below the six mg/l standard for coldwater fisheries. However, this did not result in exceedence because the standard applies only to epilimnetic or upper 1/3 of the water column.

Fecal coliform results of 1,100/100ml, from a sample taken near the wastewater lagoons during the summer visit exceeded the site specific standard for fecal coliform bacteria of 100/100 ml. Current protocols used to assess use attainment for secondary contact would result in "Full Support, Impacts Observed." There were no other exceedences of water quality criteria observed from water chemistry samples collected during the study.

El Vado Reservoir, Rio Arriba County, April 15, July 22 and October 28, 1998.
Danny R. Davis, Primary Investigator

El Vado Reservoir in north-central New Mexico was completed in 1935, and is located 45 kilometers southwest of Chama, New Mexico. It has a capacity of 186,250 acre-feet between gage heights of 2,060 m and 2,104 m. The drainage basin of the reservoir is 2,263 km^2, of which 260 km^2 is non-contributing. The reservoir surface area is about 13 km^2; its mean depth is 18.3 m and maximum depth is 38 m. The reservoir impounds the Rio Chama and release water from Heron Lake. The watershed is generally characterized as Southern Rocky Mountain ecoregion (Omernik, 1987), where mean annual rainfall averages 35.6 cm per year (Gabin and Lesperance 1977). Water quality standards for El Vado Lake are set forth in sections 2117 and 3101 of the New Mexico water quality standards (NMWQCC 1995), which includes Heron Reservoir. Designated uses include irrigation storage, livestock watering, wildlife habitat, primary contact and coldwater fishery.

Table 1. Seasonal variation of physical characteristics of El Vado Reservoir.

Physical Characteristics	Deep Station		Shallow Station	
Secchi (M)	Sp	1.50	Sp	0.90
	Su	1.60	Su	1.40
	Fall	0.40	Fall	0.50
Forel Ule Color	Sp	4	Sp	5
	Su	3	Su	4
	Fall	5	Fall	5
Maximum Depth (M)	Sp	±40.0	Sp	11.0
	Su	>45.0	Su	9.50
	Fall	26.8	Fall	6.70
Euphotic Zone (M)	Sp	3.50	Sp	2.50
	Su	3.60	Su	3.20
	Fall	1.70	Fall	1.70
Surface Area (Acres)	Sp	2,818	Sp	2,818
	Su	3,003	Su	3,003
	Fall	1,709	Fall	1,709
Storage Capacity (Ac. Ft.)	Sp	147,162	Sp	147,162
	Su	162,278	Su	162,278
	Fall	74,511	Fall	74,511

Physical Characteristics	Deep Station		Shallow Station	
Anoxic Hypolimnion (Y/N)	Sp	No	Sp	No
	Su	No	Su	No
	Fall	No	Fall	No
Stratified (Y/N) @ depth (M)	Sp	No	Sp	No
	Su	Yes @ 6 meters	Su	Yes @ 2.5 meters
	Fall	No	Fall	No
pH (Surface)	Sp	7.92	Sp	8.08
	Su	8.51	Su	8.43
	Fall	7.57	Fall	7.86
Conductivity (Surface)	Sp	249	Sp	249
	Su	164	Su	165
	Fall	245	Fall	239
Turbidity (ntu)	Sp	7.14	Sp	15.2
	Su	10.5	Su	8.33
	Fall	23.9	Fall	22.3
Integrated Sample surface to (M)	Sp	3.5	Sp	2.5
	Su	35	Su	8.5
	Fall	1.7	Fall	1.7
Dissolved Oxygen Surface (mg/L)	Sp	9.5	Sp	9.6
	Su	7.1	Su	6.8
	Fall	7.6	Fall	7.6
Dissolved Oxygen Bottom (mg/L)	Sp	9.55	Sp	9.4
	Su	6.2	Su	4.95
	Fall	5.9	Fall	7.65
Temperature Surface (C)	Sp	6.5	Sp	6.6
	Su	24.7	Su	24.6
	Fall	12.5	Fall	12.3
Temperature Bottom (C)	Sp	5.7	Sp	6.4
	Su	8.9	Su	15.6
	Fall	11.7	Fall	12.3
Chlorophyll *a* (corrected)	Sp	1.93	Sp	2.62
	Su	0.19 (RQ)	Su	1.40
	Fall	0.35	Fall	1.74

MDP = missing data point; RQ = results questionable.

Table 2. Trophic State (Carlson's, 1977)

Trophic State Indices		Deep Station		Shallow Station
Secchi depth	Sp	Eutrophic	Sp	Eutrophic
	Su	Eutrophic	Su	Eutrophic
	Fall	Eutrophic	Fall	Eutrophic
Chlorophyll *a*	Sp	Oligotrophic	Sp	Oligotrophic
	Su	Oligotrophic	Su	Oligotrophic
	Fall	Oligotrophic	Fall	Oligotrophic
Total Phosphorus	Sp	Mdp	Sp	Mdp
	Su	Eutrophic	Su	Oligotrophic
	Fall	Eutrophic	Fall	Eutrophic

Overall Trophic Condition	Mesotrophic

Table 3. Use Attainment

Designated or Attainable Use	Criteria Exceedence	Attainment Status
Irrigation storage	None	Fully Supporting
Livestock watering	None	Fully Supporting
Wildlife Habitat	None	Fully Supporting
Primary Contact	None	Fully Supporting
Coldwater Fishery	1 aluminum exceedence; Summer surface temp	Fully Supporting

FS = Full Support; FSIO = Full Support Impacts Observed; PS = Partial Support; NS = Not Supported.

Table 4. Nitrogen/Phosphorus Ratio

	Deep Station		Shallow Station	
Limiting Nutrient	Sp	N	Sp	N
	Su	N	Su	P
	Fall	N	Fall	N

Water Quality Assessment

Lake chemistry sampling consists of total and dissolved nutrients (Total, inorganic and organic nitrogen species were calculated), anions and cations, total and dissolved heavy metals, organics, radionuclides, and cyanide, which covers all standards criteria pertinent to the protection of all designated uses. These data are available upon request, though any criteria exceedences will be discussed in the following narrative.

El Vado Reservoir may be classified as mesotrophic according to Carlson's (1977) indices, and algal community composition (Likens 1975). Table 2 shows trophic variation observed seasonally between stations for secchi depth, chlorophyll *a*, and total

phosphorus. Phytoplankton community composition consisted of members from the class' Cryptophyceae and Bacillariophyceae resulting in relatively low community richness. Benthic diatom community composition consisted of 38 total species, and a high diversity according to Shannon-Weaver (1949). The diatom community consisted of common members, many of which preferred waters of moderate to high nutrient enrichment with moderate mineral content. Nitrogen was the limiting nutrient for all seasonal station visits except for the summer visit at the shallow station, where phosphorus was determined to be limiting.

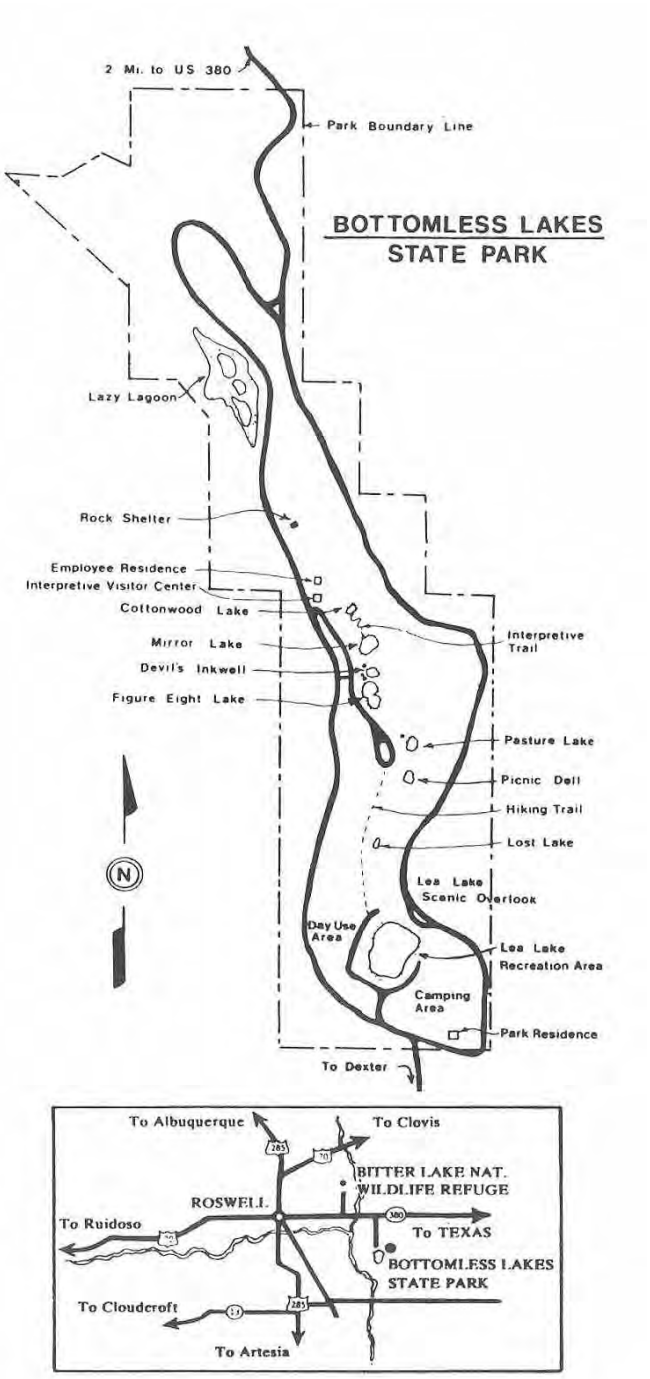
Water quality criteria exceedences for temperature and dissolved aluminum were observed during summer sampling. Both deep and shallow stations showed temperatures of 24.6º C at the surface, returning to the acceptable range of 20º C at 6 to 7 meter depths, however, no impacts were observed to the fishery use for which this standard applies. Furthermore, the conditions, which may exist during seasonally hot ambient temperatures compounded by changing reservoir pool size, are not interpreted as exceedences per paragraph "I" of the general standards, which state that, "High water temperatures caused by unusually high ambient air temperatures are not violations of these standards."

One exceedence for dissolved aluminum was found at the shallow station during the summer sampling run. The reported value of 100 ug/L would be considered a very marginal exceedence of the 87 ug/L criteria when taking into account the ± 10 ug/L detection limit associated with this laboratory result. In addition, under the current applicable assessment protocol, where "The chronic screening level is 1.5 times the chronic criteria shall be applied to grab samples," this is not considered an exceedance. Based on these interpretations, the coldwater fishery use is fully supported. All other listed uses were fully supported throughout the sampling period.

Bottomless Lakes State Park, Five small lakes, Chaves County, April 27-29, 1998.

Danny R. Davis, Primary Investigator

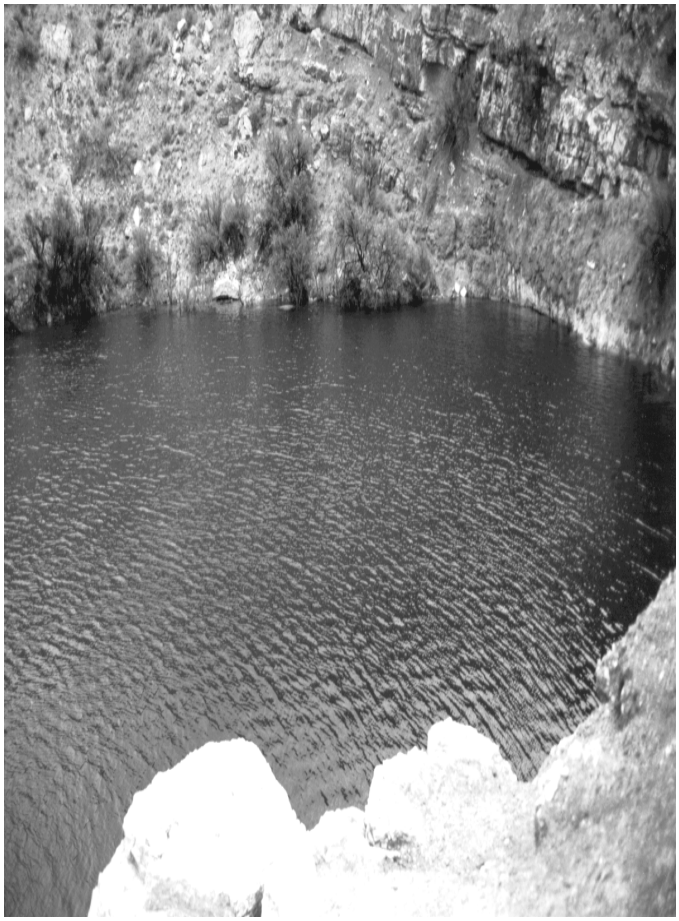
Bottomless Lakes State Park is a unique and beautiful area located about 10 miles southeast of Roswell, New Mexico. Bottomless Lakes State Park was dedicated in 1933 and was the first area state park established in New Mexico (see inset map). This park is is dtinguished by the presence of many desolation basins or sinkholes formed by the collapse of caverns formed by the dissolution of underlying salt and gypsum deposits. The name for the Bottomless Lakes came from stories of cowboys, who could not reach the bottom of the pools with their lariats tied together. In fact, currents from spring inflow probably pushed their lariats aside. Depths actually range from 17 to 90 feet. The lakes are located in the Southern Deserts ecoregion (Omernik, 1987) and receive an average of 32.3 centimeters (12.7 inches) of precipitation per year.



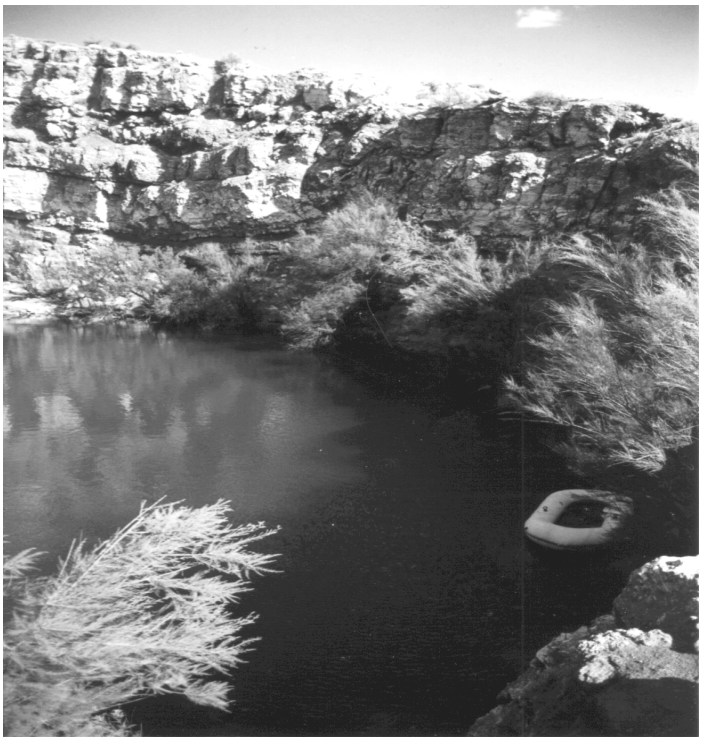
Before this study, no intensive water quality sampling had been conducted by this agency at Bottomless Lakes. It was felt that a comprehensive water quality sampling effort would enhance our understanding of these unclassified waters, and provide baseline information to help recognize existing and attainable uses. Below are a description, site photo, associated data and assessment for each lake. All basins were sampled for total and dissolved metals, total and dissolved nutrients, anions and cations, sediment metals, radionuclides, organics, chlorophyll, phytoplankton, diatoms and benthic macroinvertebrate. Physical measurements were recorded by depth to the bottom. Only limnological data specific to each lake is provided along with trophic and limiting nutrient evaluations. All other data are available upon request.

Mirror Lake, North Basin (MLN) was sampled on April 27, 1998 at a single deep station located close to the center of the lake using a small Jon boat as a work platform. It is reported that the New Mexico Department of Game and Fish stocks trout for winter fishing. The surface area is about three acres with a station elevation of 1,061 meters (3,480 feet) above mean sea level. Physical data, ions, total and dissolved nutrients and metals, sediment metals, radionuclides, organics, phytoplankton benthic macroinvertebrates, and diatoms were collected.

Mirror Lake, South Basin (MLS), was sampled immediately following efforts on the north basin. At one time, the north and south basins were separated by a landmass, which resulted in two very different basins with regard to water chemistry characteristics. At the time of the study, water levels in the basin, which are directly influenced by groundwater inflow, had risen substantially resulting in one lake. State Parks reported that prior to this rise in water level, the southern pond supported game fish while the northern pond could not due to extreme salinity. This suggests that water chemistry can vary significantly, even in such close proximity to another basin. Specific data, trophic evaluations, limiting nutrients, use evaluations and attainment determinations are provided in tabular form below.



Cottonwood Lake (CWL) was sampled on April 28, 1998, and had a maximum depth of 8.4 meters (27.5 ft.) at the time the survey was performed. This sinkhole has a surface area of about one-half acre with steep sides. Due to access limitations, an inflatable raft was lowered over the edge, followed by sampling equipment. Staff anchored in the center of the pool, allowing for sample collection and depth profile measurements. As with all of the study sites within Bottomless Lakes State Park, a complete suite of water chemistry samples was collected including nutrients, metals, ions. and organics. Physical measurements were recorded at one-meter intervals. Biological samples were also collected. The New Mexico Department of Game and Fish stock this lake with trout during winter months. A turtle and numerous fish rises were observed. The lake is also suitable for waterfowl loafing and feeding.



Devil's Inkwell (DI) was sampled on April 28, 1998. It is surrounded by very steep walls and is named for the dark appearance of the water. In fact, the watercolor, using the Forel-Ule colorometric method, was very low, as was turbidity. The Secchi depth was moderately high at 2.4 meters (7.9 ft.), and the euphotic zone, or that depth where one percent of the surface illumination remains, was estimated to be 7.2 meters (23.6 ft.). Surface area for Devil's Inkwell is reported to be 0.36 acres in size. Rainbow trout are stocked during winter months, and some fish rises were observed during sampling. Specific water quality data are presented in the following table. Water chemistry data are available upon request, but otherwise are only presented if they indicate a water quality criteria exceedence.

Lea Lake (LL) was sampled on April 29, 1998, and though not the largest water body in Bottomless Lakes State Park, is the largest surveyed during this study. The largest basin is Lazy Lagoon, which covers 26 acres, and actually consists of three sinkholes reported to be 27.4 meters (90 ft.) deep. Lea Lake is 15 acres in surface area, and reported to be 90 feet at the deepest point. Our Lea Lake station sampling depth was 24 meters (78.7 ft.).

Lea Lake is a popular recreational spot for those wishing to cool down from the hot, semiarid climate. The park operates a concession where petal cruisers and paddleboards are available for rent. The park also provides camping and boating at the lake. Due to the 2.5 million gallons of daily spring flow, which wells up from beneath the lake, water clarity is very good. This condition attracts scuba divers to the park. During this sampling effort, the euphotic zone was determined to end at 20 meters (65.6 ft.). Due to the primary contact uses common to Lea Lake, a fecal coliform sample was collected at this lake on the morning of April 30, 1998.

The photo to the right is of **Lea Lake** from an overlook (see previous map), and shows the visitors center on the south end of the lake. Due to high conductivity, Lea Lake does not support a sport fishery, however, the state listed Pecos pupfish, other small indigenous fishes, migratory waterfowl and neotropical migrants are common to the lake. Black Necked Stilts, American Coot and Western Grebe were present during the sampling visit. In addition, macroinvertebrate samples collected with an Eckman dredge yielded representatives of the Trichoptera, Odonata, Hemiptera and a gastropod snail. Algal samples were collected from a variety of substrates and showed a large and diverse community of benthic and planktonic representatives.

Table 1. Seasonal variation of physical characteristics for Bottomless Lakes.

Physical Characteristics	Mirror Lake No.	Mirror Lake 0o.	Cottonwood Lake	Devil's Inkwell	Lea Lake
Secchi Depth (M)	4.8	4.2	6.0	2.4	5.8
Forel Ule Color	3	3	4	4	2
Maximum Depth (M)	10.0	13.2	8.4	8.2	24
Euphotic Zone (M)	>10.0	11.0	>8.4 (est 18)	Est. 7.2	20
Surface Area (Acres)	± 3.0	0.44	0.52	0.36	15
Anoxic Hypolimnion (Y/N)	N	N	Y	N	N
Stratified (Y/N) @ (M)	Y @ 6.5	N	N	Y @ 0.5	Y @ 13.5
Ph (Surface)	8.08	8.13	7.8	8.06	7.85
Conductivity (Surface)	>20,000	>20,000	9,540	6,230	12,600
Turbidity (ntu)	1.78	1.03	0.67	2.87	0.93
Integrated sample surface to (M)	10	13	8.0	7.2	24
Dissolved Oxygen Surface (mg/L)	9.0	8.8	6.6	8.3	7.9
Dissolved Oxygen Bottom (mg/L)	2.0	8.6	0.2	8.0	8.2
Temperature Surface	17.2	17.2	14.6	17.2	17.5
Temperature Bottom	16.9	16.9	13.4	15.0	14.15
Chlorophyll *a* (corrected)	1.92 RQ	0.37 RQ	0.47 RQ	0.0 RQ	0.14 RQ

MDP = missing data point; RQ = result questionable.

Table 2. Trophic State (Carlson's, 1977)

Trophic Indices	Mirror Lake No.	Mirror Lake 0o.	Cottonwood Wood Lk.	Devil's Inkwell	Lea Lake
Secchi Depth	OM	OM	OM	M	OM
Chlorophyll *a*	O	O	MDP	MDP	MDP
Total Phosphorus	O	O	O	O	O
Overall Trophic Determination	OM	OM	OM	OM	OM

O = Oligotrophy; M = Mesotrophy; E = Eutrophy; MDP = Missing Data Point.

Table 3. Nitrogen/Phosphorus Ratio

	Mirror Lake No.	Mirror Lake 0o.	Cottonwood Wood Lk.	Devil's Inkwell	Lea Lake
Limiting Nutrient	N	N	N &/OR P	N	N

Table 4. Use Attainment for Bottomless Lakes study sites

Mirror Lake North

Designated or Attainable Use	Criteria Exceedence	Attainment Status
Wildlife Habitat	None	Fully Supporting
Warmwater Fishery	None	Fully Supporting

FS = Full Support; FSIO = Full Support Impacts Observed; PS = Partial Support; NS = Not Supported.

Mirror Lake South

Designated or Attainable Use	Criteria Exceedence	Attainment Status
Wildlife Habitat	None	Fully Supporting
Warmwater Fishery	None	Fully Supporting

FS = Full Support; FSIO = Full Support Impacts Observed; PS = Partial Support; NS = Not Supported.

Cottonwood Lake

Designated or Attainable Use	Criteria Exceedence	Attainment Status
Wildlife Habitat	None	Fully Supporting
Marginal Coldwater Fishery	None	Fully Supporting

FS = Full Support; FSIO = Full Support Impacts Observed; PS = Partial Support; NS = Not Supported.

Devil's Inkwell

Designated or Attainable Use	Criteria Exceedence	Attainment Status
Wildlife Habitat	None	Fully Supporting
Marginal Coldwater Fishery	None	Fully Supporting

FS = Full Support; FSIO = Full Support Impacts Observed; PS = Partial Support; NS = Not Supported.

Lea Lake

Designated or Attainable Use	Criteria Exceedence	Attainment Status
Wildlife Habitat	None	Fully Supporting
Primary Contact	None	Fully Supporting
Warmwater Fishery	None	Fully Supporting

FS = Full Support; FSIO = Full Support Impacts Observed; PS = Partial Support; NS = Not Supported.

Water Quality Assessment

Bottomless Lakes State Park is a unique natural grouping of groundwater fed sinkholes, which range from one third of an acre to 26 acres in size. Depth varies between 17 and 90 feet with pool size and volume generally consistent due to continued groundwater inflow. Groundwater characteristics may vary substantially from year to year depending on winter snow pack in the Sacramento Mountains to the west, seasonal groundwater agricultural withdrawal, and changes to the karst delivery aspects affecting groundwater inflow to the lakes. For example, at the time of this study, groundwater input to Lea Lake was about 2.5 million gallons per day (mgd). At the time of this writing, the outflow from this lake was 13 mgd.

These basins are located in a very arid environment, which makes them attractive for wildlife and the recreating public. These waters of the State are unclassified, however, some uses do exist, and must be protected. Water quality and standards attainment for each basin will be addressed individually in the following narrative. These uses are also presented in the preceding table for each individual lake basin.

Both north and south basins of **Mirror Lake** are currently one pool due to the rise in water level, which has resulted in a breach of the natural dam that used to separate the two basins. The Mirror Lake basins may be classified as oligomesotrophic according to Carlson's (1977) indices, and algal community composition (Likens 1975). Nitrogen was the limiting nutrient during this study. Uses currently attainable for both aspects of this basin are wildlife habitat, and warmwater fishery. In the past when groundwater input was of a suitable quality, a marginal coldwater fishery was possible for rainbow trout during winter months. Current groundwater quality is not supportive of this use, however, a warmwater fishery supportive of some fish species currently exists. Swimming in all basins is forbidden except in Lea Lake. Water chemistry data, physical characteristics and biological findings show all existing uses are being attained. There were no exceedences of water quality criteria.

Cottonwood Lake, though within walking distance from Mirror Lake, had less than half the conductivity of Mirror Lake, and is able to support a seasonal trout fishery during winter months. Cottonwood Lake may be classified as oligomesotrophic according to Carlson's (1977) indices, and algal community composition (Likens 1975). Nitrogen and phosphorus nutrient ratio showed that they were co-limiting during this sampling effort.

Like many of the basins of Bottomless Lakes, primary contact is a temptation during the hot summer months, however, swimming in all basins except for Lea Lake is against park regulations. Wildlife of all types find this basin suitable for feeding, loafing and permanent residence, and a marginal coldwater fishery use exists at least during the winter season. There were no criteria exceedences observed, and all existing uses were attained. Limited limnological data are presented within this assessment summary, however, a complete list of all water chemistry results, physical measurements, and macroinvertebrate, algal and diatom community information are available upon request.

Devils Inkwell, is a small, steep sided sinkhole with no outfall or overflow. Pool water exchange with groundwater is suspected, which may explain the good water clarity, low Forel-Ule color and low relative nutrient concentration. This basin showed the lowest conductivity of all the basins studied during this survey and an oxygen concentration from top to bottom were suitable for wildlife and fishery uses. This basin is stocked with trout during the winter months for public use. Devil's Inkwell may be classified as oligomesotrophic according to Carlson's (1977) indices, and algal community composition (Likens 1975). Nitrogen was the limiting nutrient during the sampling visit.

Wildlife of all types find this basin suitable for feeding, loafing and permanent residence and a marginal coldwater fishery use exists during the winter season. There were no criteria exceedences observed, and all existing uses were attained. Limited limnological data are presented within this assessment summary, however, a complete list of all water chemistry results, physical measurements, and biological community information are available upon request.

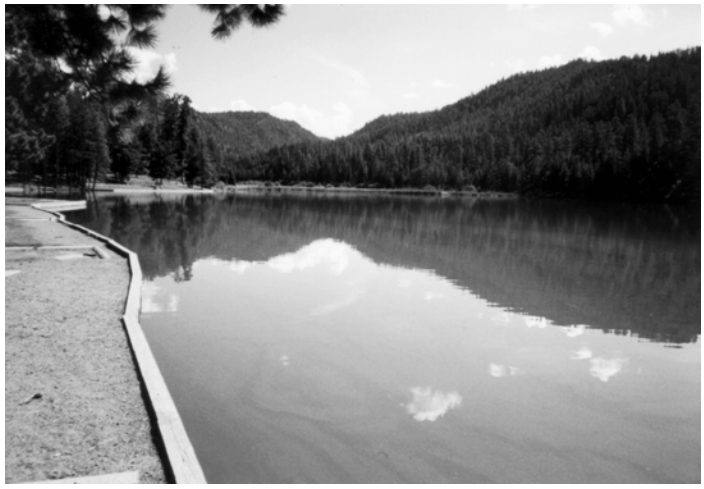
Lea Lake is the recreational lake within the State park, which boasts a visitor's center, concessions area, picnic area, recreational vehicle and camping areas. A lifeguard protected swimming beach attracts over a thousand visitors per day on weekends, and hundreds during the week during summer months. Migratory waterfowl frequent Lea Lake and many warm water fishes are suspected of inhabiting the lake.

Lea Lake may be classified as oligomesotrophic according to Carlson's (1977) trophic state indices, and algal community composition (Likens 1975). Nitrogen was the limiting nutrient during the sampling visit. Due to the existence of the primary contact use, a fecal coliform sample was collected. The result from this bacteriological sample was below detection. There were no water quality criteria exceedences for the existing uses of wildlife habitat, warmwater fishery and primary contact resulting in attainment of these uses. Complete water chemistry data, physical depth profiles, macroinvertebrate, algal and benthic diatom data are available upon request.

Fenton Lake, Sandoval County, August 27, 1998.
Seva J. Joseph, Primary Investigator

The Surveillance and Standards Section conducted a water quality and biological assessment survey of Fenton Lake at one deep station near the dam. Fenton Lake is located in north-central New Mexico about 53 kilometers (33 miles) northwest of San Ysidro via New Mexico State Highways 4 and 126. The lake is an impoundment of the Rio Cebolla, a tributary of the Rio Guadalupe, and is approximately 6.4 kilometers (4 miles) downstream of Seven Springs State Fish Hatchery, and the community of Seven Springs, a small village consisting mostly of summer cabins. In 1994, the earthen dam was improved and reinforced enabling a two foot increase in lake level.

The Reservoir is in the Southern Rocky Mountain ecoregion (Omernik, 1987) and receives an average of 47 centimeters (18 inches) of precipitation per year (Gabin and Lesperance, 1975). Fenton Lake covers approximately 35 acres and is at an elevation of 2,407 meters (7900 feet). Despite its small size, Fenton Lake receives heavy recreational use during the summer. Fenton Lake is stocked with Rainbow Trout and contains a breeding population of German Brown Trout. The reservoir serves as a resting and nesting area for migratory waterfowl.



Water quality standards and applicable criteria for Fenton Lake are set forth in sections 1102 and 2106 of the New Mexico water quality standards (NMWQCC 1995), which include the Jemez River and all tributaries above State Highway 4 near the town of Jemez Springs and the Guadalupe River. Designated uses for the reservoir are: domestic water supply, fish culture, high quality coldwater fishery, irrigation, livestock watering, wildlife habitat, and secondary contact. Water quality sampling methods were in accordance with the "Quality Assurance Project Plan for Water Quality Management Programs" (NMED 1996). The following tables provide specific limnological information specific to Fenton Lake. The following narrative summarizes water quality findings, water quality standards assessment and use attainment status.

Table 1. Seasonal variation of physical characteristics for Fenton Lake.

Physical Characteristics	Mirror Lake No.
Secchi Depth (M)	0.65
Forel Ule Color	13
Maximum Depth (M)	6.0
Euphotic Zone (M)	2.0
Surface Area (Acres)	35
Anoxic Hypolimnion (Y/N)	Y
Stratified (Y/N) @ (M)	Y @ 1.0
Ph (Surface)	9.28
Conductivity (Surface)	112
Turbidity	MDP
Integrated sample surface to (M)	4.5
Dissolved Oxygen Surface (mg/L)	10.6
Dissolved Oxygen Bottom (mg/L)	0.4
Temperature Surface (C)	20.4
Temperature Bottom (C)	17.5
Chlorophyll *a* (corrected)	86.44

Mdp = missing data point; RQ = results questionable.

Table 2. Trophic State (Carlson's, 1977)

Trophic State Indices	Deep Station	
Secchi depth	Su	Eutrophic
Chlorophyll *a*	Su	Eutrophic
Total Phosphorus	Su	Eutrophic

Overall Trophic Condition	Eutrophic

Table 3. Nitrogen/Phosphorus Ratio

	Deep Station
Limiting Nutrient	N &/or P

Table 4. Use Attainment

Designated or Attainable Use	Criteria Exceedence	Attainment Status
Domestic Water Supply	None	Fully Supporting
Fish culture	None	Fully Supporting
Wildlife Habitat	None	Fully Supporting
Livestock watering	None	Fully Supporting
High Quality Coldwater Fishery	PH, Ammonia	FSIO
Irrigation	None	Fully Supporting
Secondary Contact	None	Fully Supporting

FS = Full Support; FSIO = Full Support Impacts Observed; PS = Partial Support; NS = Not Supported.

Water Quality Assessment

Fenton Lake may be classified as eutrophic according to Carlson's (1977) indices for Chlorophyll *a,* Secchi depth and, total phosphorus. Phytoplankton community composition suggests eutrophic conditions exist due to the dominance of Anabaena species, which comprised 84 percent of the total community (Likens 1975). Qualitative diatom analysis of benthic scrapes resulted in 45 species and showed a high diversity according to Shannon-Weaver (1949). Nitrogen and phosphorus ratios showed co-limitation with regard to these plant nutrients.

The lake was weakly stratified at the time of sampling. Below two meters, the dissolved oxygen concentration dropped below the 6 mg/l criteria for coldwater fisheries, however, this does not constitute an exceedence as the criteria only applies to the epilimnion, or upper 1/3 of the water column. The measured pH of 9.28 exceeded the standard for coldwater fishery use. Duplicate grab samples were collected for nutrients during this sampling run, and when results were averaged, the chronic value for ammonia was exceeded. An average of the two values was used for assessing aquatic life use support, which stipulates that a single grab sample must exceed the chronic level by 1.5 times the chronic criteria. The ammonia exceedence resulted in an aquatic life use determination of "Full Support, Impact Observed." Hardness dependent criteria for heavy metals showed no exceedences and all other sampling results were within criteria limits.

Assessment of chemical and biological characteristics and general appearance of Fenton Lake indicate that the lake is highly eutrophic. Exceedence of ammonia and pH plus anoxic conditions in this relatively shallow lake suggest that this level of eutrophication may be causing stress to the aquatic community as well as reducing the esthetic character

of the lake. It is the natural progression of lakes to become eutrophic over time, however, this process is accelerated in man made lakes with large watersheds that serve to collect and concentrate nutrients. In the case of Fenton Lake, a small stream cannot supply the flow in quantities which will allow flushing of nutrients regardless of the source, but much is known about the potential sources of nutrient input to Fenton Lake. A few of these sources include cattle and elk grazing, riparian degradation, road construction, septic tanks associated with upstream cabins and homes, the Seven Springs Fish Hatchery and Fenton Lake State Park visitors. Future development, continued grazing and other activities within the watershed will continue posing threats to Fenton Lake and the Rio Cebolla watershed. Responsible care for water quality will require a watershed association consisting of New Mexico State Parks Division, New Mexico Department of Game and Fish, U.S. Forest Service Jemez Ranger District, New Mexico State Highway and Transportation Department, and the Surface Water Quality Bureau. Actions that these and concerned citizens may address are:

1) Construction of roads and maintenance of parking, camping, picnicking and trail areas to minimize sediment runoff

2) Enhancement of wetlands immediately above Fenton Lake and below the fish hatchery

3) Introduction and maintenance of beaver population

4) Improve grazing and range management practices including construction of exclosures along lake and stream to allow limited access by cattle and elk

5) Additional treatment of Seven Springs Fish Hatchery effluent

6) Application for grants and revolving funds available for watershed improvements,

7) Land purchases, trades or acquisitions around lake to protect immediate area from overuse and provide greater space for recreation.

Though limited data are provided in this assessment summary, all water chemistry, physical, biological and depth profile data are available upon request.

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