PUBLIC COMMENT DRAFT

TOTAL MAXIMUM DAILY LOAD (TMDL)

FOR

BLUEWATER LAKE

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Prepared By

New Mexico Environment Department Surface Water Quality Bureau

Monitoring, Assessment, and Standards Section

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Cover Photo: Dam at Bluewater Lake, 2015

TABLE OF CONTENTS

List of Abbreviations

AU	Assessment Unit
BMP	Best Management Practices
CFR	Code of Federal Regulations
cfs	Cubic Feet Per Second
cfu	Colony Forming Units
CGP	Construction General Storm Water Permit
CoolWAL	Cool Water Aquatic Life
CWA	Clean Water Act
CWAL	Cold Water Aquatic Life
^oC	Degrees Celsius
DMR	Discharge Monitoring Report
^oF	Degrees Fahrenheit
hm^3/yr	Cubic Hectometers Per Year
HUC	Hydrologic Unit Code
$j/m^2/s$	Joules Per Square Meter Per Second
km^2	Square Kilometers
LA	Load Allocation
lbs/day	Pounds Per Day
mgd	Million Gallons Per Day
mg/L	Milligrams Per Liter
mi^2	Square Miles
mL	Milliliters
MCWAL	Marginal Coldwater Aquatic Life
MOS	Margin of Safety
MOU	Memorandum of Understanding
MRL	Minimum Reporting Level
MS4	Municipal Separate Storm Sewer System
MSGP	Multi-sector General Storm Water Permit
NADP	National Atmospheric Deposition Program
NM	New Mexico
NHD	USGS National Hydrography Dataset
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
PRISM	PRISM (Parameter-elevation Regressions on Independent Slopes Model) Climate Group
QAPP	Quality Assurance Project Plan
RFP	Request for Proposal
SEE	Standard Error of the Estimate
SLO	State Land Office
SSTEMP	Stream Segment Temperature Model
SWPPP	Storm Water Pollution Prevention Plan
SWQB	Surface Water Quality Bureau
TMDL	Total Maximum Daily Load

TN	Total Nitrogen
TP	Total Phosphorous
UAA	Use Attainability Analysis
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WBP	Watershed-Based Plan
WLA	Waste Load Allocation
WQCC	Water Quality Control Commission
WQS	Water Quality Standards (20.6.4 NMAC as amended through 5/20/2020)

EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act, 33 U.S.C. § 1313(CWA), requires states to develop Total Maximum Daily Load (TMDL) management plans for water bodies determined to be water quality limited. A TMDL is defined as "a written plan and analysis established to ensure that a water body will attain and maintain water quality standards including consideration of existing pollutant loads and reasonably foreseeable increases in pollutant loads" (USEPA, 1999). A TMDL defines the amount of a pollutant a water body can assimilate without violating a state's water quality standards. It also allocates that load capacity to known point sources and nonpoint sources at a given flow. It further identifies potential methods, actions, or limitations that could be implemented to achieve water quality standards. TMDLs are defined in 40 Code of Federal Regulations Part 130 (40 C.F.R. § 130.2(i)) as the sum of individual Waste Load Allocations (WLAs) for point sources, and Load Allocations (LAs) for nonpoint source and background conditions, and a Margin of Safety (MOS) in acknowledgement of various sources of uncertainty in the analysis.

The New Mexico Environment Department (NMED) Surface Water Quality Bureau (SWQB) conducted a water quality survey at Bluewater Lake in west-central New Mexico in 2011. The Bluewater Lake watershed is comprised of six Hydrologic Unit Code (HUC) 12 watersheds (130202070201-130202070206) and makes up the extreme headwaters of the Rio San Jose HUC 08 watershed (13020207). Water quality monitoring stations were located in the lake itself, as well as upstream and downstream of the lake, to evaluate ambient water quality conditions and the impact of tributaries. Additional samples for plant nutrient analysis were collected in May 2014 at the "Bluewater Lake at Dam" and "Bluewater Creek below Dam" stations. Assessment of data generated during the 2011 and 2014 monitoring efforts was conducted according to the 2018-2020 SWQB Assessment Protocols (NMED/SWQB 2019). This TMDL document addresses the documented impairments as summarized in Table ES-1, below. Additional information regarding these impairments can be reviewed in the 2018-2020 Clean Water Act §303(d)/§305(b) Integrated Report and List (IR) (NMED/SWQB 2018a). The SWQB has previously prepared nutrient and temperature TMDLs for the segments of Bluewater Creek that are immediately upstream and downstream of Bluewater Lake, approved in 2007 (NMED/SWQB 2007). Bluewater Creek is the major tributary, as well as receiving water, of Bluewater Lake.

The next scheduled water quality monitoring date for the Rio San Jose basin is 2021-2022, at which time TMDL targets will be re-examined and potentially revised, as this document is considered to be part of an evolving management plan. In the event that new data indicate that the targets used in this analysis are not appropriate and/or if new WQS standards are adopted, the load capacity will be adjusted accordingly. However, absent any of these events, this TMDL will remain in effect as a protective TMDL. When water quality standards have been achieved, the lake will be moved to the appropriate category in the IR.

Table ES-1: TMDL for Bluewater Lake.

New Mexico Standards Segment	20.6.4.135
Assessment Unit Identifier	NM-2107.B_00
NPDES Permits	None
Segment Area	617.83 acres
Parameters of Concern	Plant Nutrients (Total Nitrogen and Total Phosphorous)
Designated Uses Affected	Coldwater Aquatic Life
USGS Hydrologic Unit Code	13020207: Rio San Jose
Size of Watershed	210.84 square miles
Land Type	Ecoregion 23c: Montane Conifer Forests (81.2%) Ecoregion 23e: Conifer Woodlands and Savannas (18.8%)
Land Use/Cover	81.4% evergreen forest, 17.9% shrub/scrub, 1.2% grassland, less than 1.0% each- open water, developed, deciduous forest, mixed forest, wetlands and barren
Geology	84.0% sedimentary, 8.1% mixed igneous and metamorphic, 7.5% purely metaphoric, 0.4% purely igneous
Land Ownership/Management	73.1% Forest Service, 23.5% Private, 1.7% State, 1.2% State Park, less than 1.0% each Tribal (Navajo Nation) and Bureau of Land Management
Probable Sources	Angling pressure, atmospheric deposition, campgrounds, drought-related impacts, gravel or dirt roads, low water crossing, rangeland grazing, waterfowl, wildlife other than waterfowl, stream channel incision
IR Category	5/5A
Priority Ranking	High
WLA + LA + MOS = TMDL	
Total Nitrogen	0.0 mg/L + 0.81 mg/L + 0.09 mg/L = 0.9 mg/L
Total Phosphorous	0.0 mg/L + 0.027 mg/L + 0.003 mg/L = 0.03 mg/L

1.0 BACKGROUND

This document establishes TMDLs for Bluewater Lake (**Figure 1.1**). Impairment determinations were based on data collected during 2011 and 2014 SWQB water quality surveys.

1.1 Bluewater Lake Description

Bluewater Lake is a shallow, well mixed manmade reservoir dammed in 1925 by the Bluewater-Toltec Irrigation District and is the dominant feature of Bluewater Lake State Park. Portions of the shore of Bluewater Lake are in Bluewater Lake State Park, administered by the New Mexico Energy, Minerals & Natural Resources Department (EMNRD), including a popular developed campground. The rest of the lakeshore is private, except for a small section owned by the Navajo Nation. More than 75,000 people visited Bluewater Lake State Park in 2011. Most visitors access the park from nearby Interstate 40, and many are anglers from Albuquerque or the local area (EMNRD 2015). The dam is an 80 ft tall concrete arch structure located in the Las Tuces Valley of northwestern New Mexico, near the Continental Divide and west of Grants (EMNRD 2015). The lake surface area is approximately 3,020 acres at the spillway, with a maximum storage capacity of approximately 38,500 acre-feet. The Bluewater-Toltec Irrigation District attempts to maintain the lake above a minimum pool of 320 surface acres, by their estimate corresponding to approximately 3,500 acre-feet of storage. The park's management plan states that the average lake surface area is approximately 1,500 acres, by their estimate corresponding to approximately 16,000 acre-feet of storage. Above the minimum pool, the Bluewater-Toltec Irrigation District maintains the water rights for irrigation purposes (EMNRD 2015). Below the minimum pool, the State Game Commission maintains water rights for conservation. Since the year 2000, reservoir storage has been below 3,500 acre-feet 46.60% of the time. Releases are not tracked by the state park, and NMED-SWQB was unable to contact the Bluewater-Toltec Irrigation District. Therefore, any discharge information must be tied to the inactive U.S. Geological Survey (USGS) gage downstream of the dam, the active gage on the reservoir itself, or through park staff observations. Previous studies suggest Bluewater Lake to be nitrogen limited in spring and summer, yet phosphorus limited in the fall (USEPA 1977).

1.2 Bluewater Lake Watershed Description

The Bluewater Lake watershed is made up of six HUC 12 watersheds (130202070201-130202070206) and covers of 210.84 square miles of the Zuni Mountains in the extreme upper headwaters of the Rio San Jose basin (**Figure 1.1, Table 1.1**). Approximately 79% of the watershed lies in Cibola County, while 21% of the watershed lies in McKinley County. Elevation ranges from 7,369 feet at the lake outlet to 9,256 feet at the summit of Mount Sedgwick, with an average elevation of 8,092 feet. Slopes range from 0 degrees to 66 degrees, with an average slope of 7 degrees. The watershed receives approximately 18 inches of precipitation per year, with an average annual air temperature of approximately 46 degrees

Fahrenheit. Runoff from stormwater and snowmelt is inconsistent and typically low, resulting in limited surface inputs to the lake from the two main streams feeding it; Cottonwood Creek on the west shore and Bluewater Creek on the south shore.

Bluewater Creek above the lake (AU ID: NM-2107.A_01) was listed as temperature impaired prior to 1996, and it remains listed for temperature. From 1984 through 1997, the Forest Service conducted a number of watershed improvement projects, including both physical and management measures (USDA NRCS, undated). In 1996 the creek was listed for turbidity, and in 2006 a nutrients listing was added. In 2009-2010, NMED's Non-Point Source program funded stream channel improvements, and the Forest Service rounded up wild horses in the watershed. The turbidity listing was removed in 2010. In 2011 the Forest Service completed a Watershed Restoration Action Plan (USDA Forest Service, 2011), which led to $7.6 million in funding from the Collaborative Forest Landscape Restoration Program over 10 years. Cibola National Forest partnered with several stakeholders to complete work on treatments including mechanical thinning, prescribed burns, and meadow restoration. In 2014, the nutrients listing was removed for the creek and a nutrients listing was added for the lake, both actions based on the results of the 2011 SWQB survey. From 2015 through 2018, the state park completed major upgrades to their plumbing system and installed a new wastewater treatment facility and dump station.

The Zuni Mountains are an uplifted core of Precambrian granite and metamorphic rocks, surrounded by Permian sandstone and the Triassic Chinle group. The range was formed through uplift of the Paleoproterozoic basement and more recent sedimentary rocks during the Laramide orogeny, approximately 75 million years ago. Bluewater Lake is located along the north-south trending Bluewater fault zone in Triassic, Permian, and recent units. More specifically, the San Andres Formation bounds the lake to the east, the Bluewater Creek, Moenkopi, and Petrified Forest formations are to the north, and the Glorieta formation and recent valley slope alluvium and floodplain deposits lie to the south and west of the lake (NMBGMR 1998). Sedimentary rocks underly approximately 84.0% percent of the watershed, mixed igneous and metamorphic rocks approximately 8.1%, 7.5% purely metamorphic rocks, and 0.4% purely igneous rocks (**Figure 1.2**). The watershed landscape is dominated by mesas and cuestas. Soils in the watershed are typically well-drained with the exception of some units found on the valley floor. Parent material for modern soils is typically bedrock or the alluvium and colluvium derived from it. Bedrock varies in depth from surface outcrops to greater than 60 in below the surface, and where soils are well developed, they are typically loams with varying sand and clay content (Soil Survey Staff, 2020). Soils underlying the Bluewater Creek watershed, to the south of Bluewater Lake, generally have higher infiltration rates than those underlying the Cottonwood Creek watershed, to the west of the lake. Hydrologic Group B soils (moderate infiltration rate) make up approximately 41.3% of the watershed, Group C soils (slow infiltration rate) 31.9% of the watershed, Group D soils (very slow infiltration rate) 24.3% of the watershed, while the remaining hydrologic soil groups are unknown (**Figure 1.3**) (NRCS 2020).

As of 2016, land cover for the watershed is approximately 81.4% evergreen forest (a decrease of 1.9% since 2001), 17.9% shrub/scrub (an increase of 1.7% since 2001), 1.2% grassland, and less than 1.0% each open water, developed, deciduous forest, mixed forest, wetlands and barren (**Figure 1.4**). Approximately 80.7% of the watershed is situated in Level IV Ecoregion 23c (Montane Conifer Forests) and 19.3% is situated in Ecoregion 23e (Conifer Woodlands and Savannas) (Griffith et al. 2006). Land ownership is approximately 73.1% Forest Service, 23.5% Private, 1.7% State, 1.2% State Park, and less than 1.0% each Tribal (Navajo Nation) and Bureau of Land Management (**Figure 1.5**). The majority of the watershed is within the Mount Taylor Ranger District of the Cibola National Forest. Major land uses in the area include livestock grazing and recreation, such as camping, hunting, boating and fishing. Species listed as either Threatened or Endangered by state and/or federal agencies found within the Bluewater Lake watershed include Bald Eagle (*Haliaeetus leucocephalus*), Gray Vireo (*Vireo vicinior*), Mexican Spotted Owl (*Strix occidentalis lucida*, designated critical habitat), Peregrine Falcon (*Falco peregrinus*), Spotted Bat (*Euderma maculatum*), and Zuni Bluehead Sucker (*Catostomus discobolus jarrovii*, designated critical habitat) (NMDGF Environmental Review Tool, https://nmert.org/home, accessed 4/16/2020).

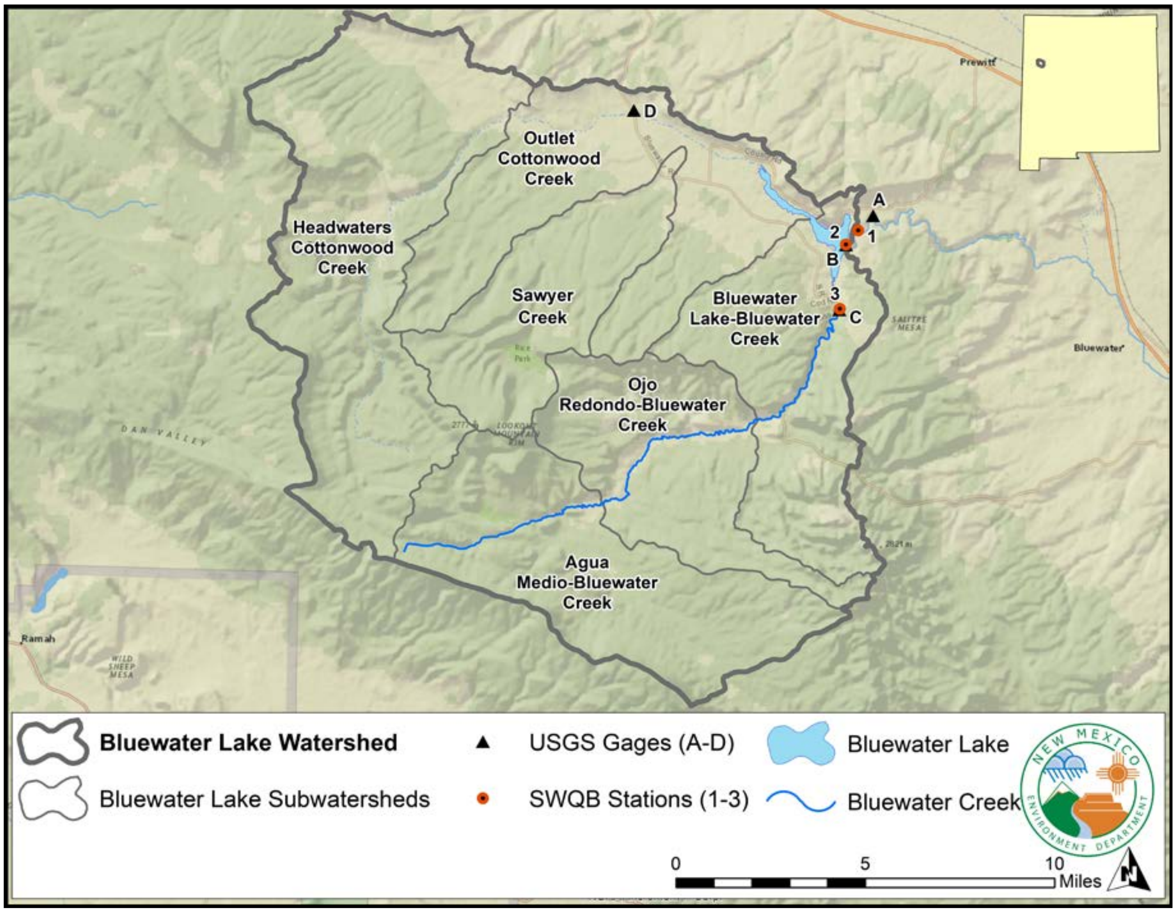

Figure 1.1: Overview map of the Bluewater Lake watershed and subwatersheds. SWQB Stations (1-3) and USGS Gages (A-D) are identified in Table 1.1.

Table 1.1: Relevant SWQB Stations and USGS Gages shown in Figure 1.2.1.

Map Label	Name	Station/Gage Number
1	Bluewater Creek Below Dam	36Bluewa016.7
2	Bluewater Lake At Dam	36BluWaterLkDm
3	Bluewater Creek Above Bluewater Lake at USGS Gage 8341300	36Bluewa018.9
A	Bluewater Creek Below Bluewater Dam, NM	USGS Gage 08341500
B	Bluewater Lake Near Bluewater, NM	USGS Gage 08341400
C	Bluewater Creek Above Bluewater Dam, NM	USGS Gage 08341300
D	Cottonwood Creek Near Thoreau, NM	USGS Gage 08341365

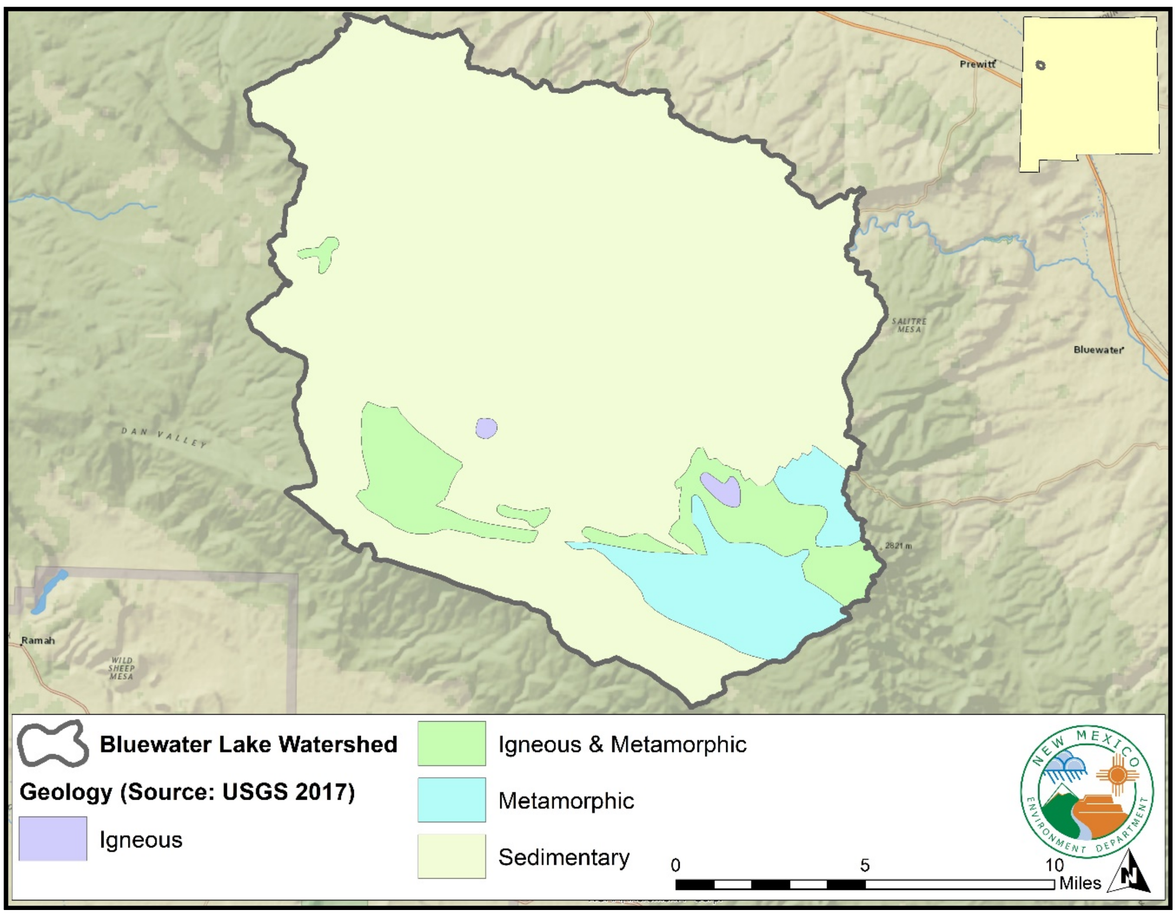

Figure 1.2: Surface geology of the Bluewater Lake watershed.

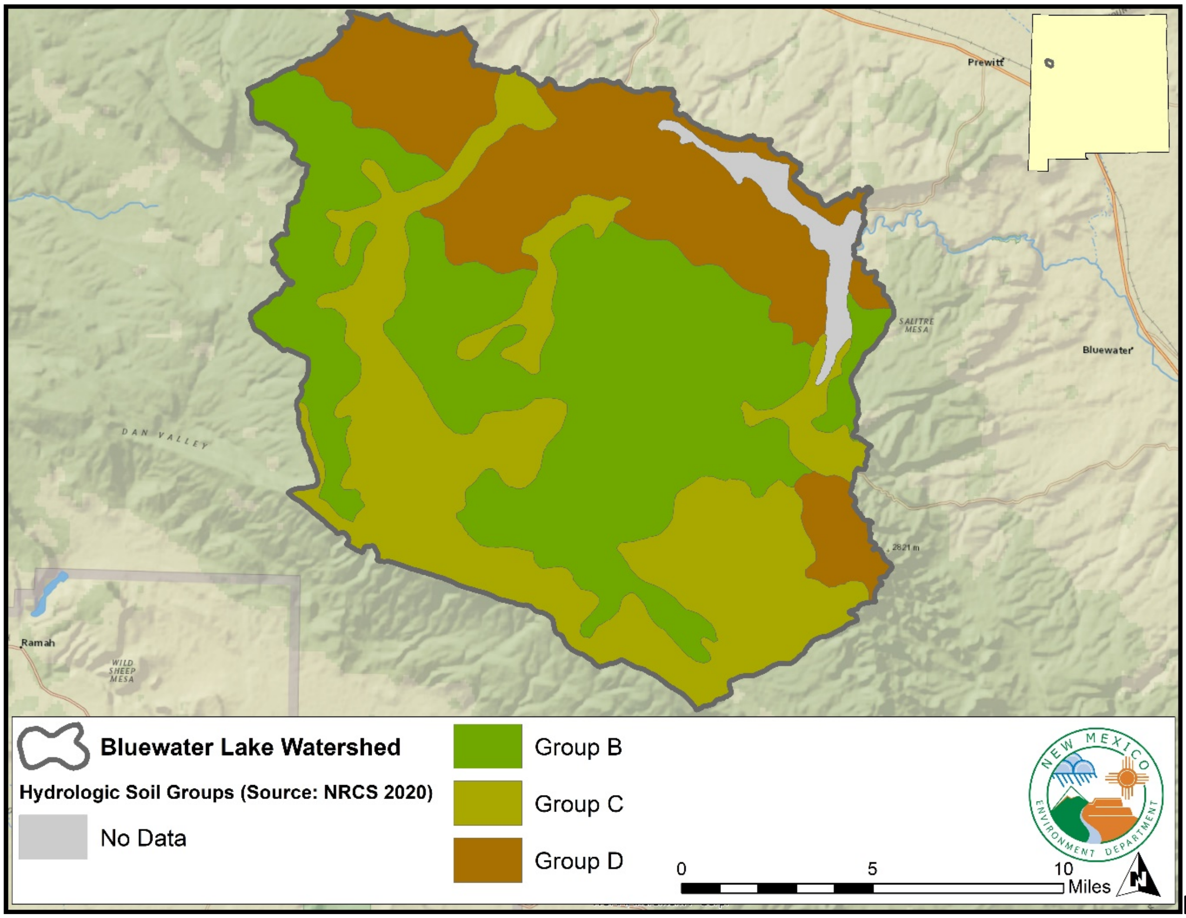

Figure 1.3: Hydrologic Soil Groups of the Bluewater Lake watershed.

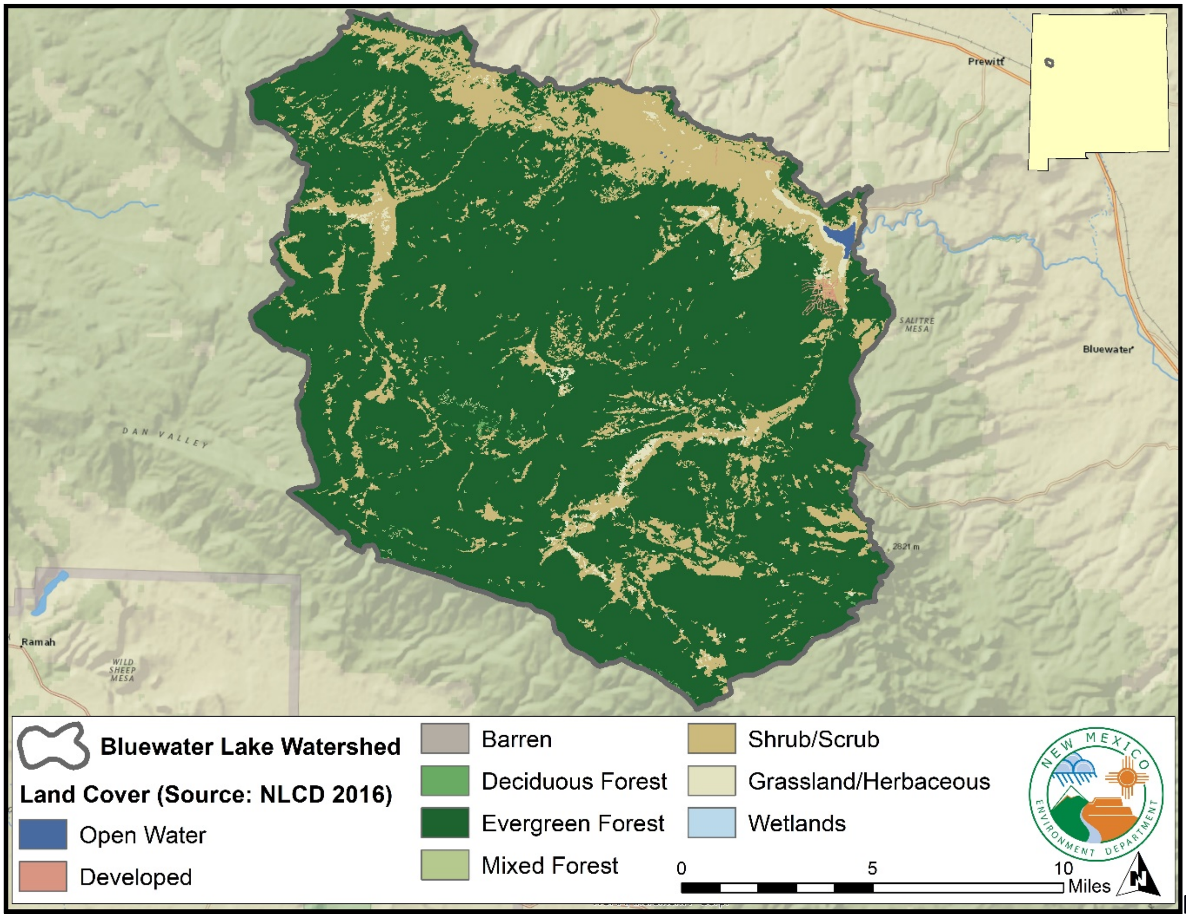

Figure 1.4: Land Cover of the Bluewater Lake watershed.

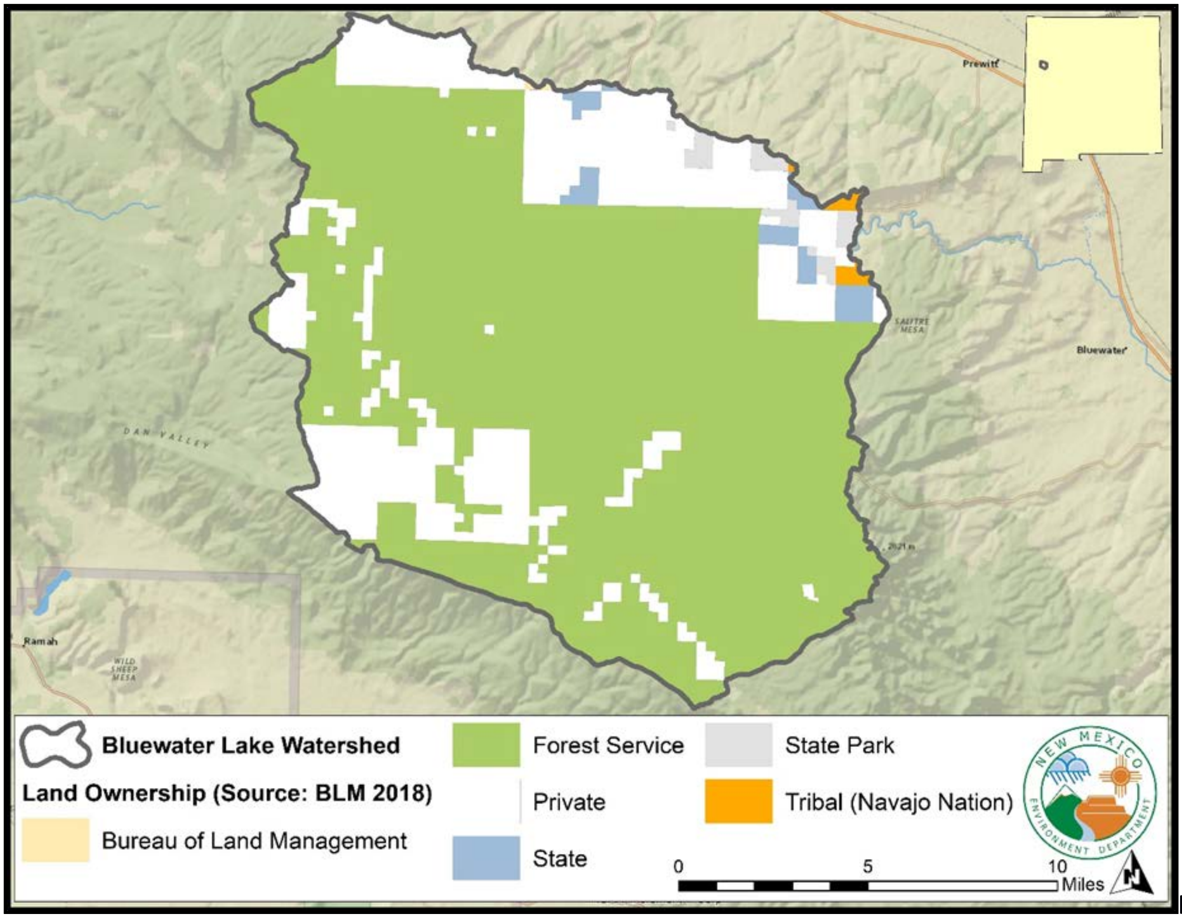

Figure 1.5: Land Ownership of the Bluewater Lake watershed.

1.3 Water Quality Standards

New Mexico *Standards for Interstate and Intrastate Surface Waters* (20.6.4 NMAC) establish surface water quality standards that consist of designated uses of surface waters of the State, the water quality criteria necessary to protect the uses, and an antidegradation policy. New Mexico's antidegradation policy, which is based on the requirements of 40 C.F.R. § 131.12, describes how waters are to be protected from degradation (20.6.4.8(A) NMAC), while the *Antidegradation Policy Implementation Procedures* establish the process for implementing the antidegradation policy (NMED/SWQB 2011). At a minimum, the policy mandates that "the level of water quality necessary to protect the existing uses shall be maintained and protected in all surface waters of the state." In addition, regardless of whether or not a segment is impaired, the State's antidegradation policy requirements, as detailed in the *Antidegradation Policy Implementation Procedures* (NMED/SWQB 2011), must be met. TMDLs are consistent with the policy because implementation of a TMDL restores water quality so that existing uses are protected, and water quality criteria are achieved. The *Antidegradation Policy Implementation Procedure* can be found in Appendix A of the *Statewide Water Quality Management Plan and Continuing Planning Process* document.

The intent of nutrient criteria, whether numeric or narrative, is to limit nutrient inputs in order to control the excessive growth of attached algae and higher aquatic plants. Controlling algae and plant growth preserves aesthetic and ecologic characteristics along the waterway. While conceptually there may be a number of possible combinations of total nitrogen (TN) and total phosphorus (TP) concentrations that are protective of water quality, the application of simple chemical limitation concepts to a complex biologic system to determine these combinations is challenging. One of the primary reasons for this is that different species of algae and higher aquatic plants will have different nutritional needs. Some species will thrive in nitrogen limited environments while others will thrive in phosphorous limited environments. Because of the diversity of nutritional needs amongst organisms, numeric thresholds for both TN and TP are required to preserve the aesthetic and ecologic characteristics along a waterway. Focusing on one nutrient or trading a decrease in one for an increase in the other may simply favor a particular species without achieving water quality standards (USEPA 2012).

Water quality standards (WQS) for Bluewater Lake are set forth in Section 135 of the *Standards for Interstate and Intrastate Surface Waters*, 20.6.4 New Mexico Administrative Code (NMAC), as approved by the New Mexico's Water Quality Control Commission (WQCC) effective as of May 22, 2020 for purposes of State implementation (NMAC, 2020).These standards were approved by USEPA for CWA purposes on July 24, 2020. The following is the relevant NMAC section:

> **20.6.4.135 RIO GRANDE BASIN – Bluewater lake**
>
> **A. Designated Uses:** coldwater aquatic life, irrigation, domestic water supply, primary contact, livestock watering and wildlife habitat.
>
> **B. Criteria:** the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses except that the following segment-specific criteria apply: phosphorus (unfiltered sample) 0.1 mg/L or less; the monthly geometric mean of *E. coli* bacteria 126 cfu/100mL or less, single sample 235cfu/100mL or less.

Additionally, general criteria applicable to all surface water of the New Mexico are outlined in NMAC. With respect to nutrients the following narrative criterion guidance is set forth in 20.6.4.13(E) NMAC:

20.6.4.13 GENERAL CRITERIA

E. Plant Nutrients: Plant nutrients from other than natural causes shall not be present in concentrations which will produce undesirable aquatic life or result in the dominance of nuisance species in surface waters of the state.

This narrative criterion can be challenging to assess because the relationships between nutrient levels and impairment of designated uses are not defined, and distinguishing nutrients from "other than natural causes" is difficult. Numeric thresholds are necessary to establish targets for TMDLs, to develop water quality-based permit limits and source control plans, and to support designated uses within the watershed. Therefore, SWQB, with the assistance from USEPA and the University of Arkansas (Scott and Haggard 2011),, developed nutrient-related thresholds, or *narrative translators*, to address both cause (TN and TP) and response variables (dissolved oxygen [DO], pH, chlorophyll-*a*, and percent cyanobacteria). Water quality assessments for nutrients are based on quantitative measurements of these causal and response indicators. If these measurements exceed the numeric nutrient threshold values, indicate excessive primary production, and/or demonstrate an unhealthy biological community, the waterbody is considered impaired (NMED/SWQB 2018a). Narrative translators applicable to lakes for the narrative criteria outlined in 20.6.4.13 NMAC are outlined in Appendix D of the 2019 Comprehensive Assessment and Listing Methodology (CALM) (NMED/SWQB 2019). Bluewater Lake is designated a coldwater lake, meaning total nitrogen is considered a nutrient impairment at levels above 0.9 mg/L and total phosphorous is considered a nutrient impairment at levels above 0.03 mg/L despite the higher 0.1 mg/L value cited in 20.6.4.135 NMAC.

1.4 Antidegradation and TMDLs

New Mexico's antidegradation policy, which is based on the requirements of 40 C.F.R. § 131.12, describes how waters are to be protected from degradation (20.6.4.8(A) NMAC). At a minimum, the policy mandates that "the level of water quality necessary to protect the existing uses shall be maintained and protected in all surface waters of the state." Furthermore, the policy's requirements must be met regardless of whether or not a segment is impaired. TMDLs are consistent with this policy because implementation of a TMDL restores water quality so that existing uses (defined as the highest quality of water that has been attained since 1975) are protected and water quality criteria are achieved.

The Antidegradation Policy Implementation Procedure establishes the process for implementing the antidegradation policy (Appendix A of NMED/SWQB 2011). However, certain specific requirements in the Antidegradation Policy Implementation Procedure do not apply to the Water Quality Control Commission's (WQCC) establishment of TMDLs because these types of water quality-related actions already are subject to extensive requirements for review and public participation, as well as various limitations on degradation imposed by state and federal law (NMED/SWQB 2011).

1.5 Water Quality Monitoring Survey

The SWQB performed water quality sampling at Bluewater Lake and immediate upstream and downstream AUs during the Rio San Jose survey of 2011. One station was located on the reservoir itself, and one station each was located on the immediately upstream and downstream AUs. See **Figure 1.1** and **Table 1.1** for station locations and identification. Additional samples for plant nutrient analysis were collected in May 2014 at the “Bluewater Lake at Dam” and “Bluewater Creek below Dam” stations. The next SWQB survey of the Bluewater Lake area is scheduled for 2021-2022 as part of the Rio Puerco/Rio San Jose survey.

Monitoring of surface waters across the State has historically occurred on an eight-year rotational watershed approach, meaning a given waterbody is generally surveyed intensively, on average, every eight years. Monitoring occurs during the non-winter months (March through November), focuses on physical, chemical, and biological conditions in perennial waters, and includes sampling for most pollutants that have numeric and/or narrative criteria in the WQS. Each assessment unit is represented by a small number of monitoring stations (often only one), each of which receives 4–8 site visits during the survey. Beginning with the 2021 SWQB monitoring survey, a ten-year rotational watershed approach will be adopted.

The SWQB introduced a new strategy during the 2015-2016 seasons where a larger area is monitored over a longer period of time, with 2-6 water chemistry samples collected at each AU per year (4-12 total samples over the entire survey). Through public outreach, inter-agency coordination, and a scoring system considering a variety of factors, a three-tier monitoring system − primary, secondary, and tertiary – was developed to prioritize AUs. High ranking priority waters (primary AUs) receive the greatest amount of monitoring, whereas low ranking waters (i.e., tertiary AUs) receive the least. This two-year monitoring allows more data to be collected from the highest priority waters to better capture inter-annual variability primarily due to hydrologic conditions during the sampling events. Bluewater Lake will be designated as a primary AU during the 2021 and 2022 SWQB sampling efforts.

1.6 Hydrologic Conditions

The only active USGS gage in the Bluewater Lake watershed is at the dam (USGS 08341400: Bluewater Lake near Bluewater, NM), which records reservoir storage and elevation. The period of record for reservoir storage is from 1988 to present. Despite Bluewater State Park's management plan estimate that average storage is 16,000 acre-feet, Bluewater Lake has not exceeded 15,000 acre-feet of storage since October of 1998 and has only exceeded 10,000 acre-feet of storage three times since the year 2000 (**Figure 1.6**). Since the year 2000, reservoir storage has been below the conservation pool of 3,500 acre-feet 46.60% of the time. Lake storage from January 2000 – May 2020 has ranged from 1,576 acre-feet in 2003 to 12,390 acre-feet in 2010. The NHD High Resolution Bluewater Lake polygon is 617.83 acres, corresponding to an estimated storage of approximately 7,023.09 acre-feet and an average depth of 11.37 feet. During 2011, the year most data this TMDL is based on was collected, the average storage was 5,650.89 acre-feet, corresponding to an estimated average surface area of 510.16 acres and an average depth of 11.08 feet (**Figure 1.7**).

There are additional USGS gages in the Bluewater Lake watershed both upstream and downstream of the reservoir, although none of these gages are presently active. Inactive gages can provide information on basic hydrologic function, presuming that local conditions have not changed significantly since the gage period of record. Two inactive gages were located upstream of Bluewater Lake and provide valuable information about historic surface lake inflows from the two major inlet streams, Bluewater Creek and Cottonwood Creek. USGS Gage 08341300 (Bluewater Creek above Bluewater Dam, NM) has a period of record from 1989 to 2001 and shows the creek running dry in 5.15% of observations (**Figure 1.8**). USGS Gage 08341365 (Cottonwood Creek near Thoreau, NM) has a period of record from 1989 to 2001 and shows the creek running dry in 69.07% of observations (**Figure 1.9**). Downstream of Bluewater Lake, USGS Gage 08341500 (Bluewater Creek below Bluewater Dam, NM) records lake discharges, has a period of record from 1951 to 2001 (though no data were collected from September 1963 to July 1989) and shows the creek running dry in only 0.30% of observations (**Figure 1.10**). Gage locations are shown in **Figure 1.1**.

Precipitation patterns in the Bluewater Lake watershed are monsoonal in nature, and while there is one active U.S. Forest Service (USFS) weather station in the watershed (Bluewater Ridge New Mexico, 8289 feet elevation, (35.19417, 108.16310)), data from this single point is not representative of the entire watershed. Better estimates of area-weighted average precipitation, as well as other area-weighted climatic parameters, can be extracted from PRISM Climate Group recent years modeled data (PRISM, 2020), which integrate and interpolate weather station data from the aforementioned USFS weather station as well as many others. Considering the 30-year period from 1989-2018 (the most recent complete year available from PRISM at the time of this writing), annual precipitation ranged from a low of 10.60 inches in 1989 to a high of 25.07 inches in 1997 (**Figure 1.11**). Considering monthly precipitation, July and August are the wettest months, accounting for nearly 30% of annual precipitation on average (**Figure 1.12**). Annual average air temperatures have ranged from a low of 44.79 ^{o}F in 1997 to a high of 48.99 ^{o}F in 2017 (**Figure 1.13**). Monthly average air temperatures ranged between 28.75 ^{o}F in January to 65.96 ^{o}F in July (**Figure 1.14**). Annual and monthly average vapor pressure deficits followed similar trends to average air temperatures. The lowest average annual vapor pressure deficit was observed in 1997 and the highest was observed in 2012 (**Figure 1.15**), while the lowest monthly vapor pressure deficit generally occurs in January and the highest generally occurs in June (**Figure 1.16**).

Considering the small size of Bluewater Lake relative to its watershed, low storage volume relative to cumulative annual watershed precipitation, and locally high evaporative demand driven by high air temperatures and high vapor pressure deficits, water in the lake has a low hydraulic residence time, estimated at just over one year. Historic gage record evidence that surface inflows from the two main contributing streams are intermittent, in conjunction with the aforementioned high evaporative demands, imply a majority of water in the lake arrives either through short periods of high volume surface runoff following high-intensity monsoon precipitation or groundwater recharge facilitated by the Hydrologic Group B (moderate infiltration rate) soils that make up over 40% of the watershed. Given the regularity of steady to high winds throughout the watershed, the long fetch of the lake (nearly 2.65 miles on average), and shallow water depths, the lake is very well mixed and has never exhibited a thermocline during SWQB sampling.

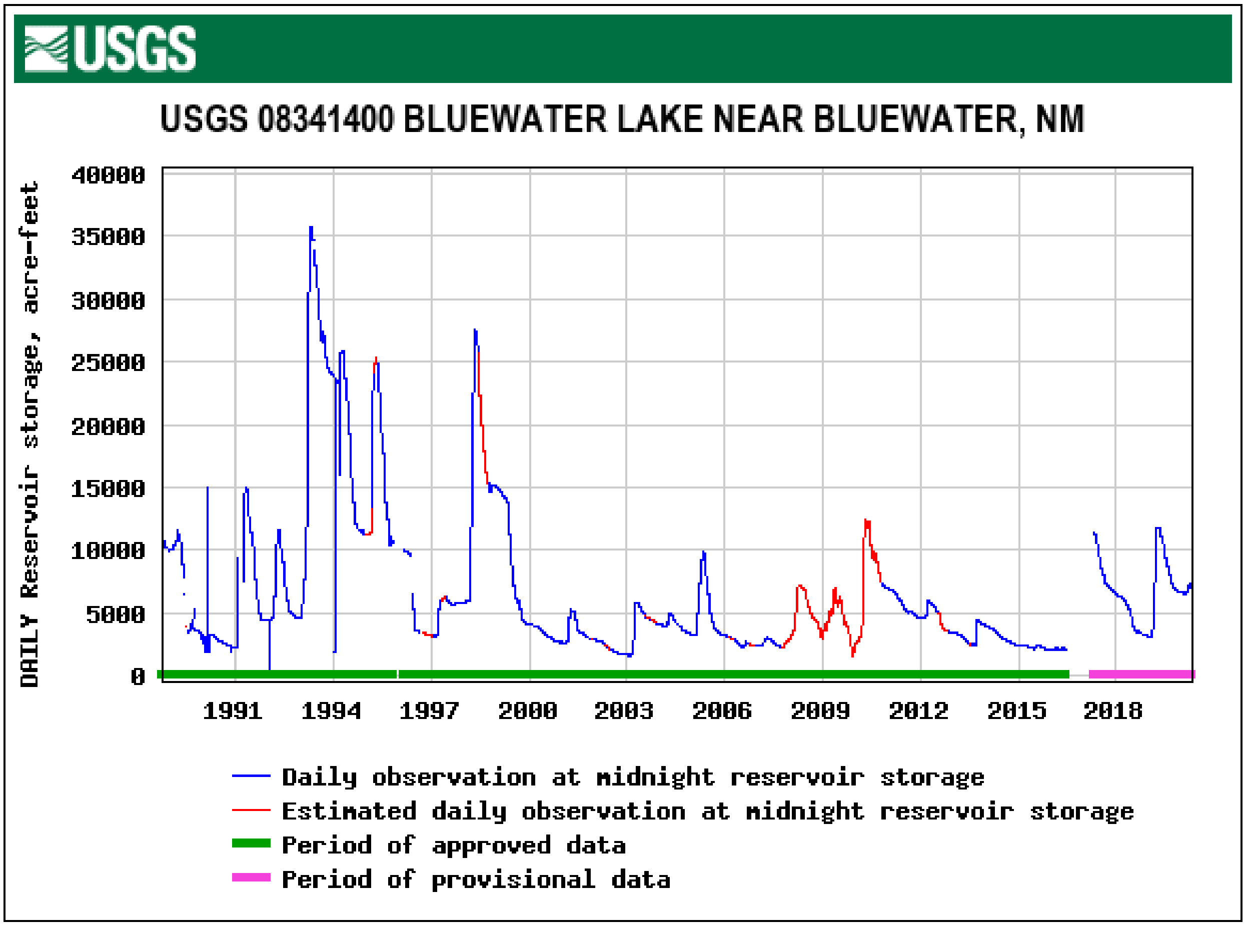

Figure 1.6: Daily reservoir storage 1988-2020 at Bluewater Lake. Lake levels are highly variable throughout the period of record, ranging from 12,390 acre-feet in April 2010 to 1,576 acre-feet in February 2003.

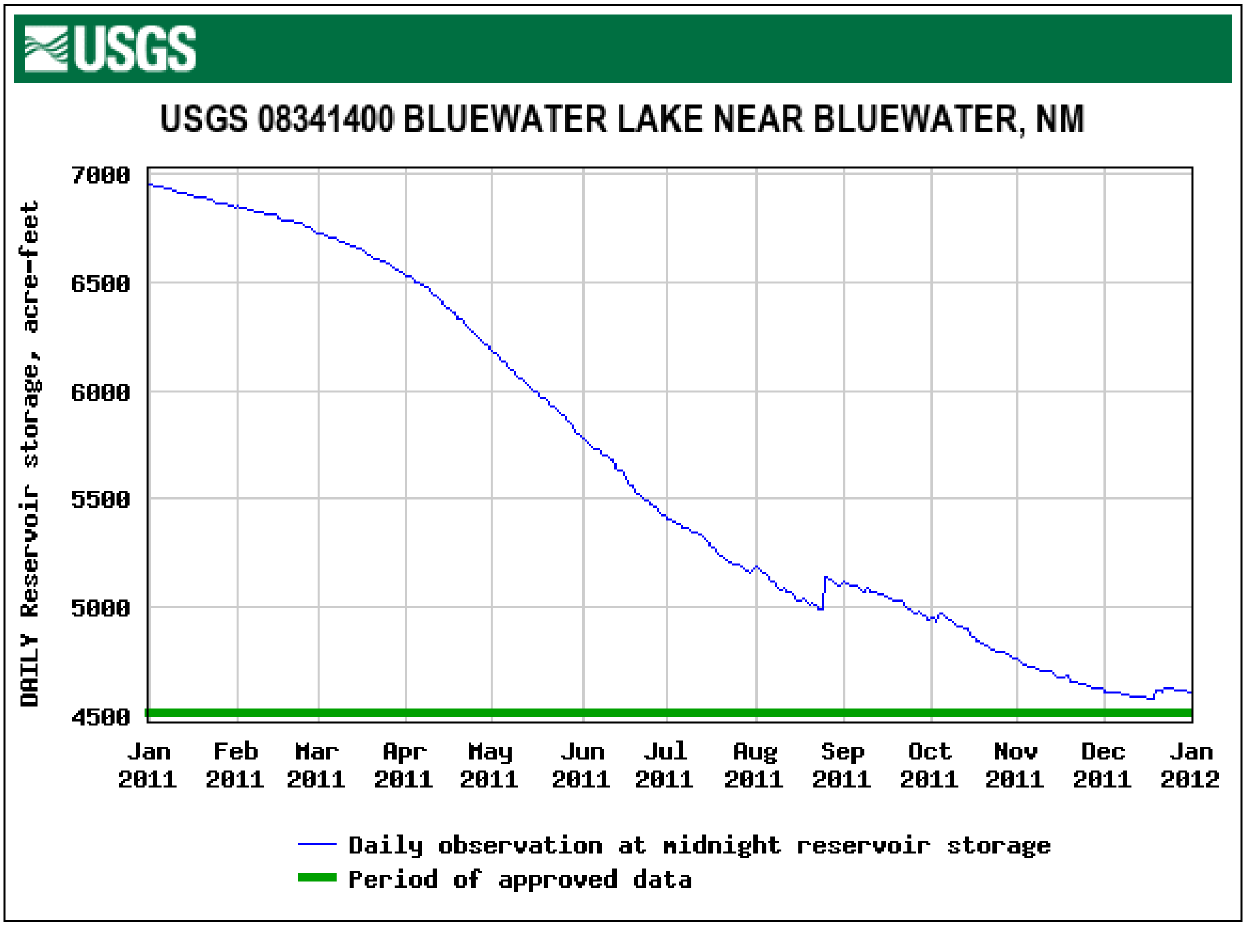

Figure 1.7: Daily reservoir storage in 2011 at Bluewater Lake. Lake levels steadily decreased throughout most of the year, ranging from 6,690 acre-feet 01/01/2011 to 4,680 acre-feet 12/31/2011.

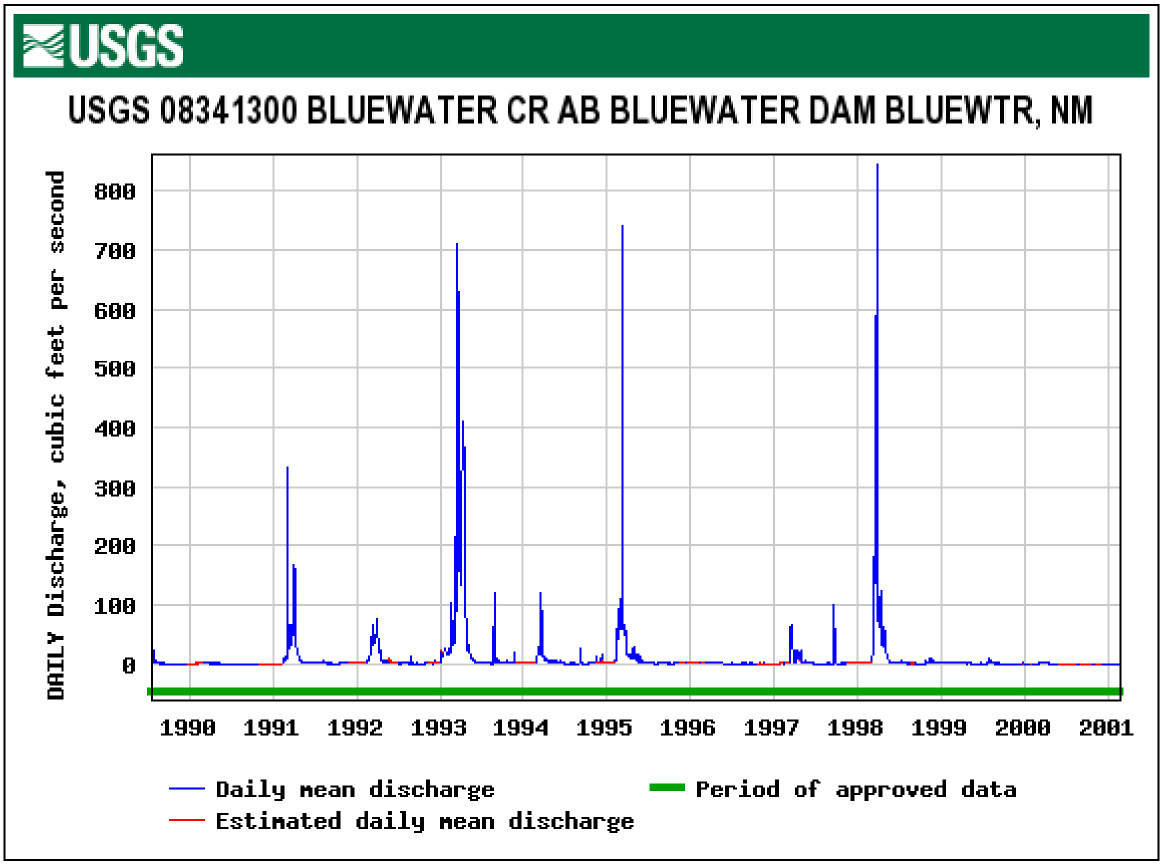

Figure 1.8: Bluewater Creek above Bluewater Dam 1989-2001. The creek runs dry in 5.15% of observations.

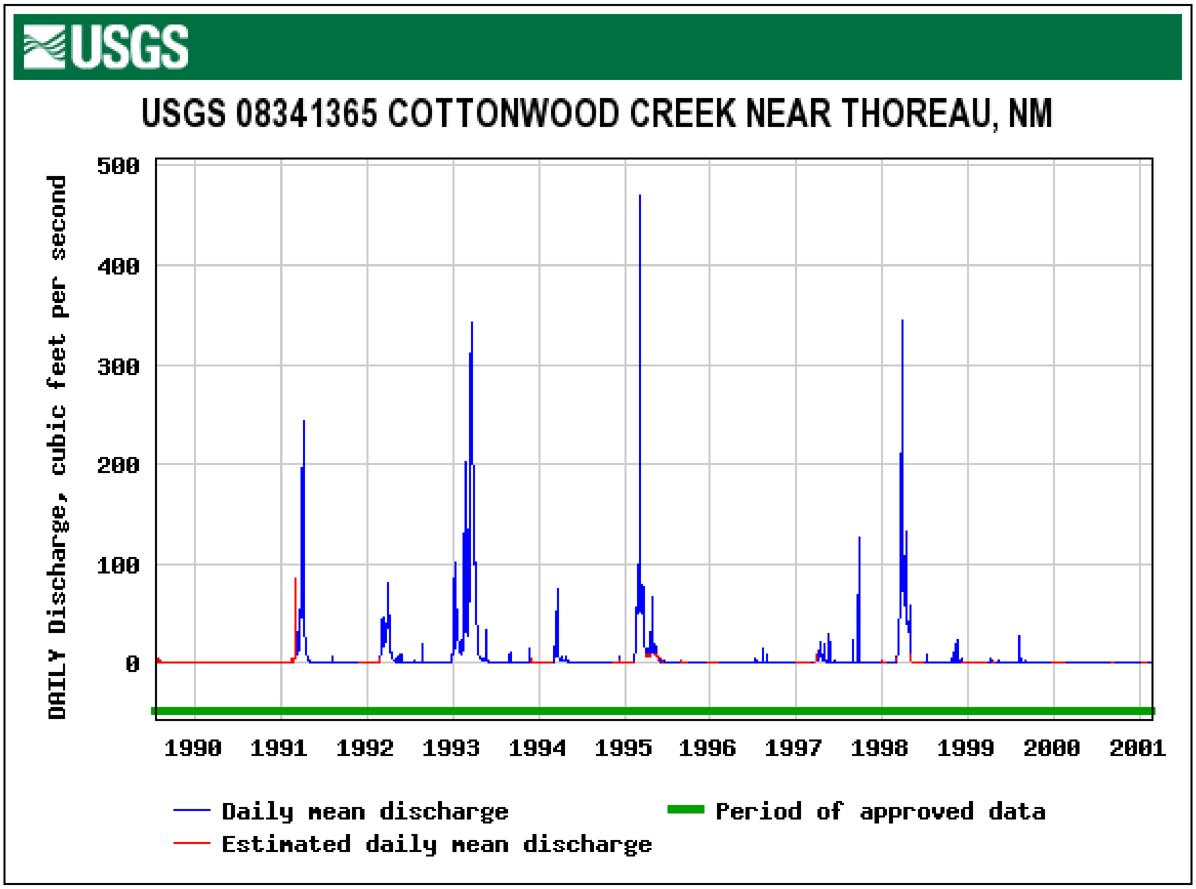

Figure 1.9: Cottonwood Creek near Thoreau, NM 1989-2001. The creek runs dry in 69.07% of observations.

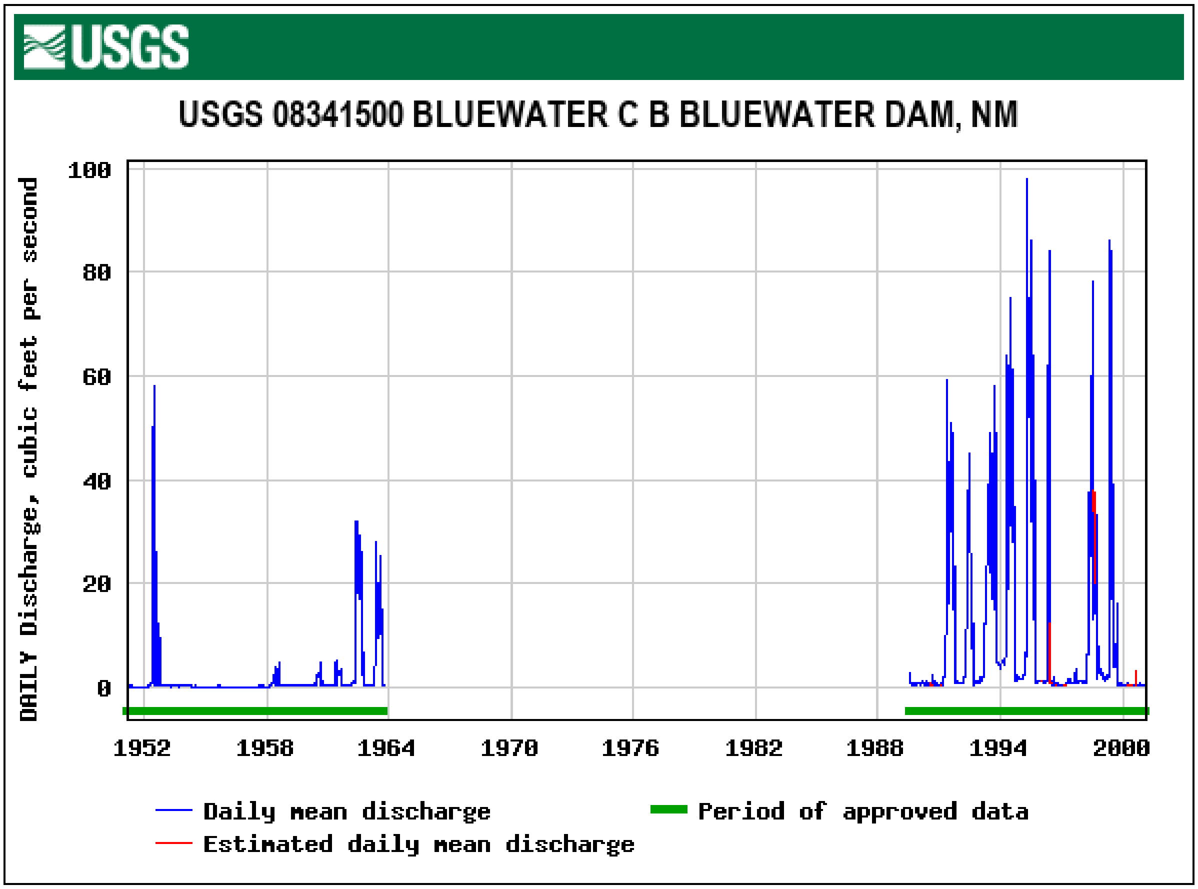

Figure 1.10: Bluewater Creek below Bluewater Dam 1951-2001. The creek runs dry in 0.30% of observations.

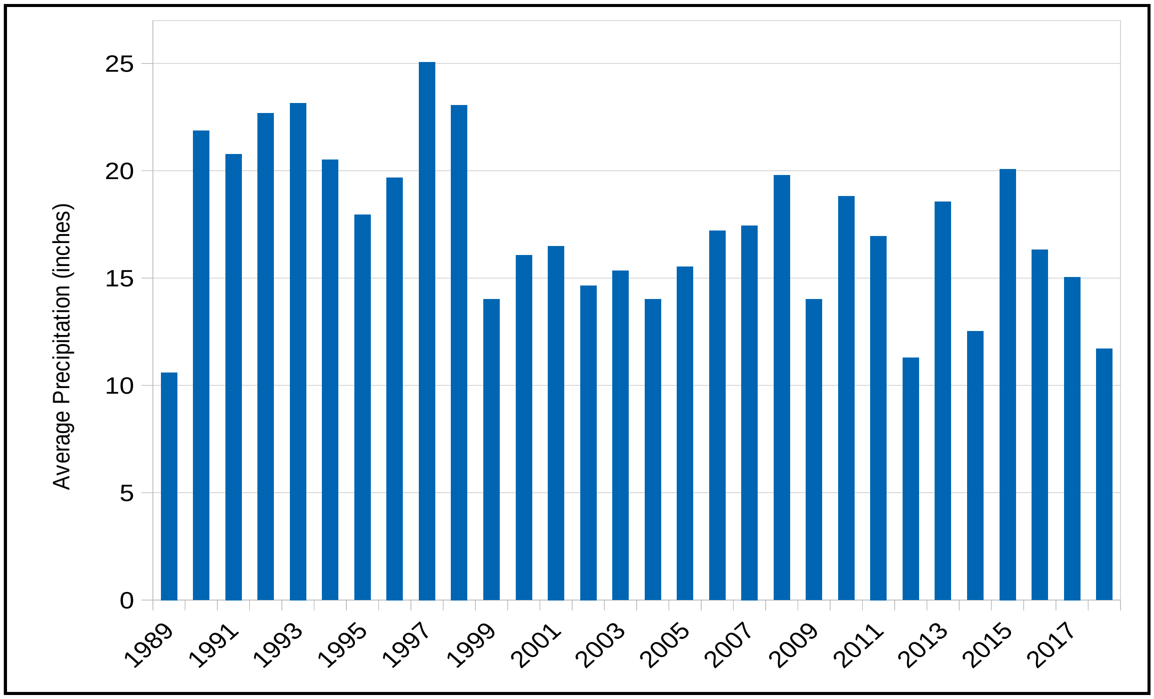

Figure 1.11: Average annual modeled PRISM 1989-2018 precipitation for the Bluewater Lake watershed.

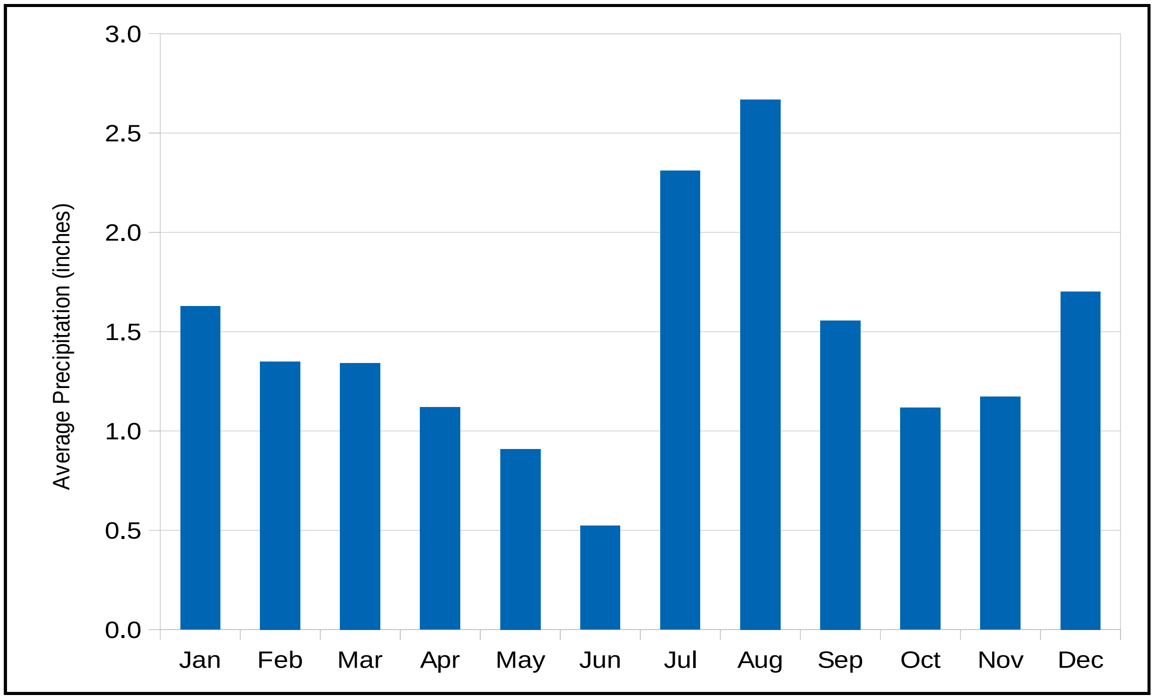

Figure 1.12: Average monthly modeled PRISM 1989-2018 precipitation for the Bluewater Lake watershed.

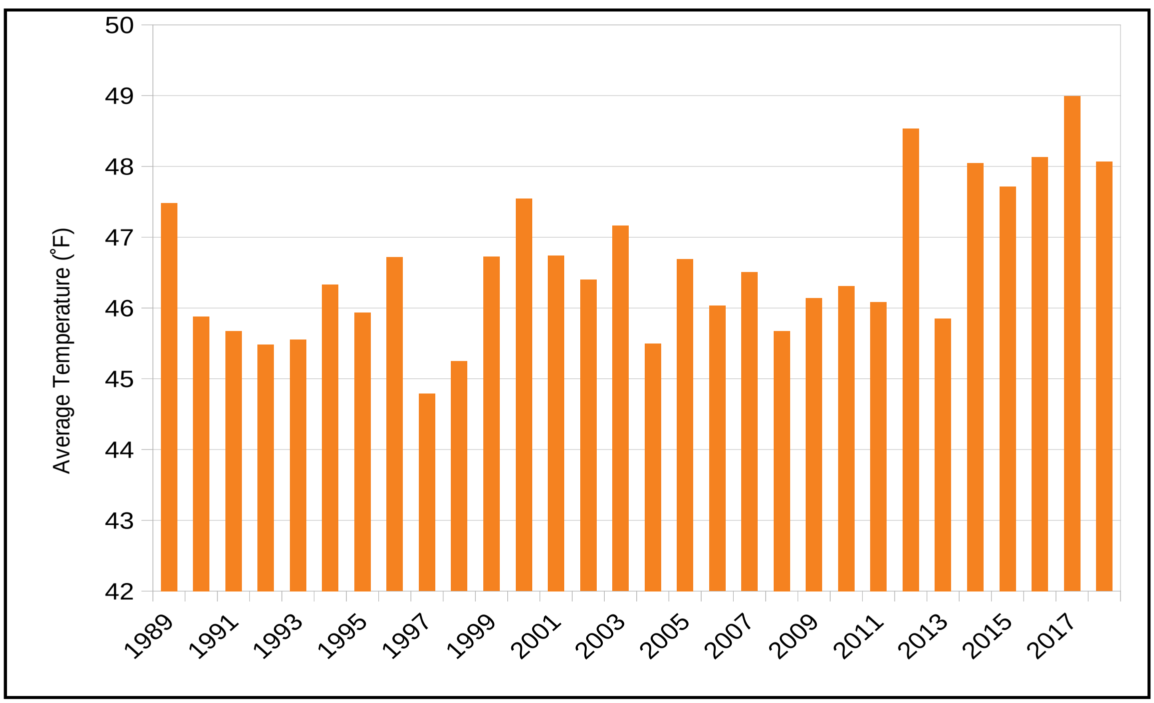

Figure 1.13: Average annual modeled PRISM 1989-2018 temperature for the Bluewater Lake watershed.

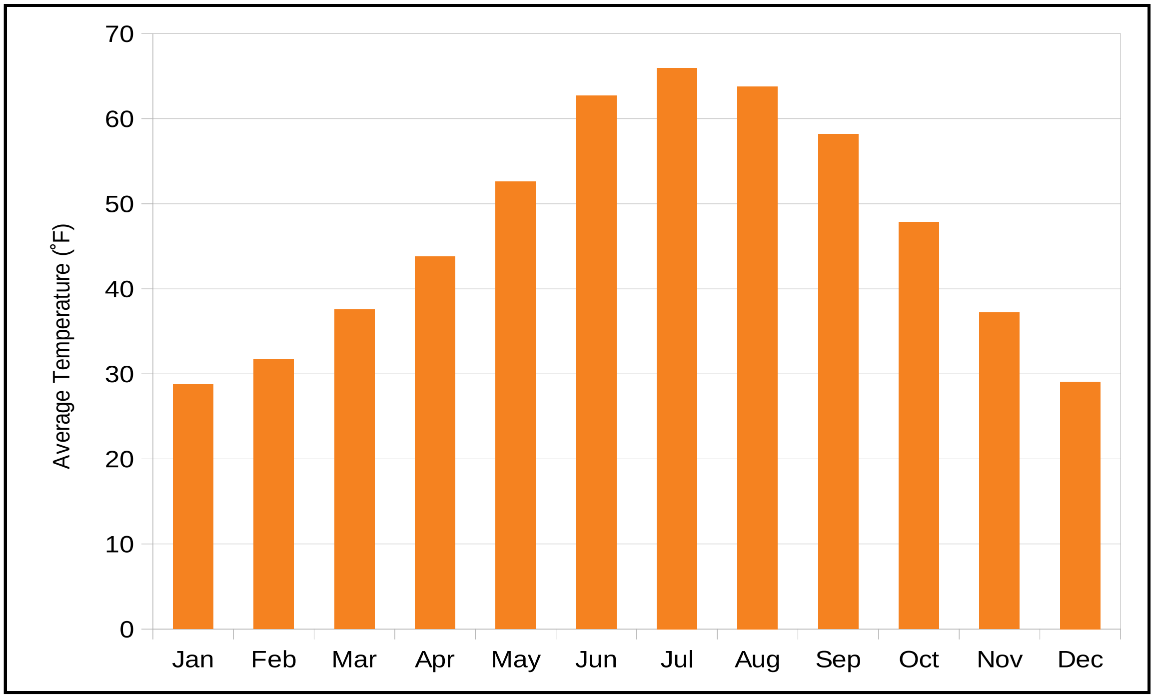

Figure 1.14: Average monthly modeled PRISM 1989-2018 temperature for the Bluewater Lake watershed.

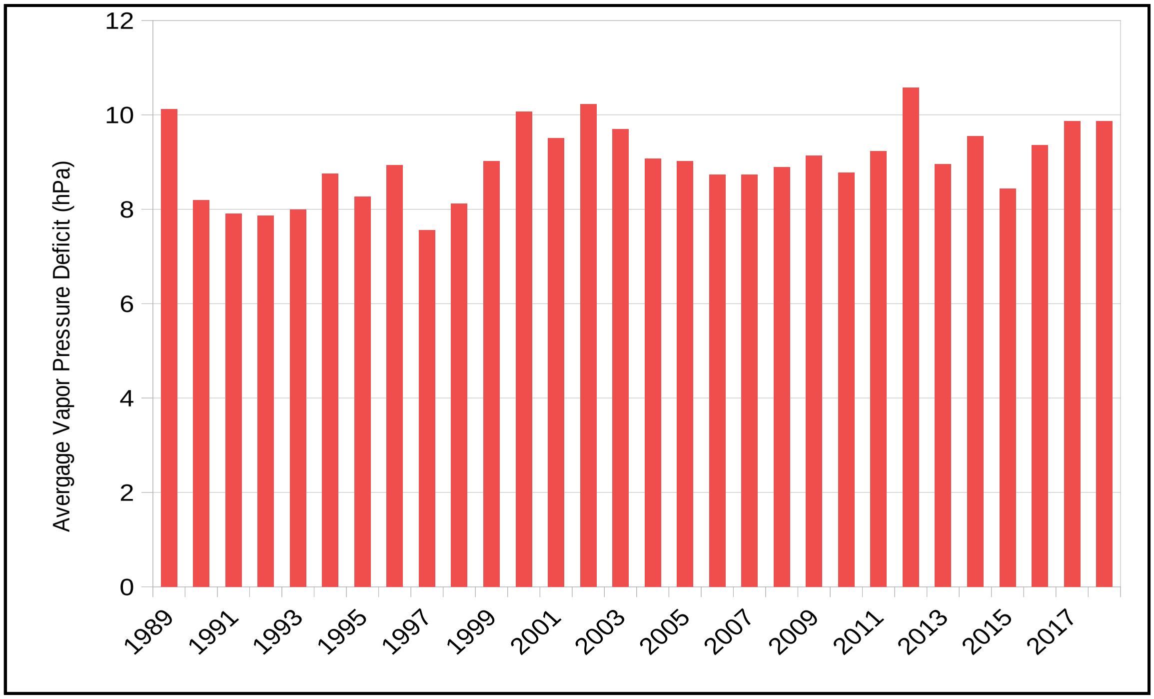

Figure 1.15: Average annual modeled PRISM 1989-2018 vapor pressure deficit for the Bluewater Lake watershed.

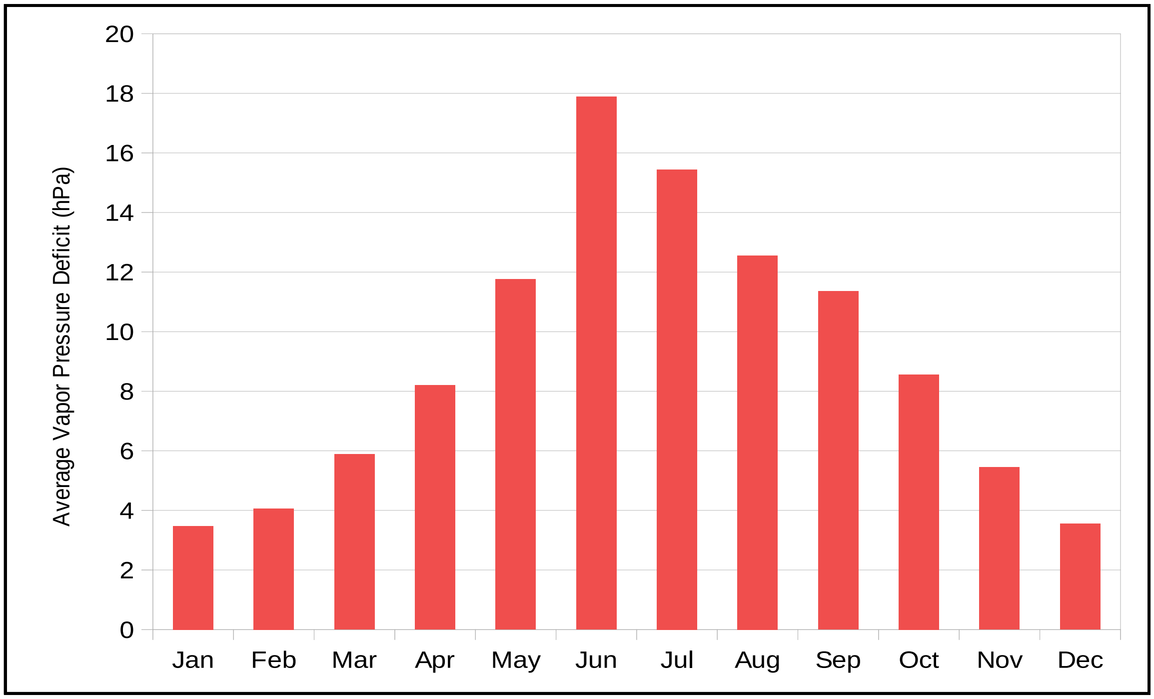

Figure 1.16: Average monthly modeled PRISM 1989-2018 vapor pressure deficit for the Bluewater Lake watershed.

2.0 PLANT NUTRIENTS

Nutrient assessments for Bluewater Lake were included in the 2014-2016 CWA Integrated §303(d)/§305(b) List of Assessed Waters (NMED/SWQB 2014). Assessment of water quality data indicated total nitrogen impairment of the CALM coldwater lake threshold of 0.9 mg/L for TN in the reservoir, but did not identify exceedances of the segment-specific New Mexico water quality total phosphorus (TP) criterion of 0.1 mg/L for TP in the reservoir. However, exceedances of the more stringent CALM coldwater lakes TP threshold of 0.03 mg/L were observed. The following TP TMDL was developed as a protective TMDL, to work in parallel with the total nitrogen (TN) TMDL to affect water quality improvement in the reservoir.

Nitrogen and phosphorus are essential for proper functioning of aquatic ecosystems. However, nuisance levels of algae and other aquatic vegetation can develop rapidly in response to nutrient enrichment when other factors (e.g., light, temperature, substrate) are not limiting.

2.1 Target Loading Capacity

There are two potential causes of nutrient enrichment in any given water body: excessive phosphorus and/or nitrogen. Phosphorous is found in water primarily as orthophosphate. In contrast nitrogen may be found as several species, all of which must be considered in nutrient loading. Total nitrogen is defined as the sum of Nitrate+Nitrite (N+N) and Total Kjeldahl Nitrogen (TKN). Presently, there is no USEPA-approved method to test for total nitrogen, however adding the results of USEPA methods 351.2 (TKN) and 353.2 (N+N) is appropriate for estimating total nitrogen (APHA 1989). While not a USEPA-approved method, Method SM4500-N for Total Nitrogen using a persulfate digest, is an approved method in the SWQB QAPP (NMED/SWQB 2019) and is used in cases where a lower detection limit is needed.

The applicable threshold values for cause and response variables for Bluewater Lake nutrient TMDLs are 0.9 mg/L for TN and 0.03 mg/L for TP based on the value identified for coldwater lakes, such as Bluewater Lake, in Appendix D of the 2019 Comprehensive Assessment and Listing Methodology (CALM) (NMED/SWQB 2019). These threshold values were used for water quality assessments and as a starting point for TMDL development. For New Mexico lakes, potential numeric nutrient targets were collated from the water quality standards, SWQB analyses of existing data, other state agency examples, or published literature. While a nutrient ratio of 30:1 diverges from other recently adopted nutrient limits in the Rocky Mountain West, previous USEPA studies of Bluewater Lake show that the reservoir is phosphorous limited (USEPA 1977), meaning excess nitrogen is unlikely to lead to unwanted algal production. Colorado and Montana are two Mountain West states that have recently adopted numeric TN and TP standards. Colorado adopted interim nutrient limits which have a TN:TP ratio of 11.4 and 11.8 for warm and cold-water streams and rivers, respectively (Colorado Department of Public Health and Environment 2013). Montana’s nutrient standards have TN:TP ratios that range from 2.4 to 13.3, with an average ratio of 7.6 (Montana Department of Environmental Quality 2014). Target values were selected for the CALM based on ecoregional considerations and best professional judgement. The target TN value is derived from change point and regression tree analyses of existing water quality data from New Mexico (Scott and Haggard 2011). The target TP value is derived from the boundary between mesotrophic and eutrophic lakes identified by Nürnberg (1996).

Table 2.1: Applicable nutrient-related thresholds for Bluewater Lake.

Ecoregion	23-Arizona/New Mexico Mountains
WQS segment	20.6.4.135
Aquatic Life Use	Coldwater
Chlorophyll-*a*	≤ 7.5 µg/L[(a)]
Cyanobacteria	≤ 38%[(a)]
Dissolved Oxygen	6.0 mg/L**[(a)]**
Total Nitrogen	0.90 mg/L[(a)]
Total Phosphorus	0.03 mg/L[(a)]

Notes: (a) Threshold value identified for coldwater lakes in the 2019 CALM.

During the survey there were three exceedances (50%) of the nitrogen threshold and two exceedances (50%) of the phosphorous threshold (**Table 2.2**). In addition to the nutrient measurements, the response variables chlorophyll-*a,* cyanobacteria, and secchi depth all also exceeded applicable thresholds, though secchi depth has been removed from the nutrient assessment protocol in the most recent lake CALM (**Table 2.3**). Dissolved oxygen concentration measurements did not exceed the applicable threshold.

Table 2.2: Causal variable exceedances of applicable water quality criteria.

Parameter	Associated Criterion/Threshold	Exceedance Ratio[(a)]
Total Nitrogen	0.90 mg/L	2/4
Total Phosphorus	0.03 mg/L	2/4

Notes: (a) Exceedance ratio is the number of exceedances observed in the total number of samples.

Table 2.3: Response variable exceedances of applicable water quality criteria.

Parameter	Associated Criterion/Threshold	Exceedance Ratio[(a)]
Chlorophyll-*a*	≤ 7.5 µg/L	2/4
Cyanobacteria	≤ 38%	1/5
Dissolved Oxygen	6.0 mg/L	0/5
Secchi Depth[(b)]	2 m	4/5

Notes: (a) Exceedance ratio is the number of exceedances observed in the total number of samples.

(b) Secchi depth is not used in the current lake nutrient CALM, though it was when the original impairment of Bluewater Lake was determined.

2.2 Flow

40 CFR 130.7(c)(1) requires states to calculate a TMDL using the critical conditions for stream flow, with TMDLs generally described in mass units per time (USEPA 2007). Given historic variability of reservoir levels, however, a single-value mass-based TMDL based on daily loading would only offer appropriate protections for a single reservoir level, while a concentration-based TMDL would offer appropriate protections at all lake levels. Determining the critical flow condition for a lake is more complex than simply considering low-flow conditions of a stream, and subsequently TMDLs for Bluewater Lake are described in concentrations per volume. During the 2011 survey, reservoir storage levels generally declined from higher average historical levels and ranged from a volume of 6,531 acre-feet in April to 4,620 acre-feet in November, averaging 5,651 acre-feet over the year. As virtually all data used to calculate these TMDLs were collected in 2011, and the average storage over that year is broadly representative of recent Bluewater Lake storage levels, these TDMLs are calculated to apply to that lake storage level. However, we also recognize the conservation pool reservoir level of 3,500 acre-feet is a meaningful ecological threshold for the lake and is broadly analogous to critical conditions for a stream system. For ease of implementation, estimated surface water inputs of both TN and TP necessary to achieve the Bluewater Lake concentration-based TMDL values are also described in mass-based units for both 2011 average storage volumes and the conservation pool storage volume in subsequent sections.

2.3 TMDL Calculation

This subsection describes the relationship between the numeric nutrient targets and the allowable pollutant-level by determining the total assimilative capacity of the waterbody, or loading capacity, for the pollutant. The loading capacity is the maximum amount of pollutant loading that a waterbody can receive while meeting its water quality objectives. This total TMDL for Bluewater Lake is then allocated as follows: first the MOS is subtracted as described in Section 2.4, then the Waste Load Allocation is subtracted as described in Section 2.5.1, and the remainder is the Load Allocation as described in Section 2.5.2 and **Equation 2.1**.

Every lake has a specific carrying capacity for nutrients based on applicable WQS. This carrying capacity, or TMDL, is defined as the concentration of pollutant that can be carried without violating the target concentration for that constituent. These TMDLs were developed based on observed concentrations using 2011 lake storage and the numeric targets. The specific carrying capacity of a receiving water for a given pollutant was estimated using **Equation 2.1**. The calculated carrying concentrations (i.e., TMDLs) for TN and TP for the average 2011 storage volume are summarized in **Table 2.4**. The same calculated carrying concentrations, expressed as masses for the average 2011 storage volume, are summarized in **Table 2.5**.

$$\mathbf{WLA + LA + MOS = TMDL} \qquad \text{(Eq. 2.1)}$$

Table 2.4: 2011 Bluewater Lake (5,650.89 acre-feet) target concentrations for total nitrogen and total phosphorous.

Parameter	Target Concentration (mg/L)[(a)]	Measured Arithmetic Mean Concentration (mg/L)[(b)]	Concentration Reduction Necessary (mg/L)[(c)]

Parameter	Target Concentration (mg/L)[(a)]	Measured Arithmetic Mean Concentration (mg/L)[(b)]	Concentration Reduction Necessary (mg/L)[(c)]
Total Nitrogen	0.810	1.380	0.570
Total Phosphorus	0.027	0.065	0.038

Notes: *(a)* Target Concentration = TMDL – MOS. The MOS is not included in the concentration reduction calculations because it is a set aside value, which accounts for any uncertainty or variability in TMDL calculations and therefore should not be subtracted from the measured concentration.

(b) The measured concentration is the magnitude of point and nonpoint sources. It is calculated using mean measured exceedance values (Appendix A).

(c) Concentration reduction necessary is the concentration by which the existing measured concentration must be reduced to achieve the target concentration and is calculated as follows: Measured Concentration – Target Concentration.

Table 2.5: 2011 Bluewater Lake (5,650.89 acre-feet) target concentrations for total nitrogen and total phosphorous, expressed as masses.

Parameter	Target Concentration as Mass (lbs)[(a)]	Measured Arithmetic Mean Concentration as Mass (lbs)[(b)]	Concentration Reduction Necessary as Mass (lbs)[(c)]
Total Nitrogen	12,447,106	21,206,180	8,759,074
Total Phosphorus	414,904	998,842	583,938

Notes: *(a)* Target Concentration Mass = TMDL – MOS, expressed as mass based on 2011 lake storage volume. The MOS is not included in the load reduction calculations because it is a set aside value, which accounts for any uncertainty or variability in TMDL calculations and therefore should not be subtracted from the measured load.

(b) The measured concentration mass is the magnitude of point and nonpoint sources, expressed as mass based on 2011 lake storage volume. It is calculated using mean measured exceedance values (Appendix A).

(c) Concentration reduction necessary as mass is the mass by which the existing measured concentration as mass must be reduced to achieve the target concentration as mass and is calculated as follows: Measured Concentration as Mass – Target Concentration as Mass.

2.4 Margin of Safety

TMDLs should reflect a MOS based on the uncertainty or variability in the data, the point and nonpoint source load estimates, and the modeling analysis. The MOS can be expressed either implicitly or explicitly. An implicit MOS is incorporated by making conservative assumptions in the TMDL analysis, such as allocating a conservative load to background sources. An explicit MOS is applied by reserving a portion of the TMDL and not allocating it to any other sources.

For these nutrient TMDLs, the margin of safety was developed using a combination of conservative assumptions and explicit recognition of potential errors. Therefore, this margin of safety is the sum of the following two elements:

- *Conservative Assumptions*
  - Treating phosphorus and nitrogen as pollutants that do not readily degrade in the environment.

- *Explicit Recognition of Potential Errors*
  - Uncertainty exists in sampling nonpoint sources of pollution. A conservative MOS for this element is therefore **5%**.
  - There is inherent variability in lake volumes, both measured and estimated. A conservative MOS for this element in lakes is **5%**.

2.5 Waste Load Allocations and Load Allocations

2.5.1 Waste Load Allocation

There are no National Pollutant Discharge Elimination System (NPDES) individual permits in the Bluewater Lake watershed, thus the WLA is zero for both TN and TP. Similarly, there are no Municipal Separate Storm Sewer System (MS4) permits in the Bluewater Lake watershed. However, excess nutrient loading may be a component of some storm water discharges covered under general NPDES permits. There may be storm water discharges from construction activities covered under the NPDES Construction General Permit (CGP). Permitted sites require preparation of a SWPPP that includes identification and control of all pollutants associated with the construction activities to minimize impacts to water quality. The current CGP also includes state-specific requirements to implement site-specific interim and permanent stabilization, managerial, and structural solids, erosion, and sediment control Best Management Practices (BMPs) and/or other controls. BMPs are designed to prevent to the maximum extent practicable an increase in sediment load to the water body or an increase in a sediment-related parameter, such as total suspended solids, turbidity, siltation, stream bottom deposits, etc. BMPs also include measures to reduce flow velocity during and after construction compared to pre-construction conditions to assure that WLAs or applicable water quality standards, including the antidegradation policy, are met. Compliance with a SWPPP that meets the requirements of the CGP is generally assumed to be consistent with this TMDL.

Storm water discharges from active industrial facilities are generally covered under the current NPDES Multi-Sector General Permit (MSGP). This permit also requires preparation of an SWPPP, which includes specific requirements to limit (or eliminate) pollutant loading associated with the industrial activities in order to minimize impacts to water quality. Compliance with a SWPPP that meets the requirements of the MSGP is generally assumed to be consistent with this TMDL.

It is not possible to calculate individual WLAs for facilities covered by these General Permits at this time using available tools. Loads that are in compliance with the General Permits are therefore currently included as part of the LA.

2.5.2 Load Allocation

The load allocation (LA) accounts for the non-point sources (NPS) of pollution in the respective watersheds. Nonpoint sources include all other categories not classified as point sources (i.e., WLAs). In order to calculate the LA, the WLAs and MOS were subtracted from the TMDL using **Equation 2.2**. The calculated carrying concentrations (i.e., TMDLs) for TN and TP for are summarized in **Table 2.6**. The same calculated carrying concentrations, expressed as masses, are summarized in **Table 2.7**.

$$\mathbf{TMDL = WLA + LA + MOS} \qquad \textbf{(Eq. 2.2)}$$

therefore,

$$\mathbf{LA = TMDL - MOS - WLA}$$

Table 2.6: Bluewater Lake Concentration-based Plant Nutrient TMDLs.

Parameter	MOS (mg/L)	LA (mg/L)	WLA (mg/L)	TMDL (mg/L)
Total Nitrogen	0.090	0.810	0.000	0.900
Total Phosphorus	0.003	0.027	0.000	0.030

Table 2.7: Bluewater Lake Concentration-based Plant Nutrient TMDLs, expressed as masses.

Storage Volume	Parameter	MOS (lbs)	LA (lbs)	WLA (lbs)	TMDL (lbs)
2011 Average (5,650.89 acre-feet)	Total Nitrogen	1,383,012	12,447,106	0	13,830,118
2011 Average (5,650.89 acre-feet)	Total Phosphorus	46,100	414,904	0	461,004
Conservation Pool (3,500 acre-feet)	Total Nitrogen	856,598	7,709,382	0	8,565,980
Conservation Pool (3,500 acre-feet)	Total Phosphorus	28,553	256,979	0	285,533

2.5.3 Load Reductions

The Bluewater Lake load reductions necessary to meet target loads were calculated as the difference between the calculated daily target load and the measured load. Load reductions necessary are given as both concentrations (**Table 2.8**) and masses (**Table 2.9**).

Table 2.8: Calculation of load reductions for TN and TP necessary to achieve Bluewater Lake target concentrations based on 2011 average storage volume (5,650.89 acre-feet), expressed as concentrations.

Parameter	Target Concentration[(a)] (mg/L)	Mean Measured Concentration (mg/L)[(b)]	Concentration Reduction Necessary (mg/L)	Percent Reduction Necessary[(c)]
Total Nitrogen	0.81	1.380	0.570	41.3%
Total Phosphorus	0.027	0.065	0.038	58.5%

Notes: *(a)* Target Concentration = TMDL – MOS. The MOS is not included in the concentration reduction calculations because it is a set aside value, which accounts for any uncertainty or variability in TMDL calculations and therefore should not be subtracted from the measured concentration.

(b) The measured concentration is the magnitude of point and nonpoint sources. It is calculated using mean measured exceedance values (Appendix A).

(c) Percent reduction necessary is the percent the existing measured concentration must be reduced to achieve the target concentration and is calculated as follows: (Measured Concentration – Target Concentration) / Measured Concentration x 100.

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Table 2.9: Calculation of surface runoff load reductions for TN and TP necessary to achieve Bluewater Lake target concentrations based on 2011 average storage volume (5,650.89 acre-feet), expressed as masses.

Parameter	Target Load[(a)] (lbs)	Mean Measured Load (lbs)[(b)]	Load Reduction Necessary (lbs)	Percent Reduction Necessary[(c)]
Total Nitrogen	12,447,106	21,206,180	8,759,074	41.3%
Total Phosphorus	414,904	998,842	583,938	58.5%

Notes: *(a)* Target Concentration Mass = TMDL – MOS, expressed as mass based on 2011 lake storage volume. The MOS is not included in the load reduction calculations because it is a set aside value, which accounts for any uncertainty or variability in TMDL calculations and therefore should not be subtracted from the measured load.

(b) The measured concentration mass is the magnitude of point and nonpoint sources, expressed as mass based on 2011 lake storage volume. It is calculated using mean measured exceedance values (Appendix A).

(c) Percent reduction necessary is the percent the existing measured load must be reduced to achieve the target load and is calculated as follows: (Measured Concentration Mass – Target Concentration Mass) / Measured Concentration Mass x 100.

2.6 Identification and Description of Pollutant Sources

SWQB fieldwork includes an assessment of the probable sources of impairment (**Appendix B)**. The approach for identifying "Probable Sources of Impairment" was recently modified by SWQB to include additional input from a variety of stakeholders including land owners, watershed groups, and local, state, tribal and federal agencies. Although this procedure is qualitative, SWQB feels that it provides the best available information for the identification of probable sources of impairment in a watershed. The list of "Probable Sources" is not intended to single out any particular land owner or single land management activity and has therefore been labeled "Probable" and generally includes several sources for each impairment. Additionally, it should be noted that the extensive data collection and analyses necessary to determine background nutrient loads were beyond the resources available for this study. It is therefore assumed that a portion of the nutrient load allocation is made up of natural background loads. Probable sources of nutrients will be evaluated, refined, and changed as necessary through the Watershed-Based Plan (WBP). The draft probable source list (**Table 2.10**) will be reviewed and modified, as necessary, with watershed group/stakeholder input during the TMDL public meeting and comment period.

Table 2.10: Pollutant source summary for plant nutrients.

NPDES permits	Probable Sources
None	Angling pressure, atmospheric deposition, campgrounds, drought-related impacts, gravel or dirt roads, low water crossing, rangeland grazing, waterfowl, wildlife other than waterfowl

2.7 Linkage between Water Quality and Pollutant Sources

The source assessment phase of TMDL development identifies sources of nutrients that may contribute to both elevated nutrient concentrations and the stimulation of algal growth in a waterbody (**Figure 2.1**). Where data gaps exist or the level of uncertainty in the characterization of sources is large, the recommended approach to TMDL assignments requires the development of allocations based on estimates utilizing the best available information.

Phosphorus and nitrogen generally drive the productivity of algae and macrophytes in aquatic ecosystems, therefore they are regarded as the primary limiting nutrients in freshwaters. The main reservoirs of natural phosphorus are rocks and natural phosphate deposits. Weathering, leaching, and erosion are all processes that breakdown rock and mineral deposits allowing phosphorus to be transported to aquatic systems via water or wind. The breakdown of mineral phosphorus produces inorganic phosphate ions ($H_2PO_4^-$, HPO_4^{2-}, and PO_4^{3-}) that can be absorbed by plants from soil or water (USEPA 1999). Phosphorus primarily moves through the food web as organic phosphorus (after it has been incorporated into plant or algal tissue) where it may be released as phosphate in urine or other waste by heterotrophic consumers and reabsorbed by plants or algae to start another cycle (Nebel and Wright 2000).

The largest reservoir of nitrogen is the atmosphere. About 80% of the atmosphere by volume consists of nitrogen gas (N_2). Although nitrogen is plentiful in the environment, it is not readily available for biological uptake. Nitrogen gas must be converted to other forms, such as ammonia (NH_3 and NH_4^+), nitrate (NO_3^-), or nitrite (NO_2^-) before plants and animals can use it. Conversion of gaseous nitrogen into usable mineral forms occurs through three biologically mediated processes of the nitrogen cycle: nitrogen fixation, nitrification, and ammonification (USEPA 1999). Mineral forms of nitrogen can be taken up by plants and algae and incorporated into their tissue. Nitrogen follows the same pattern of food web incorporation as phosphorus and is released in waste primarily as ammonium compounds. The ammonium compounds are usually converted to nitrates by nitrifying bacteria, making it available again for uptake, starting the cycle anew (Nebel and Wright 2000).

Rain, overland runoff, groundwater, drainage networks, and industrial and residential waste effluents transport nutrients to receiving waterbodies. Once nutrients have been transported into a waterbody they can be taken up by algae, macrophytes, and microorganisms either in the water column or in the benthos; they can sorb to organic or inorganic particles in the water column and/or sediment; they can accumulate or be recycled in the sediment; or they can be transformed and released as a gas from the waterbody (**Figure 2.1**).

As noted above, phosphorus and nitrogen are essential for proper functioning of ecosystems. However, excess nutrients cause conditions unfavorable for the proper functioning of aquatic ecosystems. Nuisance levels of algae and other aquatic vegetation (macrophytes) can develop rapidly in response to nutrient enrichment when other factors (e.g., light, temperature, substrate) are not limiting (**Figure 2.1**). The relationship between nuisance algal growth and nutrient enrichment in aquatic systems has been well documented in the literature (Welch 1992; Van Nieuwenhuyse and Jones 1996; Dodds et al. 1997; Chetelat et al. 1999). Unfortunately, the magnitude of nutrient concentration that constitutes an “excess” is difficult to determine and varies by ecoregion. The recommended level of total phosphorus to avoid algal blooms in nitrogen-limited ecosystems is 0.01 to 0.1 mg/L and 0.1 mg/L to 1 mg/L of total nitrogen. The upper end of these ranges also support less biological diversity (NOAA/USEPA 1988).

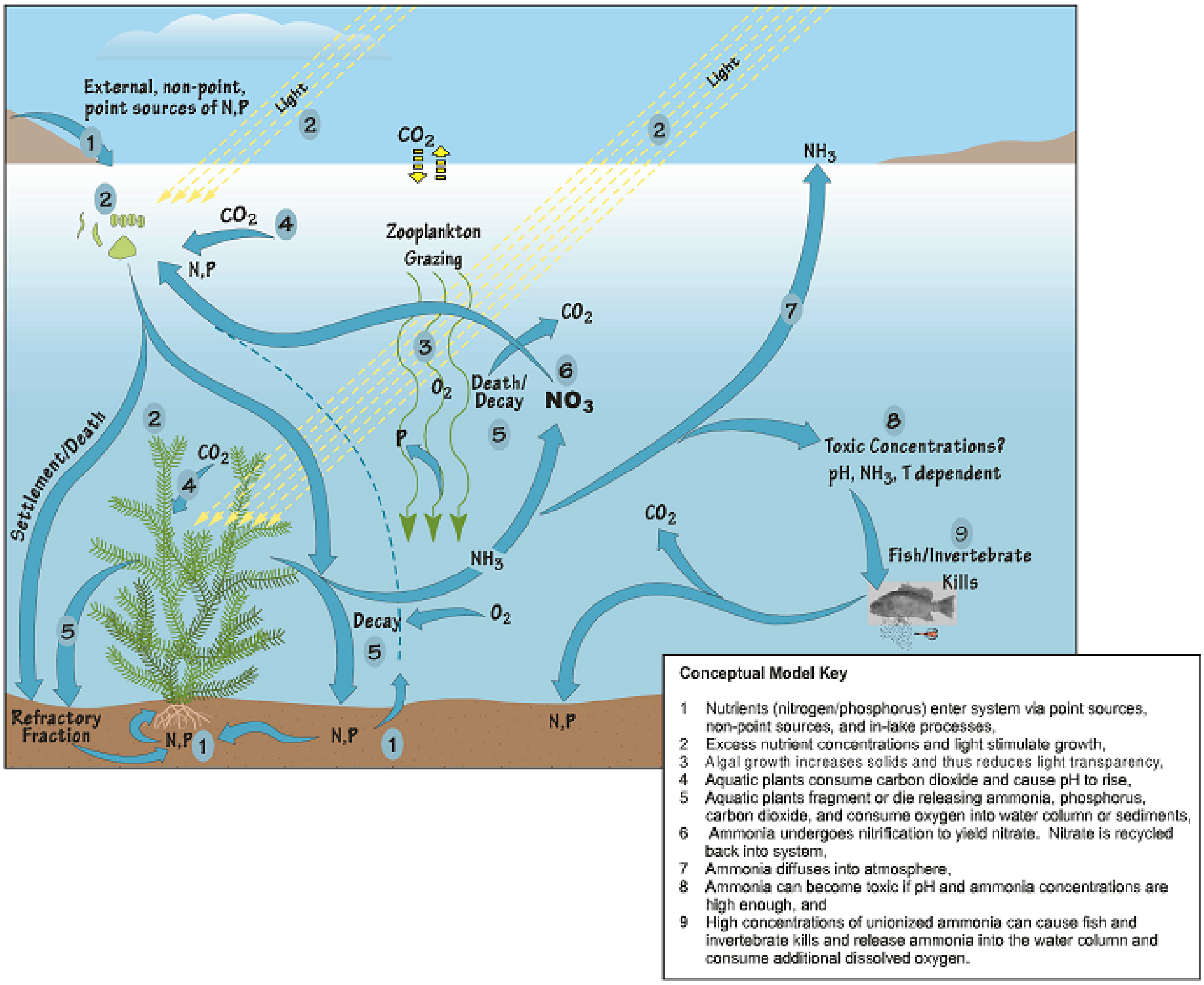

Figure 2.1: Nutrient conceptual model (USEPA 1999).

As described in Section 4.2, the presence of plant nutrients in a lake often varies primarily as a function of surface runoff nutrient concentrations, surface runoff volume, and the hydrologic residence time of the lake. As surface runoff nutrient concentrations increase and surface runoff volume decreases through water diversions and/or drought-related stressors, the lake cannot effectively dilute its constituents, causing the concentration of plant nutrients to increase. These in-lake nutrient increases can be further exacerbated if the hydrologic residence time of the lake increases due to impoundments and/or the lake volume drops due to drought-related stressors. Nutrients more readily reach a lake from land uses in close proximity to the lake because the hydrological pathways are shorter and have fewer obstacles than land uses located farther away from the lake. During periods of intense precipitation, such as that common to the monsoonal precipitation dynamics that define New Mexico's climate, distant land uses can become directly hydrologically connected to the lake, thus transporting nutrients to the lake from distant parts of the lake watershed. Additionally, any land cover transitions that reduce vegetation, especially near riparian corridors (e.g., ongoing and legacy grazing effects), and increase runoff ratios effectively serve to increase the nutrient transport capacity of surface runoff in both magnitude and distance

While the Bluewater Lake watershed is sparsely populated and there are no major agricultural or industrial operations to consider, the importance of human-related activities that contribute to lake nutrient inputs must be considered. Grazing is common throughout the watershed, and few cattle exclosures exist to keep livestock away from sensitive riparian areas. Residential areas within the Bluewater Lake watershed are all located near the lake shore and conceivably contribute nutrients from septic tanks, by direct application of nutrients to landscaping, as well as backyard livestock (e.g., horses) and pet wastes. Water pollution caused by on-site septic systems is a widespread problem in New Mexico (McQuillan 2004). Septic system effluents have contaminated more acre-feet of ground water than all other sources in the state combined. Groundwater contaminated by septic system effluent can discharge into surface streams gaining from groundwater inflow, and the proximity of septic systems to the southwest shore of Bluewater Lake should be noted. Nutrients such as nitrogen and phosphorous released into gaining lakes from aquifers contaminated by septic systems can contribute to eutrophic conditions. Residential development can also contribute nutrients by disturbing the land and consequently increasing soil erosion, as well as increasing the impervious area within the watershed thereby increasing runoff ratios. Recreational activities such as hiking, biking and especially stream crossings for vehicles can also contribute nutrients to the lake by increasing soil erosion (e.g., trail networks, streambank destabilization), as can inappropriate disposal of human waste and dumping trash near the riparian corridor. A majority of the most intense human use of the watershed, both residential and recreational, occurs near the lake shore on hydrologic group D soils that have a high runoff potential.

Undeveloped, or natural, landscapes also can deliver nutrients to a waterbody through decaying plant material, soil erosion, and wild animal waste. Another important nutrient source is atmospheric deposition, which adds nutrients directly to the waterbody through dryfall and rainfall. Atmospheric phosphorus and nitrogen can be found in both organic and inorganic particles, such as pollen and dust, as well as anthropogenic sources such as combustion. The contributions from these natural sources are generally considered to represent background levels.

2.8 Consideration of Seasonal Variability

Section 303(d)(1) of the CWA requires TMDLs to be "established at a level necessary to implement the applicable WQS with seasonal variation." Data used in the calculation of this TMDL were collected during the spring, summer, and fall to ensure coverage of any potential seasonal variation in the system. Exceedances were observed during summer and fall seasons, which captured lake storage level alterations related to the growing season and summer monsoonal rains. The critical condition used for calculating the TMDL is considered to be conservative and protective of the water quality standard under all lake storage levels. Calculations made under average 2011 lake storage levels, in addition to using other conservative assumptions as described in the previous section on MOS, should be protective of the water quality standards designed to preserve aquatic life in the lake. It was assumed that if critical conditions were met during this time period, coverage of any potential seasonal variation would also be met. Lake level considerations are discussed in Section 4.2.

2.9 Future Growth

Growth estimates by county are available from the University of New Mexico (https://gps.unm.edu/pru/projections, accessed 4/20/2020). These estimates project growth to the year 2040. The Bluewater Lake watershed falls within Cibola and McKinley counties (**Table 2.9)**. For Cibola County slow growth is predicted through 2040, resulting in a net increase from 2020 population. For McKinley County slow growth is predicted through 2030, followed by a slight net decline from 2020 population.

Table 2.11: TMDL Study Area County Population Estimates.

County	2020	2025	2030	2035	2040	% Increase (2020-2040)
Cibolla	28,647	28,875	29,030	29,103	29,058	1.42%
McKinley	76,435	76,604	76,623	76,256	76,365	-0.09%

Estimates of future growth are not anticipated to lead to a significant increase in nutrients that cannot be controlled with BMPs. However, it is imperative that BMPs continue to be utilized to improve road conditions and grazing allotments and adhere to SWPPP requirements related to construction and industrial activities covered under the general permit. Any future growth would be considered part of the existing load allocation, assuming persistence of the hydrologic conditions used to develop these TMDLs.

3.0 MONITORING PLAN

Pursuant to CWA Section 106(e)(1), 33 U.S.C. Section 1251, the SWQB has established appropriate monitoring methods, systems and procedures in order to compile and analyze data on the quality of the surface waters of New Mexico. In accordance with the New Mexico Water Quality Act, NMSA 1978, Sections 74-6-1 to -17, the SWQB has developed and implemented a comprehensive water quality monitoring strategy for the surface waters of the State.

The monitoring strategy establishes the methods of identifying and prioritizing water quality data needs, specifies procedures for acquiring and managing water quality data, and describes how these data are used to progress toward three basic monitoring objectives: to develop water quality-based controls, to evaluate the effectiveness of such controls, and to conduct water quality assessments. SWQB revised its 10-year monitoring and assessment strategy (NMED/SWQB 2016a) and submitted it to USEPA Region 6 for review in June 2016. The strategy details both the extent of monitoring that can be accomplished with existing resources plus expanded monitoring strategies that could be implemented given additional resources. The SWQB utilizes a rotating basin approach to water quality monitoring. In this approach, a select number of watersheds are intensively monitored each year with an established return frequency of approximately every eight years. The next scheduled monitoring date for the Canadian River watershed is 2023-2024.

The SWQB maintains current quality assurance and quality control plans to cover all monitoring activities. This document, called the Quality Assurance Project Plan (NMED/SWQB 2018b), is updated regularly and approved by USEPA Region 6. In addition, the SWQB identifies the data quality objectives required to provide information of sufficient quality to meet the established goals of the program. Current priorities for monitoring by the SWQB are driven by the CWA Section 303(d) list of streams requiring TMDLs or TMDL alternatives; water bodies identified as needing ALU verification; the need to monitor unassessed perennial waters; and water bodies receiving point source discharge(s). Short-term efforts were directed toward those waters that are on the USEPA TMDL consent decree list (U.S. District Court for the District of New Mexico 1997), however NMED/SWQB completed the final remaining TMDL on the consent decree in December 2006 and USEPA approved this TMDL in August 2007. The U.S. District Court terminated the Consent Decree on April 21, 2009.

Once assessment monitoring is completed, those reaches showing impacts and requiring a TMDL will be targeted for more intensive monitoring. The methods of data acquisition include fixed-station monitoring, intensive surveys of priority assessment units (including biological assessments), and monitoring of industrial, federal, and municipal dischargers, as specified in the SWQB Standard Operating Procedures.

Long-term monitoring for assessments will be accomplished through the establishment of sampling sites that are representative of the water body and which can be revisited approximately every eight years. This information will provide time relevant information for use in CWA Section 303(d) listing and 305(b) report assessments and to support the need for developing TMDLs. The approach provides:

- a systematic, detailed review of water quality data which allows for a more efficient use of valuable monitoring resources;
- information at a scale where implementation of corrective activities is feasible;

- an established order of rotation and predictable sampling in each basin which allows for enhanced coordinated efforts with other programs; and
- program efficiency and improvements in the basis for management decisions.

It should be noted that a watershed would not be ignored during the years in between water quality surveys. The rotating basin program will be supplemented with other data collection efforts such as on-going studies being performed by the USGS and USEPA. Data will be analyzed, and field studies will be conducted to further characterize acknowledged problems and TMDLs will be developed and implemented accordingly. Both long-term and intensive field studies can contribute to the State’s Integrated 303(d)/§305(b) listing process for waters requiring TMDLs.

4.0 IMPLEMENTATION OF TMDLs

When approving TMDL documents, USEPA takes action on the TMDL, LA, WLA, and other components of the TMDL as needed (e.g., MOS and future growth). USEPA does not take action on the implementation section of the TMDL, and USEPA is not bound to implement any recommendations found in this section, in particular if they are found to be inconsistent with CWA and NPDES regulations, guidance, or policy.

4.1 Point Sources – NPDES Permitting

There are no NPDES individual permits in the Bluewater Lake watershed.

4.2 Nonpoint Sources

4.2.1 WBP and BMP Coordination

Public awareness and involvement will be crucial to the successful implementation of these plans and improved water quality. A WBP is a written plan intended to provide a long-range vision for various activities and management of resources in a watershed. It includes opportunities for private land owners and public agencies to reduce and prevent nonpoint source impacts to water quality. This long-range strategy will become instrumental in coordinating efforts to achieve water quality standards in the watershed. The WBP is essentially the Implementation Plan, or Phase Two, of the TMDL process. The completion of the TMDLs and WBPs leads directly to the development of on-the-ground projects to address surface water impairments in the watershed. BMPs to be considered as part of on-the ground-projects to address plant nutrients include establishment of additional riparian vegetation and/or stream channel restoration work, grazing exclusions, and rangeland restoration aimed at slowing/reducing surface runoff to stream channels. The Bluewater Lake watershed is addressed briefly in the 2018 Rio Puerco WBP, though Bluewater Creek and not the lake itself are the focus there. The Rio Puerco WBP can be found on the NMED SWQB website at: https://www.env.nm.gov/wp-content/uploads/sites/25/2017/06/RioPuercoPlan_FINALVERSION.pdf Additional information about the reduction of non-point source pollution can be found online at: https://www.epa.gov/polluted-runoff-nonpoint-source-pollution

SWQB staff will continue to provide technical assistance such as selection and application of BMPs needed to meet WBP goals. Stakeholder public outreach and involvement in the implementation of this TMDL will be ongoing.

4.2.2 BATHTUB Modeling Conceptual Overview

These TMDLs were developed with the support of the steady-state reservoir modeling program BATHTUB, which was developed by the US Army Corps of Engineers for modeling nutrients in lakes and reservoirs (Walker 2006). While BATHUB was originally developed for shallow warmwater lakes of the southeastern United States, the morphology and hydrology of Bluewater Lake is similar enough to those systems that it is easily adapted here. Application of the BATHTUB model for Bluewater Lake began with using recent and contemporaneous USGS gage data from streams flowing directly into the lake, lake storage levels gaged at the dam, and gaged discharge on Bluewater Creek below the dam to create water balance parameters. Bluewater Lake watershed was divided into three subwatersheds for BATHTUB modeling; one each with outlets at the USGS gages above the lake, and a third making up the contributing drainage area containing the lakeshore (**Figure 4.1**). Since water quality data assessed for this TMDL was collected primarily in 2011, a decade after the stream gages above and below the lake were decommissioned, only gage data from years in the gage periods of record hydrologically similar to 2011 were used to estimate input coefficients for

BATHTUB modeling. The BATHTUB model was designed to function at an annual time step, and the model presented here was derived from the best available assumptions for the year 2011. A complete list of all BATHTUB model inputs and results can be found in **Appendix C**.

4.2.2.1 BATHTUB Lake Morphology Inputs

Lake surface area is highly correlated with lake storage levels, expanding in a non-linear fashion with increasing storage, so average 2011 lake area was derived from an exponential regression between lake surface area and lake storage. Using manually delineated lake surface area polygons from high-resolution satellite imagery from 2011, 2012, 2014 and 2016, and corresponding USGS gaged daily reservoir storage volumes for the days the images were captured, a simple exponential regression equation relating lake surface area and lake storage was calculated to allow estimation of lake surface area at any storage level (**Equation 4.1**). During 2011, the year most data this TMDL is based on was collected, the average storage was 5,650.89 acre-feet, calculated using an estimated average surface area of 510.16 acres and an average depth of 11.08 feet. The complexity of a lake shoreline is best described by the shoreline development ratio, which compares the shoreline distance to surface area ratio of a lake to a that of a perfectly circular lake (shoreline development ratio = 1.0). Bluewater Lake has a highly irregular shoreline, resulting in a shoreline development ratio of 2.89. The lake is approximately 2.65 miles wide along the east-west axis, from the mouth of Cottonwood Creek to the dam, and approximately 1.65 miles wide along the north-south axis, from the main facilities of the Bluewater State Park to the mouth of Bluewater Creek. The BATHTUB model allows division of large lakes with high shoreline development ratios into smaller segments exhibiting distinct water quality metrics, but given the small average surface area, small storage volume, and well mixed nature of Bluewater Lake, as well as the fact there is only one SWQB station providing water quality data in the lake to calibrate the model to, the entire reservoir was represented by a single segment with no thermocline.

$$\text{Lake Surface Area (acres)} = 146.8616 * \log_e(0.0002*(\text{Lake Storage(acre-feet)}) \qquad \text{(Eq. 4.1)}$$

$$R^2 = 0.9686$$

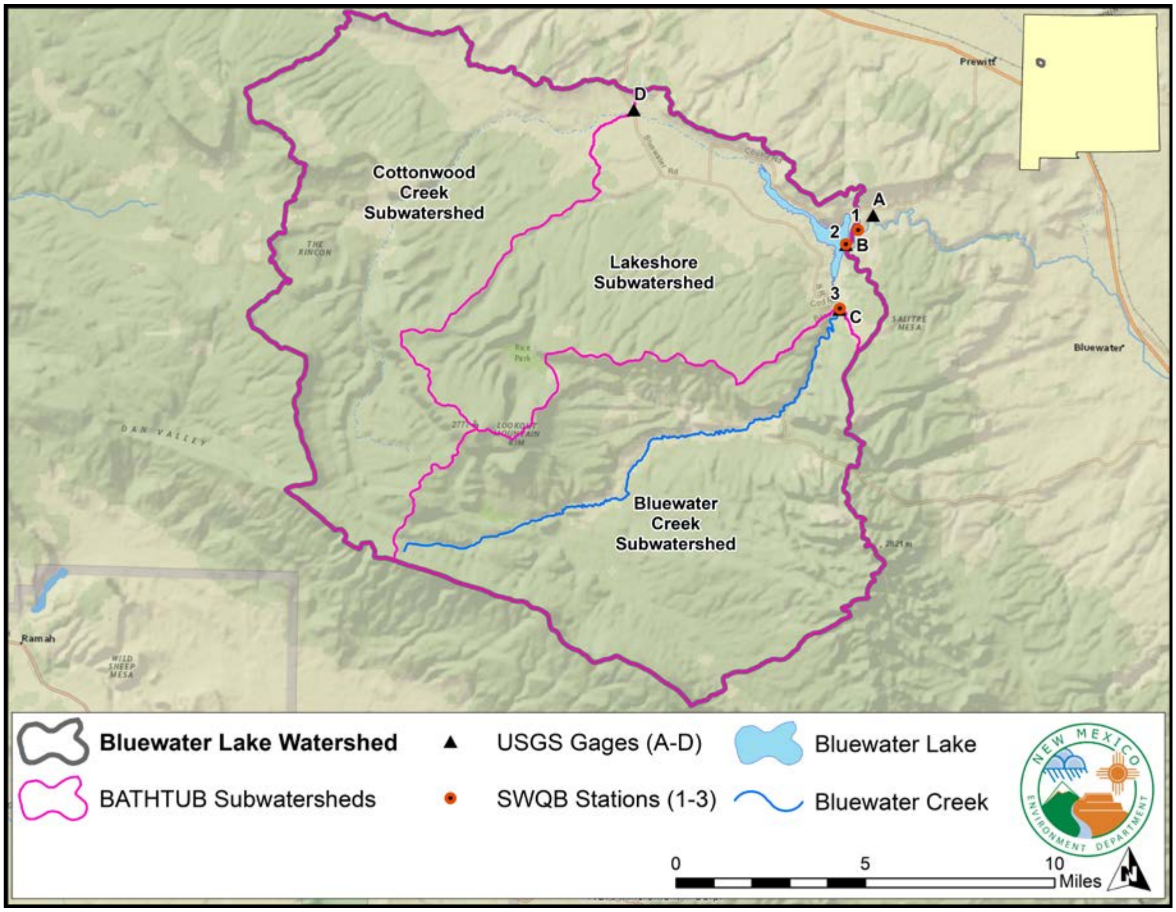

Figure 4.1: Subwatersheds used for Bluewater Lake BATHTUB modeling.

4.2.2.2 BATHTUB Water Balance Inputs

An accurate water balance, accounting for all inflows and outflows, is critical to development of an informative lake water quality model, so historic weather conditions derived from PRISM 4 km resolution stable annual data and contemporaneous USGS gage data were used in combination to estimate 2011 hydrologic conditions. Annual PRISM precipitation for 1991, 1994, 1995, 1996, 1999, and 2000 were all within 25% of 2011 annual PRISM precipitation, and PRISM mean air temperatures and vapor pressure deficits were also broadly comparable to 2011 data. USGS gage data from these years were used to estimate 2011 surface inflows to the lake from the three subwatersheds shown in **Figure 4.1**. For the Bluewater Creek and Cottonwood Creek subwatersheds the average runoff coefficients from the aforementioned years, 0.0405 and 0.0317 respectively, were applied to 2011 precipitation data. For the Lakeshore subwatershed a distance weighted approach based on those coefficients observed in the Bluewater Creek and Cottonwood Creek subwatersheds was employed to interpolate a runoff coefficient of 0.0364, which was then also applied to 2011 precipitation data. Seepage from the lake into Bluewater Creek below the dam is highly correlated with lake storage levels, responding to head pressure from the mass of water impounded by the dam in a non-linear fashion with increasing storage. Average 2011 lake seepage below the dam was derived from a simple logarithmic regression equation relating gaged lake storage volume and gaged creek discharge (**Equation 4.2**). Lake surface evaporation was estimated from 2011 Penman evaporation data collected by a USFS weather station approximately 6.75 miles SSE of Bluewater Lake at an elevation of 8,289 ft.

$$\text{Below Dam Discharge(acre-feet*yr}^{-1}\text{)} = 7{,}230.59*\log_e(\text{Lake Storage(acre-feet)}) - 57{,}252.98 \quad \text{(Eq. 4.2)}$$

$$R^2 = 0.8395$$

4.2.2.3 BATHTUB Nutrient Balance Inputs

Surface inflow, lake, and outflow nutrient concentrations were estimated from average observed values taken from SWQB survey data. These data were primarily collected in 2011, though Bluewater Creek below the dam was also sampled twice in 2014. Given land cover/use, geology, and hydrologic soil groups between the three subwatersheds used for BATHUB modeling are relatively evenly distributed, average nutrient concentrations observed in Bluewater Creek above the reservoir during April, May, June, August and November of 2011 are applied to all estimated surface inflows from each of the three subwatersheds. While there is likely some variation in actual surface inflow nutrient concentrations between subwatersheds, the nutrient concentration data collected from Bluewater Creek above the reservoir are the best estimate available. Nutrient concentrations in Bluewater Lake (TN = 1.148 mg/L, TP = 0.053 mg/L), as well as chlorophyll-*a* concentrations and secchi depths, used for modeling were averaged from all collected in April, June, August, and November of 2011. Atmospheric contributions of TN were estimated from NADP Total Deposition Science Committee 2011 total nitrogen deposition data, which take into account atmospheric concentrations and both wet and dry deposition, as well as deposition velocity. Atmospheric contributions of TP were estimated from a peer-reviewed study of lake nutrient concentrations (Ellis et al. 2019). Average nutrient concentrations observed in Bluewater Creek below the reservoir during April, June, August and November of 2011, as well as May of 2014, are applied to all estimated seepage.

4.2.2.4 BATHTUB Model Calibration and Results

The final BATHTUB model results in a logical and realistic water balance, estimating the hydraulic residence time of the reservoir at 1.11 years. Nutrient residence times are estimated at 0.88 years for both TN and TP. Using default model coefficients of 1.0 for all parameters, TN, TP, and chlorophyll-*a* were all initially under-predicted, while secchi depth was initially over-predicted. These initial discrepancies between observed and predicted data likely stem from the fact that BATHTUB was originally developed for lakes in the verdant southeastern United States, where most shorelines and littoral zones host dense terrestrial and aquatic vegetation communities that continually take up nutrients. The shoreline and littoral zone of Bluewater Lake are generally devoid of any vegetation, so model coefficients were increased to calibrate predicted nutrient concentrations to observed nutrient concentrations. Previous applications of the BATHTUB model and resulting best practices guidance from other modelers advise 2.0 as a maximum adjusted model coefficient threshold, but none were raised to that value. Given the disparate precipitation inputs and runoff coefficients of the three subwatersheds modeled, nutrient source partitioning is also logical and realistic. Considering TN, the model estimates that 37.9% comes from the Bluewater Creek subwatershed, 27.3% from the Cottonwood Creek subwatershed, 21.7% from the Lakeshore subwatershed, and 13.1% from precipitation. Considering TP, the model estimates that 38.4% comes from the Bluewater Creek subwatershed, 27.7% from the Cottonwood Creek subwatershed, 22.0% from the Lakeshore subwatershed, and 11.9% from precipitation.

Iterative nutrient input concentration reductions were explored until modeled lake nutrient concentrations met both the TMDL and target concentration values. Assuming no changes in surface runoff volumes or atmospheric nutrient deposition, a 34.1% reduction in surface inflow TN concentration (from 0.925 mg/L to 0.610 mg/L) will result in Bluewater Lake TN concentration achieving the TDML of 0.900 mg/L. Assuming no changes in surface runoff volumes or atmospheric nutrient deposition, a 45.3% reduction in surface inflow TN concentration (from 0.925 mg/L to 0.506 mg/L) will result in Bluewater Lake TN concentration achieving the target concentration of 0.810 mg/L. Assuming no changes in surface runoff volumes or atmospheric nutrient deposition, a 62.1% reduction in surface inflow TP concentration (from 0.0435 mg/L to 0.0165 mg/L) will result in Bluewater Lake TP concentration achieving the TDML of 0.03 mg/L. Assuming no changes in surface runoff volumes or atmospheric nutrient deposition, a 68.3% reduction in surface inflow TP concentration (from 0.0435 mg/L to 0.0138 mg/L) will result in Bluewater Lake TP concentration achieving the target concentration of 0.027 mg/L. The surface runoff load reductions necessary to meet the Bluewater Lake TMDL target loads, expressed as concentrations, were calculated as the difference between the modeled daily target surface runoff concentration and the measured surface runoff concentration as shown in **Table 4.1**. The same surface runoff load reductions necessary to meet the Bluewater Lake TMDL target loads, expressed as masses, are shown in **Table 4.2**.

Assuming no changes in surface runoff volume or atmospheric nutrient deposition, as well as assuming constant runoff throughout the year, the concentration-based TN reductions outlined above translate to the following mass-based reductions. To achieve the TMDL of 0.900 mg/L TN, a cumulative reduction of 9.334 lbs/day runoff TN, from 27.384 lbs/day to 18.050 lbs/day, is necessary. This cumulative reduction would be met by reducing Bluewater Creek Subwatershed TN export by 4.071 lbs/day, Cottonwood Creek Subwatershed TN export by 2.936 lbs/day, and Lakeshore Subwatershed TN export by 2.327 lbs/day. To achieve the target concentration of 0.810 mg/L TN, a cumulative reduction of 12.391 lbs/day runoff TN, from 27.384 lbs/day to 14.993 lbs/day, is necessary. This cumulative reduction would be met by reducing Bluewater Creek Subwatershed TN export by 5.404 lbs/day, Cottonwood Creek Subwatershed TN export by 3.897 lbs/day, and Lakeshore Subwatershed TN export by 3.090 lbs/day. However, Bluewater Lake may well attain the TN TMDL with slightly less severe reductions in surface inflow TN concentration, as atmospheric TN deposition was anomalously high in 2011 (5.15 lbs N/acre), but has generally decreased from 4.97 lbs N/acre in 2000 to 3.57 lbs N/acre in 2018, a trend that will hopefully continue (**Figure 4.2**).

Assuming no changes in surface runoff volume or atmospheric nutrient deposition, as well as assuming constant runoff throughout the year, the concentration-based TP reductions outlined above translate to the following mass-based reductions. To achieve the TMDL of 0.030 mg/L TP, a cumulative reduction of 1.390 lbs/day runoff TP, from 2.240 lbs/day to 0.850 lbs/day, is necessary. This cumulative reduction would be met by reducing Bluewater Creek Subwatershed TP export by 0.606 lbs/day, Cottonwood Creek Subwatershed TP export by 0.437 lbs/day, and Lakeshore Subwatershed TP export by 0.347 lbs/day. To achieve the target concentration of 0.027 mg/L TP, a cumulative reduction of 1.532 lbs/day runoff TP, from 2.240 lbs/day to 0.708 lbs/day, is necessary. This cumulative reduction would be met by reducing Bluewater Creek Subwatershed TP export by 0.668 lbs/day, Cottonwood Creek Subwatershed TP export by 0.482 lbs/day, and Lakeshore Subwatershed TP export by 0.347 lbs/day.

Table 4.1: Calculation of surface runoff load reductions for TN and TP necessary to achieve Bluewater Lake TMDL target concentrations based on 2011 average storage volume (5,650.89 acre-feet), expressed as concentrations.

Parameter	Surface Runoff Target Concentration (mg/L)	2011 Surface Runoff Measured Arithmetic Mean Concentration (mg/L)	Necessary Surface Runoff Concentration Reduction (mg/L)	Necessary Surface Runoff Percent Reduction[b]
Total Nitrogen	0.506	0.925	0.419	45.3%
Total Phosphorus	0.017	0.044	0.027	68.3%

Notes: *(a)* Percent reduction necessary is the percent the existing measured load must be reduced to achieve the target load and is calculated as follows: (Measured Concentration – Target Concentration) / Measured Concentration x 100.

Table 4.2: Calculation of surface runoff load reductions for TN and TP necessary to achieve Bluewater Lake TMDL target concentrations based on 2011 average storage volume (5,650.89 acre-feet), expressed as masses.

Parameter	Surface Runoff Target Load (lbs/day)	2011 Surface Runoff Measured Arithmetic Mean Load (lbs/day)	Necessary Surface Runoff Reduction (lbs/day)	Necessary Surface Runoff Percent Reduction[a]
Total Nitrogen	14.993	27.384	12.391	34.1%
Total Phosphorus	0.708	2.240	1.532	0.0%

Notes: *(a)* Percent reduction necessary is the percent the existing measured load must be reduced to achieve the target load and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100.

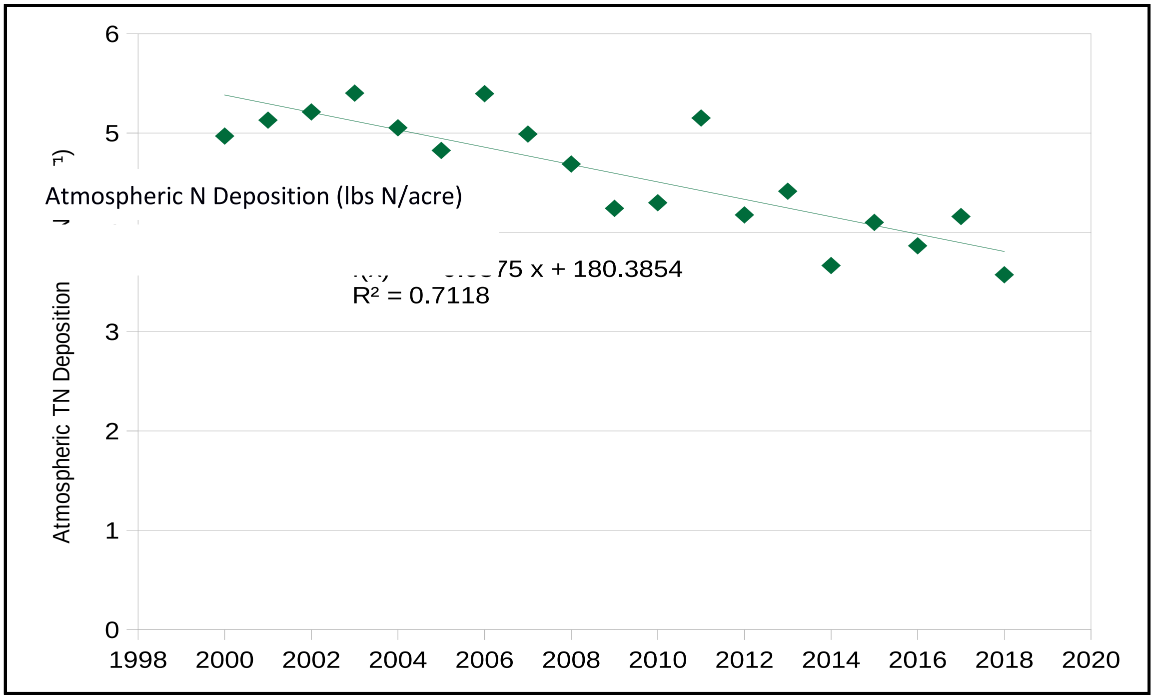

Figure 4.2: Average annual modeled NADP total atmospheric nitrogen deposition for the Bluewater Lake watershed.

4.3 Clean Water Act Section 319(h) Funding

The Watershed Protection Section of the SWQB can potentially provide USEPA Section 319(h) funding to assist in implementation of BMPs to address water quality problems on reaches listed as category 4 or 5 waters on the Integrated 303(d)/§305(b) list. These monies are available to all private, for-profit, and nonprofit organizations that are authenticated legal entities, or governmental jurisdictions including: cities, counties, tribal entities, federal agencies, or agencies of the state. Proposals are submitted by applicants through a Request for Proposal (RFP) process. Selected projects require a non-federal match of 40% of the total project cost consisting of funds and/or in-kind services. Funding is potentially available, generally annually, for both watershed-based planning and on-the-ground projects to improve surface water quality and associated habitat. Further information on funding from the CWA Section 319(h) can be found at the SWQB website: http://www.nmenv.state.nm.us/swqb/.

There is currently an approved WBP for the Rio Puerco, but Bluewater Lake is only mentioned briefly. SWQB staff will continue to conduct outreach related to the CWA Section 319(h) funding program which could lead to the formation of a Bluewater Lake watershed-specific group in the area.

4.4 Other Funding Opportunities and Restoration Efforts

Several other sources of funding exist to address impairments discussed in this TMDL document. NMED's Construction Programs Bureau assists communities in need of funding for wastewater treatment plant upgrades and improvements to septic tank configurations. They can also provide matching funds for appropriate CWA Section 319(h) projects using state revolving fund monies. The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Environmental Quality Incentive Program (EQIP) program can provide assistance to private land owners in the basin. The USDA Forest Service aligns their mission to protect lands they manage with the TMDL process and are another source of assistance. The Bureau of Land Management (BLM) has several programs in place to provide assistance to improve unpaved roads and grazing allotments.

The SWQB annually makes available CWA Section 604(b) funds through a Request for Quotes (RFQ) process. The SWQB requests quotes from regional public comprehensive planning organizations to conduct water quality management planning as defined under Sections 205(j) and 303(e) and the CWA. The SWQB seeks proposals to conduct water quality management planning with a focus on projects that clearly address the State's water quality goals to preserve, protect and improve the water quality in New Mexico. The SWQB encourages proposals focused on TMDLs and UAAs or other water quality management planning activities that will directly address identified water quality impairments. The SWQB 604(b) RFQ is released annually in September.

The New Mexico Legislature appropriated $2.3 million in state funds for the River Stewardship Program during the 2014 Legislative Session, $1 million during the 2015 Special Session, and

$1.5 million during the 2016 Legislative Session. The River Stewardship Program has the overall goal of addressing the root causes of poor water quality and stream habitat. Objectives of the River Stewardship Program include: “restoring or maintaining hydrology of streams and rivers to better handle overbank flows and thus reduce flooding downstream; enhancing economic benefits of healthy river systems such as improved opportunities to hunt, fish, float or view wildlife; and providing state matching funds required for federal CWA grants.” A competitive request for proposals was conducted for 2014 funding and 12 projects located throughout the state were selected. Responsibility for the program is assigned to NMED, and SWQB staff administer the projects. The SWQB issued a competitive request for proposals for the 2015-2016 funding in early 2016. Submitted project proposals have been reviewed, funding has been approved, and contracts are currently in development.

Information on additional watershed restoration funding resources is available on the SWQB website at: https://www.env.nm.gov/swqb/Watershed_Protection/FundingSourcesforWatershedProtection.pdf

5.0 APPLICABLE REGULATIONS AND REASONABLE ASSURANCES

New Mexico's Water Quality Act, NMSA 1978 Sections 74-6-1 to -17 (Act), authorizes the WQCC to "promulgate and publish regulation to prevent or abate water pollution in the state" and to require permits. The Act authorizes a constituent agency to take enforcement action against any person who violates a water quality standard. Several statutory provisions on nuisance law could also be applied to NPS water pollution. The Act also states in Section 74-6-12(A):

> *The Water Quality Act (this article) does not grant to the commission or to any other entity the power to take away or modify the property rights in water, nor is it the intention of the Water Quality Act to take away or modify such rights.*

In addition, the State of New Mexico Surface Water Quality Standards (20.6.4.6(C) NMAC) states:

> *Pursuant to Subsection A of Section 74-6-12 NMSA 1978, this part does not grant to the water quality control commission or to any other entity the power to take away or modify property rights in water.*

New Mexico policies are in accordance with the federal CWA Section 101(g):

> *It is the policy of Congress that the authority of each State to allocate quantities of water within its jurisdiction shall not be superseded, abrogated or otherwise impaired by this Act. It is the further policy of Congress that nothing in this Act shall be construed to supersede or abrogate rights to quantities of water which have been established by any State. Federal agencies shall co-operate with State and local agencies to develop comprehensive solutions to prevent, reduce and eliminate pollution in concert with programs for managing water resources.*

New Mexico's CWA Section 319 Program has been developed in a coordinated manner with the State's CWA Section 303(d) process. All watersheds that are targeted in the annual §319 request for proposal process coincide with the State's biennial impaired waters list as approved by USEPA. The State has given a high priority for funding, assessment, and restoration activities to these watersheds.

As a constituent agency, NMED has the authority under NMSA 1978, Section 74-6-10 to issue a compliance order or commence civil action in district court for appropriate relief if NMED determines that actions of a "person" (as defined in the Act) have resulted in a violation of a water quality standard including a violation caused by a NPS. The NMED NPS water quality management program has historically strived for and will continue to promote voluntary compliance to NPS water pollution concerns by utilizing a voluntary, cooperative approach. The State provides technical support and grant monies for implementation of BMPs and other NPS prevention mechanisms through Section 319 of the CWA. Since portions of this TMDL will be implemented through NPS control mechanisms, the New Mexico Watershed Protection Program will target efforts to this and other watersheds with TMDLs.

In order to obtain reasonable assurances for implementation in watersheds with multiple land owners, including federal, state, and private land, NMED has established Memoranda of Understanding (MOUs) with various federal agencies, in particular the U.S. Forest Service and the BLM. MOUs have also been developed with other state agencies, such as the New Mexico Department of Transportation. These MOUs provide for coordination and consistency in dealing with NPS issues.

The time required to attain standards for all reaches is estimated to be approximately 10-20 years. This estimate is based on a five-year time frame implementing several watershed projects that may not be starting immediately or may be in response to earlier projects. Stakeholders in this process will include the SWQB, and other parties identified in the WBP. The cooperation of watershed stakeholders will be pivotal in the implementation of these TMDLs as well.

6.0 PUBLIC PARTICIPATION

Public participation was solicited in development of this TMDL. The draft TMDL was first made available for a 30-day comment period beginning Thursday, February 18, 2021 and ending on Monday, March 22, 2021. The draft document notice of availability was advertised via email distribution lists and webpage postings. A public meeting will be held online due to COVID precautions on Thursday, February 25, 2021, from 5:30 p.m. to 7:30 MDT. Specific meeting details will be made available in a meeting flyer posted to the SWQB website during the week of February 22, 2021. A response to comments will be added to the TMDL document as **Appendix D**.

Once the TMDL is approved by the WQCC at a regularly scheduled public meeting, the next step for public participation will be integration with existing WBPs and watershed protection projects, including those that may be funded by CWA Section 319(h) grants managed by SWQB.

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APPENDIX A: WATER QUALITY DATA

Table A1: Plant Nutrient Data. Asterisk (*) indicates one half of MRL, and double asterisk (**) indicates exceedance of applicable causal threshold.

Site ID	Date	Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N (mg/L)	Kjeldahl Nitrogen (mg/L)	Total Nitrogen, (Nitrite N + Nitrate N + Kjeldahl N) (mg/L)	Total Phosphorus (mg/L)
36Bluewa016.7 (Bluewater Creek Below Dam)	2011-04-05 16:00	0.05*	0.25*	0.30	0.023
36Bluewa016.7 (Bluewater Creek Below Dam)	2011-06-08 13:00	0.05*	0.46	0.51	0.049
36Bluewa016.7 (Bluewater Creek Below Dam)	2011-08-10 12:40	0.05*	0.25*	0.30	0.056
36Bluewa016.7 (Bluewater Creek Below Dam)	2014-05-09 16:00	0.05*	0.25*	0.30	0.013
36BluWaterLkDm (Bluewater Lake at Dam)	2011-04-05 13:30	0.05*	0.64	0.69	0.035**
36BluWaterLkDm (Bluewater Lake at Dam)	2011-06-08 11:30	0.05*	0.99**	1.04**	0.029
36BluWaterLkDm (Bluewater Lake at Dam)	2011-08-10 10:00	0.05*	1.57**	1.62**	0.094**
36BluWaterLkDm (Bluewater Lake at Dam)	2014-05-09 9:30	0.05*	0.53	0.58	0.017
36Bluewa018.9 (Bluewater Creek Above Lake)	2011-04-05 11:30	0.05*	0.54	0.59	0.034
36Bluewa018.9 (Bluewater Creek Above Lake)	2011-04-28 17:22	2.60	0.72	3.32	0.010
36Bluewa018.9 (Bluewater Creek Above Lake)	2011-15-18 13:58	0.05*	0.16	0.21	0.024
36Bluewa018.9 (Bluewater Creek Above Lake)	2011-06-07 21:07	0.05*	0.30	0.35	0.058
36Bluewa018.9	2011-08-10	0.05*	0.73	0.78	0.122

(Bluewater Creek Above Lake)	19:55				

APPENDIX B: SOURCE DOCUMENTATION

“Sources” are defined as activities that may contribute pollutants or stressors to a water body (USEPA 1997). The list of “Probable Sources of Impairment” in the Integrated 303(d)/305(b) List, Total Maximum Daily Load documents (TMDLs), and Watershed-Based Plans (WBPs) is intended to include any and all activities that could be contributing to the identified cause of impairment. Data on Probable Sources is routinely gathered by Monitoring and Assessment Section staff and Watershed Protection Section staff during water quality surveys and watershed restoration projects and are housed in the ATTAINS Database. ADB was developed by USEPA to help states manage information on surface water impairment and to generate §303(d)/§305(b) reports and statistics. More specific information on Probable Sources of Impairment is provided in individual watershed planning documents (e.g., TMDLs, WBPs, etc.) as they are prepared to address individual impairments by AU.

USEPA, through guidance documents, strongly encourages states to include a list of Probable Sources for each listed impairment. According to the 1998 Section 305(b) report guidance, “…, states must always provide aggregate source category totals…” in the biennial submittal that fulfills CWA section 305(b)(1)(C) through (E) (USEPA 1997). The list of “Probable Sources” is not intended to single out any particular land owner or single land management activity and has therefore been labeled “Probable” and generally includes several sources for each known impairment.

The approach for identifying “Probable Sources of Impairment” was recently modified by SWQB (NMED/SWQB 2020). Any new impairment listing will be assigned a Probable Source of “Source Unknown.” Probable Source Sheets will continue to be filled out during watershed surveys and watershed restoration activities by SWQB staff. Information gathered from the Probable Source Sheets will be used to generate a draft Probable Source list in consequent TMDL planning documents. These draft Probable Source lists will be finalized with watershed group/stakeholder input during the pre-survey public meeting, TMDL public meeting, WBP development, and various public comment periods. The final Probable Source list in the approved TMDL will be used to update the subsequent Integrated List.

Literature Cited:

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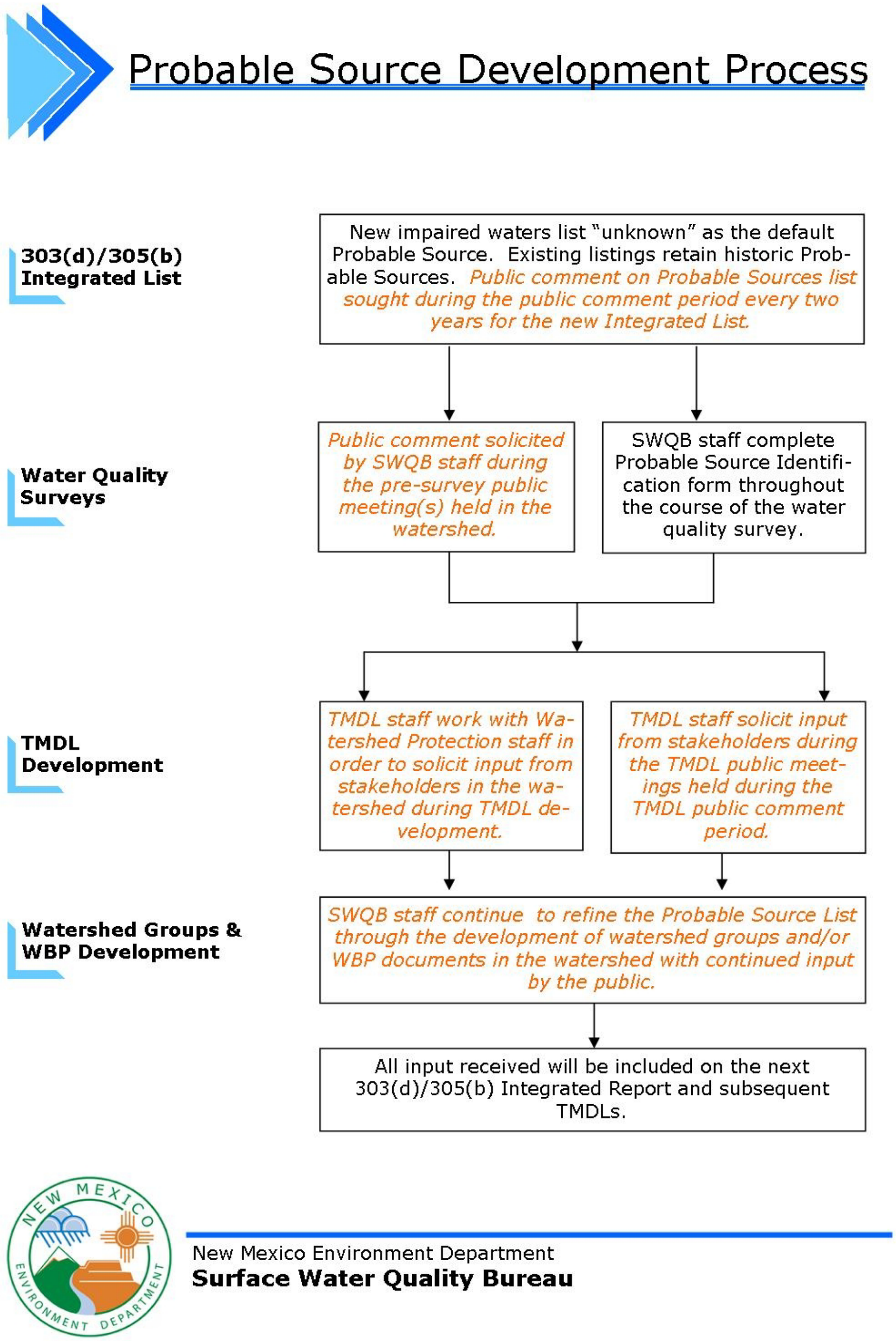

Figure B1: Probable Source Development Process and Public Participation Flowchart

APPENDIX C: BATHTUB INPUT DATA

A complete overview of the BATHTUB model is presented in “Simplified Techniques for Eutrophication Assessment and Prediction” (Walker 2006). BATHTUB is designed to facilitate application of empirical eutrophication models to reservoirs or lakes. The program formulates steady-state water and nutrient mass balances in a spatially segmented hydraulic network that accounts for advective transport, diffusive transport, and nutrient sedimentation. Eutrophication-related water quality conditions (expressed in terms of total phosphorus, total nitrogen, chlorophyll-*a*, transparency, organic nitrogen, non-ortho-phosphorus, and hypolimnetic oxygen depletion rate) are predicted using empirical relationships previously developed and tested for reservoir applications (Walker, 1985). To provide regional perspectives on reservoir water quality, controlling factors, and model performance, BATHTUB can also be configured for simultaneous application to collections or networks of reservoirs. As described in Chapter 1 (Walker, 1999), applications of the program would normally follow use of the FLUX program for reducing tributary monitoring data and use of the PROFILE program for reducing pool monitoring data, although use of the data reduction programs is optional if independent estimates of tributary loadings and/or average pool water quality conditions are used.

The program generates output in various tabular and graphic formats, as appropriate for specific applications. Descriptions of underlying theory, program operation, model options, output variables, application scenarios, sample input files, and recent updates are attached. The help screens provided with the model are not intended to be comprehensive. The user is referred to Walker (1985) for a description of the model derivation and to Walker, 1999 (Chapter 1) for a discussion of basic modeling concepts and data requirements.

Basic elements defining each application include:

- Segments - Reservoir zones specified in a one-dimensional, branched network (e.g., upper pool, mid pool, near dam, different tributary arms).
- Tributaries - Inflow or outflow streams, each associated with a particular segment.

The functions of the program can be broadly classified as diagnostic or predictive:

Diagnostic:

- Formulation of water and nutrient balances, including identification and ranking of potential sources of prediction error.
- Ranking of trophic state indicators in relation to user-defined reservoir groups and/or the CE reservoir database.
- Identification of factors controlling algal production.

Predictive:

- Assessing impacts of changes in water and/or nutrient loadings.
- Assessing impacts of changes in mean pool elevation during the growing season.
- Estimating nutrient loadings consistent with given water quality management objectives.

Predicted confidence limits can be calculated for each output variable using a first-order error analysis scheme that incorporates effects of uncertainty in model input values (e.g., tributary flows and loadings, reservoir morphometry, monitored water quality) and inherent model error. While BATHTUB offers a variety of empirical models that have been pre-calibrated to CE reservoir data (Walker, 1985), the program allows includes a routine for calibrating the model to reservoir-specific monitoring data. If sufficient data are available, calibration may reduce prediction error.

This appendix provides site-specific data used as inputs for the Bluewater Lake BATHTUB model. A two-prong approach was applied to obtain the variable data needed to run SSTEMP: field in situ measurements from the field surveys and through remote sensing data. **Table C-1** of this Appendix provides the data values for each variable and the reference provides the data source.

Literature cited:

Walker, W.W. 2006. Bathtub – Version 6.1: Simplified Techniques for Eutrophication Assessment and Prediction. Available online at: http://wwwalker.net/bathtub/help/bathtubWebMain.html

Table C1: Bluewater Lake 2011 baseline BATHTUB inputs. Model utilizes one lake segment and four tributaries (three inflows, one outflow)

Global Variables			
Variable	**Value**	**Units**	**Data Source**
Averaging Period	1	yr	N/A
Precipitation	0.4308	m	PRISM
Evaporation	1.5154	m	USFS Weather Station
Storage Increase	-1.0846	m	calculated value
Atmospheric Loads			
Variable	**Value**	**Units**	**Data Source**
Total N	24.3558	$mg/m^2/yr$	NADP
Total P	577.3858	$mg/m^2/yr$	Ellis et al. 2019
Lake Segment Data			
Variable	**Value**	**Units**	**Data Source**
Surface Area	2.0645	km^2	calculated value
Mean Depth	3.3761	m	calculated value
Length	4.2585	km	calculated value
Mixed Depth	3.3761	m	calculated value
Observed Lake Water Quality Data			
Variable	**Value**	**Units**	**Data Source**
Non-Algal Turbidity	0.5	1/m	SWQB Survey
Total Nitrogen	1147.5	ppb	SWQB Survey
Total Phosphorous	53.3	ppb	SWQB Survey
Chlorophyll-*a*	32.5	ppb	SWQB Survey
Secchi Depth	0.76	m	SWQB Survey
Bluewater Creek Subwatershed Tributary Data			
Variable	**Value**	**Units**	**Data Source**
Drainage Area	208.54	km^2	calculated value
Flow	3.7203	hm^3/yr	calculated value
Total Nitrogen	925	ppb	SWQB Survey
Inorganic Nitrogen	475	ppb	SWQB Survey
Total Phosphorous	43.5	ppb	SWQB Survey

Ortho Phosphorous	1	ppb	estimated value
Cottonwood Creek Subwatershed Tributary Data			
Variable	**Value**	**Units**	**Data Source**
Drainage Area	189.58	km^2	calculated value
Flow	2.6830	hm^3/yr	calculated value
Total Nitrogen	925	ppb	estimated value
Inorganic Nitrogen	475	ppb	estimated value
Total Phosphorous	43.5	ppb	estimated value
Ortho Phosphorous	1	ppb	estimated value
Lakeshore Subwatershed Tributary Data			
Variable	**Value**	**Units**	**Data Source**
Drainage Area	145.15	km^2	calculated value
Flow	2.1270	hm^3/yr	calculated value
Total Nitrogen	925	ppb	estimated value
Inorganic Nitrogen	475	ppb	estimated value
Total Phosphorous	43.5	ppb	estimated value
Ortho Phosphorous	1	ppb	estimated value
Bluewater Creek Below Dam Tributary Data			
Variable	**Value**	**Units**	**Data Source**
Drainage Area	545.3289	km^2	calculated value
Flow	6.4340	hm^3/yr	calculated value
Total Nitrogen	342	ppb	SWQB Survey
Inorganic Nitrogen	50	ppb	SWQB Survey
Total Phosphorous	32.6	ppb	SWQB Survey
Ortho Phosphorous	1	ppb	estimated value

Model Coefficients		
Coefficient	**Value**	**Coefficient of Variation**
Dispersion Rate	1	0.7
Total Nitrogen	1.7587	0.55
Total Phosphorous	1.8770	0.45
Chlorophyll-*a* Model	1.1711	0.26
Secchi Model	1	0.1

Organic Nitrogen Model	1	0.12
TP-OP Model	1	0.15
HODv Model	1	0.15
MODv Model	1	0.22
Secchi/Chlorophyll-*a* Slope (m^2*mg)	0.025	0
Minimum Qs (m*yr^{-1})	0.1	0
Chlorophyll-a Flushing Term	1	0
Chlorophyll-a Temporal CV	0.62	0
Availability Factor - Total Nitrogen	0.59	0
Availability Factor - Inorganic Nitrogen	0.79	0
Availability Factor - Total Phosphorous	0.33	0
Availability Factor – Ortho Phosphorous	1.93	0

Model Options

Option	Selection
Conservative Substance	0
Phosphorus Balance	9
Nitrogen Balance	4
Chlorophyll-a	6
Secchi Depth	2
Dispersion	1
Phosphorus Calibration	2
Nitrogen Calibration	2
Error Analysis	1
Availability Factors	0
Mass-Balance Tables	1
Output Destination	2

APPENDIX D: RESPONSE TO COMMENTS