PUBLIC COMMENT DRAFT

TOTAL MAXIMUM DAILY LOAD (TMDL)

FOR THE

CHAMA RIVER WATERSHED

MAY 1, 2020

Prepared by

New Mexico Environment Department, Surface Water Quality Bureau

Monitoring, Assessments, and Standards Section

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For Additional Information please visit:

https://www.env.nm.gov/surface-water-quality/

~or~

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Cover photo: Rio Brazos, 2012. Photo: SWQB staff

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List of Abbreviations

4Q3	4-Day, 3-year low-flow frequency
6T3	Temperature not to be exceeded for 6 or more consecutive hours on more than 3 consecutive days
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
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
MS4	Municipal separate storm sewer system
MSGP	Multi-sector general storm water permit
NM	New Mexico
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint source
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
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 12/17/19)

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 of the Chama River basin in 2012. Water quality monitoring stations were located to evaluate the impact of tributary streams and ambient water quality conditions. Impairments addressed in this TMDL document, as well as existing approved TMDLs, are shown on Tables ES-1 to ES-8, below. Additional information regarding these impairments is available in the 2018-2020 Clean Water Act §303(d)/§305(b) Integrated Report and List (IR) (NMED/SWQB, 2018a).

The next water quality monitoring survey for the Chama River basin is scheduled for 2021-2022, at which time TMDL targets will be re-examined and potentially revised, as this document is considered to be 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 standards are adopted, the TMDL will be adjusted accordingly. When water quality standards (WQS) have been achieved, the reaches will be moved to the appropriate category in the IR.

Table ES-1. TMDL for Cañones Creek (Abiquiu Reservoir to Chihuahuenos Creek)	
New Mexico Standards Segment	20.6.4.119
Assessment Unit Identifier	NM-2116.A_010
NPDES Permit(s)	None
Segment Length	8.35 miles
Parameters of Concern	*E. coli*
Designated Uses Affected	Primary contact
USGS Hydrologic Unit Code	13020102 – Rio Chama
Scope/size of Watershed	89.8 square miles
Land Type	21f Sedimentary Mid-Elevation Forests; 22h North Central New Mexico Valleys and Mesas
Land Use/Cover	69.9% evergreen forest; 14.2% shrubland; 12.5% grassland; 1.5% deciduous forest
Land Management	90.1% Forest Service; 8.3% Private; 1.4% Bureau of Land Management; <1% State Land Office, <1% National Park Service
Geology	39.2% metamorphic, 34.6% unconsolidated, 20.5% sedimentary, 5.7% igneous/metamorphic
Probable Sources	Bridges/culverts/RR crossings; Drought-related impacts; Dumping/garbage/trash/litter; Exotic species; Flow alteration; Gravel or dirt roads; Grazing in riparian zone; Inappropriate waste disposal; Paved roads; Rangeland grazing; Residences/buildings; Stream channel incision
IR Category	5/5A
Priority Ranking	High
Existing TMDLs	Fecal coliform bacteria, Aluminum, Turbidity (2004)
	WLA + LA + MOS = TMDL
E. coli (cfu/day)	0 + (3.53×10^9) + (3.92×10^8) = (3.92×10^9)

Table ES-2. TMDL for Coyote Creek (Rio Puerco de Chama to headwaters)	
New Mexico Standards Segment	20.6.4.119
Assessment Unit Identifier	NM-2116.A_022
NPDES Permit(s)	None
Segment Length	13.74 miles
Parameters of Concern	Sedimentation/siltation
Designated Uses Affected	High Quality Coldwater Aquatic Life Use
USGS Hydrologic Unit Code	13020102 – Rio Chama
Scope/size of Watershed	45.2 square miles
Land Type	21f Sedimentary Mid-Elevation Forests
Land Use/Cover	61.7% evergreen forest,13.2% shrubland, 7.7% deciduous forest, 7.4% grassland, 6.0% mixed forest, 3.4% wetlands.
Land Management	86.2% Forest Service; 12.1% Private; 1.6% State Land Office; <1% National Park Service
Geology	69.5% metamorphic, 30.5% unconsolidated
Probable Sources	Bridges/culverts/RR crossings; Crop production (dry land); Drought-related impacts; Dumping/garbage/trash/litter; Exotic species; Flow alteration; Gravel or dirt roads; Grazing in riparian zone; Mass wasting; Rangeland grazing; Residences/buildings; Stream channel incision; Wildlife other than waterfowl
IR Category	5/5A
Priority Ranking	High
Existing TMDLs	None
	WLA + LA + MOS = TMDL
Sedimentation/siltation (lbs/day)	0 + 20.45 + 81.74 = 102.18

Table ES-3. TMDL for Placer Creek (Hopewell Lake to headwaters)	
New Mexico Standards Segment	20.6.4.115
Assessment Unit Identifier	NM-2112.A_03
NPDES Permit(s)	None
Segment Length	2.38 miles
Parameters of Concern	Temperature
Designated Uses Affected	High Quality Coldwater Aquatic Life
USGS Hydrologic Unit Code	13020102 – Rio Chama
Scope/size of Watershed	4.97 square miles
Land Type	21f Sedimentary Mid-Elevation Forests
Land Use/Cover	50.1% shrubland, 23.2% evergreen forest, 11.3% grassland, 9.1% deciduous forest, 4.3% developed, 1.8% wetlands
Land Management	99.7% Forest Service; <1%% Private;
Geology	38.1% metamorphic, 32.5% unconsolidated, 29.4% igneous/sedimentary
Probable Sources	Angling pressure; Exotic species; Paved roads; Rangeland grazing; Stream channel incision; Wildlife other than waterfowl
IR Category	5/5A
Priority Ranking	High
Existing TMDLs	None
	WLA + LA + MOS = TMDL
Temperature (kJ/day)	0 + (1.91×10^8) + (2.12×10^7) = (2.12×10^8)

Table ES-4. TMDL for Poleo Creek (Rio Puerco de Chama to headwaters)	
New Mexico Standards Segment	20.6.4.119
Assessment Unit Identifier	NM-2116.A_023
NPDES Permit(s)	None
Segment Length	7.96 miles
Parameters of Concern	Sedimentation/siltation
Designated Uses Affected	High Quality Coldwater Aquatic Life Use
USGS Hydrologic Unit Code	13020102 – Rio Chama
Scope/size of Watershed	9.34 square miles
Land Type	21f Sedimentary Mid-Elevation Forests
Land Use/Cover	55.3% evergreen forest, 34.5% shrubland, 2.5% deciduous forest, 2.2% mixed forest, 1.3% developed, 1.3% grassland, 1.3% wetlands, 1.0% cultivated crops
Land Management	81.8% Forest Service; 18.2% Private
Geology	88.7% metamorphic, 11.3% sedimentary
Probable Sources	Bridges/culverts/RR crossings; Drought-related impacts; Exotic species; Gravel or dirt roads; Grazing in riparian zone; Rangeland grazing
IR Category	5/5A
Priority Ranking	High
Existing TMDLs	Turbidity (2004)
WLA + LA + MOS = TMDL	
Sedimentation/siltation (lbs/day)	0 + 2.34 + 9.34 = 11.68

Table ES-5. TMDL for Rio Nutrias (Perennial portions Rio Chama to headwaters)	
New Mexico Standards Segment	20.6.4.119
Assessment Unit Identifier	- NM-2116.A_060
NPDES Permit(s)	None
Segment Length	34.57 miles
Parameters of Concern	*E. coli*
Designated Uses Affected	Primary contact
USGS Hydrologic Unit Code	13020102 – Rio Chama
Scope/size of Watershed	114 square miles
Land Type	21f Sedimentary Mid-Elevation Forests
Land Use/Cover	70.4% shrubland, 17.2% evergreen forest, 5.5% deciduous forest, 4.0% grassland, 1.0% wetlands
Land Management	72.8% Private; 14.0% Forest Service; 8.9% Bureau of Land Management; 2.5% State Land Office; 1.8% NM Dept of Game & Fish
Geology	86.2% metamorphic, 13.3% sedimentary, <1% unconsolidated
Probable Sources	Drought-related impacts; Exotic species; Flow alteration; Gravel or dirt roads; Livestock feeding operation; Low water crossing; Mass wasting; Rangeland grazing; Stream channel incision
IR Category	5/5A
Priority Ranking	High
Existing TMDLs	Turbidity (2004)
WLA + LA + MOS = TMDL	
E. coli (cfu/day)	$0 + (9.00 \times 10^{8}) + (1.00 \times 10^{8}) = (1.00 \times 10^{9})$

Table ES-6. TMDL for Rio Tusas (Perennial portions Rio Vallecitos to headwaters)	
New Mexico Standards Segment	20.6.4.116
Assessment Unit Identifier	NM-2113_30
NPDES Permit(s)	None
Segment Length	42.73 miles
Parameters of Concern	Temperature
Designated Uses Affected	Coldwater Aquatic Life Use
USGS Hydrologic Unit Code	13020102 – Rio Chama
Scope/size of Watershed	198 square miles
Land Type	21f Sedimentary Mid-Elevation Forests
Land Use/Cover	69.4% evergreen forest, 24.3% shrubland, 3.1% deciduous forest, 1.5% grassland, 1.0% wetlands
Land Management	91.4% Forest Service; 8.1% Private; <1% State Land Office
Geology	59.7% unconsolidated, 23.2% igneous/sedimentary, 6.5% igneous, 5.7% metamorphic, 4.9% sedimentary
Probable Sources	Abandoned mine/tailings; Bridges/culverts/RR crossings; Channelization; Crop production (dry land); Dams/diversions; Drought-related impacts; Exotic species; Flow alteration; Gravel or dirt roads; Grazing in riparian zone; Irrigated crop production; Livestock operations; Low water crossing; Paved roads; Rangeland grazing; Stream channel incision; Residences/buildings
IR Category	5/5A
Priority Ranking	High
Existing TMDLs	Plant nutrients (2011)
WLA + LA + MOS = TMDL	
Temperature (kJ/day)	0 + (2.94×10^{8})+ (3.27×10^{7}) = (3.27×10^{8})

Table ES-7. TMDL for Rito Encino (Rio Puerco de Chama to headwaters)	
New Mexico Standards Segment	20.6.4.119
Assessment Unit Identifier	NM-2116.A_021
NPDES Permit(s)	None
Segment Length	9.85 miles
Parameters of Concern	Sedimentation/siltation
Designated Uses Affected	High Quality Coldwater Aquatic Life Use
USGS Hydrologic Unit Code	13020102 – Rio Chama
Scope/size of Watershed	19.7 square miles
Land Type	21f Sedimentary Mid-Elevation Forests; 22h North Central New Mexico Valleys and Mesas
Land Use/Cover	67.8% evergreen forest, 24.2% shrubland, 2.6% deciduous forest, 3.1% grassland, 1.6% mixed forest
Land Management	72.0% Forest Service; 14.7% Private; 13.2% State Land Office; <1% Bureau of Land Management
Geology	60.8% metamorphic, 39.2% unconsolidated
Probable Sources	Campgrounds (dispersed); Drought-related impacts; Exotic species; Gravel or dirt roads; Grazing in riparian zone; Logging ops - Legacy; Rangeland grazing; Stream channel incision; Wildlife other than waterfowl
IR Category	5/5A
Priority Ranking	High
Existing TMDLs	None
	WLA + LA + MOS = TMDL
Sedimentaton/siltation (lbs/day)	0 + 8.18 + 2.04 = 10.22

Table ES-8. TMDL for Sixto Creek (Rio Chama to CO border) -	
New Mexico Standards Segment	20.6.4.119
Assessment Unit Identifier	NM-2116.A_112
NPDES Permit(s)	None
Segment Length	1.12 miles
Parameters of Concern	Temperature
Designated Uses Affected	High Quality Coldwater Aquatic Life Use
USGS Hydrologic Unit Code	13020102 – Rio Chama
Scope/size of Watershed	5.1 square miles
Land Type	21f Sedimentary Mid-Elevation Forests
Land Use/Cover	42.1% deciduous forest, 23.0% evergreen forest, 15.8% mixed forest, 10.4% shrubland, 7.6% grassland, 1.0% wetlands
Land Management	98.3% Private; 1.1% NM Dept of Game & Fish; <1%Forest Service
Geology	67.8% sedimentary, 32.2% metamorphic
Probable Sources	Drought-related impacts; Wildlife other than waterfowl
IR Category	5/5A
Priority Ranking	High
Existing TMDLs	None
	WLA + LA + MOS = TMDL
Temperature (kJ/day)	0 + (6.31×10^8) +(7.01×10^7) = (7.01×10^8)

1.0 BACKGROUND

1.1 Watershed Description

This document establishes TMDLs for eight Assessment Units (AUs) in the Rio Chama watershed (**Figure 1.1**). Impairment determinations were based on data collected during the 2012 SWQB water quality survey. Hydrologic Unit Code (HUC) 13020102 covers 3,158 square miles of north central New Mexico, almost entirely within Rio Arriba County, NM, with very small portions in the surrounding Sandoval and Taos Counties, NM, and Archuleta County, Colorado.

The project area includes the Rio Chama and its tributaries from the Ohkay Owingeh Pueblo boundary to the Colorado state line at Sixto Creek. The upper Rio Chama watershed includes the Tierra Amarilla land grant and a portion of the Jicarilla Apache reservation. The lower portion of the watershed includes the Lobato, Piedro and Polvadera land grants. The main population centers are the Villages of Chama, Tierra Amarilla and Abiquiu.

The San Juan-Chama Project is a US bureau of Reclamation interbasin transfer project, which diverts water from three rivers in southern Colorado, through a series of tunnels, to the Rio Chama. Heron Lake dam was completed in 1971, for the purpose of storing the Project waters. Heron Lake releases water into the Rio Chama above El Vado Lake. The Rio Chama is impounded at El Vado Lake and Abiquiu Lake, then enters Ohkay Owingeh Pueblo just above its confluence with the Rio Grande.

The three water bodies with sedimentation/siltation TMDLs in this document – Coyote Creek, Poleo Creek and Rito Encino – are all tributaries of the Rio Puerco de Chama, which flows directly into Abiquiu Reservoir. The headwaters of the Rio Puerco de Chama originate in the San Pedro Parks Wilderness (administered by Santa Fe National Forest). Several of those headwater streams – the upper Rio Puerco de Chama mainstem, Rito Redondo, Oso Creek and Corralitos Creek – are designated Outstanding National Resource Waters (ONRWs). ONRWs are streams, lakes and wetlands that receive special protection against degradation under the State of New Mexico's Standards for Interstate and Intrastate Surface Waters (Water Quality Standards) and the federal Clean Water Act. An ONRW designation is the highest level of protection against degradation that can be afforded for a waterbody under the State of New Mexico's Water Quality Standards. The Rio Puerco de Chama is divided into two AUs. The upstream AU has no documented impairments. The downstream AU, to which the three TMDL streams are tributary, is impaired for *E. coli*, plant nutrients and temperature.

The Rio Chama between El Vado and Abiquiu Reservoirs includes 24.6 miles which are designated as a Wild and Scenic River (21.6 miles Wild plus 3 miles Scenic), administered by Santa Fe National Forest and the Bureau of Land Management. For federally administered rivers, the designated boundaries generally average one-quarter mile on either bank in the lower 48 states. The Wild and Scenic section of the Rio Chama is surrounded by the Chama River Canyon Wilderness (administered by Santa Fe National Forest). The Rio Nutrias, which flows into the Chama in the Wild and Scenic section, is impaired for *E. coli* (present TMDL) and turbidity (2004 TMDL, https://www.env.nm.gov/surface-water-quality/tmdl/). The Rio Chama itself is not water quality impaired either above or below Abiquiu Reservoir, but every perennial tributary into the reservoir and from the reservoir down to Espanola, except one, is documented to have one or more impairments.

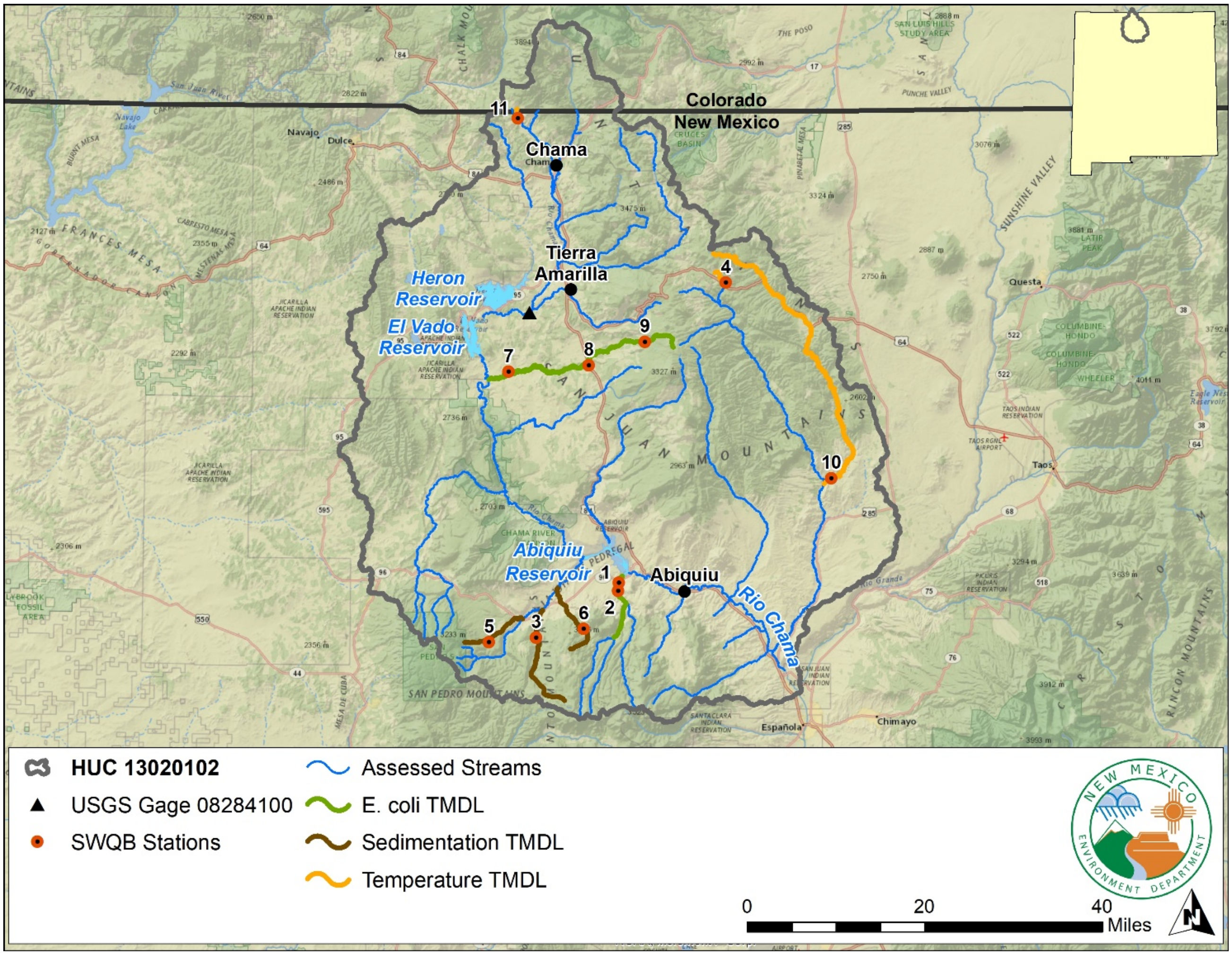


Figure 1.1 Location map for 2019 Rio Chama TMDLs. Monitoring station names are shown on Table 1.1

Table 1.1 SWQB monitoring stations shown on Figure 1.1

Site #	Station ID	Station name
1	29CanonA001.7	Cañones Creek at HWY 96
2	29CanonA003.4	Cañones Creek at first CR 194 crossing upstream of HWY 96
3	29Coyote003.8	Coyote Creek at FR 316
4	29Placer005.1	Placer Creek at NM 64
5	29PoleoC009.5	Poleo Creek at FR 103
6	29REncin009.7	Rito Encino at FR 100Z
7	29RNutri005.4	Rio Nutrias abv Rio Chama
8	29RNutri0028.4	Rio Nutrias at US 84
9	29RNutri0040.5	Rio Nutrias at National Forest Boundary
10	29RTusas001.9	Rio Tusas at forest service boundary
11	29SixtoC000.1	Sixto Creek above Rio Chamita

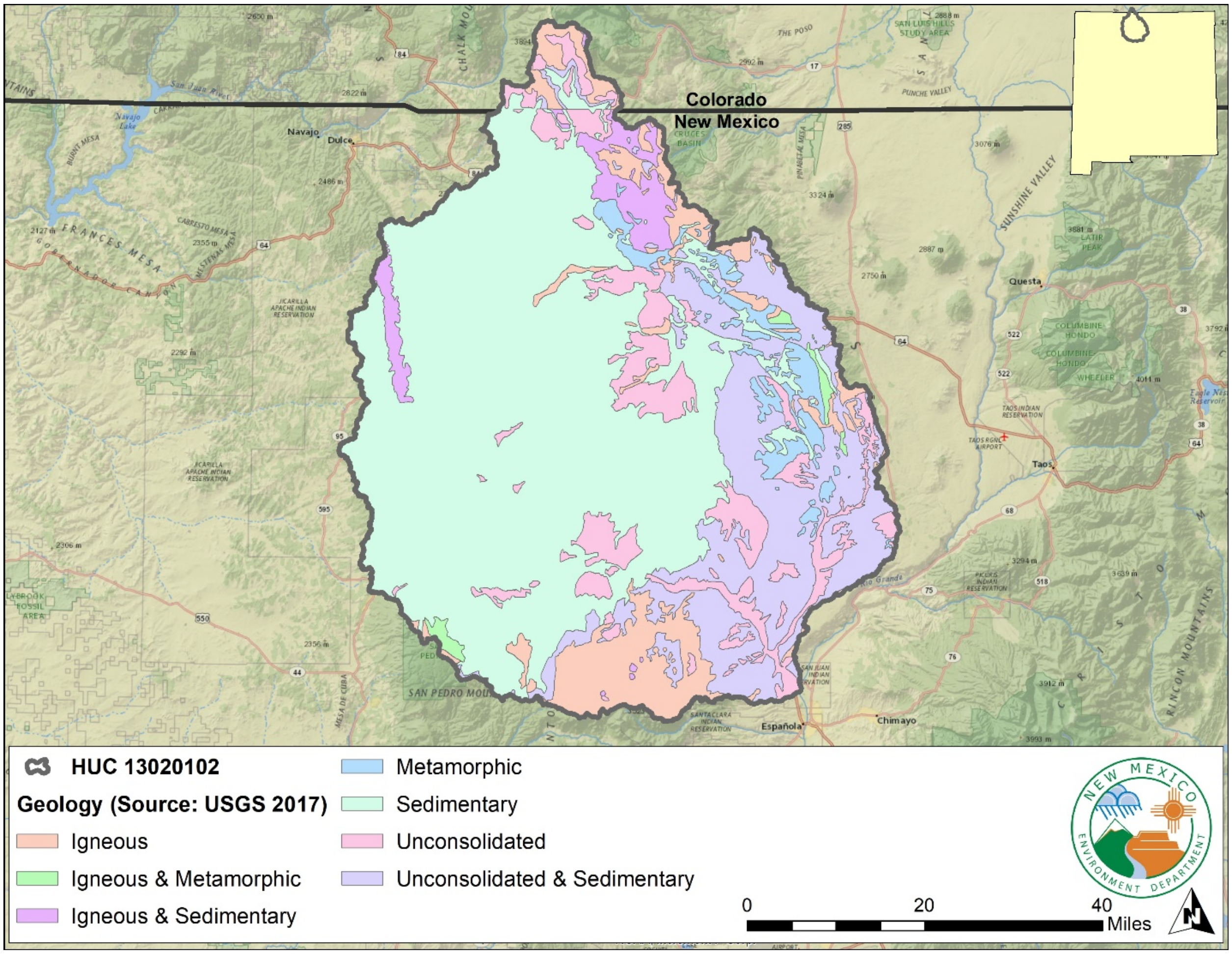


Figure 1.2 Surface geology of the Rio Chama HUC-8

The eastern boundary of the basin is defined by the Tusas and Brazos mountain chains. These mountains are cored with Precambrian granite and metamorphosed sedimentary rock, overlain by conglomerate and sandstone rich in volcanic ash from eruptions in the San Juan Mountains to the north and northwest. The Brazos Box is a dramatic 2000-foot-deep box canyon formed of Precambrian quartzite. West of the mountains are Pleistocene glacial gravels, in places overlying Mancos shale, a particularly weak Cretaceous rock unit that is prone to landslides. The name Tierra Amarilla refers to the yellowish soil derived from Mancos shale. The Cumbres Mountains north of the Village of Chama are composed of Precambrian granite and Tertiary volcanic rocks (Chronic, 1987). The southern portion of the basin slopes down from the Jemez Mountains, a circular range surrounding the base of an immense ancient volcano. One of the most recognized landmarks in northern New Mexico is Cerro Pedernal, a peak on the northern slopes of the Jemez, which is capped by 8-million-year-old basalt and andesite flows (Kelley, undated, https://geoinfo.nmt.edu/tour/landmarks/cerro_pedernal/home.html). Surface geology of the Chama basin is 54.9% Sedimentary, 18.1% Unconsolidated and Sedimentary, 10.1% Unconsolidated, 9.5% Igneous, 3.6% Metamorphic, 3.3% Igneous and Sedimentary, and 0.6% Igneous and Metamorphic (**Figure 1.2**).

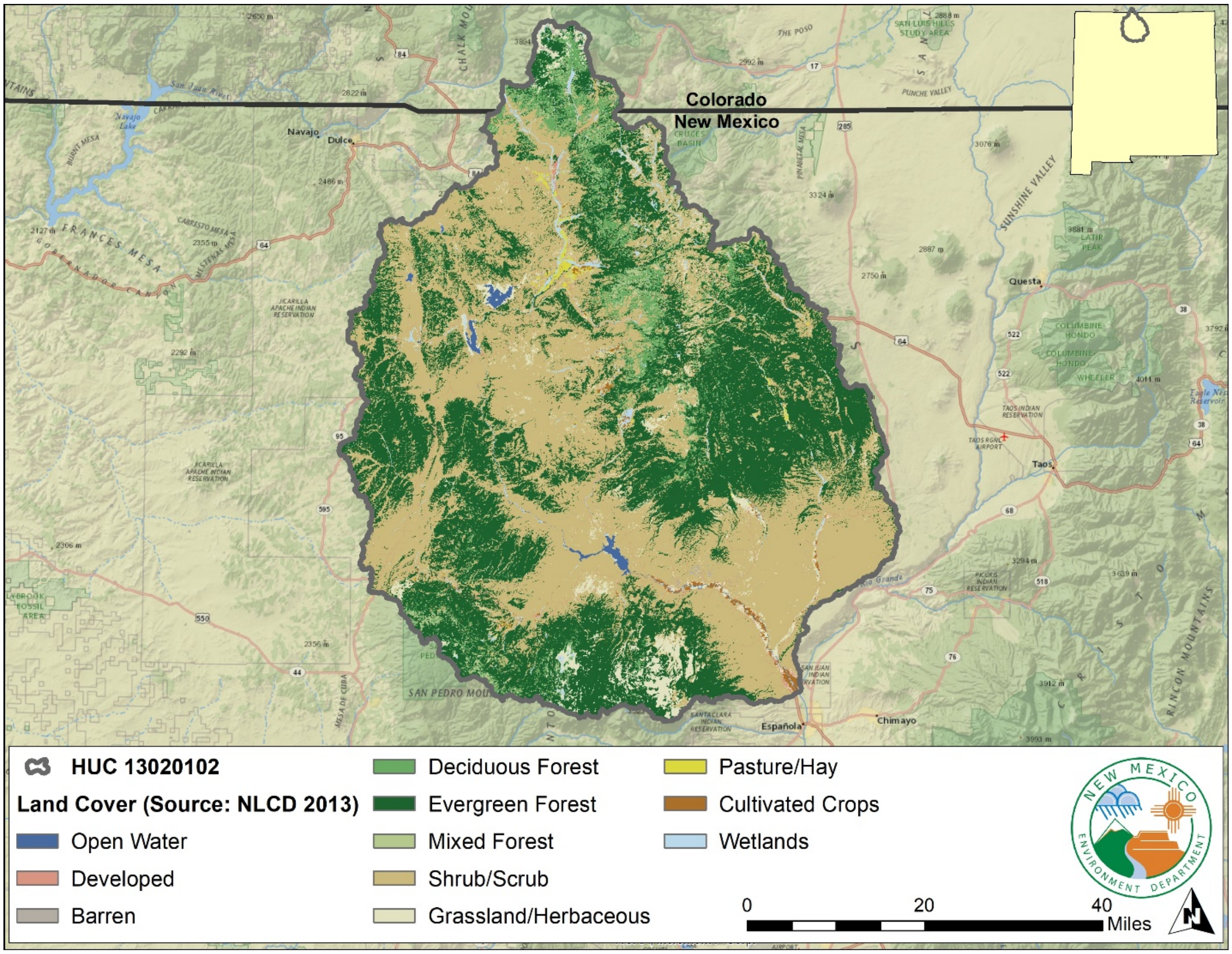


Figure 1.3 Land cover in the Rio Chama HUC-8

Land cover in the Chama basin HUC includes 42.5% Evergreen forest, 32.1% Shrub/Scrub, 15.1% Grassland/Herbaceous, 4.9% Deciduous forest, 1.4% Woody wetlands, and 1.3% Mixed forest (**Figure 1.3**). Land management is 49.8% US Forest Service, 28.1% private, 12.2% Tribal, 5.6% Bureau of Land Management, 2.0% NM Dept of Game & Fish, and 1.4% State Land Office (**Figure 1.4**).

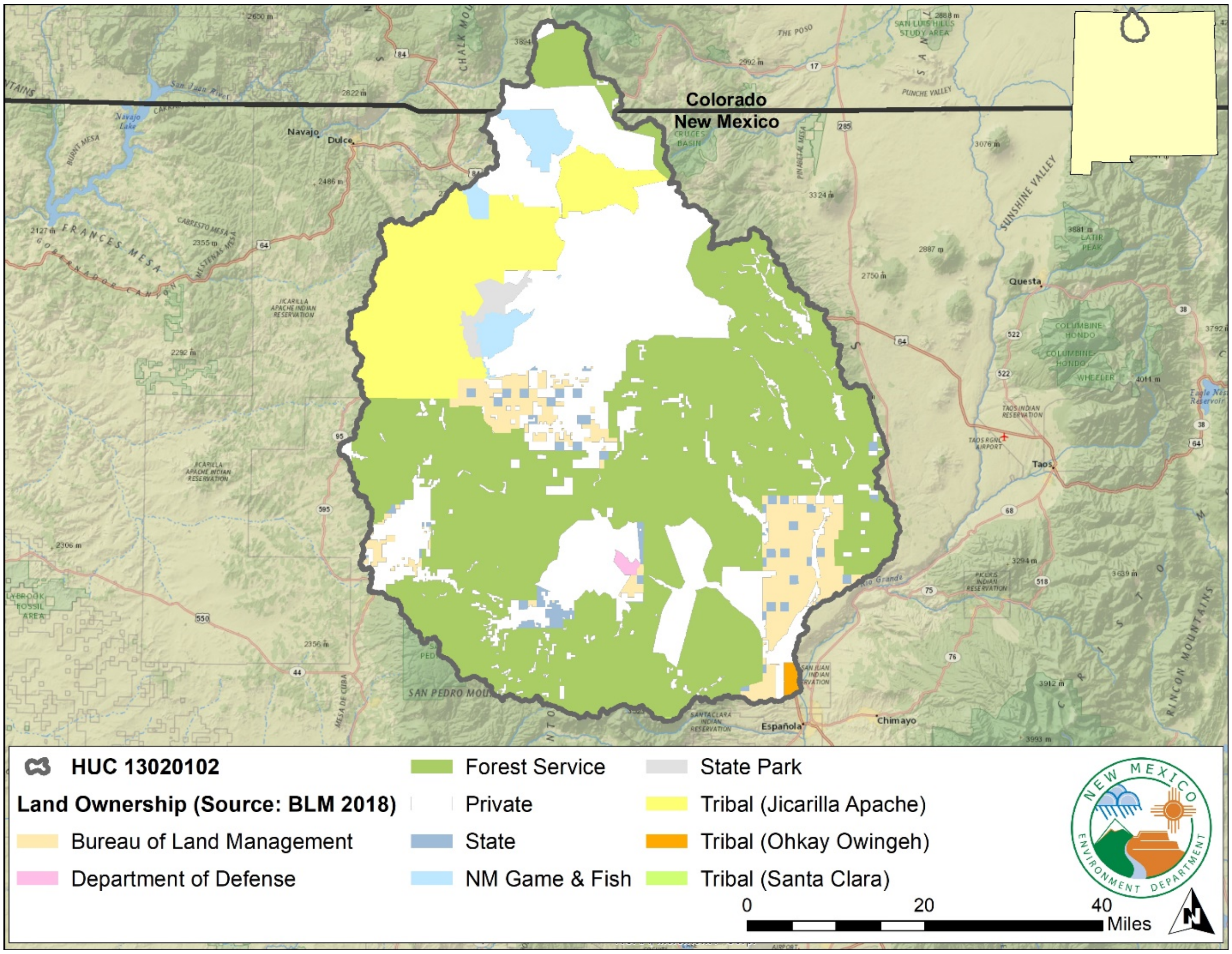


Figure 1.4 Land ownership in the Rio Chama HUC-8

Species listed by the federal Fish & Wildlife Service (USFWS) and/or the New Mexico Department of Game & Fish as Threatened or Endangered, which are known to occur in the Rio Chama HUC, are shown on **Table 1.2** (Natural Heritage New Mexico Conservation Information System, https://nhnm.unm.edu/bcd/results, accessed on 10/10/19). Of those, the Rio Grande Silvery Minnow, Boreal Toad, Yellow-billed Cuckoo, Southwestern Willow Flycatcher, and New Mexico Meadow Jumping Mouse have primary habitat association with aquatic, riparian and/or wetland habitats (Biota Information System of New Mexico, https://www.bison-m.org, accessed 11/14/19). There is no USFWS designated Critical Habitat in the watershed (USFWS, Environmental Conservation Online System, https://ecos.fws.gov/ecp/, accessed on 10.10.19).

Table 1.2 Federal and state listed species known to occur in the Rio Chama HUC.

Common Name	Scientific Name	Federal Status*	State Status**
Rio Grande Silvery Minnow	*Hybognathus amarus*	LE	E
Boreal Toad	*Anaxyrus boreas boreas*	PS	E
Jemez Mountains Salamander	*Plethodon neomexicanus*	LE	E
Yellow-Billed Cuckoo	*Coccyzus americanus*	LT	--
American Peregrine Falcon	*Falco peregrinus anatum*	--	T
Boreal Owl	*Aegolius funereus*	--	T
Mexican Spotted Owl	*Strix occidentalis lucida*	LT	--
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	LE	E
New Mexican Meadow Jumping Mouse	*Zapus hudsonius luteus*	LE	E
Pacific Marten	*Martes caurina*	--	T
Spotted Bat	*Euderma maculatum*	--	T

*Federal Status: LE – listed Endangered; PS – species has status in only a portion of its range; LT – listed Threatened.
**State Status: E – Endangered; T – Threatened.

1.2 Water Quality Standards

Water quality standards for Placer Creek (Hopewell Lake to headwaters) are set forth in the following sections of New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 New Mexico Administrative Code [NMAC], 2018, https://www.env.nm.gov/surface-water-quality/wqs/):

20.6.4.115 RIO GRANDE BASIN: - The perennial reaches of Rio Vallecitos and its tributaries except Hopewell lake, and perennial reaches of Rio del Oso and perennial reaches of El Rito creek above the town of El Rito.

A. Designated uses: domestic water supply, irrigation, high quality coldwater aquatic life, livestock watering, wildlife habitat and primary contact; public water supply on the Rio Vallecitos and El Rito creek.

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: specific conductance 300 µS/cm or less; the monthly geometric mean of *E. coli* bacteria 126 cfu/100 mL or less, single sample 235 cfu/100 mL or less.

[20.6.4.115 NMAC - Rp 20 NMAC 6.1.2112, 10-12-00; A, 05-23-05; A, 12-01-10; A, 07-10-12] [**NOTE:** The standards for Hopewell lake are in 20.6.4.134 NMAC, effective 07-10-12]

Water quality standards for Rio Tusas (Perennial prt Rio Vallecitos to headwaters) are set forth in the following sections of New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 New Mexico Administrative Code [NMAC] 2018):

20.6.4.116 RIO GRANDE BASIN: The Rio Chama from its mouth on the Rio Grande upstream to Abiquiu reservoir, perennial reaches of the Rio Tusas, perennial reaches of the Rio Ojo Caliente, perennial reaches of Abiquiu creek and perennial reaches of El Rito creek downstream of the town of El Rito.

A. Designated uses: irrigation, livestock watering, wildlife habitat, coldwater aquatic life, warmwater aquatic life and secondary contact.

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 criterion applies: temperature 31°C (87.8°F) or less.

[20.6.4.116 NMAC - Rp 20 NMAC 6.1.2113, 10-12-2000; A, 05-23-2005; A, 12-01-2010; A, 03-02-2017]

Water quality standards for Cañones Creek (Abiquiu Rsvr to Chihuahuenos Ck), Coyote Creek (Rio Puerco de Chama to headwaters), Poleo Creek (Rio Puerco de Chama to headwaters), Rio Nutrias (Perennial prt Rio Chama to headwaters), Rito Encino (Rio Puerco de Chama to headwaters, and Sixto Creek (Rio Chama to CO border) are set forth in the following sections of New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 New Mexico Administrative Code [NMAC] 2018):

20.6.4.119 RIO GRANDE BASIN: - All perennial reaches of tributaries to the Rio Chama above Abiquiu dam, except Canjilon lakes a, c, e and f and the Rio Gallina and Rio Puerco de Chama north of state highway 96 and excluding waters on Jicarilla Apache reservation, and the main stem of the Rio Chama from the headwaters of El Vado reservoir upstream to the New Mexico-Colorado line. Some Cañones creek and Rio Chama waters in this segment are under the joint jurisdiction of the state and the Jicarilla Apache tribe.

A. Designated uses: domestic water supply, fish culture, high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat and primary contact; and public water supply on the Rio Brazos and Rio Chama.

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: specific conductance 500 µS/cm or less (1,000 µS or less for Coyote creek); the monthly geometric mean of *E. coli* bacteria 126 cfu/100 mL or less, single sample 235 cfu/100 mL or less.

[20.6.4.119 NMAC - Rp 20 NMAC 6.1.2116, 10-12-00; A, 05-23-05; A, 12-01-10; A, 07-10-12] [**NOTE:** The standards for Canjilon lakes a, c, e and f are in 20.6.4.134 NMAC, effective 07-10-12]

20.6.4.900 NMAC provides criteria applicable to existing, attainable or designated uses unless otherwise specified in an AU's specific segment. 20.6.4.13 NMAC lists general criteria that apply to all surface waters of the state at all times, unless a specified standard is provided elsewhere in the NMAC.

1.3 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 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, https://www.env.nm.gov/surface-water-quality/wqmp-cpp/). 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).

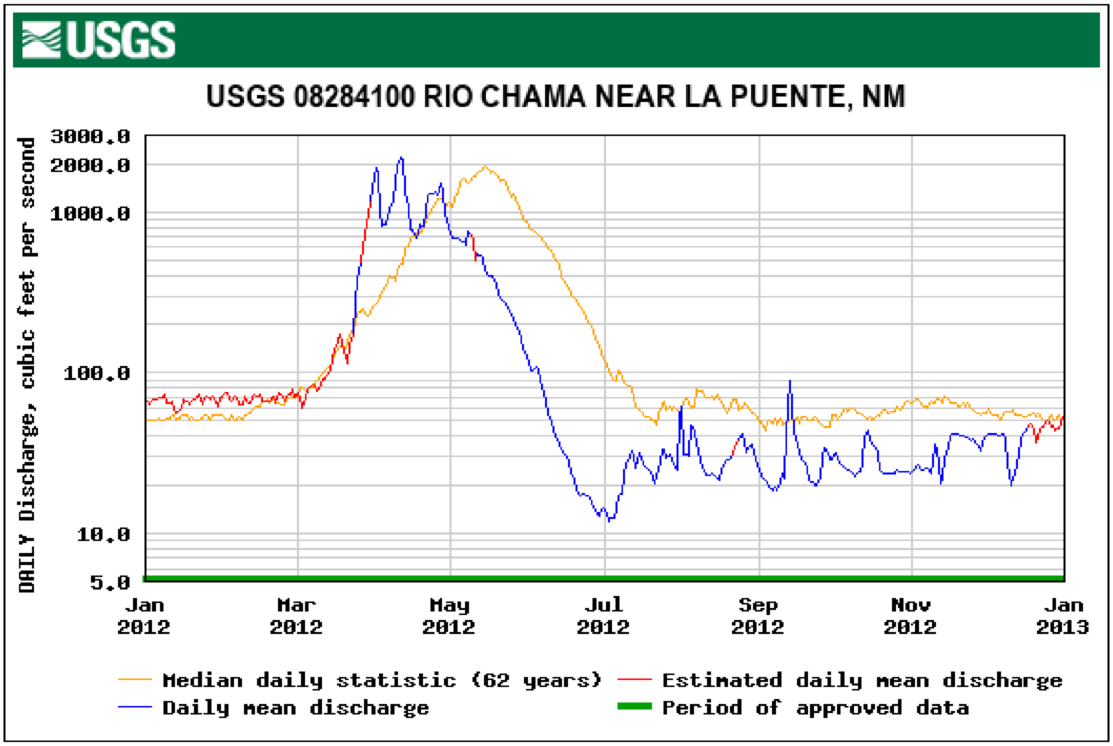
1.4 Water Quality Monitoring Survey

The 2012 survey included the Rio Chama and tributaries from the Ohkay Owingeh pueblo boundary upstream to the Colorado state line. Rivers were divided into AUs based on differing geological and hydrological properties, and each AU was assessed individually using data from one or more monitoring sites located within the AU. Based on a variety of factors, selected monitoring locations were sampled for water quality constituents several times over the year, and geomorphology and continuously logged data were collected at least once for each perennial AU. Geomorphology parameters were measured following the then-current revision of the SWQB Standard Operating Procedure 5.0, Physical Habitat Measurements (https://www.env.nm.gov/surface-water-quality/sop/). Data-logged parameters may include temperature, turbidity, dissolved oxygen, pH, and/or conductivity, and were measured following the then-current revision of the SWQB Standard Operating Procedures 6.1-6.4, Sondes and Thermographs (https://www.env.nm.gov/surface-water-quality/sop/). Follow-up monitoring was conducted in 2014 in order to fill data gaps. Impaired AUs addressed in this TMDL report are shown on **Figure 1.1**.

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. More detail about the 2012 and 2014 water quality survey can be found in the survey summary report (NMED/SWQB, 2015b, https://www.env.nm.gov/surface-water-quality/water-quality-monitoring/).

1.5 Hydrologic Conditions

In order to characterize streamflow conditions in which the thermograph and water chemistry data were collected, discharge data were obtained for 2012 and 2014 from USGS gage 08284100 – Rio Chama near La Puente, NM (**Figure 1.5**). The discharge data show that flow in the Chama, above the influence of the San Juan-Chama Project and the dams, was lower than normal during both years of the water quality survey, although there were some high flows in April of 2012.



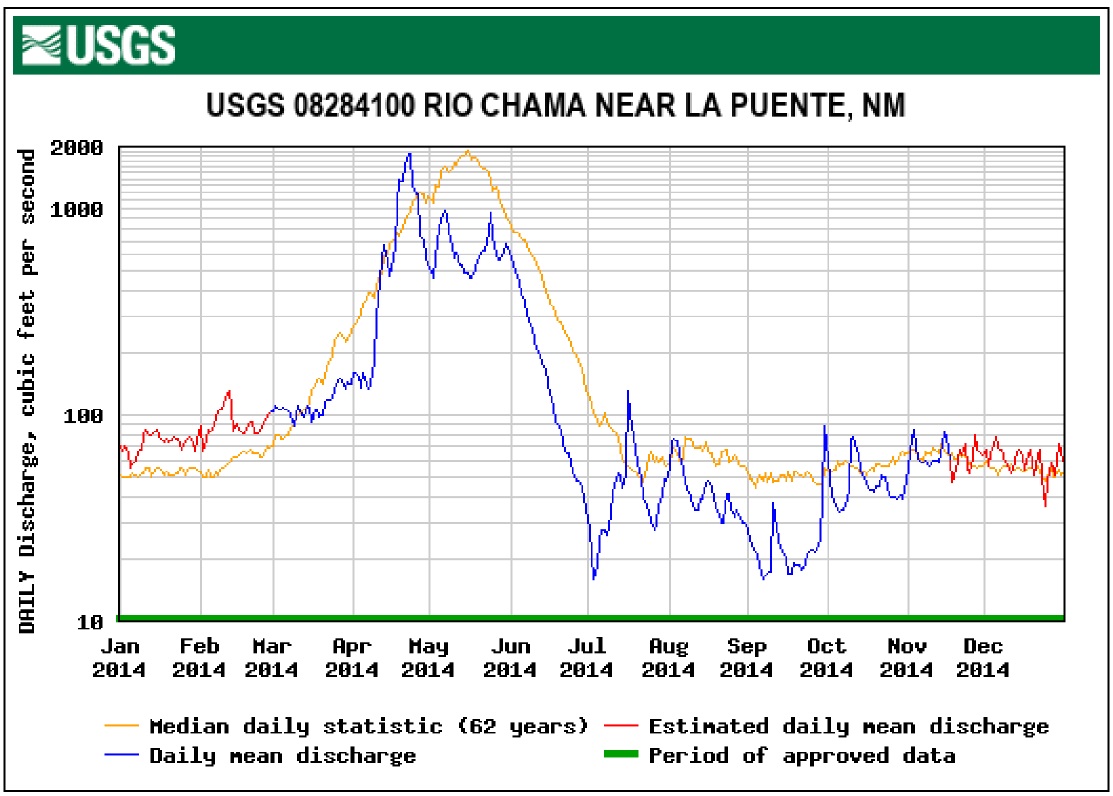


Figure 1.5 Daily discharge in 2012 and 2014 on the Rio Chama above Heron Lake.

2.0 *E. COLI*

Escherichia coli (E. coli) is a species of fecal coliform bacteria that is present in the intestinal tracts and feces of warm-blooded animals. Most *E. coli* are harmless and are actually an important part of a healthy human intestinal tract. However, some strains of *E. coli* are pathogenic, meaning they can cause illness, either diarrhea or illness outside of the intestinal tract. It is also used as an indicator of the potential presence of other pathogens that may present human health concerns.

Bacterial data collected from the impaired AUs during the 2012 SWQB water quality survey of the Rio Chama basin are shown in Appendix A and summarized on **Table 2.1**, below. Samples were assessed by comparing the *E. coli* results to the applicable single sample criterion. Assessment of the data identified exceedences of the New Mexico water quality standards for *E. coli* bacteria. As a result, these AUs are listed on the Integrated CWA §303(d)/ §305(b) List with *E. coli* as an impairment of the primary contact designated use (NMED/SWQB 2018a, https://www.env.nm.gov/surface-water-quality/2018-2020-ir/).

Table 2.1 Exceedences of *E. coli* criteria documented during the 2012 SWQB survey.

Assessment Unit	Water Quality Criterion* (single sample, cfu/100mL)	Number of Exceedences
Cañones Creek (Abiquiu Rsvr to Chihuahuenos Ck)	235	4/7
Rio Nutrias (Perennial prt Rio Chama to headwaters)	235	4/10

*Although the default single sample criterion for primary contact is 410 cfu/mL, these assessment units have a segment-specific single sample criterion of 235 cfu/100 mL or less (NMAC 20.6.4.119).

2.1 Target Loading Capacity

The TMDL is a value calculated at a defined critical flow condition as part of a planning process designed to achieve water quality standards. For this *E. coli* TMDL, the appropriate critical flow condition is at low flow in order to be protective when the assimilative capacity of a stream is at its lowest. For this TMDL document, target values for *E. coli* bacteria are based on achievement of the monthly geometric mean numeric criteria of 126 cfu/100 mL associated with the primary contact designated use. The monthly geometric mean criterion is utilized in TMDL calculations to provide a conservative protective value. If the single sample criterion was used and achieved as a target, the geometric mean criterion may still not be achieved.

2.2 Flow

According to the New Mexico Water Quality Standards, the low flow critical condition for numeric criteria (excluding human health-organism only criteria) set in 20.6.4.97 through 20.6.4.900 NMAC and 20.6.4.13(F) NMAC is defined as the 4-day, 3-year low-flow frequency (4Q3, 20.6.4.11(B)(2) NMAC). The 4Q3 is the annual lowest four (4) consecutive day flow that occurs with a frequency of at least once every three (3) years.

Critical flow values used to calculate the *E. coli* TMDLs were obtained using a regression model. Because these streams are ungaged, an analysis method developed by Waltemeyer (2002) was used to estimate the critical low flow. In Waltemeyer's analysis, two regression equations for estimating 4Q3 were developed based on physiographic regions of New Mexico (i.e., statewide and mountainous regions above 7,500 ft in elevation). The average elevation of each of the Chama basin *E. coli* impaired watersheds is above 7,500 ft, so the mountainous regions regression equation was used. The following mountainous regions regression equation

(**Equation 2.1**) is based on data from 40 gaging stations located above 7,500 ft in elevation with non-zero discharge (Waltemeyer, 2002):

Equation 2.1 $4Q3 = 7.3287 \times 10^{-5} DA^{0.70} {P_w}^{3.58} S^{1.35}$

Where:

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = Drainage area (mi^2)
P_w = Average basin mean winter precipitation (inches)
S = Average basin slope (ft/ft)

The 4Q3 values calculated using Waltemeyer's method are presented in **Table 2.2**. Parameters used in the calculation were determined using the StreamStats online GIS application developed by the USGS (https://streamstats.usgs.gov/ss/). The critical flow was converted from cfs to million gallons per day (MGD) using a conversion factor of 0.646. The TMDL itself is a value calculated at a defined critical condition as part of a planning process designed to achieve water quality standards. Since flows vary throughout the year in these systems, the actual load at any given time will vary based on the changing flow. Management of the load to improve stream water quality is the goal of SWQB efforts.

Table 2.2 Calculation of 4Q3 for *E. coli* TMDLs

Assessment Unit	Average Elevation (ft)	Drainage Area (mi^2)	Mean Winter Precipitation (in)	Average Basin Slope (ft/ft)	4Q3 (cfs)	4Q3 (MGD)
Cañones Creek (Abiquiu Rsvr to Chihuahuenos Ck)	8720	89.8	10.7	0.25	1.27	0.82
Rio Nutrias (Perennial prt Rio Chama to headwaters)	7700	114	9.85	0.10	0.32	0.21

2.3 TMDL Calculations

The WQS for bacteria are expressed as colony forming units (cfu) per unit volume. TMDLs for bacteria (**Table 2.3**) were calculated based on flow values (**Table 2.2**), water quality standards, and a conversion factor, using **Equation 2.2**.

Equation 2.2 $C\ as \frac{cfu}{100mL} * 1000 \frac{mL}{L} * \frac{L}{0.264\ gallons} * Q\ in\ 1{,}000{,}000 \frac{gallons}{day} = cfu/day$

Where C = water quality criterion for bacteria
Q = the critical stream flow in million gallons per day (MGD)

Table 2.3 Calculation of TMDLs

Assessment Unit	Geometric Mean *E. coli* criterion (cfu/100 mL)	Critical Flow (MGD)	Conversion Factor	TMDL (cfu/day)
Cañones Creek (Abiquiu Rsvr to Chihuahuenos Ck)	126	0.82	3.79×10^7	3.92×10^9
Rio Nutrias (Perennial prt Rio Chama to headwaters)	126	0.21	3.79×10^7	1.00×10^9

2.4 Margin of Safety (MOS)

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. For these bacteria TMDLs, the MOS was developed using a combination of conservative assumptions and inputs and explicit recognition of potential errors in flow calculations. Therefore, the MOS is the sum of the following:

- *Conservative Assumptions:*

  E. coli bacteria do not readily degrade in the environment; and,

  Basing the target load capacity on the geometric mean criterion rather than the higher-concentration single sample criterion; and

- *Explicit recognition of potential errors:*

  There is inherent error in all flow measurements and estimations; a conservative MOS for this element is 10%.

2.5 Waste Load Allocation (WLA)

There are no National Pollutant Discharge Elimination System (NPDES) individual permits that discharge to the Cañones Creek or Rio Nutrias drainages. Therefore no WLA is assigned for this TMDL.

Stormwater discharges from construction activities are transient because they occur mainly during the construction itself, and then only during storm events. Coverage under the USEPA NPDES Construction General Permit (CGP) for construction sites of one or more acres, or smaller if part of a common plan of development, requires preparation of a Storm Water Pollution Prevention Plan (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 waste load allocations and/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.

Stormwater discharges from industrial activities and facilities, based on industrial classification codes, may be eligible for coverage under the current NPDES Multi-Sector General Permit (MSGP). The MSGP also requires preparation of a SWPPP. Some of the industrial facilities and activities covered under the MSGP have technology based effluent limitation and/or benchmark monitoring for pollutants. The current MSGP includes state-specific requirements that the benchmark values be protective of State of New Mexico WQS.

It is not possible to calculate individual WLAs for facilities covered by the General Permits at this time using the available tools. The discharges from these permits are typically transitory as the activities are temporary. Loads that are in compliance with the General Permits are therefore currently included as part of the Load Allocation (LA). While these sources are not given individual allocations, they are addressed through other means, including BMPs, stormwater pollution prevention conditions, and other requirements.

2.6 Load Allocation (LA)

In order to calculate the LA, the WLA and MOS are subtracted from the TMDL using the equation below.

$$WLA + LA + MOS = TMDL$$

Since there is no WLA, the LA is equal to the TMDL minus the 10% MOS. Results of the LA calculations are presented in **Table 2.4**. The extensive data collection and analyses necessary to determine background *E. coli* loads are beyond the resources available for this study. It is assumed that a portion of the LA is made up of natural background loads. It is important to note that WLAs and LAs are estimates based on a specific flow condition. Under differing hydrologic conditions, the loads will change. Successful implementation of this TMDL will be determined based on achievement of the *E. coli* standards under any flow condition.

Table 2.4 Load allocations for *E. coli*

Assessment Unit	WLA (cfu/day)	LA (cfu/day)	10% MOS (cfu/day)	TMDL (cfu/day)
Cañones Creek (Abiquiu Rsvr to Chihuahuenos Ck)	0	3.53×10^9	3.92×10^8	3.92×10^9
Rio Nutrias (Perennial prt Rio Chama to headwaters)	0	9.00×10^8	1.00×10^8	1.00×10^9

E. coli impairment determinations were based on exceedences of the State's single sample criteria and the TMDL is written to address the monthly geometric mean standard. As such, a simple comparison of the numbers would not necessarily represent an amount of contaminant reduction that would result in removing the impairment, and would instead result in an overestimation of the actual reduction necessary. Neither Section 303 of the Clean Water Act nor 40 C.F.R. Part 130.7 requires states to include discussions of percent reductions in TMDL documents. Although NMED believes that it is often useful to discuss the magnitude of water quality exceedences in the TMDL report, the "percent reduction" value can be calculated in multiple ways and as a result is often misinterpreted. Therefore, a percent reduction value is not provided for *E. coli* TMDLs.

2.7 Identification and Description of Pollutant Sources

The SWQB process includes an assessment of the probable sources of impairment. Probable source sheets are filled out by SWQB staff during watershed surveys and watershed restoration activities. The draft probable source list was reviewed and modified as necessary with watershed group/stakeholder input during the TMDL public meeting and comment period. The probable source documentation process is fully described in Appendix B. Although this procedure includes subjective and qualitative elements, SWQB has concluded 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 individual land owner or particular land management activity and generally includes several sources per impairment. Pollutant sources that may contribute to each segment were determined by field reconnaissance and evaluation (**Table 2.5**). Probable sources of bacteria impairments will be evaluated, refined, and changed as necessary through the Watershed Based Plans.

Table 2.5 Probable Source Summary for E. coli

Assessment Unit	Probable Sources
Cañones Creek (Abiquiu Rsvr to Chihuahuenos Ck)	Bridges/culverts/RR crossings; Drought-related impacts; Dumping/garbage/trash/litter; Exotic species; Flow alteration; Gravel or dirt roads; Grazing in riparian zone; Inappropriate waste disposal; Paved roads; Rangeland grazing; Residences/buildings; Stream channel incision
Rio Nutrias (Perennial prt Rio Chama to headwaters)	Drought-related impacts; Exotic species; Flow alteration; Gravel or dirt roads; Livestock feeding operation; Low water crossing; Mass wasting; Rangeland grazing; Stream channel incision

Among the potential sources of coliform bacteria are municipal point source discharges such as wastewater treatment facilities, septic tanks which are poorly maintained, improperly installed, or missing, livestock grazing of uplands and riparian areas, and waste from pets and wildlife. Howell et al. (1996) found that bacteria concentrations in underlying sediment increase when cattle have direct access to streams. Natural sources of *E.coli* are also present in the form of wildlife such as elk, deer, waterfowl and other warm-blooded animals.

In addition to the initial loading, several ambient parameters have been documented to influence coliform bacteria survival and, potentially, regrowth, in fresh water bodies (Howell et al, 1996; Wcislo and Chrost, 2000). Abiotic factors include visible light, ultraviolet light, temperature, organic and metal pollutants, dissolved organic matter, suspended sediment concentration and particle size, and pH. Biotic, or ecological, factors include viral parasites and protozoan predators. Bacterial concentrations may become elevated when bacteria-laden sediment is re-suspended during storm events or by other subsequent disturbance such as trampling by livestock or wildlife (Howell et al, 1996).

Further study would be needed in order to determine exact sources of *E. coli* and their relative contributions. One method of characterizing sources of bacteria is Bacterial, or Microbial, Source Tracking (BST or MST). The extensive data collection and analyses necessary to determine bacterial sources are beyond the resources available for this TMDL. While sufficient data currently exist to support development of *E. coli* TMDLs to address the stream standards exceedences, a BST dataset would likely be useful to better identify the sources of *E. coli* impacting the stream.

The Rio Nutrias Watershed Based Plan Implementation project was funded by the SWQB in 2017 and 2019 (Grant 996100116, Projects 15R and 16D). The project was intended to address probable causes of the turbidity impairment, but might also have some effect on *E. coli* concentrations. Project elements include bridge replacement, bank stabilization, upland erosion control, sage brush removal, riparian fencing, and education and outreach.

2.8 Consideration of Seasonal Variation

Federal regulations (40 C.F.R. § 130.7(c)(1)) require that TMDLs take into consideration seasonal variation in watershed conditions and pollutant loading. Data used in the calculation of these TMDLs were collected during the spring, summer, and fall of 2012 in order to ensure coverage of potential seasonal variation in the system. In Cañones Creek, exceedences of the WQS were documented in April, and again from July through September - possibly as a result of snowmelt and monsoon events - but show no discernible correlation with streamflow at the time of the sampling event. In the Rio Nutrias, samples were collected at three separate locations: 29RNutri040.5, which is in the Carson National Forest at 8500 feet elevation, 29RNutri028.4, at US Highway 84, and 29RNutri005.4, above the confluence with the Rio Chama below El Vado Lake. There were no exceedences of the WQS at 29RNutri040.5. Exceedences at the two lower stations occurred during the irrigation season, from April through August.

2.9 Future Growth

Growth estimates by county and Water Planning Region (WPR) are available from the New Mexico Bureau of Business and Economic Research (BBER, 2008, available at http://bber.unm.edu/data). These estimates project growth to the year 2060. The 2012 Rio Chama water quality survey area falls within the Rio Chama WPR. BBER projects that the Rio Chama WPR will begin to experience population decline, despite recent slow positive growth, as detailed on **Table 2.6**.

Table 2.6 TMDL Study Area Water Planning Region Population Estimates

WPR	2020	2030	2040	2050	2060	% Increase (2020-2060)
Rio Chama	7952	7750	7366	7038	6849	-13.9

Estimates of future growth are not anticipated to lead to a significant increase in *E. coli* that cannot be controlled with BMP implementation. BMPs should be utilized and improved upon while continuing to improve watershed conditions and adhering to SWPPP requirements related to construction and industrial activities covered under the general permit.

3.0 SEDIMENTATION

The New Mexico WQS (20.6.4.13 NMAC) include a general narrative standard for "bottom deposits and suspended or settleable solids", which reads:

> *"Surface waters of the state shall be free of water contaminants including fine sediment particles (less than two millimeters in diameter), precipitates or organic or inorganic solids from other than natural causes that have settled to form layers on or fill the interstices of the natural or dominant substrate in quantities that damage or impair the normal growth, function or reproduction of aquatic life or significantly alter the physical or chemical properties of the bottom."*

Stream bottom substrate provides optimum habitat for many fish and aquatic insect communities when it does not include excessive fine sediment filling the interstitial spaces. Excessive fine sediment occurs when biologically-important habitat components such as spawning gravels and cobble surfaces are physically covered by fines (Chapman and McLeod 1987). Substrate fining decreases intergravel oxygen and results in reduced or eliminated quality and quantity of habitat for fish, macroinvertebrates, and algae (Lisle 1989; Waters 1995). Chapman and Mcleod (1987) found that bed material size is related to habitat suitability for fish and macroinvertebrates and that excess fine sediment decreased both density and diversity of aquatic insects.

Sediment loads that exceed a stream's sediment transport capacity often trigger changes in stream morphology (Leopold et al, 1964). Streams that become overwhelmed with sediment often go through a period of accelerated channel widening and streambank erosion before returning to a stable form (Rosgen, 1996). These morphological changes can accelerate erosion, reduce habitat diversity (pools, riffles, etc.) and place additional stress on the designated aquatic life use.

The assessment approach used to determine these sedimentation impairments is described in detail in the 2015 Assessment Protocol (NMED/SWQB, 2015a, https://www.env.nm.gov/surface-water-quality/calm/). Target values for this TMDL were based on the numeric thresholds identified in the Assessment Protocol. The Assessment Protocol establishes a procedure for determining impairment due to excessive sedimentation/siltation in perennial, wadeable streams. Bedded sediments cannot be treated as introduced pollutants such as pesticides because they are not uniquely generated through human input or disturbance. Rather, bedded sediments are components of natural systems that are present even in pristine settings and to which stream organisms have evolved and adapted. Therefore, the detection of a sediment imbalance is more complicated than detecting an absolute concentration or percentage that represents a clear biological impact.

The SWQB and USEPA Region 6 contracted with Tetra Tech, Inc., to develop sediment translators or thresholds. The contractor generally followed the steps provided in USEPA's Framework for developing suspended and bedded sediment water quality criteria (USEPA, 2006). This effort included the identification of sediment characteristics that are expected under the range of environmental settings in New Mexico, especially in undisturbed or best available reference streams. Examining the relationships between biological measures and sediment indicators helped to identify where disturbance had caused sediment imbalance and biologically relevant habitat degradation. The analysis resulted in threshold recommendations for two bedded sediment indicators for New Mexico perennial streams (**Table 3.1**) – percent Sand & Fines (%SaFN) and log Relative Bed Stability calculated without bedrock (LRBS_NOR) -- for three different site classes, Mountains, Foothills, and Xeric. The site classes are defined by Level 3 and 4 ecoregions (Griffith et al, 2006) and distinguish sediment expectations across New Mexico. The report detailing this effort (Jessup et al, 2010) is available at https://www.env.nm.gov/surface-water-quality/sedimentation/.

Table 3.1. Bedded sediment indicators (from Jessup et al, 2010)

Sediment Indicator	Description
Percent Sand & Fines (%SaFN)	**The percentage of systematically selected streambed substrate particles that are ≤2.0 mm in diameter from reach-wide pebble count.**
Log Relative Bed Stability (LRBS)	**A measure of the relationship of the median particle size in a stream reach compared to the critical particle size calculated to be mobilized by standardized fluvial stresses in the reach.** Median particle size is determined using a reach-wide pebble count (Peck et al. 2006). Critical particle size is calculated from channel dimensions, flow characteristics, and channel roughness factors (Kaufmann et al. 2008). The measure is expressed as a logarithm of the ratio of geometric mean to critical particle size.
LRBS_NOR	**RBS without bedrock or hardpan (log10).** This measure regards only the potentially mobile streambed particles in determining the geometric mean particle size, and improved associations between the bedded sediment measure and biological responses in the TetraTech analyses (Jessup et al. 2010)

To determine if there is excessive sedimentation/siltation in the study stream reach, two levels of assessment are performed in sequential order. The first level considers the simpler indicator of biological impairment, and then refines the assessment with the second indicator of geomorphic impairment as needed when the first level threshold is exceeded. The % SaFN sediment indicator is used in the Level One assessment because it is easily measured and related strongly with biological metrics. If the %SaFN indicates excessive fine sediment in the stream bed, a Level Two survey is performed to collect data used to calculate the LRBS_NOR value.

In minimally disturbed streams, the measured geometric mean particle size should trend towards the expected particle size (i.e., the size the stream is capable of moving as bedload at bankfull). The LRBS_NOR indicator considers site-specific hydraulic potential for moving bed sediments, so that the observed amount of fine sediments is considered impaired only when the streambed is more easily mobilized and transported than expected. It incorporates stream channel, shape, slope, flow, and sediment supply. The LRBS_NOR measure is appropriate as a second-tier indicator because it is scaled to hydro-geomorphic factors of the individual sites, as well as to the broader site classes, thus allowing evaluation of the potential of the specific site in terms of retaining or flushing fine sediments.

Table 3.2 Sedimentation indicator thresholds based on biological responses and reference distributions (Jessup et al, 2010)

Site Class	% Sand and Fines	LRBS_NOR Units
Mountain	< 20	> -1.1
Foothill	< 37	> -1.3
Xeric	< 74	> -2.5

If the calculated LRBS_NOR is greater than the applicable site class threshold in **Table 3.2**, the AU is regarded as **Full Support** with respect to New Mexico's narrative sedimentation/siltation standard found at NMAC

20.6.4.13 NMAC. If the calculated LRBS_NOR is less than or equal to the applicable site class threshold, the AU is considered **Non Support**.

3.1 Target Loading Capacity

During the 2012 survey, impairment of the narrative criterion for sedimentation in 20.6.4.13 NMAC was documented in the Coyote Creek (Rio Puerco de Chama to headwaters), Poleo Creek (Rio Puerco de Chama to headwaters), and Rito Encino (Rio Puerco de Chama to headwaters), due to exceedances of numeric sedimentation thresholds (**Table 3.3**).

Table 3.3 Numeric thresholds applied to Assessment Units impaired for sedimentation

Assessment Unit	Ecoregion/Site Class	% Sand and Fines Threshold	% Sand and Fines Observed	LRBS_NOR Threshold	Calculated LRBS_NOR
Coyote Creek (Rio Puerco de Chama to headwaters)	21d/Foothill	37	81	-1.3	-1.92
Poleo Creek (Rio Puerco de Chama to headwaters)	21f/Mountain	20	56.2	-1.1	-1.73
Rito Encino (Rio Puerco de Chama to headwaters)	21f/Mountain	20	45.7	-1.1	-1.31

A load-based indicator is needed in order to generate a TMDL based on mass balance. Jessup et al (2010) suggests an interpretation of the indicator value distributions for sites which fully support their designated uses, using the 90th percentile value for Mountain and Foothills sites and the 75th percentile value for Xeric sites (**Table 3.4**). Therefore the target Total Suspended Solids (TSS) value for Coyote Creek will be 16.12 mg/L, and the TSS target value for Poleo Creek and the Rito Encino will be 8.75 mg/L.

Table 3.4 Suspended sediment indicator percentiles for fully supporting sites and all sites in three site classes

		Fully Supporting Sites			All Sites		
		Valid N	75th	90th	Valid N	25th	Median
Mountains	Turbidity (ntu)	68	4.88	9.50	217	1.25	3.10
	TSS (mg/L)	70	5.05	8.75	221	3.00	3.89
FootHills	Turbidity (ntu)	24	12.18	19.30	136	2.33	5.99
	TSS (mg/L)	24	9.88	16.12	138	3.71	6.71
Xeric	Turbidity (ntu)	83	68.50	191.76	289	5.60	16.00
	TSS (mg/L)	85	60.23	262.80	295	7.00	17.00

Monitoring data for flow, TSS and turbidity (which is correlated with TSS for a given water body) are presented for these three AUs in Appendix A, however the data are not sufficient to generate measured loads for TSS.

3.2 Flow

The TMDL is a value calculated at a defined critical flow condition as part of a planning process designed to achieve water quality standards. For this sedimentation TMDL, the appropriate critical flow condition is at low flow in order to be protective when the assimilative capacity of a stream is at its lowest. According to the New Mexico Water Quality Standards, the low flow critical condition for numeric criteria (excluding human health-organism only criteria) set in 20.6.4.97 through 20.6.4.900 NMAC and Subsection F of 20.6.4.13 NMAC is defined as the 4-day, 3-year low-flow frequency (4Q3, 20.6.4.11(B)(2) NMAC). The 4Q3 is the annual lowest four (4) consecutive day flow that occurs with a frequency of at least once every three (3) years.

Critical flow values used to calculate the sedimentation/siltation TMDLs were obtained using a regression model. Because these streams are ungaged, an analysis method developed by Waltemeyer (2002) was used to estimate the critical low flow. In Waltemeyer's analysis, two regression equations for estimating 4Q3 were developed based on physiographic regions of New Mexico (i.e., statewide and mountainous regions above 7,500 ft in elevation). The average elevation of each of the Chama basin sedimentation impaired watersheds is above 7,500 ft, so the mountainous regions regression equation was used. The following mountainous regions regression equation (**Equation 3.1**) is based on data from 40 gaging stations located above 7,500 ft in elevation with non-zero discharge (Waltemeyer, 2002):

Equation 3.1 $4Q3 = 7.3287 \times 10^{-5} DA^{0.70} {P_w}^{3.58} S^{1.35}$

Where:

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = Drainage area (mi^2)
P_w = Average basin mean winter precipitation (inches)
S = Average basin slope (ft/ft)

The 4Q3 values calculated using Waltemeyer's method is presented in **Table 3.5**. Parameters used in the calculation were determined using the StreamStats online GIS application developed by the USGS (https://streamstats.usgs.gov/ss/). The critical flow was converted from cfs to million gallons per day (MGD) using a conversion factor of 0.646. The TMDL itself is a value calculated at a defined critical condition as part of a planning process designed to achieve water quality standards. Since flows vary throughout the year in these systems, the actual load at any given time will vary based on the changing flow. Management of the load to improve stream water quality is the goal of SWQB efforts.

Table 3.5 Calculation of 4Q3 for Sedimentation/Siltation TMDLs

Assessment Unit	Average Elevation (ft)	Drainage Area (mi^2)	Mean Winter Precipitation (in)	Average Basin Slope (ft/ft)	4Q3 (cfs)	4Q3 (mgd)
Coyote Creek (Rio Puerco de Chama to headwaters)	8740	45.2	13.3	0.19	1.18	0.76
Poleo Creek (Rio Puerco de Chama to headwaters)	8170	9.34	13.4	0.13	0.24	0.16
Rito Encino (Rio Puerco de Chama to headwaters)	8200	19.7	9.08	0.22	0.21	0.14

3.3 TMDL Calculations

The TMDL is defined as the mass of pollutant that can be carried under critical flow conditions without violating the target concentration for that constituent. The TMDL is calculated based on simple dilution using critical flow, the numeric target, and a conversion factor to correct the units of measure, according to the formula:

Critical flow (4Q3) x WQS x Conversion Factor = TMDL.

TMDLs are presented on **Table 3.6** for the critical low flow condition.

Table 3.6 Calculation of Target Loads

Assessment Unit	TSS Indicator Value (mg/l)	Flow (mgd)	Conversion Factor	TMDL (lbs/day)
Coyote Creek (Rio Puerco de Chama to headwaters)	16.12	0.76	8.34	102.18
Poleo Creek (Rio Puerco de Chama to headwaters)	8.75	0.16	8.34	11.68
Rito Encino (Rio Puerco de Chama to headwaters)	8.75	0.14	8.34	10.22

The TMDL is a planning tool to be used to achieve water quality standards. Since flows vary throughout the year in these systems the target load will vary based on the changing flow. Management of the load to improve stream water quality and meet water quality criteria is the goal of SWQB efforts. The TMDL is further allocated to a MOS, WLA (permitted point sources), and LA (nonpoint sources), according to the formula: *WLA + LA + MOS = TMDL.*

3.4 Margin of Safety (MOS)

The CWA requires that each TMDL be calculated with a MOS. This statutory requirement that TMDLs incorporate a MOS is intended to account for uncertainty in available data or in the actual effect controls will have on loading reductions and receiving water quality. A MOS may be expressed as unallocated assimilative capacity or conservative analytical assumptions used in establishing the TMDL (e.g., derivation of numeric targets, modeling assumptions or effectiveness of proposed management actions). The MOS may be implicit, utilizing conservative assumptions for calculation of the loading capacity, WLAs, and LAs. The MOS may also be explicitly stated as an added separate quantity in the TMDL calculation. For this TMDL, the MOS was developed using explicit allocations. Therefore, this MOS is the sum of the following two elements:

- Explicit Recognition of Potential Errors:
    - Uncertainty exists in the relationship between TSS and deposition of excess sediment. A conservative MOS for this element is **10%**.
    - There is error inherent in flow estimation. A conservative MOS for this element in is **10%**.

Total MOS for this TMDL is **20%**.

3.5 Waste Load Allocation (WLA)

There are no active National Pollutant Discharge Elimination System (NPDES) permits that discharge to the sedimentation impaired AUs, therefore the WLA for this TMDL is zero.

Stormwater discharges from construction activities are transient because they occur mainly during the construction itself, and then only during storm events. Coverage under the USEPA NPDES Construction General Permit (CGP) for construction sites of one or more acres, or smaller if part of a common plan of development, requires preparation of a Storm Water Pollution Prevention Plan (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 waste load allocations and/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.

Stormwater discharges from industrial activities and facilities, based on industrial classification codes, may be eligible for coverage under the current NPDES Multi-Sector General Permit (MSGP). The MSGP also requires preparation of a SWPPP. Some of the industrial facilities and activities covered under the MSGP have technology based effluent limitation and/or benchmark monitoring for pollutants. The current MSGP includes state-specific requirements that the benchmark values be protective of State of New Mexico WQS.

It is not possible to calculate individual WLAs for facilities covered by the General Permits at this time using the available tools. The discharges from these permits are typically transitory as the activities are temporary. Loads that are in compliance with the General Permits are therefore currently included as part of the Load Allocation (LA). While these sources are not given individual allocations, they are addressed through other means, including BMPs, stormwater pollution prevention conditions, and other requirements.

3.6 Load Allocation (LA)

In order to calculate the LA, the WLA and the MOS were subtracted from the target capacity (TMDL), as shown on **Table 3.7**. The MOS was developed using a combination of conservative assumptions and explicit recognition of potential errors (see Section 3.4 for details).

Table 3.7 TMDL Allocations for Total Suspended Solids to Meet WQS for Sedimentation/siltation

Assessment Unit	WLA (lbs/day)	20% MOS (lbs/day)	LA (lbs/day)	TMDL (lbs/day)
Coyote Creek (Rio Puerco de Chama to headwaters)	0	20.45	81.74	102.18
Poleo Creek (Rio Puerco de Chama to headwaters)	0	2.34	9.34	11.68
Rito Encino (Rio Puerco de Chama to headwaters)	0	2.04	8.18	10.22

The extensive data collection and analyses necessary to determine background sediment loads were beyond the resources available for this study. It is therefore assumed that a portion of the load allocation is made up of natural background loads. The target load for TSS is the TMDL minus the MOS, in this case equal to the LA.

3.7 Identification and Description of Pollutant Sources

The SWQB process includes an assessment of the probable sources of impairment in the AU drainage area (Appendix B). Probable Source Sheets were filled out by SWQB staff during watershed surveys and watershed restoration activities. The list of probable sources is not intended to single out any particular land owner or land management activity and generally includes several sources per pollutant. **Table 3.8** displays probable pollutant sources that have the potential to contribute to sedimentation impairment within each AU in the TMDL study area, as determined by field reconnaissance and knowledge of watershed activities. The draft probable source list will be reviewed and modified as necessary, with watershed group/stakeholder input during the TMDL public meeting and comment period. Probable sources of impairment will be further evaluated, refined, and changed as necessary through the Watershed-Based Plan (WBP).

Table 3.8 Probable source summary for Sedimentation/siltation

Assessment Unit	Probable Sources
Coyote Creek (Rio Puerco de Chama to headwaters)	Bridges/culverts/RR crossings; Crop production (dry land); Drought-related impacts; Dumping/garbage/trash/litter; Exotic species; Flow alteration; Gravel or dirt roads; Grazing in riparian zone; Mass wasting; Rangeland grazing; Residences/buildings; Stream channel incision; Wildlife other than waterfowl
Poleo Creek (Rio Puerco de Chama to headwaters)	Bridges/culverts/RR crossings; Drought-related impacts; Exotic species; Gravel or dirt roads; Grazing in riparian zone; Rangeland grazing
Rito Encino (Rio Puerco de Chama to headwaters)	Campgrounds (dispersed); Drought-related impacts; Exotic species; Gravel or dirt roads; Grazing in riparian zone; Logging ops - Legacy; Rangeland grazing; Stream channel incision; Wildlife other than waterfowl

Although natural rates of sediment input vary among and within regions, human activities can alter these inputs. Excessive watershed erosion from these activities can transport large amounts of fine sediments into streams, leading to frequent bed mobility and poor instream habitat. Conversely, some human alterations like dredging, channelization or upstream impoundments, may lead to a lack of fine sediments in some parts of the channel, but an excess in other places. Clearing vegetation from banks and riparian areas may increase siltation and reduce large woody debris in streams. Logging or farming up to the stream banks, building roads across or along streams, dredging and straightening the stream channel, and building dams or other diversion structures in the stream channel may destabilize stream banks and change bottom substrate size and composition. Even in streams draining relatively pristine watersheds that are at equilibrium between sediment supply and transport, one might expect different characteristic values of Relative Bed Stability that are dependent upon the natural rates of erosion. In the absence of human activities, these natural erosion rates would depend upon climate, basin geology, geomorphology, channel position within the watershed, and related features such as glaciers and natural landslide frequency (Kaufman et al, 2008).

The headwaters of the impaired AUs occur on land managed by the Santa Fe National Forest. The Forest recently adopted a Travel Management Rule (USDA Forest Service, 2012, https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5376151.pdf), to regulate the routes open or closed to various types of motorized vehicle use. Forestwide, it reduces the total acres available to drive and camp by 19 percent, acres on soils with an erosion hazard rating of moderate or severe by 18 percent, acres within 300 feet of all streams by 29 percent, and acres within 300 feet of impaired streams by 45 percent. The Travel Management Rule also eliminates any legal motorized travel within 100 feet of perennial water. Roads, culverts and crossings with no traffic may continue to contribute excess sediment and storm flow to water bodies. The Forest Service estimated that natural recovery would take in excess of 15 years. Some routes, in order to completely return to natural condition, would require the Forest Service to physically decommission them. Closing them to motorized use is the first step, and it is likely that the Forest will decommission some routes.

3.8 Consideration of Seasonal Variation

The sediment moving capacity of a stream is exponentially related to flow velocity and discharge. Therefore, most of the work of streams is accomplished during floods, when stream velocity and discharge (and therefore capacity) are many times their level during low flow conditions. This work is in the form of bed scouring (erosion), sediment transport (bed and suspended loads), and sediment deposition. It is likely that the excess fine sediment loading and deposition occur during periods of higher flow, which in northern New Mexico are most likely to occur during spring snowmelt and summer monsoon storms. TSS samples were collected in May, July and September of 2012, capturing the late spring through early fall seasons. In two of the three TMDL AUs, TSS and turbidity were highest in spring and lowest in the fall.

3.9 Future Growth

Growth estimates by county and Water Planning Region (WPR) are available from the New Mexico Bureau of Business and Economic Research (BBER, 2008, available at http://bber.unm.edu/data). These estimates project growth to the year 2060. The 2012 Rio Chama water quality survey area falls within the Rio Chama WPR. BBER projects that the Rio Chama WPR will begin to experience population decline, despite recent slow positive growth, as detailed on **Table 3.9**.

Table 3.9 TMDL Study Area Water Planning Region Population Estimates

WPR	2020	2030	2040	2050	2060	% Increase (2020-2060)
Rio Chama	7952	7750	7366	7038	6849	-13.9

Estimates of future growth are not anticipated to lead to a significant increase in sedimentation that cannot be controlled with BMP implementation. BMPs should be utilized and improved upon while continuing to improve watershed conditions and adhering to SWPPP requirements related to construction and industrial activities covered under the GCP.

4.0 TEMPERATURE

Water temperature influences the metabolism, behavior, and mortality of fish and other aquatic organisms. Natural temperatures of a water body fluctuate daily and seasonally. These natural fluctuations do not eliminate indigenous populations, but may affect existing community structure and geographical distribution of species. Anthropogenic impacts such as thermal pollution, deforestation, flow modification and climate change can modify these natural temperature cycles, often leading to deleterious impacts on aquatic life communities. Such modifications may contribute to changes in geographical distribution of species and their ability to persist in the presence of additional stressors such as introduced species. One mechanism by which temperature affects fish is that warmer water has a lower capacity for dissolved oxygen. Water temperature within the stream substrate can influence the growth of insects and salmon eggs. In addition to direct effects, the toxicity of many chemical contaminants increases with temperature (Caissie, 2006).

Fish and other aquatic organisms have specific ranges of temperature tolerance and preference. Cold water fish such as salmonids (salmon and trout) are especially vulnerable to increased water temperature. For that reason, coldwater criteria are typically designed primarily to support reproducing populations of salmonids. A coolwater Aquatic Life Use (ALU) was approved by the WQCC in October 2010, to support aquatic life whose physiologic tolerances are intermediate between those of warmwater and coldwater aquatic life (NMED/SWQB, 2009). Acute temperature criteria (such as New Mexico's T_{MAX}) are intended to protect aquatic life from lethal exposures, whereas chronic criteria (the 4T3 or 6T3) protect from sub-lethal exposures sufficient to cause long-term detrimental effects (Todd et al, 2008). The acute and chronic criteria are established to protect the most sensitive members of fish communities, based on laboratory studies of the upper thermal limits of individual species.

4.1 Target Loading Capacity

For this TMDL document, target values for temperature are based on the reduction in thermal loading necessary to achieve numeric criteria. Thermal loading in a given AU can often be correlated to changes in shade and/or canopy cover. Temperature criteria for ALUs in New Mexico are shown on **Table 4.1**. New Mexico's aquatic life temperature criteria are expressed as $T_{MAX,}$ 4T3 and 6T3. T_{MAX} is the maximum recorded temperature, 4T3 means the temperature not to be exceeded for four or more consecutive hours in a 24-hour period on more than three consecutive days, and 6T3 means the temperature not to be exceeded for six or more consecutive hours in a 24-hour period on more than three consecutive days.

Table 4.1 Aquatic Life Use Temperature (°C) Water Quality Criteria

Criterion	*High Quality Coldwater*	*Coldwater*	*Marginal Coldwater*	*Coolwater*	*Warmwater*	*Marginal Warmwater*
4T3	20	---	---	---	---	---
6T3	---	20	25	---	---	---
T_{MAX}	23	24	29	29	32.2	32.2

The TMDL is further allocated to a Margin of Safety (MOS), Waste Load Allocation (WLA; permitted point sources), and Load Allocation (LA; nonpoint sources), according to the formula:

$$WLA + LA + MOS = TMDL$$

Assessment of the 2012 Rio Chama watershed thermograph data determined that three of the AUs exceeded the T_{MAX} for their designated ALU. One of the three impaired AUs, Sixto Creek, flows into New Mexico across the Colorado border about one mile before entering the Rio Chamita. The state of Colorado does not have any thermograph data from Sixto Creek and this water body is currently not listed as impaired in Colorado (personal comm., Holly Brown, TMDL Specialist, CO Water Quality Control Division, September 19, 2019).

Table 4.2 Rio Chama watershed temperature impairments

AU Name	AU ID	Designated ALU	T_{MAX} Criterion (°C)	Date of Measured T_{MAX}	Measured T_{MAX} (°C)
Placer Creek (Hopewell Lake to headwaters)	NM-2112.A_03	HQCWAL	23	6/23/12	23.74
Rio Tusas (Perennial prt Rio Vallecitos to headwaters)	NM-2113_30	Coldwater	31*	7/12/14	31.66
Sixto Creek (Rio Chama to CO border)	NM-2116.A_112	HQCWAL	23	6/24/12	26.72

*Although the T_{MAX} criterion for Coldwater ALU is generally 24 °C, the Rio Tusas has a segment-specific criterion of 31 °C (NMAC 20.6.4.116).

4.2 Flow

The TMDL is a value calculated at a defined critical flow condition as part of a planning process designed to achieve water quality standards. For this temperature TMDL, the appropriate critical flow condition is at low flow in order to be protective when the assimilative capacity of a stream is at its lowest. According to the New Mexico Water Quality Standards, the low flow critical condition for numeric criteria (excluding human health-organism only criteria) set in 20.6.4.97 through 20.6.4.900 NMAC and Subsection F of 20.6.4.13 NMAC is defined as the 4-day, 3-year low-flow frequency (4Q3, 20.6.4.11(B)(2) NMAC). The 4Q3 is the annual lowest four consecutive day flow that occurs with a frequency of at least once every three years.

Because these streams are ungaged, a regression model developed by Waltemeyer (2002) was used to estimate the critical low flow. In Waltemeyer's analysis, two regression equations for estimating 4Q3 were developed based on physiographic regions of New Mexico (i.e., statewide and mountainous regions above 7,500 ft in elevation). The average elevation of each of the Chama basin sedimentation impaired watersheds is above 7,500 ft, so the mountainous regions regression equation was used. The following mountainous regions regression equation (**Equation 4.1**) is based on data from 40 gaging stations located above 7,500 ft in elevation with non-zero discharge (Waltemeyer, 2002):

Equation 4.1 $4Q3 = 7.3287 \times 10^{-5} DA^{0.70} {P_w}^{3.58} S^{1.35}$

Where:

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = Drainage area (mi^2)
P_w = Average basin mean winter precipitation (inches)
S = Average basin slope (ft/ft)

The 4Q3 values calculated using Waltemeyer's method are presented in **Table 4.3**. Parameters used in the calculation were obtained using the StreamStats online GIS application developed by the USGS (https://streamstats.usgs.gov/ss/). The TMDL is a value calculated at a defined critical condition as part of a planning process designed to achieve water quality standards. Since flows vary throughout the year in these systems, the actual load at any given time will vary based on the changing flow. Management of the load to improve stream water quality is the goal of SWQB efforts.

Table 4.3 Critical flow values for Rio Chama temperature TMDLs

Assessment Unit	Average Elevation (ft)	Drainage Area (mi^2)	Mean Winter Precipitation (in)	Average Basin Slope (ft/ft)	4Q3 (cfs)
Placer Creek (Hopewell Lake to headwaters)	10,100	4.97	24.2	0.10	0.90
Rio Tusas (Perennial prt Rio Vallecitos to headwaters)	8410	198	9.77	0.18	1.03
Sixto Creek (Rio Chama to CO border)	9550	5.1	25.4	0.21	2.98

4.3 TMDL Calculations

The calculation of a TMDL is governed by the basic equation,

WQS criterion x flow x conversion factor = TMDL target capacity

For temperature TMDLs, the WQS criterion is a temperature specified either by the designated ALU or segment-specific criteria and can be either a maximum temperature or time-duration temperature such as the 4T3 or 6T3. The 4Q3 low-flow is generally used for the critical flow unless another flow statistic or multiple flow conditions are more appropriate for the situation. The conversion factor is a variable needed to convert units used by SWQB for temperature (in Celsius) and flow (in cfs) to units needed to balance the thermal energy equation. Substituting the appropriate unit conversion factors, the equation used for temperature is the following:

WQS (°C) x Flow (cfs) x 1.023E+7 = TMDL (kJ/day)

Details of the derivation of the TMDL equation are presented in Appendix C. **Table 4.4** shows the TMDL calculation values for each TMDL AU.

Table 4.4 Temperature TMDL calculations based on WQS T_{MAX}

Assessment Unit Name	WQS T_{MAX} (°C)	4Q3 critical flow (cfs)	Conversion factor	TMDL (kJ/day)
Placer Creek (Hopewell Lake to headwaters)	23	0.90	1.023×10^7	2.12×10^8
Rio Tusas (Perennial prt Rio Vallecitos to headwaters)	31	1.03	1.023×10^7	3.27×10^8
Sixto Creek (Rio Chama to CO border)	23	2.98	1.023×10^7	7.01×10^8

4.4 Margin of Safety (MOS)

The CWA requires that each TMDL be calculated with a MOS, intended to account for uncertainty in available data or in the actual effect controls will have on loading reductions and receiving water quality. A MOS may be expressed as unallocated assimilative capacity or conservative analytical assumptions used in establishing the TMDL (e.g., derivation of numeric targets, modeling assumptions or effectiveness of proposed management actions). The MOS may be implicit, utilizing conservative assumptions for calculation of the loading capacity, WLAs, and LAs. The MOS may also be explicitly stated as an added separate quantity in the TMDL calculation.

Because of the uncertainty in determining critical low flow, an explicit MOS of 10% is assigned to this TMDL.

4.5 Waste Load Allocation (WLA)

There are no National Pollutant Discharge Elimination System (NPDES) individual permits that discharge to Placer Creek (Hopewell Lake to headwaters), Rio Tusas (Perennial prt Rio Vallecitos to headwaters), or Sixto Creek (Rio Chama to CO border). There are no Municipal Separate Storm Sewer System (MS4) permits in these AUs. Therefore, no WLA is assigned for this TMDL.

There may be storm water discharges from industrial, including construction, activities covered under the National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP) or Multi-Sector General Permit (MSGP). Excess temperature loading may be a component of some storm water discharges covered under general NPDES permits. Stormwater discharges from industrial, including construction, activities are generally considered transient because they occur mainly during the construction itself and/or only during storm events.

Coverage under the USEPA NPDES CGP for construction sites one acre or greater or smaller if part of a common plan of development require preparation of a Storm Water Pollution Prevention Plan (SWPPP) that includes identification and control of 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. Stormwater discharges from industrial activities and facilities, based on industrial classification codes, may be eligible for coverage under the current NPDES MSGP. The MSGP also requires preparation of a SWPPP. Some of the industrial facilities and activities covered under the MSGP have technology based effluent limitation and/or benchmark monitoring for pollutants. The current MSGP includes state-specific requirements that the benchmark values reflect State of New Mexico WQS.

It is not possible to calculate individual WLAs for facilities covered by the General Permits at this time using the available tools. Loads that are in compliance with the General Permits are therefore currently included as part of the Load Allocation (LA). While these sources are not given individual allocations, they are addressed through other means, including BMPs, stormwater pollution prevention conditions, and other requirements. State certification of federal permits ensure that applicable water quality standards, including the antidegradation policy, are met. Compliance with a CGP or MSGP SWPPP that meets the requirements of the general permits is generally assumed to be consistent with this TMDL.

4.6 Load Allocation (LA)

Load Allocation is pollution from any nonpoint source(s) or natural background and is addressed through Best Management Practices (BMPs). Since there are no WLAs for these AUs, the LA is equal to the TMDL value minus the MOS.

Table 4.5 Temperature TMDL allocation summary. Units are kilojoules per day.

Assessment Unit	MOS	WLA	LA	TMDL
Placer Creek (Hopewell Lake to headwaters)	2.12×10^7	0	1.91×10^8	2.12×10^8
Rio Tusas (Perennial prt Rio Vallecitos to headwaters)	3.27×10^7	0	2.94×10^8	3.27×10^8
Sixto Creek (Rio Chama to CO border)	7.01×10^7	0	6.31×10^8	7.01×10^8

Load reductions necessary to meet the target loads could not be calculated for these ungaged AUs because flow data is not available for the date of the maximum thermograph reading. Section 6 of this report, Implementation of TMDLs, includes the results of temperature modeling which provide estimated increases in riparian shading, and/or decreases in stream channel width, which may result in achievement of the WQS criteria.

4.7 Identification and Description of Pollutant Source(s)

The SWQB process includes an assessment of the probable sources of impairment (Appendix B). Probable Source Sheets are filled out by SWQB staff during watershed surveys and watershed restoration activities.

The list of Probable Sources is not intended to single out any single land owner or particular land management activity and generally includes several sources per pollutant. **Table 4.6** displays probable pollutant sources that have the potential to contribute to increased temperature as determined by field reconnaissance and knowledge of watershed activities. The draft probable source list will be reviewed and modified, as necessary, with watershed group/stakeholder input during the TMDL public meeting and comment period. Probable sources of temperature impairments can be further evaluated, refined, and changed as necessary through the Watershed-Based Plan (WBP).

Table 4.6 Probable Source summary for temperature impairments in the Rio Chama watershed

Assessment Unit	Probable Sources
Placer Creek (Hopewell Lake to headwaters)	Angling pressure; Exotic species; Paved roads; Rangeland grazing; Stream channel incision; Wildlife other than waterfowl
Sixto Creek (Rio Chama to CO border)	Drought-related impacts; Wildlife other than waterfowl
Rio Tusas (Perennial prt Rio Vallecitos to headwaters)	Abandoned mine/tailings; Bridges/culverts/RR crossings; Channelization; Crop production (dry land); Dams/diversions; Drought-related impacts; Exotic species; Flow alteration; Gravel or dirt roads; Grazing in riparian zone; Irrigated crop production; Livestock operations; Low water crossing; Paved roads; Rangeland grazing; Stream channel incision; Residences/buildings;

A variety of factors can impact stream temperature (**Figure 4.1**). Decreased effective shade levels may result from reduction of riparian vegetation. When canopy densities are reduced, thermal loading increases in response to the increase in incident solar radiation. Likewise, it is well documented that past hydromodification activities have led to channel incision and widening. Wider stream channels also increase the stream surface area exposed to sunlight, thereby increasing heat transfer. Riparian area and channel morphology disturbances may also be attributed to past or current rangeland grazing practices that have resulted in reduction of riparian vegetation and streambank destabilization. These nonpoint sources of pollution primarily affect the water temperature through increased solar loading by: (1) increasing stream surface solar radiation influx, and (2) increasing stream surface area exposed to solar radiation.

Riparian vegetation, stream morphology, hydrology, climate, geographic location, and aspect all influence stream temperature. Although climate, geographic location, and aspect are outside of human control, the condition of the riparian area, channel morphology, and hydrology can be affected by land use activities. Specifically, elevated summertime stream temperatures attributable to anthropogenic causes may result from the following conditions:

1. Channel widening (i.e., increased width to depth ratios) that has increased the stream surface area exposed to incident solar radiation;
2. Riparian vegetation disturbance that has reduced stream surface shading, riparian vegetation height and density;

3. Reduced summertime base flows that result from instream impoundments and withdrawals and/or inadequate riparian vegetation; and,
4. Inflow from heated surfaces, such as road pavement, buildings, bare land, etc. and the flow of water over hardened channel bottoms and walls.

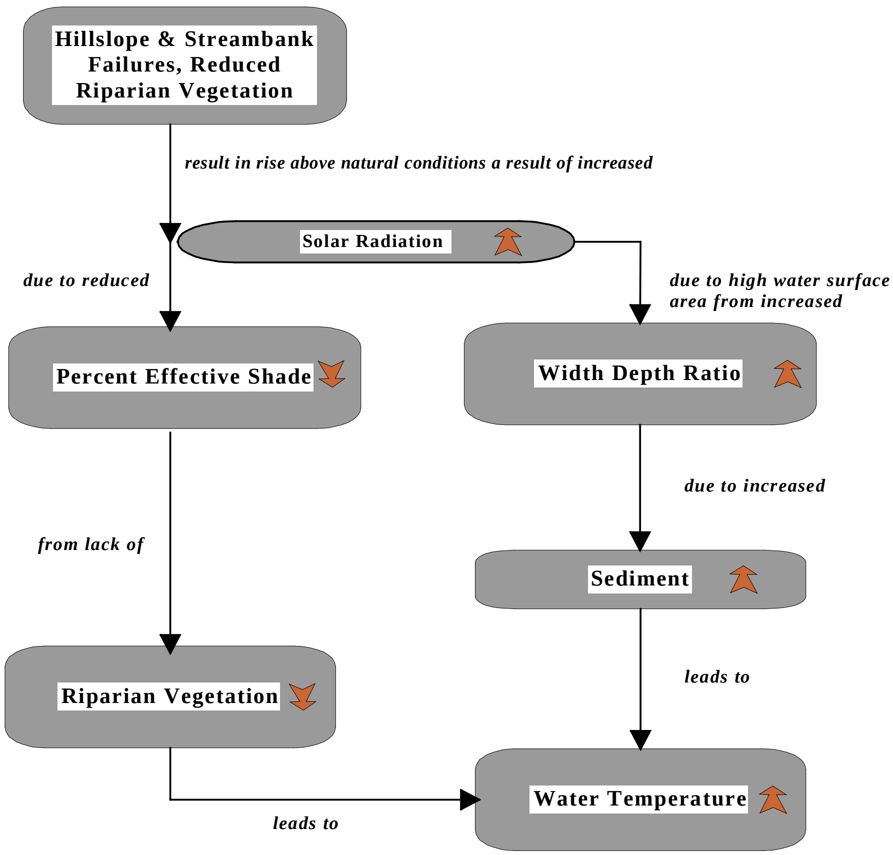


Figure 4.1 Factors Impacting Stream Temperature

Loss of a functioning riparian system may lower and sometimes eliminate baseflows. Although removal of upland vegetation has been shown, in some cases, to increase water yield, studies show that removal of riparian vegetation along the stream channel subjects the water surface and adjacent soil surfaces to wind and solar radiation, partially offsetting the reduction in transpiration with evaporation. In losing reaches, where the stream loses water through infiltration to the surrounding ground as it flows downstream, increased temperatures can result in increased streambed infiltration, which can result in lower base flow (Constrantz et al, 1994).

Vegetation density increases will provide necessary shading, as well as encourage bank-building processes in severe hydrologic events (see Section 6 of this report for modeling of shade increases to reduce water temperature). However shade is only one avenue which may be pursued to decrease water temperature and ultimately meet WQS. Changes in geomorphological parameters might also prove useful. For example, unstable channels may be characterized by excess sedimentation. Many aquatic organisms respond to high temperature by seeking thermal refuge, moving into cooler tributaries or small cold patches within the stream. Creation of thermal refuges, or enhanced connectivity, may mitigate the effects of increased water temperature (Caissie, 2006). The SWQB encourages stakeholders to explore options to determine the most appropriate approach for each particular watershed or project, with the ultimate goal being that the stream meets the WQS.

A riparian restoration project was installed in 2009 by the NM Department of Transportation (DOT) on a 2000 foot stretch of Placer Creek, about 0.9 miles above the 2012 SWQB thermograph location, comprising a livestock exclusion fence and 53 instream features, although livestock were not fully excluded until some time during the growing season of 2012. Follow-up monitoring was conducted in fall of 2012. Despite fencing issues and short duration, the project had effectively raised the water table adjacent the creek, and caused dramatic increases to total vegetative cover and the percentage of wetland vegetation. However, the temperature criterion exceedance was documented in June of that year. In January of 2014, the US Army Corps of Engineers released DOT from further monitoring, and the site was turned back over to the US Forest Service. The Forest Service has not maintained the project or the fence around it since that time.

4.8 Consideration of Seasonal Variation

Section 303(d)(1) of the CWA requires TMDLs to be "established at a level necessary to implement the applicable WQS with seasonal variations." Both stream temperature and flow vary seasonally and from year to year. Water temperatures are coolest in the winter and early spring months.

The warmest stream temperatures correspond to prolonged solar radiation exposure, warmer air temperature, and low flow conditions. Maximum temperatures were recorded in Placer Creek and Sixto Creek in June of 2012. The maximum temperature was recorded in the Rio Tusas in July of 2014. Future climate change is expected to increase air temperatures and decrease streamflow, potentially causing increases in maximum water temperature.

4.9 Future Growth

Growth estimates by county and Water Planning Region (WPR) are available from the New Mexico Bureau of Business and Economic Research (BBER, 2008, available at http://bber.unm.edu/data). These estimates project growth to the year 2060. The 2012 Rio Chama water quality survey area falls within the Rio Chama WPR. BBER projects that the Rio Chama WPR will begin to experience population decline (**Table 4.7**), despite recent slow positive growth.

Table 4.7 TMDL Study Area Water Planning Region Population Estimates

WPR	2020	2030	2040	2050	2060	% Increase (2020-2060)
Rio Chama	7952	7750	7366	7038	6849	-13.9

Estimates of future growth are not anticipated to lead to a significant increase in temperature that cannot be controlled with BMP implementation. BMPs should be utilized and improved upon while continuing to improve watershed conditions and adhering to SWPPP requirements related to construction and industrial activities covered under the GCP.

5.0 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. The 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 Rio Chama watershed is 2021-2022.

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 in 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 compliance 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.

6.0 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.

6.1 Nonpoint Sources

6.1.1 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 landowners and public agencies in reducing and preventing 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 WBP 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 temperature include establishment of additional woody riparian vegetation for shade and/or stream channel restoration work, particularly at road crossings. Additional information about the reduction of nonpoint 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.

6.1.2 Temperature modeling

Freshwater systems have interrelated biotic and abiotic parameters that drive the temperature of the waterbody. For a stream, these parameters can be generalized into simple categories that include: vegetation and land cover, channel morphology, and hydrology. Parameters such as channel width, meteorological measurements and microclimates, and solar irradiance, can exhibit considerable spatial variability. Together these parameters affect heat transfer and mass transfer processes to varying degrees. Due to the complexity of these systems, temperature modeling techniques are useful to facilitate the computation and prediction of the extent to which different parameters can affect a fresh water system. Temperature models can also identify the sensitivity of water temperature to individual parameters, to improve understanding of actions that may lead towards TMDL implementation.

The SSTEMP Model, Version 2.0.8, developed by the USGS Biological Resource Division (Bartholow, 2002, http://www.fort.usgs.gov) was used to predict stream temperatures of the impaired AUs based on watershed geometry, hydrology, and meteorology (**Figure 6.1**). The model predicts mean, minimum, and maximum daily water temperatures throughout a stream reach by estimating the heat gained or lost from a parcel of water as it passes through a stream segment (Bartholow, 2002). The model is calibrated by comparing predicted temperature values with actual thermograph readings measured in the field. SSTEMP is useful to inform TMDL implementation practices for temperature impaired AUs. The model analysis focuses mainly on changes in the riparian shade percentage and/or modification to channel dimensions (width). Total percent shade was chosen as a first-step analysis for TMDL implementation since it is easily translated into quantifiable management objectives.

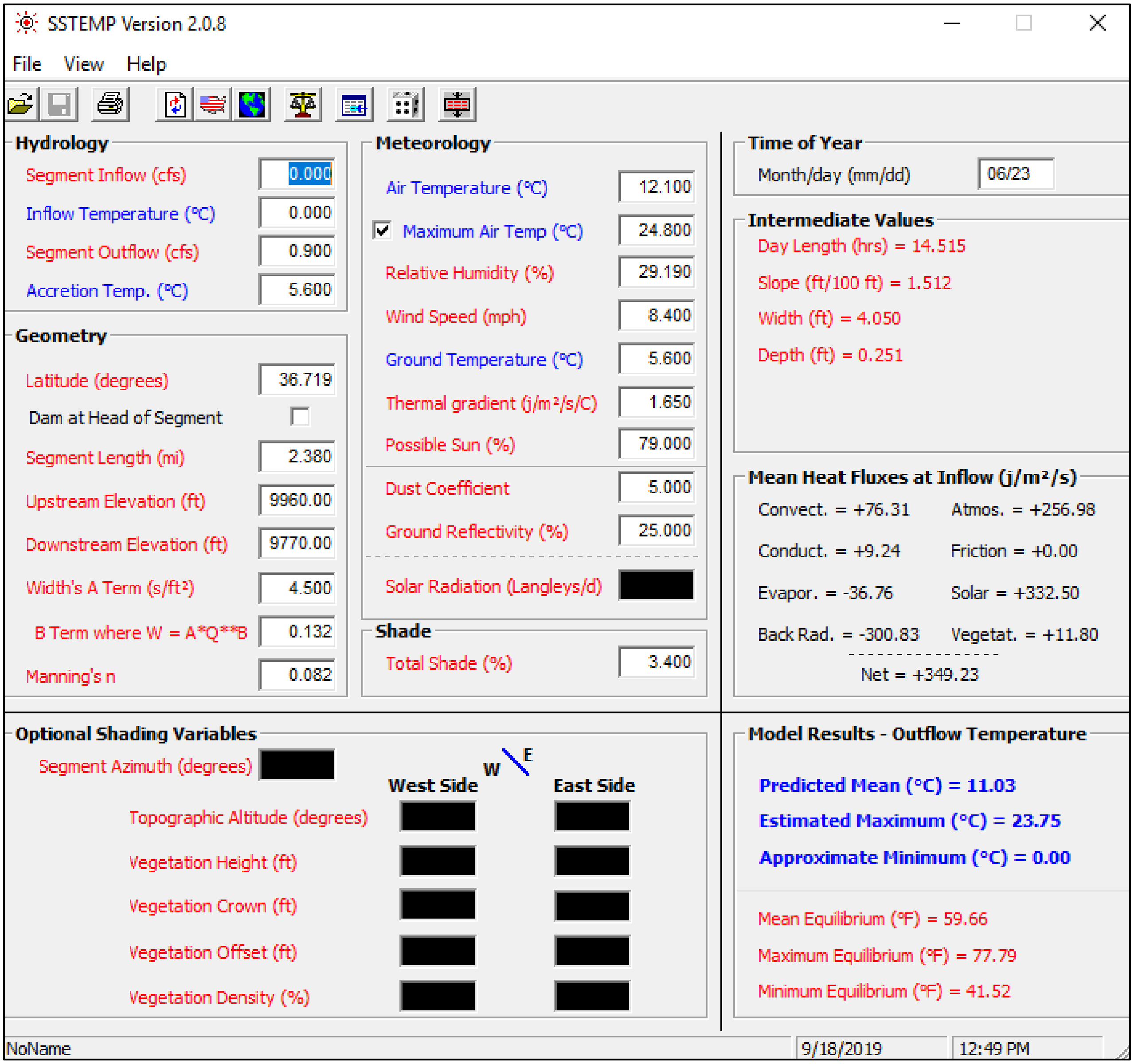


Figure 6.1 Example of SSTEMP output for Placer Creek (Hopewell L to headwaters).

A series of assumptions are associated with the SSTEMP run conditions. Running the model outside of these assumptions may result in inaccuracies or model instability. The assumptions used in the development of

SSTEMP that are most relevant to the present TMDLs are listed below. For a complete list of assumptions and model deficiencies, please see the SSTEMP user manual (Bartholow, 2002).

- Water in the system is instantaneously and thoroughly mixed at all times; there is no lateral temperature distribution across channel OR vertical gradients in pools.
- Stream geometry is characterized by mean conditions.
- Solar radiation and other meteorological and hydrological variables are 24-hour means.
- Distribution of lateral inflow is uniformly apportioned throughout the segment length
- Manning's n and travel time do not vary as functions of flow.
- Modeled/representative time periods must be long enough for water to flow the full length of the segment.
- SSTEMP is not able to model cumulative effects; for example, adding or deleting vegetation mathematically is not the same as in real life.

Water temperature can be expressed as heat energy per unit volume. SSTEMP provides an estimate of heat energy expressed in joules per square meter per second ($j/m^2/s$). The program will predict the minimum, mean, and maximum daily water temperature for the set of variables input into the model. The theoretical basis for the model is strongest for the mean daily temperature. The predicted maximum is largely an estimate and likely to vary widely with the maximum daily air temperature. The predicted minimum is computed by subtracting the difference between maximum and mean, from the mean; but the predicted minimum is always positive (Bartholow, 2002).

SSTEMP input values are presented in Appendix D. The SSTEMP predicted maximum temperature was calibrated against thermograph data. Then the percent total shade was increased until the maximum 24-hour temperature decreased to the applicable temperature criterion. Width's A term was then decreased, at the existing percent shade, until the criterion was reached. **Table 6.1** details model outputs for the TMDL AUs. The model predicts that, since the Placer Creek and Rio Tusas AUs exceed their WQS standards by only a small margin, only small increases in riparian canopy would be needed to result in support of the designated ALU. Sixto Creek is temperature impaired by a wider margin, so a large increase in shade would be needed to result in support of the designated ALU. Morphological modifications which decrease channel width would also be expected to result in lower maximum water temperatures.

SSTEMP may be used to compute, one at a time, the sensitivity to input values. The sensitivity analysis varies active input variables by 10% in both directions, and displays a screen for resulting changes to maximum temperatures. The "Relative Sensitivity" schematic graph that accompanies the display gives an indication of which variables most strongly influence the results (Bartholow, 2002). Sensitivity analysis outputs are shown in **Figure 6.2**. Meteorological variables will always have the greatest impact on predicted maximum temperature. For Placer Creek, the sensitivity analysis indicates that it is also moderately sensitive to streamflow and width. For the Rio Tusas, on the other hand, the model is relatively insensitive to flow and width, but is moderately sensitive to total shade. The only non-meteorological variable to which the model is particularly sensitive for Sixto Creek is the inflow temperature. This suggest that, in addition to increasing shade, it may be advisable to work across state borders to improve conditions or remove stressors along the headwaters reach in Colorado.

The SSTEMP model does not consider any impacts of climate change. The SWQB encourages implementation practitioners to design projects to reduce water temperature well below the WQS, such that currently impaired AUs will be likely to meet WQS standards well into the future with some resiliency to climate change.

Table 6.1 SSTEMP model results for Rio Chama basin temperature impaired AUs

Assessment Unit	Measured % Shade [a]	WQS % Shade [b]	Width's A	WQS Width's A [c]
Placer Creek (Hopewell Lake to headwaters)	3.4	9.8	4.5	3.3
Rio Tusas (Perennial prt Rio Vallecitos to headwaters)	10.3	15.6	10.34	4.4
Sixto Creek (Rio Chama to CO border)	0	50.0	2.843	NA [d]

[a] Shade values measured during water quality monitoring survey
[b] % shade at which the SSTEMP predicted maximum temperature is below the applicable WQS, all other variables being held the same.
[c)] Width's A term at which the SSTEMP predicted maximum temperature is below the applicable WQS, all other variables being held the same.
[d] Width's A term cannot be less than 1.0. Setting Width's A at 1.0 did not bring the SSTEMP predicted maximum temperature below the applicable WQS.

Sensitivity for maximum temperature values (10% varaition)   SSTEMP (2.0.8)
Original maximum temperature = 74.76°F

Variable	Temperature change (°F) if variable is: Decreased	Increased	Relative Sensitivity
Segment Inflow (cfs)	+0.00	+0.00	
Inflow Temperature (°C)	0.00	0.00	
Segment Outflow (cfs)	+0.36	-0.37	********
Accretion Temp. (°C)	-0.14	+0.14	***
Width's A Term (s/ft²)	-0.39	+0.47	**********
B Term where W = A*Q**B	+0.04	-0.04	*
Manning's n	+0.27	-0.28	******
Air Temperature (°C)	-0.05	+0.05	*
Relative Humidity (%)	-0.29	+0.30	******
Wind Speed (mph)	+0.74	-0.79	*****************
Ground Temperature (°C)	-0.04	+0.04	*
Thermal gradient (j/m²/s/C)	+0.13	-0.13	***
Possible Sun (%)	-1.18	+1.23	**************************
Dust Coefficient	+0.06	-0.06	*
Ground Reflectivity (%)	-0.05	+0.05	*
Total Shade (%)	+0.07	-0.07	**
Maximum Air Temp (°C)	-1.38	+1.42	******************************

A

Sensitivity for maximum temperature values (10% varaition)   SSTEMP (2.0.8)
Original maximum temperature = 80.11°F

Variable	Temperature change (°F) if variable is: Decreased	Increased	Relative Sensitivity
Segment Inflow (cfs)	-0.06	+0.06	*
Inflow Temperature (°C)	-1.01	+1.02	**********************
Segment Outflow (cfs)	+0.14	-0.15	***
Accretion Temp. (°C)	+0.00	+0.00	
Width's A Term (s/ft²)	-0.09	+0.12	**
B Term where W = A*Q**B	-0.02	+0.02	*
Manning's n	+0.17	-0.17	****
Air Temperature (°C)	+0.12	-0.10	***
Relative Humidity (%)	-0.21	+0.22	*****
Wind Speed (mph)	+0.68	-0.72	***************
Ground Temperature (°C)	-0.03	+0.03	*
Thermal gradient (j/m²/s/C)	+0.09	-0.09	**
Possible Sun (%)	-0.79	+0.82	*****************
Dust Coefficient	+0.04	-0.04	*
Ground Reflectivity (%)	-0.03	+0.03	*
Total Shade (%)	+0.00	+0.00	
Maximum Air Temp (°C)	-1.39	+1.42	******************************

B

Sensitivity for maximum temperature values (10% varaition)   SSTEMP (2.0.8)
Original maximum temperature = 88.93°F

Variable	Temperature change (°F) if variable is: Decreased	Increased	Relative Sensitivity
Segment Inflow (cfs)	+0.00	+0.00	
Inflow Temperature (°C)	0.00	0.00	
Segment Outflow (cfs)	+0.05	-0.05	*
Accretion Temp. (°C)	-0.01	+0.01	
Width's A Term (s/ft²)	-0.05	+0.07	**
B Term where W = A*Q**B	+0.01	-0.01	
Manning's n	+0.05	-0.05	*
Air Temperature (°C)	-0.69	+0.64	****************
Relative Humidity (%)	-0.55	+0.57	*************
Wind Speed (mph)	+0.60	-0.63	**************
Ground Temperature (°C)	-0.05	+0.05	*
Thermal gradient (j/m²/s/C)	+0.17	-0.17	****
Possible Sun (%)	-1.02	+1.09	*************************
Dust Coefficient	+0.05	-0.05	*
Ground Reflectivity (%)	-0.05	+0.05	*
Total Shade (%)	+0.22	-0.22	*****
Maximum Air Temp (°C)	-1.30	+1.32	******************************

C

Figure 6.2 SSTEMP sensitivity analyses for Placer Creek (A), Sixto Creek (B) and Rio Tusas (C)

6.2 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 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: https://www.env.nm.gov/surface-water-quality/.

There is currently one approved WBP, the Rio Nutrias Watershed Based Plan (https://www.env.nm.gov/surface-water-quality/accepted-wbp/), and two active watershed groups, the Rio Nutrias/Cebolla Watershed Association and the Rio Chama Congreso, working on the Rio Chama. SWQB staff will continue to conduct outreach related to the CWA Section 319(h) funding program.

6.3 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 WWTP 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 US 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 $1,250,000 in state funds for the River Stewardship Program during the 2020 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 will be conducted to select projects for the

2020 funding. Responsibility for the program is assigned to NMED, and SWQB staff administer the projects. Additional funding sources for watershed protection and improvement projects are listed in Appendix C of the New Mexico Nonpoint Source Management Plan, available at https://www.env.nm.gov/surface-water-quality/nps-plan.

Information on additional watershed restoration funding resources is available on the SWQB website at- https://www.env.nm.gov/surface-water-quality/watershed-protection-section/.

7.0 APPLICABLE REGULATIONS AND REASONABLE ASSURANCES

New Mexico's Water Quality Act, NMSA 1978 §§ 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 Standards for Interstate and Intrastate Surface Waters (20.6.4.6(C) NMAC) state:

> *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 landowners, 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 SWQB, and other parties identified in the WBP. The cooperation of watershed stakeholders will be pivotal in the implementation of these TMDLs as well.

8.0 PUBLIC PARTICIPATION

Public participation was solicited in development of this TMDL. The draft TMDL will be made available for a 30-day comment period beginning May 1, 2020 and ending on June 1, 2020. The draft document notice of availability will be advertised via email distribution lists and webpage postings. A public meeting will be held on May 6, 2020, from 5:30 to 7:30 pm, using virtual meeting technology. A response to comments will be added to the TMDL document as Appendix E.

Once the TMDL is approved by the WQCC, the next step for public participation will be development of 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: *E.coli* data

Asterisk (*) indicates exceedance of the applicable criterion. MDP is a missing data point. MPN is the most probable number of colony forming units, and is equivalent to cfu in the New Mexico WQS.

Cañones Creek (Abiquiu Rsvr to Chihuahuenos Ck)			
Site ID	**Date**	***E.coli* results (MPN/100mL)**	**Flow (cfs)**
29CanonA001.7	4/24/2012	*>2419.6	MDP
29CanonA001.7	5/29/2012	16	1.43
29CanonA003.4 (There was no flow at Hwy 96 due to diversion and loss to alluvium, so these samples were collected about 1 mile upstream at the most downstream bridge on County Road 194 (36.20875, 106.45265))	6/28/2012	52.8	MDP
29CanonA001.7	7/31/2012	*307.6	2.74 (high flow within the last 2 weeks)
29CanonA001.7	8/28/2012	*866.4	0.66
29CanonA001.7	9/25/2012	*1119.9	0.8
29CanonA001.7	10/31/2012	172.3	2.72

Rio Nutrias (Perennial prt Rio Chama to headwaters)			
Site ID	**Date**	***E.coli* results (cfu/100mL)**	**^Flow (cfs)**
29RNutri040.5	4/24/2012	5.2	MDP
29RNutri040.5	6/5/2012	8.4	MDP
29RNutri040.5	9/18/2012	62	MDP
29RNutri028.4	6/27/2012	*980.4	MDP
29RNutri028.4	7/24/2012	*272.3	MDP

29RNutri028.4	9/27/2012	151.5	MDP
29RNutri005.4	4/25/2012	*>2419.6	MDP
29RNutri005.4	8/22/2012	*435.2	MDP
29RNutri005.4	9/7/2012	72.3	MDP
29RNutri005.4	10/31/2012	41.4	MDP

^ Flow condition was rated 3, meaning “Moderate flow (obvious flow, below bankfull)”, on April 24, June 5, and September 3, 9, and 18.

Table A2: Sedimentation/Siltation data

Coyote Creek at FR 316 -29Coyote003.8			
Date	**TSS (mg/L)**	**Turbidity (NTU)**	**Flow (cfs)**
5/31/12	<1.3	0.4	0.21
7/17/12	<1.3	2.7	**1
9/26/12	12	1.3	**0.1

Poleo Creek at FR 103 - 29PoleoC009.5			
Date	**TSS (mg/L)**	**Turbidity (NTU)**	**Flow (cfs)**
5/30/12	9	14.4	1.31
7/17/12	<1.3	7.3	**1
9/25/12	8	0.6	**0.5

Rito Encino at FR 100Z - 29REncin009.7			
Date	**TSS (mg/L)**	**Turbidity (NTU)**	**Flow (cfs)**
5/30/12	52	23.8	0.28
7/24/12	MDP	16.7	**0.5
9/26/12	15	4.0	0.18

****** Visual estimate of flo

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 is housed in the Assessment Database (ADB version 2). 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. 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:

USEPA. 1997. Guidelines for preparation of the comprehensive state water quality assessments (305(b) reports) and electronic uptakes. EPA-841-B-97-002A. Washington, D.C.

APPENDIX C
CALCULATION OF TEMPERATURE TMDL

Calculation of Temperature TMDL

Problem Statement: Convert Temperature Criteria into a Daily Load

Background

The temperature of water is essential for proper metabolic regulation in the aquatic community. Water at a given temperature has a thermal mass that can be represented in units of energy (thermal energy). There are a variety of sources of temperature loading to a waterbody, including air temperature, solar radiation and point source discharge (if present). In addition, how the temperature loading to a stream is translated to the thermal mass of the stream is dependent on its hydrologic characteristics and condition of riparian area (i.e., shading).

The calculation of a TMDL target is governed by the basic equation,

Eq1. *WQS criterion * flow * conversion factor = TMDL target capacity*

For Temperature TMDLs, the WQS criterion is a temperature specified either by the designated Aquatic Life Use (ALU) or site-specific criteria and can be either a maximum temperature or time-duration temperature such as the 4T3 or 6T3.

Flow will generally use the 4Q3 low-flow for the critical flow unless another flow statistic or multiple flow conditions are more appropriate for the situation.

The conversion factor is a variable needed to 1) convert units used by SWQB for flow (in cfs) to cubic meters (m^3) and 2) convert water temperature (C) to a volumetric heat capacity (kJ/(m^3*C).

Calculation of Thermal Energy

The thermal loading capacity of a volume is governed by the following equation,

Eq2. *thermal energy = specific heat capacity * mass * temperature*

Specific heat capacity is the amount of energy needed to raise the temperature of one kilogram of a substance by 1 degree Celsius.

Mass can be replaced by volume via density.

Accepted Scientific Units for the variables above are:

thermal energy = kilojoule (kJ) (calories are less common and considered archaic)

specific heat capacity = kJ/(kg*C)

mass = kilograms (kg)

temperature = Celsius (C)

The specific heat capacity of water at 25^{o}C = 4.182 kJ/(kg*C). This is the isobaric (under constant pressure) value for heat capacity at an absolute atmospheric pressure of 585 mmHg. Note: varying water temperature and absolute pressure to minimum and maximum ambient values has negligible effect on the resulting heat capacity.

Calculation of Conversion Factor

Flow (cfs) to (m^3/day)

Eq3. 1 cf/s * 86,400 s/day * 0.0283 m^3/cf = 2445.12 m^3/day

Heat Capacity to Volumetric Heat Capacity

Eq4. 4.182 kJ/(kg*C) * 1000 kg/m^3 = 4,182 kJ/(m^3*C)

Note: water density varies with temperature but only at a fraction of a percent.

Conversion Factor = 2445.12 m^3/day * 4,182 kJ/(m^3*C) = 1.023 x 10^7 kJ/(day*C)

Form of TMDL Equation

Eq5. [**^{o}C**] x [**cfs]** x 1.023 x 10^7 = TMDL (kJ/day)

Input variables in **bold**, **^{o}C** = WQC and **cfs** = critical flow

The resulting value is the increase in kJ/day above 0^o Celsius.

APPENDIX D
SSTEMP INPUT DATA

D 1.0 INTRODUCTION

This appendix provides site-specific hydrology, geometry, and meteorological data for input into the Stream Segment Temperature (SSTEMP) Model (Bartholow, 2002). Hydrology variables include segment inflow, inflow temperature, segment outflow, and accretion temperature. Geometry variables are latitude, segment length, upstream and downstream elevation, Width's A-term, Width's B-term, and Manning's n. Meteorological inputs to SSTEMP Model include maximum air temperature, air temperature, relative humidity, windspeed, ground temperature, thermal gradient, possible sun, dust coefficient, ground reflectivity, and solar radiation. In the following sections, data sources for these parameters are discussed in detail for each Assessment Unit (AU) to be modeled using SSTEMP Model. Initial input values are shown on **Table D.1**, following the discussion of data sources. Each AU was modeled on the date of the maximum recorded water temperature on the thermograph record which was used to assess impairment.

D 2.0 HYDROLOGY

D 2.1 Segment Inflow and Outflow

This parameter is the streamflow at the top and bottom of the stream segment. To be conservative, the lowest four-consecutive-day discharge that has a recurrence interval of three years, but that does not necessarily occur every three years (4Q3), was used instead of the mean daily flow. These critical low flows were used to reflect the decreased assimilative capacity of the stream to absorb and disperse solar energy. The Placer Creek and Rio Tusas AUs begin at true headwaters, so a value of zero was entered for inflow, as instructed in the SSTEMP manual. The 4Q3 was determined for all other locations using Waltemeyer's mountainous regions regression equation (Waltemeyer, 2002), with input variables derived from the US Geological Survey's online tool StreamStats, Version 3.0 (https://water.usgs.gov/osw/streamstats/new_mexico.html).

D 2.2 Inflow Temperature

This parameter represents the mean water temperature at the top of the segment on the modeled date. The Placer Creek and Rio Tusas AUs begin at true headwaters, so a value of zero was entered for inflow temperature, as instructed in the SSTEMP manual. Inflow temperature for the Sixto Creek AU was estimated by using the SWQB Air-Water Temperature Correlation model (NMED/SWQB, 2011) to derive predicted 6T3 values for the top and bottom of the AU, then subtracting the difference between those values from the mean average measured thermograph temperature on the day that the maximum water temperature occurred.

D 2.3 Accretion Temperature

The temperature of the lateral inflow, barring tributaries, generally should be the same as groundwater temperature. In turn, groundwater temperature may be approximated by the mean annual air temperature. Mean annual air temperatures for 2012 and 2014, obtained from the PRISM database (http://www.prism.oregonstate.edu/), were used in the absence of measured data. PRISM was queried using a 4 km grid cell covering a central portion of each AU, with the interpolation function switched on in cases where the AU spanned a number of grid cells.

D 3.0 GEOMETRY

D 3.1 Latitude

Latitude refers to the position of the stream segment on the earth's surface. Latitude was obtained from the SWQB Mapper, a GIS application, by taking the mean average between the highest and lowest values for the stream corridor for each AU.

D 3.2 Dam at Head of Segment

None of the AUs have a dam at the upstream end of the segment.

D 3.3 Segment Length

Segment length was obtained from the SWQB Surface Water Quality Database.

D 3.4 Upstream and Downstream Elevation

Elevations were obtained from the SWQB Mapper, a GIS application, using a USGS topographic map base layer.

D 3.5 Width's A and Width's B Term

Field measurements of particle size distribution, water surface slope, and bankfull cross-section were collected following the SWQB Standard Operating Procedure for Physical Habitat Measurements (NMED/SWQB, 2011). These field data were entered into the Windows-Based Stream Channel Cross-Section Analysis (WINXSPRO 3.0) Program (USDA, 2005), to generate values for width, discharge, and Manning's n coefficient at various stages up to bankfull. Width's B Term was calculated as the slope of the regression of the natural log of width and the natural log of flow. Theoretically, the Width's A Term is the untransformed Y-intercept. However, because the width versus discharge relationship tends to break down at very low flows, Width's A Term was estimated by solving for the following equation:

$$W = A \times Q^B$$

Where,

W =Known width (feet)
A =Width's A Term (seconds per square foot)
Q =Known discharge (cfs)
B =Width's B Term (unitless)

D 3.6 Manning's n or Travel Time

Site- and stage-specific values were generated by the WINXSPRO program described above. Manning's n is a measure of channel roughness which varies with depth of flow, increasing in value at shallower stages. The Manning's n coefficient associated with the 4Q3 flow being modelled was selected.

D 4.0 METEOROLOGICAL PARAMETERS

D 4.1 Air Temperature

In the absence of measured air temperature at the thermograph stations, 24 hour mean temperature on the modelled date was obtained from the nearest available weather station posted on the New Mexico

Climate Center website (https://weather.nmsu.edu/). Air temperature for the Placer Creek and Sixto Creek AUs was temperature at the Chama weather station, adjusted for elevation difference using the adiabatic lapse rate of 9.8 degrees C/km. Air temperature for the Rio Tusas AU was taken from the El Rito weather station, with no correction.

D 4.2 Maximum Air Temperature

The maximum daily air temperature in SSTEMP overrides a calculated value only if the check box is checked. Since the WQS standard of concern is the T_{MAX}, which is particularly sensitive to the maximum air temperature (Bartholow, 2002), an empirical value was entered in this field. In the absence of measured air temperature at the thermograph stations, maximum temperature on the modelled date was obtained from same weather stations used for mean daily air temperature, above.

D 4.3 Relative Humidity

Mean relative humidity on the modelled date at the nearest available location was obtained from the Visual Crossing website (https://www.visualcrossing.com/). Relative humidity for the Placer Creek and Sixto Creek AUs was from Chama. Relative humidity for the Rio Tusas AU was from El Rito.

D 4.4 Wind Speed

Wind speed is highly variable based on location, aspect and local topography. Therefor it was used as a calibration variable such that the selected value caused the SSTEMP maximum output temperature to most closely match the measured thermograph maximum on the modeled date. In all cases the selected values are intuitively plausible for the locations and dates involved.

D 4.5 Ground Temperature

Same as Accretion Temperature, above.

D 4.6 Thermal Gradient

The software default value of 1.65 was used in the absence of measured data.

D 4.7 Possible Sun

Percent possible sun was obtained from the Western Regional Climate Center (http://www.wrcc.dri.edu/htmlfiles/westcomp.sun.html#NEW_MEXICO). The nearest location with monthly possible sun data is Albuquerque.

D 4.8 Dust Coefficient

The software default value of 5 was used.

D 4.9 Ground Reflectivity

The software default value of 25% was used.

D 4.10 Solar Radiation

If you do not enter a value for solar radiation, SSTEMP will internally calculate this value. No value was entered.

D 5.0 SHADE

Estimates of vegetative canopy were generated using the attribute table of the USDA NorWest Stream Temperature Modeled Stream Temperature Scenario map for New Mexico (https://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html).

D 6.0 REFERENCES

Bartholow, J.M. 2002. SSTEMP for Windows: The Stream Segment Temperature Model (Version 2.0). U.S. Geological Survey computer model and documentation. Available on the internet at http://www.fort.usgs.gov. Revised August 2002.

New Mexico Environment Department/Surface Water Quality Bureau (NMED/SWQB). 2011. State of New Mexico Standard Operating Procedures, Revision 1. January, 2011.

U.S. Department of Agriculture (USDA). 2005. WinXSPRO 3.0. A Channel Cross Section Analyzer. WEST Consultants Inc. San Diego, CA & Utah State University.

Table D-1. SSTEMP Input Variables:

VARIABLE	Placer Creek (Hopewell Lake to headwaters) NM-2112.A_03	Rio Tusas (Perennial prt Rio Vallecitos to headwaters) NM-2113_30	Sixto Creek (Rio Chama to CO border) NM-2116.A_112
Segment Inflow (cfs)	0	0	3.64
Inflow Temperature (C)	0	0	17.74
Segment Outflow (cfs)	0.9	1.03	2.98
Accretion Temp (C)	5.6	7.1	6.9
Latitude (deg)	36.719	36.572	36.986
Dam?	No	No	No
Segment Length (mi)	2.38	42.73	1.12
Upstream Elevation (ft)	9960	10280	8480
Downstream Elevation (ft)	9770	6500	8300
With's A Term (s/sqft)	4.5	10.34	2.843
B Term	0.1315	.02386	0.2014
Manning's n	0.082	0.088	0.046
Air Temperature (C)	12.1	20.6	18.9
Max Air Temp (C)	24.8	29.4	30.3
Relative Humidity	29.19	48.87	23.23
Wind Speed (mph)	8.4	4.0	16.1
Ground Temp (C)	5.6	7.1	6.9
Thermal Gradient (j/sqm/s/C)	1.65	1.65	1.65
Possible Sun %	79	83	79
Dust Coefficient	5	5	5
Ground Reflectivity (%)	25	25	25
Total Shade (%)	3.4	10.3	0
Time of year	6/23/2012	7/12/2014	6/24/2012

APPENDIX E
RESPONSE TO COMMENTS

SWQB hosted a public meeting on May 6, 2020, from 5:30-7:30 pm, using virtual meeting technology. Notes from the public meeting are available in the SWQB TMDL files in Santa Fe.

SWQB received the following public comments on the Rio Chama Watershed TMDLs:

PLEASE NOTE:
When feasible, original typed letters that were not received electronically were scanned and converted to MSWord. Likewise, when feasible, letters received electronically were also converted to MSWord. All text was converted to Times New Roman 12 font with standard page margins for ease of collation. Contact information such as phone number, street addresses, and e-mail addresses from private citizens were removed for privacy reasons. All original letters of comment are on file at the SWQB office in Santa Fe, NM.