USEPA-APPROVED

TOTAL MAXIMUM DAILY LOAD (TMDL)
FOR THE
CANADIAN RIVER WATERSHED – PART 1
[MORA RIVER TO THE COLORADO BORDER]

SEPTEMBER 21, 2007

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COVER PHOTO*: Upstream view of the Mora River channel and surrounding landscape near the Village of Chacon, May 16, 2006*

LIST OF ABBREVIATIONS

4Q3	4-Day, 3-year low-flow frequency
BLM	Bureau of Land Management
BMP	Best management practices
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CGP	Construction general storm water permit
cms	Cubic meters per second
CWA	Clean Water Act
CWAL	Coldwater aquatic life
^oC	Degrees Celcius
^oF	Degrees Farenheit
EPT	Ephemeroptera/Plecoptera/Tricoptera
FR	Forest Road
GIS	Geographic Information Systems
GPS	Global Positioning System
HBI	Hilsenhoff's Biotic Index
HQCWAL	High quality cold water aquatic life
HUC	Hydrologic unit code
IOWDM	Input and Output for Watershed Data Management
$j/m^2/s$	Joules per square meter per second
LA	Load allocation
lb/day	Pounds per Day
mg/L	Milligrams per Liter
mi^2	Square miles
mL	Milliliters
mm	Millimeters
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
NTU	Nephelometric turbidity units
QAPP	Quality Assurance Project Plan
RBP	Rapid Bioassessment Protocol
RFP	Request for proposal
SBD	Stream bottom deposits
SSTEMP	Stream Segment Temperature Model
SWPPP	Storm Water Pollution Prevention Plan
SWQB	Surface Water Quality Bureau
SWSTAT	Surface Water Statistics

TMDL	Total maximum daily load
TSS	Total suspended solids
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WLA	Waste load allocation
WQCC	Water Quality Control Commission
WQS	Water quality standards (NMAC 20.6.4 as amended through February 16, 2006)
WRAS	Watershed Restoration Action Strategy
WWTP	Wastewater treatment plant
μmhos	Micromhos
μmhos/cm	Micromhos per centimeter

EXECUTIVE SUMMARY

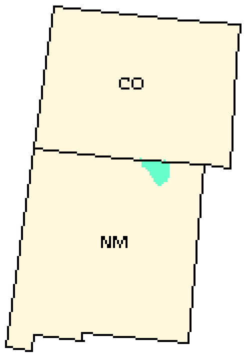
Section 303(d) of the Federal Clean Water Act requires states to develop Total Maximum Daily Load (TMDL) management plans for water bodies determined to be water quality limited. A TMDL documents the amount of a pollutant a waterbody can assimilate without violating a state's water quality standards. It also allocates that load capacity to known point sources and nonpoint sources at a given flow. TMDLs are defined in 40 Code of Federal Regulations Part 130 as the sum of the individual Waste Load Allocations (WLAs) for point sources and Load Allocations (LAs) for nonpoint source and background conditions, and includes a Margin of Safety (MOS).

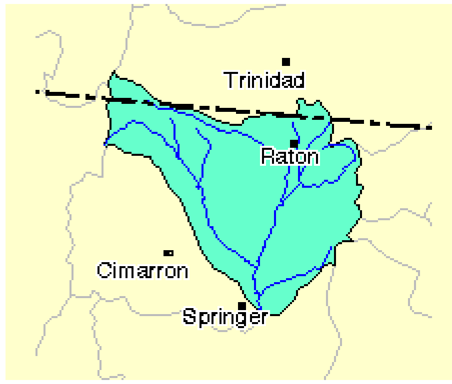
The Canadian watershed is located in northeastern New Mexico. The Surface Water Quality Bureau (SWQB) conducted an intensive surface water quality survey of the Canadian basin in 2002. Water quality monitoring stations were located within the Canadian watershed during the intensive watershed survey to evaluate the impact of tributary streams and ambient water quality conditions. As a result of assessing data generated during this monitoring effort impairment determinations of New Mexico water quality standards for **specific conductance** were documented for Caliente Canyon (Vermejo River to headwaters), Vermejo River (Rail Canyon to York Canyon), York Canyon (Vermejo River to headwaters), Coyote Creek (Mora River to Black Lake), and Mora River (Hwy 434 to headwaters). Impairment of the narrative **plant nutrients** criterion was determined for Little Coyote Creek (Black Lake to headwaters) and the Mora River (USGS gage east of Shoemaker to Hwy 434). Exceedences of the **temperature** criterion were documented on Vermejo River (Rail Canyon to York Canyon), Vermejo River (York Canyon to headwaters), and Coyote Creek (Mora River to Black Lake). Impairment due to **sedimentation/siltation** was determined on Mora River (Hwy 434 to headwaters) and Sapello River (Mora River to Manuelitas Creek). This TMDL document addresses the above noted impairments as summarized in the tables below.

A number of assessment units could not be assessed in this document due to insufficient data. These impairments will remain on the Integrated Clean Water Act §303(d)/§305(b) list of waters until additional data are available. Additionally, assessment units whose designated uses are not existing or attainable and those that will be de-listed are detailed in this document.

Additional water quality data will be collected by the SWQB during the standard rotational period for intensive stream surveys. As a result, 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 load capacity will be adjusted accordingly. When water quality standards have been achieved, the reach will be moved to the appropriate category on the Integrated Clean Water Act §303(d)/§305(b) list of waters.

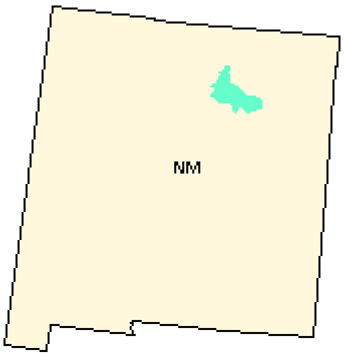
TOTAL MAXIMUM DAILY LOAD FOR
CALIENTE CANYON (VERMEJO RIVER TO HEADWATERS)

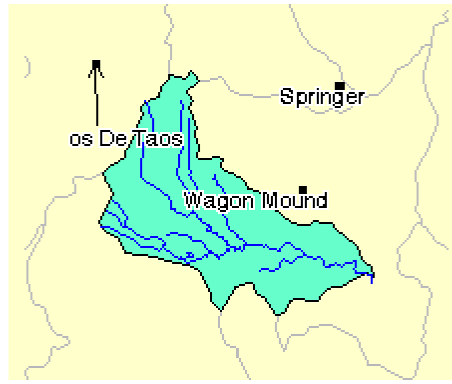




New Mexico Standards Segment	Canadian Headwaters River Basin 20.6.4.309
Waterbody Identifier	NM-2306.A_151
Segment Length	17.42 miles
Parameters of Concern	Specific Conductance
Uses Affected	High Quality Coldwater Aquatic Life
Geographic Location	Canadian Headwaters USGS Hydrologic Unit Code 11080001
Scope/size of Watershed	73.38 sq. mi.
Land Type	Southern Rockies Ecoregion (21)
Land Use/Cover	69% Forest; 23% Shrubland; 8% Grasslands
Probable Sources	Natural Sources; Source Unknown
Land Management	100% Private
IR Category	5/5B
TMDL for: Specific Conductance	**WLA + LA + MOS = TMDL** **0 + 194 + 34 = 228 lbs/day of TDS**

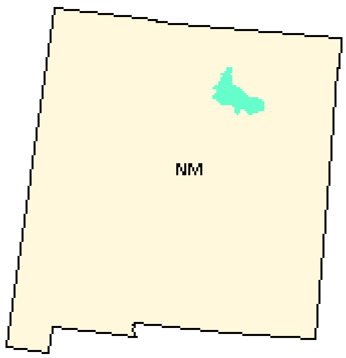
TOTAL MAXIMUM DAILY LOADS FOR
COYOTE CREEK (MORA RIVER TO BLACK LAKE)

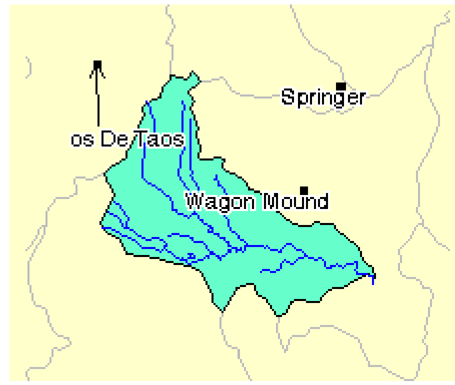




New Mexico Standards Segment	Mora River Basin 20.6.4.309						
Waterbody Identifier	NM-2306.A_020						
Segment Length	37.50 miles						
Parameters of Concern	Specific Conductance; Temperature						
Uses Affected	High Quality Coldwater Aquatic Life						
Geographic Location	Mora USGS Hydrologic Unit Code 11080004						
Scope/size of Watershed	243.49 sq. mi.						
Land Type	Southern Rockies Ecoregion (21) Southwestern Tablelands Ecoregion (26)						
Land Use/Cover	61% Forest; 30% Grassland; 8% Shrubland; 1% Agriculture						
Probable Sources	Natural Sources; Rangeland Grazing						
Land Management	89% Private; 7% State; 4% Forest Service						
IR Category	5/5B						
TMDL for:	**WLA**	+	**LA**	+	**MOS**	=	**TMDL**
Specific Conductance	**0**	+	**769**	+	**136**	=	**905 lbs/day of TDS**
Temperature	**0**	+	**114**	+	**13.0**	=	**127 j/m^2/s/day**

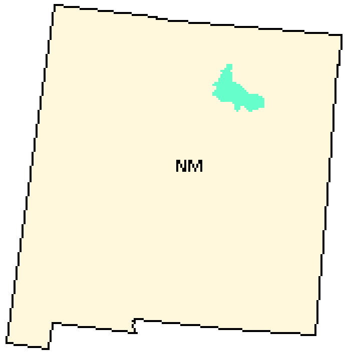
TOTAL MAXIMUM DAILY LOAD FOR
LITTLE COYOTE CREEK (BLACK LAKE TO HEADWATERS)

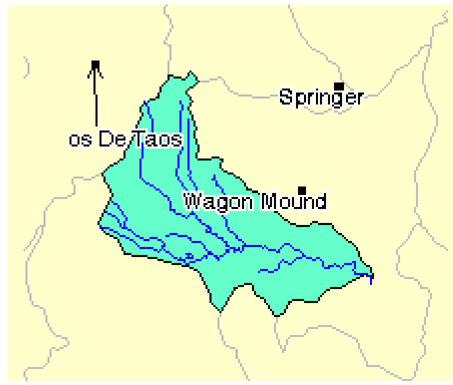




New Mexico Standards Segment	Mora River Basin 20.6.4.309
Waterbody Identifier	NM-2306.A_024
Segment Length	2.20 miles
Parameters of Concern	Nutrient/Eutrophication Biological Indicators; pH
Uses Affected	High Quality Coldwater Aquatic Life
Geographic Location	Mora USGS Hydrologic Unit Code 11080004
Scope/size of Watershed	19.59 sq. mi.
Land Type	Southern Rockies Ecoregion (21)
Land Use/Cover	78% Forest; 20% Grassland; 2% Shrubland
Probable Sources	Natural Sources; Rangeland Grazing; Source Unknown
Land Management	56% State; 44% Private
IR Category	5/5B
TMDL for:	
Plant Nutrients:	**WLA + LA + MOS = TMDL**
Total Phosphorus	**0 + 0.013 + 0.002 = 0.015 lbs/day**
Total Nitrogen	**0 + 0.167 + 0.019 = 0.186 lbs/day**

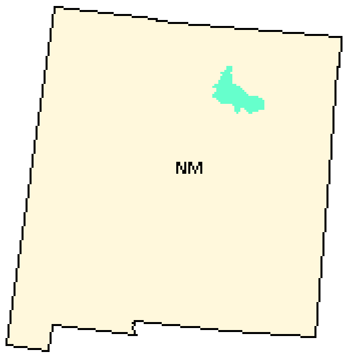
TOTAL MAXIMUM DAILY LOAD FOR
MORA RIVER (USGS GAGE EAST OF SHOEMAKER TO HWY 434)

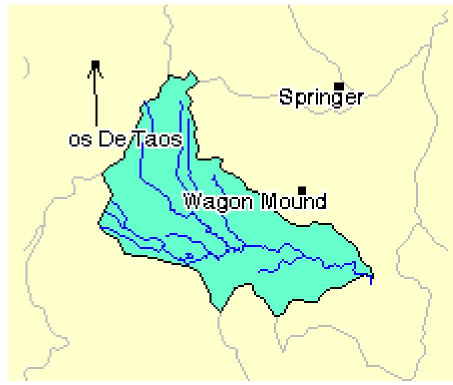




New Mexico Standards Segment	Mora River Basin 20.6.4.307
Waterbody Identifier	NM-2305.A_00
Segment Length	52.40 miles
Parameters of Concern	Nutrient/Eutrophication Biological Indicators
Uses Affected	Marginal Coldwater Aquatic Life
Geographic Location	Mora USGS Hydrologic Unit Code 11080004
Scope/size of Watershed	1104 sq. mi.
Land Type	Southwestern Tablelands Ecoregion (26)
Land Use/Cover	58% Grassland; 30% Forest; 12% Shrubland; <1% Agriculture
Probable Sources	Flow Alterations from Water Diversions; Municipal Point Source Discharge; On-Site Treatment Systems (Septic Systems and Similar Decentralized Systems)
Land Management	84% Private; 13% Forest Service; 3% State
IR Category	5/5A
TMDL for:	
Plant Nutrients:	**WLA + LA + MOS = TMDL**
Total Phosphorus	**0.135 + 0.004 + 0.015 = 0.154 lbs/day**
Total Nitrogen	**1.705 + 0.046 + 0.195 = 1.946 lbs/day**

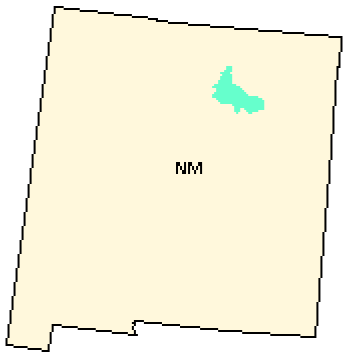
TOTAL MAXIMUM DAILY LOADS FOR
MORA RIVER (HWY 434 TO HEADWATERS)

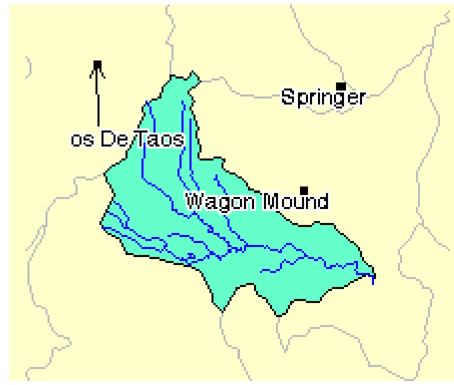




New Mexico Standards Segment	Mora River Basin 20.6.4.309
Waterbody Identifier	NM-2306.A_000
Segment Length	17.90 miles
Parameters of Concern	Specific Conductance; Sedimentation/Siltation
Uses Affected	High Quality Coldwater Aquatic Life
Geographic Location	Mora USGS Hydrologic Unit Code 11080004
Scope/size of Watershed	144.5 sq. mi.
Land Type	Southern Rockies Ecoregion (21)
Land Use/Cover	84% Forest; 13% Grassland; 2% Shrubland; 1% Agriculture
Probable Sources	Natural Sources; Rangeland Grazing; Silviculture Harvesting
Land Management	68% Private; 32% Forest Service
IR Category	5/5B
TMDL for:	**WLA + LA + MOS = TMDL**
Specific Conductance	**0 + 3754 + 663 = 4417 lbs/day of TDS**
Sedimentation/Siltation	**0 + 81.0 + 27.0 = 108 lbs/day of TSS**

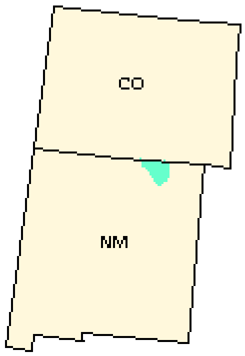
TOTAL MAXIMUM DAILY LOAD FOR
SAPELLO RIVER (MORA RIVER TO MANUELITAS CREEK)

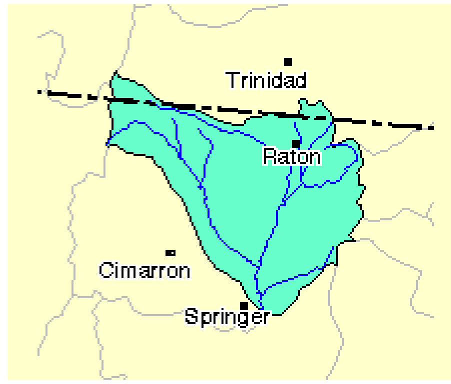




New Mexico Standards Segment	Mora River Basin 20.6.4.307
Waterbody Identifier	NM-2305.3.A_20
Segment Length	27.39 miles
Parameters of Concern	Sedimentation/Siltation
Uses Affected	Marginal Coldwater Aquatic Life
Geographic Location	Mora USGS Hydrologic Unit Code 11080004
Scope/size of Watershed	289.3 sq. mi.
Land Type	Southwestern Tablelands Ecoregion (26)
Land Use/Cover	55% Rangeland; 42% Forest; 2% Agriculture; <1% Water
Probable Sources	Source Unknown
Land Management	86% Private; 14% Forest Service
IR Category	5/5A
TMDL for: Sedimentation/Siltation	**WLA + LA + MOS = TMDL** **0 + 60.6 + 20.2 = 80.8 lbs/day of TSS**

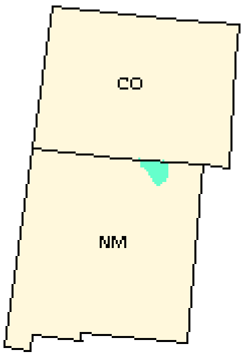
TOTAL MAXIMUM DAILY LOADS FOR
VERMEJO RIVER (RAIL CANYON TO YORK CANYON)

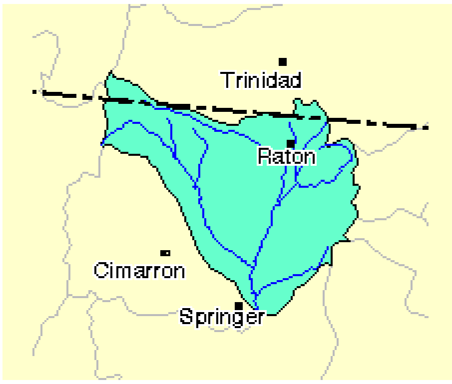




New Mexico Standards Segment	Canadian Headwaters River Basin 20.6.4.309
Waterbody Identifier	NM-2305.A_220
Segment Length	23.55 miles
Parameters of Concern	Specific Conductance; Temperature
Uses Affected	High Quality Coldwater Aquatic Life
Geographic Location	Canadian Headwaters USGS Hydrologic Unit Code 11080001
Scope/size of Watershed	343.32 sq. mi.
Land Type	Southern Rockies Ecoregion (21)
Land Use/Cover	60% Forest; 27% Shrubland; 13% Grasslands
Probable Sources	Habitat Modification – other than Hydromodification; Rangeland Grazing; Source Unknown
Land Management	99% Private; 1% Forest Service
IR Category	5/5A
TMDL for:	**WLA + LA + MOS = TMDL**
Specific Conductance	**0 + 1352 + 239 = 1591 lbs/day of TDS**
Temperature	**0 + 82.1 + 9.1 = 91.2 j/m^2/s/day**

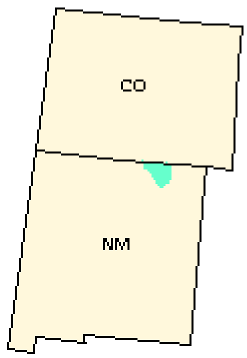
TOTAL MAXIMUM DAILY LOAD FOR
VERMEJO RIVER (YORK CANYON TO HEADWATERS)

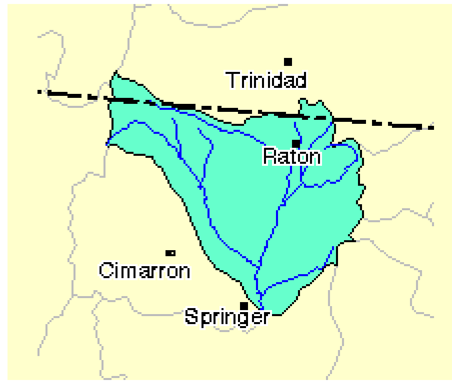




New Mexico Standards Segment	Canadian Headwaters River Basin 20.6.4.309
Waterbody Identifier	NM-2305.A_230
Segment Length	25.05 miles
Parameters of Concern	Temperature
Uses Affected	High Quality Coldwater Aquatic Life
Geographic Location	Canadian Headwaters USGS Hydrologic Unit Code 11080001
Scope/size of Watershed	171.26 sq. mi.
Land Type	Southern Rockies Ecoregion (21)
Land Use/Cover	59% Forest; 26% Shrubland; 14% Grasslands; <1% Agriculture
Probable Sources	Rangeland Grazing; Streambank Modifications/Destabilization
Land Management	97% Private; 3% Forest Service
IR Category	5/5A
TMDL for: Temperature	**WLA + LA + MOS = TMDL** **0 + 80.7 + 9.0 = 89.7 j/m^2/s/day**

TOTAL MAXIMUM DAILY LOAD FOR
YORK CANYON (VERMEJO RIVER TO HEADWATERS)





New Mexico Standards Segment	Canadian Headwaters River Basin 20.6.4.309
Waterbody Identifier	NM-2306.A_153
Segment Length	11.14 miles
Parameters of Concern	Specific Conductance; Turbidity
Uses Affected	High Quality Coldwater Aquatic Life
Geographic Location	Canadian Headwaters USGS Hydrologic Unit Code 11080001
Scope/size of Watershed	29.86 sq. mi.
Land Type	Southern Rockies Ecoregion (21)
Land Use/Cover	63% Forest; 26% Shrubland; 11% Grasslands
Probable Sources	Impacts from Abandoned Mine Lands (Inactive)
Land Management	100% Private
IR Category	5/5C
TMDL for: Specific Conductance	**WLA + LA + MOS = TMDL** **0 + 167 + 29 = 196 lbs/day of TDS**

1.0 INTRODUCTION

Under Section 303 of the Clean Water Act (CWA), states establish water quality standards, which are submitted and subject to the approval of the U.S. Environmental Protection Agency (USEPA). Under Section 303(d)(1) of the CWA, states are required to develop a list of waters within a state that are impaired and establish a total maximum daily load (TMDL) for each pollutant. A TMDL is defined as "*a written plan and analysis established to ensure that a waterbody will attain and maintain water quality standard including consideration of existing pollutant loads and reasonably foreseeable increases in pollutant loads*" (USEPA 1999). A TMDL documents the amount of a pollutant a waterbody 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. TMDLs are defined in 40 Code of Federal Regulations (CFR) Part 130 as the sum of the individual Waste Load Allocations (WLAs) for point sources and Load Allocations (LAs) for nonpoint sources and natural background conditions, and includes a margin of safety (MOS). This document provides TMDLs for assessment units within the Canadian watershed that have been determined to be impaired based on a comparison of measured concentrations and conditions with water quality criteria and numeric translators for narrative standards.

This document is divided into several sections. Section 2.0 provides background information on the location and history of the Canadian watershed, provides applicable water quality standards for the assessment units addressed in this document, and briefly discusses the intensive water quality survey that was conducted in the Canadian watershed in 2002. Section 3.0 provides detailed descriptions of the individual watersheds for which TMDLs were developed. Section 4.0 presents the TMDLs developed for specific conductance in the Canadian watershed. Section 5.0 provides nutrient TMDLs, Section 6.0 contains temperature TMDLs, and Section 7.0 details sedimentation/siltation TMDLs. Pursuant to Section 106(e)(1) of the Federal CWA, Section 8.0 provides a monitoring plan in which methods, systems, and procedures for data collection and analysis are discussed. Section 9.0 discusses implementation of TMDLs (phase two) and the relationship between TMDLs and Watershed Restoration Action Strategies (WRASs). Section 10.0 discusses assurance, Section 11.0 public participation in the TMDL process, and Section 12.0 provides references.

2.0 CANADIAN BACKGROUND

The Canadian Basin was intensively sampled by the Surface Water Quality Bureau (SWQB) from March to November 2002 and is addressed in this document. The Canadian Basin includes perennial reaches of the Canadian River from the Texas/New Mexico Border to Colorado/New Mexico, as well as tributaries that enter the Canadian River along those perennial reaches. Surface water quality monitoring stations were selected to characterize water quality of the stream reaches. Assessment units that will have a TMDL prepared in this document and those receiving de-list letters are discussed in their respective individual watershed sections. A number of assessment units could not be assessed due to insufficient data. These impairments will remain on the Integrated CWA §303(d)/§305(b) list of waters until additional data are available.

2.1 Location Description

The Canadian River watershed (US Geological Survey [USGS] Hydrologic Unit Codes [HUC] 11080001, 11080002, 11080003, 11080004, 11080005, 11080006, 11080007, 11080008, and 11090101) is part of the vast drainage system of the Arkansas River. The Canadian Watershed encompasses about one-sixth the land area of New Mexico or about 1720 square miles (1.1 million acres). Canadian River tributaries flow east and southeast from their origins on the east slopes of the Sangre de Cristo cordillera of northern New Mexico and southern Colorado. As it traverses the Great Plains in a southerly and then easterly direction, several perennial tributaries, including the Vermejo, Cimarron, Mora, and Conchas Rivers join the South Canadian River before it exits New Mexico toward Texas near Logan, New Mexico. The Canadian River flows generally east through the Texas panhandle into Oklahoma, where it drains a sizeable portion of that state before reaching its confluence with the Arkansas River just west of Fort Smith, Arkansas. The drainage system encompasses approximately 47,700 square miles in the three states.

The Canadian River is a braided, meandering system fed by the numerous streams and creeks and drains semi-deserts, plains, prairies, forests, and mountains. The vegetation of the New Mexican Canadian Watershed includes both the Great Plains and Rocky Mountain floras (Omernik 2006). As presented in Figure 2.1, land use is 39% forest, 44% grassland, 14% shrubland, 2% agricultural, and <1% urban.

Several species within this watershed are listed as either threatened or endangered by both State and federal agencies. Endangered species include the Southern redbelly dace (*Phoxinus erythrogaster*), Southwestern willow flycatcher (*Empidonax traillii extimus*), Least tern (*Sterna antillarum*), Black-footed ferret (*Mustela nigripes*), and Holy Ghost ipomopsis (*Holy Ghost ipomopsis*). Threatened species include the Arkansas River shiner (*Notropis girardi*), Suckermouth minnow (*Phenacobius mirabilis*), Arkansas River speckled chub (*Macrhybopsis tetranema*), Bald eagle (*Haliaeetus leucocephalus*), Mexican spotted owl (*Strix occidentalis lucida*), and Piping plover (*Charadrius melodus*).

2.2 Geology and Land Use

The laterally extensive pediments, topographically inverted basalt-capped mesas, and stripped structural surfaces of the Las Vegas Plateau of northeastern New Mexico gradually slope to the southeast away from the eastern flank of the Sangre de Cristo Mountains, which represent both the southern Rocky Mountain front in New Mexico as well as the eastern flank of the Rio Grande rift. The Canadian River has carved a deep bedrock canyon into the gently warped strata of the Las Vegas Plateau in response to a complex interaction of epeirogenic rock-uplift processes (characterized by domes, arches, and basins) and downstream baselevel fall caused by evaporite dissolution. The Las Vegas Plateau terminates to the south in a 250–300 meter high, embayed line of cliffs known as the Canadian escarpment. The canyon is deepest (~400 m) and widest (~1.5 km) where it breaches the escarpment north of Conchas Lake near Sabinoso, New Mexico (Wisniewski & Pazzaglia 2002).

Historic and current land uses in the watershed include farming, ranching, recreation, and municipal related activities (Raton, Springer, Angel Fire, Eagle Nest, Mora). Much of the land ownership adjacent to the river is private with the exceptions of Maxwell National Wildlife Refuge, Fort Union National Monument near Watrous, and national forest land in the higher elevations. The Bureau of Land Management and the State of New Mexico also own and manage tracts of public lands in the eastern portions of the watershed (refer to Figures 3.2 and 3.5). The Canadian watershed is located in Omernick Level III Ecoregion 21 (Southern Rockies) in the headwaters and Level III Ecoregion 26 (Southwestern Tablelands) in the lowlands. The elevation range for the various sampling sites in the survey was 5771' to 8826' above sea level.

2.3 Water Quality Standards

Water quality standards (WQS) for all assessment units in this document are set forth in sections, 20.6.4.305, 20.6.4.306, 20.6.4.307, and 20.6.4.309 of the *NM Standards for Interstate and Intrastate Surface Waters* (New Mexico Administrative Code [NMAC] 20.6.4) (NMAC 2006).

20.6.4.305 CANADIAN RIVER BASIN - The main stem of the Canadian river from the headwaters of Conchas reservoir upstream to the New Mexico-Colorado line, perennial reaches of the Conchas river, the Mora river downstream from the USGS gaging station near Shoemaker, the Vermejo river downstream from Rail canyon and perennial reaches of Raton, Chicorica and Uña de Gato creeks.

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

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0, temperature 32.2°C (90°F) or less and TDS 3,500 mg/L or less at flows above 10 cfs. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.305 NMAC - Rp 20 NMAC 6.1.2305, 10-12-00; A, 05-23-05]

20.6.4.306 CANADIAN RIVER BASIN - The Cimarron river downstream from state highway 21 in Cimarron to the Canadian river and all perennial reaches of tributaries to the Cimarron river downstream from state highway 21 in Cimarron.

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

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0, temperature 32.2°C (90°F) or less and TDS 3,500 mg/L or less at flows above 10 cfs. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.306 NMAC - Rp 20 NMAC 6.1.2305.1, 10-12-00; A, 7-19-01; A, 05-23-05]

20.6.4.307 CANADIAN RIVER BASIN - Perennial reaches of the Mora river from the USGS gaging station near Shoemaker upstream to the state highway 434 bridge in Mora, all perennial reaches of tributaries to the Mora river downstream from the USGS gaging station at La Cueva in San Miguel and Mora counties, perennial reaches of Ocate creek and its tributaries downstream of Ocate, and perennial reaches of Rayado creek downstream of Miami lake diversion in Colfax county.

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

B. Criteria:

(1) In any single sample: temperature 25°C (77°F) or less and pH within the range of 6.6 to 9.0. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.307 NMAC - Rp 20 NMAC 6.1.2305.3, 10-12-00; A, 05-23-05]

20.6.4.309 CANADIAN RIVER BASIN - The Mora river and perennial reaches of its tributaries upstream from the state highway 434 bridge in Mora, all perennial reaches of tributaries to the Mora river upstream from the USGS gaging station at La Cueva, perennial reaches of Coyote creek and its tributaries, the Cimarron river and its perennial tributaries above state highway 21 in Cimarron, all perennial reaches of tributaries to the Cimarron river north and northwest of highway 64, perennial reaches of Rayado creek and its tributaries above Miami lake diversion, Ocate creek and perennial reaches of its tributaries upstream of Ocate, perennial reaches of the Vermejo river upstream from Rail canyon and all other perennial reaches of tributaries to the Canadian river northwest and north of U.S. highway 64 in Colfax county unless included in other segments.

A. Designated Uses: domestic water supply, irrigation, high quality coldwater aquatic life, livestock watering, wildlife habitat, municipal and industrial water supply and secondary contact.

B. Criteria:

(1) In any single sample: specific conductance 500 µmhos/cm or less, pH within the range of 6.6 to 8.8 and temperature 20°C (68°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.309 NMAC - Rp 20 NMAC 6.1.2306, 10-12-00; A, 7-19-01; A, 05-23-05]

[**NOTE: The segment covered by this section was divided effective 05-23-05. The standards for the additional segment are under 20.6.4.310 NMAC**.]

20.6.4.900 NMAC provides criteria applicable to attainable or designated uses unless otherwise specified in 20.6.4.101 through 20.6.4.899 NMAC. 20.6.4.13 NMAC lists general criteria that apply to all surface waters of the state at all times, unless a specific criterion is provided elsewhere in NMAC (2006).

2.4 Intensive Water Quality Sampling

The Canadian River watershed was intensively sampled by the SWQB in 2002. A brief summary of the survey and the hydrologic conditions during the intensive sample period is provided in the following subsections.

2.4.1 Survey Design

Surface water quality samples were collected monthly between March and November for the 2002 intensive SWQB study. Temperature data also were collected in 2002. Surface water quality monitoring stations were selected to characterize water quality of various assessment units (i.e., stream reaches and reservoirs) throughout the basin (Table 2.1, Figure 2.1). The locations of 2002 thermograph deployments in the Canadian River Basin are described in Section 6.0 (Table 6.1 and Figure 6.1). Stations were located to evaluate the impact of tributary streams and to determine ambient water quality conditions. Data results from grab sampling are housed in the SWQB provisional water quality database and were uploaded to USEPA's Storage and Retrieval (STORET) database.

All temperature and chemical/physical sampling and assessment techniques are detailed in the *Quality Assurance Project Plan* (QAPP, NMED/SWQB 2002) and the SWQB assessment protocols (NMED/SWQB 2004b & 2006). As a result of the 2002 monitoring effort and subsequent assessment of results, several surface water impairments were determined. Accordingly, these impairments were added to New Mexico's 2004-2006 Integrated CWA §303(d)/305(b) List (NMED/SWQB 2004a).

Table 2.1 SWQB 2002 Canadian River Basin Sampling Stations

Station	Station Location	STORET ID
1	Vermejo River below confluence with Leandro Creek	04Vermej094.1
2	Vermejo River at Juan Baca Canyon	04Vermej080.2
3	Vermejo River above York Canyon Creek	04Vermej076.0
4	York Canyon Creek above Vermejo River	04YorkCa000.1
5	Vermejo River below York Canyon Creek	04Vermej073.7
6	Vermejo River above Caliente Canyon	04Vermej060.8
7	Caliente Canyon above Vermejo River	04Calien000.1
8	Blosser Arroyo at Blosser Gap	04BlossA013.3
9	Vermejo River (downstream of) Dawson (below conf with Rail)	04Vermej038.8
10	VanBremmer Creek @ Hwy 64	04VanBre009.4
11	Vermejo River at I-25.	04Vermej002.9
12	Cimarron River above Springer WWTP	05Cimarr011.8
13	Cimarron River below Springer WWTP	05Cimarr010.4
14	Wheaton Creek ~ 0.5 mi above confluence with Ocate Creek	06Wheato000.8
15	Manuelas Creek above Ocate Creek	06Manuel008.7
16	Ocate Creek above village of Ocate	06OcateC063.0
17	Ocate creek @ I-25	06OcateC025.1
18	Little Coyote @ Hwy 434	07LitCoy001.3
19	Coyote Creek above Black Lake	07Coyote057.0
20	Coyote Creek below Black Lake at HWY 434	07Coyote047.9

Station	Station Location	STORET ID
21	Coyote Creek at Harold Brock Fishing Area	07Coyote041.3
22	Coyote Creek at Coyote State Park above USGS gage	07Coyote040.0
23	Coyote Creek at USGS Gage at Thal Ranch	07Coyote004.2
24	Coyote Creek 1 mile above Mora River at Thal Ranch	07Coyote001.7
25	Mora River at Chacon 0.6 miles above gage	07MoraRi170.9
26	Mora River at Cleveland by bridge on Church Rd.	07MoraRi154.8
27	Rio de la Casa 4 miles above Mora River	07RioLaC006.2
28	Mora River above Mora WWTP lagoons	07MoraRi147.1
29	Mora River above Hatchery	07MoraRi147.2
30	Mora River below Mora WWTP lagoons	07MoraRi146.6
31	Mora River at La Cueva USGS gage	07MoraRi139.9
32	Mora River below El Queso	07MoraRi139.3
33	Buena Vista Ditch above Mora River	07BuenoVDitch
34	Santiago Creek at State Hwy 94 near Ledoux, NM	07Santia002.3
35	Rito Morphy at State Hwy 94 near Ledoux, NM	07RMorph001.6
36	Rito Cebolla @ Hwy 161	07RitoCe000.3
37	Rito de Gascon abv Rito San Jose	07RGasco002.0
38	Manuelitas Cr. abv Maestas Cr.	07Manuel020.9
39	Maestas Cr. abv Manuelitas Cr.	07Maesta000.4
40	Rito San Jose abv Manuelitas Cr.	07RSanJo000.5
41	Manuelitas Creek blw Rociada	07Manuel021.7
42	Manuelitas Creek at Hwy 94 bridge	07Manuel006.1
43	Sapello River ¼ mile inside Mosimann Ranch gate	07Sapell069.8
44	Sapello R. at San Ignacio	07Sapell052.4
45	Sapello R. at Hwy 518	07Sapell044.4
46	Sapello R. at Hwy 161 (near Watrous)	07Sapell000.1
47	Mora River @ Watrous	07MoraRi094.0
48	Mora R. at Black Willow Ranch.	07MoraRi086.0
49	Wolf Cr. abv Mora R.	07WolfCr000.6
50	Mora R. blw Shoemaker at Rd. 97	07MoraRi078.0

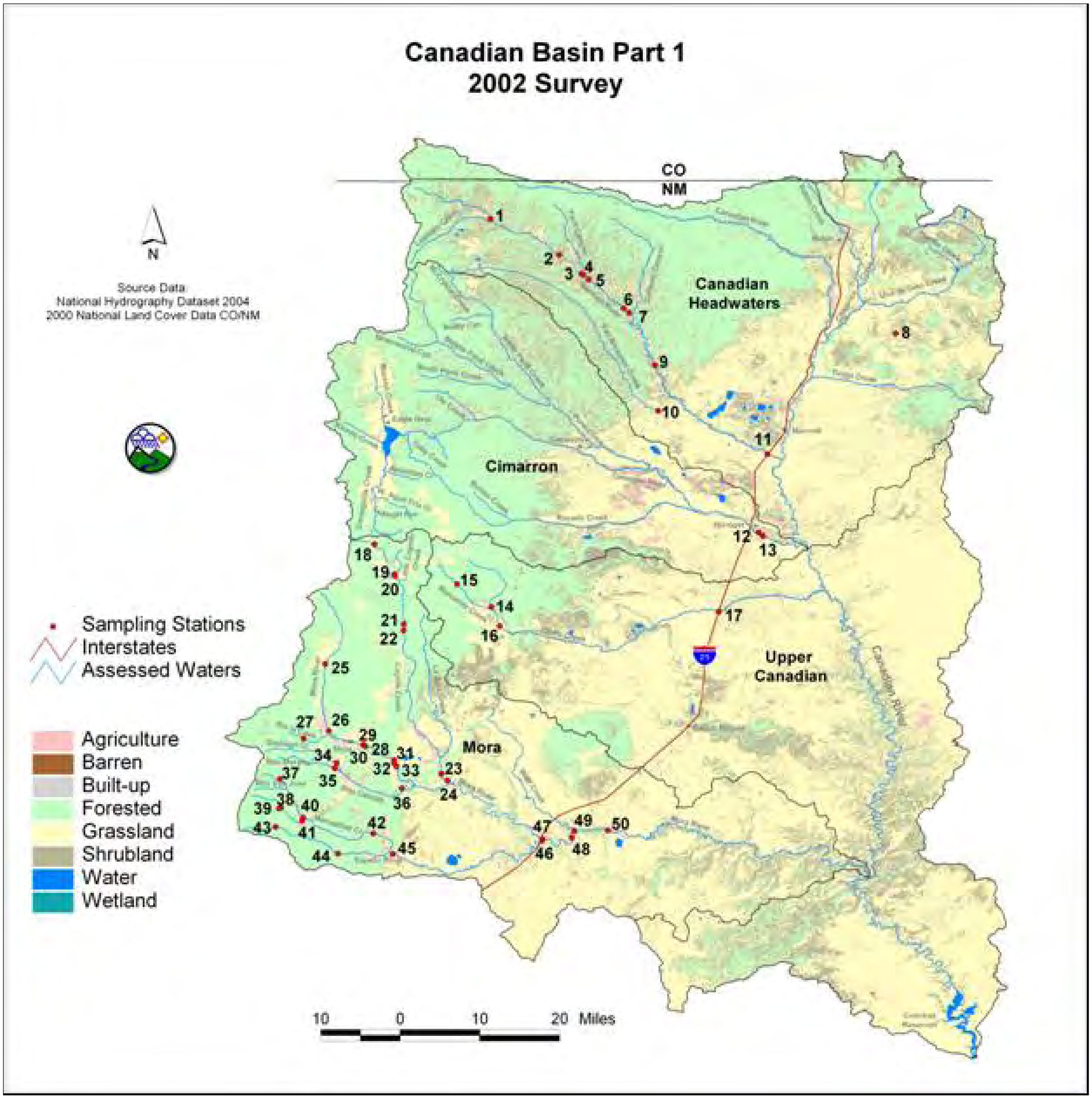


Figure 2.1 Land Use and 2002 Sampling Stations in the Canadian Watershed

2.4.2 Hydrologic Conditions

There are three active USGS gaging stations in the Upper Canadian and Mora Watersheds: the Vermejo River near Dawson, NM with a period of record from 1915 to present day; Coyote Creek near Golondrinas, NM with a period of record from 1917 to present day; and the Mora River at La Cueva, NM, which has a period of record from 1906 to present day. The annual daily mean streamflow for Vermejo River is 19.4 cubic feet per second (cfs); the annual daily mean streamflow for Coyote Creek near Golondrinas, NM is 12.8 cfs; and, the annual daily mean streamflow for the Mora River at La Cueva, NM is 28.2 cfs. Streamflow records (Figures 2.2, 2.3, and 2.4) illustrate the dry conditions that New Mexico is currently experiencing, which is particularly noticeable from 2000-2004.

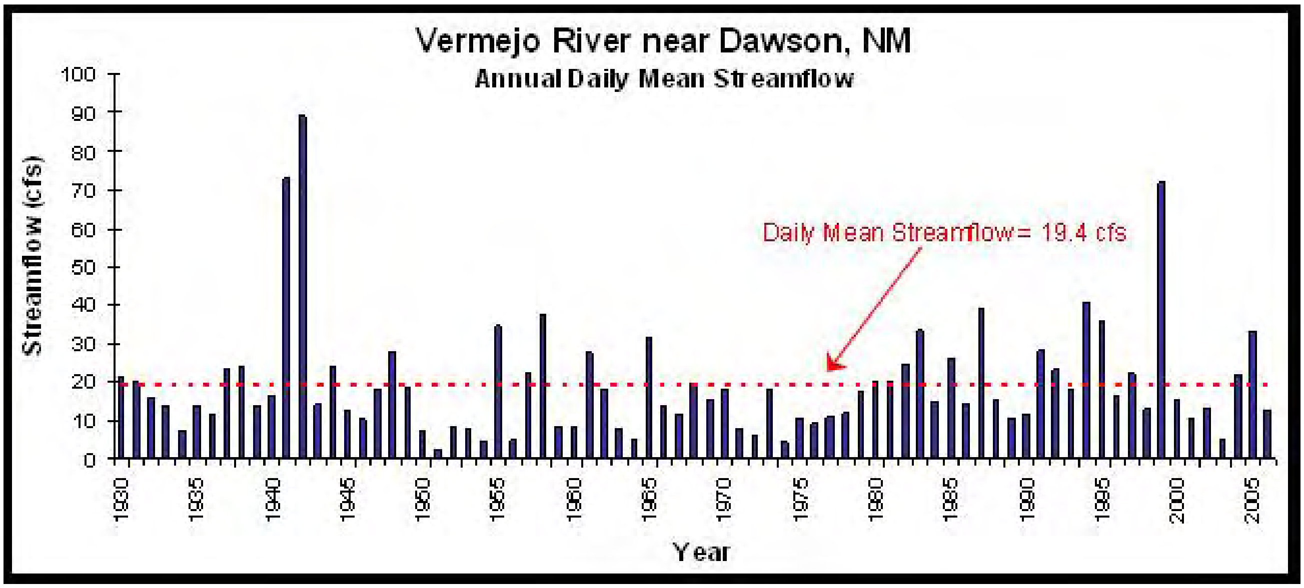


Figure 2.2 Vermejo River near Dawson, NM (01 Oct 1996 – 30 Sept 2006)

During the 2002 watershed survey, flows in the Vermejo River (USGS Gage 07203000) were below average with an annual daily mean streamflow of 13.3 cfs, approximately 31% below the "normal" streamflow of 19.4 cfs.

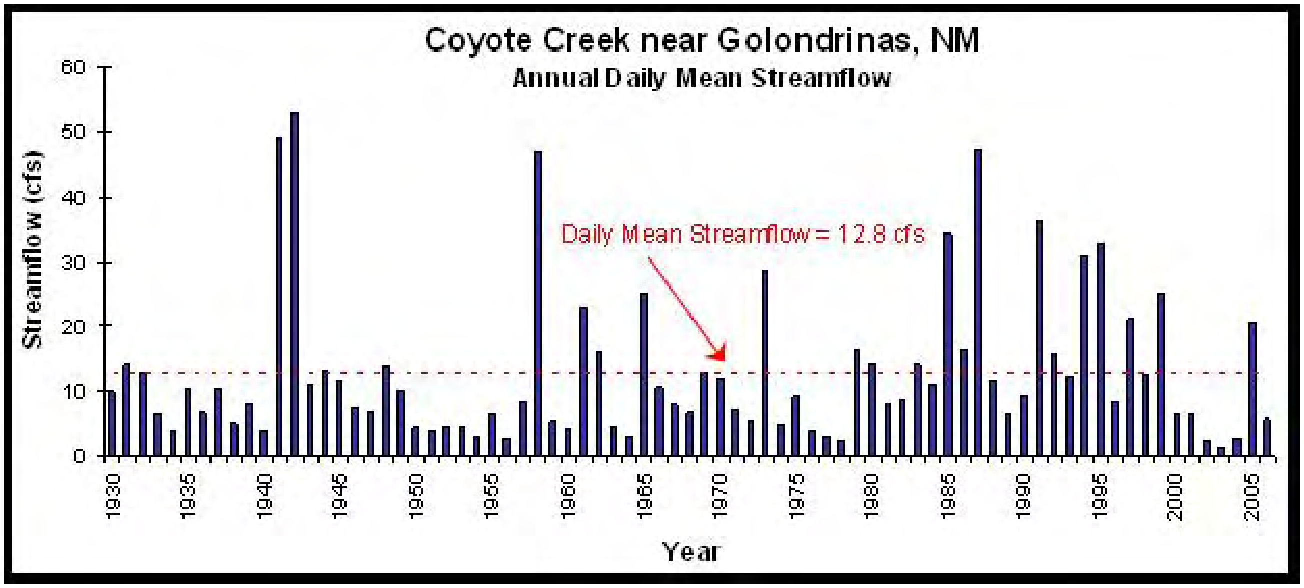


Figure 2.3 Coyote Creek near Golondrinas, NM (01 Oct 1996 – 30 Sept 2006)

Flows in Coyote Creek (USGS Gage 07215500) during the 2002 survey year were well below normal with an annual average daily mean streamflow of 2.38 cfs, approximately 81% below the "normal" streamflow of 12.8 cfs.

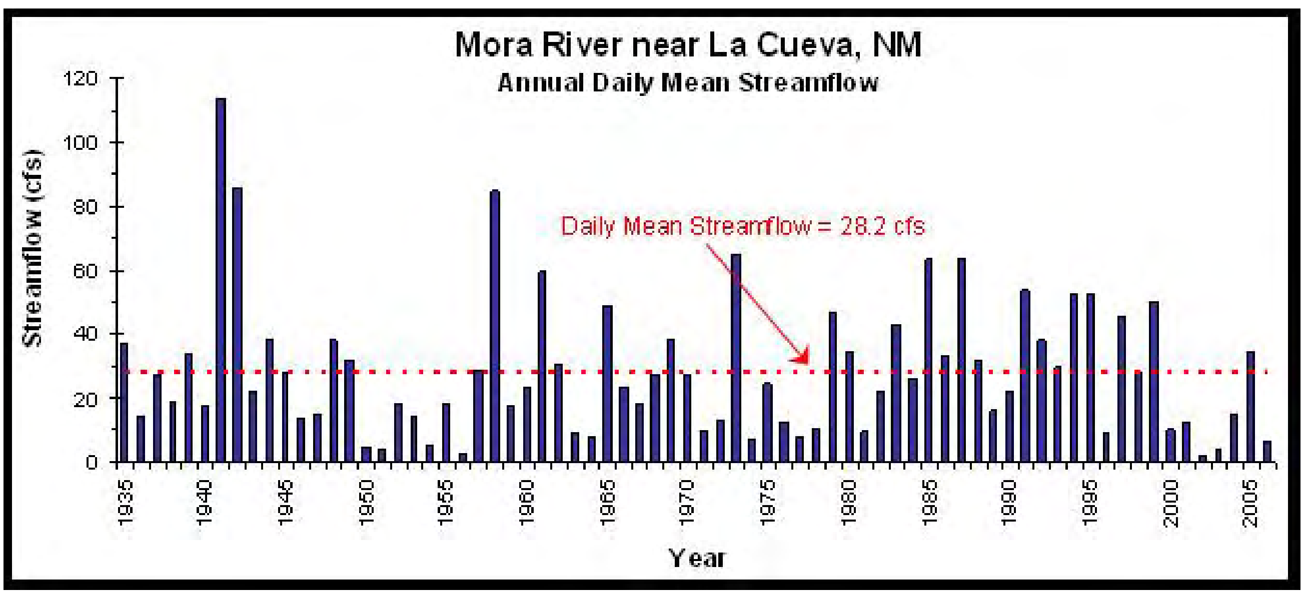


Figure 2.4 Mora River at La Cueva, NM (01 Oct 1996 – 30 Sept 2006)

SWQB also surveyed the Mora River in 1999, 2004 and 2006. Flows in the Mora River (USGS Gage 07215500) during the 1999 survey year were well above normal, with an annual daily mean streamflow of 50.1 cfs, roughly 78% above the "normal" streamflow of 28.2 cfs.

However, streamflow during the 2002, 2004, and 2006 surveys were below “normal” with annual average daily mean streamflows of 2.27 cfs (~95% below average), 14.6 cfs (~48% below average), and 6.64 cfs (~76% below average), respectively.

As stated in the Assessment Protocol (NMED/SWQB 2004b & 2006), data collected during all flow conditions, including low flow conditions (i.e., flows below the 4-day, 3-year low-flow frequency [4Q3]), will be used to determine designated use attainment status during the assessment process. In terms of assessing designated use attainment in ambient surface waters, water quality standards (WQS) apply at all times under all flow conditions.

3.0 INDIVIDUAL WATERSHED DESCRIPTIONS

TMDLs were developed for assessment units for which constituent (or pollutant) concentrations measured during the 2002 water quality survey indicated impairment. Because characteristics of each subwatershed, such as geology, land use, and land ownership provide insight into probable sources of impairment, they are presented in this section for the individual subwatersheds within the Canadian River basin. In addition, the 2006-2008 Integrated CWA §303(d)/§305(b) listings within the Canadian River basin are discussed (NMED/SWQB 2007). Assessment units that will have delist letters prepared are discussed in their respective individual subwatershed sections.

3.1 Canadian Headwaters Subwatershed

The Canadian Headwaters watershed (US Geological Survey [USGS] Hydrologic Unit Code [HUC] 11080001) is located in northeastern New Mexico (NM) and is bounded by the Sangre de Cristo Mountains to the west and the Great Plains to the east. The Canadian Headwaters watershed from a point southeast of Maxwell, NM to its headwaters drains approximately 2850 square miles (mi^2). Elevation ranges from 11,610 feet (ft.) at Vermejo Peak to 5640 ft. at the USGS Gage 07211500 near Taylor Springs, NM.

As presented in Figure 3.1, land uses include 52% forest, 34% grassland; 11% shrubland; 1% agriculture, 1% riparian, and 1% urban. Land ownership is 92% private, 6% State, 1% US Forest Service (USFS), 1% US Fish and Wildlife Service (USFWS), <1% Bureau of Land Management (BLM), and <1% Bureau of Reclamation (BOR) (Figure 3.2). Much of the land ownership adjacent to the river is private with the exceptions of Maxwell National Wildlife Refuge and a small portion of the Valle Vidal in the headwaters of Leandro Creek. According to available Geographic Information System (GIS) coverages, the average annual precipitation in the Colfax County is 16.34 inches. Average annual snowfall in the study area is 72 inches (or 7.2 inches of precipitation).

The geology of the Canadian Headwaters watershed is characterized by sandstone, shale, mudstone, and claystone that are flanked by limestone or calcareous rocks in the west and mafic volcanic rocks in the east (Figure 3.3). Alluvium, basin, and valley fill is generally found in river valleys and eastern basins.

Tributaries to the Canadian Headwaters include: Caliente Canyon Creek, York Canyon Creek, Leandro Creek, Vermejo River, VanBremmer Creek, Raton Creek, Chicorica Creek, Uña de Gato Creek, Blosser Arroyo, and Tinaja Creek.

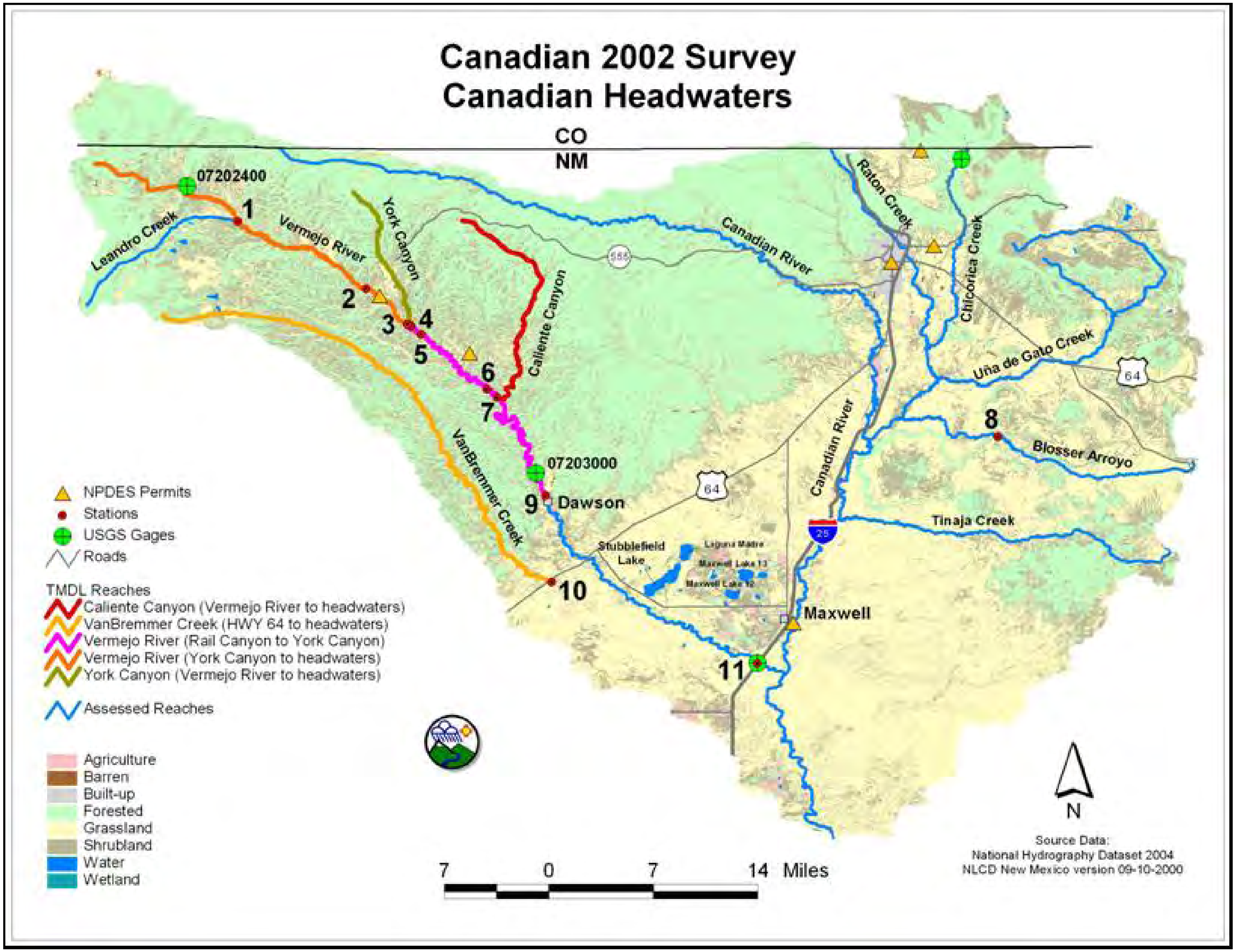


Figure 3.1 Land Use in the Canadian Headwaters Watershed

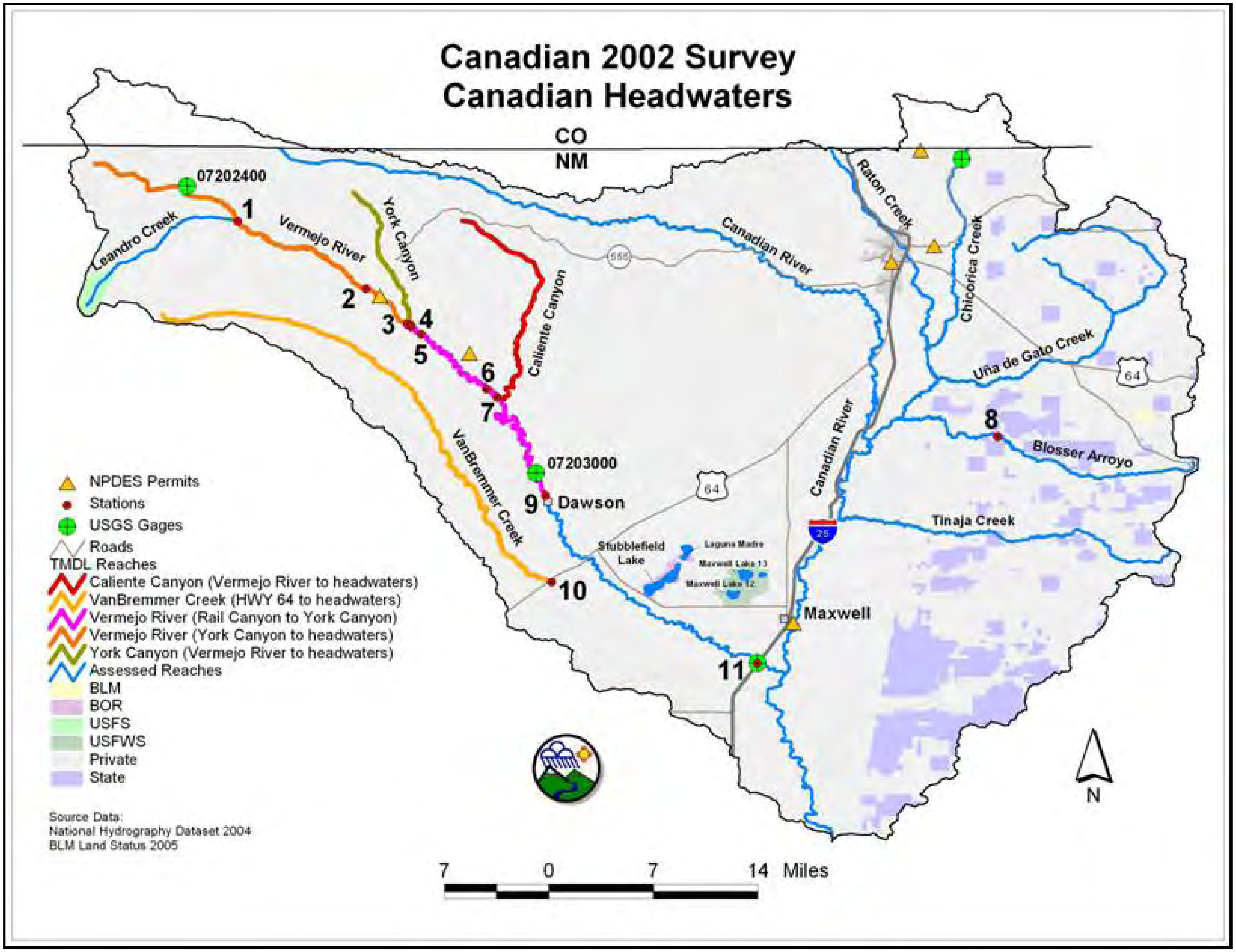


Figure 3.2 Land Ownership of the Canadian Headwaters Watershed

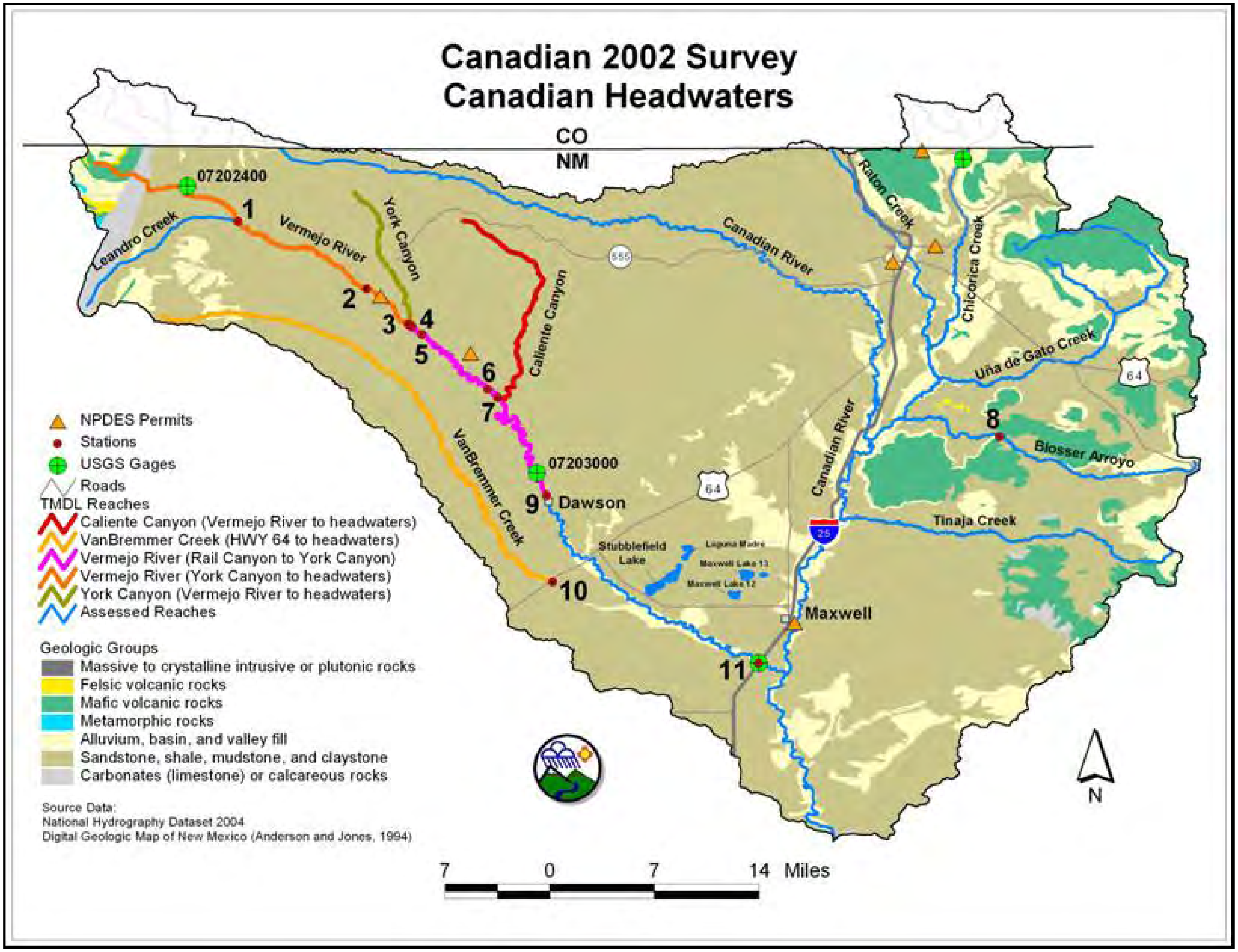


Figure 3.3 Geology of the Canadian Headwaters Watershed

Caliente Canyon (Vermejo River to Headwaters) is approximately 17 miles in length. SWQB established one station along this assessment unit during the 2002 intensive survey. Caliente Canyon (Vermejo River to Headwaters) was included on the 2004-2006 Integrated CWA §303(d)/§305(b) list for specific conductance. No TMDLs have previously been established for this assessment unit. Therefore, a TMDL was developed for inclusion in this document for the following assessment unit in the Canadian Headwaters subbasin:

- ***Specific Conductance*:** Caliente Canyon (Vermejo River to Headwaters)

VanBremmer Creek (Hwy 64 to Headwaters) is approximately 41 miles in length. SWQB established one station along this assessment unit during the 2002 intensive survey. VanBremmer Creek (Hwy 64 to Headwaters) was included on the 2004-2006 Integrated CWA §303(d)/§305(b) list for temperature, specific conductance, and turbidity. No thermograph data were available to address the existing temperature impairment on Van Bremmer Creek (Hwy 64 to headwaters). In addition, according to staff observations, VanBremmer Creek should be classified as a coldwater aquatic life (CWAL) use instead of a high quality coldwater aquatic life (HQCWAL) use. A Use Attainability Analysis (UAA) will be developed to correct the classification of VanBremmer Creek. Since CWAL does not have a specific conductance criterion, the specific conductance listing will be removed once the UAA is approved. Furthermore, the 2002 New Mexico WQS segment-specific turbidity criterion (20.6.4.309 NMAC) was used to assess the 2002 Canadian River Watershed water quality results. However, all numeric segment-specific turbidity criteria were removed as part of the 2005 WQS rule amendment and replaced with a general turbidity criterion that reads:

> *20.6.4.13(J) NMAC: Turbidity attributable to other than natural causes shall not reduce light transmission to the point that the normal growth, function or reproduction of aquatic life is impaired or that will cause substantial visible contrast with the natural appearance of the water. Turbidity shall not exceed 10 NTU over background turbidity when the background turbidity is 50 NTU or less, or increase more than 20 percent when the background turbidity is more than 50 NTU. Background turbidity shall be measured at a point immediately upstream of the turbidity causing activity…*

The SWQB is currently evaluating how to implement this provision. Options include developing a protocol to determine background turbidity in order to use the general criterion in future assessments. New assessment methods to determine turbidity impairment based on this new language are not yet available. SWQB will retain historic turbidity listings in the interim. Because of the reasons presented above, no TMDLs were written for this assessment unit.

Vermejo River (Rail Canyon to York Canyon) is approximately 24 miles in length. SWQB established two stations along this assessment unit and deployed one thermograph during the 2002 intensive survey. Vermejo River (Rail Canyon to York Canyon) was included on the 2004-2006 Integrated CWA §303(d)/§305(b) list for specific conductance and temperature. No TMDLs have previously been established for this assessment unit. Therefore, TMDLs were developed for inclusion in this document for the following assessment unit in the Canadian Headwaters subbasin:

- ***Specific Conductance*:** Vermejo River (Rail Canyon to York Canyon)
- ***Temperature*:** Vermejo River (Rail Canyon to York Canyon)

Vermejo River (York Canyon to Headwaters) is approximately 25 miles in length. SWQB established three stations along this assessment unit and deployed one thermograph during the 2002 intensive survey. Vermejo River (Rail Canyon to York Canyon) was included on the 2004-2006 Integrated CWA §303(d)/§305(b) list for temperature. No TMDLs have previously been established for this assessment unit. Therefore, a TMDL was developed for inclusion in this document for the following assessment unit in the Canadian Headwaters subbasin:

- ***Temperature*:** Vermejo River (York Canyon to Headwaters)

York Canyon Creek (Vermejo River to Headwaters) is approximately 11 miles in length. SWQB established one station along this assessment unit and deployed one thermograph during the 2002 intensive survey. York Canyon Creek (Vermejo River to Headwaters) was included on the 2004-2006 Integrated CWA §303(d)/§305(b) list for specific conductance and turbidity. However, the 2002 New Mexico WQS segment-specific turbidity criterion (20.6.4.309 NMAC) was used to assess the 2002 Canadian River Watershed water quality results. All numeric segment-specific turbidity criteria were removed as part of the 2005 WQS rule amendment and replaced with a general turbidity criterion that reads:

> *20.6.4.13(J) NMAC: Turbidity attributable to other than natural causes shall not reduce light transmission to the point that the normal growth, function or reproduction of aquatic life is impaired or that will cause substantial visible contrast with the natural appearance of the water. Turbidity shall not exceed 10 NTU over background turbidity when the background turbidity is 50 NTU or less, or increase more than 20 percent when the background turbidity is more than 50 NTU. Background turbidity shall be measured at a point immediately upstream of the turbidity causing activity…*

The SWQB is currently evaluating how to implement this provision. Options include developing a protocol to determine background turbidity in order to use the general criterion in future assessments. New assessment methods to determine turbidity impairment based on this new language are not yet available. SWQB will retain historic turbidity listings in the interim. No TMDLs have previously been established for this assessment unit. Therefore, a TMDL was developed for inclusion in this document for the following assessment unit in the Canadian Headwaters subbasin:

- ***Specific Conductance*:** York Canyon Creek (Vermejo River to Headwaters)

3.2 Mora Subwatershed

The Mora watershed (US Geological Survey [USGS] Hydrologic Unit Code [HUC] 11080004) is located in northeastern New Mexico (NM) and is bounded by the Sangre de Cristo Mountains to the west and the Canadian River and Great Plains to the east. The Mora River watershed from Shoemaker, NM (just east of I-25) to its headwaters drains approximately 1104 square miles (mi^2). Elevation ranges from 13,102 feet (ft.) at South Truchas Peak to 6145 ft. at the USGS Gage 07221000 near Shoemaker.

There are three main land uses in the Mora River watershed, as presented in Figure 3.4. They include forest (spruce-fir-pine-aspen in higher elevations and piñon-juniper in lower elevations) in the western mountainous region, rangeland characterized by gramma grass in association with other species in the eastern plains, and agriculture, which is located primarily along narrow, alluvial valleys and river corridors. Land ownership is 91% private, 6% USFS, 3% State, <1% National Park Service (NPS), and <1% BLM (Figure 3.5). Much of the land ownership adjacent to the river is private with the exceptions of Fort Union National Monument on Wolf Creek and Coyote Creek State Park and USFS land in the headwaters.

The average annual precipitation in Mora County ranges from 16 inches in the eastern plains to 25 inches in the mountain valleys. Over forty inches can accumulate in the highest western mountains (Tuan et. al 1973). Average annual snowfall in the study area ranges from about 30 inches to well over 100 inches at the higher elevations.

The geology of the Mora River watershed (Figure 3.6) is characterized by broad, elevated, north-trending belts of crystalline rocks that are generally flanked by steeply dipping sedimentary rocks in the west and high mesas and extensive dissected plateaus in the east. The core of the Sangre de Cristo Mountains to the west consists of metamorphic and igneous rocks overlain by the Pennsylvanian Magdalena Group. This thick sequence of rocks includes the Sandia Formation (carbonaceous shales and sandstones) and the Madera Limestone (limestone with interbedded shales). Shales, silts, mudstones, and sandstones overlay the Magdalena Group. The Permian Yeso formation consisting of argillaceous sandstone with lenses of silty sandstone overlies the shales, silts, mudstones, and sandstones. The Yeso is overlain by the Glorieta Sandstone, which is exposed near Mora and Ocate, NM. In addition, volcanic rocks are exposed over a large part of Mora County (Glorieta Geoscience, Inc. 1990).

Both the geologic and the bedrock hydrologic system are complex. The Mora River and its tributaries originate in the Sangre de Cristo Mountains. Luna and Lujan Creeks form the headwaters of the Mora River. After their confluence just north of Chacón, the Mora River flows southeast through the villages of Holman, Cleveland, Mora, Buena Vista, and Watrous. The river turns east near Watrous and begins to entrench into the plains as it travels towards the Canadian River.

Tributaries to the Mora River include: La Jara Creek, Coyote Creek, Little Coyote Creek, Rio la Casa, Santiago Creek, Rito Morphy, Rito Cebolla, Rito de Gascon, Rito San Jose, Manuelitas Creek, Sapello River, and Wolf Creek. All of the perennial streams in Mora County are diverted for irrigation.

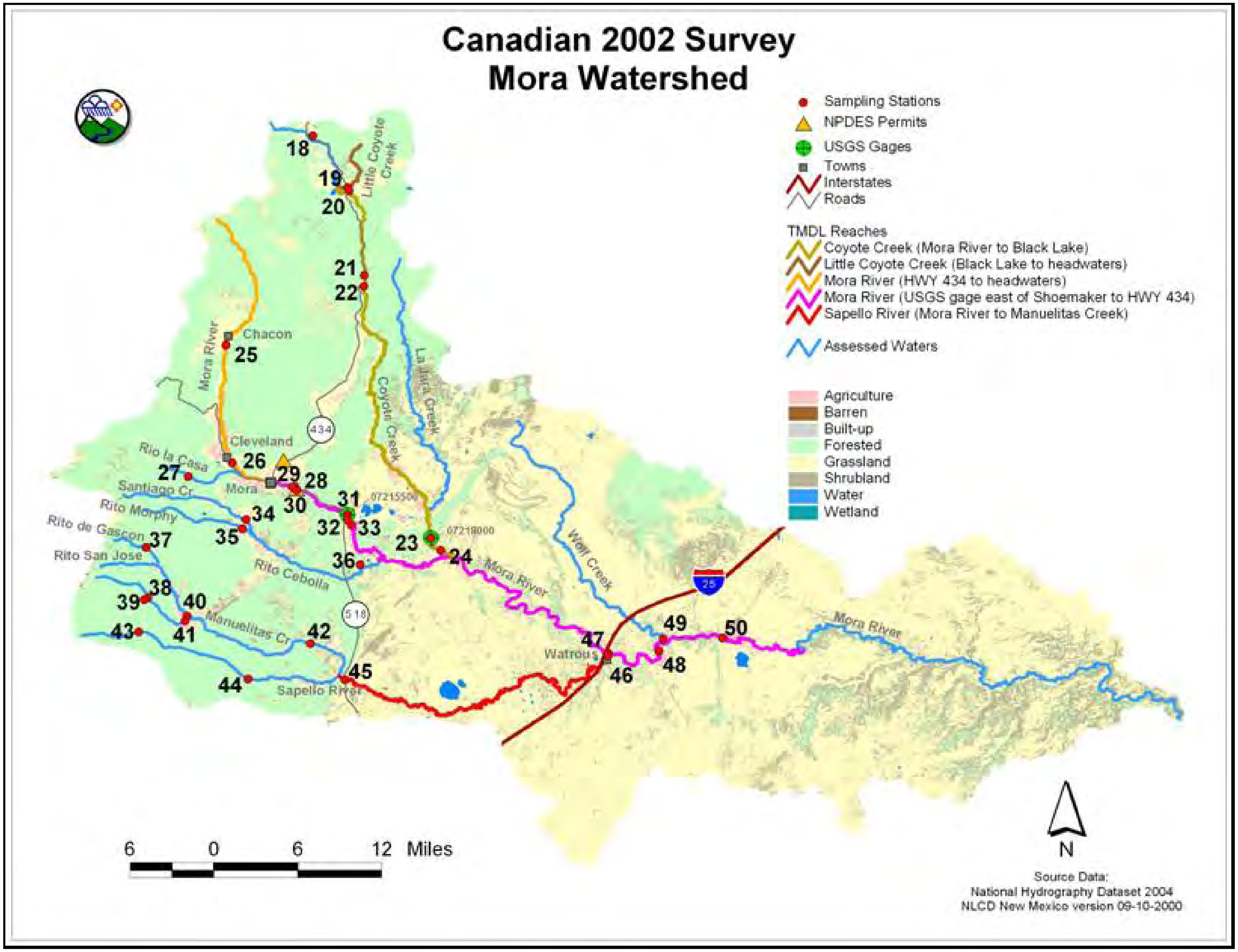


Figure 3.4 Land Use/Land Cover of the Mora River Watershed

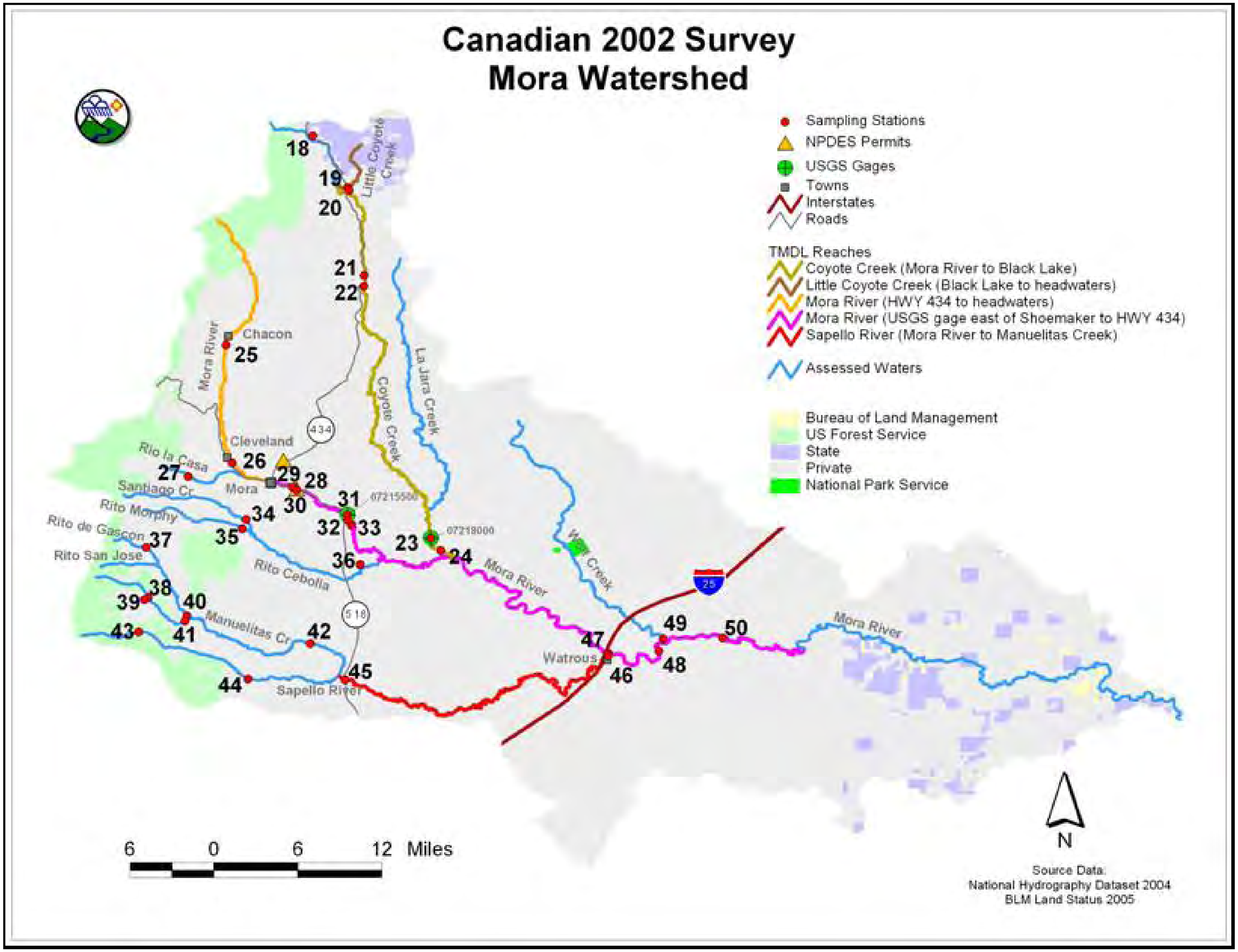


Figure 3.5 Land Ownership of the Mora River Watershed

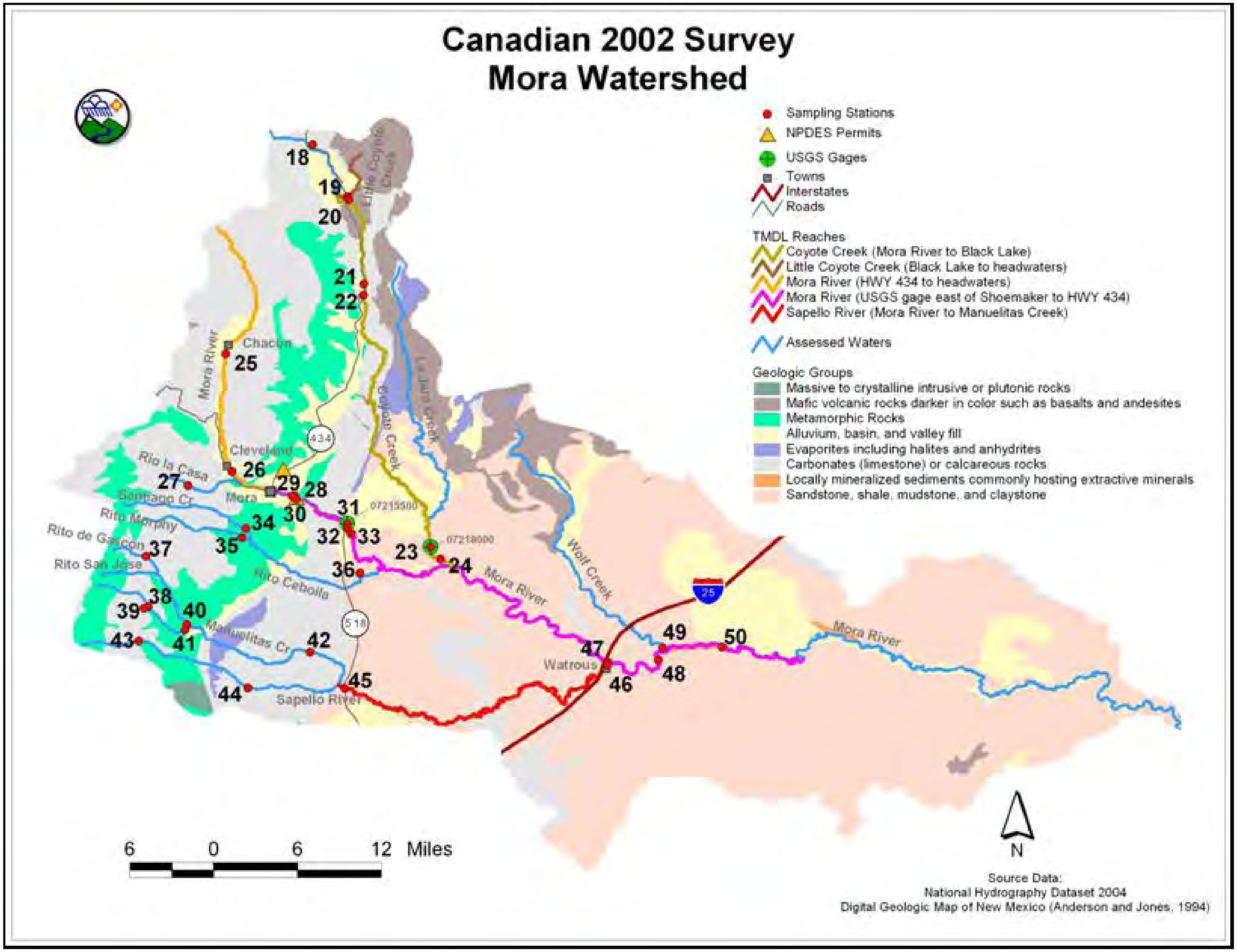


Figure 3.6 Geology of the Mora River Watershed

Coyote Creek (Mora River to Black Lake) is approximately 37 miles in length. SWQB established five stations along this assessment unit and deployed two thermographs during the 2002 intensive survey. Coyote Creek (Mora River to Black Lake) was included on the 2004-2006 Integrated CWA §303(d)/§305(b) list for specific conductance and temperature. No TMDLs have previously been established for this assessment unit. Therefore, TMDLs were developed for inclusion in this document for the following assessment unit in the Mora River subbasin:

- ***Specific Conductance*:** Coyote Creek (Mora River to Black Lake)
- ***Temperature*:** Coyote Creek (Mora River to Black Lake)

Little Coyote Creek (Black Lake to headwaters) is approximately 2 miles in length. SWQB established one station along this assessment unit and deployed one thermograph during the 2002 intensive survey. Little Coyote Creek (Black Lake to headwaters) was included on the 2004-2006 Integrated CWA §303(d)/§305(b) list for nutrient/eutrophication biological indicators, pH, and temperature. In preparing the 2006-2008 Integrated CWA §303(d)/§305(b) list, SWQB staff reevalauted the thermograph data from the 2002 Canadian Part 1 survey and discovered that the thermograph was unknowingly placed downstream of a diversion and most of the streamflow was diverted during the summer, which contributed to the temperature exceedences. According to Paragraph (2) of Subsection I of 20.6.4.11 NMAC, numeric criteria for temperature adopted under the Water Quality Act do not apply when changes in temperature in a surface water of the state are attributable to the reasonable operation of irrigation and flood control facilities that are not subject to federal or state water pollution control permitting. Based on the exception to the applicability of water quality standards noted above, temperature was removed from the 2006-2008 Integrated CWA §303(d)/§305(b) list as a cause of non-support in the reach Little Coyote Creek (Black Lake to headwaters). No TMDLs have previously been established for this assessment unit. Therefore, TMDLs and de-list letters were developed for the following assessment unit in the Mora River subbasin:

- ***Plant Nutrients*:** Little Coyote Creek (Black Lake to headwaters)
- **DE-LIST for *Temperature*:** Little Coyote Creek (Black Lake to headwaters)

Mora River (Canadian River to USGS gage east of Shoemaker) is approximately 50 miles in length. SWQB established one station along this assessment unit and deployed one thermograph during the 2002 intensive survey. Mora River (Canadian River to USGS gage east of Shoemaker) was included on the 2004-2006 Integrated CWA §303(d)/§305(b) list for dissolved oxygen (DO) based on grab data and categorized as 5C indicating that a sonde would be deployed to verify the DO listing. A sonde was deployed in 2006 to record DO every hour for a 10-day period. This resulted in 240 data points being generated. Based on the application of these data to current assessment protocols (NMED/SWQB 2006), DO was removed from the 2006-2008 Integrated CWA §303(d)/§305(b) list as a cause of non-support in the reach Mora River (Canadian River to USGS gage east of Shoemaker). Therefore, a delist letter was developed for the following assessment unit in the Mora River subbasin:

- **DE-LIST for *Dissolved Oxygen*:** Mora River (Canadian River to USGS gage east of Shoemaker)

Mora River (USGS gage east of Shoemaker to Hwy 434) is approximately 52 miles in length. SWQB established eight stations along this assessment unit and deployed one thermograph during the 2002 intensive survey. Mora River (USGS gage east of Shoemaker to Hwy 434) was included on the 2004-2006 Integrated CWA §303(d)/§305(b) list for nutrient/eutrophication biological indicators. No TMDLs have previously been established for this assessment unit. Therefore, a TMDL was developed for inclusion in this document for the following assessment unit in the Mora River subbasin:

- ***Plant Nutrients*:** Mora River (USGS gage east of Shoemaker to Hwy 434)

Mora River (Hwy 434 to headwaters) is approximately 18 miles in length. SWQB established two stations along this assessment unit and deployed one thermograph during the 2002 intensive survey. Mora River (Hwy 434 to headwaters) was included on the 2004-2006 Integrated CWA §303(d)/§305(b) list for sedimentation/siltation and specific conductance. No TMDLs have previously been established for this assessment unit. Therefore, TMDLs were developed for inclusion in this document for the following assessment unit in the Mora River subbasin:

- ***Specific Conductance*:** Mora River (Hwy 434 to headwaters)
- ***Sedimentation/Siltation*:** Mora River (Hwy 434 to headwaters)

Sapello River (Mora River to Manuelitas Creek) is approximately 27 miles in length. SWQB established two stations along this assessment unit and deployed one thermograph during the 2002 intensive survey. Sapello River (Mora River to Manuelitas Creek) was included on the 2004-2006 Integrated CWA §303(d)/§305(b) list for sedimentation/siltation. No TMDLs have previously been established for this assessment unit. Therefore, a TMDL was developed for inclusion in this document for the following assessment unit in the Mora River subbasin:

- ***Sedimentation/Siltation*:** Sapello River (Mora River to Manuelitas Creek)

4.0 SPECIFIC CONDUCTANCE

During the 2002 SWQB intensive water quality survey, exceedences of the NM water quality criteria for specific conductance (SC) were documented in the following assessment units (20.6.4.309 NMAC):

- Caliente Canyon (Vermejo River to headwaters)
- Vermejo River (Rail Canyon to York Canyon)
- York Canyon (Vermejo River to headwaters)
- Coyote Creek (Mora River to Black Lake)
- Mora River (Hwy 434 to headwaters)

According to the NM WQS (Paragraph (1) of Subsection (B) of 20.6.4.309 NMAC), the standard for SC reads:

> *In any single sample: specific conductance 500 µmhos/cm or less. . .*

The following subsections present the SC TMDLs for these five assessment units.

4.1 Target Loading Capacity

Target values for these SC TMDLs will be determined based on 1) the presence of numeric criteria, 2) the degree of experience in applying the indicator, and 3) the ability to easily monitor and produce quantifiable and reproducible results. For this TMDL document, target values for SC are based on the reduction in total dissolved solids (TDS) necessary to achieve numeric SC criteria.

The NM Water Quality Control Commission (WQCC) has adopted a numeric water quality criterion for SC to protect the designated use of High Quality Coldwater Aquatic Life (HQCWAL). The HQCWAL use designation requires that a stream have water quality, streambed characteristics, and other attributes of habitat sufficient to protect and maintain HQCWAL. As mentioned in Section 4.0, the numeric criteria for SC applicable to the five assessment units is 500 µmhos/cm.

4.2 Flow

SC in a stream can vary as a function of flow. As flow decreases, the concentration of TDS can increase, thereby increasing the SC. Similarly, as flows decline, temperatures have a tendency to increase, thus affecting SC values. These TMDLs are calculated for each reach at a specific flow.

The flow values used to calculate the TMDL for SC on these assessment units were obtained using a 4-day, 3-year low-flow frequency (4Q3) regression model. The 4Q3 is the annual lowest 4 consecutive day period discharge that will not fall below that discharge at least every 3 years

(Waltemeyer 2002). Low flow was chosen as the critical flow because of the negative effect decreasing, or low, flows have on SC.

The 4Q3 for Vermejo River (Rail Canyon to York Canyon) and Coyote Creek (Mora River to Black Lake) is based on USGS gage data. Vermejo River near Dawson, NM (USGS Gage 07203000) was used for the Vermejo River and Coyote Creek near Golondrinas, NM (USGS Gage 07218000) was used for Coyote Creek. The 4Q3 was estimated using the USGS A193 calculation for Log Pearson Type III distribution through DFLOW software, Version 3.1 (USEPA 2006). DFLOW 3.1 is a Windows-based tool developed to estimate user selected design stream flows for low flow analysis. The calculated 4Q3s are as follows:

- Vermejo River (Rail Canyon to York Canyon) = 0.99 cfs
- Coyote Creek (Mora River to Black Lake) = 0.48 cfs

It is often necessary to calculate a critical flow for a portion of a watershed where there is no active flow gage as in Caliente Canyon, York Canyon, and the upper Mora River. 4Q3 derivations for ungaged streams were based on analysis methods described by Waltemeyer (2002). In this analysis, two regression equations for estimating 4Q3 were developed based on physiographic regions of NM (i.e., statewide and mountainous regions above 7,500 feet in elevation). The following statewide regression equation is based on data from 50 gaging stations with non-zero discharge (Waltemeyer 2002):

$$4Q3 = 1.2856 \times 10^{-4}\ DA^{0.42}\ P_w^{\ 3.16} \qquad \text{(Eq. 1)}$$

where,

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

The average standard error of estimate (SEE) and coefficient of determination are 126 and 48 percent, respectively, for this regression equation (Waltemeyer 2002). The following regression equation for mountainous regions above 7,500 feet in elevation is based on data from 40 gaging stations with non-zero discharge (Waltemeyer 2002):

$$4Q3 = 7.3287 \times 10^{-5}\ DA^{0.70}\ P_w^{\ 3.58}\ S^{1.35} \qquad \text{(Eq. 2)}$$

where,

S = Average basin slope (percent).

The average SEE and coefficient of determination are 94 and 66 percent, respectively, for this regression equation (Waltemeyer 2002). The 4Q3s for Caliente Canyon, York Canyon, and the upper Mora River were estimated using the regression equation for mountainous regions because the mean elevations for these assessment units were above 7,500 feet in elevation (Table 4.1).

Table 4.1 Calculation of 4Q3 Low-Flow Frequencies

Assessment Unit	Average Elevation (ft.)	Drainage Area (mi^2)	mean winter precipitation (in.)	Average basin slope (percent)	4Q3 (cfs)
Caliente Canyon (Vermejo River to headwaters)	7628	73.38	6.20	19.7	0.114
York Canyon (Vermejo River to headwaters)	8156	29.86	6.90	22.6	0.107
Mora River (Hwy 434 to headwaters)	8927	144.49	11.3	26.0	2.276

The 4Q3 values were converted from cubic feet per second (cfs) to units of million gallons per day (MGD) as follows:

$$\_\_\_\_\_ \frac{ft^3}{sec} \times 1{,}728 \frac{in^3}{ft^3} \times 0.004329 \frac{gal}{in^3} \times 86{,}400 \frac{sec}{day} \times 10^{-6} = \_\_\_\_\_ \text{ MGD}$$

It is important to remember that the TMDL itself is a value calculated at a defined critical condition, and is calculated as part of 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 should be a goal to be attained.

4.3 Calculations

SC may be used to estimate the total ion concentration of a surface water sample, and is often used as an alternative measure of dissolved solids. In order to calculate a load in pounds per day (lb/day), TDS is used as a surrogate for SC. The TDS to SC ratio ranges from 0.5 to 0.9 milligrams per liter (mg/L)/microhos per centimeter (µmhos/cm) (American Public Health Association [APHA] 1998). Specific correlation should be derived by site, if TDS values are available.

TDS values were obtained for these assessment units during the 2002 SWQB/NMED sampling season. These values as well as the SC values are located in Table 4.7 at the end of this section. The TDS to SC ratio values were calculated, and averaged, resulting in TDS:SC ratios of:

- Caliente Canyon (Vermejo River to headwaters): TDS:SC = 0.74
- Vermejo River (Rail Canyon to York Canyon): TDS:SC = 0.65
- York Canyon (Vermejo River to headwaters): TDS:SC = 0.68
- Coyote Creek (Mora River to Black Lake): TDS:SC = 0.70
- Mora River (Hwy 434 to headwaters): TDS:SC = 0.72

The NM WQS to protect the designated HQCWAL use states that SC 500 µmhos/cm or less. The TDS concentration required to achieve the applicable WQS is defined by **Equation 3**.

$$\text{TDS (mg/L)} \cong \text{SC } (\mu\text{mhos/cm}) \times \text{(ratio)} \qquad \text{(Eq. 3)}$$

Using the above mentioned reference ratios and an SC value of 500 μmhos/cm, the TDS concentrations required to achieve NM WQS are:

- Caliente Canyon (Vermejo River to headwaters)

$$500\ \mu\text{mhos/cm} \times (0.74) \cong 370 \text{ mg/L of TDS}$$

- Vermejo River (Rail Canyon to York Canyon)

$$500\ \mu\text{mhos/cm} \times (0.65) \cong 325 \text{ mg/L of TDS}$$

- York Canyon (Vermejo River to headwaters)

$$500\ \mu\text{mhos/cm} \times (0.68) \cong 340 \text{ mg/L of TDS}$$

- Coyote Creek (Mora River to Black Lake)

$$500\ \mu\text{mhos/cm} \times (0.70) \cong 350 \text{ mg/L of TDS}$$

- Mora River (Hwy 434 to headwaters)

$$500\ \mu\text{mhos/cm} \times (0.72) \cong 360 \text{ mg/L of TDS}$$

For the purpose of TMDL development, these TDS criteria were used. The TMDLs were developed based on simple dilution calculations using 4Q3 flow and the TDS criteria above (from **Equation 3**). The TMDL calculation includes wasteload allocations (WLAs), load allocations (LAs), and a margin of safety (MOS).

Target loads for TDS are calculated based on the 4Q3 flow, the calculated target TDS concentration based on the current WQS for SC, and a conversion factor of 8.34, that is used to convert mg/L units to pounds per day (lbs/day) (see **Appendix A** for conversion factor derivation).

Critical Flow (MGD) x Target TDS Concentration (mg/L) x 8.34 = Target Loading Capacity
(Eq. 4)

The target loads (TMDLs) predicted to attain standards were calculated using **Equation 4** and are shown in Table 4.2.

Table 4.2 Calculation of Target Loads for TDS (SC surrogate)

Assessment Unit	Flow[a] (MGD)	Target TDS[b] Concentration (mg/L)	Conversion Factor[c]	Target Load Capacity (lbs/day)
Caliente Canyon (Vermejo River to headwaters)	0.074	370	8.34	228
Vermejo River (Rail Canyon to York Canyon)	0.640	325	8.34	1734
York Canyon (Vermejo River to headwaters)	0.069	340	8.34	196
Coyote Creek (Mora River to Black Lake)	0.310	350	8.34	905
Mora River (Hwy 434 to headwaters)	1.471	360	8.34	4417

Notes:
[a] Flow is the 4Q3 value calculated on the previous pages converted from cubic feet per second to million gallons per day.
[b] TDS is used as a surrogate measure for SC in order to calculate a load in lbs/day.
[c] Conversion factor used to convert mg/L to lbs/day (See **Appendix A**).
MGD = Million gallons per day
mg/L = Milligrams per liter
lbs/day = Pounds per day

Background loads were not possible to calculate in this watershed. A reference reach, having similar stream channel morphology and flow, was not found. It is assumed that all or a portion of the LA is made up of natural background loads. In future water quality surveys, finding a suitable reference reach will be a priority.

The measured loads were also calculated using **Equation 4**. In order to achieve comparability between the target and measured loads, the flow rate used was the same for both calculations. The same conversion factor of 8.34 was used. Results are presented in Table 4.3.

Table 4.3 Calculation of Measured Loads for TDS (SC surrogate)

Assessment Unit	Flow[a] (MGD)	Field[b] TDS (mg/L)	Conversion Factor[c]	Measured Load (lbs/day)
Caliente Canyon (Vermejo River to headwaters)	0.074	482	8.34	297
Vermejo River (Rail Canyon to York Canyon)	0.640	384	8.34	2049
York Canyon (Vermejo River to headwaters)	0.069	809	8.34	466
Coyote Creek (Mora River to Black Lake)	0.310	320	8.34	827
Mora River (Hwy 434 to headwaters)	1.471	405	8.34	4969

Notes:
[a] Flow is the 4Q3 value calculated on the previous pages converted from cubic feet per second to million gallons per day.
[b] The field measurement is the arithmetic mean of the SC exceedences, converted to TDS (see Table 4.7).
[c] Conversion factor used to convert mg/L to lbs/day (See **Appendix A**).
MGD = Million gallons per day
mg/L = Milligrams per liter
lbs/day = Pounds per day

4.4 Waste Load Allocations and Load Allocations

4.4.1 Waste Load Allocation

There are no individually permitted point source facilities or MS4 storm water permits in these assessment units. TDS may be a component of some (primarily construction) storm water discharges so these discharges should be addressed.

In contrast to discharges from other industrial storm water and individual process wastewater permitted facilities, storm water discharges from construction activities are transient because they occur mainly during the construction itself, and then only during storm events. Coverage under the NPDES construction general storm water permit (CGP) 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. In addition, the current CGP also includes state specific requirements to implement best management practices that are designed to prevent to the maximum extent practicable, an increase in sediment, or a parameter that addresses sediment (e.g., total suspended solids, turbidity, siltation, stream bottom deposits, etc.) and flow velocity during and after construction compared to pre-construction conditions. In this case, compliance with a SWPPP that meets the requirements of the CGP is generally assumed to be consistent with this TMDL.

Other industrial storm water facilities are generally covered under the current NPDES Multi-Sector General Storm Water Permit (MSGP). This permit also requires preparation of an SWPPP that includes identification and control of all pollutants associated with the industrial activities to minimize impacts to water quality. In addition, the current MSGP also includes state specific requirements to further limit (or eliminate) pollutant loading to water quality impaired/water quality limited waters from facilities where there is a reasonable potential to contain pollutants for which the receiving water is impaired. In this case, compliance with a SWPPP that meets the requirements of the MSGP is generally assumed to be consistent with this TMDL.

Therefore, this TMDL does not include a specific WLA for storm water discharges for these five assessment units, nor does it exclude these discharges.

4.4.2 Load Allocation

In order to calculate the LA, the WLA and MOS were subtracted from the target capacity (TMDL), as shown below in **Equation 5**.

$$WLA + LA + MOS = TMDL \qquad \text{(Eq. 5)}$$

Results using a MOS of 15% (as explained in Section 4.7), are presented in Table 4.4.

Table 4.4 Calculation of TMDL for TDS (SC Surrogate)

Assessment Unit	WLA (lbs/day)	LA (lbs/day)	MOS (15%) (lbs/day)	TMDL (lbs/day)
Caliente Canyon (Vermejo River to headwaters)	0	194	34	228
Vermejo River (Rail Canyon to York Canyon)	0	1474	260	1734
York Canyon (Vermejo River to headwaters)	0	167	29	196
Coyote Creek (Mora River to Black Lake)	0	769	136	905
Mora River (Hwy 434 to headwaters)	0	3754	663	4417

Notes:
WLA = Waste load allocation
LA = Load allocation
MOS = Margin of safety
TMDL = Total maximum daily load
lbs/day = Pounds per day

The load reduction that would be necessary to meet the target load was calculated to be the difference between the LA (Table 4.4) and the measured load (Table 4.3), and is shown in Table 4.5.

Table 4.5 Calculation of Load Reduction for TDS (SC Surrogate)

Assessment Unit	Target Load (lbs/day)	Measured Load (lbs/day)	Percent Reduction
Caliente Canyon (Vermejo River to headwaters)	194	297	35%
Vermejo River (Rail Canyon to York Canyon)	1474	2049	28%
York Canyon (Vermejo River to headwaters)	167	466	64%
Coyote Creek (Mora River to Black Lake)	769	827	7%
Mora River (Hwy 434 to headwaters)	3754	4969	24%

Notes:
lbs/day = Pounds per day
Target Load = WLA + LA
Percent reduction is the percent the existing measured load must be reduced to achieve the target load, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100.

4.5 Identification and Description of Pollutant Source(s)

Pollutant sources that could contribute to these waterbodies are listed in Table 4.6.

Table 4.6 Pollutant Source Summary

Pollutant	Magnitude[(a)] (lbs/day)	Location	Probable Sources* (% from each)
Point Source			
None	0	---	0
Nonpoint Source			
TDS	297	Caliente Canyon (Vermejo River to headwaters)	100% Natural Sources; Source Unknown
TDS	2049	Vermejo River (Rail Canyon to York Canyon)	100% Habitat Modification; Rangeland Grazing; Source Unknown
TDS	466	York Canyon (Vermejo River to headwaters)	100% Impacts from Abandoned Mine Lands (Inactive)
TDS	827	Coyote Creek (Mora River to Black Lake)	100% Natural Sources; Rangeland Grazing
TDS	4969	Mora River (Hwy 434 to headwaters)	100% Natural Sources; Rangeland Grazing; Silviculture Harvesting

Notes:

[+] The magnitude is equal to the measured load (see Table 4.3 for details).

* From the 2006-2008 Integrated CWA §303(d)/§305(b) List. This list of probable sources is based on staff observation and known land use activities in the watershed. These sources are not confirmed or quantified at this time.

TDS = Total dissolved solids

lbs/day = Pounds per day

4.6 Link Between Water Quality and Pollutant Sources

TDS refers to the total amount of all inorganic and organic substances – including minerals, salts, metals, anions, and cations – that are dispersed within a volume of water. Higher concentrations of TDS may occur during and after precipitation events. In the United States, elevated TDS has been due to natural environmental features such as mineral springs, carbonate deposits, salt deposits, and silt, the decomposition of leaves and plankton, and the weathering erosion of rocks. Other sources may include stormwater and agricultural runoff, mining operations, industrial wastewater, and sewage.

The electrical conductivity of water is directly related to the concentration of dissolved solids in the water because TDS concentrations are equal to the sum of positively charged ions (cations) and negatively charged ions (anions) in the water. These electrically charged dissolved particles make ordinary natural water a good conductor of electricity. Conversely, pure water has a high electrical resistance, and resistance is frequently used as a measure of its purity.

Conductivity is measured in micromhos per centimeter (µmhos/cm) or microsiemens per centimeter (µs/cm). The conductivity of rivers in the United States generally ranges from 50 to 1500 µmhos/cm. Studies of inland fresh waters indicate that streams supporting good mixed fisheries have a range between 150 and 500 µhos/cm. Conductivity outside this range could indicate that the water is not suitable for certain species of fish or macroinvertebrates.

Conductivity in streams and rivers is affected primarily by the geology of the area through which the water flows. Streams that run through areas with granite bedrock tend to have lower conductivity because granite is composed of more inert materials that do not dissolve into ionic components when washed into the water. On the other hand, streams that run through areas with clay soils tend to have higher conductivity because of the presence of materials that ionize when washed into the water. Ground water inflows can have the same effects depending on the bedrock they flow through. In addition, discharges to streams can change the conductivity depending on their make-up. For example, a failing sewage system would raise the conductivity because of the presence of chloride, phosphate, and nitrate.

The components of a watershed continually change through natural ecological processes such as vegetation succession, erosion, and evolution of stream channels. Intrusive human activity often affects watershed function in ways that are inconsistent with the natural balance. These changes, often rapid and sometimes irreversible, occur when people:

- cut forests
- clear and cultivate land
- remove stream-side vegetation
- alter the drainage of the land
- channelize watercourses
- withdraw water for irrigation
- build towns and cities
- discharge pollutants into waterways.

Factors affecting TDS in a waterway include:

1. Increases or decreases in flow rates
    - heavy rains can pick up sand, silt, clay, and organic particles (such as leaves and soil) from the land and carry it to surface water destroying the aquatic habitat and harming and/or killing the aquatic life, but the actual concentration of TDS may decrease because of dilution by all that rainwater.
    - during low flow, there is not enough water in the stream for dilution to occur and TDS concentrations tend to increase. Therefore, sudden inputs

of concentrated pollutant, especially during low flow periods, can cause significant negative impacts to aquatic organisms.

2. Soil erosion caused by disturbance of a land surface
    - increases TDS in the water
    - reduces transmission of sunlight needed for photosynthesis
    - interferes with animal behaviors dependent on sight (foraging, mating, and escape from predators)
    - impedes respiration (e.g., by gill abrasion in fish) and digestion
    - reduces oxygen in the water
3. Clearing of trees and shrubs from shorelines
    - destabilizes banks and promote erosion
    - increases sedimentation and turbidity
    - reduces shade and increase water temperature which could disrupt fish metabolism
    - causes channels to widen and become more shallow, increasing temperatures

Where data gaps exist or the level of uncertainty in the characterization of sources is large, the recommended approach to TMDL assignments requires the development of allocations based on estimates utilizing the best available information.

SWQB fieldwork includes an assessment of the probable sources of impairment (NMED/SWQB 1999). The completed *Pollutant Source(s) Summary Table* in **Appendix B** provides documentation of a visual analysis of probable sources along an impaired reach. Although this procedure is subjective, SWQB feels that it provides the best available information for the identification of probable sources of impairment in this watershed. Staff completing these forms identify and quantify probable sources of NPS impairments along each reach as determined by field reconnaissance and assessment. It is important to consider not only the land directly adjacent to the stream, which is predominantly privately held, but also to consider upland and upstream areas in a more holistic watershed approach to implementing this TMDL.

The main sources of impairment along these assessment units appear to be natural or unknown sources, habitat modification, rangeland grazing, impacts from inactive mines, and silviculture harvesting.

4.7 Margin of Safety

TMDLs should reflect a MOS based on the uncertainty or variability in the data, the point and nonpoint source load estimates, and the modeling analysis. The MOS for SC is estimated to be 15 percent of the TMDL. This MOS incorporates several factors:

- Errors in calculating nonpoint source loads

  A level of uncertainty exists in sampling nonpoint sources of pollution. Accordingly, a conservative MOS equals 10 percent of the TMDL.

- Errors in calculating flow

  Flow estimates were based on the estimation of the 4Q3 for gaged and ungaged streams and compared to actual flows and cross-sectional information taken in the field. Techniques used for measuring flow in water have a ±5 percent precision. Accordingly, a conservative MOS equals 5 percent of the TMDL.

4.8 Consideration of Seasonal Variation

Data used in the calculation of this TMDL were collected during high and low flow seasons in order to ensure coverage of any potential seasonal variation in the system. As shown in Table 4.7, exceedences were observed from May through October, which are months that capture the spring runoff, summer monsoonal rains, and baseflow conditions. The critical condition used for calculating the TMDL was low flow.

4.9 Future Growth

Estimates of future growth are not anticipated to lead to a significant increase in SC that cannot be controlled with best management practice (BMP) implementation in this watershed.

Table 4.7 SC and TDS Measurements from 2002 Sampling Survey

Location	Sample Date	SC (µmhos/cm)	TDS (mg/L)	Site-Specific TDS to SC Ratio
Caliente Canyon above Vermejo River	05-07-2002	***633****	382	0.60
	08-01-2002	***671****	591	0.88
			Average	**0.74**
Arithmetic Mean of Exceedences Converted to TDS = 652 x 0.74 = 484 mg/L				
Vermejo River above Caliente Canyon	04-09-2002	481	287	0.60
	05-07-2002	***552****	324	0.59
	06-05-2002	***625****	375	0.60
	07-03-2002	***656****	424	0.65
	08-01-2002	***570****	416	0.73
	08-28-2002	***636****	432	0.68
	10-17-2002	***616****	430	0.70
			Average	**0.65**
Arithmetic Mean of Exceedences Converted to TDS = 591 x 0.65 = 383 mg/L				
York Canyon Creek above Vermejo River	04-09-2002	***1237****	768	0.62
	05-07-2002	***1205****	784	0.65
	06-05-2002	***1225****	720	0.59
	07-03-2002	***1331****	790	0.59
	08-01-2002	***1268****	920	0.73
	08-28-2002	***1359****	922	0.68
	09-18-2002	***1030****	606	0.59
	10-17-2002	***867****	856	0.99
			Average	**0.68**
Arithmetic Mean of Exceedences Converted to TDS = 1190 x 0.68 = 808 mg/L				
Coyote Creek 1 mile abv Mora R. at Thal Ranch	04-02-2002	***637****	464	0.73
	05-01-2002	***621****	410	0.66
	06-05-2002	***781****	522	0.67
	07-02-2002	***813****	488	0.60
	07-31-2002	***799****	538	0.67
	08-27-2002	***749****	496	0.66
	09-17-2002	***665****	468	0.70
	10-16-2002	***715****	450	0.63
	11-10-2004	***596****	394	0.66
Coyote Creek at Coyote State Park above USGS gage	04-02-2002	235	180	0.77
	05-02-2002	259	136	0.53
	06-04-2002	290	220	0.76
	07-02-2002	281	194	0.69
	07-30-2002	269	190	0.71
	08-27-2002	282	192	0.68
	09-17-2002	240	220	0.92
	10-16-2002	246	178	0.72
Coyote Creek below Black Lake at HWY 434	05-02-2002	216	108	0.50
	07-31-2002	247	190	0.77
	10-16-2002	207	206	0.995
			Average	**0.70**
Arithmetic Mean of Exceedences Converted to TDS = 469 x 0.70 = 327 mg/L				

Location	Sample Date	SC (µmhos/cm)	TDS (mg/L)	Site-Specific TDS to SC Ratio
Mora River at Chacon 0.6 miles above gage	04-01-2002	***577****	432	0.75
	05-01-2002	***581****	352	0.61
	06-03-2002	***567****	374	0.66
	07-01-2002	***571****	416	0.73
	07-30-2002	***541****	378	0.70
	08-27-2002	***570****	414	0.73
	09-17-2002	389	506	1.30
	10-15-2002	***656****	480	0.73
	05-16-2006	***509****	-	-
	08-03-2006	***574****	-	-
	09-27-2006	498	336	0.67
Mora River at Cleveland by bridge on Church Road	04-01-2002	***584****	410	0.70
	05-01-2002	***558****	343	0.61
	06-03-2002	***598****	420	0.70
	07-01-2002	***589****	382	0.65
	07-30-2002	***581****	364	0.63
	08-27-2002	***586****	372	0.63
	09-17-2002	***588****	424	0.72
	10-15-2002	***586****	408	0.70
	05-16-2006	***599****	-	-
	08-03-2006	***525****	-	-
	09-27-2006	***528****	356	0.67
			Average	**0.72**
Arithmetic Mean of Exceedences Converted to TDS = 564 x 0.72 = 404 mg/L				

Notes:
SC = Specific conductance
µmhos/cm = microhos per centimeter
* = Exceeds water quality criterion for SC
TDS = Total dissolved solids
mg/L = Milligrams per liter

5.0 PLANT NUTRIENTS

The potential for excessive nutrients in the Little Coyote Creek and the Mora River were noted through visual observation during the 2002 SWQB intensive watershed survey. Assessment of various water quality parameters indicated nutrient impairment in Little Coyote Creek (Black Lake to headwaters) and the Mora River (USGS gage east of Shoemaker to Hwy 434).

5.1 Target Loading Capacity

The target values for nutrient loads are determined based on 1) the presence of numeric or narrative criteria, 2) the degree of experience in applying the indicator, and 3) the ability to easily monitor and produce quantifiable and reproducible results. For this TMDL document the target value for plant nutrients is based on both narrative and numeric translators.

The New Mexico WQCC has adopted narrative water quality standards criterion for plant nutrients to sustain and protect existing or attainable uses of the surface waters of the state. This general criterion applies to surface waters of the state at all times unless a specific criterion is provided elsewhere. The narrative criterion for plant nutrients leading to an assessment of use impairment is as follows (Subsection E of 20.6.4.13 NMAC):

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

There are two potential contributors to nutrient enrichment in a given stream: excessive nitrogen and/or phosphorus. The reason for controlling plant growth is to preserve aesthetic and ecologic characteristics along the waterway. The intent of numeric criteria for phosphorus and nitrogen is to control the excessive growth of attached algae and higher aquatic plants that can result from the introduction of these plant nutrients into streams. Numeric criteria also are necessary to establish targets for total maximum daily loads (TMDLs), to develop water quality-based permit limits and source control plans, and to support designated uses within the watershed.

Nutrient criteria development in the State of New Mexico has taken place in three steps, thus far. First, the EPA compiled nutrient data from the national nutrient dataset, divided it by waterbody type, grouped it into nutrient ecoregions, and calculated the 25th percentiles for each aggregate and Level III ecoregion. EPA published these recommended water quality criteria to help states and tribes reduce problems associated with excess nutrients in waterbodies in specific areas of the country (USEPA 2000). Next a U.S. Geological Survey (USGS) employee, Evan Hornig, who assisted EPA Region 6 with nutrient criteria development, refined the recommended ecoregional nutrient criteria. Hornig used regional nutrient data from EPA's Storage and Retrieval System (STORET), the USGS, and the SWQB to create a regional dataset for New Mexico. Threshold values were calculated based on EPA procedures and the median for each Level III ecoregion.

The third round of analysis was conducted by SWQB to produce nutrient threshold values for streams based on ecoregion and designated aquatic life use. For this analysis, total phosphorus

(TP), total Kjeldahl nitrogen (TKN), and nitrate plus nitrite (N+N) data from the National Nutrient Dataset (1990-1997) was combined with Archival STORET data from 1998, and 1999-2006 data from the SWQB in-house database. The data were then divided by waterbody type, removing all rivers, reservoirs, lakes, wastewater treatment effluent, and playas. For all of the stream data, Level III and IV Omernik ecoregions (Omernik 2006) as well as the designated aquatic life use were assigned to all stream data using GIS coverages and the station's latitude and longitude. Medians were calculated for each ecoregion/aquatic life use group using Excel. For comparison purposes, values below the detection limit were estimated in two ways; using the substitution method (one half the detection limit) in Excel and using the nonparametric Kaplan-Meier method in Minitab. Interestingly, the results from the different analysis produced very similar results. However, this analysis was conducted on an incomplete dataset. The threshold values that will be incorporated into the SWQB Stream Nutrient Assessment Protocol are shown in Table 5.1. They were generated with the complete dataset using the substitution method given that the substitution and Kaplan-Meier methods produced similar results.

Table 5.1. SWQB's Recommended Nutrient Targets for streams (in mg/L)

<table>
<tr><th></th><th colspan="10">ECOREGION</th></tr>
<tr><th>Parameter</th><th colspan="2">21-Southern Rockies</th><th colspan="2">23-AZ/NM Mountains</th><th colspan="2">22-AZ/NM Plateau</th><th>24-Chihuahuan Desert</th><th colspan="3">26-SW Tablelands</th></tr>
<tr><td>TP</td><td colspan="2">0.02</td><td colspan="2">0.02</td><td colspan="2">0.05</td><td>0.04</td><td colspan="3">0.03</td></tr>
<tr><td>TN</td><td colspan="2">0.25</td><td colspan="2">0.25</td><td colspan="2">0.35</td><td>0.53</td><td colspan="3">0.38</td></tr>
<tr><td>ALU</td><td>CW</td><td>T/WW (volcanic)</td><td>CW</td><td>T/WW</td><td>CW</td><td>T/WW</td><td>T/WW</td><td>CW</td><td>T</td><td>WW</td></tr>
<tr><td>TP</td><td>0.02</td><td>0.02 (0.05)</td><td>0.02</td><td>0.05</td><td>0.04</td><td>0.09</td><td>0.04</td><td>0.02</td><td>0.03</td><td>0.03</td></tr>
<tr><td>TN</td><td>0.25</td><td>0.25</td><td>0.25</td><td>0.29</td><td>0.28</td><td>0.48</td><td>0.53</td><td>0.25</td><td>0.38</td><td>0.45</td></tr>
</table>

NOTES:
TN = Total Nitrogen
TP = Total Phosphorus
ALU = Designated Aquatic Life Use
CW = Coldwater (those water quality segments having only coldwater uses)
T = Transitional (those water quality segments with marginal coldwater or both cold and warmwater uses)
WW = Warmwater (those water quality segments having only warmwater uses)

Little Coyote Creek (Black Lake to headwaters) is located in Ecoregion 21 (Southern Rockies). In addition, this assessment unit is designated as high quality coldwater aquatic life (20.6.4.309 NMAC). According to Table 5.1, Little Coyote Creek (Black Lake to headwaters) should have numeric nutrient targets of 0.02 mg/L for total phosphorus and 0.25 mg/L for total nitrogen.

The Mora River (USGS gage east of Shoemaker to Hwy 434) is located in Ecoregion 21 (Southern Rockies) and Ecoregion 26 (Southwestern Tablelands); however the majority of this assessment unit falls within Ecoregion 26. In addition, this assessment unit has designated aquatic life uses of marginal coldwater and warmwater (20.6.4.307 NMAC). According to Table 5.1, the Mora River (USGS gage east of Shoemaker to Hwy 434) should have numeric nutrient targets of 0.03 mg/L for total phosphorus and 0.38 mg/L for total nitrogen.

Total Nitrogen is defined as the sum of Nitrate+Nitrite (N+N), and Total Kjeldahl Nitrogen (TKN). At the present time, there is no USEPA-approved method to test for Total Nitrogen, however a combination of USEPA method 351.2 (TKN) and USEPA method 353.2 (Nitrate + Nitrite) may be appropriate for estimating Total Nitrogen.

Table 5.2. Nutrient TMDL Target Concentrations

Assessment Unit	Total Phosphorus	Total Nitrogen
Little Coyote Creek (Black Lake to headwaters)	0.02 mg/L	0.25 mg/L
Mora River (USGS gage east of Shoemaker to Hwy 434)	0.03 mg/L	0.38 mg/L

5.2 Flow

The presence of plant nutrients in a stream can vary as a function of flow. As flow decreases, the stream cannot effectively dilute its constituents, which causes the concentration of plant nutrients to increase. Thus, a TMDL is calculated for each assessment unit at a specific flow.

The *critical condition* can be thought of as the "worst case" scenario of environmental conditions in the waterbody in which the loading expressed in the TMDL for the pollutant of concern will continue to meet water quality standards. Critical conditions are the combination of environmental factors (e.g., flow, temperature, etc.) that results in attaining and maintaining the water quality criterion and has an acceptably low frequency of occurrence. The critical flow is used in calculation of point source (National Pollutant Discharge Elimination System [NPDES]) permit WLA and in the development of TMDLs.

The critical flow condition for these TMDLs occurs when the ratio of effluent to stream flow is the greatest and was obtained using a 4Q3 regression model. The 4Q3 is the minimum average four consecutive day flow that occurs with a frequency of at least once every 3 years. Low flow was chosen as the critical flow because of the negative effect decreasing, or low, flows have on nutrient concentrations and algal growth.

The 4Q3 for Mora River (USGS gage east of Shoemaker to Hwy 434) is based on USGS Gage 07215500: Mora River at La Cueva, NM. The 4Q3 was estimated using the USGS A193 calculation for Log Pearson Type III distribution through DFLOW software, Version 3.1 (USEPA 2006). DFLOW 3.1 is a Windows-based tool developed to estimate user selected design stream flows for low flow analysis. The calculated 4Q3 is as follows:

- Mora River (USGS gage east of Shoemaker to Hwy 434) = 0.87 cfs

It is often necessary to calculate a critical flow for a portion of a watershed where there is no active flow gage. The 4Q3 derivation for Little Coyote Creek was based on analysis methods described by Waltemeyer (2002). In this analysis, two regression equations for estimating 4Q3 were developed based on physiographic regions of NM (i.e., statewide and mountainous regions above 7,500 feet in elevation). The following statewide regression equation is based on data from 50 gaging stations with non-zero discharge (Waltemeyer 2002):

$$4Q3 \quad = \quad 1.2856 \times 10^{-4}\ DA^{0.42}\ P_w^{\ 3.16} \qquad \text{(Eq. 1)}$$

where,

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

The average standard error of estimate (SEE) and coefficient of determination are 126 and 48 percent, respectively, for this regression equation (Waltemeyer 2002). The following regression equation for mountainous regions above 7,500 feet in elevation is based on data from 40 gaging stations with non-zero discharge (Waltemeyer 2002):

$$4Q3 \quad = \quad 7.3287 \times 10^{-5}\ DA^{0.70}\ P_w^{\ 3.58}\ S^{1.35} \qquad \text{(Eq. 2)}$$

where,

S = Average basin slope (percent).

The average SEE and coefficient of determination are 94 and 66 percent, respectively, for this regression equation (Waltemeyer 2002). The 4Q3 for Little Coyote Creek was estimated using the regression equation for mountainous regions because the mean elevation for this assessment unit was above 7,500 feet in elevation (Table 5.3).

Table 5.3 Calculation of 4Q3 Low-Flow Frequencies

Assessment Unit	**Average Elevation (ft.)**	**Drainage Area (mi^2)**	**mean winter precipitation (in.)**	**Average basin slope (percent)**	**4Q3 (cfs)**
Little Coyote Creek (Black Lake to headwaters)	9475	19.59	10.4	11.4	0.137

The 4Q3 values were converted from cubic feet per second (cfs) to units of million gallons per day (MGD) as follows:

$$\underline{\qquad} \frac{ft^3}{sec} \times 1{,}728 \frac{in^3}{ft^3} \times 0.004329 \frac{gal}{in^3} \times 86{,}400 \frac{sec}{day} \times 10^{-6} = \underline{\qquad} \text{ MGD}$$

It is important to remember that the TMDL itself is a value calculated at a defined critical condition, and is calculated as part of 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 should be a goal to be attained.

5.3 Calculations

This section describes the relationship between the numeric target and the allowable pollutant-level by determining the waterbody's total assimilative capacity, or loading capacity, for the pollutant. The loading capacity is the maximum amount of pollutant loading that a waterbody can receive while meeting its water quality objectives.

As a river flows downstream it has a specific carrying capacity for nutrients. This carrying capacity, or TMDL, is defined as the mass of pollutant that can be carried under critical low-flow conditions without violating the target concentration for that constituent. These TMDLs were developed based on simple dilution calculations using 4Q3 flow, the numeric target, and a conversion factor. The specific carrying capacity of a receiving water for a given pollutant, may be estimated using **Equation 3**.

4Q3 (in MGD) x Numeric Target (in mg/L) x 8.34 = TMDL (pounds per day [lbs/day]) (**Eq. 3)**

The annual target loads for TP and TN are summarized in Table 5.4.

Table 5.4 Estimates of Annual Target Loads for TP & TN

Assessment Unit	Parameter	4Q3 Flow (MGD)	Numeric Target (mg/L)	Conversion Factor	Target Load (lbs/day)
Little Coyote Creek (Black Lake to headwaters)	Total Phosphorus	0.089	0.02	8.34	0.015
	Total Nitrogen	0.089	0.25	8.34	0.186
Mora River (gage east of Shoemaker to Hwy 434)	Total Phosphorus	0.614+	0.03	8.34	0.154
	Total Nitrogen	0.614+	0.38	8.34	1.946

Notes:
\+ *Combined Flow = 4Q3 low-flow (0.562 MGD) + WWTP design capacity (0.052 MGD)*

The measured loads for TP and TN were similarly calculated. In order to achieve comparability between the target and measured loads, the same flow value was used for both calculations. The geometric mean of the collected data that exceeded the target concentrations (Table 5.5) was substituted for the target in **Equation 3**. The same conversion factor of 8.34 was used. The results are presented in Table 5.6.

Table 5.5 SWQB Nutrient Data

Sample site	Collection date/time	TP (mg/L)	TN (mg/L)
Little Coyote Creek (Black Lake to headwaters)			
Little Coyote at Hwy 434	4/2/2002 9:45	<0.03	0.417
Little Coyote at Hwy 435	5/2/2002 13:15	0.062	0.550
Little Coyote at Hwy 436	6/4/2002 10:20	0.09	0.407
Little Coyote at Hwy 437	6/27/2002 16:30	0.075	0.604
Little Coyote at Hwy 438	7/2/2002 10:00	0.047	0.502
Little Coyote at Hwy 439	7/31/2002 9:45	0.082	0.487
Little Coyote at Hwy 440	8/27/2002 13:00	0.058	0.377
Little Coyote at Hwy 441	9/17/2002 12:20	0.13	0.422
Little Coyote at Hwy 442	10/16/2002 9:35	<0.03	0.287
GEOMETRIC MEAN of Exceedences		**0.074**	**0.441**
Mora River (USGS gage east of Shoemaker to Hwy 434)			
Mora River above Hatchery	6/3/2002 13:40	<0.03	0.22
Mora River above Hatchery	8/27/2002 10:10	<0.03	0.10
Mora River above Hatchery	10/15/2002 16:30	<0.03	0.24
Mora River above Hatchery	8/3/2006 11:45	<0.03	0.19
Mora River above Mora WWTP lagoons	4/1/2002 13:30	<0.03	0.10
Mora River above Mora WWTP lagoons	5/1/2002 11:30	<0.03	0.10
Mora River above Mora WWTP lagoons	6/3/2002 13:10	<0.03	0.27
Mora River above Mora WWTP lagoons	6/27/2002 14:00	<0.03	0.44
Mora River above Mora WWTP lagoons	7/30/2002 11:15	<0.03	0.22
Mora River above Mora WWTP lagoons	8/27/2002 9:55	<0.03	0.17
Mora River above Mora WWTP lagoons	9/17/2002 9:25	0.514	0.24
Mora River above Mora WWTP lagoons	5/16/2006 12:20	0.042	0.60
Mora River above Mora WWTP lagoons	8/3/2006 11:40	<0.03	0.10
Mora River above Mora WWTP lagoons	9/27/2006 12:25	<0.03	0.28
MORA WASTEWATER TREATMENT PLANT	5/16/2006 13:00	0.256	2.86
MORA WASTEWATER TREATMENT PLANT	8/3/2006 9:50	0.169	2.09
MORA WASTEWATER TREATMENT PLANT	9/27/2006 13:23	0.143	0.96
Mora River below Mora WWTP lagoons	4/2/2002 13:50	<0.03	0.30
Mora River below Mora WWTP lagoons	5/1/2002 12:00	<0.03	0.24
Mora River below Mora WWTP lagoons	6/3/2002 13:00	<0.03	0.28
Mora River below Mora WWTP lagoons	6/27/2002 10:30	<0.03	0.24
Mora River below Mora WWTP lagoons	7/30/2002 10:40	0.04	0.40
Mora River below Mora WWTP lagoons	8/27/2002 9:40	0.057	0.38
Mora River below Mora WWTP lagoons	9/17/2002 9:00	0.073	0.57
Mora River below Mora WWTP lagoons	10/15/2002 15:50	0.033	0.41
Mora River below Mora WWTP lagoons	5/16/2006 13:20	0.058	0.89
Mora River below Mora WWTP lagoons	8/3/2006 10:05	<0.03	0.39
Mora River below Mora WWTP lagoons	9/27/2006 13:30	<0.03	0.24
MORA RIVER AT LA CUEVA USGS GAGE	4/1/2002 13:30	<0.03	0.20
MORA RIVER AT LA CUEVA USGS GAGE	5/1/2002 12:30	0.044	0.59
MORA RIVER AT LA CUEVA USGS GAGE	6/3/2002 15:00	<0.03	0.51
MORA RIVER AT LA CUEVA USGS GAGE	7/1/2002 11:00	<0.03	0.32
MORA RIVER AT LA CUEVA USGS GAGE	7/30/2002 9:30	0.063	0.35
MORA RIVER AT LA CUEVA USGS GAGE	8/27/2002 9:15	0.035	0.23

Sample site	Collection date/time	TP (mg/L)	TN (mg/L)
MORA RIVER AT LA CUEVA USGS GAGE	9/17/2002 8:30	0.04	0.28
MORA RIVER AT LA CUEVA USGS GAGE	10/15/2002 14:00	<0.03	0.19
MORA RIVER AT LA CUEVA USGS GAGE	5/16/2006 13:45	0.054	0.65
MORA RIVER AT LA CUEVA USGS GAGE	8/3/2006 16:15	0.198	0.31
MORA RIVER AT LA CUEVA USGS GAGE	9/27/2006 13:47	<0.03	0.22
Mora River at Watrous	4/2/2002 14:15	<0.03	0.10
Mora River at Watrous	4/24/2002 10:30	<0.03	0.10
Mora River at Watrous	5/15/2002 11:35	<0.03	0.18
Mora River at Watrous	6/5/2002 11:30	<0.03	0.26
Mora River at Watrous	7/2/2002 9:50	<0.03	0.10
Mora River at Watrous	7/31/2002 11:55	<0.03	0.20
Mora River at Watrous	8/27/2002 13:35	<0.03	0.42
Mora River at Watrous	9/17/2002 14:00	<0.03	0.27
Mora River at Watrous	10/16/2002 15:15	<0.03	0.23
GEOMETRIC MEAN of Exceedences		**0.064**	**0.515**
Mora River (Hwy 434 to headwaters)			
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	4/1/2002 11:00	<0.03	0.37
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	5/1/2002 9:10	<0.03	0.17
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	6/3/2002 11:00	<0.03	0.26
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	7/1/2002 13:30	<0.03	0.24
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	7/30/2002 12:25	<0.03	0.28
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	8/27/2002 11:20	<0.03	0.20
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	9/17/2002 10:50	<0.03	0.39
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	10/15/2002 12:30	<0.03	0.15
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	5/16/2006 10:10	0.048	0.49
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	8/2/2006 12:10	<0.03	0.25
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	9/27/2006 10:25	<0.03	0.21
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	4/1/2002 12:00	<0.03	0.31
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	5/1/2002 9:40	<0.03	0.32
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	6/3/2002 12:00	<0.03	0.36
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	7/1/2002 12:30	<0.03	0.26
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	7/30/2002 11:40	0.045	0.24
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	8/27/2002 10:35	<0.03	0.17
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	9/17/2002 10:00	<0.03	0.25
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	10/15/2002 13:00	<0.03	0.10
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	5/16/2006 11:30	0.032	0.33
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	8/3/2006 13:40	<0.03	0.17
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	9/27/2006 11:20	<0.03	0.20

Notes:
TP = Total Phosphorus
TN = Total Nitrogen
mg/L = Milligrams per liter
Exceedences of the nutrient targets are highlighted in **GOLD**.

Table 5.6. Estimates of Annual Measured Loads for TP and TN

Assessment Unit	Parameter	Flow (MGD)	Geometric Mean Conc.* (mg/L)	Conversion Factor	Measured Load (lbs/day)
Little Coyote Creek (Black Lake to headwaters)	Total Phosphorus	0.089	0.074	8.34	0.055
	Total Nitrogen	0.089	0.441	8.34	0.327
Mora River (gage east of Shoemaker to Hwy 434)	Total Phosphorus	0.614+	0.064	8.34	0.328
	Total Nitrogen	0.614+	0.515	8.34	2.637

Notes:

\+ *Combined Flow = 4Q3 low-flow (0.562 MGD) + WWTP design capacity (0.052 MGD)*

* *Geometric mean of TP and TN exceedences (See Table 5.5)*

5.4 Waste Load Allocations and Load Allocations

5.4.1 Waste Load Allocation

There are no facilities with an NPDES permit in the Little Coyote Creek assessment unit. However, there are two existing point sources with individual NPDES permits in the Mora River assessment unit. These permitted facilities include the wastewater treatment plant (WWTP) owned and operated by the Mora Mutual Domestic Water and Sewerage Works Association (MMDWSWA) (NM0024996) and the Mora National Fish Hatchery and Technology Center (NM0030031). The WWTP discharges directly into the Mora River between the gage east of Shoemaker and Hwy 434. The fish hatchery discharges into an ephemeral unnamed ditch, then into Tambley Ditch, then into the Mora River between the gage east of Shoemaker and Hwy 434. There are no individually permitted Municipal Separate Storm Sewer System (MS4) storm water permits in either assessment unit.

Excess nutrient levels may be a component of some (primarily construction) storm water discharges so these discharges should be addressed. In contrast to discharges from other industrial storm water and individual process wastewater permitted facilities, storm water discharges from construction activities are transient because they occur mainly during the construction itself, and then only during storm events. Coverage under the NPDES construction general storm water permit (CGP) 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. In addition, the current CGP also includes state specific requirements to implement BMPs that are designed to prevent to the maximum extent practicable, an increase in sediment, or a parameter that addresses sediment (e.g., total suspended solids, turbidity, siltation, stream bottom deposits, etc.) and flow velocity during and after construction compared to preconstruction conditions. In this case, compliance with a SWPPP that meets the requirements of the CGP is generally assumed to be consistent with this TMDL.

Other industrial storm water facilities are generally covered under the current NPDES Multi-Sector General Storm Water Permit (MSGP). This permit also requires preparation of an SWPPP that includes identification and control of all pollutants associated with the industrial activities to minimize impacts to water quality. In addition, the current MSGP also includes state specific requirements to further limit (or eliminate) pollutant loading to water quality impaired/water quality limited waters from facilities where there is a reasonable potential to contain pollutants for which the receiving water is impaired. In this case, compliance with a SWPPP that meets the requirements of the MSGP is generally assumed to be consistent with this TMDL.

Because there are no individually permitted MS4 storm water permits in either assessment unit, this TMDL does not include a specific WLA for storm water discharges for Little Coyote Creek or the Mora River. However, because there are facilities with NPDES permits that discharge into the Mora River between the gage east of Shoemaker and Hwy 434, WLAs for the WWTP and the National Fish Hatchery are included in this TMDL (Table 5.7 and 5.8).

Table 5.7 TP Waste Load Allocations for the Mora River

Assessment Unit	Facility	Flow[a] (MGD)	TP Target[b] (mg/L)	Conversion Factor[c]	Waste Load Allocations[d] (lbs/day)
Mora River (gage east of Shoemaker to Hwy 434)	**NM0024996** Mora Mutual Domestic Water and Sewerage Works	0.052	0.03	8.34	0.013
	NM0030031 Mora National Fish Hatchery and Technology Center	0.486	0.03	8.34	0.122

Notes:
[a] Based on design capacity for the WWTP and the 24-month highest discharge for the Fish Hatchery.
[b] Based on the numeric TP target discussed in Section 5.1 and presented in Table 5.1.
[c] Based on equation 3.
[d] WLA = (flow) x (TP target concentration) x (conversion factor)

Table 5.8 TN Waste Load Allocations for the Mora River

Assessment Unit	Facility	Flow (MGD)	TN Target (mg/L)	Conversion Factor[b]	Waste Load Allocations[d] (lbs/day)
Mora River (gage east of Shoemaker to Hwy 434)	**NM0024996** Mora Mutual Domestic Water and Sewerage Works	0.052	0.38	8.34	0.165
	NM0030031 Mora National Fish Hatchery and Technology Center	0.486	0.38	8.34	1.540

Notes:
[a] Based on design capacity for the WWTP and the 24-month highest discharge for the Fish Hatchery.
[b] Based on the numeric TN target discussed in Section 5.1 and presented in Table 5.1.
[c] Based on equation 3.
[d] WLA = (flow) x (TN target concentration) x (conversion factor)

5.4.2 Load Allocation

In order to calculate the LAs for phosphorus and nitrogen, the WLAs and MOSs were subtracted from the target capacity (TMDL) using the following equation:

WLA + LA + MOS = TMDL **(Eq.2)**

The MOS was developed using a combination of conservative assumptions and explicit recognition of potential errors in flow calculations. Results using an explicit MOS of 15% (see Section 5.7 for details) are presented in Table 5.9.

Table 5.9. Calculation of Annual TMDL for TP and TN

Assessment Unit	Parameter	WLA (lbs/day)	LA (lbs/day)	MOS (10%) (lbs/day)	TMDL (lbs/day)
Little Coyote Creek (Black Lake to headwaters)	TP	0	0.013	0.002	0.015
	TN	0	0.167	0.019	0.186
Mora River (gage east of Shoemaker to Hwy 434)	TP	0.135	0.004	0.015	0.154
	TN	1.705	0.046	0.195	1.946

The load reductions that would be necessary to meet the target loads were calculated to be the difference between the calculated target load allocation (Table 5.4) and the measured load (Table 5.6), and are shown in Table 5.10.

Table 5.10. Calculation of Load Reduction for TP and TN

Assessment Unit	Parameter	Target Load[(a)] (lbs/day)	Measured Load (lbs/day)	Load Reduction (lbs/day)	Percent Reduction [(b)]
Little Coyote Creek (Black Lake to headwaters)	TP	0.013	0.055	0.042	76%
	TN	0.167	0.327	0.160	49%
Mora River (gage east of Shoemaker to Hwy 434)	TP	0.139	0.328	0.189	58%
	TN	1.751	2.637	0.886	34%

Note: The MOS is not included in the load reduction calculations because it is a set aside value which accounts for any uncertainty or variability in TMDL calculations and therefore should not be subtracted from the measured load.
(a) Target Load = LA + WLA (refer to Table 5.9)
(b) Percent reduction is the percent the existing measured load must be reduced to achieve the target load, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100.

5.5 Identification and Description of Pollutant Sources

Probable sources of impairment for TP that could contribute to this assessment unit are listed in Table 5.11. Probable sources of impairment for TN are listed in Table 5.12.

Table 5.11 Pollutant Source Summary for Total Phosphorus

Assessment Unit	Pollutant Sources	Magnitude (lbs/day)	Probable Sources* (% from each)
Little Coyote Creek (Black Lake to headwaters)	Point:	0	0%
	Nonpoint:	0.055	100% Natural Sources; Rangeland Grazing; Source Unknown
Mora River (gage east of Shoemaker to Hwy 434)	Point: NM0024996 NM0030031	0.177[a]	54% Municipal Point Source Discharge; Industrial Point Source Discharge
	Nonpoint:	0.151[b]	46% Flow Alterations from Water Diversions; On-Site Treatment Systems (Septic Systems and Similar Decentralized Systems)

Notes:

[a] The magnitude for point sources was calculated by adding the individual loads from the WWTP and the Mora Fish Hatchery. The individual loads were calculated multiplying the geometric mean TP concentration (0.184 mg/L for the WWTP and 0.024 mg/L from the hatchery), the discharge from the facility (0.052 MGD for the WWTP and 0.486 for the hatchery), and the 8.34 conversion factor to get a result in lbs/day.

[b] The magnitude for nonpoint sources was calculated by subtracting the magnitude of the point sources from the measured load (Section 5.3, Table 5.6).

* From the 2006-2008 Integrated CWA §303(d)/§305(b) List. This list of probable sources is based on staff observation and known land use activities in the watershed. These sources are not confirmed or quantified at this time.

Table 5.12 Pollutant Source Summary for Total Nitrogen

Assessment Unit	Pollutant Sources	Magnitude (lbs/day)	Probable Sources* (% from each)
Little Coyote Creek (Black Lake to headwaters)	Point:	0	0%
	Nonpoint:	0.327	100% Natural Sources; Rangeland Grazing; Source Unknown
Mora River (gage east of Shoemaker to Hwy 434)	Point: NM0024996 NM0030031	1.632[a]	62% Municipal Point Source Discharge; Industrial Point Source Discharge
	Nonpoint:	1.005[b]	38% Flow Alterations from Water Diversions; On-Site Treatment Systems (Septic Systems and Similar Decentralized Systems)

Notes:

[a] The magnitude for point sources was calculated by adding the individual loads from the WWTP and the Mora Fish Hatchery. The individual loads were calculated multiplying the geometric mean TN concentration (1.790 mg/L for the WWTP and 0.211 mg/L from the hatchery), the discharge from the facility (0.052 MGD for the WWTP and 0.486 for the hatchery), and the 8.34 conversion factor to get a result in lbs/day.

[b] The magnitude for nonpoint sources was calculated by subtracting the magnitude of the point sources from the measured load (Section 5.3, Table 5.6).

* From the 2006-2008 Integrated CWA §303(d)/§305(b) List. This list of probable sources is based on staff observation and known land use activities in the watershed. These sources are not confirmed or quantified at this time.

5.6 Linkage Between Water Quality and Pollutant Sources

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

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

The largest reservoir of nitrogen is the atmosphere. About 80 percent of the atmosphere by volume consists of nitrogen gas (N_2). Although nitrogen is plentiful in the environment, it is not readily available for biological uptake. Nitrogen gas must be converted to other forms, such as ammonia (NH_3 and NH_4^+), nitrate (NO_3^-), or nitrite (NO_2^-) before plants and animals can use it.

Conversion of gaseous nitrogen into usable mineral forms occurs through three biologically mediated processes of the nitrogen cycle: nitrogen fixation, nitrification, and ammonification (USEPA 1999). Mineral forms of nitrogen can be taken up by plants and algae and incorporated into plant or algal tissue. Nitrogen follows the same pattern of food web incorporation as phosphorus and is released in waste primarily as ammonium compounds. The ammonium compounds are usually converted to nitrates by nitrifying bacteria, making it available again for uptake, starting the cycle anew (Nebel and Wright 2000).

Rain, overland runoff, groundwater, drainage networks, and industrial and residential waste effluents transport nutrients to receiving waterbodies. Once nutrients have been transported into a waterbody they can be taken up by algae, macrophytes, and microorganisms either in the water column or in the benthos; they can sorb to organic or inorganic particles in the water column and/or sediment; they can accumulate or be recycled in the sediment; or they can be transformed and released as a gas from the waterbody (Figure 5.1).

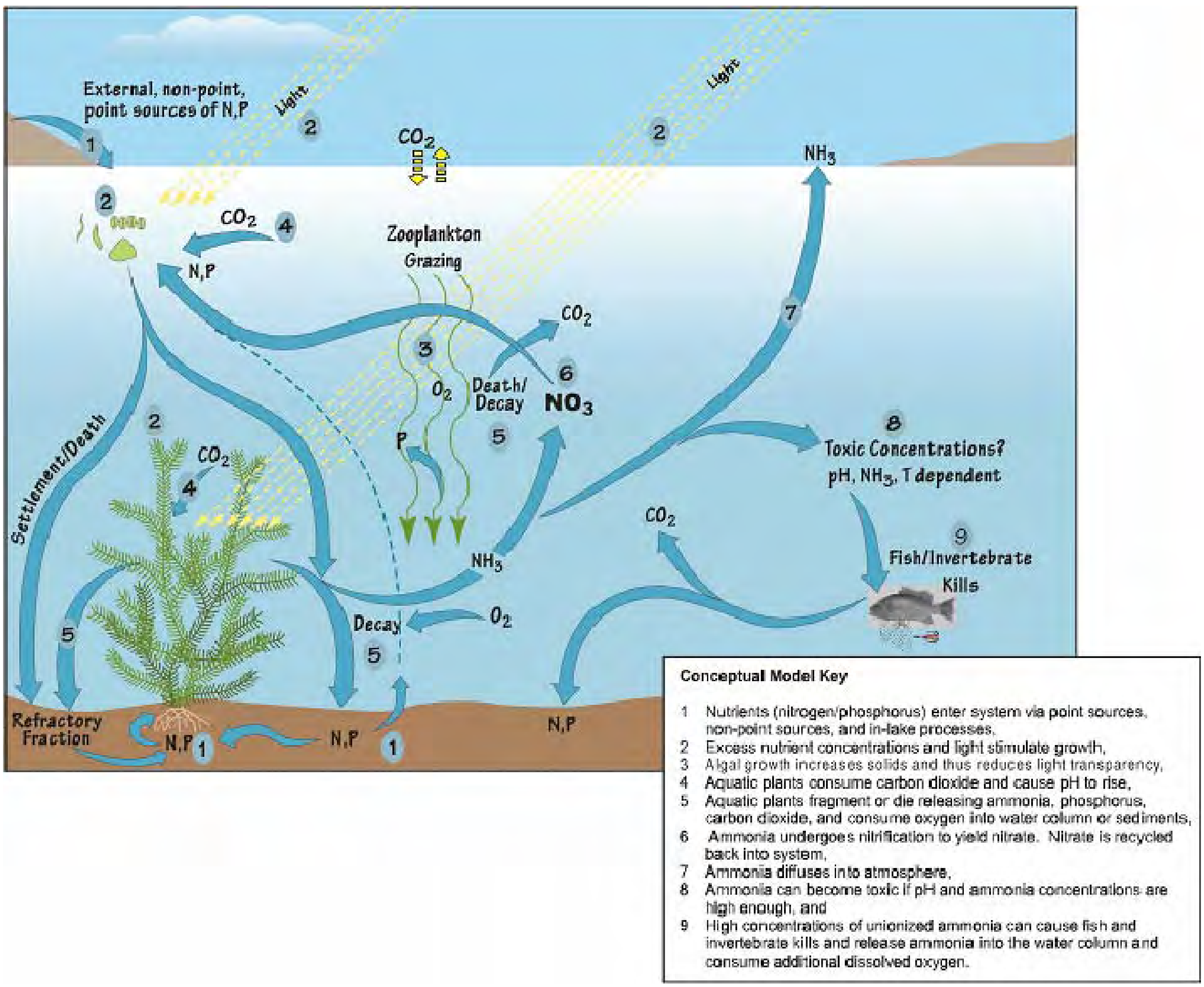


Figure 5.1. Nutrient Conceptual Model (USEPA 1999)

As noted above, phosphorus and nitrogen are essential for proper functioning of ecosystems. However, excess nutrients cause conditions unfavorable for the proper functioning of aquatic ecosystems. Nuisance levels of algae and other aquatic vegetation (macrophytes) can develop rapidly in response to nutrient enrichment when other factors (e.g., light, temperature, substrate, etc.) are not limiting (Figure 5.1). The relationship between nuisance algal growth and nutrient enrichment in stream systems has been well documented in the literature (Welch 1992; Van Nieuwenhuyse and Jones 1996; Dodds et al. 1997; Chetelat et al. 1999). Unfortunately, the magnitude of nutrient concentration that constitutes an “excess” is difficult to determine and varies by ecoregion.

The Mora River and its tributaries have three main land covers, as presented in Figure 3.4. They include forest (spruce-fir-pine-aspen in higher elevations and piñon-juniper in lower elevations) in the western mountainous region, rangeland characterized by gramma grass in association with shrubland in the eastern plains, and agriculture, which is located primarily along narrow, alluvial valleys and river corridors. As described in Section 5.2, the presence of plant nutrients in a stream can vary as a function of flow. As flow decreases through water diversions and/or drought-related stressors, the stream cannot effectively dilute its constituents, which causes the concentration of plant nutrients to increase. Nutrients generally reach a waterbody from land uses that are in close proximity to the stream because the hydrological pathways are shorter and have fewer obstacles than land uses located away from the riparian corridor. However, during the growing season (i.e. in agricultural return flow) and in storm water runoff, distant land uses can become hydrologically connected to the stream, thus transporting nutrients from the hillslopes to the stream during these time periods.

In addition to agriculture, there are several other human-related activities that influence nutrient concentrations in rivers and streams. Residential areas contribute nutrients from septic tank disposal systems, landscape maintenance, as well as backyard livestock (e.g. cattle, horses) and pet wastes. Urban development contributes nutrients by disturbing the land and consequently increasing soil erosion, by increasing the impervious area within the watershed, and by directly applying nutrients to the landscape. Recreational activities such as hiking and biking can also contribute nutrients to the stream by reducing plant cover and increasing soil erosion (e.g. trail network, streambank destabilization), direct application of human waste, campfires and/or wildfires, and dumping trash near the riparian corridor.

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

Water pollution caused by on-site septic systems is a widespread problem in New Mexico (McQuillan 2004). Septic system effluents have contaminated more water supply wells, and more acre-feet of ground water, than all other sources in the state combined. Groundwater contaminated by septic system effluent can discharge into streams gaining from groundwater inflow, such as the Mora River. Nutrients such as phosphorous and nitrogen released into gaining streams from aquifers contaminated by septic systems can contribute to eutrophic conditions. The Village of Mora has several on-site domestic wells and the Mora Valley has numerous septic systems, with sewerage services being available for approximately 110 households.

SWQB fieldwork includes an assessment of the probable sources of impairment (NMED/SWQB 1999). The completed *Pollutant Source(s) Summary Table* in Appendix B provides documentation of a visual analysis of probable sources along an impaired reach. Although this procedure is subjective, SWQB feels that it provides the best available information for the identification of probable sources of impairment in this watershed. It is important to consider not only the land directly adjacent to the stream, which is predominantly privately held, but also to consider upland and upstream areas in a more holistic watershed approach to implementing TMDLs. These nutrient TMDLs were calculated using the best available methods that were known at the time of calculation and may be revised in the future.

5.7 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. The MOS can be expressed either implicitly or explicitly. An implicit MOS is incorporated by making conservative assumptions in the TMDL analysis, such as allocating a conservative load to background sources. An explicit MOS is applied by reserving a portion of the TMDL and not allocating it to any other sources.

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

- *Conservative Assumptions*

  Treating phosphorus and nitrogen as conservative pollutants, that is a pollutant that does not readily degrade in the environment, was used as a conservative assumption in developing these loading limits.

  Using the 4Q3 critical low flow “worst case scenario” to calculate the allowable loads.

  Using the treatment plant design capacity for calculating the point source loading when, under most conditions, the treatment plant is not operating at full capacity.

  Using the 24-month highest average discharge from the National Fish Hatchery for calculating the point source loading when, under most conditions, the hatchery is not operating at this maximum discharge.

- *Explicit recognition of potential errors*

  A level of uncertainty exists in water quality sampling. Accordingly, a conservative MOS equals 10 percent of the TMDL.

5.8 Consideration of Seasonal Variability

Section 303(d)(1) of the CWA requires TMDLs to be "established at a level necessary to implement the applicable WQS with seasonal variation." Data used in the calculation of this TMDL were collected during spring, summer, and fall in order to ensure coverage of any potential seasonal variation in the system. Exceedences were observed from March through November, during all seasons and across multiple years, which captured flow alterations related to snowmelt, agricultural diversions, and summer monsoonal rains. Data that exceeded the target concentration for TP and TN were used in the calculation of the measured loads (Table 5.6) and can be found in Table 5.5. The critical condition used for calculating the TMDL was low-flow. Calculations made at the critical low-flow (4Q3), in addition to using other conservative assumptions as described in the previous section on MOS, should be protective of the water quality standards designed to preserve aquatic life in the stream. It was assumed that if critical conditions were met during this time, coverage of any potential seasonal variation would also be met.

5.9 Future Growth

Growth estimates by county are available from the New Mexico Bureau of Business and Economic Research. These estimates project growth to the year 2030. Growth estimates for Mora County project a 40% growth rate through 2030. Since future projections indicate that nonpoint sources of nutrients will more than likely increase as the region continues to grow and develop, it is imperative that BMPs continue to be utilized and improved upon in this watershed while continuing to improve road conditions and grazing allotments and adhering to SWPPP requirements related to construction and industrial activities covered under the general permit.

6.0 TEMPERATURE

Monitoring for temperature was conducted by SWQB in 2002. Based on available data, several exceedences of the New Mexico WQS for temperature were noted throughout the watershed (Figures 5.1-5.2). Thermographs were set to record once every hour for several months during the warmest time of the year (generally May through October). Thermograph data are assessed using Appendix C of the *State of New Mexico Procedures for Assessing Standards Attainment for the Integrated CWA §303(d)/§305(b) Water Quality Monitoring and Assessment Report* (NMED/SWQB 2006). Based on 2002 data, temperature listings retained on the *2006-2008 State of NM §303(d) List for Impaired Waters* (NMED/SWQB 2007) for Coyote Creek (Mora River to Black Lake), Vermejo River (York Canyon to headwaters), and Vermejo River (Rail Canyon to York Canyon). Temperature data from 2002 were used to develop these TMDLs. No thermograph data were available to address the existing temperature impairment on Van Bremmer Creek (Hwy 64 to headwaters).

6.1 Target Loading Capacity

Target values for these temperature TMDLs will be determined based on 1) the presence of numeric criteria, 2) the degree of experience in applying the indicator, and 3) the ability to easily monitor and produce quantifiable and reproducible results. For this TMDL document, target values for temperature are based on the reduction in solar radiation necessary to achieve numeric criteria as predicted by a temperature model. This TMDL is also consistent with New Mexico's antidegradation policy.

The State of New Mexico has developed and adopted numeric water quality criteria for temperature to protect the designated use of high quality coldwater aquatic life (HQCWAL) (20.6.4.900.H NMAC). These WQS have been set at a level to protect coldwater aquatic life such as trout. The HQCWAL use designation requires that a stream reach must have water quality, streambed characteristics, and other attributes of habitat sufficient to protect and maintain a propagating coldwater fishery (i.e., a population of reproducing salmonids). The standard leading to an assessment of use impairment is the numeric criterion for temperature of 20°C (68°F). Table 5.1 and Figure 5.1 highlight the 2002 thermograph deployments. The following TMDLs address three reaches where temperatures exceeded the criterion (**Appendix D** of this document provides a graphical representation of thermograph data):

<u>*Coyote Creek (Mora River to Black Lake):*</u> Two thermographs was deployed on this reach in 2002 at Coyote Creek at Thal Ranch (Site E) and Coyote Creek at Coyote State Park (Site D). The thermograph at site D recorded temperatures from April 29 through September 20 exceeded the CWAL use criterion 275 of 3,460 times (8%) with a maximum temperature of 22.69°C on July 19. The thermograph at site E recorded temperatures from April 29 through October 8 exceeded the CWAL use criterion 1,417 of 3,889 times (36%) with a maximum temperature of 28.26°C on July 8.

<u>*Vermejo River (York Canyon to headwaters)):*</u> One thermograph was deployed on this reach in 2002 at Vermejo River at Juan Baca Canyon (Site Q). Recorded temperatures from April

29 through September 20 exceeded the CWAL use criterion 1,029 of 3,460 times (30%) with a maximum temperature of 30.08°C on July 8.

Vermejo River (Rail Canyon to York Canyon): One thermograph was deployed on this reach in 2002 at Vermejo River above Caliente Canyon (Site R). Recorded temperatures from April 29 through August 1 exceeded the CWAL use criterion 749 of 2,257 times (33%) with a maximum temperature of 30.48°C on July 12.

Table 6.1 Canadian Basin Thermograph Sites

Site Number	Site Name	Deployment Dates
A	Canadian below Ute Dam[1]	5/6/02-11/1/02
B	Chicorica below Lake Alice	4/29/02-10/21/02
C	Chicorica below Una de Gato Creek	4/29/02-9/20/02
D	Coyote Creek at State Park at USGS gage	4/29/02-9/20/02
E	Coyote Creek at Thal Ranch	4/29/02-10/8/02
F	Little Coyote Creek @ Hwy 434	4/29/02-9/20/02
G	Manuelas above Ocate Creek	4/29/02-9/20/02
H	Manuelitas @ Hwy 94 bridge	5/13/02-10/8/02
I	Manuelitas above Maestas	5/13/02-10/18/02
J	Mora at Black Willow Ranch	6/11/02-10/8/02
K	Mora at Cleveland by bridge on Church Rd	4/29/02-9/20/02
L	Mora at La Cueva USGS gage	4/29/02-9/20/02
M	Rito Cebolla above Mora River at Hwy 161	4/29/02-11/1/02
N	Sapello @ Hwy 518	5/13/02-10/8/02
O	Sapello @ Mossiman Ranch[1]	5/13/02-10/8/02
P	Vermejo River @ I-25	4/30/02-9/16/02
Q	Vermejo River @ Juan Baca Canyon	4/29/02-9/20/02
R	Vermejo above Caliente Canyon	4/29/02-8/1/02

[1] *Duplicate water thermographs deployed*

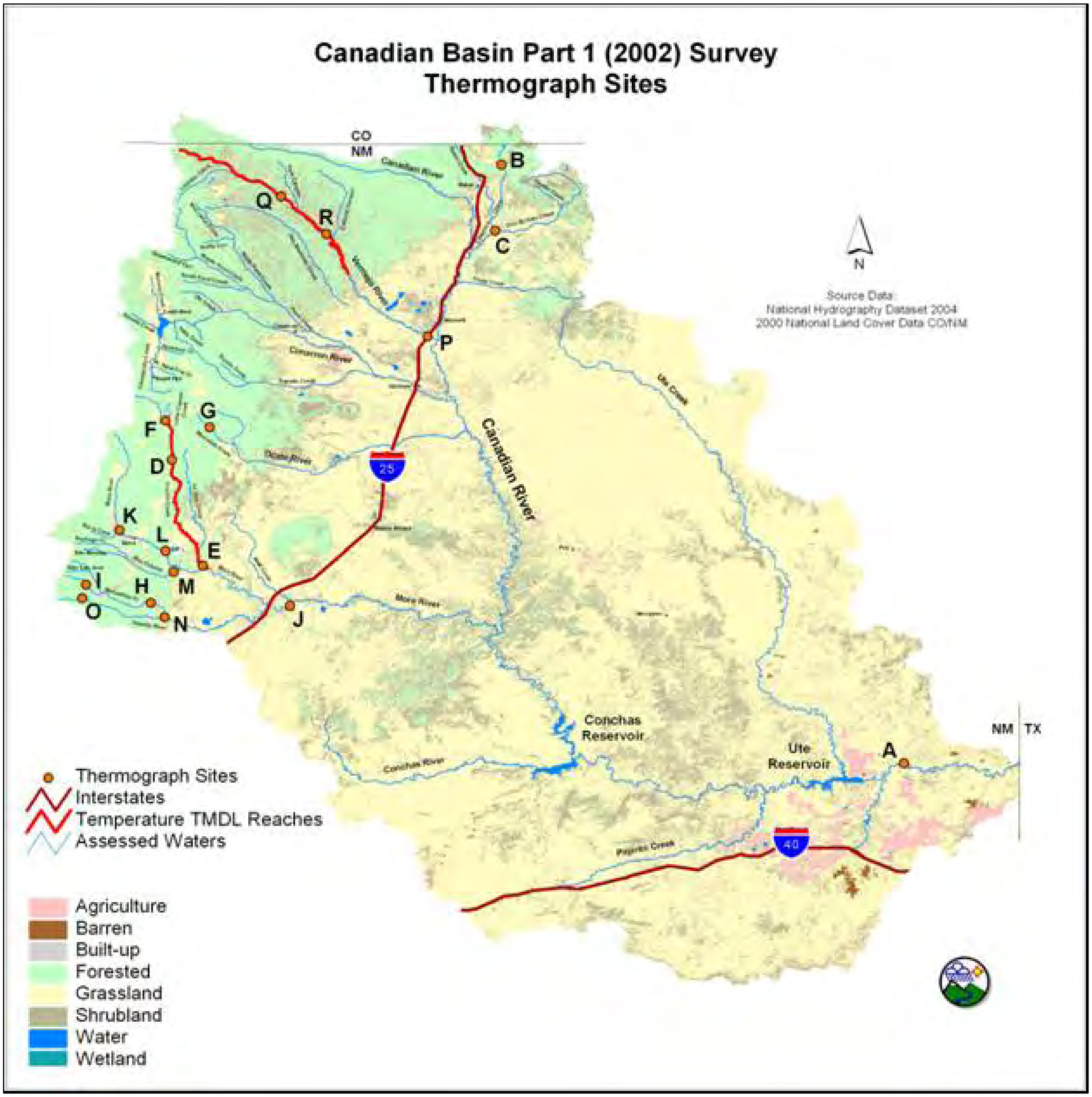


Figure 6.1 Canadian Basin thermograph sites

6.2 Calculations

The Stream Segment Temperature (SSTEMP) Model, Version 2.0 (Bartholow 2002) was used to predict stream temperatures based on watershed geometry, hydrology, and meteorology. The USGS Biological Resource Division developed this model (Bartholow 2002). 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 predicted temperature values are compared to actual thermograph readings measured in the field in order to calibrate the model. The SSTEMP model identifies current stream and/or watershed characteristics that control stream temperatures. The model also quantifies the maximum loading capacity of the stream to meet water quality criteria for temperature. This model is important for estimating the effect of changing controls, or constraints, (such as riparian grazing, stream channel alteration, and reduced streamflow) on stream temperature. The model can also be used to help identify possible implementation activities to improve stream temperature by targeting those factors causing impairment to the stream.

6.3 Waste Load Allocations and Load Allocations

6.3.1 Waste Load Allocation

There are no permitted point source contributions associated with these TMDLs.

6.3.2 Load Allocation

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 ($j/m^2/s$) and Langley's per day. The following information relevant to the model runs used to determine temperature TMDLs is taken from the SSTEMP documentation (Bartholow 2002). Please refer to the SSTEMP User's Manual for complete text. Various notes have been added below in brackets to clarify local sources of input data.

The program will predict the minimum, mean, and maximum daily water temperature for the set of variables you provide. The theoretical basis for the model is strongest for the mean daily temperature. The maximum is largely an estimate and likely to vary widely with the maximum daily air temperature. The minimum is computed by subtracting the difference between maximum and mean from the mean; but the minimum is always positive. (Bartholow 2002).

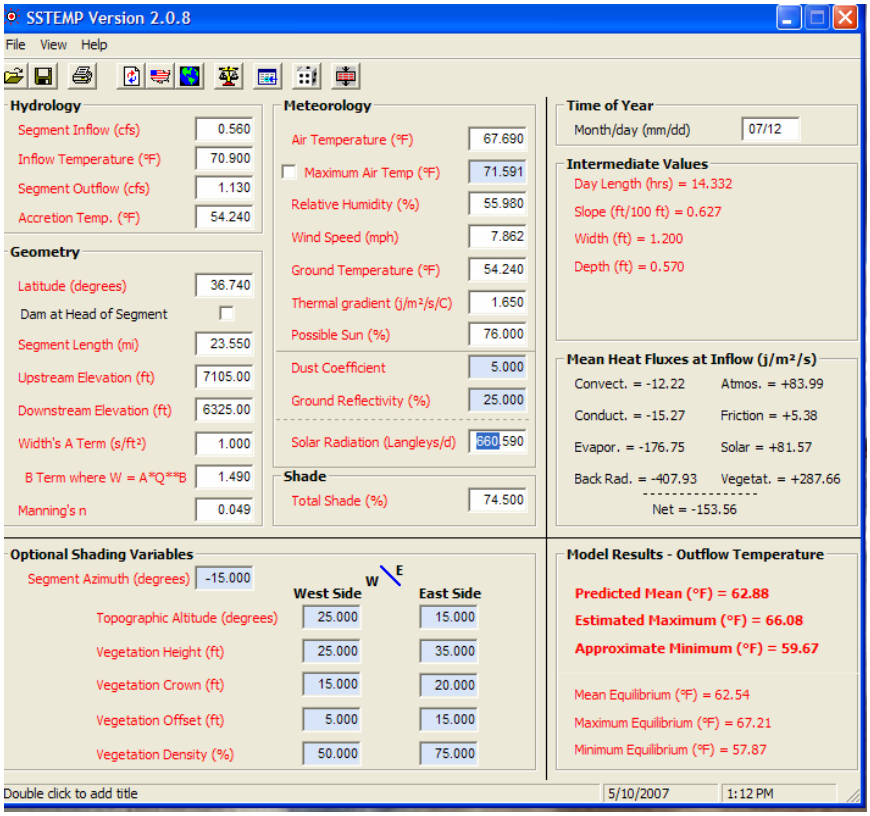


Figure 6.2 Example of SSTEMP input and output for Vermejo River

SSTEMP may be used to compute a one-at-a-time sensitivity of a set of input values. This simply increases and decreases most active input (i.e., non-grayed out values) by 10% and displays a screen for changes to mean and maximum temperatures. The schematic graph that accompanies the display gives an indication of which variables most strongly influence the results (Bartholow 2002). See Figure 6.3 for an example of a sensitivity analysis.

6.3.2.1 Temperature Load Allocations as Determined by % Total Shade and Width-to-Depth Ratios

SSTEMP was first calibrated against thermograph data to determine the standard error of the model. Initial conditions were determined. As the percent total shade was increased and the Width's A term was decreased, the maximum 24-hour temperature decreased until the segment-specific standard of 20ºC was achieved. The calculated 24-hour solar radiation component is the maximum solar load that can occur in order to meet the WQS (i.e., the target capacity). In order to calculate the actual LA, the WLA and MOS were subtracted from the target capacity (TMDL) following **Equation 2**.

$$WLA + LA + MOS = TMDL \qquad \text{(Eq. 2)}$$

The allocations for each assessment unit requiring a temperature TMDL are provided in the following tables.

Temperature Load Allocation for Coyote Creek (Mora River to Black Lake)

For Coyote Creek (Mora River to Black Lake), the WQS for temperature is achieved when the percent total shade is increased to 60.5%. According to the SSTEMP model, the actual LA of 113.88 j/m^2/s/day is achieved when the shade is further increased to 64.5% (Table 6.2).

Table 6.2 SSTEMP Model Results for Coyote Creek (Mora River to Black Lake)

<table>
<tr><th>Rosgen Channel Type</th><th>WQS (HQCW Aquatic Life)</th><th>Model Run Dates</th><th>Segment Length (miles)</th><th>Solar Radiation Component per 24-Hours (+/-)</th><th>% Total Shade</th><th>Width's A Term</th><th>Modeled Temperature °C (24 hour)</th></tr>
<tr><td>B5c or F</td><td>20°C (68°F)</td><td>7/8/02</td><td>35.26</td><td>Current Field Condition
+253.06
j/m^2/s/day</td><td>21</td><td>7.35</td><td>Minimum: 15.37
Mean: 19.69
Maximum: 24.02</td></tr>
<tr><td colspan="4" rowspan="3">TEMPERATURE ALLOCATIONS FOR Coyote Creek (Mora River to Black Lake)

[a] 24-HOUR ACHIEVEMENT OF SURFACE WQS FOR TEMPERATURE

[b] 24-HOUR LOAD ALLOCATION (LA) NEEDED TO ACHIEVE SURFACE WQS WITH A 10% MARGIN OF SAFETY

Actual reduction in solar radiation necessary to meet surface WQS for temperature:

Current Condition – Load Allocation =

253.06 j/m^2/s/day – 113.88 j/m^2/s/day

=139.18 j/m^2/s/day</td><td>Run 1
+192.20
j/m^2/s/day</td><td>40</td><td>7.35</td><td>Minimum: 14.81
Mean: 18.48
Maximum: 22.16</td></tr>
<tr><td>Run 2
+126.53 [a]
j/m^2/s/day</td><td>60.5</td><td>7.35</td><td>Minimum: 14.24
Mean: 17.11
Maximum: 19.97</td></tr>
<tr><td>Actual LA
113.88 [b]
j/m^2/s/day</td><td>64.5</td><td>7.35</td><td>Minimum: 14.14
Mean: 16.83
Maximum: 19.52</td></tr>
</table>

<u>Temperature Load Allocation for Vermejo River (York Canyon to headwaters)</u>

For Vermejo River (York Canyon to headwaters), the WQS for temperature is achieved when the percent total shade is increased to 72%. According to the SSTEMP model, the actual LA of 80.72 j/m^2/s/day is achieved when the shade is further increased to 75% (Table 6.3).

Table 6.3 SSTEMP Model Results for Vermejo River (York Canyon to headwaters)

<table>
<tr><th>Rosgen Channel Type</th><th>WQS (HQCW Aquatic Life)</th><th>Model Run Dates</th><th>Segment Length (miles)</th><th>Solar Radiation Component per 24-Hours (+/-)</th><th>% Total Shade</th><th>Width's A Term</th><th>Modeled Temperature °C (24 hour)</th></tr>
<tr><td>C4</td><td>20°C (68°F)</td><td>7/8/02</td><td>25.05</td><td>Current Field Condition
+320.33
j/m^2/s/day</td><td>0</td><td>0.337</td><td>Minimum: 17.61
Mean: 22.26
Maximum: 26.91</td></tr>
<tr><td colspan="4" rowspan="3">TEMPERATURE ALLOCATIONS FOR Vermejo River (York Canyon to headwaters)

[a] 24-HOUR ACHIEVEMENT OF SURFACE WQS FOR TEMPERATURE

[b] 24-HOUR LOAD ALLOCATION (LA) NEEDED TO ACHIEVE SURFACE WQS WITH A 10% MARGIN OF SAFETY

Actual reduction in solar radiation necessary to meet surface WQS for temperature:

Current Condition – Load Allocation =

320.33 j/m^2/s/day – 80.72 j/m^2/s/day

=239.61 j/m^2/s/day</td><td>Run 1
+160.16
j/m^2/s/day</td><td>50</td><td>0.337</td><td>Minimum: 16.17
Mean: 19.24
Maximum: 22.32</td></tr>
<tr><td>Run 2
+89.69 [a]
j/m^2/s/day</td><td>72</td><td>0.337</td><td>Minimum: 15.61
Mean: 17.78
Maximum: 19.97</td></tr>
<tr><td>Actual LA
80.72 [b]
j/m^2/s/day</td><td>75</td><td>0.337</td><td>Minimum: 15.53
Mean: 17.58
Maximum: 19.63</td></tr>
</table>

Temperature Load Allocation for Vermejo River (Rail Canyon to York Canyon)

For Vermejo River (Rail Canyon to York Canyon), the WQS for temperature is achieved when the percent total shade is increased to 71.5%. According to the SSTEMP model, the actual LA of 82.05 j/m^2/s/day is achieved when the shade is further increased to 74.5% (Table 6.4).

Table 6.4 SSTEMP Model Results for Vermejo River (Rail Canyon to York Canyon)

<table>
<tr><th>Rosgen Channel Type</th><th>WQS (HQCW Aquatic Life)</th><th>Model Run Dates</th><th>Segment Length (miles)</th><th>Solar Radiation Component per 24-Hours (+/-)</th><th>% Total Shade</th><th>Width's A Term</th><th>Modeled Temperature °C (24 hour)</th></tr>
<tr><td>C4</td><td>20°C (68°F)</td><td>7/12/02</td><td>23.55</td><td>Current Field Condition
+319.89
j/m^2/s/day</td><td>0</td><td>0.082</td><td>Minimum: 17.08
Mean: 22.77
Maximum: 28.45</td></tr>
<tr><td colspan="4" rowspan="3">TEMPERATURE ALLOCATIONS FOR Vermejo River (Rail Canyon to York Canyon)

(a) 24-HOUR ACHIEVEMENT OF SURFACE WQS FOR TEMPERATURE

(b) 24-HOUR LOAD ALLOCATION (LA) NEEDED TO ACHIEVE SURFACE WQS WITH A 10% MARGIN OF SAFETY

Actual reduction in solar radiation necessary to meet surface WQS for temperature:

Current Condition – Load Allocation =

319.89 j/m^2/s/day – 82.05 j/m^2/s/day

=237.84 j/m^2/s/day</td><td>Run 1
+174.96
j/m^2/s/day</td><td>45</td><td>0.082</td><td>Minimum: 15.36
Mean: 19.42
Maximum: 23.48</td></tr>
<tr><td>Run 2
+91.17 (a)
j/m^2/s/day</td><td>71.5</td><td>0.082</td><td>Minimum: 14.46
Mean: 17.23
Maximum: 19.99</td></tr>
<tr><td>Actual LA
82.05 (b)
j/m^2/s/day</td><td>74.5</td><td>0.082</td><td>Minimum: 14.37
Mean: 16.96
Maximum: 19.56</td></tr>
</table>

According to the Sensitivity Analysis feature of the model runs (Figure 6.3), mean daily air temperature had the greatest influence on the predicted outflow temperatures and total shade values have the greatest influence on temperature reduction. However, reducing Width's A term had an insignificant effect on the predicted maximum temperature. There were no air thermograph data available from the 2002 survey in order to display the relationship between air and water temperatures. Ordinarily, the figures would show a greater diurnal swing in impaired reaches as compared to those in an unimpaired reach.

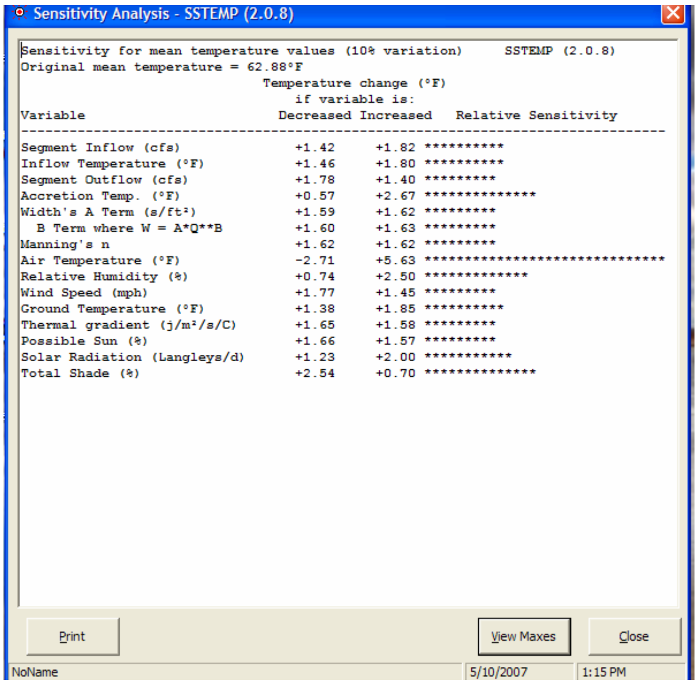


Figure 6.3 Example of SSTEMP sensitivity analysis for Vermejo River

The estimate of total shade used in the model calibration was based on densiometer readings (field notes) and examination of aerial photographs (see **Appendix E**). Target loads as determined by the modeling runs are summarized in Tables 6.2-6.4. The MOS is estimated to be 10% of the target load calculated by the modeling runs. Results are summarized in Table 6.5. Additional details on the MOS are presented in Section 6.6 below.

Table 6.5 Calculation of TMDLs for Temperature

Assessment Unit	WLA ($j/m^2/s/day$)	LA ($j/m^2/s/day$)	MOS (10%)[a] ($j/m^2/s/day$)	TMDL ($j/m^2/s/day$)
Coyote Creek (Mora River to Black Lake)	0	114*	13.0*	127*
Vermejo River (York Canyon to headwaters)	0	80.7*	9.0*	89.7*
Vermejo River (Rail Canyon to York Canyon)	0	82.1*	9.1*	91.2*

Notes:
(a) Actual MOS values may be slightly greater than 10% because the final MOS is back calculated after the Total Shade value is increased enough to reduce the modeled solar radiation component to a value less than the target load minus 10%.
* Values rounded to three significant figures.

The load reductions that would be necessary to meet the target loads were calculated to be the difference between the calculated target load and the measured load (i.e., current field condition in Tables 6.2-6.4), and are shown in Table 6.6.

Table 6.6 Calculation of Load Reduction for Temperature

Location	Target Load[a] ($j/m^2/s/day$)	Measured Load ($j/m^2/s/day$)	Load Reduction ($j/m^2/s/day$)	Percent Reduction[b]
Coyote Creek (Mora River to Black Lake)	114*	253*	139*	55
Vermejo River (York Canyon to headwaters)	80.7*	320*	239*	75
Vermejo River (Rail Canyon to York Canyon)	82.1*	320*	238	74

Notes: The MOS is not included in the load reduction calculations because it is a set aside value which accounts for any uncertainty, or variability, in TMDL calculations and therefore should not be subtracted from the measured load.
(a) Target Load = LA + WLA
(b) Percent reduction is the percent the existing measured load must be reduced to achieve the target load, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100.
* Values rounded to three significant figures.

6.4 Identification and Description of pollutant source(s)

Pollutant sources that could contribute to each segment are listed in Table 6.7.

Table 6.7 Pollutant source summary for Temperature

Pollutant Sources	Magnitude[(a)]	Location	Probable Sources[(b)] (% from each)
Point:			
None	0	--------	0%
Nonpoint:			
	253	Coyote Creek (Mora River to Black Lake)	100% Natural sources Rangeland grazing
	320	Vermejo River (York Canyon to headwaters)	100% Rangeland Grazing Streambank Modifications/destablization
	320	Vermejo River (Rail Canyon to York Canyon)	100% Habitat modification-other than hydromodification Rangeland grazing Source unknown

Notes:
(a) Measured Load as j/m^2/s/day. Expressed as solar radiation.
(b) From the 2006-2008 Integrated CWA §303(d)/305(b) list unless otherwise noted.

6.5 Linkage of Water Quality and Pollutant Sources

Water temperature influences the metabolism, behavior, and mortality of fish and other aquatic organisms. Natural temperatures of a waterbody fluctuate daily and seasonally. These natural fluctuations do not eliminate indigenous populations, but may affect existing community structure and geographical distribution of species. In fact, such temperature cycles are often necessary to induce reproductive cycles and may regulate other aspects of life history (Mount 1969). Behnke and Zarn (1976) in a discussion of temperature requirements for endangered western native trout recognized that populations cannot persist in waters where maximum temperatures consistently exceed 21-22°C, but they may survive brief daily periods of higher temperatures (25.5-26.7°C). Anthropogenic impacts can lead to modifications of these natural temperature cycles, often leading to deleterious impacts on the fishery. Such modifications may contribute to changes in geographical distribution of species and their ability to persist in the presence of introduced species. Of all the environmental factors affecting aquatic organisms in a waterbody, temperature is always a factor. Heat, which is a quantitative measure of energy of molecular motion that is dependent on the mass of an object or body of water is fundamentally different than temperature, which is a measure (unrelated to mass) of energy intensity. Organisms respond to temperature, not heat.

Temperature increases, as observed in SWQB thermograph data, show temperatures that exceed the State Standards for the protection of aquatic habitat, namely the CWAL designated uses. Through monitoring, and pollutant source documentation, it has been observed that the most probable cause for these temperature exceedences are due to the alteration of the stream's hydrograph, removal of riparian vegetation, livestock grazing, and natural causes. Alterations can be historical or current in nature.

A variety of factors impact stream temperature (Figure 6.4). Decreased effective shade levels result from reduction of riparian vegetation. When canopy densities are compromised, thermal loading increases in response to the increase in incident solar radiation. Likewise, it is well documented that many past hydromodification activities have lead to channel widening. Wider stream channels also increase the stream surface area exposed to sunlight and heat transfer. Riparian area and channel morphology disturbances are attributed to past and to some extent 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 and (2) increasing stream surface area exposed to solar radiation.

Riparian vegetation, stream morphology, hydrology, climate, geographic location, and aspect 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, the elevated summertime stream temperatures attributable to anthropogenic causes in the Canadian basin 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, and
3. Reduced summertime base flows that result from instream withdrawals and/or inadequate riparian vegetation. Base flows are maintained with a functioning riparian system so that loss of a functioning riparian system may lower and sometimes eliminate baseflows. Although removal of upland vegetation has been shown 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 stream reaches, increased temperatures can result in increased streambed infiltration, which can result in lower base flow (Constantz et al. 1994).

Analyses presented in these TMDLs demonstrate that defined loading capacities will ensure attainment of New Mexico WQS. Specifically, the relationship between shade, channel dimensions, solar radiation, and water quality attainment was demonstrated. Vegetation density increases will provide necessary shading, as well as encourage bank-building processes in severe hydrologic events.

Where available data are incomplete or where the level of uncertainty in the characterization of sources is large, the recommended approach to TMDL assignments requires the development of allocations based on estimates utilizing the best available information.

SWQB fieldwork includes a determination of the probable sources of impairment (NMED/SWQB 1999). The completed *Pollutant Source(s) Summary Table* in **Appendix B** provides documentation of a visual analysis of probable sources along an impaired reach. Although this procedure is subjective, SWQB feels that it provides the best available information for the identification of probable sources of impairment in this watershed. Table 6.7 identifies and quantifies probable sources of nonpoint source impairments along each reach as determined by field reconnaissance and assessment. It is important to consider not only the land directly adjacent to the stream, but also to consider upland and upstream areas in a more holistic watershed approach to implementing this TMDL.

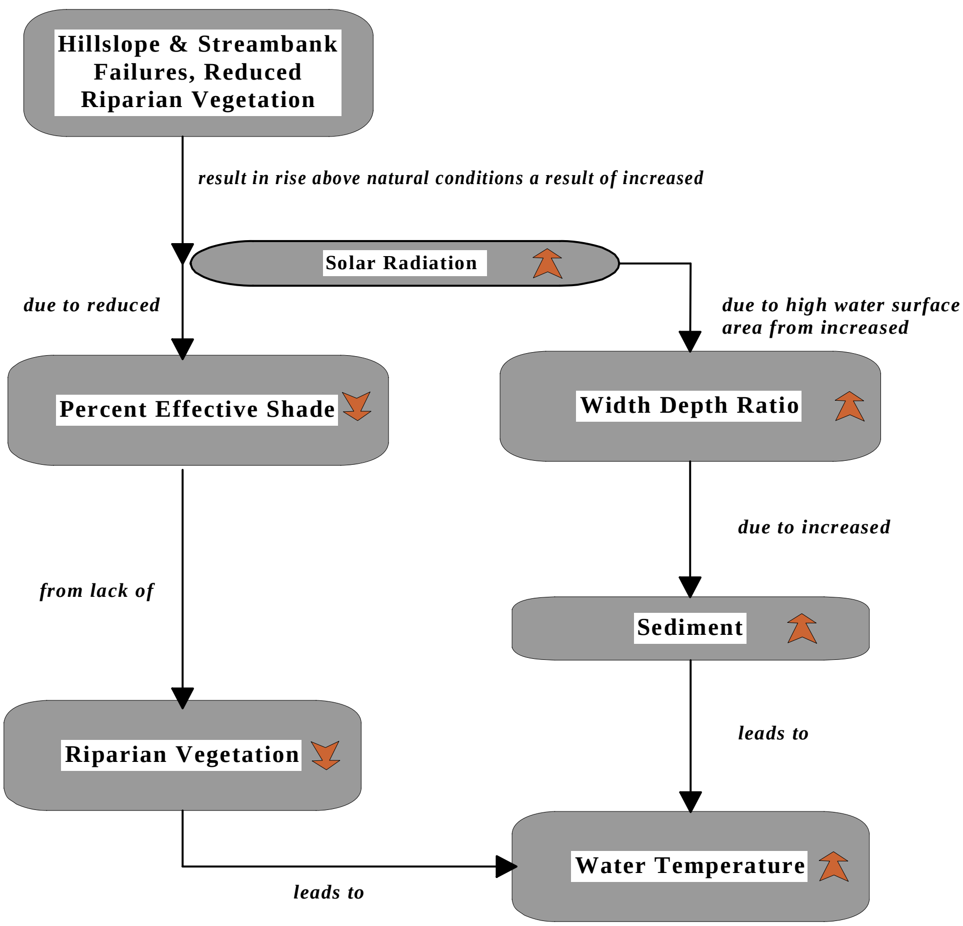


Figure 6.4 Factors That Impact Water Temperature

6.6 Margin of Safety (MOS)

The Federal 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, there were no MOS adjustments for point sources since there are none.

In order to develop this temperature TMDL, the following conservative assumptions were used to parameterize the model:

- Data from the warmest time of the year were used in order to capture the seasonality of temperature exceedences.
- Critical upstream and downstream low flows were used because assimilative capacity of the stream to absorb and disperse solar heat is decreased during these flow conditions.
- Low flow was modeled using formulas developed by the USGS. One formula (Thomas et al. 1997) is recommended when the ratio between the gaged watershed area and the ungaged watershed area is between 0.5 and 1.5. When the ratio is outside of this range, a different regression formula is used (Waltemeyer 2002). See **Appendix E** for details.

As detailed in **Appendix E,** a variety of high quality hydrologic, geomorphologic, and meteorological data were used to parameterize the SSTEMP model. Because of the high quality of data and information that was put into this model and the continuous field monitoring data used to verify these model outputs, an explicit MOS of 10% is assigned to this TMDL.

6.7 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 variation." Both stream temperature and flow vary seasonally and from year to year. Water temperatures are coolest in winter and early spring months.

Thermograph records show that temperatures exceed State of New Mexico WQS in summer and early fall. Warmest stream temperatures corresponded to prolonged solar radiation exposure, warmer air temperature, and low flow conditions. These conditions occur during late summer and early fall and promote the warmest seasonal instream temperatures. It is assumed that if critical conditions are met, coverage of any potential seasonal variation will also be met.

6.8 Future Growth

Estimations of future growth are not anticipated to lead to a significant increase for temperature that cannot be controlled with BMP implementation in this watershed.

7.0 SEDIMENTATION/SILTATION (STREAM BOTTOM DEPOSITS)

During the 2002 SWQB intensive water quality survey in the Canadian Watershed (Part 1), impairment due to excessive sedimentation/siltation (previously listed as impairment due to Stream Bottom Deposits [SBD]) was confirmed for Mora River [NM-2306.A_000] (Hwy 434 to headwaters) and Sapello River [NM-2305.3.A_20] (Mora River to Manuelitas Creek).

7.1 Target Loading Capacity

Target values for this Sedimentation/Siltation TMDL will be determined based on 1) the presence of numeric criteria or appropriate numeric translator to a narrative standard, 2) the degree of experience in applying the indicator, and 3) the ability to easily monitor and produce quantifiable and reproducible results. This TMDL is also consistent with New Mexico's antidegradation policy.

The state of New Mexico has developed and adopted a narrative criterion for "bottom deposits." The current general narrative criterion for the deposition of material on the bottom of a stream channel is specifically found in Paragraph (1) of Subsection A of 20.6.4.13 of the State of New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 NMAC):

> ***A. Bottom Deposits and Suspended or Settleable Solids:***
> ***(1)*** *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.*

Clean stream bottom substrates are essential for optimum habitat for many fish and aquatic insect communities. The impact of fine sediment deposits is well documented in the literature. Impairment occurs when critical habitat components, such as spawning gravels and cobble surfaces, are physically covered by fines thereby decreasing intergravel oxygen and reducing or eliminating the quality and quantity of habitat for fish, macroinvertebrates, and algae (Chapman and McLeod 1987, Lisle 1989, Waters 1995). An increased sediment load is often the most important adverse effect of activities on streams, according to a monitoring guidelines report (USEPA 1991). This impact is largely a mechanical action that severely reduces the available habitat for macroinvertebrates and fish species that utilize the streambed in various life stages. Minshall (1984) cited the importance of substratum size to aquatic insects and found that substratum is a primary factor influencing the abundance and distribution of insects. Aquatic detritivores also can be affected when their food supply either is buried under sediments or diluted by increased inorganic sediment load and by increasing search time for food (Relyea et al. 2000). In addition, sediment loads that exceed a river'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 (Schumm 1977, Knighton 1984). These morphological changes tend to accelerate erosion, thereby reducing habitat diversity and placing additional stress on designated aquatic life uses.

The SWQB Sediment Workgroup evaluated a number of methods described in the literature that would provide information allowing a direct assessment of the impacts to the stream bottom substrate. In order to address the narrative criteria for bottom deposits, SWQB compiled techniques to measure the level of sedimentation of a stream bottom. These procedures are presented in Appendix C of the *State of New Mexico Procedures for Assessing Standards Attainment for the Integrated §303(d)/§305(b) Water Quality Monitoring and Assessment Report* (NMED/SWQB 2004b), which is online at http://www.nmenv.state.nm.us/swqb/links.html. The purpose of the protocol is to provide a reproducible quantification of the narrative criteria for bottom deposits. A final set of monitoring procedures was implemented at a wide variety of sites during the 2002 monitoring season. These procedures included conducting pebble counts (to determine percent (%) fines), stream bottom cobble embeddedness, geomorphologic measurements, and the collection and enumeration of benthic macroinvertebrates. The SWQB is in the process of reviewing the sedimentation assessment protocol in order to improve it in the future, and will solicit input on revisions and improvements to this protocol.

Excessive stream bottom deposits impact a stream's health by reducing the interstitial space and subsequently reducing intergravel dissolved oxygen, which adversely impact the macroinvertebrate population by reducing the stream's spawning and rearing potential. From a channel morphology vantage point, increasing cobble embeddedness reduces channel roughness (Manning's "n"), thus reducing instream bed friction, which ultimately leads to further channel instability. By addressing sources of suspended sediment (i.e. watershed disturbances) that contribute to instream total suspended solids (TSS), there should be an improvement in biological community and reduction in the amount of embeddedness overtime, thus improving overall stream health.

Target Setting

In setting TMDL targets for the Mora and Sapello Rivers, the State uses a reference watershed approach when developing TMDLs for sediment. The reference waterbodies for these TMDLs are Rio la Casa at the inactive USGS gage 7-2148 and the Sapello River at Highway 518. Both reference sites are in the Mora subwatershed.

Rio la Casa at the inactive USGS gage 7-2148 was chosen as the benthic macroinvertebrate reference station for the Mora River at Cleveland near Bridge on Church Rd. Likewise, Sapello River at Highway 518 was chosen as the benthic macroinvertebrate reference station for the Sapello River at Emplazado. The reference and study sites are in the same ecoregion (Southern Rockies) and have similar geomorphic characteristics as displayed in Table 7.1. Benthic macroinvertebrate samples and pebble counts were collected at both stations according to methods described by Barbour et al. (1999) and Wohlman (1954).

Collection of benthic macroinvertebrates involved the compositing of three individual kick net samples taken from a riffle at each sampling location. Each kick involved the disturbance of approximately one-third of a square meter of substrate for one minute into a 500-micron mesh net. The rapid bioassessment protocol (RBP) metrics were applied to a 300-organism subsample of the composite sample at each site (Barbour et al. 1999).

Selection of those metrics that are particularly suited to the delineation of sediment impacts highlights the degree of impairment. Ephemeroptera/Plecoptera/Tricoptera (EPT) taxa, the number of sediment adapted organisms, taxa richness, and Hilsenhoff's Biotic Index (HBI) all indicate some degree of impairment attributable to sedimentation (Table 7.2). Select results of the pebble count and benthic macroinvertebrate surveys are shown in Table 7.2.

Table 7.1 Geomorphic Characteristics of Benthic Macroinvertebrate Sampling Sites

	Mora River		Sapello River	
Dimensions	**Reference Site[(a)]**	**Study Site[(b)]**	**Reference Site[(c)]**	**Study Site[(d)]**
Cross-section Area (sq. ft.)	27.8	53.1	59.2	n/a
Width (feet)	17.4	29.5	34.1	n/a
Maximum Depth (feet)	2.4	2.5	2.4	n/a
Mean Depth (feet)	1.6	1.8	1.7	n/a
Width:Depth Ratio	10.9	16.4	19.6	n/a
Entrenchment Ratio	5.75	1.27	1.77	n/a

Notes:
[(a)] Reference Site = Rio la Casa at inactive USGS gage 7-2148 (2002 Data)
[(b)] Study Site = Mora River at Cleveland by Bridge on Church Rd. (2002 Data)
[(c)] Reference Site = Sapello River at Highway 518 (2006 Data)
[(d)] Study Site = Sapello River at Emplazado (2006 Data)
n/a = not available

Table 7.2 Pebble Count and Benthic Macroinvertebrate Results

	Mora River			Sapello River		
Results	**Reference Site[(a)]**	**Study Site[(b)]**	**Percent of Reference**	**Reference Site[(c)]**	**Study Site[(d)]**	**Percent of Reference**
Pebble count						
% Fines (< 2 mm)	15	51	240%	40	56	40%
D50	75.9 mm	0.1 mm	—	32 mm	0.59 mm	—
D84	181 mm	76 mm	—	190 mm	44 mm	—
Benthic metrics						
Ephemeroptera/ Plecoptera/ Tricoptera Taxa	15	17	—	9	5	—
Taxa Richness	32	36	—	22	16	—
Hilsenhoff's Biotic Index	4.101	6.23	—	4.32	5.09	—
Total Biologic Score	40	26	65%	40	26	65%
Total Habitat Score (out of a possible 200)	176	96	55%	121	n/a	n/a

Notes:
[(a)] Reference Site = Rio la Casa at inactive USGS gage 7-2148 (2002 Data)
[(b)] Study Site = Mora River at Cleveland by Bridge on Church Rd. (2002 Data)
[(c)] Reference Site = Sapello River at Highway 518 (2006 Data)
[(d)] Study Site = Sapello River at Emplazado (2006 Data)
mm = Millimeters — = Not applicable
n/a = not available

In establishing a target for the Mora and the Sapello Rivers, NMED considered several factors. First, a recent District of Columbia Court of Appeals decision (*Friends of the Earth, Inc. v. EPA et al*), has now made it necessary for TMDLs to include "*daily load*" calculation. Currently the Clean Water Act Section 303(d)(1)(C) requires that TMDLs be established for pollutants which are, "suitable for calculation." In this case it is impossible to calculate a "*daily load*" for stream bottom deposits. Secondly, the Mora subwatershed (Figure 7.1) has both natural processes and watershed disturbances (both anthropogenic and non-anthropogenic) that contribute to sediment deposition. Therefore, this TMDL will focus on reducing TSS.

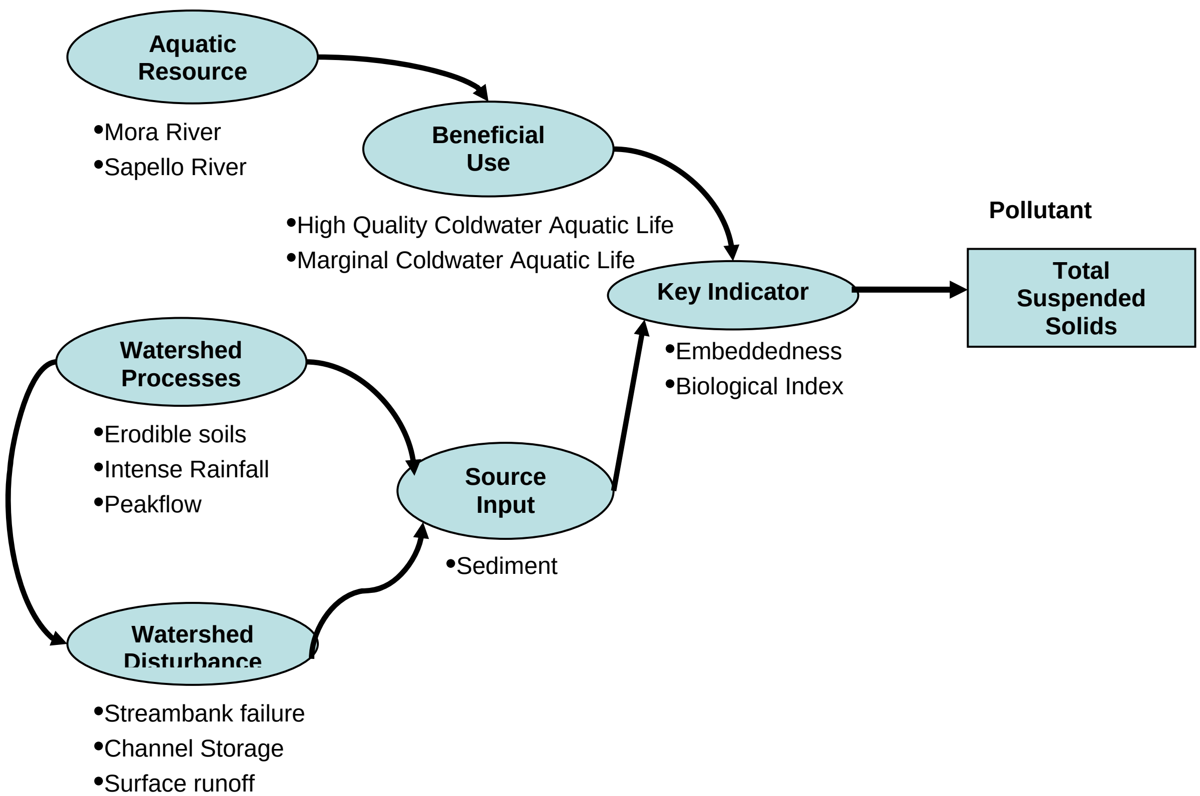


Figure 7.1 Sediment Issues and TMDL Target Setting

In examining the existing water quality data for the Mora and Sapello Rivers, limited streamflow, TSS, and turbidity data was available (Table 7.3). Analyzing the water quality data by station was impracticable because the data were limited. Therefore, the data were aggregated and an analysis was performed on the entire data set which represents the entire segment.

Table 7.3 Available Water Quality Data for the Mora and Sapello Rivers

	Number of Samples		
Mora River (Hwy 434 to headwaters)	TSS	Turbidity	Flow
Mora River at Chacon 0.6 miles above gage	9	9	8
Mora River at Cleveland by bridge on Church Rd.	9	9	9
Total Available Data	18	18	17
Sapello River (Mora River to Manuelitas Creek)	TSS	Turbidity	Flow
Sapello River at Hwy 161 (near Watrous)	8	8	8
Sapello River at Highway 518	9	9	9
Total Available Data	17	17	17

The segment-specific or use-specific turbidity values from the 2002 State of New Mexico Surface Water Quality Standards were used to obtain target values for each assessment unit. Based on the 2002 State standards, it was determined that a turbidity value of 25 NTU is the target that should be protective of the high quality coldwater aquatic use in the Mora River and the marginal coldwater aquatic use in the Sapello River. Remembering that in order to calculate a load in pounds per day (lb/day), TSS is used as a surrogate for stream bottom deposits. Figures 7.2 and 7.3 depict the relationship between TSS and turbidity for the Mora River and Sapello River, respectively (R^2 = 0.28; R^2 = 0.34).

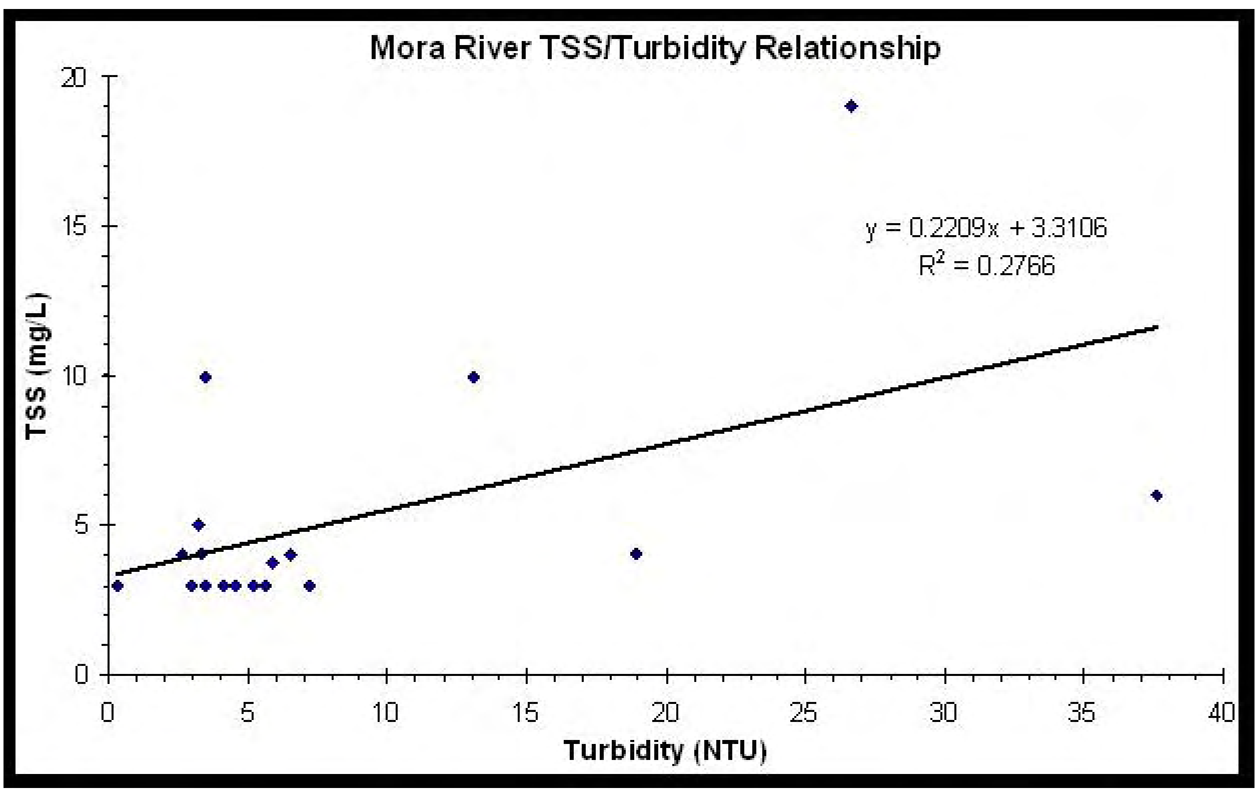


Figure 7.2 Mora River TSS vs. Turbidity Relationship

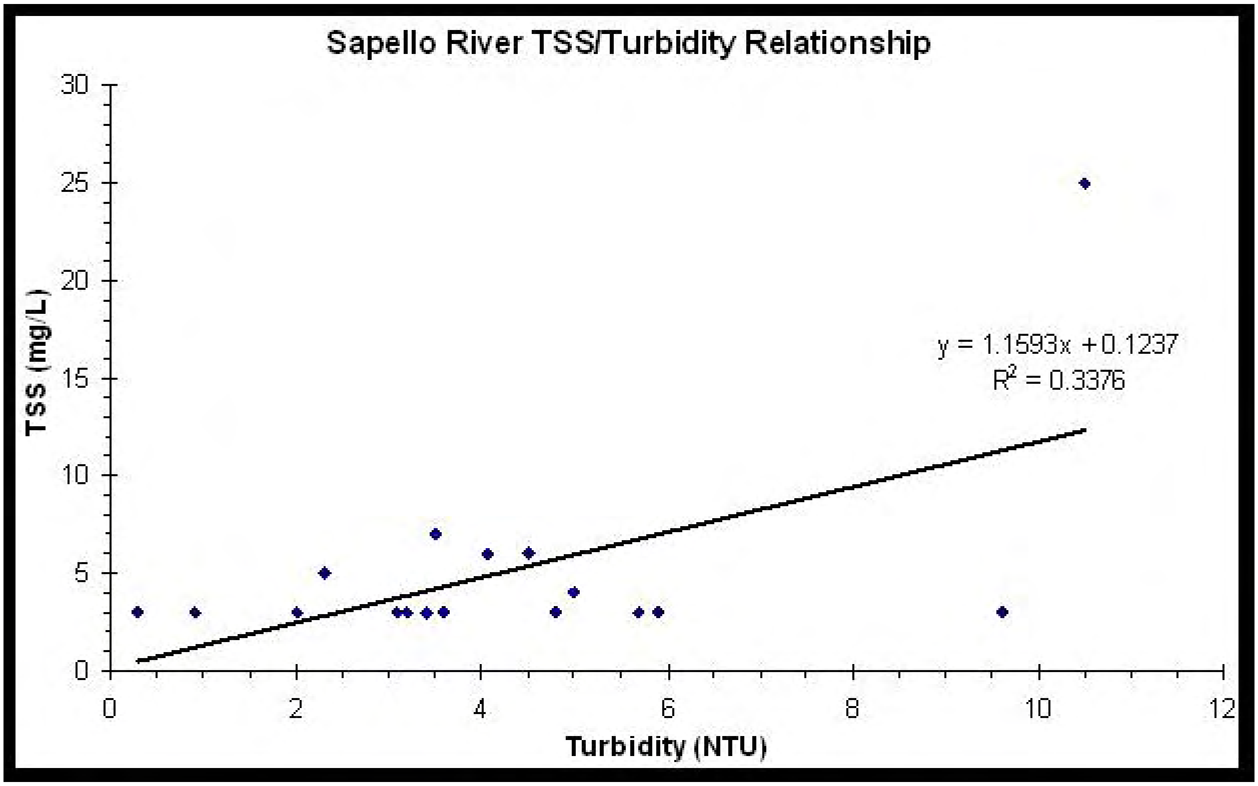


Figure 7.3 Sapello River TSS vs. Turbidity Relationship

The data shows that 28% of the variability in turbidity is explained by TSS in the Mora River and 34% of the variability is explained by TSS in the Sapello River. In addition, Pearson correlation coefficient was used to assess whether a statistical association existed between TSS and turbidity. Pearson correlation coefficient measures the strength and direction of a *linear* relationship between *X* and *Y* variables. Like other numerical measures, the population correlation coefficient is "ρ" (the Greek letter "rho") and the sample correlation coefficient is denoted by *r*.

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}}$$

When examining the entire data set, the data for the Mora River shows a positive association between TSS and turbidity (r = 0.53). Additionally, the data for the Sapello River shows a positive association between TSS and turbidity (r = 0.58). The relationship between TSS and turbidity show that potential sources of suspended sediment impact both TSS and turbidity.

Using the TSS/Turbidity relationship from Figures 7.2 and 7.3 and a turbidity target of 25 NTU, the TSS concentrations required to achieve NM water quality standards are:

- Mora River (Hwy 434 to headwaters)

$$(0.2209 \text{ x } 25 \text{ NTU}) + 3.3106 \cong 8.83 \text{ mg/L of TSS}$$

- Sapello River (Mora River to Manuelitas Creek)

$$(1.1593 \text{ x } 25 \text{ NTU}) + 0.1237 \cong 29.1 \text{ mg/L of TSS}$$

7.2 Flow

Sediment transport in a stream varies as a function of flow. As flow increases, the amount of sediment being transported increases. This TMDL is calculated at specific flows, however it is often necessary to calculate a critical flow for a portion of a watershed where there is no active flow gage as in the Mora and Sapello Rivers. 4Q3 derivations for ungaged streams were based on analysis methods described by Waltemeyer (2002). In this analysis, two regression equations for estimating 4Q3 were developed based on physiographic regions of NM (i.e., statewide and mountainous regions above 7,500 feet in elevation). The following statewide regression equation is based on data from 50 gaging stations with non-zero discharge (Waltemeyer 2002):

$$4Q3 \quad = \quad 1.2856 \times 10^{-4} \; DA^{0.42} \; P_w^{\;3.16} \qquad \text{(Eq. 1)}$$

where,

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

The average standard error of estimate (SEE) and coefficient of determination are 126 and 48 percent, respectively, for this regression equation (Waltemeyer 2002). The following regression equation for mountainous regions above 7,500 feet in elevation is based on data from 40 gaging stations with non-zero discharge (Waltemeyer 2002):

$$4Q3 \quad = \quad 7.3287 \times 10^{-5} \; DA^{0.70} \; P_w^{\;3.58} \; S^{1.35} \qquad \text{(Eq. 2)}$$

where,

S = Average basin slope (percent).

The average SEE and coefficient of determination are 94 and 66 percent, respectively, for this regression equation (Waltemeyer 2002). The 4Q3 for the Mora River was estimated using the regression equation for mountainous regions because the mean elevation for this assessment unit was above 7,500 feet in elevation. The 4Q3 for the Sapello River was estimated using the statewide regression equation because the mean elevation for this assessment unit was less than 7,500 feet in elevation (Table 7.4).

Table 7.4 Calculation of 4Q3 Low-Flow Frequencies

Assessment Unit	**Average Elevation (ft.)**	**Drainage Area (mi^2)**	**mean winter precipitation (in.)**	**Average basin slope (percent)**	**4Q3 (cfs)**
Mora River (Hwy 434 to headwaters)	8927	144.49	11.3	26.0	2.276
Sapello River (Mora River to Manuelitas Creek)	7050	289.3	6.5	---	0.515

The 4Q3 values were converted from cubic feet per second (cfs) to units of million gallons per day (MGD) as follows:

$$\_\_\_\_\_ \frac{ft^3}{sec} \times 1{,}728 \frac{in^3}{ft^3} \times 0.004329 \frac{gal}{in^3} \times 86{,}400 \frac{sec}{day} \times 10^{-6} = \_\_\_\_\_ \text{ MGD}$$

It is important to remember that the TMDL itself is a value calculated at a defined critical condition, and is calculated as part of 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.

7.3 Calculations

Target loads for stream bottom deposits (expressed as TSS) are calculated based on the critical flow, the water quality criterion, and a conversion factor (8.34) that is a used to convert milligram per liter (mg/L) units to pounds per day (lbs/day) (see Appendix A for Conversion Factor Derivation). The target loading capacity is calculated using **Equation 4**. The results are shown in Table 7.5.

Critical Flow (mgd) x Criterion (mg/L) x 8.34 = Target Loading Capacity (Eq. 4)

Table 7.5 Calculation of Target Loads for TSS (Sedimentation/Siltation surrogate)

Assessment Unit	4Q3 Flow (MGD)	TSS (mg/L)	Conversion Factor	Target Load Capacity (lbs/day)
Mora River (Hwy 434 to headwaters)	1.471	8.83*+	8.34	108+
Sapello River (Mora River to Manuelitas Creek)	0.333	29.1^+	8.34	80.8+

Notes:
* The TSS value was calculated using the relationship established between TSS and turbidity in Figure 7.2 (y=0.2209x + 3.3106, R^2=0.28) using the turbidity standard of 25 NTU for the X variable.
^ The TSS value was calculated using the relationship established between TSS and turbidity in Figure 7.3 (y=1.1593x + 0.1237, R^2=0.34) using the turbidity standard of 25 NTU for the X variable.
+ Values rounded to three significant figures.

7.4 Waste Load Allocations and Load Allocations

7.4.1 Waste Load Allocation

There are no individually permitted point source facilities or Municipal Separate Storm Sewer System (MS4) storm water permits in this assessment unit. Sediment may be a component of some (primarily construction) storm water discharges so these discharges should be addressed.

In contrast to discharges from other industrial storm water and individual process wastewater permitted facilities, storm water discharges from construction activities are transient because they occur mainly during the construction itself, and then only during storm events. Coverage under the National Pollutant Discharge Elimination System (NPDES) construction general storm water permit (CGP) for construction sites greater than one acre 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. In addition, the current CGP also includes state specific requirements to implement Best Management Practices (BMPs) that are designed to prevent to the maximum extent practicable, an increase in sediment, or a parameter that addresses sediment (e.g., total suspended solids, turbidity, siltation, stream bottom deposits, etc.) and flow velocity during and after construction compared to pre-construction conditions. In this case, compliance with a SWPPP that meets the requirements of the CGP is generally assumed to be consistent with this TMDL.

Other industrial storm water facilities are generally covered under the current NPDES Multi-Sector General Storm Water Permit (MSGP). This permit also requires preparation of an SWPPP that includes identification and control of all pollutants associated with the industrial activities to minimize impacts to water quality. In addition, the current MSGP also includes state specific requirements to further limit (or eliminate) pollutant loading to water quality impaired/water quality limited waters from facilities where there is a reasonable potential to contain pollutants for which the receiving water is impaired. In this case, compliance with a SWPPP that meets the requirements of the MSGP is generally assumed to be consistent with this TMDL.

Individual WLAs for the General Permits were not possible to calculate at this time in this watershed using available tools. Loads that are in compliance with the General Permits from facilities covered are therefore currently calculated as part of the watershed load allocation (LA).

7.4.2 Load Allocation

In order to calculate the LA, the WLA and MOS were subtracted from the target capacity TMDL following **Equation 5**:

$$WLA + LA + MOS = TMDL \qquad \text{(Eq. 5)}$$

The MOS is estimated to be 25% of the target load calculated in Table 7.6. Results are presented in Table 7.7. Additional details on the MOS chosen are presented in Section 7.7.

Table 7.7 Calculation of TMDL for TSS (Sedimentation/Siltation surrogate)

Assessment Unit	WLA (lbs/day)	LA (lbs/day)	MOS (25%) (lbs/day)	TMDL (lbs/day)
Mora River (Hwy 434 to headwaters)	0	81.0^{+}	27.0^{+}	108^{+}
Sapello River (Mora River to Manuelitas Creek)	0	60.6^{+}	20.2^{+}	80.8^{+}

Notes:
$^{+}$ Values rounded to three significant figures.

The extensive data collection and analyses necessary to determine background sediment loads for the Mora and Sapello watersheds was beyond the resources available for this study. Therefore, it is assumed that a portion of the load allocation is made up of natural background loads.

7.5 Identification and Description of Pollutant Source(s)

Pollutant sources that could contribute to these reaches are listed in Table 7.9.

Table 7.9 Pollutant source summary

Pollutant	Magnitude	Location	Probable Sources[b]
Point Source			
None	0%	---	0%
Nonpoint Source			
Sedimentation	51%[a]	Mora River (Hwy 434 to headwaters)	100% Natural Sources; Rangeland Grazing; Silviculture Harvesting
Sedimentation	56%[a]	Sapello River (Mora River to Manuelitas Creek)	100% Source Unknown

Notes:

(a) The magnitude is equal to the measured load expressed as percent fines. Fines are defined as particles less than 2 millimeters (mm) in diameter.

(b) From the 2006-2008 Integrated CWA §303(d)/§305(b) List. This list of probable sources is based on staff observation and known land use activities in the watershed. These sources are not confirmed or quantified at this time.

Probable sources of sedimentation for this assessment unit will be evaluated, refined, and changed as necessary through the Watershed Restoration Action Strategy (WRAS) process.

7.6 Linkage of Water Quality and Pollutant Sources

Total suspended solids (TSS) include all particles suspended in water which will not pass through a filter. TSS can include a wide variety of material, such as silt and clay, decaying plant and animal matter, plankton, industrial wastes, and sewage. High concentrations of suspended solids can cause many problems for stream health and aquatic life.

As levels of TSS increase, a water body begins to lose its ability to support a diversity of aquatic life. Suspended solids absorb heat from sunlight, which increases water temperature and subsequently decreases levels of dissolved oxygen (warmer water holds less oxygen than cooler water). Photosynthesis also decreases, since less light penetrates the water. Reduced rates of photosynthesis causes less dissolved oxygen to be released into the water by plants. If light is completely blocked from bottom dwelling plants, the plants will stop producing oxygen and will die. As the plants are decomposed, bacteria will use up even more oxygen from the water. Some cold water species, such as trout, are especially sensitive to changes in dissolved oxygen resulting in fish kills.

TSS can also destroy aquatic habitat because suspended solids settle to the bottom and can eventually blanket the river bed. Suspended solids can smother the eggs of fish and aquatic insects, and can suffocate newly-hatched insect larvae. Suspended solids can also harm fish directly by clogging gills, reducing growth rates, lowering resistance to disease, and preventing egg and larval development. Changes to the aquatic environment may result in a diminished food sources and increased difficulties in finding food. Natural movements and migrations of aquatic populations may be disrupted. In addition, settling sediments can fill in spaces between rocks which could have been used by aquatic organisms for homes.

The components of a watershed continually change through natural ecological processes such as vegetation succession, erosion, and evolution of stream channels. Intrusive human activity often affects watershed function in ways that are inconsistent with the natural balance. These changes, often rapid and sometimes irreversible, occur when people:

- cut forests
- clear and cultivate land
- remove stream-side vegetation
- alter the drainage of the land
- channelize watercourses
- withdraw water for irrigation
- build towns and cities
- discharge pollutants into waterways.

Factors affecting total suspended solids in a waterway include:

1. Increases or decreases in flow rates
    - land clearing, constructing drainage ditches, and straightening natural water channels may strand fish upstream or dry out recently spawned eggs due to the subsequent low flows
    - fast running water can carry more particles and larger-sized sediment creating an obstacle to the upstream movement of fish
    - heavy rains can pick up sand, silt, clay, and organic particles (such as leaves and soil) from the land and carry it to surface water destroying the aquatic habitat and harming and/or killing the aquatic life
    - during low flow, the sediment that was carried by faster moving water will settle to the bottom of the streambed, which can have detrimental effects on the aquatic community by smothering eggs or suffocating newly hatched larvae and burying the homes of aquatic organisms

2. Soil erosion caused by disturbance of a land surface
    - increases suspended solids in the water
    - reduces transmission of sunlight needed for photosynthesis
    - interferes with animal behaviors dependent on sight (foraging, mating, and escape from predators)
    - impedes respiration (e.g., by gill abrasion in fish) and digestion
    - reduces oxygen in the water

- covers bottom gravel and degrade spawning habitat
- covers eggs, which may suffocate or develop abnormally; fry may be unable to emerge from the buried gravel bed

3. Clearing of trees and shrubs from shorelines
   - destabilizes banks and promote erosion
   - increases sedimentation and turbidity
   - reduces shade and increase water temperature which could disrupt fish metabolism
   - causes channels to widen and become more shallow

Where data gaps exist or the level of uncertainty in the characterization of sources is large, the recommended approach to TMDL assignments requires the development of allocations based on estimates utilizing the best available information.

SWQB fieldwork includes an assessment of the probable sources of impairment (NMED/SWQB 1999). The completed *Pollutant Source(s) Summary Table* in **Appendix B** provides documentation of a visual analysis of probable sources along an impaired reach. Although this procedure is subjective, SWQB feels that it provides the best available information for the identification of probable sources of impairment in this watershed. Staff completing these forms identify and quantify probable sources of NPS impairments along each reach as determined by field reconnaissance and assessment. It is important to consider not only the land directly adjacent to the stream, which is predominantly privately held, but also to consider upland and upstream areas in a more holistic watershed approach to implementing this TMDL.

The main sources of impairment along the Mora River (Hwy 434 to headwaters) appear to be from natural sources, rangeland grazing, and silviculture harvesting. The main sources of impairment along the Sapello River (Mora River to Manuelitas Creek) appear to be from unknown sources.

7.7 Margin of Safety (MOS)

TMDLs should reflect a MOS based on the uncertainty or variability in the data, the point and nonpoint sourceload estimates, and the modeling analysis. The MOS is estimated to be **25%** of the TMDL. This MOS incorporates several factors:

- Errors in calculating nonpoint source loads

  A level of uncertainty does exist in the relationship between TSS and turbidity. In this case, the TSS measure does not include bedload and therefore does not account for a complete measure of sediment load. There is also a potential to have errors in measurements of nonpoint source loads due to equipment accuracy, time of sampling, etc. Accordingly, a conservative MOS of **15%** will be assigned to account for uncertainties in calculating nonpoint source loads.

- Errors in calculating flow

  Flow estimates were based on USGS gages and field measurements. Techniques used for measuring flow in water have a ±5 percent precision. In addition, there is a potential to have errors in measurements of flow due to equipment accuracy, time of sampling, etc. To be conservative, an additional MOS of **10%** will be included to account for accuracy of flow computations.

7.8 Consideration of Seasonal Variation

Data used in the calculation of this TMDL were collected during high and low flow seasons in order to ensure coverage of any potential seasonal variation in the system. Fall is a critical time in the life cycle stages of benthic macroinvertebrates in NM. Fall is also generally the low-flow period of the mean annual hydrograph in NM when bottom deposits are most likely to settle and cause impairment, after the summer monsoon season but before annual spring runoff. Thus, the critical condition used for calculating the TMDL was low flow. It is assumed that if critical conditions are met during this time, coverage of any potential seasonal variation will also be met.

7.9 Future Growth

Estimations of future growth are not anticipated to lead to a significant increase in sedimentation that cannot be controlled with BMP implementation in this watershed.

8.0 MONITORING PLAN

Pursuant to Section 106(e)(1) of the Federal CWA, 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, 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 utilizes a rotating basin system approach to water quality monitoring. In this system, a select number of watersheds are intensively monitored each year with an established return frequency of approximately every seven years. The next scheduled monitoring date for the Canadian Watershed was in 2006. The SWQB maintains current quality assurance and quality control plans to cover all monitoring activities. This document, called the QAPP, is updated and certified annually by USEPA Region 6 (NMED/SWQB 2002). 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. Short-term efforts will be 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.

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 Assessment Protocols (NMED/SWQB 2006).

Long-term monitoring for assessments will be accomplished through the establishment of sampling sites that are representative of the waterbody and which can be revisited approximately every seven 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.

SWQB developed a 10-year monitoring strategy submitted to USEPA on September 30, 2004. 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. According to the draft proposed 8-year rotational cycle, which assumes the existing level of resources, the next time SWQB will intensively sample segments of the Upper Canadian and Mora watersheds is 2010.

It should be noted that a watershed would not be ignored during the years in between intensive sampling. The rotating basin program will be supplemented with other data collection efforts such as the funding of long-term USGS water quality gaging stations for long-term trend data and 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.

9.0 IMPLEMENTATION OF TMDLS

9.1 NPDES Permitting

Mora Mutual Domestic Water and Sewerage Works Association (MMDWSWA)

Currently the Village has 110 active hookups to the wastewater collection system that delivers untreated wastewater to the lagoon system. Additionally, within the service area, there are estimated to be 177 septic tanks. The MMDWSWA's existing WWTP is an aerated lagoon system that is not designed to treat wastewater for TP or TN removal. The village is currently working with an engineering firm to make improvements to the collection system and to reline the existing lagoons. These improvements will not improve the plant's ability to treat for TP or TN. Alternative methods of treatment must be considered by the MMDWSWA in order to meet or address the nutrient impairment in the Mora River. Funding of treatment facility modification or replacement needs some consideration in this TMDL.

One potential source of funding to carry out a project that embraces the intent of the WLA is the New Mexico Clean Water State Revolving Loan Fund program administered by NMED's Construction Program Bureau. The State of New Mexico Statewide Water Quality Management Plan Work Element 5 (adopted by the WQCC December 17, 2002 and approved by the USEPA April 16, 2003) notes that "…[a]s specified at 40 CFR 130.12(b), CWA Section 201 funding can only be awarded to DMAs [Designated Management Agencies] that are in conformance with the statewide Water Quality Management Plan (WQMP)." The MMDWSWA is a not currently a Designated Management Agency (WQMP Work Element 5). If the Association chooses to become a DMA, the first part of the above requirement has been met. As this WLA is a part of the WQMP, funding will be contingent on, among other factors, conformance with this part of the plan as well. This WLA recognizes the technological and economic challenge of meeting the nutrient effluent limitations presented herein and as discussed below and therefore provides two options for the MMDWSWA WWTP.

As noted above the facility discharges to the Mora River under authorization of an NPDES permit. Federal regulations (40 CFR 130.12(a) and 40 CFR 122.44(d)(1)(vii)) clearly require that NPDES permits must be consistent with the WLA of an adopted and approved TMDL. Thus it important to provide direction on implementation of the WLA such that effluent limits and schedules can be readily incorporated within the structure of a permit.

The New Mexico WQS (Subsection J of 20.6.4.12 NMAC) states it is the policy of the WQCC to allow schedules of compliance in NPDES permits where facility modifications need to be made to meet new water quality based requirements.

Option 1.

The facility will be required to meet the WLA. This option would necessitate that the MMDWSWA contract with an engineering firm to develop a Preliminary Engineering Review (PER) of a WWTP design that would meet the WLA. Once the design is completed, the Association would then need to construct and operate the WWTP.

A compliance schedule for completion of the PER, plant construction, and completion of the project will be:

- Interim Effluent Limits from the date of permit issuance through the completion of construction (not to exceed 4 years)
- Monitor and report TP and TN by 3-hour composite, not less than once per two weeks
- Final Effluent Limits after completion of construction of the New WWTP where the 30-day average concentration based limit (mg/L) by the facility design flow (MGD) x 8.34:
  - ➔ TP = 0.013 lbs/day (30-day average), 0.03 mg/L (30-day average), [30-day avg x 1.5] = 0.045 mg/L (daily max) measured by 3-hour composite, not less than once per two weeks.
  - ➔ TN = 0.165 lbs/day (30-day average), 0.38 mg/L (30-day average), [30-day avg x 1.5] = 0.57 mg/L (daily max) measured by 3-hour composite, not less than once per two weeks

Option 2.

Cluster Systems for wastewater treatment are an alternative to the centralized treatment of the existing aerated lagoons. The Cluster Systems offer a management solution that will eliminate the effluent discharge to the Mora River. Instead of discharging effluent to the river, the final dispersal of treated wastewater would be to leach fields and possibly to agricultural reuse. The NMED CPB and GWQB both support this option for wastewater treatment for the MMDWSWA.

A compliance schedule for completion of the PER, Cluster System construction, and completion of the project will be:

- Interim Effluent Limits from the date of permit issuance through the completion of construction (not to exceed 4 years)
- Monitor and report TP and TN by 3-hour composite, not less than once per two weeks
- Final Effluent Limits from 4 years and 1 day from the data of permit issuance through the end of the permit:
  - ➔ TP = 0.00 lbs/day (30-day average), 0.00 mg/L (30-day average), [30-day avg x 1.5] = 0.00 mg/L (daily max) measured by 3-hour composite, not less than once per two weeks.
  - ➔ TN = 0.00 lbs/day (30-day average), 0.00 mg/L (30-day average), [30-day avg x 1.5] = 0.00 mg/L (daily max) measured by 3-hour composite, not less than once per two weeks

In the event that MMDWSWA proceeds with this option, and after completion of construction, when the new treatment system is operational, the resulting WLA for the Mora River will be Zero for the WWTP. At that time, NMED may recalculate the WLA for the Mora National Fish Hatchery and Technology Center.

Mora National Fish Hatchery and Technology Center

The Mora National Fish Hatchery and Technology Center is currently not designed to treat effluent for TN and TP. The facility will need to develop and implement treatment to meet the new effluent requirements that will result from this TMDL.

A compliance schedule will be included in the NPDES permit for the facility to meet the new effluent requirements.

- Interim Effluent Limits from the date of permit issuance through the completion of treatment modification (not to exceed 4 years):
- Monitor and report TP and TN by 3-hour composite, not less than once per two weeks
- Final Effluent Limits from 4 years and 1 day from the data of permit issuance through the end of the permit:
  - ➔ TP = 0.122 lbs/day (30-day average), 0.03 mg/L (30-day average), [30-day avg x 1.5] = 0.045 mg/L (daily max) measured by 3-hour composite, not less than once per two weeks.
  - ➔ TN = 1.540 lbs/day (30-day average), 0.38 mg/L (30-day average), [30-day avg x 1.5] = 0.57 mg/L (daily max) measured by 3-hour composite, not less than once per two weeks

9.2 WRAS and BMP Coordination

In this watershed, public awareness and involvement will be crucial to the successful implementation of these plans and improved water quality. Staff from SWQB will work with stakeholders to provide guidance in developing the Watershed Restoration Action Strategy (WRAS). The WRAS 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 impacts to water quality. This long-range strategy will become instrumental in coordinating and achieving constituent levels consistent with New Mexico's WQS, and will be used to prevent water quality impacts in the watershed. The WRAS is essentially the Implementation Plan, or Phase Two of the TMDL process. The completion of the TMDLs and WRAS leads directly to the development of on-the-ground projects to address surface water impairments in the watershed.

SWQB staff will assist with any technical assistance such as selection and application of BMPs needed to meet WRAS goals. Stakeholder public outreach and involvement in the implementation of this TMDL will be ongoing. Stakeholders in this process will include SWQB, and other members of the WRAS. SWQB will actively pursue engagement with land owners, ranchers and acequia associations as stakeholders in the implementation of this TMDL.

Implementation of BMPs within the watershed to reduce pollutant loading from nonpoint sources will be encouraged. Reductions from point sources will be addressed in revisions to NPDES discharge permits. SWQB will communicate to designated federal land management agencies the intent of the TMDL and desire that BMPs be developed through the above coordination process.

9.3 Time Line

Table 9.1 details the proposed implementation timeline.

9.4 Clean Water Act §319(h) Funding Opportunities

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

Table 9.1 Proposed Implementation Timeline

Implementation Actions	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Public Outreach and Involvement	X	X	X	X	X	X	X	X
Form watershed groups	X	X						
TMDL Development					X	X	X	X
WRAS Development				X	X	X		
Revise any NPDES permits as necessary (currently EPA Region 6)			X					X
Establish Performance Targets				X				
Secure Funding			X	X				
Implement Management Measures (BMPs)			X	X	X	X	X	X
Monitor BMPs			X	X	X			
Determine BMP Effectiveness					X	X	X	X
Re-evaluate Performance Targets						X	X	X

9.5 Other Funding Opportunities and Restoration Efforts in the Canadian River Basin

Several other sources of funding existing 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 (such as the design of cluster systems). They can also provide matching funds for appropriate CWA §319(h) projects using state revolving fund monies. The USDA 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 BLM has several programs in place to provide assistance to improve unpaved roads and grazing allotments.

10.0 ASSURANCES

New Mexico's Water Quality Act (Act) does authorize 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 Water Quality Act also states in §74-6-12(a):

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

In addition, the State of New Mexico Surface Water Quality Standards (see Subsection C of 20.6.4.6 NMAC) (NMAC 2006) states:

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

New Mexico policies are in accordance with the federal Clean Water Act §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 §319 Program has been developed in a coordinated manner with the State's 303(d) process. All 319 watersheds that are targeted in the annual RFP 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 Chapter 74, Article 6-10 NMSA 1978 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 §319 of the Clean Water Act. 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 Forest Service and the Bureau of Land Management. MOUs have also been developed with other State agencies, such as the New Mexico State Highway and Transportation Department. 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 members of the WRAS. The cooperation of watershed stakeholders will be pivotal in the implementation of these TMDLs as well.

11.0 PUBLIC PARTICIPATION

Public participation was solicited in development of this TMDL (see **Appendix F**). The draft TMDL was made available for a 35-day comment period on June 15, 2007. Response to comments are attached as **Appendix G** to the final draft of this document. The draft document notice of availability was extensively advertised via newsletters, email distribution lists, webpage postings (http://www.nmenv.state.nm.us), and press releases to area newspapers. Public meetings in the Canadian Watershed were held on July 12, 2007 from 11:00am – 1:00pm in the Raton Public Library in Raton, NM and on July 12, 2007 from 6:00pm – 8:00pm in the CHET Fire House in Cleveland, NM.

Once the TMDL is approved by the Water Quality Control Commission, the next step for public participation is revision of the Canadian WRAS as described in Section 9.0 and participation in watershed protection projects including those that may be funded by Clean Water Act Section 319(h) grants. The WRAS development process is open to any member of the public who wants to participate.

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APPENDIX A
CONVERSION FACTOR DERIVATION

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Flow (as million gallons per day [MGD]) and concentration values (milligrams per liter [mg/L]) must be multiplied by a conversion factor in order to express the load in units “pounds per day.” The following expressions detail how the conversion factor was determined:

TMDL Calculation:

$$Flow\left(MGD\right) \times Concentration\left(\frac{mg}{L}\right) \times CF\left(\frac{L-lb}{gal-mg}\right) = Load\left(\frac{lb}{day}\right)$$

Conversion Factor Derivation:

$$CF = 10^6 \times \frac{3.785\,L}{gal} \times \frac{1\,lb}{454{,}000\,mg} = 8.34\,\frac{L-lb}{gal-mg}$$

APPENDIX B
SOURCE(S) DOCUMENTATION AND SOURCES SUMMARY TABLE

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Canadian Part 1 TMDL Probable Sources Summary

Assessment Unit	Parameter[1]	Probable Sources (ADB v.2 terminology)
Caliente Canyon (Vermejo River to headwaters)	Specific Conductance	Natural Sources; Source Unknown
Van Bremmer Creek (Hwy 64 to headwaters)	Specific Conductance; Temperature; Turbidity	Natural Sources; Rangeland Grazing
Vermejo River (Rail Canyon to York Canyon)	Specific Conductance; Temperature	Habitat Modification – other than Hydromodification; Rangeland Grazing; Source Unknown
Vermejo River (York Canyon to Headwaters)	Benthic-Macroinvertebrate Bioassessments (Streams); Temperature	Rangeland Grazing; Streambank Modifications/Destabilization
York Canyon (Vermejo River to headwaters)	Specific Conductance; Turbidity	Impacts from Abandoned Mine Lands (Inactive)
Coyote Creek (Mora River to Black Lake)	Specific Conductance; Temperature	Natural Sources; Rangeland Grazing
Little Coyote Creek (Black Lake to Headwaters)	Nutrient/Eutrophication Biological Indicators; pH	Natural Sources; Rangeland Grazing; Source Unknown
Mora River (USGS Gage east of shoemaker to Hwy 434)	Nutrient/Eutrophication Biological Indicators	Flow Alterations from Water Diversions; Municipal Point Source Discharge; Industrial Point Source Discharge; On-Site Treatment Systems (Septic Systems and Similar Decentralized Systems)
Mora River (Hwy 434 to headwaters)	Specific Conductance; Sedimentation/Siltation	Natural Sources; Rangeland Grazing; Silviculture Harvesting
Sapello River (Mora River to Manuelitas Creek)	Sedimentation/Siltation	Source Unknown

[1] From the 2006-2008 State of New Mexico CWA §303(d) Integrated List

APPENDIX C
NUTRIENT DATA

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Sample site	Collection date/time	TN (mg/L)	TP (mg/L)
Little Coyote @ Hwy 434	4/2/2002 9:45	0.417	<0.03
Little Coyote @ Hwy 434	5/2/2002 13:15	0.550	0.062
Little Coyote @ Hwy 434	6/4/2002 10:20	0.407	0.09
Little Coyote @ Hwy 434	6/27/2002 16:30	0.604	0.075
Little Coyote @ Hwy 434	7/2/2002 10:00	0.502	0.047
Little Coyote @ Hwy 434	7/31/2002 9:45	0.487	0.082
Little Coyote @ Hwy 434	8/27/2002 13:00	0.377	0.058
Little Coyote @ Hwy 434	9/17/2002 12:20	0.422	0.13
Little Coyote @ Hwy 434	10/16/2002 9:35	0.287	<0.03
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	4/1/2002 11:00	0.37	<0.03
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	5/1/2002 9:10	0.17	<0.03
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	6/3/2002 11:00	0.26	<0.03
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	7/1/2002 13:30	0.24	<0.03
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	7/30/2002 12:25	0.28	<0.03
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	8/27/2002 11:20	0.20	<0.03
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	9/17/2002 10:50	0.39	<0.03
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	10/15/2002 12:30	0.15	<0.03
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	5/16/2006 10:10	0.49	0.048
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	8/2/2006 12:10	0.25	<0.03
MORA RIVER AT CHACON .6 MILES ABOVE GAGE	9/27/2006 10:25	0.21	<0.03
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	4/1/2002 12:00	0.31	<0.03
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	5/1/2002 9:40	0.32	<0.03
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	6/3/2002 12:00	0.36	<0.03
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	7/1/2002 12:30	0.26	<0.03
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	7/30/2002 11:40	0.24	0.045
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	8/27/2002 10:35	0.17	<0.03
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	9/17/2002 10:00	0.25	<0.03
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	10/15/2002 13:00	0.10	<0.03
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	5/16/2006 11:30	0.33	0.032
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	8/3/2006 13:40	0.17	<0.03
MORA RIVER AT CLEVELAND BY BRIDGE ON CHURCH RD	9/27/2006 11:20	0.20	<0.03
Mora River above Hatchery	6/3/2002 13:40	0.22	<0.03
Mora River above Hatchery	8/27/2002 10:10	0.10	<0.03
Mora River above Hatchery	10/15/2002 16:30	0.24	<0.03
Mora River above Hatchery	8/3/2006 11:45	0.19	<0.03
Mora River above Mora WWTP lagoons	4/1/2002 13:30	0.10	<0.03
Mora River above Mora WWTP lagoons	5/1/2002 11:30	0.10	<0.03
Mora River above Mora WWTP lagoons	6/3/2002 13:10	0.27	<0.03
Mora River above Mora WWTP lagoons	6/27/2002 14:00	0.44	<0.03
Mora River above Mora WWTP lagoons	7/30/2002 11:15	0.22	<0.03
Mora River above Mora WWTP lagoons	8/27/2002 9:55	0.17	<0.03
Mora River above Mora WWTP lagoons	9/17/2002 9:25	0.24	0.514
Mora River above Mora WWTP lagoons	5/16/2006 12:20	0.60	0.042
Mora River above Mora WWTP lagoons	8/3/2006 11:40	0.10	<0.03
Mora River above Mora WWTP lagoons	9/27/2006 12:25	0.28	<0.03
MORA WASTEWATER PLANT * NM0024996	5/16/2006 13:00	2.86	0.256
MORA WASTEWATER PLANT * NM0024996	8/3/2006 9:50	2.09	0.169
MORA WASTEWATER PLANT * NM0024996	9/27/2006 13:23	0.96	0.143

Sample site	Collection date/time	TN (mg/L)	TP (mg/L)
Mora River below Mora WWTP lagoons	4/2/2002 13:50	0.30	<0.03
Mora River below Mora WWTP lagoons	5/1/2002 12:00	0.24	<0.03
Mora River below Mora WWTP lagoons	6/3/2002 13:00	0.28	<0.03
Mora River below Mora WWTP lagoons	6/27/2002 10:30	0.24	<0.03
Mora River below Mora WWTP lagoons	7/30/2002 10:40	0.40	0.04
Mora River below Mora WWTP lagoons	8/27/2002 9:40	0.38	0.057
Mora River below Mora WWTP lagoons	9/17/2002 9:00	0.57	0.073
Mora River below Mora WWTP lagoons	10/15/2002 15:50	0.41	0.033
Mora River below Mora WWTP lagoons	5/16/2006 13:20	0.89	0.058
Mora River below Mora WWTP lagoons	8/3/2006 10:05	0.39	<0.03
Mora River below Mora WWTP lagoons	9/27/2006 13:30	0.24	<0.03
MORA RIVER AT LA CUEVA USGS GAGE	4/1/2002 13:30	0.20	<0.03
MORA RIVER AT LA CUEVA USGS GAGE	5/1/2002 12:30	0.59	0.044
MORA RIVER AT LA CUEVA USGS GAGE	6/3/2002 15:00	0.51	<0.03
MORA RIVER AT LA CUEVA USGS GAGE	7/1/2002 11:00	0.32	<0.03
MORA RIVER AT LA CUEVA USGS GAGE	7/30/2002 9:30	0.35	0.063
MORA RIVER AT LA CUEVA USGS GAGE	8/27/2002 9:15	0.23	0.035
MORA RIVER AT LA CUEVA USGS GAGE	9/17/2002 8:30	0.28	0.04
MORA RIVER AT LA CUEVA USGS GAGE	10/15/2002 14:00	0.19	<0.03
MORA RIVER AT LA CUEVA USGS GAGE	5/16/2006 13:45	0.65	0.054
MORA RIVER AT LA CUEVA USGS GAGE	8/3/2006 16:15	0.31	0.198
MORA RIVER AT LA CUEVA USGS GAGE	9/27/2006 13:47	0.22	<0.03
Mora River @ Watrous	4/2/2002 14:15	<0.10	<0.03
Mora River @ Watrous	4/24/2002 10:30	<0.10	<0.03
Mora River @ Watrous	5/15/2002 11:35	0.18	<0.03
Mora River @ Watrous	6/5/2002 11:30	0.26	<0.03
Mora River @ Watrous	7/2/2002 9:50	<0.10	<0.03
Mora River @ Watrous	7/31/2002 11:55	0.20	<0.03
Mora River @ Watrous	8/27/2002 13:35	0.42	<0.03
Mora River @ Watrous	9/17/2002 14:00	0.27	<0.03
Mora River @ Watrous	10/16/2002 15:15	0.23	<0.03

Notes:
TN = Total Nitrogen
TP = Total Phosphorus
mg/L = Milligrams per liter
Exceedences of the nutrient targets concentrations are highlighted in **GOLD**.

APPENDIX D
THERMOGRAPH SUMMARY DATA AND GRAPHICS

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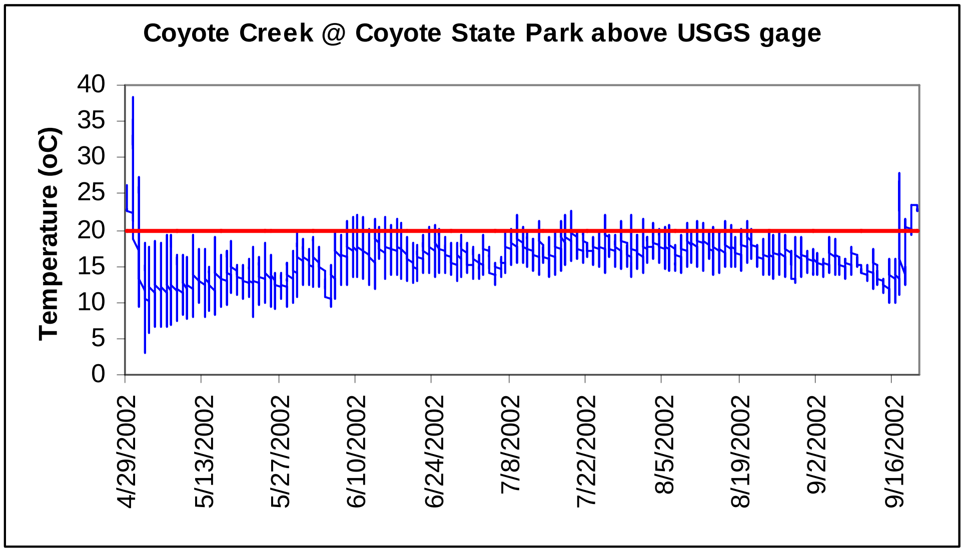
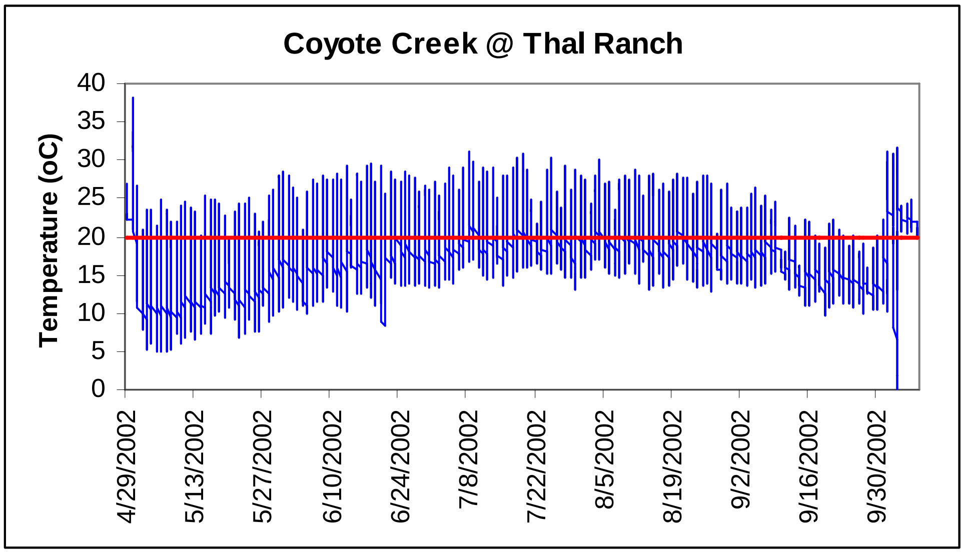
D1.0 Coyote Creek (Mora River to Black Lake)

April 29, 2002 through September 20, 2002:	
Number of Data Points:	3,460
Number of Measurements >20^{o}C:	275
Percentage Data Points >20^{o}C:	8%
Minimum Water Temperature (^{o}C):	2.95
Maximum Water Temperature (^{o}C):	22.69



**Due to a lack of documentation of actual deployment in water, all data is presented here. However, data that is reasonably assumed to have been collected when the thermograph (ie: en route to and from the site) was not deployed in the water was not inlcuded in the assessments.*

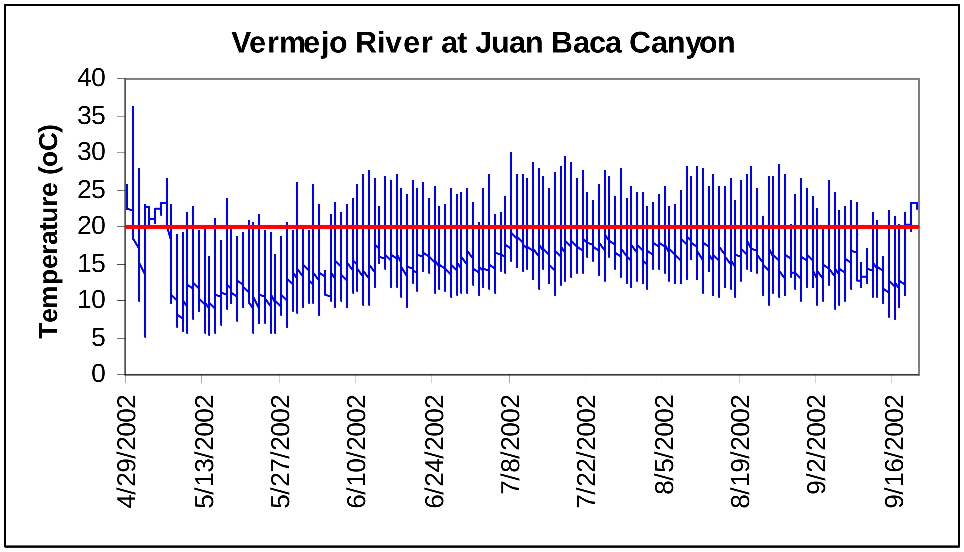
April 29, 2002 through October 8, 2002:	
Number of Data Points:	3,889
Number of Measurements >20°C:	1,417
Percentage Data Points >20°C:	36%
Minimum Water Temperature (°C):	0.29
Maximum Water Temperature (°C):	28.26



**Due to a lack of documentation of actual deployment in water, all data is presented here. However, data that is reasonably assumed to have been collected when the thermograph (ie: en route to and from the site) was not deployed in the water was not inlcuded in the assessments.*

D2.0 Vermejo River (York Canyon to headwaters)

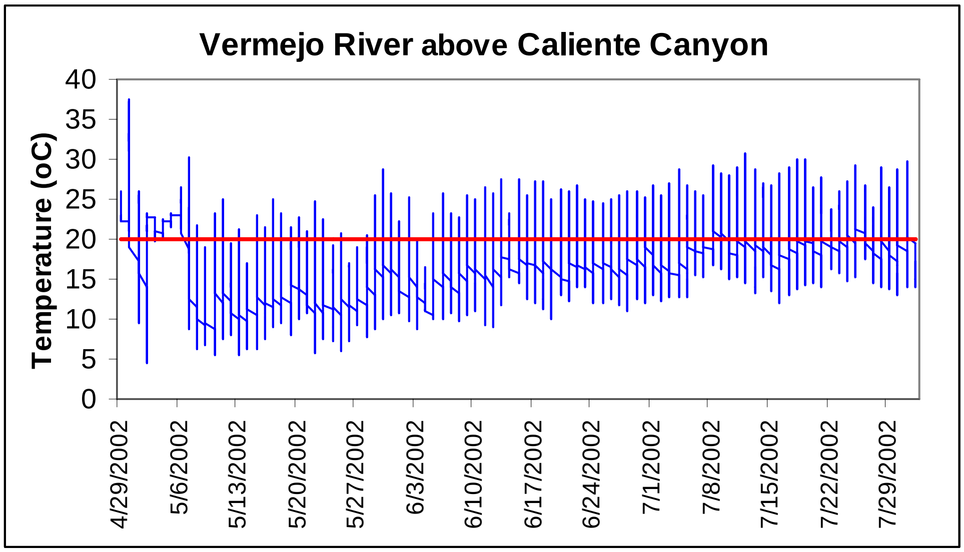
April 29, 2002 through September 20, 2002:	
Number of Data Points:	3,460
Number of Measurements >20°C:	1029
Percentage Data Points >20°C:	29.7%
Minimum Water Temperature (°C):	5.14
Maximum Water Temperature (°C):	30.08



**Due to a lack of documentation of actual deployment in water, all data is presented here. However, data that is reasonably assumed to have been collected when the thermograph (ie: en route to and from the site) was not deployed in the water was not inlcuded in the assessments.*

D3.0 Vermejo River (Rail Canyon to York Canyon)

April 29, 2002 through August 1, 2002:	
Number of Data Points:	2,257
Number of Measurements >20°C:	749
Percentage Data Points >20°C:	33%
Minimum Water Temperature (°C):	4.49
Maximum Water Temperature (°C):	30.48



**Due to a lack of documentation of actual deployment in water, all data is presented here. However, data that is reasonably assumed to have been collected when the thermograph (ie: en route to and from the site) was not deployed in the water was not inlcuded in the assessments.*

APPENDIX E
HYDROLOGY, GEOMETRY, AND METEROLOGICAL INPUT DATA FOR SSTEMP

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LIST OF ACRONYMS

4Q3	Four-consecutive day discharge that has a recurrence interval of three years
cfs	Cubic Feet per Second
GIS	Geographic Information Systems
GPS	Global Positioning System
IOWDM	Input and Output for Watershed Data Management
mi^2	Square Miles
^oC	Degrees Celcius
SEE	Standard Error of Estimate
SSTEMP	Stream Segment Temperature
SWSTAT	Surface-Water Statistics
TMDL	Total Maximum Daily Load
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WinXSPRO	Windows-Based Stream Channel Cross-Section Analysis

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E 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. Meterological inputs to SSTEMP Model include air temperature, relative humidity, windspeed, ground temperature, thermal gradient, possible sun, dust coefficient, ground reflectivity, and solar radiation. In the following sections, these parameters are discussed in detail for each assessment unit to be modeled using SSTEMP Model. The assessment units were modeled on the day of the maximum recorded thermograph measurement. The assessment units and modeled dates are defined as follows:

Table E.1 Assessment Units and Modeled Dates

Assessment Unit ID	Assessment Unit Description	Modeled Date
NM-2306.A_020	Coyote Creek (Mora River to Black Lake)	7/8/2002
NM-2305.A_230	Vermejo River (York Canyon to headwaters)	7/8/2002
NM-2305.A_220	Vermejo River (Rail Canyon to York Canyon)	7/12/2002

E 2.0 HYDROLOGY

E2.1 Segment Inflow

This parameter is the *mean daily* flow at the top of the stream segment. If the segment begins at an effective headwater, the flow is entered into SSTEMP Model as zero. Flow data from USGS gages were used when available. 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 as the inflow instead of the mean daily flow. These critical low flows were used to decrease assimilative capacity of the stream to adsorb and disperse solar energy. The 4Q3 would be determined for gaged sites using a log Pearson Type III distribution through "*Input and Output for Watershed Data Management*" (IOWDM) software, Version 4.1 (USGS 2002a) and "*Surface-Water Statistics*" (SWSTAT) software, Version 4.1 (USGS 2002b).

Discharges for ungaged sites on gaged streams were estimated based on methods published by Thomas *et al.* (1997). If the drainage area of the ungaged site is between 50 and 150 percent of the drainage area of the gaged site, the following equation is used:

$$Q_u = Q_g \left(\frac{A_u}{A_g} \right)^{0.5}$$

where,

Q_u = Area weighted 4Q3 at the ungaged site (cubic feet per second [cfs])
Q_g = 4Q3 at the gaged site (cfs)
A_u = Drainage area at the ungaged site (square miles [mi^2])
A_g = Drainage area at the gaged site (mi^2)

Drainage areas for assessment units to which this method was applied are summarized in the following table:

Table E.2 Drainage Areas for Estimating Flow by Drainage Area Ratios

Assessment Unit	USGS Gage	Drainage Area from Gage (mi^2)	Drainage Area from Top of AU (mi^2)	Drainage Area from Bottom of AU (mi^2)	Ratio of DA of Ungaged (upstream) to Gaged Site	Ratio of DA of Ungaged (downstream) to Gaged Site
NM-2306.A_020	07218000	215	24.05	243.49	**11%**[(b)]	113%
NM-2305.A_230	07203000	301	<0.3	171.26	**–**[(a)]	57%
NM-2305.A_220	07203000	301	171.26	343.32	57%	114%

Notes:
[(a)] Assessment unit begins at headwaters.
[(b)] The method developed by Thomas et al. (1997) is not applicable because the drainage area of the ungaged site is less than 50 percent of the drainage area of the gaged site. Therefore, the method developed by Waltemeyer (2002) was used to estimate flows for this assessment unit.

mi^2 = Square miles
USGS = U.S. Geological Survey
AU = Assessment Unit

4Q3 derivations for ungaged streams were based on analysis methods described by Waltemeyer (2002). Two regression equations for estimating 4Q3 were developed based on physiographic regions of New Mexico (i.e., statewide and mountainous regions above 7,500 feet in elevation). The following statewide regression equation is based on data from 50 gaging stations with non-zero discharge (Waltemeyer 2002):

$$4Q3 = 1.2856 \times 10^{-4} \; DA^{0.42} \; P_w^{\;3.16}$$

where,

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

The average standard error of estimate (SEE) and coefficient of determination are 126 and 48 percent, respectively, for this regression equation (Waltemeyer 2002). The following regression equation for mountainous regions above 7,500 feet in elevation is based on data from 40 gaging stations with non-zero discharge (Waltemeyer 2002):

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

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 (percent)

The average SEE and coefficient of determination are 94 and 66 percent, respectively, for this regression equation (Waltemeyer 2002). The drainage areas, average basin mean winter precipitation, and average basin slope for assessment units where this regression method was used are presented in the following table:

Table E.3 Parameters for Estimating Flow using USGS Regression Model

Assessment Unit	Regression Model[a]	Average Elevation for Assessment Unit (feet)	Mean Basin Winter Precipitation (inches)	Average Basin Slope (unitless)
NM-2306.A_020	Mountainous	8,008	6.61	0.163
NM-2305.A_230	Mountainous	8,684	9.63	0.245
NM-2305.A_220	Mountainous	8,090	7.73	0.23

Notes:
mi^2 = Square miles
[a] Waltemeyer (2002)

Based on the methods described above, the following values were estimated for inflow:

Table E.4 Inflow

Assessment Unit	Ref.	4Q3 (cfs)	DAt (mi^2)	DAg (mi^2)	Pw (in)	S unitless	Inflow (cfs)
NM-2306.A_020	(a)	0.48[1]	24.05	215	6.61	0.163	0.05
NM-2305.A_230	N/A	–	<0.3	301	9.63	0.245	0.00[2]
NM-2305.A_220	(b)	0.99 [2]	171.26	301	7.73	0.23	0.56

Notes:
N/A = Not applicable, assessment unit begins at headwaters.
Ref. = Reference
[a] Waltemeyer (2002), mountainous
[b] Thomas et al. (1997)

cfs = cubic feet per second
mi^2 = Square miles
in = Inches
Pw = Mean winter precipitation
DAt = Drainage area from top of segment
DAb = Drainage area from bottom of segment
DAg = Drainage area from USGS gage
S = Average basin slope
[1] Based on period of record for USGS gage-Coyote Creek near Golondrinas, NM (07218000)
[2] Inflow is zero because assessment unit begins at headwaters.
[3] Based on period of record for USGS gage-Vermejo River near Dawson, NM (07203000)

E2.2 Inflow Temperature

This parameter represents the *mean daily* water temperature at the top of the segment. 2002 data from thermographs positioned at the top of the assessment unit were used when possible. If the segment began at a true headwater, the temperature entered was zero degrees Celcius (°C) (zero flow has zero heat). The following inflow temperatures for impaired assessment units were modeled in SSTEMP:

Table E.5 Mean Daily Water Temperature

Assessment Unit	Upstream Thermograph Location	Inflow Temp. (°C)	Inflow Temp. (°F)
NM-2306.A_020	Coyote Creek at Coyote State Park above USGS gage[1]	17.7	63.9
NM-2305.A_230	None (headwaters)	0	32.0
NM-2305.A_220	Vermejo River above Caliente Canyon	21.6	70.9

Notes:
°C = Degrees Celcius
°F = Degrees Farenheit
[1] uppermost thermograph in AU

E2.3 Segment Outflow

Flow data from USGS gages were used when available. To be conservative, the 4Q3 was used as the segment outflow. These critical low flows were used to decrease assimilative capacity of the stream to adsorb and disperse solar energy. Outflow was estimated using the methods described in Section 2.1. The following table summarizes 4Q3s used in the SSTEMP Model:

Table E.6 Segment Outflow

Assessment Unit	Ref.	4Q3 (cfs)	DAb (mi^2)	DAg (mi^2)	Pw (in)	S unitless	Outflow (cfs)
NM-2306.A_020	(a)	0.48	243.49	215	6.61	0.163	0.54
NM-2305.A_230	(a)	0.99	171.26	301	9.63	0.245	0.56
NM-2305.A_220	(a)	0.99	343.32	301	7.73	0.23	1.13

Notes:
Ref. = Reference
(a) Thomas et al. (1997)

cfs = cubic feet per second
mi^2 = Square miles
in = Inches
Pw = Mean winter precipitation
DAb = Drainage area from bottom of segment
DAg = Drainage area from USGS gage
S = Average basin slope
[c] USGS gage-Coyote Creek near Golondrinas, NM (07218000)
[d] USGS gage-Vermejo River near Dawson, NM (07203000)

E2.4 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 temperature for 2002 was used in the absence of measured data. The following table presents the mean annual air temperature for each assessment unit:

Table E.7 Mean Annual Air Temperature as an Estimate for Accretion Temperature

Assessment Unit	Ref.	Mean Annual Air Temperature (°C)	Mean Annual Air Temperature (°F)
NM-2306.A_020	(a)	12.36	54.24
NM-2305.A_230	(a)	12.36	54.24
NM-2305.A_220	(a)	12.36	54.24

Notes:
Ref. = References for Weather Station Data are as follows:
(a) *New Mexico State University Climate Network (Raton METAR, Elevation 1,936 meters; Latitude 36° 44' 0" N, Longitude 104° 30' 0" W),* ***2002***
ºF = Degrees Farenheit
ºC = Degrees Celcius

E 3.0 GEOMETRY

E3.1 Latitude

Latitude refers to the position of the stream segment on the earth's surface. Latitude is generally determined in the field with a global positioning system (GPS) unit. Latitude for each assessment unit is summarized below:

Table E.8 Assessment Unit Latitude

Assessment Unit	Latitude (decimal degrees)
NM-2306.A_020	36.09
NM-2305.A_230	36.90
NM-2305.A_220	36.74

E3.2 Dam at Head of Segment

The following assessment units have a dam at the upstream end of the segment with a constant, or nearly constant diel release temperature:

Table E.9 Presence of Dam at Head of Segment

Assessment Unit	Dam?
NM-2306.A_020	No
NM-2305.A_230	No
NM-2305.A_220	No

E3.3 Segment Length

Segment length was determined with National Hydrographic Dataset Reach Indexing GIS tool. The segment lengths are as follows:

Table E.10 Segment Length

Assessment Unit	Length (miles)
NM-2306.A_020	35.26
NM-2305.A_230	25.05
NM-2305.A_220	23.55

E3.4 Upstream Elevation

The following upstream elevations were determined with National Hydrographic Dataset Reach Indexing GIS tool.

Table E.11 Upstream Elevations

Assessment Unit	Upstream Elevation (feet)
NM-2306.A_020	8,528
NM-2305.A_230	10,740
NM-2305.A_220	7,105

E3.5 Downstream Elevation

The following downstream elevations were determined with National Hydrographic Dataset Reach Indexing GIS tool.

Table E.12 Downstream Elevations

Assessment Unit	Downstream Elevation (feet)
NM-2306.A_020	6,720
NM-2305.A_230	7,105
NM-2305.A_220	6,325

E3.6 Width's A and Width's B Term

Width's B Term was calculated as the slope of the regression of the natural log of width and the natural log of flow. Width-versus-flow regression analyses were prepared by entering cross-section field data into a Windows-Based Stream Channel Cross-Section Analysis (WINXSPRO 3.0) Program (U.S. Department of Agriculture [USDA] 2005). 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, the Width's B-Term was first calculated as the slope and 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)

The following table summarizes Width's A- and B-Terms for assessment units requiring temperature TMDLs:

Table E.13 Width's A and Width's B Terms

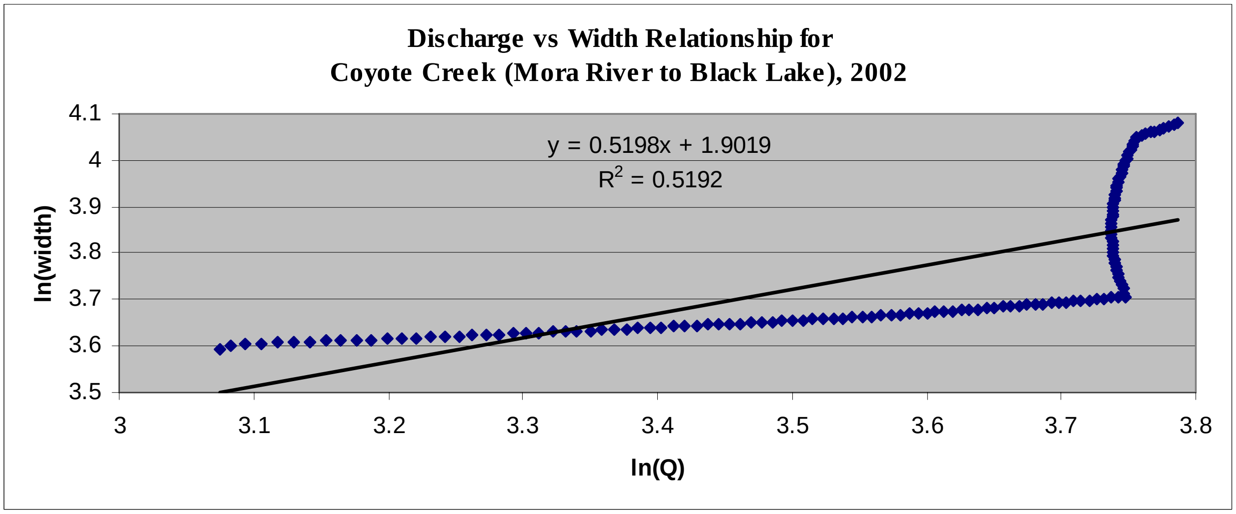
Assessment Unit	Width's B-Term	Width's A-Term [1]
NM-2306.A_020	0.520	7.35
NM-2305.A_230	1.11	0.337
NM-2305.A_220	1.49	0.082

[1] A=e^constant from regression

The following figures present the detailed calculations for the Width's B-Term.

Measurements were collected at one site within these assessment units. The regression of natural log of width and natural log of flow for each location is as follows:

Figure E.1 Wetted Width versus Flow for Assessment Unit NM-2306.A_020



SUMMARY OUTPUT

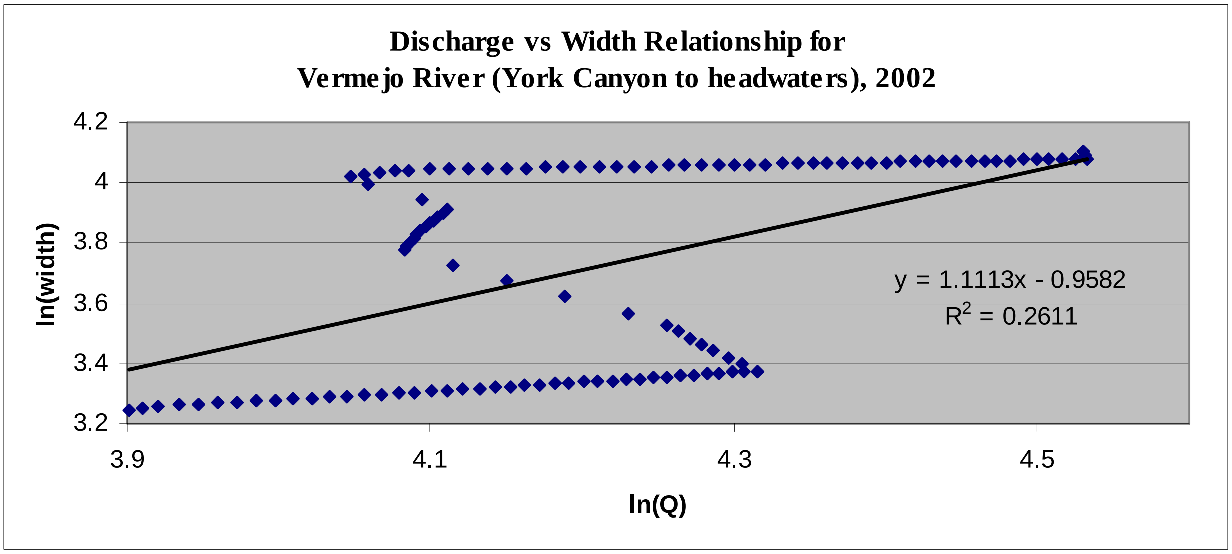
Regression Statistics	
Multiple R	0.720535668
R Square	0.519171648
Adjusted R Square	0.515712452
Standard Error	0.104807943
Observations	141

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.648633408	1.648633	150.0845	7.37051E-24
Residual	139	1.526873985	0.010985		
Total	140	3.175507393			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.901878299	0.151914739	12.51938	1.5E-24	1.601515866	2.202241	1.601515866	2.202240731
X Variable 1	0.519783763	0.042428225	12.2509	7.37E-24	0.435895624	0.603672	0.435895624	0.603671902

Figure E.2 Wetted Width versus Flow for Assessment Unit NM-2305.A_230



SUMMARY OUTPUT

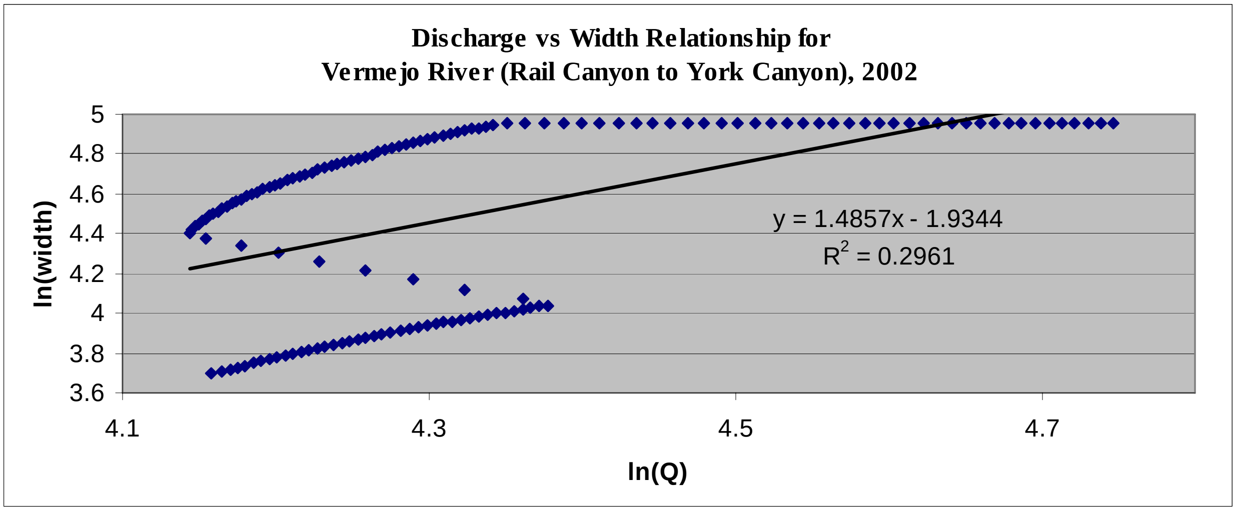
Regression Statistics	
Multiple R	0.511010308
R Square	0.261131534
Adjusted R	0.254650232
Standard E	0.294979955
Observatio	116

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regressior	1	3.505758953	3.505759	40.28998	4.5963E-09
Residual	114	9.91950185	0.087013		
Total	115	13.4252608			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.958185456	0.738032046	-1.298298	0.196805	-2.420221208	0.50385	-2.420221208	0.503850296
X Variable	1.111263287	0.175072707	6.347439	4.6E-09	0.764445614	1.458081	0.764445614	1.458080959

Figure E.3 Wetted Width versus Flow for Assessment Unit NM-2305.A_220



SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.544138535
R Square	0.296086745
Adjusted R	0.291022621
Standard E	0.379835714
Observatio	141

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	8.435410383	8.43541	58.46751	3.09E-12
Residual	139	20.05424856	0.144275		
Total	140	28.48965895			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-1.934390545	0.843171856	-2.294183	0.023279	-3.601491	-0.26729	-3.60149113	-0.267289959
X Variable	1.485702409	0.194300768	7.646405	3.09E-12	1.101535	1.86986955	1.101535265	1.869869552

E3.7 Manning's n or Travel Time

Site-specific values generated from WINXSPRO were used for Manning's n. The following table summarizes the input values:

Table E.14 Manning's n Values

Assessment Unit	Manning's n
NM-2306.A_020	0.019
NM-2305.A_230	0.028 [a]
NM-2305.A_220	0.049 [b]

[a] data from site below confluence with Leandro Creek
[b] data from site below York Canyon Creek

E 4.0 METEOROLOGICAL PARAMETERS

E4.1 Air Temperature

This parameter is the mean daily air temperature for the assessment unit (or average daily temperature at the mean elevation of the assessment unit). Air temperature will usually be the single most important factor in determining mean daily water temperature. Air temperatures are usually measured directly (in the shade) using air thermographs and adjusted to what the temperature would be at the mean elevation of the assessment unit. However, there were no air thermographs deployed in 2002 during this study. The following table summarizes mean daily air temperatures for each assessment unit (for its modeled date) requiring a temperature Total Maximum Daily Load (TMDL):

Table E.15 Mean Daily Air Temperature

Assessment Unit	Elevation at Air Thermograph[1] Location (meters)	Measured Mean Daily Air Temperature (°C)	Mean Elevation for Assessment Unit (meters)	Adjusted Mean Daily Air Temperature (°C)	Adjusted Mean Daily Air Temperature (°F)
NM-2306.A_020	1,936	22.56	2,440	19.25	66.65
NM-2305.A_230	1,936	22.56	2,646	17.90	64.22
NM-2305.A_220	1,936	23.30	2,465	19.83	67.69

Notes:
ºF = Degrees Farenheit
ºC = Degrees Celcius
[1] *No air thermographs deployed. New Mexico State University Climate Network (Raton METAR, Elevation 1,936 meters; Latitude 36° 44' 0" N, Longitude 104° 30' 0" W),* ***2002***

The adiabatic lapse rate was used to correct for elevational differences from the met station:

$$T_a \quad = \quad T_o + C_t \times (Z - Z_o)$$

where,

T_a = air temperature at elevation E (°C)
T_o = air temperature at elevation E_o (°C)
Z = mean elevation of segment (meters)
Z_o = elevation of station (meters)
C_t = moist-air adiabatic lapse rate (-0.00656 °C/meter)

E4.2 Maximum Air Temperature

Unlike the other variables, the maximum daily air temperature overrides only if the check box is checked. If the box is not checked, the SSTEMP Model estimates the maximum daily air temperature from a set of empirical coefficients (Theurer et al., 1984 as cited in Bartholow 2002) and will print the result in the grayed data entry box. A value cannot be entered unless the box is checked.

E4.3 Relative Humidity

Relative humidity data were obtained from the New Mexico State University Climate Network (http://weather.nmsu.edu/data/data.htm). The data were corrected for elevation and temperature using the following equation:

$$R_h = R_o \times \left(1.0640^{(To-Ta)}\right) \times \left(\frac{T_a + 273.16}{T_o + 273.16}\right)$$

where,

R_h = relative humidity for temperature T_a (decimal)
R_o = relative humidity at station (decimal)
T_a = air temperature at segment (°C)
T_o = air temperature at station (°C)

The following table presents the adjusted mean daily relative humidity for each assessment unit:

Table E.16 Mean Daily Relative Humidity

Assessment Unit	Ref.	Mean Daily Air Temp. at Weather Station (°C)	Mean Daily Air Temperature at AU (°C)	Mean Daily Relative Humidity at Weather Station (percent)	Mean Daily Relative Humidity for AU (percent)
NM-2306.A_020	(a)	22.56	19.25	49.095	59.61
NM-2305.A_230	(a)	22.56	17.90	49.095	64.52
NM-2305.A_220	(b)	23.30	19.83	45.673	55.98

Notes:
Ref. = References for Weather Station Data are as follows:
(a) *New Mexico State University Climate Network (Raton METAR, Elevation 1,936 meters; Latitude 36° 44' 0” N, Longitude 104° 30' 0” W),* ***July 8, 2002***
(b) *New Mexico State University Climate Network (Raton METAR, Elevation 1,936 meters; Latitude 36° 44' 0” N, Longitude 104° 30' 0” W),* ***July 12, 2002***
AU = Assessment Unit
ºC = Degrees Celcius

E4.4 Wind Speed

Average daily wind speed data were obtained from the New Mexico State University Climate Network (http://weather.nmsu.edu/data/data.htm). The following table presents the mean daily wind speed for each assessment unit:

Table E.17 Mean Daily Wind Speed

Assessment Unit	Ref.	Mean Daily Wind Speed (miles per hour)	Date
NM-2306.A_020	(a)	12.814	7/8/2002
NM-2305.A_230	(a)	12.814	7/8/2002
NM-2305.A_220	(a)	7.862	7/12/2002

Notes:
Ref. = References for Weather Station Data are as follows:
(a) *Wind speed data not available for Raton METAR. New Mexico State University Climate Network (Clayton, Elevation 1,515 meters; Latitude 36° 28' 4.02" N, Longitude 103° 5' 17.88" W)*

E4.5 Ground Temperature

Mean annual air temperature data for 2002 were used in the absence of measured data. The following table presents the mean annual air temperature for each assessment unit:

Table E.18 Mean Annual Air Temperature as an Estimate for Ground Temperature

Assessment Unit	Ref.	Mean Annual Air Temperature (°C)	Mean Annual Air Temperature (°F)
NM-2306.A_020	(a)	12.36	54.24
NM-2305.A_230	(a)	12.36	54.24
NM-2305.A_220	(a)	12.36	54.24

Ref. = References for Weather Station Data are as follows:
(b) *New Mexico State University Climate Network (Raton METAR, Elevation 1,936 meters; Latitude 36° 44' 0" N, Longitude 104° 30' 0" W),* ***2002***

°F = Degrees Farenheit
°C = Degrees Celcius

E4.6 Thermal Gradient

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

E4.7 Possible Sun

Percent possible sun for Albuquerque is found at the Western Regional Climate Center web site http://www.wrcc.dri.edu/htmlfiles/westcomp.sun.html#NEW%20MEXICO. The percent possible sun is 76 percent for July for Albuquerque as there were no data for the Clayton station.

E4.8 Dust Coefficient

If a value is entered for solar radiation, SSTEMP Model will ignore the dust coefficient and ground reflectivity and "override' the internal calculation of solar radiation. Solar radiation data are available from the New Mexico State University Climate Network (see Section 4.10).

E4.9 Ground Reflectivity

If a value is entered for solar radiation, SSTEMP Model will ignore the dust coefficient and ground reflectivity and "override' the internal calculation of solar radiation. Solar radiation data are available from the New Mexico State University Climate Network (see Section 4.10).

E4.10 Solar Radiation

Because solar radiation data were obtained from an external source of ground level radiation, it was assumed that about 90% of the ground-level solar radiation actually enters the water. Thus, the recorded solar measurements were multiplied by 0.90 to get the number to be entered into the SSTEMP Model. The following table presents the measured solar radiation at Clayton for 2002 as there were no data available for the Raton METAR station:

Table E.19 Mean Daily Solar Radiation

Assessment Unit	Ref.	Date	Mean Solar Radiation (L/day)	Mean Solar Radiation x 0.90 (L/day)
NM-2306.A_020	(a)	7-8-2002	735	661.5
NM-2305.A_230	(a)	7-8-2002	735	661.5
NM-2305.A_220	(a)	7-12-2002	733.992	660.59

Ref. = References for Weather Station Data are as follows:

(a) *Solar radiation data not available for Raton METAR. New Mexico State University Climate Network (Clayton, Elevation 1,515 meters; Latitude 36° 28' 4.02" N, Longitude 103° 5' 17.88" W)*

E 5.0 SHADE

Percent shade was estimated for the assessment units using field estimations per geomorphological survey field notes from 2002. The measurements may have also been averaged along with visual estimates using USGS digital orthophoto quarter quadrangles downloaded from New Mexico Resource Geographic Information System Program (RGIS), online at http://rgis.unm.edu/. This parameter refers to how much of the segment is shaded by vegetation, cliffs, etc. The following table summarizes percent shade for each assessment unit:

In a 2002 study, Optional Shading Parameters and concurrent densiometer readings were measured at seventeen stations in order to compare modeling results from the use of these more extensive data sets to modeling results using densiometer readings as an estimate of Total Shade. The estimated value for Total Shade was within 15% of the calculated value in all cases. Estimated values for Maximum Temperatures differed by less than 0.5% in all cases. The Optional Shading Parameters are dependent on the exact vegetation at each cross section, thus requiring multiple cross sections to determine an accurate estimate for vegetation at a reach scale. Densiometer readings are less variable and less inclined to measurement error in the field. Aerial photos are examined and considered whenever available.

Table E.20 Percent Shade

Assessment Unit	Percent Shade
NM-2306.A_020	<1% and 42% [a]
NM-2305.A_230	0% [b]
NM-2305.A_220	0% [c]

[a] data from site at Thal Ranch and Harold Brock Fishing Area
[b] data from site below confluence with Leandro Creek
[c] data from site below York Canyon Creek

E 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.

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Theurer, Fred D., Kenneth A. Voos, and William J. Miller. 1984. Instream Water Temperature Model. Instream Flow Inf. Pap. 16 Coop. Instream Flow and Aquatic System Group. U.S. Fish & Wildlife Service, Fort Collins, CO.

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Waltemeyer, Scott D. 2002. Analysis of the Magnitude and Frequency of the 4-Day Annual Low Flow and Regression Equations for Estimating the 4-Day, 3-Year Low-Flow Frequency at Ungaged Sites on Unregulated Streams in New Mexico. USGS Water-Resources Investigations Report 01-4271. Albuquerque, New Mexico.

APPENDIX F
PUBLIC PARTICIPATION PROCESS FLOWCHART

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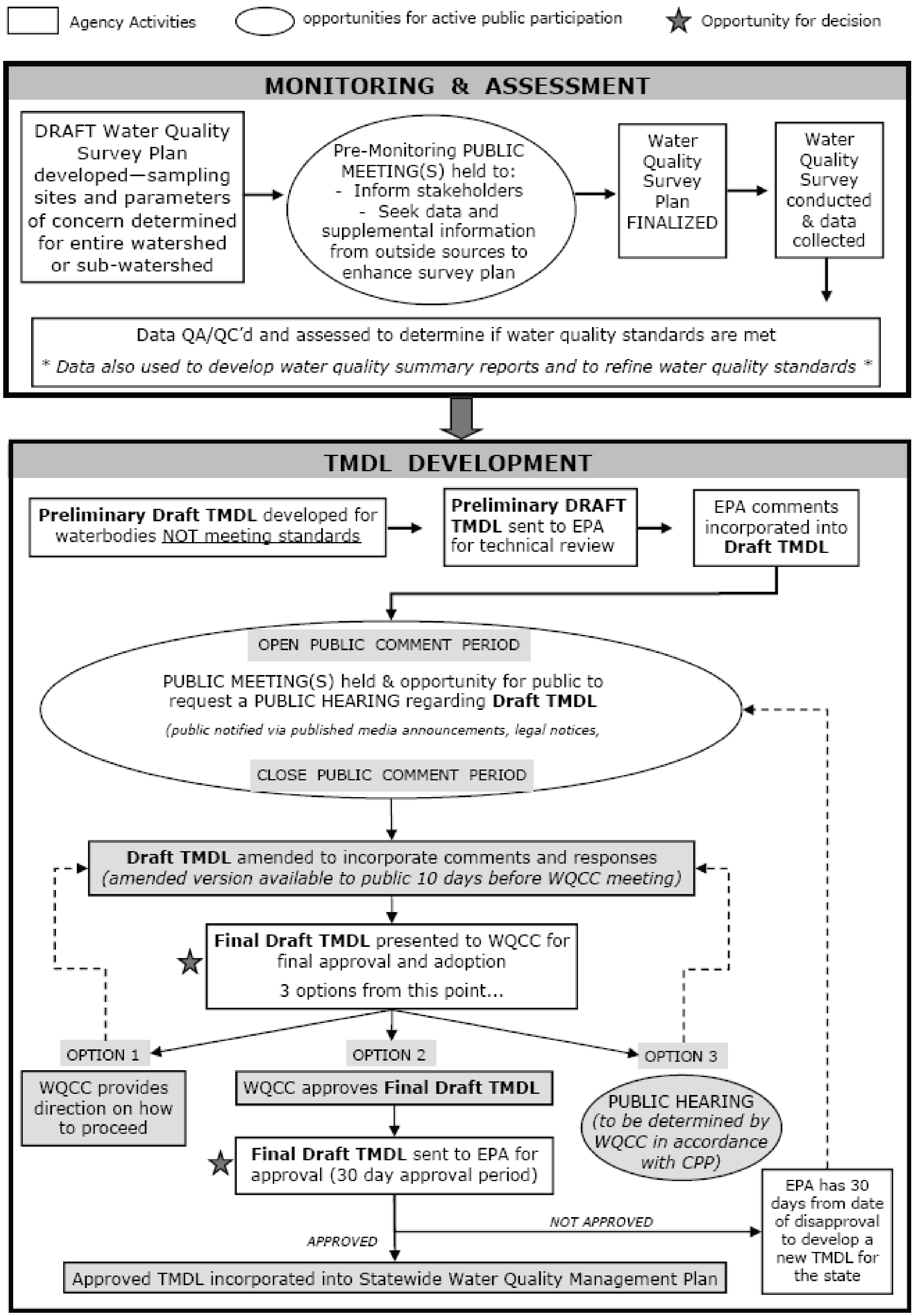
Monitoring, Assessment, & TMDL Development Process



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APPENDIX G
RESPONSE TO COMMENTS

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Changes made during public comment period based on staff review:

1. Table 5.5 now includes all nutrient data for Little Coyote Creek and the Mora River

2. Moved discussion of options for the Mora Mutual Domestic Water & Sewer Works Association and the Mora National Fish Hatchery from *Plant Nutrients – Wasteload Allocation* (Section 5.4.1) to *Implementation of TMDLs – NPDES Permitting* (Section 9.1)

Comment Set A:

From: Clarence Aragon [mailto:mwsa@nnmt.net]
To: Drinkard, Shelly, NMENV
Subject: Public Comment TMDL Mora River
Sent: Thursday, July 19, 2007 4:43 PM

TMDL Comments 7/19/2007
Mora Mutual Domestic Water & Sewer Works Association

As one of two point sources located on the Mora River, the Association and its membership know first hand the importance of maintaining the Quality and Health of the receiving stream. After review of the Draft TMDL document there a number of points the Association would like to make in reference to how this study will ultimately affect our ability to comply in light of the TMDL data used by our surface water permitting agency for more stringent limitations.

For the record, we would like to point out that the two point sources on the affected stretches of the Mora River have been, since their origin, the only users to implement any type of treatment to the returned water flow going back into the river. This is relevant because under the proposed guidelines point source discharge requirements are enforceable under federal and State environmental law and non point sources are encouraged to implement BMP (Best Management Practices), clearly an educational and voluntary process. The impact on the community based on the source you are classified in is quite different. Sewer customers on the Associations community sewer system are now facing a tremendous cost increases for the Operation and maintaince of new facilities and a possible debt service of up to forty years. The funding availability for water and waste water infrastructure is far less than the need. Time and time again small water systems throughout the state go every year and try and compete with large municipalities for limited funds. Unfortunately the dispersement brake down reflects very limited money allocations that rarely can address completed projects of any magnitude. The focal point for leveraging public monies is local capacity and economics. As you can imagine this is not a strong point for rural communities, thus creating a multitude of problems in our ability to move towards complying with what we see as unfunded mandates.

As part of a comprehensive approach to improving the quality of the receiving streams on rural communities affected by the TMDL data, we would like to see a BMP approach for the point source contributors of nutrients to the stream as well. Infrastructure, Affordability and the cost of operating the facilities required to meet more stringent permits is a major problem for small rural facilities with a limited customer base and small economies. Mora Mutual Water & Sewer Association wants to be part of the solution in improving the quality of water in the Mora River and we have demonstrated that for over thirty years by providing the only form of waste water treatment in western Mora County. Forcing the Association into financial obligations far beyond its capacity can not be the only answer. We have neither the resources or the desire to argue the science behind the TMDL because we are aware that there is a problem, what we will question is the current approach in solving it. The village of Mora is home to a struggling economy, and although census numbers show improvement in median house hold incomes over the last ten years, those numbers reflect the development of properties on the outlining areas (non point sources) and not the 100 customers currently the Association's collection system.

Based on our extensive experience with the funding opportunities presented to us thus far, we are not encouraged by our options in attaining the necessary funding for compliance. The Association will make every effort to comply but the reality is that our capacity is limited as is our ability to secure funding under the current criteria.

Clarence Aragon,
System Manager
Mora Mutual Water & Sewer
Association

SWQB Response: *Thank you for your comment. SWQB acknowledges that the wasteload allocations (WLAs) established in the TMDL for the point source pollution from the Mora Mutual Domestic Water & Sewer Works Association (MMDWWA) and the Mora National Fish Hatchery will require changes and improvements to the design and operation of those facilities. SWQB would like to reiterate the fact that the development of a TMDL opens up various funding opportunities. NMED's Construction Programs Bureau (CPB) assists communities in need of funding for WWTP upgrades and improvements to septic tank configurations (such as the design of cluster systems). They can also provide matching funds for appropriate Clean Water Act §319(h) projects using state revolving fund monies. The USDA 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. And, the BLM has several programs in place to provide assistance to improve unpaved roads and grazing allotments.*

The Watershed Protection Section of SWQB administers CWA §319(h) funding to assist in the implementation of BMPs to address water quality problems on reaches listed 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. Funding is available for both watershed group formation (which includes WRAS development) and on-the-ground projects to improve surface water quality and associated habitat. Work plans developed and funded under CWA §319(h) comprise a variety of efforts; including watershed association development, pollutant source tracking, riparian area restoration, and spill response. Further information on funding from the CWA §319 (h) can be found on the SWQB website: http://www.nmenv.state.nm.us/swqb/WPS/index.html. It is possible that over time, the positive impacts resulting from nonpoint source pollutant reductions could affect the wasteload allocations required for point source pollutants.

As noted in the TMDL, MMDWWA discharges to the Mora River under authorization of an NPDES permit. Federal regulations (40 CFR 130.12(a) and 40 CFR 122.44(d)(1)(vii)) clearly require that NPDES permits must be consistent with the WLA of an adopted and approved TMDL. The regulations do not allow point source dischargers to be treated the same way as *nonpoint source discharges regarding BMPs to meet water quality criteria. Thus, it important to provide direction on implementation of the WLA such that effluent limits and schedules can be readily incorporated within the structure of a permit.*

The implementation portion of the TMDL (Section 9.0) includes an optional alternative (i.e. cluster systems) to the costly upgrades that would be necessary for continued discharge to the river. Cluster Systems offer a management solution that would eliminate the effluent discharge to the Mora River. Instead of discharging effluent to the river, the final dispersal of treated wastewater would be to leach fields and possibly to agricultural reuse. Because of this, cluster systems are considered nonpoint sources. Therefore, if the cluster system option is chosen MMDWWA would be subject to BMPs as well as discharge requirements from the Ground Water Quality Bureau (GWQB) of NMED. The cluster system option could effectively remove the MMDWWA from any effluent requirements in the NPDES permit. Furthermore, inclusion of this option in the TMDL lends supporting justification for funding through sources such as the NM Revolving Loan program administered in part by the CPB and CWA §319 (h) funding administered by SWQB's Watershed Protection Section. CPB is currently working with the MMDWWA to procure funding and to manage improvement projects for the wastewater treatment plant and the wastewater collection system. The SWQB, CPB, and GWQB will continue to work collaboratively with the community on these important issues.

Comment Set B:

From: Gilbert Quintana
To: Shelly Drinkard
Comments Regarding: the Canadian River Watershed
Letter received: 7/18/2007

****PDF Inserted****

Surface Water Quality Bureau

NEW MEXICO ENVIRONMENT DEPARTMENT

Public Comment Card

Meeting Date: 6/12/07

Comments Regarding: Canadian River Watershed

***OPTIONAL INFORMATION :**

*Name: Gilbert Quintana

*Affiliation: Acequia Del Molino de Tramperos/Commissioner/ Acequia de la Monedad, parciante Mora Land Grant, Vice President

*E-Mail: apachequintana@netscape.net

*Mailing Address: PO Box 51 Holman, New Mexico 87723

Comments must be submitted in writing in order to be included in the public record. Please provide comments in the space below (use back if necessary):

In the meeting held on the above date, I left with a better understanding of maximum amount of a pollutant that enters our stream, Rio Agua Negra, the headwaters of the Mora River. I believe several of my community members a Mr. Clarence Aragon and Mr. Ivan Roper spoke well regarding this issue and hopefully their comments will be incorporated into public comment. The issue of specific conductance, plant nutrients, sedimentation/siltation and temperature and how they affect our water is of upmost concern to my family, friends and community members. Some of my concerns are as follows; the study was conducted during a drought period unlike nothing I had seen before. I was born here and have lived the majority of my life on my homelands. I do believe that the acequias are one of the best life lines in filtering our water. These water systems protect our well being and should be funded for improvements to continue this positive way of life and health. Best management practices have to be addressed without pointing fingers or laying blame. Ownership and education of the problems brings solutions to this matter. Non point sources and point sources needed to be addressed. I can see things in the Mora Valley such as the use of spray pesticides, chemical fertilizer and processed seed (ie Range cube/Cuba Seed) that impact these conditions, just to mention a few. I would hope that the government in (over)

Turn comment card in tonight or mail / fax:

TMDL Coordinator
Surface Water Quality Bureau, P. O. Box 26110. Santa Fe, NM 87502
Phone: (505) 827-0187; Fax: (505) 827-0160

conjunction with local people could begin to address these issues. through education, training and funding. As Mr. Aragon stated "without pointing fingers and laying blame" we could begin the healing of our mother earth. I would be willing to practice and partake in this process with these type of thinkers to come up with best management practices for our community.

SWQB Response: *Thank you for your comment. Even though New Mexico has been experiencing drought conditions for multiple years, streamflow measurements taken during SWQB's water quality survey were above the critical low flows for the waterbodies. As stated in SWQB's Assessment Protocol, data collected during all flow conditions, including low flow conditions (i.e., flows below the 4-day, 3-year low-flow frequency [4Q3]), will be used to determine designated use attainment status during the assessment process. In terms of assessing designated use attainment in ambient surface waters, water quality standards (WQS) apply at all times under all flow conditions.*

SWQB appreciates your willingness to "practice and partake in the process" of restoring your watershed "without pointing fingers or laying blame." One of the positive aspects of a TMDL is that it opens up various funding opportunities. For example, the Watershed Protection Section of SWQB administers Clean Water Act §319(h) funding to assist in the implementation of BMPs to address water quality problems on reaches listed 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. Funding is available for both watershed group formation (which includes Watershed Restoration Action Strategy development) and on-the-ground projects to improve surface water quality and associated habitat. Work plans developed and funded under CWA §319(h) comprise a variety of efforts; including watershed association development, pollutant source tracking, riparian area restoration, and spill response. Further information on funding from the CWA §319 (h) can be found on the SWQB website:
http://www.nmenv.state.nm.us/swqb/WPS/index.html.

Additionally, NMED's Construction Programs Bureau (CPB) assists communities in need of funding for WWTP upgrades and improvements to septic tank configurations (such as the design of cluster systems). They can also provide matching funds for appropriate Clean Water Act §319(h) projects using state revolving fund monies. The USDA 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. And, the BLM has several programs in place to provide assistance to improve unpaved roads and grazing allotments.