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)

	ECOREGION									
Parameter	21-Southern Rockies		23-AZ/NM Mountains		22-AZ/NM Plateau		24-Chihuahuan Desert	26-SW Tablelands		
TP	0.02		0.02		0.05		0.04	0.03		
TN	0.25		0.25		0.35		0.53	0.38		
ALU	CW	T/WW (volcanic)	CW	T/WW	CW	T/WW	T/WW	CW	T	WW
TP	0.02	0.02 (0.05)	0.02	0.05	0.04	0.09	0.04	0.02	0.03	0.03
TN	0.25	0.25	0.25	0.29	0.28	0.48	0.53	0.25	0.38	0.45

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:

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

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.

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:

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

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).

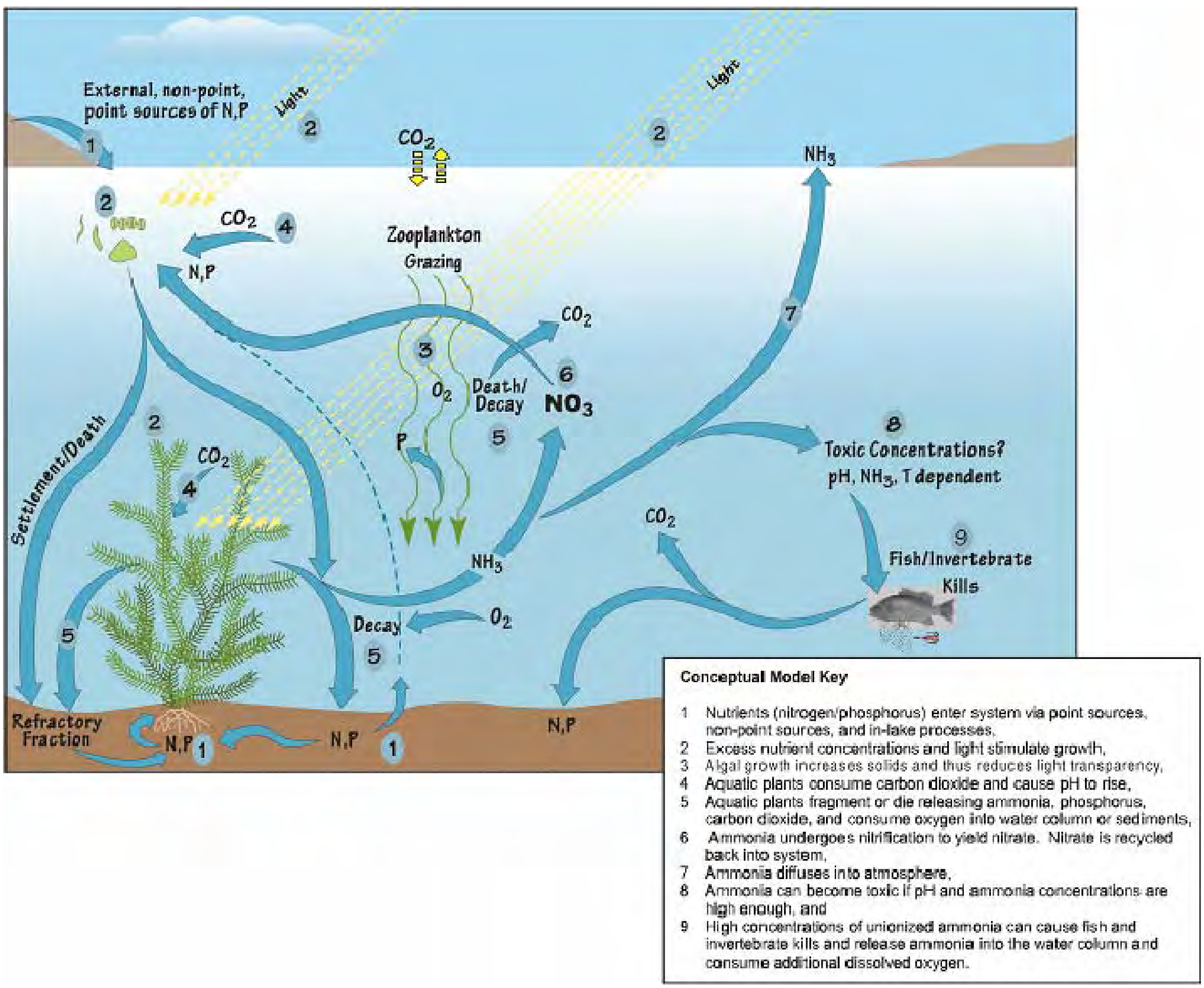

Figure 5.1. Nutrient Conceptual Model (USEPA 1999)

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.