5.0 PLANT NUTRIENTS

The potential for excessive nutrients in Cieneguilla Creek, Cimarron River, Moreno Creek, Ponil Creek, Rayado Creek, and Sixmile Creek was noted through visual observation during the 2006 SWQB watershed survey. Assessment of various water quality parameters indicated nutrient impairment in Cieneguilla Creek (Eagle Nest Lake to headwaters), Cimarron River (Canadian River to Cimarron Village), Cimarron River (Turkey Creek to Eagle Nest Lake), Moreno Creek (Eagle Nest Lake to headwaters), Ponil Creek (US 64 to confluence of North and South Ponil Creeks), Rayado Creek (Cimarron River to Miami Lake diversion), and Sixmile Creek (Eagle Nest Lake to headwaters).

5.1 Target Loading Capacity

For this TMDL document the target value for plant nutrients is based on numeric translators for the narrative criterion set forth in 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 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 or translators are necessary to establish targets for TMDLs, to develop water quality-based permit limits and source control plans, and to support designated uses within the watershed.

Phosphorous is found in water primarily as ortho-phosphate. In contrast nitrogen may be found as several dissolved species all of which must be considered in loading. Total Nitrogen is defined as the sum of Nitrate+Nitrite (N+N), and Total Kjeldahl Nitrogen (TKN). At the present time, there is no EPA-approved method to test for Total Nitrogen, however a combination of EPA method 351.2 (TKN) and EPA method 353.2 (Nitrate + Nitrite) is appropriate for estimating Total Nitrogen.

Development of numeric translators for the plant nutrients criterion is the result of a three-step analysis. 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 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) were 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 using GIS coverages and the station's latitude and longitude. Medians were calculated for each ecoregion/aquatic life use group. 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. The threshold values from 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 (WQ) segments having only CW uses)
T = Transitional (those WQ segments with marginal CW or both CW and WW uses)
WW = Warmwater (those WQ segments having only WW uses)

Cimarron River (Turkey Creek to Eagle Nest Lake), Moreno Creek (Eagle Nest Lake to headwaters), Ponil Creek (US 64 to confluence of North and South Ponil Creeks), and Sixmile Creek (Eagle Nest Lake to headwaters) are located in Ecoregion 21 (Southern Rockies). These assessment units are designated as high quality coldwater aquatic life (20.6.4.309 NMAC). According to Table 5.1, these waters have nutrient targets of 0.02 mg/L for total phosphorus and 0.25 mg/L for total nitrogen.

Cimarron River (Canadian River to Cimarron Village) and Rayado Creek (Cimarron River to Miami Lake diversion) are located in Ecoregion 26 (Southwestern Tablelands). These assessment units have a designated use of warmwater aquatic life (20.6.4.306 NMAC).

According to Table 5.1, these waters have nutrient targets of 0.03 mg/L for total phosphorus and 0.45 mg/L for total nitrogen.

Cieneguilla Creek (Eagle Nest Lake to headwaters) is designated as high quality coldwater aquatic life (20.6.4.309 NMAC) and is located in Ecoregion 21 (Southern Rockies). According to Table 5.1, this creek has nutrient targets of 0.02 mg/L for total phosphorus and 0.25 mg/L for total nitrogen. However, SWQB's nutrient survey and assessment indicated the stream is fully supporting its designated uses in the upper portion of the creek where average nutrient concentrations were 0.06 mg/L for total phosphorus and 0.56 mg/L for total nitrogen and not supporting its designated uses in the lower portion of the creek where average concentrations were 0.12 mg/L and 0.86 mg/L, respectively. Since the upstream values have proven to be effective at maintaining water quality standards and fully supporting the designated uses, they are being recommended as the in-stream target concentrations for Cieneguilla Creek.

Table 5.2. In-stream nutrient target concentrations

Assessment Unit	Total Phosphorus	Total Nitrogen
Cieneguilla Creek (Eagle Nest Lake to headwaters)	0.06 mg/L	0.56 mg/L
Cimarron River (Canadian River to Cimarron Village)	0.03 mg/L	0.45 mg/L
Cimarron River (Turkey Creek to Eagle Nest Lake)	0.02 mg/L	0.25 mg/L
Moreno Creek (Eagle Nest Lake to headwaters)	0.02 mg/L	0.25 mg/L
Ponil Creek (US 64 to confluence of North and South Ponil)	0.02 mg/L	0.25 mg/L
Rayado Creek (Cimarron River to Miami Lake diversion)	0.03 mg/L	0.45 mg/L
Sixmile Creek (Eagle Nest Lake to headwaters)	0.02 mg/L	0.25 mg/L

5.2 Flow

The presence of plant nutrients in a stream can vary as a function of flow. Higher nutrient concentrations typically occur during low-flow conditions because there is reduced stream capacity to assimilate discharges due to less streamflow available for dilution. In other words, as flow decreases, the stream cannot effectively dilute its constituents causing the concentration of plant nutrients to increase. Thus, a TMDL is calculated for each assessment unit at a specific flow.

The critical flow condition for these TMDLs occurs when the ratio of nutrient concentrations 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 adverse effect low flows have on water quality due to increased nutrient concentrations and algal growth.

Table 5.3. USGS gages in the Cimarron Watershed (HUC 11080002)

Agency	Site Number	Site Name	Period of Record
USGS	7204000	Moreno Creek at Eagle Nest, NM	1928 - 2008
USGS	7204500	Cieneguilla Creek near eagle Nest. NM	1928 - 2008
USGS	7205000	Sixmile Creek near Eagle Nest, NM	1958 - 2008
USGS	7205500	Eagle Nest Lake near Eagle Nest, NM	1987 - present
USGS	7206000	Cimarron River below Eagle Nest Dam, NM	1950 - present
USGS	7207000	Cimarron River near Cimarron, NM	1950 - present
USGS	7207500	Ponil Creek near Cimarron, NM	1916 - present
USGS	7208500	Rayado Creek near Cimarron, NM	1911 - present
USGS	7211000	Cimarron River at Springer, NM	1907 - 2004

When available, USGS gages are used to estimate flow. There are nine gages that were active in the Cimarron Watershed around the time of the water quality survey and data collection efforts (Table 5.3). The 4Q3 flows for Cieneguilla Creek, Cimarron River, Moreno Creek, Ponil Creek, and Sixmile Creek were estimated using the appropriate gage data and DFLOW software, Version 3.1b (USEPA 2006). DFLOW 3.1b is a Windows-based tool developed to estimate user selected design stream flows for low flow analysis by utilizing algorithms based on Log Pearson Type III distribution.

A climatic year starting April 1 of the prior year and ending March 31 is often used when examining critical low flow conditions in the United States. This choice reduces the likelihood of splitting low flow periods - typically found in the summer or fall - across different years and thereby affecting the results of Log Pearson Type III analysis of series of annual low flows. A different climatic year or shorter season may be used if low flow periods occur at other times of the year or overlap the boundaries of the climatic year.

DFLOW 3.1 allows the user to specify a season that lasts less than a year by indicating the start date and end date of the season. A seasonal component was added to the higher elevation reaches (i.e. Cieneguilla Creek, Moreno Creek, and Sixmile Creek) because cold temperatures and freezing conditions combine to create zero dischage during the winter months. The 4Q3 flows for Cieneguilla Creek, Moreno Creek, and Sixmile Creek were calculated using gage data from the typical growing season for the ecoregion and elevation (July 1 – September 30). The growing seasons were established for three general regions by using the median annual dates of the last and first frost from the National Weather Service (Table 5.4). If a full year's worth of data were included in the critical flow calculations for these high elevation streams then the 4Q3 values would be zero.

Table 5.4. Growing season definitions for ecoregion and elevation classes

Regions	Ecoregion Names	Ecoregion	Begin	End	Length
Mountain >7500 ft	S. Rockies & AZ/NM Mountains	22 & 23	1-July	1-Oct	3 months
Mountains <7500 ft & Plateau	S. Rockies, AZ/NM Mountains & AZ/NM Plateau	20, 21, 22 & 23	15-Jun	1-Nov	4 ½ months
S. Deserts and Plains	SW Tablelands & Chihuahuan Desert	24, 25, 26, & 79	15-May	15-Nov	6 months

A seasonal component was also added to the Cimarron River (Turkey Creek to Eagle Nest Lake) because streamflow in this reach is dependent on releases from Eagle Nest Dam. Eagle Nest Water is released from Eagle Nest Dam because of irrigation demands downstream. The 4Q3 flow for this portion of the Cimarron River was calculated using gage data from the Cimarron River near Cimarron, NM (USGS 07207000) during the typical growing season for the ecoregion and elevation (June 15 – October 31). Consistent water releases of 45 to 50 cubic feet per second occur throughout the growing season and can be expected until October. However, in the winter months when water is stored up in Eagle Nest Lake, flows in the Cimarron River can slow to a trickle.

More than 80 percent of the water used in Colfax County goes into agricultural activities and surface water is the primary source of water for irrigated agriculture in the county (DBS&A 2003). Water is diverted from Ponil Creek to Chase Ranch Ditch near Cimarron, NM. Assuming a 1.5 acre-foot allotment, the estimated maximum amount of water diverted from Ponil Creek is 462 acre-feet (ac-ft) per year, or roughly 1.28 cfs during the growing season; however the ranch has never received their full 1.5 acre-foot allotment. The most they have ever received is 9.5 inches per acre, and in a typical year they receive about 4 inches per acre (DBS&A 2003) translating to approximately 0.67 cfs (highest diversion) and 0.28 cfs (average diversion) during the growing season. The 4Q3 flow for this portion of Ponil Creek was calculated using gage data from the typical growing season for the ecoregion and elevation (May 15 – November 15). The typical amount of water diverted from Ponil Creek during the growing season (0.28 cfs) was added to the calculated 4Q3 value (0.04 cfs) to obtain an estimate of the actual critical flow.

The calculated 4Q3s using DFLOW software are as follows:

- Cieneguilla Creek (Eagle Nest Lake to headwaters) = 0.31 cfs
- Cimarron River (Canadian River to Cimarron Village) = 0.39 cfs
- Cimarron River (Turkey Creek to Eagle Nest Lake) = 3.30 cfs
- Moreno Creek (Eagle Nest Lake to headwaters) = 0.18 cfs
- Ponil Creek (US 64 to confl of North & South Ponil) = 0.32 cfs
- Sixmile Creek (Eagle Nest Lake to headwaters) = 0.17 cfs

It is necessary to estimate a critical flow for a portion of a watershed where there is no active flow gage such as lower Rayado Creek. 4Q3 derivations for ungaged streams are 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):

$$4Q3 \quad = \quad 1.2856 \times 10^{-4} \; DA^{0.42} \; P_w^{\;3.16} \qquad \text{(Eq. 5-1)}$$

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 4Q3 for lower Rayado Creek was estimated using the statewide regression equation (Eq. 5-1) because the mean elevation for this assessment unit was below 7,500 feet in elevation (Table 5.5).

Table 5.5 Calculation of 4Q3 Low-Flow Frequencies

Assessment Unit	Average Elevation (ft.)	Drainage Area (mi^2)	Mean Winter Precipitation (in.)	4Q3 (cfs)
Rayado Creek (Cimarron River to Miami Lake diversion)	7428	202	6.4	0.42

The 4Q3 value for Rayado Creek (Cimarron River to Miami Lake diversion) was converted from cubic feet per second (cfs) to units of million gallons per day (mgd) as follows:

$$0.42 \frac{ft^3}{\sec} \times 1{,}728 \frac{in^3}{ft^3} \times 0.004329 \frac{gal}{in^3} \times 86{,}400 \frac{\sec}{day} \times 10^{-6} = 0.27 mgd$$

The 4Q3 values for the other waterbodies were calculated in a similar manner.

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 Eq. 5-2.

4Q3 (in mgd) x Numeric Target (in mg/L) x 8.34 = TMDL (pounds per day [lbs/day]) (Eq. 5-2)

The daily target loads for TP and TN are summarized in Table 5.6.

Table 5.6 Daily Target Loads for TP & TN

Assessment Unit	Parameter	4Q3 Flow (mgd)	Numeric Target (mg/L)	Conversion Factor	Target Load (lbs/day)
Cieneguilla Creek (Eagle Nest Lake to headwaters)	Total Phosphorus	0.70+	0.06	8.34	0.35
	Total Nitrogen	0.70+	0.56	8.34	3.3
Cimarron River (Canadian R to Cimarron, NM)	Total Phosphorus	0.55*	0.03	8.34	0.14
	Total Nitrogen	0.55*	0.45	8.34	2.1
Cimarron River (Turkey Crk to Eagle Nest Lake)	Total Phosphorus	2.13	0.02	8.34	0.36
	Total Nitrogen	2.13	0.25	8.34	4.4
Moreno Creek (Eagle Nest Lake to headwaters)	Total Phosphorus	0.12	0.02	8.34	0.02
	Total Nitrogen	0.12	0.25	8.34	0.25
Ponil Creek (US 64 to confl of N & S Ponil)	Total Phosphorus	0.21	0.02	8.34	0.04
	Total Nitrogen	0.21	0.25	8.34	0.44
Rayado Creek (Cimarron R to Miami Lake div)	Total Phosphorus	0.27	0.03	8.34	0.07
	Total Nitrogen	0.27	0.45	8.34	1.02
Sixmile Creek (Eagle Nest Lake to headwaters)	Total Phosphorus	0.11	0.02	8.34	0.02
	Total Nitrogen	0.11	0.25	8.34	0.23

Notes:

+ *Combined Flow = 4Q3 low-flow (0.20 mgd) + Angel Fire WWTP design capacity (0.50 mgd)*

* *Combined Flow = 4Q3 low-flow (0.25 mgd) + Springer WWTP design capacity (0.30 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 arithmetic mean of the collected data was substituted for the target in Equation 5-2. The same conversion factor of 8.34 was used. The results are presented in Table 5.7.

Table 5.7 Measured Loads for TP and TN

Assessment Unit	Parameter	4Q3 Flow (mgd)	Arithmetic Mean Conc.^ (mg/L)	Conversion Factor	Measured Load (lbs/day)
Cieneguilla Creek	Total Phosphorus	0.70+	0.09	8.34	0.53
(Eagle Nest Lake to headwaters)	Total Nitrogen	0.70+	0.71	8.34	4.1
Cimarron River	Total Phosphorus	0.55*	0.04	8.34	0.18
(Canadian R to Cimarron, NM)	Total Nitrogen	0.55*	0.71	8.34	3.3
Cimarron River	Total Phosphorus	2.13	0.08	8.34	1.4
(Turkey Crk to Eagle Nest Lake)	Total Nitrogen	2.13	0.64	8.34	11.4
Moreno Creek	Total Phosphorus	0.12	0.04	8.34	0.04
(Eagle Nest Lake to headwaters)	Total Nitrogen	0.12	0.41	8.34	0.41
Ponil Creek	Total Phosphorus	0.21	0.05	8.34	0.09
(US 64 to confl of N & S Ponil)	Total Nitrogen	0.21	0.45	8.34	0.79
Rayado Creek	Total Phosphorus	0.27	0.06	8.34	0.14
(Cimarron R to Miami Lake div)	Total Nitrogen	0.27	0.60	8.34	1.35
Sixmile Creek	Total Phosphorus	0.11	0.04	8.34	0.04
(Eagle Nest Lake to headwaters)	Total Nitrogen	0.11	0.32	8.34	0.29

Notes:

+ *Combined Flow = 4Q3 low-flow (0.20 mgd) + Angel Fire WWTP design capacity (0.50 mgd)*

* *Combined Flow = 4Q3 low-flow (0.25 mgd) + Springer WWTP design capacity (0.30 mgd)*

^ *Arithmetic mean of TP and TN concentrations from SWQB's 2006 water quality survey.*

5.4 Waste Load Allocations and Load Allocations

5.4.1 Waste Load Allocation

There are no Municipal Separate Storm Sewer System (MS4) storm water permits in these AUs. However, excess nutrient loading may be a component of some storm water discharges covered under general NPDES permits, so the load from these dischargers should be addressed.

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 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. The current CGP also includes state-specific requirements to implement site-specific interim and permanent stabilization, managerial, and structural solids, erosion, and sediment control Best Management Practices (BMPs) and/or other controls. BMPs are designed to prevent to the maximum extent practicable an increase in sediment load to the water body or an increase in a sediment-related parameter, such as total suspended solids, turbidity, siltation, stream bottom deposits, etc. BMPs also include measures to reduce flow velocity during and after construction compared to pre-construction conditions to assure that waste load allocations (WLAs) or applicable water quality standards, including the antidegradation policy, are met. Compliance with a SWPPP that meets the requirements of the CGP is generally assumed to be consistent with this TMDL.

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

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

There are no active point source dischargers on the upper Cimarron River, Moreno Creek, Ponil Creek, Rayado Creek, or Sixmile Creek AUs. However, there are existing point sources with individual NPDES permits in the Cieneguilla Creek and lower Cimarron River assessment units. Each NPDES-permitted facility that discharges into an impaired reach has a WLA included in this TMDL (Tables 5.8 – 5.10).

The City of Springer's Water Treatment Plant (WTP) discharges into the Cimarron River near its confluence with the Canadian River. Currently, the City's NPDES permit does not have limitations or monitoring requirements for nutrients. Effluent from water treatment plants has never been noted to be a significant source contributor of nutrients and should not have an impact on nutrient concentrations in the stream, thus the WLA for the WTP is zero (Table 5.8).

Table 5.8 Wasteload Allocation for City of Springer WTP (NM0030627)

Facility	Parameter	Design Capacity (mgd)	Effluent Limit[(a)] (mg/L)	Conversion Factor	Wasteload Allocation (lbs/day)
NM0030627 City of Springer Water Treatment Plant[⊕] (expires September 30, 2012)	Total Phosphorus	variable	n/a	8.34	0
	Total Nitrogen	variable	n/a	8.34	0

Notes:
[⊕] Effluent from water treatment plants has never been noted to be a significant source contributor of nutrients.

The Village of Angel Fire wastewater treatment plant (WWTP) (NM0030503) is authorized to discharge directly into Cieneguilla Creek under the stipulations described in its NPDES permit. The City of Springer WWTP (NM0030295) is authorized to discharge to the Cimarron River, however this facility has been under construction and the outfall pipe to the river has not yet been completed. The facility currently discharges to a series of lined and unlined lagoons. Currently, these WWTPs are not designed to treat effluent for the removal of nitrogen and phosphorus. The facilities will need to develop and implement treatment to remove nutrients and improve water quality. It is the policy of the Water Quality Control Commission to allow schedules of compliance in NPDES permits when facility modifications are necessary to meet new water quality based requirements.

Nutrient removal is one of the most pressing challenges facing wastewater treatment facilities. Nutrients can be removed from wastewater via biological, chemical, or combined biological and chemical processes. There are theoretical limits that can be achieved with different removal mechanisms. The limit of technology, based on annual averages, is generally considered to be 0.1 mg/L for total phosphorus (TP) and 3 mg/L for total nitrogen (TN) (Jeyanayagam 2005). TP concentrations in treated effluent typically range from 0.1 to 1.0 mg/L, while TN concentrations typically range from 3.0 to 10.0 mg/L, depending on the removal process and site-specific conditions. Some facilities may be able to achieve lower concentrations by using a combination of biological and chemical treatments, however biological treatment is highly temperature dependent therefore seasonal limits may need to be considered in some cases. The choice of technology to be used as well as the option and use of seasonal limits depend on the site-specific conditions, such as temperature, dissolved oxygen levels, and pH in combination with the economic feasibility.

NMED believes that a TMDL should be written to targets that are protective of the stream and scientifically defensible however there should also be some recognition of the limits of technology for nutrient removal. Even though the limits of technology preclude the attainment of the target concentrations defined in this TMDL, advanced treatment would significantly reduce the load of TP and TN that is introduced into the stream. After implementation of effluent limits based on the limits of technology and given enough time to allow the aquatic to system to respond, NMED will reevaluate the condition of Cieneguilla Creek and the Cimarron River. At that time, if the waterbodies are still impaired for plant nutrients and there is no substantial improvement observed in the water quality of these waters, the WWTPs would be

required to enhance the treatment of the effluent by adding more effective treatment or find other means of disposal (Figure 5.1; Tables 5.9 and 5.10).

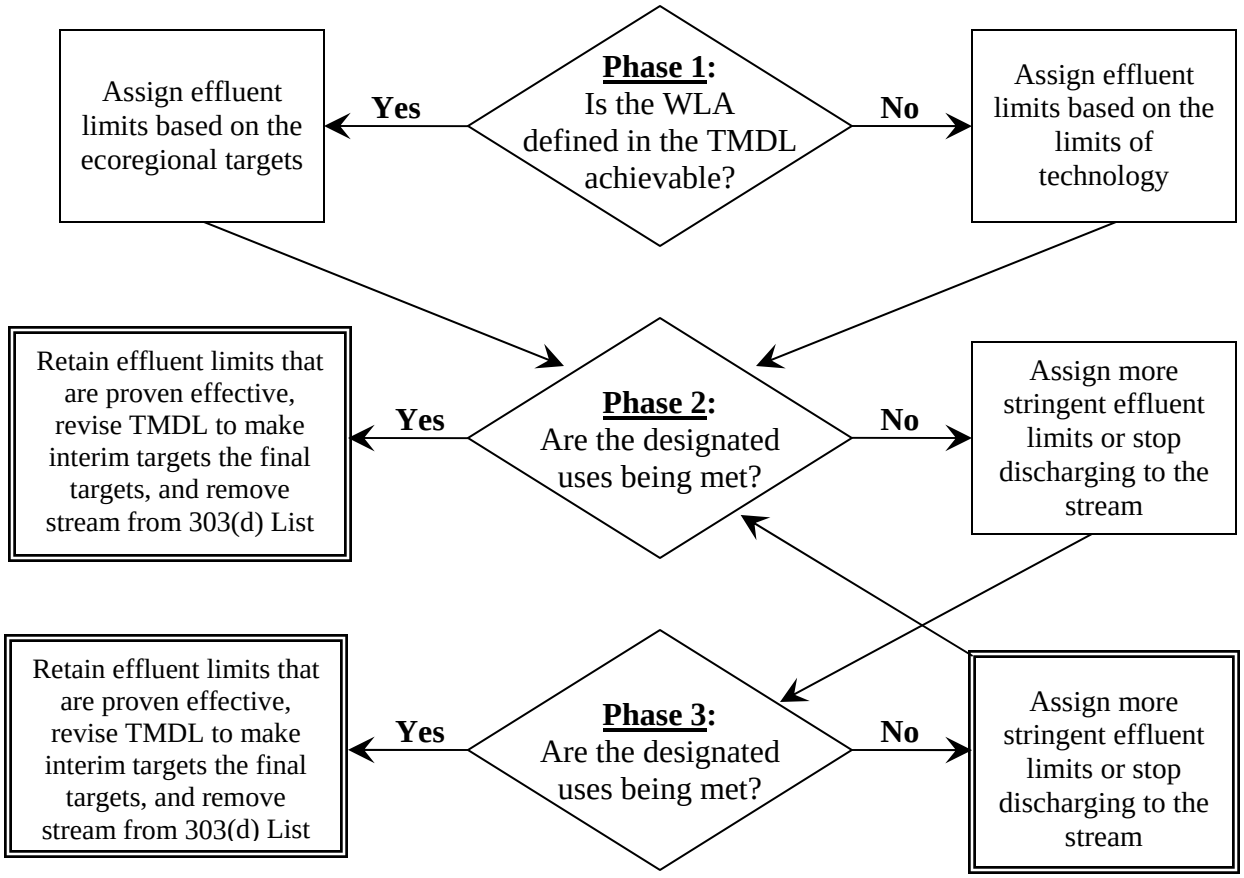

Figure 5.1. Decision process for assigning effluent limits in a phased TMDL

A phased strategy is an iterative process and will require future data collection and analysis to determine if the load reductions achieved using effluent limits that are based on alternative target concentrations actually lead to attainment of water quality standards. Please refer to "Clarification Regarding "Phased" Total Maximum Daily Loads," an August 2, 2006 memorandum from the USEPA, for more information on this topic. The next scheduled monitoring date for the Cimarron Watershed is 2016 at which time the water quality of this watershed will be re-examined, designated use attainment will be re-assessed, and target concentrations and waste load allocations re-evaluated.

Table 5.9 *Phase 1* Nutrient Wasteload Allocations

Phase	Facility	Parameter	Design Capacity (mgd)	Effluent Limit (mg/L)	Conversion Factor	Wasteload Allocation[d] (lbs/day)
1st	**NM0030503** Village of Angel Fire WWTP (expires October 31, 2012)	Total Phosphorus	0.50	0.1[a]	8.34	0.42
		Total Nitrogen	0.50	3.0[a]	8.34	12.5
1st	**NM0030295** City of Springer WWTP* (expires February 28, 2013)	Total Phosphorus	0.30	0.1[a]	8.34	0.25
		Total Nitrogen	0.30	3.0[a]	8.34	7.5

Table 5.10 *Target* Nutrient Wasteload Allocations *(Phase "n")*

Phase	Facility	Parameter	Design Capacity (mgd)	Effluent Limit (mg/L)	Conversion Factor	Wasteload Allocation[d] (lbs/day)
nth	**NM0030503** Village of Angel Fire WWTP	Total Phosphorus	0.50	0.06[b]	8.34	0.25
		Total Nitrogen	0.50	0.56[b]	8.34	2.3
nth	**NM0030295** City of Springer WWTP	Total Phosphorus	0.30	0.03[c]	8.34	0.075
		Total Nitrogen	0.30	0.45[c]	8.34	1.1

Notes:

* Currently, the Springer WWTP is not discharging to the Cimarron River.

(a) Phase 1 effluent limits are based on annual averages for the limits of technology. Biological treatment is highly temperature dependent therefore the permit may need to consider seasonal targets based on WWTP design.
(b) Phase "n" effluent limits based on in-stream nutrient concentrations that are proven effective at maintaining water quality standards and fully supporting the designated uses of the stream. As of 2010, these values are technologically unachievable.
(c) Phase "n" effluent limits based on in-stream target concentrations from Table 5.2. As of 2010, these values are technologically unachievable.
(d) WLA = (design capacity) x (effluent limit) x (conversion factor)

5.4.2 Load Allocation

In order to calculate the LA for phosphorus and nitrogen, the WLA and MOS were subtracted from the target capacity (TMDL) using the following equation:

$$WLA + LA + MOS = TMDL \qquad \text{(Eq. 5-3)}$$

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 10% (see Section 5.7 for details) are presented in Table 5.11.

Table 5.11 Calculation of TMDL for TP and TN

Assessment Unit	Parameter	WLA (lbs/day)	LA (lbs/day)	MOS (10%)	TMDL (lbs/day)
Cieneguilla Creek (Eagle Nest Lake to headwaters)	Total Phosphorus	0.25	0.065	0.035	0.35
	Total Nitrogen	2.3	0.67	0.33	3.3
Cimarron River (Canadian R to Cimarron, NM)	Total Phosphorus	0.075	0.051	0.014	0.14
	Total Nitrogen	1.1	0.79	0.21	2.1
Cimarron River (Turkey Crk to Eagle Nest Lake)	Total Phosphorus	0	0.324	0.036	0.36
	Total Nitrogen	0	3.96	0.44	4.4
Moreno Creek (Eagle Nest Lake to headwaters)	Total Phosphorus	0	0.018	0.002	0.02
	Total Nitrogen	0	0.225	0.025	0.25
Ponil Creek (US 64 to confl of N & S Ponil)	Total Phosphorus	0	0.036	0.004	0.04
	Total Nitrogen	0	0.396	0.044	0.44
Rayado Creek (Cimarron R to Miami Lake div)	Total Phosphorus	0	0.063	0.007	0.07
	Total Nitrogen	0	0.918	0.102	1.02
Sixmile Creek (Eagle Nest Lake to headwaters)	Total Phosphorus	0	0.018	0.002	0.02
	Total Nitrogen	0	0.207	0.023	0.23

The load reductions that would be necessary to meet the target loads were calculated to be the difference between the calculated annual target load (Table 5.6) and the measured load (Table 5.7), and are shown in Table 5.12.

Table 5.12 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)]
Cieneguilla Creek (Eagle Nest Lake to headwaters)	Total Phosphorus	0.315	0.525	0.210	40%
	Total Nitrogen	2.97	4.14	1.18	28%
Cimarron River (Canadian R to Cimarron, NM)	Total Phosphorus	0.126	0.183	0.057	31%
	Total Nitrogen	1.89	3.26	1.37	42%
Cimarron River (Turkey Crk to Eagle Nest Lake)	Total Phosphorus	0.324	1.42	1.10	77%
	Total Nitrogen	3.96	11.4	7.41	65%
Moreno Creek (Eagle Nest Lake to headwaters)	Total Phosphorus	0.018	0.040	0.022	55%
	Total Nitrogen	0.225	0.410	0.185	45%
Ponil Creek (US 64 to confl of N & S Ponil)	Total Phosphorus	0.036	0.088	0.052	59%
	Total Nitrogen	0.396	0.788	0.392	50%
Rayado Creek (Cimarron R to Miami Lake div)	Total Phosphorus	0.063	0.135	0.072	53%
	Total Nitrogen	0.918	1.35	0.433	32%
Sixmile Creek (Eagle Nest Lake to headwaters)	Total Phosphorus	0.018	0.037	0.019	51%
	Total Nitrogen	0.207	0.294	0.087	29%

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 = TMDL – MOS (refer to Table 5.10)
(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

SWQB fieldwork includes an assessment of the probable sources of impairment (Appendix B). The approach for identifying "Probable Sources of Impairment" was recently modified by SWQB to include additional input from a variety of stakeholders including landowners, watershed groups, and local, state, tribal and federal agencies. Probable Source Sheets are filled out by SWQB staff during watershed surveys and watershed restoration activities. The draft probable source list will be reviewed and modified, as necessary, with watershed group/ stakeholder input during the TMDL public meeting and comment period.

Table 5.13 Pollutant Source Summary for Total Phosphorus

Assessment Unit	Pollutant Sources	Magnitude (lbs/day)	Probable Sources* (% from each)
Cieneguilla Creek (Eagle Nest Lake to headwaters)	Point: NM0030503 Nonpoint:	0.89[a] 0.31[b]	74% Municipal Point Source Discharge 26% Rangeland grazing, other recreational pollution sources
Cimarron River (Canadian R to Cimarron, NM)	Point: NM0030295 NM0030627 Nonpoint:	0[c] 0.18	0% Municipal Point Source Discharges 100% Flow alterations from water diversions, on-site treatment systems (septic systems and other decentralized systems), impervious surface/parking lot runoff, rangeland grazing
Cimarron River (Turkey Crk to Eagle Nest Lake)	Point: Nonpoint:	n/a 0.89	0% 100% Dam or impoundment, on-site treatment systems (septic systems and other decentralized systems), other recreational pollution sources, wildlife other than waterfowl
Moreno Creek (Eagle Nest Lake to headwaters)	Point: Nonpoint:	n/a 0.04	0% 100% On-site treatment systems (septic systems and other decentralized systems), rangeland grazing, wastes from pets
Ponil Creek (US 64 to confl of N & S Ponil)	Point: Nonpoint:	n/a 0.09	0% 100% Livestock (grazing or feeding operations), on-site treatment systems (septic systems and other decentralized systems), rangeland grazing, wastes from pets
Rayado Creek (Cimarron R to Miami Lake div)	Point: Nonpoint:	n/a 0.14	0% 100% Dam or impoundment, rangeland grazing,
Sixmile Creek (Eagle Nest Lake to headwaters)	Point: Nonpoint:	n/a 0.05	0% 100% Animal feeding operations (NPS), livestock (grazing or feeding operations), natural sources, on-site treatment systems (septic systems and other similar decentralized systems), rangeland grazing, wildlife other than waterfowl.

Notes:

[a] The magnitude for NM0030503 was calculated by multiplying the mean TP concentration (1.34 mg/L for the WWTP), the average annual daily discharge in 2006 (0.08 mgd), and the 8.34 conversion factor to get a result in lbs/day.

[b] The magnitude for nonpoint sources is the average TP load above the WWTP (Cieneguilla Creek at Angel Fire Road).

[c] The Springer WWTP currently is not discharging to the Cimarron River. In addition, effluent from water treatment plants has never been noted to be a significant source contributor of nutrients. Therefore the magnitude from point sources is zero.

* From the Integrated CWA §303(d)/§305(b) List (NMED/SWQB 2010a). This list of probable sources is based on staff observation and known land use activities in the watershed. These sources are not confirmed nor quantified at this time.

Table 5.14 Pollutant Source Summary for Total Nitrogen

Assessment Unit	Pollutant Sources	Magnitude (lbs/day)	Probable Sources* (% from each)
Cieneguilla Creek (Eagle Nest Lake to headwaters)	Point: NM0030503 Nonpoint:	3.18[a] 3.34[b]	49% Municipal Point Source Discharge 51% Rangeland grazing, other recreational pollution sources
Cimarron River (Canadian R to Cimarron, NM)	Point: NM0030295 NM0030627 Nonpoint:	0[c] 3.3	0% Municipal Point Source Discharges 100% Flow alterations from water diversions, on-site treatment systems (septic systems and other decentralized systems), impervious surface/parking lot runoff, rangeland grazing
Cimarron River (Turkey Crk to Eagle Nest Lake)	Point: Nonpoint:	n/a 7.2	0% 100% Dam or impoundment, on-site treatment systems (septic systems and other decentralized systems), other recreational pollution sources, wildlife other than waterfowl
Moreno Creek (Eagle Nest Lake to headwaters)	Point: Nonpoint:	n/a 0.41	0% 100% On-site treatment systems (septic systems and other decentralized systems), rangeland grazing, wastes from pets
Ponil Creek (US 64 to confl of N & S Ponil)	Point: Nonpoint:	n/a 0.79	0% 100% Livestock (grazing or feeding operations), on-site treatment systems (septic systems and other decentralized systems), rangeland grazing, wastes from pets
Rayado Creek (Cimarron R to Miami Lake div)	Point: Nonpoint:	n/a 1.35	0% 100% Dam or impoundment, rangeland grazing
Sixmile Creek (Eagle Nest Lake to headwaters)	Point: Nonpoint:	n/a 0.40	0% 100% Animal feeding operations (NPS), livestock (grazing or feeding operations), natural sources, on-site treatment systems (septic systems and other similar decentralized systems), rangeland grazing, wildlife other than waterfowl

Notes:

[a] The magnitude for NM0030503 was calculated by multiplying the mean TN concentration (4.76 mg/L for the WWTP), the average annual daily discharge in 2006 (0.08 mgd), and the 8.34 conversion factor to get a result in lbs/day.

[b] The magnitude for nonpoint sources is the average TN load above the WWTP (Cieneguilla Creek at Angel Fire Road).

[c] The Springer WWTP currently is not discharging to the Cimarron River. In addition, effluent from water treatment plants has never been noted to be a significant source contributor of nutrients. Therefore the magnitude from point sources is zero.

* From the Integrated CWA §303(d)/§305(b) List (NMED/SWQB 2010a). This list of probable sources is based on staff observation and known land use activities in the watershed. These sources are not confirmed nor quantified at this time.

The Probable Source Identification Sheets in Appendix B provide an approach for a visual analysis of a pollutant source 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 a watershed. The list of "Probable Sources" is not intended to single out any particular land owner or single land management activity and has therefore been labeled "Probable" and generally includes several sources for each known impairment. Table 5.13 and Table 5.14 display probable sources of impairment along each reach as determined by field reconnaissance and assessment. Probable sources of nutrients will be evaluated, refined, and changed as necessary through the Watershed-Based Plan (WBP).

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 5.2).

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.

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 tanks, 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, 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. Nutrients such as phosphorous and nitrogen released into gaining streams from aquifers contaminated by septic systems can contribute to eutrophic conditions.

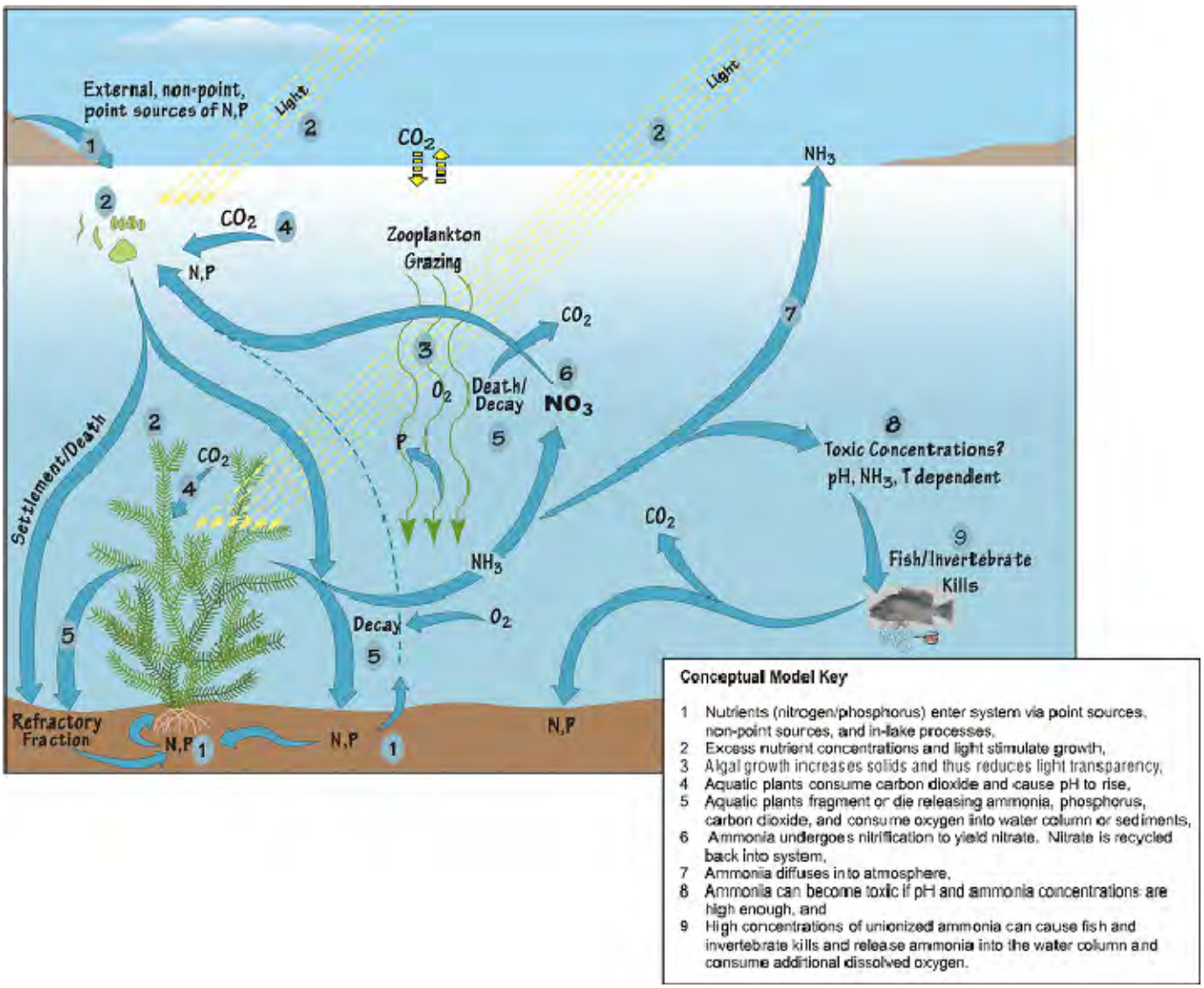

Figure 5.2. Nutrient Conceptual Model (USEPA 1999)

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 pollutants that do not readily degrade in the environment.

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

  Using the design capacity for calculating the point source loading even though under most conditions the treatment plants do not discharge continuously and are not operating at full capacity.

- *Explicit recognition of potential errors*

  A level of uncertainty exists in water quality sampling. Accordingly, a conservative MOS for this element is **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 October, during all seasons, which captured flow alterations related to snowmelt, the growing season, and summer monsoonal rains. 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 2035. Growth estimates for Colfax County project a 14% growth rate through 2035. However, as of 2008, the largest incorporated town in the county, Raton, had an estimated population of 6,465 people. This showed a decrease of 11.22 percent from the 2000 census population and Raton's population is not expected to have much growth in the future.

Nutrient loading in this watershed is due to both point and nonpoint sources. 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 in this watershed to improve road conditions and grazing allotments and adhere to SWPPP requirements related to construction and industrial activities covered under the general permit.