4.0 NUTRIENTS

The potential for excessive nutrients in the lower Animas were noted through visual observation during the 2002 study. To address this concern, a workgroup was formed comprised of state and tribal environmental specialists, as well as concerned citizens.

The nutrient assessment protocol was performed on 8/25/03 at the site approximately one mile above the San Juan River at Boyd Park (Station 10; Figure 2.2). Total nitrogen values were above the ecoregion criteria of 0.42 milligram per liter (mg/L) in greater than 15% of the samples, the percent dissolved oxygen (DO) saturation was greater than 120%, and the ash free dry mass of algal sampling was greater than 5 milligrams per square centimeter (mg/cm^2). The nutrient assessment protocol was also performed on 8/25/03 at the Flora Vista site (Station 9; Figure 2.2). The chlorophyll a concentration was greater than 0.010 mg/cm^2, the percent DO saturation was greater than 120%, and the ash free dry mass of algal sampling was greater than 5 mg/cm^2. Since three or more indicators were present at both sites, nutrients will be added as a cause of non support.

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 1999a). 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 1999a). 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 4.1).

As noted above, phosphorus and nitrogen are essential for proper functioning of ecosystems. However, excess nutrients cause conditions unfavorable for the proper functioning of aquatic ecosystems. Nuisance levels of algae and other aquatic vegetation (macrophytes) can develop rapidly in response to nutrient enrichment when other factors (e.g., light, temperature, substrate, etc.) are not limiting (Figure 4.1). 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.

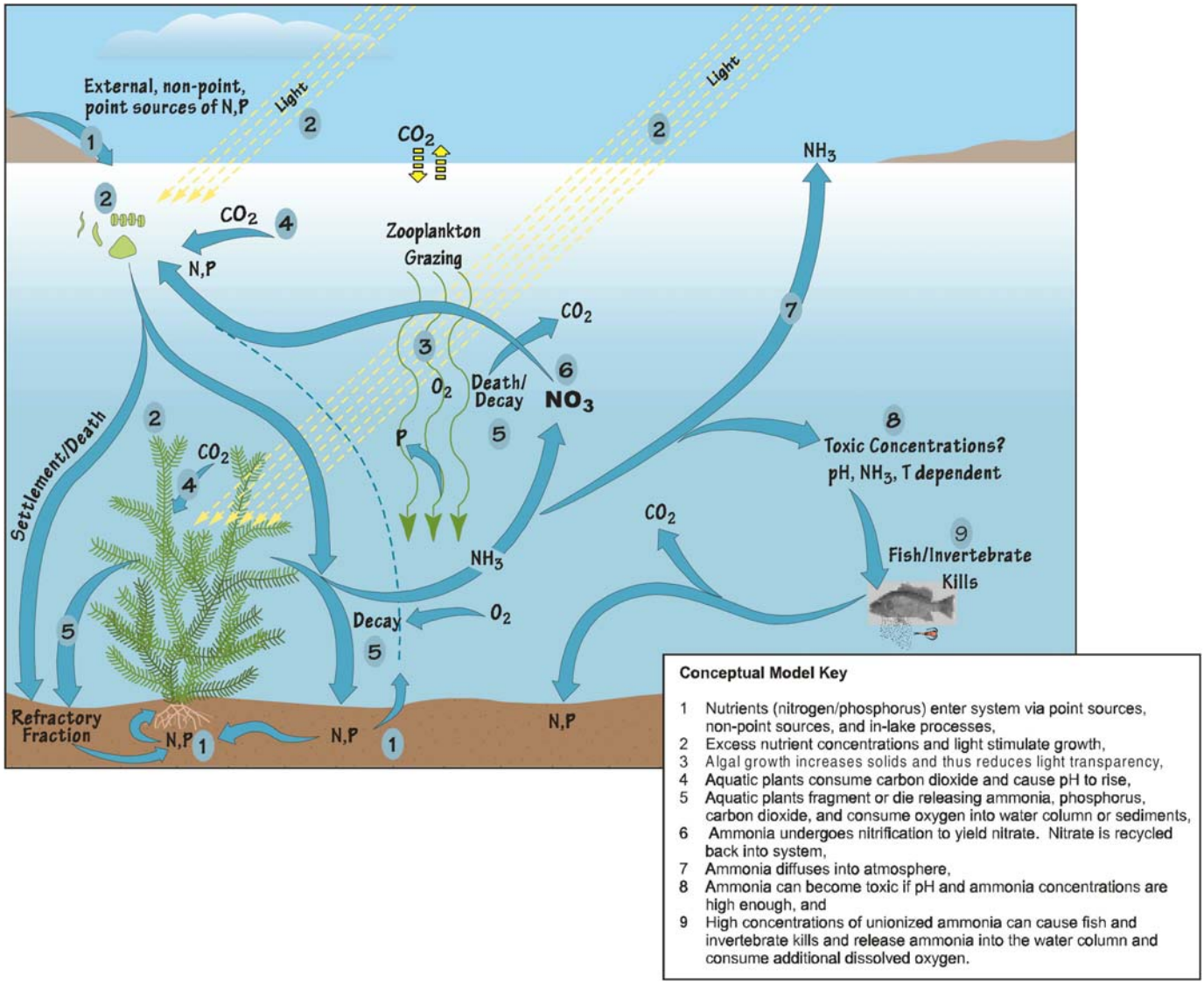

Figure 4.1 Nutrient Conceptual Model (USEPA 1999a)

4.1 Target Loading Capacity

Target values for this Nutrient 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 New Mexico Water Quality Control Commission (WQCC) has adopted narrative water quality standards for plant nutrients to sustain and protect existing or attainable uses of the surface waters of the state. This general standard applies to surface waters of the state at all times unless a specified standard is provided elsewhere. These water quality standards have been set at a level to protect cold-water aquatic life.

The marginal coldwater aquatic life use designation requires that a stream have water quality, streambed characteristics, and other attributes of habitat sufficient to protect and maintain marginal coldwater aquatic life. The plant nutrient standard leading to an assessment of use impairment is as follows (NMAC 20.6.4.12.E):

> *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 standards for nitrogen and phosphorus 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. Algal bioassays and laboratory analysis of waters sampled along this assessment unit showed a range of results (Appendix A). In water collected at Flora Vista, phosphorus addition did not increase algal growth by itself but did increase growth when added along with nitrogen addition. Similarly, in water sampled at Aztec, growth was stimulated when both nitrogen and phosphorus were added. These results indicate that both sites are limited for both nitrogen and phosphorus and both nutrients are driving the productivity of algae and macrophytes in the stream. Therefore, to ensure that the narrative water quality standards are met, management procedures should avoid any increase in both nitrogen and phosphorus inputs.

Currently, there are no numeric standards applicable to this assessment unit for total phosphorus (TP) and total nitrogen (TN). Numeric standards are necessary to control the amount of nutrients in the stream and prevent excessive plant growth, to establish targets for TMDLs, to develop water quality-based permit limits and source control plans, and to support designated uses within the Animas River.

The USEPA has published recommended nutrient criteria for causal (TN and TP) and response (chlorophyll a and turbidity) variables associated with the prevention and assessment of eutrophic conditions (USEPA 2000). The criteria are empirically derived from data in USEPA's STORET to represent conditions of surface waters that are minimally impacted by human

activities and protective of aquatic life and recreational uses. Ideally, USEPA wanted to base these criteria on actual reference conditions. The criteria would have been based on the 75th percentile of reference condition data. However, much of USEPA's data could not be considered to be reference conditions. Consequently, USEPA performed a statistical analysis of the entire body of non-reference data. The 25th percentile of each season (winter, spring, summer, fall) was calculated, and then the median of these four values was calculated. This approach assumes that the lower 25th percentile of all data overlaps with the 75th percentile of reference condition data, so therefore the 25th percentile data can be used to represent reference conditions.

The Animas River watershed is located in Level III Ecoregion 22 (the Arizona/New Mexico [AZ/NM] Plateau) contained within Aggregate Ecoregion III (the Xeric West). The USEPA's recommended criteria for total phosphorus and total nitrogen in streams associated with these ecoregions are presented in Table 4.1 below.

Table 4.1 USEPA's Recommended Nutrient Criteria for Ecoregion III (Xeric West), Subecoregion 22 (AZ/NM Plateau)

Nutrient Parameter	USEPA's Recommended Criteria	
	Xeric West	AZ/NM Plateau
Total Phosphorus	0.02 mg P/L	0.015 mg P/L
Total Nitrogen	0.38 mg N/L	0.23 mg N/L

The USEPA developed these criteria with the intention that they serve as a starting point for states to develop more refined nutrient criteria, as appropriate. There is a great deal of variability in nutrient levels and nutrient responses throughout the country due to differences in geology, climate and waterbody type. Rather than promulgate the proposed criteria, USEPA has allowed states and tribes to submit nutrient criteria development plans to document how nutrient criteria will be developed. SWQB has submitted a plan to USEPA that uses a weight-of-evidence approach, which includes a number of indicators of nutrient enrichment:

- Total Nitrogen concentration (TN)
- Total Phosphorus concentration (TP)
- Dissolved Oxygen Concentration
- Dissolved Oxygen Saturation
- pH
- Algal Productivity (from algal bioassays)
- Chlorophyll a concentration
- Hilsenhoff Biotic Index
- Benthic Macroinvertebrate IBI Score

USEPA Region 6 contracted with USGS-Austin, TX to provide technical support to states in the development of site-specific ecoregional nutrient criteria that fully reflect localized conditions and protect specific designated uses. As part of this assistance, the USGS modified the proposed USEPA ecoregional numeric criteria for TP and TN based on further stratification and analysis of the available TP and TN data. The aggregate ecoregions used in the proposed criteria were stratified to Level III Ecoregions (Omernik 1987) and site medians were used for sites with multiple data points. The USGS's proposed Ecoregion 22 criteria for TP and TN are 0.07 mg/L and 0.42 mg/L, respectively. The criteria for the other indicators are from USEPA guidance documents, peer reviewed literature, and NMED WQSs.

This TMDL document is adopting the philosophy and numeric targets suggested by the USGS-Austin, TX because the suggested numeric targets are site-specific ecoregional criteria that reflect the localized conditions of the AZ/NM Plateau and protect the designated uses along this assessment unit. The USGS suggests an instream TP concentration of less than 0.07 mg/L and an instream TN concentration of less than 0.42 mg/L (Table 4.2).

Table 4.2 Numeric Nutrient Targets

Constituent or Factor	TMDL Target Concentrations
Total Phosphorus	0.07 mg P/L
Total Nitrogen	0.42 mg N/L

4.2 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 conditions for this TMDL occur when the ratio of effluent to stream flow is the greatest and was obtained using a 4Q3 regression model (Appendix B). The 4Q3 is the minimum average four consecutive day flow that occurs with a frequency of at least once every 3 years. It is assumed that 4Q3 flows will be the critical periods for aquatic life.

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

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. The Linkage Analysis therefore represents the critical quantitative link between the TMDL and attainment of the water quality standards.

As the Animas River flows past Aztec, Flora Vista, and Farmington 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 proposed by the USGS in Austin, TX, and a conversion factor. The specific carrying capacity of a receiving water for a given pollutant, may be estimated as:

Combined Flow (in million gallons per day [mgd]) x Numeric Target (in mg/L) x 8.34 = TMDL (pounds per day [lbs/day]). **(Eq. 1)**

USGS gage data were used to determine the 4Q3 for this calculation (Figure 2.5 and Appendix B). The 4Q3 was estimated through application of USGS gage data to a log Pearson Type III distribution using "*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). A unit-less conversion factor of 8.34 is used to convert units to pounds per day (Appendix C). By applying Equation 1 to total phosphorus, it is determined that the lower Animas River can transport approximately 33.5 lbs/day of total phosphorus and 201 lbs/day of total nitrogen during critical low-flow conditions and in-stream concentrations will not exceed 0.07 mg/L and 0.42 mg/L, respectively. The annual target loads for TP and TN are summarized in Table 4.3.

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 numeric criteria was substituted for the numeric target in Equation 1 (Table 4.4). The same conversion factor of 8.34 was used. The results are presented in Table 4.5.

Table 4.3 Estimates of Annual Target Loads for TP and TN: Animas River (San Juan River to Estes Arroyo)

Parameter	Combined Flow[1] (mgd)	Numeric Target (mg/L)	Conversion Factor	Estimate of Target Loading (lbs/day)
Total Phosphorus	57.4	0.07	8.34	33.5[2]
Total Nitrogen	57.4	0.42	8.34	201[2]

1. Combined Flow = 4Q3 low-flow + current WWTP design capacity (1.0 mgd).
2. Values rounded to three significant figures.

Table 4.4 SWQB data that *exceeded* the numeric criteria for TP and TN: Animas River (San Juan River to Estes Arroyo)

Location	Sampling Date	TP (mg/L)	TN (mg/L)
Animas River near Flora Vista			
	09-19-2002	0.118	0.517
	08-25-2003	0.399	1.250
	04-23-2004	0.071	0.591
Animas River @ Farmington			
	07-16-2002	---	0.656
	09-17-2002	0.147	0.476
	08-25-2003	0.181	0.654
	GEOMETRIC MEAN	**0.155**	**0.654**

Table 4.5 Estimates of Annual Measured Loads for TP and TN: Animas River (San Juan River to Estes Arroyo)

Parameter	Combined Flow[1] (mgd)	Geometric Mean Conc.[2] (mg/L)	Conversion Factor	Measured Load Capacity (lbs/day)
Total Phosphorus	57.4	0.155	8.34	74.2[3]
Total Nitrogen	57.4	0.654	8.34	311[3]

1. Combined Flow = 4Q3 low-flow + current WWTP design capacity (1.0 mgd).
2. Geometric mean of TP and TN *exceedences* (See Table 4.4 for data).
3. Values rounded to three significant figures.

4.4 Waste Load Allocations and Load Allocations

4.4.1 Waste Load Allocation

The only existing point source along this assessment unit is the NPDES-permitted wastewater treatment plant (WWTP) owned and operated by the city of Aztec (NM0020168). There are no individually permitted Municipal Separate Storm Sewer System (MS4) storm water permits in this 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 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 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.

Therefore, this TMDL does not include a specific WLA for storm water discharges for this assessment unit. However, because the city of Aztec owns and operates an NPDES-permitted wastewater treatment plant a WLA for the WWTP is included in this TMDL.

A simple mixing model was used to calculate the WLA for NM0020168. The effluent limitations for TP and TN were calculated using the Equation 2:

$$C_e = \frac{C_s(Q_a + Q_e) - C_a Q_a}{Q_e} \qquad \textbf{(Eq. 2)}$$

where C_e = allowable WWTP effluent concentration (mg/L)
C_s = numeric target (TP = 0.07 mg/L & TN = 0.42 mg/L)
C_a = average stream concentration upstream of assessment unit (mg/L)
Q_e = design capacity of WWTP (mgd)
Q_a = critical 4Q3 low-flow of stream (mgd)

The equation is based on a simple steady-state mass balance model. The numeric target and ambient upstream concentrations used to calculate the annual effluent limitation are 0.07 and 0.05 mg/L, respectively for TP and 0.42 and 0.37 mg/L, respectively for TN. The data that were used to calculate the average ambient upstream concentration are listed in Table 4.6. The results of this mixing calculation for TP are presented in Table 4.7 and in Table 4.8 for TN.

Table 4.6 Data used to calculate ambient upstream concentrations (C_a)

Location	Sampling Date	TP (mg/L)	TN (mg/L)
Animas River @ Hwy 550 Bridge @ Aztec	04-16-2002	0.015	0.282
	05-20-2002	0.069	0.329
	05-28-2002	0.046	0.248
	06-18-2002	0.015	0.226
	07-15-2002	0.036	0.407
	08-20-2002	0.015	0.282
	09-19-2002	0.177	0.515
	10-22-2002	0.015	0.100
	08-25-2003	0.208	0.689
	10-07-2003	0.015	0.233
	04-23-2004	0.076	0.640
	11-18-2004	0.006	0.230
Animas River @ Colorado State Line	04-17-2002	0.015	0.285
	05-21-2002	0.048	0.231
	05-28-2002	0.015	0.263
	06-18-2002	0.015	0.231
	07-15-2002	0.029	0.277
	08-21-2002	0.073	0.303
	09-16-2002	0.115	0.398
	10-21-2002	0.400	0.100
	08-26-2003	0.121	0.304
	10-06-2003	0.015	0.284
Aggregate Ecoregion III Level III Ecoregion 22 [(a)]			
Fall	n = 78 & 31	0.031	0.310
Spring	n = 83 & 33	0.080	0.460
Summer	n = 82 & 33	0.050	0.350
Winter	n = 58 & 13	0.033	0.470
AVERAGE AMBIENT CONCENTRATION		**0.051[(b)]**	**0.374[(b)]**

NOTE: TP = Total Phosphorus TN = Total Nitrogen mg/L = milligrams per liter
n = number of samples collected (1st number for TP; 2nd number for TN)
[(a)] Taken from USEPA's ecoregional nutrient criteria dataset. Median values for each season are shown. (USEPA 2000)
[(b)] Values rounded to three significant figures.

Table 4.7 Allowable TP effluent concentration and WLA to meet water quality standards in the Animas River (San Juan River to Estes Arroyo)

	Discharge		Total Phosphorus		
Time Scale	Q_a (mgd)	Q_e (mgd)	C_a (mg/L)	C_e (mg/L)	WLA (lbs/day)
Annual	**56.4***	**1.00**	**0.051***	**1.12***	**9.32***

NOTE: Q_a = critical 4Q3 low-flow of stream (mgd)
Q_e = design capacity of WWTP (mgd)
C_a = average stream concentration upstream of assessment unit (mg/L)
C_e = allowable WWTP effluent concentration (mg/L)
WLA = Waste Load Allocation (lbs/day)
* = Values rounded to three significant figures.

Table 4.8 Allowable TN effluent concentration and WLA to meet water quality standards in the Animas River (San Juan River to Estes Arroyo)

	Discharge		Total Nitrogen		
Time Scale	Q_a (mgd)	Q_e (mgd)	C_a (mg/L)	C_e (mg/L)	WLA (lbs/day)
Annual	**56.4***	**1.00**	**0.374***	**3.04***	**25.3***

NOTE: Q_a = critical 4Q3 low-flow of stream (mgd)
Q_e = design capacity of WWTP (mgd)
C_a = average stream concentration upstream of assessment unit (mg/L)
C_e = allowable WWTP effluent concentration (mg/L)
WLA = Waste Load Allocation (lbs/day)
* = Values rounded to three significant figures.

Current loading from the WWTP was estimated from a grab sample collected on June 13, 2005 by SWQB staff. The TP and TN concentrations measured at the WWTP outfall pipe were 0.833 and 2.56 mg/L, respectively. Assuming that discharge was at plant capacity (1.0 mgd), the current phosphorus loading from the plant into the Animas River is 6.95 lbs/day and the current nitrogen loading from the plant into the Animas River is 21.3 lbs/day. Therefore, a TP WLA of 9.30 lbs/day and TN WLA of 25.2 lbs/day are justifiable given that the current load is based on one data point and the WWTP only accounts for approximately 2% of the flow in the Animas River.

4.4.2 Background Load

Soil erosion, leaf litter decay, and wild animal waste supply background phosphorus and nitrogen loads from undeveloped land to the Animas River. Background concentrations were determined from USEPA/USGS ecoregional reference criteria and SWQB nutrient data from the Colorado/New Mexico border.

Reference sites are relatively undisturbed by human influences. The definition of a reference condition ranges from a pristine, undisturbed state of a stream, to merely the "best available" or "best attainable" conditions. In the case of the New Mexican streams used in this study, the seasonal concentrations from Level III Ecoregion 22 were used to help determine background water quality. SWQB nutrient data from upstream sampling sites and the USEPA seasonal concentrations from Level III Ecoregion 22 reference sites were averaged to calculate an annual background concentration.

The background load to the Animas River is calculated by multiplying the combined flow volume (in mgd) by the background concentration (in mg/L). A unit-less conversion factor of 8.34 is used to convert units to lbs/day (Appendix C). The TP background load for the assessment unit is summarized in Table 4.9 and the TN background load is summarized in Table 4.10.

Table 4.9 Calculated Total Phosphorus Background Load to the Animas River

Time Interval	Combined Flow[1] (mgd)	Background Concentration (mg P/L)	Unit-less Conversion Factor	Estimated TP Background Load (lbs/day)
Annual	57.4	0.017	8.34	8.18

1. Combined Flow = 4Q3 low-flow + current WWTP design capacity (1.0 mgd).

Table 4.10 Calculated Total Nitrogen Background Load to the Animas River

Time Interval	Combined Flow (mgd)	Background Concentration (mg N/L)	Unit-less Conversion Factor	Estimated TN Background Load (lbs/day)
Annual	57.4	0.24	8.34	115

4.4.3 Load Allocation

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

$$WLA + LA + BL + MOS = TMDL \qquad \textbf{(Eq.3)}$$

The results are presented in Table 4.11 and Figures 4.2 and 4.3.

Table 4.11 Calculation of Annual TMDL for TP and TN

Parameter	WLA (lbs/day)	LA (lbs/day)	BL (lbs/day)	MOS (10%) (lbs/day)	TMDL (lbs/day)
Total Phosphorus	9.32	12.6	8.18	3.35	33.5
Total Nitrogen	25.3	40.6	115	20.1	201

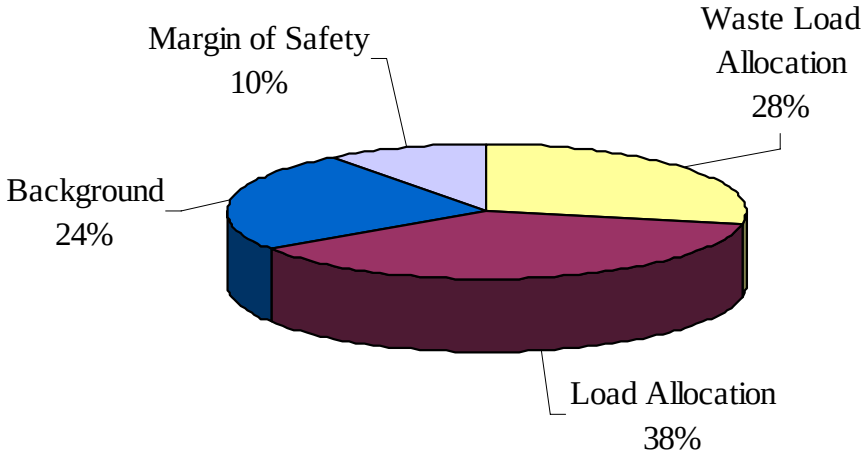

Figure 4.2 Annual TMDL for Total Phosphorus

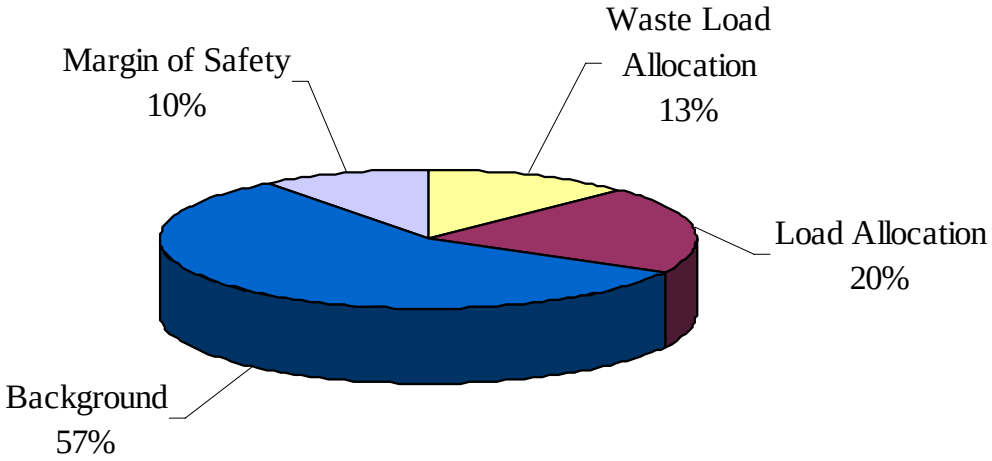

Figure 4.3 Annual TMDL for Total Nitrogen

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 4.3) and the measured load (Table 4.5), and are shown in Table 4.12.

Table 4.12 Calculation of Load Reduction for TP and TN

Parameter	Target Load[(a)] (lbs/day)	Measured Load (lbs/day)	Load Reduction (lb/day)
Total Phosphorus	30.1	74.2	44.1
Total Nitrogen	181	311	130

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 +BL

4.5 Identification and Description of Pollutant Source(s)

Potential pollutant sources of total phosphorus that could contribute to this assessment unit are listed in Table 4.13. Potential sources of total nitrogen are listed in Table 4.14.

Table 4.13 Pollutant Source Summary for Total Phosphorus

Pollutant Sources	**Magnitude** (Measured Load [lbs/day])	**Location**	**Potential Sources** (% from each)
Point: NM0020168	6.95[a]	Aztec WWTP	9%
Nonpoint:	67.3[b]	Animas River (San Juan River to Estes Arroyo)	91% Drought-related Impacts Flow Alterations from Water Diversions Municipal (Urbanized High Density Area) Municipal Point Source Discharges On-site Treatment Systems (septic systems and similar decentralized systems) Range Grazing - Riparian or Upland Natural Sources

[a] Measured load for the Aztec WWTP (NM0020168) was calculated based on one SWQB grab sample from 06/23/05. *Refer to Section 4.4.1 for details.*

[b] Measured load for nonpoint sources was estimated to be the difference between the measured load (74.2 lbs/day) calculated in Section 4.3 (Table 4.5) and the current load from the Aztec WWTP (6.95 lbs/day; Section 4.4.1).

Table 4.14 Pollutant Source Summary for Total Nitrogen

Pollutant Sources	**Magnitude** (Measured Load [lbs/day])	**Location**	**Potential Sources** (% from each)
Point: NM0020168	21.3[a]	Aztec WWTP	7%
Nonpoint:	290[b]	Animas River (San Juan River to Estes Arroyo)	93% Drought-related Impacts Flow Alterations from Water Diversions Municipal (Urbanized High Density Area) Municipal Point Source Discharges On-site Treatment Systems (septic systems and similar decentralized systems) Range Grazing - Riparian or Upland Natural Sources

[a] Measured load for the Aztec WWTP (NM0020168) was calculated based on one SWQB grab sample from 06/23/05. *Refer to Section 4.4.1 for details*.

[b] Measured load for nonpoint sources was estimated to be the difference between the measured load (311 lbs/day) calculated in Section 4.3 (Table 4.5) and the current load from the Aztec WWTP (21.3 lbs/day; Section 4.4.1).

4.6 Linkage of 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.

SWQB fieldwork includes an assessment of the potential sources of impairment (NMED/SWQB 1999). The completed Pollutant Source(s) Documentation Protocol forms in Appendix D provide 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 potential sources of impairment in this watershed. Staff completing these forms identify and quantify potential 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. This nutrient TMDL was calculated using the best available methods that were known at the time of calculation and may be revised in the future.

The Animas River has six main land uses that were identified as potential sources of phosphorus and nitrogen (Figure 4.4). They include residential, industrial, mixed agriculture, forest, shrubland, and grasslands. As described in Section 4.2, 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 the Animas River 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. Industrial areas and urban development contribute 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. Background loads were estimated using SWQB water quality data and USEPA data from regional reference streams (Section 4.4.2).

Nutrients from anthropogenic and natural sources reach the Animas River primarily by two routes: directly in overland flow (stormwater runoff and irrigation return flow) and indirectly in ground water. Nutrients applied directly to land (e.g. fertilizers, pet wastes) can be carried overland in storm water runoff and agricultural return flow or can dissolve and percolate through the soil to reach ground water. Septic tank disposal systems contribute nutrients primarily into ground water, which may eventually discharge into the stream. There are a total of 131 houses located within 100 meters of the Animas River in New Mexico (Figure 4.5). It was assumed that all 131 houses have on-site wastewater systems (i.e. septic tanks) because they are located outside of the city limits of Farmington and Aztec and do not have access to a wastewater treatment facility. Some of the phosphorus and nitrogen loads will be removed through plant uptake, but site-specific uptake rates are not known, therefore accurate groundwater loads could not be calculated.

This source-specific analysis accounts for the differences in magnitudes between sources and provides a basis for allocating loads. Analyses presented in these TMDLs demonstrate that defined loading capacities will ensure attainment of New Mexico water quality standards.

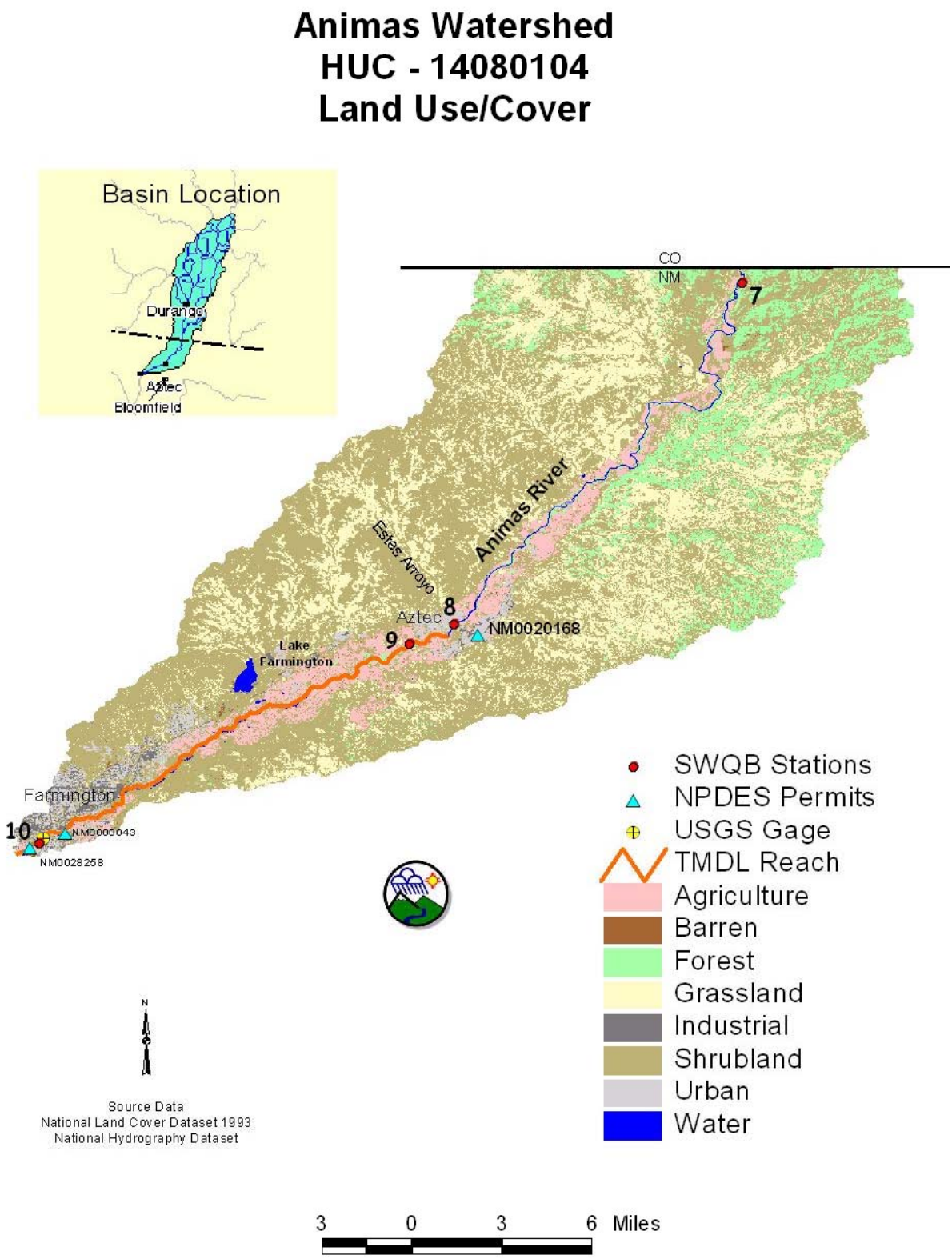

Figure 4.4 Land Use/Land Cover in the New Mexican portion of the Animas Watershed

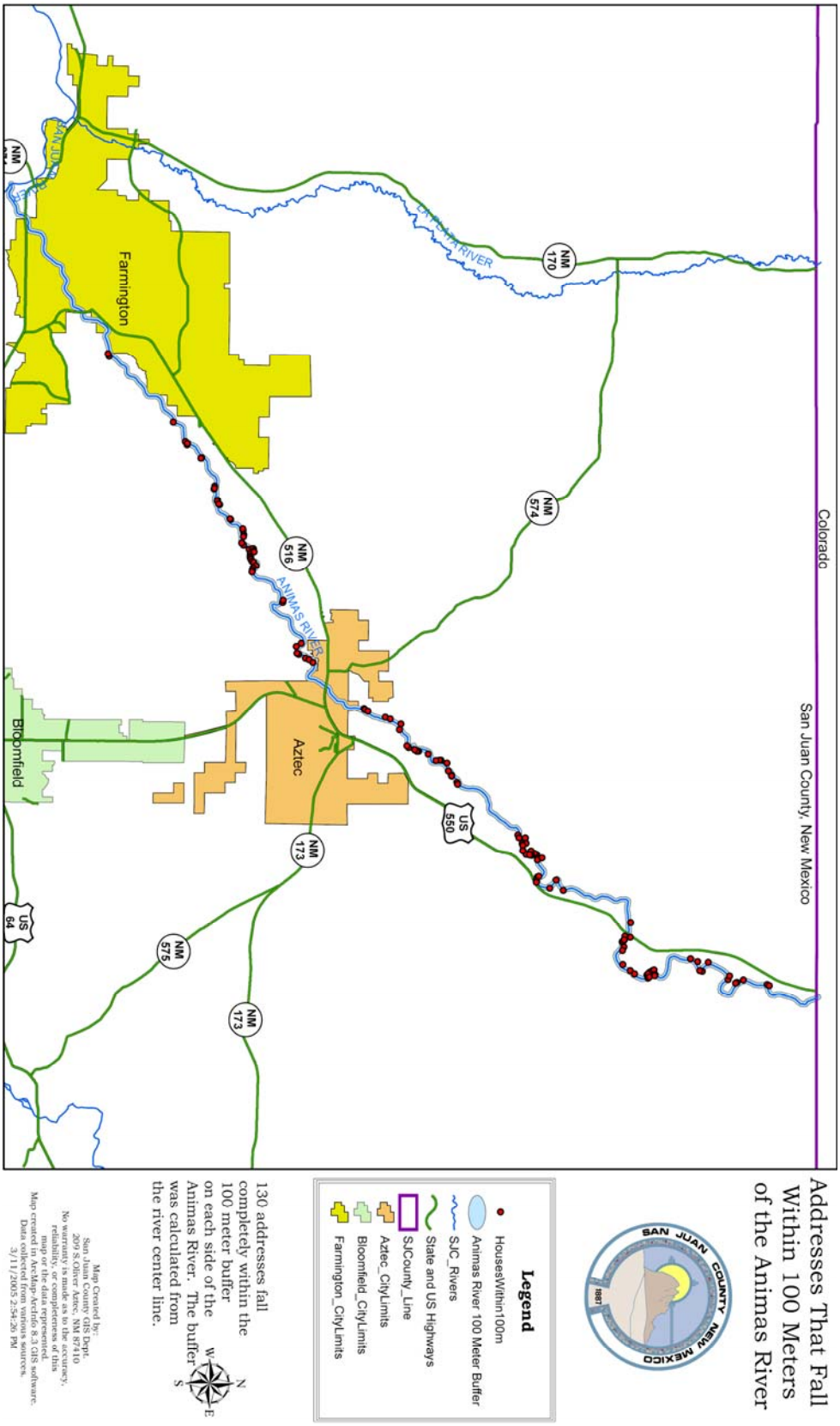

Figure 4.5 Residences that fall within 100 meters of the Animas River, NM

4.7 Margin of Safety (MOS)

TMDLs should reflect a MOS based on the uncertainty or variability in the data, the point and NPS load estimates, and the modeling analysis. For these nutrient TMDLs, the MOS was developed using a combination of conservative assumptions and explicit recognition of potential errors in flow calculations. 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 4-day, 3-year (4Q3) critical low flow to calculate the allowable load.
    - Using the USGS gage station #09364500 (Animas River at Farmington, NM) for historic records that provide confident datasets in order to determine flow.
    - 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.
    - A more conservative limit of the geometric mean value, rather than the current and proposed standards which allow for higher concentrations in individual grab samples, was used to calculate measured loading values.
- *Errors and uncertainty in data collection*
    - Data uncertainty and collection error in nutrient data collection. A conservative MOS for this element is **10 percent**.

4.8 Consideration of 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 during all seasons, 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 to calculate the geometric mean concentrations and can be found in Tables 4.4 and 4.15. Subsequently, the geometric means were used to calculate the measured loads (Table 4.5). The critical condition used for calculating the TMDL was low flow. It was assumed that if critical conditions are met during this time, coverage of any potential seasonal variation will also be met.

Table 4.15 Nutrient Results from the 2002-2004 Sampling Efforts

Location	Sampling Date	TP (mg/L)	TN (mg/L)
Animas River near Flora Vista	04-16-2002	0.015	0.318
	05-21-2002	0.069	0.325
	05-28-2002	0.037	0.243
	06-19-2002	0.015	0.244
	07-17-2002	0.041	0.416
	08-20-2002	0.015	0.389
	09-19-2002	0.118*	0.517*
	10-22-2002	0.015	0.100
	08-25-2003	0.399*	1.250*
	10-07-2003	0.015	0.227
	04-23-2004	0.071*	0.591*
	11-17-2004	0.017	0.295
Animas River @ Farmington	04-16-2002	0.015	0.395
	05-21-2002	0.057	0.301
	05-28-2002	0.032	0.297
	06-19-2002	0.015	0.266
	07-16-2002	0.015	0.656*
	08-19-2002	0.032	0.409
	09-17-2002	0.147*	0.476*
	08-25-2003	0.181*	0.654*
	10-08-2003	0.015	0.303

NOTE:
* = Exceeds water quality criterion for given nutrient
mg/L = milligrams per liter
TP = Total Phosphorus
TN = Total Nitrogen

4.9 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 San Juan County project a 44% growth rate through 2030. According to the calculations, the overwhelming source of nutrient loading is from nonpoint sources. Estimates of future growth are not anticipated to lead to a significant increase in nutrient concentrations that cannot be controlled with BMP implementation in this watershed. However, 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.