# ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

Proposal of a Total Maximum Daily Load For:
**Tonto Creek (Headwaters to Haigler Creek)**
Salt River Watershed
Tonto National Forest near Payson, Gila County, Arizona
HUC-Reach: 15060105-013A
HUC-Reach: 15060105-013B

Parameter: **Total Nitrogen**

June 20, 2005

Open File Report 05-04

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**TMDL Checklist**

**State:** **Arizona**

**Waterbodies:** **Tonto Creek (headwaters to Haigler Creek) (2 listed segments)**

**Pollutant(s):** **total nitrogen**

**Date of State Submission:** **June 20, 2005**

**Date Received By EPA:** **June 27, 2005**

**EPA Reviewer:** **Peter Kozelka**

| Review Criteria | Comments |
|---|---|
| **1. Submittal Letter:** State submittal letter indicates final TMDL(s) for specific water(s)/pollutant(s) were adopted by state and submitted to EPA for approval under 303(d). | Letter dated June 20, 2005.<br>Arizona Department of Environmental Quality (ADEQ) completed the Tonto Creek nitrogen TMDLs on June 19, 2005. Public comments were received on the draft TMDL, first released in March 2005. These TMDLs were published in the Arizona Administrative Register on May 5, 2005 and no comments were received during the 45-day review period. ADEQ developed TMDLs to address nitrogen specific segments identified on the State's 2004 303(d) list. |
| **2. Water Quality Standards Attainment:** TMDL and associated allocations are set at levels adequate to result in attainment of applicable water quality standards. | TMDL Report, dated June 20, 2005.<br>These TMDLs are designed to implement the existing numeric standards for nitrogen. (TMDL Report, p. 7). The State's Administrative Code (Title 18, Chapter 11) defines numeric water quality standards for nitrogen to protect the designated uses of Roosevelt Lake, a reservoir at the mouth of Tonto Creek.<br><br>The State reasonably concluded that attainment of the specified numeric targets and associated TMDLs, load allocations, and waste load allocations will result in elimination of the adverse effects associated with high nitrogen concentrations in the water and bring about attainment of the applicable numeric standards. |
| **3. Numeric Target(s):** Submission describes applicable water quality standards, including beneficial uses, applicable numeric and/or narrative criteria. Numeric water quality target(s) for TMDL identified, and adequate basis for target(s) as interpretation of water quality standards is provided. | TMDL Report, dated June 20, 2005.<br>The numeric targets for nitrogen concentrations are based on the water quality standards established in the State's Admin. Code. The concentration-based numeric targets for nitrogen have both single sample maximum and annual mean values; both represent the applicable numeric standards equal the single sample maximum numeric standard. (TMDL report, pp. 7)<br><br>EPA concurs with the State's analysis that the nitrogen reductions required by these TMDLs should be sufficient to address the observed violations of numeric standards for nitrogen. It remains to be seen if this numeric standard will also address other in-stream indicators; e.g., thick vegetation observed in 2002 and 2003. |

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| | The numeric target for these TMDLs is as follows:<br>**Nitrogen**<br>Single sample maximum = 2 mg/L;<br>Annual mean = 0.5 mg/L |
| **4. Source Analysis:** Point, nonpoint, and background sources of pollutants of concern are described, including the magnitude and location of sources. Submittal demonstrates all significant sources have been considered. | TMDL Report, pp 8-14.<br>The TMDL analysis considered existing information concerning the sources of nitrogen into Tonto Creek. The concentrations of nitrogen at various points along the creeks are estimated based on sample results. The primary sources of nitrogen are assumed to be non-point sources such as leakage from septic systems and vault toilets. Minor inputs of nitrogen come from natural background loads, based on samples from the most upstream sample sites. The sole point source, Tonto Creek Fish Hatchery, discharges water into the upper segment of Tonto Creek and is considered a specific source of nitrogen because it is included in the Fish Hatchery releases. The TMDL analysis indicates the concentrations of nitrogen released from the Fish Hatchery are within the range of those observed for non-point source contributions.<br><br>The TMDL report adequately considered all significant sources of nitrogen to these creeks. The TMDL sufficiently described all sources of impairments. |
| **5. Allocations:** Submittal identifies appropriate wasteload allocations for point sources and load allocations for nonpoint sources. If no point sources are present, wasteload allocations are zero. If no nonpoint sources are present, load allocations are zero. | TMDL Report, pp 14-22.<br>The TMDL analysis assigns mass-based TMDLs for each segment upstream of the sampling sites. These TMDLs include specific load allocations for all significant nonpoint sources and a wasteload allocation for the stream segment that includes the Fish Hatchery.<br><br>EPA concludes the State's approach of setting the TMDLs and allocations on a mass-basis is appropriate for the waters and pollutants of concern and consistent with the provisions of 40 CFR 130.2(i), which authorizes expression of TMDLs in terms of "mass per time, toxicity, or other appropriate measure."<br><br>**Waste load Allocation for Point Source**<br>A waste load allocation is included for the Fish Hatchery, which represents a source of nitrogen loading to Tonto Creek. The fish hatchery waste load allocation does account for natural background levels from upstream segments of Tonto Creek. This waste load allocation indicates a 13% reduction in nitrogen from the Fish Hatchery is required to meet the TMDL for that specific stream segment.<br><br>**Load Allocations for Nonpoint Sources** |

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| | Source assessment analysis indicates that several middle segments do not show nitrogen exceedences, thus the load allocations for these segments are set equivalent to current loading and do not require pollutant reductions. However, the same analysis indicates that nitrogen loads from non-point sources are significant and constitute the majority of pollutant loads in the downstream segments of Tonto Creek. Load allocations are included in these TMDLs, by segment upstream of the sampling sites (Table 27, p. 25).<br><br>The State's TMDL focuses on both point and nonpoint source loadings of nitrogen. EPA concludes these TMDLs include as appropriate load and wasteload allocations that are consistent with the TMDLs and with the provisions of the Clean Water Act and federal regulations. |
| **6. Link Between Numeric Target(s) and Pollutant(s) of Concern:** Submittal describes relationship between numeric target(s) and identified pollutant sources. For each pollutant, describes analytical basis for conclusion that sum of wasteload allocations, load allocations, and margin of safety does not exceed the loading capacity of the receiving water(s). | TMDL Report, pp 13-21.<br>The linkage between nitrogen sources and in-stream water quality was assessed by data analysis for general trends and spatial correlation. In general, nitrogen loads are highest just below the Fish Hatchery and at two downstream sites.<br><br>EPA concludes the analysis sufficiently describes the link between numeric targets and the pollutant sources in Tonto Creek. |
| **7. Margin of Safety:** Submission describes explicit and/or implicit margin of safety for each pollutant. | TMDL Report, pp 17.<br>The TMDL includes an explicit margin of safety of 10% for nitrogen loads to account for uncertainty in sample collection and analytical methods. This is applied to all stream segments.<br><br>EPA considers this a permissible and appropriate way of dealing with uncertainty concerning the relationships between TMDLs, WLAs, LAs and water quality conditions. |
| **8. Seasonal Variations and Critical Conditions:** Submission describes method for accounting for seasonal variations and critical conditions in the TMDL(s) | TMDL Report, pp 18-19.<br>Based on data analysis of nitrogen exceedences, these TMDLs apply from the third week of May through the second week of September. It also applies to all stream flow conditions. The critical condition for this TMDL is based on seasonal water quality condition of the subject waterbodies (including Roosevelt Lake) and the corresponding nitrogen exceedences.<br><br>The State's TMDL analysis adequately accounts for the seasonal variations and critical conditions by examining the existing flow record and water quality data. |
| **9. Public Participation:** | Letter dated June 20, 2005. |

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| Submission documents provision of public notice and public comment opportunity; and explains how public comments were considered in the final TMDL(s). | ADEQ offered sufficient opportunity for public comments on these TMDLs. ADEQ held one public stakeholder meeting in February 2005. This meeting and public notices on these TMDLs were communicated via phone calls, newspaper announcements, and email and web page notifications.<br><br>The State demonstrated how it considered comments submitted by the public in its final decision by providing reasonably detailed responsiveness summaries, which include responses to each written comment. |
| **10. Technical Analysis:** Submission provides appropriate level of technical analysis supporting TMDL elements. | The TMDL analysis provides a thorough review and summary of available information concerning nitrogen loadings in the specific areas of concern.<br><br>EPA concludes that ADEQ was reasonably diligent in its technical analysis of nitrogen loads into Tonto Creek. |

**ACRONYMS**

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| ADEQ | Arizona Department of Environmental Quality |
| AGFD | Arizona Game and Fish Department |
| AZPDES | Arizona Pollutant Discharge Elimination Systems (CWA point source permits program administered by ADEQ) |
| CWA | Clean Water Act |
| HUC | Hydrologic Unit Code |
| LA | Load Allocation (Non-Point Sources) |
| MOS | Margin of Safety |
| NPDES | National Pollutant Discharge Elimination Systems (CWA point source permits program administered by USEPA) |
| TMDL | Total Maximum Daily Load |
| USEPA | United States Environmental Protection Agency (also EPA) |
| USFS | United States Forest Service |
| USFWS | United States Fish and Wildlife Service |
| USGS | United States Geological Survey |
| WLA | Waste Load Allocation (Point Source) |
| WQS | Water Quality Standards |
| cfs | cubic feet per second (commonly used discharge measurement unit) |
| ft | feet |
| mg/l | milligrams per liter (pollutant concentration measurement unit) |
| kg/day | kilograms per day (pollutant load measurement unit) |
| kg/year | kilograms per year (pollutant load measurement unit) |

**DEFINITIONS OF TERMS USED IN THIS REPORT**

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| Baseflow discharge | The perennial portion of the stream discharge; the flow not directly dependent on precipitation events. In the case of an ephemeral stream, baseflow equals zero. |
| Ephemeral | A stream that has a channel that is at all times above the water table and that flows only in direct response to precipitation. |
| Intermittent | A stream or reach of a stream that flows continuously only at certain times of the year, as when it receives water from a spring or from another surface source, such as melting snow. (A.A.C. R18-11-101(30)) |
| Perennial | A surface water which flows continuously throughout the year. (A.A.C. R18-11-101(38)) |
| Point source | Any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fixture, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel, or other floating craft from which pollutants are or may be discharged. (40 CFR 122.2) |
| Loading Capacity | Is the maximum amount of pollutant loading the stream can sustain at any given discharge without exceeding standards. The TMDL is equal to or less than the load capacity. |

NOTE: ADEQ uses USGS maps as the source of names for streams, mines, and other features. Where local usage varies, such differences are noted.

## PREFACE

### The Clean Water Act (CWA) '303[d] and Its Significance

The CWA '303[d][1][A] requires that "each State shall identify those waters within its boundaries for which the effluent limitations...are not stringent enough to implement any water quality standard applicable to such waters." This act also requires states to establish Total Maximum Daily Loads (TMDLs) for such waters.

The CWA '303[d] requires states to submit to the United States Environmental Protection Agency (USEPA) a list of the surface waterbodies for which the designated use (e.g. irrigation, partial body contact, etc.) of that waterbody is impaired or "water quality limited". Surface water quality data are compared with water quality standards and other criteria to determine whether the waterbody is meeting its designated uses. ADEQ publishes a report on the status of surface water and groundwater quality in Arizona every two years (in accordance with the CWA '305(b)) and from this report derives the "Impaired Waters" or "303[d] List".

The TMDL process provides a flexible assessment and planning framework for identifying load reductions or other actions needed to attain surface water quality standards; i.e. water quality goals to protect aquatic life, drinking water, and other water uses. The CWA established the TMDL process to guide application of state surface water quality standards to individual waterbodies and their watersheds.

### TMDL Defined

The requirements of a TMDL analysis are described in 40 CFR '130.2 & '130.7, based upon CWA '303[d]. A TMDL is described as "the sum of the individual wasteload allocations for point sources and load allocations for non-point sources and natural background" and a margin of safety such that the capacity of the waterbody to assimilate pollutant loadings is not exceeded. Represented as a mathematical equation:

TMDL = WLA + LA + MOS,

where WLA is the wasteload allocation consisting of loads from point sources, LA is the load allocation consisting of non-point source loads, and MOS is a Margin of Safety which serves to address uncertainties in the analysis and the natural system.

### The TMDL Process

A TMDL analysis is a tool for implementing state surface water quality standards and is based on the relationship between pollution sources and in-stream water quality conditions. The TMDL process is a method used in balancing the pollution concerns for a waterbody and allocating the acceptable pollutant loads among the different point and non-point sources allowing the selection and implementation of suitable control measures to attain water quality standards.

In implementing TMDLs, certain criteria must be taken into account. These criteria include loading capacity, load allocation, wasteload allocation, natural background, and the margin of safety. The loading capacity is the greatest amount of loading that a waterbody can receive without violating water quality standards. Load allocation is the portion of a receiving water's loading capacity that is attributed either to one of its existing non-point sources of pollution or to natural background sources. The portion of the receiving waters' loading capacity that is attributed to existing point sources of pollution is known as the wasteload allocation. Finally, the margin of safety is the factor that accounts for any uncertainty in the relationship between the pollutant loads and the quality of the

receiving waterbody (40 CFR '130.2[f-g]). Total pollutant loads are determined by combining the point, non-point and background sources of pollution.

ADEQ has adopted a stakeholder process for many of its programs, including TMDLs. ADEQ works closely with affected stakeholders in developing the TMDL by holding meetings to solicit input on a variety of topics including background information; potential modeling scenarios; identifying possible pollutant sources for allocation; and discussing potential implementation strategies. Once TMDLs are developed for all the water quality problems, they are submitted to the EPA for review and approval.

The TMDL process is not complete once waste load allocations and load allocations have been determined. Assessment of the TMDL effectiveness must be made. Ideally, this would begin within two years after implementation and continue for the period necessary to measure effectiveness of any implementation actions to ensure surface water quality standards are attained.

**Project History**

From 1994 through 1996, as a part of an intensive study, ADEQ measured nitrogen levels in upper Tonto Creek and Christopher Creek. This data was sufficient to determine impairment which resulted in the 303[d]-listing, but was insufficient by itself to isolate sources or calculate loads. ADEQ supplemented the historic data by collecting additional data (during 2000, 2002 and 2003) specific to the goals of source quantification and TMDL calculation.

**303[d] Listing History**

Tonto Creek (headwaters - Haigler Creek)

- The 1996 303(d) list added impairments due to nitrogen and phosphorus.
- The 1998 303(d) list identified impairments due to nitrogen and phosphorus and added *e. coli.*
- The 2002 303[d] list added impairments due to turbidity, delisted phosphorus and nitrogen, and moved *e. coli.* to the Planning List.
- The 2004 303[d] added impairments due to nitrogen and dissolved oxygen for the segment from the headwaters to the un-named tributary at 34E 18' 10'/111E 4' 14". A TMDL for *e. coli.* was completed in June 2004 and approved by the U.S.E.P.A. in July 2004.

## PURPOSE

This study focused on the uppermost approximately ten miles of Tonto Creek from its headwaters to Haigler Creek.

The purpose of this study was to collect sufficient data that, when combined with the historic data, would permit the identification of load sources and calculation of a TMDL and necessary reductions for each source of nitrogen. Meeting proposed load reductions will ensure that Tonto Creek meets the nitrogen standard.

Concurrent with this study, samples were collected to support source identification, and load allocation and TMDL calculation for *E. coli.* in Tonto Creek which is covered in a separate report.

## PHYSICAL SETTING (ADEQ, 1995)

The project area (Figure 1) is located within the northeastern portion of the Tonto National Forest, Gila County, Arizona. The closest town is Payson, Arizona. The approximate center of the basin is: latitude: 34E 20'N, longitude: 111E 05' W.

Two major perennial streams, Tonto and Christopher Creeks, and three minor streams, Hunter, Horton, and Dick Williams Creeks, are located in the project area. Hunter Creek is tributary to Christopher Creek and Christopher, Horton, and Dick Williams Creeks are tributary to Tonto Creek. The upper Tonto Creek basin and the Christopher Creek Basin cover approximately 30 square miles each.

Project area elevation ranges from approximately 6,500 feet at the upper end of the perennial reaches to just below 5,000 feet near Bear Flats, for a relief of approximately 1,500 feet.

The project area is characterized by mild summers and cold winters. The area receives approximately 28 inches of precipitation annually (Western Regional Climatic Center website). The precipitation pattern is divided into two distinct seasons, winter (December-March) and monsoon (July-September).

The Tonto Creek basin is covered by a predominately Ponderosa Pine forest, but the northwestern portion of the basin was decimated by the Dude Fire in 1992 and is currently dominated by grasses, scrub, snags, and scattered groves of pines.

A telephone conversation (2/5/04) with Glen Knowles, a biologist with the U.S. Fish and Wildlife Service, brought forth the information that while presence of threatened or endangered species in the subject stream segment is not confirmed, potential habitat for the following is present: Spike Dace, Loach Minnow, Headwater Chub, Chiricahua Leopard Frog and Bald Eagle. It is not believed that these are directly threatened by the presence of the subject stressor: nitrogen.

The geology of the project basin is predominately sedimentary rocks including limestone, sandstone, and shale. The basin fill is mainly clay and silt with some sand and gravel.

**Hydrology**

The subject stream and reaches are described in the Arizona surface water quality standards as, "Headwaters to confluence with unnamed tributary at 34E 18' 10"/111E 04' 14"@ and Aun-named tributary at 34E 18' 10"/111E 04' 14" to Haigler Creek@.

Upstream of the springs above the hatchery, flow is either intermittent or ephemeral (undetermined and not relevant to the purposes of this investigation). From the springs to the end of the listed reach, flow is perennial. Based upon measurements at baseflow, groundwater (from the headwaters springs and other un-delineated springs along the reach) is the primary source of flow in the perennial portion of the stream. During the course of this project, measured discharges ranged from 0.04 to 107 cubic feet per second (cfs) at various points along the subject reach. Field observations confirm that all of the tributaries to upper Tonto Creek, except for Christopher Creek, are intermittent or ephemeral.

**Land Use/Land Ownership**

The upper Tonto Creek basin is wholly contained within the Tonto National Forest, and as such, is available for recreational usage. Various privately-owned properties are primarily used for recreational purposes; e.g., summer cabins, are located within the basin.

The subject basin is bisected from east to west by Highway 260 which is lined with various cabins, lodges, stores and restaurants. Highway 260 is in the process of being widened to four lanes and re-routed to allow gentler curves and slopes. This widening project began in the Christopher Creek area during Summer 2002 and was mostly completed by Summer 2003 and began in the Tonto Creek area during Fall 2003.

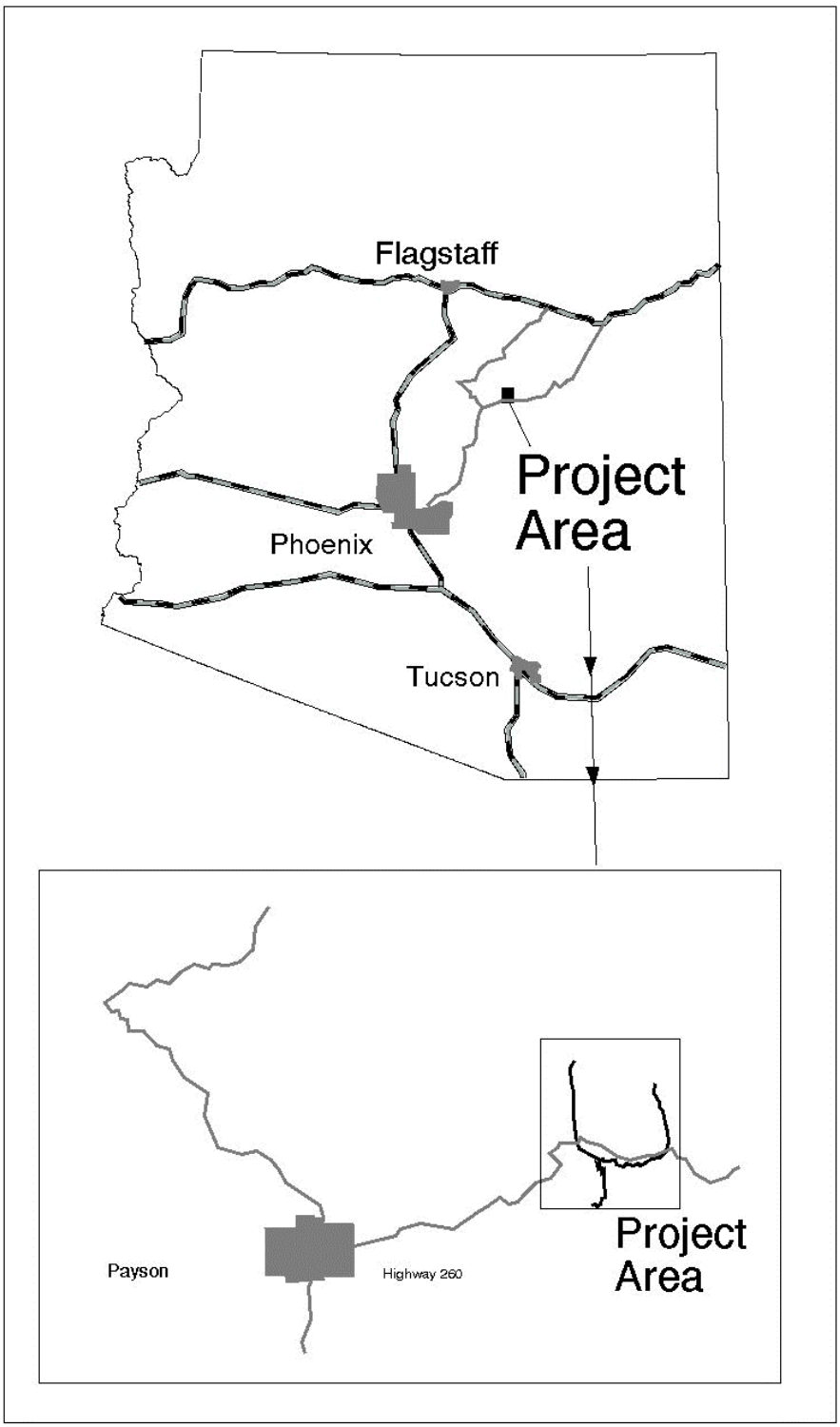


**Figure 1**
**Tonto & Christopher Creeks**
**TMDL Project**

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## NUMERIC TARGETS

The numeric target for the listed pollutant has been set so that the water quality standard for the assigned parameter can be met.

Tonto Creek from the headwaters to Haigler Creek has the following designated uses:

A&Wc - Aquatic and Wildlife cold water above 5000 foot elevation.
A&Ww - Aquatic and Wildlife warm water below 5000 foot elevation.
FBC - Full Body Contact
FC - Fish Consumption
AgL - Agricultural Livestock watering
AgI - Agricultural Irrigation

The nitrogen standard is not tied to a particular designated use; the primary intention behind this standard is the prevention of eutrophication in the Roosevelt Lake reservoir at the mouth of Tonto Creek on the Salt River. (ADEQ, 1981)

### Surface Water Quality Standards

Total nitrogen concentration is calculated as the sum of nitrite plus nitrate concentration and total Kjeldahl nitrogen concentration in milligrams per liter (mg/l).

The applicable standards are: single sample maximum = 2 milligrams per liter (mg/l); the annual mean standard = 0.5 mg/l. The Arizona Surface Water Quality Standards (A.A.C., R18-11-101 [6]) states: A>Annual mean= means the arithmetic mean of monthly values determined over a consecutive 12-month period, provided that monthly values are determined for at least 3 months. The monthly value is the arithmetic mean of all values determined in a calendar month.@

Exceedances of the annual mean standard have resulted in the listing of Tonto Creek as AImpaired@ and are addressed by the TMDL. Tonto Creek had only two single sample exceedances out of 208 samples (Appendix A).

### In-stream Indicators

Reliable in-stream indicators related to nitrogen impacts on water quality have not been observed in the subject watershed. The "normal" indicators (i.e., insects, fish, and vegetation) can be adversely affected by low flows as well as excess nitrogen. The current drought makes it difficult to differentiate between the effects caused by low flow and excess nitrogen.

During the 2002 and 2003 sampling events, vegetation at one sample point (SRTON068.00 on the border between Kohl=s Ranch and the downstream Camp Tontozona) regularly was thick enough to prevent measurement of the discharge. The most likely explanations of the heavy vegetation are high nutrient concentrations, upwelling groundwater or a combination of the two. However comparison of the nitrogen concentrations and flows of the sample points immediately upstream and downstream did not reveal a pattern that could be used to assign a cause to the thick vegetation growth.

## SOURCE IDENTIFICATION, LINKAGE ANALYSIS AND SAMPLE COLLECTION POINTS

The primary objective of this investigation was to collect data sufficient to isolate, geographically and temporally, and quantify the primary pollutant load sources in the project area. All significant sources have been identified and linkages between these significant sources and loads are discussed below.

Other than the Tonto Creek Fish Hatchery (AZPDES Permit No. AZ0021211), there are no known AZPDES-permitted point sources in the subject basin; however, a complete review of all sources may result in the classification of some as point source which would then require AZPDES discharge permits.

In addition to natural background, there are several additional sources including basin-wide recreational uses and unincorporated communities/summer home clusters located in the project area. There is no cattle grazing in the subject basin, nor will it likely occur in the future (e-mail communication from William Barcus, USFS, 5/25/04).

The potential impact of atmospheric deposition has not been specifically measured, but nitrogen samples were collected at a background site at the headwaters of Tonto Creek to determine the background level of nitrogen. In a watershed as small as Tonto Creek, it is assumed that the background level of nitrogen due to atmospheric causes is consistent throughout the watershed. Samples at the background site did not exceed the annual mean standard, nor did samples taken at the sites in between the Fish Hatchery segment and the Below Christopher segment, which would suggest that atmospheric deposition is not the cause of the exceedences seen.

ADEQ-collected samples from precipitation runoff-induced flows from at least three storm events during 2003. These measurements inherently include any atmospheric deposition effects on the stream. The only stream segment to fail to meet standards in 2003 was the segment immediately downstream of the Tonto Creek Hatchery, which suggests that atmospheric deposition is not the source of the exceedences measured in Tonto Creek.

Tonto Creek was monitored from its headwaters to the upstream end of the wilderness area just downstream from Bear Flats. The wilderness area between Bear Flats and Haigler Creek has no previous monitoring data or non-natural sources in its approximately six mile reach. Christopher Creek was monitored at its mouth.

ADEQ has developed a system for naming surface water sample point I.D.s, for example: SRTON072.66 or SRCRS000.08. The first two characters are the major basin code ("SR" is the Salt River), the next three characters are the stream code ("TON" for Tonto Creek), and the number is the distance in miles from the stream mouth to the sample point. For purposes of this project, the number is the actual stream miles as measured on USGS maps in scales of 1:250,000 and 1:24,000.

Sample sites (Figure 2) were selected to meet TMDL project goals; i.e., identification and quantification of pollutant sources.

The tables in Appendix A display the measured data and include the calculated annual mean concentrations and discharge. Table 1 (below) displays a summary of annual means for each sample point. Table 2 displays a summary of the annual mean concentrations and discharge for each sample point used to calculate the TMDL and associated loads.

Table 1 Data Summary - Total Nitrogen Annual Means (mg/l) (Standard = 0.5 mg/l)

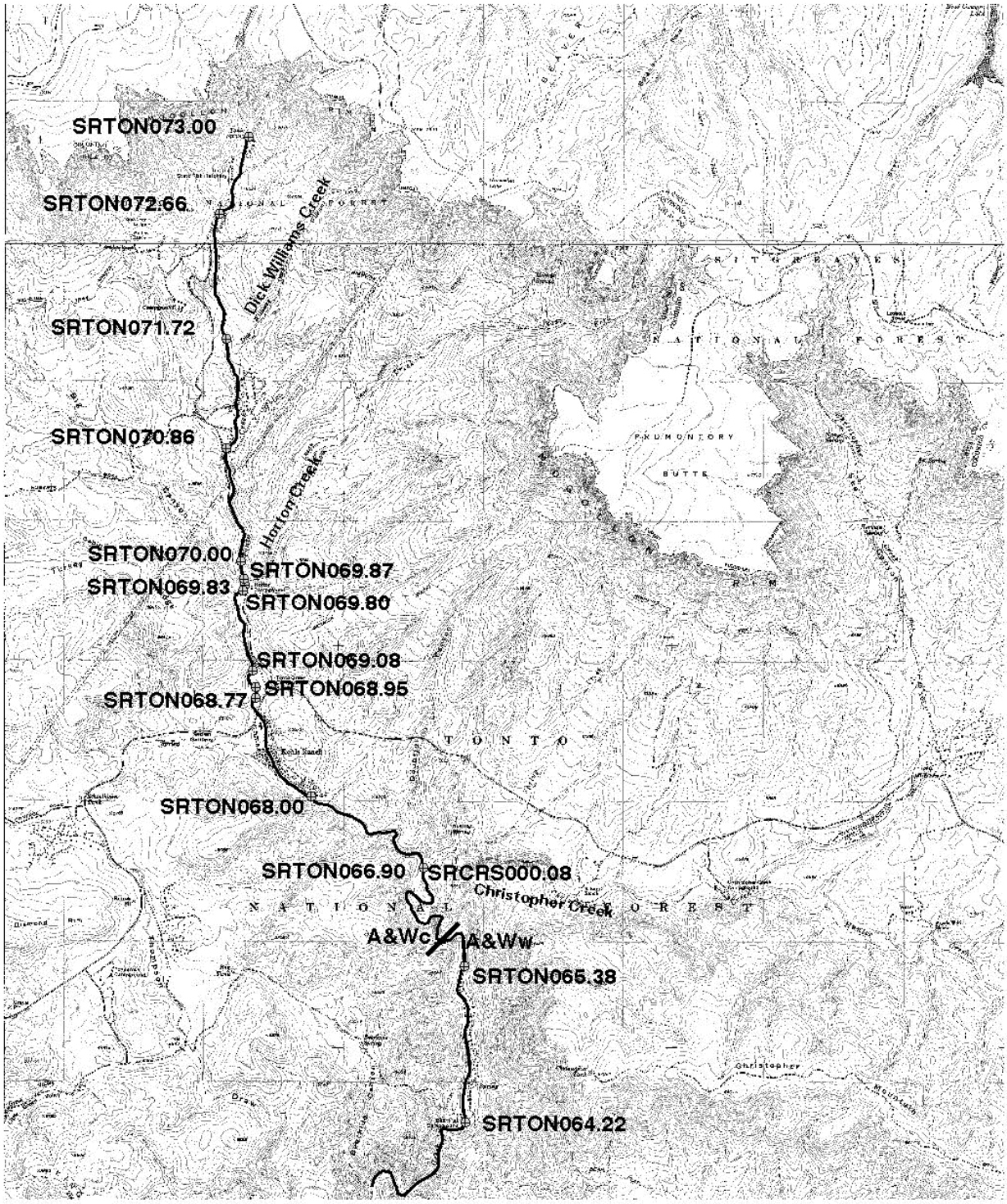
| Segment - Site | Year | Annual Mean | Exceedences |
|---|---|---|---|
| Natural Background - Site: SRTON073.00 | 2000 | Insufficient data | |
| Natural Background - Site: SRTON073.00 | 2001 | Insufficient data | |
| Natural Background - Site: SRTON073.00 | 2002 | 0.14 | |
| Natural Background - Site: SRTON073.00 | 2003 | 0.10 | |
| Fish Hatchery - site: SRTON072.66 | 2000 | Insufficient data | |
| Fish Hatchery - site: SRTON072.66 | 2002 | 0.638 | Exceeds standard by 0.138 |
| Fish Hatchery - site: SRTON072.66 | 2003 | 0.552 | Exceeds standard by 0.052 |
| Fish Hatchery - site: SRTON071.71 | 2000 | Insufficient data | |
| Fish Hatchery - site: SRTON071.71 | 2002 | 0.439 | |
| Fish Hatchery - site: SRTON071.71 | 2003 | 0.481 | |

Table 1 (cont.) Data Summary - Total Nitrogen Annual Means (mg/l) (Standard = 0.5 mg/l)

| Segment - Site | Year | Annual Mean | Exceeds |
|---|---|---|---|
| Baptist Camp - site: SRTON070.86 | 2000 | Insufficient data | |
| Baptist Camp - site: SRTON070.86 | 2002 | 0.530 | Exceeds standard by 0.030 |
| Baptist Camp - site: SRTON070.86 | 2003 | 0.404 | |
| Baptist Camp - site: SRTON070.00 | 2003 | 0.365 | |
| Baptist Camp - site: SRTON069.87 | 2000 | Insufficient data | |
| Baptist Camp - site: SRTON069.87 | 2002 | 0.343 | |
| Below Horton Creek - site: SRTON069.83 | 2003 | 0.338 | |
| Below Horton Creek - site: SRTON069.80 | 2000 | Insufficient data | |
| Below Horton Creek - site: SRTON069.80 | 2002 | 0.313 | |
| Below Horton Creek - site: SRTON068.95 | 2000 | Insufficient data | |
| Below Horton Creek - site: SRTON068.95 | 2002 | 0.323 | |
| Below Horton Creek - site: SRTON068.77 | 2003 | 0.242 | |
| Kohl's Ranch - Site: SRTON068.00 | 2000 | Insufficient data | |
| Kohl's Ranch - Site: SRTON068.00 | 2002 | 0.335 | |
| Kohl's Ranch - Site: SRTON068.00 | 2003 | 0.210 | |
| Kohl's Ranch - Site: SRTON066.90 | 2000 | Insufficient data | |
| Kohl's Ranch - Site: SRTON066.90 | 2002 | 0.300 | |
| Kohl's Ranch - Site: SRTON066.90 | 2003 | 0.300 | |
| Christopher Creek mouth - Site: SRCRS000.08 | 2000 | Insufficient data | |
| Christopher Creek mouth - Site: SRCRS000.08 | 2002 | Insufficient data | |
| Christopher Creek mouth - Site: SRCRS000.08 | 2003 | 0.338 | |
| Below Christopher - site: SRTON065.38 | 1995 | 0.953 | Exceeds standard by 0.453 |
| Below Christopher - site: SRTON065.38 | 2000 | Insufficient data | |
| Below Christopher - site: SRTON065.38 | 2002 | 0.585 | Exceeds standard by 0..085 |
| Below Christopher - site: SRTON065.38 | 2003 | 0.410 | |
| Bear Flats - Site: SRTON064.22 | 1995 | 0.795 | Exceeds standard by 0.265 |
| Bear Flats - Site: SRTON064.22 | 1996 | Insufficient data | |
| Bear Flats - Site: SRTON064.22 | 1999 | Insufficient data | |
| Bear Flats - Site: SRTON064.22 | 2000 | Insufficient data | |
| Bear Flats - Site: SRTON064.22 | 2001 | Insufficient data | |
| Bear Flats - Site: SRTON064.22 | 2002 | 0.443 | |
| Bear Flats - Site: SRTON064.22 | 2003 | 0.399 | |

Table 2 Data Summary - Stream Segment Means (for load calculations)

| Segment | Mean Discharge (cfs) | Mean N (mg/l) |
|---|---|---|
| Natural Background | 0.67 | 0.12 |
| Fish Hatchery | 1.98 | 0.528 |
| Baptist Camp | 1.36 | 0.411 |
| Below Horton Creek | 1.14 | 0.304 |
| Kohl's Ranch | Events without discharge cannot be used to calc loads. | |
| Kohl's Ranch & Tontozona | 1.68 | 0.300 |
| Christopher Creek mouth | 1.63 | 0.338 |
| Below Christopher | 3.59 | 0.649 |
| Bear Flats | 3.99 | 0.546 |




# Figure 2 - Sample Points
# Tonto Creek TMDL Project

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03/15/04

**Segments and Sources Linkage**

In general, waste from wildlife or humans; e.g., hikers, septic systems, decomposed plant material (including algae) and fertilizers (lawn care, etc.), all can provide inputs to one or more points in the nitrogen cycle. There are no waste water treatment plants in the subject basin, nor is there any cattle grazing. For purposes of this TMDL, ADEQ assigns loads to the segment upstream of the measurement points.

**Starting at the Headwaters of Tonto Creek:**

Tonto Springs is the perennial source of Tonto Creek and is thus considered **natural background**. Sample point SRTON073.00 is used to measure the natural background loading. Tonto Creek Fish Hatchery diverts the first 700 gallons per minute from Tonto Springs into its operation - in recent years, this is nearly all the spring discharge.

Discharge from the **Tonto Creek Fish Hatchery** passes through a pond system designed to reduce nutrient loading. The hatchery is the only AZPDES-permitted point source (Permit No. AZ0021211) in the project area. On the hatchery grounds are several homes (with septic systems) for hatchery employees. Additionally, the area immediately downstream from the hatchery is used for recreation purposes. Sample point SRTON072.66 is used to quantify the impact due to the hatchery and sample point SRTON071.72 quantifies the impacts from the other uses in this segment.

**Baptist Camp** is a cluster of mostly summer homes approximately 12 mile downstream from the hatchery. All these homes are on septic systems and are located within 1/4 mile of Tonto Creek. Dick Williams Creek (intermittent or ephemeral) is tributary to Tonto Creek between the hatchery and Baptist Camp. Sample points SRTON070.86,SRTON070.00 and SRTON069.87 are used to quantify the impact due to the Baptist Camp cottage cluster.

**Horton Creek** (intermittent or ephemeral) is tributary to Tonto Creek approximately one mile below Baptist Camp. There is an USFS day recreation site and campground located at the mouth of Horton Creek. Tonto Creek between Horton Creek and Highway 260 is heavily used for camping, picnicking, and fishing. The USFS had a developed campground at the Tonto Creek junction with Highway 260 approximately one mile below Horton Creek. This campground was closed in 2002 and obliterated in 2003 to make way for the new Highway 260 bridge as part of the highway widening project. The impact due to Horton Creek and the downstream recreation area was measured using sample points SRTON069.83, SRTON069.80, SRTON069.08, SRTON068.95 and SRTON068.77.

Starting at Highway 260 and extending for about : of a mile downstream is the **Kohls Ranch** area, a resort and collection of primarily summer homes. These are all on septic systems and are located within 1/4 mile of Tonto Creek. Butting against the downstream end of Kohls Ranch is **Camp Tontozona**, a retreat center and sports training camp run by Arizona State University. Tontozona has less than 3 mile active frontage on Tonto Creek and is also on septic system. Due to their proximity, the impact of nitrogen due solely to camp Tontozona cannot be differentiated from the Kohl=s Ranch impact. The Kohl=s Ranch impact is quantified using sample point SRTON068.00 and sample points SRTON067.95 and SRTON066.90 quantify the impacts due to both Kohl=s Ranch and Camp Tontozona.

About one mile downstream from Tontozona and approximately 100 feet downstream from sample point SRTON066.90 is the **mouth of Christopher Creek** on Tonto Creek. Sample point SRCRS000.08 is on Christopher Creek at its mouth.

The reach between Christopher Creek and for approximately 12 mile downstream (to the north end of the Bear Flats community) is quantified using sample points SRTON066.80 and SRTON065.38.

**Bear Flats**, a cluster of mostly summer homes on septic systems, all within c mile of Tonto Creek, stretches approximately one mile to the USFS Bear Flat recreation site and its impact is quantified using sample point SRTON064.22.

**Data Analysis**

For purposes of data analysis and trend determination, ADEQ combined the historic 1994 - 1996 data and the source identification data collected in 2000, 2002 and 2003.

Factors such as weather and varying recreational use levels, have an effect great enough to conceal or blur trends; however, several **general** observations are apparent.

- $ Nitrogen levels stay relatively constant over the summer suggesting accumulation is not an issue.
- $ Nitrogen levels correspond to the level of use along a particular reach; i.e., the hatchery and more popular use areas show a greater impact, but nitrogen levels decrease downstream of these areas.
- $ Nitrogen and discharge were not found to be related (Chart 1 displays the data supporting this conclusion).

## LOAD, ALLOCATION AND TMDL CALCULATIONS

For purposes related to the widening of Highway 260, the Arizona Department of Transportation (ADOT) installed a stage gage on Tonto Creek just upstream from the old Highway 260 bridge. This gage has been recording stage data since July 2002 and the associated software has been calibrated to provide discharge (in cfs) corresponding to the stage. The highest discharge measured during this period is 107 cfs which is the highest the gage is capable of recording; i.e., the actual discharge may be higher. The range of ADEQ-measured discharge was 0.01 to 80 cfs. Higher discharges have occurred, but could not be safely measured on the subject stream segments.

ADEQ considered using the ADOT gage data, ADEQ discharge measurements and sampling results to construct a ALoad-Duration Curve@ for use in applying the TMDL to a range of discharges from baseflow to well above flood. Unfortunately, the nitrogen data did not exhibit a correlation with discharge (Chart 1) and therefore, this approach was discounted. ADEQ has instead chosen to use a simple annual load reduction concept in implementing the TMDL.

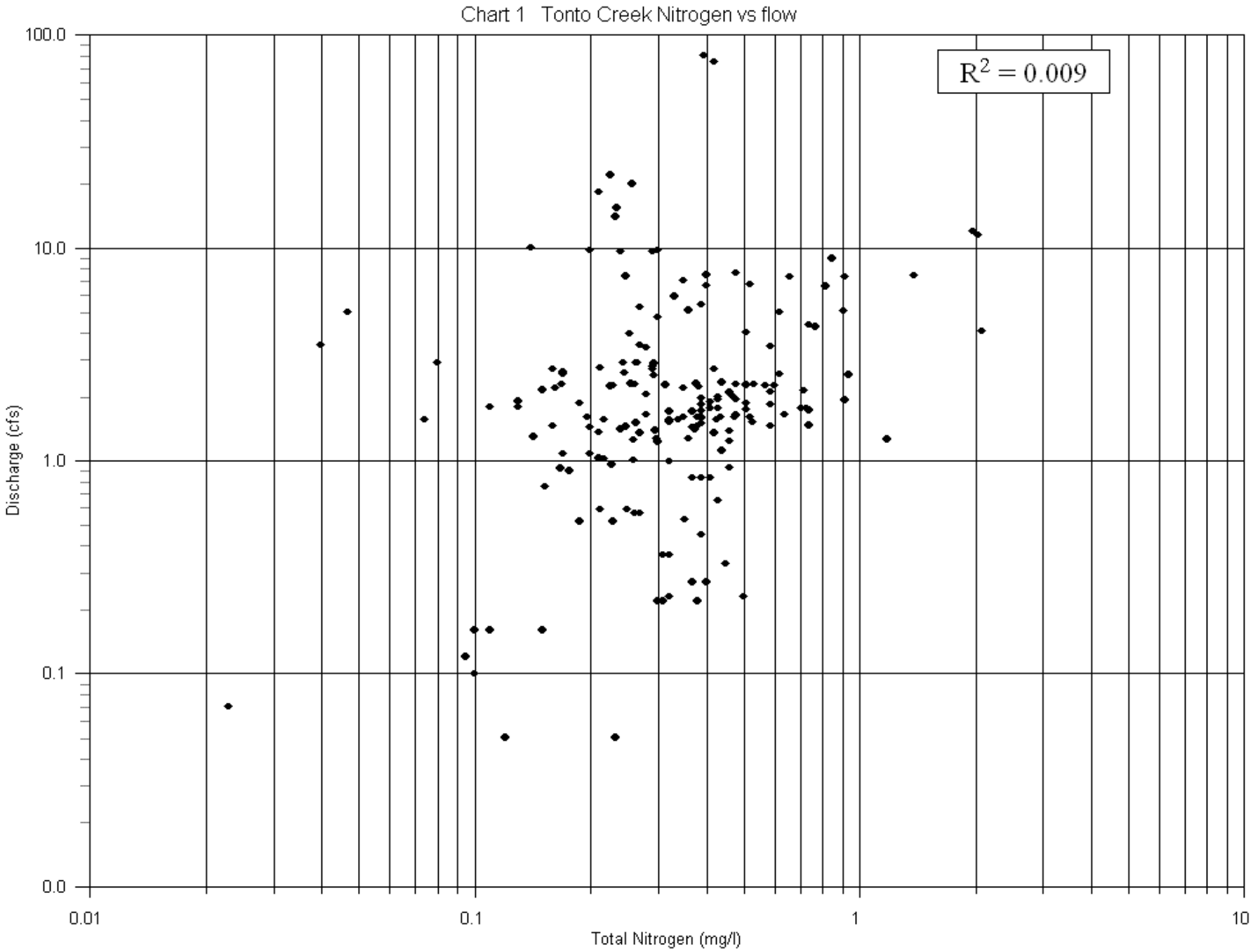
Chart 1 Tonto Creek Nitrogen vs flow
$R^2 = 0.009$
100.0
10.0
1.0
0.1
0.0
Discharge (cfs)
0.01
0.1
1
10
Total Nitrogen (mg/l)

**Units Conversion Factor**

The need to apply measurements of cubic feet per second and milligrams per liter to determine a load in units of kilograms per year necessitated the determination of a conversion factor. This is calculated through:

$[1.0 \times 10^{-6}\ kg/mg \cong 28.316\ l/ft^3 \cong 31{,}536{,}000\ sec/year] = \underline{892.97}$

The value 31,536,000 sec/year is based upon a standard year of 365 days and is considered sufficiently accurate for the purpose of calculating this TMDL.

To use: multiply concentration in mg/l by discharge in $ft^3$/sec then multiply by 892.97 to get the result in kg/year.

**TMDL Calculation**

The in-stream water quality in the subject waterbody is such that loads need to be reduced in order to meet standards. The TMDLs and associated reductions are set at levels adequate to result in the attainment of applicable water quality standards. A TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards. TMDLs can be expressed in terms of mass per time or by other appropriate measures. For purposes of this TMDL, ADEQ has chosen to use kilograms per year (kg/yr) in keeping with the standard which is an annual mean.

The load capacity is the annual mean standard (0.5 mg/l) multiplied by the stream segment discharge and a units conversion factor (892.97) to calculate a load in kilograms per year (kg/year). The TMDL is equal to or less than the load capacity for each segment.

The TMDL is represented by the a mathematical equation:

TMDL = WLA + LA + MOS, where:

WLA is the wasteload allocation consisting of loads from point sources. Tonto Creek Fish Hatchery (NPDES permit no. AZ0021211) is only known point source in the subject basin.

LA is the load allocation consisting of non-point source loads and natural background. The natural background measurements collected at the headwaters of both streams are applied equally to the downstream segments in each stream.

Allocations are assigned as the mean of the measured load from each segment (subtracting the natural background for the WLA) when no exceedence exists. Allocations for segments with exceedences are calculated as detailed in the MOS section.

MOS is a Margin of Safety which serves to address uncertainties in the analysis and the natural system and is detailed below.

Load reductions are calculated as the mean of the measured load minus the WLA minus the LA. The percent reduction is the load reduction divided by the mean of the measured load and is included here to display relative change.

Loads at each sample point include the upstream loads. ADEQ may elect to revisit this TMDL and break out the upstream load from each load when enough data have been collected to allow more accurate accounting for in-stream processes. If this were done, load allocations might be able to be calculated for discrete sources.

**Margin of Safety (MOS)**

ADEQ has chosen to allow 5% for the variation in sample analysis and another 5% as a standard error to allow for variation in sampling process (e.g. design, field collection, source identification). Both the sampling process variation amount and the sample analysis variation amount are based upon the Arizona State Laboratory allowance of 5% for each.

This variation may include:

$ The lack of characterization of many of the minor sources in the subject basin.

$ The potential for unidentified sources to contribute pollutant loads or identified sources to provide larger loads than anticipated.

$ Precipitation events can occur in portions of the watershed with other portions receiving none and thereby resulting in runoff patterns and stream discharges different from those observed.

Therefore, the total explicit MOS is 10% and, since it is based upon potential errors in measurement, it applies to the measured load.

A non-quantifiable implicit margin of safety was applied by not allocating additional loading when capacity was available. When the existing load for a stream segment was less than the load capacity, (e.g., standards are not being exceeded) instead of using the difference between load capacity and existing loading as additional allowable load, ADEQ instead chose not to allow any additional loading. This was done for several reasons:

$ Even if one or more segments meet standards, the stream reach as a whole does not and therefore additional loading shall not be allocated.

$ To allow for non-quantifiable errors in measurement.

$ ADEQ assumes conservative mixing and does not account for physical and chemical processes occurring in-stream that may reduce concentrations between sample points.

The MOS is applied by one of two methods:

$ If the mean of the measured load plus 10% of the mean of the measured load is less than or equal to the load capacity, the MOS is 10% of the mean of the measured load calculated thusly: mean of the measured concentration multiplied by the discharge multiplied by 892.97 (conversion factor) multiplied by 0.1, or

$ If the mean of the measured load plus 10% of the mean of the measured load is greater than the load capacity, the MOS is 10% of the maximum allowable load that will not exceed the load capacity as calculated thusly (For ease of explanation, assume WLA + LA = (W)LA):

TMDL = (W)LA + MOS => (W)LA = TMDL - MOS

The TMDL = 0.5 and MOS = 10% of (W)LA

□ (W)LA = 0.5 - 0.1A(W)LA => (W)LA + 0.1A(W)LA = 0.5 =>

1.1A(W)LA = 0.5 => (W)LA = 0.5/0.1 = 0.46

□ <u>(W)LA = 0.46 Qk</u> = The maximum (W)LA that will result in a TMDL # the load capacity. The corresponding MOS is derived:

TMDL = (W)LA + MOS => MOS = TMDL - (W)LA =>

MOS = 0.5 - 0.46 = 0.04 => <u>MOS = 0.04 Qk</u>

Q = discharge, k = units conversion factor of 892.97

**Critical Conditions**

Seasonality is apparent because the stream freezes over for at least a portion of each winter and hatchery production (and its attendant discharge) and recreational visitation is minimal during the Aoff-season@. Therefore, this TMDL applies during the late spring to early fall recreation season and is not necessary during the rest of the year due to the lack of human-caused loading inputs.

Most ADEQ samples were collected at relatively low discharges, but included precipitation-induced higher flows. For the following reasons, ADEQ can only document impairment at discharges less than 100 cfs therefore, this TMDL applies solely to all discharges up to 100 cfs:

$ Because comparison of nitrogen measurements to discharge does not exhibit a linear relationship (Chart 1),

$ ADEQ was only able to measure at discharges up to approximately 100 cfs.

TMDL and Allocations

The TMDL is either:

1) Where the mean of the measured load plus 10% exceeds the load capacity, the TMDL is equal to the load capacity, or

2) Where the mean of the measured load plus 10% does not exceed the load capacity, the TMDL is equal to the sum of the measured load and the MOS. This is the application of the non-quantifiable portion of the MOS explained previously.

The discharge and measured data used to calculate loads and reductions was calculated by taking the arithmetic mean (where more than one year of annual means was calculable) of the annual arithmetic means of the monthly arithmetic means of both the discharge and measured nitrogen concentrations for each segment of the stream. In the instances (4 out of 208 samples) where the laboratory reported a non-detect for both total nitrogen as nitrite and nitrate and total Kjedahl nitrogen, one half of the reporting limit was used as the concentration value for calculating the TMDL and related loads (per A.A.C. R18-11-603[1]).

The natural background measurements collected at the headwaters of both streams are applied to the downstream segments.

The WLA and LA (in kg/year) are calculated as follows:

> Where the mean of the measured load plus 10% exceeds the load capacity, the WLA is equal to 0.46 multiplied by discharge multiplied by 892.97and then the natural background is subtracted out. (Similarly, the LA is equal to 0.46 multiplied by discharge multiplied by 892.97), or
>
> Where the mean of the measured load plus 10% is equal to or less than the load capacity, the WLA is equal to the mean of the measured load minus natural background and the LA is equal to the mean of the measured load.

Load reductions are calculated as the mean of the measured load minus the WLA minus the LA. The percent reduction is the load reduction divided by the mean of the measured load and is included here to display relative change.

Table 3 displays the TMDLs, allocations, reductions and supporting data. All loads, reductions and the TMDL are loads in units of kg/year. These TMDLs, allocations and reductions apply to all flows **from the third week of May through the second week of September.**

**Waste Load Allocations and Load Allocations must be met by all of the identified sources in order for the stream to meet the TMDL**. The point(s) of compliance are the sample points used in this study unless or until a means of differentiating between clustered sources is devised.

Table 3 - TMDL and Related Loads for Total Nitrogen Annual Mean.
Based upon Annual Mean Standard of 0.5 mg/l. Units are kg/year and displayed as rounded to nearest whole number unless otherwise indicated.
Natural background load = 72 kg/year and is the nitrogen measured at the natural background site and applied to all other sites.

| Segment - sources - sites [1] | Mean of measured [2] | | | MOS [3] | Load Capacity [4] | WLA [5] | LA [5] | **TMDL [6]** | Load Reduction [7] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Discharge (cfs) | concentration (mg/l) | load | | | | | | kg/year | percent |
| Natural Background - spring Site: 73.00 | 0.67 | 0.12 | 72 | 7 | 299 | | 72 | **79** | 0 | 0% |
| Fish Hatchery Sites: 72.66, 71.72 | 1.98 | 0.528 | 934 | 71 | 884 | 742 | 72 | **884** | 120 | 13% |
| Baptist Camp - septic & recreation Sites: 70.86, 70.00, 69.87 | 1.36 | 0.411 | 499 | 50 | 607 | | 499 | **549** | 0 | 0% |
| Below Horton Creek - recreation Sites: 69.83, 69.80, 68.95, 68.77 | 1.14 | 0.304 | 309 | 31 | 509 | | 309 | **340** | 0 | 0% |
| Kohl's Ranch & Tontozona - septic & recreation Site: 66.90 | 1.68 | 0.3 | 450 | 45 | 750 | | 450 | **495** | 0 | 0% |
| Christopher Creek mouth - recreation Site: 0.08 [9] | 1.63 | 0.338 | 492 | 49 | 728 | | 492 | | | |
| Below Christopher - recreation Sites: 66.80, 65.38 | 3.59 | 0.649 | 2081 | 128 | 1603 | | 1475 | **1603** | 606 | 29% |
| Bear Flats - septic & recreation Site: 64.22 | 3.99 | 0.546 | 1945 | 143 | 1781 | | 1639 | **1781** | 306 | 16% |

1) All segments include natural background. Recreational use includes hiking, biking, camping, picnicking, wading, fishing and hunting.
2) Arithmetic mean of annual arithmetic means for each segment. Discharge and concentration from Table 2. Load = discharge x concentration x 892.97
3) If load + 10% > load capacity, then: MOS = 0.04 x 892.97 x discharge, else: MOS = mean of measured concentration x 0.1 x discharge x 892.97. (see MOS section of report for detailed explanation.)
4) Load Capacity = standard x discharge x 892.97 (conversion factor from cfs and mg/l to kg/year)
5) If the load + MOS > load capacity, then: WLA = 0.46 x discharge x 892.97 - natural background, else: WLA = mean of measured load - natural background. Likewise, if the load + MOS > load capacity, then: LA = 0.46 x discharge x 892.97, else: LA = mean of measured load. For the Fish Hatchery segment, the entire LA is natural background.
6) If mean of measured load + MOS exceeds load capacity, then: TMDL = Load capacity for segments, else: the TMDL = mean of measured load + MOS.
7) Load Reduction (kg/year) = Mean of measured load - WLA - LA.
8) Load Reduction (%) = Load Reduction divided by mean of measured load.
9) Christopher Creek mouth site included as a load source. A TMDL was not calculated for Christopher Creek; however, the TMDLs assigned to the two segments downstream of Christopher Creek assume the loading from Christopher Creek will not increase.

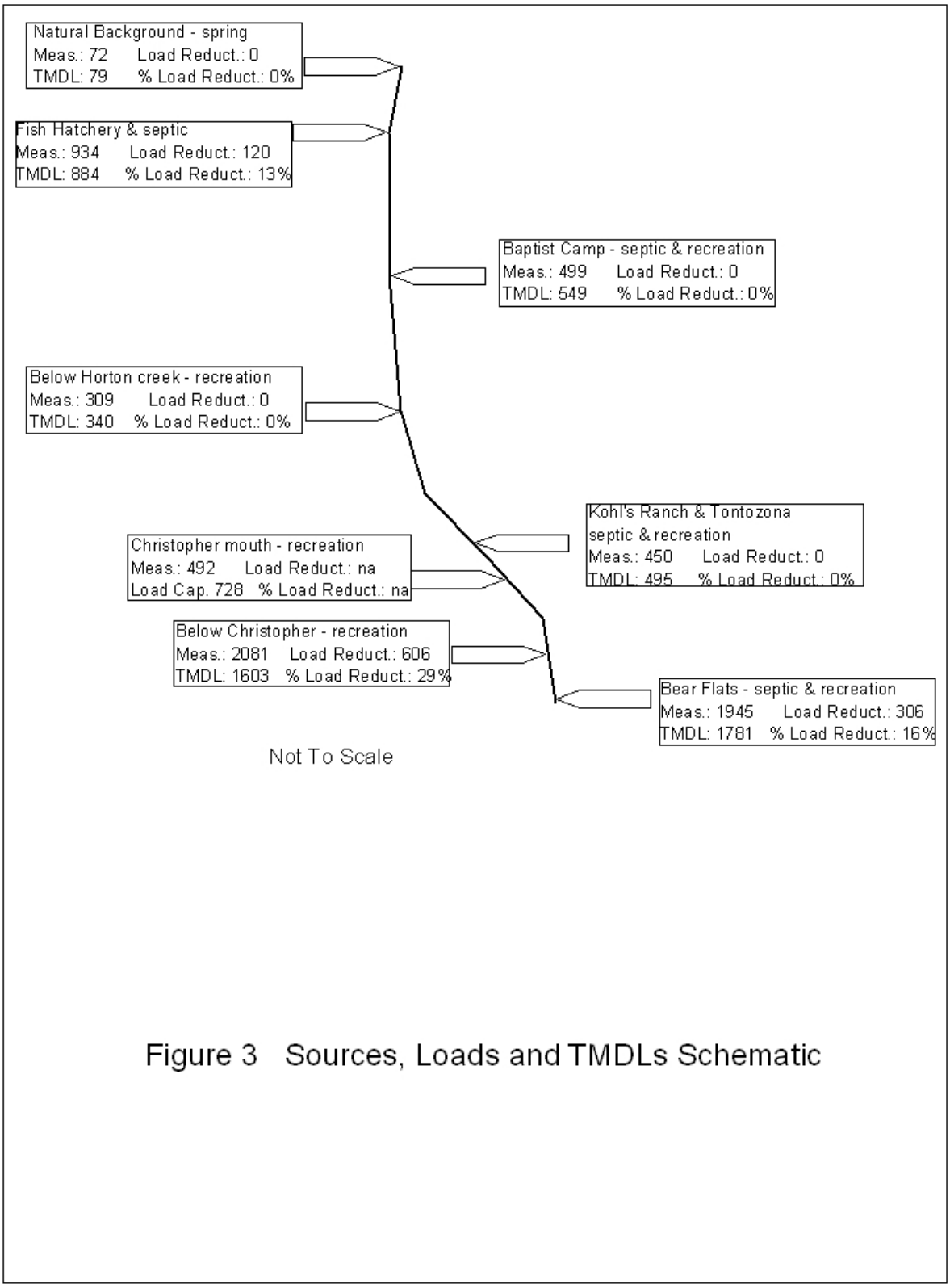


Figure 3 Sources, Loads and TMDLs Schematic

## IMPLEMENTATION

This investigation shows that water quality standards will be met when the load reductions are achieved. Identification of major sources of pollutant loading and quantification of contributions will allow management decisions to be made.

Targets for Tonto Creek should include the inspection and repair or upgrade as necessary of all septic and waste systems in the basin. The USFS has, in the last few years, added or upgraded toilets with vault units. The USFS may wish to determine usage statistics for the various recreation areas and design a system for controlling human impacts; e.g., installing more vault toilets, establishing hours of use, daily monitoring of bacteria levels, restrictions based upon discharge, etc.

ADEQ will work with the Arizona Game and Fish Department in determining new permit limits for the Tonto Creek Fish Hatchery and the means of achieving them. Under current Licensing Time Frame requirements, the new permit is due for completion by May 31, 2005.

The U.S. Forest Service (Tonto National Forest) and the Gila County Health Department may wish to establish regular monitoring of total nitrogen levels for the reaches most likely to show a problem in the future. Gila County has recently been awarded a grant which they intend to apply towards addressing septic systems in the subject watershed.

Monitoring should be planned to allow collection of sufficient samples to determine compliance with both the single sample maximum and annual mean standards. The use of tracers; e.g., fluorescent dyes, may be useful if a means of differentiating between tightly clustered sources such as septic systems can be devised. Future studies may also include collection of the data necessary to permit the use of fate and transport modeling.

## PUBLIC PARTICIPATION AND RESPONSIVENESS SUMMARY

Development of the Tonto Creek TMDL included public participation in accordance with 40 CFR Parts 25 & 130.7. Public participation included review and input from stakeholder groups. A project presentation meeting was held by the ADEQ in February 2005. Property owners; environmental groups; representatives of local, state, and federal agencies; and other interested members of the public were notified and attended this meeting. A copy of this report is also available on the ADEQ TMDL Web site.

A notice regarding availability of the draft TMDL report was made in the *Payson Roundup & Advisor* and after a 30-day public comment period, only the Arizona Department of Game and Fish made comments. After a 45-day public notice period in the A.A.R., which included comments and ADEQ responses; no additional comments were received.

Written documentation of public participation will be on file with ADEQ's Hydrologic Support and Assessment Section, located at 1110 W. Washington Street, 5th Floor, Phoenix, Arizona 85007.

This report is also posted on the ADEQ TMDL Website at:
http://www.adeq.state.az.us/environ/water/assess/tmdl.html

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U.S.F.W.S. - Personal communication with Glen Knowles (2/5/04).

U.S.F.S. - Personal communication with William Barcus (5/25/04).

Western Regional Climate Center website: *http://www.wrcc.dri.edu/*

# APPENDIX A - DATA TABLES

Table 1 - Natural Background - Site: SRTON073.00

| Date | Flow (cfs) | Total N (mg/l) | Mean Flow | Mean N | Period |
|---|---|---|---|---|---|
| 01/11/00 | 1.92 | 0.21 | | | |
| 04/6/00 | 4.02 | 0.20 | | | |
| 05/23/00 | 0.05* | 0.12 | | | |
| 07/11/00 | 1.87 | 0.21 | | | |
| 09/06/00 | 0.05* | 0.232 | | | |
| 10/03/00 | | 0.24 | | | |
| 10/11/00 | 1.83 | 0.21 | | | Insufficient data for annual mean. |
| | | | | | |
| 01/22/01 | 2.54 | 0.12 | | | |
| 02/06/01 | 4.1 | 0.36 | | | |
| 03/09/01 | 3.92 | 0.23 | | | |
| 04/16/01 | 4.01 | 0.33 | | | |
| 05/08/01 | 3.94 | 0.17 | | | |
| 06/18/01 | 2.82 | 0.21 | | | |
| 07/06/01 | 2.46 | 0.2 | | | |
| 08/08/01 | 2.41 | 0.1 | | | |
| 09/20/01 | 1.95 | 0.22 | | | |
| 10/18/01 | 2.27 | 0.1 | | | |
| 11/13/01 | 1.84 | 0.12 | | | |
| 12/20/01 | 1.56 | 0.2 | | | Insufficient data for annual mean. |

Table 1 - Natural Background - Site: SRTON073.00 (cont.)

| Date | Flow (cfs) | Total N (mg/l) | Mean Flow | Mean N | Period |
|---|---|---|---|---|---|
| 01/15/02 | 1.56 | 0.1 | | | |
| 02/05/02 | 1.56 | 0.14 | | | |
| 03/13/02 | 1.56 | 0.25 | | | |
| 04/16/02 | 1.56 | 0.2 | | | |
| 05/06/02 | 0.05* | 0.11 | | | |
| 05/14/02 | 1.56 | 0.19 | | | |
| 05/23/02 | 0.05* | 0.1 | | | |
| 05/31/02 | | | 0.55 | 0.13 | monthly mean |
| 06/12/02 | 0.05* | 0.11 | | | |
| 06/12/02 | 1.53 | 0.33 | | | |
| 06/26/02 | 0.05* | 0.1 | | | |
| 07/30/02 | | | 0.54 | 0.18 | monthly mean |
| 07/08/02 | 0.05* | 0.1 | | | |
| 07/16/02 | 1.45 | 0.11 | | | |
| 07/22/02 | 0.05* | 0.15 | | | |
| 07/31/02 | | | 0.52 | 0.12 | monthly mean |
| 08/21/02 | 1.6 | 0.23 | | | |
| 09/17/02 | 1.6 | 0.24 | | | |
| 10/22/02 | 1.54 | 0.18 | | | |
| 11/19/02 | 1.9 | 0.12 | | | |
| 12/27/02 | 1.66 | 0.2 | | | |
| | | | 0.54 | 0.14 | Annual Mean - 2002 |

* Discharge estimated

Table 1 - Natural Background - Site: SRTON073.00 (cont.)

| Date | Flow (cfs) | Total N (mg/l) | Mean Flow | Mean N | Period |
|---|---|---|---|---|---|
| 01/28/03 | 2.89 | 0.26 | | | |
| 02/21/03 | 3.13 | 0.42 | | | |
| 03/24/03 | 4.01 | 0.38 | | | |
| 04/23/03 | 4.01 | 0.22 | | | |
| 05/14/03 | 3.31 | 0.31 | | | |
| 06/25/03 | 2.54 | 0.23 | | | |
| 07/07/03 | 0.12 | 0.095 | | | |
| 07/16/03 | 2.15 | 0.16 | | | |
| 07/21/03 | 0.06 | 0.025 | | | |
| | | | 0.78 | 0.09 | monthly mean |
| 08/05/03 | 0.04 | 0.025 | | | |
| 08/12/03 | 2.57 | 0.21 | | | |
| 08/18/03 | 0.07 | 0.023 | | | |
| | | | 0.89 | 0.09 | monthly mean |
| 09/18/03 | 3.57 | 0.28 | | | |
| 10/07/03 | 0.09 | 0.025 | | | |
| 10/22/03 | 2.04 | 0.25 | | | |
| 10/21/03 | 0.1* | 0.095 | | | |
| | | | 0.74 | 0.12 | monthly mean |
| 11/19/03 | 2.6 | 0.26 | | | |
| 12/23/03 | 2.03 | 0.25 | | | |
| | | | 0.8 | 0.1 | Annual Mean - 2002 |
| | | | 0.67 | 0.12 | Segment mean for load calculation |

* Discharge estimated

Table 2 - Fish Hatchery - site: SRTON072.66

| Date | Flow (cfs) | Total N (mg/l) | Mean Flow | Mean N | Period |
|---|---|---|---|---|---|
| 5/23/2000 | 2.15 | 0.72 | | | |
| 9/6/2000 | 1.5 | 0.39 | | | |
| 10/31/2000 | 9.64 | 0.29 | | | Insufficient data for annual mean. |
| 5/6/2002 | 1.52 | 0.53 | | | |
| 5/23/2002 | 1.83 | 0.59 | 1.675 | 0.56 | monthly mean |
| 6/12/2002 | 1.47 | 0.74 | | | |
| 6/26/2002 | 1.65 | 0.64 | 1.56 | 0.69 | monthly mean |
| 7/8/2002 | 1.76 | 0.73 | | | |
| 7/22/2002 | 2.26 | 0.6 | 2.01 | 0.665 | monthly mean |
| | | | 1.75 | 0.638 | Annual - 2002 |
| 7/7/2003 | 1.46 | 0.59 | | | |
| 7/21/2003 | 2.55 | 0.62 | 2.005 | 0.605 | monthly mean |
| 8/5/2003 | 2.29 | 0.48 | | | |
| 8/18/2003 | 1.6 | 0.52 | 1.945 | 0.5 | monthly mean |
| 10/7/2003 | 4 | 0.51 | | | |
| 10/21/2003 | 2.1 | 0.59 | 3.05 | 0.55 | monthly mean |
| | | | 2.33 | 0.552 | Annual - 2003 |
| site: SRTON071.72 | | | | | |
| Date | Flow (cfs) | Total N (mg/l) | Mean Flow | Mean N | Period |
| 5/23/2000 | 1.99 | 0.43 | | | |
| 9/6/2000 | 1.7 | 0.32 | | | |
| 10/31/2000 | 7.03 | 0.35 | | | Insufficient data for annual mean. |
| 5/6/2002 | 1.94 | 0.43 | | | |
| 5/23/2002 | 1.89 | 0.41 | 1.915 | 0.42 | monthly mean |
| 6/12/2002 | 1.6 | 0.474 | | | |
| 6/26/2002 | 1.75 | 0.51 | 1.675 | 0.492 | monthly mean |
| 7/8/2002 | 1.38 | 0.46 | | | |
| 7/22/2002 | 1.6 | 0.35 | 1.49 | 0.405 | monthly mean |
| | | | 1.69 | 0.439 | Annual - 2002 |
| 7/7/2003 | 2.25 | 0.57 | | | |
| 7/21/2003 | 2.27 | 0.51 | 2.26 | 0.54 | monthly mean |
| 8/5/2003 | 1.87 | 0.51 | | | |
| 8/18/2003 | 2.01 | 0.47 | 1.94 | 0.49 | monthly mean |
| 10/7/2003 | 2.34 | 0.44 | | | |
| 10/21/2003 | 2.23 | 0.384 | 2.285 | 0.412 | monthly mean |
| | | | 2.16 | 0.481 | Annual - 2003 |
| | | | 1.98 | 0.528 | Segment mean for load calculation |

Table 3 - Baptist Camp - site: SRTON070.86

| Date | Flow (cfs) | Total N (mg/l) | Mean Flow | Mean N | Period |
|---|---|---|---|---|---|
| 5/23/2000 | 2.09 | 0.46 | | | |
| 9/6/2000 | 1.45 | 0.248 | | | |
| 10/31/2000 | 9.8 | 0.3 | | | Insufficient data for annual mean. |
| 5/6/2002 | 1.12 | 0.44 | | | |
| 5/23/2002 | 1.41 | 0.374 | 1.265 | 0.407 | monthly mean |
| 6/12/2002 | 1.56 | 0.428 | | | |
| 6/26/2002 | 1.24 | 0.46 | 1.4 | 0.444 | monthly mean |
| 7/8/2002 | 1.26 | 1.18 | | | |
| 7/22/2002 | 1.27 | 0.298 | 1.265 | 0.739 | monthly mean |
| | | | 1.31 | 0.53 | Annual - 2002 |
| 7/7/2003 | 1.63 | 0.48 | | | |
| 7/21/2003 | 1.71 | 0.388 | 1.67 | 0.434 | monthly mean |
| 8/5/2003 | 1.76 | 0.41 | | | |
| 8/18/2003 | 2.19 | 0.35 | 1.975 | 0.38 | monthly mean |
| 10/7/2003 | 2.27 | 0.315 | | | |
| 10/21/2003 | 1.94 | 0.48 | 2.105 | 0.3975 | monthly mean |
| | | | 1.92 | 0.404 | Annual - 2003 |
| site: SRTON070.00 | | | | | |
| 7/8/2003 | 1.84 | 0.39 | | | |
| 7/23/2003 | 1.76 | 0.43 | 1.8 | 0.41 | monthly mean |
| 8/6/2003 | 1.59 | 0.39 | | | |
| 8/19/2003 | 1.53 | 0.32 | 1.56 | 0.355 | monthly mean |
| 10/7/2003 | 2.06 | 0.28 | | | |
| 10/21/2003 | 1.46 | 0.38 | 1.76 | 0.33 | monthly mean |
| | | | 1.71 | 0.365 | Annual - 2003 |
| site: SRTON069.87 | | | | | |
| 5/23/2000 | 1.7 | 0.37 | | | |
| 9/6/2000 | 0.90 * | 0.177 | | | |
| 10/31/2000 | 14.00 * | 0.232 | | | Insufficient data for annual mean. |
| 5/6/2002 | 0.65 | 0.43 | | | |
| 5/23/2002 | 0.83 | 0.37 | 0.74 | 0.4 | monthly mean |
| 6/11/2002 | 0.27 | 0.4 | | | |
| 6/25/2002 | 0.36 | 0.32 | 0.315 | 0.36 | monthly mean |
| 7/8/2002 | 0.22 | 0.31 | | | |
| 7/22/2002 | 0.52 | 0.23 | 0.37 | 0.27 | monthly mean |
| | | | 0.48 | 0.343 | Annual - 2002 |
| * Discharge estimated | | | 1.36 | 0.411 | Segment mean for load calculation |

Table 4 - Below Horton Creek - site: SRTON069.83

| Date | Flow (cfs) | Total N (mg/l) | Mean Flow | Mean N | Period |
|---|---|---|---|---|---|
| 7/8/2003 | 0.93 | 0.46 | | | |
| 7/23/2003 | 1.27 | 0.36 | 1.1 | 0.41 | monthly mean |
| 8/6/2003 | 1.57 | 0.34 | | | |
| 8/19/2003 | 1.23 | 0.3 | 1.4 | 0.32 | monthly mean |
| 10/7/2003 | 2.16 | 0.15 | | | |
| 10/21/2003 | 1.35 | 0.42 | 1.755 | 0.285 | monthly mean |
| | | | 1.42 | 0.338 | Annual - 2003 |
| site: SRTON069.80 | | | | | |
| 5/23/2000 | 1.43 | 0.37 | | | |
| 9/6/2000 | 0.83 | 0.41 | | | |
| 10/31/2000 | 18.33 | 0.211 | | | Insufficient data for annual mean. |
| 5/6/2002 | 0.99 | 0.32 | | | |
| 5/23/2002 | 0.83 | 0.39 | 0.91 | 0.355 | monthly mean |
| 6/11/2002 | 0.27 | 0.37 | | | |
| 6/25/2002 | 0.36 | 0.31 | 0.315 | 0.34 | monthly mean |
| 7/8/2002 | 0.22 | 0.3 | | | |
| 7/22/2002 | 0.52 | 0.188 | 0.37 | 0.244 | monthly mean |
| | | | 0.53 | 0.313 | Annual - 2002 |
| site: SRTON068.95 | | | | | |
| 5/24/2000 | 1.64 | 0.28 | | | |
| 5/30/2000 | 1.60 * | 0.197 | | | |
| 9/6/2000 | 2.26 | 0.23 | | | |
| 11/1/2000 | 15.48 | 0.234 | | | Insufficient data for annual mean. |
| 5/7/2002 | 0.92 | 0.167 | | | |
| 5/21/2002 | 1.86 | 0.188 | 1.39 | 0.1775 | monthly mean |
| 6/11/2002 | 1.39 | 0.296 | | | |
| 6/25/2002 | 0.96 | 0.228 | 1.175 | 0.262 | monthly mean |
| 7/9/2002 | 0.53 | 0.351 | | | |
| 7/23/2002 | 1.76 | 0.71 | 1.145 | 0.5305 | monthly mean |
| | | | 1.24 | 0.323 | Annual - 2002 |
| site: SRTON068.77 | | | | | |
| 7/8/2003 | 1.25 | 0.26 | | | |
| 7/23/2003 | 1.61 | 0.38 | 1.43 | 0.32 | monthly mean |
| 8/6/2003 | 1.02 | 0.218 | | | |
| 8/19/2003 | 1.08 | 0.2 | 1.05 | 0.209 | monthly mean |
| 10/7/2003 | 1.56 | 0.074 | | | |
| 10/21/2003 | 1.55 | 0.32 | 1.555 | 0.197 | monthly mean |
| | | | 1.35 | 0.242 | Annual - 2003 |
| * Discharge estimated | | | 1.14 | 0.304 | Segment mean for load calculation |

Table 5 - Kohl's Ranch - Site: SRTON068.00
Events without discharge cannot be used to calc loads.

| Date | Flow (cfs) | Total N (mg/l) | Mean Flow | Mean N | Period |
|---|---|---|---|---|---|
| 5/25/2000 | 2.24 | 0.226 | | | |
| 5/31/2000 | 2.20 * | 0.162 | | | |
| 9/6/2000 ** | 2.30 * | 0.534 | | | |
| 10/31/2000 | 20.00 * | 0.258 | | | Insufficient data for annual mean. |
| | | | | | |
| 5/7/2002 ** | | 0.13 | | | |
| 5/21/2002 ** | | 0.27 | | 0.2 | monthly mean |
| 6/11/2002 ** | | 0.277 | | | |
| 6/25/2002 ** | | 0.28 | | 0.2785 | monthly mean |
| 7/10/2002 ** | | 0.21 | | | |
| 7/23/2002 ** | | 0.84 | | 0.525 | monthly mean |
| | | | | 0.335 | Annual - 2002 |
| | | | | | |
| 7/8/2003 ** | | 0.24 | | | |
| 7/22/2003 ** | | 0.199 | | 0.22 | monthly mean |
| 8/6/2003 ** | | 0.208 | | | |
| 8/19/2003 ** | | 0.26 | | 0.23 | monthly mean |
| 10/8/2003 ** | | 0.154 | | | |
| 10/22/2003 ** | | 0.22 | | 0.19 | monthly mean |
| | | | | 0.21 | Annual - 2003 |

* Discharge estimated
** Large quantities of watercress.

Table 6 - Kohl's Ranch & Tontozona - Site: SRTON066.90

| Date | Flow (cfs) | Total N (mg/l) | Mean Flow | Mean N | Period |
|---|---|---|---|---|---|
| 5/25/2000 | 2.31 | 0.255 | | | |
| 5/28/2000 | 2.30 * | 0.262 | | | |
| 5/31/2000 | 2.30 * | 0.168 | | | |
| 9/4/2000 | 2.31 | 0.376 | | | |
| 11/1/2000 | 22.03 | 0.226 | | | Insufficient data for annual mean. |
| | | | | | |
| 5/7/2002 | 1.08 | 0.17 | | | |
| 5/20/2002 | 0.76 | 0.153 | 0.92 | 0.1615 | monthly mean |
| 6/10/2002 | 0.59 | 0.212 | | | |
| 6/24/2002 | 1.01 | 0.26 | 0.8 | 0.236 | monthly mean |
| 7/9/2002 | 0.57 | 0.262 | | | |
| 7/24/2002 | 1.73 | 0.74 | 1.15 | 0.501 | monthly mean |
| | | | 0.96 | 0.3 | Annual - 2002 |
| | | | | | |
| 7/9/2003 | 2.74 | 0.213 | | | |
| 7/30/2003 | 2.78 | 0.29 | 2.76 | 0.25 | monthly mean |
| 8/12/2003 | 1.41 | 0.24 | | | |
| 8/20/2003 | 4.27 | 0.77 | 2.84 | 0.51 | monthly mean |
| 10/9/2003 | | 0.09 | | | |
| 10/23/2003 | 1.56 | 0.217 | 1.56 | 0.15 | monthly mean |
| | | | 2.39 | 0.3 | Annual - 2003 |
| | | | 1.68 | 0.3 | Segment mean for load calculation |

* Discharge estimated

Table 7 - Christopher Creek mouth - Site: SRCRS000.08

| Date | Flow (cfs) | Total N (mg/l) | Mean Flow | Mean N | Period |
|---|---|---|---|---|---|
| 5/25/2000 | 0.75 | 0.15 | | | |
| 5/27/2000 | 0.75 * | 0.102 | | | |
| 5/28/2000 | 0.75 * | 0.2 | | | |
| 5/31/2000 | 0.75 * | 0.271 | | | |
| 9/4/2000 | 0.46 | 0.42 | | | |
| 11/1/2000 | 30.00 * | 0.253 | | | Insufficient data for annual mean. |
| | | | | | |
| 5/7/2002 | 0.46 | 0.17 | | | |
| 5/20/2002 | 0.13 | 0.091 | | | |
| 7/24/2002 | 0.12 | 0.8 | | | Insufficient data for annual mean. |
| | | | | | |
| 7/9/2003 | 0.3 | 0.16 | | | |
| 7/30/2003 | 0.63 | 0.143 | 0.465 | 0.1515 | monthly mean |
| 8/12/2003 | 2.54 | 0.32 | | | |
| 8/20/2003 | 5.56 | 1.27 | 4.05 | 0.795 | monthly mean |
| 10/9/2003 | | 0.068 | | | |
| 10/23/2003 | 0.37 | 0.067 | 0.37 | 0.0675 | monthly mean |
| | | | 1.63 | 0.338 | Annual - 2003 |

* Discharge estimated

Table 8 - Below Christopher - site: SRTON066.80

| Date | Flow (cfs) | Total N (mg/l) | Mean Flow | Mean N | Period |
|---|---|---|---|---|---|
| 8/30/1996 | 3.49 | 0.04 | | | |
| 8/31/1996 | 2.61 | 0.17 | | | |
| 9/1/1996 | 2.88 | 0.08 | | | |
| 9/2/1996 | 2.71 | 0.16 | | | Insufficient data for annual mean. |
| 7/15/1999 | | 1.53 | | | |
| 9/22/1999 | 7.38 | 0.247 | | | |
| 12/21/1999 | 5 | 0.047 | | | Insufficient data for annual mean. |
| 2/1/2000 | 3.5 | 0.27 | | | |
| 5/2/2000 | 3.96 | 0.254 | | | |
| 9/6/2000 | 2.7 | 0.29 | | | Insufficient data for annual mean. |
| 2/7/2001 | 7.5 | 0.402 | | | |
| 6/6/2001 | 4.72 | 0.3 | | | |
| 7/18/2001 | 2.7 | 0.42 | | | |
| 9/7/2001 | 1.6 | 0.438 | | | Insufficient data for annual mean. |
| 5/27/2002 | 1.3 | 0.143 | | | |
| 9/26/2002 | 1.03 | 0.21 | | | |
| 12/12/2002 | 2.52 | 0.292 | | | Insufficient data for annual mean. |
| 5/7/2003 | 10 | 0.14 | | | |
| 7/30/2003 | 3.4 | 0.28 | | | Insufficient data for annual mean. |

Table 8 (cont) - site: SRTON065.38

| Date | Flow (cfs) | Total N (mg/l) | Mean Flow | Mean N | Period |
|---|---|---|---|---|---|
| 6/15/1995 | 9.6 | 0.24 | | | |
| 7/8/1995 | 7.44 | 1.39 | | | |
| 7/19/1995 | 7.31 | 0.92 | 7.375 | 1.155 | monthly mean |
| 8/2/1995 | 5.11 | 0.36 | | | |
| 8/16/1995 | 6.68 | 0.4 | 5.895 | 0.38 | monthly mean |
| 9/7/1995 | 11.46 | 2.03 | | | |
| 9/20/1995 | 4.98 | 0.62 | 8.22 | 1.325 | monthly mean |
| 11/15/1995 | 5.27 | 0.27 | | | |
| | | | 7.16 | 0.953 | Annual - 1995 |
| 5/24/2000 | 2.87 | 0.294 | | | |
| 5/27/2000 | 2.90 * | 0.263 | | | |
| 5/28/2000 | 2.90 * | 0.266 | | | |
| 5/30/2000 | 2.90 * | 0.244 | | | |
| 9/5/2000 | 1.93 | 0.92 | | | |
| 10/31/2000 | 74.86 | 0.42 | | | Insufficient data for 2000 annual mean. |
| 5/8/2002 | 1.36 | 0.21 | | | |
| 5/21/2002 | 0.59 | 0.25 | 0.975 | 0.23 | monthly mean |
| 6/11/2002 | 0.22 | 0.38 | | | |
| 6/25/2002 | 0.57 | 0.27 | 0.395 | 0.325 | monthly mean |
| 7/10/2002 | 0.23 | 0.321 | | | |
| 7/23/2002 | 4.08 | 2.08 | 2.155 | 1.2005 | monthly mean |
| | | | 1.18 | 0.585 | Annual - 2002 |
| 7/8/2003 | 1.9 | 0.13 | | | |
| 7/23/2003 | 2.54 | 0.94 | 2.22 | 0.535 | monthly mean |
| 8/7/2003 | 1.51 | 0.264 | | | |
| 8/20/2003 | 5.04 | 0.91 | 3.275 | 0.587 | monthly mean |
| 10/9/2003 | | 0.084 | | | |
| 10/22/2003 | 1.80 * | 0.13 | 1.8 | 0.107 | monthly mean |
| | | | 2.43 | 0.41 | Annual - 2003 |
| | | | 3.59 | 0.649 | Segment mean for load calculation |

* Discharge estimated

Table 9 - Bear Flats - Site: SRTON064.22

| Date | Flow (cfs) | Total N (mg/l) | Mean Flow | Mean N | Period |
|---|---|---|---|---|---|
| 6/15/1995 | 9.75 | 0.2 | | | |
| 7/8/1995 | 7.64 | 0.48 | | | |
| 7/19/1995 | 7.32 | 0.66 | 7.48 | 0.57 | monthly mean |
| 8/2/1995 | 5.41 | 0.39 | | | |
| 8/16/1995 | 6.75 | 0.52 | 6.08 | 0.455 | monthly mean |
| 9/7/1995 | 12.00 * | 1.98 | | | |
| 9/20/1995 | 4.37 | 0.74 | 8.185 | 1.36 | monthly mean |
| 11/15/1995 | 5.9 | 0.33 | | | |
| | | | 7.25 | 0.795 | Annual - 1995 |
| | | | | | |
| 5/24/2000 | 2.56 | 0.17 | | | |
| 5/30/2000 | 2.60 * | 0.246 | | | |
| 9/5/2000 | 3.44 | 0.59 | | | |
| 10/31/2000 | 80.00 * | 0.394 | | | Insufficient data for annual mean. |
| | | | | | |
| 5/8/2002 | 1.43 | 0.2 | | | |
| 5/21/2002 | 1.35 | 0.27 | 1.39 | 0.235 | monthly mean |
| 6/11/2002 | 0.33 | 0.45 | | | |
| 6/25/2002 | 0.45 | 0.39 | 0.39 | 0.42 | monthly mean |
| 7/10/2002 | 0.23 | 0.5 | | | |
| 7/23/2002 | 8.93 | 0.85 | 4.58 | 0.675 | monthly mean |
| | | | 2.12 | 0.443 | Annual - 2002 |
| | | | | | |
| 7/8/2003 | 1.46 | 0.16 | | | |
| 7/23/2003 | | 0.89 | 1.46 | 0.525 | monthly mean |
| 8/7/2003 | 1.97 | 0.388 | | | |
| 8/20/2003 | 6.6 | 0.82 | 4.285 | 0.604 | monthly mean |
| 10/9/2003 | 2.39 | 0.025 | | | |
| 10/22/2003 | 1.80 * | 0.11 | 2.095 | 0.068 | monthly mean |
| | | | 2.61 | 0.399 | Annual - 2003 |
| | | | 3.99 | 0.546 | Segment mean for load calculation |

* Discharge estimated