Region 6 Development of Minimum Quantification Levels October 30, 2007

Introduction

Since 1992, EPA Region 6 has used MQLs as the benchmark for decision making and compliance in NPEDS permits. MQLs serve the dual purpose of ensuring that sufficiently sensitive analytical methodology is used for analyses and for resolving data management issues where water quality limitations are below concentrations which can reasonable be quantified. EPA Region 6 is proposing to revise the MQLs to more accurately reflect effluent data in permitting and enforcement decision making and to better protect water quality by incorporating advances in analytical techniques that have occurred since our 1992 policy was implemented .

The need for such Policy was highlighted with the development of water quality-based permit limits to protect numeric criteria for toxics. This process focused attention on the analytical sensitivity used when those toxic parameters are measured. In a number of cases, numeric water quality criteria have been established at low concentrations, which cannot currently be quantified using older EPA approved analytical methodologies. One example of this is the water quality criteria to protect aquatic life for copper. The criterion has been established at 2 µg/l; whereas, the Region 6 accepted Minimum Quantification Level (MQL) for Copper established in our1992 policy is 10 µg/l.

Although this is an issue common to all states, as an example, in New Mexico's Water Quality Standards the State has established 38 numeric criteria at concentrations which are less than Region 6's 1992 established corresponding MQLs. A comparison of those 38 water quality criteria and the associated MQLs, established in 1992, is shown below in Table 1 of the Appendix. EPA Region 6 is undertaking the exercise of determining the MQLs which can be reduced.

In the fourteen intervening years laboratories have made advances in the quantification levels that are typically achieved through method enhancements and additional EPA approved test methods have been approved. EPA regulations found at 40 CFR Part 136 set acceptable methodologies for satisfying the analytical requirements of NPDES permits. In the case where there is more than one approved method there are no requirements that the most sensitive method be used. MQLs establish a benchmark to assure that analytical methodologies with acceptable sensitivities are used for NPDES permitting purposes.

A number of advances in analytical methodology, such as clean techniques for Mercury under Method 1631, have been made since Region 6's policy was established in 1992. On August 23, 2007, EPA issued a Memorandum titled "Use of Sufficiently Sensitive EPA-Approved Analytical Methods in NPDES Permits. This Memorandum establishes that while there are several approved EPA methods for analyzing for mercury "in many cases, only the most sensitive methods" are appropriate for NPDES permit requirements. Consistent with this concept and as a result of such advances in methodology, it appears that a number of the MQLs established in 1992 can be revised and will result in MQLs lower than the corresponding criteria. Therefore, EPA has explored the need to update the established MQLs.

In an effort to respond to those developments, Region 6 staff has worked with the

Houston Lab to develop updated MQLs following a similar procedure as used in 1992, which considered method appropriateness and cost effectiveness. In a number of cases, the revised MQL values are now below water quality criteria levels which were previously not attainable.

Only those MQLs that are presently greater than the corresponding water quality criteria are being examined. There does not appear to be a value in reexamining those MQLs which are presently lower than the water quality criteria since no additional protection of Water Quality Standards would be afforded.

In the early 1990s Region 6 undertook a study to provide an approach and set quantification levels with which defensible permits could be written. The resulting MQLs have been used in implementing water quality based permit limits and the associated permit decision making tasks since 1992.

EPA Region 6 will begin to implement the new MQLs established in this document as it reissues permits for facilities located in New Mexico. As the revised MQLs are adopted in individual State Implementation Plans, EPA expects that they will be phased in under State issued permits.

Terminology

Analytical results are characterized by a number of different terms, including Method Detection Level and Minimum Levels. These “detection levels” convey different information about the analysis. A true detection limit connotes the lowest concentration that a given instrument can record. A quantification limit is the lowest concentration that can be measured with known accuracy. The parameters evaluated by Region 6 in establishing the 1992 MQLs were the Method Detection Level (MDL) defined by EPA at 40 CFR Part 136, Appendix B, Instrument Detection Level (IDL) defined by EPA Method 1620, the Limit of Detection (LOD) and Limit of Quantification (LOQ) described by the American Chemical Society, the Practical Quantification Level (PQL), and the Minimum Level (ML) defined by EPA in 40 CFR Part 136 “1600" series. LOD, IDL, and MDL are described as approximately three times the standard deviation obtained from replicate measurements and may be described as that value determined to be statistically significant from the measurement of a reagent blank. An IDL is determined from the analysis of a chemical in a reagent or sample matrix. LOQ and PQL are the products of an LOD or MDL and a constant factor. The LOQ and PQL are attempts to define a level of analyte that may be repeatedly measured. The ML is defined as the concentration in a sample equivalent to the concentration of the lowest point on the calibration curve.

The concept of an ML, or the lowest point on a calibration curve, was judged to be a true quantification limit. Since the comparison of instream waste concentration to water quality criteria or effluent concentrations to permit limits are both quantitative exercises best done with a measured level of a pollutant rather than an indication of its presence, Region 6 has elected to define a minimum quantification level (MQL) as the lowest concentration at which a particular substance can be quantitatively measured. The most straightforward estimator of a minimum quantification level currently available is the lowest concentration used in the calibration of a measurement system. This method of evaluating acceptable limits of quantification has been used by EPA in other cases, namely the development of the 1624 and 1625 organic analysis methods, the regulation of dioxin from pulp and paper mills, and the development of Organic Chemical effluent limitations guidelines.

When the MQLs were established, available statistics and terms were examined to determine an analytical benchmark to select a minimum level of sensitivity for each pollutant. EPA approved methods which could be expected to achieve those minimum levels were then identified.

Establishing MQLs for Priority Pollutants

In developing the 1992 MQLs, a literature review was made of analytical methods that have been characterized by a low calibration point or minimum level. These sources of information were used to arrive at appropriate low calibration points for the available analytical methods. Similar methods have been used in reevaluation of those MQL values.

Volatile and Semivolatile Organics

When MQLs were developed in 1992, Gas chromatography-mass spectroscopy (GC-MS) as detailed in 40 CFR Part 136 Methods 624 and 625 was determined to be appropriate and cost effective means to screen an effluent for the entire set of volatile and semivolatile priority pollutants. Two sources of information were used to set appropriate low calibration points or MQLs for these methods. The Contract Laboratory Program (CLP) administered under CERCLA contains a list of priority pollutants and the associated Contract Required Quantitation Levels (CRQL). These quantitation levels were developed under the assumption that Methods 624 and 625 GC-MS were used to perform analysis on the target compounds. In 1992, Region 6 used the CRQL as the primary basis for establishing its own MQLs for organic pollutants. The Minimum Levels found in the Federal regulations describing the similar GC-MS 1624 and 1625 methods were used as a cross reference (see 40 CFR Part 136, Appendix A).

The CRQL was used to establish the MQL for sixty seven of the eighty four volatile and semivolatile pollutants. For sixty five of these compounds, the CRQL and ML were equal. The MQLs for the remaining seventeen pollutants were taken from the ML value. Some priority pollutants are not target compounds under the CERCLA program, these being acrolein, acrylonitrile, 2-chloroethyl vinyl ether, benzidine, 3,4-benzofluoranthene, and 1,2 diphenlyhydrazine. Although they are in the same order of magnitude, the MQLs of eight halogenated aliphatic hydrocarbons, hexachloroethane, 2-nitrophenol, benzopyrylene, indenopyrene, dibenzoanthrcene, and three nitrosomes are higher than the CRQL by a factor of 2 to 5, although in the same order of magnitude. These higher MLs were used as the basis for the regional MQL in recognition of the difficulty in recovery and identification of these pollutants.

Pesticides

Gas chromatography was determined to be the most sensitive analytical method for pesticides. It is also relatively inexpensive and readily available. CRQLs have been established for pesticides. The required quantification level assumes analyses using the gas chromatography method as detailed in 40 CFR Part 136, Method 608. Region 6 chose to base the MQL on the CRQL for priority pollutants pesticides, with the exception of the pesticide chlordane. The regional Environmental Services Division Laboratory located in Houston, Texas provided professional guidance in setting the MQL for chlordane at 0.2 ug/l. A CRQL has been established at 0.05 ug/l for pure alpha and gamma chlordane isomers. The pesticide listed as a priority pollutant and encountered in waste waters is technical grade chlordane, which does not provide as strong and distinctive chromatographic response as the pure isomers. Thus, chlordane is more reliably quantified at this higher level.

Metals

Region 6 used the Contract Required Detection Level (CRDL) for metals in the CERCLA CLP as the primary basis for MQLs. The EPA approved methods for the measurement of priority pollutant metals included graphite furnace and flame atomic absorption spectrometry (AA) and inductively coupled plasma (ICP). Each of these methods has a different level of sensitivity. The CRDLs reflect acceptable ICP analysis of some metals and the more sensitive graphite furnace measurement of the remainder of the set of priority metals.

The CRDL served as the basis for the MQL for four metals (Arsenic, Mercury, Selenium, and Thallium) and Cyanide, and it represented analysis by the most sensitive available technique. CRDLs were used to establish MQLs for Antimony, Tri and Hexavalent Chromium, and Zinc at levels of sensitivity attainable by ICP analysis. Those levels are sufficiently sensitive to demonstrate compliance with water quality standards. The MQL for Beryllium was based on the CRDL attainable by ICP analysis. In 1992 Beryllium was not regulated by the states in Region 6; therefore, more sensitive measurement of the pollutant was not deemed necessary for water quality based permitting decisions. Water quality criteria for Beryllium has since been adopted by New Mexico.

The CRDL for Nickel is sufficient to protect water quality when discharges to fresh water are being evaluated and was chosen as the MQL for those cases. The ambient marine criteria for Nickel are two orders of magnitude lower than the fresh water standards. To adequately assess Nickel in discharges to marine waters, a lower MQL predicating the use of graphite furnace analysis will be necessary. Region 6 previously selected an MQL for Nickel of 5 ug/l for use in marine discharges, based of the optimum concentration range described in EPA Method 249.2.

Similarly, the MQL for Cadmium, Lead, and Silver were based on the optimum lower range described in the graphite furnace methods for these pollutants. Silver is governed by a low water quality criteria. The MQL for Silver was set to reflect the most sensitive analysis available. The lower end of the optimal range for Lead was slightly higher than the CRDL and was used to reflect the difficulty in overcoming background contamination of this metal. The optimum concentration range for Cadmium reflected a sensitivity protective of the water quality criteria for this metal and was used to set the MQL.

The CRDL has a direct relation to the low calibration standard for atomic absorption methods. The QA/QC requirements in the CLP state that one AA calibration standard must be at the CRDL for all metals except Mercury. For ICP measurements in which the lowest calibration point may not be directly related to quantitation, a demonstration of sensitivity may be made by measurement of a standard equal to the CRDL. The measurement value should be within ten percent of the known concentration. Due to the need to protect Mercury criteria in a number of impaired waters the MQL for Mercury is based on the more sensitive Method 1631E, Isotope Dilution High Resolution Gas Spectrometry / High Resolution Mass Spectrometry or method 245.7 as specified in the individual permit.

<u>Chlorine</u>

The 18th edition of Standard Methods for the Examination of Water and Waste Water (1992) states that the method detection limit for total residual chlorine is 10 ug/l for method number 4500-Cl E (EPA Method 330.5). Based on that information and the method described below for determining an MQL from a method detection limit, EPA is establishing a new MQL of 33 ug/l.

<u>Discharge Specific Quantification Levels</u>

The process of setting MQLs for the pollutants described above is a general approach to describing the minimum sensitivity that would be acceptable in evaluating discharges. The MQLs for organic pollutants have been set to evaluate scans of the entire list of organic priority pollutants by GC-MS. The measure of individual organic pollutants at trace levels may be made with greater sensitivity in many cases by a specific gas chromatography technique. This is, however, dependent on the pollutant and the matrix. If permit application information indicates that a specific pollutant regulated at a trace level is being discharged, appropriate evaluation will include a comparison of the sensitivity of GC-MS and GC tests for that specific pollutant and matrix. The most sensitive method may then be required for analysis. A matrix specific Method Detection Level may be determined for the pollutant as described in 40 CFR Part 136, Appendix B. The MDL and LOD[2] being similar descriptors and both equivalent to three standard deviations about replicate measurements, a relationship between the MDL and the LOQ is drawn as follows:

LOD = 3 s.d.
LOQ = 10 s.d.
LOQ = 10/3 LOD
LOD = MDL   Minimum Quantitation Level = 3.3 MDL

EPA Region 6 included conditions in NPDES permits which allows development of discharge specific MQLs in cases where effluent matrix make the general MQL inappropriate.

Revision of Existing Minimum Quantification Levels

Information was obtained from EPA's Houston, Texas laboratory, on quantification levels which are routinely achieved by analytical laboratories in EPA Region 6. A comparison of that new information with water quality criteria and the previously established MQLs is shown below in Table 2 of the Appendix, using New Mexico's criteria as an example. The comparison demonstrates that the quantification level routinely achieved by laboratories is less than EPA's previously established MQLs in 29 out of the 38 cases examined. The current laboratory quantification levels are also lower than water quality criteria in twelve more cases than EPA's MQLs (shown in bold in Table 2 fo the Appendix). Seven of those twelve cases are for metals. Since there are ten metals with an MQL which is greater than the criteria, use of the current laboratory quantification level rather than EPA's existing MQLs would mark a significant improvement in water quality analysis used in permit decision making. Use of the lowest achievable levels shown in Table 2 would result in an additional eight parameters with quantification levels lower than water quality criteria; however, for all parameters except Mercury, EPA does not plan to use those lower levels to establish revised MQLs. Matrix effects in effluents are likely to make the lowest achievable levels difficult to reach in a number of cases. EPA Method 1631 (Oxidation / Purge and Trap / Cold Vapor Atomic Fluorescence Spectrometry) is widely available and has been show to be viable. Therefore, that more sensitive method is being required for monitoring Mercury.

The routine quantification level and existing MQLs are compared with the current CRQLs in Table 3 of the Appendix. In most cases, the CRQLs are lower than the existing MQLs. The CRQLs for most metals are slightly higher than the routine quantification levels obtained from the Houston Lab. In most cases the CRQLs are the same value as the routine quantification levels for organic pollutants and pesticides. The fact that the routine quantification levels and CRQLs are either identical or in a very close range appears to verify the routine levels and support their suitability for use as MQLs in the future, for most parameters.

Selection of MQLs

For most parameters shown in Table 3, the routine quantification level is either the same as or lower than the CRQL. The routine quantification level is being used for the revised MQL in those cases. EPA's existing MQL is shown to be equal to the CRQL for Selenium in Table 3 and is not being revised. The CRQL for Cyanide is lower than the existing MQL and is being used as the revised MQL. The CRQL for Carbon Tetrachloride is lower than the existing MQL and the routine quantification level. However, the routine quantification level is sufficiently low to protect water quality and will be used as the revised MQL. The revised list of MQLs is shown below in Table 4 of the Appendix.

Summary

EPA has embraced Minimum Level (defined as the lowest calibration point) as a valid scientific and regulatory concept for establishing water quality based limits in the Dioxin Permitting Strategy. A Federal Advisory Committee (FAC) has been formed to address the issue of permit limits which are below analytical quantification levels. A goal of this FAC is to publish Minimum Levels reflecting matrix effects for all of the EPA approved analytical quantification methods for waste water. Until the exercise is completed, the states and regions must have some benchmark of required analytical sensitivity.

Region 6 developed MQLs in an effort to obtain reliable data with which to evaluate the universe of dischargers and protect water quality standards. In stipulating these calibration points to permittees, an easily identified baseline for quantification on which the decision to impose permit limits was established.

APPENDIX

Table 1: List of MQLs Presently Higher than New Mexico's Numeric Criteria

Parameter	Numeric Criteria (ug/l)	Existing EPA MQL (ug/l)
Aluminum	87	100
Arsenic	2.3	10
Beryllium	4	5
Copper	2	10
Mercury	0.012	0.2
Nickel	13	40
Selenium	0.25	5
Silver	0.21	2
Thallium	2	10
Cyanide	2.6	20
2,3,7,8-TCDD	0.00000014	0.00001
Acrylonitrile	6.6	50
Carbon Tetrachloride	4.4	10
Pentachlorophenol	15	50
Benzidine	0.0054	50
Benzo(a)anthracene	0.49	10
Benzo(a)pyrene	0.49	10
3,4-Benzofluoranthene	0.49	10
Benzo(k)fluoranthene	0.49	10
Chrysene	0.49	10
Dibenzo(a,h)anthracene	0.49	20
3,3'-Dichlorobenzidine	0.77	50
1,2-Diphenylhydrazene	5.4	20
Hexachlorobenzene	0.0077	10
Indo(1,2,3-cd)pyrene	0.49	20
Aldrin	0.0014	0.05
Chlordane	0.022	0.2

4,4'-DDT	0.001	0.1
Dieldrin	0.0014	0.1
Alpha-endosulfan	0.056	0.1
Beta-endosulfan	0.056	0.1
Endrin	0.036	0.1
Heptachlor	0.0021	0.05
Heptachlor epoxide	0.0011	1.0
PCBs	0.0017	1.0
Toxaphene	0.0002	5.0
Chlorine	11	100

Table 2: Comparison of Existing MQLs with Quantification Levels Reported by EPA's Houston, Texas Laboratory

Parameter	Numeric Criteria (ug/l)	Existing EPA MQL (ug/l)	R6 Routine Level (ug/l)	Achievable (ug/l)
Aluminum	**87**	**100**	**2.5** [*1]	
Arsenic	**2.3**	**10**	**0.5** [*1]	**0.005** [*2]
Beryllium	**4**	**5**	**0.5** [*1]	
Copper	**2**	**10**	**0.5** [*1]	
Lead	**5**	**5**	**0.5** [*1]	
Mercury	**0.012**	**0.2**		**0.0002** [*3]
Nickel	**13**	**40**	**0.5** [*1]	
Selenium	0.25	5	10 [*1]	3 [*4]
Silver	0.21	2	0.5 [*1]	
Thallium	**2**	**10**	**0.5** [*1]	
Cyanide	2.6	20 [*9]		
2,3,7,8-TCDD	0.00000014	0.00001 [*5]		
Acrylonitrile	6.6	50	20 [*6]	
Carbon Tetrachloride	**4.4**	**10**	**2** [*6]	**0.5**
Pentachlorophenol	**15**	**50**	**5** [*7]	**1**
Benzidine	0.0054	50 [*7]		
Benzo(a)anthracene	0.49	10	5 [*7]	0.2
Benzo(a)pyrene	0.49	10	5 [*7]	
3,4-Benzofluoranthene	0.49	10		0.5
Benzo(k)fluoranthene	0.49	10	5 [*7]	0.2
Chrysene	0.49	10	5 [*7]	0.2
Dibenzo(a,h)anthracene	0.49	20	5 [*7]	0.2
3,3'-Dichlorobenzidine	0.77	50	5 [*7]	
1,2-Diphenylhydrazene	5.4	20 [*7]		
Hexachlorobenzene	0.0077	10	5 [*7]	0.01
Indo(1,2,3-cd)pyrene	0.49	20	5 [*7]	0.2
Aldrin	0.0014	0.05	0.01 [*8]	0.004
Chlordane	0.022	0.2	0.2 [*8]	0.01
4,4'-DDT	0.001	0.1	0.02 [*8]	0.001

Dieldrin	0.0014	0.1	0.02 *8	
Alpha-endosulfan	**0.056**	**0.1**	**0.01 *8**	**0.004**
Beta-endosulfan	**0.056**	**0.1**	**0.02 *8**	**0.008**
Endrin	**0.036**	**0.1**	**0.02 *8**	**0.008**
Heptachlor	0.0021	0.05	0.01 *8	0.004
Heptachlor epoxide	0.0011	1.0	0.01 *8	0.004
PCBs	0.0017	1.0	0.2 *8	0.08
Toxaphene	0.0002	5.0	0.3 *8	0.06
Chlorine	11	100	33 *10	

Footnotes

*1 EPA Method 200.8 - Inductively Coupled Plasma / Mass Spectrometry
*2 EPA Method 1632 - Hydride Atomic Absorption
*3 EPA Method 1631 - Oxidation / Purge and Trap / Cold Vapor Atomic Fluorescence Spectrometry
*4 EPA Method 200.9 - Graphite Furnace Atomic Absorption Spectrometry
*5 EPA Method 1613 - Isotope Dilution High Resolution Gas Spectrometry / High Resolution Mass Spectrometry
*6 EPA Method 624 - Gas Chromatography/Mass Spectrometry (GC/MS) (Purgeables)
*7 EPA Method 625 - Gas Chromatography/Mass Spectrometry (GC/MS) (Base Nuetrals and Acids)
*8 EPA Method 608 - Gas Chromatography with Electron Capture Detector
*9 EPA Method 335.2 - Titrimetric, Spectrophotometric
*10 EPA Method 330.5 - Spectrophotometric

Note: EPA Method 200.8 has been used for NPDES permits and approved as an alternate test procedure. The final method approval will be published in late 2006.

Table 3: Comparison of Existing and Laboratory Reported Quantification Levels with CRQLs

Parameter	Existing EPA MQL (ug/l)	R6 Routine Level (ug/l)	Achievable (ug/l)	CRQL (ug/l)
Aluminum	100	2.5[*1]		200
Arsenic	10	0.5 [*1]	0.005 [*2]	1 [*1]
Beryllium	5	0.5 [*1]		1 [*1]
Copper	10	0.5 [*1]		2 [*1]
Lead	5	0.5 [*1]		1 [*1]
Mercury	0.2		0.0002 [*3]	0.2 [*9]
Nickel	40	0.5 [*1]		1 [*1]
Selenium	5	10 [*1]	3 [*4]	5 [*1]
Silver	2	0.5 [*1]		1 [*1]
Thallium	10	0.5 [*1]		1 [*1]
Cyanide	20			10 [*10]
2,3,7,8-TCDD	0.00001 [*5]			0.00001 [*5]
Acrylonitrile	50	20 [*6]		
Carbon Tetrachloride	10	2 [*6]	0.5	0.5 [*6]
Pentachlorophenol	50	5 [*7]	1	5 [*7]
Benzidine	50 [*7]			
Benzo(a)anthracene	10	5 [*7]	0.2	5 [*7]
Benzo(a)pyrene	10	5 [*7]		5 [*7]
3,4-Benzofluoranthene	10		0.5	
Benzo(k)fluoranthene	10	5 [*7]	0.2	5 [*7]
Chrysene	10	5 [*7]	0.2	5 [*7]
Dibenzo(a,h)anthracene	20	5 [*7]	0.2	5 [*7]
3,3'-Dichlorobenzidine	50	5 [*7]		5 [*7]
1,2-Diphenylhydrazene	20 [*7]			
Hexachlorobenzene	10	5 [*7]	0.01	5 [*7]
Indo(1,2,3-cd)pyrene	20	5 [*7]	0.2	5 [*7]
Aldrin	0.05	0.01 [*8]	0.004	0.01 [*8]
Chlordane	0.2	0.2 [*8]	0.01	
4,4'-DDT	0.1	0.02 [*8]	0.001	0.02 [*8]
Dieldrin	0.1	0.02 [*8]		0.02 [*8]
Alpha-endosulfan	0.1	0.01 [*8]	0.004	0.01 [*8]
Beta-endosulfan	0.1	0.02 [*8]	0.008	0.02 [*8]
Endrin	0.1	0.02 [*8]	0.008	0.01 [*8]
Heptachlor	0.05	0.01 [*8]	0.004	0.01 [*8]
Heptachlor epoxide	1.0	0.01 [*8]	0.004	0.01 [*8]
PCBs	1.0	0.2 [*8]	0.08	
Toxaphene	5.0	0.3 [*8]	0.06	1.0 [*8]
Chlorine	100			

10

Footnotes

*1	EPA Method 200.8 -	Inductively Coupled Plasma / Mass Spectrometry
*2	EPA Method 1632 -	Hydride Atomic Absorption
*3	EPA Method 1631 -	Oxidation / Purge and Trap / Cold Vapor Atomic Fluorescence Spectrometry
*4	EPA Method 200.9 -	Graphite Furnace Atomic Absorption Spectrometry
*5	EPA Method 1613 -	Isotope Dilution High Resolution Gas Spectrometry / High Resolution Mass Spectrometry
*6	EPA Method 624 -	Gas Chromatography/Mass Spectrometry (GC/MS) (Purgeables)
*7	EPA Method 625 -	Gas Chromatography/Mass Spectrometry (GC/MS) (Base Nuetrals and Acids)
*8	EPA Method 608 -	Gas Chromatography with Electron Capture Detector
*9	EPA Method 245.1 -	Cold Vapor Atomic Absorption Spectrometry
*10	EPA Method 335.2 -	Titrimetric, Spectrophotometric

Table 4: EPA Region 6 Revised MQLs

Parameter	Existing MQL (ug/l)	Revised MQL (ug/l)
Aluminum	100	2.5
Arsenic	10	0.5
Beryllium	5	0.5
Copper	10	0.5
Lead	5	0.5
Mercury	0.2	0.0005/0.005[1]
Nickel	40	0.5
Selenium	5	5
Silver	2	0.5
Thallium	10	0.5
Cyanide	20	10
2,3,7,8-TCDD	0.00001	0.00001
Acrylonitrile	50	20
Carbon Tetrachloride	10	2
Pentachlorophenol	50	5
Benzidine	50	50
Benzo(a)anthracene	10	5
Benzo(a)pyrene	10	5
3,4-Benzofluoranthene	10	10
Benzo(k)fluoranthene	10	5
Chrysene	10	5
Dibenzo(a,h)anthracene	20	5
3,3'-Dichlorobenzidine	50	5
1,2-Diphenylhydrazene	20	20
Hexachlorobenzene	10	5
Indo(1,2,3-cd)pyrene	20	5
Aldrin	0.05	0.01
Chlordane	0.2	0.2
4,4'-DDT	0.1	0.02
Dieldrin	0.1	0.02
Alpha-endosulfan	0.1	0.01
Beta-endosulfan	0.1	0.02
Endrin	0.1	0.02
Heptachlor	0.05	0.01
Heptachlor epoxide	1.0	0.01
PCBs	1.0	0.2
Toxaphene	5.0	0.3
Chlorine	100	33

[1] As specified in your individual permit.

Chronology of Activities pertaining to

2015 Joint Stipulation between Amigos Bravos, the U.S. Department of Energy, Los Alamos National Security LLC, and the New Mexico Environment Department

Date	**Description**
10/9/2015	Amigos Bravos, the U.S. Department of Energy and Los Alamos National Security LLC (collectively "LANL"), and the New Mexico Environment Department ("NMED") enter into a Joint Stipulation Regarding Proposed Changes to 20.6.2.128 NMAC (**NMED Exhibit 72**).
11/30/2015	LANL transmits Level 1 Hydrology Protocol surveys, photographs, gage data and precipitation data from 2010-2014.
2/17/2016	LANL provides a site tour for Amigos Bravos of the west and east canyon sites.
6/27/2016	LANL sends a map of the plateau, surface water data from 2010-2013, 2007 Riparian Inventory, 2008-2009 Riparian Inventory, 2011 Riparian Inventory, and Stream Assessment documents for Segment 128 waters (photos, Level 1 Hydrology Protocol surveys and precipitation data).
7/7/2016	LANL leads a site tour for Amigos Bravos of Water Canyon, Pajarito Canyon, Three Mile Canyon, DP Canyon and Los Alamos Canyon.
7/19/2016	Amigos Bravos requests to expand the Hydrology Protocol surveys to include Assessment Units ("AUs") within Los Alamos Canyon.
11/17/2016	All parties participate in a Level 1 Hydrology Protocol survey in DP Canyon and upper Water Canyon.
2/14/2017	NMED requests a meeting with LANL and Amigos Bravos in March to go over quality assurance of Hydrology Protocol field survey documentation.
2/23/2017	All parties ("Green Ribbon committee") meet to review aerial imagery, 303(d) list, stream gage and precipitation data, and Hydrology Protocol surveys for Water Canyon and DP Canyon.
4/20/2017	NMED provides a tentative list of Hydrology Protocol needs based on the meeting on February 23, 2017.
5/25/2017	All parties participate in Level 1 Hydrology Protocol surveys of Ancho Canyon below the basalt plug and Ancho Canyon below Ancho Springs.
8/25/2017	NMED emails LANL and Amigos Bravos requesting availability for conducting Hydrology Protocol surveys in September and October 2017.
10/10/2017	NMED emails LANL and Amigos Bravos requesting availability for conducting Hydrology Protocol surveys.
10/16/2017	LANL emails NMED stating they are not available to conduct Hydrology Protocol surveys.
10/25/2017	Amigos Bravos requests an update from NMED regarding Fall 2017 field work.
10/26/2017	NMED emails LANL and Amigos Bravos postponing work due to scheduling conflicts. NMED requests picking up field work in May/June 2018.
2/15/2018	NMED requests quality assurance review of existing work and plan for spring-summer 2018.

3/5/2018	LANL emails NMED agreeing to conduct a quality assurance review and requests to develop an agreed-upon process for determining appropriate designated uses for Ancho Canyon, Water Canyon and DP Canyon. LANL also states they are unable to commit to 2018 field work due to their existing workload.
3/5/2018	LANL emails NMED requesting a discussion on the proposed path forward and declining to participate or support any field work until this is finalized.
3/13/2018	NMED and Amigos Bravos discuss potential field work for 2018.
4/16/2018	NMED emails LANL and Amigos Bravos postponing HP field work due to exceptional drought.
6/12/2018	All parties meet to review the HP surveys for quality assurance.
6/26/2018	Amigos Bravos emails NMED and LANL announcing their availability for field work for Fall 2018.
6/27/2018	LANL emails NMED denying the potential for conducting field work due to new management.
6/28/2018	NMED emails LANL requesting dates when field work can recommence.
6/29/2018	LANL emails NMED requesting to revisit the topic of field work in January 2019.
7/12/2018	NMED emails LANL concurring with LANL's proposal to postpone field work for Fall 2018 and coordinating in early 2019.
7/16/2018	LANL emails NMED and Amigos Bravos providing notification that LANL would not commit to field work in 2018 due to new management and other priority work.
2/27/2019	NMED emails Amigos Bravos and LANL requesting availability for conducting field work between late May and mid-July 2019.
2/27/2019	Amigos Bravos responds to NMED and LANL providing their availability for field work in 2019.
3/15/2019	NMED emails LANL and Amigos Bravos asking for availability to conduct field work in June 2019.
4/12/2019	NMED emails LANL and Amigos Bravos following up on availability for field work.
5/1/2019	LANL meets with NMED. LANL asserts that their obligations under the Joint Stipulation have been fulfilled.
6/3/2019	NMED sends a letter to LANL and Amigos Bravos requesting clarification in writing regarding progress on actions in the Joint Stipulation and collaboration to complete field work in 2019.
6/18/2019	LANL sends letter to NMED and Amigos Bravos notifying the parties that LANL will conduct the field work independently. LANL presents the option for adopting a new section for intermittent waters in LANL and removal of the combined ephemeral/intermittent section.
7/19/2019	NMED sends a response to LANL and Amigos Bravos requesting participation and a tentative survey schedule for waterbodies that the Department will propose amendments regarding.
8/8/2019	NMED participates in Level 1 Hydrology Protocol surveys with LANL in Arroyo de la Delfe and Pajarito Canyon.
8/9/2019	NMED participates in Level 1 Hydrology Protocol surveys with LANL in Ancho Canyon and Los Alamos Canyon.
8/15/2019	LANL emails NMED requesting an extension of field work into spring/summer 2020.

8/16/2019	NMED emails LANL declining the extension of field work to 2020 due to deadlines for the Triennial Review.
8/16/2019	NMED participates in Level 1 Hydrology Protocol surveys with LANL in Arroyo de la Delfe and Pajarito Canyon.
8/20/2019	LANL emails NMED requesting the status of the draft Existing Use Analysis ("EUA") work plan.
8/20/2019	NMED emails LANL and responds that the draft EUA work plan is undergoing internal review.
8/23/2019	NMED participates in Level 1 Hydrology Protocol surveys with LANL in Canon de Valle and Water Canyon.
8/29/2019	NMED participates in Level 1 Hydrology Protocol surveys with LANL in Canon de Valle, Fish Ladder Canyon and S-Site Canyon/Martin Spring.
8/30/2019	NMED participates in Level 1 Hydrology Protocol surveys with LANL in Fence Canyon and Portrillo Canyon.
9/5/2019	NMED participates in Level 1 Hydrology Protocol surveys with LANL in Effluent Canyon, Mortandad Canyon and Ten Site Canyon.
9/12/2019	NMED participates in Level 1 Hydrology Protocol surveys with LANL in Twomile Canyon.
9/13/2019	NMED participates in Level 1 Hydrology Protocol surveys with LANL in Ancho Canyon above N. Fork Ancho Canyon.
10/3/2019	NMED participates in Level 1 Hydrology Protocol surveys with LANL in DP Canyon and Los Alamos Canyon.
10/8/2019	NMED emails LANL requesting the schedule for Hydrology Protocol work for October 10 and 11, 2019.
10/9/2019	LANL emails NMED stating field work is postponed for the week.
10/17/2019	NMED participates in Level 1 Hydrology Protocol surveys with LANL in Fence Canyon, Los Alamos Canyon, S-Site Canyon and Water Canyon.
10/30/2019	LANL emails NMED requesting a timeline for the Triennial Review so LANL could write a task order to conduct additional Segment 128 water HP work for the next Triennial Review
10/30/2019	NMED emails LANL in response asking if LANL would like to be on the stakeholder list. NMED provides the process for conducting a UAA based on HPs and informs LANL that there is not restriction for a petition outside the Triennial Review. NMED advises LANL to consult with NMED on the proposed work.
11/18/2019	NMED emails Amigos Bravos providing an update of the 2019 field work NMED conducted with LANL. NMED also notifies Amigos Bravos that NMED plans to schedule a meeting in January 2020 to discuss findings and preparation of a demonstration.
1/30/2020	LANL emails NMED providing Level 1 Hydrology Protocol surveys from 2019.
2/20/2020	LANL transmits a map with Hydrology Protocol locations to NMED.
2/27/2020	NMED sends a meeting invite for March 17, 2020, to Amigos Bravos and LANL to collaboratively go over the data and results and discuss the next steps necessary to determine the appropriate levels of water quality protections.

3/9/2020	NMED emails Amigos Bravos and LANL notifying parties the meeting scheduled for March 17th needs to be rescheduled due to scheduling conflicts and technology needs.
3/10/2020	LANL emails NMED rescheduling the meeting to April 8, 2020.
3/12/2020	NMED emails LANL and Amigos Bravos postponing the meeting due to the Statewide Health Emergency.
3/31/2020	NMED emails LANL requesting access to the HP survey map through teleconferencing.
4/8/2020	LANL emails NMED providing Level 2 Hydrology Protocol surveys.
4/8/2020	Regular check-in meeting between NMED and LANL on various standards actions. Discussion on the progress for work associated with the Joint Stipulation focuses on scheduling a meeting with Amigos Bravos to discuss 2019 field season surveys.
5/6/2020	Regular check-in meeting between NMED and LANL on various standards actions. Discussion focuses on the progress for work associated with the Joint Stipulation and the development of a demonstration work plan, including data required, to support NMED's petition to amend a designated use at the upcoming Triennial Review.
6/1/2020	LANL determines Level 1 Hydrology Protocol surveys warrant additional information for 12 sites.
7/8/2020	Regular check-in meeting between NMED and LANL on various standards actions. Discussion on the progress for work associated with the Joint Stipulation focuses on how NMED will discuss amendments with stakeholders. NMED recognizes there is no consensus yet, but based on the restrictive timelines for rulemaking, NMED hopes to achieve consensus, as required, after filing for the upcoming Triennial. NMED states it is developing a work plan to evaluate the available data and determine data useability a demonstration to support appropriate designated uses. NMED states it is unsure of what the end product will look like.
8/12/2020	Regular check-in meeting between NMED and LANL on various standards actions. Discussion on the progress for work associated with the Joint Stipulation focuses on the findings in the work plan currently undergoing internal review. NMED states that the primary source of evidence was the HP surveys but that there was also supplemental data that NMED was evaluating. LANL states that they were alright with the approach.
8/19/2020	NMED files Petition for Hearing with the WQCC with proposed revisions with potential amendments to LANL waters, in accordance with the 2015 Joint Stipulation.
9/9/2020	Regular check-in meeting between NMED and LANL on various standards actions. Discussion focuses on what data needed for the demonstration and how NMED will pursue the proposed amendments. NMED says it will likely base the demonstration on existing use, which would be appropriate pursuant to 40 CFR 131.10(i). LANL concurs that we should move forward on this approach and try to work out a plan for other waters that do not have sufficient evidence to bring forward at this time.
9/18/2020	NMED coordinates discussion with LANL and Amigos Bravos regarding results of surveys and the process to come up with consensus for the amendments.
9/18/2020	NMED coordinates a meeting to discuss progress and next steps to fulfilling obligations under the Joint Stipulation and potential designated use amendments.

	NMED notifies LANL and Amigos Bravos of the work plan to evaluate designated uses for waters within LANL.
9/18/2020	Amigos Bravos emails NMED and LANL with a response of availability for a discussion.
9/24/2020	NMED emails LANL and Amigos Bravos scheduling a discussion for October 15, 2020.
9/24/2020	LANL emails NMED requesting other individuals, including legal counsel be included on the list of invitees.
10/7/2020	NMED emails Amigos Bravos requesting availability in the event the meeting needs to be rescheduled.
10/7/2020	Amigos Bravos emails NMED and responds with availability for discussion.
10/7/2020	Regular check-in meeting between NMED and LANL on various standards actions. Discussion on the progress for work associated with the Joint Stipulation focused on scheduling a discussion on the draft EUA work plan.
10/12/2020	LANL emails NMED and requests rescheduling of the discussion.
10/13/2020	NMED sends an email to LANL and Amigos Bravos requesting availability to reschedule the meeting.
10/15/2020	NMED schedules a meeting for October 28, 2020, to discuss how waters that have consensus can be petitioned for amendment.
10/15/2020	LANL emails NMED requesting the draft EUA work plan by the next business day.
10/15/2020	NMED emails LANL stating that the draft EUA work plan is not ready, but NMED would send it before the scheduled discussion.
10/27/2020	NMED emails the draft EUA work plan to LANL and Amigos Bravos.
10/27/2020	LANL emails NMED and Amigos Bravos requesting to reschedule the discussion.
10/27/2020	NMED offers to reschedule the discussion based on the short time to review the EUA.
10/27/2020	LANL requests that NMED reschedule the meeting.
10/27/2020	NMED requests the availability of parties to reschedule the discussion.
10/30/2020	NMED provides an additional date for rescheduling, based on LANL's unavailability.
11/6/2020	NMED reschedules the meeting for November 19, 2020.
11/19/2020	All parties meet to discuss draft EUA work plan and the path forward.
11/19/2020	LANL provides NMED with comments on the draft EUA work plan.
11/19/2020	NMED emails LANL and Amigos Bravos to schedule a follow up discussion and requests comments on the EUA work plan by December 4, 2020.
11/19/2020	Amigos Bravos calls NMED to discuss a question regarding the EUA work plan. NMED also notifies Amigos Bravos of an extension to the public comment period for the Triennial Review.
11/23/2020	LANL calls NMED requesting more time to review the work plan and consider potential agreement. LANL feels that there are additional waters to consider where NMED did not participate in HP surveys. LANL also requests that NMED copy LANL on any data provided to Amigos Bravos. LANL confirms they did not provide any of the data sets to Amigos Bravos. LANL is also uncertain how an existing use determination is related to the Joint Stipulation.

12/3/2020	Regular check-in meeting between NMED and LANL on various standards actions. Discussion on the progress for work associated with the Joint Stipulation focuses on the draft work plan and the need for LANL to provide their proposed designated uses and tributaries before the discussion scheduled for December 16, 2020. NMED explains that, although there may be consensus among the parties, NMED needs a demonstration to support a standards amendment. NMED explains that EUA is not something novel but is just the demonstration and data that support the amendment. NMED also explains that, although there may be more data available, the Department is the petitioner and the work plan discusses the data the Department can defend. NMED states that if other data are available and LANL wishes to defend it, the Department supports LANL presenting the information at the Triennial Review.
12/7/2020	Amigos Bravos provides comments to NMED on draft EUA work plan.
12/8/2020	NMED emails Amigos Bravos requesting a determination on appropriate designated uses for each of the waterbodies.
12/8/2020	Amigos Bravos called NMED to discuss the EUA and potential support for NMED's approach.
12/9/2020	NMED emails LANL requesting comments and designated uses for next week's meeting with time for everyone to review.
12/9/2020	LANL emails NMED with a response stating they will provide comments in next few days.
12/10/2020	Amigos Bravos emails NMED with a response supporting the designated uses for LANL waters as proposed.
12/14/2020	LANL emails NMED with comments on draft EUA work plan. LANL does not copy Amigos Bravos on the correspondence.
12/15/2020	Amigos Bravos emails NMED clarifying that in accordance with EPA, establishing an existing use needs to either demonstrate the use is supported or water quality for the use is supported, but not both.
12/15/2020	LANL emails NMED with the areas of potential agreement.
12/15/2020	LANL called NMED to discuss logistics and the areas LANL is prepared to discuss at the December 16, 2020, meeting.
12/16/2020	All parties meet to discuss the technical aspects of the draft EUA work plan and path forward.
12/17/2020	Amigos Bravos emails NMED stating they are not in full agreement that Twomile Canyon is intermittent, given one of the surveys demonstrated perennial hydrology.
1/6/2021	LANL provides NMED comments on the Triennial Review Petition as distributed to the public on November 1, 2020.
1/6/2021	Amigos Bravos provides NMED with comments on the Triennial Review petition as distributed to the public on November 1, 2020.
1/11/2021	NMED requests the map and legend presented by LANL at the December 16, 2020, meeting and LANL's delineations of waters they support.
1/12/2021	LANL notifies NMED via email that there is a delay in getting information transmitted to NMED.

1/13/2021	LANL provides a map of potentially agreed-upon tributaries based on the discussion from December 16, 2020.
1/13/2021	Regular check-in meeting between NMED and LANL on various standards actions. Discussion on the progress for work associated with the Joint Stipulation focuses on several topics. LANL provides NMED with the map used at the December 16, 2020, meeting. NMED asks for revisions to include references to landmarks such as canyons or roads. NMED states it has received and is working through the comments on the draft EUA work plan, as provided by LANL and Amigos Bravos, and will be amending the work plan, as appropriate. NMED notes that although there are other standards needs for LANL waters, NMED is focusing on completing the obligations under the Joint Stipulation first. NMED explains that 20.6.4.128 NMAC does not describe the unclassified perennial waters identified during the HP surveys. NMED also requests a revised map depicting reference points and an index.
2/8/2021	LANL provides NMED with a revised map, based on the conversation on January 13, 2021.
2/10/2021	NMED notifies LANL in a meeting that NMED will limit the petition for amendments to 20.6.4.140 NMAC based on consensus attained between the parties in December 2020.
2/10/2021	Regular check-in meeting between NMED and LANL on various standards actions. Discussion on the progress for work associated with the Joint Stipulation focuses on several topics. NMED notifies LANL that the EUA work plan was still in draft. Based on the very restrictive timelines associated with the Triennial Review, NMED will develop the EUA without further input from the parties. NMED drafted the work plan to facilitate the discussion and move towards the development of the demonstration. NMED notifies LANL that the focus is limited in scope to only those waters that all three parties came to consensus on in December 2020, but agrees there is still work needed on other tributaries within LANL. LANL does not concur that the unclassified perennials are protected under 20.6.4.99 NMAC but are considered classified in 20.6.4.128 NMAC and wanted these perennial waters to be amended to have designated uses equivalent to other perennial waters in LANL, in 20.6.4.126 NMAC. NMED notes that due to resources and time constraints under the 2015 Joint Stipulation, NMED placed its focus on amending the agreed-upon non-perennial tributaries. NMED discusses a plan to analyze the other waters within LANL in a phased approach to ensure the appropriate designated uses.
2/19/2021	NMED emails LANL and Amigos Bravos providing the amended language to NMAC defining the scope of proposed amendments. NMED also requests concurrence from the parties to proceed with the demonstration, as prescribed in the 2015 Joint Stipulation.
2/19/2021	Amigos Bravos emails NMED stating they are not in support of replacement of prior language with one with such a limited scope.
2/22/2021	NMED emails Amigos Bravos in response, clarifying that although this action is limited due to the Joint Stipulation, it is the opinion of the Department that additional analyses are warranted for other waters (perennial and non-perennial).
2/24/2021	Amigos Bravos schedules a discussion regarding the limited proposed amendment.
3/1/2021	LANL emails NMED requesting an extension to respond.

3/1/2021	NMED emails LANL, granting their requested extension to respond.
3/1/2021	NMED meets with Amigos Bravos and clarifies that the proposed waters are limited to those to which all the parties concur and expains why this is different from the original proposal. Amigos Bravos expresses support for the initially proposed language to classify all non-perennial waters with designated uses with more stringent criteria. NMED reiterates that the limited scope of work for this demonstration is not indicative of NMED's opinion and that additional analysis is warranted to determine the appropriate designated uses for other LANL waters. NMED presented a plan for addressing other waters within LANL that still warrant analysis.
3/3/2021	Amigos Bravos sends an email to NMED and LANL concurring with the designated uses for Effluent Canyon, Upper S-Site Canyon and portions of Twomile Canyon, but clarifies that there is need for more determinations for LANL waters.
3/3/2021	Amigos Bravos requests clarification on how NMED determines unclassified perennial waters.
3/3/2021	LANL sends a written response to NMED's draft language for amendments to 20.6.4.126, 20.6.4.128 and 20.6.4.140 NMAC.
3/12/2021	NMED files an amended petition with the WQCC reflecting the consensus reached by the parties for LANL waters pursuant to the 2015 Joint Stipulation.
4/14/2021	Regular check-in meeting between NMED and LANL on various standards actions. Discussion on the progress for work associated with the Joint Stipulation focuses on several topics. NMED notifies LANL that a draft the EUA is undergoing internal review but that it may or may not be completed prior to the filing date for the Triennial Review. NMED advised it is prepared to distribute to the parties if it could complete the document prior to filing. NMED clarified it restricted the EUA to the three reaches agreed upon by the parties and that the aquatic life use was found to be at least marginal warmwater and the recreational was at least secondary contact.
5/3/2021	NMED filed their Notice of Intent to Present Technical Testimony ("NOI") for WQCC 20-51R with amended language to 20.6.4 NMAC.
5/12/2021	Regular check-in meeting between NMED and LANL on various standards actions. Discussion on the progress for work associated with the Joint Stipulation focused on NMED's update regarding the completion of the EUA filed with the Commission.
6/9/2021	NMED met with LANL, per their request, to discuss potential areas of agreement for proposed amendments regarding LANL waters.

From:	Gallegos, Robert M
To:	Lemon, Shelly, NMENV; Barrios, Kristopher, NMENV; Fullam, Jennifer, NMENV
Cc:	Armijo, Karen (CONTR) (Karen.Armijo@nnsa.doe.gov); Saladen, Michael Thomas; Iacona, Brian M
Subject:	[EXT] EPC-DO-20-031 Transmittal of Hydrology Protocol Documents and Supporting Information
Date:	Thursday, January 30, 2020 3:54:00 PM
Attachments:	EPC-DO-20-031 Hydrology Protocol Documents and Supporting Information.pdf

All,
Please see enclosed. The attachments will follow from LANLs Transfer File System. Please let me know if you have any problems downloading the information. The transfer will come in two separate transmissions.

Thank you,
rg

Robert Gallegos (rgallegos@lanl.gov)
Los Alamos National Laboratory
Post Office Box 1663 MS K490 - 87545
EPC–CP Water Quality – Permitting and Compliance
505.665.0450

Los Alamos NATIONAL LABORATORY EST.1943

Environmental Protection & Compliance Division
Compliance Programs Group
P.O. Box 1663, LANL MS K490
Los Alamos, New Mexico 87545
(505) 667-0666

National Nuclear Security Administration
Los Alamos Field Office
3747 West Jemez Road, A316
Los Alamos, New Mexico 87544
(505) 667-7314/Fax (505) 667-5948

Symbol: EPC-DO: 20-031
LA-UR: 20-20785
Date: JAN 30 2020

Ms. Shelly Lemon
Bureau Chief
Surface Water Quality Bureau
New Mexico Environment Department
P.O. Box 5469
Santa Fe, NM 87502

SUBJECT: Transmittal of Hydrology Protocol Documents and Supporting Information – Pursuant to Stipulated Agreement between U.S. Department of Energy (DOE-NNSA), Triad National Security, LLC (Triad), and Amigos Bravos

Dear Ms. Lemon:

Attached are documents generated from Hydrology Protocol (HPs) assessments conducted in Los Alamos National Laboratory (LANL) Segment 20.6.4.128 NMAC Waters during the summer and fall of 2019. The completion of the HPs advance the work elements identified in the October 9, 2015 Stipulated Agreement between NMED, DOE-NNSA, Amigos Bravos and Triad.

A total of 104 Level 1 HPs were completed in all Segment 128 Waters and within all the major watersheds at LANL. The following documents are attached:

1. Level 1 Hydrology Determination Field Sheets and photographs of each site.
2. Summary spreadsheet containing HP Level 1 individual attribute scores and total scores.
3. Map containing: Streams and classifications, HP sites, HP scores, springs, gages, alluvial wells and NPDES Outfalls.

Please contact Karen E. Armijo by telephone at (505) 665-7314 or by email at Karen.Armijo@nnsa.doe.gov, or Michael T. Saladen by telephone at (505) 665-6085 or by email at Saladen@lanl.gov if you have questions regarding this information.

Sincerely,

Taunia S. Van Valkenburg
Group Leader
Compliance Programs
Triad National Security, LLC

Sincerely,

Karen E. Armijo
Permitting and Compliance Program Manager
National Nuclear Security Administration
U.S. Department of Energy

TVV/KEA/MTS/RMG/BMI:jdm

Attachment(s): Attachment 1 Level 1 Hydrology Determination Field Sheets and Site Photographs
Attachment 2 Summary Spreadsheet Containing HP Level 1 Individual Attribute Scores
Attachment 3 Map Containing: Streams and Classifications, HP Sites and HP Scores

Copy: Jennifer Fullam, NMED/SWQB, Jennifer.Fullam@state.nm.us
Kristopher Barrios, NMED/SWQB, Kristopher.Barrios@state.nm.us
Peter Maggiore, LASO-MA, peter.maggiore@nnsa.doe.gov
Michael W. Hazen, ALDESHQSS, mhazen@lanl.gov
William R. Mairson, ALDESHQSS, wrmairson@lanl.gov
Enrique Torres, EWP, etorres@lanl.gov
Jennifer E. Payne, EPC-DO, jpayne@lanl.gov
Taunia S. Van Valkenburg, EPC-DO, tauniav@lanl.gov
Michael T. Saladen, EPC-CP, saladen@lanl.gov
Robert M. Gallegos, EPC-CP, rgallegos@lanl.gov
Brian M. Iacona, EPC-CP, biacona@lanl.gov
Adesh-records@lanl.gov
epccorrespondence@lanl.gov
epccat@lanl.gov

From:	Gallegos, Robert M
To:	Lemon, Shelly, NMENV; Barrios, Kristopher, NMENV; Fullam, Jennifer, NMENV
Cc:	Saladen, Michael Thomas; Martinez, Joline Denys; Armijo, Karen (CONTR) (Karen.Armijo@nnsa.doe.gov); Iacona, Brian M; Lemke, Terrill
Subject:	[EXT] EPC-DO-20-113 Hydrology Protocol Documents - Stipulated Agreement
Date:	Wednesday, April 8, 2020 1:22:28 PM
Attachments:	EPC-DO-20-113 Hydrology Protocol Documents - Stipulated Agreement April 2020 (1).pdf

Shelly,

Attached is the transmittal letter for the final distribution of Hydrology Protocol documents (EPC-DO-20-113) to NMED.

The following documents will be placed on LANL's File Transfer Site. Shortly you will receive an email message indicating their availability.

- Level 2 Field Sheets and Photographs – 30 Sites
- Macroinvertebrate Metrics from Level 2 Sites – 14 Sites
- Surface Flow Hydrographs w/index
- Alluvial Well Hydrographs w/index

The transfer will come in three separate transmissions.

Please let me know if you have trouble accessing the documents or have any questions.

Thanks,
rg

Robert Gallegos (rgallegos@lanl.gov)
Los Alamos National Laboratory
Post Office Box 1663 MS K490 - 87545
EPC–CP Water Quality – Permitting and Compliance
505.665.0450

Los Alamos
NATIONAL LABORATORY
EST.1943

Environmental Protection & Compliance Division
Los Alamos National Laboratory
PO Box 1663, K490
Los Alamos, NM 87545
505-667-0666

Symbol: EPC-DO: 20-113
LAUR: 20-22724
Date: APR 08 2020

Ms. Shelly Lemon
Bureau Chief
Surface Water Quality Bureau
New Mexico Environment Department
P.O. Box 5469
Santa Fe, NM 87502

SUBJECT: Level 2 Hydrology Protocol Documents and Supporting Information

Dear Ms. Lemon:

The attached Level 2 Hydrology Protocol (HP) documents represent the second installment from the summer-fall 2019 field work in Segment 20.6.4 128 NMAC waters at Los Alamos National Laboratory. On January 30, 2020 Triad/DOE-NNSA submitted the first installment.

The following HP documents and supplemental information are attached:

- Level 2 Field Sheets and Photographs – 30 Sites
- Macroinvertebrate Metrics from Level 2 Sites – 14 Sites
- Surface Flow Hydrographs
- Alluvial Well Hydrographs

The completion of the HPs advance the work elements identified in the October 9, 2015 Stipulated Agreement between NMED, DOE-NNSA, Amigos Bravos and Triad.

Please contact Robert Gallegos at (505) 665-0450 or by email at rgallegos@lanl.gov if you have questions regarding this information.

Sincerely,

Taunia S. Van Valkenburg
Group Leader
Compliance Programs
Triad National Security, LLC

TVV/MTS/RMG:jdm

Attachment(s): Attachment 1 Level 2 Hydrology Determination Field Sheets and Site Photographs
Attachment 2 Surface Gage Hydrographs
Attachment 3 Alluvial Well Hydrographs
Attachment 4 Macroinvertebrate Metric Information

Copy: Jennifer Fullam, NMED/SWQB, Jennifer.Fullam@state.nm.us
Kristopher Barrios, NMED/SWQB, Kristopher.Barrios@state.nm.us
Karen E. Armijo, LASO-MA-LS, karen.armijo@nnsa.doe.gov
Michael W. Hazen, Triad, ALDESHQSS, mhazen@lanl.gov
William R. Mairson, Traid, ALDESHQSS, wrmairson@lanl.gov
Enrique Torres, Triad, EWP, etorres@lanl.gov
Jennifer E. Payne, Triad, EPC-DO, jpayne@lanl.gov
Taunia S. Van Valkenburg, Triad, EPC-CP, tauniav@lanl.gov
Michael T. Saladen, Triad, EPC-CP, saladen@lanl.gov
Robert M. Gallegos, Triad, EPC-CP, rgallegos@lanl.gov
Adesh-records@lanl.gov
epccorrespondence@lanl.gov
epccat@lanl.gov

[~~shall not exceed~~] 20°C (68°F) or less [~~, and turbidity shall not exceed l0 NTU~~]. The use-specific numeric [~~standards~~] criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) [~~The monthly geometric mean of fecal coliform bacteria shall not exceed 100/100 mL; no single sample shall exceed 200/100 mL~~] The monthly geometric mean of E. coli bacteria 126/100 mL or less; single sample 235/100 mL or less (see Subsection B of 20.6.4.13 NMAC).

20.6.4.121a RIO GRANDE BASIN –Perennial Portions of Cañon deValle from Los Alamos National Laboratory (LANL) stream gage E256 upstream to Burning Ground spring, Sandia canyon from Sigma canyon upstream to LANL NPDES outfall 001, Pajarito canyon from Arroyo de La Delfe upstream into Starmers gulch and Starmers spring, and Water canyon from Area-A canyon upstream to State Route 501.

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

B. Criteria:

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

(2) The monthly geometric mean of E. coli bacteria 2507/100 mL or less; single sample 2507/100 mL or less (see Subsection B of 20.6.4.13 NMAC).

NMED proposes to add a new segment to classify waters based upon an intensive study by the U.S. Fish and Wildlife Service. Exhibit 23. As previously discussed aquatic life, wildlife habitat and recreation (primary or secondary contact) are CWA Section 101(a)(2) goal uses that must be included in water quality standards unless a use attainability analysis supports not including them. As proposed by NMED, the coldwater aquatic life use is appropriate because it is consistent with the aquatic life use in adjacent Segment 121, which includes tributaries of the Rio Grande in Bandelier National Monument (where high quality coldwater is a designated use), and is supported by the conclusions of the U.S. Fish and Wildlife Service report. Livestock watering is also an appropriate use because it has historically been presumed to be a use for all unclassified surface waters of the state. Although a proposal from LANL does not include livestock watering as a designated use, publications of LANL acknowledge the presence of livestock on or adjacent to the LANL property including horseback riding (Exhibit 37a at page 16), cattle grazing in lower Los Alamos Canyon (Exhibit 37a at page 18), free-range chickens and dairy goats at the Los Alamos townsite and Pueblo of San Ildefonso (Exhibit 37b at page 225), and cattle grazing at the boundaries of LANL on the Pueblo of San Ildefonso (Exhibit 37b at page 228). NMED proposes inclusion of livestock watering as a designated use based upon the apparent existing use of livestock watering as defined under the CWA, and for protection of downstream livestock watering uses. Secondary contact use is proposed because full-body contact in these small streams is unlikely and if it does occur the proposed criteria offer a level of protection for that infrequent use. The proposed criteria are the criteria generally associated with the proposed uses.

Other petitioners' proposals:

LANL proposes:

<u>20.6.4.121a RIO GRANDE BASIN – Perennial portions of Cañon de Valle from Los Alamos National Laboratory (LANL) stream gage E256 upstream to Burning Ground Spring, Sandia Canyon from Sigma Canyon upstream to LANL NPDES Outfall 001, Pajarito Canyon from Arroyo de La Delfe upstream into Starmers Gulch and Starmers Spring, and Water Canyon from Area-A Canyon upstream to State Route 501.</u>

*<u>**A. Designated Uses:** limited aquatic life, wildlife habitat, and secondary contact.</u>*

*<u>**B. Criteria**:</u>*

*<u>**(1)** The use-specific numeric criteria set forth in 20.6.4.900.G2, 20.6.4.900.L, and 20.6.4.900.L2 NMAC and the acute and chronic criteria for aquatic life in 20.6.4.900.J and 20.6.4.900.M NMAC are applicable to the designated uses listed above in Subsection A of this section. The total ammonia criteria set forth in sections 20.6.4.900.N (Salmonids Absent) and 20.6.4.900.O2 NMAC are applicable to this use.</u>*

*<u>**(2)** The monthly geometric mean of E. coli bacteria 548/100 mL or less; single sample 2507/100 mL or less (see Subsection B of 20.6.4.13 NMAC).</u>*

<u>(3) For Pajarito Canyon, Starmers Gulch, and Water Canyon: pH within the range of 6.6 to 8.8, temperature 22˚ C (71.6˚ F) or less, dissolved oxygen 5 mg/L or more.</u>

<u>(4) For Canon de Valle and Sandia Canyon: pH within the range of 6.6 to 9.0, temperature 30˚ C (86˚ F) or less, dissolved oxygen 4 mg/L or more, 24-hour average dissolved oxygen 5 mg/L or more.</u>

NMED appreciates LANL's concern that classification of all the surface waters of the state on the laboratory property would eliminate questions regarding the uses and criteria that apply to those waters. The uses and criteria proposed by LANL for site-specific application depart from the norms for other waters in the state. Although NMED supports adoption of site-specific uses and criteria when warranted, data supporting these should be substantial and clearly demonstrate a unique situation warranting segment-specific criteria that address attainable as well as existing uses as those terms are defined for purposes of the CWA and the standards.

<u>20.6.4.121b RIO GRANDE BASIN – Perennial portions of Los Alamos Canyon upstream from Los Alamos Reservoir and Los Alamos Reservoir.</u>

*<u>**A. Designated Uses**: coldwater aquatic life, livestock watering, wildlife habitat, irrigation, secondary contact, and primary contact.</u>*

*<u>**B. Criteria**:</u>*

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

*<u>**(2)** The monthly geometric mean of E. coli bacteria 126/100 mL or less; single sample 410/100 mL or less (see Subsection B of 20.6.4.13 NMAC).</u>*

NMED proposes a new segment to classify waters based upon a study by the U.S. Fish and Wildlife Service. Exhibit 23. As previously discussed aquatic life, wildlife habitat and recreation (primary or secondary contact) are CWA Section 101(a)(2) goal uses that must be included in *water quality standards unless a use attainability analysis supports not including them. As proposed by NMED, the coldwater aquatic life use is appropriate because it is consistent with the aquatic life use in adjacent Segment 121, which includes tributaries of the Rio Grande in Bandelier National Monument (where high quality coldwater is a designated use), and is supported by the conclusions of the U.S. Fish and Wildlife Service report. Livestock watering is also an appropriate use because it has historically been presumed to be a use for all unclassified surface waters of the state. Primary contact use is proposed because swimming at Los Alamos Reservoir is noted as an existing use. The proposed criteria are the criteria generally associated with the proposed uses.*

Other petitioners' proposals:

LANL proposal is substantially similar but retains the "fishery" use. NMED proposes to use "aquatic life" instead of "fishery", and there is no reason to differ in this segment.

20.6.4.121c RIO GRANDE BASIN – Ephemeral and intermittent portions of water courses within lands managed by US Department of Energy (DOE) within Los Alamos National Laboratory, including but not limited to, Mortandad Canyon, Cañon del Buey, Ancho Canyon, Chaquehui Canyon, Indio Canyon, Fence Canyon, Potrillo Canyon, and portions of Cañon de Valle, Los Alamos Canyon, Sandia Canyon, Pajarito Canyon, and Water Canyon not specifically identified in 20.6.4.121a. (Surface waters within lands scheduled for transfer from DOE to tribal, state or local authorities are specifically excluded.

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

B. Criteria:

(1) The use-specific criteria in 20.6.4.900 NMAC, except the chronic criteria for aquatic life are applicable for the designated uses listed in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 548/100 mL or less; single sample 2507/100 mL or less (see Subsection B of 20.6.4.13 NMAC).:

NMED proposes a new segment to classify waters based on a study by the U.S. Fish and Wildlife Service. Exhibit 23. The segment is identical to LANL's original proposal. Criteria and uses proposed are those included in the proposal for all other ephemeral and intermittent surface waters in Section 20.6.4.98. Livestock watering is an appropriate use because it has historically been presumed to be a use for all surface waters of the state. See also the discussion accompanying NMED's proposal for Section 20.6.4.121a.

Other petitioners' proposals:

LANL proposes substantially similar language except that LANL does not proposed to include livestock watering as a designated use, and has amended its proposal to add "The acute total ammonia criteria set forth in section 20.6.4.900.N (Salmonids Absent) are applicable to this use" to Paragraph B(1). NMED appreciates LANL's concern that classification of all the surface waters of the state on the laboratory property would eliminate questions regarding the *uses and criteria that apply to those waters. Although NMED supports adoption of site-specific uses and criteria when warranted, data supporting these should be substantial and clearly demonstrate a unique situation warranting segment-specific criteria that address attainable as well as existing uses as those terms are defined for purposes of the CWA and the standards.*

20.6.4.122 RIO GRANDE BASIN - The main stem of the Rio Grande from [~~Taos Junction bridge~~] Rio Pueblo de Taos upstream to the New Mexico-Colorado line, the Red river from its mouth on the Rio Grande upstream to the mouth of Placer creek, and the Rio Pueblo de Taos from its mouth on the Rio Grande upstream to the mouth of the Rio Grande del Rancho.

A. Designated Uses: coldwater [~~fishery~~] aquatic life, fish culture, irrigation, livestock watering, wildlife habitat, and primary contact.

B. [~~Standards~~]Criteria:

(1) In any single sample: pH [~~shall be~~] within the range of 6.6 to 8.8, and temperature [~~shall not exceed~~] 20°C (68°F) or less [~~, and turbidity shall not exceed 50 NTU~~]. The use-specific numeric [~~standards~~] criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

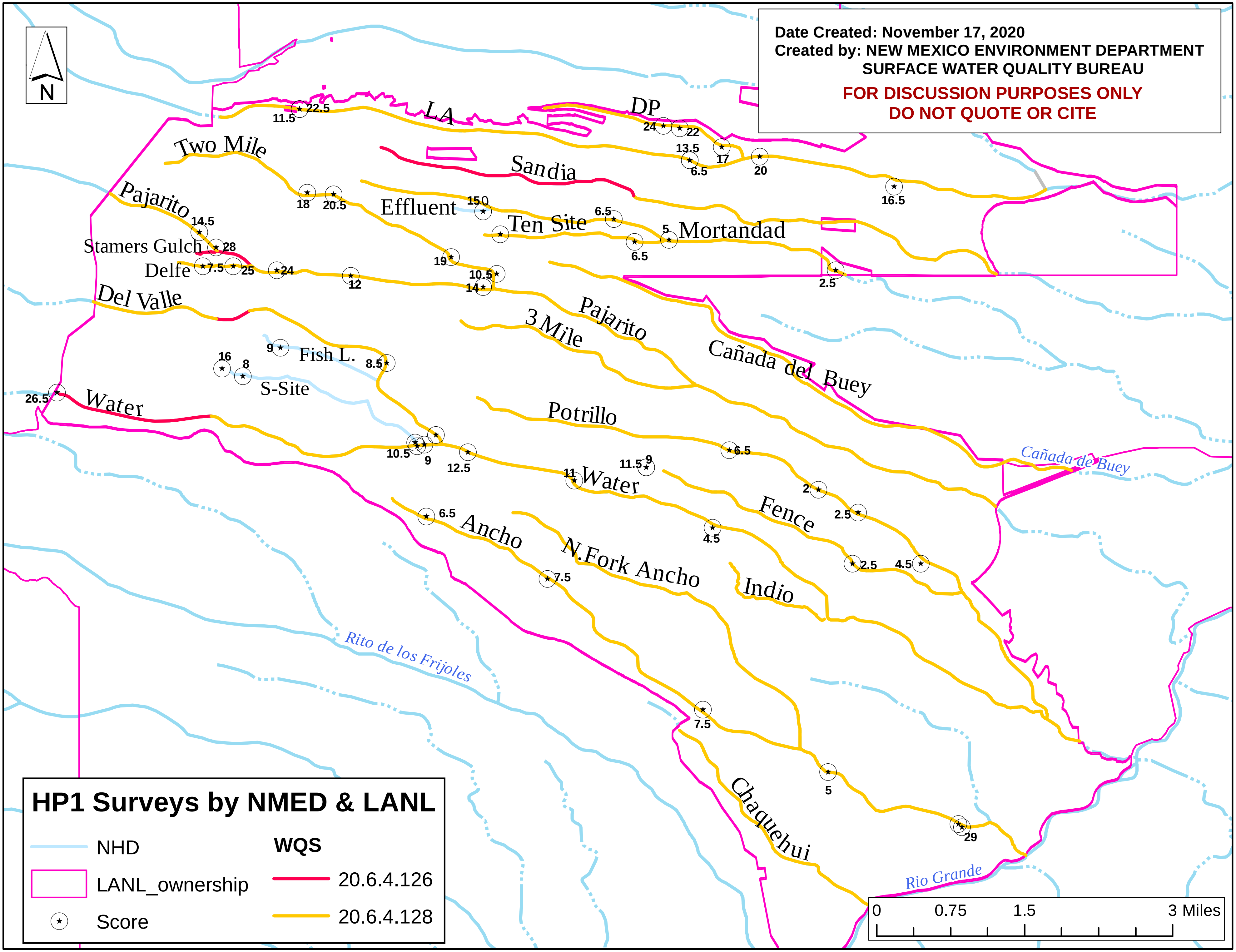
(2) [~~The monthly geometric mean of fecal coliform bacteria shall not exceed 100/100 mL; no single sample shall exceed 200/100 mL~~] The monthly geometric mean of E. coli bacteria 126/100 mL or less; single sample 235/100 mL or less (see Subsection B of 20.6.4.13 NMAC).

NMED proposes to change "Rio Pueblo de Taos" to "Taos Junction bridge" to use a hydrologic rather than a cultural feature. Exhibit 38h. Division points between segments that use cultural features were generally designated based upon convenience of identification rather than an actual change in stream conditions. The use of highway crossings, although convenient, can cause ambiguity when highways are rerouted or renumbered. The confluence of Rio Pueblo de Taos lies approximately a quarter mile upstream from the bridge, and is considered a de minimis change.

Other petitioners' proposals:

Amigos Bravos proposes a new segment for the Red River from the fish hatchery to the mouth of Placer Creek. The WQCC This reach move this reach from Segment 123 to Segment 122 during the 1990 Triennial Review. EPA approved the change. To the extent that Amigos Bravos challenges the WQCC or EPA's decision in 1990 because no UAA was performed at the time, those challenges are untimely. Moreover, the change was based on an intensive survey, which at the time probably would have been considered the functional equivalent of a UAA.

On the merits, NMED is concerned about several deficiencies in Amigos Bravos' proposal. First, Amigos Bravos omits the designated use of wildlife habitat. Presumably this omission is an oversight, but NMED cannot support a new segment that does not include this use. Second, Amigos Bravos proposes to designate the segment as "high quality coldwater aquatic life" but there is no evidence to suggest that aquatic uses in this segment differ from the directly adjoining Segment 122. Amigos Bravos does not propose any substantive change to the segment-specific criteria currently applicable to this reach. Moreover, the only criterion that would be added by



NMED Exhibit 130

3-101. STANDARDS[1] APPLICABLE TO ATTAINABLE OR DESIGNATED USES UNLESS OTHERWISE SPECIFIED IN PART 2.

A. Coldwater Fishery: Un-ionized ammonia (as N) shall not exceed 0.03 mg/l, dissolved oxygen shall be greater than 6.0 mg/l, temperature shall be less than 20 C (68 F), total chlorine residual shall not exceed 0.004 mg/l, and pH shall be within the range of 6.6 to 8.8. The acute and chronic standards set out in Section 3-101.J are applicable to this use.

B. Domestic Water Supply: Waters designated for use as domestic water supplies shall not contain substances in concentrations that create a lifetime cancer risk of more than one cancer per 100,000 exposed persons. The following numeric standards shall not be exceeded:

Dissolved arsenic	0.05 mg/l
Dissolved barium	1. mg/l
Dissolved cadmium	0.010 mg/l
Dissolved chromium	0.05 mg/l
Dissolved lead	0.05 mg/l
Total mercury	0.002 mg/l
Dissolved nitrate (as N)	10. mg/l
Dissolved selenium	0.05 mg/l
Dissolved silver	0.05 mg/l
Dissolved cyanide	0.2 mg/l
Dissolved uranium	5.0 mg/l
Radium-226 + radium-228	30.0 pCi/l

C. High Quality Coldwater Fishery: Dissolved oxygen shall be greater than 6.0 mg/l or 85% of saturation, whichever is greater; temperature shall be less than 20 C (68 F); pH shall be within the range of 6.6 to 8.8; un-ionized ammonia (as N) shall not exceed 0.02 mg/l; total chlorine residual shall not exceed 0.004 mg/l; total phosphorus (as P) shall be less than 0.1 mg/l;[2] total inorganic nitrogen (as N) shall be less than 1.0 mg/l;[2] total organic carbon shall be less than 7 mg/l; turbidity shall be less than 10 NTU (25 NTU in certain reaches where natural background prevents attainment of lower turbidity); and conductivity (at 25 C) shall be less than a limit varying between 300 umhos/cm and 1,500 umhos/cm depending on the natural background in particular stream reaches (the intent of this standard is to prevent excessive increases in dissolved solids which would result in changes in stream community structure). The acute and chronic standards set out in Section 3-101.J are applicable to this use.

D. Irrigation (or Irrigation Storage): The monthly logarithmic mean of fecal coliform bacteria shall not exceed 1,000/100 ml; no single sample shall exceed 2,000/100 ml. The following numeric standards shall not be exceeded:

Dissolved aluminum	5.0 mg/l
Dissolved arsenic	0.10 mg/l
Dissolved boron	0.75 mg/l
Dissolved cadmium	0.01 mg/l
Dissolved chromium	0.10 mg/l
Dissolved cobalt	0.05 mg/l
Dissolved copper	0.20 mg/l
Dissolved lead	5.0 mg/l
Dissolved selenium	0.13 mg/l
Dissolved selenium in presence of >500 mg/l SO4	0.25 mg/l
Dissolved vanadium	0.1 mg/l
Dissolved zinc	2.0 mg/l

E. Limited Warmwater Fishery: Standards are the same as for "Warmwater Fishery" except on a case by case basis, the dissolved oxygen may reach a minimum of 4.0 mg/l or maximum temperatures may exceed 32.2 C. The acute and chronic standards set out in Section 3-101.J are applicable to this use.

F. Marginal Coldwater Fishery: Standards are the same as for "Coldwater Fishery" except on a case by case basis, the dissolved oxygen may reach a minimum of 5.0 mg/l or maximum temperatures may exceed 25 C and the pH may range from 6.6 to 9.0. The acute and chronic standards set out in Section 3-101.J are applicable to this use.

G. Primary Contact Recreation: The monthly logarithmic mean of fecal coliform bacteria shall not exceed 200/100 ml, no single sample shall exceed 400/100 ml; the open water shall be free of algae in concentrations which cause nuisance conditions or gastrointestinal or skin disorders; pH shall be within the range of 6.6 to 8.8; and turbidity shall be less than 25 NTU.

H. Warmwater Fishery: Un-ionized ammonia (as N) shall not exceed 0.06 mg/l, dissolved oxygen shall be greater than 5 mg/l, temperature shall be less than 32.2 C (90 F), and pH shall be within the range of 6.0 to 9.0 and total chlorine residual shall not exceed 0.008 mg/l. The acute and chronic standards set out in Section 3-101.J are applicable to this use.

I. Fish culture and municipal and industrial water supply and storage are also designated in particular stream reaches where these uses are actually being realized. However, no numeric standards apply uniquely to these uses. Water quality adequate for these uses is ensured by the general standards and numeric standards for bacterial quality, pH, and temperature which are established for all stream reaches listed in Part 2 of the standards.

J. The following schedule of numeric standards and equations for the substances listed shall apply to the subcategories of fisheries identified in Section 3-101:

Chronic Criteria[3]

Dissolved aluminum	87.0	(10^{-3}) mg/l
Dissolved beryllium	5.3	(10^{-3}) mg/l
Total mercury	0.012	(10^{-3}) mg/l
Dissolved selenium	5.0	(10^{-3}) mg/l
Dissolved silver	0.12	(10^{-3}) mg/l
Total cyanide	5.2	(10^{-3}) mg/l
Total chlordane	0.0043	(10^{-3}) mg/l
Dissolved cadmium[5]	e(0.7852[ln(hardness)]-3.49)	(10^{-3}) mg/l
Dissolved chromium[6]	e(0.819[ln(hardness)+1.561)	(10^{-3}) mg/l
Dissolved copper	e(0.8545[ln(hardness)]-1.465)	(10^{-3}) mg/l
Dissolved lead	e(1.273[ln(hardness)]-4.705)	(10^{-3}) mg/l
Dissolved nickel	e(0.846[ln(hardness)]+1.1645)	(10^{-3}) mg/l
Dissolved zinc	e(0.8473[ln(hardness)]+0.7614)	(10^{-3}) mg/l

Acute Criteria[4]

Dissolved aluminum	750	(10^{-3}) mg/l
Dissolved beryllium	130	(10^{-3}) mg/l
Total mercury	2.4	(10^{-3}) mg/l
Dissolved selenium	20.0	(10^{-3}) mg/l
Dissolved silver	e(1.72[ln(hardness)]-6.52)	(10^{-3}) mg/l
Total cyanide	22.0	(10^{-3}) mg/l
Total chlordane	2.4	(10^{-3}) mg/l
Dissolved cadmium	e(1.128[ln(hardness)]-3.828)	(10^{-3}) mg/l
Dissolved chromium[6]	e(0.819[ln(hardness)+3.688)	(10^{-3}) mg/l
Dissolved copper	e(0.9422[ln(hardness)]-1.464)	(10^{-3}) mg/l
Dissolved lead	e(1.273[ln(hardness)]-1.46)	(10^{-3}) mg/l
Dissolved nickel	e(0.76[ln(hardness)]+4,02	(10^{-3}) mg/l
Dissolved zinc	e(0.8473[ln(hardness)]+0.8604)	(10^{-3}) mg/l

K. Livestock and Wildlife Watering: The following numeric standards shall not be exceeded:

Dissolved aluminum	5.0	mg/l
Dissolved arsenic	0.02	mg/l
Dissolved boron	5.0	mg/l
Dissolved cadmium	0.05	mg/l
Dissolved chromium[6]	1.0	mg/l
Dissolved cobalt	1.0	mg/l
Dissolved copper	0.5	mg/l
Dissolved lead	0.1	mg/l
Total mercury	0.01	mg/l
Dissolved selenium	0.05	mg/l
Dissolved vanadium	0.1	mg/l
Dissolved zinc	25.0	mg/l
Radium-226 + radium-228	30.0	pCi/l

[1]For waters with more than a single attainable or designated use the applicable criteria are those which will protect and sustain the most sensitive use.

[2]As the need arises, the State shall determine for specified stream segments or relevant portions thereof whether the limiting nutrient for the growth of aquatic plants is nitrogen or phosphorus. Upon such a determination the waters in question shall be exempt from the standard for the nutrient found to be not limiting. Until such a determination is made, standards for both nutrients shall apply. If co-limitation is found, the waters in question shall be exempt from the total inorganic nitrogen standard. The State shall make available a list of those waters for which the limiting nutrient has been determined.

[3]The chronic criteria shall be applied to the arithmetic mean of four samples collected on each of four consecutive days. Chronic criteria shall not be exceeded more than once every three years.

[4]The acute criteria shall be applied to any single grab sample. Acute criteria shall not be exceeded.

[5]For numeric standards dependent on hardness, hardness (as mg $CaCO_3/l$) shall be determined as needed from available verifiable data sources including, but not limited to, the U.S. Environmental Protection Agency's STORET water quality database.

[6]The criteria for chromium shall be applied to an analysis which measures both the trivalent and hexavalent ions.

FILED
04 APR 28 AM 8:52
COURT OF APPEALS
STATE OF NEW MEXICO
P.R. WALLACE, CLERK

IN THE COURT OF APPEALS OF THE STATE OF NEW MEXICO

Opinion Number______________

Filing Date: April 28, 2004

Docket No. 23,498

THE REGENTS OF THE UNIVERSITY OF CALIFORNIA,

Appellant,

vs.

NEW MEXICO WATER QUALITY CONTROL COMMISSION,

Appellee.

APPEAL FROM THE NEW MEXICO WATER QUALITY CONTROL COMMISSION
Peter Maggiore, Chairperson

Louis W. Rose
Jeff L. Martin
Montgomery & Andrews, P.A.
Santa Fe, NM

Deborah K. Woitte
N. Philip Wardwell
Office of Laboratory Counsel
Los Alamos National Laboratory
Los Alamos, NM

for Appellant

Patricia A. Madrid
Attorney General
Zachary Shandler
Assistant Attorney General
Eric Ames
Special Assistant Attorney General
Santa Fe, NM

for Appellee

OPINION

CASTILLO, Judge.

{1} This case requires us to determine whether the New Mexico Water Quality Control Commission (Commission) appropriately adopted a sentence in the water quality standards amended in May 2002. The sentence, contained in 20.6.4.10.G NMAC (2002), reads as follows: "The human health standards for persistent toxic pollutants, as identified in Subsection M of Section 20.6.4.900 NMAC, shall also apply to all tributaries of waters with a designated, existing or attainable fishery use." Subsection M sets forth numeric criteria for persistent toxic pollutants. The Regents of the University of California (Regents), on behalf of Los Alamos National Laboratory (LANL), challenge the Commission's adoption of the sentence as arbitrary, capricious, lacking substantial evidence, and being contrary to law. We affirm.

I. BACKGROUND

{2} Several interrelated provisions of state and federal law and regulations form the framework for regulating toxic pollutants in surface water. The federal Clean Water Act requires states to establish criteria for specified toxic pollutants, "the discharge or presence of which in the affected waters could reasonably be expected to interfere with those designated uses adopted by the State, as necessary to support such designated uses." 33 U.S.C. § 1313(c)(2)(B) (2000). The Clean Water Act further requires the United States Environmental Protection Agency (EPA) to impose its own criteria if a state's standards fail to comply with the act. 33 U.S.C. §

1313(c)(3). Pursuant to the Clean Water Act, EPA has published its own numeric criteria for priority toxic pollutants and other regulations to implement the act's statutory requirements.

{3} New Mexico's Water Quality Act, NMSA 1978, §§ 74-6-1 to -17 (1967, as amended through 2003) establishes the Commission as the "state water pollution control agency . . . for all purposes of the federal [Clean Water] act." Section 74-6-3(E). The Water Quality Act mandates that the Commission "take all action necessary and appropriate to secure to this state . . . the benefits of [the] act." Section 74-6-3(E). The Water Quality Act also authorizes the Commission to adopt surface water quality standards (standards), including water quality criteria to protect designated uses of surface waters. Section 74-6-4(C). The Commission has applied criteria as necessary to "secure to this state . . . the benefits of [the federal Clean Water Act]." One such benefit is that a state can adopt its own toxic pollutant criteria, rather than having the criteria imposed by the EPA.

{4} The Commission is administratively attached to the New Mexico Environment Department (Department). Section 74-6-3(F). The Department recommends for the Commission's approval those revisions to the state's water quality standards that are necessary to comply with state and federal law and regulations. On November 29, 2001, the Department's Surface Water Quality Bureau petitioned the Commission to adopt a series of amendments to certain sections of the standards. The amended standards were proposed in response to a warning issued by the EPA that the state would be out of compliance with 33 U.S.C. § 1313(c)(2)(B) of the Clean Water Act unless it adopted numeric criteria for priority toxic pollutants or demonstrated to the EPA's satisfaction that such criteria were not needed; failure of the state to do so would risk the EPA's imposing more stringent numeric criteria on New Mexico.

{5} The proposed amended standards included the second sentence of 20.6.4.10.G NMAC, which applied the human health standards for persistent toxic pollutants to all tributaries of waters with a designated, existing, or attainable fishery use. These persistent toxic pollutants include "some of the most . . . dangerous chemicals and heavy metals" known to exist, "including dioxins and toxaphene, DDT, PCBs, chlordane, benzopyrene, aldrin/dieldrin, hexacholorbenzene, and tetracholorethylene."

{6} In accord with proper procedure, the Commission scheduled a public hearing on the proposed amendments; the Department gave timely notice of the hearing through publication and direct notice to interested parties. Prior to the hearing, the Department met with a range of entities, including LANL, and solicited input on the amendments. The Department made certain modifications to the amendments as a result of the meetings. The hearing on the modified amendments was held on March 13 and 14, 2002; representatives of the Department, Regents, the San Juan Water Commission, the Forest Guardians, and a consultant with the Elephant Butte Irrigation District testified on various provisions and submitted written testimony. The New Mexico Mining Association, the United States Department of the Interior, the Pueblo of Isleta, and the New Mexico Municipal Environmental Quality Association submitted written testimony only.

{7} At the Commission's May 2002 meeting, after deliberation and discussion, the Commission unanimously adopted the amended standards with minor changes not relevant to this opinion. The Commission subsequently issued an order to that effect and a statement of reasons for adopting the amendments. Regents appealed the adoption of the second sentence of 20.6.4.10.G NMAC to this Court pursuant to the Water Quality Act. See Section 74-6-7(A) (stating that appeals from regulations adopted by the Commission are taken to this Court).

II. DISCUSSION

A. Standard of Review

{8} We are required to set aside the Commission's action if we find it to be "(1) arbitrary, capricious or an abuse of discretion; (2) not supported by substantial evidence in the record; or (3) otherwise not in accordance with law." Section 74-6-7 (B); see Tenneco Oil Co. v. Water Quality Control Comm'n, 107 N.M. 469, 470-71, 760 P.2d 161, 162-63 (Ct. App. 1988).

{9} We first address whether the Commission acted contrary to law. We then analyze whether there was substantial evidence for the Commission's action. Finally, we determine if the action was arbitrary or capricious.

B. The Commission Acted in Accord with Law

{10} Regents' arguments that the Commission acted contrary to law fall into two categories. First, Regents argue that the Commission's statement of reasons does not comport with our case law in City of Roswell v. New Mexico Water Quality Control Commission, 84 N.M. 561, 565, 505 P.2d 1237, 1241 (Ct. App. 1972). Second, Regents argue that the Commission failed to comply with statutory requirements of the Water Quality Act, § 74-6-4(C), (D) and § 74-6-6 (A), (C), and the Clean Water Act, 33 U.S.C. § 1313(c)(2)(A). We are not persuaded by either set of arguments.

1. Statement of Reasons

{11} The Commission gave the following pertinent reasons for adopting the entire set of amendments to the standards:

> 4. The changes approved herein to New Mexico's water quality standards protect public health and welfare, enhance the quality of New Mexico's waters, and serve the purposes of the Clean Water Act and the New Mexico Water Quality Act.
> 5. The changes approved herein . . . respect the use and value of the water for water supplies, propagation of fish and wildlife, recreational purposes, and agricultural, industrial and other purposes.
> 6. The regulatory changes affected herein are designed to meet the EPA *Guidelines*.

{12} Citing our decision in City of Roswell, 84 N.M. at 565, 505 P.2d at 1241, Regents complain that the reasons fail because they provide no insight into why the Commission adopted the second sentence of 20.6.4.10.G NMAC. Regents also assert that the statement of reasons does not specifically respond to the concerns about the sentence raised in the testimony of Regents and others. In City of Roswell, this Court concluded that we were unable to review from the record what the Commission relied upon in adopting the regulations under consideration in that case. Id. at 565, 505

P.2d at 1241. The record "reveal[ed] only the notice of the public hearing, the testimony of the various experts and others, some exhibits and the regulations." Id. We stated that we could not effectively review a decision "unless the record indicate[d] what facts and circumstances were considered and the weight given to those facts and circumstances." Id. We held that formal findings were not required but that "the record must indicate the reasoning of the Commission and the basis on which it adopted the regulations." Id.

{13} We disagree with Regents that the statement of reasons must state why the Commission adopted each individual provision of the standards or must respond to all concerns raised in testimony. Such a requirement would be unduly onerous for the Commission and unnecessary for the purposes of appellate review. City of Roswell does, however, require a record sufficient for appellate review. We observe that the Commission's statement of reasons for adopting the regulations is quite general, more so than approved in other cases. See Bokum Res. Corp. v. N.M. Water Quality Control Comm'n, 93 N.M. 546, 552-53, 603 P.2d 285, 291-92 (1979) (approving a set of reasons "similar" to the "rather general statements" given in N.M. Mun. League, Inc. v. N.M. Envtl. Improvement Bd.); N.M. Mun. League, Inc. v. N.M. Envtl. Improvement Bd., 88 N.M. 201, 204-05, 539 P.2d 221, 224-25 (Ct. App. 1975) (listing the set of reasons for adopting regulations). Nevertheless, we believe it an adequate statement, albeit barely so.

{14} Our review of the entire record in this case reveals it to be thorough and comprehensive; we are able to determine from the record the basis for the Commission's adoption of the regulations. In this regard, our case is distinguishable from City of Roswell, where the record was insufficient for appellate review. City of Roswell, 84 N.M. at 565, 505 P.2d at 1241. Here, there are more than one thousand pages in the record proper, including five hundred pages of transcript, all exhibits, and several tapes of deliberations. The record shows that the Department's staff presented to the Commission substantial explanations of the purposes of the regulations, a section-by-section analysis, including 20.6.4.10.G NMAC, and twenty-one exhibits. The Commission heard Regents' cross-examination of the Department's staff, Regents' own testimony, and the Department's cross-examination of that testimony. Furthermore, on direct examination, the Department presented to the Commission a point-by-point rebuttal of Regents' arguments. Regents also presented written testimony and exhibits. As a result of the hearing, the Department proposed additional changes to certain portions of the proposed amendments; Regents submitted comments on those changes. From the record containing oral testimony, written testimony, exhibits, comments, and statement of reasons, this Court has a sufficient foundation to perform its task of review. See Bokum Res. Corp., 93 N.M. at 552-53, 603 P.2d at 291-92 (rejecting an argument that the Commission failed to comply with City of Roswell when the Commission submitted a general statement of reasons and a record similar to the record presented here).

2. Statutory Requirements

{15} We now turn to Regents' contention that the Commission failed to comply with various statutes when it adopted the second sentence of 20.6.4.10.G NMAC. The entire section reads as follows:

> G. Human health standards shall apply to those waters with a designated, existing or attainable fishery use. The human health standards for persistent toxic pollutants, as identified in Subsection M of Section 20.6.4.900 NMAC, shall also apply to all tributaries of waters with a designated, existing or attainable fishery use.

20.6.4.10.G NMAC.

{16} Underlying Regents' statutory arguments is their concern that the Commission adopted standards to protect humans from consuming fish detrimental to human health but that the second sentence applies the standards to ephemeral tributaries without fish. Ephemeral tributaries, which contain water infrequently and generally as a result of storms or other precipitation events, are, by definition, unable to support a self-sustaining population of fish.

{17} Regents argue that the Commission failed to designate a use for tributaries, as required under Section 74-6-4(C) of the Water Quality Act and 33 U.S.C. § 1313(c)(2)(A) of the Clean Water Act. Additionally, they argue that by applying the human health standards to tributaries, the Commission effectively designates to tributaries an unattainable fishery use. Lastly, they argue that the sentence adopted by the Commission is a regulation, as well as a standard, and that the Commission was therefore required to comply with the requirements for adopting regulations under Section 74-6-4(D), which it did not do. As part of the last argument, Regents contend that the Commission failed to provide statutorily required notice under Section 74-6-6(A), (C) when the Commission did not disclose that it would consider a regulation at its March 2002 hearing.

{18} We consider each argument in turn by starting with the language of the statute. If the statute is clear and unambiguous, we apply its plain meaning. Sims v. Sims, 1996-NMSC-078, ¶ 17, 122 N.M. 618, 930 P.2d 153. "In construing a statute, we assume that the legislative purpose is expressed by the ordinary meaning of the words used." Old Abe Co. v. N.M. Mining Comm'n, 121 N.M. 83, 90, 908 P.2d 776, 783 (Ct. App. 1995). When more than one section of a statute is involved, we consider the sections together to give effect to the legislature's intent. High Ridge Hinkle Joint Venture v. City of Albuquerque, 1998-NMSC-050, ¶ 5, 126 N.M. 413, 970 P.2d 599. In addition, "in determining [legislative] intent we look to the language used and consider the statute's history and background." Key v. Chrysler Motors Corp., 121 N.M. 764, 768-69, 918 P.2d 350, 354-55 (1996).

{19} We turn now to Regents' first argument, that the Commission must, under state and federal law, designate a use for tributaries in its water quality standards. Section 74-6-4(C) of the Water Quality Act requires the Commission to

> adopt water quality standards for surface and ground waters . . . . The standards shall include narrative standards and as appropriate, the designated uses of the waters and the water quality criteria necessary to protect such uses. The standards shall at a minimum protect the public health or welfare, enhance the quality of water and serve the purposes of the Water Quality Act.

{20} The Clean Water Act stipulates that standards "shall consist of the designated uses of the navigable waters involved and the water quality criteria for such waters based upon such uses." 33 U.S.C. § 1313(c)(2)(A).

{21} We are somewhat puzzled with Regents' argument that the Commission failed to designate a use for tributaries; the pre-existing water quality standards do designate such a use. The standards protect water quality in ephemeral streams for livestock watering and wildlife habitat uses. 20.6.4.10.A NMAC. The Department initially contended in its answer brief that it could assign criteria without designating a use. At oral argument, however, the Department clarified that the second sentence of 20.6.4.10.G NMAC provides additional protective criteria for the already existing uses of tributaries, as well as adding further protective criteria for waters with designated fishery uses. We observe that the Department's testimony to the Commission also referred to the pre-existing designated uses for tributaries. In light of the existence of these designated uses, we need not further address Regents' contention that a use was not designated or the Department's initial theory that a designation was not required.

{22} If Regents are implying that Section 74-6-4(C) requires the Commission to designate a fishery use for ephemeral tributaries before applying the human health standards to them, we disagree. We find nothing in the plain language of Section 74-6-4(C) or 33 U.S.C. § 1313(c)(2)(A) that prohibits the Commission from protecting waters with fishery uses by applying the standards to tributaries of those waters.

Regents conceded as much when it testified it did not believe either the Water Quality Act or the Clean Water Act prohibited the Commission from adopting the criteria for ephemeral streams.

{23} The EPA's approval of 20.6.4.10.G NMAC reinforces our view that the Commission acted properly in adopting the second sentence. In its review of the adopted regulations, the EPA advised the Department that it was within the state's authority under the Clean Water Act to apply the numeric criteria to ephemeral tributaries in order to protect downstream uses. The EPA noted that the tributaries may not support permanent fish populations and observed that although the state's approach is a restrictive one when applied statewide, it is nevertheless legal under the Clean Water Act. The Department informed this Court of the EPA's decision, pursuant to Rule 12-213(D)(2) NMRA 2004. We conclude that based on the plain language of both the state and federal statutes, the Department did not act contrary to § 74-6-4(C) or 33 U.S.C. § 1313(c)(2)(A) when it adopted the second sentence.

{24} Nor do we believe that the Commission has designated a fishery use for tributaries by applying the human health standards to them. As we discussed above, the standards apply livestock watering and wildlife habitat uses to ephemeral tributaries; there is no indication that the Commission has added to those uses.

{25} We now turn to Regents' argument that the second sentence is a regulation and that the Commission must therefore comply with Section 76-4-6(D). Section 76-4-6(D) requires the Commission to consider, among other things, the technical practicability and economic reasonableness of a regulation before adopting it. Both parties agree that a standard defines the amount of contaminant in the ambient water and that a regulation defines the conduct necessary for an entity that discharges pollutants to comply with the standard. In this case, the entity is Regents. Regents contend the "substance, character, and effect" of the second sentence define their conduct because the sentence regulates the effluent Regents may discharge from a pipe.

{26} Criteria are not directly applied to a discharge; they are applied to ambient water. The criteria are just a measure for determining water quality in a stream.. Regents reason, however, that since ephemeral streams are frequently dry, at most times, the only water in the ephemeral streams will be the effluent released by dischargers. As a result, they assert, the standard will have to be met at the end of the pipe. An effluent is defined in pertinent part as "[a] discharge of liquid waste, as from [a pipe of] a factory or nuclear plant." <u>The American Heritage Dictionary of the English Language</u> 570 (4th ed. 2000).

{27} We disagree that the second sentence regulates the effluent. As the Department explained, there is quite a distinction between setting water quality standards and setting effluent limits. There is a specific procedure for setting effluent limits for a discharger under the Clean Water Act. Regents' argument discounts that procedure. Any point source discharging a pollutant into a body of water is required to obtain a permit issued by the EPA, in accordance with the National Pollutant

Discharge Elimination System (NPDES). Effluent limits for these permits are typically based on the best available technology. After the technology-based effluent limit is set, the EPA considers a state's water quality standards in order to determine whether the effluent limit meets those standards. Only if the technology-based limits are insufficient to meet those water quality standards is the NPDES permit required to be changed to impose more stringent effluent limits. Regents speculated at the hearing that the EPA might alter Regents' NPDES permit to reflect the state's human health standards for tributaries. That the federal government might ultimately impose more stringent effluent limits in Regents' permit does not support a conclusion that the state's standard is consequently a regulation. Regents' argument fails.

{28} Regents further contend that they received inadequate notice under 74-6-6(A), (C) because the Commission failed to disclose in its published notice that a regulation as opposed to a standard would be considered at the hearing. Section 74-6-6 sets forth the notice and hearing requirements, which are the same for standards or regulations. Regents do not dispute that they received direct as well as constructive notice of the petition and hearing. In addition, as noted above, the Department met with Regents prior to the hearing to discuss the proposed amendments. Regents' claim, then, is solely that the content of the notice failed to indicate a regulation was under consideration. However, we have concluded that the second sentence is not a regulation. Accordingly, we hold that the Commission complied with Section 74-6-6(A), (C).

C. There Was Substantial Evidence for the Commission's Action

{29} "Substantial evidence supporting administrative agency action is relevant evidence that a reasonable mind might accept as adequate to support a conclusion." Oil Transp. Co. v. N.M. State Corp. Comm'n, 110 N.M. 568, 571, 798 P.2d 169, 172 (1990); Wolfley v. Real Estate Comm'n, 100 N.M. 187, 189, 668 P.2d 303, 305 (1983). We review the whole record, considering evidence both favorable and unfavorable, to determine the sufficiency of the evidence. Perkins v. Dep't of Human Servs., 106 N.M. 651, 654, 748 P.2d 24, 27 (Ct. App. 1987). We do not reweigh the evidence but decide, on balance, whether there was substantial evidence to support the agency's decision. Id. at 655, 748 P.2d at 28.

{30} At the March 2002 hearing, the Department emphasized that the purpose of the human health criteria is to protect humans from consuming fish "with toxic pollutants in their flesh." The Department clarified that the second sentence in 20.6.4.10.G NMAC only applies to fifteen pollutants, "the very worst of the worst of the toxic chemicals." "There is no good reason to release any of these [fifteen pollutants] into the watersheds of the state," the Department told the Commission. The Department testified that these persistent toxic pollutants pose a substantial risk over many lifetimes—that they adhere to sediments in ephemeral streams and are transported downstream to waters containing fish consumed by humans. The smallest sediments, which tend to pick up the greatest number of these contaminants, are most easily moved downstream. Some of the pollutants are bioaccumulative; that is, they "accumulate in fish, which absorb them from the water and the aquatic organisms which they eat, who in turn have absorbed them from the water column and from the sediments. Over time, these pollutants bioaccumulate to concentrations which are dangerous to humans [who] consume the fish." Many of the ephemeral tributaries contain aquatic organisms but generally do not contain fish consumed by humans.

{31} The Department presented data from the EPA that showed the presence of twenty priority toxic pollutants in effluent discharges, including DDT. The Department also presented its findings of high levels of PCBs and dioxin in ephemeral storm waters on LANL property and in fish caught in Cochiti Reservoir. While clarifying that it was not implying a causal relationship between the presence of the pollutants in these two locations, the Department indicated that the findings show the pollutants currently exist in both ephemeral streams and in fishery waters. The Department testified that the second sentence was designed to ensure that certain highly persistent toxics do not reach fishery waters. The Department further explained the inadequacy of the current strategies to control these toxics and that "a different strategy is needed" for persistent toxic pollutants. That strategy, the Department stated, is applying numeric criteria for persistent toxic pollutants to the tributary itself.

{32} Regents countered that existing programs, including the issuance of storm water permits, are effective tools to protect downstream fishery waters; the tools just need to be utilized to the fullest extent possible. However, according to the

Department, the existing approaches only apply when discharges routinely reach downstream waters. The Department explained that these approaches create "a very large loophole in the standards" because they exclude discharges that reach the downstream waters during storms or other runoff events. Regents also insisted that the Department's findings of persistent toxic pollutants rely "on a very narrow and sparse data set," which can have biased results; Regents requested further data and study. It stated that although PCBs have been found in fish, the level of the toxic is not harmful to human health.

{33} As an alternative to a blanket application of the numeric criteria to tributaries, Regents urged the Department to wait until it finds a risk to human health in fishery waters, then find the source of the problem and work with the discharger to come to a solution. Regents agreed their approach could be described, in their words, "as waiting until the horse is out of the barn before you deal with the problem." They acknowledged that while studies are pursued, precipitation events continue and rainfall runoff flows down from an ephemeral stream on their property to a fishery water. Regents also conceded that it is essentially a policy choice for the Commission whether to accept their approach to protecting downstream uses or to adopt the Department's approach.

{34} We reiterate that in reviewing for substantial evidence, although we consider the evidence on both sides of the issue, we affirm if there is substantial evidence supporting the Commission's decision. We find in the whole record ample evidence to affirm.

D. The Commission's Action Was Not Arbitrary or Capricious

{35} An action is arbitrary or capricious if it is "unreasonable, irrational, wilful, and does not result from a sifting process." Oil Transp. Co., 110 N.M. at 572, 798 P.2d at 173. We may find an action arbitrary or capricious if there is "no rational connection between the facts found and the choices made." Colonias Dev. Council v. Rhino Envtl. Servs., Inc., 2003-NMCA-141, ¶ 5, 134 N.M. 637, 81 P.3d 580 (internal quotation marks and citation omitted), cert. granted, 2003-NMCERT-003, ___ N.M. ___, 84 P.3d 669; Perkins, 106 N.M. at 655, 748 P.2d at 28. Even if a different conclusion might have been reached from the facts, the choice made "is not arbitrary or capricious if exercised honestly and upon due consideration." Id.

{36} We do not find the adoption of the second sentence arbitrary or capricious. The Commission made the decision to adopt the sentence after evidence was presented that persistent toxic pollutants exist in ephemeral streams in New Mexico, that these pollutants may flow into fishery waters as a result of storms or other precipitation events, and that the pollutants in sufficient quantities are harmful to human health. We find the decision to adopt the sentence both reasoned and rational; that there were possibly other choices available to the Commission to protect downstream waters from persistent toxic pollutants does not make the decision arbitrary or capricious.

III. CONCLUSION

{37} We affirm the Commission's adoption of the second sentence of 20.6.4.10.G NMAC, which applies the human health standards to tributaries of fishery waters.

{38} **IT IS SO ORDERED.**

Celia Foy Castillo

CELIA FOY CASTILLO, Judge

WE CONCUR:

A. JOSEPH ALARID, Judge

MICHAEL E. VIGIL, Judge

NEW MEXICO WATER QUALITY CONTROL COMMISSION

IN THE MATTER OF PROPOSED AMENDMENTS TO SECTIONS 10, 11, 12, 113 AND 900 OF THE COMMISSION'S STANDARDS FOR INTERSTATE AND INTRASTATE SURFACE WATERS, 20 NMAC 6.4.

TRANSCRIPT OF PROCEEDINGS

VOLUME 1

BE IT REMEMBERED that on the 13th day of March, 2002, this matter came on for hearing before the Water Quality Control Commission, at the Bataan Memorial Building, Santa Fe, New Mexico, at the hour of 1:50 PM.

A P P E A R A N C E S

FOR THE WATER QUALITY CONTROL COMMISSION:

MR. PETER MAGGIORE, Chairman
MR. STEVE GLASS
MR. HOWARD HUTCHINSON
MR. CONRAD KEYES, JR.
MS. LYNN BRANDVOLD
MR. DAVID JOHNSON
MR. BILL OLSON
MS. JULIE MAITLAND
MR. JOHN WHIPPLE
MR. DAVID JOHNSON
Water Quality Control Commission
1190 St. Francis Drive
Harold Runnels Building
Santa Fe, New Mexico 87501

MS. TRACY HUGHES
Assistant Attorney General

FOR THE NEW MEXICO ENVIRONMENT DEPARTMENT:

MR. ERIC AMES
Assistant General Counsel
1190 St. Francis Drive
Harold Runnels Building
Santa Fe, New Mexico 87501

FOR THE BOARD OF REGENTS OF THE UNIVERSITY OF CALIFORNIA:

MONTGOMERY & ANDREWS
Attorneys at Law
325 Paseo de Peralta
Santa Fe, New Mexico 87501
By: MR. LOUIS ROSE

FOR THE SAN JUAN WATER COMMISSION:

WOLF, TAYLOR & MC CALEB, PA
Attorneys at Law
4163 Montgomery, Northeast
Albuquerque, New Mexico 87109
By: MS. JOLENE L. MC CALEB

I N D E X

I N D E X (CONTINUED)

E X H I B I T S	ADMITTED
NMED EXHIBITS:	
1. Clean Water Act	135
2. Water Quality Standards Regulation	135
3. EPA Administered Permit Programs: NPDES	135
4. EPA Water Quality Standards Handbook	135
5. EPA National Recommended Water Quality Criteria	135
6. EPA References for Priority Pollutant Criteria	135
7. EPA Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health	135
8. EPA List of Priority Bioaccumulative and Toxic Chemicals	135
9. Priority Pollutant Monitoring Data	135

E X H I B I T S (CONTINUED)

MR. MAGGIORE: Good afternoon everybody. My name is Pete Maggiore. I'm the Chairman of the Water Quality Control Commission. I've been designated by the Water Quality Control Commission to act as Hearing Officer at this hearing.

It's being held to consider proposed amendments to Section -- as I was saying, thank you -- amendments to Sections 10, 11, 12, 113 and 900 of the New Mexico Water Quality Control Commission's Standards for Interstate and Intrastate Surface Waters, 20 NMAC 6.4.

Timely notice of this hearing was published in the Albuquerque Journal, the Newsline for the Blind, and the New Mexico Register.

The amendments are proposed by the Surface Water Bureau of the Environment Department. The proposed amendments would adopt human health and aquatic life criteria for Environmental Protection Agency priority toxic pollutants.

The Commission may make a decision on the proposed amendments at the conclusion of this hearing, and if the regulations are approved, the regulations will be reformatted for consistency with the New Mexico Administrative Code.

The record in this matter includes the petition to amend the regulations and to request this hearing, the notice of public hearing and evidence of publications, and several notices of intent to provide technical testimony.

This hearing will be conducted in accordance with the Commission's Guidelines for Regulation Hearings. Pursuant to Section 401 of these guidelines, I will conduct the hearing so as to provide a reasonable opportunity for all persons to be heard without making the hearing unreasonably lengthy or cumbersome.

The Rules of Civil Procedure and the Rules of Evidence do not apply, but I will make whatever orders are necessary to preserve the decorum and to protect the orderly hearing process.

All testimony will be given under oath and all persons giving testimony will be subject to cross-examination by any other person in attendance on the subject matter of their testimony and on matters affecting their credibility. I may limit cross-examination, if necessary, to avoid harassment, intimidation or repetition.

This hearing is being transcribed. Transcription services are provided by Kathy Townsend Court Reporters. Please contact them directly if you wish to purchase a transcript.

We will first proceed by hearing the technical case. The order of presentation will be as follows: the Surface Water Bureau, as proponents of the amendments, shall present its case first. Those generally supporting the petition will go next, and I have listed there Larry Webb, the New Mexico Municipal Environmental Quality Association, the US Department of Interior, the Fish & Wildlife Service, and the Board of Regents of the University of California. Then we'll proceed with those who are generally opposed to the petition, which include the San Juan Water Commission.

The Commission's secretary received no other notices of intent to present technical testimony, so we will then go to nontechnical testimony, which will be taken in the order in which the attendees signed in. If you have not previously signed in, please do so now regardless of whether you wish to present testimony.

Are there any questions from any of the Commissioners or members of the audience regarding the hearing format?

MS. HUGHES: Mr. Chairman, there are no questions regarding the format. I just bring up a preliminary procedural matter.

Prior to the hearing, you got a letter from the San Juan Water Commission requesting that this hearing be postponed or delayed and held during the regular triennial review. It was your position that you didn't have authority --

MR. MAGGIORE: That's right.

MS. HUGHES: -- on behalf of the Commission to -- after the Commission had decided to hear this matter, that you didn't have authority to postpone or delay the hearing unilaterally.

MR. MAGGIORE: Right.

MS. HUGHES: So I just bring that up as a preliminary procedural matter.

MR. MAGGIORE: I did correspond, I think -- or you corresponded on my behalf -- with the San Juan Water Commission precisely that, that I did not have unilateral authority given to me by the Commission to summarily change or postpone the hearing.

I guess, Commissioners, there was that correspondence, though, and if there is any -- is there any need to discuss that?

Do you have some concerns, ma'am?

MS. MC CALEB: My name is Jolene L. McCaleb. I'm the attorney for the San Juan Water Commission.

What I would like to do at this point in time is -- I'm not certain whether it's correct to call it still a pending motion, given your letter, or whether I need to make a -- I need to move to renew --

MS. HUGHES: I would renew your motion.

Go ahead.

MS. MC CALEB: What I would like to do is I would like to renew the San Juan Water Commission's motion that this hearing be postponed.

The grounds for the motion are twofold: One is based on policy reasons why the subject matter of this hearing should be considered during the next triennial review. Also, we now have some procedural grounds based on concerns about the procedural fairness of this proceeding.

So I would propose that Mr. Kirkpatrick be permitted to present the policy concerns of San Juan Water Commission, and then I can make the legal arguments about the procedure.

MR. MAGGIORE: Any objections, Commissioners? If not, please proceed.

MS. MC CALEB: Thank you.

We'll try asking questions of Mr. Kirkpatrick from up here, if that works, so everyone doesn't need to move.

MR. MAGGIORE: Do we have a witness table?

MS. HUGHES: Let me just ask you, are you making argument? All you're making is argument, or is Mr. Kirkpatrick going to present testimony regarding -- I mean, your motion is really a procedural motion, it sounds like, or a --

MS. MC CALEB: It's twofold.

MS. HUGHES: Okay.

MS. MC CALEB: The first portion of the motion is that for public policy reasons, it is not appropriate to consider this petition until the triennial review.

MS. HUGHES: Can you argue that? Can't you, as counsel, argue that motion?

MS. MC CALEB: I could argue that, if you would prefer.

MS. HUGHES: I think we would, because I think this is a motion for just -- that the lawyers should argue on that behalf, and then the Commission could make a decision.

MS. MC CALEB: Sure.

MS. HUGHES: Rather than having the witness be sworn in, et cetera, I think you should argue it.

MS. MC CALEB: Since I have people behind me, is it all right if I sit and make my argument?

MR. MAGGIORE: Do you have a microphone that she could use?

MR. PIERCE: We don't have a speaker.

MS. MC CALEB: You know what --

MR. MAGGIORE: Why don't you come down to the front.

MS. MC CALEB: Thank you. Mr. Hearing Officer, Members of the Commission.

By letter of January 31st, Mr. Kirkpatrick, on behalf of the San Juan Water Commission, sent a letter to the Water Quality Control Commission requesting that this hearing be postponed for various policy reasons.

The primary policy reason is the scope of the Environment Department's proposal. The petition that we are here to discuss today essentially proposes the adoption of 113 new water quality standards.

It is the position of the San Juan Water Commission that such a broad proposal would more appropriately be considered during the next triennial review, so that it could be considered in context with the review of all other water quality issues at that time.

With regard to procedural issues and concerns, the New Mexico Environment Department, in our opinion, has made several substantive changes to its original petition, and, therefore, that requires a renoticing of this hearing.

For example, the Environment Department has submitted a revised petition that creates, for example, a new subset of, quote, persistent toxic pollutants, and there have been various other changes that we believe are substantive and not just fine-tuning.

In addition, with regard to the fairness of the current procedure, I would like to bring to the Commission's attention that it was not possible to obtain copies of notices of intent that were filed, including the one filed by the Department, until six days after they were actually filed, because the Commission office was closed. We left several phone messages, and I guess because of the transition in the administrative secretary's position, no one was minding the shop, and that worked a disadvantage for my client.

In addition, we have a concern about the procedure under which the Environment Department listed its written technical testimony as an exhibit to potentially be filed in its notice of intent and then ten days later actually filed significant written testimony.

Other parties who actually intended to make an exhibit of written technical testimony provided it with their notice of intent, and I think that that is an unfair procedure for the Environment Department to be able to do that.

In addition, if you have the guidelines in front of you, I'm not sure whether you do, for Commission hearings, Guideline 303, with regard to the submission of the notice of intent to present technical testimony states that the notice of intent shall either summarize or include a copy of the direct testimony.

It's our position that the Environment Department's notice of intent did neither of those things.

If you will look at the Department's notice of intent with regard to each witness, they indicate the topic that a witness will testify about, but in no way summarize or indicate what that testimony will be, and for the Department to then later file their written direct ten days after everyone else is an unfair procedure.

So for these various policies reasons and procedural reasons, we request that this hearing be postponed.

MR. MAGGIORE: Okay.

Thank you.

MS. MC CALEB: Thank you.

MR. MAGGIORE: Counsel?

MR. AMES: Yes. Thank you, Mr. Chairman, Members of the Commission.

My name is Eric Ames. I'm an attorney in the Office of General Counsel at the New Mexico Environment

Department, and I'm here today on behalf of the Surface Water Quality Bureau.

The Department opposes San Juan's request for a delay in this hearing. There are a number of reasons, in our estimation, why a delay is neither warranted nor prudent.

First, there is no defect in public notice. None has been mentioned here. Second, there would be prejudice to both the Department and the other parties who have prepared and sat and waited for this hearing for the past two days. Third, there is some urgency in having this hearing and proceeding to a decision on the petition. Finally, this is a regular Commission hearing on a proposal to amend these water quality standards. It's subject to the exact same procedural safeguards as any proceeding this Commission holds to amend the water quality standards, including the triennial review.

Before discussing these reasons in more detail, however, I'd like to provide a little context for the motion you just heard.

As Chairman Maggiore and Ms. McCaleb said, there was a letter on January 31st from the Commission -- the San Juan Water Commission requesting a delay. That was the first request for a delay that was made by a letter, as was said.

The San Juan Water Commission never sent a copy to the Department -- a copy of that letter to the Department. They never called us before sending the letter to tell us they were going to ask for a delay, and they never called us after the letter to tell us they had asked for a delay. In fact, we only learned about the request for a delay on February 25th when I went down to the hearing clerk's office to obtain copies of the other parties' notices of intent.

More troubling, the letter is essentially an argument on the merits. I thought the whole matter had been resolved, because the Chairman, as he said, sent a letter to the Commission on February 20th telling them that the request for a delay had been denied, and on February 26th, San Juan sent a letter to the Commission Chairman telling him that, in fact, they were withdrawing their request for a delay -- or at least that's how we understood the letter.

So we're a bit surprised to hear the request raised for a second time here.

With that said, we'll wait until our case in chief to argue the merits of the so-called policy reasons for San Juan's request for a delay. At this time I'll explain in a little more detail our reasons for opposing the delay on procedural grounds.

First, as I said, there is no defect in the legitimacy of this hearing. There has been no claim that the public notice was improper or this hearing was improperly scheduled.

Second, the delay would be prejudicial to the Department and to the other parties. A petitioner generally has a right to a prompt hearing on its petition. It shouldn't be strung along for months by repeated requests for a delay.

Finally, the Department and other parties have expended a significant amount of time and resources to prepare for this hearing and to be here today.

The final reason is one which I would not have intended to offer in response to a motion, but since it was raised earlier by Dr. Davis, I will say, again, that Mr. Pierce will not be here after the 21st of March, and Mr. Pierce is an important part of the Department's case in chief, and it would work a severe hardship on the Department if this hearing were not held today or at least before March 21st.

San Juan did not make a proposal for how long a delay they would like. I presume they are asking for more than a week, based on the grounds for stay identified as the basis for their request.

Third, as I said, there is some urgency in hearing this petition. The Department has filed this petition to address deficiencies in the triennial review identified by the EPA. The EPA has said that it will initiate federal promulgation for numeric criteria for the State of New Mexico unless the Commission acts. It's the Commission's decision whether to act, but we don't even get to that point unless we have a hearing, and we need to move promptly to get this done.

Second, there is a risk that an ongoing federal lawsuit could be amended to include a claim against the EPA, and that would only make the matter -- make matters much worse. It would thrust the state -- well, it would raise the stakes for the state in a matter in which it has already decided to intervene.

Lastly, I'd like to respond to the arguments that were made by Ms. McCaleb. Basically, in my view, San Juan has not made a convincing argument for delay.

First, they've had ample notice and time to prepare for this hearing. This hearing was petitioned when we -- let me rephrase. The petition was filed three-and-a-half months ago. A hearing was scheduled three months ago. The Department met with San Juan to discuss the proposal that's currently before you two months ago.

Since this petition was filed three-and-one-half months ago, San Juan has made only one request for information. The Department responded promptly to that request, and we've heard nothing since. Nowhere in San Juan's written testimony is there a challenge to any specific criterion that the Department has proposed. They haven't even brought an expert witness to testify in this hearing or to listen to the testimony that's about to be offered.

I would submit that this is not a function of insufficient time to prepare for the hearing, but a function of having no evidence.

As to the argument that this proceeding should be delayed until the next triennial review, I would submit that this is still the triennial review. New Mexico has not completed the triennial review that it began in 1997. This is the last item.

Second, the next triennial review is not due until January of 2003. Under EPA guidance -- EPA -- the way EPA interprets the requirements, the next triennial review must begin three years after the submittal of the prior. This hearing excluded, we interpret that as January of 2000, meaning the next hearing would need to be initiated by January of 2003. Holding off on this hearing that long does raise the stakes with regard to this hearing.

If this hearing is delayed, I would suggest there is a significant risk that EPA would act in the interim. There is nothing to be gained with respect to procedural safeguards. This is an identical public notice and procedure as the regular triennial review that was held in '97 and that will be held again in January of 2003. This hearing and the triennial review are conducted under the same Commission guidelines, and they must comply with the same EPA requirements for amending water quality standards.

Further, there is the same opportunity for public participation as the triennial review. The Department, in fact, conducted a wide -- talked to a wide number of people in getting ready for this hearing, consulted with a wide range of people after it initiated its petition.

San Juan, in its written submittal, acknowledges the Department addressed many of its concerns. In some it's hard to see what the Department could have done more or should have done more prior to this hearing.

As for the argument that the Department made additional changes to its petition after November 21st -- November 29th, that, in fact, is true; the Department, on February 1st, revised its petition and sent copies to everyone who attended any of the meetings, including San Juan, as well as all people on the Commission mailing list and all members of the Commission.

These changes were in direct response to concerns raised at the meetings the Department held in January with a wide range of interest groups, including San Juan.

There is no need to renotice this petition in order for the Commission to proceed. The Water Quality Control Commission guidelines allow a party -- or allow a petitioner, as well as any party -- to submit modifications to the petition with its notice of intent.

The Department decided that it would be in the best interests of everyone if it did it sooner than the notice of intent. Notices of intent weren't due until February 22nd. The Department decided to do it immediately, and, therefore, within days of concluding the meetings, it submitted the revisions to everyone so they could prepare their written testimony and prepare their notices of intent.

I submit the Department did more than it was required to do by the Commission guidelines. It seems strange the Department now would be punished for it.

As to the one item which the Department did change that was addressed in San Juan's motion, the list regarding persistent toxins, I would suggest that's a red herring.

The Department had already proposed to apply the human health criteria, all of them, to ephemeral waters, and, more appropriately, to tributaries of water with designated or existing attainable fishery use.

In the parlance you'll hear today, we're talking about them as ephemeral waters because they are waters that are not themselves designated as fisheries, but are a tributary to fisheries, so I will call them ephemeral waters.

Our original proposal was to apply the human health criteria to all tributaries, all ephemeral waters. In our proposal we restricted that list, we actually backed off from our broader proposal and limited it to those pollutants which the Department termed are persistent bioaccumulative toxic pollutants.

So to the extent that San Juan didn't have notice that we were going to restrict the list, that's a bit of a red herring, since we'd already said we were going to apply the -- apply the criteria -- all the criteria to these waters.

San Juan's next argument is that the Department violated the Commission guidelines regarding notices of intent. Their argument is essentially the Department did not submit its written testimony with the notice of intent; and that, secondly, the Department's summary of its testimony in the notice of intent was not sufficient to meet that requirement.

The requirement is to submit a summary; that's it. There is no requirement to submit all your written testimony. San Juan chose to do so; Los Alamos National Laboratory chose to do so. Dr. Hernandez, I believe, did not choose to do so, he submitted an outline. The Department submitted a summary.

The fact that the Department listed its written testimony as an exhibit and then provided it ten days later does not create a violation of the Commission guidelines.

As to the argument that the summary is not sufficient, that is for the Commission to decide. The Department's notice of intent in this case is fundamentally no different than the Department's notices of intent that it filed in the primary contact designation hearing in Las Cruces in October or in the hearing on the changes to the surface water definition that it did, oh, last spring. In fact, I don't think it's much different than the notice of intent the Department filed in the triennial review in 1997.

The Commission has never established a standard for what constitutes a summary. So there is very little for the Department to do in that context, but the Department believes that what it did provided a broad enough outline to put other parties on notice of the scope of its testimony and that that meets the requirement.

San Juan's final argument is that it was unable to obtain the notices of intent until six days after the filing deadline, and that, therefore, it was prejudiced in its ability to prepare for this hearing. Six days seems like a fairly short time in the scope of the -- of this matter to allege a prejudice, particularly since San Juan had already prepared its full position at the time it filed its notice of intent.

At the time it filed its notice of intent, it was prepared to go to hearing. It had already written down and announced to the public and to this Commission what it was going to say. What was left for it to prepare was to review everyone else's notice of intent.

It had a delay of six days. That's not the Surface Water Quality Bureau's fault, but that said, it's hard to see how a delay of six days can require this entire hearing be rescheduled for some undefined period of time in order to correct it.

In conclusion, the Department sees no need and no good reason for a delay. The hearing is required to give the state a chance to avoid federal imposition of numeric criteria. A delay increases the risk that this will occur.

The hearing was properly noticed and scheduled. There is going to be significant prejudice to the Department, as well as other parties, if a delay is granted.

In this light, the Department urges the Commission to proceed with this hearing today.

Thank you.

MR. MAGGIORE: Thank you, Counselor.

Any other parties wishing to argue this motion?

MS. MC CALEB: If I may, I would like to respond to the Environment Department.

MR. MAGGIORE: Please proceed.

MS. MC CALEB: Thank you.

The first comment I would like to make, before I get into the substance of what Mr. Ames said, is that I believe it is entirely inappropriate, the derogatory remarks he made to this Commission concerning the type of San Juan -- the type of testimony that San Juan Water Commission may be presenting and his interpretation that because we do not have a technical expert here that there are no -- essentially, there is nothing important to hear from the San Juan Water Commission.

I believe that that was the shadow that was cast over what we are here to do, and I think that was entirely inappropriate on Mr. Ames' part.

With regard to the prejudice issue, and specifically, again, with Mr. Ames' concern that we are not here with an expert witness, that is because of circumstances outside our control and the date that this hearing was scheduled for, and so we have done our best to prepare Mr. Kirkpatrick in place of Mr. Pitts.

However, I would like to point out that in our attempts to get assistance from our technical expert, we were prejudiced in the fact that the Environment Department did not even send us a copy of its notice of intent, and I had to wait to try to get that from the Commission secretary.

Mr. Ames did provide the information to me on February 28th, when I had not been able to get ahold of the Commission secretary, but the Environment Department, even though they had our notice of intent and knew we would be participating, did not voluntarily provide their notice of intent to us.

With regard to Mr. Kirkpatrick's letter to the Commission to postpone this hearing, I have no proof that a copy of the letter was sent to Mr. Davis, because, unfortunately, Mr. Kirkpatrick's secretary did not include the copy list on her letter; however, she was instructed to send a copy of that letter to Mr. Davis, and it's my belief that it was sent, and we certainly had no intention to not notify the Environment Department of our request to the Commission.

With regard to Mr. Ames' statement that he believes that San Juan Water Commission withdrew its motion based on Mr. Kirkpatrick's February 26th letter, Mr. Maggiore's letter and Mr. Kirkpatrick's letters passed in the mail.

In his letter, Mr. Kirkpatrick essentially said, "We haven't heard from the Water Quality Control Commission, and, therefore, do we need to assume that our motion has been denied?"

So in no way did we withdrew our motion; we just indicated that we hadn't heard anything, because the letters crossed in the mail.

With regard to our motion and when we would request that this hearing be rescheduled, we would request that it be part of the next triennial review, and that is for this Commission to set.

With regard to the severe hardship that would be imposed on the Department, I'd first like to point out that I realize everyone is here today prepared to go to a hearing, but there is no other procedure available for an interested party to request that a motion -- that a hearing be postponed other than the way we attempted to do it. That's the best way we thought we could do it, first to send a letter to the Commission, after you had scheduled the hearing, requesting a postponement; and then if the Water Quality Control Commission does not consider that at that time, this is our first opportunity to present our motion.

And while we do understand that Mr. Pierce will be retiring, and we will miss him greatly, we mean that wholeheartedly, he's always been very helpful to us, I don't believe that the fact that the Department may be losing an employee is a sufficient reason to fail to postpone a hearing of this magnitude that requires more consideration and should appropriately be heard during the triennial review.

Thank you.

MR. MAGGIORE: Thank you.

Commissioners, any thoughts on the preliminary motion?

I'll entertain a motion.

MR. GLASS: One second before the motion, please.

MR. MAGGIORE: Commissioner Glass.

MR. GLASS: When Mr. Ames testified that the hearing we have scheduled today is really an extension of or a completion of the 1997 triennial review, I guess that brings to me -- brings up for me a question of what constitutes the conclusion of the triennial review.

Is it the final full approval by EPA of the standards, or is it some other measure of conclusion?

In fact, is this a continuation, or can it be classified as that?

MR. AMES: Mr. Glass, my understanding is that the Department's position is that the triennial review that was initiated in '97 will conclude when the Department -- when this Commission has considered all remaining issues left from EPA's record of decision issued in January of 2001. This is the last issue.

MR. GLASS: So it's predicated on Commission consideration of -- not so much EPA approval of the water quality --

MR. AMES: That's correct.

MR. GLASS: Okay.

MR. AMES: If this Commission were to decide to take no action on the Department's petition, or deny the petition, I suppose that would be the end of the triennial review, and from the Department's perspective, the ball would then be in EPA's court to decide how to respond, but in the record of decision, EPA clearly left open for the Commission the opportunity to address issues which it considered problematic, and among those were the priority contact designation for the lower Rio Grande, a few involving the definition of surface waters, and this big issue of numeric criteria for toxic pollutants.

EPA said it would consider making a finding that the Department's -- or that the state's standards were inadequate, essentially giving us the opportunity to address that concern before EPA did it for us, and it's in that light that the Department has come back with this petition as an effort to close out all remaining open issues which EPA has given us an opportunity to address.

So it's the Department's position that this is the last piece of the 1997 triennial review.

MR. GLASS: In my view, a denial to even consider the petition would not constitute a Commission hearing or consideration of the issue brought up by EPA, just a -- if we were to deny to hear any of the petition today, we would not have considered it, and you've stated that our denial would bring the triennial review to a close, but I don't think that's true.

MR. AMES: Mr. Glass, I think you may have misunderstood me. I meant a denial of the petition after a hearing.

MR. GLASS: Oh, okay. So we're considering --

MR. AMES: I think one could also argue that if the Commission refused to even consider the petition, that would be a final action by this Commission that the EPA could look at and say, "Well, the Commission has decided -- the State of New Mexico has decided that it's not going to deal with this issue, so now the ball is now in our court."

So I think we come to the same place, yes.

MR. GLASS: Okay. Thanks.

MR. MAGGIORE: Commissioner Hutchinson.

MR. HUTCHINSON: I just have a question for our legal counsel. Well, I guess Mr. Ames could answer it as well.

It's my understanding that regardless of a triennial review taking place that any person can request a change to the standards or a new standard at any time. So -- is that correct?

MR. AMES: Mr. Hutchinson, I'd be pleased to answer that.

I half expected that issue to be raised in San Juan's motion. It was not.

It is entirely appropriate for this Commission to hold separate hearings on a distinct issue -- on any issue. Anyone can petition this Commission for a change in the water quality standards, and this Commission would decide whether to have a hearing and would have a hearing and decide on the matter. This is particularly true when there may be some urgency to the matter.

From a different perspective, the Commission might want to consider whether it's really a good idea to postpone hearing issues, particularly issues of some magnitude, until the triennial review, which then makes the triennial review quite an unwieldy and potentially unproductive forum.

Many of us sat through the -- or participated in the eight-and-a-half days that that triennial review required, and it led to a number of problems both for the Commissioners and for the parties themselves in terms of participating and gathering the necessary information to make a decision.

So not only do the guidelines allow -- not only does the act allow the Commission to have hearings when it deems it appropriate, but from a policy perspective, it makes sense for the Commission to have hearing when they -- on issues as they arise.

MR. GLASS: I move that we proceed with the hearing.

MR. JOHNSON: Second.

MR. MAGGIORE: A motion from Commissioner

Glass; a second from John the very end.

MR. MAGGIORE: The very end, Commissioner Johnson.

Any further discussion?

Seeing none, all in favor please signify by saying aye.

(Vote taken.)

MR. MAGGIORE: Motion carries.

We'll proceed.

Thank you, Counselors.

Please proceed with your case in chief.

MR. AMES: Thank you, Mr. Chairman.

As I stated at the beginning, my name is Eric Ames. I'm representing the Department here today.

The Department in this proceeding proposes the adoption of numeric criteria for priority toxic pollutants. There are 23 criteria for the protection of aquatic life, 11 are acute and 10 are chronic and 92 criteria are for the protection of human health based on fish consumption.

These criteria are the values recommended by EPA pursuant to the Clean Water Act, adjusted for the cancer-causing pollutants to reflect the Commission's preferred risk level.

The Department also proposes a procedure for setting or deriving numeric criteria for the protection of human health in the future. The procedure would allow EPA, which issues NPDES permits in the State of New Mexico, to write and issue these permits for toxic pollutants in effluent discharges where the Commission has not adopted a numeric criteria for a specific priority toxic pollutant.

In addition, the Department proposes a special requirement that it return to the Commission for hearing on any such criterion. In other words, when EPA derives a criterion pursuant to the procedure, the Department will come back to this Commission and ask that it consider and adopt that criterion into the standards themselves.

Finally, the Department proposes to apply these human health criteria to all waters with a designated, existing or attainable fishery use and their tributaries.

With me today to present the Department's proposal are four members of the Surface Water Quality Bureau. The first to my right is Dr. James Davis, chief of the Bureau; to his right, Mr. Saums, manager of the Point Source Regulation Section; next to him is Mr. John Montgomery, who is the water quality standards coordinator for the Department, or will be upon Steve's retirement, I'm not sure of the precise timing of the transition; and, lastly, Mr. Pierce, who is the manager of the Surveillance and Standards Section, which has traditionally been the section within the Bureau responsible for maintaining and updating the water quality standards.

I'll give you a very brief outline of our testimony.

Dr. Davis will begin by explaining the purpose of the Department's petition and explaining how it responds to EPA's identification of deficiencies in the last triennial review and why it is necessary for this Commission to take action to avert federal promulgation.

He will describe how the Department solicited public input during meetings with groups, and he will explain why the Department modified the petition on February 1st.

Mr. Montgomery will go next. He'll explain the legal and regulatory framework for the requirement to adopt numeric criteria for toxic pollutants. His discussion will include the relevant provisions of the Clean Water Act, including the specific requirement for states to adopt numeric criteria, and EPA's process for developing and updating its recommended criteria upon which the Department relies today.

Mr. Pierce will pick up John's thread. He'll describe the evolution of the national policy for the control of toxic pollutants in surface waters of the United States, New Mexico's response to that national policy or strategy, and EPA's decision in January of 2001 which started this whole petition rolling.

He will describe the options for adopting numeric criteria to comply with the Clean Water Act and avoid federal promulgation, and he will describe the Department's preferred alternative for doing so.

He will then proceed with a section-by-section analysis of the Department's proposal, beginning with the numeric criteria and their bases on EPA's values. He will explain why numeric criteria should be generally applicable to fishery waters and why certain criteria, specifically those for persistent toxic pollutants, those that are persistent and bioaccumulative, to be more specific, should be applied to tributaries of fishery waters, even when those tributaries do not have water and do not have fish at the point of discharge.

He will describe why other approaches to controlling these kinds of discharges are not effective. He will explain why the Department is proposing the harmonic mean flow, why it is consistent with EPA's policy and practice, and why the Department has agreed to support LANL's -- or Los Alamos National Laboratory's proposal for a modified harmonic mean flow formula for tributary waters which are ephemeral.

Mr. Saums will be next. He will testify regarding the effect of these criteria and the translation procedure on the development and issuance of NPDES permits in the State of New Mexico, to explain how the Department's proposal promotes consistency in the development of permits, and, in fact, will have a minimal impact on NPDES permittees, at least in the near term, and he will finally explain why the Commission's adoption of the Department's proposal provides the greatest opportunity for state control of numeric criteria within the EPA regulatory framework.

Finally, Dr. Davis will close out. He will testify about the effect of these criteria on the 303(d) program, specifically the impaired listings, and the TMDL program, as well as nonpoint sources.

The Department's testimony is accompanied, as you can tell, by a PowerPoint presentation. Copies of the presentation have been distributed to everyone in the audience, at least as of the beginning of the hearing. If anyone needs a copy, there are some more in the box at the front of this box here. Feel free to come down and get a copy.

The Department has already submitted its full written testimony. That, too, has been distributed. Therefore, the Department will make every effort to abbreviate its oral testimony using the PowerPoint slides as guideposts.

You may note some changes in the Department's oral testimony from the written testimony. Those changes were made to reflect the testimony of other parties. The Department read and reviewed and discussed everyone else's testimony and decided that in some cases changes were warranted, and we will indicate what those changes are during our oral presentation.

Finally, the Department has submitted 21 exhibits in support of the petition. NMED Exhibits 1 through 20 were filed with the notice of intent. They were supplied on the compact disk for all Commissioners. I assume they were -- that most Commissioners, or all the Commissioners, received it. The CD was also available to anyone who asked, as indicated in the notice of intent, and the CDs were sent to counsel for Los Alamos and San Juan Water Commission.

NMED Exhibit 21, which is the Department's written testimony, was filed on March 4th, about -- what's that? -- about ten days after the notice of intent.

The testimony was sent electronically and by mail to all Commissioners, as well as to all parties or their counsel.

In addition, there are nine paper copies of the entire set of the Department's exhibits, including the written testimony available here in this box. If anyone needs one, feel free to take one. As you can tell by the volume of the exhibits, we were attempting to save paper and state resources by not simply sending full copies, but as Mr. Olson knows, we made copies available when people needed them.

One point with respect to the CD approach to distributing exhibits and testimony. When this hearing is all over, if you had some problem with this approach, or you'd like it in a different way, or you think the way we did it can be improved, we would welcome some input. This may be the first time that a party to a proceeding for the Commission has tried to do everything -- or a large portion of their proposal electronically, and we'd like to know how it worked for you.

All these exhibits, including the testimony, are already in the record, but I will still move for their introduction at the close of the Department's case in chief.

That concludes my opening statement, and now I ask that the Hearing Officer swear the witnesses.

(Oath administered to James Davis, John Montgomery, Steven Pierce and Glenn Saums.)

JAMES DAVIS

after having been first duly sworn under oath, was questioned and testified as follows:

DIRECT EXAMINATION

BY MR. AMES:

Q. Please state your name for the record.

A. James Davis.

Q. Where do you work, Dr. Davis?

A. I work in Santa Fe, at the New Mexico Environment Department, Surface Water Quality Bureau.

Q. What is your position there?

A. I'm Bureau chief.

Q. How long have you been Bureau chief?

A. A little over four years.

Q. Is your resume accurately reflected in the Department's notice of intent?

A. I believe so, yes.

Q. Then we'll proceed directly to your testimony.

What is the purpose of the Department's petition today?

A. The purpose of the Department's petition, as has been alluded to in introductory comments, is to complete the triennial review process that began in 1997, or was initiated in 1997, and that was heard by this Commission during September of 1998.

This Commission deliberated on the record that resulted from that hearing -- do I need this? I'll simply speak up. I have never -- there was a witness yesterday who indicated that they'd never been accused of having a soft voice, and in this very similar manner, I have never been accused of having a soft voice; however, if there is anyone in the audience that has difficulty hearing me, I would be pleased to use the microphone. I don't believe it's necessary, however.

MS. VIGIL: Excuse me. Some people in the back can't hear. Maybe if you can face your voice that way.

MR. AMES: That seems to indicate the microphone is probably necessary.

MR. DAVIS: Okay.

Hopefully, there will come -- it's worse.

I'll speak up, and if anybody can't hear me, let me know.

This Commission deliberated on the record that was generated during that eight-and-a-half day hearing in September of 1998. Following that deliberation, this Commission issued a decision concerning the items discussed in the triennial review, revised the water quality standards accordingly, and submitted that to the

USEPA in January of 2000.

EPA responded to that submittal on January 23rd of 2001. In their response, they included what's known as a record of decision, or ROD, R-O-D. In that record of decision, they approved most of the revisions to New Mexico's Water Quality Standards, they disapproved some revisions, and they advised that they would consider recommending disapproval of other revisions unless New Mexico took certain actions.

Now, these various documents, I believe, are found in Exhibit NMED 12.

Since that time, since January of 2001, both the Water Quality Control Commission and the New Mexico Environment Department have worked to address those various revisions that were either disapproved or provisionally disapproved by EPA.

Again, as has been alluded to in introductory comments, the Water Quality Control Commission clarified the exemption that applies to five numeric standards, the violation of which may arise from the reasonable operation of irrigation and flood control facilities.

In addition, the Department petitioned the Water Quality Control Commission to revise the definition of surface waters of the state. Also, as many of the Commissioners know, last October, the Commission held a hearing in Las Cruces to consider more stringent fecal coliform criteria for the lower Rio Grande.

Q. (BY MR. AMES) What does the Department propose today?

A. Specifically, today, the Department is proposing for the Commission's consideration the adoption of numeric criteria for priority toxic pollutants.

As you can see on the slide, these consist primarily of numeric criteria to protect human health, and this addresses the last pending issue for completion of the triennial review process initiated in 1997.

Specifically, the Department proposes 11 acute and 10 chronic numeric criteria for priority toxic pollutants to protect various fishery designated uses. The Department also proposes 92 numeric criteria for priority toxic pollutants to protect human health.

We propose a procedure for selecting or deriving numeric criteria when there are no criteria in the water quality standards, and a method of determining compliance with the human health criteria.

The Department also is proposing to apply these human health criteria to waters with an existing, designated, or attainable fishery use and tributaries for those waters.

Today, the Department will provide to the Water

Quality Control Commission information that is both necessary and sufficient to support a decision to adopt these criteria.

Q. Dr. Davis, what might happen if the Commission does not adopt the criteria?

A. Again, as was heard in introductory remarks, if the Commission does not adopt criteria today -- that are being proposed today, there is a risk that the US Environmental Protection Agency will impose more stringent criteria that would be broadly based on national concerns.

Specifically, EPA stated in their record of decision in January of last year that New Mexico's failure to address these issues could result in a finding that new water quality standards are needed to comply with the federal Clean Water Act, specifically Section 303(c)(4)(B) of the federal Clean Water Act.

Again, I would refer you to Exhibits NMED 1 and 12 in this regard. Specifically, that section of the Clean Water Act requires EPA to promulgate water quality standards whenever it finds that such standards are required to meet the requirements of the federal Clean Water Act.

On the slide in front of you now, you'll see examples where EPA has already taken such action for many states.

In 1992, EPA promulgated the National Toxics Rule, which imposed priority toxic pollutant criteria on 11 states. I do not have an exhaustive list in front of me, but these included Nevada, Alaska and Florida, the District of Columbia, the territory of Puerto Rico and one recognized Indian reservation, the Colville Indian Reservation. This list is found in NMED Exhibit 2.

Additionally, EPA promulgated what is known as the Great Lakes Initiative in 1995. The Great Lakes Initiative imposed priority toxic pollutant criteria on the several states and Indian tribes which border the Great Lakes.

Most recently, EPA promulgated what is known as the California Toxics Rule in 2000, which imposed priority toxic pollutant criteria on the State of California.

In short, EPA has a well-developed procedure and a successful track record for imposing priority pollutant criteria on states which do not act for themselves.

Q. Does EPA have any other incentive for imposing the priority criteria?

A. Yes.

Again, as was mentioned in introductory

remarks, there is a suit -- a federal lawsuit pending. EPA has been sued over the New Mexico standards.

In December of last year, 2001, two New Mexico environmental groups filed a notice of intent to sue EPA for several alleged failures relating to New Mexico's surface water quality standards. Included in that was EPA's failure to promulgate priority toxic pollutant criteria for the State of New Mexico in the NOI.

The complaint, which was filed last month, does not repeat this particular claim, and it is our presumption that that is because the Commission seems poised to consider and decide this matter.

Q. If the EPA is not sued, what might it do, or what will it do with regard to numeric criteria?

A. As you'll hear in much more detail later in the testimony, EPA will continue to apply numeric criteria equivalent to the National Toxics Rule.

In fact, this has been occurring, and you'll hear much more detail about that later in the testimony.

The additional witnesses from the Department will explain the reasons, but, again, in summary, if New Mexico does not adopt numeric criteria, by default, EPA will impose its own.

Q. It has been argued that the Commission should only adopt limited criteria for toxic pollutants now.

What is the Department's response to that?

A. We believe that it's a very straightforward thing to do it now. If there is any need in the future to revise numeric criteria, we have well-established procedures to allow that before this Commission. There is really no benefit in delaying adoption.

Again, as I stated just a moment ago, EPA already uses criteria at a more stringent level, and it could very easily continue to do that, and there is -- there is no cost -- no additional cost right now in adopting all of these criterion; however, any future effort to do so would incur the costs of another hearing and all of the ancillary activities associated with it.

Q. How do the Department's proposed numeric criteria compare to the criteria EPA is using right now?

A. EPA's criteria are more stringent, at least with respect to the risk factor for cancer-causing pollutants. We believe they are less responsive to New Mexico water quality issues than those proposed by the Department.

The principal difference is the risk level for cancer-causing pollutants. The Department is proposing a risk level of ten to the minus fifth. Interpreting that,

that would be the risk of one additional cancer in 100,000 exposed persons, and this is consistent with this Commission's policy.

EPA, on the other hand, would impose criteria using a risk level of ten to the minus sixth, which would be the risk of one additional cancer in one million exposed persons.

There is a potential, a real potential, that EPA's more stringent criteria could affect NPDES permittees in New Mexico -- NPDES stands for National Pollutant Discharge Elimination System -- including municipalities with treatment works discharging into waters of the US.

In this light, we recommend that the WQCC, the Commission, should carefully consider this issue in adopting numeric criteria for priority toxic pollutants.

Q. The Department will explain in its testimony why it's proposing ten to the minus five as opposed to ten to the minus six as the risk level, correct?

A. That's correct.

Q. Why don't we skip a little bit.

A. Yes.

Q. What has the Department done to solicit public input?

A. We made a fairly substantial effort in this regard. As the Commission knows, on November 29th of last year, the Department submitted the original petition to the Water Quality Control Commission, and that's found in Exhibit NMED 16.

On December 11th of last year, at the regularly scheduled meeting of the Commission, the Commission considered the petition and granted the public hearing, set it for this meeting.

Following the Commission's decision, the Department published the petition and notice of public hearing on its web page and in the Albuquerque Journal. We gave specific notice to all persons on the Commission's mailing list, and to other persons who had expressed interest or would likely be interested in the matter, and this is found in Exhibits NMED 17 and 18; and then the Bureau initiated a dialogue with several organizations and persons known to be interested in the triennial review and surface water quality standards.

Specifically, we met with a list of entities during the month of January, and that's on the slide in front of you.

On January 11th, we met with the Municipal League, Environmental Quality Association. On January 15th, we met with Los Alamos National Laboratory. That same day, January 15th, we met with the Dairy Producers of New Mexico. On January 16th, we met with Forest Guardians and Amigos Bravos. On January 18th, we met with the Middle Rio Grande Conservancy District, the Elephant Butte Irrigation District, the Carlsbad Irrigation District, the San Juan Water Commission and representatives from the City of Farmington. On January 31st, we met with the US Fish & Wildlife Service. Exhibit NMED 19 contains the sign-in sheets from these several meetings.

We also attempted to meet with the New Mexico Acequia Commission, the New Mexico Cattle Growers Association, and the New Mexico Department of Agriculture. We were not successful in that. Scheduling difficulties for those various organizations prevented that.

Q. Did these meetings prompt any changes to the Department's proposal?

A. Yes, in fact, they did.

Our purpose in holding these meetings was to engage in dialogue with interested parties and persons, hoping to obtain their insights into this petition. We specifically selected these persons or parties because they had participated in previous hearings before the Water Quality Control Commission, they had demonstrated a continued interest in the Commission's work and in the protection of the state's waters, and we felt that they were knowledgeable about the petition, about the issues at hand, and were affected by the petition.

Speaking very personally, I am pleased in the outcome of this effort. This required a fair amount of time and commitment on the part of the persons who met with us. We appreciate that.

It's also important to state that information was presented in these meetings that helped to clarify both our objective and intent with respect to the several sections of the petition.

So this was an effort that I believe very strongly benefited the Department, and I would hope also benefited the participants in the meeting -- meetings.

MR. AMES: Okay. We'll now move on to Mr. Montgomery.

JOHN MONTGOMERY

after having been first duly sworn under oath,
was questioned and testified as follows:

DIRECT EXAMINATION

BY MR. AMES:

Q. Please state your name for the record.

A. John Montgomery.

Unlike Dr. Davis, I have been accused of having a soft voice. The microphones are gone, so I'll do my best.

Q. Okay. Mr. Montgomery, where do you work?

A. I work in the Surveillance and Standards Section of the Surface Water Quality Bureau, New Mexico Environment Department.

Q. What is your job there?

A. I'm the surface water quality standards coordinator.

Q. How long have you done that?

A. A little over six months.

Q. What did you do before coming to the Department?

A. For about 14-and-a-half years, I worked for the Wyoming State Engineer's Office. I was in the Groundwater Section for nine years as a geologist. I worked another four-and-a-half years as the hydrographic commissioner on the Upper Green River, basically administering water rights.

I then attended law school. After graduation, I practiced law for about five years. I then took a position as the county planning director in Laramie, Wyoming, until the time I moved down here to take this position.

Q. Is your biography accurately reflected in the notice of intent?

A. I believe it is.

Q. Let's move on to your testimony.

What is the subject of your testimony?

A. I'll be testifying regarding the interrelated provisions of federal and state law and the regulations that combine to form the legal framework of regulating toxic pollutants in the surface water.

First, I'll describe the provisions of the federal Clean Water Act that establish the requirements for states to regulate toxic pollutants in surface water.

Second, I will identify the EPA regulations implementing these requirements.

Finally, I will discuss the provisions of state law that authorize the Commission to adopt the narrative and numeric criteria necessary to comply with the federal Clean Water Act.

Q. Please continue.

A. If it pleases the Commission, I won't read the statutes verbatim, in the interest of time.

First, we start with Section 101 of the Clean Water Act, which states the policy of Congress with regard to toxic pollutants -- that being that it is the national policy that the discharge of toxic pollutants in toxic amounts be prohibited.

Congress then set forth a method by which this goal should be achieved in Section 303(c)(2)(B), which requires states to adopt toxic pollutant criteria to protect designated uses. The state must adopt numeric criteria if they are available; and if not, the state must adopt criteria based on biological monitoring or assessment methods.

Next, Section 307(a)(1) establishes the preliminary list of toxic pollutants and authorizes EPA to revise the list and add to or remove pollutants after consideration of specified factors. EPA has exercised this authority, adding and removing pollutants on a number of occasions. Initially, there was a list of 65 chemicals and families of chemicals that was expanded to a list of 129, and three have been delisted, bringing the current list to 126 toxic pollutants in the National Recommended Water Quality Criteria.

Finally, Section 304(a)(1) requires EPA to develop and publish numeric criteria for the toxic pollutants that are listed in Section 307(a)(1). These values are commonly known as the Section 304(a) criteria for toxic pollutants.

We have some examples on this slide of some of the substances, certainly not a full list of the 92, but perhaps gives an idea of the types of substances that are involved.

EPA has published numeric criteria for many, but not all, of the priority toxic pollutants. These criteria are compiled in 40 CFR 131.36(b)(1). This is contained in NMED Exhibit 2 and in related EPA documents, such as the National Recommended Water Quality Criteria - Correction of April of 1999, which is available as Exhibit NMED 5.

Most of the criteria were originally published in 1980. Those were a series of documents for demonstration purposes. They look like this. They take up about two-and-a-half to three feet of shelf space.

Okay. Many of these documents are available from the EPA website. There are a number that have not been put onto the site, but a large number of them are. The documents can also be found in most federal repository libraries.

The basis for each criterion, and a full list of references on which the criterion is based, is set forth in these formal criteria documents.

Q. Are these criteria subject to ongoing review by EPA?

A. Yes. The criteria are subject to ongoing review.

Section 304(a)(1) requires EPA to revise its criteria to accurately reflect the latest scientific knowledge. Accordingly, EPA has, from time to time, updated criteria based on the new information. In addition, EPA derives new criteria for listed pollutants through a routine process.

In my written testimony, there may be a small amount of confusion. I believe I stated in there that EPA would routinely revise their criteria. In fact, it is not something that happens that frequently, but when it does happen, it happens through a routine process.

That process begins with a comprehensive review by EPA of available data and information. EPA then publishes a notice in the Federal Register and on the Internet announcing its intent to evaluate an existing criterion, or to derive a new one, identifying the available data and information and inviting the submission of new data and information relative to criteria development.

After reviewing any responses, EPA develops a draft recommended water quality criterion and publishes notice in the Federal Register and on the Internet announcing the availability of the draft criterion and inviting public comment and scientific review.

Concurrently with the notice, EPA initiates an agency peer review. This review is conducted by a panel of experts who produce a report of their findings. The peer review process is itself subject to public scrutiny. EPA's peer review practices are published in the Science Policy Council's Peer Review Handbook, which is EPA Document 100-B-98-001, and it may be viewed at the EPA website.

At the conclusion of the public comment and peer review processes, EPA evaluates the public comments and the panel's report and publishes its response in the record. EPA then revises the draft criterion, if necessary, and again publishes notice in the Federal Register and on the Internet announcing the availability of the final water quality criterion. At this point, the EPA's decision is subject to judicial review.

Q. John, how does the EPA reflect to the public how -- that it's actually conducting this ongoing review?

A. If I understand your question correctly, it is through publication, through notice in the Federal Register and on the Internet. Is that --

Q. And is the IRIS a part of this?

A. Oh, okay. Well, yes.

EPA maintains a record of its ongoing review of scientific knowledge relating to water quality criteria by posting new data and information on the Integrated Risk Information System, or IRIS, database. A detailed description of IRIS is contained in Exhibit NMED 4, Appendix N.

On the screen we have, for demonstration purposes, a slide of the introductory IRIS web page. IRIS is a publicly available electronic database that provides chemical-specific risk information on the relationship between exposure and human health effects.

The next slide shows a drop-down list where you can click on a particular substance of interest. The next slide is a sample of one of the -- at least the beginning of one of the pages. This one happens to be for PCBs. The next screen shows a later portion of one of these that shows where the cancer risk information is published.

EPA originally developed the IRIS to assist federal government agencies in responding to the growing demand for consistent chemical-specific information for risk assessments, standard-setting, and other regulatory activities. Information is posted on IRIS only after a consensus has been reached by an interdisciplinary team of scientists representing EPA's various program offices that information -- after a consensus that the information is credible.

Consequently, the IRIS represents an agency-wide consensus regarding the latest scientific knowledge about the chemical. The EPA updates this IRIS list on a monthly basis.

In addition to chemical-specific information, the IRIS database also identifies the most significant and recent references on which EPA's risk assessment is based. To be added to the IRIS database, each reference must have been peer reviewed.

Exhibit NMED 6 contains a compilation of references for each of the toxic pollutant numeric criteria adopted by EPA under Section 304(a)(1). The compilation includes references in the original 1980 criterion documents, as well as references considered by EPA in its ongoing review of those criteria. These latter references were obtained from the IRIS database.

Q.   Would it be correct to say that the listings of references in Exhibit 6 are the scientific basis for the numeric criteria that EPA has adopted pursuant -- or recommended pursuant to Section 304(a)(1) of the Clean Water Act?

A.   Yes.

In my discussions with personnel of EPA and other research I've done, I found that the references listed in the 1980 documents -- well, let me rephrase.

The 1980 documents are the criteria guidance, and the references in there are the references that were cited by EPA in the development of those documents, and then, as they are revised, as new information is made available, that information appears on the IRIS database and its list of references.

Q. You've compiled all the references, as you said, for all of the pollutants for which the Department is proposing to correct here today, or all the criteria the Department is proposing today; correct?

A. That's correct.

Q. How long is that document?

A. The document, including some chemical synonyms lists, is approximately 750 pages. There are 683 pages of actual references.

Q. Do you know how many references are actually there?

A. I calculated that once. I don't recall the number, but it seems like it's in excess of 10,000 references. Some of those references do duplicate between different substances, so the actual count will be less than that.

Q. How has EPA implemented Section 303(c)(2)(B) of the Clean Water Act?

A. EPA has established and published regulations to implement the statutory requirements in Section 303(c)(2)(B). These regulations are set forth in 40 CFR, Part 131, Water Quality Standards.

Of particular relevance is Section 131.11(a)(2), which requires the state to adopt criteria for toxic pollutants which may adversely affect water quality or the attainment of the designated water use or which warrant concern.

The criteria must be set at levels sufficient to protect the designated use, and 40 CFR 131.11(a)(1) requires the criteria must be based on sound, scientific rationale.

The EPA regulations also establish the acceptable form of criteria. 40 CFR 131.11(b) states a presumption that numeric criteria will be adopted. However, the states are authorized to adopt narrative criteria when numeric criteria cannot be established or to supplement numeric criteria.

This Commission long ago adopted, and EPA approved, a general narrative criteria for toxic pollutants. More recently, the Commission has adopted numeric criteria for certain chemicals and heavy metals. Steve Pierce will describe the Commission's historical approach to toxic pollutants during his testimony, as well as the basis for the Department's proposal to add numeric criteria and a procedure for selecting and deriving new criteria.

With respect to numeric criteria, Section 131.11(b) authorizes the state to use one of three approaches. First, the state may rely on EPA's published Section 304(a) criteria for priority toxic pollutants. As I previously described, these criteria are developed and published by EPA pursuant to the Clean Water Act and only after scientific peer review process and subject to judicial review.

As Steve Pierce will explain, these criteria, with one exception, are the numeric values which the Department proposes today.

Second, the state may adopt EPA's Section 304(a) criteria for priority toxic pollutants with modifications to reflect site-specific conditions. This approach requires substantial information about a water body, and if applied state-wide, will quickly exhaust the Department's resources. However, it may be possible to use this approach to adjust the numeric criteria, after their adoption by the Commission, to account for surface waters with substantially different physical, chemical, or biological characteristics.

Finally, the state may use other scientifically defensible methods. However, the Department is reluctant to develop its own method for deriving new values for all of the priority toxic pollutants in Sections 307(a)(1) due to the cost and uncertainty whether EPA would accept those methods.

Q. Mr. Montgomery, does the New Mexico Water Quality Act authorize the Commission to adopt numeric and narrative criteria for priority toxic pollutants?

A. Yes.

The New Mexico Water Quality Act establishes the Commission and its powers and duties regarding the water quality in the State of New Mexico.

First, the New Mexico Water Quality Act designates the Commission as the state water pollution control agency, quote, for all purposes of the federal act, unquote, and directs the Commission to take all action necessary and appropriate to secure the state -- to secure to this state the benefits of the federal Clean Water Act and its programs.

One such benefit is the opportunity, under Section 303(c)(2)(B), for the state to adopt toxic pollutant criteria for itself under its own terms, rather than having the criteria imposed upon it by the federal government.

Second, the New Mexico Water Quality Act expressly authorizes the Commission to adopt water quality standards that shall, at a minimum, protect the public health and welfare, including water quality criteria to protect designated uses.

The scope of this power is broad enough to authorize numeric and narrative criteria, and, in practice, the Commission has interpreted and applied this power to adopt both types of criteria as necessary to secure to this state the benefits of the federal act.

MR. AMES: Thank you, Mr. Montgomery.

Now, I'll move to Mr. Pierce.

STEVEN PIERCE

after having been first duly sworn under oath,
was questioned and testified as follows:

DIRECT EXAMINATION

BY MR. AMES:

Q. Mr. Pierce, please state your name for the record.

A. My name is Steven Pierce.

Q. And, Mr. Pierce, where do you work?

A. I work at the Environment Department, Surface Water Quality Bureau, in the Surveillance and Standards Section.

Q. What do you do there?

A. I'm the program manager of the section.

Q. Is your biography accurately reflected in the notice of intent?

A. It is.

MR. AMES: At this point I'd like to interject a statement. Mr. Pierce is a bit under the weather and is not going to be able to present all of his testimony as planned.

The written testimony had already been previously provided to all the Commissioners, and I hope the Commission has had a chance to look it over, so we're actually going to skip substantial portions of Mr. Pierce's testimony, both to preserve time, move this proceeding to a conclusion, and also to preserve Mr. Pierce's voice for cross -- at least when we get there.

Q. So with your indulgence, Mr. Pierce, we're going to skip through the national -- the discussion about the national experience, which is background information for you all to understand how the United States got to this point, or how we got to the point of 303(c)(2)(B) of the Clean Water Act, which is the driver behind this particular petition. We're going to hit some questions along the way.

In particular, I'd like to ask Mr. Pierce what EPA has done to enforce the requirement for numeric criteria.

A. EPA has taken two steps to accelerate compliance with the requirement to adopt numeric criteria.

First, while the states take the necessary steps to adopt --

MR. AMES: I think we're actually going to interrupt Mr. Pierce at this point, because I don't know how productive this is going to be for anyone, particularly Mr. Pierce.

I think we'll let Mr. Davis -- Dr. Davis present his testimony, if that's acceptable. It is Mr. Pierce's testimony, he's available for cross on that testimony. I don't believe that there have been, in the section that Dr. Davis is going to do, any changes from the written testimony itself.

With the Hearing Officer's indulgence, could we proceed in that manner?

In the Hearing Officer's absence, can we proceed?

MR. JOHNSON: Proceed.

MR. KEYES: We could take a five-minute break.

MR. AMES: That would be fine. I'd sure appreciate that.

(Recess held.)

MR. MAGGIORE: Let's go ahead and return from our recess.

I apologize for -- I was powdering my nose when

I guess Commissioner Keyes made an executive decision to go on break, which is excellent judgment.

I believe you were going to proceed with the direct testimony from Mr. Pierce?

MR. AMES: Yes, we are --

MR. MAGGIORE: Okay.

MR. AMES: -- Mr. Chairman.

Thank you.

MR. MAGGIORE: Please proceed.

Q. (BY MR. AMES) Mr. Pierce, what has EPA done to enforce the requirement for numeric criteria in the Clean Water Act?

A. EPA has taken two steps to accelerate compliance with the criteria.

First, while the states take the necessary steps to adopt numeric criteria, EPA adopted an interim measure to provide numeric criteria for NPDES permitting. The measure authorizes three alternatives for translating narrative toxic criterion, which is no toxics in toxic amounts, into chemical-specific applicable numeric criteria.

One alternative is to use the EPA's numeric criteria for priority toxic pollutants. Another alternative is to use the state-approved translation procedure.

The second step taken by EPA is to begin federal promulgation of numeric criteria. Rather than rely on permit writers, state and federal, to comply with the interim measure, EPA has imposed numeric criteria through the National Toxics Rule, the California Toxics Rule, and the Great Lakes Initiative.

It's in the context of these federal promulgations that EPA has demanded that New Mexico adopt numeric criteria for itself.

Q. What has New Mexico done to regulate toxic pollutants in surface water?

A. Well, for many years the State of New Mexico has relied on the narrative toxics criteria to satisfy its obligation under the Clean Water Act. In 1991, at the Department's request, the Commission supplemented this narrative criterion with numeric criteria for 13 priority toxic pollutants, but only for the protection of aquatic life.

EPA approved the new criteria, although it cautioned that additional criteria would be required in the future.

In 1992, EPA promulgated the National Toxics Rule. The Department responded by expanding its sampling program to include the entire list of priority toxic pollutants. The Department collected these samples during all major water quality surveys at each location that was deemed to pose the highest probability of detecting priority toxic pollutants. The Department entered all these results into EPA's STORET water quality database. After considerable data evaluation, the Department determined that two organic priority toxic pollutants were present in state waters -- DDE, a breakdown of DDT, and gamma BHC, also known as lindane.

These priority toxic pollutants were detected in samples collected and analyzed by USGS -- DDE in two tributary drains of the Rio Grande, and lindane in the Santa Fe River. However, the measured concentrations were far below EPA's 304(a) criteria for these pollutants.

Accordingly, the Department determined that no priority toxic pollutants could reasonably be expected to interfere with the designated use of any water covered by the Clean Water Act, and it did not propose that the Commission adopt any numeric criteria for priority toxic pollutants during the 1998 triennial review.

Q. What was EPA's response?

A. On January 23rd, 2001, EPA issued its record of decision on New Mexico's 1998 triennial review. The ROD stated that EPA would consider recommending that the administrator make a finding that New Mexico water quality standards did not comply with the Clean Water Act because they do not contain human health and aquatic life criteria for all priority toxic pollutants listed pursuant to Section 307(a)(1).

EPA gave two options for avoiding this result: we could adopt aquatic life and human health criteria for the remaining priority pollutants, or we could provide data analysis demonstrating these criteria are not needed because the pollutants are not present in concentrations that threaten aquatic life and human health.

Q. Now, in response to the ROD, the Department sought data from EPA and then they got back some effluent discharge screening data.

In addition to that data, you mentioned the ambient data we had on the tributaries to the Rio Grande and the Santa Fe River.

After the Department reviewed all this information, what position did it take and what position is it taking now regarding EPA's demand for numeric criteria?

A. Well, the Department has pretty well concluded that it might be most prudent to adopt all the remaining priority pollutant criteria. We have no data to prove that the presence of priority toxic pollutants in various effluent discharges and in the ambient waters of Los

Alamos National Laboratory and the Santa Fe River will not interfere with designated uses in affected waters of the United States.

Indeed, the levels of priority toxic pollutants in the ambient waters at Los Alamos National Laboratory indicate a threat to aquatic life and human health downstream in the Rio Grande. Moreover, it must be acknowledged that EPA's interpretation of the Clean Water Act, which it's charged with implementing, may be entitled to substantial deference.

Indeed, having stated its position that the Clean Water Act requires New Mexico to adopt numeric criteria for all priority toxic pollutants, EPA may have a difficult time evading the obligation to promulgate such criteria in the face of state inaction. In this light, the Department recommends that the Commission take the opportunity to adopt the numeric criteria it deems most appropriate and advantageous to the interests of the State of New Mexico.

Q. Assuming the Commission accepts the Department's recommendation, what options does it have?

A. EPA recognizes three options for complying with these requirements. The options are explained in more detail in the Water Quality Standards Handbook, which is

Exhibit NMED 4.

Option one is to adopt numeric criteria for all priority pollutants for which EPA has developed Section 304(a) recommended criteria, which are applicable to all state waters without regard to whether the pollutants are known to be present in those waters.

Most states exercise this option, and use EPA's Section 304(a) recommended criteria, because it achieves comprehensive coverage with scientifically defensible criteria, therefore, avoiding the need to conduct resource-intensive evaluations of numerous waters.

Option two. The state could adopt numeric criteria only for those priority toxic pollutants which are discharged or present in a state water and which could reasonably be expected to interfere with designated uses, and only to the extent necessary to protect those uses.

Functionally, this option requires the development of site-specific criteria. While the option comports with the statutory requirement and only requires criteria in response to a specific problem, in practice this option is difficult to implement. It is time- and resource-intensive to determine if, and which, priority pollutants are interfering with a designated use.

Moreover, the time and resources required to develop and defend site-specific criterion on a recurring basis pose substantial problems for the Department, for the Commission, and for other interested parties.

In this regard, the option suffers from the same flaws that doomed the pre-1972 approach to water pollution control.

Option three. Adopt a procedure for translating a general narrative toxic criterion, no toxics in toxic amounts, into chemical-specific numeric criteria. At a minimum, this procedure must be used to derive numeric criteria for priority toxic pollutants whose discharge or presence could reasonably be expected to interfere with a designated use.

This option provides the flexibility of calculating numeric criteria on an as-needed basis, reducing the time and cost of adoption and allowing the immediate use of the latest scientific information.

And then there is option four that EPA didn't state, and that's that no action is taken. The result of this is it's possible EPA could promulgate these standards, these criteria, for the State of New Mexico.

The Water Quality Standards Handbook indicates that the most appropriate use of option three is to supplement option one or two. This would provide numeric criteria for priority toxic pollutants with statewide applicability to ensure precision in the calculation of effluent limitations for NPDES permits and total maximum daily loads, backed up by a predictable method for developing additional numeric criteria as needed.

Q. What option has the Department been implementing for the past decade?

A. Since 1990, the Department has followed option two. It selected this option because it called for a more limited collection of samples for analysis during some water quality surveys and therefore was less expensive.

However, since EPA issued the ROD in January, 2001, the Department has been collecting and analyzing more extensive samples for all priority toxic pollutants during all water quality surveys. Accordingly, the principal argument against option one, which was the expense of sampling and analyzing for all priority toxic pollutants during all water quality surveys, is no longer applicable because we're already doing that.

Q. What is the Department's preferred option today?

A. The Department recommends that the Commission adopt a combination of option one and option three. With respect to option one, the Department recommends the adoption of numeric criteria for all priority toxic pollutants for which EPA has published Section 304(a) criteria for the consumption of organisms.

With respect to option three, the Department recommends the adoption of a translation procedure for the existing general toxic standard to allow EPA to derive a numeric criterion for priority toxic pollutants in NPDES-regulated discharges but for which the Commission has not yet adopted numeric criteria.

The translation procedure has many advantages for New Mexico. First, it would allow the Department to certify NPDES permits with a reasonable assurance that designated uses are being protected. The translation procedure requires the use of the IRIS data, which is consistent with the federal requirement to use the most current risk information in calculating criteria for the protection of human health. It also requires the Department to incorporate the appropriate EPA-approved formulae for calculating numeric criteria into the Water Quality Management Plan.

These formulae, recently revised by EPA, are established in EPA's Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health. That's Exhibit NMED 7, and also shown on the slide.

Second, the translation procedure ensures that

EPA will implement the Commission's policy choice regarding the appropriate risk level for cancer-causing priority toxic pollutants.

In this petition, the Department proposes a cancer risk level of ten to the minus fifth. That's one additional cancer in 100,000 exposed persons.

The proposal reflects the Commission's previous endorsements of this risk level. They have endorsed this specifically in the water quality standards under the section of domestic water supply and also in the regulations at 20.6.2.7.UU, which is the definition of a toxic pollutant as one that would cause a risk level of ten to the minus fifth.

Third, the translation procedure tells EPA how to calculate numeric criteria when none is provided in the state water quality standards.

Finally, as I'll explain later in my testimony, the translation procedure requires the Commission to review and approve the numeric criterion itself. Notwithstanding the advantages of the translation procedure, it should be noted that the approach is not new. The Commission already employs a similar translation procedure for calculating aquatic life chronic numeric criterion, and it's the Department's practice to petition the Commission to review and approve criteria that have been derived through this process.

Q. How are you doing?

A. I'm fine.

Q. We're now going to go on and talk about the petition itself section by section. We'll try and focus on the primary sections. There are a number of changes in the petition that probably don't warrant a discussion.

So why don't we start with Section 10, one of the primary changes.

Can you please explain what the Department has proposed with respect to Section 10 of the water quality standards?

A. Yes, I can.

The Department proposes a new flow value for evaluating compliance with human health criteria. The new value, which is known as the harmonic mean flow, is defined in EPA's Water Quality Standards Handbook, which is Exhibit NMED 4.

This definition says, "Harmonic mean flow is the number of daily flow measurements divided by the sum of the reciprocals of the flows," and it restates it as it is the reciprocal of the mean of reciprocals.

The Department initially did not propose a definition for this term because the Commission had indicated during the 1998 triennial review and deliberations that standard statistical terms should not be defined in the standards. However, during the Department's January meetings with interested groups, several persons recommended that a common reference be provided. In response, the Department selected the EPA Water Quality Standards Handbook, which is publicly available in hard copy and also electronically on the Internet.

Nonetheless, LANL has suggested that actual language from the Water Quality Standards Handbook be added. The Department supports this proposal on the condition that the definition be contained in Section 20.6.4.10, which is the section that would have the reference to the harmonic mean flow, and that's because in the public notification, we did not notify that there would be any changes to Section 7, which is where definitions would be contained.

If this is the case, we could recommend a definition be adopted in that section during the triennial review.

The Department's specification of the harmonic mean flow and the proposed reference to the EPA definition ensures that the application of water quality standards complies with federal requirements. Since

1992, EPA has developed a Section 304(a) criteria for cancer-causing pollutants using exposure assumptions which are best reflected by the harmonic mean flow.

Specifically, EPA's model for human health effects assumes long-term exposures to low concentrations. Recently, EPA amended its implementation procedures to require the use of harmonic mean flow for noncancer-causing pollutants as well. As a result, EPA now requires the use of harmonic mean flow to implement all human health criterion.

The Department's proposing to retain the existing flow value, the critical low flow, for all other criteria. This value is used to calculate the NPDES effluent limitations to ensure that discharges comply with the criteria during most flow regimes -- that is, during all flow regimes above a specified low point, the critical low flow.

The specification of this low point is important, because, without it, a discharge would have to comply with the applicable numeric criteria at the end of the pipe. The standard would become the effluent limit.

The current critical low flow is the 4Q3, the lowest four-day flow which has a return frequency of three years. The Commission adopted this value in 1991 in order to implement new aquatic life criteria for heavy metals, which are a subset of the priority toxic pollutants listed pursuant to Section 307(a)(1) of the Clean Water Act.

Before 1991, the Commission had specified this low point, the critical low flow, as the 7Q10, the lowest consecutive seven-day flow which recurs once in a ten-year period.

The difference between the harmonic mean flow, the 4Q3 and the 7Q10 is illustrated by the graphs shown in Exhibit NMED 11, which is shown on the screen.

Generally speaking, for a given stream, the harmonic mean flow is higher than the 4Q3, and both are higher than the 7Q10.

Originally, EPA took their use of the harmonic mean flow from an article that was published in the Journal of Hydraulic Engineering, which gives more information on the harmonic mean flow. In here, they state flows for 60 different watersheds throughout the country, and in every single case, the harmonic mean flow is lower than the average. The shorter the term, the closer the two are together.

If you look at the average on the seven-day period, the two terms are no more than two percent apart. As the time length grows longer, the harmonic mean flow starts diverging from the average, but it's always less than the average.

The graphs show these flows for two different streams. The first graph shown here represents data for the free-flowing Rio Chama at La Puente, which is near Tierra Amarilla. The flow shown for each day shows the average for all flows for that day from 1956 to 1997, as measured by USGS. The total average flow for all days in the entire period is 364 cfs. The harmonic mean flow is 62.6 cfs. The 4Q3 flow, which is used for all other standards now, is 17.5 cfs. The 7Q10 that we used to use is 7.4 cfs.

So you can see that the harmonic mean flow is a less stringent way of applying standards.

The second and third graphs present the data for the Rio Grande at Albuquerque. Since 1973, the flow of the Rio Grande at Albuquerque has been controlled by Cochiti Dam, dams on the Rio Chama, Willow Creek, Jemez River, Galisteo Creek, and also the irrigation diversion at Angostura. For this stretch of river, the total average flow from 1975 to 1999 is 1,489 cfs.

In order to get a clearer picture of the others, we have to enlarge that section that's there, and it shows the harmonic mean flow would be 161 cfs, the 4Q3 flow is down toward the bottom at 32.2 cfs, and the 7Q10 flow is right at the baseline at 7.8 cfs.

So the harmonic mean flow here, again, is a lot less stringent way of implementing these standards.

One recurring issue regarding the use of harmonic mean flow concerns the application of human health criteria to ephemeral waters. The Department's proposing to apply human health criteria for a small number of the priority toxic pollutants to ephemeral waters which are tributaries of those waters with existing, designated or attainable fishery uses.

Specifically, the Department seeks to prevent persistent toxic pollutants, such as dioxin, DDT, PCBs, and various heavy metals, from reaching waters which contain fisheries used by New Mexico residents.

In a moment, I'll explain the Department's rationale for this proposal. It's been pointed out that it's not possible to calculate the harmonic mean flow for ephemeral waters, and, therefore, it's not possible to apply the human health criteria to these waters except at the end-of-pipe basis.

LANL has proposed in these procedures using the modified harmonic mean formula currently used by the State of Texas, which accommodates ephemeral waters that have periods of zero flow. The original formula could not take zero flows because it has to have the reciprocal of the flow, which is a nondefined term.

The Department believes that LANL's proposal has merit and supports the use of this formula for those waters that are ephemeral.

Finally, San Juan Water Commission argues that the Department should have evaluated whether harmonic mean flow represents the long-term average flow on which the human health criteria are based and adopt a long-term average flow if it reflects the appropriate flow conditions.

EPA stated in the California Toxics Rule, which is their most recent promulgation of human health criteria, that it believes that the harmonic mean flow is the correct statistic to use in computing such design flows rather than any other averaging techniques. Since EPA has conducted extensive studies into this matter, the Department sees no reason to invest its resources and reinvent the wheel.

Q. Mr. Pierce, the Department has proposed a new subparagraph in Section 10 regarding the applicability of the human health criteria.

Can you please explain what the Department's proposal is?

A. Yes, I can.

The Department proposes this new section to identify the waters that are subject to the numeric criteria for the protection of human health. Specifically, these criteria would apply to all waters with a designated, existing or attainable fishery use.

There is little dispute about the application of the criteria to this. This language was adopted at public meetings for our proposal.

The Department's proposed human health criteria were developed to protect humans consuming fish, so it's appropriate to apply these criteria to waters with a designated, existing or attainable fishery use. The Department also proposes to apply a small subset of these criteria to waters which are tributary to waters with a designated, existing or attainable fishery use. This application is more contentious, because some of these tributaries are ephemeral or have ephemeral reaches. Many of these waters may have aquatic organisms, but they do not generally have fish which are consumed by humans.

The Department believes that it's appropriate to apply the criteria for persistent toxic pollutants to these ephemeral waters in order to protect downstream waters which do have fish communities. As I previously stated, the purpose of the human health criteria is to protect human health from the consumption of fish with toxic pollutants in their flesh.

For most of the toxic pollutants, this goal can be accomplished by protecting the water in which the fish live from direct discharges of these pollutants. These pollutants degrade into less toxic compounds in a relatively short period of time, a matter of days or weeks.

Other toxic pollutants are more persistent, or else they degrade to equally toxic components, such as DDT. These pollutants pose a substantial risk in the environment over a period of many lifetimes. In many cases, they adhere to sediments and are mobilized during runoff events and transported downstream to live waters. These pollutants are bioaccumulative. They accumulate in fish, which absorb them from the water and the aquatic organisms which they eat, who in turn have absorbed them from the water column and from the sediments. Over time, these pollutants bioaccumulate to concentrations which are dangerous to humans which consume the fish.

This problem is real and it exists currently in New Mexico. The table in Exhibit NMED 10 indicates high levels of PCBs and dioxin in ephemeral storm waters at Los Alamos National Laboratory. These data were collected by the NMED-DOE Oversight Bureau, and they were analyzed by the Access Analytical Laboratories in

Vancouver.

There also is evidence that these pollutants are being transported downstream into waters containing fish consumed by New Mexicans. Exhibit NMED 9 contains a February, 2002, data review which reveals high levels of PCBs and dioxin in fish that were caught in Cochiti Reservoir.

This is only an example, and it's not my intent to single out LANL. These are very hard-to-detect pollutants. They may be found in other locations of the state if these same precise sampling and analytical procedures, which are very expensive, are conducted. But the example illustrates a larger point. For persistent toxic pollutants in ephemeral waters, the most common control strategies in place do not work.

For persistent toxic pollutants, a different strategy is needed. To protect downstream fisheries, the pollutant load discharged to the ephemeral water must be controlled. To achieve this objective, the numeric criteria for persistent toxic pollutants must be applied to the tributary itself, even if it does not have fish or a designated fishery use.

Q. LANL opposes the applicability of human health criteria to ephemeral waters. What arguments does it make in this regard?

A. LANL argues that ephemeral waters do not contain fisheries, and that is true. However, the Department's proposal is designed to ensure that loads of certain highly persistent toxics do not reach fishery waters.

LANL argues that applying criteria to ephemeral waters is not the best way to protect the downstream uses. They talk about the Rio Grande, and if a domestic water supply use were designated, that every tributary upstream of that segment would be required to be designated as a domestic water supply. This is really a straw-man argument. Standards are set on upstream waters to protect downstream uses. Natural free-flowing streams have the ability to attenuate levels of pollutants. They clean themselves up over distance and time. That's why not all waters upstream from primary contact waters have to be designated as primary contact. In those cases, the standards that are in place in upstream waters do protect the primary contact use downstream. However, that would not be the case for these highly persistent subsets of contaminants. These will stay in the environment for generations and will bioaccumulate.

Under LANL's proposal, these persistent contaminants would not be regulated in ephemeral streams. The Department's proposal only applies to 15 -- the very worst of the worst of the toxic chemicals -- to ephemeral tributaries. These substances persist in the environment and bioaccumulate to dangerous levels in fish. There is no good reason to release any of these 15 persistent toxic chemicals into the watersheds of the state.

LANL argues that existing approaches are effective. The current application of standards to effluent-dependent reaches only applies when discharges routinely reach classified waters downstream, and it excludes all those discharges which reach those classified waters during runoff events. This is a very large loophole in the standards.

The LANL proposal is a blank check for discharges which add loading of persistent toxics to waters of the state. Water flows downhill and it carries sediments with it, and the sediments -- the smallest sediments have the largest surface water area and tend to pick up the greatest number of those contaminants. It's these fine sediments that get moved most easily downstream.

Any of these persistent priority toxic pollutants that are allowed to enter ephemeral waters will move downstream over time. Allowing these contaminants to enter ephemeral waters is the same as allowing them to enter waters that have fish in them.

Q. Mr. Pierce, in its written testimony the San Juan Water Commission argues that the Department intends to apply the criteria to private waters.

What is the Department's response?

A. There is absolutely nothing in the Department's proposal that says this. Jim Davis did not say this during the public outreach meetings.

If the San Juan Water Commission believes that this was said, why did they not question this at that meeting at that time? The meetings were set up for the purpose of openly exchanging information in a non-confrontational situation and to arrive at the very best proposal for all parties.

Private waters are and will continue to be exempt under the New Mexico Water Quality Act. That's simply not a prerogative of the Surface Water Quality Bureau.

Q. Mr. Pierce, what method will the Department use to determine compliance with the human health standards?

A. The Department proposes to add this section in order to specify the method for determining compliance with human health criteria.

The single grab sample approach is consistent with the compliance method adopted by the Commission for all the other numeric criteria, except for compliance with chronic aquatic life criteria, which is based on the arithmetic mean of analytical results using appropriate protocol.

Now, in practice, the Department doesn't make compliance determinations on fewer than two samples, even if the method does allow for a single grab sample. When the Department detects an exceedence of a numeric criteria in an analytical result, after all QA/QC requirements have been investigated and found to be in effect, it goes out and collects at least one second sample from the same location. Only if the Department confirms this exceedence in the second sample does it conclude that an exceedence has occurred. It doesn't even consider a violation at that point. For a full assessment of attainment of the use, our protocol requires seven sample results are needed, and this includes all the standards for which the Commission has specified that compliance is based on a single grab sample.

Q. Steve, let's move on to Section 12.F. This is the heart of the Department's proposal.

Could you please explain how the Department proposes to use the Section 304(a), recommended values that EPA has developed and as well the translation mechanism, to derive such a criteria when the Commission has not adopted them?

A. Okay. The Department proposes to amend Section 12.F to establish a procedure for using new EPA Section 304(a) criteria for priority toxic pollutants to protect aquatic life and human health. The Department also proposes a procedure for deriving numeric criteria for those priority toxic pollutants when EPA has not published Section 304(a) recommendations.

The Department's proposal regarding human health criteria is new, but the proposed language regarding aquatic life criteria follows the existing Commission procedures and language in the standards. It's important to retain this procedure because new toxic pollutants are occasionally detected in our aquatic ecosystems.

EPA, the Department, the regulated community, the public, and the environment are served by the availability of a readily identifiable, Commission-approved procedure for calculating these numeric criteria. Without the procedure, the Department would have to request a hearing every time a new toxic pollutant is detected in ambient water, delaying protection of the environment, and taxing the resources of the Department and other interested persons.

I'm going to go through the Section 12.F paragraph by paragraph.

The first paragraph, we propose to amend paragraph one to clarify the general toxic standard, no toxics in toxic amounts, applies to all sources except natural causes.

Deletion of the term "attributable to discharges" is necessary to ensure the general toxic standard applies to the full range of activities which contribute toxic pollutants to state waters. Specifically, the word "discharge" substantially narrowed the scope of the standard. The state water quality standards do not define "discharge," but the EPA, at 40 CFR Section 122.2, excludes pollutants deposited in dry channels and upland areas which may be mobilized into state waters from this definition. The exception for natural causes was added to clarify the Department recognizes the concept of natural background for evaluating the conditions of state waters.

Finally, the Department proposes to amend paragraph one to clarify the general toxic standard applies to toxicity affecting humans, livestock and to other animals, as well as fish and other aquatic organisms.

The Department proposes to amend paragraph two to establish the procedure be followed when the Section 900.M table, which we are proposing for inclusion in the back part of the standards, does not contain a human health criterion for a priority toxic pollutant.

First, under paragraph 2(a), the human health criteria would be the recommended human health criterion for the category "consumption of organisms only" published by the US Environmental Protection Agency pursuant to Section 304(a) of the Clean Water Act. Of particular importance, the procedure specifies the category of organisms only and the ten to the minus fifth risk level for cancer-causing pollutants.

The Department proposes the organisms only category because it believes these criteria adequately protect human health in New Mexico. EPA publishes two categories of recommended human health criteria. The first category is consumption of water and organisms together, and the second is the consumption of organisms only.

The difference between the categories is the exposure route. The first category assures that the public -- I'm sorry, assumes that the public is consuming raw, untreated surface water and consuming fish caught in that same water. Because conventional drinking water treatment methods can remove the priority toxic pollutants that might be found in surface waters of New Mexico, the Department does not consider the criteria based on the consumption of untreated surface water is necessary to protect human health in New Mexico.

The second category assumes that the public is exposed only through the consumption of fish, and other aquatic organisms, if appropriate. It assumes that the public obtains drinking water from a source which meets the requirements of the Federal Safe Drinking Water Act, which would limit the level of these priority toxic pollutants.

The Department concludes that this second category of criteria would adequately protect public health in New Mexico.

The Department proposes the ten to the minus fifth risk level because, as I've said previously, it's consistent with existing Commission policy. In at least two places, the Commission has endorsed this risk level.

When EPA has not published a Section 304(a) recommended criteria, under paragraph 2(b), the criterion would be derived using the appropriate formulae specified in the Water Quality Management Plan -- the New Mexico Water Quality Standards Management Plan.

These formulae were published by EPA in October of 2000 and are included in NMED Exhibit 7.

EPA has stated that the states may adopt Section 304(a) recommended criteria or criteria which have been calculated according to this formulae. Accordingly, in the absence of a Section 304(a) criterion, these formulae provide a method for deriving valid criteria.

Q. Does the Department address Los Alamos National Laboratory's concern by including these formulae by reference in its proposal?

A. Yes.

LANL argues that the formula implementing translation procedure should be included in the CPP and proposes language for such a formula.

The Department agrees with the thrust of these comments and of this proposal. We've modified the proposal in the notice of intent to present technical testimony to include the formulae in the Water Quality Management Plan instead of the CPP. We feel that the Water Quality Management Plan is the appropriate document in which to include this formula. We would also include the formulae that EPA published in October of 2000, which they state are the only supported formulae to be used now. So there would be no need for the recommended. It's there.

These again are the formulae -- these are the new formulae that were revised by EPA. The difference is fairly slight, but EPA has stated that when they published the new formulae that they wouldn't accept criteria derived after that point by the old formulae.

Q. What other requirement does paragraph 2(b) impose on the translation procedure?

A. Paragraph 2(b) also requires the use of data available on the IRIS database. This requirement ensures that the latest information concerning reference doses for noncancer-causing pollutants and cancer potency slopes for cancer-causing pollutants is used.

As John Montgomery explained, EPA publishes these values on IRIS only after extensive peer review, and these numbers don't jump around. They are based on 20 years of data that have been in IRIS, and so at the most, there are very, very slight changes when new studies come out.

In most cases, the criteria that would be developed using these formulae, from IRIS figures, wouldn't show any change to any significant level that would affect a standard.

The Department does not expect that EPA, as the NPDES permitting authority for New Mexico, will invoke this procedure very often. Currently, there are only 17 priority toxic pollutants for which human health criteria have not been published. EPA may add more toxic pollutants to the priority list under its Section 307(a)(1) authority. The Department is not aware of any pending proposals. Even if the EPA added more pollutants, the procedure would only apply if EPA also did not adopt human health criteria for those pollutants.

It's important to note that this procedure takes advantage of the confluence between EPA regulations authorizing a narrative criterion when numeric criteria cannot be established and another EPA regulation requiring EPA, as the NPDES permitting authority, to derive criteria from a state regulation interpreting the narrative criteria.

In this case, the Commission has adopted a narrative toxic criterion in Section 12.F(1) which prohibits toxic pollutants in toxic amounts, and it's adopted a procedure in paragraph F.2(b) which tells the EPA how to derive criteria to achieve that standard when EPA Section 304(a) criteria are not available.

In the absence of the procedure in Section F.2(b), EPA would have to calculate its own criterion without any guidance from the state regarding the category of protection -- i.e., water plus organisms versus organisms only -- and the risk level. By dictating the procedure and these categories, the

Commission constrains EPA's discretion to calculate and impose numeric criteria not consistent with the Commission's policy and practice. In other words, the Commission gets to say how EPA will develop those permit limits.

Nevertheless, some persons have questioned whether the procedure would result in the adoption of criteria without Commission review and approval.

Q. What is the Department's response to those arguments?

A. In the Department's view, the risk is no greater under paragraph 2(b) than under any of the other paragraphs in 12.F. The Department also questions whether EPA's use of the procedure to develop a numeric criterion for developing NPDES permit effluent limits constitutes, quote, adoption, unquote, under state law.

The real argument here seems to be that the Water Quality Control Commission has seen not to be able to adopt narrative criteria, and this is not true. Adoption of narrative criteria and the translation procedures to translate those narrative criteria are well within the scope of the authority.

The Commission has already adopted a narrative criteria, no toxics in toxic amounts, and this standard has to be translated by someone. The numeric criteria that's derived would be subsequently presented to the WQCC for their adoption only after public notice and public hearing and all full notification requirements.

EPA already uses a translator to derive criteria for the statement no toxics in toxic amounts. However, they use the risk levels that they deem to be the best for New Mexico.

The Commission has the choice of specifying the translation used. The proposed procedure only clarifies how the narrative standard is to be applied. It specifies the procedure and the formula. It directs EPA to interpret a narrative standard in a specific way, rather than allowing the EPA to interpret the narrative standard as it wishes. The translator makes this narrative standard more understandable and its application throughout waters of New Mexico more consistent.

The WQCC has the authority to clarify this narrative standard and is doing so after public notice and during a public hearing.

Q. Now, Mr. Pierce, you earlier said that the numeric criteria that's derived from these, subsequently adopted by the Commission after public notice and hearing, or would be offered to the Commission for such adoption.

Are you actually referring to paragraph 2(c), which is the Department's response to this concern?

A. Yes. This concern was voiced during our public outreach activities.

One of the suggestions that came from Mr. Hernandez was to have the Department petition the Commission after any kind of standard -- to petition the Commission after any numeric criteria have been calculated by EPA and implemented into any kind of effluent limits.

The section proposed as 2(c) would require the Department to do so within 90 days of the issuance of a final NPDES permit by EPA which contains numeric criteria that were calculated under paragraph 2(b).

So if EPA uses paragraph 2(b), that NPDES permit, we would then step forward within 90 days and request a hearing.

The petition would propose the adoption of the new criteria and would afford interested persons an opportunity for comment and the Commission an opportunity to thoroughly review and then to approve or disapprove the new criterion during a public hearing.

Q. Mr. Pierce, the Department proposed this new paragraph (c) in its notice of intent, is that correct?

A. Yes. This was included in the Department's notice of intent to present technical testimony filed on February 21st.

Q. Let's move on to paragraphs three and four of the Department's proposal. There are no changes in paragraph five, as I understand it, so why don't you just address three and four at this point.

A. Okay. Paragraph three would reflect the existing provisions that are in the standards right now for determining chronic criteria for the protection of aquatic life.

Only minor modifications have been made to the original language, primarily to parallel the language and format of paragraph two. The original language was moved in Section F, the no toxics in toxic amounts, which was at the end of Section F, and so in order to put it at this particular place in Section F, we had to strike it all out and show it as new language at this place in Section F.

As you may have remembered, over the last three or four years, Section F went from a very small paragraph to about a page long.

The Department proposes to amend paragraph four to specify the acute aquatic life criterion published by EPA may be used under the New Mexico Water Quality

Standards. This approach parallels the paragraph 3(a) for chronic aquatic life criteria, except for the calculation method that is afforded to the chronic criteria.

Although chronic criteria are almost always much lower than the acute criteria, and, therefore, are more protective, acute criteria may be important to determine the concentration of a toxic pollutant that would be immediately toxic to aquatic life. For example, in storm water runoff for which it may only be possible to get a single grab sample, but which could have very toxic impacts to the aquatic life.

Paragraph five just has minor changes.

Q. Those are simply -- I said no changes earlier, but those changes are very minor and simply intended to accommodate the changes that occur before it?

A. That is correct.

Q. Nothing substantive?

A. That's right.

Q. We've now reached Section 900, which is the last big section which changes -- in which changes are proposed.

Let's start with the cold-water fishery section. The Department has proposed some changes here. Would you explain them?

A. The Department proposes to amend this section to update references and to identify the specific parts of the new criterion table in Section 900.M which apply to this designated use, including the human health criteria.

The new heading for the criteria table in Section 900.M is "Aquatic Life." The term has caused great confusion, because it's not clear how aquatic life is related to the designated use of fisheries. In fact, the Department is not proposing any change in the designated uses. The designated uses refer to aquatic life, which is a shorthand term for the column in the table containing most of the numeric criteria.

The general standards refer to aquatic life because this is the EPA term of art that's been used ever since the Clean Water Act was first passed for the type of criteria used by New Mexico for the fishery designated uses.

When the Commission adopted numeric acute and chronic criteria to protect the fishery designated uses, it used EPA's aquatic life criteria and was fulfilling a federal requirement to protect aquatic life uses.

Q. Mr. Pierce, you mentioned that the use of the term aquatic life was confusing to some people. Can you explain why?

A. Some confusion may be caused by a misperception about the meaning of the term "fisheries." In some circles, the term has been read narrowly to exclude all other aquatic organisms. Such reading is contrary to the Clean Water Act, which requires the protection of fish and other aquatic organisms. It is also contrary to the Commission's history of designated uses.

In 1973, the Commission selected the term "fisheries" to identify the designated use commonly referred to by EPA as aquatic life. New Mexico's fishery designated uses are designed to protect both fish communities and the other aquatic organisms in a particular type of ecosystem. For instance, a cold-water fishery designated use was adapted from the 1967 water quality standards, in which these waters were called trout-producing waters, but the intent was to protect the entire aquatic life of such waters.

The warm-water fishery designated uses evolved from the earlier warm-water fish-producing waters designated use, which was an aquatic life use.

Q. There are some changes to this section on domestic water supply. I think these are accurately reflected in Mr. Pierce's written testimony, and none of them, as I understand it, are controversial, so we'll skip them for a moment and come back to them if we need to on rebuttal, if necessary.

The same applies, I think, to high-quality cold-water fishery, in which the Department proposes to strike the criterion for total organic carbon. We'll skip that for the moment and move on to irrigation.

Mr. Pierce, what changes are proposed in the designated use of irrigation?

A. The Department proposes changes to this section to include irrigation storage in the title and direct users to the new criteria table in Section 900.M where the criteria that had been deleted here in this paragraph have been moved.

The title change is intended to clarify the long-standing assumption that these criteria apply to waters used directly for irrigation, but for the waters that are stored for that use as well.

The Department has consistently applied these criteria to irrigation storage designated uses when conducting water quality surveys, and irrigation storage facilities, reservoirs, and these are already subject to the far more stringent numeric criteria for fishery designated uses.

Accordingly, the title change does not substantively change the designated use. The relocated criteria values have not changed, but the units have been converted from milligrams per liter to micrograms per liter to achieve consistency in the table. The one exception is selenium. Selenium will remain in this section because it requires explanatory information, and under the NMAC 2.0 rules, you can have no footnotes to any tables. They don't like tables themselves, you have to kind to beg them to put a table in, but they draw the line at footnotes.

Finally, the Commission should consider converting the selenium criteria that remain in this particular paragraph to micrograms per liter just to ensure consistency, but we did not indicate that change.

Q. Mr. Pierce, Los Alamos National Laboratories suggested the term "irrigation storage" should be defined.

What is your response?

A. Well, it appears to me that the term is pretty self-evident. "Irrigation storage" is the storage of water for irrigation. The definitions section of the standards again was not included in our public notice, and probably cannot be legally modified at this time, although I'm not one to speak on whether or not that would be legal.

Also, LANL has not proposed a definition for this term at this time. In that light, these proposals could be brought up at the upcoming triennial review when all sections may be open for modification.

Q. Now, Mr. Pierce, I think we'll skip right through marginal cold-water fishery, warm-water fishery and limited warm-water fishery, as well as Section 900.J, livestock watering and wildlife habitat.

Those changes, as far as I'm aware, are not controversial and we can address any concerns people have later in this hearing.

Why don't we move on to Section 900.M. This is the table to which you refer. It contains many of the numeric -- or most of the numeric criteria which the Department is proposing. Let me rephrase that, it includes all of the numeric criteria which the Department is proposing. It includes many of the criteria from other parts of the Section 900.

Can you describe for the Commission the table and how it's organized?

A. Yes. This table, which we're calling Section M, is a table of all numeric criteria for priority toxic pollutants, except for those pollutants for specific uses which requires some type of explanation, but generally we would require a footnote to make it more understandable.

In those situations, this table includes a reference to the subsection where the criteria and explanation can be found. This reference responds to LANL's concern that a person using the table might overlook some criteria applicable to a designated use.

The table contains most of the criteria for the priority toxic pollutants for easier reference. For each pollutant, the table identifies the Chemical Abstract System, shorthand is CAS, registry number assigned by the American Chemical Society. This doesn't make a lot of difference in a term such as mercury, but when you get to some of the long organic chemicals that can be stated by any of 150 different names, the CAS number becomes fairly important. Even in EPA documents, in some cases, they have recommended criteria under one name for one of these chemicals and IRIS has it under a different name.

MR. AMES: Steve, can you pause for us for a moment?

Is there some difficulty finding the table? I notice some Commissioners looking around frantically.

MS. BRANDVOLD: It's not in the testimony, but it is in Exhibit 20.

MR. AMES: Yes. It is in the Department's original proposal of November 29th and the revised one dated February 1st. It's toward the very end. It is at the very end, I believe. We did not include the table in our written testimony itself.

MR. PIERCE: I have some extras.

MR. AMES: Mr. Secretary, are you looking for your copy?

MR. MAGGIORE: No, I'm looking for the adapter for my laptop. I've only got it for about ten more seconds.

MR. AMES: Okay.

MS. BRANDVOLD: Here, you can look at this copy.

MR. KEYES: There is no security on the Secretary's laptop.

MR. PIERCE: There are more copies of the February 1st proposal.

MR. AMES: Does anyone need a copy of our proposal so they can locate the table?

MR. JOHNSON: Yes. It's somewhere in this pile of stuff.

MR. AMES: Anybody?

MS. HUGHES: Give me one. Thanks.

MR. AMES: Okay.

MS. BRANDVOLD: Okay.

MR. PIERCE: If everybody can see the table now.

MR. KEYES: I don't see how anybody caught that one mistake.

MR. AMES: There is another one we'll get to in a second.

MR. PIERCE: The table is composed of two alphabetical lists, and the way we propose it, the first alphabetical list is comprised of the first 24 priority toxic pollutants. They are all contained on the first page of these tables.

These pollutants are the inorganic compounds, and these inorganic compounds have the greatest number of criteria across all of the designated uses. For instance, the metal chromium has five numeric criteria for four different designated uses. By moving all of these pollutants to the first page of the table, the Department sought to make it easier to find these commonly applicable criteria. The remainder of the table, the next three pages, contains criteria for those organic priority toxic pollutants. The table also expresses all criteria in micrograms per liter. To achieve this consistency, the Department has proposed to convert the criteria for domestic water supply, irrigation and livestock watering designated uses from their current milligrams per liter to micrograms per liter. In converting these units, the Department did not intend to change any values. Any change in values that might be detected would be corrected immediately.

The table contains all the new priority toxic pollutant criteria being proposed today. Most of the criteria, 92, are for the protection of human health, through the fish consumption pathway, while 21 are for the fishery designated uses. In the table, the fishery designated uses appear under the title "Aquatic Life," as they do under EPA recommended criteria tables.

The table contains 11 new acute and 10 new chronic criteria for priority toxic pollutants for the fishery designated uses.

The remainder of the new criteria are designated to protect human health based on fish consumption. In all, new human health criteria for 92 priority toxic pollutants are proposed. Of these 92 pollutants, the Department proposes to designate 56 of them as either carcinogens or persistent. The last column in the table indicates whether the pollutant is carcinogenic by a C or persistent by a P. Some pollutants are both carcinogenic and persistent.

Q. Mr. Pierce, Los Alamos National Laboratories suggested the term "human health" be defined. What is your response to that suggestion?

A. Here again, the term seems to be self-evident, and the Commission had indicated that self-evident matters didn't need to be defined. However, it's been used at the federal level for about 25 years.

LANL has not proposed a definition at this time. If a definition appears warranted, it can certainly be proposed during the upcoming triennial review.

Q. What is the Department's basis for identifying certain pollutants as carcinogenic?

A. The Department based its determination of carcinogenicity on designations included in the 1999 EPA National Recommended Criteria, which is NMED Exhibit 5.

The designation is important because different formulae are used to derive human health criteria for carcinogens and noncarcinogens under Section 12.F. By providing this information in the table, the Department allows interested persons to use the appropriate formula to calculate criteria for their own purposes.

The Department based its determination of persistence on the EPA's identification of pollutants which are persistent, bioaccumulative and toxic, and which are the subject of an enhanced effort by EPA to eliminate all occurrences of these from the environment. This is Exhibit NMED 8.

The list of persistent toxic pollutants includes aldrin/dieldrin, benzopyrene, chlordane, DDT, hexachlorobenzene, alkyl-lead, mercury, mirex, octachlorostyrene, PCBs, dioxins and furans, toxaphenes, and probably a few more that I couldn't even pronounce right now.

The designation of any new persistent toxic pollutants would require a hearing and rule-making before the Commission.

Q. Before we talk about the persistent toxics some more, is there a change to the list of carcinogenic pollutants identified by the Department?

A. Yes.

It was pointed out by LANL that for antimony, we had in our table a C and a P. It should have just been P; it was not a C.

Once again, it was not our intention to change any of the recommended designations that EPA had supplied in the recommended criteria. We thank them for finding that, and we do propose to change that.

Q. Now, in its testimony, Los Alamos National Laboratory suggested that there are some discrepancies between the Department's list of persistent toxic pollutants and the list published by the Environmental Protection Agency for the Great Lakes and Michigan.

What is the Department's response to that testimony?

A. We based our list of persistent toxics on the EPA list of toxics that's published on the Internet and is included as Exhibit Number 8. This is the list of priority PBTs, persistent, bioaccumulative and toxic compounds, currently being addressed by the PBT initiative by the EPA.

The New Mexico list also includes the toxic metals, which by their very nature are persistent.

The EPA Great Lakes Initiative list differs from the official EPA recommended list. This slide shows the GLI list. It might be very hard for you to see, and it's hard to see, but a number of these we put a black line through, and they indicate those that are also found on the Commission's list.

That's the next slide.

Then, also, delta-hexachlorohexane, which is indicated by a red line on the next slide, has no EPA recommended criterion at this time. Mercury, in the next slide, is indicated by a green line, and it's not been proposed, for reasons that I'll explain in a minute.

Q. Go ahead.

A. The three substances indicated with a yellow line, in the next slide, are not contained in the IRIS database and are not priority toxic pollutants. These were selected based on known problems in the Great Lakes area.

The substances indicated by blue lines, which includes the rest of them on the GLI list, are nonpriority toxic pollutants, and New Mexico is not required to adopt criteria for these compounds.

That covers all the criteria that are in the Great Lakes Initiative list.

Q. Now, this is a little different -- that's much better. Before it was almost impossible to read.

Does the Commission want a summation of the differences between the two lists? We can perhaps do that.

Steve, do you think you can point to -- identify which pollutants on the GLI list are not included on ours, or vice versa, or would you need a moment to do that?

A. Okay. Which ones are not?

Q. Why don't we -- let's put that aside for a minute. I don't want to belabor the point. We'll go back and try and come up with an oral presentation that will supplement this, because this is a little difficult to read. We apologize. Let's just move on.

Mr. Pierce, where did the Department get the numeric criteria in table 900.M?

A. All new recommended numeric criteria in the table were taken from the EPA 304(a) recommended values for priority toxic pollutants, with the exception of the recommended criterion for arsenic. EPA published these values in the National Recommended Water Quality Criteria, Corrected Version, that was published in April, 1999, and is NMED Exhibit 5.

There are many similarities between these values and the human health criteria for organisms only imposed by federal promulgation in the National Toxics Rule and the California Toxics Rules.

Q. Has EPA indicated whether it would approve these criteria?

A. EPA has indicated that it would approve these criteria. However, I note for the record that EPA is in the process of revising the criteria for human health based on a methodology that they published in October of 2000. This methodology takes into account the scientific knowledge gained since EPA developed the 1980 methodology on which the current criteria are based. In particular, the new methodology uses a bioaccumulation factor, a BAF, rather than the bioconcentration factor, BCF, that was used earlier.

The BAF considers the entire exposure of an organism to the toxic pollutant from water, sediment and food. However, EPA has not yet published peer review BAF values for the priority toxic pollutants and has not said when it will do so, so it's not possible at this time, using the methodology, to calculate numeric criteria.

Q. Mr. Pierce, you said the Department deviated from EPA's Section 304(a) recommended values for one pollutant and you also said that the Department has not proposed a criterion for another pollutant.

Let's start with the deviation. Which pollutant are we referring to and what is the reason for the deviation?

A. The Department reviewed EPA's Section 304(a) recommended value for arsenic, and we believe that EPA's recommended value of 1.4 micrograms per liter, which is what their value would be expressed at ten to the minus fifth, is unreasonably stringent in light of natural background levels in New Mexico, which generally range from three to five and can at times be much higher.

On the other hand, the Department believes that Region 6's alternate recommendation of 20.5 micrograms per liter at ten to the minus sixth, which would be translated to 205 micrograms per liter at ten to the minus fifth, is not adequate to protect human health and would probably be disapproved by EPA.

Given the range between these EPA recommended values, 1.4 all the way up to 205, the Department sought to derive a more appropriate criteria for arsenic for New Mexico. A recent federal study provided the basis for the Department's proposed criterion.

In 1997, USGS published a study of arsenic and other metals in the Rio Grande in the vicinity of Albuquerque. The study, conducted in conjunction with EPA, NMED, Isleta Pueblo, the City of Albuquerque, yielded some numbers that could be used to calculate an arsenic criteria.

The Department believes that this criterion protects human health and is realistic for New Mexico waters. The calculation uses a New Mexico-specific derived BAF for arsenic and the percentage of inorganic-to-total arsenic in fish tissue, 65 percent, which accounts for the toxic form of arsenic. Most arsenic criteria are developed to measure total arsenic because inorganic arsenic, the toxic form, is difficult and very expensive to detect through laboratory processes.

Q. Does the Department have any -- well, first of all, how much did this federal study cost?

A. The federal study went about $300,000.

Q. Is the Department aware of any similar studies for other pollutants in New Mexico -- other toxic pollutants and priority toxic pollutants, specifically,

in New Mexico?
A. No.
Q. The Department has not proposed one numeric criteria, you said earlier. Which metals or which pollutant is that?
A. That pollutant would be mercury. The Department has not proposed a numeric human health criterion for mercury. At this time it's simply not possible to do so.

On January 8th of 2001, EPA withdrew all Section 304(a) recommended human health criteria applied to the water column for mercury. In its place, EPA substituted a fish-tissue-based criterion that would require the calculation of watershed specific criteria.

To implement the standard, EPA stated that it would publish a guidance before the end of 2001. However, no guidance has been published at the time of this hearing. My staff says that it will be impossible at this time to implement that mercury criterion without the implementation guidance.

When EPA publishes the guidance, the Department will review the propriety of recommending a new criterion for mercury.

EPA's failure to publish the implementation guidance for its new criterion does not leave the state without protection for mercury. The Commission adopted a chronic mercury criterion for aquatic life of 0.012 micrograms per liter in 1991. This was intended, at that time, to protect humans consuming fish in New Mexico. In other words, the Commission did adopt a human health criterion, but under a different label.

EPA has informed us that this criterion complies with federal requirements that were in place at that time, since the value is based on then-current EPA recommendations that were adopted to protect human health, and it was approved at that time by EPA. In other words, the water quality standards already contain the criterion to protect human health from the bioaccumulative effects of mercury in fish.

Q. Now, for the last question of Mr. Pierce.

How does the surface water quality in New Mexico compare to the Department's proposed human health criteria?

A. At this point, I'd like to describe how current water quality compares with our proposed criteria priority pollutants.

The data which I will present -- it's slide 79 -- are contained in the table labeled NMED 10. This table compares the Department's proposed human health criterion to information obtained from Section 308 effluent monitoring reports and ambient data collected by the Department and Los Alamos National Laboratory for all priority toxic pollutants detected in effluents or ambient water in New Mexico.

In all, 23 priority toxic pollutants are listed. 20 pollutants were found in effluent discharges from municipal wastewater treatment facilities. These were the data that the Commission and the Department had a long battle with the EPA to obtain during most of 2001.

The remaining three pollutants, gamma-BHC, PCBs and dioxin, were detected in ambient waters in New Mexico. For each of the 23 pollutants, the table identifies the Department's proposed criterion, the number of effluents containing that pollutant, the range of concentrations found in those effluents, the location of the highest concentration and the date of the sampling for the highest concentration, and then finally the magnitude of this concentration as a percentage relative to the Department's proposed criterion, whereas the same figure as the Department's criterion would be a hundred percent.

The table shows that most of the priority toxic pollutants detected currently in New Mexico are a very small fraction of the Department's proposed criterion. In fact, the majority, 13 out of 23 of these, are only a fraction of one percent of the proposed criterion.

On the other hand, six priority toxic pollutants have been detected at levels which exceed the criterion. Arsenic was detected at 11 facilities, with the highest concentration in the effluent discharge at Jemez Springs, where the concentration was 364 percent of the proposed criterion. Two pesticides, chlordane and DDT, were detected in the effluent discharge at Cuba at concentrations greater than 40 times the proposed criteria.

Two persistent priority toxic pollutants, PCBs and dioxin, were detected at Los Alamos National Laboratory in ambient storm waters at concentrations that are hundreds of times higher than the proposed criterion. Thallium, a heavy metal, was detected in an effluent discharge from Los Alamos Bayo wastewater treatment facility at a level that's 190 percent of the proposed criterion.

It's important to note that the proposed human health criteria for ambient water quality -- are for ambient water quality and not effluent limits. So even though we're showing effluent data as a percentage of the standard, that would not be a direct relationship, because the standard would not apply to effluents, it would apply to the ambient waters after a dilution factor.

The NPDES permittee might exceed the ambient water quality standard for a priority toxic pollutant in its effluent as long as the resulting in-stream concentration does not exceed the criteria. This in-stream concentration is a calculated value, taking into account ambient concentrations of the pollution, available dilution from the critical low flow, and other factors.

In the case of priority toxic pollutants, NPDES effluent limits would be calculated based on the harmonic mean flow dilution. For example, tetrachloroethylene, one of the priority toxic pollutants, was detected in the effluent discharge at Farmington's wastewater treatment facility in samples collected by Farmington at concentrations of 12 micrograms per liter. This exceeds EPA's Section 304(a) criteria at a ten to the minus sixth risk level, and, therefore, an effluent limitation would be required if the effluent caused a violation of the in-stream concentration. By comparison, the Farmington effluent discharge of tetrachloroethylene is only 13.6 percent of the Department's proposed numeric criterion and would not require an effluent limit under the Department's proposal.

That concludes my proposed testimony.

MR. AMES: Thank you, Mr. Pierce.

The Department has about 20 more minutes of testimony, ten minutes for Mr. Saums and ten minutes for Dr. Davis.

What is the Commission's pleasure?

MR. MAGGIORE: Commissioners, I suggest we get through the direct testimony and then we can decide if we want to go straight into cross or take a break.

Does that sound okay?

Please proceed, Mr. Ames.

MR. AMES: Okay.

GLENN SAUMS

after having been first duly sworn under oath,
was questioned and testified as follows:

DIRECT EXAMINATION

BY MR. AMES:

Q. Mr. Saums, please state your full name for the record.

A. My name is Glenn Saums, S-a-u-m-s.

Q. Where do you work, Mr. Saums?

A. I work for the Surface Water Quality Bureau of the Environment Department.

Q. What do you do there?

A. I'm the program manager of the Point Source Regulation Section.

Q. How long have you done that?

A. I've been program manager of the section since 1985.

Q. What are your responsibilities there?

A. My responsibilities include preparing certifications of NPDES permits, under Section 401 of the Clean Water Act, and reviewing permits. Part of that review is to ensure that the permits are protective of state water quality standards and are consistent with the appropriate requirements of state law.

Q. Perhaps a little bit closer.

What is the subject of your testimony, Mr. Saums?

A. The subject of my testimony today will be a discussion of the EPA's approach for calculating numeric effluent limits for priority pollutants in NPDES permits in New Mexico, and the effect of the Department's modified petition on this approach.

Just for clarification and reminder, NPDES stands for National Pollutant Discharge Elimination System, which is the permitting program under the federal Clean Water Act.

Q. Let's move on to the legal framework.

How does EPA regulate toxic pollutants in NPDES permits?

A. Currently, Region 6 of the EPA must prepare the NPDES permits in accordance with all requirements of federal law, regulations, as well as EPA policy and guidelines.

To accomplish the Clean Water Act's goal of no discharge of toxic pollutants in toxic amounts, which was mentioned earlier in testimony, the EPA published a national policy which is applicable to NPDES permits being issued today.

The policy ensures that NPDES permits protect state narrative criteria for toxic pollutants, as well as chemical-specific numeric criteria.

Five years after EPA adopted that policy, they adopted regulations to implement this policy. In 40 CFR, Section 122.44(d)(1), the EPA required all permitting authorities to evaluate each NPDES-regulated discharge for the potential to exceed state narrative criteria for a toxic pollutant. You can refer to NMED Exhibit 3.

Discharges which might exceed these narrative criteria must have effluent limitations imposed in their NPDES permits. These effluent limitations should be chemical specific, but if the permitting authority determines that such limits are not sufficient, it must also impose effluent limitations based on whole effluent toxicity, also known as biomonitoring.

Q. Mr. Saums, these regulations established a process for translating state narrative criteria for toxic pollutants into chemical-specific numeric criteria, as necessary to evaluate discharges and write limits.

What are the four approaches that this regulation authorized for doing that?

A. I believe the four approaches are up on the slide being projected.

The first approach is to use the proposed state criterion or use a proposed state criterion.

The second approach would be to derive the criterion from an explicit state policy or regulation interpreting the narrative criterion.

The third option would be to use EPA's Section -- Clean Water Act Section 304(a) criteria for priority pollutants.

Last, the fourth option, would be the utilization of an indicator or surrogate parameter for monitoring, subject to several conditions which are stated in the regulation, which include reopening the permit if the monitoring no longer satisfies the narrative criterion.

Q. Mr. Saums, which approach has Region 6 adopted?

A. The EPA has described, in 40 CFR, 122.44(d) (1) --

Q. I think you can skip by that for the moment and just move on and describe the procedure that EPA Region 6 has adopted under this regulation.

A. Okay. Under this regulation, EPA has been reviewing NPDES permits on the basis of the national criteria of the -- as expressed in the National Toxics Rule. The EPA has expressed its intent to rely on Section 304(a) criteria when the state has not adopted a numeric criterion for the toxic pollutants or expressed a policy choice regarding derivation of the applicable values.

Region 6 also prohibited any regulated discharge which could endanger a drinking water supply, cause aquatic bioaccumulation which threatens human health, causes in-stream acute or chronic toxicity, causes a violation of a numeric water quality criterion.

The EPA Region 6, in order to accomplish these objectives, has stated that it would identify and address sources which may exceed the EPA water quality criteria for human health protection.

Q. What risk level is Region 6 using now to evaluate effluent discharges in New Mexico?

A. Currently, and for a number of years, the EPA has used the ten to the minus sixth risk level for carcinogenic pollutants.

Q. And that's applied to the EPA's Section 304 recommended values, correct?

A. That is correct.

Q. So give us a little more detail how EPA has actually implemented this approach for NPDES permits, some specific examples to put this in context.

A. EPA Region 6 has implemented the approach consistently in New Mexico. Between 1999 and the year 2001, Region 6 proposed to issue or reissue approximately 100 NPDES permits in New Mexico.

In the fact sheets that accompany these proposed permits, Region 6 stated that the criteria for the National Toxics Rule, which are identical to the Section 304(a) criteria, were used to evaluate the effluent discharge.

Region 6 also stated that it evaluated cancer-causing pollutants at the ten to the minus sixth risk level. In the majority of cases, there was no effect or result to the human health stream -- that is, no additional requirements were added to a permit.

For two NPDES permits, this practice could have resulted in more stringent effluent limitations. For example, in the case of Molycorp, Region 6 found a reasonable potential that the discharge would exceed the Section 304(a) criterion for arsenic, but ultimately the more stringent technology-based effluent limitation was imposed in the permit.

In the case of the City of Roswell, Region 6 also found a reasonable potential that the discharge might exceed a 304(a) criterion for mercury, but later obtained additional data which controverted this finding.

The matter is still not settled with regard to a third NPDES permit. In this case, which is the case of the City of Rio Rancho -- in that case, Region 6 found a reasonable potential that the discharge would exceed the Section 304(a) criteria for pollutant, but the permit -- since the permit has not been issued at this time, it's unresolved, but it appears at this time, also, that it's likely that the issue will be resolved without the imposition of an effluent limitation based on the Section 304(a) criteria.

At this point in time, Region 6 has not imposed an effluent limitation in an NPDES permit based on Section 304(a) criteria using the ten to the minus sixth risk level; however, the possibility that that could happen concerns NPDES permittees who recognize the Commission has indicated a preference in previous actions for a lower risk level -- that is, ten to the minus fifth.

Q. Now, Mr. Glenn, you've said that EPA Region 6 uses the ten to the minus sixth risk level for carcinogens.

Does Region 6 also use the harmonic mean flow?

A. Yes, they do.

Q. What effect will the Department's proposal have on EPA's current practice?

A. The EPA would begin to evaluate NPDES permits -- NPDES-regulated discharges differently if the Commission adopts the Department's proposal. That is that they would cease using their protocol and start using the Commission's.

First, the Department's proposed numeric criteria for priority toxic pollutants uses a risk level of carcinogens one order of magnitude less stringent than the EPA.

Second, the Department's proposal establishes a procedure for directing the EPA how to select or derive a numeric criterion in the absence of a value in the state water quality standards. Please refer to Section 20.6.4.12.F.2 of the water quality standards.

This procedure ensures that the EPA will use a consistent approach to selecting or deriving any numeric criteria for priority pollutant toxic -- priority toxic pollutants in the absence of approved values and is expressly authorized by 40 CFR 122.44(d)(1)(vi), which also requires the EPA to select or derive missing criteria from Section 304(a) recommended criteria or a regulation interpreting the narrative criteria. Please refer to NMED Exhibit 4.

MR. AMES: Thank you, Mr. Saums.

Now, we will conclude with Dr. Davis.

JAMES DAVIS

after having been previously duly sworn under oath, was questioned and testified further as follows:

FURTHER DIRECT EXAMINATION

BY MR. AMES:

Q. Dr. Davis, what will be the effect of the numeric criteria on the TMDL program?

A. Minor, at best.

As the Commission knows, Section 303(d) of the Clean Water Act requires that the state survey state waters, anything that is found to be not in compliance with applicable standards is listed, and then a TMDL is developed.

As Mr. Pierce indicated in his testimony, we've been doing this on a routine basis. We simply don't think that this will have much of an impact on 303 lists, nor on the TMDL program.

Q. What effect will the Department's proposed numeric criteria have on nonpoint sources?

A. We will survey all state waters regardless of source of pollution, as is our normal and current practice.

Mr. Pierce, in his testimony, indicated that we propose to delete the clause "attributable to discharges" from Section 12.F of the standards. Accordingly, these -- these -- I'm multi-tasking, excuse me -- these -- and I'm not doing it very well -- these criteria would apply to those waters, and we would -- we would survey them for the purpose of determining whether or not they are in compliance with these criteria.

It makes no distinction between point sources or nonpoint sources.

Q. And, finally, could you please sum up the Department's proposal one last time so it's fresh in the Commission's mind?

A. That's the slide that is currently up. We are asking -- we are proposing that numeric criteria for priority toxic pollutants be adopted, they consist primarily of numeric criteria for the protection of human health.

Again, to reiterate, this addresses the last pending issue for completion in the triennial review initiated in 1997. Specifically, as the slide indicates, we propose 11 acute and 10 chronic numeric criteria for priority toxic pollutants to protect various fisheries designated uses and 92 numeric criteria for priority toxic pollutants to protect human health.

We propose a procedure for selecting and deriving numeric criteria when there are no such criteria in the water quality standards and a method of determining compliance.

We're also proposing to apply these human health criteria to waters with existing, designated or attainable fishery use and their tributaries, as explained by Mr. Pierce in his testimony.

Today, we've provided to the Water Quality Control Commission information that is both necessary and sufficient to support the decision to adopt these criteria.

MR. AMES: Thank you, Dr. Davis.

That concludes the Department's direct testimony.

I would now move the admission of the Department's exhibits, NMED 1 through 21, as well as the PowerPoint presentation, which is mostly for demonstrative purposes, but I'd move its admission now, too.

MR. MAGGIORE: Any objections for admission of

Environment Department Exhibits 1 through 21, and I guess we can go ahead and label the PowerPoint presentation Exhibit 22?

MR. AMES: Please.

Thank you.

MR. MAGGIORE: Can you take care of labeling that exhibit, Carolyn?

Seeing no objections, those exhibits have been entered.

(NMED Exhibits 1 through 22 admitted.)

MR. MAGGIORE: Thank you, Mr. Ames.

MR. AMES: Thank you, Mr. Chairman. That concludes the Department's case in chief.

MR. MAGGIORE: Commissioners, do we want to proceed with cross? Do we want to take a five-minute break? Do you want to take a supper break? What's the pleasure of the Commission?

MR. GLASS: At least a five-minute break.

MR. MAGGIORE: Five minutes for right now. Let's do a five-minute leg stretch and we'll move into cross.

(Recess held.)

MR. MAGGIORE: It's about 5:35. We're back on the record.

We will proceed with cross-examination of the

Department's witnesses.

I'll ask the Commissioners first, any cross-examination of the witnesses?

Do you wish to be crossed as a panel?

MR. AMES: Please.

MR. MAGGIORE: Okay.

MS. BRANDVOLD: This would be for whoever can answer, but adding all of these extra chemicals onto the list, what does that do to a dischargers' costs?

Does that increase their costs, or are those covered already in, say, a biomonitoring?

MR. SAUMS: Currently, EPA is -- when they are reissuing NPDES permits, they require -- they require the applicant to scan their effluent by sampling. So they are already sampling for all of these pollutants.

When EPA, we call it, screens the effluent against the standards, they only develop effluent limitations for those parameters for which there is a potential exceedence of a water quality standard.

So if for pollutant A, they screen it, and they determine that there is no reasonable potential that a water quality standard -- any water quality standard, whether it's human health based, or some other use -- if there is no reasonable potential, there is no effluent limitation.

Conversely, if there is a reasonable potential, then they would write an effluent limit, but since EPA is already scanning all effluent discharges against their human health criteria, our adoption of the same number of parameters is --

MS. BRANDVOLD: Doesn't matter?

MR. SAUMS: -- it comes out equal.

MS. BRANDVOLD: Thank you.

MR. GLASS: Except that, if I might --

MR. MAGGIORE: Commissioner Glass.

MR. GLASS: -- if I might add to that, in the process of obtaining an NPDES permit, there is a certain amount of effluent monitoring that has to be assembled by the municipality or dischargers, so to speak.

With this additional list of chemicals, is that cost going to increase? I mean, these are not inexpensive chemicals to test for.

So on whatever cycle it is, you know, ideally five years, more like 15 years, but, whatever, there is a time period during which you do have to possibly spend more money to do it.

MR. SAUMS: That's correct.

The EPA has already been asking permittees to run these pollutant scans as part of their reapplication. So since they are already doing that, and then they are taking that data from those scans and running it against their numbers, they would continue to do that process, so it's not an increase, it would remain constant with what they are doing now in terms of asking for the data in advance.

Dr. Davis was just refreshing my memory that where there possibly was an increase is where there are now very few NPDES permits that are extremely old in terms of their expiration date, such as the City of Bernalillo, which was last issued by the EPA in 1988, and so there might be an increase for them because they haven't had a permit reissued in a long time.

There are other administrative and legal reasons that that's not happened, which are kind of outside of today's hearing.

Right now, the percentage of NPDES permits that are current has increased dramatically -- I don't have the numbers at my fingertips, I apologize for that, but EPA has, in the last three years, worked very diligently with the Department to update NPDES permits and bring them to be current -- current being within the five-year expiration date of a permit.

MR. GLASS: I guess from that you can conclude that -- we're on the third, is that true, the third round? Is that -- of NPDES?

MR. SAUMS: Third round, yes.

Third-round permits is a term that EPA uses to refer to NPDES permits where they are seeking to protect the -- particularly with regard to the discharge -- no discharge of toxics in toxic amounts.

MR. GLASS: So third-round permits will include the requirement for this?

MR. SAUMS: Most facilities in New Mexico are already into their third-round permit, and, arguably, I guess you could call it the fourth round.

MR. KEYES: May I ask a question --

MS. HUGHES: Commissioner Keyes.

MR. KEYES: -- along this line?

In your testimony on Exhibit Number 10, where you had the list of the dates when some of the items were, in fact, exceeded, some of the suggested levels, what are the termination -- or expiration dates of some of those communities that were listed in there?

Are their expiration dates way earlier than when these actually were collected?

MR. SAUMS: Most of the permits in NMED Exhibit 10 have been reissued within probably the last four or five years. I don't have the precise expiration dates in front of me, but my recollection is that we've gone through the effort to update NPDES permits, particularly, in the last three years.

These all look familiar to me as having -- we've seen these in the last three or four years.

MR. KEYES: Thank you.

MR. MAGGIORE: Commissioner Hutchinson.

MR. HUTCHINSON: Just one quick question.

Dr. Davis, you said that there would be a negligible impact on TMDLs or 303(d) listings. Is that what I heard?

MR. DAVIS: Yes.

Mr. Chairman, Commissioner Hutchinson, I didn't use the word "negligible," but I said that I thought it would be, you know, a very small impact. I don't think it's significant.

MR. HUTCHINSON: So in that arena, we're proposing to apply these to ephemeral stretches.

Would that result in ephemeral stretches showing up on the 303(d) list that are not present there now because we don't classify them in that regard?

MR. DAVIS: Mr. Chairman, Commissioner Hutchinson, I don't know that it's correct to say that no ephemerals appear on the 303(d) list.

Wildlife habitat and livestock watering standards apply. When water is present, we measure it. It also depends on how the standards are actually written. Some sections of the standards refer to perennial tributaries and other sections refer to all tributaries. Perennial tributaries, obviously, is self-explanatory. Ephemeral reaches, therefore, are not in that classified segment.

Where it says all tributaries, then ephemeral reaches are, by definition, included in that classified segment.

MR. HUTCHINSON: So it would just depend on the description of the reach?

MR. DAVIS: Yes, I think so.

Again, these chemicals that are in our proposal, typically, I think you would expect to not find them in most areas of the state that we're talking about, higher portions of a watershed or ephemeral tributaries to a -- you just typically would not expect to find them. That doesn't mean that we might not find them, but I would not expect it to occur very frequently.

MR. HUTCHINSON: That's what I was expecting. I just wanted to get a clarification on that.

Thank you.

MR. MAGGIORE: Thank you.

Any other cross-examination of the Department witnesses from the Commission?

Commissioner Whipple and then Commissioner

Keyes.
MR. WHIPPLE: Thank you, Mr. Chairman.
I have some questions for Mr. Pierce about his testimony.
One thing that I'm curious about that I don't understand is what does the harmonic mean flow have -- relate to anything physically?
Like the 4Q3 flow, I can visualize what that relates to physically.
MR. PIERCE: We do have the article in which the Journal of Hydraulic Engineering explained a little bit more about it and why they felt that it more accurately described long-term flow, kind of moderating out the highs and lows and a lot of the other methods, but, no, it doesn't -- there is nothing that you can visualize, like a 4Q3 or a 7Q10.
MR. WHIPPLE: So how would you describe how the exposure assumption used by EPA are best reflected by the harmonic mean flow?
MR. PIERCE: When they applied them to waters, they used the harmonic mean flow of those waters.
MR. WHIPPLE: So that's just the tie? Anything physically?
MR. PIERCE: Anything that was found based on the harmonic mean. It's like when they developed for the

chronic, they used four-day averages, and so most of the states, including New Mexico, went to a 4Q3, because that came closer to what EPA was using to determine those criteria.

MR. KEYES: Is that your question?

MR. MAGGIORE: Is this a friendly amendment to Mr. Whipple's question?

No problem.

MR. KEYES: When did Texas accept the harmonic mean flow and particularly in relation to the common reach? Do you know what year they accepted it in their review process?

MR. PIERCE: I don't know that answer, but it's possible that Mr. Meyerhoff from LANL would know that.

MR. MAGGIORE: Do you want to defer to -- is there someone that could help with the response to this question?

MR. MEYERHOFF: I do not have any answer to that question.

MR. MAGGIORE: Okay.

MR. AMES: That makes it easy.

MR. WHIPPLE: Mr. Chairman, I have a few more questions.

MR. MAGGIORE: Please.

MR. WHIPPLE: Mr. Pierce, on page 11 of your testimony, of your written testimony, in the second complete paragraph, it talks about high levels of PCBs and dioxin in ephemeral storm waters at Los Alamos National Laboratory, and then a February of 2002 analysis indicating high levels of PCBs and dioxin in fish caught in Cochiti Reservoir.

Are there other potential sources of those PCBs and dioxins other than from streams off the laboratory property?

MR. PIERCE: Mr. Chairman, Commissioner Whipple, certainly, particularly with the fire up in that area, there are lots of other potential sources than the lab itself.

We found elevated levels in Cochiti. We found elevated, but not nearly as high levels, in Abiquiu and in Navajo, but these are only places we've looked so far in the state.

We're looking a lot of other places, but the funding is quite low for us, unfortunately. We have a lot of fish that have already exceeded holding times that we're trying to get these kind of analyses on.

The PCB sampling, I believe, currently costs $1,200 a sample, and it doesn't take too many of those to go through a budget pretty quick, particularly when you have to do QA, and you don't base it on one sample.

Yes, we're just starting to find these. EPA is looking for these contaminants in fish throughout the country. We're a part of that study. That's how Navajo Lake got -- our samples got analyzed for Navajo Lake.

The chemicals of concern that they are finding everywhere are mercury, of course, and dioxins and PCBs. So these are being found in other places, and, obviously, LANL is not at all those other places around the country, so, yes, there must be other sources.

MR. WHIPPLE: Okay. I have a question about the proposed changes to Section 20.6.4.900, Subsection D, in particular.

Is there a definition for irrigation storage?

MR. PIERCE: No, there is not.

MR. WHIPPLE: The reason why I ask is, I guess, I have a couple of concerns about the applicability to the standards, for example, where somebody may pump groundwater into an irrigation pond, where then it would become irrigation storage, or other instances where you might have a reservoir with no dedicated irrigation storage, per se, even though water flowing to the dam might be used for irrigation.

So I was wondering about the applicability of this standard to those types of surface waters.

MR. PIERCE: Mr. Chairman, Commissioner Whipple, irrigation storage is a designated use that this Commission has designated on 15 different waters of the state. Among those waters are Elephant Butte, Abiquiu, El Vado, Heron, Brantley, Sumner, Storrie, Avalon, Conchas and Navajo. These have been designated as irrigation storage for many years.

MR. WHIPPLE: So that's -- okay. Got you.

MR. PIERCE: So, I mean, there hasn't been a definition, but there hasn't been a definition for many years, either.

MR. WHIPPLE: Another question.

On ephemeral streams, would the human -- what I'm thinking of is a small reservoir that might be up along an ephemeral stream that might be supplied by diversions from a river or from groundwater, might have some surface water storage that could potentially spill during times of large rainfall runoff, but that would be the only times.

Would the criteria for the persistent toxic substances apply, I assume, to such a water body, as long as that was a tributary drainage to a stream segment that was designated fishery use?

MR. PIERCE: Mr. Chairman, Commissioner Whipple, that's correct, but currently also the livestock watering and wildlife habitat all do apply to that.

Now, to be realistic, most of these little ponds aren't going to have dioxin, PCBs, or any of these priority toxic pollutants in them, so -- but those are currently subject to the standards. Unless there is a problem, probably nobody will go out and look at it, but they are -- they are already -- several of these are applicable if they happen to be in one of those segments for which the Commission has said that this stretch and all tributaries and they are also subject to fishery uses.

MR. WHIPPLE: Thank you.

MR. MAGGIORE: Dr. Davis.

MR. DAVIS: Thank you, Mr. Chairman.

To make sure I understand your question, Commissioner Whipple, are you referring to what could perhaps in common parlance be called a dirt tank, where a berm of dirt is placed in an arroyo to intercept intermittent or ephemeral flows and accumulate water for the purposes of livestock?

Is that the kind of thing you're referring to?

MR. WHIPPLE: No. But now that you've raised it --

MR. DAVIS: Okay. If you would, please,

explain in more detail what it is you're referring to.
MR. WHIPPLE: For instance, Morgan Lake, where PNM's water supply reservoir -- that are fed by the diversions off the San Juan River, but don't necessarily release water back into the system -- into the stream system.
MR. DAVIS: In any case, Mr. Pierce's answer is still a good one. I just -- I was visualizing, when you were describing -- when you described this, I was visualizing what -- what are known as dirt tanks, of which there are 30,000, 50,000, 100,000 of them around this state. I have no idea.
Nevertheless, in waters impounded like that, wildlife habitat and livestock watering standards apply. You don't expect to find these sorts of things in them, obviously.
Just a point of clarification. Thank you, Mr. Chairman.
MR. WHIPPLE: Thank you.
That's all I have.
MR. MAGGIORE: Any other cross-examination of Department witnesses from the Commission?
Commissioner Glass.
MR. GLASS: With apologies, I have a few questions, actually. I'm trying to trim them down.

The first issue that comes to mind is that your slide indicates that you have, for aquatic life, 11 acute and 10 chronic criteria being proposed. Those are new criteria, I suppose.

When I look at the table, I see many more than 10 acute and 11 chronic, and I just -- I assume that some of these existed prior and they've just been moved into the table.

Is there some way they could be -- the new ones could be highlighted so that the reader would know which are the new ones being proposed?

MR. PIERCE: Yes, Commissioner.

After the first 24, I believe everything is new.

MR. GLASS: Okay. The first 24 are old, just moved in from the textual tables, and then the ones --

MR. PIERCE: Except for the ones for human health, but for -- it's all the alphabet compounds that are on the next three pages that are new.

MR. GLASS: Okay.

MR. PIERCE: Except for chlordane and PCB, which we have existing standards, and DDT under wildlife habitat.

MR. GLASS: So everything in number 25 and after -- except for chlordane and DDT --

MR. PIERCE: And PCB.

MR. GLASS: Okay. I see the proposal is to include the formula, or the formulae -- there are several formulae for calculating criteria from the IRIS database -- to include those in the Water Quality Management Plan, and I guess I have kind of a timing problem with that in that one would publish -- we would adopt these standards when the formula isn't in the Water Quality Management Plan. Is that a problem? Do we have to revise the Water Quality Management Plan before these -- you see my point?

MR. DAVIS: Mr. Chairman, Commissioner Glass, yes, and we specifically thought about that, because as this Commission is very aware, we are undergoing a major update of the Water Quality Management Plan.

We looked at a calendar and anticipated a sequence of events, recognizing that in order to do this, we would need to modify the Draft Water Quality Management Plan that is currently in its 60-day public comment period.

This, obviously, is simply a proposed calendar. We anticipate that the Water Quality Management Plan -- see, this isn't going to work anymore. We do have a timing issue.

MR. GLASS: Maybe you can ask -- I was going to ask counsel about that, but it's empty over there. Maybe I can ask their counsel.

MR. MAGGIORE: Is the question the concern that we will be adopting regulations that contain a formula which the Water Quality Management Plan is yet to --

MR. GLASS: Exactly.

MR. MAGGIORE: -- provide for?

MR. GLASS: The standards say that the formula will be used and give a reference to the location of the formula where it cannot be found.

MR. DAVIS: We would be -- Commissioner Glass, we would be able -- I believe we could approach the Commission in a very timely manner to make the change in the Water Quality Management Plan, such that action on this proposal would not be in effect yet, have no procedure specified in the plan, we would simply change the plan.

If the Commission adopts this approach that we're proposing and approves the inclusion into the Water Quality Management Plan, we would simply then move forward and make that change in the Water Quality Management Plan and approach the Commission at its next meeting to debate, discuss and adopt that change in the management plan.

I don't believe we can put something into the management plan that references the standards if the standards have not yet been adopted by the Commission. So we have to -- we have to allow the Commission to act on the standards, and then following that, we would immediately act on the management plan.

MR. AMES: If I might add, Mr. Glass, if you recall, the EPA will either look to a state -- explicit state policy or a state regulation in deciding how to make the translation mechanism work, and I would suggest that if the Commission were to adopt this language into section 12.F.2(b) that the Department would point the EPA toward the transcript of the proceeding for evidence of the Commission's policy regarding the formula to use in the absence of those formulae in the management plan yet.

So there may be a gap in time, but EPA is not going to like run out and use whatever formula they want. After all, the formulae we're proposing for inclusion in the Water Quality Management Plan are EPA's current formulae, so the likelihood that we're going to hit the wall here, because the plan has not yet been amended to reflect what the standards require, I think, is extremely unlikely in these circumstances.

MR. DAVIS: And practically speaking, Commissioner Glass, it would be perhaps one month, at the most two months, before we were able to do this. So, as a practical matter, I don't think it would be a problem.

It is very -- it is correct that it is a hypothetical problem, but I don't think it would be practical.

Glenn just pointed out that there is no prohibition for updating the Water Quality Management Plan more frequently than we have done in the past, and, accordingly, we would propose that the management plan be amended accordingly in a timely manner.

MR. GLASS: And I personally wouldn't have a problem with the approach here. I was just thinking more of a procedural or -- or something beyond my knowledge, if you will, just an issue.

But on the same page there, on the notice of intent, page five -- and I've flagged it elsewhere, too -- is the statement that -- actually you added it, I think, in response to a -- I forgot who expressed the concern, but it's on page five of your notice of intent to present technical testimony where you say that within 90 days of the issuance of an NPDES permit containing a numeric criterion calculated pursuant to, the Department shall petition the Commission to adopt such criterion into these standards.

My question is that if EPA establishes -- well, I guess that would be -- you're talking here about EPA establishing a stream criterion, right, a stream standard?

I mean EPA issues final permits, right, and it would be they that calculate the criterion? Is that true?

MR. SAUMS: Commissioner Glass, I think we're not talking about establishing a stream standard.

What we're talking about is them deriving a criterion for scanning in the permit issuance. When they are drafting the permit, if they don't have a number to scan the data against, as they review the permit, they would come up with a number according to that, and they would pursue their permitting action, and then upon the finalization of the permit, we would take that and come to the Commission to establish as a stream standard.

MR. GLASS: To propose a stream standard?

MR. SAUMS: As a stream standard, going through the full public participation process.

MR. GLASS: That was my concern, that we may be establishing here a mechanism to establish stream standards without the required public hearing, but that obviously is not the case, because the criterion that EPA would use for a permit is not tantamount to a standard.

It is a starting point for a standard, it would be proposed as a standard, but is not actually a standard?

MR. DAVIS: That's correct.

MR. SAUMS: I think that's correct, Commissioner Glass.

MR. GLASS: Okay. Got that. Thank you.

I guess just a last question. I did trim them down pretty well. There were 30 or 40.

In Mr. Pierce's testimony, on page 27, when discussing the issue of arsenic, as much as I hesitate to make Steve try to talk, you stated that you believed that Region -- it's in Pierce's testimony, page 27 -- you stated that the Department believes that Region 6's alternate recommendation of 20.5 micrograms per liter is not adequate to protect human health and would be disapproved by EPA.

I guess my question is that if EPA recommends it, why would EPA disapprove it, or is it a national or regional problem?

MR. PIERCE: That's part of it, Commissioner Glass.

Region 6 saw that there is a problem with arsenic -- as you're very aware, with the arsenic standard. National EPA is waiting for a study that's being conducted to be finalized, which is already overdue.

Region 6 felt that they couldn't wait, so they put out what they called an interim recommended criterion of 20.5.

When you look at the basis, they based it on ten to the minus sixth. They don't say that this standard would be good if you went ahead and translated it to ten to the minus fifth. The standard they recommended was 20.5. So if we take it and change it to ten to the minus fifth, we kick it all the way up to 205, which is well above drinking levels, et cetera. So I'm pretty sure they would not approve that.

What they want people to do in the interim is to adopt the 20.5, but that wouldn't have the same basis as our other criterion, and so if we took it and changed it to 205, they wouldn't approve it at that level.

MR. GLASS: So it's the level of risk difference that really has the impact here?

MR. PIERCE: That's correct.

MR. GLASS: I understand that.

MR. PIERCE: Our calculated level is real close to that 20.5 at 24.2.

MR. GLASS: I noticed that. Yeah.

Thank you.

MS. BRANDVOLD: Is that your last question?

MR. GLASS: Yes.

MS. BRANDVOLD: Mr. Olson, you had some questions.

MR. OLSON: Just a couple.

I guess it's Mr. Pierce. I guess this is on the toxic pollutants, 20.6.4.12.F.

On removing that language "attributable to discharges," it sounds like that's going to be making nonpoint source activities and problems mandatory. Do you have any comment on that?

MR. PIERCE: Commissioner Olson, I don't believe that's the case.

Nonpoint sources aren't addressed by our standards and neither are point sources. Standards apply to the ambient water. So to the extent that there have been problems for nonpoint sources, they still need to be addressed, even though there is no mechanism except voluntary within the state, or the mechanism is they get a much higher priority rate when it comes to issuing 319 grants, but by removing that, it doesn't mean that nonpoint sources would be a mandatory enforcement.

It would just mean, you know, that we're applying the standard to the ambient stream.

MR. OLSON: Okay.

MR. PIERCE: And it wouldn't allow the loophole of being able to put large quantities out there that aren't coming specifically out of a pipe today that would get into the waters.

Did that answer your question?

MR. OLSON: Yes.

MR. DAVIS: Commissioner Olson, if I could, I'd like to expand a little bit on Steve's answer.

MR. OLSON: Yes.

MR. DAVIS: The logic of this is precisely the same logic that the Commission used when it clarified the exemption for irrigation flood control facilities of five numeric standards, and that is that the standards, as Steve pointed out, apply to the ambient water. They do not address the source of the pollutant. They establish the criteria against which ambient water is measured.

That logic, as it applies to the irrigation and flood control facility exemption, is correct. Equally, it would be correct under this circumstance, and that is that these standards are applicable to the water and they do not restrict themselves vis-a-vis the source of the pollutant.

MR. OLSON: Thank you.

I just have two others.

Mr. Pierce, on page 16 of your testimony, you talked about a logic for not putting in drinking water -- or because of conventional drinking water treatment methods can remove the priority toxic pollutants, the Department doesn't consider those criteria based on the consumption of untreated surface water are necessary to protect public health.

If that's the case, why would we have -- we have some other domestic standards in the table M that we had currently. Is there some conflict with that, with what you're saying there, and the inclusion of those other domestic standards, because those things could be removed by treatment? Should they be in table M?

MR. PIERCE: The statement that conventional treatment could remove those was our way of thinking about whether or not, in a few years when Albuquerque is drinking river, would they be at a higher risk of eating fish and getting that through their drinking water, and the answer was no, based on that, because it would be treated and be removed, but also the water quality standards -- the drinking water standards would apply to Albuquerque.

We were looking to see if there was any significant risk of people who are drinking raw water and eating fish out of the same water, and in that that doesn't seem to be a very widespread situation in the state; however, if it is determined to be occurring somewhere, then we would be quite willing to come back and propose a different basis for a site-specific standard for someplace where people are consuming the water and eating fish out of that same water.

MR. OLSON: But we do have some standards then for domestic water supply?

MR. PIERCE: That's correct.

These are drinking water standards from the Safe Drinking Water Act that would apply to surface water that people would use after filtration and disinfection.

Since the drinking water standards represent the level that is found to be healthful for people consuming two liters of water over 70 years, the Commission has always adopted those standards in those stretches of water that are recognized to be used directly for people to drink without any treatment beyond filtration or disinfection.

MR. OLSON: So is that the rationale that these ones that are in here wouldn't be removed by the conventional treatment and why there would be a standard, say, for, you know, barium, arsenic?

MR. PIERCE: Those standards do not apply to a municipal water supply. They only apply to a domestic water supply. The assumption under the domestic water supply is that people use the water, disinfecting it and filtering it, and no other treatment.

MR. OLSON: Okay.

MR. PIERCE: Municipal water supply carries no standards whatsoever at the moment. The municipal water supply designated use carries no standards with it specifically at the moment.

MR. OLSON: Okay.

MR. PIERCE: If there was something that somebody was found not to be able to remove in treatment, then they might request such a site-specific standard for a stream to try to prevent that from going into the water.

Currently, all the items we're looking at now are removed by conventional treatment common in New Mexico.

MR. OLSON: Okay. This is just a question on table M.

Most of the aquatic life calculations that you have here, you have some -- most of them have acute and chronic, but you have a couple that have acute and no chronic criteria calculated.

Why is that? Is there --

MR. PIERCE: Commissioner Olson, these are directly out of the EPA guidelines, so they must have found some problem with the calculation of a chronic or of acute for certain things.

It may be that some things have an effect over a long period of time -- i.e., the chronic standard can be developed, but the higher level doesn't cause immediate toxicity. So they may have been able to develop a chronic for some things, and it may be that some things that have an acute impact don't have any effect over a long period of time, but if they get it right away, it could kill them.

So I'm surmising there. My straight answer is EPA had no recommended criteria for those particular ones. Beyond that, I think what I'm saying is what I think the reason is.

MR. OLSON: Okay. It just seemed like every one had a -- except for a couple that had an acute standard also had a chronic. That didn't --

MR. PIERCE: For a few of these, they originally had proposed acute and chronic, and due to some problem, they removed one or the other.

For an example of one we had, the Commissioners will remember, we had acute and chronic standards for silver, and it was determined, after further experimentation, that the chronic standards for silver really was not necessary, that there wasn't a chronic toxicity being shown, so that the Commission dropped its chronic standard and we just have an acute standard for silver.

MR. OLSON: Okay. I think that's all I have. Thank you.

MR. MAGGIORE: Any other cross-examination questions from the Commissioners?

Commissioner Keyes.

MR. KEYES: Mr. Chairman.

Mr. Pierce, I'm curious to know what the history is on the definition of grab sample, and is there a reason that the Commission has not defined that and whether it should be a split grab sample or use the protocol that you all have on the second sample only being used if, in fact, it's an exceedence of the criteria or the standard.

MR. PIERCE: Mr. Chairman, Commissioner Keyes, there is a theory that I've been around since before God, but it's not true. There are people around that have been here a lot longer. In fact, Commissioner Johnson has been on the Commission now for 26 years, so he may have more information.

I'm not aware of why the term was not defined. The protocol we used to determine the assessment were borne out of necessity when all at once the 303(d) list became a very important document, and in what projects had highest priority, what TMDL developments had to be, and at that time we developed the assessment protocol, which were based on other states' assessment protocols and were based on a more logical look at the overall data.

We still have problems now on large data sets. We may go out and in a single season get 20,000 readings for temperature, and the way the standards read, if one of those 20,000 exceeded, we would consider it at least an exceedence.

So what we've done through the protocol is determined what we would use to determine whether or not the use is actually being nonattained. These are still undergoing tweaking, and I'm sure that they will be proposed to be part of the standards or part of the management plan when they are fully tweaked.

Currently, they are approved as part of our standards by EPA, and they have been tweaked almost yearly, and we're working on several of the large data set protocols, but, no, I do not know why the term grab sample has not been defined, or even if a definition has been kicked around at some point in the past.

MR. KEYES: Mr. Chair, I would like to make a comment off the record, if I may, to Mr. Pierce.

MR. MAGGIORE: Sure. We can go off the record for a minute.

(Off-the-record discussion.)

MR. MAGGIORE: We can go back on the record.

MR. KEYES: That's all I have.

MR. GLASS: I have a follow-up to that, if I might.

The proposed compliance with water quality standards for the protection of human health that shall be determined from the analytical result of a single grab sample, that is your proposed changes, you stated that that never actually really happens, that you don't -- that there is a confirmation, and I think, in fact, that your protocol requires seven samples.

I mean, you've got a couple of them, a second sample, you get an exceedence -- seven samples, I think you said substantiates a violation. Do I remember that right? Is that the QAPD, Q-A-P-D?

MR. DAVIS: Mr. Chairman, Commissioner Glass, let me try to answer that.

As Steve correctly points out, we have a data assessment protocol that the Bureau has developed that addresses a number of these types of issues. A single grab sample is in the standards.

My interpretation, not a definition of it, but the interpretation that we use practically is that that means there is no averaging or weighting or other kind of statistical manipulation of the result, rather it is the result that derives from a single sample.

However, given that there is uncertainty associated with any analytical result, it is not, in my estimation, prudent to rely on a single number that only occurs -- that you only have one occurrence of. So we sample multiple times to achieve a level of confidence that the number, in fact, is correct, but we do not average cross those multiple samples, we simply use one numeric value to estimate or to determine whether or not a standard has been exceeded.

So, practically, we find ourselves taking multiple samples, but we apply no statistical methodology across those multiple samples, rather we use the result of a single sample, as is specified in the standards.

We simply can't go out and say, "Well, if we have one hit, is that real?" There has to be some repeatability to that, and so we sample multiple times to achieve that repeatability.

Does that help?

MR. GLASS: No, but that sounds very scientifically valid, absolutely, that -- but I guess my concern, or my suggestion is, or my wish is, that that process could somehow be incorporated here so that we would -- you know, that the dischargers wouldn't be subject or feel subject to just sort of that single instance and then all of a sudden it's $25,000 a day.

MR. DAVIS: Right.

Commissioner Glass, the protocols that I speak of that the Bureau has developed over the last three-and-a-half years or so are currently in the Quality Assurance Project Plan that the Bureau develops every year and submits to EPA. This is a requirement of the federal act -- the various regulations under the federal act.

EPA reviews the procedures that any state is using. We have developed these with both internal and external review, again, to pick up on the -- one of the examples that Steve used is that we have a temperature protocol. We may, in fact, accumulate 20,000 or more temperature readings of a particular segment of stream in the state. We've worked with US Fish & Wildlife Service, New Mexico Department of Game and Fish and EPA to understand what a 15-minute, one-degree Celsius exceedence of the standard might mean, as opposed to a 45-minute, one-and-a-half-degree Celsius exceedence of the standard. Those are different for the biological community.

Accordingly, we developed a protocol that specifies -- I don't have it memorized, but, say, a two-degree Celsius exceedence of the standard for two hours is not acceptable, but a .5-degree Celsius exceedence of the standard for 15 minutes is.

Now, this is something that the Bureau has done to help us understand -- help us interpret the language in the standards that is absolute; where it says, for example, in a high-quality cold-water fishery the temperature is 20-degrees Celsius, shall not exceed.

These protocols are on our website, and they have been -- they are available for review by any interested party. They have been since they were developed. They do undergo routine and ongoing review, or tweaking, as the term of art is, and we're constantly interested in making these things better.

They are not codified anywhere, but we do anticipate, in the rewrite of the CPP, that we will be addressing these protocols through that document, which would then bring into play a review by the Commission. This is -- in any case --

MR. GLASS: But there is no hope, I don't suppose, for these interpretative -- interpretative criteria, if you will, or these methods of interpretation ever to translate themselves into a more -- a less-limiting compliance scenario for the standards themselves.

I mean, couldn't this sentence say, for instance, compliance with water quality standards can be determined from the analytical results of a single grab sample after confirmation with a second sample?

MR. DAVIS: Mr. Chairman, Commissioner Glass, yes, that kind of thing would be very imaginable.

In fact, some states in the country do precisely that, they place into their standards these interpretative phrases to provide guidance or very clear examples of how the standards apply.

We've not had the opportunity to do that, quite frankly, with the Commission. It would be a very major undertaking in the standards, as you can well imagine, but something like that is, obviously, an option and it would be something we'd be -- we'd be happy to consider.

MR. GLASS: Then are you saying it's your opinion that we couldn't do it with this set of revisions for human health standards because of the potential impact to other parts of the standards?

MR. DAVIS: Mr. Chairman, Commissioner Glass, as a practical matter, no one has proposed it. We do not have any -- we do not have a proposal in front of us to do that, but as a -- again, speaking, if you will, hypothetically, I see no -- I see no absolute barrier to that at all. I think that approach could be used in the standards.

MR. GLASS: I take it that the Bureau would have no objection to inserting "as confirmed by a second grab sample" in that 20.6.4.11(d)?

Is that a reasonable --

MR. DAVIS: Mr. Chairman, Commissioner Glass, I would ask that we take a careful -- that we give ourselves time to carefully think through the ramifications of it.

Again, as a practical matter, if you're basing -- I mean, I'm speaking simply off the top of my head right now, but if you're basing your estimation of compliance with the standards on a single grab sample that you can take multiple times, do you simply take samples until you find the result that you want, and that would not be appropriate. What would it mean to a permitted discharger?

Again, I don't think that there is any barrier to this approach, hypothetically, but I would like to take the time to think it through carefully.

I do know that I have seen examples of temperature standards in other states where they have some graduated scale. You know, in discussions with this Commission in other forums, we've recognized this particular problem with the Gila River and San Francisco River Basins in the southwestern portion of the state that are typically exposed to higher ambient temperatures than the mountain streams in the Sangre de Christo Mountains at the border of Colorado.

Accordingly, you might expect a different temperature regime to occur in those waters, yet we have an absolute standard that applies everywhere in the state of 20-degrees Celsius for the designated use of high-quality cold-water or warm-water fishery.

It may in fact be that we need to capture some of that natural variation in the standards, but the way to do that is the difficult part, and so I would -- like I say, I would request that we take our time and think it through very carefully before we do it.

MR. GLASS: Okay. Thanks.

MS. HUGHES: Do you want me to take over?

MS. BRANDVOLD: Are there any more questions from the Commission?

MR. WHIPPLE: One more question.

Mr. Pierce, what is the fish consumption rate under these water quality standards?

MR. PIERCE: The consumption rate used in these calculations by EPA is six-and-a-half grams of fish a day.

MR. WHIPPLE: Is that like a nationwide average, or is that a considerably high number that EPA has just assumed?

MR. PIERCE: That was developed as a nationwide number on an average of people that eat fish and people that don't eat fish.

Part of the risk level -- EPA has stated that you cannot go below a ten to the minus fourth risk level, and one of the assumptions they have is that you'll have an exposed population that eats a lot more fish.

So our proposal, even somebody who eats a lot of fish, would be protected at least by ten to the minus fourth level -- risk level.

Yes, they used six-and-a-half grams per day per person. There has been some talk of them changing that to 17-and-a-half grams a day, which I feel might be too high for New Mexico, and it might behoove us at that point to try to develop some local guidance to fish consumption.

Right now, we felt the six-and-a-half grams was a valid assumption to start with for New Mexico residents.

MR. WHIPPLE: Thank you.

MR. MAGGIORE: Any other cross-examination from the Commission?

If not, I'll open it up to cross-examination from the public.

If you're cross-examining, please rise and state your name slowly and clearly for the record and then proceed.

Mr. Rose.

MR. ROSE: Thank you, Mr. Chairman.

MR. MAGGIORE: Before you begin, can you estimate how long your cross might be?

MR. ROSE: Depending on the questions, hopefully, not more than ten minutes --

MR. MAGGIORE: Thank you.

MR. ROSE: -- but you never know. It depends on the questions.

For the record, my name is Louis Rose, I'm with Montgomery & Andrews in Santa Fe, and I'm here representing the University of California Board of Regents.

CROSS EXAMINATION BY MR. ROSE

MR. ROSE: It's a question for whoever wants to answer it. It's a toss-up question here.

With respect to -- I'm referring to Section 12.F.2(c) -- I think that's the proposed language that the Department had in their notice of intent concerning petitioning the Commission for review of the standards.

I was curious, you've chosen 90 days from the final NPDES permit containing the numeric criteria. As I understand it, there would be an interim process where you would be required to certify a number in a proposed NPDES permit.

I wondered why you chose from the date the final permit was issued rather than from the date you certify compliance with the state requirements of the 401 certification?

MR. SAUMS: Mr. Rose, I guess I received the toss-up on that question.

MR. ROSE: I noticed Jim pointed to you.

MR. SAUMS: I think the answer to that is simply that a permit isn't final until it's final, and when EPA makes its final decision, that would be the time to act.

Well, in the case of the Molycorp permit that I referred to in my testimony, while EPA calculated that a number -- that their effluent might cause a water quality -- a human health standard violation, ultimately, a technology-based effluent limit prevailed, and, therefore, the issue of the human health criterion became moot.

So I think in that case it's prudent to wait until a permit is finalized by EPA before we go petitioning the Commission and approaching them with something, that if we were to go earlier than that, we might be premature.

MR. ROSE: In terms of the final number in an individual permit -- but would, for example, the calculation of what was appropriate to be the new -- the narrative standard, would that then be -- would that process be -- could it be replicated later, and in essence, the same analysis be done on a later permit?

Wouldn't it be more prudent to have the Commission review that analysis sooner than later in the process or even in a subsequent permit?

MR. SAUMS: I think that's a suggestion worthy of consideration.

MR. ROSE: When you reference "final NPDES permit," I assume you include storm water permits as well as point source, normal point source discharge permits, do you not?

MR. SAUMS: I think we're referring to all NPDES permits, whether they are individual permits or general permits.

MR. ROSE: Okay. I understand your reference to petition the Commission to be a petition under the

Commission's guidelines for rule-making.
Is that what you understood your testimony to be?
MR. SAUMS: Mr. Rose, I think that we would always adhere to the Commission's guidelines or preferences as they saw fit.
MR. ROSE: While the requirement obligates you to petition the Commission, there is no statement about what happens subsequent to the petition.
I was curious, say, for example, if the Commission were to either not go to hearing on a petition or not accept the number and adopt a different number in the standards, what would be the process?
Would you go back, and if it were a less stringent number, would you be amending or seek to amend the NPDES permit, or what would be the result of this if the Commission were not to agree with analysis of what the appropriate numeric translation of the narrative standard would be?
MR. DAVIS: My turn.
I think at that time, as the Commission deliberated and made its decision known, both to us and to the affected public, we would then probably seek guidance on what the next step should be, and that debate would occur -- the Commission would engage in that debate

and it would occur in the full view of the public.

I don't know that we can anticipate -- I mean, your question is interesting, but it's hypothetical, and I don't know that we can -- that we can speculate in a particularly beneficial manner on what the Commission may or may not do.

MR. ROSE: And I take it that the translation of narrative standards to numeric standards in F.2 is not the only place where that analysis takes place, is it not?

Wouldn't a similar sort of analysis take place under F.3, or could it not, where you translate a narrative into a numeric number? Particularly in F.3 -- I think it's F.3(b) -- or F.3.

Actually, it talks about how you calculate if there is a number in 900, then what you do, and what you apply in sequential order.

MR. AMES: Did you hear the question, Mr. Pierce?

Could you rephrase the question?

MR. PIERCE: I'm sorry, if you could rephrase it.

MR. ROSE: I was curious, as I was reading this -- we've been talking about F.2 and translating a narrative into a numeric standard, and it was my reading that that's not the only place where that could take place, it could also take place under F.3.

I was curious -- I mean, that's the way I read them, and I wasn't sure if I was correct. I was asking for confirmation of that.

MR. PIERCE: You are correct. It does occur under F.3, which is existing language, and it has occurred at least once since 1995 when the Commission adopted these standards.

MR. ROSE: And I was curious, since you're proposing a process to deal with those narrative standards, which are calculated based on standards under F.2, why the Department did not consider a similar process under F.3 for Commission confirmation of those standards?

MR. DAVIS: That question or that idea was simply not raised. We didn't think of it, and neither did anyone else.

MR. ROSE: Would you object to similar language being interposed as to that process as well?

MR. DAVIS: I don't believe so, but I would prefer to have the opportunity to think about it a little longer.

MR. KEYES: You've got five minutes.

MR. DAVIS: I don't --

MR. MAGGIORE: You can handle that on rebuttal. You could address that, Dr. Davis, on rebuttal if you don't want to --

MR. DAVIS: Yes. That's fine.

MR. AMES: Thank you.

MR. ROSE: That's fine. I have no further questions.

MR. MAGGIORE: Thank you, Mr. Rose.

Any other cross-examination?

Ma'am.

MS. MC CALEB: Yes, Jolene McCaleb on behalf of San Juan Water Commission.

MR. MAGGIORE: Just quickly an estimate on time.

MS. MC CALEB: I'm guessing 45 minutes to an hour.

MR. MAGGIORE: Okay. That's why I asked, I guess.

Let me just ask the members from the public that had indicated they cannot return tomorrow -- there were two folks.

Ma'am, you had indicated earlier and you had already signed in and been sworn in --

MS. GNATKOWSKI: Yes.

MR. MAGGIORE: -- and you had said your

testimony will be relatively brief.

MS. GNATKOWSKI: Yes, it will be very short.

MR. MAGGIORE: Mr. Shields, yourself?

MR. SHIELDS: Yes, it will be very short.

MR. MAGGIORE: Short.

Okay. Commission, what do you want to do? Do you want to hear the public stuff and then call it a night or -- I'm seeing a lot of head shaking.

Okay. Let's go ahead and do that.

If I can ask you two individuals who want to provide some public comment -- ma'am, we will get to you first thing in the morning with cross-examination.

Mr. Shields.

MR. SHIELDS: Mr. Chairman, I had a couple of questions that I have for cross-examination. If I may address those first.

MR. MAGGIORE: I'm sorry?

MS. BRANDVOLD: If he can't come back tomorrow --

MR. MAGGIORE: Yes. Okay. I'm assuming -- I don't mean to inconvenience you, but you have apparently some robust questioning, and you will be back tomorrow; is that right?

MS. MC CALEB: Absolutely.

MR. MAGGIORE: All right.

Having heard that, then, Mr. Shields, why don't you proceed then with cross-examination of the Department, and then we'll move to public comment, and then we'll call it a night.

MR. SHIELDS: Thank you, Mr. Chairman.

MR. MAGGIORE: If you wouldn't mind coming up to the front, Mr. Shields, and stating your name and affiliation clearly for the record.

MR. SHIELDS: My name is Brian Shields. I'm the executive director of Amigos Bravos.

I just had a couple of questions that I wanted to ask.

CROSS EXAMINATION BY MR. SHIELDS

MR. SHIELDS: I guess I'm kind of curious to know how many communities in New Mexico actually use water for domestic purposes at this point. Use surface water, right. Sorry. A little technicality.

MR. MAGGIORE: Hopefully, Mr. Shields, but I think we --

MR. KEYES: Every one of them.

MR. SHIELDS: I was trying to save words. I can just use my voice.

MR. PIERCE: Mr. Chairman, Mr. Shields, right now we don't know -- I don't know that there are any -- any communities that use it. These would be mostly individuals.

There are houses in Northern New Mexico that run pipes out to a stream for the drinking water. We had at least one of our NMED employees who carries water up from the river and pours it through a sand filter for his household. We know people do take water from the acequias.

I don't think that any communities draw it. If they do, then they would come under the Safe Drinking Water Act as a municipal system, and that's not the same as domestic water supply.

MR. SHIELDS: Okay. I'm aware that there are some -- like the community of Llano, I know that they depend on their water from the acequias, because many people don't have wells there, domestic wells.

So, I was wondering, in terms of that, I noticed that you used the criteria developed for consumption of organisms only, and I assume that the criteria for the consumption of water and organisms would be more protective of human health.

MR. PIERCE: It is a more stringent standard, yes.

MR. SHIELDS: It is a more stringent standard.

Can you tell me how it would relate to, for instance, the arsenic standard?

MR. PIERCE: Under the current recommendations, the arsenic standard for organisms only is 0.14 micrograms per liter. Water plus organisms is 0.018, which is a standard that some of the pueblos have adopted.

It isn't as great a difference in arsenic as it is in some of the highly bioaccumulative organic biocontaminants. So there it's an order of magnitude.

MR. SHIELDS: So I'm wondering, both with this -- using this criteria and also looking at the numbers that were used for risk -- for assessing risk criteria at ten to the minus five, as opposed to ten to the minus six, I'm just wondering, in terms of downstream receiving waters, like the pueblos, for instance, or other states, does -- how that affects what kind of -- what water we're delivering to those people.

MR. PIERCE: Mr. Chairman, Mr. Shields, currently, all of these are at real low levels, so there is probably not a current problem.

There could be a problem, as there could be with a lot of other aspects of water quality standards, because there are so many different sets of standards that apply to different areas of New Mexico.

I believe that the Rio Grande alone goes in and out of eight different jurisdictions and a lot of those standards are quite different.

These standards were not chosen to be protective of any particular tribal standards. We don't know that they aren't protective, but they are not the same standards as some of the tribes have adopted.

MR. SHIELDS: So do we know, in terms of how many of our neighboring states have used the ten to the minus sixth criteria or -- I mean, I don't know how the pueblo standards are developed, but are they developed in the same manner, so how many pueblos adopted this, the more stringent criteria?

MR. PIERCE: I believe three of the pueblos have adopted human health, the others have not, and those three all adopted at ten to the minus sixth.

There is an exhibit that's being submitted by San Juan Water Commission that shows that Colorado uses ten to the minus sixth, Montana uses the same, Nevada uses the same, Texas is ten to the minus fifth. I can't make it out what it says for Utah. It looks like it's ten to the minus sixth. So they've gone back and forth.

MR. SHIELDS: Okay.

MR. AMES: Point of clarification, this document actually was prepared by the Department; correct?

MR. PIERCE: Originally, it was prepared by the Department in draft form, yes, but we did not introduce it as an exhibit.

MR. AMES: Okay.

MR. SHIELDS: I'm just curious whether adopting ten to the minus five places the state in a situation where they might be liable for not meeting -- not delivering water quality sufficient -- at a sufficient level for those downstream recipients?

MR. DAVIS: Mr. Chairman, Mr. Shields, in the interests of time, in the closing part of my testimony, we were moving quite rapidly, however, I --

MR. AMES: From our perspective.

MR. DAVIS: -- have a protocol for that that we've developed -- no, this is in my written testimony, but I can say it now.

Let me find it. I want to make sure that I say it correctly.

Okay. I say in my written testimony that the Department's proposal is squarely within the range of values authorized by federal law and regulation and would be acceptable to EPA. That's on page four of my written testimony, the last paragraph.

I thought I had a bullet in my notes to that effect, but I can't find it.

So your question of whether or not we would -- the state would be liable, I think -- I think what we're proposing is completely within what EPA would find acceptable, that doesn't go to, you know, hypothetical liability, but I believe it addresses what the federal agency --

MR. SHIELDS: At least it sounds like we don't have to worry about Texas on this one.

Mr. Chairman and Members of the Commission, that brings to a conclusion my cross-examination.

MR. MAGGIORE: Okay. Thank you, Mr. Shields.

Do you want to go straight into your public comment and then we'll have public comment from the Cattle Growers and we'll recess for the evening?

(Oath administered to Brian Shields.)

BRIAN SHIELDS

after having been first duly sworn under oath,
was questioned and testified as follows:

DIRECT TESTIMONY

MR. SHIELDS: Mr. Chairman and Members of the Commission, thank you for providing this opportunity for me to make a brief presentation.

As many of you know, Amigos Bravos is a New Mexico river conservation advocacy organization. We have offices in both Taos and in Albuquerque, and we have a membership of 1,500 members. We have a track record of working on water quality issues, having formally participated in the last triennial review of water quality standards and having helped to secure the NPDES and state water quality permits to control acid mine drainage from the Molycorp Mine in Questa, among other things.

On behalf of our members, who are mainly in New Mexico, we would like to offer support for the Bureau's present petition for the following reasons.

First, many of the priority pollutants in the petition are synthetic, often chlorinated, compounds which do not break down in nature and which, because of their unnaturalness, cause severe problems in natural systems ranging from ecosystems to human bodies. They include many of the worst, most persistent poisons on the planet. Many are known or suspected carcinogens and/or cause human reproduction or nervous system damage.

Second, the Bureau's present effort to prevent toxic bioaccumulations in fish is very valuable. Moreover, there are many other pathways through which these substances can potentially affect the environment and human beings through the use of river water for domestic supplies, for instance, which are being planned for Albuquerque, Santa Fe and other New Mexico cities in the near future.

We believe that this is a good proactive measure to take at this time.

Third, we're only now finding out exactly where the substances exist in New Mexico surface waters. It seems that the more you look, the more you find. So we think it's important to be looking in order to protect human health.

In conclusion, Amigos Bravos believes that the precautionary principle is highly appropriate for regulating priority pollutants in New Mexico, because of their extreme toxicity, persistence, and uncertain systemic effects. This means that there should be strong efforts to locate and monitor these substances, to determine their extent and sources, and means minimizing the quantities that are allowed to enter the environment, preferably preventing their discharge completely at the source.

We believe that the present petition, as a whole, goes a considerable way towards this by helping to put the monitoring and control of these dangerous substances on a formal, transparent and systematic basis, and for those reasons, Amigos Bravos supports the petition.

Thank you for taking these comments into consideration.

MR. MAGGIORE: Thank you, Mr. Shields.

Appreciate that.

I believe we have one more.

MS. BRANDVOLD: And cross.

MR. MAGGIORE: I'm sorry, any cross-examination of the witness by the Commission?

Seeing none, any cross-examination from the audience?

MR. AMES: No.

MR. MAGGIORE: None.

Thank you, Mr. Shields. Appreciate that.

(Oath administered to Callie Gnatkowski.)

CALLIE GNATKOWSKI

after having been first duly sworn under oath,

was questioned and testified as follows:

DIRECT TESTIMONY

MS. GNATKOWSKI: Mr. Chairman, Members of the Commission, my name is Callie Gnatkowski. I'm here today representing the New Mexico Cattle Growers and the New Mexico Wool Growers Associations.

Caren Cowan, who was here yesterday with the Cattle Growers, wasn't able to come today.

Both organizations would support the San Juan Water Commission's position that the standards, since they are of this magnitude and could have such impacts, should be considered during the next triennial review process when other standards, such as these, are considered.

Both associations are very interested in issues like this because of the impacts they can have on our membership and would be -- and would like to be involved in the process.

The Wool Growers Association was never notified about the process. I hadn't heard anything about it until I read an article in the New Mexico -- The New Mexican a couple of days ago.

The Cattle Growers were -- Caren asked me to say that the Cattle Growers were contacted by the Department in December about the potential for meeting with them, and she did say that she would like to meet with them, but then never heard back from them again. So that's really all I have to say.

MR. MAGGIORE: Okay. Thank you.

MS. GNATKOWSKI: Thank you.

MR. MAGGIORE: Thank you very much, and thank you for sticking around to share that with us.

Any cross-examination of the witness from the members of the Commission?

Seeing none, any cross-examination of the witness from the audience?

Seeing none, thank you.

You're excused.

MS. GNATKOWSKI: Thanks.

MR. MAGGIORE: I think we can go off the record now and recess until 8:00 tomorrow morning, where we will pick up with the cross-examination of the Department's witnesses by San Juan.

I will not be able to be here tomorrow, and if it's the Commission's pleasure, I would like to -- since I was voted to be the Hearing Officer for this matter, I would ask the Commission's counsel, Tracy Hughes, to do that.

Is that okay with the fellow Commissioners?

Tracy, is that okay with you?

MS. HUGHES: I will do longer lunches, I promise.

MR. MAGGIORE: I'll give you a lot of work to work with there, Counsel.

(Hearing recessed at 6:54 PM.)

STATE OF NEW MEXICO)
)ss.
COUNTY OF BERNALILLO)

I, Kathy Townsend, the officer before whom the foregoing hearing was taken, do hereby certify that the witnesses whose testimony appears in the foregoing transcript were duly sworn by me; that I personally recorded the testimony by machine shorthand; that said transcript is a true record of the testimony given by said witnesses; that I am neither attorney nor counsel for, nor related to or employed by any of the parties to the action in which this matter is taken, and that I am not a relative or employee of any attorney or counsel employed by the parties hereto or financially interested in the action.

____
NOTARY PUBLIC
CCR License Number: 23
Expires: 12/31/02

My Commission Expires: 9/12/05

This document does not substitute for EPA regulations; nor is it a regulation itself. Thus, it does not and cannot impose legally binding requirements on the EPA, the states, tribes or the regulated community, and may not apply to a particular situation based on the circumstances. If there are any differences between this web document and the statute or regulations related to this document, the statute and/or regulations govern. The EPA may change this guidance in the future.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OCT 1 1993

OFFICE OF WATER

MEMORANDUM

SUBJECT: Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria

FROM: Martha G. Prothro
Acting Assistant Administrator for Water

TO: Water Management Division Directors
Environmental Services Division Directors
Regions I-X

Introduction

The implementation of metals criteria is complex due to the site-specific nature of metals toxicity. We have undertaken a number of activities to develop guidance in this area, notably the Interim Metals Guidance, published May 1992, and a public meeting of experts held in Annapolis, MD, in January 1993. This memorandum transmits Office of Water (OW) policy and guidance on the interpretation and implementation of aquatic life criteria for the management of metals and supplements my April 1, 1993, memorandum on the same subject. The issue covers a number of areas including the expression of aquatic life criteria; total maximum daily loads (TMDLs), permits, effluent monitoring, and compliance; and ambient monitoring. The memorandum covers each in turn. Attached to this policy memorandum are three guidance documents with additional technical details. They are: Guidance Document on Expression of Aquatic Life Criteria as Dissolved Criteria (Attachment #2), Guidance Document on Dynamic Modeling and Translators (Attachment #3), and Guidance Document on Monitoring (Attachment #4). These will be supplemented as additional data become available. (See the schedule in Attachment #1.)

Since metals toxicity is significantly affected by site-specific factors, it presents a number of programmatic challenges. Factors that must be considered in the management of metals in the aquatic environment include: toxicity specific to effluent chemistry; toxicity specific to ambient water chemistry; different patterns of toxicity for different metals; evolution of the state of the science of metals toxicity, fate, and transport; resource limitations for monitoring, analysis, implementation, and research functions; concerns regarding some of the analytical data currently on record due to possible sampling and analytical contamination; and lack of standardized protocols for clean and ultraclean metals analysis. The States have the key role in the risk management process of balancing these factors in the management of water programs. The site-specific nature of this issue could be perceived as requiring a permit-by-permit approach to implementation. However, we believe that this guidance can be effectively implemented on a broader level, across any waters with roughly the same physical and chemical characteristics, and recommend that we work with the States with that perspective in mind.

Expression of Aquatic Life Criteria

o Dissolved vs. Total Recoverable Metal

A major issue is whether, and how, to use dissolved metal concentrations ("dissolved metal") or total recoverable metal concentrations ("total recoverable metal") in setting State water quality standards. In the past, States have used both approaches when applying the same Environmental Protection Agency (EPA) criteria numbers. Some older criteria documents may have facilitated these different approaches to interpretation of the criteria because the documents were somewhat equivocal with regards to analytical methods. The May 1992 interim guidance continued the policy that either approach was acceptable.

It is now the policy of the Office of Water that the use of dissolved metal to set and measure compliance with water quality standards is the recommended approach, because dissolved metal more closely approximates the bioavailable fraction of metal in the water column than does total recoverable metal. This conclusion regarding metals bioavailability is supported by a majority of the scientific community within and outside the Agency. One reason is that a primary mechanism for water column toxicity is adsorption at the gill surface which requires metals to be in the dissolved form.

The position that the dissolved metals approach is more accurate has been questioned because it neglects the possible toxicity of particulate metal. It is true that some studies have indicated that particulate metals appear to contribute to the toxicity of metals, perhaps because of factors such as desorption of metals at the gill surface, but these same studies indicate the toxicity of particulate metal is substantially less than that of dissolved metal.

Furthermore, any error incurred from excluding the contribution of particulate metal will generally be compensated by other factors which make criteria conservative. For example, metals in toxicity tests are added as simple salts to relatively clean water. Due to the likely presence of a significant concentration of metals binding agents in many discharges and ambient waters, metals in toxicity tests would generally be expected to be more bioavailabile than metals in discharges or in ambient waters.

If total recoverable metal is used for the purpose of water quality standards, compounding of factors due to the lower bioavailability of particulate metal and lower bioavailability of metals as they are discharged may result in a conservative water quality standard. The use of dissolved metal in water quality standards gives a more accurate result. However, the majority of the participants at the Annapolis meeting felt that total recoverable measurements in ambient water had some value, and that exceedences of criteria on a total recoverable basis were an indication that metal loadings could be a stress to the ecosystem, particularly in locations other than the water column.

The reasons for the potential consideration of total recoverable measurements include risk management considerations not covered by evaluation of water column toxicity. The ambient water quality criteria are neither designed nor intended to protect sediments, or to prevent effects due to food webs containing sediment dwelling organisms. A risk manager, however, may consider sediments and food chain effects and may decide to take a conservative approach for metals, considering that metals are very persistent chemicals. This conservative approach could include the use of total recoverable metal in water quality standards. However, since consideration of sediment impacts is not incorporated into the criteria methodology, the degree of conservatism inherent in the total recoverable approach is unknown. The uncertainty of metal impacts in sediments stem from the lack of sediment criteria and an imprecise understanding of the fate and transport of metals. EPA will continue to pursue research and other activities to close these knowledge gaps.

Until the scientific uncertainties are better resolved, a range of different risk management decisions can be justified. EPA recommends that State water quality standards be based on dissolved metal. (See the paragraph below and the attached guidance for technical details on developing dissolved criteria.) EPA will also approve a State risk management decision to adopt standards based on total recoverable metal, if those standards are otherwise approvable as a matter of law.

o Dissolved Criteria

In the toxicity tests used to develop EPA metals criteria for aquatic life, some fraction of the metal is dissolved while some fraction is bound to particulate matter. The present criteria were developed using total recoverable metal measurements or measures expected to give equivalent results in toxicity tests, and are articulated as total recoverable. Therefore, in order to express the EPA criteria as dissolved, a total recoverable to dissolved correction factor must be used. Attachment #2 provides guidance for calculating EPA dissolved criteria from the published total recoverable criteria. The data expressed as percentage metal dissolved are presented as recommended values and ranges. However, the choice within ranges is a State risk management decision. We have recently supplemented the data for copper and are proceeding to further supplement the data for copper and other metals. As testing is completed, we will make this information available and this is expected to reduce the magnitude of the ranges for some of the conversion factors provided. We also strongly encourage the application of dissolved criteria across a watershed or waterbody, as technically sound and the best use of resources.

o Site-Specific Criteria Modifications

While the above methods will correct some site-specific factors affecting metals toxicity, further refinements are possible. EPA has issued guidance (Water Quality Standards Handbook, 1983; Guidelines for Deriving Numerical Aquatic Site-Specific Water Quality Criteria by Modifying National Criteria, EPA-600/3-H4-099, October 1984) for three site-specific criteria development methodologies: recalculation procedure, indicator species procedure (also known as the water-effect ratio (WER)) and resident species procedure. Only the first two of these have been widely used.

In the National Toxics Rule (57 FR 60848, December 22, 1992), EPA identified the WER as an optional method for site-specific criteria development for certain metals. EPA committed in the NTR preamble to provide guidance on determining the WER. A draft of this guidance has been circulated to the States and Regions for review and comment. As justified by water characteristics and as recommended by the WER guidance, we strongly encourage the application of the WER across a watershed or waterbody as opposed to application on a discharger by discharger basis, as technically sound and an efficient use of resources.

In order to meet current needs, but allow for changes suggested by protocol users, EPA will issue the guidance as "interim." EPA will accept WERs developed using this guidance, as well as by using other scientifically defensible protocols. OW expects the interim WER guidance will be issued in the next two months.

Total Maximum Daily Loads (TMDLs) and National Pollutant Discharge Elimination System (NPDES) Permits

o Dynamic Water Quality Modeling

Although not specifically part of the reassessment of water quality criteria for metals, dynamic or probabilistic models are another useful tool for implementing water quality criteria, especially for those criteria protecting aquatic life. These models provide another way to incorporate site-specific data. The 1991 Technical Support Document for Water Quality-based Toxics Control (TSD) (EPA/505/2-90-001) describes dynamic, as well as static (steady-state) models. Dynamic models make the best use of the specified magnitude, duration, and frequency of water quality criteria and, therefore, provide a more accurate representation of the probability that a water quality standard exceedence will occur. In contrast, steady-state models make a number of simplifying, worst case assumptions which makes them less complex and less accurate than dynamic models.

Dynamic models have received increased attention over the last few years as a result of the widespread belief that steady-state modeling is over-conservative due to environmentally conservative dilution assumptions. This belief has led to the misconception that dynamic models will always lead to less stringent regulatory controls (e.g., NPDES effluent limits) than steady-state models, which is not true in every application of dynamic models. EPA considers dynamic models to be a more accurate approach to implementing water quality criteria and continues to recommend their use. Dynamic modeling does require commitment of resources to develop appropriate data. (See Attachment #3 and the TSD for details on the use of dynamic models.)

o Dissolved-Total Metal Translators

Expressing water quality criteria as the dissolved form of a metal poses a need to be able to translate from dissolved metal to total recoverable metal for TMDLs and NPDES permits. TMDLs for metals must be able to calculate: (1) dissolved metal in order to ascertain attainment of water quality standards, and (2) total recoverable metal in order to achieve mass balance necessary for permitting purposes.

EPA's NPDES regulations require that limits of metals in permits be stated as total recoverable in most cases (see 40 CFR §122.45(c)) except when an effluent guideline specifies the limitation in another form of the metal, the approved analytical methods measure only dissolved metal, or the permit writer expresses a metals limit in another form (e.g., dissolved, valent, or total) when required to carry out provisions of the Clean Water Act. This is because the chemical conditions in ambient waters frequently differ substantially from those in the effluent; and there is no assurance that effluent particulate metal would not dissolve after discharge. The NPDES rule does not require that State water quality standards be expressed as total recoverable; rather, the rule requires permit writers to translate between different metal forms in the calculation of the permit limit so that a total recoverable limit can be established. Both the TMDL and NPDES uses of water quality criteria require the ability to translate between dissolved metal and total recoverable metal. Attachment #3 provides methods for this translation.

<u>Guidance on Monitoring</u>

o Use of Clean Sampling and Analytical Techniques

In assessing waterbodies to determine the potential for toxicity problems due to metals, the quality of the data used is an important issue. Metals data are used to determine attainment status for water quality standards, discern trends in water quality, estimate background loads for TMDLs, calibrate fate and transport models, estimate effluent concentrations (including effluent variability), assess permit compliance, and conduct research. The quality of trace level metal data, especially below 1 ppb, may be compromised due to contamination of samples during collection, preparation, storage, and analysis. Depending on the level of metal present, the use of "clean" and "ultraclean" techniques for sampling and analysis may be critical to accurate data for implementation of aquatic life criteria for metals.

The magnitude of the contamination problem increases as the ambient and effluent metal concentration decreases and, therefore, problems are more likely in ambient measurements. "Clean" techniques refer to those requirements (or practices for sample collection and handling) necessary to produce reliable analytical data in the part per billion (ppb) range. "Ultraclean" techniques refer to those requirements or practices necessary to produce reliable analytical data in the part per trillion (ppt) range. Because typical concentrations of metals in surface waters and effluents vary from one metal to another, the effect of contamination on the quality of metals monitoring data varies appreciably.

We plan to develop protocols on the use of clean and ultra-clean techniques and are coordinating with the United States Geological Survey (USGS) on this project, because USGS has been doing work on these techniques for some time, especially the sampling procedures. We anticipate that our draft protocols for clean techniques will be available in late calendar year 1993. The development of comparable protocols for ultra-clean techniques is underway and will be available in 1995. In developing these protocols, we will consider the costs of these techniques and will give guidance as to the situations where their use is necessary. Appendix B to the WER guidance document provides some general guidance on the use of clean analytical techniques. (See Attachment #4.) We recommend that this guidance be used by States and Regions as an interim step, while the clean and ultra-clean protocols are being developed.

o Use of Historical Data

The concerns about metals sampling and analysis discussed above raise corresponding concerns about the validity of historical data. Data on effluent and ambient metal concentrations are collected by a variety of organizations including Federal agencies (e.g., EPA, USGS), State pollution control agencies and health departments, local government agencies, municipalities, industrial dischargers, researchers, and others. The data are collected for a variety of purposes as discussed above.

Concern about the reliability of the sample collection and analysis procedures is greatest where they have been used to monitor very low level metal concentrations. Specifically, studies have shown data sets with contamination problems during sample collection and laboratory analysis, that have resulted in inaccurate measurements. For example, in developing a TMDL for New York Harbor, some historical ambient data showed extensive metals problems in the harbor, while other historical ambient data showed only limited metals problems. Careful resampling and analysis in 1992/1993 showed the latter view was correct. The key to producing accurate data is appropriate quality assurance (QA) and quality control (QC) procedures. We believe that most historical data for metals, collected and analyzed with appropriate QA and QC at levels of 1 ppb or higher, are reliable. The data used in development of EPA criteria are also considered reliable, both because they meet the above test and because the toxicity test solutions are created by adding known amounts of metals.

With respect to effluent monitoring reported by an NPDES permittee, the permittee is responsible for collecting and reporting quality data on a Discharge Monitoring Report (DMR). Permitting authorities should continue to consider the information reported to be true, accurate, and complete as certified by the permittee. Where the permittee becomes aware of new information specific to the effluent discharge that questions the quality of previously submitted DMR data, the permittee must promptly submit that information to the permitting authority. The permitting authority will consider all information submitted by the permittee in determining appropriate enforcement responses to monitoring/reporting and effluent violations. (See Attachment #4 for additional details.)

<u>Summary</u>

The management of metals in the aquatic environment is complex. The science supporting our technical and regulatory programs is continuing to evolve, here as in all areas. The policy and guidance outlined above represent the position of OW and should be incorporated into ongoing program operations. We do not expect that ongoing operations would be delayed or deferred because of this guidance.

If you have questions concerning this guidance, please contact Jim Hanlon, Acting Director, Office of Science and Technology, at 202-260-5400. If you have questions on specific details of the guidance, please contact the appropriate OW Branch Chief. The Branch Chiefs responsible for the various areas of the water quality program are: Bob April (202-260-6322, water quality criteria), Elizabeth Fellows (202-260-7046, monitoring and data issues), Russ Kinerson (202-260-1330, modeling and translators), Don Brady (202-260-7074, Total Maximum Daily Loads), Sheila Frace (202-260-9537, permits), Dave Sabock (202-260-1315, water quality standards), Bill Telliard (202-260-7134, analytical methods) and Dave Lyons (202-260-8310, enforcement).

Attachments

ATTACHMENT #1

TECHNICAL GUIDANCE FOR METALS

Schedule of Upcoming Guidance

Water-effect Ratio Guidance - September 1993

Draft "Clean" Analytical Methods - Spring 1994

Dissolved Criteria - currently being done; as testing is completed, we will release the updated percent dissolved data

Draft Sediment Criteria for Metals - 1994

Final Sediment Criteria for Metals - 1995

ATTACHMENT #2

GUIDANCE DOCUMENT ON DISSOLVED CRITERIA

Expression of Aquatic Life Criteria

October 1993

Percent Dissolved in Aquatic Toxicity Tests on Metals

The attached table contains all the data that were found concerning the percent of the total recoverable metal that was dissolved in aquatic toxicity tests. This table is intended to contain the available data that are relevant to the conversion of EPA's aquatic life criteria for metals from a total recoverable basis to a dissolved basis. (A factor of 1.0 is used to convert aquatic life criteria for metals that are expressed on the basis of the acid-soluble measurement to criteria expressed on the basis of the total recoverable measurement.) Reports by Grunwald (1992) and Brungs et al. (1992) provided references to many of the documents in which pertinent data were found. Each document was obtained and examined to determine whether it contained useful data.

"Dissolved" is defined as metal that passes through a 0.45-μm membrane filter. If otherwise acceptable, data that were obtained using 0.3-μm glass fiber filters and 0.1-μm membrane filters were used, and are identified in the table; these data did not seem to be outliers.

Data were used only if the metal was in a dissolved inorganic form when it was added to the dilution water. In addition, data were used only if they were generated in water that would have been acceptable for use as a dilution water in tests used in the derivation of water quality criteria for aquatic life; in particular, the pH had to be between 6.5 and 9.0, and the concentrations of total organic carbon (TOC) and total suspended solids (TSS) had to be below 5 mg/L. Thus most data generated using river water would not be used.

Some data were not used for other reasons. Data presented by Carroll et al. (1979) for cadmium were not used because 9 of the 36 values were above 150%. Data presented by Davies et al. (1976) for lead and Holcombe and Andrew (1978) for zinc were not used because "dissolved" was defined on the basis of polarography, rather than filtration.

Beyond this, the data were not reviewed for quality. Horowitz et al. (1992) reported that a number of aspects of the filtration procedure might affect the results. In addition, there might be concern about use of "clean techniques" and adequate QA/QC.

Each line in the table is intended to represent a separate piece of information. All of the data in the table were determined in fresh water, because no saltwater data were found. Data are becoming available for copper in salt water from the New York

Harbor study; based on the first set of tests, Hansen (1993) suggested that the average percent of the copper that is dissolved in sensitive saltwater tests is in the range of 76 to 82 percent.

A thorough investigation of the percent of total recoverable metal that is dissolved in toxicity tests might attempt to determine if the percentage is affected by test technique (static, renewal, flow-through), feeding (were the test animals fed and, if so, what food and how much), water quality characteristics (hardness, alkalinity, pH, salinity), test organisms (species, loading), etc.

The attached table also gives the freshwater criteria concentrations (CMC and CCC) because percentages for total recoverable concentrations much (e.g., more than a factor of 3) above or below the CMC and CCC are likely to be less relevant. When a criterion is expressed as a hardness equation, the range given extends from a hardness of 50 mg/L to a hardness of 200 mg/L.

The following is a summary of the available information for each metal:

Arsenic(III)

The data available indicate that the percent dissolved is about 100, but all the available data are for concentrations that are much higher than the CMC and CCC.

Cadmium

Schuytema et al. (1984) reported that "there were no real differences" between measurements of total and dissolved cadmium at concentrations of 10 to 80 ug/L (pH = 6.7 to 7.8, hardness = 25 mg/L, and alkalinity = 33 mg/L); total and dissolved concentrations were said to be "virtually equivalent".

The CMC and CCC are close together and only range from 0.66 to 8.6 ug/L. The only available data that are known to be in the range of the CMC and CCC were determined with a glass fiber filter. The percentages that are probably most relevant are 75, 92, 89, 78, and 80.

Chromium(III)

The percent dissolved decreased as the total recoverable concentration increased, even though the highest concentrations reduced the pH substantially. The percentages that are probably most relevant to the CMC are 50-75, whereas the percentages that are probably most relevant to the CCC are 86 and 61.

Chromium(VI)

The data available indicate that the percent dissolved is about 100, but all the available data are for concentrations that are much higher than the CMC and CCC.

Copper

Howarth and Sprague (1978) reported that the total and dissolved concentrations of copper were "little different" except when the total copper concentration was above 500 ug/L at hardness = 360 mg/L and pH = 8 or 9. Chakoumakos et al. (1979) found that the percent dissolved depended more on alkalinity than on hardness, pH, or the total recoverable concentration of copper.

Chapman (1993) and Lazorchak (1987) both found that the addition of daphnid food affected the percent dissolved very little, even though Chapman used yeast-trout chow-alfalfa whereas Lazorchak used algae in most tests, but yeast-trout chow-alfalfa in some tests. Chapman (1993) found a low percent dissolved with and without food, whereas Lazorchak (1987) found a high percent dissolved with and without food. All of Lazorchak's values were in high hardness water; Chapman's one value in high hardness water was much higher than his other values.

Chapman (1993) and Lazorchak (1987) both compared the effect of food on the total recoverable LC50 with the effect of food on the dissolved LC50. Both authors found that food raised both the dissolved LC50 and the total recoverable LC50 in about the same proportion, indicating that food did not raise the total recoverable LC50 by sorbing metal onto food particles; possibly the food raised both LC50s by (a) decreasing the toxicity of dissolved metal, (b) forming nontoxic dissolved complexes with the metal, or (c) reducing uptake.

The CMC and CCC are close together and only range from 6.5 to 34 ug/L. The percentages that are probably most relevant are 74, 95, 95, 73, 57, 53, 52, 64, and 91.

Lead

The data presented in Spehar et al. (1978) were from Holcombe et al. (1976). Both Chapman (1993) and Holcombe et al. (1976) found that the percent dissolved increased as the total recoverable concentration increased. It would seem reasonable to expect more precipitate at higher total recoverable concentrations and therefore a lower percent dissolved at higher concentrations. The increase in percent dissolved with increasing concentration might be due to a lowering of the pH as more metal is added if the stock solution was acidic.

The percentages that are probably most relevant to the CMC are 9, 18, 25, 10, 62, 68, 71, 75, 81, and 95, whereas the percentages that are probably most relevant to the CCC are 9 and 10.

Mercury

The only percentage that is available is 73, but it is for a concentration that is much higher than the CMC.

Nickel

The percentages that are probably most relevant to the CMC are 88, 93, 92, and 100, whereas the only percentage that is probably relevant to the CCC is 76.

Selenium

No data are available.

Silver

There is a CMC, but not a CCC. The percentage dissolved seems to be greatly reduced by the food used to feed daphnids, but not by the food used to feed fathead minnows. The percentages that are probably most relevant to the CMC are 41, 79, 79, 73, 91, 90, and 93.

Zinc

The CMC and CCC are close together and only range from 59 to 210 ug/L. The percentages that are probably most relevant are 31, 77, 77, 99, 94, 100, 103, and 96.

Recommended Values (%)[A] and Ranges of Measured Percent Dissolved Considered Most Relevant in Fresh Water

Metal	CMC		CCC	
	Recommended Value (%)	(Range %)	Recommended Value (%)	(Range %)
Arsenic(III)	95	100-104[B]	95	100-104[B]
Cadmium	85	75-92	85	75-92
Chromium(III)	85	50-75	85	61-86
Chromium(VI)	95	100[B]	95	100[B]
Copper	85	52-95	85	52-95
Lead	50	9-95	25	9-10
Mercury	85	73[B]	NA[E]	NA[E]
Nickel	85	88-100	85	76
Selenium	NA[E]	NA[C]	NA[E]	NA[C]
Silver	85	41-93	YY[D]	YY[D]
Zinc	85	31-103	85	31-103

[A] The recommended values are based on current knowledge and are subject to change as more data becomes available.

[B] All available data are for concentrations that are much higher than the CMC.

[C] NA = No data are available.

[D] YY = A CCC is not available, and therefore cannot be adjusted.

[E] NA = Bioaccumulative chemical and not appropriate to adjust to percent dissolved.

Concn.[A] (ug/L)	Percent Diss.[B]	n[C]	Species[D]	SRF[E]	Food	Hard.	Alk.	pH	Ref.
ARSENIC(III) (Freshwater: CCC = 190 ug/L; CMC = 360 ug/L)									
600-15000	104	5	?	?	?	48	41	7.6	Lima et al. 1984
12600	100	3	FM	F	No	44	43	7.4	Spehar and Fiandt 1986
CADMIUM (Freshwater: CCC = 0.66 to 2.0 ug/L; CMC = 1.8 to 8.6 ug/L)[F]									
0.16	41	?	DM	R	Yes	53	46	7.6	Chapman 1993
0.28	75	?	DM	R	Yes	103	83	7.9	Chapman 1993
0.4-4.0	92[G]	?	CS	F	No	21	19	7.1	Finlayson and Verrue 1982
13	89	3	FM	F	No	44	43	7.4	Spehar and Fiandt 1986
15-21	96	8	FM	S	No	42	31	7.5	Spehar and Carlson 1984
42	84	4	FM	S	No	45	41	7.4	Spehar and Carlson 1984
10	78	?	DM	S	No	51	38	7.5	Chapman 1993
35	77	?	DM	S	No	105	88	8.0	Chapman 1993
51	59	?	DM	S	No	209	167	8.4	Chapman 1993
6-80	80	8	?	S	No	47	44	7.5	Call et al. 1982
3-232	90[H]	5	?	F	?	46	42	7.4	Spehar et al. 1978
450-6400	70	5	FM	F	No	202	157	7.7	Pickering and Gast 1972

CHROMIUM(III) (Freshwater: CCC = 120 to 370 ug/L; CMC = 980 to 3100 ug/L)[F]

5-13	94	?	SG	F	?	25	24	7.3	Stevens and Chapman 1984
19-495	86	?	SG	F	?	25	24	7.2	Stevens and Chapman 1984
>1100	50-75	?	SG	F	No	25	24	7.0	Stevens and Chapman 1984
42	54	?	DM	R	Yes	206	166	8.2	Chapman 1993
114	61	?	DM	R	Yes	52	45	7.4	Chapman 1993
16840	26	?	DM	S	No	<51	9	6.3[1]	Chapman 1993
26267	32	?	DM	S	No	110	9	6.7	Chapman 1993
27416	27	?	DM	S	No	96	10	6.0[1]	Chapman 1993
58665	23	?	DM	S	No	190	25	6.2[1]	Chapman 1993

CHROMIUM(VI) (Freshwater: CCC = 11 ug/L; CMC = 16 ug/L)

>25,000	100	1	FM,GF	F	Yes	220	214	7.6	Adelman and Smith 1976
43,300	99.5	4	FM	F	No	44	43	7.4	Spehar and Fiandt 1986

COPPER (Freshwater: CCC = 6.5 to 21 ug/L; CMC = 9.2 to 34 ug/L)[F]

10-30	74	?	CT	F	No	27	20	7.0	Chakoumakos et al. 1979
40-200	78	?	CT	F	No	154	20	6.8	Chakoumakos et al. 1979
30-100	79	?	CT	F	No	74	23	7.6	Chakoumakos et al. 1979
100-200	82	?	CT	F	No	192	72	7.0	Chakoumakos et al. 1979
20-200	86	?	CT	F	No	31	78	8.3	Chakoumakos et al. 1979
40-300	87	?	CT	F	No	83	70	7.4	Chakoumakos et al. 1979
10-80	89	?	CT	F	No	25	169	8.5	Chakoumakos et al. 1979

300-1300	92	?	CT	F	No	195	160	7.0	Chakoumakos et al. 1979
100-400	94	?	CT	F	No	70	174	8.5	Chakoumakos et al. 1979
3-4[J]	125-167	2	CD	R	Yes	31	38	7.2	Carlson et al. 1986a,b
12-91[J]	79-84	3	CD	R	Yes	31	38	7.2	Carlson et al. 1986a,b
18-19	95	2	DA	S	No	52	55	7.7	Carlson et al. 1986b
20[J]	95	1	DA	R	No	31	38	7.2	Carlson et al. 1986b
50	96	2	FM	S	No	52	55	7.7	Carlson et al. 1986b
175[J]	91	2	FM	R	No	31	38	7.2	Carlson et al. 1986b
5-52	>82[K]	?	FM	F	Yes[L]	47	43	8.0	Lind et al. 1978
6-80	83[G]	?	CS	F	No	21	19	7.1	Finlayson and Verrue 1982
6.7	57	?	DM	S	No	49	37	7.7	Chapman 1993
35	43	?	DM	S	Yes	48	39	7.4	Chapman 1993
13	73	?	DM	R	Yes	211	169	8.1	Chapman 1993
16	57	?	DM	R	Yes	51	44	7.6	Chapman 1993
51	39	?	DM	R	Yes	104	83	7.8	Chapman 1993
32	53	?	DM	S	No	52	45	7.8	Chapman 1993
33	52	?	DM	S	No	105	79	7.9	Chapman 1993
39	64	?	DM	S	No	106	82	8.1	Chapman 1993
25-84	96	14	FM,GM	S	No	50	40	7.0	Hammermeister et al. 1983
17	91	6	DM	S	No	52	43	7.3	Hammermeister et al. 1983
120	88	14	SG	S	No	48	47	7.3	Hammermeister et al. 1983
15-90	74	19	?	S	No	48	47	7.7	Call et al. 1982
12-162	80[M]	?	BG	F	Yes[L]	45	43	7-8	Benoit 1975
28-58	85	6	DM	R	No	168	117	8.0	Lazorchak 1987
26-59	79	7	DM	R	Yes[M]	168	117	8.0	Lazorchak 1987
56,101	86	2	DM	R	Yes[N]	168	117	8.0	Lazorchak 1987

96	86	4	FM	F	No	44	43	7.4	Spehar and Fiandt 1986
160	94	1	FM	S	No	203	171	8.2	Geckler et al. 1976
230-3000	>69->79	?	CR	F	No	17	13	7.6	Rice and Harrison 1983

<u>LEAD</u> (Freshwater: CCC = 1.3 to 7.7 ug/L; CMC = 34 to 200 ug/L)[F]

17	9	?	DM	R	Yes	52	47	7.6	Chapman 1993
181	18	?	DM	R	Yes	102	86	7.8	Chapman 1993
193	25	?	DM	R	Yes	151	126	8.1	Chapman 1993
612	29	?	DM	S	No	50	--	---	Chapman 1993
952	33	?	DM	S	No	100	--	---	Chapman 1993
1907	~38	?	DM	S	No	150	--	---	Chapman 1993
7-29	10	?	EZ	R	No	22	--	---	JRB Associates 1983
34	62[M]	?	BT	F	Yes	44	43	7.2	Holcombe et al. 1976
58	68[M]	?	BT	F	Yes	44	43	7.2	Holcombe et al. 1976
119	71[M]	?	BT	F	Yes	44	43	7.2	Holcombe et al. 1976
235	75[M]	?	BT	F	Yes	44	43	7.2	Holcombe et al. 1976
474	81[M]	?	BT	F	Yes	44	43	7.2	Holcombe et al. 1976
4100	82[M]	?	BT	F	No	44	43	7.2	Holcombe et al. 1976
2100	79	7	FM	F	No	44	43	7.4	Spehar and Fiandt 1986
220-2700	96	14	FM,GM,DM	S	No	49	44	7.2	Hammermeister et al. 1983
580	95	14	SG	S	No	51	48	7.2	Hammermeister et al. 1983

<u>MERCURY(II)</u> (Freshwater: CMC = 2.4 ug/L)

172	73	1	FM	F	No	44	43	7.4	Spehar and Fiandt 1986

NICKEL (Freshwater: CCC = 88 to 280 ug/L; CMC = 790 to 2500 ug/L)[F]

21	81	?	DM	R	Yes	51	49	7.4	Chapman 1993
150	76	?	DM	R	Yes	107	87	7.8	Chapman 1993
578	87	?	DM	R	Yes	205	161	8.1	Chapman 1993
645	88	?	DM	S	No	54	43	7.7	Chapman 1993
1809	93	?	DM	S	No	51	44	7.7	Chapman 1993
1940	92	?	DM	S	No	104	84	8.2	Chapman 1993
2344	100	?	DM	S	No	100	84	7.9	Chapman 1993
4000	90	?	PK	R	No	21	--	---	JRB Associates 1983

SELENIUM (FRESHWATER: CCC = 5 ug/L; CMC = 20 ug/L)

No data are available.

SILVER (Freshwater: CMC = 1.2 to 13 ug/L; a CCC is not available)

0.19	74	?	DM	S	No	47	37	7.6	Chapman 1993
9.98	13	?	DM	S	Yes	47	37	7.5	Chapman 1993
4.0	41	?	DM	S	No	36	25	7.0	Nebeker et al. 1983
4.0	11	?	DM	S	Yes	36	25	7.0	Nebeker et al. 1983
3	79	?	FM	S	No	51	49	8.1	UWS 1993
2-54	79	?	FM	S	Yes[O]	49	49	7.9	UWS 1993
2-32	73	?	FM	S	No	50	49	8.1	UWS 1993
4-32	91	?	FM	S	No	48	49	8.1	UWS 1993
5-89	90	?	FM	S	No	120	49	8.2	UWS 1993
6-401	93	?	FM	S	No	249	49	8.1	UWS 1993

ZINC (Freshwater: CCC = 59 to 190 ug/L; CMC 65 to 210 ug/L)[F]

52	31	?	DM	R	Yes	211	169	8.2	Chapman 1993
62	77	?	DM	R	Yes	104	83	7.8	Chapman 1993
191	77	?	DM	R	Yes	52	47	7.5	Chapman 1993
356	74	?	DM	S	No	54	47	7.6	Chapman 1993
551	78	?	DM	S	No	105	85	8.1	Chapman 1993
741	76	?	DM	S	No	196	153	8.2	Chapman 1993
7[J]	71-129	2	CD	R	Yes	31	38	7.2	Carlson et al. 1986b
18-273[J]	81-107	2	CD	R	Yes	31	38	7.2	Carlson et al. 1986b
167[J]	99	2	CD	R	No	31	38	7.2	Carlson et al. 1986b
180	94	1	CD	S	No	52	55	7.7	Carlson et al. 1986b
188-393[J]	100	2	FM	R	No	31	38	7.2	Carlson et al. 1986b
551	100	1	FM	S	No	52	55	7.7	Carlson et al. 1986b
40-500	95[O]	?	CS	F	No	21	19	7.1	Finlayson and Verrue 1982
1940	100	?	AS	F	No	20	12	7.1	Sprague 1964
5520	83	?	AS	F	No	20	12	7.9	Sprague 1964
<4000	90	?	FM	F	No	204	162	7.7	Mount 1966
>4000	70	?	FM	F	No	204	162	7.7	Mount 1966
160-400	103	13	FM,GM,DM	S	No	52	43	7.5	Hammermeister et al. 1983
240	96	13	SG	S	No	49	46	7.2	Hammermeister et al. 1983

[A] Total recoverable concentration.

[B] Except as noted, a 0.45-μm membrane filter was used.

[C] Number of paired comparisons.

[D] The abbreviations used are:

AS = Atlantic salmon
BT = Brook trout
CD = _Ceriodaphnia dubia_
CR = Crayfish
CS = Chinook salmon
CT = Cutthroat trout
DA = Daphnids
DM = _Daphnia magna_
EZ = _Elassoma zonatum_
FM = Fathead minnow
GF = Goldfish
GM = Gammarid
PK = _Palaemonetes kadiakensis_
SG = _Salmo gairdneri_

[E] The abbreviations used are:

S = static
R = renewal
F = flow-through

[F] The two numbers are for hardnesses of 50 and 200 mg/L, respectively.

[G] A 0.3-μm _glass fiber_ filter was used.

[H] A 0.10-μm membrane filter was used.

[I] The pH was below 6.5.

[J] The dilution water was a clean river water with TSS and TOC below 5 mg/L.

[K] Only limited information is available concerning this value.

[L] It is assumed that the solution that was filtered was from the test chambers that contained fish and food.

[M] The food was algae.

[N] The food was yeast-trout chow-alfalfa.

[O] The food was frozen adult brine shrimp.

References

Adelman, I.R., and L.L. Smith, Jr. 1976. Standard Test Fish Development. Part I. Fathead Minnows (Pimephales promelas) and Goldfish (Carassius auratus) as Standard Fish in Bioassays and Their Reaction to Potential Reference Toxicants. EPA-600/3-76-061a. National Technical Information Service, Springfield, VA. Page 24.

Benoit, D.A. 1975. Chronic Effects of Copper on Survival, Growth, and Reproduction of the Bluegill (*Lepomis macrochirus*). Trans. Am. Fish. Soc. 104:353-358.

Brungs, W.A., T.S. Holderman, and M.T. Southerland. 1992. Synopsis of Water-Effect Ratios for Heavy Metals as Derived for Site-Specific Water Quality Criteria.

Call, D.J., L.T. Brooke, and D.D. Vaishnav. 1982. Aquatic Pollutant Hazard Assessments and Development of a Hazard Prediction Technology by Quantitative Structure-Activity Relationships. Fourth Quarterly Report. University of Wisconsin-Superior, Superior, WI.

Carlson, A.R., H. Nelson, and D. Hammermeister. 1986a. Development and Validation of Site-Specific Water Quality Criteria for Copper. Environ. Toxicol. Chem. 5:997-1012.

Carlson, A.R., H. Nelson, and D. Hammermeister. 1986b. Evaluation of Site-Specific Criteria for Copper and Zinc: An Integration of Metal Addition Toxicity, Effluent and Receiving Water Toxicity, and Ecological Survey Data. EPA/600/S3-86-026. National Technical Information Service, Springfield, VA.

Carroll, J.J., S.J. Ellis, and W.S. Oliver. 1979. Influences of Hardness Constituents on the Acute Toxicity of Cadmium to Brook Trout (*Salvelinus fontinalis*).

Chakoumakos, C., R.C. Russo, and R.V. Thurston. 1979. Toxicity of Copper to Cutthroat Trout (*Salmo clarki*) under Different Conditions of Alkalinity, pH, and Hardness. Environ. Sci. Technol. 13:213-219.

Chapman, G.A. 1993. Memorandum to C. Stephan. June 4.

Davies, P.H., J.P. Goettl, Jr., J.R. Sinley, and N.F. Smith. 1976. Acute and Chronic Toxicity of Lead to Rainbow Trout *Salmo gairdneri*, in Hard and Soft Water. Water Res. 10:199-206.

Finlayson, B.J., and K.M Verrue. 1982. Toxicities of Copper, Zinc, and Cadmium Mixtures to Juvenile Chinook Salmon. Trans. Am. Fish. Soc. 111:645-650.

Geckler, J.R., W.B. Horning, T.M. Neiheisel, Q.H. Pickering, E.L. Robinson, and C.E. Stephan. 1976. Validity of Laboratory Tests for Predicting Copper Toxicity in Streams. EPA-600/3-76-116. National Technical Information Service, Springfield, VA. Page 118.

Grunwald, D. 1992. Metal Toxicity Evaluation: Review, Results, and Data Base Documentation.

Hammermeister, D., C. Northcott, L. Brooke, and D. Call. 1983. Comparison of Copper, Lead and Zinc Toxicity to Four Animal Species in Laboratory and ST. Louis River Water. University of Wisconsin-Superior, Superior, WI.

Hansen, D.J. 1993. Memorandum to C.E. Stephan. April 15.

Holcombe, G.W., D.A. Benoit, E.N. Leonard, and J.M. McKim. 1976. Long-Term Effects of Lead Exposure on Three Generations of Brook Trout (*Salvelinus fontinalis*). J. Fish. Res. Bd. Canada 33:1731-1741.

Holcombe, G.W., and R.W. Andrew. 1978. The Acute Toxicity of Zinc to Rainbow and Brook Trout. EPA-600/3-78-094. National Technical Information Service, Springfield, VA.

Horowitz, A.J., K.A. Elrick, and M.R. Colberg. 1992. The Effect of Membrane Filtration Artifacts on Dissolved Trace Element Concentrations. Water Res. 26:753-763.

Howarth, R.S., and J.B. Sprague. 1978. Copper Lethality to Rainbow Trout in Waters on Various Hardness and pH. Water Res. 12:455-462.

JRB Associates. 1983. Demonstration of the Site-specific Criteria Modification Process: Selser's Creek, Ponchatoula, Louisiana.

Lazorchak, J.M. 1987. The Significance of Weight Loss of Daphnia magna Straus During Acute Toxicity Tests with Copper. Ph.D. Thesis.

Lima, A.R., C. Curtis, D.E. Hammermeister, T.P. Markee, C.E. Northcott, L.T. Brooke. 1984. Acute and Chronic Toxicities of Arsenic(III) to Fathead Minnows, Flagfish, Daphnids, and an Amphipod. Arch. Environ. Contam. Toxicol. 13:595-601.

Lind, D., K. Alto, and S. Chatterton. 1978. Regional Copper-Nickel Study. Draft.

Mount, D.I. 1966. The Effect of Total Hardness and pH on Acute Toxicity of Zinc to Fish. Air Water Pollut. Int. J. 10:49-56.

Nebeker, A.V., C.K. McAuliffe, R. Mshar, and D.G. Stevens. 1983. Toxicity of Silver to Steelhead and Rainbow Trout, Fathead Minnows, and *Daphnia magna*. Environ. Toxicol. Chem. 2:95-104.

Pickering, Q.P., and M.H. Gast. 1972. Acute and Chronic Toxicity of Cadmium to the Fathead Minnow (*Pimephales promelas*). J. Fish. Res. Bd. Canada 29:1099-1106.

Rice, D.W., Jr., and F.L. Harrison. 1983. The Sensitivity of Adult, Embryonic, and Larval Crayfish *Procambarus clarkii* to Copper. NUREG/CR-3133 or UCRL-53048. National Technical Information Service, Springfield, VA.

Schuytema, G.S., P.O. Nelson, K.W. Malueg, A.V. Nebeker, D.F. Krawczyk, A.K. Ratcliff, and J.H. Gakstatter. 1984. Toxicity of Cadmium in Water and Sediment Slurries to *Daphnia magna*. Environ. Toxicol. Chem. 3:293-308.

Spehar, R.L., R.L. Anderson, and J.T. Fiandt. 1978. Toxicity and Bioaccumulation of Cadmium and Lead in Aquatic Invertebrates. Environ. Pollut. 15:195-208.

Spehar, R.L., and A.R. Carlson. 1984. Derivation of Site-Specific Water Quality Criteria for Cadmium and the St. Louis River Basin, Duluth, Minnesota. Environ. Toxicol. Chem. 3:651-665.

Spehar, R.L., and J.T. Fiandt. 1986. Acute and Chronic Effects of Water Quality Criteria-Based Metal Mixtures on Three Aquatic Species. Environ. Toxicol. Chem. 5:917-931.

Sprague, J.B. 1964. Lethal Concentration of Copper and Zinc for Young Atlantic Salmon. J. Fish. Res. Bd. Canada 21:17-9926.

Stevens, D.G., and G.A. Chapman. 1984. Toxicity of Trivalent Chromium to Early Life Stages of Steelhead Trout. Environ. Toxicol. Chem. 3:125-133.

University of Wisconsin-Superior. 1993. Preliminary data from work assignment 1-10 for Contract No. 68-C1-0034.

GUIDANCE DOCUMENT ON DYNAMIC MODELING AND TRANSLATORS

August 1993

Total Maximum Daily Loads (TMDLs) and Permits

o Dynamic Water Quality Modeling

Although not specifically part of the reassessment of water quality criteria for metals, dynamic or probabilistic models are another useful tool for implementing water quality criteria, especially those for protecting aquatic life. Dynamic models make best use of the specified magnitude, duration, and frequency of water quality criteria and thereby provide a more accurate calculation of discharge impacts on ambient water quality. In contrast, steady-state modeling is based on various simplifying assumptions which makes it less complex and less accurate than dynamic modeling. Building on accepted practices in water resource engineering, ten years ago OW devised methods allowing the use of probability distributions in place of worst-case conditions. The description of these models and their advantages and disadvantages is found in the 1991 Technical Support Document for Water Quality-based Toxic Control (TSD).

Dynamic models have received increased attention in the last few years as a result of the perception that static modeling is over-conservative due to environmentally conservative dilution assumptions. This has led to the misconception that dynamic models will always justify less stringent regulatory controls (e.g. NPDES effluent limits) than static models. In effluent dominated waters where the upstream concentrations are relatively constant, however, a dynamic model will calculate a more stringent wasteload allocation than will a steady state model. The reason is that the critical low flow required by many State water quality standards in effluent dominated streams occurs more frequently than once every three years. When other environmental factors (e.g. upstream pollutant concentrations) do not vary appreciably, then the overall return frequency of the steady state model may be greater than once in three years. A dynamic modeling approach, on the other hand, would be more stringent, allowing only a once in three year return frequency. As a result, EPA considers dynamic models to be a more accurate rather than a less stringent approach to implementing water quality criteria.

The 1991 TSD provides recommendations on the use of steady state and dynamic water quality models. The reliability of any modeling technique greatly depends on the accuracy of the data used in the analysis. Therefore, the selection of a model also depends upon the data. EPA recommends that steady state wasteload allocation analyses generally be used where few or no whole effluent toxicity or specific chemical measurements are available, or where daily receiving water flow records are not available. Also, if staff resources are insufficient to use and defend the use of dynamic models, then steady state models may be necessary. If adequate receiving water flow and effluent concentration data are available to estimate frequency distributions, EPA recommends that one of the dynamic wasteload allocation modeling techniques be used to derive wasteload allocations which will more exactly maintain water quality standards. The minimum data required for input into dynamic models include at least 30 years of river flow data and one year of effluent and ambient pollutant concentrations.

o Dissolved-Total Metal Translators

When water quality criteria are expressed as the dissolved form of a metal, there is a need to translate TMDLs and NPDES permits to and from the dissolved form of a metal to the total recoverable form. TMDLs for toxic metals must be able to calculate 1) the dissolved metal concentration in order to ascertain attainment of water quality standards and 2) the total recoverable metal concentration in order to achieve mass balance. In meeting these requirements, TMDLs consider metals to be conservative pollutants and quantified as total recoverable to preserve conservation of mass. The TMDL calculates the dissolved or ionic species of the metals based on factors such as total suspended solids (TSS) and ambient pH. (These assumptions ignore the complicating factors of metals interactions with other metals.) In addition, this approach assumes that ambient factors influencing metal partitioning remain constant with distance down the river. This assumption probably is valid under the low flow conditions typically used as design flows for permitting of metals (e.g., 7Q10, 4B3, etc) because erosion, resuspension, and wet weather loadings are unlikely to be significant and river chemistry is generally stable. In steady-state dilution modeling, metals releases may be assumed to remain fairly constant (concentrations exhibit low variability) with time.

EPA's NPDES regulations require that metals limits in permits be stated as total recoverable in most cases (see 40 CFR §122.45(c)). Exceptions occur when an effluent guideline specifies the limitation in another form of the metal or the approved analytical methods measure only the dissolved form. Also, the permit writer may express a metals limit in another form (e.g., dissolved, valent, or total) when required, in highly unusual cases, to carry out the provisions of the CWA.

The preamble to the September 1984 National Pollutant Discharge Elimination System Permit Regulations states that the total recoverable method measures dissolved metals plus that portion of solid metals that can easily dissolve under ambient conditions (see 49 Federal Register 38028, September 26, 1984). This method is intended to measure metals in the effluent that are or may easily become environmentally active, while not measuring metals that are expected to settle out and remain inert.

The preamble cites, as an example, effluent from an electroplating facility that adds lime and uses clarifiers. This effluent will be a combination of solids not removed by the clarifiers and residual dissolved metals. When the effluent from the clarifiers, usually with a high pH level, mixes with receiving water having significantly lower pH level, these solids instantly dissolve. Measuring dissolved metals in the effluent, in this case, would underestimate the impact on the receiving water. Measuring with the total metals method, on the other hand, would measure metals that would be expected to disperse or settle out and remain inert or be covered over. Thus, measuring total recoverable metals in the effluent best approximates the amount of metal likely to produce water quality impacts.

However, the NPDES rule does not require in any way that State water quality standards be in the total recoverable form; rather, the rule requires permit writers to consider the translation between differing metal forms in the calculation of the permit limit so that a total recoverable limit can be established. Therefore, both the TMDL and NPDES uses of water quality criteria require the ability to translate from the dissolved form and the total recoverable form.

Many toxic substances, including metals, have a tendency to leave the dissolved phase and attach to suspended solids. The partitioning of toxics between solid and dissolved phases can be determined as a function of a pollutant-specific partition coefficient and the concentration of solids. This function is expressed by a linear partitioning equation:

$$C = \frac{C_{TT}}{1 + K_d \cdot TSS \cdot 10^{-6}}$$

where,

C = dissolved phase metal concentration,
C_{TT} = total metal concentration,
TSS = total suspended solids concentration, and
K_d = partition coefficient.

A key assumption of the linear partitioning equation is that the sorption reaction reaches dynamic equilibrium at the point of application of the criteria; that is, after allowing for initial mixing the partitioning of the pollutant between the adsorbed and dissolved forms can be used at any location to predict the fraction of pollutant in each respective phase.

Successful application of the linear partitioning equation relies on the selection of the partition coefficient. The use of a partition coefficient to represent the degree to which toxics adsorb to solids is most readily applied to organic pollutants; partition coefficients for metals are more difficult to define. Metals typically exhibit more complex speciation and complexation reactions than organics and the degree of partitioning can vary greatly depending upon site-specific water chemistry. Estimated partition coefficients can be determined for a number of metals, but waterbody or site-specific observations of dissolved and adsorbed concentrations are preferred.

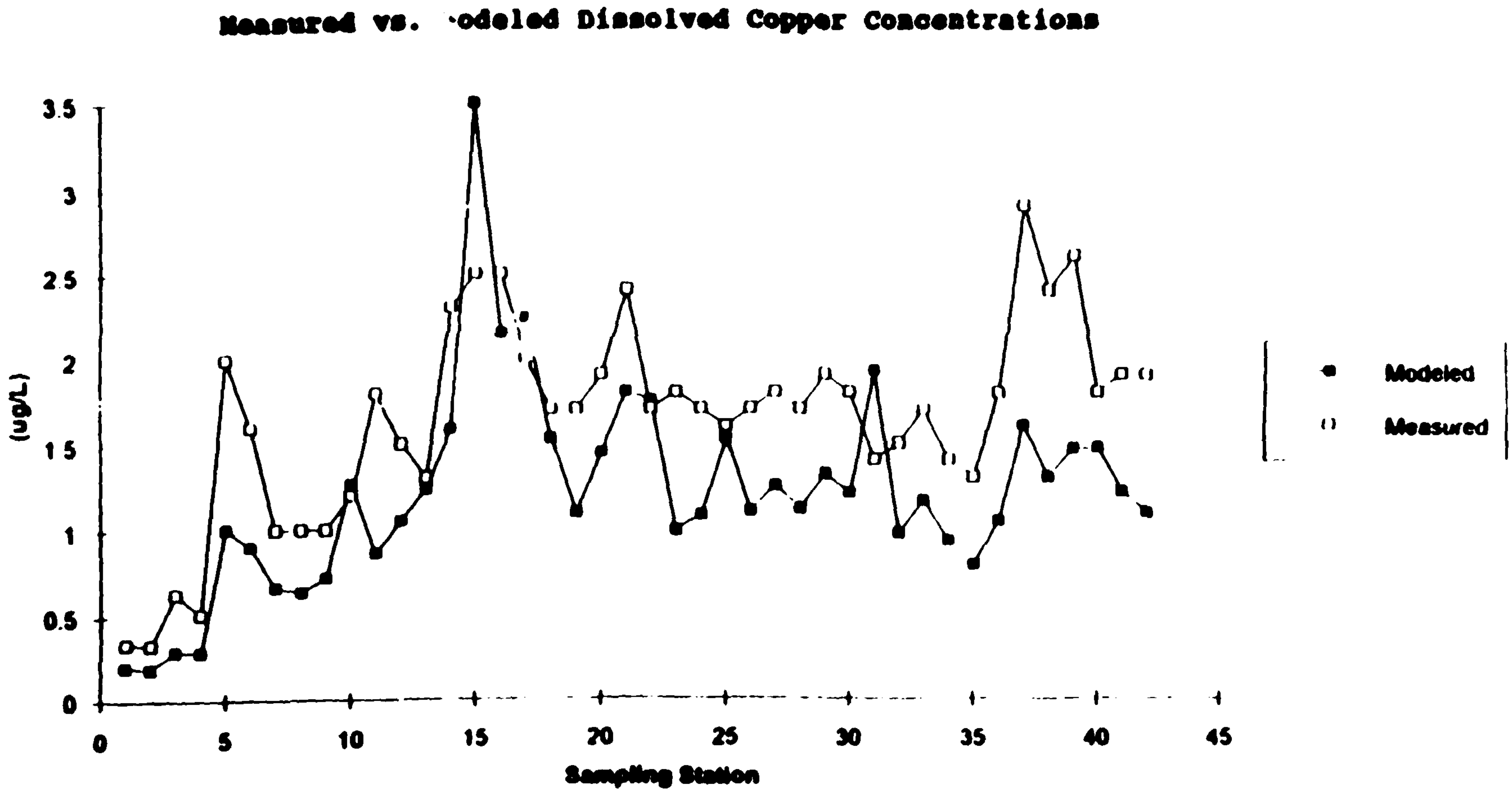
EPA suggests three approaches for instances where a water quality criterion for a metal is expressed in the dissolved form in a State's water quality standards:

1. Using clean analytical techniques and field sampling procedures with appropriate QA/QC, collect receiving water samples and determine site specific values of K_d for each metal. Use these K_d values to "translate" between total recoverable and dissolved metals in receiving water. This approach is more difficult to apply because it relies upon the availability of good quality measurements of ambient metal concentrations. This approach provides an accurate assessment of the dissolved metal fraction providing sufficient samples are collected. EPA's initial recommendation is that at least four pairs of total recoverable and dissolved ambient metal measurements be made during low flow conditions or 20 pairs over all flow conditions. EPA suggests that the average of data collected during low flow or the 95th percentile highest dissolved fraction for all flows be used. The low flow average provides a representative picture of conditions during the rare low flow events. The 95th percentile highest dissolved fraction for all flows provides a critical condition approach analogous to the approach used to identify low flows and other critical environmental conditions.

2. Calculate the total recoverable concentration for the purpose of setting the permit limit. Use a value of 1 unless the permittee has collected data (see #1 above) to show that a different ratio should be used. The value of 1 is conservative and will not err on the side of violating standards. This approach is very simple to apply because it places the entire burden of data collection and analysis solely upon permitted facilities. In terms of technical merit, it has the same characteristics of the previous approach. However, permitting authorities may be faced with difficulties in negotiating with facilities on the amount of data necessary to determine the ratio and the necessary quality control methods to assure that the ambient data are reliable.

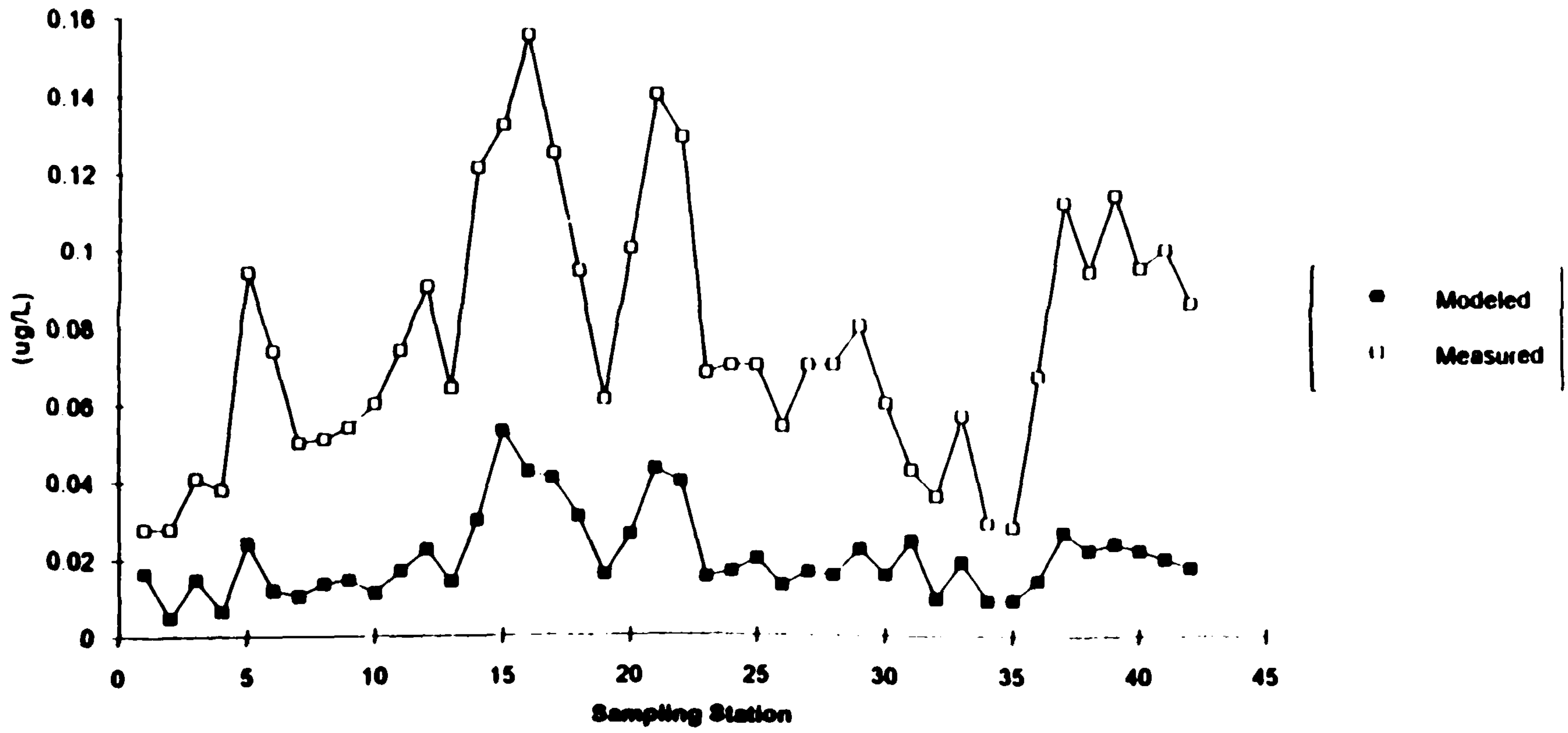
3. Use the historical data on total suspended solids (TSS) in receiving waterbodies at appropriate design flows and K_d values presented in the Technical Guidance Manual for Performing Waste Load Allocations. Book II. Streams and Rivers. EPA-440/4-84-020 (1984) to "translate" between (total recoverable) permits limits and dissolved metals in receiving water. This approach is fairly simple to apply. However, these K_d values are suspect due to possible quality assurance problems with the data used to develop the values. EPA's initial analysis of this approach and these values in one site indicates that these K_d values generally over-estimate the dissolved fraction of metals in ambient waters (see Figures following). Therefore, although this approach may not provide an accurate estimate of the dissolved fraction, the bias in the estimate is likely to be a conservative one.

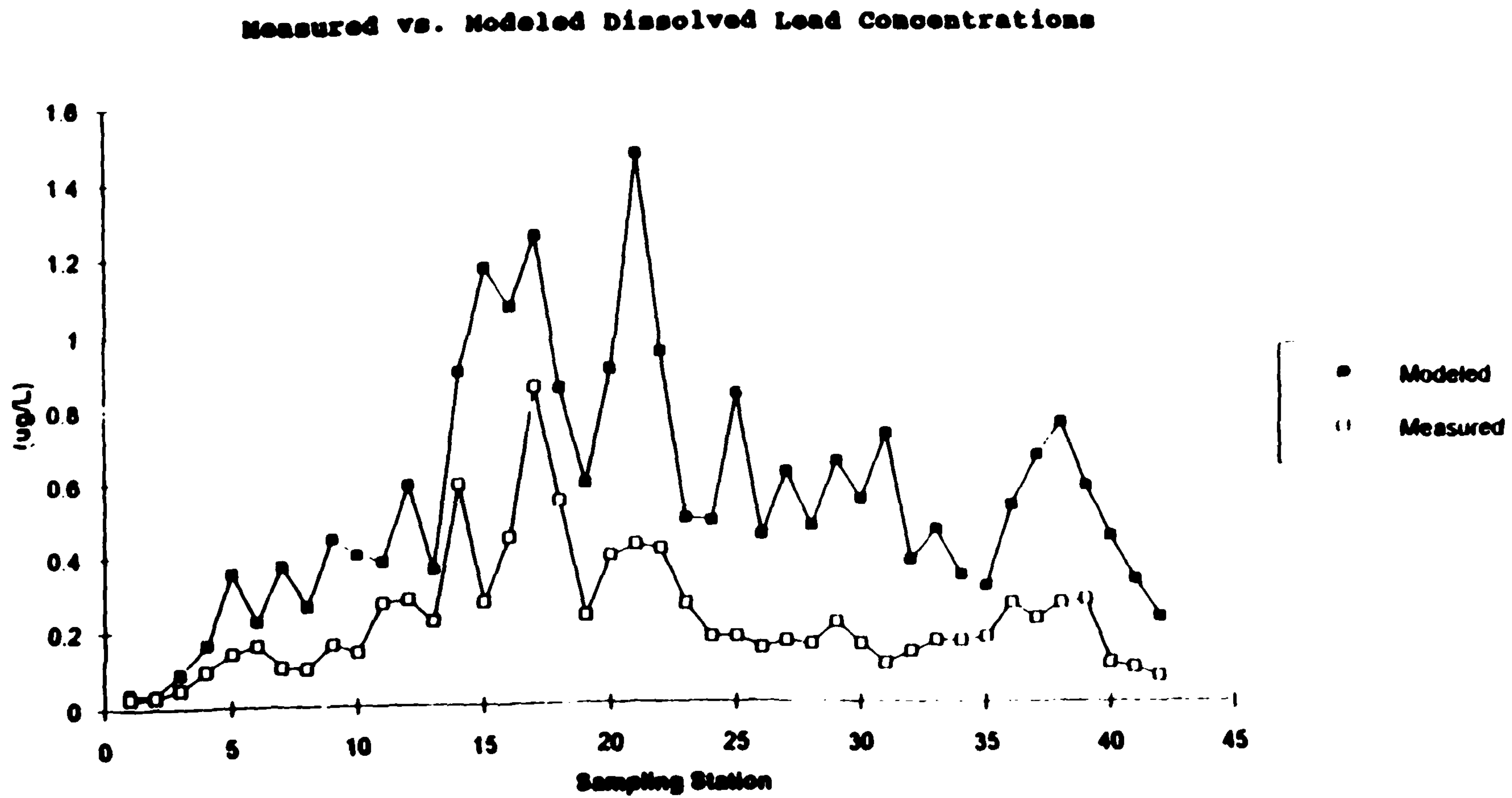
EPA suggests that regulatory authorities use approaches #1 and #2 where States express their water quality standards in the dissolved form. In those States where the standards are in the total recoverable or acid soluble form, EPA recommends that no translation be used until the time that the State changes the standards to the dissolved form. Approach #3 may be used as an interim measure until the data are collected to implement approach #1.

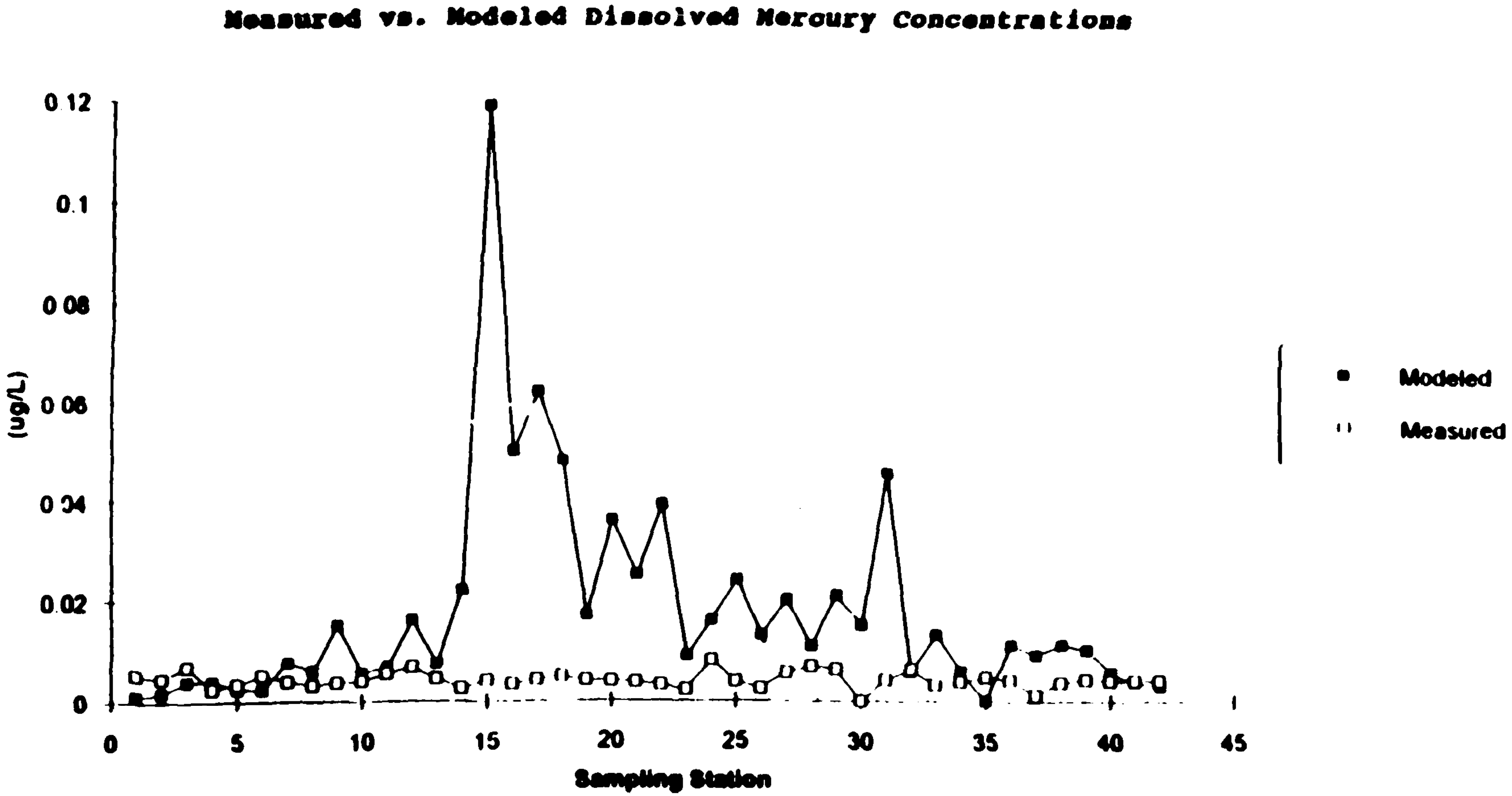


Measured vs. Modeled Dissolved Copper Concentrations
3.5
3
2.5
2
1.5
1
0.5
0
(ug/L)
0
5
10
15
20
25
30
35
40
45
Sampling Station
Modeled
Measured

Measured vs. Modeled Dissolved Cadmium Concentrations

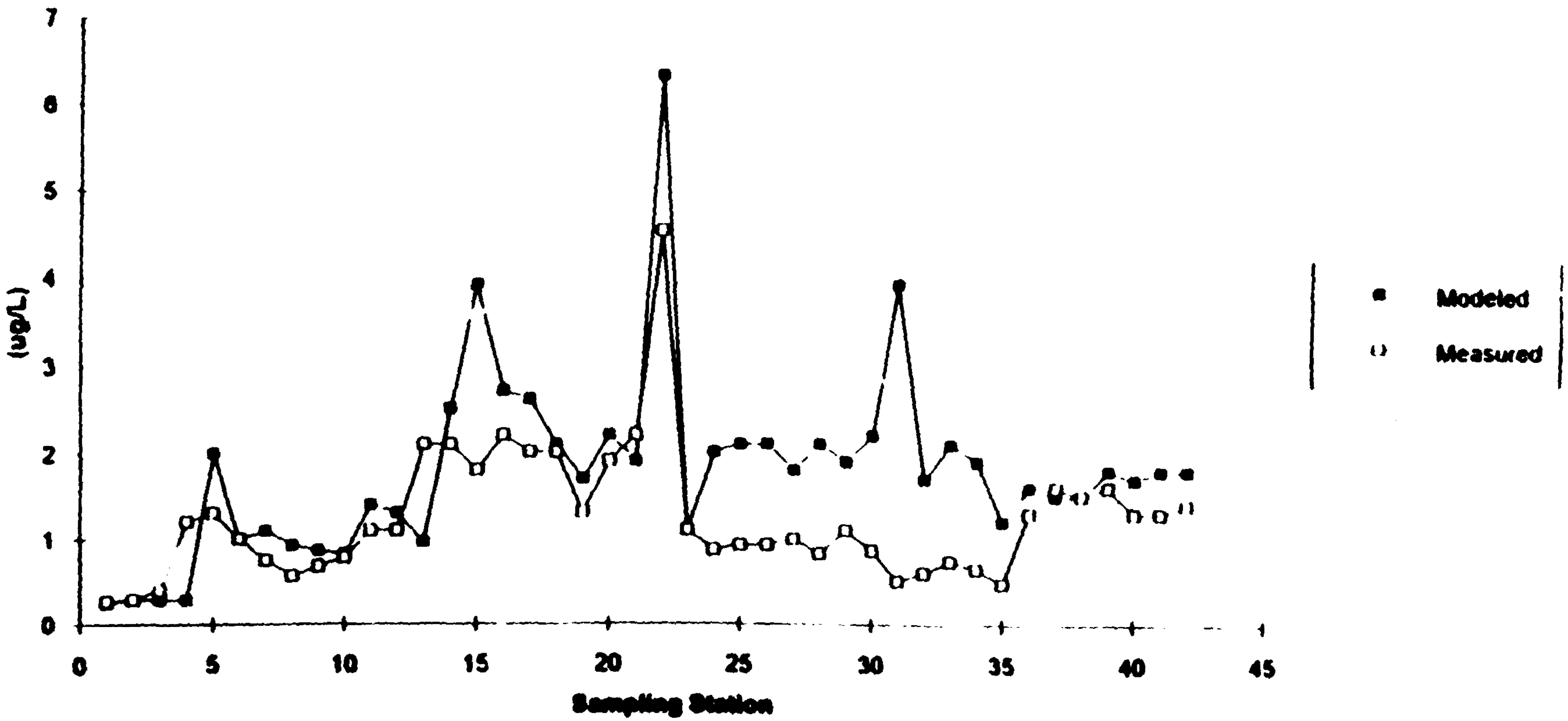


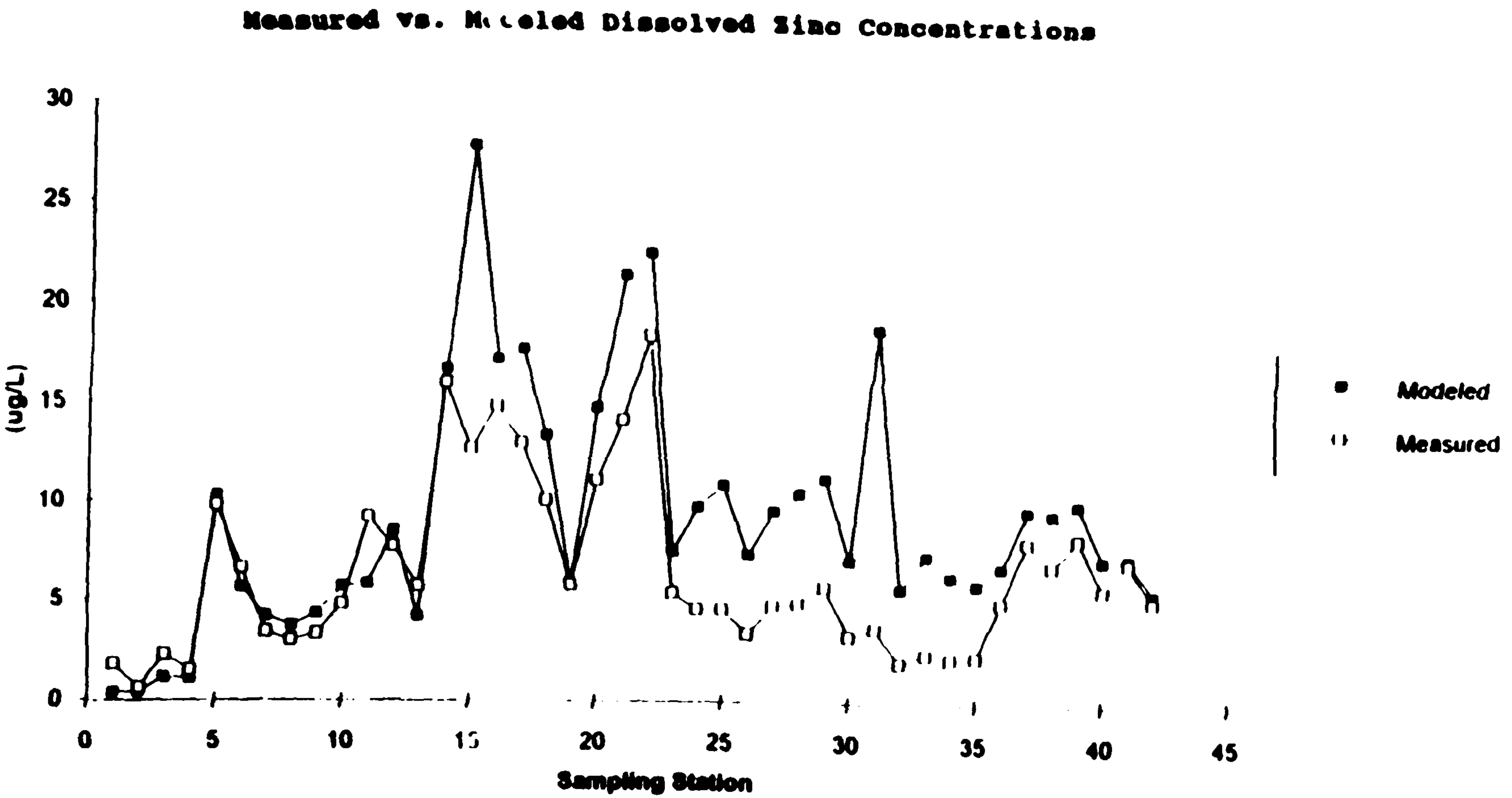

Measured vs. Modeled Dissolved Lead Concentrations
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
(ug/L)
0
5
10
15
20
25
30
35
40
45
Sampling Station
Modeled
Measured

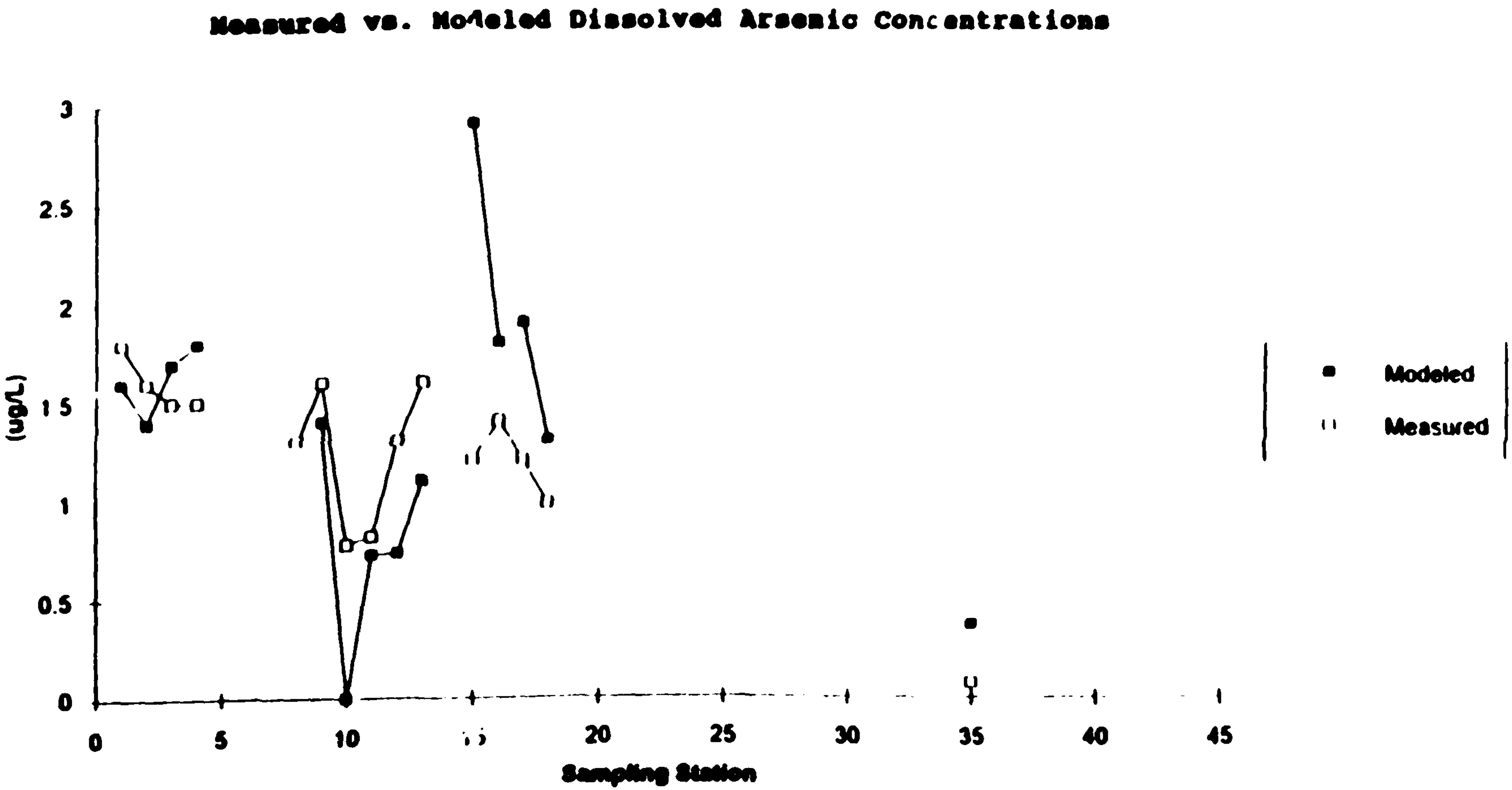


Measured vs. Modeled Dissolved Mercury Concentrations
0.12
0.1
0.08
0.06
0.04
0.02
0
(ug/L)
0
5
10
15
20
25
30
35
40
45
Sampling Station
Modeled
Measured

Measured vs. Modeled Dissolved Nickel Concentrations




Measured vs. M. .eled Dissolved Zinc Concentrations
30
25
20
15
10
5
0
(ug/L)
0
5
10
20
25
30
35
40
45
Sampling Station
Modeled
Measured



NMED Exhibit 134

ATTACHMENT #4

GUIDANCE DOCUMENT
ON CLEAN ANALYTICAL TECHNIQUES AND MONITORING
October 1993

Guidance on Monitoring

o Use of Clean Sampling and Analytical Techniques

Appendix B to the WER guidance document (attached) provides some general guidance on the use of clean techniques. The Office of Water recommends that this guidance be used by States and Regions as an interim step while the Office of Water prepares more detailed guidance.

o Use of Historical DMR Data

With respect to effluent or ambient monitoring data reported by an NPDES permittee on a Discharge Monitoring Report (DMR), the certification requirements place the burden on the permittee for collecting and reporting quality data. The certification regulation at 40 CFR 122.22(d) requires permittees, when submitting information, to state: "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Permitting authorities should continue to consider the information reported in DMRs to be true, accurate, and complete as certified by the permittee. Under 40 CFR 122.41(l)(8), however, as soon as the permittee becomes aware of new information specific to the effluent discharge that calls into question the accuracy of the DMR data, the permittee must submit such information to the permitting authority. Examples of such information include a new finding that the reagents used in the laboratory analysis are contaminated with trace levels of metals, or a new study that the sampling equipment imparts trace metal contamination. This information must be specific to the discharge and based on actual measurements rather than extrapolations from reports from other facilities. Where a permittee submits information supporting the contention that the previous data are questionable and the permitting authority agrees with the findings of the information, EPA expects that permitting authorities will consider such information in determining appropriate enforcement responses.

In addition to submitting the information described above, the permittee also must develop procedures to assure the collection and analysis of quality data that are true, accurate, and complete. For example, the permittee may submit a revised quality assurance plan that describes the specific procedures to be undertaken to reduce or eliminate trace metal contamination.

Appendix B. Guidance Concerning the Use of "Clean Techniques" and QA/QC in the Measurement of Trace Metals

Recent information (Shiller and Boyle 1987; Windom et al. 1991) has raised questions concerning the quality of reported concentrations of trace metals in both fresh and salt (estuarine and marine) surface waters. A lack of awareness of true ambient concentrations of metals in saltwater and freshwater systems can be both a cause and a result of the problem. The ranges of dissolved metals that are typical in surface waters of the United States away from the immediate influence of discharges (Bruland 1983; Shiller and Boyle 1985,1987; Trefry et al. 1986; Windom et al. 1991) are:

Metal	Salt water (ug/L)	Fresh water (ug/L)
Cadmium	0.01 to 0.2	0.002 to 0.08
Copper	0.1 to 3.	0.4 to 4.
Lead	0.01 to 1.	0.01 to 0.19
Nickel	0.3 to 5.	1. to 2.
Silver	0.005 to 0.2	------------
Zinc	0.1 to 15.	0.03 to 5.

The U.S. EPA (1983,1991) has published analytical methods for monitoring metals in waters and wastewaters, but these methods are inadequate for determination of ambient concentrations of some metals in some surface waters. Accurate and precise measurement of these low concentrations requires appropriate attention to seven areas:

1. Use of "clean techniques" during collecting, handling, storing, preparing, and analyzing samples to avoid contamination.
2. Use of analytical methods that have sufficiently low detection limits.
3. Avoidance of interference in the quantification (instrumental analysis) step.
4. Use of blanks to assess contamination.
5. Use of matrix spikes (sample spikes) and certified reference materials (CRMs) to assess interference and contamination.
6. Use of replicates to assess precision.
7. Use of certified standards.

In a strict sense, the term "clean techniques" refers to techniques that reduce contamination and enable the accurate and precise measurement of trace metals in fresh and salt surface waters. In a broader sense, the term also refers to related issues concerning detection limits, quality control, and quality assurance. Documenting data quality demonstrates the amount of confidence that can be placed in the data, whereas increasing the sensitivity of methods reduce the problem of deciding how to interpret results that are reported to be below detection limits.

<u>This appendix is written for those analytical laboratories that want guidance concerning ways to lower detection limits, increase precision, and/or increase accuracy.</u> The ways to achieve these goals are to increase the sensitivity of the analytical methods, decrease contamination, and decrease interference. Ideally, validation of a procedure for measuring concentrations of metals in surface water requires demonstration that agreement can be obtained using completely different procedures beginning with the sampling step and continuing through the quantification step (Bruland et al. 1979), but few laboratories have the resources to compare two different procedures. Laboratories can, however, (a) use techniques that others have found useful for improving detection limits, accuracy, and precision, and (b) document data quality through use of blanks, spikes, CRMs, replicates, and standards.

In general, in order to achieve accurate and precise measurement of a particular concentration, both the detection limit and the blanks should be less than one-tenth of that concentration. Therefore, the term "metal-free" can be interpreted to mean that the total amount of contamination that occurs during sample collection and processing (e.g., from gloves, sample containers, labware, sampling apparatus, cleaning solutions, air, reagents, etc.) is sufficiently low that blanks are less than one-tenth of the lowest concentration that needs to be measured.

Atmospheric particulates can be a major source of contamination (Moody 1982; Adeloju and Bond 1985). The term "class-100" refers to a specification concerning the amount of particulates in air (Moody 1982); although the specification says nothing about the composition of the particulates, generic control of particulates can greatly reduce trace-metal blanks. Except during collection of samples and initial cleaning of equipment, all handling of samples, sample containers, labware, and sampling apparatus should be performed in a class-100 bench, room, or glove box.

<u>Nothing contained or not contained in this appendix adds to or subtracts from any regulatory requirements set forth in other EPA documents concerning metal analyses.</u> The word "must" is used in this appendix merely to indicate items that are considered very important by analytical chemists who have worked to increase accuracy and precision and lower detection limits in trace-metal analysis. Some items are considered important because they have been found to have received inadequate attention in some laboratories performing trace-metal analyses.

Two topics that are not addressed in this appendix are:
1. The "ultraclean techniques" that are likely to be necessary when trace analyses of mercury are performed.
2. Safety in analytical laboratories.

Other documents should be consulted if these topics are of concern.

Avoiding contamination by use of "clean techniques"

Measurement of trace metals in receiving waters must take into account the potential for contamination during each step in the process. Regardless of the specific procedures used for collection, handling, storage, preparation (digestion, filtration, and/or extraction), and quantification (instrumental analysis), the general principles of contamination control must be applied. Some specific recommendations are:

a. Non-talc latex or class-100 polyethylene gloves must be worn during all steps from sample collection to analysis. (Talc seems to be a particular problem with zinc; gloves made with talc cannot be decontaminated sufficiently.) Gloves should only contact surfaces that are metal-free; gloves should be changed if even suspected of contamination.
b. The acid used to acidify samples for preservation and digestion and to acidify water for final cleaning of labware, sampling apparatus, and sample containers must be metal-free. The quality of the acid used should be better than reagent-grade. Each lot of acid must be analyzed for the metal(s) of interest before use.
c. The water used to prepare acidic cleaning solutions and to rinse labware, sample containers, and sampling apparatus may be prepared by distillation, deionization, or reverse osmosis, and must be demonstrated to be metal-free.
d. The work area, including bench tops and hoods, should be cleaned (e.g., washed and wiped dry with lint-free, class-100 wipes) frequently to remove contamination.
e. All handling of samples in the laboratory, including filtering and analysis, must be performed in a class-100 clean bench or a glove box fed by particle-free air or nitrogen; ideally the clean bench or glove box should be located within a class-100 clean room.
f. Labware, reagents, sampling apparatus, and sample containers must never be left open to the atmosphere; they should be stored in a class-100 bench, covered with plastic wrap, stored in a plastic box, or turned upside down on a clean surface. Minimizing the time between cleaning and using will help minimize contamination.
g. Separate sets of sample containers, labware, and sampling apparatus should be dedicated for different kinds of samples, e.g., receiving water samples, effluent samples, etc.
h. To avoid contamination of clean rooms, samples that contain very high concentrations of metals and do not require use of "clean techniques" should not be brought into clean rooms.
i. Acid-cleaned plastic, such as high-density polyethylene (HDPE), low-density polyethylene (LDPE), or a fluoroplastic, must be the only material that ever contacts a sample, except possibly during digestion for the total recoverable

measurement. (Total recoverable samples can be digested in some plastic containers.) Even HDPE and LDPE might not be acceptable for mercury, however.

J. All labware, sample containers, and sampling apparatus must be acid-cleaned before use or reuse.

1. Sample containers, sampling apparatus, tubing, membrane filters, filter assemblies, and other labware must be soaked in acid until metal-free. The amount of cleaning necessary might depend on the amount of contamination and the length of time the item will be in contact with samples. For example, if an acidified sample will be stored in a sample container for three weeks, ideally the container should have been soaked in an acidified metal-free solution for at least three weeks.
2. It might be desirable to perform initial cleaning, for which reagent-grade acid may be used, before the items are allowed into a clean room. For most metals, items should be either (a) soaked in 10 percent concentrated nitric acid at 50°C for at least one hour, or (b) soaked in 50 percent concentrated nitric acid at room temperature for at least two days; for arsenic and mercury, soaking for up to two weeks at 50°C in 10 percent concentrated nitric acid might be required. For plastics that might be damaged by strong nitric acid, such as polycarbonate and possibly HDPE and LDPE, soaking in 10 percent concentrated hydrochloric acid, either in place of or before soaking in a nitric acid solution, might be desirable.
3. Chromic acid must not be used to clean items that will be used in analysis of metals.
4. Final soaking and cleaning of sample containers, labware, and sampling apparatus must be performed in a class-100 clean room using metal-free acid and water. The solution in an acid bath must be analyzed periodically to demonstrate that it is metal-free.
5. After labware and sampling apparatus are cleaned, they may be stored in a clean room in a weak acid bath prepared using metal-free acid and water. Before use, the items should be rinsed at least three times with metal-free water. After the final rinse, the items should be moved immediately, with the open end pointed down, to a class-100 clean bench. Items may be dried on a class-100 clean bench; items must not be dried in an oven or with laboratory towels. The sampling apparatus should be assembled in a class-100 clean room or bench and double-bagged in metal-free polyethylene zip-type bags for transport to the field; new bags are usually metal-free.
6. After sample containers are cleaned, they should be filled with metal-free water that has been acidified to a pH of 2 with metal-free nitric acid (about 0.5 mL per liter) for storage until use. At the time of sample collection, the sample containers should be emptied and rinsed at least twice with the solution being sampled before the actual

sample is placed in the sample container.

k. Field samples must be collected in a manner that eliminates the potential for contamination from the sampling platform, probes, etc. Exhaust from boats and the direction of wind and water currents should be taken into account. The people who collect the samples must be specifically trained on how to collect field samples. After collection, all handling of samples in the field that will expose the sample to air must be performed in a portable class-100 clean bench or glove box.
l. Samples must be acidified (after filtration if dissolved metal is to be measured) to a pH of less than 2, except that the pH must be less than 1 for mercury. Acidification should be done in a clean room or bench, and so it might be desirable to wait and acidify samples in a laboratory rather than in the field. If samples are acidified in the field, metal-free acid can be transported in plastic bottles and poured into a plastic container from which acid can be removed and added to samples using plastic pipettes. Alternatively, plastic automatic dispensers can be used.
m. Such things as probes and thermometers must not be put in samples that are to be analyzed for metals. In particular, pH electrodes and mercury-in-glass thermometers must not be used if mercury is to be measured. If pH is measured, it must be done on a separate aliquot.
n. Sample handling should be minimized. For example, instead of pouring a sample into a graduated cylinder to measure the volume, the sample can be weighed after being poured into a tared container; alternatively, the container from which the sample is poured can be weighed. (For saltwater samples, the salinity or density should be taken into account when weight is converted to volume.)
o. Each reagent used must be verified to be metal-free. If metal-free reagents are not commercially available, removal of metals will probably be necessary.
p. For the total recoverable measurement, samples should be digested in a class-100 bench, not in a metallic hood. If feasible, digestion should be done in the sample container by acidification and heating.
q. The longer the time between collection and analysis of samples, the greater the chance of contamination, loss, etc.
r. Samples must be stored in the dark, preferably between 0 and 4°C with no air space in the sample container.

<u>Achieving low detection limits</u>

a. Extraction of the metal from the sample can be extremely useful if it simultaneously concentrates the metal and eliminates potential matrix interferences. For example, ammonium 1-pyrrolidinedithiocarbamate and/or diethylammonium diethyldithiocarbamate can extract cadmium, copper, lead, nickel, and zinc (Bruland et al. 1979; Nriagu et al. 1993).

b. The detection limit should be less than ten percent of the lowest concentration that is to be measured.

Avoiding interferences

a. Potential interferences must be assessed for the specific instrumental analysis technique used and each metal to be measured.
b. If direct analysis is used, the salt present in high-salinity saltwater samples is likely to cause interference in most instrumental techniques.
c. As stated above, extraction of the metal from the sample is particularly useful because it simultaneously concentrates the metal and eliminates potential matrix interferences.

Using blanks to assess contamination

a. A laboratory (procedural, method) blank consists of filling a sample container with analyzed metal-free water and processing (filtering, acidifying, etc.) the water through the laboratory procedure in exactly the same way as a sample. A laboratory blank must be included in each set of ten or fewer samples to check for contamination in the laboratory, and must contain less than ten percent of the lowest concentration that is to be measured. Separate laboratory blanks must be processed for the total recoverable and dissolved measurements, if both measurements are performed.
b. A field (trip) blank consists of filling a sample container with analyzed metal-free water in the laboratory, taking the container to the site, processing the water through tubing, filter, etc., collecting the water in a sample container, and acidifying the water the same as a field sample. A field blank must be processed for each sampling trip. Separate field blanks must be processed for the total recoverable measurement and for the dissolved measurement, if filtrations are performed at the site. Field blanks must be processed in the laboratory the same as laboratory blanks.

Assessing accuracy

a. A calibration curve must be determined for each analytical run and the calibration should be checked about every tenth sample. Calibration solutions must be traceable back to a certified standard from the U.S. EPA or the National Institute of Science and Technology (NIST).
b. A blind standard or a blind calibration solution must be included in each group of about twenty samples.

c. At least one of the following must be included in each group of about twenty samples:
   1. A matrix spike (spiked sample; the method of known additions).
   2. A CRM, if one is available in a matrix that closely approximates that of the samples. Values obtained for the CRM must be within the published values.

The concentrations in blind standards and solutions, spikes, and CRMs must not be more than 5 times the median concentration expected to be present in the samples.

Assessing precision

a. A sampling replicate must be included with each set of samples collected at each sampling location.
b. If the volume of the sample is large enough, replicate analysis of at least one sample must be performed along with each group of about ten samples.

Special considerations concerning the dissolved measurement

Whereas the total recoverable measurement is especially subject to contamination during the digestion step, the dissolved measurement is subject to both loss and contamination during the filtration step.

a. Filtrations must be performed using acid-cleaned plastic filter holders and acid-cleaned membrane filters. Samples must not be filtered through glass fiber filters, even if the filters have been cleaned with acid. If positive-pressure filtration is used, the air or gas must be passed through a 0.2-um in-line filter; if vacuum filtration is used, it must be performed on a class-100 bench.
b. Plastic filter holders must be rinsed and/or dipped between filtrations, but they do not have to be soaked between filtrations if all the samples contain about the same concentrations of metal. It is best to filter samples from low to high concentrations. A membrane filter must not be used for more than one filtration. After each filtration, the membrane filter must be removed and discarded, and the filter holder must be either rinsed with metal-free water or dilute acid and dipped in a metal-free acid bath or rinsed at least twice with metal-free dilute acid; finally, the filter holder must be rinsed at least twice with metal-free water.
c. For each sample to be filtered, the filter holder and membrane filter must be conditioned with the sample, i.e., an initial portion of the sample must be filtered and discarded.

The accuracy and precision of the dissolved measurement should be assessed periodically. A large volume of a buffered solution (such as aerated 0.05 N sodium bicarbonate) should be spiked so that the concentration of the metal of interest is in the range of the low concentrations that are to be measured. The total recoverable concentration and the dissolved concentration of the metal in the spiked buffered solution should be measured alternately until each measurement has been performed at least ten times. The means and standard deviations for the two measurements should be the same. All values deleted as outliers must be acknowledged.

Reporting results

To indicate the quality of the data, reports of results of measurements of the concentrations of metals must include a description of the blanks, spikes, CRMs, replicates, and standards that were run, the number run, and the results obtained. All values deleted as outliers must be acknowledged.

Additional information

The items presented above are some of the important aspects of "clean techniques"; some aspects of quality assurance and quality control are also presented. This is not a definitive treatment of these topics; additional information that might be useful is available in such publi-:-ions as Patterson and Settle (1976), Zief and Mitchell (1976 Bruland et al. (1979), Moody and Beary (1982), Moody (1982), Br..and (1983), Adeloju and Bond (1985), Berman and Yeats (1985), Byrd and Andreae (1986), Taylor (1987), Sakamoto-Arnold (1987), Tramontano et al. (1987), Puls and Barcelona (1989), Windom et al. (1991), U.S. EPA (1992), Horowitz et al. (1992), and Nriagu et al. (1993).

References

Adeloju, S.B., and A.M. Bond. 1985. Influence of Laboratory Environment on the Precision and Accuracy of Trace Element Analysis. Anal. Chem. 57:1728-1733.

Berman, S.S., and P.A. Yeats. 1985. Sampling of Seawater for Trace Metals. CRC Reviews in Analytical Chemistry 16:1-14.

Bruland, K.W., R.P. Franks, G.A. Knauer, and J.H. Martin. 1979. Sampling and Analytical Methods for the Determination of Copper, Cadmium, Zinc, and Nickel at the Nanogram per Liter Level in Sea Water. Anal. Chim. Acta 105:233-245.

Bruland, K.W. 1983. Trace Elements in Sea-water. In: Chemical Oceanography, Vol. 8. J.P. Riley and R. Chester, eds. Academic Press, New York, NY. pp. 157-220.

Byrd, J.T., and M.O. Andreae. 1986. Dissolved and Particulate Tin in North Atlantic Seawater. Marine Chemistry 19:193-200.

Horowitz, A.J., K.A. Elrick, and M.R. Colberg. 1992. The Effect of Membrane Filtration Artifacts on Dissolved Trace Element Concentrations. Water Res. 26:753-763.

Moody, J.R. 1982. NBS Clean Laboratories for Trace Element Analysis. Anal. Chem. 54:1358A-1376A.

Moody, J.R., and E.S. Beary. 1982. Purified Reagents for Trace Metal Analysis. Talanta 29:1003-1010.

Nriagu, J.O., G. Lawson, H.K.T. Wong, and J.M. Azcue. 1993. A Protocol for Minimizing Contamination in the Analysis of Trace Metals in Great Lakes Waters. J. Great Lakes Res. 19:175-182.

Patterson, C.C., and D.M. Settle. 1976. The Reduction in Orders of Magnitude Errors in Lead Analysis of Biological Materials and Natural Waters by Evaluating and Controlling the Extent and Sources of Industrial Lead Contamination Introduced during Sample Collection and Processing. In: Accuracy in Trace Analysis: Sampling, Sample Handling, Analysis. P.D. LaFleur, ed. National Bureau of Standards Spec. Publ. 422, U.S. Government Printing Office, Washington, DC.

Puls, R.W., and M.J. Barcelona. 1989. Ground Water Sampling for Metals Analyses. EPA/540/4-89/001. National Technical Information Service, Springfield, VA.

Sakamoto-Arnold, C.M., A.K. Hanson, Jr., D.L. Huizenga, and D.R. Kester. 1987. Spatial and Temporal Variability of Cadmium in Gulf Stream Warm-core Rings and Associated Waters. J. Mar. Res. 45:201-230.

Shiller, A.M., and E. Boyle. 1985. Dissolved Zinc in Rivers. Nature 317:49-52.

Shiller, A.M., and E.A. Boyle. 1987. Variability of Dissolved Trace Metals in the Mississippi River. Geochim. Cosmochim. Acta 51:3273-3277.

Taylor, J.K. 1987. Quality Assurance of Chemical Measurements. Lewis Publishers, Chelsea, MI.

Tramontano, J.M., J.R. Scudlark, and T.M. Church. 1987. A Method for the Collection, Handling, and Analysis of Trace Metals in Precipitation. Environ. Sci. Technol. 21:749-753.

Trefry, J.H., T.A. Nelsen, R.P. Trocine, S. Metz., and T.W. Vetter. 1986. Rapp. P.-v. Reun. Cons. int. Explor. Mer. 186:277-288.

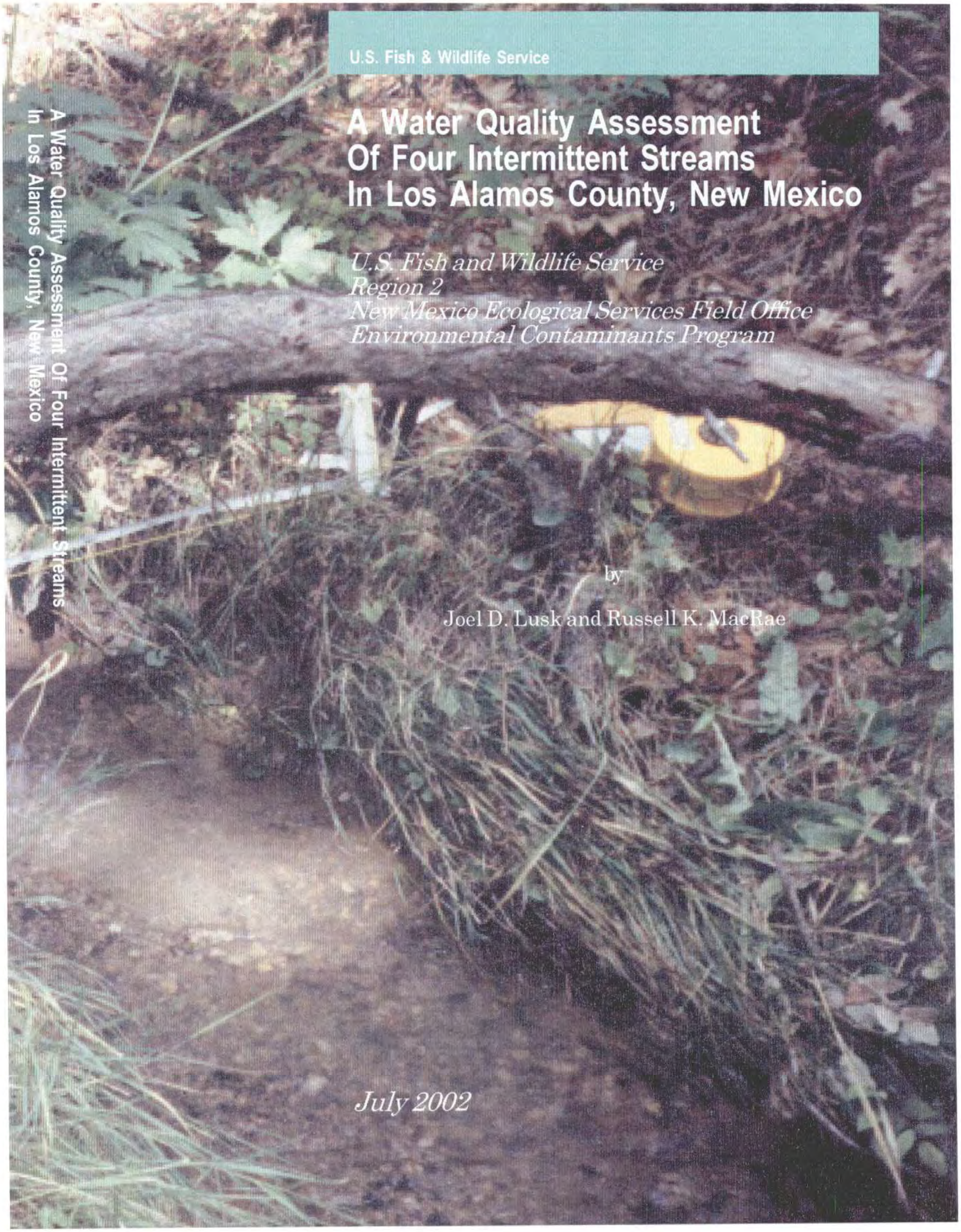
U.S. Environmental Protection Agency. 1983. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020. National Technical Information Service, Springfield, VA. Sections 4.1.1, 4.1.3, and 4.1.4

U.S. Environmental Protection Agency. 1991. Methods for the Determination of Metals in Environmental Samples. EPA-600/4-91-010. National Technical Information Service, Springfield, VA.

U.S. Environmental Protection Agency. 1992. Evaluation of Trace-Metal Levels in Ambient Waters and Tributaries to New York/New Jersey Harbor for Waste Load Allocation. Prepared by Battelle Ocean Sciences under Contract No. 68-C8-0105.

Windom, H.L., J.T. Byrd, R.G. Smith, and F. Huan. 1991. Inadequacy of NASQAN Data for Assessing Metals Trends in the Nation's Rivers. Environ. Sci. Technol. 25:1137-1142. (Also see Comment and Response, Vol. 25, p. 1940.)

Zief, M., and J.W. Mitchell. 1976. Contamination Control in Trace Element Analysis. Chemical Analysis Series, Vol. 47. Wiley, New York, NY.



U.S. Fish & Wildlife Service

A Water Quality Assessment Of Four Intermittent Streams In Los Alamos County, New Mexico

U.S. Fish and Wildlife Service
Region 2
New Mexico Ecological Services Field Office
Environmental Contaminants Program

by

Joel D. Lusk and Russell K. MacRae

July 2002

A Water Quality Assessment Of Four Intermittent Streams
In Los Alamos County, New Mexico

A Water Quality Assessment of Four Intermittent Streams in Los Alamos County, New Mexico

Prepared for the:

United States Department of Energy
Los Alamos Area Office
Los Alamos, New Mexico

New Mexico Environment Department
Surface Water Quality Bureau
Santa Fe, New Mexico

Los Alamos National Laboratory
University of California Regents
Berkeley, California

Prepared by:

Joel D. Lusk
and
Russell K. MacRae

United States Fish and Wildlife Service
New Mexico Ecological Services Field Office
Environmental Contaminants Program
Albuquerque, New Mexico

with:

Duane Chapman
and
Anne Allert

United States Geological Survey
Biological Research Division
Columbia Environmental Research Center
Columbia, Missouri

JULY 2002

(This page intentionally left blank)

ABSTRACT

In 1996 and 1997, the United States Fish and Wildlife Service investigated the biological, chemical, and physical characteristics of four intermittent streams on the Los Alamos National Laboratory in New Mexico. Width, depth, substrate, temperature, velocity, cover, and other physical parameters were measured. Water, sediment, sediment porewater, and biota were analyzed for various inorganic, organic, or radioactive chemicals. Habitat suitability models and rapid bioassessment protocols were used to identify suitable living space for fish and benthic macroinvertebrates. Toxicity tests of water and sediment porewater and surveys for benthic macroinvertebrates were also conducted. Adult, female, fathead minnow (*Pimephales promelas*) were caged in these streams for two months to measure their survival, growth, and contaminant accumulation. Each measured characteristic was compared to the reference site or to applicable criteria, and these ratios were converted into indices of biological, chemical, and physical quality, which were summed into a Water Quality Index in order to identify any stream impairment.

All stream segments were found to contain cold, flowing water and a community of aquatic life. Los Alamos Canyon contained a perennial stream above the Los Alamos Reservoir with a population of brook trout (*Salvelinus fontinalis*), and was the reference site for all comparisons. Sandia Canyon, Pajarito Canyon, and Valle Canyon stream segments had no fish populations. The Sandia Canyon stream was composed of waste water effluents, although the proportion and contributions of these discharges and storm water runoff were not quantified. Elevated concentrations of aluminum, barium, chromium, molybdenum, explosives, or polychlorinated biphenyls were found either in water, sediment, sediment porewater, caddisflies (*Hesperophylax sp.*), or in the caged-fish. Surface water toxicity to laboratory invertebrates was identified in Valle Canyon, probably from a runoff event, and reproductive toxicity was found in laboratory invertebrates using sediment porewater from Sandia Canyon. However, the causes of toxicity were not conclusive in either event. No surface water toxicity to fathead minnows was found during laboratory testing. In the caged-fish study, factors other than contaminants, particularly flooding, accounted for most of the mortality observed. The benthic macroinvertebrate community was slightly impaired in Pajarito and Valle Canyons, and moderately impaired in Sandia Canyon; where taxa richness was one-fourth of that from the reference site.

Habitat suitability models for brook trout indicated above-average to marginal quality habitat. Lack of flow velocity in riffle habitats resulted in poor quality longnose dace (*Rhinichthys cataractae*) habitat. The Valle Canyon stream segment lacked the flow volume necessary to fully support adult trout, while excess fines in riffles reduced the quality of potential habitat for trout eggs. Diminished stream velocity, cover, prey abundance and diversity, as well as excess nutrients in the Sandia Canyon reduced potential trout habitat. Scouring, erosion, and embedded substrates also reduced the quality of the habitat for benthic macroinvertebrates. The Pajarito Canyon segment had fair trout habitat, though the lower portion had reduced flow and fewer deep pools.

The Water Quality Index suggested a 30 percent impairment of the water quality in Valle Canyon, a 22 percent impairment in Pajarito Canyon, and a 30 percent impairment in Sandia Canyon compared to the reference site. Physical impacts were greater in Pajarito and Valle Canyons, whereas chemical impacts were greatest in Sandia Canyon. However, the Cerro Grande Fire burned a large portion of these canyons watersheds and therefore, water quality impairments are expected to increase as are restoration efforts. Recommendations were provided to focus water quality management objectives on protection of aquatic life in these intermittent streams. The techniques and evaluation procedures used in this study may be applicable to the water quality assessments of other water bodies in New Mexico.

(This page intentionally left blank)

TABLE OF CONTENTS

TABLE OF CONTENTS ~ *Continued*

LIST OF TABLES

LIST OF TABLES ~ *Continued*

LIST OF FIGURES

LIST OF FIGURES ~ *Continued*

LIST OF FIGURES ~ *Continued*

LIST OF FIGURES ~ *Continued*

ATTACHMENT A AND LIST OF APPENDICES

(On Enclosed CD-ROM)

Attachment A. Chapman, D., and A. Allert. 1998. Los Alamos National Laboratory Use Study Phase II: Toxicity Testing of Surface Waters and Sediment Porewaters at Los Alamos National Laboratory. With Appendices A through C. United States Geological Survey, Biological Resources Division Report, Columbia, Missouri.

Appendix I. Settlement Agreement.

Appendix II. Proposed Use Study of the Los Alamos National Laboratory - July 1996.

Appendix III. Species List of Aquatic Invertebrates and Community Metrics provided by the New Mexico Environment Department Oversight Bureau, 1999.

Appendix IV. Identification Number, Type, Collection Date, Stream Reach, Percent Moisture, Sand, Silt, Clay, and Element Concentrations (µg/L in Water and Porewater, mg/kg Dry Weight in Sediment and Tissues) of Samples Collected for the Los Alamos National Laboratory Water Quality Assessment, 1996-1997.

(This page intentionally left blank)

ACKNOWLEDGMENTS

This study was funded by the U. S. Fish and Wildlife Service Division of Environmental Contaminants under Project Number 2F33-9620003 and by the U. S. Department of Energy under Interagency Agreement Number DE-A132-96AL76575. We would also like to acknowledge the assistance or contributions provided by James Alarid, Alan Allert, Ann Allert, Rey Aragon, Mark Bailey, Kathy Bennett, Sky Bristol, Dennis Byrnes, Colleen Caldwell, Karen Cathey, Duane Chapman, Kathy Crist, Phil Crockett, Saul Cross, Michael Dale, Harvey Decker, Bob Deitner, the Ecology Group, Brenda Edeskuty, Magdalena Etemadi-Naghani, Stephen Fettig, Tiffani Fieldler-Harper, Susan Finger, Ralph Ford-Schmid, Jennifer Fowler-Propst, Terri Foxx, Marcelle Francke, Gil Gonzales, Eugene Greer, Brian Hanson, Hector Hinojosa, Patty Hoban, Bonnie Koch, Wendy Kuhne, Sam Lovato, Charlie MacDonald, Susan MacMullin, Alice Mayer-Heaton, John Moore, Antonia Nevarez, Joy Nicholopoulos, Jim Piatt, Steve Pierce, John Pittenger, Alex Puglisi, Steve Rae, Stephen Robertson, Mike Saladen, Zach Simpson, Craig Springer, Bob Vocke, the Water Quality Group, Diana Webb, Mark Wilson, Yoli, Pat Zamora, Patricia Zenone, as well as the various staff of Federal, State, and Tribal agencies.

DISCLAIMER

(This page intentionally left blank)

EXECUTIVE SUMMARY

The Federal Water Pollution Control Act (commonly known as the Clean Water Act) provides a national framework for the protection and restoration of the quality of America's surface waters. It consists of two parts: regulatory provisions that impose progressively more stringent requirements on industries and cities to abate pollution and meet the goal of zero discharge of pollutants; and provisions that authorize federal financial assistance, research, and enforcement. States (or Tribes) with jurisdiction over a particular water body have the primary responsibility to prevent, reduce and eliminate pollution, to determine and formally designate the appropriate use(s) of their waters, and to set water quality standards and criteria that both define the goals of a water body and protect it's beneficial uses. Beneficial uses of the waters in New Mexico to be achieved and protected can include:

- drinking water supplies, domestic use, and human health;
- primary & secondary contact (*e.g.*, swimming, fishing, recreation, ceremony);
- navigation, commerce, and welfare;
- habitat for aquatic life (often listed as coldwater or warmwater fisheries);
- irrigation, other agricultural and aquaculture practices;
- municipal and industrial water supply and storage;
- drinking water for livestock and wildlife; and,
- habitat for wildlife (*e.g.*, wetland plants, amphibians, birds, mammals).

The beneficial uses of a water body include designated uses and existing uses. Designated uses are those uses formally classified and listed by a State (or Tribe) for their surface waters. Existing uses are those that have been attained on or after November 28, 1975, in or on any water body, whether they have been designated or not. Whenever a water body has a designated use that does not include an existing use or the uses identified in section 101(a)(2) of the Clean Water Act, then that use is considered attainable. After discovery of an attainable use, States often revise the designated use of a water body, because, with improved water quality, additional beneficial uses as well as the finite resource of clean water are protected for its citizens.

A Use Attainability Analysis (UAA) is conducted in the event that a designated use is considered inappropriate for a water body. A UAA is a structured scientific evaluation of the conditions affecting the attainment of uses, which often include an investigation into the physical, chemical, biological, and socioeconomic characteristics associated with the surface water body. Some physical factors often investigated include the volume of water, its movement, its temperature, and the texture of the substrate. Some chemical characteristics of a water body often investigated include the dissolved oxygen content, the amount of minerals and nutrients, acidity, alkalinity, dissolved and suspended solids, and sources of pollution. Some of the biological characteristics of a water body often investigated include the organisms known to inhabit or depend upon the surface water, such as aquatic life (*e.g.*, wetland plants, fish, shellfish, aquatic insects, amphibians, and other organisms), livestock drinking, and use by other wildlife (*e.g.*, birds, mammals, amphibians). The socioeconomic characteristics of a water body are often tied to local people and their respective uses of the water, recreational activities, and aesthetic values.

As with other states, New Mexico is in an ongoing process of bringing previously unclassified streams and lakes into the State's water quality management systems, through public participation and the designation of water body uses. In 1995, the New Mexico Water Quality Control Commission (NMWQCC 1995) designated the uses of all waters that were created by point or nonpoint source discharges in a non-classified otherwise ephemeral water of the State for livestock watering and wildlife habitat use only. During this same period, the Department of Energy (USDOE), the University of California Regents (UCR), the New Mexico Environment Department (NMED), the United States Environmental Protection Agency (USEPA), and the NMWQCC were exchanging ideas and opinions about the beneficial uses of the intermittent streams in the canyons on the Los Alamos National Laboratory (LANL or the Laboratory). Rather than conduct a UAA immediately, a Settlement Agreement allowed the USDOE, UCR, and NMED, to hire a third party consultant to gather additional information and conduct a study ". . . for the purposes of identifying the stream uses associated with the watercourses in the canyons into which the parties [USDOE and UCR] discharge waters subject to [National Pollutant Discharge Elimination System] NPDES regulation." The Settlement Agreement also established a four-member selection committee representing the USDOE, the LANL, and the NMED to oversee this study. The USFWS submitted a proposal for the study to evaluate the existing uses of water bodies selected in four canyons that cross the LANL. Eventually, the New Mexico Ecological Services Field Office of the United States Fish and Wildlife Service (USFWS) was selected as the third party consultant to conduct the study (although previously termed the 'LANL Use Study,' this study is now called the 'LANL Water Quality Assessment'). As proposed, the LANL Water Quality Assessment was designed more as a stream survey and assessment of the biological, chemical, and physical characteristics of the selected water bodies, and was not intended as a substitute for a UAA, nor was it designed to determine the waste load allocations necessary to protect downstream waters or provide a socioeconomic analysis often found in a UAA.

Working with the USDOE, NMED, LANL, and others, the USFWS assembled and employed a number of techniques to investigate the biological, chemical, and physical characteristics of four intermittent canyon stream segments on the Laboratory, and a nearby reference site. Physical evaluations of stream segments in these canyons included measurements of stream width, depth, substrate, temperature, flow velocity, cover, channel stability, and other parameters. Water, sediment, sediment porewater, and biota were chemically analyzed for various inorganic, organic, or radioactive chemicals and then compared to applicable water quality standards, or other conditions reported in the literature. These physical and chemical parameters were also used to identify suitable living space for two species of fish and benthic macroinvertebrates using habitat suitability models and rapid bioassessment protocols. In addition, the USFWS contracted the Columbia Environmental Research Center (CERC) of the United States Geological Survey Biological Resources Division to quantify the toxic response of standard test organisms to the canyon stream waters and sediment porewaters in a laboratory setting. Also, the Department of Energy Oversight Bureau of the NMED (Oversight Bureau) previously conducted surveys of benthic macroinvertebrate communities in these four canyon stream segments. Finally, the USFWS caged adult, female, fathead minnow (*Pimephales promelas*) in these streams for two months to measure their survival and growth as well as the bioaccumulation of various contaminants. Each of the measured characteristics were compared to those at the reference site, and to applicable criteria, and then these ratios were converted into indicators of physical, chemical, or biological quality. A Water Quality Index was developed using these indicators to identify the type and amount of water quality impairment compared to the reference site.

All stream segments were found to contain cold, flowing water and a community of aquatic life, plants, and wildlife. Los Alamos Canyon contained a perennial stream segment above the Los Alamos Reservoir with a population of brook trout (*Salvelinus fontinalis*) as well as a diverse community of aquatic macroinvertebrates, and was used as the reference site. Sandia, Pajarito, and Valle Canyon stream segments had aquatic macroinvertebrates, but no existing fish populations, and all but Sandia Canyon had shellfish populations (*i.e.*, the ridged-beak peaclam, *Pisidium compressum*). The Sandia Canyon stream segment was predominantly composed of waste water effluents, although the proportion and contributions of the discharges and storm water runoff were not quantified. Elevated concentrations of contaminants (mostly aluminum, but also barium, chromium, molybdenum, explosives, and polychlorinated biphenyls) were found either in water, sediment, sediment porewater, caddisflies (*Hesperophylax sp.*), or in the caged-fish. Toxicity of the surface water to laboratory invertebrates was identified in Valle Canyon, probably from a runoff event, and reproductive toxicity to laboratory invertebrates was found using sediment porewater from Sandia Canyon. However, the causes of toxicity were not conclusive in either event. No toxicity of surface water was found to fathead minnow during laboratory testing, and in the caged study, factors other than contaminants, particularly flooding, accounted for most the mortality observed. The benthic macroinvertebrate community was considered slightly impaired in Pajarito and Valle Canyons, and moderately impaired in Sandia Canyon where the taxa richness was one-fourth that of the reference site.

Habitat suitability models for brook trout indicated above-average to marginal quality habitat at the time of study. Lack of flow velocity in riffle habitats resulted in poor quality longnose dace (*Rhinichthys cataractae*) habitat. The Valle Canyon stream segment studied lacked the flow volume to fully support adult trout, while excess fines in riffles reduced potential trout egg habitat. Diminished stream velocity, stream side cover, prey abundance, and prey diversity, as well as excess nutrients in the Sandia Canyon segment studied reduced the quality of potential trout habitat. Scouring, erosion, and embedded substrates also reduced the quality of the habitat for aquatic macroinvertebrates in Sandia Canyon. The Pajarito Canyon stream segment had fair trout habitat, though the lower reach had reduced flow and few deep pools. Stream channel stability was fair in Valle, Pajarito, and Los Alamos Canyons but poor in Sandia Canyon.

The final Water Quality Index suggested a 30 percent impairment of the water quality in Valle Canyon, a 22 percent impairment in Pajarito Canyon, and a 30 percent impairment in Sandia Canyon compared to the reference site. Physical impacts were comparatively greater in Pajarito and Valle Canyons, whereas chemical impacts were comparatively greater in Sandia Canyon. Recently however, the Cerro Grande Fire burned a large portion of these canyons' upper watersheds and therefore, water quality impairments are expected to increase, as are restoration efforts.

Recommendations were provided to increase the value of monitoring by using integrative studies and non traditional sampling and to focus water quality management objectives on aquatic life protection in these intermittent streams. The USDOE and the LANL are encouraged to adopt all aquatic life criteria in the evaluation and management of flowing water and sediment resources on the Laboratory, to increase the use of integrative assessments, and continue to seek zero discharge and downstream transport of any persistent, bioaccumulative, or toxic substances. The goals of any water quality management actions should include protecting native species diversity, maintaining healthy macroinvertebrate communities, shellfish, and all other aquatic life species that have adapted to stream conditions unique to the Pajarito Plateau.

INTRODUCTION

Water is necessary for all life. At our houses, we drink, cook, bathe, wash, and garden with water, and in the landscape, we harvest materials (crops, timber, game, livestock, wild plants), energy (power generation transportation, mining, navigation), and recreate (swim, wade, fish, ski, boat) with water moving through the hydrologic cycle. The hydrologic cycle is the circulation of water from the oceans to the atmosphere, to the land, streams, lakes, ponds, ground water, and plants and animals then back again to the oceans (Wesche 1993). The need for clean water, and its beneficial uses and services, are balanced by political organizations and water management agencies, and have been subject to increasingly frequent litigation. During the 1970s, pollution was obviously degrading the quality of freshwater resources available for any one use, and subsequently, Federal, State, and Tribal laws were passed not only to protect surface waters, but to improve the quality of America's lakes, ponds, streams, and other fresh water resources.

Public Law 92-500, the Federal Water Pollution Control Act (commonly referred to as the Clean Water Act) enacted by Congress in 1972, as amended, provides a national framework for water quality protection and restoration. The Clean Water Act recognized that it is the primary responsibility of the States and Tribes, with jurisdiction over a water body, to prevent, reduce and eliminate water pollution, to determine and formally designate the appropriate use(s) of their waters and to set water quality standards and criteria to both define the water quality goals of a water body (or portion thereof) and to protect it beneficial uses. Beneficial uses of the waters in New Mexico to be achieved and protected can include:

- drinking water supplies, domestic use, and human health;
- primary & secondary contact (*e.g.*, swimming, fishing, recreation, ceremony);
- habitat for aquatic life (often listed as coldwater or warmwater fisheries);
- irrigation, other agricultural and aquaculture practices;
- municipal and industrial water supply and storage;
- drinking water for livestock and wildlife;
- navigation, commerce, and welfare; and,
- habitat for wildlife (*e.g.*, wetland plants, amphibians, birds, mammals).

The beneficial uses of a water body include its designated uses and existing uses. Designated uses are those uses formally classified and listed by a State (or Tribe) for their surface waters. Existing uses are those that have been attained on or after November 28, 1975, in or on any water body, whether they have been designated or not. Whenever a water body has a designated use that does not include an existing use or the uses identified in section 101(a)(2) of the Clean Water Act, then that use is considered attainable. After discovery of an attainable use, States often consider revising the designated use, because, with water quality improvements, the water body can support beneficial uses that must be protected under the Clean Water Act.

By 1987, and routinely thereafter, New Mexico, as well as several Tribes, have investigated and elaborated on the beneficial uses of waters in New Mexico to be achieved and protected. The State and Tribes have adopted water quality standards to protect public health and welfare, to enhance or improve various waters' quality, and "serve the purposes of the Act." "Serve the purposes of the Act" (defined in sections 101(a)(2), and 303(c) of the Clean Water Act), is a national stipulation that State or Tribal water quality standards should, wherever attainable, provide water quality sufficient for the protection and propagation of fish, shellfish, and wildlife, and recreation in and on the water.

By 1987, the State of New Mexico also required protection of downstream water users and their designated uses, as well as established procedures, conditions and requirements to justify removal of the State's designated uses of water. In the event that a designated use: 1) is other than that necessary to serve the purposes of the Act; 2) is somehow considered inappropriate; or, 3) should a State or Tribe and its citizenry wish to adopt subcategories of use where water quality standards are less stringent, the means by which the uses of a particular water body are adjusted and the water quality standards are adjusted is by conducting a Use Attainability Analysis (UAA). A UAA is a structured scientific evaluation of the conditions affecting the attainment of uses, which often include an investigation into the physical, chemical, biological, and socioeconomic characteristics associated with a water body. In general, physical factors are the foundation of the investigation and can include the volume of water, its movement, temperature, and depth, the texture of substrate, and channel characteristics for streams. Chemical characteristics of a water body can include its dissolved oxygen content, the amount of minerals and nutrients, the acidity, alkalinity, dissolved and suspended solids; as well as toxic substances, whether from point sources or nonpoint sources. The biological characteristics of a water body can include a survey of the organisms known to inhabit or depend upon the surface water, such as the local people and their activities, aquatic life (*e.g.*, wetland plants, fish, shellfish, invertebrate communities), livestock, and wildlife uses. Occasionally, a UAA can include an extensive socioeconomic analysis when a designation results in a demonstrated, substantial or widespread economic or social impact often accompanied by extensive citizen participation and public outcry.

As with other states, the State of New Mexico is in an ongoing process of bringing previously unclassified streams and lakes into the State's water quality management systems, through public participation and the designation of water body uses. In 1995, the NMWQCC (1995) designated the uses of all waters that were created by point or nonpoint source discharges in a non-classified otherwise ephemeral water of the State for livestock watering and wildlife habitat use only. During this same period, the

Department of Energy (USDOE), the University of California Regents (UCR), the New Mexico Environment Department (NMED), the United States Environmental Protection Agency (USEPA), and the NMWQCC were exchanging ideas and opinions about the beneficial uses of the intermittent streams in the canyons on the Los Alamos National Laboratory (LANL or the Laboratory). Rather than conduct a UAA immediately, a Settlement Agreement (Appendix I) allowed the USDOE, UCR, and NMED, to hire a third party consultant to gather additional information and conduct a study ". . . for the purposes of identifying the stream uses associated with the watercourses in the canyons into which the parties [USDOE and UCR] discharge waters subject to [National Pollutant Discharge Elimination System] NPDES regulation." The Settlement Agreement also established a four member selection committee representing the USDOE, LANL, and NMED to oversee this study. The USFWS submitted a proposal for the LANL Water Quality Assessment (formerly called the LANL Use Study; Appendix II) to evaluate the existing uses of water bodies selected in four canyons that cross the LANL. Eventually, the New Mexico Ecological Services Field Office of the United States Fish and Wildlife Service (USFWS) was selected as the third party consultant to conduct the study (this study is herein called the 'LANL Water Quality Assessment'). As proposed, the LANL Water Quality Assessment was designed more as a stream survey and assessment of the biological, chemical, and physical characteristics of the selected water bodies, and was not intended as a substitute for a UAA, nor was it designed to determine the waste load allocations necessary to protect downstream waters or provide a socioeconomic analysis often found in a UAA.

After review and concurrence by the USDOE, LANL, and NMED, the USFWS proposed to: 1) conduct evaluations of the physical habitat, including stream width, depth, substrate, temperature, current velocity, cover, and other variables that determine suitable habitat for several species of aquatic life; 2) quantify inorganic and organic chemicals in water, sediment, porewater, and biota that could affect fish and wildlife or indirectly affect food production and quality; 3) conduct biological evaluations of species expected regionally and quantify the toxic response of standard test organisms in both laboratory and field settings. All evaluations were to be conducted using comparisons to the reference site, the reference site was selected, *a priori*, as the stream segment in Los Alamos Canyon above the Los Alamos Reservoir. Additionally, biological, chemical, and physical conditions were also compared to applicable standards or criteria, and with other conditions reported in the literature. Taken together, the LANL Water Quality Assessment evaluated the existing and potential uses of these canyon streams based upon their biological, chemical, and physical characteristics and the evaluations identified in Table 1.

In New Mexico, the aquatic life use designation is broken into five fishery subcategories on the basis of representative fish that may be found in cold or warm waters. The various fishery subcategories are: coldwater fishery, high quality coldwater fishery, limited warmwater fishery, marginal coldwater fishery, and warmwater fishery. This subcategorization of the aquatic life use was designed to better protect the classes of coldwater fishery and to designate as superior those coldwater fisheries found in New Mexico's mountains (NMED 2001a). Only the marginal coldwater fishery subcategory requires the actual presence of fish. For the LANL Water Quality Assessment, the USFWS focused on the assessment of fish habitat, because the ability of these shallow and intermittent streams to support fish was questioned by the LANL, and is an important aspect of the fishery use subcategorization. Habitat for fish is a place in which a fish, a fish population, or a fish assemblage can find the biological, chemical, and physical features needed for life, such as suitable water quality, spawning areas, feeding sites, resting sites, and shelter from predators or adverse weather (Orth and White 1993). Physical habitat refers to the stream characteristics of bed materials, water depth, current velocity, bank slope, and cover as well as riparian characteristics that determined the amount of suitable living space for various species and life history stages. Physical habitat varies by life stage. For example, juvenile fish prefer shallow areas with cover, while adult fish tend to select habitats close to foraging locations and escape cover. The biological, chemical, and physical characteristics of a stream play a large role in determining the numbers, sizes, and species of fish that can be sustained or the assemblage of other aquatic life use.

The assessment of the streams' aquatic life potential was conducted in three phases. During Phase I, the physical and chemical characteristics of these streams were compared with New Mexico's water quality standards designed to protect aquatic life, as well as drinking water, and other beneficial uses. Each stream segment's physical habitat relative to two species of fish and the benthic macroinvertebrate community was then characterized. During Phase II, each segment's water and sediment (*i.e.*, sediment porewater) were tested to determine if they posed any acute or chronic toxicity to fish and invertebrates, under laboratory conditions. During Phase III, fish were placed in cages in the stream (*in situ*) to observe their response in the stream environment. A fourth phase of the evaluation was planned, and included the stocking of a native, montane fish assemblage (*e.g.*, Rio Grande trout, longnose dace, Rio Grande chub, and Rio Grande sucker [species names listed in Table 2]), but due to fiscal constraints, was not conducted during the LANL Water Quality Assessment. Such an endeavor would also require public review, but stocking native fish into suitable streams for their recovery remains a valuable conservation opportunity for natural resource management by USDOE, the National Park Service, the Santa Fe National Forest, or others.

Working with others, the USFWS assembled and employed a number of contractors and techniques to evaluate the biological, chemical, and physical characteristics of these four canyon streams. All information made available during this study concerning the existing uses of waters in these four canyons into which the LANL and the USDOE discharge, was collected and evaluated for this LANL Water Quality Assessment. This report summarized the objectives, methods, results, and findings of the LANL Water Quality Assessment. The biological evaluations were greatly assisted by toxicity testing, advice, and other services provided by the CERC. Also significant were the contributions of the New Mexico State University Fish and Wildlife Cooperative Research Unit and the LANL's Ecology Group, which has conducted numerous biological surveys in conjunction with USDOE projects that provided for an extensive database on the biodiversity of the LANL and surrounding areas. Both the LANL and the NMED have investigated and continue to survey the aquatic invertebrates in these streams (Bennett 1994; Cross 1994a, 1995a, 1997; Ford-Schmid 1996), including the stream segments selected for the LANL Water Quality Assessment (Ford-Schmid 1999). In the case of Sandia Canyon, benthic macroinvertebrate surveys were conducted annually from 1990 to 1997 (Bennett 1994; Cross 1994a, 1995a; Ford-Schmid 1999), often elaborating on the water quality impairment by acids or chlorine. Since the benthic macroinvertebrate community was recently surveyed, additional benthic macroinvertebrate surveys were considered unnecessary to meet the objectives of the study. Because the benthic macroinvertebrate community surveys conducted by Ford-Schmid (1999) were contemporaneous (except Pajarito Canyon surveyed in 1994) with the LANL Water Quality Assessment and overlapped the study locations, these results were used in our evaluation.

Guidance on water body survey and assessment techniques was also found in the Technical Support Manual, Volume I: Waterbody Surveys and Assessments for Conducting Use Attainability Analyses (USEPA 1983) and in the Water Quality Standards Handbook: Second Edition (USEPA 1995a). The combination of the techniques reported here may be applicable to the evaluation of other similar water bodies in New Mexico. Water body surveys and assessments should be designed with sufficient detail to answer the following questions:

1. What aquatic life uses or other beneficial uses are currently being achieved in or on the water body?

2. What are the causes of any impairment of water quality for a beneficial use?

3. What aquatic or other beneficial uses can be attained based on the biological, chemical, and physical characteristics of the water body?

(This page intentionally left blank)

OBJECTIVES

The objectives of this assessment were to:

1. determine the existing uses of the intermittent stream reaches in Sandia, Pajarito and Valle Canyons that cross the LANL;

2. determine if fish could be supported or propagated, or both, in the intermittent stream reaches selected by the Selection Committee;

3. identify any limiting, biological, chemical, and physical conditions that impair the water quality for aquatic life use, or a healthy fishery; and,

4. provide an informative report about the water quality of the selected intermittent streams of this area and the techniques used to evaluate them. After review by the Selection Committee, all information and data generated will be made available to the public, other researchers, monitoring organizations, and government agencies so as to allow an understanding of how the data were collected and analyzed.

(This page intentionally left blank)

ENVIRONMENTAL SETTING

General Setting

The study area is located within Los Alamos County on the Pajarito Plateau, the east slope of the Jemez Mountains in north-central New Mexico (Figure 1). The Jemez Mountains rise as a large volcanic landmass at the southern end of the Rocky Mountains approximately 80 kilometers (km) by air north of Albuquerque and 32 km northwest of Santa Fe. The Jemez Mountains are a remnant of a massive volcano that became active approximately 16 million years ago. Volcanic eruptions approximately 8.5 and 1.5 million years ago deposited thick lava flows, surge ash, and fall ash, which together, with sedimentary deposits, formed the soils and distinct plateaus around the Jemez Mountains (Kelly 1978; Nyhan *et al.* 1978; Self *et al.* 1996). The prominent physiographic features (Figure 2) that remained after the volcanism ended are the calderas (e.g, the Valle Grande and the Valle Toledo), dome mountains within the calderas (*e.g.*, Redondo Peak, Cerro de Abrigo), and the semicircular, mountainous rim of the collapsed volcano (*e.g*, the Sierra de los Valles are the easternmost portion of this rim that has nine peaks including Cerro Grande, Pajarito Mountain, and Tschicoma Peak) (Foxx *et al.* 1998). One material deposited, called the "Bandelier Tuff," which is mostly pumice and rhyolite ash, was laid down 1.4 to 1.1 million years ago on the western flanks (*i.e.*, the Jemez Plateau) and eastern flanks (*i.e.*, the Pajarito Plateau) of this volcanic mountain (Kudo 1974; Nyhan *et al.* 1978).

The Pajarito Plateau is a geologic feature that is about 32 to 40 km in length and 8 to 16 km wide (Figure 3). The Pajarito Plateau consists of a series of east- to southeast-trending mesas, separated by approximately 14 deeply incised canyons cut by subsequent erosion, runoff, and base flow. Some of the major canyons of the plateau include Santa Clara, Guaje, Pueblo, Los Alamos, Pajarito, Water, Frijoles, Ancho, and Capulin. The Pajarito Plateau slopes eastward from an elevation of about 2,286 meters (m) below the Sierra de los Valles (that range from 2,895 m to 3,526 m) towards White Rock Canyon that contains the Rio Grande (Figure 4). The White Rock Canyon rim is at an elevation of about 1,889 m with steep slopes formed by the down-cutting of the Rio Grande that is at an elevation of about 1,647 m. All of the surface water that drains from the Plateau, as well as ground water discharge, is into the Rio Grande (Purtymun 1995).

Environmental History

A brief summary of historical natural resource use identifies some of the human interactions with the ecosystems of the Jemez Mountains. Evidence of dry farming corn, beans, and squash was found as early as 4,000 years ago and continued through 1000 A.D. (Stuart 1986), and is still conducted by the LANL and the Pueblo people (Fresquez *et al.* 1997). During the Upland Period (~1100 A.D.), many people moved into the forest and woodlands, and evidence of larger scale farming began on the Pajarito Plateau (Foxx and Tierney 1984). A great drought around 1290 A.D., and other factors, led to large population declines, abandonment of the uplands, and the relocation of many villages to the confluences of major rivers and streams (Scurlock 1998). Many Pueblos in the region today, still reside near springs, arroyos, rivers and streams, and their people often consider the upland ruins sacred and certain natural resources to be ancestral. Several of the Pueblos of northern New Mexico have maintained a close relationship with wildlife, particularly migratory birds (Scurlock 1998). Archaeologist Edgar L. Hewett, who gave the name "Pajarito" to this plateau, was said to be inspired by the name of a pueblo ruin, "Tshirege," which means place of the bird people (Julyan 1996). Game hunting has been well documented, but historically, the ancestral people were not known to subsist upon or consume fish, amphibians, reptiles, or mollusks (Scurlock 1998). Nonetheless, fish bones were excavated from ruins at the Bandelier National Monument indicating some consumption, albeit not subsistence (Hubbard 1976). Bivalve shells have also been found (Steen 1977). Cultural traditions today include: using the Pajarito Plateau's natural resources for food, agriculture, trade, medicines, construction, crafts, arts, and ceremonies.

From the mid 1500s to the mid 1900s, the environmental history of the Jemez Mountains largely reflects the exploration and colonization by the Spanish, Europeans, and Anglo-Americans. The activities of farming, livestock raising, silviculture, mining, hunting, and trade in fur, settlement, and conflict with Puebloan people increased during this period. Several wildlife species (*e.g.*, grizzly bear, beaver, bighorn sheep, elk, mink, river otter, and gray wolf), were depleted from this environment, though later some were reintroduced or recovered naturally (Bailey 1971; Findley *et al.* 1975; New Mexico Department of Game and Fish [NMDGF] 1998). Portions of the Pajarito Plateau were then alternatively used for farming, grazing, mining, silviculture, recreation, and homesteading by various groups (USERDA no date; Foxx *et al.* 1998; Scurlock 1998). Steen (1977) reported a water control system, with a ditch and diversion dam, on Pajarito Creek (Site LA 12701), but these irrigation facilities were not clearly identifiable to their cultural provenance.

Land ownership on the Pajarito Plateau includes the Department of the Interior National Park Service Bandelier National Monument, the USDOE, the Department of Agriculture Santa Fe National Forest, the Counties of Los Alamos, Santa Fe, and Sandoval, the Pueblos of Santa Clara, San Ildefonso, Cochiti, and Jemez, and private lands including the towns of Los Alamos and White Rock. By the mid to late 1900s, large portions of the Pajarito Plateau and Jemez Mountains were acquired by the Federal Government for the Forest Service, the Bandelier National Monument, and portions were later used for the Manhattan Project to develop the atomic bomb that subsequently became the Los Alamos National Laboratory.

The Los Alamos National Laboratory

The LANL currently covers more than 111 km^2 of mesas and canyons on the Pajarito Plateau in northern New Mexico (Figure 1). Owned by the USDOE (1 of 28 USDOE-owned laboratories in the United States), the LANL has been managed by the University of California since 1943, when it was part of the Manhattan Engineering Division's Project Y designed to create the atomic weapons used during World War II. Today, the LANL is a multi-disciplinary and multi-program scientific research center whose central mission is to design, develop, and test nuclear weaponry and reduce the nuclear danger through evaluation and stockpile stewardship. The LANL also includes programs in energy, nuclear safeguards, biomedical science, education, electronics, aeronautics, physics, chemistry, metallurgy, earth sciences, environmental cleanup, mathematics and computational science, materials science, and other basic sciences (UCR 2000). Approximately one-third of the staff are physicists, one-fourth are engineers, one-sixth are chemists and materials scientists, and the remainder work in mathematics and computational science, biological science, geoscience, and other disciplines (UCR 2000). The LANL's mission recently became integrated with the newly-formed National Nuclear Safety Administration of the USDOE. Also recently, the Cerro Grande Fire burned a large portion of the forest ecosystems on and up slope of the LANL; the appearance of the landscape has changed dramatically, and the habitats discussed herein may be altered and impacted by these watershed conditions. The LANL is currently evaluating the flood and erosion risks associated with the affected areas and implementing strategies to address the potential increased storm water runoff expected (USDOE 2001).

Climatological Setting

Weather dictates the ranges of precipitation, temperature, humidity, wind, and evaporation experienced on the Pajarito Plateau. The climate of the area is governed by latitude, elevation, and proximity to the Sierra de los Valles that locally modifies airflow and precipitation patterns. Bowen (1990, 1992) evaluated a composite record from 1961 to 1990 using weather stations at an elevation of approximately 2,250 m above sea level to describe the climate of Pajarito Plateau. The Pajarito Plateau has a temperate mountain climate with four distinct seasons. Spring tends to be windy and dry. Summer tends to be warm and dry in June, followed by a two-month rainy season. July is the warmest month with an average daily high of 27.2 degrees Celsius (°C) and an average daily low of 12.8 °C. The extreme daily high temperature on record is 35°C. In autumn, there is a return to drier, cooler, and calmer weather. January is the coldest month with temperature ranges from 4.4 to -8.3 °C. The extreme daily low temperature on record is -27.8° C.

The average annual precipitation on the Pajarito Plateau is 47.6 centimeters (cm), but varies considerably from year to year and by elevation. The lowest recorded annual precipitation for the stations on Pajarito Plateau is 17.3 cm and the highest is 77.1 cm. The source of precipitation to the Jemez Mountains comes from the winds across the

Pacific Ocean and Gulf of Mexico. The elevation of the Jemez Mountains causes cooler temperatures thus condensing water out of the rising air, resulting in higher humidity and precipitation in the mountains and semi-arid lands at lower elevations. The annual precipitation levels show this effect of the changing elevations as there is an east-to-west gradient in precipitation across the Pajarito Plateau. Lower elevations near the Rio Grande received about 35 cm average annual precipitation and the higher elevations receive 60 cm or more (Bowen 1990). The peak rainfall months are July and August. Lightning is very frequent. Most winter precipitation falls as snow with an average of 150 cm, but it can vary widely. The highest recorded snowfall for one season is 389 cm and the extreme single storm snowfall on record is 122 cm.

Hydrologic Setting

Intermittent flowing streams have helped to form the entrenched canyons on the Pajarito Plateau since its deposition 1.1 million years ago. Intermittent and ephemeral streams play a vital role in the hydrological cycle, transporting the rain collected across the Pajarito Plateau to the Rio Grande. According to Purtymun (1995):

> Los Alamos surface water occurs primarily as intermittent streams. Springs on the flanks of the Sierra de los Valles supply base flow into upper reaches of some of the canyons (Guaje, Los Alamos, Pajarito, Canyon de Valle, and Water Canyon), but the amount is insufficient to maintain surface flow across the Pajarito Plateau before it is depleted by evaporation, transpiration, and infiltration. Runoff from heavy thunderstorms or heavy snowmelt reaches the Rio Grande several times a year in some drainages. Effluents from sanitary sewage, industrial waste treatment plants, and cooling-tower blowdown are released into some canyons at rates sufficient to maintain surface flow for short distances on the Pajarito Plateau.

Purtymun (1995), and the USDOE (1999) identified several portions of these intermittent streams as perennial. Dale (1998) identified portions of Sandia Canyon, Pajarito Canyon, Valle Canyon, and Los Alamos Canyon above the reservoir as having perennial flow. Since 1943, the primary use of Sandia Canyon has been disposal of liquid waste from industrial and sanitary systems, and the resultant downstream wetlands had nearly reached their full areal extent by 1974 (LANL 1999a). The Sandia Canyon benthic macroinvertebrate community has been investigated annually from 1990 to 1997 (Bennett 1994; Cross 1994a, 1995a; Ford-Schmid 1999; this study). These intermittent streams, invertebrate communities, and other aquatic wildlife have been investigated annually for years or have also been reported as perennial by many researchers (Brooks 1989; Bennett 1994; Cross 1994a, 1995a, 1995b; Foxx and Blea-Edeskuty 1995; Cross and Davila 1996; Cross 1997; and Ford-Schmid 1996, 1999).

However, definitions of what constitutes perennial are varied. The NMWQCC (1995) defines "perennial stream: as a stream or reach of a stream that flows continuously throughout the year in all years; its upper surface, generally, is lower than the water table of the region adjoining the stream." The location of the regional water tables near these streams was not determined for this study, although springs were observed above the stream bed. Also, the stream segments were visited from July 1996 to November 1997 and found free-flowing (though ice-covered during winter). Potentially surface water flow may be altered by recharge of the alluvial aquifer, recharge due to the establishment (or cessation) of discharged waste water effluents, or variability of rainfall, but any consequent change in flow might take decades to fully manifest itself as the mechanism of ground water recharge and discharge along these canyons is not well known (Frenzel 1995). However, Blake *et al.* (1995) suggested, based on tritium data and stable isotope analyses, that an area of recharge at an average elevation of 2,530±100m was the most likely source of the waters found in Los Alamos Creek and Pajarito Creek.

Geologic Setting

Geologic characteristics influence the nature and extent of groundwater storage, the type of material available for erosion and transport, and to some extent the chemical quality of the surface and ground water (Grant 1997). The natural geochemistry of the surrounding soils, alluvial ground waters, and surface waters at the LANL are largely determined by the local geology, which is primarily made up of the Bandelier Tuff (rhyolite ash flow and falls, pumice and breccia, some welded), and alluvium derived from the Tschicoma Formation (latite, quartz latite, and pyroxene andesite flows; some tuffs) (Kelly 1978; Self *et al.* 1996). The stream segments studied in Sandia, Valle, and Pajarito Canyons were dominated by soil subtypes derived from the Bandelier Tuff, whereas soils in the upper portion of Los Alamos Canyon were derived primarily from the more stable and less erodible Tschicoma Formation (Nyhan *et al.* 1978; Gray 1996). The generalized soil types in Los Alamos Canyon are primarily sandy loams, as in the other canyons studied. Sandy loams have a moderately high precipitation runoff potential, and a low water transmission rate (Gray 1996). Nyhan *et al.* (1978) found that Sandia Canyon also contained Carjo loams and rock out-croppings. Pajarito and Valle Canyons were more heterogenous. Pajarito was dominated by Carjo loams on the north-facing slopes and a combination of Tocal very fine sandy loams, fine loamy Typic Eutroboralfs, and clayey skeletal Typic Eutroboralfs elsewhere. Nyhan *et al.* (1978) did not identify Carjo loams in Valle Canyon, and reported mostly Tocal very fine sandy loams and Typic Eutroboralfs.

Given the volcanic origins, soils on the Pajarito Plateau have surprisingly variable physical and chemical characteristics (*e.g.*, percent calcium carbonate, clay mineralogy, iron oxides, and trace element chemistry), thus, generalized statements regarding 'background" soil and water mineral and trace element concentrations or mobility may require caution in their interpretation. Because soils with higher clay content may also have higher concentrations of aluminum and iron, and perhaps barium (Ferenbaugh *et al.* 1990; Longmire *et al.* 1996), canyons with higher clay content soils could correspondingly have higher background concentrations of these minerals in water, sediment, and porewater. While all canyons contain some percentage of clay soils, Pajarito Canyon contained a distinctly clayey soil (Nyhan *et al.* 1978). Soil clay fractions were primarily composed of montmorillonite and illite, which were the weathered products of the Bandelier Tuff (Gray 1996, citing others). Clay soils can also restrict the movements of certain heavy metals and have a higher cation exchange capacity, so they may influence the dissolution, mobility, and toxicity of metals (Ebinger *et al.* 1994; Longmire *et al.* 1996). Graf (1995) reported that soil and sediment transport of sorbed metals and radionuclides are a primary mechanism for contaminant distribution within the watersheds of the Pajarito Plateau. High absorption affinities of fine-grained sediments for metals and radionuclides enhanced their transport to the Rio Grande downstream (Graf 1995).

Ecoregional Setting

Knowledge and classification of the ecological communities of the Jemez Mountains can form a basis for natural resource conservation and management. Ecological classifications have been recognized as important tools to identify the unique interactions among plant and animal species as well as systematically characterizing the current pattern and condition of the landscape. Ecoregional classifications recognize the limiting effects of the moisture regime and temperature minima as well as the evolutionary origin on the structure and composition of terrestrial plant and animal communities in the West. Several biogeographers (Bailey 1976; Brown and Kerr 1979; Omernik 1987; Grossman *et al.* 1998; Brown *et al.* 1998) have developed hierarchical classification systems for the biotic communities of North America that include those of the Jemez Mountains and the Pajarito Plateau. Omernik (1986, 1987) identified the Jemez Mountains as part of the Southern Rockies Ecoregion. These ecological classifications were used to facilitate the LANL Water Quality Assessment in the biotic inventory of expected plants and animals, in the delineation of habitat, in the interpretation of biological values, and in the selection of a reference site.

Using interpretation of high altitude aerial photography, the National Wetland Inventory mapped the wetlands of the Pajarito Plateau using the Cowardin *et al.* (1979) wetland classification system. In this montane region, wetlands and riparian areas are located in a wide range of sites from cliff faces to flat canyon valley floors (Windell *et al.* 1986; USFWS 1990; USDOE 1999). Perennial, temporarily flooded, seasonally flooded, or artificially flooded palustrine wetlands in forested and scrub/shrub habitats, as well as perennial, intermittent, and temporarily flooded, riverine streambed, wetlands and riparian areas were identified and mapped on the LANL by the USFWS (1990).

Jacobi *et al.* (1995) and Cowley *et al.* (1997) classified the intermittent and perennial streams of New Mexico that included those of the Jemez Mountains into Aquatic Ecoregions. Based on a statistical analysis of 25 chemical, physical, and climate variables, Jacobi *et al.* (1995) and Cowley *et al.* (1997) identified streams above 2,135 m on the Jemez Mountains as being part of Aquatic Ecoregion 1 and those waters on the Jemez Mountains from 2,135 m to 1,675 m as part of Aquatic Ecoregion 2. Jacobi *et al.* (1995) characterized Aquatic Ecoregion 1 by elevation (>2,135 m), low water hardness, low alkalinity and other chemical constituents, low fish species diversity, and a rich benthic invertebrate fauna. This classification, however, does not take into account geologic and zoogeographic histories of native fish in watersheds (Hatch *et al.* 1998) or previous historical disturbances such as logging, fire, agricultural activities, long-term isolation from other streams, or other factors that could account for any lack of fish fauna observed in a water body.

Floral Communities

A considerable database of plant species of the Jemez Mountains including the Pajarito Plateau has been acquired over the past 40 years and reported by Foxx *et al.* (1998). Foxx and Tierney (1984) described 6 major plant communities that included 16 different types of plant habitats (Figure 4). The six major communities were:

1. the subalpine meadows atop the Sierra de los Valles and Valle Caldera;
2. the spruce-fir (*Picea*, *Pseudotsuga*, and *Abies spp.*) or conifer forest, of the upper mountains at elevations from 2,900 m to 3,050 m;
3. the mixed conifer forest of the mountainsides, high mesa slopes, and upper canyons at elevations from 2,440 m to 2,740 m;
4. the ponderosa pine (*Ponderosa pinus*) forest of the mesa tops and mid-canyons at elevations from 1,980 m to 2,440 m;
5. the woodlands (*Juniperus* and *Pinus spp.*) of the lower mesas and canyons at elevations from 1,950 to 2,290 m; and,
6. the woodland savannah and grasslands of the lower elevation mesas and canyons at elevations from 1,650 m to 1,950 m.

The elevations of these six plant communities reported by Foxx and Tierney (1984), were estimated, as local changes in temperature, soil moisture, altitude, aspect, slope, geology, and differences in the amount of solar radiation result in many transitional overlaps of these soils and plants. Dick-Peddie (1993, citing others) recognized this canyon effect on New Mexico plant communities when he wrote of the tendency of the higher elevation plant communities to move further down canyons than expected and of the lower plant communities to move further up the mesa and ridges than expected in connection with available soil moisture. Foxx and Tierney (1984) did not report riparian and wetland vegetation as a major community.

In total, Foxx *et al.* (1998), reported over 1,060 plant species on the LANL and surrounding areas and classified each species according to a variety of taxonomic, geographic, economic, ethnographic and biotic attributes. Fifteen percent (160/1061) of the total plant species listed almost always occur in wetlands (obligate, 7 percent) or usually occur in wetlands (facultative, 8 percent). Some of the vegetation in this region has an obligate relationship with fungus. Jarmie and Rogers (1996) reported 228 species of fungi on the Pajarito Plateau. Some of these fungi are harvested for food, most assist in the transformation of nitrogen compounds, and some are poisonous.

Faunal Communities

By virtue of its location on a mountain in a semi-arid climate, the Pajarito Plateau offers diverse land forms, a decisive change in elevation and temperature, and clean water from melted snow, runoff, springs, and seeps, that have all produced a diverse plant and animal community. The interfingering of deep, steep-sided canyons with narrow mesas that descend the Jemez Mountains and Pajarito Plateau with an inversion of the normal altitudinal distribution of vegetative communities along the canyon floors has also resulted in many transitional overlaps of plant and animal communities and increased biological diversity. Beardsley (1994) reported that areas with abundant sunshine and water, such as the Jemez Mountains, favor an abundance of plant species, and with strongly varying temperatures between summer and winter, there were more abundant animal species compared with areas of low seasonality.

The extraordinary biodiveristy found on the Jemez Mountains including the Pajarito Plateau was illustrated by the presence of over 1,060 species of vascular plants (Foxx *et al.* 1998), 67 species of mammals, 208 species of birds (Travis 1992), 23 species of reptiles, 9 species of amphibians, over 1,200 species of arthropods, over 230 taxa of aquatic macroinvertebrates (Cross 1996b), and 9 species of fish (Calamusso and Rinne 1999; Sublette *et al.* 1990). Of the 310 vertebrate species of the Jemez Mountains (listed in Table 2), 7 percent are fully aquatic including 9 montane species of fish (with 14 other species found in the Rio Grande). An additional 13 percent of the vertebrate species are semi-aquatic, such as amphibians, ducks, herons, and the American dipper, that are found in suitable habitat (lakes, ponds, streams, wetlands) on the Jemez Mountains. For instance, waterfowl visited the standing bodies of water on the Pajarito Plateau as well as foraged along the Rio Grande and other wetlands in tributary canyons (Brooks 1989; Travis 1992; Foxx and Blea-Edeskuty 1995). Twenty-eight percent of the species are entirely terrestrial, but an additional 34 percent of the terrestrial species are also found in association with wetlands and riparian vegetation resulting in the majority (63 percent) of the vertebrates species found on the Jemez Mountains depending in some way on wetland or riparian habitat to complete their life cycles. A list of common and scientific names of wildlife discussed in this report is provided in Table 2.

STUDY AREA AND SITE SELECTION

Description of the Canyons

Four watersheds contain the stream segments studied, including Los Alamos, Sandia, Pajarito, and Valle Canyons (the term Valle Canyon is used in place of Cañon de Valle, and since Valle Canyon is not an entire watershed, the term drainage is used where appropriate). These canyons were evaluated as watersheds (Table 3), and their various geomorphic dimensions were obtained from LANL reports (LANL 1999b; USDOE 1999) or United States Geologic Survey topographic maps (Figure 5).

Los Alamos Canyon

Los Alamos Canyon, the largest drainage basin (28.4 km^2), ranged in elevation from 3,182 m at the top of Pajarito Mountain to 1,725 m at its confluence with Guaje Canyon. Los Alamos Canyon had the greatest proportion of spruce-fir forest and least amount of grassland compared with other canyons studied (Table 3). The top elevation of the stream segment studied was 2,371 m and the predominant vegetation type was a mixed conifer forest (Figure 6). Biological resources for portions of Los Alamos Canyon were reported by Ferenbaugh *et al.* (1990); Bennett (1993); Foxx *et al.* (1995); Cross and Davila (1996); Gray (1996); Hinojosa (1997); Ford-Schmid (1999); and Hansen *et al.* (1999).

Los Alamos Canyon on lands owned by the Santa Fe National Forest is a popular recreational area. Camping, picnic areas, and an ice-skating rink are located near Los Alamos Reservoir, and the reservoir itself was used for fishing, swimming, and ice sports in the winter. Purtymun (1979) and Purtymun *et al.* (1983, 1984, 1985, 1986a, 1986b, 1987, 1991, and 1993) have documented the uses of water from this reservoir for irrigation, municipal, and industrial purposes, and these uses consumed an average of about 7,570 m^3 per year.

The LANL Technical Areas within the Los Alamos watershed included: TA-2, TA-3, TA-21, TA-41, TA-43, TA-62, TA-72, TA-73, and TA-74, that are all below the stream segment studied. Activities conducted at these technical areas are potential sources of contamination including a nuclear reactor housed at TA-2, and weapons development at TA-41 (LANL 1995b). There is also mesa top contamination that may eventually reach the canyon through erosive processes. The most probable contaminants of the middle and lower canyon are radiological and chemical including uranium, plutonium, tritium, strontium, cesium, chromium, mercury, acids, and solvents (LANL 1995b).

The NPDES discharges to Los Alamos Canyon have numbered as many 12, but have now been reduced to 5. Discharges are from research laboratories and cooling towers. The USDOE (1999) reported the total volume of wastewater discharged to Los Alamos

Canyon was 74,573 m^3 per year. None of these discharges or potential sources of contaminants are located in or above the stream segment studied.

Sandia Canyon

Sandia Canyon had the smallest watershed (14.2 km^2) and ranged in elevation from ~2,286 m to 1,664 m at its confluence with the Rio Grande. The canyon vegetation was dominated by piñon and/or juniper woodland, although the stream segment studied was in a mixed ponderosa pine forest (Figure 6). The top elevation of the stream segment studied was 2,192 m. Although access is restricted on USDOE lands, Sandia Canyon received some employee recreation as well as public trespass visitation. Biological resources for portions of Sandia Canyon were reported by Dunham (1993); Cross (1993); Bennett (1994); Cross (1994b); Cross (1994c); Cross and Davila (1996); Hinojosa (1997); Ford-Schmid (1999), Bennett *et al.*(1999), and Bennett *et al.*(2001).

The LANL Technical Areas within the Sandia Canyon watershed included: TA-3, TA-5, TA-53, TA-60, and TA-61. Activities conducted at these technical areas that are potential sources of contamination included research laboratories, a sewage treatment plant, cooling towers, and salvage yard, a county landfill on the north slope, a former Atomic Energy Commission facility, several firing ranges, and the proton accelerator and support facility (LANL 1999b). There is also mesa top contamination that may eventually reach the canyon through erosive processes. The contaminants most likely in the upper canyon, above the stream segment studied, are polychlorinated biphenyls (PCBs), metals, and other organic chemicals (LANL 1999b). In the remainder of the canyon soils and sediments, contaminants included tritium, uranium, plutonium, lead, mercury, cadmium, hydrocarbons, and other metals or organic chemicals (LANL 1999b).

The NPDES discharges associated with Sandia Canyon have numbered as many as 10, but now number 7. Discharges are from the power plant, sewage treatment, and cooling towers. The USDOE reported the total volume of wastewater discharged to Sandia Canyon was 408,446 m^3 per year (USDOE 1999; Bennett *et al.*2001).

Pajarito Canyon

Pajarito Canyon ranged in elevation ranged from 3,182 m at the top of Pajarito Mountain to 1,658 m at its confluence the Rio Grande. The canyon vegetation was dominated by ponderosa pine and spruce-fir forest (Figure 7). The vegetation near the stream segment studied was also spruce/fir mixed with ponderosa pine and contained a steep-sided narrow canyon with a 2-m waterfall. Pajarito Canyon was also substantially developed (15.3 percent) compared with other canyons studied, largely owing to the town of White Rock, New Mexico, downstream (Table 3, Figure 7). The top elevation of the stream segment studied was 2,249 m. Although access is restricted in the upper watershed, some daytime, employee recreation occurred, and downstream, Pajarito Canyon received unrestricted recreation near the town of White Rock. Biological resources for portions of Pajarito Canyon were reported by Banar (1993); Raymer (1993); Salisbury (1994); Keller and Risberg (1995); Benson *et al.* (1995); Cross *et al.* (1996); Ford-Schmid (1996); and Hinojosa (1997).

There are numerous LANL Technical Areas within the Pajarito Canyon watershed. Activities conducted at these technical areas that are potential sources of contamination included the research and testing of explosives, firing and detonation sites, material disposal areas, and Material Disposal Area M in particular (LANL 1999b). There is also mesa top and building contamination that may eventually reach the canyon through erosive processes. The most probable contaminants of the upper canyon, above the segment studied, are heavy metals such as lead, iron, mercury, and cadmium. These, along with explosives, radionuclides including depleted uranium, asbestos, and other heavy metals would likely be found in the remainder of the canyon soils and sediments downstream of the segment studied (LANL 1999b).

The NPDES discharges associated with Pajarito Canyon have previously included 17 outfalls, but now there are none. Previous discharges were associated with explosive testing, other material laboratories and shops, and an X-ray building. Activities associated with explosives manufacture and testing as well as runoff from the material disposal areas could contribute contaminants to the segment studied. The USDOE reported the total volume of wastewater discharged to Pajarito Canyon was 34,826 m^3 per year (USDOE 1999).

Water Canyon Watershed and the Valle Canyon Drainage

The Valle Canyon drainage ranged in elevation from 3,182 m at the top of Pajarito Mountain to 2,073 m at its confluence with the parent watershed, Water Canyon. Water Canyon vegetation was mostly forest and woodlands (87 percent, Table 3), although it also had the greatest amount of grasslands (Figure 7), which was attributed to the succession and effects of the La Mesa Fire of 1977. The vegetation near the stream segment studied was ponderosa pine. There are five springs in the Valle drainage and stream baseflow reported by Cross (1997) was 6.5×10^{-4} m^3/second. The top elevation of the stream segment studied was 2,237 m. Although access is strictly restricted for most of watershed, there was some daytime, employee recreation. The lowermost portion of Water Canyon received unrestricted public recreation. Biological resources for portions of Water Canyon were reported by Banar (1993); Cross (1995b); Haarmann (1995); USDOE (1996); Cross (1997); Hinojosa (1997); and Ford-Schmid (1999).

The LANL Technical Areas within the Valle Canyon drainage included: TA-8, TA-9, TA-14, TA-15, and TA-16. Activities conducted at these technical areas are potential sources of contamination that included the research and testing of explosives, firing and detonation sites, material disposal areas, and Material Disposal Area P in particular

(LANL 1999b). Septic system discharges, NPDES outfall discharges from the high explosives machine shop Building 260, wastes from a silver recovery shop, and the wastes from treatment plant are previously discharged directly into the canyon corridor above the stream segment studied. There is also mesa top and building contamination that may eventually reach the canyon through erosive processes. The most probable contaminants of the upper canyon, above the stream segment studied, are heavy metals such as lead, mercury, silver, and barium, explosives, and possibly PCBs (LANL 1999b), although Cross (1997) identified many more heavy metals as potential contaminants. These, along with uranium, and other heavy metals would likely be found in the remainder of the canyon soils and sediments downstream of the stream segment studied (LANL 1999b).

Before 1996, NPDES discharges associated with Valle Canyon included eight outfalls, but some of these have been removed or consolidated and now 5 discharges occur to Water Canyon or its tributaries (Haarmann 1995; USDOE 1996; USDOE 2001). Activities associated with explosives manufacture and testing, NPDES discharges, as well as runoff from the material disposal areas could have contributed contaminants to the segment studied (LANL 1998c). The USDOE (1999) reported the total volume of wastewater discharged to Valle Canyon was 63,784 m^3 per year.

Site Selection, Location, and Description of the Stream Segments Studied

Sites within four canyon drainages that were studied were not randomly selected, but instead, were identified by the Selection Committee and mutually agreed upon by all parties (Figure 5). These sites are classified as "segments of streams within canyon drainages" and further divided into "stream reaches" using the hierarchical stream system proposed by Frissell *et al.* (1986). These stream segments were selected for study by the Selection Committee based on preliminary information provided by the LANL, the Oversight Bureau, as well as other factors (presence of NPDES discharges, logistics, national security, safety, *etc.*). The stream segments in the four canyons identified by the Selection Committee to be included in the LANL Water Quality Assessment are:

- in Los Alamos Canyon (both above and below the Los Alamos Reservoir),
- in Sandia Canyon,
- in Pajarito Canyon, and
- in Valle Canyon (a tributary drainage to Water Canyon).

In each stream selected, a representative, 300-m stream segment was chosen based on similarity in habitat appearance to the general habitat features observed within approximately 600 m of the upstream boundary of perennial water flow identified by others. All LANL Water Quality Assessment activities took place in connection with this 300-m segment, including water, sediment, and biological sample collection, monitoring, observations, habitat analyses, and toxicity testing.

A large pool in each stream segment was selected for installation of a water quality monitoring device in 1996. The same pool was used for a preliminary, caged-fish study, and later in 1997, this pool also became the upstream location of the first of nine selected for the *in situ*, caged-fish bioassays. Two 100-m reaches were evaluated at the distal ends of the 300-m stream segment. The beginning of these 100-m reaches was selected at random upstream of the third set of *in situ* cages, and downstream of the seventh set of *in situ* cages (Figures 8, 9, 10, and 11). These 100-m reaches were divided into 10 transects for detailed habitat measurements (*e.g.*, flow, substrate characteristics).

Each cage, monitoring location, and habitat transect evaluation for each stream segment was documented using a global positioning system (GPS; Precision Lightweight Global Position System Receiver [PLGR Model HNV-560c, Rockwell International, Cedar Rapids, Iowa]), and this location is provided in Table 4. However, the GPS locations for the habitat evaluation transects in the lower portion of the Pajarito Canyon stream segment were unavailable at the time of study. The general location of the stream segments selected for study included:

- *Site 1: Los Alamos Canyon* (*reference site*) (Figure 8). This stream segment is located approximately 330 m upstream of Los Alamos Reservoir, on the Santa Fe National Forest, in Section 12, Township 19 North, Range 5 East of the New Mexico Principal Meridian. This Los Alamos Canyon stream segment was chosen as the reference site because it was considered relatively free of LANL contamination and wastewater discharges; it was in proximity to the other study sites; it was perennial; and has an existing trout fishery.

- *Site 2: Los Alamos Canyon, below the reservoir* (Figure 5). This stream segment is located about 330 m below the Los Alamos Reservoir in Section 18, Township 19 North, Range 6 East of the New Mexico Principal Meridian. During 1997, surface water flows were found to infiltrate the alluvial canyon bottom immediately below the dam's spillway, and then re-emerge approximately 60 m downstream and continue to State Road 501. The stream channel in this area is intermittent, as diversion of surface water from the Los Alamos Reservoir is used for irrigation in the town of Los Alamos. Only one stream reach in this segment was selected for habitat evaluation. To differentiate between the stream segment above the reservoir, this site was indicated as "Los Alamos Canyon, below the reservoir," in this report.

- *Site 3: Sandia Canyon* (Figure 9). This stream segment is located approximately 700 m downstream of the waste water Outfall 01A-001, on USDOE land, in Section 16, Township 19 North, Range 6 East of the New Mexico Principal Meridian. This stream segment receives several waste water discharges as well as runoff from the extensive paved areas in the upper watershed at TA-3, which comprise the majority of its flow. There is also a 2 hectare (ha) wetland that has formed near the top of the drainage, above the stream segment evaluated in this study.

- *Site 4: Pajarito Canyon* (Figure 10). This stream segment is on USDOE land, in Section 20, Township 19 North, Range 6 East of the New Mexico Principal Meridian. This stream segment is located approximately 300 m downstream of several springs (Charlie's Spring, Homestead Spring, and Starmer's Spring) that supply baseflow to the stream (Dale 1998).

- *Site 5: Valle Canyon* (Figure 11). This stream segment is on USDOE land, in Section 29, Township 19 North, Range 6 East of the New Mexico Principal Meridian. This stream segment is located approximately 800 m downstream of several springs (S.W.S.C. Spring, and Burning Ground Spring) that supply baseflow to the stream (Dale 1998), although recharge from the area's unique geology (faults, permeable ash layers) has been suggested (R. Ryti, Neptune Inc., pers. comm.).

MATERIALS AND METHODS

BIOLOGICAL DATA COLLECTION AND ANALYSES

Fish Surveys

The presence of fish in the study streams was determined by surveying a length of approximately one-third of the perennial stream segment using backpack electrofishing equipment (Model 12 POW Electrofisher, Smith-Root, Inc., equipped with a 24 volt battery). Electrofishing procedures applied at the sites generally followed those for wadable streams reported by Meador *et al.* (1993), with exceptions as noted below. Representative reaches were sampled in a single pass, working upstream in Los Alamos Canyon, and downstream in the other canyons surveyed.

The current density (from the backpack electrofishing equipment) was about 0.1 milliamperes per square cm. Electrofishing equipment was operated with a variable voltage (from 500 to 1,000 millivolts). This adjustment allows the system's applied power to be increased or decreased given fish response and effectiveness of capture (Kolz and Reynolds 1989). During this survey, the waveform varied from 40 to 60 hertz, input amperage ranged from 12 to 18 amps, and output amperage ranged from 0.1 to 2 amps. In canyons where no fish were found within 300 m, increased power was applied to ensure fish response would be observable. When fish were observed and captured, the electrical power applied was stopped to reduce the probability of injury to the fish.

The backpack electrofishing equipment records the time power was applied, or "shocking seconds." Shocking seconds ranged from 550 to 900, except Sandia Canyon, where over 1,500 shocking seconds were applied. To determine fish presence, the stream reach in Sandia Canyon was electrofished on November 20, 1996, in Valle Canyon and Pajarito Canyon on November 22, 1996, and in Los Alamos Canyon on January 3, 1997, October 10, 1997, and December 17, 1998. Presence and total numbers of fish and fish species collected were recorded. In October 1997, in Los Alamos Canyon, captured fish were weighed and measured, examined for general condition, then returned downstream. Capture locations were then marked with flagging stakes for a subsequent, additional habitat assessment. Habitat quality parameters were then measured at locations where the fish were found in order to calibrate the fish habitat models.

Caged-Fish Bioassays

Fish are excellent indicators of water quality since: 1) they remain in contact with their aquatic habitat and avoidance of exposure is difficult, 2) they are highly sensitive to pollution and their responses integrate multiple stressors, and 3) they can serve as a direct measure of the bioavailability of contaminants from the many different environmental compartments in aquatic systems (Cleveland *et al.* 1999). While monitoring chemicals in water and sediment are a valuable means of judging the quality of the canyon stream environments, it is not practical to monitor all stressors that may be relevant to the sustainability of a fishery. Also, routine analytical methods may not be sufficiently sensitive to reliably measure low and potentially significant concentrations of pollutants in the environment (Price 1979). The combination of stressors that are encountered in these canyon streams may be modified by site specific factors or produce effects different from those indicated in fish in a laboratory. To overcome these disadvantages or depend on the use of natural fish populations (or lack of fish populations), caged-fish were placed in the streams in order to evaluate their response to various site specific stressors.

Cage Construction, Placement, Fish Measurement, and Chemical Analyses

Cages were constructed of 2-cm, polyvinyl chloride (PVC) pipe and nylon netting (Memphis Net and Twine Co., Inc., Memphis, Tennessee). The PVC pipes were glued into a rectangular box with dimensions of 61 cm long by 38 cm wide by 38 cm deep. Nylon netting with a 0.30-cm mesh of the same box dimensions, and with a reclosable top, was secured to the piping using plastic fasteners. Numerous 0.3-cm holes were drilled into the piping to reduce buoyancy. Following construction, cages were placed in a tap-water filled pool for three days, then in the streams for several days prior to the initiation of testing, in order to leach any potentially toxic compounds present in the PVC piping or glue.

Nine sets of cages (18 total) were placed along the 300-m stream segment studied for the caged-fish bioassays. One set of nine cages was used to evaluate the *in situ* toxicity of canyon stream water (Toxicity Cages), and the other set was used to evaluate the bioaccumulation of contaminants (Bioaccumulation Cages). Each cage was weighted with a rock from the stream (~20 to 36 cm in diameter), and secured with rope to nearby trees, boulders, or stakes. The rock placed on the cage's bottom not only secured the cage to the stream bottom, but reduced stress to the fish. Cages were marked with USFWS identification tags, then each cage was supplied with 10 fathead minnow (*Pimephales promelas*). Cage sets (consisting of 1 Toxicity Cage and 1 Bioaccumulation Cage) were positioned approximately every 30 m in the 300-m stream segment. While attempts were made to place cages in a variety of habitat types, most cages were placed in pools and glides. Cage locations were documented using GPS. (Table 4, Figures 8, 9, 10, and 11).

Fathead minnows were reared in well-water for approximately seven months at the CERC, prior to shipment to the site and use in the caged-fish bioassays. Fathead minnow were selected because they are native to this region (Sublette *et al.* 1990; Platania 1993), their life-cycle is well-documented, their gender is easily distinguishable, and toxicity test methods for this species have been standardized so they are practical for caged-fish bioassays. To prevent establishment of a fishery from escaped fish, only female fish were used. Lack of male fish would also tend to reduce territorial behavior and stress, as well as reduce gender variation in contaminant body burdens. Two weeks prior to the start of the caged-fish bioassays, the fish were acclimated to a pH of 8.0 and a hardness of 100 mg/L at the Columbia Facility to simulate the water chemistry of streams at the LANL. The day before tests were to start, fish were shipped overnight to the USFWS in water-filled, plastic bags with an oxygen head space in styrofoam and cardboard coolers. Fish were then randomly separated into water and oxygen filled plastic bags in groups of 20 to 40 for ease of transport and release into the in-stream cages. Prior to release, fish were acclimated to ambient water temperatures by placing the bags in the stream and individual fish were weighed and measured. Total fish length and weight was measured in a plastic tray, on a portable electronic scale (Ohaus® Model LS-2000 Standard).

To determine the potential performance of a caged-fish study in these canyon streams, a pilot caged-fish bioassay (pilot study) was initiated on June 17, 1997, using 2 cages per stream at the beginning of the 300-m stream segment of study. Five female fish were placed in each cage, and another five fish were measured, sacrificed and composited at the start of this bioassay to establish baseline whole body concentrations of contaminants. On July 25, 1997, and July 28, 1997, these pilot study fish were removed, measured, sacrificed, composited, placed in glass jars, and frozen for PCB congener analysis.

On July 29, 1997, 90 fish were measured and sacrificed at the start of the full-scale, caged-fish bioassays to establish baseline tissue concentrations of elemental contaminants. Twenty fish were then weighed and measured and 10 each were placed in the Toxicity and the Bioaccumulation cages. Each stream then, would contain 9 sets of cages with 10 fish in each cage, for a total of 90 fish. Toxicity cages were checked for fish mortality daily for the first 96-hours of exposure, then weekly or biweekly for the remaining ~2 months. Bioaccumulation cages were checked periodically, and fish were removed for length and weight measurement and chemical residue analysis after 1 month (on August 25, 1997) and again after 2 months exposure (on September 29, 1997, from Valle Canyon, on September 30, 1997, from Los Alamos and Sandia Canyons, and on October 1, 1997, from Pajarito Canyon). At the end of the study, all remaining fish and cages were removed.

Scans of 17 elements and PCBs were performed on pre-exposure fish and on the samples of fish collected from the pilot and caged-fish studies. A list of the chemicals and elements analyzed, the symbols used in this report, the analytical methods used, and the sample types collected by the USFWS are provided in Table 5, and are also detailed in Attachment A (Chapman and Allert 1998). Generally, fish and invertebrate tissues were analyzed by the Midwest Research Institute (MRI), Kansas City, Missouri. The MRI determined the concentrations of 15 elements by the 40 CFR 136 method of inductively coupled plasma atomic emission spectrometry (ICP/AES); mercury was determined by cold vapor atomic absorption spectrometry; and selenium was determined by hydride-generation atomic spectroscopy. The CERC analyzed fish for PCBs using high performance gel permeation chromatography followed by capillary gas chromatography and electron capture detection.

Benthic Macroinvertebrate Collection, Community Surveys, and Analyses

The benthic invertebrate community of a stream may contain a variety of biota, including bacteria, protists, rotifers, bryozoans, worms, crustaceans, aquatic insect larvae, clams, crayfish, and other forms of invertebrates. Aquatic invertebrates are found in or on a multitude of microhabitats including plants, woody debris, rocks, interstitial spaces of hard substrates, and sand and muck. Invertebrate habitats exist in all vertical strata including the water column, the bottom surface, and deep below a stream bed in the hyporheic zone (Hynes 1970; The Federal Interagency Stream Restoration Working Group 1998). However, because the larger invertebrates can contribute significantly to a stream's total invertebrate biomass, as well as standard methods of their study are available, the benthic macroinvertebrate community was the focus of this study. Benthic invertebrates are also important as prey for fish, and can directly and indirectly influence the overall suitability and sustainability of a fishery. Furthermore, the health of a benthic macroinvertebrate community can be an indicator of physical or chemical stressors present in the stream that are not discernable from short-term toxicity testing or chemical analyses. For instance, organic wastes tend to decrease the species diversity, while increasing the total numbers of remaining taxa, whereas toxic substances tend to reduce both numbers and kinds of organisms (USEPA 1983).

Caddisfly (Order Trichoptera) larvae are known for the portable cases they construct using their silk to fasten together rock fragments into a tubular shape (Merritt and Cummins1996). Caddisflies were easily observable in the stream segments studied, and one family (Limnephilidae) was collected by hand for chemical analyses. On August 11 through August 13, 1997, samples of over 50 individual *Hesperophylax sp.* were hand-collected from each stream, kept on ice, and later processed. Processing consisted of removing the cases from half of the samples collected for each stream segment and rinsing the bare larvae free of debris with deionized water, prior to freezing in plastic bags. The other caddisfly larvae were similarly rinsed and frozen with cases left on. This was done to observe the differences in caddisfly larvae as they could be eaten, whole, by fish or birds and in caddisfly larvae without the geologic influence of their cases in order to compare contaminant concentrations.

Benthic macroinvertebrate community surveys were conducted by the NMED's Oversight Bureau (Ford-Schmid 1996, 1999). Methods of the surveys were reported by Ford-Schmid (1996), and included three replicate, modified Hess circular samples collected from rubble substrate. Samples were sorted, and invertebrates were keyed to the lowest taxonomic level using appropriate keys. Surveys of the invertebrate communities were conducted in the same four canyons examined during the LANL Water Quality Assessment, although at different times, and these sites were in or directly adjacent to the100-m habitat evaluation reaches studied. The sites and dates reported by Ford-Schmid (1996, 1999) associated with the LANL Water Quality Assessment stream segments are:

- Site LA 13.0, February 25, 1997, in the Los Alamos Canyon segment studied.
- Site SA 7.64, March 20, 1996, in the Sandia Canyon segment studied.
- Site PA 9.0, July 22, 1994, in the Pajarito Canyon segment studied.
- Site VA 2.6, May 12, 1997, in the Valle Canyon segment studied.

Taxonomic data were then entered into computer programs that calculated various metrics, which encompass a range of invertebrate sensitivity indices and ratios with reference site conditions (here, Site LA 13.0 in Los Alamos Canyon) including: standing crop density, taxa richness, dominant taxon, the dominant species tolerant quotients, and other community metrics. Calculation of community metrics, definitions, scoring, and interpretation were made according to Garn and Jacobi (1996). Invertebrate taxa are listed in Appendix III and compared with a list of invertebrate taxa of Pajarito Plateau reported by Cross (1997), and identified as to temperature preference, if available, using Idaho DEQ (1996).

Fish and Invertebrate Tissue Quality Evaluation Methods

Identification of contaminants of concern in whole body fish and invertebrates collected for the LANL Water Quality Assessment was accomplished on a stream segment basis. The evaluation methods included a comparison of the concentrations of chemicals in tissues on biota from Sandia, Valle, and Pajarito Canyons to the reference site biota as well as to various concentrations (Tissue Quality Criteria) reported in the literature that affect wildlife or livestock (NRC 1980; Sample *et al.* 1996; USDOI 1998). For invertebrates, the mean concentration of each stream segment was also compared to concentrations reported in invertebrates collected from other parts of New Mexico (Lynch *et al.* 1988; Failing 1993; Simpson and Lusk 1999). For whole body fish, mean concentrations reported in the caged fathead minnow were also compared to concentrations in fish collected nationwide (Schmitt *et al.* 1999), to threshold concentrations in fish consumed by people (USEPA 1997a), and in fish (fillets) collected regionally (Fresquez *et al.* 1999). Emphasis was placed on the bioaccumulation of contaminants that are known to pose serious health risks to wildlife or people in the caged fathead minnow or caddisflies.

CHEMICAL DATA COLLECTION AND ANALYSES

Water Column Monitoring

Two types of water column chemistry data were collected: 1) continuous, hourly, *in situ* measurements of temperature, dissolved oxygen (DO), conductivity, and hydrogen ion activity (pH) were collected at one location (in a pool) in Los Alamos, Sandia, Pajarito and Valle Canyons, using a Hydrolab® water quality monitoring device (Datasonde); and 2) measurements of temperature, DO, conductivity, pH, and other water quality parameters were collected concurrent with other sampling events (*e.g.*, toxicity tests, habitat assessments).

On December 13, 1996, the USFWS deployed a calibrated Hydrolab® Datasonde water quality monitoring device at the beginning of each stream segment. Each Hydrolab® Datasonde was secured in a pool within protective and vented plastic pipes. The Hydrolab® Datasonde probes measure these parameters using sensors designed to meet the criteria and specifications in section 2550 (temperature), section 2520-B (specific conductance), section 4500-O (dissolved oxygen), and section 4500-H+ (pH) in Standard Methods for the Examination of Water and Wastewater, 19th Edition (American Public Health Association and others 1995). The pH, DO, and conductivity probes were calibrated and maintained according to the manufacturer's instructions (Hydrolab Corporation 1986, 1988). Ten monitoring devices were used and exchanged at each site at approximately two week intervals. Readings were taken after a 5-minute equilibration (warmup) period, and the raw and post-calibrated data were transferred to spreadsheets for tabulation, display, and summary statistics. Datasonde monitoring ceased in Pajarito Canyon on September 25, 1997, and in Sandia, Valle, and Los Alamos Canyons on November 17, 1997.

Existing Water and Sediment Data

According to the Settlement Agreement, the USDOE, the LANL, and the NMED agreed to accept only water quality data generated using USEPA methods for this study where applicable. On July 10, 1998, the LANL provided sediment and water quality data to the NMED for review. On July 23, 1998, the NMED forwarded the LANL sediment and water quality data to the USFWS for consideration in the LANL Water Quality Assessment. The LANL provided chemical and flow monitoring data measured for various outfalls under the NPDES permit between 1994 and 1997 for the four canyons to the NMED for review and consideration prior to submission to the USFWS. Discharges were categorized according to watershed, any exceeedences of permit limits were noted, and data were then compared to water quality standards for wildlife habitat, coldwater fishery, and other use designations (NMWQCC 1995). The LANL provided hundreds of chemical measurements of sediment in the Los Alamos, Sandia, Pajarito, and Water watersheds.

Surface Water Collection and Analyses

In the summer of 1996, the CERC collected surface water for toxicity testing and chemical analyses. The CERC's methods are described in detail by Chapman and Allert (1998; Attachment A), and therefore, will only be summarized here. Individual surface water samples were prepared by compositing 120 milliliters (mL) samples collected every 20 minutes over a 24-hr period using an automated sampler. Samples were collected on August 13, August 14, August 16, and August 20, 1996. The pH, conductivity, DO, total ammonia as nitrogen, alkalinity, hardness, and turbidity, and other water chemistry (*e.g.*, nitrate as nitrogen, sulfate, phosphorus, and chloride) of these water samples were also measured, compared graphically, and descriptive statistics were calculated and presented. The *in situ* measurements of pH, conductivity, DO, and temperature of the stream water were measured and recorded daily, compared graphically, and descriptive statistics were calculated and presented. Additionally, filtered surface water samples were analyzed for a suite of 62 elements by semi-quantitative inductively coupled plasma-mass spectrometry (ICP-MS). However, ICP-MS is not an approved method under 40 CFR 136, and therefore while these data, while presented in Attachment A, were not included in the evaluation.

In 1997, the USFWS collected grab water samples from two locations in each 300-m stream segment; near the Hydrolab® Datasonde, at the upper end of the stream reach, and at the downstream end. Water was collected with a gloved hand using an acid-cleaned, low density polyethylene cubitainer from the center of stream flow at each sampling location. Water samples for analyses were collected from downstream to upstream at each location five times (July 28, July 31, August 11-13, August 25, and September 29 - October 1, 1997). Water samples were also simultaneously collected three times on July 28, August 11-12, and September 29 - October 1 for explosives analyses using 1-L amber glass bottles. In all cases, care was taken to avoid disturbing bottom sediments.

Within 4 hours of collection, approximately half of each water sample for some of the elemental and nutrient analyses was filtered through a disposable, 0.45-μm, in-line filter (Geotech High Capacity Groundwater Filtering Capsules, Model GD 045700, Geotech Environmental Equipment, Inc., Denver, CO). Sub-samples were preserved and analyzed as described in Table 6. Samples for the analysis of explosives were not filtered. Filtered samples were preserved and all were shipped under chain-of-custody to the CERC for determination of elements and explosives. The remaining unfiltered and filtered samples were retained in a USFWS laboratory at 4 °C pending nutrient analyses and other water quality parameters (Table 6). Sample collection procedures and laboratory analyses of all constituents regulated by the State of New Mexico (Title 20 New Mexico Annotated Code [NMAC] Part 6.1) were conducted in accordance with USEPA-approved methods for the 1997 water samples.

Chloride (Method 8207), nitrate-nitrogen (Method 8171), ammonia-nitrogen (Method 8038), orthophosphate (Method 8048), total phosphorus (Method 8190) and sulfate (Method 8051) were analyzed at a USFWS laboratory using colorimetric analyses (Hach® Model DR/2010 Spectrophotometer) and digital titration (Hach Company 1997a, 1997b). The pH and temperature of water was measured using a Hach® One Combination pH Electrode (Model 48600), and Hach® One Meter (Model 43800). Alkalinity was measured by titration with H_2SO_4 to a pH 5.0 endpoint (Method 8203); hardness, as calcium carbonate, was measured by EDTA titration (Method 8213); turbidity was determined using a portable Turbidimeter (Model 2100P) by nephelometry (Method 8195; Hach Company 1997c); and total suspended solids (TSS) were determined by photometry (Method 8006).

Surface Water Toxicity Testing

The surface water toxicity testing methods are described in detail by Chapman and Allert (1998; Attachment A), and are only summarized here. Toxicity tests on surface water were performed in the CERC's mobile laboratory using the crustacean, *Ceriodaphnia dubia*, as well as larval, fathead minnow. Because of the logistical difficulties in sample collection and testing methods associated with these mountainous sites, the start of the toxicity test did not occur on the same day the water was collected. Therefore, each day's water sample 24-hour composite was held overnight (after water chemistry measurements) before use in toxicity testing on the following day.

The *C. dubia* were reared at the CERC for more than three months prior to the tests. Culture techniques were those described by the USEPA (1994a). The *C. dubia* toxicity test was conducted according to USEPA (1994a), using daily static renewals. The *C. dubia* were shipped overnight to the LANL a month prior to the test and were maintained at the LANL until the test. Fathead minnows were hatched at the CERC, and larvae were shipped overnight to the LANL one day prior to the tests. Fathead minnow larvae were reared in well-water (280 mg/L hardness, pH ~7.8) and then gradually acclimated to soft water prior to their arrival at the LANL for testing.

Toxicity tests were performed in 100 percent site water, and a dilution series of 50, 25, and 12.5 percent of the composited surface water mixed with a soft water diluent prepared according to American Society for Testing and Materials methods (ASTM 1989). The soft water diluent was similar to the basic water chemistry (*e.g.* pH, alkalinity, hardness) typical of the soft waters found on the LANL. A 100 percent diluent control treatment was performed with each test. A positive control dilution series (*i.e.*, the reference toxicant) consisting of three concentrations of sodium chloride was also tested concurrently with each toxicity test. Lastly, a procedural control using well-water was also performed concurrent with each test. One neonate *C. dubia*, less than 12 hours old, was exposed to 20 mL of the composite water sample or the appropriate dilution in 30-mL glass beaker for seven days with 10 replicates of each dilution or control. Endpoints, recorded daily, were lethality (absence of movement) and reproduction (number of neonates produced). Temperature in the test beakers was maintained at 20 ± 1°C by means of a temperature controlled water bath.

A mortality event in the surface water toxicity test of the undiluted sample from Valle Canyon with *C. dubia* occurred on day three, that affected the survivorship and reproductive success. A second toxicity test was started on August 15, 1996, to see if the mortality event would reoccur. This additional test was similar in methods to those described, except no dilutions of the site waters were tested, and test duration was only 120 hours.

The larval fathead minnow tests were 96-hour static renewals conducted according to USEPA (1993) and ASTM (1989) protocols for acute toxicity testing. The test was started on August 14, 1996, and fish were less than 72 hours post-hatch at the start of the test. Test containers were 1 liter (L) beakers containing 0.75 L of composite sample or appropriate dilution, with 10 fish per container. Four replicates of the 100 percent concentration of each canyon stream segment and two replicates of each dilution concentration were tested. Fish were fed brine shrimp (*Artemia* sp.) nauplii (≤ 24 hours old) twice daily. The endpoints, recorded daily during water renewal, were lethality (*i.e.*, the animal does not move with gentle prodding) and moribundity (*i.e.*, the animal does not retain equilibrium or does not swim normally until prodded). Water quality (*e.g.*, temperature, DO, pH, conductivity) were measured daily in fathead minnow test chambers and adequate oxygen levels were maintained in test chambers by continuous, gentle aeration. Temperature in the chambers was maintained at $20 \pm 1\,^{\circ}C$ by controlling ambient temperature in the mobile lab.

Water Quality Evaluation Methods

Identification of contaminants of concern in surface waters collected for the LANL Water Quality Assessment was accomplished on a stream segment basis (*i.e.*, the two collection sites on the stream were averaged). The process began with examination of the existing water quality data for compatibility with approved collection, storage, and analytical methods. The major evaluation method included a comparison of the concentrations of chemicals in the water column to the various water quality criteria for the beneficial uses of surface waters in New Mexico existing at the time of the LANL Water Quality Assessment (NMWQCC 1995). A database evaluation system was developed for the LANL Water Quality Assessment by Deitner and Caldwell (2000) to aid in the comparison of water quality measurements against one or more water quality standards or criteria. Water quality standards and criteria from the NMWQCC (1995) as well as the USEPA (1998a) were used. The database system has the capability of computing the functional relationships of hardness and other factors as they affect the water quality criteria. When the contamination of field blanks or laboratory blanks was indicated and it was above or approached the water quality criterion, then the exceedance of that water quality criterion was either discounted by the amount found in the field blank or was discarded. The USFWS went beyond this regulatory approach by utilizing toxicity testing to evaluate the presence of a biological response that may have not been identified during the screen of the water quality data. Additional emphasis was placed on the caged-fish bioassays, bioaccumulation in organisms, and health of the macroinvertebrate community as a measure of water quality.

Sediment and Porewater Collection and Analyses

In 1996 and 1997, the CERC collected sediment and porewater (*i.e.*, the interstitial water found between sediment particles) for chemical analyses and an evaluation of toxicity. Detailed methods and location of collection sites are reported by Chapman and Allert

(1998; Attachment A). At least 3 L of porewater was collected from each site, except Los Alamos Canyon, below the reservoir. Sediments were too coarse to extract porewater at this site.

In 1996, the CERC collected sediment by compositing grab samples that were analyzed for a suite of 62 elements, and other chemical and physical parameters (*e.g.*, total organic carbon content, texture, and acid volatile sulfides). Sediment porewater was sampled by the CERC using a method based on Winger and Lasier (1995). Fused-glass aquarium air stones attached to Teflon® tubes were inserted into depositional areas of the stream bed. Negative pressure was applied by means of a syringe, and porewater was drawn from the sediment using the glass air stone as a filter. Porewater was extracted from depositional areas along the length of the 300-m stream segment studied by the USFWS. Porewater was then injected into an acid-washed, polyethylene sample bottle. The sample was then kept on ice or refrigerated until use. Several extractors were used at each site in order to obtain a sufficient total volume of porewater. Air stones were removed and relocated to a new depositional area within the same site after drawing approximately 100 mL of porewater to avoid drawing overlying water through the sediment into the sample. The 100-mL subsamples of porewater from each site were filtered (0.45 μm) and acidified with 1 percent, ultrapure nitric acid and for element analysis. The remainder of the sample was shipped for toxicity testing.

In 1997, sediment was collected by the CERC from depositional areas along the same stream segment sampled in 1996. A specially designed plastic (polyvinyl chloride) scoop was used to collect sediment while introducing a minimum of surface water into the sample. The sediment was placed in a polyethylene bucket and homogenized, and then immediately used for on-site, porewater extraction. Porewater was extracted by means of pressure filtration, using an apparatus similar to that described in Carr and Chapman (1995), but modified for portability. Pressure was provided by a manual pump. During porewater extraction, the CERC also collected sediment samples for elemental analysis as well as for acid volatile sulfides and simultaneously extractable metals. A third sample was saved for grain size analysis and total organic carbon analysis.

In 1997, sediments were also collected by the USFWS, on two dates from Los Alamos, Sandia, Valle, and Pajarito Canyons, as two composite samples per stream segment. Two composite samples were collected during July 30-31, 1997, and during September 29 - October 1, 1997. One composite sediment sample was prepared from sediments collected at three upstream locations, approximately 30 m apart, starting at the beginning of the 300-m stream segment. The second composite sample was from sediments collected at three downstream locations, approximately 30 m apart, starting at the opposite, lower end of the 300-m stream segment. Samples were collected from the top ~10 cm in depositional areas using an acid-cleaned, high density polyethylene scoop. Aside from removal of large organic matter from the samples (*e.g.*, sticks, leaves), sediments were not processed further. Scoops of sediment were evenly distributed between sample containers until each container was full. Sediments were analyzed for texture, total organic carbon, elemental, PCBs, and explosives. Containers, preservation, and analyses are presented in Tables 5 and 6.

Grain size for all sediment samples collected and analyzed for texture in 1996 and 1997 were determined by the Bouyoucous Hydrometer Method. Total organic carbon of sediment was determined in 1997 using a Coulometrics® Carbon Analyzer, Model 5020. Porewater and sediment collected in 1996, and sediment collected in 1997, were analyzed by the CERC for 62 elements using a semiquantitative ICP-MS. Mercury and selenium in sediment were analyzed by the CERC by hydride-generation atomic absorption spectroscopy. Sediment and porewater samples collected in 1997, by the USFWS, and also by the CERC, were analyzed by the MRI. The MRI analyzed 15 elements by ICP/AES, mercury by cold vapor atomic absorption spectrometry, and selenium by hydride-generation atomic spectroscopy. In 1997, sediment samples were also analyzed for PCBs and explosives. Further explanation of the methods of analysis, quality assurance and quality control, and the list of explosives and PCB congeners analyzed were reported by Chapman and Allert (1998; Attachment A).

Porewater Toxicity Testing

Porewater toxicity tests were performed with *C. dubia*. Methods used were equivalent to those used to test surface water, except that porewater was collected as a single pooled sample from each site as opposed to daily collections of surface water. The pooled sample was shipped to the CERC for toxicity testing, and was centrifuged to remove fine particles not removed by filtration. Maximum holding time between collection of porewater from the LANL, and the start of toxicity tests was 4 days in 1996, and 10 days in 1997. In 1997, the sample from Site 1 (Los Alamos Canyon) was inadvertently contaminated prior to the test. This sample was then collected again and retested four weeks later, using a separate but equivalent set of procedural controls as reported by Chapman and Allert (1998).

Sediment Quality Evaluation Methods

Sediment quality evaluation techniques have been well developed for dredging-related projects (*e.g.*, USEPA/USACE 1998). Although the majority of evaluation protocols are designed for assessing dredged materials for ocean dumping, the procedures have broader application and were applied to the LANL Water Quality Assessment of sediment quality. Identification of contaminants of concern in sediment collected from the LANL was accomplished on a stream segment basis (*i.e.*, several collection sites on the stream were averaged). The mean concentration of contaminants in the sediments were compared to background concentrations for canyon sediments on the LANL reported by Ryti *et al.* (1998), the LANL's Screening Action Levels (SALs; LANL 1998a), and to the mean sediment concentrations found in the reference site (Los Alamos Canyon). Also, Sediment Concentrations of Concern were developed using toxic thresholds reported in the literature (*e.g.*, Anonymous 1977; Long and Morgan 1991; Persaud *et al.* 1993; Ingersoll *et al.* 1996) and averaging them to produce a consensus-based toxicological threshold as described by MacDonald *et al.* (2000a). Thus, the Sediment Concentrations of Concern is a conservative threshold where biological effects would be possible, but below which adverse population effects would not be expected (Table 7). Similarly, Sediment Quality Criteria were developed using concentrations where toxicity was considered probable as reported in the literature (Long and Morgan 1991; Persaud *et al.* 1993; Ingersoll *et al.* 1996) and averaging them to produce a consensus-based toxicological threshold as described by MacDonald *et al.* (2000a). Sediment Quality Criteria (SQC) would be the concentration at which biological effects would be likely (Table 8). Any exceedance indicated a contaminant of potential toxicological concern. Finally, a weight-of-evidence approach was used to determine which contaminants were elevated in LANL sediments, by identifying those mean contaminant concentrations that exceeded at least 2 out of the 4 background comparisons (*i.e.*, to Ryti *et al.* [1998], the LANL SALs, the reference site concentrations, or the SQC). Ratios of the mean sediment concentrations of contaminants in the canyons had to be at least 10 times the background concentrations reported by Ryti *et al.* (1998) and the mean reference sediment concentrations to be considered elevated. Also, porewater toxicity tests were evaluated for the presence of a biological response that may have not been identified during this screen of sediment contaminant concentrations.

Quality Assurance and Analytical Quality Control

Sample containers for the collection of water, sediment, invertebrates, and fish, were purchased and came with a quality assurance certificate (with the exception of the plastic bags used for invertebrates). A list of sample types collected by the USFWS, the containers used, the analyses performed, and the reporting limits are presented in Table 5 and Table 6. Abiotic samples (water, sediment, and porewater) collected by the CERC were similarly quality assured and are documented by Chapman and Allert (1998; Attachment A).

The USFWS has contracts with several laboratories to provide routine chemical analyses for contaminants in animal tissues and environmental samples (USFWS 1997). These laboratories that conducted the chemical analyses of water, porewater, sediment, and biological tissues for the LANL Water Quality Assessment were responsible for establishing the precision and accuracy of their analytical procedures. Quality control procedures included the analysis of blank, replicate, split, and spiked samples as well as analyses of standard reference materials. Data from such procedures were evaluated and documented by the laboratory chemists, the CERC, and the Patuxent Analytical Control Facility prior to submittal to the USFWS and are provided in Attachment A. Quality assurance procedures included, standard operating procedures, method standardization, proper collection, preservation, and storage of samples, using appropriate methods and equipment, and collection of additional field blanks and duplicate samples, as noted in the data tables and Attachment A. While there are a few specific concerns regarding the quality of some water samples and analytes, the overall data quality was certified as acceptable by the MRI Laboratory Director. Concentrations of the contaminants in surface waters were not considered to exceed a water quality criterion or standard if the corresponding field or laboratory blank had unacceptable concentrations of these same contaminants.

Data Treatment and Statistics

Some environmental data were received in an electronic format. Other data were initially recorded by hand on printed data forms or notebooks in the field, then transferred to electronic format as spreadsheets. Printed data sheets and electronic spreadsheets were then compared to verify accuracy of transfer. Some of the environmental contaminant data were reported in either dry weight (DW) or wet weight (WW) concentrations and were so indicated. To convert dry weight concentrations into wet weight concentrations, the following equation was used:

$$WW = (DW) * [1 - (\text{sample moisture (percent)}/100)] \qquad \text{Equation (1)}$$

For statistical purposes and simplicity, all results that were below the analytical laboratory's instrument detection limit, were replaced with a value one-half the instrument's detection limit prior to further statistical treatment as per USEPA (1998b). Some data were natural log transformed to normalize the data distribution prior to parametric statistical tests (Bailey 1981) such as the one-way analysis of variance or students' t-test. Nonparametric statistical tests were also employed and are so indicated in the text. Several descriptive statistics and analyses (*e.g.*, regression, principal component analyses) were conducted on concentrations of selected contaminants in biota. Unless otherwise specified, statistical significance refers to the level of $p < 0.05$. The software program STATISTICA (StatSoft Inc. 1994) was used for statistical summaries and testing of data.

PHYSICAL DATA COLLECTION AND HABITAT EVALUATIONS

Stream Channel Measurements

Cover and habitat types (*e.g.*, pool, riffle, glide) were determined by the same biologist to avoid biases in estimation (Roper and Scarnecchia 1995). Other habitat measurements (*e.g.*, depth, width, rate of flow, bank stability, landscape characterizations) were determined under close supervision of the primary fishery biologist. Several measured parameters were reach-based measurements, in that they were measured once over the entire stream reach evaluated. Examples of "reach-based" parameters included gradient, meander length, and percent pools (see below). Most parameters, however, were measured at each transect, and in some cases at several intervals across a transect (*e.g.*, flow and depth). Photographs were taken of the streams and measurement activities and are available for review.

Stream Reach Selection and Transect Setup

Two 100-m reaches were evaluated at the distal ends of the 300-m stream segment selected in each canyon. The beginning was determined by pacing at random (using two serial numbers from United States currency) the number of steps upstream of the third set of *in situ* cages, or downstream of the seventh set of *in situ* cages (Figures 8, 9, 10, and 11). To determine appropriate transect placement, a flexible tape was extended along the stream center-point for 100-m. The length of each major stream habitat type (riffle, glide, or pool) was then identified using the methods of Meehan (1991; Table 9), measured and summed. Percentages of riffles, glides, and pools, and pool class (an index of pool quality, based on pool habitat class described Hickman and Raleigh [1982] and Hamilton and Bergersen [1984]; in Table 10), which included measurements of maximum pool depth and percent combined in-stream and bank cover were determined, then calculated by dividing the total length of each habitat type by the total reach length (100-m). These 100-m reaches were divided into 10 transects for detailed habitat measurements (*e.g.*, flow, substrate characteristics, *etc.*). Transects were preliminarily located at 10-m intervals, but the final transect locations were determined by adjusting them slightly up or downstream to include representative percentages of each major habitat type in the stream reach (*i.e.*, if 70 percent of stream was riffle habitat, then 7 out of 10 transects were adjusted to include riffles). The transect level line was stretched perpendicular to stream flow, extending across the stream to the bank-full width (defined below). Transect measurements were then taken independently- one set for bank-full dimensions and another for wetted width dimensions. Habitat transects on each stream reach were located using GPS (Table 4).

Bank-full Width

The term bank-full in stream systems is associated with the flow that just fills the channel to the top of its banks and at a point where the water begins to overflow onto a floodplain (Rosgen 1996). Bank-full width typically corresponds to the width where the stream bank gradient levels out or there is evidence of previous flow regimes (*e.g.*, scarification or discoloration of exposed rocks and bank soils, change in bank structure, change in bank vegetation, bank erosion). Bank-full width was relatively well defined in these stream reaches, possibly due to frequent storm events and snowmelt, but the bank-full channel profile was defined according to sustained water levels rather than over-bank flood events.

Flow and Discharge

Stream discharge is the volume of water flowing past a cross section in a channel per unit time (Orth and White 1993). Stream flow was measured using a portable flow meter (Model 2000, Marsh-McBirney, Inc., Maryland) and a top-setting wading rod (Model

1276-E, Scientific Instruments, Inc., Wisconsin). Flow was measured at each transect in 5-10 increments (depending on stream width) at approximately 0.6 depth (Platts *et al.* 1983). Total stream discharge (Q) was then calculated as Q = cross sectional area*flow. Variables measured and calculated are presented in Table 11. Detailed flow measurements for each stream were only collected during the summer in 1997.

Bank Stability

Bank stability is determined primarily by rooted vegetation cover, rock and rubble content, and soil type. Description and classification of bank condition and potential for future erosion (Tables 12 and 13) was determined using Platts *et al.* (1983). Bank stability (erosion potential) and bank vegetation cover were determined by visual estimation. Wetted-channel bank stability was also evaluated based on vegetation cover and indications of erosion. Additional methods of evaluating channel stability were described in the Stream Geomorphology and Habitat Stability Section below.

Cover

Cover and cover types that could provide shelter for an adult-sized fish, were rated using estimates provided by Platts *et al.* (1993; Table 14). Cover included: 1) instream structures such as boulders, rocks, logs, and vegetation; 2) bank cover in the form of overhanging or undercut channel; and, 3) overhead cover consisting of overhanging trees and shrubbery. Cover was estimated visually by considering all cover types falling within a 1-m width on either side of the habitat transect line. Percent in-stream cover was visually estimated as submerged and exposed rocks, aquatic vegetation, and submerged and overhead logs or branches capable of providing shelter for an adult-sized fish. Percent bank cover was visually estimated as overhanging bank structure, including overhead and aquatic vegetation, capable of providing shelter for at least an adult trout or an adult minnow. Percent pool cover was determined the same as cover, but applied to a length of stream containing a pool.

Substrate Characteristics

Substrate is important to fish spawning, escape cover for fry, invertebrate colonization, and overall streambed stability. Therefore, measures of substrate characteristics were incorporated into fish habitat suitability models, invertebrate habitat models, and geomorphological classifications. Under normal circumstances, descriptions of substrate will be similar from year to year for cobbles and boulders, which are less likely to move during high flow regimes. Smaller substrates, however, will move and size distributions may change in response to high flow regimes.

Using a "pebble count" method described by Lane (1947) and Platts *et al.* (1993), substrate size distribution was determined (20 pebbles were measured per transect; 10 in the wetted width and 10 additional in the bankfull width). Measurements were made at the same intervals where depths were determined. A piece of bottom substrate (*i.e.*, a pebble) was randomly selected, examined and categorized. The degree of pebble embeddedness, was determined by visual estimation or, in murky water, by touch. The pebble was then removed, and categorized to size (Table 15) and substrate type (*e.g.*, rock versus organic detritus).

Embeddedness is essentially a measure of the coverage of larger substrate material by fine sediments and was determined using the rating scale developed by Platts *et al.* (1983; Table 16). High embeddedness can lead to reduced invertebrate habitat availability and stability and reduced oxygen concentrations in fish spawning habitat (*i.e.*, redds). Subsequently, substrate data were linked to general habitat type (glide, pool, or riffle) to create new habitat-specific substrate characteristic variables. For instance, the brook trout Habitat Suitability Index model (see below) required calculation of percentages of different substrate sizes, average substrate sizes, and percent of fine silts in riffle habitats.

Detailed Site and Landscape Characterizations

A number of additional observations of the surrounding landscape were determined in the field and when possible, confirmed using topographic maps, electronic databases, or other visual observations. Information recorded included:

- color photographs and locations determined by GPS of stream transects and cages,
- approximate location of tributaries, their confluences, springs, and NPDES outfalls,
- topography, elevation, soil types and local geology,
- instream, upstream, or nearby structures, channel modification (clearing, rip-rapping, widening, deepening, realigning, lining),
- evidence of fire, logging, grazing, or agriculture,
- major habitat types or land use (*e.g.*, wetlands, grassland, forest, developed areas),
- dominant vegetation classified broadly according to major tree species or families, deciduous tree species or families, and understory vegetation,
- adjacent riparian vegetation (visually estimated using a four category classification developed by Platts *et al.* [1983]) of 0-25 percent, 26-50 percent, 51-75 percent, or 76-100 percent),
- recent precipitation (amount, date, and time), air temperature (°C) was observed and when available, confirmed using the LANL's meteorological data,
- number of days and extent of stream flow was determined through observations, data, and reports by the LANL, the USDOE, or the Oversight Bureau.

Habitat Evaluation Methods

Evaluation of general fish and invertebrate habitat suitability was quantitatively assessed at the study sites using the USFWS's Habitat Suitability Index (HSI) models for fish species typically found in the montane streams of New Mexico, and the Rapid Bioassessment Protocol (RBP) developed by the USEPA (Plafkin *et al.* 1989; Barbour *et al.* 1999, in draft form). Physical habitat and suitability relationships were measured and determined from extensive field observations, measurements of physical characteristics, a review of published literature, and consultation with biologists familiar with a particular species. All measurements necessary for calculation of the HSI models were based on the assumptions used to generate the HSI indices.

The physical habitat data were also qualitatively interpreted to address site-specific habitat limitations not quantified by the HSI or RBP models, such as the effects of stressors such as floods or drought have on long-term fish survivability. Important or limiting variables for the reach were weighed more heavily when calculating the final HSI score. This provided a more site-specific assessment of the potential long term fish habitat capability. Because predictions of habitat suitability for a particular species assume that only that particular species is present, habitat selection affected by interspecies competition is not accounted for in the HSI models, and therefore predictions cannot be made regarding the potential species diversity, distribution, or total fish biomass. The HSI models also do not indicate standing crop or production of fish, the effects from short-term perturbations, or account for interactions among different fish species. Finally, it is important to note that this study's analysis is essentially a snapshot in time, like all fluvial habitat studies, and the conclusions only indicated if the habitat was suitable, and if fish use could have existed during the time that this study was conducted.

Habitat Suitability Index Models

Numerous examples of habitat quality evaluations can be found in the literature, but few present a means to quantitatively relate these habitat characteristics to the habitat requirements of a species of fish. Because "best professional judgement" statements correlating physical conditions to habitat suitability for a particular fish species are subjective, the LANL Water Quality Assessment combined qualitative and quantitative approaches to the habitat data interpretations. The quantitative approaches employed were based primarily on the USFWS HSI models for fish (Raleigh 1982; Edwards *et al.* 1983), and the USEPA RBP (Plafkin *et al.* 1989) for habitat suitability for benthic macroinvertebrates. Habitat data were also qualitatively interpreted in light of literature findings to substantiate, and in some cases, address habitat and fish population relationships that were beyond the scope of the quantitative models, such as flood or drought effects on fish survivability over the long term. This approach provided a more site-specific assessment of fishery habitat potential and overall health of the aquatic habitat present at the LANL. Variables included in a HSI model must satisfy the following criteria: 1) the variable is related to the capacity of the habitat to support the species; 2) there is at least a basic understanding of the relationship of the variable to habitat; and, 3) the variable is practical to measure within the constraint of the model application (USFWS 1981).

The HSI models provide quantitative indicators of habitat suitability for individual species and a consistent means of comparing habitat conditions. The numerical HSI value for a particular species is derived from an evaluation of the ability of key habitat components to supply the life requisites of the species evaluated. Habitat characteristics were determined from extensive field observations and measurements, through a review of the published literature, and consultations with biologists familiar with a particular species.

Fish habitat suitability was quantitatively assessed at the study sites using the USFWS HSI models for fish species typically found in smaller streams in this region of New Mexico. Based on preliminary reviews of fish species of the Jemez Mountains that are present in montane streams similar to those on the LANL, two species, the brook trout (*Salvelinus fontinalis*) and the longnose dace (*Rhinichthys cataractae*) were selected for further study using the HSI approach (Raleigh 1982; Edwards *et al.* 1983). Several HSI models were available for other species found elsewhere in New Mexico, but were dismissed if they were not species expected in montane streams or there were key habitat parameters that would preclude them, such as water flow and depth. Such species considered but eliminated were: sucker species, such as the non-native longnose sucker (*Catostomus catostomus*), which prefers much deeper water and with higher flows than would be found on the LANL; and chub species, such as the non-native creek chub (*Semotilus atromaculatus*), which prefer much deeper pools, much wider streams, and warmer water temperatures. Native montane species, such as the Rio Grande chub (*Gila pandora*), would have been desirable to evaluate, but there was no HSI model available. Other fish species were not selected based on their preference for warmer waters, such as species of cyprinids. Although brook trout are not native to New Mexico (they were introduced prior to 1900), they occur in the Jemez Mountains (NMDGF 1998), and are a good representative of trouts that have been studied extensively, and had a developed HSI model (Raleigh 1982).

All measurements necessary for calculation of the HSIs were based on the assumptions used to generate the HSI suitability graphs. Habitat assessment techniques developed by Armour *et al.* (1983); Hamilton and Bergersen (1984); and Meador *et al.* (1993) were relied upon for methods of measurement of variables not included in the HSI models, and to supplement or clarify HSI assumptions. Some parameters were measured using two different techniques as a quality assurance measure. For instance, elevation was determined from USGS topographical maps and cross-checked with field GPS. In a few instances, when exact measurements were not available (*e.g.*, in the brook trout HSI model the average annual base-flow regime) values were estimated based on surrogate variables, historical data, and best professional judgement. The potential effects of measurement bias and natural variability on the overall calculated HSI score was also estimated.

Habitat suitability scores for each HSI parameter were integrated into a comprehensive index for each life-stage using the following equations.

$$Adult = \left[ThalwegDepth * \%InstreamCover * (\%Pools * PoolClass)^{1/2} \right]^{1/3} \quad \text{Equation (2)}$$

$$Juvenile = \frac{\%InstreamCover * \%Pools * PoolClass}{3} \quad \text{Equation (3)}$$

$$Fry = \left[\%Pools(\%SubstratSize * \%RiffleFines)^{1/2} \right]^{1/2} \quad \text{Equation (4)}$$

$$Other = \left[\left[\frac{(Substrate * \%RiffleFines)^{1/2} + \%Veg}{2} \right] * (Temp * DO * pH * BaseFlow * StreamVeg)^{1/5} \right]^{1/2} \quad \text{Equation (5)}$$

$$HSI = (LifeStage * Other)^{1/2} \quad \text{Equation (6)}$$

The final HSI score is calculated by multiplying together each individual life-stage score with the additional index "Other," which is a set of life-requisite parameters common to all life-stages. High HSI scores indicated near optimal habitat conditions for those factors included in the model. Intermediate scores indicated average habitat conditions, and low scores indicated poor or unsuitable habitat. A HSI score of zero does not necessarily mean that the species would not be present, although the probability of that species occupying that habitat would be low.

The presence of a fish species in an evaluated stream is one way to verify the output of the generalized species HSI model. If habitat scores determined for locations where fish are present are relatively high, say above a score of 0.5, this suggests that the model is applicable to this area, and furthermore, other streams in the area with similar scores would be expected to contain similarly suitable fish habitat. Brook trout were identified throughout the reaches examined in upper Los Alamos Canyon (see Results and Discussion below). Therefore, brook trout would be expected in stream habitat with characteristics (*i.e.*, HSI scores) similar to Los Alamos Canyon reference site. Because longnose dace were not present in any of the streams evaluated, no calibration or validation of the HSI model was possible. Therefore, we assumed that longnose dace in this region preferred the same types of habitat of longnose dace from other locations in the United States from which the HSI indices were derived. Parameters assessed for the brook trout and longnose dace models are outlined in Figure 12 and Figure 13, respectively.

Invertebrate Habitat Assessment

The RBP was employed to evaluate the suitability of invertebrate habitat to provide a further assessment of the ecological integrity of the streams studied (Plafkin *et al.* 1989; and Barbour *et al.* 1999, in draft form). The various habitat parameters were weighted to emphasize the most biologically significant parameters. The ratings for individual parameter measurements were totaled and compared to the Los Alamos Canyon stream segment as a reference site. Higher scores indicated increased habitat quality. A score that is fully supporting of aquatic organisms would be>75 percent of the reference. A partially supporting habitat would score >60 percent, and non-supporting habitat would score <58 percent of the reference. The RBP habitat parameters were grouped according to "microscale" habitat, which were those habitat features that have the greatest influence on benthic macroinvertebrate community structure, and "macroscale" habitat, such as channel geomorphology (Table 17). Microscale habitat parameters had a scoring range of 0-20, whereas macroscale parameters scored from 0-15, with the exception of certain tertiary parameters that scored from 0-10. The maximum possible score is 200 and scores were computed for each stream segment studied.

Habitat Quality Index

The Habitat Quality Index (HQI) was developed by Binns (1978), for streams in Wyoming, and because it involves low flow streams, it was considered to be useful in the evaluation of the LANL streams. The primary factors evaluated in this model of fish habitat suitability were low flow regime, variable annual flow regime, and warm summer water temperature. Secondary factors included in the model included water velocity, total cover, stream wetted width, food abundance and diversity, nitrate concentrations, and stream bank stability. Binns (1978) derived a multiple regression expression to relate these parameters to an index of habitat quality. In the Wyoming streams studied, the HQI score was highly correlated to trout biomass. Although the quantitative relationship between the HQI score and fish biomass determined by Binns (1978) would likely be different for Wyoming streams than for New Mexico streams, the HQI scoring process was used to compare the reference stream segment in Los Alamos Canyon (that had a existing population of brook trout) to the other stream segments under study with an unknown fishery potential (*e.g.*, Sandia, Valle, and Pajarito Canyons).

Stream Geomorphology and Habitat Stability

Stream channel geomorphological classification followed the hierarchical system developed by Rosgen (1994, 1996), which is based on the premise that dynamically-stable stream channels have a morphology that provides for the appropriate distribution of flow energy, and thus maintain a morphologically stable stream channel (Figure 14). Habitat characteristics important for dissipating flow energy included channel sinuosity, bed substrate type, and vegetative stability of the stream banks and surrounding riparian zones (Rosgen 1996). This geomorphological assessment was included to evaluate if the habitat conditions measured at the time of this study would remain relatively constant over time, as well as provide baseline information in the event that stream channels are modified in the future.

The Rosgen (1996) geomorphological classification did not assess the quality of the habitat or the ability of the habitat to support a particular species or beneficial use. However, many of the parameters used to determine geomorphologic stability are also used in the HSI models, or are found in literature discussing fish-habitat associations, and provided some insight into watershed scale influences on the stream segments studied. By relating the geomorphological characteristics of the stream segment studied on the LANL to those geomorphological characteristics observed in other stable, unaltered montane streams of the same type, conclusions were drawn regarding the stability of the LANL stream channels.

The Rosgen (1996; Figure 15) classification levels, Level I and Level II, were used to classify stream channel stability. Entrenchment, slope, and sinuosity are considered Level I characteristics, while bankfull depth and bed substrate type are considered Level II characteristics. These Level I and II characteristics helped define the current stability of a stream and help point appropriate management actions to improve a stream's stability, and thus, its habitat stability. Habitat stability was based on a Level II geomorphological survey developed by Rosgen (1996). Additional Level III parameters (Figure 16) were evaluated and used to generate a "Pfankuch Rating." By comparing the Pfankuch Rating to the stream channel classification, a habitat stability score of "GOOD," "FAIR," or "POOR" was determined. A GOOD score suggested that the stream channel is stable compared to other unaltered streams of the same type. Therefore, channel geomorphology, and thus general aquatic habitat characteristics, would likely also remain in equilibrium from year to year. A POOR score suggested the channel has changed over time, perhaps following a severe flood.

Developing A Water Quality Index

Karr and Dudley (1981) defined biological integrity as "the ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitats of a region." This definition and the underlying ecological theory provided the basis for the development of biological criteria in the United States as well as the direct incorporation of biological integrity as a goal into the Clean Water Act. Biological integrity can be represented by indices which integrate the interaction of the environment with specific populations and communities. Subsequently, numerous researchers have demonstrated that the use of an index of biological integrity as an effective tool to assess the cumulative response of the aquatic community to the total environment. These and other multimetric indices have been recommended to strengthen data interpretation and reduce error in judgement based on isolated indices and measures. Therefore, the LANL Water Quality Assessment similarly combined the ecological attributes of each stream (the biological, chemical, and physical characteristics measured) into a Water Quality Index (WQI) for an overall assessment of the condition of each stream as recommended by Karr and Chu (1997).

The biological, chemical, and physical characteristics measured in each stream segment were compared (as a ratio) to those of the reference site and to applicable criteria in order to develop separate metric indices of biological, chemical, and physical quality. Each metric was then given a rating score on an ordinal scale (*i.e.*, 5, 3, 1) to normalize the various metrics on a common scale (Table 18). These indices of biological, chemical, and physical quality scores were then summed on a site-specific basis so that sites could be compared with each other based on the ranking of data relative to the reference site. The extent to which the indices of biological, chemical, and physical quality deviated from the reference site was considered indicative of the degree of aquatic life impairment at a specific canyon stream segment studied (Table 18). The strength of the WQI is the ability to provide a direct measure of the health of these streams, as well as to detect and quantify chemical and physical impacts. The links between the biological integrity and health of a stream, and the chemical or physical agents or impacts is not definitive, but is useful in identifying the relative sources of the impairment.

RESULTS AND DISCUSSION

RESULTS OF THE BIOLOGICAL INVENTORIES

Aquatic Life and Wildlife Observed and Expected Regionally

Qualitative observations during this study, including actual sightings, and signs such as tracks, nesting areas, and scat, indicated use of these streams by a variety of organisms, including various bird species (raptors, migratory birds), amphibians (salamanders, frogs [observed in Sandia Canyon only]), and mammals (elk, squirrels, racoon). A list of common and scientific names of wildlife discussed in this report is provided in Table 2. Invertebrate surveys in the four canyons examined concurrently in these stream segments identified over 117 different taxa (Cross 1996a; Ford-Schmid 1999). Studies by the LANL have also identified elk, mule deer, coyote, red fox, porcupine, mountain lion, and bobcat in the LANL area. Twenty-nine small mammal, 200 bird (112 breeding in area), 8 reptile, 13 snail, and 25 terrestrial arthropod species have also been identified on the LANL, many of which use the canyon environments at some time for food, water, reproduction, and shelter. Many of these species are permanent residents within the LANL environment. For example, Biggs *et al.* (1997a) found that radio collared elk captured on the LANL grounds remained at the LANL year-round. Cross (1995b), in an examination of invertebrate colonization associated with NPDES outfalls, incidentally observed extensive use of several of these outfalls by elk (browsing, bedding, presumably drinking), some use by coyote, and occasional observations of snails, clams, and amphibians. Of the 310 vertebrate species of the Jemez Mountains, 7 percent are fully aquatic, 13 percent are semi-aquatic, and the majority (63 percent) depend on wetlands or riparian habitat to complete their life cycles (Table 2).

Adaptations to the semi arid conditions on the Pajarito Plateau by wildlife vary and are generally functional or behavioral. Some aquatic invertebrates reported by Cross (1997) have dessication-resistant eggs, or can survive periods of dormancy and dessication. Amphibians take advantage of temporary waters (Foxx *et al.* 1999) or have fast-growing larval stages, burrow, or estivate during hot days. Most animals likely find ways to minimize water loss (e.g, through microclimate selection as indicated by 63 percent of the vertebrate species being associated with cool and moist riparian habitats) or find water to drink. Birds and other animals of arid ecosystems and woodlands have been documented drinking and bathing from temporary waters, springs, and other wetlands (Smyth and Coulombe 1971; Williams and Koenig 1980; Gubanich and Panik 1987; Brooks 1989). Many of the bird species that were documented drinking water were reported on the LANL (Travis 1992; Hinojosa 1997). Over 60 species of vertebrate wildlife were documented by Brooks (1989), Foxx and Blea-Edeskuty (1995), and Haarmann (1995) as using artificial water bodies formed by waste discharges by the LANL for food, shelter, and drinking. Animals have been found to make repeated, and long-duration visits (*e.g.* raccoons remained near a lagoon for over 20 hours) to artificial water bodies on the

LANL, even when areas were partially fenced, or when only contaminated water was available (Brooks 1989; Hansen *et al.* 1999).

To illustrate the dependency by animals on LANL water bodies, two vertebrate groups and an avian species were selected for further discussion; amphibians, montane fish, and the American dipper, which could be considered a sentinel species for the health of these canyon streams. Amphibians of the Pajarito Plateau represent a guild of aquatic life important to ecosystem function and the biological diversity of the Jemez Mountains. Whether perennial, interrupted, intermittent, or ephemeral in nature, clean water in streams, ponds, reservoirs, or wetlands are critical for a large number of amphibians. Amphibians uniquely link aquatic and terrestrial environments. Even if temporary waters may seem insignificant, these surface waters are primary breeding sites and nursery habitats for spadefoot toad, green toad, red-spotted toad, woodhouse toad, canyon treefrog, leopard frog, and juvenile tiger salamander on the Pajarito Plateau. Hammerson (1999) reported that the red-spotted toad and canyon treefrog only breed in pools along intermittent streams, in ponds formed from rain fall, snow melt, or in springs. Many species, such as toads, frogs, salamanders, reptiles, and even migratory birds, have altered their lifestyles and behavior to take advantage of temporary pools for resting, breeding, and feeding (Mares 1999). The immature stages of many amphibians and invertebrates are entirely aquatic; for example, tiger salamanders develop gills and remain in water bodies as long as two years. Ponds, streams, and wetlands of even a temporary nature are important resources to the wildlife of this semi-arid region.

According to Calamusso and Rinne (1999), there are at least three native fish of the Jemez Mountains: the Rio Grande cutthroat trout, the Rio Grande sucker, and the Rio Grande chub. The Rio Grande cutthroat trout is a sport fish, the state fish of New Mexico, and one of the most striking and colorful of the trouts (NMDGF 1998). The Pajarito Plateau is in the known historic range of the native Rio Grande cutthroat trout. The trout likely occurred in "all waters capable of supporting trout in the Rio Grande drainage," including small, isolated, headwater streams in the Rio Grande basin (Sublette *et al.* 1990; Stumpff and Cooper 1996). Most cutthroat trout streams identified by Cowley (1993) are those above the 150-day, frost-free isoline, which included the upper portions of streams on the Pajarito Plateau.

Whether cutthroat trout inhabited any of the intermittent streams of the Pajarito Plateau is unknown, as there are few fossil records. The current occurrence of the ridged-beak peaclam in Frijoles, Pajarito, Water, and Los Alamos Canyons (Cross 1996b) suggests some historic connection to a larger body of water in the past, although passive dispersal of the pea clam is also possible. Goff *et al.* (1996) reported that the Rio Grande was once dammed by the Tshirege Member during the late Pleistocene Epoch, forming a 72 km lake that was 54 m above the rim of White Rock Canyon and at times reached as far upstream as Española, New Mexico. However, clearly these canyons are dynamic geomorphic systems and it would be difficult to ascertain the historic fish distribution without additional fossil records.

Currently, cutthroat trout populations and their distribution have been severely reduced (Stumpff and Cooper 1996). Some cutthroat trout streams have had as few as 50 adult trout in them (NMDGF 1973), and cutthroat trout populations have recently been decimated by the effects of fire, flood, drought, and habitat degradation (Propst *et al.* 1992; Stumpff and Cooper 1996). As trout streams have diminished, so has the range of the cutthroat trout in New Mexico; although steps are being taken to conserve the fish (Cowley 1993). The Rio Grande cutthroat trout prefers waters that are clean, clear, and cold, and have sufficient cover, pools, and food to support their needs (Sublette *et al.* 1990). There is an active program to reintroduce the trout to streams in its historic range that provide suitable habitat, are isolated, and contain no other trout (Cowley 1993).

Birds common to forests and woodlands compose the basic breeding avifauna of the LANL (Travis 1992). However, one bird species is particularly well-adapted to the intermittent streams found on the LANL. The American dipper, or water ouzel, is a robin-sized bird that can swim and dive using its wings and feet, and even walk under water (Kingerly 1996). Dippers are not easily confused with any other bird species and are identified by their color, size, and distinctive traits such as incessant dipping, a blinking white eyelid, and behavior near streams (Kingerly 1996). During this study, dippers were observed using the stream segments studied in Los Alamos, Sandia, and Pajarito Canyons. Similar to trout, dippers are inseparable from fast-flowing, clear montane streams, with cascades, riffles, waterfalls, and are dependent on the streams' invertebrates for food (Kingerly 1996). Because of this dependency, a dipper's health is susceptible to dietary contamination from metals, radionuclides, and organic chemicals that contaminate montane streams (Kingerly 1996, Strom 2000). For example, Strom (2000) found that sediments contaminated with lead from upstream mining activities was correlated with concentrations of lead in the dipper's tissues, such that the lead had adversely altered the dipper's physiology. The dipper is an example of an avian species that feeds high in the food web and the adults have high site fidelity (they typically do not migrate from a watershed). Thus, the dipper reflects the water quality and the health of a canyon stream environment. Measures of their productivity and any adverse effects posed by contamination should be considered as part of the evaluation of the risks to aquatic wildlife of the LANL.

Fish Surveys

While many aquatic organisms inhabit and use the LANL waters, electrofishing surveys did not locate fish in the Sandia, Pajarito, or Valle Canyon stream segments studied. In Los Alamos Canyon, brook trout were found throughout the segment studied, and occasionally rainbow trout were found in the lower reach nearest the Los Alamos Reservoir. Fish in Los Alamos Canyon were observed routinely and identified in

October 1997, and found under ice, during low-flow conditions in December 1998. Although rainbow trout have been routinely stocked in the Los Alamos Reservoir by the NMDGF (Sloane 1998), this species probably does not permanently reside in this stream segment. Brook trout prefer smaller, cooler waters than rainbow trout (NMDGF 1998) and rainbow trout tend to compete with and exclude brook trout from their territory (Raleigh 1982; Clark and Rose 1997). Even brook trout spawned in a lake will move into and overwinter in small (<2 m) tributary streams, suggesting stream residence provides some fitness advantage for this species (Curry *et al.* 1997). Rainbow trout were found only in the lowermost portions of the stream segment closest to the Los Alamos Reservoir, whereas brook trout were found throughout the stream segment sampled. As brook trout are no longer being stocked in this stream, reproductive-capable individuals were found, and the habitat was suitable, it is likely that Los Alamos Canyon supports a sustainable coldwater fishery of brook trout.

Mean sizes of brook trout sampled in Los Alamos Canyon were (Figure 17 and Figure 18) 95 and 124 mm (ranged from 71-195 mm) in October 1997, versus 119 and 123 mm (ranged from 84-207 mm) during December 1998. Sublette *et al.* (1990) reported that the minimum size of brook trout at sexual maturity was about 95 mm for males, and 100 mm for females, so fish in Los Alamos Canyon were capable of reproducing. In 1997, the mean weight of fish captured in the lower portion of the reach was significantly greater (t-test, $p=0.03$) than of fish in the upper portion of the reach. There was no significant difference in the winter 1998 sampling. No consistent trends in weight or length were noted between 1997 and 1998.

Fish captured while electrofishing in Los Alamos Canyon in October 1997 were clearly associated with areas of higher than average bank cover compared to that found during the habitat measurements taken in August 1997, and seemed to prefer pool habitats, particularly in the colder months (Figures 19 and 20). Average bank cover does not vary with moderate fluctuations in stream flows, so comparisons between the cover measured in August with those measured in October were considered valid. Evaluation of cover in December 1998 was complicated because most stream reaches electroshocked had at least some ice cover, and winter weather reduced the extent of bank vegetation as cover. Percent of pools, however, may vary with discharge. Fish captured in December 1998 did seem to be highly associated with pool habitat. During the cold, low-flow, winter months, it is likely that water depth is an important factor for fish survival, rather than cover, so a preference for pools would not be unexpected. Overall, in both October 1997 and December 1998, it appeared that fish were selecting relatively deeper waters, such as pools.

Caged-Fish Bioassays

A series of intense rainstorms occurred during the caged-fish bioassays (Figure 21). Acute mortality (96-hour exposure) was observed in Los Alamos Canyon (20 percent) and Sandia Canyon (38 percent; Figure 22). However, the high flow regime due to localized rainstorms was most likely responsible for this observed mortality. Fish were crushed by the in-cage rock or were crushed in between the cage pipe-frame and the netting. Some fish also likely escaped when the netting was ripped or separated from the pipe-frame, and occasionally, fish remaining in cages were killed when the cages themselves remained in dry areas after a flood. When mortality was accounted for by crushing or escape, no significant acute mortality was observed in the canyons studied (Figure 22). The 90 percent to 100 percent survival in one third of the cages in each stream segment also suggested that mortality was not likely due to acutely toxic substances in water. While in cages, fish were not allowed to seek refugia from high flows that they would in the wild. Therefore, the mortality experienced by the fish during high flows was considered an artifact of their caged condition, and not necessarily what would have happened to wild fish exposed to high flows.

Chronic mortality (two months exposure) was observed in Sandia Canyon and Pajarito Canyon (Figure 23). Again, high flows due to localized rainstorms were likely responsible for the observed mortality. Cages frequently had large amounts of sediment deposited in them, were thrown from the stream, were ripped, or broken. Also, the USFWS received a report of vandalism that occurred to cages in Sandia Canyon, where fish were removed and allegedly sold as bait. Because the cages were checked infrequently during the two month chronic bioassays, it was more difficult to determine a cause of death. For instance, dead fish buried in sediment at the bottom of the cage may have been trapped in the sediment during high flows, or may have died from other causes and then were buried by sediment. Therefore, the corrected percent survival only accounted for fish that were obviously killed by crushing or when the cages were thrown from the stream, when fish were missing due to ripped netting, or vandalism (Figure 23). No significant chronic mortality was observed in any of the canyon stream segments studied in 1997, when mortality due to crushing, vandalism, or escape was accounted for. In summary, although exposed to harsh conditions, at least 15 percent of the caged-fish survived long-term exposure to these stream segments. In Valle Canyon and Los Alamos Canyon, mean survival was as high as 70 percent, with 100 percent survival in some cages.

Due to the high variability associated with fish length and weight measurements, no statistically significant weight gains over time or differences in average fish weight among canyon stream segments or cages were identified. General trends, however, indicated that fish gained weight in Los Alamos, Sandia, and Pajarito Canyons (Figure 24). Fish in Valle Canyon appeared to lose weight during the first month, and then gained weight in the second month (Figure 25). Valle Canyon fish only experienced about 10 percent flood-associated mortality on average. While physiological stress associated with contaminant exposure can result in weight loss and reduced weight gain in fish, other factors, such as food availability and water temperature could also confound results. Nonetheless, the observed weight loss in Valle Canyon fish occurred in 8 out of 9 cages, suggesting that there may be an adverse physiological response to conditions in Valle Canyon that should be investigated further.

Benthic Macroinvertebrate Surveys

Ford-Schmid (1999) reported the results of the benthic macroinvertebrate community surveys in the 4 canyon stream segments studied (Appendix III). Taxonomic composition, biological condition, indices of diversity, and other assessments of the benthic macroinvertebrate community in these four canyon stream segments are presented in Table 19. Standing crop density was high at all sites and the number of taxa ranged from 10 in Sandia Canyon (Site 7.64) to 41 at the reference site (LA 13.0) in Los Alamos Canyon. This was within the range of anticipated taxa for turbulent streams in New Mexico (Cole *et al.* 1996).

One hundred and seventeen taxa were collected from these 4 canyon streams including 33 Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) taxa (*i.e.*, EPT taxa), and 29 Chironomid taxa. The EPT taxa thrive in coldwater with reliable oxygen and a mix of cobble and gravel substrate (Cole *et al.* 1996). In these 4 canyon streams, Ford-Schmid (1999) found over 50 percent of the total number of unique taxa (~230) reported by Cross (1997) found in streams on the Pajarito Plateau. Eight of the species found by Ford Schmid (1999), were identified by the Idaho DEQ (1996) as preferring coldwater, and these were found only in Los Alamos and Pajarito Canyons. A similar analysis of the invertebrate taxa reported by Cross (1996b; 1997) found 14 species preferring coldwater, and these were found mostly in Frijoles Canyon (10), and Guaje Canyon (8), but also in Los Alamos (4), Pajarito Canyon (2), Sandia Canyon (2) and Chaquehui Canyon. The majority of the invertebrate taxa preferring coldwater were caddisflies of the Families Limnephilidae and Philopotamidae of the Order Trichoptera. Interestingly, no heptageniids (a family of mayflies) were found in any canyon stream segment except Los Alamos Canyon.

Heptageniid mayflies were considered by Clements (1994) and Clements *et al.* (1999) to be sensitive to heavy metals in coldwater streams of the Southern Rocky Mountains. Nelson and Roline (1993) suggested that the absence of heptageniid mayflies can be used as a biological criterion to indicate the presence of heavy metal contamination. In this study, heptageniid mayflies were absent from canyons where the presence of excess Al, Fe, Ba, Cr, or Mo was found in sediments or in water from Sandia, Valle, and Pajarito Canyons (below). However, heptageniids were found in Los Alamos Canyon that also had elevated aluminum in water.

Garn and Jacobi (1996) suggested that low invertebrate density may be indicative of pollution or habitat degradation in their studies. Plafkin *et al.* (1989) also suggested that low invertebrate taxa richness was indicative of poor water quality. In this study, Ford-

Schmid (1999) found low invertebrate density and low taxa richness in Sandia Canyon. Combined invertebrate community scoring metrics indicated that the overall biological condition of the benthic macroinvertebrate community was slightly impaired in Valle Canyon and Pajarito Canyon, and moderately impaired in Sandia Canyon compared with the reference site (Table 19). However, the impairment of the benthic macroinvertebrate community at Sandia Canyon could be due to a number of factors, such as the elevated nitrates and salts found in the water, the eroded stream channel and sedimentation, or the reproductive toxicity demonstrated in the sediment porewater. All of these factors could have impaired the benthic macroinvertebrate community, and these conditions were not found at the other sites.

RESULTS OF THE ENVIRONMENTAL SAMPLING AND TOXICITY TESTS

Existing Water and Sediment Data

Extensive surface water quality monitoring data collected by the LANL (*e.g.* USDOE 1996; USDOE 1999) and the NMED (Ford-Schmid 1996; Dale 1998) were collected for other purposes (*e.g.*, compliance with Resource Conservation and Recovery Act regulations, research), and as such, did not satisfy the collection, storage, and analytical requirements of USEPA-approved methods for surface water. Few of the thousands of water quality monitoring data collected by the LANL or the NMED could be included and therefore, unfortunately, were not evaluated during this LANL Water Quality Assessment. The NMED reviewed all water quality data submitted for the LANL Water Quality Assessment and found only the LANL data for a biological oxygen demand and several constituents in unfiltered water could be incorporated into this LANL Water Quality Assessment. Since mostly dissolved constituents in water have applicable water quality standards, and total suspended solids data were not available to convert total measurements into dissolved concentrations, these data were not incorporated into the LANL Water Quality Assessment. Water quality data collected in 1997 by the USFWS, met the collection, storage, and analytical requirements of the USEPA-approved methods, and were evaluated against the water quality standards (NMWQCC 1995) applicable at the time of the study.

A summary of the LANL (1998b) element concentrations in sediment mostly collected at the property line were provided for use in the LANL Water Quality Assessment (Table 20). The maximum concentration reported in the canyon watershed was compared with the Sediment Quality Criteria where biological effects would be considered likely. Generally, the maximum concentrations of arsenic and selenium were elevated in Los Alamos Canyon, and silver was elevated in Los Alamos and Sandia Canyon. Mercury concentrations were above the Sediment Quality Criterion in each canyon, but the maximum concentration reported in Los Alamos Canyon was one thousand times higher than the concentrations expected to protect aquatic life from adverse effects, suggesting mercury contamination in the canyon.

Water Column Monitoring

The Hydrolab® Datasonde water quality monitoring devices made over 7,000 measurements of temperature in degrees Celsius (°C), DO in parts per million (mg/L), conductivity in millisiemens per cm (mS/cm) at 25 °C, and hydrogen ion concentrations (pH) in standard units. Occasionally an entire unit or a probe would fail to record data, due to low battery power, insufficient memory, or when removed from the stream by flood (mostly in late December 1996, mid February 1997, and April 1997). Additionally, the devices could not measure conductivity above 2 mS/cm and temperature below freezing (0 °C), although temperatures below freezing in montane streams would be expected (Hynes 1970).

The daily, quarterly (every four hours), temperature, DO, conductivity, and pH data are presented in Figures 26 through 41. The average temperature (and range) in Los Alamos Canyon was 6.6 °C (<0 to 16.7 °C); 9.4 °C (<0 to 23.0 °C) in Sandia Canyon; 8.1 °C (<0 to 22.6 °C) in Valle Canyon; and 6.9 °C (<0 to 17.8 °C) in Pajarito Canyon. The average DO (and range) in Los Alamos Canyon was 9.6 mg/L (5.2 to 13.3 mg/L); 8.6 mg/L (4.3 to 17.6 mg/L) in Sandia Canyon; 8.4 mg/L (5.4 to 15.4 mg/L) in Valle Canyon; and 9.3 mg/L (5.7 to 13.0 mg/L) in Pajarito Canyon. The average conductivity (and range) in Los Alamos Canyon was 0.09 mS/cm (0.01 to 0.14 mS/cm); 0.77 mS/cm (0.12 to >2 mS/cm) in Sandia Canyon; 0.21 mS/cm (0.07 to 0.27 mS/cm) in Valle Canyon; and 0.13 mS/cm (0.04 to 0.35 mS/cm) in Pajarito Canyon. The average pH (and range) in Los Alamos Canyon was 7.56 (6.98 to 7.86); 7.89 (7.11 to 8.70) in Sandia Canyon; 7.56 (6.89 to 9.27) in Valle Canyon; and 7.66 (6.79 to 7.99) in Pajarito Canyon.

The NMWQCC (1995) identified the standards applicable to a high quality coldwater fishery for DO, temperature, pH and conductivity as:

> Dissolved oxygen shall not be less than 6.0 mg/l, temperature shall not exceed 20 C (68 F), pH shall be within the range of 6.6 to 8.8, and conductivity (at 25 C) shall not exceed a limit varying between 0.3 mS/cm and 1.5 mS/cm depending on the natural background in particular stream reaches (the intent of this standard is to prevent excessive increases in dissolved solids which would result in changes in stream community structure).

The NMWQCC (1995) identified the standards applicable to a coldwater fishery for DO, temperature, and pH as:

> Dissolved oxygen shall not be less than 6.0 mg/l, temperature shall not exceed 20 C (68 F), and pH shall be within the range of 6.6 to 8.8.

The NMWQCC (1995) identified the standards applicable to a marginal coldwater fishery for DO, temperature, and pH as:

> Dissolved oxygen shall not be less than 6 mg/l, on a case by case basis maximum temperatures may exceed 25 C, and the pH may range from 6.6 to 9.0.

The NMWQCC (1995) identified the standards applicable to a warmwater fishery for DO, temperature, and pH as:

> Dissolved oxygen shall not be less than 5 mg/l, temperature shall not exceed 32.2 C (90 F), and pH shall be within the range of 6.5 to 9.0.

All measurements of temperature, DO, pH, and conductivity in these canyon stream segments were compared with these standards. Yearly average stream temperatures were low (<9 °C) in Los Alamos, Pajarito, and Valle Canyons. Average temperature in Sandia Canyon was elevated compared to the other canyons mostly due to the majority of flow being comprised of effluent discharges, and parking lot runoff from the upper watershed. Temperatures were elevated in Valle Canyon compared with other canyons most likely due to its shallow depth. Stream segments studied in Sandia and Valle Canyons exceeded the high temperature criteria for both a high quality coldwater fishery and coldwater fishery in summer 1997. Temperatures in no canyon stream segment rose above 24 °C, which was the short-term maxima temperatures necessary for survival of juvenile and adult brook trout (and other trout and salmon) during summer (Brungs and Jones 1977). Lee and Rinne (1980) found that cutthroat trout as well as introduced species of trout in the southwest United States could survive in waters up to 27 °C. Temperatures in the stream segments of Sandia and Valle Canyons did not exceed the standards for a marginal coldwater fishery at any time.

Average annual DO concentrations (>8 mg/L) and pH (<8) were similar among stream segments studied. Minimum DO concentrations ranged from 4.3 mg/L in Sandia Canyon to 5.7 mg/L in Pajarito Canyon. All of the stream segments occasionally fell below the minimum DO standards for both the high quality coldwater fishery and the coldwater fishery. The Los Alamos Canyon stream segment dropped to 5.6 mg/L for 3 hours on August 22, 1997, and for 2 hours on August 23, 1997. The Pajarito Canyon stream segment dropped below 6.0 mg/L for 1 hour in June 1997. The Valle Canyon stream segment dropped below 6.0 mg/L once in May, June, and August 1997, and six times in July 1997. The Sandia Canyon stream segment dropped below 6.0 mg/L repeatedly from May through September 1997, with these <6.0 mg/L DO concentrations lasting for days at a time. Additionally, for 3 days in June and 3 days in July, measured DO concentrations dropped below 5 mg/L for several hours each day. The DO followed a diurnal pattern in all streams being greatest in late afternoon and lowest in the early morning, as well as less diurnal fluctuation in the winter months compared with summer months were lower. These fluctuations suggested these streams were photosynthetically active and productive (Cole 1983).

Only the Valle Canyon stream segment had a pH above 9.0, the maximum range for all categories of a fishery. After nine months of monitoring, the pH increased greatly from mid to late afternoon during the week of October 13 to October 19, 1997, and after that, the pH fell and remained near its average pH (7.6). At the time of the measurement, a material disposal area (MDA-P) was being excavated to remove the hazardous and solid waste. It was undeterminable whether the elevated pH was associated with runoff events or with diurnal fluctuations possibly associated by plant productivity.

Conductivity was generally low (<0.3 mS/cm) in all stream segments except Sandia Canyon, which had significantly higher conductivity (at times greater than 2 mS/cm) due to effluent discharges. Elevated chlorides, carbonates, and cations likely contributed to the high conductivity (Hynes 1970). Only the stream segment in Sandia Canyon had conductivity greater than the high quality coldwater fishery conductivity standards.

Analytical Results

Many elements were initially analyzed (in 1996) using a semi-quantitative method (ICP\MS), and some elements had an insufficient rate of detection to conduct statistical analyses or a determination of trends. The analyses of those elements that were not evaluated further are: Ag, Au, Ca, Ce, Co, Cs, Dy, Er, Eu, Ga, Gd, Ge, Hf, Ho, In, K, La, Li, Lu, Na, Nb, Nd, Os, Pb, Pd, Pr, Pt, Rb, Re, Ru, Sb, Sc, Sm, Sn, Ta, Tb, Te, Th, Ti, Tl, Tm, U, W, Y, Yb, and Zr (see Table 5 for chemical symbols and names). The analytical results for moisture content, Al, As, Ba, B, Cd, Cr, Cu, Fe, Pb, Mg, Mn, Hg, Mo, Se, stable Sr, V, and Zn found in water, porewater, sediment, and tissues are presented in Figures 42 through 60 and raw data are presented in Appendix IV.

Water Chemistry

The water chemistry of the Los Alamos, Pajarito, and Valle Canyon stream segments is typical of montane streams. Generally, they are dilute, soft waters (hardness <60 mg/L $CaCO_3$, alkalinity <200 mg/L $CaCO_3$, Cl^- <20 mg/L) with low nutrients (*e.g.*, nitrate as nitrogen <0.2 mg/L, and orthophosphate <0.5 mg/L) and salts (Table 21). Waters in Sandia Canyon were atypical for this region, however. Its water had much higher concentrations of salts, nutrients, and other constituents (Figures 61 through 64). This was because the source water was composed primarily of effluent from LANL operations (USDOE 2001). Similar trends and values were reported for these canyon stream segments by Chapman and Allert (1998; Attachment A), by Dale (1998), and by LANL (1996a).

Nutrients in Sandia Canyon were elevated and as much as 10 times the concentrations found in Los Alamos, Pajarito, and Valle Canyons (Figure 61). However, nitrate concentrations in Sandia Canyon were not found in this study to exceed 10 mg/L (a water quality standard designed to protect domestic water and human health). However, Heikoop *et al.* (2001) found nitrate concentrations as high as 30 mg/L in Sandia Canyon. Phosphate concentrations were elevated (>5 mg/L) in Sandia Canyon, which could accelerate algal growth, increase biological oxygen demand, and affect the aquatic community trophic dynamics and community structure. Using annual average temperature and pH, Sandia Canyon (and the other sites studied) did not contain ammonia concentrations greater than the water quality standards for a coldwater fishery (NMWQCC 1995). Also, no dominance of nuisance species in response to excess nutrients was observed in the stream segments studied.

Pajarito Canyon stream waters were observed to be a milky white color and the measured turbidity was also quite elevated (Figure 64). Freeman and Everhart (1971) reported a white iridescent cast to water of pH 8 containing 5.2 mg/L aluminum. The white suspension may have been aluminum colloids of natural origin (see below). The water quality standards (NMWQCC 1995) identify that "turbidity attributable to other than natural causes shall not reduce light transmission to the point that the normal growth, function, or reproduction of aquatic life is impaired or that will cause substantial visible contrast with the natural appearance of the water." The NMWQCC (1995) also reported a numeric standard for turbidity of 10 nephelometric turbidity units (NTU) in streams that are designated coldwater fisheries. All canyon stream segments exceeded the 10 NTU turbidity standard at least once during the study. Except in Pajarito Canyon, the elevated turbidity was associated with an increase of total suspended solids, which were found to increase after precipitation events in the watershed.

Descriptive statistics of elements dissolved in water are presented with water quality standards in Table 22, and the range of concentrations are also presented in Figures 43 through 60. Several field-collected water blanks from the 1997 sampling contained some chromium (9.2, 3.4, and 5.6 µg/L) and nickel contamination (15.1 and 7.6 µg/L). The MRI Laboratory blanks also had detectable aluminum (50.8 µg/L), cadmium (2.8 and1.8 µg/L), chromium (7.0 µg/L), and vanadium (5.6 µg/L), which suggested that contamination of field blank water samples may have been at the laboratory, rather than from the field. The excess cadmium found in the surface water samples was greater than the water standards for a coldwater fishery. Because this cadmium was attributable to contamination of the blanks, cadmium was not viewed as exceeding the coldwater fishery standards. In Table 22, copper in water from Sandia Canyon appears to exceed the copper standard protective of a fishery. However, the copper standard was presented using a default hardness value (50 mg/L as $CaCO_3$), whereas during the individual water quality standard comparison, the individual hardness value for Sandia Canyon (averaging

~80 mg/L as $CaCO_3$) was used instead and copper was not found exceeding the water quality standard. Only aluminum and barium were found in the surface waters sampled during the LANL Water Quality Assessment to be above New Mexico water quality standards (NMWQCC 1995). Review of USEPA criteria (1998a, 1998c, 1999) identified explosives, iron, and molybdenum to be additional pollutants of concern.

Aluminum in Water

Hem (1985) reported that in most natural waters, aluminum is rarely above a few tenths of a milligram per liter, and where concentrations are greatest, the pH is often low. In the LANL Water Quality Assessment, aluminum was detected (89.5 to 14,893 micrograms per liter [µg/L]) in all water samples exceeding the chronic (85µg/L) and often acute (750µg/L) water quality standards for coldwater fishery (Figure 43). Geochemical equilibrium modeling using $MINEQL^+$ (Schecher and McAvoy 1991), and the highest measured concentrations of aluminum and iron (3.9 mg Al/L and 1.6 mg Fe/L, see below) found in Pajarito Canyon, predicted the primary precipitate to be diaspore (AlOOH), an aluminum complex, followed by lesser concentrations of the iron solid hematite (FeO_3), and a minor fraction of calcium phosphate ($Ca_5OH(PO_4)_3$). Elevated aluminum concentrations at the average pH (~7.7) found in Pajarito Canyon would likely result in the formation of a diaspore solid, which could remain in suspension and have caused the water's milky white appearance. Alternatively, amorphous aluminum complexes (such as $Al(OH)_3$ or gibbsite [Hem 1985]) may have formed from dissolution of the parent material (Bandelier Tuff) in the spring waters. Because gibbsite forms of aluminum are not at equilibrium, it would not be predicted using equilibrium models such as $MINEQL^+$ (Sposito *et al.* 1996). Gibbsite crystals have considerable stability and small size (<0.10 micrometers in diameter; Hem 1985), and they could have passed through the 0.45 micrometer filter media as a colloid in the water column sampled. Formation of an aluminum precipitate likely contributed to the elevated aluminum in water and turbidity measured in the Pajarito Canyon stream segment. The occurrence of elevated concentrations of aluminum in water samples from the Jemez River is not unusual (NMWQCC 1998). Concentrations of Al in Pajarito Canyon as high as 12 mg/L have been reported in filtered water samples by others (Dale 1998; LANL 1998a). An index of erosion was not correlated with elevated aluminum concentrations in Pajarito Canyon.

Aluminum toxicity to aquatic life vary widely due to aluminum's complex chemistry in waters of different pH (Freeman and Everhart 1971). The bioavailability and toxicity of aluminum are related to the pH of waters; at pH 5.5 to pH 6.5, fish and invertebrates are stressed and eventually asphyxiated (Sparling *et al.* 1997). Poléo (1998) found that acidic conditions favored the polymerization of aluminum at the gill surface that increased mucus secretion, and both polymers and mucus clogged the gills that lead to acute hypoxia. At no time did the pH of waters drop below 6.5 during the time of study.

However, low pH conditions have only been reported to occur during sulfuric and nitric acid spills to Sandia Canyon in1990 and 1994 (Bennett 1994; Cross 1995a).

Since previous research has focused primarily on aquatic systems with low pH, there was an information gap regarding the chemical and biological effects of elevated aluminum to aquatic life in high pH waters. The USFWS funded a study to address the effects of aluminum to the health of the native fish, *Hybognathus amarus* and *P. promelas,* by exposing the larvae of these fishes to dilutions of test water simulating the chemical characteristics of the Rio Grande and various concentrations of aluminum (Buhl 2001). There was a low solubility of the aluminum at pH 8.0-8.2 in the simulated Rio Grande water. In the acute assays, the fishes were not sensitive to dissolved aluminum concentrations as high as 1.3 mg/L (Buhl 2001). Other research was obtained for aluminum toxicity at high pH. Buhl (2001; citing Call *et al.* 1984) reported that total aluminum concentrations of 2.9 to 49.8 mg Al/L killed less than 10 percent of juvenile *P. promelas* in soft lake waters adjusted to a pH of 7.6 and 8.0. The USEPA (1988) reported a 96-h LC50 of 35 mg Al/L for juvenile *P. promelas* in water of 220 mg/L hardness. However, Freeman and Everhart (1971) reported that trout exposed to waters of pH 8, at 12 °C, containing 5.2 mg Al/L, were sluggish, fed poorly, had a darkened color, and experienced equilibrium problems or gill hyperplasia. Fifty percent of the test population of trout died after 45 days of flow-through exposure in a laboratory. However, trout in Rio de Frijoles and Santa Clara Creek have persisted in Pajarito Plateau waters that contain elevated aluminum concentrations greater than the coldwater fishery standard, but the amount of any gill damage has not been reported.

In this study, the elevated aluminum in Pajarito Canyon waters did not appear to present acute or chronic hazards to fathead minnow, crustaceans, or the benthic macroinvertebrates studied. Aluminum concentrations in Pajarito Canyon averaged over 3 mg/L, and yet caged-fathead minnow survived these exposures for 2 months. Ford-Schmid (1999) found only a slightly impaired benthic macroinvertebrate community in Pajarito Canyon. Chapman and Allert (1998) found no surface water or porewater toxicity to fathead minnow and *C. dubia* exposed to undiluted Pajarito Canyon waters in a laboratory setting. However, these species are generally less sensitive than trout (USEPA 1988). Prolonged exposures to waters containing elevated aluminum (in the form of gibbsite crystals or aluminum precipitates such as diaspore) in high pH water may affect trout gill filament function and would need further research. Water quality standards developed for streams on the Pajarito Plateau may need to consider prolonged exposure to aluminum particles in the development of a site-specific standard for aluminum in coldwater fisheries of the Jemez Mountains.

Barium in Water
Barium is a divalent, alkaline earth metal, and when pure, it is soft and silvery-white. Barium is most often found in nature as barite ($BaSO_4$) and witherite ($BaCO_3$), both of which are highly insoluble salts (Grolier Inc., 1997). The NPDES outfall at Building 260 as well as Material Disposal Area "P" in TA-16 have discharged explosives and barium nitrate sand along with other materials above the stream segment studied,(LANL 1995a). Barium compounds that easily dissolve in water may cause health effects in people (ATSDR 1992). To protect human health, the USEPA (1996a) allows no more than 2 mg Ba/L in drinking water sources and the NMWQCC (1995) groundwater standard is 1 mg Ba/L. Only stream water from Valle Canyon (range: 2.2 to 5.0 mg Ba/L) exceeded these water quality criteria (Figure 45).

There are no water quality standards for barium developed either by the USEPA (1998a) or New Mexico (NMWQCC 1995) for the protection of aquatic life. Toxicity information collected from the AQUIRE toxic effects database (USEPA 1998c) indicated that concentrations of >8 mg Ba/L are associated with adverse reproductive effects in *Daphnia magna*, a fresh water crustacean. In general, barium in the water column was not acutely toxic at concentrations <8 mg/L. The lowest barium concentration causing an adverse effect reported in the AQUIRE database, was 2.6 mg Ba/L, above which fish were observed to be "stressed." Thus, the elevated barium found in water in Valle Canyon, would not be acutely toxic to aquatic life but could contribute to stress in fish and cause weight loss or other sublethal effects. Barium was above the maximum contaminant level for acceptable drinking water and above the water quality standard for groundwater.

Molybdenum in Water
Elevated molybdenum concentrations were detected (range: 0.03 to 0.3 mg Mo/L) in water collected from the Sandia Canyon stream segment (Figure 56). There are no water quality standards for molybdenum developed either by the USEPA (1998a) or New Mexico (NMWQCC 1995) for the protection of aquatic life, or drinking water (USEPA 1996a). Additional toxicity information was obtained from the ECOTOX database (USEPA 1998d) indicating that concentrations of >0.6 mg Mo/L were associated with some adverse effects in aquatic life, and adverse reproductive effects in *Daphnia magna* were associated with molybdenum concentrations >2.1 mg/L. Molybdenum compounds are currently used for corrosion inhibition during cooling tower operations of the Steam Plant at Technical Area 3 and was the most likely source of molybdenum found in both Sandia Canyon water and sediment. While molybdenum dissolved in water from Sandia Canyon was elevated, the excess concentrations in the surface water did not appear to present any acute or chronic toxicity to aquatic (Chapman and Allert 1998). However, molybdenum is known to accumulate in plants such that their molybdenum content increases by five times that in the medium in which they grow (Kovalsky *et al.* 1961).

Therefore, bioaccumulation of molybdenum in plant species above concentrations considered to pose a dietary risk to wildlife or livestock should be evaluated if affected plant materials are used as food.

Explosives in Water

The explosive compound, RDX, is an environmentally persistent explosive compound unique to military operations, and is moderately mobile in the environment (Talmage *et al.* 1999). Although only moderately water-soluble (38.4 mg/L at 20 °C), it also has a low absorption coefficient for soils and sediments, so it tends to migrate into groundwater. RDX is resistant to aerobic microbial degradation, and only slightly biodegradable via anaerobic bacterial action, so RDX that is buried in soil tends to have a long environmental half-life. Studies on ingestion by mammals indicated that RDX is rapidly excreted and does not bioaccumulate (Talmage *et al.* 1999).

Like RDX, HMX is an environmentally persistent explosive compound that is moderately to highly mobile in the environment. In many ways its environmental fate and transport is similar to RDX, although HMX tends to be slightly less toxic and less susceptible to microbial degradation (Talmage *et al.* 1999). Talmage *et al.* (1999) estimated that HMX in the Holston River in Louisiana would persist in surface waters for a distance of over 20 km downstream of the sources.

With the notable exception of Valle Canyon, explosive compounds were not found above the reporting limits in canyon streams during the LANL Water Quality Assessment. The compounds, HMX, RDX, 4,2,6-DNT, and 2,4,6-DNT were detected twice during water sampling in each reach of the Valle Canyon stream segment and these compounds were detected at high concentrations in sediment. Concentrations of all four compounds were notably higher in the second sampling, indicating source contributions may vary over time. Nonetheless, all water samples contained explosive compounds that exceeded the chronic water quality benchmarks (Table 23) recommended for the protection of aquatic life. Explosives found in water also exceeded the human health-based drinking water guidelines. Moreover, because these compounds are resistant to degradation, and readily translocated to groundwater, downstream water resources, including water supply wells, the Rio Grande, and drinking waters may be at risk. No information was provided regarding the presence or lack of detection of explosives in downstream locations.

Radiological Constituents in Water and Porewater from the Stream Segments Studied

The radiological constituents of water and porewater samples were collected in 1996 and the data were received by the USFWS in January 2000. These data are presented as an addendum to Attachment A. Uranium 234 was most frequently detected and was greatest in Pajarito Canyon. However, no radiological constituents (gross alpha, radium) were found to exceed the few applicable water quality standards (NMWQCC 1995).

Surprisingly few empirical studies are available that quantify the effects of radionuclides in water and sediment to aquatic life and wildlife of the Pajarito Plateau and Rio Grande. Therefore, working with the Laboratory, the USFWS contracted a study by the New Mexico State University Fish and Wildlife Cooperative Research Unit on the effects of depleted uranium (DU) on the survival and health of *C. daphnia* and *Hyalella azteca* (Kuhne 2000). Depleted Uranium released to the environment is found in the soil of test fields as three uranium oxides. The low solubility of the alloyed heavy metals and the uranium oxides have led researchers to consider DU found in the soil as more of a terrestrial hazard than an aquatic one. However, research has indicated DU present in soil is not stationary and has the potential to move into intermittent stream systems. Since previous research has focused primarily on terrestrial systems, there was an information gap regarding the chemical and biological effects of DU to aquatic life. The USFWS, therefore, funded a study to address the effects of DU-contaminated soil on the health of the invertebrates *C. dubia* and the amphipod, *Hyallela azteca*, by exposing these organisms to dilutions of test water overlying and aged with DU soil and a reference soil (relatively contaminant free). In both the acute and chronic *C. dubia* assays, significant differences in survival versus the control and reference groups were observed at the estimated LC50 of 14,600 µg DU/L. Significant differences in reproduction versus the reference group was observed at 3,600 µg DU/L. Significant differences in survival of *Hyallela azteca* versus the reference group was observed at 3,600 µg DU/L and for growth at 1,800 µg DU/L. Information generated from this study enable researchers to determine the potential impact of concentrations of DU on aquatic systems in the LANL Water Quality Assessment. Concentrations of DU in water and porewater samples collected for the LANL Water Quality Assessment (Attachment A) were below the thresholds of concern identified by Kuhne (2000).

Surface Water Toxicity

Chapman and Allert (1998; Attachment A) discussed the results of the surface water toxicity tests using the fathead minnow and the crustacean, *C. dubia*. No significant toxicity was observed in the larval fathead minnow toxicity tests. *C. dubia* survival (and therefore reproduction) was completely eliminated in the undiluted Valle Canyon water sample tested in 1996. This sharp decrease in survival rate corresponded to the transfer of the day-3 water samples that were collected following a rain event. Immediately following the day-3 mortalities, a new test was started using water collected on day-4 from Valle Canyon. No further mortality was observed in this additional test, indicating that the cause of the mortality was transitory. Reproductive toxicity was not evaluated in this second test.

Although no mortality or reproductive impairment was observed in the undiluted water samples from Los Alamos, Sandia, or Pajarito Canyons, dilution of those samples with ASTM soft water resulted in some mortality and reproductive impairment in the Sandia and Pajarito Canyon waters at the 12.5 percent dilution. No adverse effects were associated with the soft-water diluent tested itself (*i.e.*, the ASTM Control), and no observable changes in basic water chemistry (pH, alkalinity, hardness) were measured. Inverse concentration-response patterns can result from toxicity in the receiving water or the limitation of necessary components (*e.g.*, ionic imbalance) in the receiving water or synthetic dilution water (USEPA 2000). The reason for this inverse concentration-response pattern at the extreme dilution (referred to as "reverse toxicity" by Chapman and Allert, 1998), or its ecological and toxicological significance, was unresolved. However, as the 100-percent concentration represented the actual condition of the ambient stream, these results were the ones that were used for the interpretation of toxicity.

Sediment Quality Discussion

Sediment interacts strongly with other water quality components. Sediments are the unconsolidated materials at the bottom of a water body, consisting of mineral particles, organic material, and water. The mineral share is most familiar as clay, silt, sand and gravel, but sediment also contains some trace elements and organic materials. Organic materials in sediments are largely derived from the activities of living organisms, but can also be composed of synthetic chemicals. Water is also a large component of sediment, occupying as much as sixty percent of the volume by filling in the spaces between the particles (*i.e.*, "porewater"). Sediments are an important component of water bodies in New Mexico because they support a wide variety of aquatic life, such as worms, clams, crustaceans, and insects. Benthic organisms are key links in the aquatic food web leading from nutrients and other constituents in water and sediment to fish, wildlife, and people (USEPA 1993).

Contaminated sediments are those that "contain chemical substances at concentrations that pose a known or suspected environmental or human health threat" (NRC 1997). Sediments can serve as a "reservoir" from which fish, shellfish, and benthic organisms can accumulate contaminants into their tissues. Contaminants are introduced to sediments through many routes including storm runoff, spills, municipal and industrial discharges, and atmospheric deposition (NRC 1997). Common contaminants in sediments are heavy metals, polycyclic aromatic hydrocarbons and PCBs. Once these pollutants are in water, they tend to accumulate in sediments and then increase in concentration in the animals at higher trophic levels, where they can pose health risks to wildlife that consume the contaminated aquatic life (USEPA 1993).

The physical and chemical characteristics of sediment samples are provided in Appendix IV and are graphically presented in Figures 43 through 60. Mean concentrations in sediments collected for the LANL Water Quality Assessment were compared to concentrations reported by Ryti *et al.* (1998) as background concentrations in canyon sediments (Table 24). The mean concentration of chromium in Sandia Canyon (114 mg/kg DW) was 10 times the background concentration for canyon sediments on the LANL (10.5 mg/kg DW) reported by Ryti *et al.* (1998). Mean concentrations in sediments collected on stream segments from the Laboratory were compared to those found in the Los Alamos Canyon reference site sediment. The mean concentration of silver was elevated in Sandia, Pajarito, and Valle Canyon sediment relative-to-reference site sediments. Barium, PCBs, HMX, and RDX were elevated in Valle Canyon sediments and Cr and PCBs were found elevated in Sandia Canyon sediments relative-to-reference site sediments (Table 24).

Mean sediment concentrations in all canyons were also compared with the SQC (*i.e.*, the consensus sediment quality criteria, see methods and Table 8). Since the SQC is a threshold concentration, mean concentrations were considered elevated when the ratio of the mean to the SQC was greater than unity. Mercury was elevated above the SQC in all canyons, largely because the detection limit (~0.1 mg/kg DW) was greater than the SQC (0.002 mg/kg DW).

Mean canyon sediment concentrations were compared to the LANL's Screening Action Levels (SALs) that were only designed to protect human health in an industrial setting (LANL 1998a). Using these SALs, only Mn in Valle Canyon sediments was considered elevated. The human health SALs were then compared to the aquatic life SQC, and were found to be less protective, as toxicity to aquatic life has been found and reported in sediment with much lower concentrations of contaminants than at concentrations at the level of the SALs. Without protection for aquatic life or wildlife, sediment evaluation using SAL will be less protective of the environment particularly for highly toxic and persistent chemicals such as explosives, mercury, and PCBs. Sediment SALs that protect aquatic life and wildlife would be one part of the restoration and maintenance of the biological, chemical, and physical integrity of these intermittent streams. The LANL Water Quality Assessment approach identified Ba and explosives as contaminants of concern in Valle Canyon, and Cr as a contaminant of concern in Sandia Canyon and these are discussed below.

Barium and Explosives in Valle Canyon Sediment

The Environmental Surveillance Group reported elevated barium in LANL surface water and foodstuffs (LANL 1998a), but barium was not reported as elevated in either sediments or soils because it did not exceed the SALs. However, Warren *et al.* (1997) reported a maximum soil concentration of 2,040 mg Ba/kg DW in the LANL's Technical Area 16 (TA-16). Material Disposal Area "P" at TA-16 was operated as a landfill until 1984 and received explosives and barium nitrate sand along with other materials (LANL 1995a). Within the entire TA-16 region wind-borne contamination of barium, lead, and uranium was likely widespread as indicated by the enrichment of these elements in area soils as reported by Warren *et al.* (1997). Ryti *et al.* (1998) reported the background barium concentration of 127 mg/kg DW for canyon sediments. Buchman (1998) reported a background for barium in freshwater sediments was 700 mg/kg. Elevated barium in the Valle Canyon sediment encountered during the LANL Water Quality Assessment would likely have originated from the Building 260 Outfall and the Material Disposal Area "P," either as runoff, or wind-borne from TA-16.

Barium was found to be elevated in Valle Canyon sediment as the mean (± standard deviation) concentration (1022 ± 654 mg/kg DW) was significantly greater (p=0.0002) than that found in the reference site sediment (Los Alamos Canyon: 35 ± 19 mg/kg DW). Barium in sediment has been reported to be toxic to benthic organisms at 40 mg/kg DW (Anonymous 1977). Buchman (1998) also reported that 48 mg/kg DW was the apparent effects threshold for amphipods. These thresholds would be exceeded by the background barium concentration reported by Ryti *et al.* (1998). However, porewater toxicity to invertebrates was not found in Valle Canyon by Chapman and Allert (1998), though the benthic macroinvertebrate community was identified as slightly impaired. Additional studies of barium exposure to aquatic life may be necessary in order to evaluate chronic toxicity.

Concentrations of nitroaromatic munition compounds (explosives) including TNT, 2,4,6, DNT, RDX, and HMX were detected in Valle Canyon sediment. Concentrations of explosives in sediment were greater from upstream sampling locations closest to the Material Disposal Area P than from sampling locations further downstream. No explosives were detected in the other canyon sediments collected. The explosive, HMX, is used in nuclear devices to implode fissionable material and is found in other military munitions (McLellan *et al.* 1988). The maximum concentration of HMX in sediment (1,130 nanograms per gram [ng/g] DW) from Valle Canyon was over 400 times greater than organic carbon-normalized (using 0.5 percent) sediment quality benchmark (2.3 ng/g DW) reported by Talmage *et al.* (1999) considered safe for benthic organisms. Similarly, the maximum concentrations of TNT (127 ng/g DW) in Valle Canyon sediment was 15 times greater than the organic carbon-normalized (using 0.5 percent) sediment quality benchmark for TNT (8 ng/g DW) reported by Talmage *et al.* (1999). Insufficient information was available to determine sediment quality benchmarks for the protection of benthic organisms from RDX. The explosives HMX and TNT detected in Valle Canyon sediment would be considered by Talmage *et al.* (1999) to be potentially toxic to benthic organisms. However, porewater toxicity was not found in Valle Canyon by Chapman and Allert (1998), and the benthic macroinvertebrate community was identified as only slightly impaired. Additional studies of munition exposures to aquatic life may be necessary to in order to better evaluate chronic toxicity.

Chromium in Sandia Canyon Sediment

Chromium is a metallic element listed by the USEPA as a priority pollutant and is one of the most persistent and prevalent toxic chemicals found at Superfund sites (USEPA 1994b). Under laboratory conditions, chromium is mutagenic, carcinogenic, and teratogenic to a wide variety of organisms (Eisler 1986a). Chromate, that has a hexavalent oxidation state, is toxic at high levels, and is often used for corrosion inhibition in water-cooling systems (Eisler 1986a; ATSDR 1993). Chromium toxicity to aquatic organisms can be influenced by the oxidation state, water hardness, pH, temperature, and salinity. The oxidation state of chromium in sediment was not measured in the LANL Water Quality Assessment. Divalent chromium was reported to be converted to less toxic trivalent chromium by the Sandia Canyon wetlands (J. Gerwin, Northern New Mexico Citizens Advisory Board, April 29, 2000, written communication).

Chromium compounds were used for corrosion inhibition during operations of the Steam Plant at Technical Area 3 (LANL 1999a). These point source discharges of effluent and blow-down water from the steam plant and cooling towers, then, were likely a major source of chromium that contaminated the Sandia Canyon sediment (Figure 49). Sandia Canyon sediments contained significantly higher concentrations ($p = 0.001$) of total chromium (114 ± 66.9 mg/kg DW) than found in sediment from other canyons including the reference site (3.7 ± 2.0 mg/kg DW). The chromium properties of the sediment are significantly altered in Sandia Canyon. The maximum chromium concentration in Sandia Canyon sediment detected by this study (198.9 mg/kg DW) was nearly 20 times the background concentration of 10.5 mg/kg DW for canyon sediments reported by Ryti *et al.* (1998) and exceeded the SQC consensus toxicity threshold concentration (176 mg/kg DW) for the protection of aquatic life. The maximum sediment concentration recently reported by LANL (1999a) was 2,080 mg/kg. Average and maximum chromium concentrations in Sandia Canyon sediment were also greater than the Probable Effects Concentration (111 mg/kg/ DW) reported by MacDonald *et al.* (2000a) to protect benthic aquatic life. Laboratory tests of porewater indicated reproductive toxicity to invertebrates exposed to porewater (Chapman and Allert 1998). However, Chapman and Allert (1998) did not attribute the reproductive toxicity found in Sandia Canyon porewater to Cr or other metal contamination. The lack of cooling tower effluent limitations that are protective of aquatic life may have allowed the contamination of Sandia Canyon sediment. According to the NMWQCC (1995), surface waters of the State shall be free of water contaminants from other than natural causes that will settle and damage or impair the normal growth, function or reproduction of aquatic life or significantly alter the physical or chemical properties of the bottom.

Sediment Texture

Using the United States Department of Agriculture standard soil texture triangle, all sediment grain sizes ranged from sand, loamy sand to sandy loam. Average grain size of sediment samples collected in each stream segment were not significantly different and would be classified as loamy sand (Table 25). Sediment organic content was low, ranging from 0.1 percent in the lower Pajarito Canyon stream segment to 2.4 percent in the upper Los Alamos Canyon stream segment. These extreme values contributed to a significant difference in the organic content measured in the stream segments (Table 25).

Sediment Porewater Toxicity

Porewater toxicity tests conducted by the CERC in 1996 were considered by Chapman and Allert (1998) to be unsuccessful due to the occurrence of male *C. dubia* in the tests (Attachment A). Tests were repeated again in1997 and significantly reduced reproduction and some decrease in survival were found in porewater from Sandia Canyon (Chapman and Allert 1998; Attachment A). While the 1996 data were considered invalid by Chapman and Allert (1998), the two tests nonetheless demonstrate a pattern of toxicity, suggesting that the adverse effects on *C. dubia* reproduction were consistent in both years.

Porewater temperature, DO, pH, and ammonia were all within acceptable limits for most aquatic organisms, and probably did not directly contribute to mortality. Nutrients, sulfates, chlorides, hardness, and alkalinity were elevated in porewaters as compared to surface waters, but were not at concentrations expected to adversely impact aquatic organisms. Concentrations of Cr, Mo, and Sr in Sandia Canyon sediments and porewaters were elevated, and the low total organic carbon and acid volatile sulfide concentrations reported by Chapman and Allert (1998) indicated that sediment metals may be highly bioavailable. Concentrations of total PCBs in Sandia Canyon sediments were detected at concentrations as high as 154 µg/kg, DW, a concentration that falls within the range where toxic effects to sediment biota have been observed (Eisler 1986b; Hoffman *et al.* 1996; ATSDR 1996). , are Potential sources of PCBs to the Sandia wetlands and to the stream segment studied could be from activities at Solid Waste Management Unit #3-0056(c) where PCB-containing electric transformers were drained, rinsed, and stored, as well as from historic PCB-contaminated sludge and waste water discharges. Nonetheless, as pointed out by Chapman and Allert (1998), Sandia Canyon receives a chemically complex effluent, so a Toxicity Reduction Evaluation (TRE) or similar study would be required to definitively identify the source of the toxicity.

During the LANL Water Quality Assessment, the USFWS and CERC were contracted to conduct the toxicity testing as part of the scope of work agreed to under Interagency Agreement Number DE-A132-96AL76575. If a consistent pattern of toxicity was detected, as was the case in Sandia Canyon sediment porewater (although the macroinvertebrate community was also identified as impaired), then the next step of evaluation would likely be to conduct a TRE. A TRE is a methodical, stepwise investigation of the cause(s) of, and appropriate control(s) for, any condition that has demonstrated acute or chronic toxicity. Investigators should seek technical review and comment from their regulatory authority when developing TRE plans that outline investigative and problem resolution techniques, including reasonable time lines and milestones, in order to avoid delays and maximize consideration of relevant factors that may affect toxicity. When multiple toxicants are present in a sample, as is the case in the Sandia Canyon, identifying and resolving the toxicants serially may be necessary due to masking or confounding influences. The LANL Water Quality Assessment did not distinguish which contaminant or combination of contaminants was responsible for the observed reproductive effects and this is not important for regulatory purposes. The result is the same, aquatic life use is impaired in Sandia Canyon. Fiscal limitations of the LANL Water Quality Assessment prevented the USFWS from conducting the TRE.

Tissue Quality Discussion

The net accumulation of a substance by an organism as a result of uptake from all environmental sources is termed bioaccumulation (USEPA 1995b). Determining the extent of bioaccumulation in organisms is widely used as a method to monitor and assess contaminant distribution and bioavailability geographically and over time (Crawford and Luoma 1992). Phillips (1980), identified three benefits from using organisms in chemical monitoring programs. First, concentrations of contaminants are often greater in tissue than in water and therefore, the probability of detecting trace amounts of contaminants in the environment is increased. Second, resident organisms provide a time-integrated assessment of a contaminant in question. Third, the direct bioavailability of contaminants that accumulate can be measured. When tissue quality is used together with water and sediment analyses, they provide complementary lines of evidence in understanding contaminant fate, transport, and effects (Crawford and Luoma 1992).

Certain mammals, birds, amphibians, and fishes rely on aquatic invertebrates for food. Bioaccumulation of contaminants in the food web may affect population abundance and survival of wildlife that is not resident in a water body, yet dependent upon it for sustenance (Hoffman *et al.* 1996). The significance of the concentrations of chemical contaminants in aquatic invertebrates is not always clear, as elevated concentrations are found in apparently healthy individuals. However, studies of chemicals in tissues can provide additional information about ecological relations such as the composition of food webs in contaminated habitats. Questions concerning the pathways of exposure among species and trophic groups are critical in the assessment of exposure. To date, few studies have reported the background concentrations of contaminants in aquatic biota of the Pajarito Plateau (*e.g.*, Nimmo *et al.* 1994; Carter 1997). Therefore, the concentrations in caddisfly nymphs and caged-fish collected for the LANL Water Quality Assessment were compared to the reference site, to values reported in the literature as regionally ambient or elevated, and to levels considered elevated and that may pose a dietary concern to fish and wildlife (Table 26).

Elemental Contaminants in Aquatic Macroinvertebrates

The bioaccumulation of metals in benthic macroinvertebrates can provide a useful measure of the extent and magnitude of contamination that temporally integrates exposure via the water column and sediment. Because invertebrates represent an important source of food for fish, their bioaccumulation of metals, may also serve as a significant exposure route to fish. The chemical concentrations of elements in caddisflies, both with and without their cases are provided in Table 26 and are graphically presented in Figures 43 through 60. Organic chemicals (*e.g.*, explosives and PCBs) were not analyzed in invertebrate tissues. Mean inorganic concentrations reported in these invertebrates collected for the LANL Water Quality Assessment were compared to concentrations reported by other researchers in New Mexico (Lynch *et al.* 1988; Failing 1993; Simpson and Lusk 1999). However, note that most of these researchers investigated agricultural or mining pollution. Concentrations of Mo, Mn, and Cr in aquatic invertebrates collected for the LANL Water Quality Assessment were regionally elevated and Cr was above levels of concern for fish or wildlife that would potentially consume these invertebrates.

Migratory birds, bats, fish, amphibians, and other wildlife often consume large quantities of aquatic invertebrates as food, and therefore are candidates for bioaccumulation of these contaminants from polluted streams and polluted food supplies. Although Los Alamos Canyon (13.1 mg/kg DW) and Pajarito Canyon (13.7 mg/kg DW) also contained invertebrates with elevated Cr, the highest mean Cr concentrations in caddisfly nymphs (without cases) were from Sandia Canyon (21.8 mg/kg DW), all of which were within the dietary concentration known to adversely affect wildlife. Growth and survival of second generation black ducks (*Anas rubripes*) were reduced when fed diets containing 10 mg/kg DW of the trivalent form of Cr (Eisler 1986a). Therefore, depending on the form of Cr and the extent of contamination of the benthic macroinvertebrates, aquatic wildlife that rely on Los Alamos, Pajarito, and Sandia Canyon invertebrates for food may be at a risk of reduced growth and reduced survival.

Manganese (861 mg/kg DW) and Mo (43.5 mg/kg DW) concentrations in invertebrates were significantly elevated in Sandia Canyon compared with concentrations in invertebrates collected from the other canyons. Manganese concentrations in Sandia Canyon were also elevated in water, sediment, and caged-fish (Figure 54). The toxicological significance of elevated Mn is not readily established, but were generally below levels of concern reported by the NRC (1980). Molybdenum concentrations in Sandia Canyon were also elevated in water, porewater, and sediment, but not fish. Concentrations of Mo in aquatic invertebrates were above dietary levels of chronic concern for wildlife, and concentrations at these levels in the diets of domestic animals could impair their bone development. Concentrations of Mn and Mo were not likely acutely toxic, although species tolerances vary widely (NRC 1980).

Contaminant Accumulation in Caged-Fish

The chemical concentrations of elements in caged-fish (female fathead minnow) are provided in Table 27 and are graphically presented in Figures 43 through 60. Explosives were not analyzed in the caged-fish tissues, but PCBs were analyzed in caged-fish after one month of exposure. No detectable As, Be, or Pb concentrations were found in fish above the reporting limit. Fish significantly accumulated Al and Mn from baseline conditions in all canyons. In addition, caged-fish accumulated Fe, Mg, Se, and V in Los Alamos Canyon; Cu, Fe, Hg, Se, and V in Sandia Canyon; Cd and Cu in Pajarito Canyon; and, Ba, Cu, Fe, and Ni in Valle Canyon compared to baseline conditions. Mean concentrations reported in fathead minnow were compared to concentrations found in fish collected nationwide (Schmitt *et al.* 1999) and in fish fillets collected regionally (Table 27). Fish had previously acquired concentrations of Cd and Zn from the CERC facility prior to shipment and subsequent exposure, and these concentrations of Cd and Zn were greater than those found in fish sampled nationwide. None of the other comparable contaminant (*i.e.*, Cu, Hg, Se) concentrations in fathead minnows were greater than the 85^{th} percentile concentration in fish sampled nationwide. With the exception of Ba, and Cr, fathead minnows contained concentrations similar to those reported as background in fish fillets collected from the Rio Grande above the LANL (Table 27). However, the metals in these fish had bioaccumulated their body burdens in only 2 months. Additional exposure time might increase or decrease the steady-state concentrations. Only concentrations of PCBs in fathead minnows were above the dietary levels of concern for predatory wildlife.

PCB Accumulation in Caged-Fish

PCBs do not occur naturally in the environment. PCBs have been used as hydraulic lubricants, insulators, heat transfer fluids, dielectric fluid for transformers and capacitors, pesticide extenders, dust-reducing agents, flame retardants, sealants, and organic diluents (Hutzinger 1979). PCBs are a complex mixture of 209 isomers and congeners with 1 to 10 chlorines attached to the biphenyl structure in various arrangements. Aroclors are commercial PCB preparations that were produced up until 1977 by the Monsanto Chemical Company that contained various amounts of chlorine by weight.

The commonly reported analytical methods used by the LANL for PCB detection and quantification (*e.g.*, LANL 1995c, 1996a; Gonzales *et al.* 1999) in environmental samples relies on matching a pattern of peaks to series of Aroclor standards. Due to differences in degradation, partitioning, and metabolism, the PCB pattern in environmental samples can be very different from these Aroclor standards, making identification and quantification of PCBs difficult and making ecological risk and human health assessments questionable (USEPA 1997c; Valoppi *et al.* 1999). The importance of PCB congener-specific information has become more evident as the toxicities of individual congeners are defined (Gerstenberger *et al.* 1997). The analysis of whole organisms was considered by

Erickson (1993) to be the most accurate measure of PCBs present in the aquatic environment.

The Environmental Surveillance Program has reported no detection of PCBs in Sandia Canyon sediments collected at the edge of the LANL boundary for nearly two decades (LANL 1979, 1986, 1993, 1994, 1995c, 1996a, 1996b, 1997, and 1998a), though it was evident from this study and others that PCBs do occur in the environment on the LANL. Sandia Canyon sediment, in the stream section studied below the wetland, had elevated PCB congeners (up to 154 µg/kg DW as the sum of PCB congeners; Attachment A, Appendix A), compared with other canyon stream sediments (Figure 65). Concentrations of PCBs in Sandia Canyon sediment were greater than the threshold for effects to benthic fauna (40 µg/kg DW), but were below the probable adverse effects threshold to benthic aquatic life (400 µg/kg DW) reported by (MacDonald *et al.* 2000b). Recently, Bennett *et al.* (2001) reported that PCB concentrations in the Sandia Canyon wetlands was as high as 2,000 µg/kg WW. MacDonald *et al.* (2000b) reported that sediment concentrations over 1,700µg/kg DW had a 82.5 percent probability of toxic effects to the community of benthic fauna, and their average survival would be less than 70 percent. Screening action levels for sediment quality that do not explicitly include the protection of benthic aquatic life have a high probability of impairing the water quality necessary to protect aquatic life as well as degrading the biological integrity of a stream or wetland.

PCBs accumulate from sediment and water to animals in the food web because they are highly lipid-soluble and persistent in the environment. PCBs have been shown to adversely affect reproduction in fish, wildlife, experimental animals, and are toxic to people (Eisler 1986b; Hoffman *et al.* 1996; ATSDR 1996). Other common adverse effects in wildlife include thymic atrophy, enzyme induction, nervous systems dysfunction, behavioral abnormalities, liver injury, estrogenic activity, endocrine disruption, immunosuppression, crossed bills, hepatotoxicity, and tumor promotion (Eisler 1986b; Eisler and Belisle 1996; Hoffman *et al.*1996; Niimi 1996). PCB congener-specific biological responses have been demonstrated through enzyme induction, estrogenic effects, hormone alterations, reproductive failure and numerous other adverse effects at extraordinarily low concentrations (*e.g.*, <1 part per quintillion in water and <50 µg/kg as falcon diet; Hoffman *et al.* 1996).

Although total PCBs (*i.e.*, the sum of the PCB congeners) are those that are discussed in this study, congener-specific data are reported in Attachment A. The concentrations of PCBs bioaccumulated in a composite of 5 fish from Sandia Canyon in 1 month were elevated (1.5 µg/g WW [or 1.2 µg/g WW with baseline removed]). Fish had previously acquired concentrations of PCBs prior to site exposure (baseline = 0.3 µg/g WW), but concentrations continued to accumulate in Sandia Canyon, and after 1 month. This concentration was greater than the geometric mean of PCBs in fish sampled nationwide

(~0.3 μg/g WW as Aroclor 1254; Schmitt *et al.* 1999). To protect wildlife and aquatic predators, Eisler (1986b) recommended that whole body fish concentrations be less than 0.3 μg/g WW, however these concentrations may not be acutely toxic to the fish themselves (Niimi 1996).

The quality of a water body can also be reflected by the relative safety for consumption of fish by people and wildlife. The concentrations of PCBs in the caged-fish could pose a risk to wildlife or people that could regularly eat them - this does not imply that consumable fish occur on portions of Sandia, Pajarito, and Valle Canyons. Rather, should wild biota taken from Sandia Canyon contain PCB concentrations equivalent to those found in the caged-fish, then there would be concern for human health and wildlife that would consume site-biota regularly. For example, the USEPA (1997a) recommends that adults do not eat even a small amount of fish tissue (<114 grams per month) containing > 0.7 μg/g WW of the PCB Aroclor 1254 (Figure 65). The USEPA (1997a) recommends that children eat even less fish containing > 0.2 μg/g WW of the PCB Aroclor 1254. It is also possible that the maximum tissue concentrations of PCBs in the caged-fish had not likely reached steady-state during the month-long exposure time (USEPA 1998e) and their body burdens could increase in a year.

Similar health risks could be posed to piscivorus wildlife or other predators that would have fed on these caged-fish or other aquatic biota with an equivalent PCB concentration from Sandia Canyon (*e.g.*, invertebrates, amphibians, riparian mammals). Embryo toxicity and reproductive impairment appear to be the most sensitive health risks for avian species exposed to PCBs (Hoffman *et al.* 1996). The primary exposure to the developing embryo results from the maternal transfer of bioaccumulated PCBs to the egg. Consequently, PCB concentrations in the egg may be the most useful measurement for estimating potential reproductive effects in species of concern. No information was collected during this study on the concentrations of PCBs in eggs from birds associated with Sandia Canyon stream and wetlands. However, using the fish-to-egg biomagnification factors provided by Hoffman *et al.* (1996), the PCBs measured in the caged fish from Sandia Canyon could result in total PCB concentrations 32 times greater (~38 μg/g WW total PCBs) in avian eggs. Field studies measuring exposure and effects in avian eggs indicates that concentrations ranging from 1 to 8 μg/g WW in terns, eagles, and falcons begin to result in embryo mortality, impaired reproductive success, edema, deformities, and mortality. Fair and Meyers (2000) reported that western bluebirds (*Sialia mexicana*) that resided and fed in Sandia Canyon had a thinner eggshell thickness index and eggs that were smaller than at other locations on the LANL. Of the species studied, bluebirds were reported by Hoffman *et al.* (1996) to be one of the least sensitive species, suggesting additional avian population effects, particularly to insectivorous bird populations, could occur in the Sandia Canyon Watershed and perhaps downstream, if PCBs are exported to the Rio Grande.

Because PCBs are difficult to detect in water and sediments (*i.e.*, no routine scans of sediment and water at the edge of the LANL boundary have found PCBs), biological samples, which accumulate PCBs, should be concurrently collected and analyzed for PCB congeners, in order to increase the probability of detecting PCB contamination, to identify the presence of those PCB congeners that are toxicologically relevant, and to provide complementary lines of evidence in understanding PCB fate, transport, and effects to biota in Sandia Canyon as well as to the receptors in the ecosystems downstream. Although initial clean up of PCBs in the Sandia Canyon watershed has been initiated in the headwaters (USDOE 2001), the PCB contamination identified in this study was further downstream, below the Sandia wetlands. PCB contamination, therefore, will likely continue to bioaccumulate in existing aquatic life and be consumed by wildlife. Also, PCBs could move downstream during storm events to the Rio Grande where it may bioaccumulate in fish and potentially affect their consumers. Although the sources of PCBS were not identified, the NMED (2001b) recently reported that concentrations of PCB congeners in Cochiti Reservoir fish tissue would exceed the USEPA-recommended screening value for the protection of human health from long-term consumption of PCB-tainted fish.

RESULTS OF THE HABITAT EVALUATIONS

Basin-wide factors, such as physiographic province, ecoregion, and climate were generally similar among the stream segments examined in this study, and therefore microhabitat features, such as substrate or available cover, were considered to be the primary influence on overall fish carrying capacity of a particular stream. Features such as discharge, flows, water depth, bottom substrate and embeddedness, riparian and in-stream cover are often the primary parameters that define suitable habitat for the majority of fishes. Additional parameters such as channel width, percentage of pools and riffles, bank stability, and general channel dimensions have also been reported as important (Idaho DEQ 1996).

Physical Habitat

The following excerpt from Beschta and Platts (1986) provided a good overview of the importance of some of the morphological features of small streams needed to maintain a stable stream and healthy fishery:

> Unit stream power, defined here as the loss of potential energy per unit mass of water, can be reduced by adding stream obstructions, increasing channel sinuosity, or increasing flow resistance with large roughness elements such as woody debris systems, logs, boulders, or bedrock. Notable morphological features of small streams are pools, riffles, bed material, and channel dimensions. Pools, which vary in size, shape, and

> causative factors, are important rearing habitat for fish. Riffles represent storage locations for bed material and are generally used for spawning. The particle size and distributions of bed material influence channel characteristics, bedload transport, food supplies for fish, spawning conditions, and rearing habitat. Riparian vegetation helps stabilize channel structure and contributes in various ways to fish productivity.

According to Karr and Dudley (1978), there are four major components of a stream system that determine the productivity of the fishery: 1) flow regime; 2) physical habitat (*e.g.*, channel form, substrate, riparian vegetation); 3) water quality (*e.g.*, temperature, pH, pollution); and, 4) energy inputs from the surrounding watershed (*e.g.*, nutrient and organic matter influx). Deficiencies in one or more of these habitat characteristics limit a fishery. For example, water depths and variations in discharge (flood levels versus summer low-flow) would have likely influenced any distribution of fish within each canyon stream studied. A study by Meador and Matthews (1991) found that even with drastic seasonal fluctuations in discharge, abundance of fish species remained relatively constant over time, but the fish varied their spatial habitat associations in response to water volume. A critical feature to the stability of fish populations in streams with varied discharge, as is found in the southwest, is the availability of pools that hold perennial water sources. Pools represent critical refugia that allow fish to survive in a stream that may, for a period of time, have extremely poor overall habitat conditions.

<u>Precipitation and Flow Regimes</u>

Precipitation during 1997 (64.8 cm) was above average (47.5 cm), due to several high intensity rainstorms in August, and from above-average snow accumulation during the previous winter (Figure 66). However, because the sandy soils in the canyons were fairly permeable and have low water holding capacities, stream flow increases were "flashy" as flows increased rapidly, then decreased to pre-storm levels within a day. Discharge data collected by the Oversight Bureau (Dale 1998) also indicated that while flows were higher in 1997 than 1996, they were fairly typical when compared to the high flow regime measured in 1994 and 1995.

The amount of useable habitat in a stream system is partly a function of the flow regime, so the quantity and quality of a fishery can vary according to seasonal flow fluctuations. Since stream flow measurements were only collected once in this study, useable habitat estimates would be valid only for the 1997 flow regime. However, because the actual mean seasonal flows were similar to historical values and, these streams were small and only moderately entrenched (with the exception of the upper reach of Sandia Canyon), habitat availability would likely not change markedly with moderately increased or decreased discharge. Therefore, fish habitat determined in 1997 could be considered a good representation of typical habitat conditions. Furthermore, if flows were higher than usual in 1997, useable habitat would not necessarily be greater at higher flows. While higher flow rates increase total cross sectional areas, high velocity regions are often unuseable by fish, and thus useable habitat can actually be lower during high flow regimes.

Mean flow velocities in all canyons ranged from less than 0.1 m/s to 0.3 m/s (Figure 67). Flows over riffles were similar to mean flows, except in Los Alamos Canyon, below the reservoir. This reach contained numerous narrow, shallow, riffles. Mean pool flows were all positive, but there were still zero flow regions in most pools measured, which provide resting and hiding areas for fish, and potential accumulation points for organic matter. For this study, mean discharge, calculated from flow velocity, depth, and width measurements, was greatest in Los Alamos Canyon (~2 cubic feet per second [CFS]), followed by Sandia Canyon and Pajarito Canyon (~0.5 CFS), and was lowest in Valle Canyon (~0.1 CFS) (Figure 68). Using 5 years of discharge data reported by Shaull *et al.* (1996a, 1996b, 1998, 1999, 2000), the mean annual discharge in Los Alamos Canyon at Gaging Station E025 was 2.2 CFS, and in Pajarito Canyon at Gaging Station E240 was 1.5 CFS. Recently, discharge monitoring stations closer to the LANL Water Quality Assessment sites have been added.

Instream Habitat

In 1997, the wetted width of all streams but Valle Canyon was 1 - 2 m (Figure 69). Valle Canyon was consistently narrower, ~0.6 m. Mean thalweg depths ranged from 0.05 to 0.12 m, with maximum depths in pools of 0.12 to 0.24 m (Figure 70). In addition to stream discharge and flow, water depth, and bed substrate (described below), other major microhabitat features that influence fish distribution and biomass were the percent glides, riffles, and pools (Figure 71), types and percentages of cover (Figure 72), and bank vegetation coverage (Figure 73). Although the basic channel geomorphology was similar among sites, the quality of the habitat varied in each stream. Variations were at least partially due to differences in water flows and surrounding topography. As discharge increases, the percentage of glides will probably increases due to the innundation of gravelly riffle areas. Additional pools may form in some areas with increases in discharge, but lack of drop structures and dams would prevent any large percentage increase in pool habitats.

For all the canyons, habitat was dominated by either glides or riffles. Riffles are a primary area for generating food, especially insects (Waters 1969) as well as an area for spawning fish. Mean percent pools ranged from a high of ~30 percent in the lower reach of Sandia Canyon, to <5 percent in the upper reach of Valle Canyon. Beschta and Platts (1986) suggested that pools were the major stream habitat feature selected by most fish. Elser (1968) noted that deep, slow-moving pools with large amounts of overhanging cover support the highest and most stable fish populations. Finally, Platts (1974) stated that,

> . . . high-quality pools supported the highest fish biomass. In the South Fork Salmon River drainage of Idaho, pool quality was an important factor accounting for variation in total fish numbers. High-quality pools alone, however, do not make the fishery. Pools of all shapes, sizes, and quality are needed. Young-of-the-year fish need shallow, low quality pools the other fish will not use.

All three canyons in the LANL could provide at least some low-flow/zero-flow habitats necessary for early lifestage fish and as refugia from spates. Likewise, pools could also provide refugia during low flows/drought and hard winter freezes, allowing fish to survive limited periods when overall habitat was sub-optimal. For instance, all canyons except Valle Canyon contain several large pools that could support fish even if flows in riffle and glide habitat temporarily stopped or had winter ice cover. Although Valle Canyon does contain a few, small pools, the pool habitat provided was poor when compared to the other canyons.

Cover

Another important habitat feature for most stream fishes is availability of cover. Fish cover may be in the form of instream objects, such as rocks, logs, and vegetation or bank undercuts and vegetation. At least 10 percent of every stream reach examined contained suitable fish cover, and cover was typically greater than 25 percent. At most sites, bank cover dominated, primarily from overhanging vegetation, although Sandia Canyon had a significant undercut bank component. Bank vegetation type varied among the sites, sometimes dominated by trees (*e.g.*, Sandia Canyon), and in others by shrubs (*e.g.*, Los Alamos Canyon) or grasses (*e.g.*, Pajarito and Valle Canyons).

Detailed vegetation surveys were not conducted for this study. However, general observations of the dominant species and vegetation cover were recorded for each stream segment studied. At the time of study, the stream segments examined were mostly within heavily vegetated areas. Overstory vegetative cover was, on average, greater than 75 percent conifers (*i.e.* spruces, firs, and ponderosa pine) with an additional 20 percent coverage by deciduous trees (Figure 74). Likewise, understory vegetation coverage was also extensive, largely dominated by small conifers in Los Alamos, Sandia, and Pajarito Canyons. Mixed deciduous vegetation dominated Los Alamos Canyon, below the reservoir, and oaks (*Quercus spp.*) dominated the understory in Valle Canyon (Figure 75). Sandia Canyon also frequently contained numerous water birch (*Betula occidentalis*). Consequently, shade likely reduced instream plant growth, and thus reduced *in situ* or autochthonous organic matter production. These systems are therefore likely heterotrophic, with most of the energy input (organic matter) coming from the surrounding watershed. Bacteria, fungi, and invertebrates decompose and feed on pine needles, leaf matter, and other organic debris, and predators, in turn, feed on these organisms. The decomposer community forms the food base for the fish that inhabit or could inhabit these streams, as well as downstream.

Substrate

The topography and land use of an area largely determines the rate at which substrate is moved. Within streams, substrates are likely transported in a "leapfrog" pattern, where particles move various distances over the streambed transported on the rising of flow and depositing on receding flow, or as suspended solids during turbulent flow (Wesche 1993). The stream segments studied on the LANL were lined with sand, gravel, pebbles, cobbles, and boulders derived from erosion and deposition from the surrounding mesa tops, canyon walls, and from upstream sources.

Substrate characteristics were measured in detail for this study and included percent of various sediment size classes, distribution in various habitat types (Figure 76; corresponding to different flow regimes), and embeddedness of larger substrates by fine materials. The mean substrate sizes in each canyon were relatively similar, with the exception of Sandia Canyon (Figure 77). Most canyons were dominated by sandy and gravely substrates with some cobbles and larger boulders. Although Sandia Canyon also contained these same fine-grained substrates, especially in the upper stream reach studied, many of the lower transects were dominated by bedrock. Following storm events, sediments were likely scoured from the surface of one bedrock area and deposited downstream. Unstable sediment could make invertebrate colonization and fish spawning difficult. However, in stream segments other than Sandia Canyon, embeddedness was low, and at least 25 percent of the substrate material was gravel or larger, resulting in good habitat for invertebrate colonization and fish spawning (see the results of the habitat model below, for details on habitat suitability).

Habitat Suitability Index Model Results

Preferred Trout Habitat and the Brook Trout HSI

The HSI scores for adult brook trout (Table 28) ranged from 0.05 (Valle Canyon) to 0.75 (Los Alamos and Sandia Canyons) and ranged from 0.30 to 0.85 for juvenile brook trout (Figure 78). Average stream depth (only for the adult fish), percent pools, and pool class were the limiting habitat features identified for adult and juvenile trout in Pajarito Canyon (Figure 79), Valle Canyon, and Los Alamos Canyon, below the reservoir. Individual suitability scores for adult brook trout in Pajarito Canyon were close to optimal for most other habitat features. The HSI scores for brook trout fry (Figure 78) were consistently high in all canyons (>0.7), but scores for eggs (Figure 78) were consistently lower (~0.5) due to a lack of preferred gravel sizes and embeddedness.

Brook trout tend to inhabit higher elevation, colder streams than other fish, such as rainbow and brown trout and dace (Gard and Flittner 1974), and will occupy the shallowest of waters. Water depth and flows, amount of pool area, and cover were considered the most important habitat features for brook trout (Raleigh 1982). However, brook trout are highly adaptable to a variety of aquatic environments and exhibit marked differences in growth rate throughout their range (they have a propensity to stunt in small stream habitats) (Raleigh 1982; NMDGF 1998). Raleigh (1982) reported that brook trout inhabiting narrow and cold streams tended to be small and short-lived (3-4 years), whereas brook trout in larger rivers and lakes tend to be larger and live longer (8-10 years). Brook trout may spend their entire lives in a restricted stream segment, moving only to avoid extreme temperatures or other fish (Raleigh 1982).

Brook trout preferred water depths greater than ~8 cm (Raleigh 1982). Wesche (1974) studied two small streams in Wyoming and found that while most of the trout preferred depths from 15-46 cm, about 10 percent of the brook trout surveyed occupied shallower depths. Several studies of cutthroat trout have also noted that standing stocks tended to be greater in pools and glides than in riffles (Glova 1987; Ireland 1993; Herger *et al.* 1996), although smaller trout seem to remain near instream cover in the form of large cobbles in riffle areas (Beschta and Platts 1986; Rinne and Minckley 1991). Brook trout will also inhabit ponds and pools (Winkle *et al.* 1990; NMDGF 1998). Enhancement of pool area, depth, and cover is a common management practice to enhance trout habitat (NMDGF 1998).

During winter, when fish may face extremely low temperatures (and become lethargic), some fish will seek deep crevices in the streambed for protection from the current, from the effects of ice, as well as from other predators (Orth and White 1993). Ponds and large pools may provide warmer, more optimal temperatures for growth, as well as overwintering habitat. Winter stream conditions can limit brook trout populations. Excessively low water temperatures are probably not a limiting factor for brook trout in the Southwest, considering that brook trout are commonly found in far colder streams in Alaska. Chisholm *et al.* (1987) noted that in Wyoming's high elevation streams, absence of extensive surface ice is important in determining suitable trout habitat. Fish also preferred pools with some cover, and tended to move downstream to deeper waters with lower flows (<0.15 m/s), presumably more so if adequate pool habitat is not available.

The optimal temperature for brook trout growth and feeding reported in the literature varies from 13-19 °C, but they typically do poorly in temperatures exceeding 20 °C for extended periods of time (Baldwin 1956; Sublette *et al.* 1990). Warm water temperatures, however, may be limiting, especially when ambient air temperatures remain elevated for long periods. An evaluation of thirteen fish species, including both cold and warmwater species, noted that temperatures selected or avoided by fish declined as the acclimation temperature got colder from summer to winter. For brook trout, at an acclimation temperature of 24 °C (near the upper lethal limit for brook trout), fish avoided temperatures above 25 °C and below 18 °C, whereas at an acclimation temperature of 12 °C, fish avoided temperatures above 16 °C and below 9 °C. For a given acclimation temperature, brook trout will remain in waters with temperatures ranged no more than 7 to 9 °C (Cherry *et al.* 1975). Upper limit temperature tolerances may also be higher for brook trout introduced to the southwestern United States. A study by Lee and Rinne (1980) found that brook trout were as well adapted to elevated water temperatures as native Gila trout (*Salmo gilae*) or Arizona trout (*S. apache*), and could even tolerate temperatures as high as 28.7 ± 0.7 °C with fluctuations of 22 to 28 °C. Acclimation of trout to higher water temperatures increased their temperature tolerance downstream of natural sources (Woodward *et al.* 2000). Therefore, slowly rising temperatures may acclimate fish, allowing them to inhabit waters with higher temperatures than would typically be selected by coldwater fish.

Many trout in New Mexico spawn shortly after snowmelt, and the young hatch and grow rapidly in early summer prior to the onset of summer rains (Rinne and Minckley 1991). Brook trout, however, typically spawn in the fall, the eggs overwinter, and they do not hatch until the following spring. While brook trout prefer spawning habitat to include groundwater upwellings, "pea to walnut" sized gravel, and nearby cover, they will spawn in sub-optimal habitats (Moyle and Baltz 1985). If access to stream spawning gravels is denied, brook trout can spawn in sub-optimal substrate as long as there are some groundwater upwellings (NMDGF 1998). Spawning success was poorest as substrate embeddedness increased (more fines) and intergravel oxygen levels dropped (Raleigh 1982). Emerging fry occupied similar habitats to adults in low-flow areas, as well as preferred some groundwater upwellings (Raleigh 1982).

Preferred Dace Habitat and the Dace HSI

The HSI scores for dace (Table 29) were all quite low (~0.2) indicating that dace habitat is only marginal (Figure 80). The primary limiting factors for dace habitat suitability was the lack of velocity of flow in riffle habitats (Figure 81). Dace generally prefer riffle habitats with higher velocity flows than were present in the stream segments studied.

The longnose dace (*Rhinichthys cataractae*) is among the most widespread minnow species in North America. They are native to middle and upper elevations of the Rio Grande, Pecos River, and Canadian River drainages (Sublette *et al.* 1990). They are small fish (typically 6.3 to 8.8 cm), and tend to inhabit cool to cold, swift-flowing, headwater streams, with depths generally less than 30 cm, over gravel/boulder substrates. Dace may also inhabit lakes and slower waters, especially when competing species are absent, but flowing water (>45 cm/sec) is part of their preferred habitat. Preferred water temperatures were 15 to 21 °C, but they have been collected from streams with water temperatures as high as 22.7 °C. They are mature at age 2, and generally live for 4 years (Edwards *et al.* 1983; NMDGF 1998).

Eggs are demersal, adhesive, transparent, and are laid in natural depressions; hatching in 7 to 10 days at 16 °C (McPhail and Lindsey 1970). Young are initially pelagic, inhabiting slow, shallow, protected regions, but will move to swifter water within a few weeks (Gee and Northcote 1963). Reproduction is bimodal in *R. osculus* (speckled dace) in the Chiricahua Mountains, Arizona, with peaks in early spring and late summer. Spawning timing can be affected by water flows (flooding) and food availability. John (1963) reported that late summer floods induced spawning by dace.

Habitat Quality Discussion

Typically, habitat evaluations are used to assess how healthy or productive a particular fish community is, or assess the impacts of a natural or anthropogenic alteration of that habitat. In the LANL Water Quality Assessment, an unusual and hypothetical question was asked, "Could the stream segments examined in this study support a fishery?" The questions were not, "What kinds of fish would inhabit such streams?" Or, "How much suitable habitat would be required to sustain a coldwater fish population?" But rather, the questions related to a relatively generic statement regarding the potential for a fishery (as the term is used by the NMWQCC [1995]) to occur in the water bodies at the LANL. For instance, the NMWQCC (1995) defined a coldwater fishery as:

> "A stream reach, lake or impoundment where the water temperature and other characteristics were suitable for support or propagation or both of coldwater fishes, such as but not limited to, longnose dace, roundtail chub, Rio Grande chub, Rio Grande Sucker, brown, Gila, cutthroat (including the native Rio Grande cutthroat), brook or rainbow trout, or speckled dace."

Additionally, the NMWQCC (1995) identified a high-quality coldwater fishery as:

> "A perennial stream reach in a minimally disturbed condition which has considerable aesthetic value and is a superior coldwater fishery habitat. A stream reach to be so categorized must have water quality, stream bed characteristics, and other attributes of habitat sufficient to protect and maintain a propagating coldwater fishery (*i.e.*, a population of reproducing salmonid)."

A sustainable fish population is not explicitly required when defining a fishery, and therefore, was not specifically addressed by the LANL Water Quality Assessment. Determining the propagation capability of a fish population in stream segments on the LANL was beyond the scope of this study and would have required several years of data to quantify relationships between instream flow and available habitat (see Bovee 1982, 1986). Therefore, no attempt was made to predict weighted useable area, or other indicators of the expected size of a fish population.

The HSI model for brook trout was developed including data from many western streams, but likely did not consider some of the unique habitat features of the semi-arid Southwest. Thus the HSI score of 0.8 for Los Alamos Canyon (rather than the maximum score 1.0) may have indicated: (1) that brook trout habitat in Los Alamos Canyon may not be optimum, even though reasonable numbers of brook trout were present, or (2) that the HSI model was not perfectly suited to predict optimum brook trout habitat in this area. Therefore, the HSI scores for the other canyon streams on the LANL were not adjusted by the amount derived by assigning a maximum HSI score of 1.0 to Los Alamos Canyon.

Ultimately, the habitat suitability of these stream reaches for fish could only be conclusively established by introduction of fish into those streams, followed by annual monitoring of survival, growth, and reproductive success. Fish populations in a particular area adapt to their habitats, so generalized models such as the HSI can only approximate the general habitat characteristics associated with a particular species. Fish in specific geographic areas adapt to localized habitat conditions, and thus could occupy habitats that a generalized HSI would predict is unacceptable.

Habitat in Los Alamos Canyon supported an apparently self-sustaining population of brook trout. The presence of the Los Alamos Reservoir may give these brook trout important refugia for sustaining the population that the other streams do not have. However, the year-round presence of brook trout observed and surveyed throughout the stream segment as well as the absence of rainbow trout in this same segment suggested that these two species have segregated into different habitats. Rainbow trout (*Oncorhynchus mykiss*) compete with, and frequently excluded, brook trout from water bodies accessible to both species. Rainbow trout encroachment has markedly reduced the brook trout's native range in the United States (NMDGF 1998). The larger rainbow trout stocked into Los Alamos Reservoir were likely too large to move very far upstream in Los Alamos Canyon, thereby leaving that habitat available for the smaller brook trout. Consequently, brook trout were likely excluded from the reservoir, and given their small size, they would be vulnerable as prey. These brook trout, survived in the Los Alamos Canyon stream segment studied, and it had similar habitat to those in the stream segments studied in the other canyons.

While there are many different approaches to evaluating fishery habitat, most had a core set of measurements in common, such as water temperature, current velocity, discharge, water depth, percent pools/glides/riffles, type and quality of pools present, cover type, bank (channel) stability, bed substrate, and food availability (*e.g.*, Binns 1978; Idaho DEQ 1996). More detailed metrics were added in the LANL Water Quality Assessment to evaluate habitat requirements for particular fish species, and to further investigate the health, diversity, and ecological integrity of a stream. In general, though, if water was deep enough, had a reasonable flow, provided a diversity of hiding, resting, foraging, and spawning locations, and had a channel that was reasonably stable, it was considered likely that a fish population would be present or potentially supported there.

Most habitat models were developed for use in limited areas, such as individual States or Ecoregions. While numerous habitat variables were typically examined, most models were generally tailored to include only those variables that were considered limiting in a particular region. For example, an alternative HSI model was designed for the high-altitude streams found in the Southern Blue Ridge Province (SBRP) in the Southeast United States by Schmitt *et al.* (1993). Schmitt *et al.* (1993) chose not to include variables such as stream flow or depth because the variables of elevation, gradient, and pH correlated better with fish biomass. This particular simplification worked for the Southeast, because there is a consistent and predictable relationship between elevation and gradient with water depth and discharge. That same predictable relationship does not hold for many streams in the Southwest, so HSI scores generated using the simplified model may be inaccurate. For example, using the SBRP HSI, scores were generated at ~0.8 for every stream segment studied on the LANL, even though the results of the Raleigh (1982) HSI model, and observations made by the USFWS biologists, suggested that it was unlikely that fish habitats were equivalent in all four canyons. Therefore, the SBRP HSI model was considered inappropriate for this assessment or for use in other montane streams of New Mexico.

Calibration and Validation of HSI Models

There is potential for variation in HSI scores due to measurement variability and the influence of changes in each parameter on the overall HSI scoring. The potential effects of measurement bias and natural parameter variability on the overall calculated HSI score was estimated. Measurement variability in actual habitat parameter measurements was based on the variability in a particular habitat parameter measurement that would result in a 0.1 unit change (10 percent) in the corresponding Suitability Index (SI) score. For example, temperature measured in the 10-16 °C range would all yield an SI score of 1.0, but for measured temperatures less than or greater than this range, a change in temperature of ~1°C would result in a 0.1 change in the SI score. Precision of temperature measurement was typically ±0.1°C, so measurement bias was unlikely to significantly affect the overall HSI scoring. Natural temperature fluctuations, however, may vary by several degrees over the course of a day, which, if temperatures were near the outside limits of the 1.0 SI score (10-16 °C), could change the SI score by 20 percent (0.2 units). As a validation of the HSI approach, Table 30 presented the optimal, worse-case, and range of HSI model parameter scores with the habitat associations reported by the New Mexico Department of Game and Fish (NMDGF 1998) and the Habitat Quality Index (Binns 1978).

Other Habitat Considerations

The steep, >250-m drop from the Pajarito Plateau into White Rock Canyon containing the Rio Grande (Figure 4), as well as the occurrence of ephemeral segments in most of these canyons, likely prevents the natural migration of fish from the Rio Grande. Such barriers are not an unusual situation in the western United States. The absence of fish or depauperate fish fauna in many western streams is often explained by geographic isolation due to cliffs, waterfalls, or mountain ranges (Smith 1981). Existing fish populations in many isolated southwestern streams were the result of fish migrating into these streams when sea levels were significantly higher, when temporary formation of lakes were caused by obstructions (*e.g.*, lava flows) across rivers, or by dispersal over drainage divides (Rinne and Minckley 1991). In some areas of the United States, fish introductions by people would be more important than ecoregional delineations in determining fish distributions (Maret *et al.* 1997). It would be reasonable to postulate that some fish populations may have persisted in the intermittent streams on the Pajarito Plateau for a time after geological isolation. However, extreme droughts or floods as well as groundwater pumping and subsequent alteration of surface water flows, grazing impacts, pollution, and over harvest may have eliminated any such isolated fish populations. Without a sustained connection to larger, fish-bearing waters, such as the Rio Grande, and lacking any augmentation by people, fish would probably not be able to naturally re-colonize these streams.

Flooding is also an important factor structuring aquatic communities in streams. Streams that are hydraulically complex (*i.e.* those that have greater hydraulic resistance and storage, pool volume, channel variability, and woody debris) with lower intensity floods will lose fewer fish, but community resilience is also dependent on the timing of spawning in relation to the timing of flood events (Pearsons *et al.* 1992). For example, Pearsons *et al.* (1992) found spring-spawning fish, such as rainbow trout, would be adversely affected by a spring flood than would fall-spawning fish, such as brook trout.

Overall, physically harsh and unpredictable environments, subject to disturbances from floods or drought, are likely to have lower fish species diversity and reduced populations. Nonetheless, a fishery can be remarkably persistent despite floods causing physically harsh and unpredictable habitat conditions (*e.g.*, John 1964; Rinne 1975; Ross *et al.* 1985; Pearsons *et al.* 1992). Habitat use by fish affected by physically harsh conditions may be less structured than in more benign systems (Rinne 1975; Ross *et al.* 1985). In a study of fish in streams of the Chiricahua Mountains in Arizona, flash-floods and drought significantly affected population dynamics and presumably reduced species diversity, but did not entirely eliminate the fishery (John 1964). Fish community persistence was greater in benign environments, than in harsh environments, although habitat use was less structured in harsh systems (Ross *et al.* 1985). Ross *et al.* (1985) pointed out four factors that affect fish community persistence: 1) high intrinsic rate of reproduction resulting in rapid repopulation by survivors of the environmental perturbation; 2) rapid return to areas dewatered during drought; 3) highly developed, refuge-seeking behavior during drought; and, 4) increased physiological tolerance to environmental change. Ross *et al.* (1985) reported that in lower elevation warmwater fisheries, fish communities were persistent, but less stable in a stream suffering from reduced or eliminated water flows and elevated water temperatures.

Younger fish are most vulnerable to flood mortality, while older and larger fish generally were displaced downstream, but not killed (John 1964; Rinne 1975). Rinne (1975) reported that fish in the streams of the Chiricahua Mountains, including speckled dace (*R. osculus*), *Agosia* spp., and *Campostoma ornatum*, spawned in early spring or late summer, and depending on conditions, they might spawn twice. The most damaging scenario to fish populations would be if fish spawned in the spring and experienced flood mortalities, and then were faced with another flash flood (John 1964; Rinne 1975). As the LANL stream segments are isolated, with natural immigration being unlikely, repeated flash floods could reduce and perhaps eliminate any isolated fish populations. However, habitat, while not ideal at all locations, did not preclude the use of these streams by a small population of fish (*i.e.*, HSI Scores were greater than zero).

In the semi-arid streams of the Southwest, drought may also adversely affect a fish population due to the combination of reduced habitat, food shortages, higher water temperatures, and reduced water quality conditions (John 1964). Crowding of fish into small, permanent pools can exacerbate these effects. Thus, potential fish populations would be expected to decrease during drought. However, if permanent pools were present, and allow even a small population of fish to persist, they could recolonize the stream during more optimal conditions. In such situations, stronger individuals would survive, and thus a more tolerant fish sub-population could develop more rapidly than in a less stressful environment.

Habitat Quality Index

In Wyoming, trout habitat and trout production is associated with a wide variety of streams. Binns (1978) used regression of trout biomass and 22 attributes characterizing trout habitat in streams to arrive at a Habitat Quality Index (HQI). Using the multiple regression equation described in Binns (1978), HQI scores were calculated for the stream reaches studied on the LANL. These HQI scores are a potential predictor of trout biomass (per Binns 1978) and the highest HQIs were from the Los Alamos Canyon (Figure 82). Scores for the other canyon stream reaches were roughly ⅓ to ¼ of those calculated for Los Alamos Canyon, suggesting a more limited biomass in these stream reaches. While the HQI methodology was generated from Wyoming streams, the HQI scores add to the weight-of-evidence that the LANL canyon streams have the potential to contain at least some fish biomass (although the predicted standing crop density would be as low as ⅓ to ¼ of the trout density that was found in the Los Alamos Canyon stream segment studied).

Invertebrate Habitat Assessment

For all stream segments but those in Sandia Canyon, the RBP habitat scores ranged from ~160 to 180 (Figure 83), indicating highly suitable habitat for invertebrate colonization. The lower suitability score associated with Sandia Canyon (~130) was driven by poor substrate characteristics, such as average size, embeddedness, and stability, as well as a high erosion potential. This did not mean that there would be no invertebrates present, but rather, that the community structure would likely be dominated by more stress-tolerant taxa. Results of benthic macroinvertebrate community assessments (Ford-Schmid 1999) indicated that the benthic macroinvertebrate community was moderately impacted, likely by pollution and degraded habitat conditions, as well as it contained more stress tolerant taxa (Cross 1995a).

Stream Geomorphology and Habitat Stability

According to the Rosgen (1996) classification scheme, Los Alamos Canyon was a "B" stream type, with moderate entrenchment, sinuosity, and width to depth ratio. The relatively steep slope of this channel type and predominance of gravel substrate resulted in a final classification of "B4A." The B4 type channel is relatively stable and does not normally supply high sediment loads. Valle Canyon was also a "B" type stream, but because of its more moderate slope it classified as a "B4" channel. Upper Pajarito Canyon also classified as a "B4" channel, while the lower reach of the segment studied was rated as a "B3" due to the predominance of a cobble substrate. Sandia Canyon classified as a "B2C" and "B2" channel, for the upper and lower reaches of the segment studied, respectively, due to the boulder and bedrock substrate common in this channel. Normally stable versions of these channel types would contribute minor quantities of sediments downstream, but the highly erodible banks in some sections of Sandia Canyon combined with the scoured bedrock bottom likely resulted in higher sediment transport during high flow events (that were found commonly in the segment studied). Los Alamos, Valle, and Pajarito Canyon stream segments ranked as fairly stable, whereas the Sandia Canyon stream segment ranked as unstable, especially the upper portion of the segment, near the upstream wetland. Therefore, this suggested that the stream habitat in Sandia Canyon was unstable and more prone to disturbances than the other streams studied. This evaluation of the stream channel stability was also used to allow predictions of the stability of the measured habitats over time.

RESULTS OF THE WATER QUALITY INDEX DEVELOPMENT

The values assigned, and the summary indices of biological, chemical, and physical quality are provided in Table 31, Table 32, and Table 33, respectively. The Index of Biological Quality for Valle, Pajarito, Sandia, and Los Alamos Canyons was 42, 48, 38, and 60. This suggests that the integrity of the aquatic community is 70 percent in Valle Canyon, 80 percent in Pajarito Canyon, and 63 percent in Sandia Canyon as compared to that in Los Alamos Canyon. Using the decision matrix in Table 18, aquatic life use was supported in Pajarito Canyon, but only partially supported in Valle and Sandia Canyons. The Index of Chemical Quality for Valle, Pajarito, Sandia, and Los Alamos Canyons was 33, 37, 31, and 41. This suggests that the chemical integrity of the water, sediment, and biota was 80 percent in Valle Canyon, 90 percent in Pajarito Canyon, and 76 percent in Sandia Canyon as compared to that in Los Alamos Canyon. Chemicals of concern identified were PCBs, Cr, Al, Fe, and explosives. The Index of Physical Quality for Valle, Pajarito, Sandia, and Los Alamos Canyons was 22, 24, 28, and 38. This suggests that the physical integrity of habitat for fish and benthic macroinvertebrates was 58 percent in Valle Canyon, 63 percent in Pajarito Canyon, and 74 percent in Sandia Canyon as compared to that in Los Alamos Canyon. Physical impairments in Valle Canyon and Pajarito Canyon were lack of adult or trout egg habitat. The unstable stream channel, sedimentation, and the embeddedness of the substrate reduced macroinvertebrate habitat, and the reduction of prey reduced the potential habitat for trout in Sandia Canyon.

When each of these biological, chemical, and physical quality indices are summed into a final Water Quality Index, Valle, Pajarito, Sandia, and Los Alamos Canyons' total scores are: 97, 109, 97, and 139, respectively. The final Water Quality Index of Valle and Sandia Canyon was 70 percent and Pajarito Canyon was 78 percent of the Los Alamos Canyon reference stream. When the chemical and physical quality scores are subtracted from the reference site, the amount of impact relative to the biological integrity can be gauged (Figure 84). Physical impacts were found at 37 percent, chemical impacts were found at 8 percent, and the resultant biological integrity of the Pajarito Canyon stream segment was 80 percent of that of the reference site. At the Valle Canyon stream reach, physical impacts were 42 percent, chemical impacts were 17 percent, and the resultant biological integrity was 70 percent of that of the reference site. At the Sandia Canyon stream reach, physical impacts were 26 percent, chemical impacts were 33 percent, and the resultant biological integrity was 63 percent of that of the reference site, suggesting that chemical impacts had a greater effect on the biological response and community than did physical impacts.

CONCLUSIONS

Currently, the designated uses of the intermittent streams that cross the LANL are livestock watering and wildlife habitat (NMWQCC 1995) and these designated uses do not include aquatic life (*i.e.*, fisheries) use. These intermittent streams have likely harbored aquatic life for millennia, though the benthic macroinvertebrate community has apparently only been formally studied since 1990 (Bennett 1994; Cross 1994a, 1995a, 1995b, 1996b, 1997; Cross and Davila 1996; Ford-Schmid 1996, 1999, and this study). Therefore, aquatic life is an existing use of these intermittent streams that should be protected. The protection of aquatic life is a basic mandate of the Clean Water Act.

The objective of the Clean Water Act (section 101(a)) is to "restore and maintain the chemical, physical, and biological integrity of our Nation's waters." In order to achieve this objective, it was declared that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and for recreation in and on the water be achieved. The USEPA (1995b) has suggested that the term "aquatic life" more accurately reflects the protection of the aquatic community that was intended in section 101 (a) of the Clean Water Act. If the designated uses of the intermittent streams that cross the LANL do not include protection of aquatic life, then the NMED may need to perform and submit to the USEPA the results of a Use Attainability Analysis.

Additionally, under New Mexico's Antidegradation Policy, no activity is allowable which would partially or completely eliminate an existing use whether or not that use has been designated in the State's water quality standards. Therefore, permits issued that might allow activities to commence without expressly protecting the aquatic life in these intermittent streams may need additional consideration. The USDOE, the USEPA and the State of New Mexico should determine if there is a need to conduct an antidegradation policy analysis or other review in order to identify if existing aquatic life uses of these intermittent streams are adequately protected by any planned or permitted activities.

Recreational Uses (Primary and Secondary Contact)

The aesthetic qualities of these canyon streams was an existing use; as evidenced by the recreation of LANL employees and citizens that was observed during the LANL Water Quality Assessment. Children were found to play in and around the Sandia Canyon stream. Some of the pools in this stream were of sufficient size for wading or bathing. In Los Alamos Canyon, extensive recreation was observed in the form of swimming, fishing, and ice skating in and on the Los Alamos Reservoir. Fishing upstream in Los Alamos Canyon is allowed on the Santa Fe National Forest. However, the USFWS did not evaluate the fecal coliform content of these waters, and no other information on fecal coliform content was provided. As fecal coliform content is an important criterion for the designation of recreational uses, the criteria for identification of use attainability was not met by the LANL Water Quality Assessment. Nonetheless, as primary contact in Los Alamos Reservoir was observed to occur, as was secondary contact in the intermittent stream segments, these uses should be considered existing.

Domestic Water Supply

No domestic water supply use was observed occurring in associated with these stream segments. Also, several constituents in water (that have domestic water supply water quality standards) were either not analyzed (*i.e.*, cyanide) or were analyzed using non-USEPA-approved methods (*e.g.*, tritium, total mercury, dissolved silver, and dissolved uranium). Therefore, statements as to the quality of these canyon stream waters for drinking water and domestic water supply was necessarily limited. However, using non-USEPA-approved methods, these constituents were reported by others (Dale 1998; LANL 1998a; Blake *et al.* 1995; this study) as being below domestic water supply standards. From the data available for the LANL Water Quality Assessment, only barium in Valle Canyon exceeded the domestic water quality standards for the State of New Mexico (NMWQCC 1995). With proper treatment, stream waters from Los Alamos, Sandia, and Pajarito Canyons could be made usable for a domestic water supply in the future and as these are source waters, this use should be considered and protected for downstream users.

Wildlife Habitat

Total mercury and total selenium, which are the applicable numeric standards for waters designated as wildlife habitat, were not analyzed by the USFWS at detection limits below the water quality standards or using USEPA-approved methods. However, no excess mercury or selenium accumulation was noted in the sediment or biota collected during the LANL Water Quality Assessment, suggesting that in the stream segments studied, selenium and mercury had not reached concentrations problematic for wildlife consumption. Concentrations of bioaccumulative contaminants of concern are best detected in biota due to the higher probability of detection (Phillips 1980). Dissolved mercury and selenium concentrations were also below the detection limits, but the water quality standards are based on total concentrations. All canyons offered stream habitat and water for wildlife to drink and bathe as well as offered food, ecosystem services, and shelter. The Sandia Canyon stream segment was found to contain PCBs at levels that led to bioaccumulation in caged-fish, which if accumulated in native biota, could present health risks to predatory wildlife that would consistently eat the aquatic life found there as food.

The majority of vertebrate wildlife species found in this region were found in association with the wetlands and riparian vegetation near the intermittent streams or tributaries. Of the 310 vertebrate species of the Jemez Mountains (Table 2), 7 percent were fully aquatic including 9 montane species of fish (with 14 other species found in the Rio Grande downstream). An additional 13 percent of these species were semi-aquatic, such as the amphibians, ducks, herons, and the American dipper, which were found in suitable habitat (lakes, ponds, streams, wetlands) on the Pajarito Plateau. For instance, waterfowl visited the standing bodies of water on the Pajarito Plateau as well as foraged along the Rio Grande and at other wetlands in tributary canyons. Birds and other animals of arid ecosystems and woodlands have been documented drinking frequently and bathing from temporary waters, springs, and other wetlands and many of these species were found using the LANL. Over 60 species of vertebrate wildlife were documented using artificial water bodies formed by waste water discharges for food, shelter, and drinking. Animals were found to make repeated, and long-duration visits to artificial water bodies on the LANL, even when access was partially restricted, or where the water was contaminated. For example, Hansen *et al.* (1999) reported that racoons entered a lagoon that was partially fenced and remained foraging there over 20 hours had accumulated tritium. Invertebrate surveys in the 4 stream segments examined identified 117 different benthic macroinvertebrate taxa which spend the majority of their life span intimately associated with these intermittent streams. Studies by the LANL, as well as qualitative observations made during this study, including actual sightings, and signs such as tracks, nesting areas, and scat, indicated use of these stream segments as habitat for a variety of wildlife species, including various birds, mammals, reptiles, and amphibians.

Livestock Watering

Tritium, total mercury and dissolved cobalt that are applicable to the livestock drinking water quality standards were not analyzed by the USFWS using USEPA-approved methods. However, dissolved mercury was not detected using USEPA-approved methods with detection limits below the livestock standard. Dissolved cobalt and tritium was analyzed by non-USEPA approved methods, so these constituents were not further addressed. Aluminum concentrations in Pajarito Canyon were greater than the livestock drinking water quality aluminum standard in one instance, and it is believed that the aluminum is of natural origin.

Livestock watering was an existing use in Los Alamos Canyon. Cattle grazing was reported in lower Los Alamos Canyon by Foxx (1992) and Ferenbaugh *et al.* (1990). Historic sheep and goat grazing (prior to 1975) was reported to occur on the Pajarito Plateau by the Homesteaders (C. Montaño, written communication) as well as by Native American peoples. Although the area has steep slopes that pose a risk to some domestic animals, quality forage and water in the canyon streams were available to support at least some individuals. Livestock watering, therefore, appears to be an attainable use in these canyons, and the NMWQCC (1995) designated this use in 1995. However, water quality for livestock drinking water might be unacceptable in Pajarito Canyon due to elevated aluminum.

Irrigation Use

The use of the Pajarito Plateau for agricultural crops was a historic use of the area (Nyhan *et al.* 1978), including diversion of waters and ditch conveyance for flood irrigation (Steen 1977). Irrigation of high elevation crops of grasses, legumes, and orchards is not unusual, as such irrigated pastures can be provided as forage for livestock (Young *et al.* 1994). Los Alamos Canyon water has been used for turf-irrigation in the Town of Los Alamos on a yearly basis. Experimental vegetable crops are also grown in Los Alamos Canyon for research purposes (Fresquez *et al.* 1999). Irrigation was an existing use of waters in Los Alamos Canyon, and may be an attainable use in the other canyons studied. However, this study did not evaluate these waters for fecal coliform content, which is a water quality parameter to be considered in the designation of irrigation use. Except for aluminum in a reach of Pajarito Canyon, no water constituent measured exceeded the water quality standards to protect irrigation use, and this aluminum was believed to be of natural origin.

Coldwater Fishery Use and Coldwater Aquatic Life

The NMED (2001a) stated that,

> ". . . definitions [of fisheries in New Mexico], except for that of marginal coldwater fishery, apply to waters where fish may or may not be present– the designation is based on water quality considerations and 'stream bed characteristics' or 'other characteristics.' The definition of 'marginal coldwater fishery requires that the water body be 'known to support a coldwater fish population during at least some portion of the year.' This is the one classified aquatic life use that actually requires the presence of fish species."

Use of coldwater streams or lakes by aquatic life could therefore be considered covered by the coldwater fishery use designation by New Mexico. According to the NMED (2001a), many people think that the coldwater fishery use designation applies only to waters that support fish, that is, "those poikilothermitic aquatic vertebrate organisms of the Superclass Pisces, characteristically having fins, gills, and a streamlined body." According to the USEPA (1995b), even if sport or commercial fish are not present in a water body, it does not mean that it may not be supporting an aquatic life protection function. An existing aquatic community composed entirely of invertebrates and plants, such as may be found in a pristine alpine tributary stream, should still be protected whether or not such a stream supports a fishery (USEPA 1995b). Therefore, a fishery is more than just a fish in water; it is the biological, chemical, and physical characteristics of a water body, including the invertebrate community and all the other aquatic life forms that provide food as well as other ecosystem functions and services.

Based on location, measurement of air and water temperatures, and the presence of coldwater indicator species of aquatic life, these intermittent streams were considered coldwater in nature. Based on the presence of an apparently propagating brook trout population in Los Alamos Canyon, above the reservoir, the presence of shellfish, and other forms of aquatic life, a coldwater fishery was considered an existing use. As Sandia Canyon contained potential trout habitat, and aquatic life was supported, a coldwater fishery was considered an existing use. Since Los Alamos Canyon, below the reservoir, and the stream segment studied in Pajarito Canyon contained potential trout habitat, and aquatic life was supported, a coldwater fishery was considered an existing use. Valle Canyon contained potential trout habitat (although marginal in quality), however, with established shellfish populations and other aquatic life, a coldwater fishery was considered an existing use. Since all these intermittent streams contained aquatic life, a coldwater fishery was considered an existing use and should be considered for State designation.

However, water temperature extremes and other physical characteristics did not support a high quality coldwater fishery in any canyon stream segment studied. Therefore, high quality coldwater fishery use was not considered an existing use. Turbidity and aluminum in the Pajarito Canyon segment were above the water quality criteria for a coldwater fishery. However, these parameters did not appear to contribute to any toxicity in the caged-fish reared in this water for over two months, or during toxicity testing, or preclude the colonization of the stream by benthic macroinvertebrates. Should it be determined that the elevated aluminum and turbidity are due to natural background conditions, then site-specific water quality standards for aluminum and turbidity may need to be developed for these intermittent streams and likely, all streams of the Jemez Mountains.

Pollution by barium and explosives, lack of sufficient pool habitat and flow, and silting of spawning substrate in Valle Canyon make it likely that it would only support a very limited trout population. Also, extremes in climate or predator harvest would likely limit the long-term viability of trout without periodic stocking and habitat restoration. Total chlorine residuals and cyanide (amenable to chlorination) were not determined in the stream segments studied, but naturally elevated concentrations of these parameters would not be expected. While water depth was a limiting habitat factor for brook trout in these streams, these conditions could be improved by creating larger pools or channels of greater depth, by using techniques proposed by Rosgen (1996), Hunter (1991), or the Federal Interagency Stream Restoration Working Group (1998).

(This page intentionally left blank)

RECOMMENDATIONS

A critical goal of any water quality management program is the protection of aquatic life. It is the basic mandate of the Clean Water Act to restore and maintain the chemical, physical, and biological integrity of our Nation's waters. Aquatic life in the form of wetland plants, aquatic invertebrates, fish, insects, shellfish, amphibians, and other biota that have adapted to the intermittent streams and other waters of the Pajarito Plateau and should be explicitly protected. Actions that could be taken by the Laboratory (and others) to protect aquatic life include:

- meet water quality standards applicable to a designated use of coldwater fishery;
- identify aquatic life use in all water quality programs, plans, permits, and reports;
- use aquatic life criteria developed by the USEPA (1998a) in the evaluation of water quality trends, conditions, and impacts;
- establish sediment screening criteria based on toxicological thresholds for aquatic life;
- employ standardized biological tests to identify the effects of waste waters or streams that contain chemicals or mixtures which either do not yet have protective criteria established or that produce their toxic effects at very low concentrations that are beyond the capability of laboratory instruments to detect;
- use narrative biological criteria and regional reference conditions to preserve, protect, and restore water resources to their most natural condition attainable;
- manage for native species diversity, including benthic macroinvertebrate communities and other aquatic life using multiple standardized measures of the physical, chemical, and biological characteristics of other similar regional water bodies;
- continue to identify pollutant sources, remove them or reduce impacts, and restore the stream channel;
- seek zero discharge of any persistent, bioaccumulative, or toxic substances found within a watershed that pose a threat to aquatic life, wildlife, or other uses; and,
- quantitatively model the total maximum daily load of any persistent, bioaccumulative, or toxic substances that threaten the function of these canyons to convey clean water and sediment downstream.

Successfully managing the health and integrity of the aquatic habitats on the Laboratory and reducing the impacts of the Cerro Grande Fire will require a sound scientific understanding of these canyon ecosystems. The connection between land cover, watershed condition, and channel dynamics will need to be better understood in these steep, coarse-bedded streams. Short-term restoration of the impacted canyon habitats will likely be limited by the fire-related inputs of sediments, salts, ash, contaminated sediments, organic inputs, and erosive processes. For a time, such processes will likely affect the energy flow dynamics and limit the numbers and diversity of aquatic life. To protect aquatic life during restoration the interactions of the entire set of landscape components will need to be incorporated: uplands and wetlands, aquatic habitats, riparian corridors, and stream beds. Detailed habitat surveys such as those of this study could be further developed in order to measure, analyze, and map the biological, chemical, and physical characteristics of these canyon streams and monitor their recovery. An approach that integrates biosurvey data, which reflects the integrity of the water resource directly, along with water chemistry, physical habitat, bioassays, and other monitoring and source information, would be central to accurately defining the health of these streams. Restoration goals should also include the production of clean water and sediment for use by resident aquatic life, wildlife, people, and the ecosystems downstream.

LITERATURE CITED

American Public Health Association, American Water Works Association, and Water Environment Federation. 1995. Standard Methods for the Examination of Water and Wastewater, 19th Edition. American Public Health Association, Washington, DC.

Anonymous. 1977. Ecological evaluation of proposed discharge of dredged or fill material into navigable water. Interim guidance for implementation of section 404(b)(1) of public law 92-500 (Federal Water Pollution Control Act Amendments of 1972). United States Department of the Army Corps of Engineers, Waterways Experimental Station Miscellaneous Paper D-76-17, Vicksburg, MS.

Armour, C. L., K. P. Burnham, and W. S. Platts. 1983. Field methods and statistical analyses for monitoring small salmonid streams. United States Department of Interior, Fish and Wildlife Service Report FWS/OBS-82/33, Fort Collins, CO.

ASTM (American Society for Testing and Materials). 1989. Standard guide for conducting acute toxicity tests with fishes, macroinvertebrates, and amphibians. Pages 378-397 *in* 1990 Annual Book of ASTM Standards, Volume 11.04. American Society for Testing and Materials, Philadelphia, PA.

ATSDR (Agency for Toxic Substances and Disease Registry). 1992. Toxicological profile for barium. United States Department of Health and Human Services, Public Health Service, Atlanta, GA.

ATSDR (Agency for Toxic Substances and Disease Registry). 1993. Toxicological profile for chromium. United States Department of Health and Human Services, Public Health Service, Atlanta, GA.

ATSDR (Agency for Toxic Substances and Disease Registry). 1996. Toxicological profile for Polychlorinated Biphenyls (update). United States Department of Health and Human Services, Public Health Service, Atlanta, GA.

Bailey, V. 1971. Mammals of the Southwestern United States (with special reference to New Mexico). Republication of the 1931 work originally published by the United States Department of Agriculture Bureau of Biological Surveys as Mammals of New Mexico, No. 53 *in* the series, North American Fauna, Dover Publications, New York, NY.

Bailey, R. G. 1976. Ecoregions of the United States. United States Department of Agriculture, Forest Service, Miscellaneous Publication 1391, with separate map at a scale of 1:7,500,000, Washington, DC.

Bailey, N. J. 1981. Statistical Methods in Biology. Second Edition. Cambridge University Press, New York, NY.

Baldwin, N. S. 1956. Food consumption and growth of brook trout at different temperatures. Pages 323-328 *in* Transactions of the American Fisheries Society, Eighty-Sixth Annual Meeting, September 10-12, 1956, Toronto, Ontario, Canada.

Banar, A. 1993. Draft biological assessment for environmental restoration project Operable Unit 1057 TA -8, -9, -223, and -69. Los Alamos National Laboratory Report LA-UR-93-4189, Los Alamos, NM.

Barbour, M. T., J. Gerritsen, B. D. Snyder, and J. B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. United States Environmental Protection Agency Office of Water Publication EPA 841-B-99-02, Washington, DC.

Beardsley, T. 1994. Some like it hot–and cold. Scientific American 274:40.

Bennett, K. 1993. Draft biological and floodplain/wetland assessment for environmental restoration project Operable Unit 1106, TA-1, and TA-21, Los Alamos and DP Canyons. Los Alamos National Laboratory Report LA-UR-93-107, Los Alamos, NM.

Bennett, K. 1994. Aquatic macroinvertebrates and water quality monitoring of Sandia Canyon. Los Alamos National Laboratory Report LA-12738, Los Alamos, NM.

Bennett, K., D. Keller, and R. Robinson. 2001. Sandia wetland evaluation. Los Alamos National Laboratory Report LA-UR-01-66, Los Alamos, NM.

Bennett, K., J. Biggs, and G. Gonzales. 1999. Evaluation of PCB concentrations in small mammals in Sandia Canyon. Los Alamos National Laboratory Report LA-99-5891, Los Alamos, NM.

Benson J., S. Cross, and T. Foxx. 1995. Draft biological assessment and floodplain/wetland assessment for environmental restoration project Operable Unit 1085 TAs 14 and 67. Los Alamos National Laboratory Report LA-UR-95-648, Los Alamos, NM.

Beschta, R. L., and W. S. Platts. 1986. Morphological features of small streams: significance and function. Water Research Bulletin 22(3):369-379.

Biggs, J., K. Bennett, and P.R. Fresquez. 1997a. Evaluation of habitat use by Rocky Mountain elk (*Cervus elaphus nelsoni*) in North-Central New Mexico using Global Positioning System (GPS) radio collars. Los Alamos National Laboratory Technical Report, LA-13279-MS, Los Alamos, NM.

Biggs, J., K. Bennett, and M. Martinez. 1997b. A checklist of mammals found at Los Alamos National Laboratory and surrounding lands. Los Alamos National Laboratory Report LA-UR-97-4786, Los Alamos, NM.

Binns, N. A. 1978. Evaluation of habitat quality in Wyoming trout streams. *In* classification, inventory, and analysis of fish and wildlife habitat. Proceedings of a National Symposium, Phoenix, Arizona, January 24-27, 1977. United States Fish and Wildlife Service Report FWS/OBS-78/76:221-242, Washington, DC.

Blake, W. D., F. Goff, A. I. Adams, and D. Counce. 1995. Environmental geochemistry for surface and subsurface waters in the Pajarito Plateau and outlying areas, New Mexico. Los Alamos National Laboratory Report LA-12912-MS, Los Alamos, NM.

Bovee, K. D. 1982. A guide to stream habitat analyses using the instream flow incremental methodology. United States Department of the Interior, Fish and Wildlife Service. Instream Flow Information Paper 12, Report FWS/OBS-82/26, Washington, DC.

Bovee, K. D. 1986. Development and evaluation of habitat suitability criteria for use in the instream flow incremental methodology. United States Fish and Wildlife Service Instream Flow Information Paper 21, Biological Report 86(7), Washington, DC.

Bowen, B. M. 1990. Los Alamos Climatology, Los Alamos National Laboratory Report LA-11735-MS, Los Alamos, NM.

Bowen, B. M. 1992. Los Alamos Climatology Summary, Los Alamos National Laboratory Report LA-12232-MS, Los Alamos, NM.

Brooks, G. H. 1989. The comparative uptake and interaction of several radionuclides in the trophic levels surrounding the Los Alamos Meson Physics Facility (LAMPF) waste water ponds. Los Alamos National Laboratory Thesis LA-11487-T, Los Alamos, NM.

Brown, K., and R. Kerr. 1979. Physiographic regions of the United States. United States Department of the Interior, Bureau of Land Management map, Albuquerque, NM.

Brown, D. E., F. Reichenbacher, and S. E. Franson. 1998. A classification of North American biotic communities. The University of Utah Press. Salt Lake City, UT.

Brungs, W. A., and B. R. Jones. 1977. Temperature criteria for freshwater fish: protocol and procedures. United States Environmental Protection Agency, Environmental Research Laboratory Report EPA-600/3-77-061, Duluth, MN.

Buchman, M. F. 1998. NOAA Screening Quick Reference Tables. National Oceanic and Atmospheric Administration, Hazardous Materials Response and Assessment Division Report 97-2, Seattle, WA.

Buhl, K. 2001. The relative toxicity of inorganic contaminants to the Rio Grande silvery minnow (*Hybognathus amarus*) and fathead minnow (*Pimephales promelas*) in a water quality simulating that in the Rio Grande, New Mexico. United States Geological Survey Draft Report, Yankton, SD.

Calamusso, B. and J. N. Rinne. 1999. Native montane fishes of the Middle Rio Grande Ecosystem: Status, trends, and conservation. Pages 231-237 *in* D. M. Finch, J. C. Whitney, J. F. Kelly, and S. R. Lofkin (Eds.), Rio Grande Ecosystems: Linking Land, Water, and People. Toward a Sustainable Future for the Middle Rio Grande Basin. June 2-5, 1988, Proceedings RMRS-P-7. United States Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ogden, UT.

Call, D. J., L. T. Brooke, C. A. Lindberg, T. P. Markee, D. J. McCauley, and S. H. Poirer. 1984. Toxicity of aluminum to freshwater organisms in water of pH 6.5-8.5. University of Wisconsin-Superior Technical Report 549-238-RT-WRD, Superior, WI.

Carr, R. S. and D. C. Chapman. 1995. Comparison of methods for conducting marine and estuarine sediment porewater toxicity tests - extraction, storage and handling techniques. Archives of Environmental Contamination and Toxicology 18:69-77.

Carter, L.F. 1997. Water-quality assessment of the Rio Grande Valley, Colorado, New Mexico, and Texas--Organic compounds and trace elements in bed sediment and fish tissue, 1992-93. United States Geological Survey Water-Resources Investigations Report 97-4002, Albuquerque, NM.

Chapman, D., and A. Allert. 1998. Los Alamos National Laboratory Use Study Phase II: Toxicity testing of surface waters and sediment porewaters at Los Alamos National Laboratory. United States Geological Survey, Biological Resources Division Report, Columbia, MO. (Attachment A).

Cherry, D. S., K. L. Dickson, and J. L. Cairns, Jr. 1975. Temperatures selected and avoided by fish at various acclimation temperatures. Journal of the Fishery Research Board of Canada 32:485-491.

Chisholm, I. M., W. A. Hubert, and T. A. Wesche. 1987. Winter stream conditions and use habitat by brook trout in high-elevation Wyoming streams. Transactions of the American Fisheries Society 116:176-184.

Clark, M. E. and K.E. Rose. 1997. An individual-based modeling analysis of management strategies for enhancing brook trout populations in southern Appalachian streams. North American Journal of Fisheries Management 17:54-76.

Clements, W. H. 1994. Benthic invertebrate community responses to heavy metals in the Upper Arkansas River Basin, Colorado. Journal of the North American Benthological Society 13:30-44.

Clements, W. H., D. M. Carlisle, J. M. Lazorchak, and P. C. Johnson. 1999. Heavy metals structure benthic communities in Colorado mountain streams. Ecological Applications 10 (2):626–638.

Cleveland, L., J. F. Fairchild, and E. E. Little. 1999. Biomonitoring and ecotoxicology: Fish as indicators of pollution-induced stress in aquatic systems. Environmental Science Forum 96: 195-232.

Cole, G. A. 1983. Textbook of Limnology. Third Edition. Waveland Press, Inc., Prospect Heights, IL.

Cole, R. A., M. R. Hatch, and P. R. Turner. 1996. Diversity of aquatic animals in New Mexico. Pages 79-100 *in* E. A. Herrera and L. F. Huenneke (Eds.), New Mexico's Natural Heritage: Biological Diversity in the Land of Enchantment. New Mexico Journal of Science, Volume 36, New Mexico Academy of Science, Desktop Publishing and Prepress, Las Cruces, NM.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRue. 1979. Classification of wetlands and deepwater habitats of the United States. United States Department of the Interior, Fish and Wildlife Service, Biological Services Program Report FWS/OBS-79/31, Washington, DC.

Cowley, D. E. 1993. Strategies for development and maintenance of a hatchery broodstock of Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis*). Envirostat Contract Report 94-516-34, Albuquerque, NM.

Cowley D. E., M. D. Hatch, S. Herrmann, G. Z. Jacobi, and J. E. Sublette. 1997. Aquatic Ecoregions of New Mexico. Appendix 3 *in* Jacobi, G. Z., J. E. Sublette, S. Herrmann, M.D. Hatch, and D. E. Cowley (Eds.), Investigation of an index of biotic integrity in New Mexico. A Performance Report for Federal Aid in Sport Fish Restoration Act, Federal Aid Grant F-59-R-4, New Mexico Department of Game and Fish, Santa Fe, NM.

Crawford, J. K., and S. N. Luoma. 1992. Guidelines for studies of contaminants in biological tissues for the National Water-Quality Assessment Program. United States Geological Survey Open-File Report 92-494, Lemoyne, PA.

Cross, S. 1993. Draft Biological evaluation for environmental restoration project Operable Unit 1114 TAs 3, 30, 59, 60, 61, and 64. Los Alamos National Laboratory Report LA-UR-94-21, Los Alamos, NM.

Cross, S. 1994a. Aquatic macroinvertebrates and water quality of Sandia Canyon, Los Alamos National Laboratory, December 1992-October 1993. Los Alamos National Laboratory Status Report LA-12734-SR, Los Alamos, NM.

Cross, S. 1994b. Biological assessment for environmental restoration project Operable Unit 1098 TA 2 and 4. Los Alamos National Laboratory Report LA-UR-93-4183, Los Alamos, NM.

Cross, S. 1994c. Biological assessment for environmental restoration project Operable Unit 1030 TA 36, 68 & 71. Los Alamos National Laboratory Report LA-UR-94-26, Los Alamos, NM.

Cross, S. 1995a. Aquatic macroinvertebrates and water quality of Sandia Canyon, Los Alamos National Laboratory, November 1993 to October 1994. Los Alamos National Laboratory Report LA-12971-SR, Los Alamos, NM.

Cross, S. 1995b. Aquatic invertebrate sampling at selected outfalls in Operable Unit 1082: Technical Areas 9, 11, 16, and 22. Los Alamos National Laboratory Report LA-13019-MS, Los Alamos, NM.

Cross, S. P. 1996a. Biological assessment for the low energy demonstration accelerator, 1996. Los Alamos National Laboratory Report LA-UR-96-4785, Los Alamos, NM.

Cross, S. 1996b. Aquatic macroinvertebrates and water quality in Guaje and Los Alamos Canyons, (1993 and 1994). Chapter 4, Pages 91- 194 *in* T. S. Foxx (Compiler), Ecological Baseline Studies in Los Alamos and Guaje Canyons, County of Los Alamos, New Mexico; A Two-Year Study. Los Alamos National Laboratory Report LA-13065-MS, Los Alamos, NM.

Cross, S. 1997. Biological and water quality assessments for the Material Disposal Area P Project area, March 1995-August 1997. Los Alamos National Laboratory Report LA-UR-97-3844, Los Alamos, NM.

Cross, S. P., and J. Davila. 1996. Aquatic macroinvertebrates and water quality in Guaje and Los Alamos Canyons, 1995. Los Alamos National Laboratory Report LA-UR-96-998, Los Alamos, NM.

Cross, S., L. Sandoval, and T. Gonzales. 1996. Aquatic macroinvertebrates and water quality of springs in White Rock Canyon along the Rio Grande, 1995. Los Alamos National Laboratory Report LA-UR-96-510, Los Alamos, NM.

Curry, R. A., C. Brady, D. L. G. Noakes, and R. G. Danzmann. 1997. Use of small streams by young brook trout spawned in a lake. Transactions of the American Fisheries Society 126:77-83.

Dale, M. R. 1998. Flow and water-quality characteristics of perennial reaches in Pajarito Canyon and Canon de Valle, Los Alamos National Laboratory. New Mexico Environment Department, Department of Energy Oversight Bureau Report NMED/DOE/AIP-98/1, Santa Fe, NM.

Degenhardt, W. G., C. W. Painter, and A. H. Price. 1996. Amphibians & Reptiles of New Mexico. University of New Mexico Press, Albuquerque, NM.

Deitner R. and C. Caldwell. 2000. Summary of Water Quality Database. Preliminary report to the U.S. Fish and Wildlife Service, Ecological Services Office, Albuquerque, NM. New Mexico State University Preliminary Report, Las Cruces, NM.

Dick-Peddie, S. 1993. New Mexico Vegetation, Past, Present, and Future. University of New Mexico Press, Albuquerque, NM.

Dunham, D. A. 1993. Biological and floodplain/wetland assessment for environmental restoration project Operable Unit 1129, TAs 4, 5, 35, 42, 44, 52, 63, and 66, and Operable Unit 1147, TA-50. Los Alamos National Laboratory Report LA-UR-93-1055, Los Alamos, NM.

Ebinger, M. H., R. W. Ferenbaugh, A. F. Gallegos, W. R. Hansen, O. B. Myers, and W. J. Wenzel. 1994. Preliminary ecological screening assessment for Operable Unit 1049. Los Alamos National Laboratory Report LA-UR-94-3875, Los Alamos, NM.

EC and MENVIQ (Environment Canada and Ministere de l'Environnement du Quebec). 1992. Interim Criteria for Quality Assessment of St. Lawrence River Sediment. Environment Canada ISBN 0-662-19849-2, Ottawa, Canada.

Edwards, E. A., H. Li, and C. B. Schreck. 1983. Habitat suitability index models: Longnose dace. United States Fish and Wildlife Service Biological Report FWS/OBS-82/10.33, Fort Collins, CO.

Eisler, R. 1985. Cadmium hazards to fish, wildlife, and invertebrates: A synoptic review. United States Fish and Wildlife Service, Biological Report 85(1.2), Laurel, MD.

Eisler, R. 1986a. Chromium hazards to fish, wildlife, and invertebrates: A synoptic review. United States Fish and Wildlife Service Biological Report 85(1.6), Laurel, MD.

Eisler, R. 1986b. Polychlorinated biphenyl hazards to fish, wildlife and invertebrates: A synoptic review. United States Fish and Wildlife Service, Biological Report 85(1.7), Laurel, MD.

Eisler, R. 1987. Mercury hazards to fish and wildlife and invertebrates: A synoptic review. United States Fish and Wildlife Service Biological Report 85(1.10), Laurel, MD.

Eisler, R. 1993. Zinc hazards to fish, wildlife, and invertebrates: A synoptic review. Biological Report 10, Patuxent Wildlife Research Center United States Fish and Wildlife Service, Laurel, MD.

Eisler, R. 1994. A review of arsenic hazards to plants and animals with emphasis on fishery and wildlife resources. Pages 185-259 *in* Nriagu, J. O, (Ed.), Arsenic in the Environment, Part II: Human Health and Ecosystem Effects, CRC Press, Inc., Boca Raton, FL.

Eisler, R and A. A. Belisle. 1996. Planar PCB hazards to fish, wildlife, and invertebrates: A synoptic review. United States Department of the Interior, National Biological Service, Biological Report 31, Washington, DC.

Elser, A. A. 1968. Fish populations of a trout stream in relation to major habitat zones and channel alterations. Transactions of the American Fisheries Society 97(4):389-397.

Erickson, M. D. 1993. Introduction to PCBs and analytical methods. Part 1.2 *in* Proceedings of the U.S. Environmental Protection Agency's National Technical Workshop, "PCBs in Fish Tissue," May 10-11, 1993. United States Environmental Protection Agency Report EPA/823-R-93-003, Washington, DC.

FDEP (Florida Department of Environmental Protection). 1994. Approach to the Assessment of Sediment Quality in Florida Coastal Waters, Volume 1. Development and Evaluation of Sediment Quality Assessment Guidelines. Florida Department of Environmental Protection, Office of Water Policy, Tallahassee, FL.

Failing, L. F. 1993. Aquatic Insects as Indicators of Heavy Metal Contamination in Selected New Mexico Streams. New Mexico Highlands University thesis, Las Vegas, NM.

Fair, J. M, and O. B. Meyers. 2000. Eggshell quality, clutch size, hatching success, and sex ratio of western bluebirds and ash-throated flycatchers: A landscape-contaminant perspective. Los Alamos National Laboratory Report LA-UR-00-5357, Los Alamos, NM.

The Federal Interagency Stream Restoration Working Group. 1998. Stream Corridor Restoration: Principles, Processes, and Practices. National Technical Information Service, PB98-158348INQ.ISBN-0-934213-59-3, Springfield, VA.

Ferenbaugh, R. W., E. S. Glodney, and G. H. Brooks. 1990. Sigma Mesa: Background elemental concentrations in soil and vegetation, 1979. Los Alamos National Laboratory Report LA-11941-MS, Los Alamos, NM.

Ferenbaugh, R. W., T. E. Buhl, A. K. Stoker, N. M. Becker, J. C. Rodgers, and W. R. Hansen. 1994. Environmental analysis of lower Pueblo and lower Los Alamos Canyon, Los Alamos, New Mexico. Los Alamos National Laboratory Report LA-12857-ENV, Los Alamos, NM.

Fettig, S. M. 1999. Bird list for Bandelier National Monument. United States National Park Service, Bandelier, NM.

Findley, J. S., A. H. Harris, D. E. Wilson, and C. Jones. 1975. Mammals of New Mexico. University of New Mexico Press, Albuquerque, NM.

Ford-Schmid, R. 1996. Reference conditions for Los Alamos National Laboratory streams using benthic macroinvertebrate assessment in Upper Pajarito Canyon. Pages 441-447 *in* Goff, F., B. S. Kues, M. A. Rogers, L. S. McFadden, and J. N. Gardner (Eds.), The Jemez Mountains Region. New Mexico Geological Society Field Conference Guidebook 47, Socorro, NM.

Ford-Schmid, R. 1999. Aquatic macroinvertebrate species lists and comparisons of community metrics for Upper Los Alamos, Sandia, Pajarito, and Valle Canyons. Copied correspondence to J. Vozella, Department of Energy, Los Alamos Area Office, from S. Yanicek, New Mexico Environment Department, Department of Energy Oversight Bureau, Santa Fe, NM.

Foxx, T. S. 1992. Biological and floodplain/wetland assessment for Environmental Restoration Program Operable Unit 1122, TA-33, and TA-70, Ancho and Chaquehui Canyon. Los Alamos National Laboratory Draft Report LA-UR-93106, Los Alamos, NM.

Foxx, T. S., and G. D. Tierney. 1984. Status of the flora of the Los Alamos National Environmental Research Park, a historical perspective. Los Alamos National Laboratory Report LA-8050-NERP Volume II, Los Alamos, NM.

Foxx, T. and B. Blea-Edeskuty. 1995. Wildlife use of NPDES outfalls at Los Alamos National Laboratory. Los Alamos National Laboratory Report LA-13009-MS, Los Alamos, NM.

Foxx, T. S., A. Banar, K. Bennett, J. Biggs, S. Cross, D. Dunham, T. Haarmann, M. Salisbury, and D. Keller. 1995. Ecological Baseline Studies in Los Alamos and Guaje Canyons, County of Los Alamos, New Mexico; A Two-Year Study. Los Alamos National Laboratory Report LA-13065-MS, Los Alamos, NM.

Foxx, T. S., L. Pierce, G.D. Tierney, and L.A. Hansen. 1998. Annotated checklist and database for vascular plants of the Jemez Mountains. Los Alamos National Laboratory Report LA-13408, Los Alamos, NM.

Foxx, T. S., T. K. Haarmann, and D. C. Kellar. 1999. Amphibians and reptiles of Los Alamos County, New Mexico. Los Alamos National Laboratory Report LA-13626-MS. Los Alamos, NM.

Freeman, R. A., and W. H. Everhart. 1971. Toxicity of aluminum hydroxide complexes in neutral and basic media to rainbow trout. Transactions of the American Fisheries Society 4:644-658.

Frenzel, P. F. 1995. Geohydrology and simulation of ground-water flow near Los Alamos, North-Central New Mexico. United States Geological Survey, Water-Resources Investigations Report 95-4091, Albuquerque, NM.

Fresquez, P.R., D. R. Armstrong, M.A. Mullen, and L. Naranjo, Jr. 1997. Radionuclide concentrations in pinto beans, sweet corn, and zucchini squash grown in Los Alamos Canyon at Los Alamos National Laboratory. Los Alamos National Laboratory Report LA-13304-MS, Los Alamos, NM.

Fresquez, P. R., D. H. Kraig, M. A. Mullen, and L. Naranjo, Jr. 1999. Radionuclide and heavy metal concentrations in fish from the confluences of major canyons that cross Los Alamos Los Alamos National Laboratory lands with the Rio Grande. Los Alamos National Laboratory Report LA-13564-MS, Los Alamos, NM.

Frissell, C. A., W. L. Liss, C. E. Warren, and M. D. Hurley. 1986. A hierarchical framework for stream habitat classification: Viewing streams in a watershed context. Environmental Management 10:199-214.

Gard, R. and G.A. Flittner. 1974. Distribution and abundance of fishes in Sagehen Creek, California. Journal of Wildlife Management 38(2):347-358.

Garn, H. S., and G. Z. Jacobi. 1996. Water quality and benthic macroinvertebrate bioassessment of Gallinas Creek, San Miguel County, New Mexico, 1987-90. United States Geological Survey Water-Resources Investigations Report 96-4011, Albuquerque, NM.

Gee, J. H. and T. G. Northcote. 1963. Comparative ecology of two sympatric species of dace (Rhinichthys) in the Fraser River system, British Columbia. Journal of the Fishery Research Board of Canada 20(1):105-118.

Gerstenberger, S.L., O. R. Tarvis, L. K. Hansen, J. Pratt-Shelley, and J. A. Dellinger. 1997. Concentrations of blood and hair mercury and serum PCBs in an Ojibwa population that consumes Great Lakes region fish. Journal of Toxicology - Clinical Toxicology 35:377-86.

Glova, G. J. 1987. Comparison of allopatric cutthroat stocks with those sympatric with coho salmon and sculpins in small streams. Environmental Biology of Fishes 20:275-284.

Goff, F., S. Reneau, M. A. Rogers, J. N. Gardner, G. Smith, D. Broxton, P. Longmire, G. Woldegabriel, A. Lavine, and S. Aby. 1996. Third-day road log, from Los Alamos through the southeastern Jemez Mountains to Cochiti Pueblo and the Rio Grande. Pages 59-97 *in* Goff, F., B. S. Kues, M. A. Rogers, L. S. McFadden, and J. N. Gardner (Eds.), The Jemez Mountains Region. New Mexico Geological Society Field Conference Guidebook 47, Socorro, NM.

Gonzales, G. J., P. R. Fresquez, and J. W. Beveridge. 1999. Organic contaminant levels in three fish species downchannel from the Los Alamos National Laboratory. Los Alamos National Laboratory Report LA-13612-MS, Los Alamos, NM.

Graf, W. L. 1995. Plutonium and the Rio Grande- Environmental Change and Contamination in the Nuclear Age. Oxford University Press, New York, N.Y.

Grant, G. E. 1997. A geomorphic basis for interpreting the hydrologic behavior of large river basins. Pages 105-120 *in* A. Laenen and D. A. Dunnette (Eds.), River Quality Dynamics and Restoration. CRC Press, Inc. Boca Raton, FL.

Gray, R. 1996. Los Alamos Canyon watershed evaluation. Completion Report for CRP-570, Watershed Management, University of New Mexico, Albuquerque, NM.

Grolier Inc. 1997. Barium. The 1998 Grolier Multimedia Encyclopedia on CD ROM, by Grolier Interactive, Inc.

Grossman, D.H., D. Faber-Langendoen, A. S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K. D. Patterson, M. Pyne, M. Reid, and L. Sneedon. 1998. International classification of ecological communities: Terrestrial vegetation of the United States. The National Vegetation Classification System: Development, Status, and Applications. The Nature Conservancy, Arlington, VA.

Gubanich, A. A. and H. R. Panik. 1987. Avian use of waterholes in pinyon juniper. Pages 534-540 *in* R. L. Everett (Ed.), Proceedings of the Pinyon-Juniper Conference, Reno, NV, January 13-16, 1986. United States Department of Agriculture, Forest Service, Intermountain Research Station, General Technical Report INT-215, Ogden, UT.

Haarmann, T. 1995. Ecological surveys of the proposed high explosives wastewater treatment facility region. Los Alamos National Laboratory Report LA-129767-MS, Los Alamos, NM.

Hach Company. 1997a. DR/2010 Spectrophotometer Procedures Manual and Hach Company DR/2010 Spectrophotometer Instrument Manual. Hach Company Handbook 49300-22 and Manual 49300-18, Loveland, CO.

Hach Company. 1997b. Hach Company Digital Titrator Model 16900 Manual. Hach Company Manual 16900-08, Loveland, CO.

Hach Company. 1997c. Hach Company Model 2100P Portable Turbidimeter Instruction Manual. Hach Company Manual 46500-88, Loveland, CO.

Hamilton, K. and E. P. Bergersen. 1984. Methods to Estimate Aquatic Habitat Variables. Colorado Cooperative Fishery Research Unit, Colorado State University, Fort Collins, CO.

Hammerson, G. A. 1999. Amphibians and Reptiles in Colorado. A Colorado Field Guide, Second Edition. University Press of Colorado, Niwot, CO.

Hansen, L. A., P. R. Fresquez, R. J. Robinson, J. D. Huchton, and T. S. Foxx. 1999. Medium-sized mammals around a radioactive liquid waste lagoon at Los Alamos National Laboratory: Uptake of contaminants and evaluation of radio-frequency identification technology. Los Alamos National Laboratory Report LA-13660-MS. Los Alamos, NM.

Hatch, M. D., D. E. Cowley, J. E. Sublette, G. Z. Jacobi, and S. J. Herrmann. 1998. Native fish faunal regions of New Mexico. Appendix 2 *in* Jacobi, G. Z., J. E. Sublette, S. Herrmann, M.D. Hatch, and D. E. Cowley (Eds.), Investigation of an Index of Biotic Integrity in New Mexico. A Performance Report for Federal Aid in Sport Fish Restoration Act, Federal Aid Grant F-59-R-4, New Mexico Department of Game and Fish, Santa Fe, NM.

Heikoop, J. M., D. D. Hickmott, and P. Longmire. 2001. Nitrogen-15 signals of treated sewage wastewater uptake and transformation in a cattail marsh. American Society of Limnology and Oceanography 2001 Aquatic Sciences Meeting Abstract Book:67.

Hem, J. D. 1985. Study and interpretation of the chemical characteristics of natural water. United States Geological Survey Water-Supply Paper 2254, Government Printing Office, Washington, DC.

Herger, L.G., W.A. Hubert, and M.K. Young. 1996. Comparison of habitat composition and cutthroat trout abundance at two flows in small mountain streams. North American Journal of Fisheries Management 16:294-301.

Hickman, T. and R. F. Raleigh. 1982. Habitat suitability index models: Cutthroat trout. United States Fish and Wildlife Service Report FWS/OBS-82/10.5, Fort Collins, CO.

Hinojosa, H. 1997. A checklist of plant and animal species at Los Alamos National Laboratory and surrounding areas. Los Alamos National Laboratory Report LA-UR-97-4501, Los Alamos, NM.

Hoffman, D. J., C. P. Rice, and T. J. Kubiak. 1996. PCBs and Dioxins in Birds. Pages 165 - 207 *in* W. N. Beyer, G. H. Heinz, and A.W. Redmon-Norwood (Eds.), Environmental Contaminants in Wildlife: Interpreting Tissue Concentrations. Society of Environmental Toxicology and Analytical Chemistry, special publication series, CRC Press, Inc., Boca Raton, FL.

Hubbard, J. 1976. Survival and the Native Fishes of New Mexico. New Mexico Wildlife May-June. New Mexico Department of Game and Fish, Santa Fe, NM.

Hunter, C. J. 1991. Better Trout Habitat. A Guide to Stream Restoration and Management. Montana Land Reliance, Island Press, Washington, DC.

Hutzinger, O., S. Safe, and V. Zitko. 1979. The Chemistry of PCBs. CRC Press, Boca Raton, FL.

Hydrolab Corporation. 1986. Hydrolab© Datasonde© I Operating Manual. Hydrolab Corporation Publication 686A, Austin, TX.

Hydrolab Corporation. 1988. Hydrolab© Datasonde© I Operating Manual (including Performance Manual). Hydrolab Corporation Publication 787 revised to 188A, Austin, TX.

Hynes, H. B. N. 1970. The Ecology of Running Waters. Liverpool University Press, Bungay, Suffolk, Great Britain.

Idaho DEQ (Department of Environmental Quality). 1996. State of Idaho 1996 Water Body Assessment Guidance: A Streams to Standards Process. Department of Environmental Quality, Boise, ID.

Ingersoll C.G., P.S. Haverland, E. L. Brunson, T. J. Canfield, F. J. Dwyer, C.E. Henke, N. E. Kemble, D.R. Mount, and R.G. Fox. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalella azteca* and the midge *Chironomus riparius*. Journal of Great Lakes Research 22:602-623.

Ireland, S. C. 1993. Seasonal Distribution and Habitat Use of Westslope Cutthroat Trout in a Sediment-rich Basin in Montana. Montana State University thesis, Bozeman, MT.

Jacobi, G. Z., J. E. Sublette, S. Herrmann, M. D. Hatch, and D. E. Cowley. 1995. Investigation of an index of biotic integrity in New Mexico. Performance Report for Federal Aid in Sport Fish Restoration Act, Federal Aid Grant F-59-R-4, New Mexico Department of Game and Fish, Santa Fe, NM.

Jarmie, N., and F. J. Rogers. 1996. A survey of Los Alamos County and Bandelier National Monument for macroscopic fungi. Los Alamos National Laboratory Report LA-UR-96-3581, Los Alamos, NM.

John, K. R. 1963. The effect of torrential rains on the reproductive cycle of *Rhinichthys osculus* in the Chiricahua Mountains, Arizona. Copeia 2:286-291.

John, K. R. 1964. Survival of fish in intermittent streams of the Chiricahua Mountains, Arizona. Ecology 45(1):112-119.

Johnson, T. H. and R. H. Wauer. 1996. Avifaunal response to the 1977 La Mesa Fire. Pages 70-94 *in* C. D. Allen (Ed.), Fire Effects in Southwestern Forests. Proceedings of the Second La Mesa Fire Symposium. United States Department of Agriculture, Rocky Mountain Forest and Range Experiment Station General Technical Report RM-GTR-286, Fort Collins, CO.

Julyan, R. 1996. The Place Names of New Mexico. University of New Mexico Press, Albuquerque, NM.

Karr, J. R., and D. R. Dudley. 1978. Biological integrity of a headwater stream: evidence of degradation, prospects for recovery. *In* J. Lake and J. Morrison (Eds.), Environmental Impact of Land Use on Water Quality, Final Report on the Black Creek Project, United States Environmental Protection Agency, Chicago, IL.

Karr, J. R., and D. R. Dudley. 1981. Ecological perspectives on water quality goals. Environmental Management 5:55-68.

Karr, J. R., and E. W. Chu. 1997. Biological monitoring and assessment: Using multimetric indexes effectively. United States Environmental Protection Agency Region VIII Report EPA 235-R97-001, Seattle, WA.

Keller, D. C., and D. Risberg. 1995. Draft biological and floodplain/wetland assessment for dual axis radiographic test facility (DARHT). Los Alamos National Laboratory Report LA-UR-95-647, Los Alamos, NM.

Kelly, V.C. 1978. Geology of the Espanola Basin, New Mexico. New Mexico Bureau of Mines and Mineral Resources, Geologic Map 48, Socorro, NM.

Kingerly, H. E. 1996. American Dipper (*Cinclus mexicanus*). Number 229 *in* A. Poole and F. Gill (Eds.), The Birds of North America. The Academy of Natural Sciences, Philadelphia, Pennsylvania, and the American Ornithologists' Union, Washington, DC.

Koch, S. W., T. K. Budge, and R. Balice. 1997. Development of a land cover map for Los Alamos National Laboratory and vicinity. Los Alamos National Laboratory Report LA-UR-97-4628, Los Alamos, NM.

Kolz, A. L., and J. B. Reynolds. 1989. Electrofishing, a power related phenomenon. United States Department of the Interior, Fish and Wildlife Technical Report 22. Washington, DC.

Kovalsky, V. V., G. A. Yarovaya, and D. M. Shmavonyan. 1961. Changes of purine metabolism in man and animals under conditions of molybdenum biogeochemical provinces. Zh Obshch Biol 1961: 22;179-191. (Russian translation as cited *in* U.S. Environmental Protection Agency, Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Integrated Risk Information System database, 1994, Cincinnati, OH).

Kudo, A. M. 1974. Outline of the Igneous Geology of the Jemez Mountains Volcanic Field. Pages 287-289 *in* C. T. Siemers, L. A. Woodward and J. F. Callender (Eds.), New Mexico Geological Society Guidebook, 25th Field Conference, Ghost Ranch, 1974. New Mexico Bureau of Mines and Mineral Resources, Socorro, NM.

Kuhne, W. 2000. Effects of Depleted Uranium on the Survival and Health of *Ceriodaphnia dubia* and *Hyalella azteca*. New Mexico State University thesis, Las Cruces, NM.

Lane, E. W. 1947. Report of the subcommittee on sediment terminology. Transactions of the American Geophysical Union 28(6):936-938.

LANL (Los Alamos National Laboratory). 1979. Environmental surveillance at Los Alamos during 1978. Los Alamos Scientific Laboratory, LA-7800-ENV, Los Alamos, NM. (Appendix H *in* USDOE 1979).

LANL (Los Alamos National Laboratory). 1986. Environmental surveillance at Los Alamos during 1985. Los Alamos National Laboratory Report LA-10721-ENV, Los Alamos, NM.

LANL (Los Alamos National Laboratory). 1993. Environmental surveillance at Los Alamos during 1991. Los Alamos National Laboratory, LA-12572-ENV, Los Alamos, NM.

LANL (Los Alamos National Laboratory). 1994. Environmental surveillance at Los Alamos during 1992. Los Alamos National Laboratory, LA-12764-ENV, Los Alamos, NM.

LANL (Los Alamos National Laboratory). 1995a. Technical Area 16, Material Disposal Area P closure plan, revision 0. Los Alamos National Laboratory Report, Los Alamos, NM.

LANL (Los Alamos National Laboratory). 1995b. Task/Site work plan for Operable Unit 1049. Los Alamos Canyon and Pueblo Canyon. Los Alamos National Laboratory Report LA-UR-95-2053. Los Alamos, NM.

LANL (Los Alamos National Laboratory). 1995c. Environmental surveillance at Los Alamos during 1993. Los Alamos National Laboratory Report LA-12973-ENV, Los Alamos, NM.

LANL (Los Alamos National Laboratory). 1996a. Environmental surveillance at Los Alamos during 1994. Los Alamos National Laboratory Report LA-13047-ENV, Los Alamos, NM.

LANL (Los Alamos National Laboratory). 1996b. Environmental surveillance at Los Alamos during 1995. Los Alamos National Laboratory Report LA-13210-ENV, Los Alamos, NM.

LANL (Los Alamos National Laboratory). 1997. Environmental surveillance and compliance at Los Alamos during 1996. Los Alamos National Laboratory Report LA-13343-ENV, Los Alamos, NM.

LANL (Los Alamos National Laboratory). 1998a. Environmental surveillance at Los Alamos during 1997. Los Alamos National Laboratory Report LA-13487-ENV, Los Alamos, NM.

LANL (Los Alamos National Laboratory). 1998b. Water quality and sediment data for Use Study. Correspondence from the Water Quality and Hydrology Group Leader to the New Mexico Environment Department Standards and Surveillance Program Manager, dated July 10, 1998, Los Alamos, NM.

LANL (Los Alamos National Laboratory). 1998c. Draft installation work plan for Environmental Restoration Project, revision 7. Los Alamos National Laboratory Report LA-UR-98-4652, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory). 1999a. Work Plan for Sandia Canyon and Cañada del Buey. Los Alamos National Laboratory, Canyons Focus Area Report LA-UR-99-3610, Los Alamos, NM.

LANL (Los Alamos National Laboratory). 1999b. February 9, 1999, draft Watershed Management Plan. Los Alamos National Laboratory, Los Alamos, New Mexico.

Lee, R. M. and J. N. Rinne. 1980. Critical thermal maxima of five trout species in the southwestern United States. Transactions of the American Fisheries Society 109:632-635.

Long, E. R., and L.G. Morgan. 1991. The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program. National Oceanic and Atmospheric Administration Technical Memorandum NOS-OMA 52. National Oceanic and Atmospheric Administration, Seattle, WA.

Longmire, P. A., S. L. Reneau, P. M. Watt, L. D. McFadden, J. N. Gardner, C. L. Duffy, R. T. Ryti. 1996. Natural background geochemistry, geomorphology, and pedogenesis of selected soil profiles and Bandelier Tuff, Los Alamos, New Mexico. Los Alamos National Laboratory Report LA-12913-MS, Los Alamos, NM.

Lynch, T. R., C. J. Popp, and G. Z. Jacobi. 1988. Aquatic insects as environmental monitors of trace element contamination: Red River, New Mexico. Water, Air, and Soil Pollution 42:19-31.

MacDonald, D. D., C. G. Ingersoll, and T. A. Berger. 2000a. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Archives of Environmental Toxicology and Chemistry 39:20-31.

MacDonald, D. D., L. M. Dipinto, J. Field, C. G. Ingersoll, E. R. Long, and R. C. Swartz. 2000b. Development and evaluation of consensus-based sediment effect concentrations for polychlorinated biphenyls. Environmental Toxicology and Chemistry 19:1403-1415.

Mares, M. A. 1999. Encyclopedia of Deserts. University of Oklahoma Press, Norman, OK.

Maret, T. R., C. T. Robinson, and G. W. Minshall. 1997. Fish assemblages and environmental correlates in least-disturbed streams of the Upper Snake River Basin. Transactions of the American Fisheries Society 126:200-216.

McLellan, W. L., W. R. Hartley, and M. E. Bower. 1988. Octahydro-1,3,5,7-tetranitrozocine (HMX). Cited *in* Talmage, S. S., D. M. Opresko, C. J. Maxwell, C. J. E. Welsh, F. M. Cretella, P. H. Renol, and F. B. Daniel. 1999. Nitroaromatic Munition Compounds: Environmental Effects and Screening Values. Reviews of Environmental Contamination and Toxicology 161:1-156.

McPhail, J .D., and C. C. Lindsey. 1970. Freshwater fishes of northwestern Canada and Alaska. Bulletin of the Fishery Research Board Canada 173.

Meador, M. R. and W. J. Matthews. 1991. Spatial and temporal patterns in fish assemblage structure of an intermittent Texas stream. American Midland Naturalist 127:106-114.

Meador M. R., T. F. Cuffney, and M. E. Gurtz. 1993. Methods for sampling fish communities as part of the national water-quality assessment program. United States Geological Survey Open-File Report 93-104k, Raleigh, NC.

Meehan, W. R. (Ed.). 1991. Influence of forest and rangeland management on salmonid fish and their habitats. American Fishery Society Special Publication, Bethesda, MD.

Merritt, R. W., and K. W. Cummins. 1996. An Introduction to the Aquatic Insects of North America. Third Edition. Kendall/Hunt Publishing Company, Dubuque, IA.

Moyle, P. B, and D. M. Baltz. 1985. Microhabitat use by an assemblage of California stream fishes: Developing criteria for instream flow determinations. Transactions of the American Fisheries Society 114:695-704.

National Geographic Society. 1987. Field Guide to the Birds of North America. Third Edition. National Geographic Society, Washington, DC.

Nelson, S.M. and R.A. Roline. 1993. Selection of the mayfly *Rithrogena hageni* as an indicator of metal pollution in the Upper Arkansas River. Journal of Freshwater Ecology 8:111-119.

Niering, W. A. 1985. The Audubon Society Nature Guides. Wetlands. Alfred A. Knopf, Inc., New York, NY.

Niimi, A. J. 1996. Chapter 5: PCBs in aquatic organisms. Pages 117-151 *in* W. N. Beyer, G. H. Heinz, and A. W. Redmon-Norwood (Eds.), Environmental Contaminants in Wildlife: Interpreting Tissue Concentrations. CRC Press, Inc., Boca Raton, FL.

Nimmo, D. R., J. Constan, J. Tessari, and M. J. Willox. 1994. An analysis of DDT and metabolites in water, soil, sediment, macroinvertebrates and fish from Frijoles Creek. National Park Service Report, Bandelier, NM.

NMDGF (New Mexico Department of Game and Fish). 1973. Rio Grande cutthroat trout. New Mexico Department of Game and Fish, Status Report, Santa Fe, NM.

NMDGF (New Mexico Department of Game and Fish). 1998. Biota Information System of New Mexico (BISON-M), Version 10/98. New Mexico Department of Game and Fish Database, Santa Fe, NM. (Available through the internet at the uniform resource locator: <http://www.fw.vt.edu/fishex/states/nm.htm>).

NMED (New Mexico Environment Department). 1998. State of New Mexico Procedures of Assessing Standards Attainment for §303(d) List and §305(b) Report Assessment Protocol. Surface Water Quality Bureau, Santa Fe, NM.

NMED (New Mexico Environment Department). 2001a. Surface Water Quality Bureau Comments on the Draft LANL Use Study Report and LANL Comments. Surface Water Quality Bureau Correspondence from J. H. Davis, Ph.D. to Dr. J. E. Nicholopoulos, Field Supervisor, New Mexico Ecological Services Field Office, dated August 2, 2001, Santa Fe, NM.

NMED (New Mexico Environment Department). 2001b. Cochiti Reservoir fish tissue sampling results PCBs and pesticides – 1999 and 2000. DOE Oversight Bureau Correspondence from T. Michael to R. Vorhees, Health Department, dated February 6, 2001, Santa Fe, NM.

NMWQCC (New Mexico Water Quality Control Commission). 1995. State of New Mexico Standards for Interstate and Intrastate Streams, as amended through January 23, 1995. Water Quality Control Commission, Santa Fe, NM.

NMWQCC (New Mexico Water Quality Control Commission). 1998. Water Quality and Water Pollution Control in New Mexico. New Mexico Environment Department, Surface Water Quality Bureau Report NMED/SWQ-98/4, Santa Fe, NM.

NRC (National Research Council). 1980. Mineral Tolerances of Domestic Animals. National Research Council, Committee on Animal Nutrition, National Academy Press, Inc., Washington, DC.

NRC (National Research Council). 1997. Contaminated Sediments in Ports and Waterways: Cleanup Strategies and Technologies. National Research Council, Committee on Contaminated Marine Sediments, National Academy Press, Inc., Washington, DC.

Nyhan, J. W., L. W. Hacker, T. E. Calhoun, and D. L. Young. 1978. Soil survey of Los Alamos County, New Mexico. Los Alamos National Laboratory Report LA-6779-MS. Los Alamos, NM.

Omernik, J. M. 1986. Ecoregions of the United States. United States Environmental Protection Agency Corvallis Environmental Research Laboratory, Corvallis, Oregon. Map (scale 1:7,500,000).

Omernik, J. M. 1987. Ecoregions of the conterminous United States. Supplement to the Annals of the Association of American Geographers 77(1):118-25.

Orth, D. J., and R. J. White. 1993. Stream habitat management. Pages 205-230 *in* C. C. Kohler and W.A. Hubert (Eds.), Inland Fisheries Management in North America. American Fisheries Society, Bethesda, MD.

Pearsons, T. N., H. W. Li, and G. A. Lamberti. 1992. Influence of habitat complexity on resistance to flooding and resilience of stream fish assemblages. Transactions of the American Fisheries Society 121:427-436.

Persaud D., R. Jaagumagi, and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Water Resources Branch, Ontario Ministry of the Environment, Toronto, Ontario.

Phillips, D. J. H. 1980. Quantitative Aquatic Biological Indicators. Applied Science Publishers, Limited, London, England.

Plafkin, J. L., M. T. Barbour, K. .D. Porter, S. K. Gross, and R. M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers: benthic macroinvertebrates and fish. United States Environmental Protection Agency, Office of Water, Report EPA/444/4-89-001, Washington, DC.

Platania, S. P. 1993. The fishes of the Rio Grande between Velarde and Elephant Butte Reservoir and their habitat associations. Report submitted to the New Mexico Department of Game and Fish, United States Bureau of Reclamation, Cooperative Agreement 0-FC-40-08870, Albuquerque, NM.

Platts, W. S. 1974. Geomorphic and aquatic conditions influencing salmonids and stream classification with application to ecosystem classification. United States Forest Service Publication, Billings, MT.

Platts, W. S., W. F. Megahan, and G. W. Marshall. 1983. Methods for evaluating stream riparian and biotic conditions. United States Department of Agriculture Intermountain Forest and Range Experiment Station, General Technical Report INT-138, Ogden, UT.

Poléo, A. B. S. 1998. Aluminum polymerization — a mechanism of acute toxicity of aqueous aluminum to fish. Aquatic Toxicology 31(4):347-356.

Poole and F. Gill (Eds.). 1999. The Birds of North America. The Academy of Natural Sciences, Philadelphia, Pennsylvania, and the American Ornithologists' Union, Washington, DC.

Popp, C. J., D. K. Branvold, K. Kirk, L. A. Branvold, V. McLemore, S. Hansen, R. Radtke, and P. Kyle. 1996. Reconnaissance investigation of trace metal sources, sinks and transport in the upper Pecos River Basin, New Mexico. New Mexico Institute of Mining and Technology Cooperative Agreement 3-PC-40-13830 Report, Socorro, NM.

Price, D. R. H. 1979. Fish as indicators of water quality. Chapter 8, pages 8-1 to 8-23 *in* A. James and L. Evison (Eds.), Biological Indicators of Water Quality. John Wiley and Sons, New York, NY.

Propst, D. L., J. A. Stefferud, and P. R. Turner. 1992. Conservation and status of Gila trout, *Oncorhynchus gilae*. The Southwestern Naturalist 37(2): 117-125.

Purtymun, W. D. 1979. Water Supply at Los Alamos during 1978. Los Alamos National Laboratory Report LA-8074-PR, Los Alamos, NM.

Purtymun, W. D. 1995. Geologic and hydrologic records of observation wells, test holes, test wells, supply wells, springs, and surface water stations in the Los Alamos area. Los Alamos National Laboratory Report LA-12883-MS, Los Alamos, NM.

Purtymun, W. D., N. M. Becker, and M. Maes. 1983. Water supply at Los Alamos during 1981. Los Alamos National Laboratory Report LA-9734-PR, Los Alamos, NM.

Purtymun, W. D., N. M. Becker, and M. Maes. 1984. Water supply at Los Alamos during 1982. Los Alamos National Laboratory Report LA-9896-PR, Los Alamos, NM.

Purtymun, W. D., N. M. Becker, and M. Maes. 1985. Water supply at Los Alamos during 1983. Los Alamos National Laboratory Report LA-10327-PR, Los Alamos, NM.

Purtymun, W. D., N. M. Becker, and M. Maes. 1986a. Water supply at Los Alamos during 1984. Los Alamos National Laboratory Report LA-10584-PR, Los Alamos, NM.

Purtymun, W. D., N. M. Becker, and M. Maes. 1986b. Water supply at Los Alamos during 1985. Los Alamos National Laboratory Report LA-10835-PR, Los Alamos, NM.

Purtymun, W. D., A. K. Stoker, and M. Maes. 1987. Water supply at Los Alamos during 1986. Los Alamos National Laboratory Report LA-11046-PR, Los Alamos, NM.

Purtymun, W. D., S. G. McLin, A. K. Stoker, and M. N. Maes. 1991. Water supply at Los Alamos during 1991. Los Alamos National Laboratory Report LA-12770-PR, Los Alamos, NM.

Purtymun, W. D., S. G. McLin, A. K. Stoker, M. N. Maes, and B. G. Hammock. 1993. Water supply at Los Alamos during 1990. Los Alamos National Laboratory Report LA-12471-PR, Los Alamos, NM.

Purtymun, W. D., S. G. McLin, A. K. Stoker, M. N. Maes, and T. A. Glasco. 1995. Water supply at Los Alamos during 1993. Los Alamos National Laboratory Report LA-12951-PR, Los Alamos, NM.

Raleigh, R .F. 1982. Habitat suitability index models: brook trout. United States Fish and Wildlife Service Report FWS/OBS-82/10.24, Fort Collins, CO.

Raymer, D. F. 1993. Draft biological and floodplain/wetland assessment for environmental restoration project Operable Unit 1082, TAs 11, 13, 16, 24, 25, 36, and 37. Los Alamos National Laboratory Report, Los Alamos, NM.

Rinne, J. N. 1975. Changes in minnow populations in a small desert stream resulting from naturally and artificially induced factors. Southwestern Naturalist 20(2):185-195.

Rinne, J. N. and W. L. Minckley. 1991. Native fishes of arid lands: A dwindling resource of the desert Southwest. United States Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experimental Station General Technical Report RM-206, Fort Collins, CO.

Rinne, J. N. and S. P. Platania. 1995. Fish fauna. Chapter 8, Pages 165-175 *in* D. M. Finch and J. A. Tainter (Eds.), Ecology, Diversity, and Sustainability of the Middle Rio Grande Basin. United States Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experimental Station General Technical Report RM-GTR-268, Fort Collins, CO.

Roper, B. B., and D. L. Scarnecchia. 1995. Observer variability in classifying habitat types in stream surveys. North American Journal of Fisheries Management 15(1): 49-53.

Rosgen, D. L. 1994. A Classification of natural rivers. Catena 22:169-199.

Rosgen, D. L. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, CO.

Ross, S. T., W. J. Matthews, and A. A. Echelle. 1985. Persistence of stream fish assemblages: Effects of environmental change. American Naturalist 126(1):24-40.

Ryti, R., P. A. Longmire, D. E. Broxton, S. L. Reneau, and E. V. McDonald. 1998. Inorganic and radionuclide background data for soils, canyon sediments, and bandelier tuff at Los Alamos National Laboratory. Los Alamos National Laboratory Report LA-UR-98-4847, Los Alamos, NM.

Salisbury, M. 1994. Draft biological assessment for environmental restoration project Operable Unit 1111, TA -6, -7, -22, -40, -58, and -62. Los Alamos National Laboratory Report, Los Alamos, NM.

Sample, B. E., D. M. Opresko, and G. W. Suter. 1996. Toxicological benchmarks for wildlife: 1996 revision. Oak Ridge National Laboratory Report ES/ER/TM-86/R3, Oak Ridge, Tennessee.

Schecher, W. D., and D. C. McAvoy. 1991. MINEQL+: A Chemical Equilibrium Program for Personal Computers. Environmental Research Software, Version 2.1, Edgewater, MD.

Schmitt, C. J., A. D. Lemly, and P. Winger. 1993. Habitat Suitability Index Model for brook trout in streams of the Southern Blue Ridge Province: Surrogate variables, model evaluation, and suggested improvements. United States Fish and Wildlife Service Biological Report 18, Washington, DC.

Schmitt, C. J., J. L. Zajicek, T. W. May, and D. F. Cowman. 1999. Organochlorine residues and elemental contaminants in U. S. freshwater fish, 1976-1986: National Contaminant Biomonitoring Program. Review in Environmental Contamination and Toxicology 162:43-104.

Scurlock, D. 1998. From the Rio to the Sierra: An Environmental History of the Middle Rio Grande Basin. United States Department of Agriculture, Forest Service, Rocky Mountain Research Station, General Technical Report RMRS-GTR-5, Fort Collins, CO.

Self, S., G. Heiken, M. L. Sykes, K. Wohletz, R. V. Fisher, and D. P. Dethier. 1996. Field excursions to the Jemez Mountains, New Mexico. New Mexico Bureau of Mines and Mineral Resources Bulletin 134, Socorro, NM.

Shaull, D. A., M. R. Alexander, and R. P. Reynolds. 1996a. Surface water data at Los Alamos National Laboratory: 1995 Water Year. Los Alamos National Laboratory Progress Report LA-13177-PR, Los Alamos, NM.

Shaull, D. A., M. R. Alexander, R. P. Reynolds, and C. T. McLean. 1996b. Surface water data at Los Alamos National Laboratory: 1996 Water Year. Los Alamos National Laboratory Progress Report LA-13234-PR, Los Alamos, NM.

Shaull, D. A., M. R. Alexander, R. P. Reynolds, and C. T. McLean. 1998. Surface water data at Los Alamos National Laboratory: 1997 Water Year. Los Alamos National Laboratory Progress Report LA-13403-PR, Los Alamos, NM.

Shaull, D. A., M. R. Alexander, R. P. Reynolds, C. T. McLean, and R. P. Romero. 1999. Surface water data at Los Alamos National Laboratory: 1998 Water Year. Los Alamos National Laboratory Progress Report LA-13551-PR, Los Alamos, NM.

Shaull, D. A., M. R. Alexander, R. P. Reynolds, C. T. McLean, and R. P. Romero. 2000. Surface water data at Los Alamos National Laboratory: 1999 Water Year. Los Alamos National Laboratory Progress Report LA-13706-PR, Los Alamos, NM.

Short, H. L. 1983. Wildlife guilds in Arizona desert habitats. United States Fish and Wildlife Service, Western Energy and Land Use Team Final Report for the U.S. Bureau of Reclamation, Interagency Agreement 851-IA1-27, Fort Collins, CO.

Simpson, Z. R. and J. D. Lusk. 1999. Environmental contaminants in aquatic plants, invertebrates, and fishes of the San Juan River mainstem, 1990-1996. United States Fish and Wildlife Service Report Prepared for the San Juan River Recovery Implementation Program, Albuquerque, NM.

Sloane, M. 1998. Fish stocking information for the Los Alamos Area. New Mexico Department of Game and Fish, Correspondence, March 31, 1998, Santa Fe, NM.

Smith, G. R. 1981. Late Cenozoic freshwater fishes of North America. Annual Review of Ecological Systematics 12:163-193.

Smith, S. L., D. D. MacDonald, K. A. Keenleyside, C. G. Ingersoll, and J. Field. 1996. A preliminary evaluation of sediment quality assessment values for freshwater ecosystems. Journal of Great Lakes Research 22:624-638.

Smyth, M. and H. N. Coulombe. 1971. Notes on the use of desert springs by birds in California. Condor 73: 240-243.

Sparling, D. W., T. P. Lowe, and P. G. C. Campbell. 1997. Ecotoxicology of aluminum to fish and wildlife. Chapter 3, pages 47-68 *in* R. A. Yokel and M. S. Golub (Eds.), Research Issues in Aluminum Toxicity. Taylor and Francis, Inc., New York, NY.

Sposito, G., M. Ladislau, and A. Yang. 1996. Atrazine complexation by soil humic acids. Journal of Environmental Quality 25:1203-1228.

StatSoft, Inc. 1994. Statistica Volume I: General Conventions & Statistics I. StatSoft, Inc., Tulsa, OK.

Steen, C. R. 1977. Pajarito Plateau Archaeological Survey and Excavations. Los Alamos Scientific Laboratory, Los Alamos, NM.

Strom, S. M. 2000. The Utility of Metal Biomarkers in Assessing the Toxicity of Metals in the American Dipper (*Cinclus mexicanus*). Colorado State University thesis, Forth Collins, CO.

Stuart, D. E. 1986. Prehistory: The Upland Period. Pages 86-88 *in* Williams, J. L. (Ed.), New Mexico in Maps. University of New Mexico Press, Albuq., NM.

Stumpff, J., and B. Cooper. 1996. Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis*) *in* D. A. Duff (Ed.), Conservation Assessment for Inland Cutthroat Trout: Distribution, Status, and Habitat Management Implications. United States Department of Agriculture, Forest Service, Intermountain Region, Ogden, UT.

Sublette, J. E., M. D. Hatch, and M. Sublette. 1990. The Fishes of New Mexico. University of New Mexico Press, Albuquerque, NM.

Talmage, S. S., D. M. Opresko, C. J. Maxwell, C. J. E. Welsh, F. M. Cretella, P. H. Renol, and F. B. Daniel. 1999. Nitroaromatic munition compounds: environmental effects and screening values. Reviews of Environmental Contamination and Toxicology 161:1-156.

Travis, J. R. 1992. Atlas of the breeding birds of Los Alamos County, New Mexico. Los Alamos National Laboratory Report LA-12206, Los Alamos, NM.

UCR (The University of California Regents). 2000. Los Alamos National Laboratory Profile. Los Alamos National Laboratory, Public Affairs Office Web Page at the uniform resource locator: <http://ext.lanl.gov/worldview/welcome/profile.html>.

USDOE (United States Department of Energy). 1979. Final environmental impact statement for the Los Alamos Scientific Laboratory Site, Los Alamos, New Mexico. United States Department of Energy Report DOE/EIS-0018, Washington, DC.

USDOE (United States Department of Energy). 1996. Environmental assessment for effluent reduction. United States Department of Energy, Los Alamos Area Office Report DOE/EA-1156, Los Alamos, NM.

USDOE (United States Department of Energy). 1999. Final Site-Wide Environmental Impact Statement for Continued Operations of the Los Alamos National Laboratory, Los Alamos, New Mexico. United States Department of Energy, Albuquerque Area Operations Office DOE/EIS-0238 Main Report Volume I, Albuquerque, NM.

USDOE (United States Department of Energy). 2001. Comments on the Los Alamos National Laboratory Use Study. Los Alamos Area Office correspondence from D. A. Gurule, P. E., to Dr. J. E. Nicholopoulos, Field Supervisor, New Mexico Ecological Services Field Office, dated April 9, 2001, Los Alamos, NM.

USDOI (United States Department of the Interior). 1998. Guidelines for interpretation of the biological effects of selected constituents in biota, water, and sediment. National Irrigation Water Quality Program Information Report 3, Bureau of Reclamation, Denver, CO.

USEPA (United States Environmental Protection Agency). 1983. Technical Support Manual: Waterbody Surveys and Assessments for Conducting Use Attainability Analyses. United States Environmental Protection Agency, Washington, DC.

USEPA (United States Environmental Protection Agency). 1988. Ambient water quality criteria for aluminum-1988. United States Environmental Protection Agency Report EPA 440/5-86-008, Washington, DC.

USEPA (United States Environmental Protection Agency). 1993. Methods for estimating the acute toxicity of effluents and receiving waters to freshwater and marine organisms. United States Environmental Protection Agency Report EPA/600/4-90/027F, Cincinnati, OH.

USEPA (United States Environmental Protection Agency). 1994a. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to freshwater organisms. United States Environmental Protection Agency Report EPA-600-4-91-002, Cincinnati, OH.

USEPA (United States Environmental Protection Agency). 1994b. Introduction to Water Quality Standards. United States Environmental Protection Agency Report EPA-823-B-95-004, Washington, DC.

USEPA (United States Environmental Protection Agency). 1995a. Water Quality Standards Handbook: Second Edition. United States Environmental Protection Agency Report EPA-823-B-94-005a, Washington, DC.

USEPA (United States Environmental Protection Agency). 1995b. Final water quality guidance for the Great Lakes system; Final rule. Federal Register 60(56): 15366–15425.

USEPA (United States Environmental Protection Agency). 1996a. Drinking water regulations and health advisories. United States Environmental Protection Agency Report EPA 822-B-96-002, Washington, DC.

USEPA (United States Environmental Protection Agency). 1996b. Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalella azteca* and the midge *Chironomus riparius*. United States Environmental Protection Agency Region V Report EPA 905-R96-008, Chicago, IL.

USEPA (United States Environmental Protection Agency). 1997a. Guidance for assessing chemical contamination data for use in fish advisories. Volume 2: Risk assessment and fish consumption limits. United States Environmental Protection Agency Report EPA 823-B-97-009, Second Edition, Cincinnati, OH.

USEPA (United States Environmental Protection Agency). 1997b. The incidence and severity of sediment contamination in surface waters of the United States. Volume 1: National sediment quality survey. United States Environmental Protection Agency Report EPA 823-R-97-006, Washington, DC.

USEPA (United States Environmental Protection Agency). 1997c. An assessment of sediments from the Upper Mississippi River. Final Report - June, 1997. Prepared by United States Department of the Interior, Geologic Survey, Columbia, Missouri. United States Environmental Protection Agency Report EPA 823-R-97-005, Washington, DC.

USEPA (United States Environmental Protection Agency). 1998a. National recommended water quality criteria: republication. Federal Register 63(237): 68354-68364.

USEPA (United States Environmental Protection Agency). 1998b. Guidance for Data Quality Assessment: Practical Methods for Data Analysis: EPA QA/G-9 QA97 Version. United States Environmental Protection Agency Report EPA/600/R-96/084, Washington, DC.

USEPA (United States Environmental Protection Agency). 1998c. An internet search of the AQUIRE: Aquatic Toxicity Information Retrieval, database was conducted on October 28, 1998, at the uniform resource locator <http://www.epa.gov/ecotox/>.

USEPA (United States Environmental Protection Agency). 1998d. An internet search of the ECOTOX: Ecotoxicology database was conducted on June 27, 2000, at the uniform resource locator <http://www.epa.gov/ecotox/>.

USEPA (United States Environmental Protection Agency). 1998e. National sediment bioaccumulation conference proceedings. United States Environmental Protection Agency Report EPA 823-R-98-002, Washington, DC.

USEPA (United States Environmental Protection Agency). 1999. An internet search of the IRIS: Integrated Risk Information System database was conducted on June 27, 2000, at the uniform resource locator <http://www.epa.gov/iris/>.

USEPA (United States Environmental Protection Agency). 2000. Method guidance and recommendations for whole effluent toxicity (WET) testing (40 CFR Part 136). United States Environmental Protection Agency Report EPA 821-B-00-004, Washington, DC.

USEPA/USACE (United States Environmental Protection Agency/ United States Army Corps of Engineers). 1998. Evaluation of Dredged Material proposed for Discharge in Waters of the U.S. - Testing Manual. United States Environmental Protection Agency EPA-823-B-98-004, Washington, DC.

USERDA (United States Energy Research and Development Administration). No date. The Los Alamos National Environmental Research Park. Los Alamos Scientific Laboratory of the University of California, Los Alamos, NM.

USFWS (United States Fish and Wildlife Service). 1981. Standards for the development of habitat suitability index models. United States Fish and Wildlife Service Release 1-81,103-ESM, Washington, DC.

USFWS (United States Fish and Wildlife Service). 1990. National Wetland Inventory Maps (1981, 1982) overlain on United States Geological Survey's 7.5 minute topographic maps - Bland, Frijoles, Guaje Mountain, Puye, Valle Toledo, White Rock. United States Fish and Wildlife Service, Region 2, National Wetland Inventory, Albuquerque, NM.

USFWS (United States Fish and Wildlife Service). 1997. Quality Assurance of Chemical Measurements Reported under Contract to the Patuxent Analytical Control Facility. United States Fish and Wildlife Service Patuxent Analytical Control Facility Report 5-97, Patuxent, MD.

Valoppi, L. M. Petreas, R.M. Donahoe, L. Sullivan, and C. A. Callahan. 1999. Use of PCB congener and homologue analysis in ecological risk assessment. Pages in press *in* F. T. Price, K. V. Brix, and N. K. Lane (Eds.), Environmental Toxicology and Risk Assessment: Recent Achievements in Environmental Fate and Transport: Ninth Volume, ASTM STP 1381. American Society for Testing and Materials, West Conshohocken, PA.

Warren, R. G., E. V. McDonald, and R. T. Ryti. 1997. Baseline Geochemistry of Soil and Bedrock Tshrige Member of the Bandelier Tuff at MDA-P. Los Alamos National Laboratory Report LA-13330-MS, Los Alamos, NM.

Waters, T. F. 1969. Invertebrate drift – ecology and significance to stream fishes, pages 121-134 *in* T. G. Northcote (Ed.), Symposium on Salmon and Trout in Streams. MacMillan Lectures in Fisheries, Vancouver, Canada.

Wesche, T. A. 1974. Evaluation of trout in smaller streams. Western Association of State Game and Fish Commissioners 54:286-294.

Wesche, T. A. 1993. Watershed management and land-use practices. Pages 2181-204 *in* C. C. Kohler and W.A. Hubert (Eds.), Inland Fisheries Management in North America. American Fisheries Society, Bethesda, MD.

Williams, P. L., and W. D. Koenig. 1980. Water dependence of birds in a temperate oak woodland. Auk 97:339-350.

Windell, J. T., B. E. Willard, D. J. Cooper, S. Q. Foster, C. F. Knud-Hansen, L. P. Rink, and G. N. Kiladis. 1986. An ecological characterization of Rocky Mountain montane and subalpine wetlands. United States Fish and Wildlife Service Biological Report 86(11), Fort Collins, CO.

Winger, P. V. and P. J. Lasier. 1995. Sediment toxicity in Savannah Harbor. Archives of Environmental Contamination and Toxicology 28:357-365.

Winkle, P. L., W. A. Hubert, and F. J. Rahel. 1990. Relations between brook trout standing stocks and habitat features in beaver ponds in southeastern Wyoming. North American Journal of Fisheries Management 10:72-79.

Woodward, D. F., A. Farag, W. A. Hubert, J. N. Goldstein, and J. S. Meyer. 2000. Effects of geothermal effluents on rainbow trout and brown trout in the Firehole River, Yellowstone National Park, Wyoming. United States Geological Survey, Columbia Environmental Research Center Final Report, Columbia, MO.

Young, D., B. Frost, and M. Schneider. 1994. Establishing irrigated pasture at 4,000- to 6,000-foot elevation in Arizona. University of Arizona, College of Agriculture Publication 194028, Tucson, AZ.

TABLES

Table 1. Biological, Chemical, and Physical Evaluations Conducted during the LANL Water Quality Assessment, 1996-1997.

BIOLOGICAL EVALUATIONS

Biological Inventory
- Wildlife Reported in Study Area
- Electrofishing Survey
- Aquatic Life Reported in the Study Area
- Benthic Macroinvertebrate Survey
  - Taxa Density and Richness
  - Diversity Indices
  - Community Metrics

Biological Response
- Surface Water Toxicity Testing
  - Using a 96-hour Static Renewal Test with laboratory invertebrates/fish
  - *In Situ* Caged-fish 96-hr & 2 months
- Sediment Toxicity Testing
  - Using a 96-hour Test of Porewater with laboratory invertebrates
- Contaminant Bioavailability
  - Metals/PCB accumulation in biota

CHEMICAL EVALUATIONS

Field and Laboratory Analyses	**Nutrients**	**Minerals**	**Dissolved Oxygen**	**pH**
Continuous Monitoring		X	X	X
Grab Water Samples	X	X	X	X
Porewater	X	X	X	X
Chemical Analyses	**Organics**	**Metals**	**Radionuclides**	**Explosives**
Water Samples		X	X	X
Porewater		X	X	
Sediment	X	X		X
Benthic Macroinvertebrates		X		
Caged Fish	X	X		

PHYSICAL EVALUATIONS

Instream Characteristics
- Width and Depth
- Flow and Discharge
- Substrate
- Cover

Watershed Characteristics
- Stream Channel Stability
- Land Use and Land Cover
- Air & Water Temperature
- Water Uses & Discharges

Habitat Conditions
- Habitat Type (*e.g.*, pool, riffle, run)
- Riparian Vegetation
- Habitat Stability

Habitat Suitability Models
- Brook Trout Life Cycle Habitat Suitability Index
- Longnose Dace Adult Habitat Suitability Index
- Rapid Bioassessment Protocol for Invertebrates

Table 2. Wildlife Species Reported in the Jemez Mountains and Characterized by Life Cycle Dependency in Water.

COMMON NAME	SCIENTIFIC NAME	Source[1]	GUILD[2] Fully Aquatic	Semi-aquatic	Riparian	Terrestrial
Fish of the Jemez Mountains						
Rio Grande Cutthroat Trout	Oncorhynchus clarki virginalis	1,2	yes	no	no	no
Rainbow Trout	Oncorhynchus mykiss	1	yes	no	no	no
Brown Trout	Salmo trutta	1,2	yes	no	no	no
Brook Trout	Salvelinus fontinalis	1,2	yes	no	no	no
Rio Grande Chub	Gila pandora	1,2	yes	no	no	no
Fathead Minnow	Pimephales promelas	1	yes	no	no	no
Longnose Dace	Rhinichthys cataractae	1	yes	no	no	no
Rio Grande Sucker	Catostomus plebeius	1,2	yes	no	no	no
White Sucker	Catostomus commersoni	1	yes	no	no	no
Additional Fish of the Rio Grande (above Cochiti Reservoir to the Rio Chama)						
Red Shiner	Cyprinella lutrensis	1,3	yes	no	no	no
Common Carp	Cyprinus carpio	1,3	yes	no	no	no
Flathead Chub	Platygobio gracilis	1,3	yes	no	no	no
River Carpsucker	Carpiodes carpio	1,3	yes	no	no	no
Black Bullhead	Ameiurus melas	1,3	yes	no	no	no
Channel Catfish	Ictalurus punctatus	1,3	yes	no	no	no
Mosquitofish	Gambusia affinis	1,3	yes	no	no	no
Green Sunfish	Lepomis cyanellus	1,3	yes	no	no	no
Bluegill	Lepomis macrochirus	1,3	yes	no	no	no
Smallmouth Bass	Micropterus dolomieui	1,3	yes	no	no	no
Largemouth Bass	Micropterus salmoides	1,3	yes	no	no	no
Black Crappie	Pomoxis nigromaculatus	1,3	yes	no	no	no
Yellow Perch	Perca flavescens	1,3	yes	no	no	no
Walleye	Stizostedion vitreum	1,3	yes	no	no	no
Amphibians of the Pajarito Plateau						
Jemez Mountain Salamander	Plethodon neomexicanus	4,5	no	no	no	yes
Tiger Salamander	Ambystoma tigrinum	4,5	no	yes	yes	no
New Mexico Spadefoot	Spea multiplicata	4,5	no	yes	yes	no
Red-spotted Toad	Bufo punctatus	4,5	no	yes	yes	no
Woodhouse's Toad	Bufo woodhousii	4,5	no	yes	yes	no
Canyon Treefrog	Hyla arenicolor	4,5	no	yes	yes	no
Western Chorus Frog	Pseudacris triseriata	4,5	no	yes	yes	no
Bullfrog	Rana catesbeiana	4	no	yes	yes	no
Northern Leopard Frog	Rana pipiens	4	no	yes	yes	no
Lizards of the Pajarito Plateau						
Collared Lizard	Crotaphytus collaris	4,5	no	no	yes	yes
Short-horned Lizard	Phrynosoma douglasii	4,5	no	no	no	yes
Prairie Lizard	Sceloporus undulatus	4,5	no	no	no	yes
Tree Lizard	Urosaurus ornatus	4,5	no	no	yes	yes
Chihuahuan Spotted Whiptail	Cnemidophorus exsanguis	4,5	no	no	no	yes
Checkered Whiptail	Cnemidophorus grahami	4	no	no	yes	yes
Little Striped Whiptail	Cnemidophorus inornatus	4,6	no	no	no	yes
New Mexico Whiptail	Cnemidophorus neomexicanus	6	no	no	no	yes
Plateau Striped Whiptail	Cnemidophorus velox	4,5	no	no	yes	yes
Many-lined Skink	Eumeces multivirgatus	4,5	no	no	yes	yes
Great Plains Skink	Eumeces obsoletus	4,5	no	no	yes	yes

Table 2. Wildlife Species Reported in the Jemez Mountains and Characterized by Life Cycle Dependency in Water ~ Continued.

COMMON NAME	SCIENTIFIC NAME	Source[1]	GUILD[2]			
			Fully Aquatic	Semi-aquatic	Riparian	Terrestrial
Snakes of the Pajarito Plateau						
Ringneck Snake	Diadophis punctatus	4,6	no	no	yes	yes
Great Plains Rat Snake	Eleaphe guttata	4,5	no	no	yes	yes
Night Snake	Hypsiglena torquata	4,5	no	no	no	yes
Smooth Green Snake	Liochlorophis vernalis	4,5	no	no	yes	yes
Coachwhip	Masticophis flagellum	4,5	no	no	yes	yes
Striped Whipsnake	Masticophis taeniatus	4,5	no	no	yes	yes
Gopher Snake ("Bull Snake")	Pituophis melanoleucus	4,5	no	no	yes	yes
Mountain Patch-nosed Snake	Salvadora grahamiae	4,5	no	no	yes	yes
Blackneck Garter Snake	Thamnophis cyrtopsis	4,5	no	no	yes	yes
Western Terrestrial Garter Snake	Thamnophis radix	4,5	no	no	yes	yes
Western Diamondback Rattlesnake	Crotalus atrox	4,5	no	no	yes	yes
Western ("Prairie") Rattlesnake	Crotalus viridis	4,5	no	no	no	yes
Mammals of the Jemez Mountains						
Shrews						
Dwarf Shrew	Sorex nanus	6,7	no	no	yes	yes
Masked Shrew	Sorex cinereus	7	no	no	yes	no
Water Shrew	Sorex palustris	8,9	no	no	yes	no
Bats						
Townsend's Big-eared Bat	Plecotus townsendii	7,8	no	no	yes	yes
Big Brown Bat	Eptesicus fuscus	7,8	no	no	yes	yes
Big Free-tailed Bat	Nyctinomops macrotis	7,8	no	no	yes	yes
Brazilian Free-tailed Bat	Tadarida brasiliensis	7,8	no	no	yes	yes
California Myotis	Myotis californicus	7,8	no	no	yes	yes
Fringed Myotis	Myotis thysanodes	7,8	no	no	yes	yes
Hoary Bat	Lasiurus cinereus	7,8	no	no	yes	yes
Long-eared Myotis	Myotis evotis	7,8	no	no	yes	yes
Long-legged Myotis	Myotis volans	7,8	no	no	yes	yes
Pallid Bat	Antrozous pallidus	7,8	no	no	yes	yes
Western Pipistrelle	Pipistrellus hesperus	7,8	no	no	yes	yes
Silver-haired Bat	Lasionycteris noctivagans	7,8	no	no	yes	yes
Western Small-footed Myotis	Myotis ciliolabrum	7,8	no	no	yes	yes
Spotted Bat	Euderma maculatum	7,8	no	no	yes	yes
Yuma Myotis	Myotis yumanensis	7,8	no	no	yes	yes
Hares, rabbits, and pikas						
Desert Cottontail	Sylvilagus audubonii	6,8	no	no	yes	yes
Nuttall's Mountain Cottontail	Sylvilagus nuttallii	8	no	no	no	yes
Pika	Ochotona princeps	7,8	no	no	no	yes
Squirrels, Gophers, and relatives						
Colorado Chipmunk	Tamias quadrivittatus	7,8	no	no	no	yes
Least Chipmunk	Tamias minimus	7,8	no	no	no	yes
Abert's Squirrel	Sciurus aberti	7,8	no	no	no	yes
Golden-mantled Ground Squirrel	Spermophilus lateralis	7,8	no	no	no	yes
Spotted Ground Squirrel	Spermophilus spilosoma	7,8	no	no	yes	yes
Red Squirrel	Tamiasciurus hudsonicus	7,8	no	no	yes	yes
Rock Squirrel	Spermophilus variegatus	7,8	no	no	yes	yes
Gunnison's Prairie Dog	Cynomys gunnisoni	7,8	no	no	no	yes
Botta's Pocket Gopher	Thomomys bottae	7,8	no	no	yes	yes

Table 2. Wildlife Species Reported in the Jemez Mountains and Characterized by Life Cycle Dependency in Water ~ Continued.

COMMON NAME	SCIENTIFIC NAME	Source[1]	GUILD[2]			
			Fully Aquatic	Semi-aquatic	Riparian	Terrestrial
Northern Pocket Gopher	Thomomys talpoides	7,8	no	no	no	yes
Mice, Rats, and Voles						
Brush Mouse	Peromyscus boylii	7,8,9	no	no	yes	yes
Deer Mouse	Peromyscus maniculatus	7,8,9	no	no	yes	yes
Western Harvest Mouse	Reithrodontomys megalotis	7,8	no	no	yes	yes
House Mouse	Mus musculus	7,8	no	no	yes	yes
Pinyon Mouse	Peromyscus truei	7,8	no	no	no	yes
Plains Pocket Mouse	Perognathus flavescens	6	no	no	no	yes
Rock Pocket Mouse	Chaetodipus intermedius	6	no	no	yes	yes
Silky Pocket Mouse	Perognathus flavus	7,8	no	no	yes	yes
Northern Rock Mouse	Peromyscus nasutus	7,8	no	no	no	yes
White-footed Mouse	Peromyscus leucopus	7,8,9	no	no	yes	yes
Bushy-tailed Wood Rat	Neotoma cinerea	7,8	no	no	no	yes
Mexican Wood Rat	Neotoma mexicana	8,9	no	no	yes	yes
White-throated Wood Rat	Neotoma albigula	7,8,9	no	no	yes	yes
Long-tailed Vole	Microtus longicaudus	7,8,9	no	no	yes	yes
Meadow Vole	Microtus pennsylvanicus	7,8	no	no	yes	yes
Montane Vole	Microtus montanus	7,8,9	no	no	yes	yes
Red-backed Vole	Clethrionomys gapperi	7,8	no	no	yes	yes
New Mexican Jumping Mouse	Zapus hudsonius	7,8	no	no	yes	yes
Beaver, Raccoon, Ringtail, Skunk and Porcupine						
Beaver	Castor canadensis	7	no	yes	yes	no
Raccoon	Procyon lotor	7,8	no	yes	yes	yes
Ringtail	Bassariscus astutus	8	no	no	yes	yes
Striped Skunk	Mephitis mephitis	7,8	no	no	yes	yes
Porcupine	Erethizon dorsatum	7,8	no	no	yes	yes
Dogs and relatives						
Coyote	Canis latrans	6,8	no	no	yes	yes
Gray Fox	Urocyon cinereoargenteus	7,8	no	no	yes	yes
Red Fox	Vulpes vulpes	8	no	no	no	yes
Bear						
Black Bear	Ursus americanus	7,8	no	no	yes	yes
Weasels						
Ermine Weasel	Mustela erminea	7,8	no	no	no	yes
Long-tailed Weasel	Mustela frenata	8	no	no	yes	yes
Black-footed Ferret	Mustela nigripes	8	no	no	no	yes
Cats						
Bobcat	Lynx rufus	7,8	no	no	yes	yes
Mountain Lion	Felis concolor	7,8	no	no	yes	yes
Deer and Elk (Wapiti)						
Mule Deer	Odocoileus hemionus	7,8	no	no	yes	yes
Elk	Cervus elaphus nelsoni	7,8	no	no	no	yes
Other mammals						
Feral Burro	Equus asinus	7,8	no	no	yes	yes
Human	Homo sapiens	7	no	no	yes	yes
Birds of the Jemez Mountains and Wetlands						
Eared Grebe	Podiceps nigricollis	13	no	yes	yes	no
Pied-billed Grebe	Podilymbus podiceps	13	no	yes	yes	no
American Bittern	Botaurus lentiginosus	11,13	no	yes	yes	no
Great Blue Heron	Ardea herodias	6,14	no	yes	yes	no
Black-crowned Night Heron	Nycticorax nycticorax	11,13	no	yes	yes	no

Table 2. Wildlife Species Reported in the Jemez Mountains and Characterized by Life Cycle Dependency in Water ~ Continued.

COMMON NAME	SCIENTIFIC NAME	Source[1]	GUILD[2]			
			Fully Aquatic	Semi-aquatic	Riparian	Terrestrial
Turkey Vulture	Cathartes aura	6, 10	no	no	yes	yes
Canada Goose	Branta canadensis	13	no	yes	yes	no
Wood Duck	Aix sponsa	13	no	yes	yes	no
Gadwall	Anas strepera	13,14	no	yes	yes	no
American Wigeon	Anas americana	13,14	no	yes	yes	no
Mallard	Anas platyrhynchos	6, 10,14	no	yes	yes	no
Blue-winged Teal	Anas discors	13,14	no	yes	yes	no
Green-winged Teal	Anas crecca	13,14	no	yes	yes	no
Cinnamon Teal	Anas cyanoptera	13,14	no	yes	yes	no
Northern Shoveler	Anas clypeata	13,14	no	yes	yes	no
Northern Pintail	Anas acuta	13,14	no	yes	yes	no
Ring-necked Duck	Aythya collaris	13,14	no	yes	yes	no
Lesser Scaup	Aythya affinis	13,14	no	yes	yes	no
Bufflehead	Bucephala albeola	13,14	no	yes	yes	no
Common Goldeneye	Bucephala clangula	13,14	no	yes	yes	no
Hooded Merganser	Lophodytes cucullatus	14	no	yes	yes	no
Common Merganser	Mergus merganser	6	no	yes	yes	no
Osprey	Pandion haliaetus	13,14	no	yes	yes	no
Bald Eagle	Haliaeetus leucocephalus	6,14	no	yes	yes	no
Northern Harrier	Circus cyaneus hudsonius	13,14	no	no	yes	yes
Sharp-shinned hawk	Accipiter striatus	10,14	no	no	yes	yes
Cooper's hawk	Accipiter cooperii	10,12, 14	no	no	yes	yes
Northern goshawk	Accipiter gentilis	10,14	no	no	yes	yes
Swainson's Hawk	Buteo swainsoni	13,14	no	no	yes	yes
Zone-tailed Hawk	Buteo albonotatus	10,13,14	no	no	no	yes
Red-tailed Hawk	Buteo jamaicensis	6, 10,13,14	no	no	no	yes
Ferruginous Hawk	Buteo regalis	13	no	no	no	yes
Rough-legged Hawk	Buteo lagopus	13	no	no	yes	yes
Golden Eagle	Aquila chrysaetos	6,13,14	no	no	no	yes
American Kestrel	Falco sparverius	6, 10,14	no	no	yes	yes
Merlin	Falco columbarius	11, 14	no	no	no	yes
Prairie Falcon	Falco mexicanus	14	no	no	no	yes
American Peregrine Falcon	Falco peregrinus	10	no	no	yes	yes
Blue Grouse	Dendragapus obscurus	10	no	no	no	yes
Wild Turkey	Meleagris gallopavo	10	no	no	yes	no
Scaled Quail	Callipepla squamata	6,13	no	no	no	yes
Gambel's Quail	Callipepla gambelii	10, 13	no	no	no	yes
American Coot	Fulica americana	6,14	no	yes	yes	no
Sandhill Crane	Grus canadensis	14	no	yes	yes	no
Killdeer	Charadrius vociferus	13	no	yes	yes	no
Mountain Plover	Charadrius montanus	13	no	no	yes	yes
Spotted Sandpiper	Actitis macularia	10, 13	no	yes	yes	no
Ring-billed Gull	Larus delawarensis	14	no	no	yes	yes
Rock Dove	Columba livia	13	no	no	no	yes
Band-tailed Pigeon	Columba fasciata	6	no	no	no	yes
Mourning Dove	Zenaida macroura	6, 12	no	no	yes	no
Greater Roadrunner	Geococcyx californianus	14	no	no	yes	yes
Barn Owl	Tyto alba	13	no	no	yes	yes
Flammulated Owl	Otus flammeolus	6, 10	no	no	no	yes

Table 2. Wildlife Species Reported in the Jemez Mountains and Characterized by Life Cycle Dependency in Water ~ Continued.

COMMON NAME	SCIENTIFIC NAME	Source[1]	GUILD[2]			
			Fully Aquatic	Semi-aquatic	Riparian	Terrestrial
Western Screech Owl	Otus kennicottii	6	no	no	no	yes
Great-horned Owl	Bubo virginianus	10, 13	no	no	no	yes
Northern Pygmy Owl	Glaucidium gnoma	10	no	no	no	yes
Mexican Spotted Owl	Strix occidentalis lucida	6, 10	no	no	no	yes
Northern Saw-whet Owl	Aegolius acadicus	10, 13	no	no	yes	yes
Common Nighthawk	Chordeiles minor	10	no	no	no	yes
Common Poorwill	Phalaenoptilus nuttalli	10	no	no	no	yes
Whip-poor-will	Caprimulgus vociferus	6, 13	no	no	no	yes
White-throated swift	Aeronautes saxatalis	6, 10, 13	no	no	yes	yes
Black-chinned Hummingbird	Archilochus alexandri	6, 10, 13	no	no	yes	no
Calliope Hummingbird	Stellula calliope	14	no	no	no	yes
Broad-tailed Hummingbird	Selasphorus platycercus	6, 10, 11	no	no	no	yes
Rufous Hummingbird	Selasphorus rufus	14	no	no	yes	yes
Belted Kingfisher	Ceryle alcyon	13	no	yes	yes	no
Lewis's Woodpecker	Melanerpes lewis	6	no	no	yes	no
Acorn Woodpecker	Melanerpes formicivorus	6, 10	no	no	no	yes
Yellow-bellied Sapsucker	Sphyrapicus varius varius	6	no	no	yes	no
Red-naped Sapsucker	Sphyrapicus nuchalis	10	no	no	yes	yes
Williamson's Sapsucker	Sphyrapicus thyroideus	10	no	no	no	yes
Ladder-backed Woodpecker	Picoides scalaris	10	no	no	yes	no
Downy Woodpecker	Picoides pubescens	10	no	no	no	yes
Hairy Woodpecker	Picoides villosus	6, 10, 11, 12	no	no	no	yes
Three-toed Woodpecker	Picoides tridactylus	10, 12	no	no	no	yes
Northern Flicker	Colaptes auratus	6, 10, 12 ,13	no	no	yes	yes
Olive-sided Flycatcher	Contopus cooperi	13	no	no	yes	yes
Western Wood-Pewee	Contopus sordidulus	6, 10, 12	no	no	yes	yes
Willow Flycatcher	Empidonax traillii	6	no	no	yes	yes
Hammond's Flycatcher	Empidonax hammondii	10, 12	no	no	no	yes
Dusky Flycatcher	Empidonax oberholseri	10	no	no	no	yes
Gray Flycatcher	Empidonax wrightii	6, 10	no	no	no	yes
Cordilleran Flycatcher	Empidonax occidentalis	10, 12	no	no	yes	yes
Black Phoebe	Sayornis nigricans semiatra	10	no	no	yes	yes
Say's Phoebe	Sayornis saya	6, 10	no	no	yes	no
Ash-throated Flycatcher	Myiarchus cinerascens	10, 12	no	no	yes	no
Western Kingbird	Tyrannus verticalis	13	no	no	yes	no
Cassin's Kingbird	Tyrannus vociferans	6, 10	no	no	yes	no
Loggerhead Shrike	Lanius ludovicianus	13	no	no	yes	no
Gray Vireo	Vireo vicinior	13	no	no	no	yes
Solitary Vireo	Vireo solitarius	6, 10, 12	no	no	yes	yes
Warbling Vireo	Vireo gilvus	10, 12	no	no	yes	no
Gray Jay	Perisoreus canadensis	10	no	no	no	yes
Steller's Jay	Cyanocitta stelleri	6, 10,12	no	no	no	yes
Western Scrub Jay	Aphelocoma californica	6, 10, 13	no	no	no	yes
Pinon Jay	Gymnorhinus cyanocephalus	10, 11	no	no	no	yes
Clark's Nutcracker	Nucifraga columbiana	6, 10	no	no	no	yes
Black-billed Magpie	Pica pica hudsonia	6, 10	no	no	no	yes
American Crow	Corvus brachyrhynchos	10	no	no	yes	no
Chihuahuan raven	Corvus cryptoleucus	6	no	no	no	yes
Common Raven	Corvus corax sinuatus	6, 10,13	no	no	no	no

Table 2. Wildlife Species Reported in the Jemez Mountains and Characterized by Life Cycle Dependency in Water ~ Continued.

COMMON NAME	SCIENTIFIC NAME	Source[1]	GUILD[2]			
			Fully Aquatic	Semi-aquatic	Riparian	Terrestrial
Horned Lark	Eremophila alpestris	13	no	no	no	yes
Tree Swallow	Tachycineta bicolor	14	no	no	yes	no
Violet-green Swallow	Tachycineta thalassina	10, 14	no	no	yes	yes
N. Rough-winged Swallow	Stelgidopteryx serripennis	14	no	no	yes	no
Bank Swallow	Riparia riparia	14	no	no	yes	no
Barn Swallow	Hirundo rustica	14	no	no	yes	yes
Cliff Swallow	Petrochelidon pyrrhonota	10	no	no	yes	yes
Black-capped Chickadee	Poecile atricapillus	13	no	no	yes	yes
Mountain Chickadee	Poecile gambeli	6, 10, 12	no	no	no	yes
Juniper ("Plain") Titmouse	Baeolophus ridgwayi	6, 10	no	no	yes	yes
Bushtit	Psaltriparus minimus	10, 5	no	no	yes	no
Red-breasted Nuthatch	Sitta canadensis	10	no	no	no	yes
White-breasted Nuthatch	Sitta carolinensis	10, 12, 14	no	no	no	yes
Pygmy Nuthatch	Sitta pygmaea	6, 10, 12	no	no	no	yes
Brown Creeper	Certhia americana	13,14	no	no	yes	yes
Rock Wren	Salpinctes obsoletus	10, 12, 14	no	no	no	yes
Canyon Wren	Catherpes mexicanus	10, 12, 13	no	no	no	yes
Bewick's Wren	Thryomanes bewickii	10	no	no	yes	yes
House Wren	Troglodytes aedon	6, 10, 12	no	no	yes	yes
American Dipper	Cinclus mexicanus	10,11,13	no	yes	yes	no
Golden-crowned Kinglet	Regulus satrapa	6	no	no	yes	yes
Ruby-crowned Kinglet	Regulus calendula	10	no	no	yes	no
Blue-gray Gnatcatcher	Polioptila caerulea	10, 12	no	no	yes	yes
Western Bluebird	Sialia mexicana	6, 10, 14	no	no	yes	no
Mountain Bluebird	Sialia currucoides	6, 10, 14	no	no	no	no
Townsend's Solitaire	Myadestes townsendi	6, 10, 14	no	no	yes	yes
Hermit Thrush	Catharus guttatus	10, 12, 13	no	no	no	no
American Robin	Turdus migratorius	6, 10, 12	no	no	yes	no
Gray Catbird	Dumetella carolinensis	13	no	no	no	yes
Northern Mockingbird	Mimus polyglottos	10	no	no	yes	no
European Starling	Sturnus vulgaris	6	no	no	yes	no
American Pipit	Anthus rubescens	13	no	no	no	yes
Orange-crowned Warbler	Vermivora celata	10, 11	no	no	no	yes
Virginia's Warbler	Vermivora virginiae	10, 11	no	no	yes	yes
Yellow Warbler	Dendroica petechia	6	no	no	yes	yes
Yellow-rumped Warbler	Dendroica coronata	6, 10, 12	no	no	yes	no
Black-throated Gray Warbler	Dendroica nigrescens	10	no	no	no	yes
Townsend's Warbler	Dendroica townsendi	13	no	no	yes	yes
Grace's Warbler	Dendroica graciae	10, 12	no	no	no	yes
Macgillivray's Warbler	Oporornis tolmiei	10	no	no	no	yes
Common Yellowthroat	Geothlypis trichas	13	no	no	yes	no
Wilson's Warbler	Wilsonia pusilla	6	no	no	no	yes
Yellow-breasted Chat	Icteria virens	13	no	no	yes	no
Hepatic Tanager	Piranga flava	10	no	no	yes	yes
Summer Tanager	Piranga rubra	13	no	no	yes	no
Western Tanager	Piranga ludoviciana	6, 10	no	no	yes	no
Green-tailed Towhee	Pipilo chlorurus	10, 14	no	no	yes	no
Canyon Towhee	Pipilo fuscus	6, 10	no	no	no	yes
Spotted Towhee	Pipilo maculatus	6, 10	no	no	no	yes

Table 2. Wildlife Species Reported in the Jemez Mountains and Characterized by Life Cycle Dependency in Water ~ Continued.

COMMON NAME	SCIENTIFIC NAME	Source[1]	GUILD[2]			
			Fully Aquatic	Semi-aquatic	Riparian	Terrestrial
Cassin's Sparrow	Aimophila cassinii	13	no	no	no	yes
Rufous-crowned Sparrow	Aimophila ruficeps	10, 13	no	no	no	yes
Chipping Sparrow	Spizella passerina	6, 10, 14	no	no	yes	no
Brewer's Sparrow	Spizella breweri	13	no	no	yes	no
Black-chinned sparrow	Spizella atrogularis	6	no	no	no	yes
Vesper Sparrow	Pooecetes gramineus	10	no	no	no	yes
Lark Sparrow	Chondestes grammacus	6, 10, 12, 13	no	no	yes	no
Black-throated Sparrow	Amphispiza bilineata	13	no	no	yes	no
Sage Sparrow	Amphispiza belli	13	no	no	yes	no
Savannah Sparrow	Passerculus sandwichensis	14	no	no	yes	no
Fox Sparrow	Passerella iliaca	13	no	no	no	yes
Song Sparrow	Melospiza melodia	10	no	no	yes	no
Lincoln's Sparrow	Melospiza lincolnii	10	no	no	yes	no
White-crowned Sparrow	Zonotrichia leucophrys	6	no	no	yes	no
Dark-eyed Junco	Junco hyemalis	6, 10	no	no	yes	no
Black-headed Grosbeak	Pheucticus melanocephalus	14	no	no	yes	no
Blue Grosbeak	Guiraca caerulea	14	no	no	no	yes
Lazuli Bunting	Passerina amoena	10	no	no	yes	no
Indigo Bunting	Passerina cyanea	10	no	no	no	yes
Red-winged Blackbird	Agelaius phoeniceus	10, 13	no	no	yes	no
Western Meadowlark	Sturnella neglecta	10	no	no	no	yes
Brewer's Blackbird	Euphagus cyanocephalus	10	no	no	yes	no
Great-tailed Grackle	Quiscalus mexicanus	6	no	no	yes	no
Brown-headed Cowbird	Molothrus ater	10	no	no	yes	no
Bullock's Oriole	Icterus bullockii	10	no	no	no	yes
Scott's Oriole	Icterus parisorum	10	no	no	yes	no
Pine Grosbeak	Pinicola enucleator	13	no	no	no	yes
Cassin's Finch	Carpodacus cassinii	6, 13	no	no	yes	yes
House Finch	Carpodacus mexicanus	6, 12	no	no	yes	no
Red Crossbill	Loxia curvirostra	6, 10, 12	no	no	no	yes
Pine Siskin	Carduelis pinus pinus	10, 12, 13	no	no	yes	yes
Lesser Goldfinch	Carduelis psaltria	10, 12,13	no	no	yes	no
American Goldfinch	Carduelis tristis pallidus	13	no	no	yes	no
Evening Grosbeak	Coccothraustes vespertinus	10, 13	no	no	no	yes
House Sparrow	Passer domesticus	10	no	no	yes	no
**Aquatic Invertebrates of the Los Alamos, Sandia, Valle, and Pajarito Canyons are listed in Appendix III. Over 250 aquatic invertebrate taxa were reported in canyon streams on the Pajarito Plateau by Cross 1997.						

[1] Source:

1 Sublette *et al.* 1990
2 Calamusso and Rinne 1999
3 Rinne and Platania 1995
4 Degenhardt *et al.* 1996
5 Foxx *et al.* 1999
6 Hinojosa 1997
7 Findley *et al.* 1975
8 Biggs *et al.* 1997b
9 Biggs *et al.* 1997a
10 Travis 1992
11 Poole and Gill 1999
12 Johnson and Wauer 1996
13 National Geographic Society 1987
14 Fettig 1999

Table 2. Wildlife Species Reported in the Jemez Mountains and Characterized by Life Cycle Dependency in Water ~ Continued.

COMMON NAME	SCIENTIFIC NAME	Source[1]	GUILD[2]			
			Fully Aquatic	Semi-aquatic	Riparian	Terrestrial

[2] Guild = Wildlife species were associated with a habitat classified as fully aquatic, semi-aquatic, riparian, or terrestrial according to NMDGF 1998, Short 1983, and Niering 1985.

Table 3. Watershed Characteristics of Canyons that Contain the Stream Segments Studied For the LANL Water Quality Assessment, 1996-1997.

Variable	Canyon Watershed or Drainage				
	Los Alamos	Sandia	Pajarito	Water[a]	Valle
Drainage Area (km^2)	28.4	14.2	20.7	15.4	10.8
Basin Length (km)	25.9	15.8	22.5	21.7	11.9
Stream Order at Mouth	3	2	3	3	2
Stream Order at Study Site	2	2[b]	2	--	2
Vegetation[c] and Land Use					--
% Spruce/Fir	38.8	1.2	25.4	26.4	--
% Aspen	4.1	<0.1	2.7	3.1	--
% Ponderosa Pine	14.8	13.2	33.8	37.6	--
% Piñon/Juniper and Juniper Savannah	24.7	59.8	16.3	23.1	--
% Grassland	2.3	3.2	3.9	6.5	--
% Unvegetated	9.6	13.1	3.4	2.5	--
% Developed	4.9	9.5	15.3	0.6	--

[a] Land use data only available for Water Canyon, which contains Valle Canyon.

[b] Stream order determined from topographic maps indicated a first order stream at the study location, however, effluent discharges that are similar to tributaries in volume and location indicated a second order stream.

[c] Based on the preliminary vegetation and land cover classification for the Los Alamos National Laboratory and vicinity as reported by Koch *et al.* (1997).

Table 4. Location of Cages, Hydrolab Monitoring, and Habitat Measurements in Canyon Stream Reaches for the LANL Water Quality Assessment, 1996-1997.

Canyon Stream Reach	Cage Number, Monitoring, or Habitat Measurement	X - Y Coordinates	
		Easting	Northing
Los Alamos AR[a]	Hydrolab monitoring	377385	3971927
Sandia Canyon	Hydrolab monitoring	381852	3970414
Pajarito Canyon	Hydrolab monitoring	379362	3968959
Valle Canyon	Hydrolab monitoring	379703	3967945
Los Alamos AR	Cages T1[b] and B1[c]	377230	3972135
Los Alamos AR	Cages T2 and B2	377262	3972104
Los Alamos AR	Cages T3 and B3	377286	3972095
Los Alamos AR	Cages T4 and B4	377310	3972058
Los Alamos AR	Cages T5 and B5	377332	3972024
Los Alamos AR	Cages T6 and B6	377336	3972009
Los Alamos AR	Cages T7 and B7	377341	3971986
Los Alamos AR	Cages T8 and B8	377353	3971958
Los Alamos AR	Cages T9 and B9	377385	3971927
Sandia Canyon	Cages T1 and B1	381852	3970414
Sandia Canyon	Cages T2 and B2	381894	3970414
Sandia Canyon	Cages T3 and B3	381943	3970388
Sandia Canyon	Cages T4 and B4	381967	3970386
Sandia Canyon	Cages T5 and B5	381997	3970372
Sandia Canyon	Cages T6 and B6	382052	3970367
Sandia Canyon	Cages T7 and B7	382079	3970352
Sandia Canyon	Cages T8 and B8	382007	3970337
Sandia Canyon	Cages T9 and B9	382048	3970348
Pajarito Canyon	Cages T1 and B1	379362	3968959

Table 4. Location of Cages and Habitat Measurements in Canyon Stream Reaches for the LANL Water Quality Assessment, 1996-1997. ~ *Continued.*

Pajarito Canyon	Cages T2 and B2	379409	3968940
Pajarito Canyon	Cages T3 and B3	379446	3968926
Pajarito Canyon	Cages T4 and B4	379475	3968950
Pajarito Canyon	Cages T5 and B5	379508	3968925
Pajarito Canyon	Cages T6 and B6	379531	3968916
Pajarito Canyon	Cages T7 and B7	379566	3968911
Pajarito Canyon	Cages T8 and B8	379589	3968907
Pajarito Canyon	Cages T9 and B9	379601	3968885
Valle Canyon	Cages T1 and B1	379703	3967945
Valle Canyon	Cages T2 and B2	379736	3967982
Valle Canyon	Cages T3 and B3	379773	3968004
Valle Canyon	Cages T4 and B4	379800	3968018
Valle Canyon	Cages T5 and B5	379826	3968033
Valle Canyon	Cages T6 and B6	379860	3968030
Valle Canyon	Cages T7 and B7	379895	3968033
Valle Canyon	Cages T8 and B8	379914	3968025
Valle Canyon	Cages T9 and B9	379971	3968045
Los Alamos AR	Upper Habitat Transect 1	377188	3972147
Los Alamos AR	Upper Habitat Transect 2	377188	3972143
Los Alamos AR	Upper Habitat Transect 3	377197	3972138
Los Alamos AR	Upper Habitat Transect 4	377213	3972124
Los Alamos AR	Upper Habitat Transect 5	377221	3972131
Los Alamos AR	Upper Habitat Transect 6	377233	3972131
Los Alamos AR	Upper Habitat Transect 7	377246	3972123
Los Alamos AR	Upper Habitat Transect 8	377256	3972115
Los Alamos AR	Upper Habitat Transect 9	377261	3972115

Table 4. Location of Cages and Habitat Measurements in Canyon Stream Reaches for the LANL Water Quality Assessment, 1996-1997. ~ *Continued.*

Los Alamos AR	Upper Habitat Transect 10	377262	3972104
Los Alamos AR	Lower Habitat Transect 1	377312	3972048
Los Alamos AR	Lower Habitat Transect 2	377317	3972045
Los Alamos AR	Lower Habitat Transect 3	377319	3972029
Los Alamos AR	Lower Habitat Transect 4	377321	3972019
Los Alamos AR	Lower Habitat Transect 5	377332	3972024
Los Alamos AR	Lower Habitat Transect 6	377332	3972008
Los Alamos AR	Lower Habitat Transect 7	377343	3971998
Los Alamos AR	Lower Habitat Transect 8	377338	3971988
Los Alamos AR	Lower Habitat Transect 9	377339	3971987
Los Alamos AR	Lower Habitat Transect 10	377334	3971971
Los Alamos BR[d]	Habitat Transect 1	378133	3971548
Los Alamos BR	Habitat Transect 2	378134	3971536
Los Alamos BR	Habitat Transect 3	378142	3971533
Los Alamos BR	Habitat Transect 4	378159	3971542
Los Alamos BR	Habitat Transect 5	378165	3971535
Los Alamos BR	Habitat Transect 6	378174	3971533
Los Alamos BR	Habitat Transect 7	378183	3971532
Los Alamos BR	Habitat Transect 8	378184	3971528
Los Alamos BR	Habitat Transect 9	378194	3971534
Los Alamos BR	Habitat Transect 10	378201	3971520
Sandia Canyon	Upper Habitat Transect 1	381895	3970407
Sandia Canyon	Upper Habitat Transect 2	381909	3970407
Sandia Canyon	Upper Habitat Transect 3	381911	3970406
Sandia Canyon	Upper Habitat Transect 4	381920	3970404
Sandia Canyon	Upper Habitat Transect 5	381931	3970392

Table 4. Location of Cages and Habitat Measurements in Canyon Stream Reaches for the LANL Water Quality Assessment, 1996-1997. ~ *Continued.*

Sandia Canyon	Upper Habitat Transect 6	381935	3970390
Sandia Canyon	Upper Habitat Transect 7	381945	3970390
Sandia Canyon	Upper Habitat Transect 8	381956	3970388
Sandia Canyon	Upper Habitat Transect 9	381963	3970386
Sandia Canyon	Upper Habitat Transect 10	381973	3970373
Sandia Canyon	Lower Habitat Transect 1	382083	3970352
Sandia Canyon	Lower Habitat Transect 2	382093	3970352
Sandia Canyon	Lower Habitat Transect 3	382101	3970343
Sandia Canyon	Lower Habitat Transect 4	382105	3970340
Sandia Canyon	Lower Habitat Transect 5	382110	3970338
Sandia Canyon	Lower Habitat Transect 6	382121	3970343
Sandia Canyon	Lower Habitat Transect 7	382129	3970345
Sandia Canyon	Lower Habitat Transect 8	382139	3970344
Sandia Canyon	Lower Habitat Transect 9	382148	3970343
Sandia Canyon	Lower Habitat Transect 10	382158	3970338
Pajarito Canyon	Upper Habitat Transect 1	379367	3968954
Pajarito Canyon	Upper Habitat Transect 2	379375	3968954
Pajarito Canyon	Upper Habitat Transect 3	379384	3968950
Pajarito Canyon	Upper Habitat Transect 4	379393	3968945
Pajarito Canyon	Upper Habitat Transect 5	379401	3968942
Pajarito Canyon	Upper Habitat Transect 6	379405	3968916
Pajarito Canyon	Upper Habitat Transect 7	379421	3968932
Pajarito Canyon	Upper Habitat Transect 8	379427	3968929
Pajarito Canyon	Upper Habitat Transect 9	379430	3968924
Pajarito Canyon	Upper Habitat Transect 10	379445	3968941
Pajarito Canyon	Lower Habitat Transect 1		

Table 4. Location of Cages and Habitat Measurements in Canyon Stream Reaches for the LANL Water Quality Assessment, 1996-1997. ~ *Continued.*

Pajarito Canyon	Lower Habitat Transect 2		
Pajarito Canyon	Lower Habitat Transect 3		
Pajarito Canyon	Lower Habitat Transect 4		
Pajarito Canyon	Lower Habitat Transect 5		
Pajarito Canyon	Lower Habitat Transect 6		
Pajarito Canyon	Lower Habitat Transect 7		
Pajarito Canyon	Lower Habitat Transect 8		
Pajarito Canyon	Lower Habitat Transect 9		
Pajarito Canyon	Lower Habitat Transect 10		
Valle Canyon	Upper Habitat Transect 1	379737	3967981
Valle Canyon	Upper Habitat Transect 2	379740	3967990
Valle Canyon	Upper Habitat Transect 3	379757	3967988
Valle Canyon	Upper Habitat Transect 4	379761	3967994
Valle Canyon	Upper Habitat Transect 5	379769	3968001
Valle Canyon	Upper Habitat Transect 6	379773	3968001
Valle Canyon	Upper Habitat Transect 7	379784	3968028
Valle Canyon	Upper Habitat Transect 8	379895	3968012
Valle Canyon	Upper Habitat Transect 9	379806	3968009
Valle Canyon	Upper Habitat Transect 10	379813	3968007
Valle Canyon	Lower Habitat Transect 1	379994	3968015
Valle Canyon	Lower Habitat Transect 2	380002	3968014
Valle Canyon	Lower Habitat Transect 3	380011	3968024
Valle Canyon	Lower Habitat Transect 4	380013	3968010
Valle Canyon	Lower Habitat Transect 5	380026	3968016
Valle Canyon	Lower Habitat Transect 6	380036	3968012
Valle Canyon	Lower Habitat Transect 7	380040	3968027

Table 4. Location of Cages and Habitat Measurements in Canyon Stream Reaches for the LANL Water Quality Assessment, 1996-1997. ~ *Continued.*

Valle Canyon	Lower Habitat Transect 8	380051	3968023
Valle Canyon	Lower Habitat Transect 9	380053	3968021
Valle Canyon	Lower Habitat Transect 10	380055	3968012

[a] AR = above the Los Alamos Reservoir.
[b] T1 = Toxicity Cage 1, and so on. See text.
[c] B1 = Bioaccumulation Cage 1, and so on. See text.
[d] BR = below the Los Alamos Reservoir.

Table 5. Chemical Name, Symbol, Method of Analysis, and Reporting Limits for the LANL Water Quality Assessment, 1996-1997.

Chemical Name	Symbol	Method	Reporting Limits[a]			
			water	pore water	sediment	tissue
Elements			μg/L	μg/L	mg/kg DW[b]	mg/kg DW
aluminum	Al	ICP-MS[c]	0.01	0.01	1	—[d]
aluminum	Al	ICP/AES[e]	21.5	21.5	5	2
antimony	Sb	ICP-MS	0.001	0.001	0.1	---
arsenic	As	ICP-MS	0.01	0.01	1	---
arsenic	As	ICP/AES	21.5	21.5	1.6	1.5
barium	Ba	ICP-MS	0.001	0.001	0.1	---
barium	Ba	ICP/AES	0.8	0.8	0.1	0.1
beryllium	Be	ICP/AES	0.3	0.3	0.2	0.02
boron	B	ICP/AES	19.3	19.3	0.2	3
cadmium	Cd	ICP-MS	0.01	0.01	1	---
cadmium	Cd	ICP/AES	1.5	1.5	0.2	0.01
calcium	Ca	ICP-MS	0.01	0.01	1	---
cerium	Ce	ICP-MS	0.001	0.001	0.1	---
cesium	Cs	ICP-MS	0.001	0.001	0.1	---
chromium	Cr	ICP-MS	0.01	0.01	1	---
chromium	Cr	ICP/AES	2.5	2.5	0.4	0.5
cobalt	Co	ICP-MS	0.01	0.01	1	---
copper	Cu	ICP-MS	0.01	0.01	1	---
copper	Cu	ICP/AES	2.2	2.2	0.3	0.5
dysprosium	Dy	ICP-MS	0.001	0.001	0.1	---
erbium	Er	ICP-MS	0.001	0.001	0.1	---
europium	Eu	ICP-MS	0.001	0.001	0.1	---
gadolinium	Gd	ICP-MS	0.001	0.001	0.1	—
gallium	Ga	ICP-MS	0.01	0.01	1	---
germanium	Ge	ICP-MS	0.01	0.01	1	---

Table 5. Chemical Name, Symbol, Method of Analysis, and Reporting Limits for the Los Alamos National Laboratory Use Study, 1996-1997 ~ *Continued.*

Chemical Name	Symbol	Method	Reporting Limits			
			water	pore water	sediment	tissue
gold	Au	ICP-MS	0.001	0.001	0.1	---
hafnium	Hf	ICP-MS	0.001	0.001	0.1	---
holmium	Ho	ICP-MS	0.001	0.001	0.1	---
indium	In	ICP-MS	0.001	0.001	0.1	---
iridium	Ir	ICP-MS	0.001	0.001	0.1	---
iron	Fe	ICP-MS	0.01	0.01	1	---
iron	Fe	ICP/AES	2.6	2.6	8.1	5
lanthanum	La	ICP-MS	0.001	0.001	0.1	---
lead	Pb	ICP-MS	0.001	0.001	0.1	---
lead	Pb	ICP/AES	15.9	15.9	1.4	4
lithium	Li	ICP-MS	0.01	0.01	1	---
lutetium	Lu	ICP-MS	0.001	0.001	0.1	---
magnesium	Mg	ICP-MS	0.01	0.01	1	---
magnesium	Mg	ICP/AES	36.3	36.3	3.5	5
manganese	Mn	ICP-MS	0.01	0.01	1	---
manganese	Mn	ICP/AES	1.6	1.6	0.1	1
mercury	Hg	CVAA[f]	---	---	0.2	0.1
molybdenum	Mo	ICP-MS	0.001	0.001	0.1	---
molybdenum	Mo	ICP/AES	4.0	4.0	0.3	0.4
neodymium	Nd	ICP-MS	0.001	0.001	0.1	---
nickel	Ni	ICP-MS	0.01	0.01	1	---
nickel	Ni	ICP/AES	4.4	4.4	0.1	1
niobium	Nb	ICP-MS	0.001	0.001	0.1	---
osmium	Os	ICP-MS	0.001	0.001	0.1	---
palladium	Pd	ICP-MS	0.01	0.01	1	---
platinum	Pt	ICP-MS	0.001	0.001	0.1	---

Table 5. Chemical Name, Symbol, Method of Analysis, and Reporting Limits for the Los Alamos National Laboratory Use Study, 1996-1997 ~ *Continued.*

Chemical Name	Symbol	Method	Reporting Limits			
			water	pore water	sediment	tissue
potassium	K	ICP-MS	0.1	0.1	1	---
praseodymium	Pr	ICP-MS	0.001	0.001	0.1	---
rhenium	Re	ICP-MS	0.001	0.001	0.1	---
rubidium	Rb	ICP-MS	0.01	0.01	1	---
ruthenium	Ru	ICP-MS	0.001	0.001	0.1	---
samarium	Sm	ICP-MS	0.001	0.001	0.1	---
scandium	Sc	ICP-MS	0.01	0.01	1	---
selenium	Se	HGAA[g]	0.5	0.5	0.01	---
selenium	Se	HGAA	2.6	2.6	0.25	0.1
silver	Ag	ICP-MS	0.001	0.001	0.1	---
sodium	Na	ICP-MS	0.01	0.01	1	---
strontium	Sr	ICP-MS	0.01	0.01	1	---
strontium	Sr	ICP/AES	0.2	0.2	0.01	0.5
tantalum	Ta	ICP-MS	0.001	0.001	0.1	---
tellurium	Te	ICP-MS	0.01	0.01	1	---
terbium	Tb	ICP-MS	0.001	0.001	0.1	---
thallium	Tl	ICP-MS	0.001	0.001	0.1	---
thorium	Th	ICP-MS	0.001	0.001	0.1	---
thulium	Tm	ICP-MS	0.001	0.001	0.1	---
tin	Sn	ICP-MS	0.01	0.01	1	---
titanium	Ti	ICP-MS	0.01	0.01	1	---
tungsten	W	ICP-MS	0.001	0.001	0.1	---
uranium	U	ICP-MS	0.001	0.001	0.1	---
vanadium	V	ICP-MS	0.01	0.01	1	---
vanadium	V	ICP/AES	2.0	2.0	0.4	0.5
ytterbium	Yb	ICP-MS	0.001	0.001	0.1	---

Table 5. Chemical Name, Symbol, Method of Analysis, and Reporting Limits for the Los Alamos National Laboratory Use Study, 1996-1997 ~ *Continued.*

Chemical Name	Symbol	Method	Reporting Limits			
			water	pore water	sediment	tissue
yttrium	Y	ICP-MS	0.001	0.001	0.1	---
zinc	Zn	ICP-MS	0.01	0.01	1	---
zinc	Zn	ICP/AES	4.0	4.0	0.4	1.0
zirconium	Zr	ICP-MS	0.001	0.001	0.1	---
Radionuclides and Radiochemical Activity			pCi/L	pCi/L		
uranium-238	U^{238}	GS[h]	0.03	0.02	---	---
uranium-235	U^{235}	GS	0.04	0.03	---	---
uranium-234	U^{234}	GS	0.04	0.03	---	---
thorium-232	Th^{232}	GS	0.3	0.3	---	---
thorium-230	Th^{230}	GS	0.4	0.3	---	---
thorium-228	Th^{228}	GS	0.4	0.4	---	---
thorium-227	Th^{227}	GS	0.4	0.4	---	---
radium-228	Ra^{228}	GS	56	50	---	---
radium-226	Ra^{226}	GS	260	260	---	---
barium-140	Ba^{140}	GS	6200	5300	---	---
cesium-137	Cs^{137}	GS	77	48	---	---
iodine-131	I^{131}	GS	87000	46000	---	---
cobalt-60	Co^{60}	GS	75	57	---	---
potassium-40	K^{40}	GS	220	250	---	---
gross alpha	α	GS	64	55	---	---
gross beta	β	GS	72	71	---	---
Explosives			µg/L		µg/kg DW	
hexahydro-1,3,5-trinitro-1,3,5-triazine	RDX	HPLC/UV[i]	0.06	---	50	---

Table 5. Chemical Name, Symbol, Method of Analysis, and Reporting Limits for the Los Alamos National Laboratory Use Study, 1996-1997 ~ *Continued.*

Chemical Name	Symbol	Method	Reporting Limits			
			water	pore water	sediment	tissue
octahydro-1,3,5,7-teranitro-1,3,5,7-tetrazocine	HMX	HPLC/UV	0.06	---	50	---
1,3,5-trinitrobenzene	TNB	HPLC/UV	0.06	---	50	---
1,3-dinitrobenzene	DNB	HPLC/UV	0.06	---	50	---
tetryl	---	HPLC/UV	0.06	---	50	---
nitrobenze	NB	HPLC/UV	0.06	---	50	---
2,4,6-trinitrobenzene	TNT	HPLC/UV	0.06	---	50	---
2-amino-4,6-dinitrotoluene	2,4,6-DNT	HPLC/UV	0.06	---	50	---
4-amino-2,6-dinitrotoluene	4,2,6-DNT	HPLC/UV	0.06	---	50	---
2,4-dinitrotoluene	2,4-DNT	HPLC/UV	0.06	---	50	---
2,6-dinitrotoluene	2,6-DNT	HPLC/UV	0.06	---	50	---
2-nitrotoluene	2-NT	HPLC/UV	0.06	---	50	---
4-nitrotoluene	4-NT	HPLC/UV	0.06	---	50	---
3-nitrotoluene	3-NT	HPLC/UV	0.06	---	50	---
Polychlorinated Biphenyls					μg/kg DW	μg/kg WW[j]
PCB congener	PCB	HP-GPC GC/ECD[k]	highest reporting limit of 129 congeners analyzed		1.1	7.5
total PCBs (sum of congeners)	∑PCB	HP-GPC GC/ECD	highest reporting limit plus error		2.6	64.4

[a] Reporting Limit = Note that instrument and method detection limits may differ for the same analyte, depending on the laboratory method used, sample interference, *etc.* Laboratory reports were provided in Attachment A and may be consulted for method detection and reporting limits.
[b] "DW" = dry weight
[c] Inductively coupled plasma - mass spectrometry
[d] "—" = not analyzed using this method
[e] Inductively coupled plasma/atomic absorption spectrometry (EPA Method 200.7)
[f] Cold vapor atomic absorption spectrometry
[g] Hydride generation atomic absorption spectrometry
[h] Gamma spectrometry
[i] High performance liquid chromatography/ultraviolet absorbance detection (EPA Method 8330)
[j] "WW" = wet weight
[k] High performance-gel permeation chromatography followed by gas chromatography/electron capture detection

Table 6. Sample, Preparation, Preservatives, Collection Containers, and Subsequent Analyses for the Los Alamos National Laboratory Use Study, 1996-1997.

Sample Type	Preparation	Preservative[a]	Container	Analyses
Water	none	none	none	field measurements[b]
Water	none	cold[c]	1 gallon, or 1 quart, cubitainer	lab measurements[d]
Water	none	cold/dark	1 L, amber, Boston round, glass jar	explosives[e]
Water	none	cold	1 gallon, or 1 quart cubitainer	field collection for below filtered-water analyses
Water	filtered though inline 0.45 µm	HNO_3	500 mL, HDPE[f], WM[g] Nalgene jar	trace elements[h], radios[i]
Water	filtered though inline 0.45 µm	cold	500 mL, HDPE, WM Nalgene jar	chloride, sulfate, alkalinity, hardness
Water	filtered though inline 0.45 µm	H_2SO_4	250 mL, HDPE, WM Nalgene jar	nitrate-N, ammonia-N, ortho-phosphate
Sediment	debris removed	cold	500 mL, WM glass jar	trace elements, radios, acid volatile sulfides
Sediment	debris removed	cold	250 mL, WM glass jar	organic carbon, texture
Sediment	debris removed	cold/dark	500 mL, WM, foil-wrapped, glass jar	polychlorinated biphenyl congeners and explosives
Invertebrates	some had cases removed&rinsed	cold/frozen	7.5 x 19 cm, whirl-pak or food quality bags	trace elements
Fish	length and weight measured	cold/frozen	100 mL, WM glass jar	trace elements
Fish	length and weight measured	cold/frozen	100 mL, WM glass jar	polychlorinated biphenyl congeners

[a] Acid preservatives met USEPA purity standards.
[b] Temperature, pH, dissolved oxygen, and conductivity.
[c] Samples were kept on ice in the field, and then either transferred to a refrigerator (4 °C) or frozen.
[d] Laboratory measurements included pH, temperature, total suspended solids and turbidity.
[e] Explosives were RDX, HMX, TNT, DNT, and five major breakdown products (see Table 5).
[f] HDPE = High density polyethylene plastic.
[g] WM = wide-mouth.
[h] Elements analyzed are listed in Table 5, also percent moisture was determined.
[i] Radiochemical activity was analyzed on 1996 samples of water and sediment porewater only.

Table 7. Consensus-Based, Conservative Sediment Concentrations of Concern for the LANL Water Quality Assessment.

Contaminant[a] (mg/kg DW)	Buchman[b]	Smith[c]	Ingersoll[d]	FDEP[e]	Long[f]	Pursuad[g]	Anon[h]	EC & MENVIQ[i]	Sediment Concentration of Concern
Ag				0.7	1.0	0.5			**1**
Al	2600								**2600**
As	10.8	5.9	12.1	7.2	8.2	6.0	3.0	3.0	**7**
Ba							20		
Be									
B									
Cd	0.58	0.60	0.59	0.68	1.20	0.60	0.90	0.20	**1**
Cr	36.3	37.3	56.0	52.3	81.0	26.0	25.0	55.0	**46**
Cu	28.0	35.7	28.0	18.7	34.0	16.0	25.0	28.0	**27**
Fe						20000	21000		**20500**
Hg		0.0017		0.0001	0.0002	0.0002	0.0001	0.0002	**0.0004**
Mg									
Mn	615		1673			460	300		**762**
Mo									
Ni	19.5	18.0	39.6	15.9	20.9	16.0	20.0	35.0	**23**
Pb	34.2	35.0	34.2	30.2	46.7	31.0	40.0	23.0	**34**
Se									
Sr									
V									
Zn	94.2	123.1	159.0	124.0	150.0	120.0	145.0	150.0	**133**
PCBs	0.0316	0.0341	0.0316	0.0216	0.0227	0.0700		0.2000	**0.06**
DNB									
HMX									
RDX									
TNT									

[a] See Table 5 for chemical names and symbols
[b] Buchman 1998.
[c] Smith *et al.* 1996.
[d] Ingersoll *et al.* 1996.
[e] FDEP 1994.
[f] Long and Morgan 1991.
[g] Persuad *et al.* 1993.
[h] Anonymous 1977.
[i] EC and MENVIQ 1992.

Table 8. Consensus-Based, Sediment Quality Criteria to Evaluate Sediment for the LANL Water Quality Assessment.

Contaminant (mg/kg DW)[a]	Smith[b]	Ingersoll[c]	FDEP[d]	USEPA[e]	Long[f]	Pursuad[g]	Anon[h]	EC & MENVIQ[i]	Talmadge[j]	Sediment Quality Criteria
Ag	1.8		1.8	3.7	3.7					**2.7**
Al		580300								**580300**
As	17.0	57.0	41.6	70.0	70.0	33.0	5.5	17.0		**39**
Ba							40			
Be										
B										
Cd	3.53	11.70	4.21	9.60	9.60	10.00	2.00	3.00		**7**
Cr	90.0	159.0	160.0	370.0	370.0	110.0	50.0	100.0		**176**
Cu	197.0	77.7	108.0	270.0	270.0	110.0	50.0	86.0		**146**
Fe						40000	25000			**32500**
Hg	0.0049		0.0007	0.0007	0.0007	0.0020	0.0010	0.0010		**0.002**
Mg										
Mn		1081				1110				**1096**
Mo										
Ni	35.9	38.5	42.8	52.0	51.6	75.0	50.0	61.0		**51**
Pb	91.3	396.0	112.0	218.0	218.0	250.0	60.0	170.0		**189**
Se										
Sr										
V										
Zn	315.0	1532.0	271.0	410.0	410.0	820.0	200.0	540.0		**562**
PCBs	0.2770	0.2447	0.1890	0.0025	0.1800	0.5300	1.0000			**0.35**
DNB									0.335	**0.34**
HMX									0.235	**0.24**
RDX									0.65	**0.65**
TNT									4.6	**4.60**

[a] All values are mg/kg dry weight. See Table 5 for chemical names and symbols, see text for method of SQC development.

[b] Smith *et al.* 1996.

[c] Ingersoll *et al.* 1996.

[d] FDEP 1994.

[e] USEPA 1997b.

[f] Long and Morgan 1991.

[g] Persuad *et al.* 1993.

[h] Anonymous 1977.

[i] EC and MENVIQ 1992.

[i] Talmage *et al.* 1999.

Table 9. Major Stream Habitat Classification (Based on Meehan 1991).

Habitat	Description
Riffle	Shallow section of stream with rapid current and a water surface broken by gravel, rubble, or boulders.
Run	Swiftly flowing stream reach with little surface agitation and no major flow obstructions. A run often appears as a flooded riffle.
Glide	Slow, relatively shallow stream section with water velocities of 10 to 20 m^3/s and little, or no, surface turbulence.
Pool	Portion of a steam with reduced water velocity, water depth greater than surrounding areas, water surface gradient at low flow often near zero and bed often concave in shape forming a depression in the profile of the thalweg.

Table 10. Pool Classification (Based on Hickman and Raleigh 1982; Hamilton and Bergersen 1984).

Pool Class	Description
1st class	Large and deep. Pool depth and size are sufficient to provide a low velocity resting area for several adult fish. More than 30 percent of the pool bottom is obscured due to depth, surface turbulence, or the presence of structures, for example, logs, debris, boulders, or overhanging banks and vegetation.
2nd class	Moderate size and depth. Pool depth and size are sufficient to provide a low velocity resting area for a few adult fish. From 5 to 30 percent of the pool bottom is obscured due to depth, surface turbulence, or structures.
3rd class	Small or shallow or both. Pool depth and size are sufficient to provide a low velocity resting area for one or two adult fish. Cover, if present, is in the form of shade, surface turbulence, or very limited structure. Typical third-class pools are wide, shallow pool areas of streams or small eddies behind boulders. Virtually the entire bottom are is discernable.

Table 11. Flow and Discharge Measurements (Recorded at Each Transect).

Variable	Description
Mean depth	Mean of the 5 to 10 depth measurements taken at each transect interval.
Thalweg depth	Thalweg depth. Mean of the five deepest, adjacent depth measurements.
Riffle depth	Calculated as mean depth measured at riffle habitats.
Flow	Velocity (V) in meters/second. Water flows were measured using a flow-meter and bulb, set to average readings over a 10-second interval. Measurements were taken at the midpoint between two adjacent transect depth measurements, and at approximately 0.6 of the water depth.
Riffle flow	Calculated by averaging flows determined at transects in riffle habitat.
Pool flow	Calculated by averaging flows determined at transects in pool habitat.
Calculated discharge	Calculated discharge (Q); $\sum$ (Width*Depth*Velocity) at each transect interval.
Measured discharge	Measured discharge (Q) m^3/s, with 10 gallon bucket below culvert at Valle Canyon only.

Table 12. Bank Erosion Ratings (Based on Platts *et al.* 1983).

Rating	Rating Description
0	Stable. Not altered by water flows, animals, or people.
1 - 25	Slight alteration. Less than 25 percent of stream-bank is false*, broken down, or eroding.
26 - 50	Moderate alteration. Less than 50 percent of stream-bank is false, broken down, or eroding.
51 - 75	Major alteration. Greater than 50 percent of stream-bank is false, broken down, or eroding.
76 - 100	Severe alteration. Greater than 75 percent of stream-bank is false, broken down, or eroding.

* False stream banks have been eroded away, and have receded back from the water's edge.

Table 13. Bank Vegetative Stability Ratings (Based on Platts *et al.* 1983).

Rating	Rating Description
4 (Excellent)	Greater than 80 percent of stream bank surfaces covered by healthy vegetation, and/or, were protected by boulders and rubble.
3 (Good)	50 to 79 percent of stream bank surfaces covered by healthy vegetation, and/or, were protected by gravel or larger material.
2 (Fair)	25 to 49 percent of stream bank surfaces covered by healthy vegetation, and/or, are protected by gravel or larger material.
1 (Poor)	Less than 25 percent of stream bank surfaces covered by healthy vegetation, was not protected from erosion, and banks were usually eroded each year.

Table 14. Stream Bank Cover Ratings (Based on Platts *et al.* 1983).

Rating	Dominant Vegetation Rating Description
4	Shrubs.
3	Trees.
2	Grasses and/or forbs.
1	Greater than 50 percent of stream bank transect intercepts had no vegetation, or dominant material was soil, rock, bridge materials, culverts, *etc*.

Table 15. Classification of Substrate
(Based on Lane 1947; and Platts *et al.* 1983).

Substrate Type	Size Range (mm)
Boulder	> 256
Cobble	64 - 256
Gravel	2.0 - 64
Sand	0.062 - 2.0
Silt	0.004 - 0.062
Clay	< 0.004

Table 16. Embeddedness Ratings for Gravel, Rubble, and Boulders (Based on Platts *et al.* 1983).

Rating	Rating Description
5	Gravel, rubble, and boulder particles have less than 5 percent of their surface covered by fine sediment.
4	Gravel, rubble, and boulder particles have 5 to 25 percent of their surface covered by fine sediment.
3	Gravel, rubble, and boulder particles have 25 to 50 percent of their surface covered by fine sediment.
2	Gravel, rubble, and boulder particles have 50 to 75 percent of their surface covered by fine sediment.
1	Gravel, rubble, and boulder particles have more than 75 percent of their surface covered by fine sediment.

Table 17. Parameters Measured to Assess Stream Geomorphic Characteristics.

Variable	Description
Order	Stream order determined from USGS topographical maps.
Aspect	Stream aspect determined from upstream compass direction.
Elevation	Elevation at upstream end of the habitat reach determined from topographic maps.
Gradient	Percent channel slope measured with survey rod and scope level; calculated as elevation change divided by G.P.S.-determined down-valley length.
Meander length	Measured as straight distance between stream channel curves.
Sinuosity	Measured stream channel length divided by G.P.S.-determined down-valley length.
Habitat length	length (m) of riffles, glides, or pools.
Percent Pools	Percent Pools, categorized by pool quality- 1st, 2nd, or 3rd class; calculated as total length of pool sections/reach length.
Percent Riffles	Percent riffles, including runs and cascades; calculated as total length of riffle sections divided by the reach length.
Percent Pools/ Percent Riffles	Ratio of percent pools to percent riffles.
Belt width	Measured by sighting up and downstream at each transect, then measuring the total path width where the stream meanders.
Bank-full width	Width measured by visual inspection of immediate channel surroundings; corresponds to the width where the stream bank gradient levels out and/or there is other evidence of previous sustained water levels.
Stream width	Wetted-channel width measured at the edge of water at time of evaluation.
Mean depth	Depth across bank-full and wetted width transect lines. Ten equally spaced readings were taken for both bank-full and wetted widths. Bank-full depths were measured from a level string to the channel bottom, and wetted depths were measured from the water surface to the channel bottom.
Maximum depth	Mean maximum channel depth.

Table 17. Parameters Measured to Assess Stream Geomorphic Characteristics.~ *Continued.*

Width/Depth	Width to depth ratio. Calculated as bankfull width divided by mean water depth.
Riffle Length/ Width	Ratio of distance between riffle habitat and width.
D50	Dominant substrate material. Boulders, cobble, gravel, sand, silt, clay in pools and riffles were calculated from a plot of cumulative distribution of substrate size.
Bank Stability	Bank stability. Rating visually estimated, and scored according to Table 12.
Vegetation Stability	Bank vegetational stability rating. Visually estimated along a 1m-wide swath following the transect line, and scored at each transect according to Table 13.
Entrenchment	Calculated as bankfull width divided by maximum depth.

Table 18. Decision Matrix and Values Assigned to the Indices of Biological, Chemical, and Physical Quality using Comparison with the Reference Site and Comparison with Criteria (adapted from NMED 1998).

Decision	Criteria for Decision	Value Assigned
INDEX OF BIOLOGICAL QUALITY:		
Indicators of Biological Diversity		
Supported	# fish species > 80 % of reference site	5
Partially Supported	# fish species > 50-80 % of reference site	3
Not Supported	# fish species < 50 % of reference site	1
Supported	# shellfish species > 80 % of reference site	5
Partially Supported	# shellfish species > 50-80 % of reference site	3
Not Supported	# shellfish species < 50 % of reference site	1
Supported	# aquatic invertebrates > 80 % of reference site	5
Partially Supported	# aquatic invertebrates > 50-80% of reference site	3
Not Supported	# aquatic invertebrates < 50 % of reference site	1
Supported	Biological Condition > 80 % of reference site	5
Partially Supported	Biological Condition > 50-80 % of reference site	3
Not Supported	Biological Condition ≤ 50 % of reference site	1
Indicators of water toxicity (laboratory test of surface water at 100 % dilution)		
Supported	No chronic toxicity	5
Partially Supported	Chronic toxicity in 1 test	3
Not Supported	Any acute toxicity or chronic toxicity in > 1 test	1

Table 18. Decision Matrix and Values Assigned to the Indices of Biological, Chemical, and Physical Quality Using Comparison with a Reference Site and Comparison with Criteria (adapted from NMED 1998). ~ Continued.

Decision	Criteria for Decision	Value Assigned
Indicators of water toxicity (in situ, caged-fish bioassay [with flood effects removed])		
Supported	No chronic toxicity	5
Partially Supported	Chronic toxicity in 1 test	3
Not Supported	Any acute toxicity or chronic toxicity in >1 test	1
Indicator of sediment toxicity (laboratory test of pore water at 100 % dilution)		
Supported	No chronic toxicity	5
Partially Supported	Chronic toxicity in 1 test	3
Not Supported	Any acute toxicity or chronic toxicity in > 1 test	1
INDEX OF CHEMICAL QUALITY		
Indicators of surface water quality for coldwater aquatic life use support		
Supported	Temperature ≤ 20° C	5
Partially Supported	Temperature ≤ 22.5° C	3
Not Supported	Temperature ≤ 25° C	1
Supported	Dissolved oxygen ≥ 6 mg/l at all times	5
Partially Supported	Few measurements of dissolved oxygen < 6 mg/l	3
Not Supported	Dissolved oxygen ≤ 5 mg/l	1
Supported	No pH < 6 or > 9	5
Partially Supported	Few pH measurements < 6 or > 9	3
Not Supported	Many pH measurements < 6 or > 9	1

Table 18. Decision Matrix and Values Assigned to the Indices of Biological, Chemical, and Physical Quality Using Comparison with a Reference Site and Comparison with Criteria (adapted from NMED 1998). ~ Continued.

Decision	Criteria for Decision	Value Assigned
Supported	No conductivity measurement > 1.5 mS/cm^2	5
Partially Supported	Few conductivity measurements > 1.5 mS/cm^2	3
Not Supported	Many conductivity measurements > 1.5 mS/cm^2	1
Supported	No turbidity (minus background) > 10 NTU	5
Partially Supported	No turbidity (minus background) > 25 NTU	3
Not Supported	No turbidity (minus background) > 50 NTU	1
Supported	Total phosphorus ≤ 0.1 mg/L	5
Partially Supported	Total phosphorus ≤ 6.3 mg/L	3
Not Supported	Total phosphorus > 6.3 mg/L	1
Supported	Total ammonia as N < 1.0 mg/L	5
Partially Supported	Total ammonia as N < as limited by pH	3
Not Supported	Total ammonia as N > as limited by pH	1
Indicators of water quality criteria for coldwater aquatic life use		
Supported	For the mean of any parameter, does not exceed any chronic criterion	5
Partially Supported	For the mean of any parameter, exceeds one chronic criterion	3
Not Supported	Exceeds any acute criterion or multiple chronic criteria	1

Table 18. Decision Matrix and Values Assigned to the Indices of Biological, Chemical, and Physical Quality Using Comparison with a Reference Site and Comparison with Criteria (adapted from NMED 1998). ~ Continued.

Decision	Criteria for Decision	Value Assigned
Indicators of regional water quality criteria for coldwater aquatic life use		
Supported	Exceeds chronic criteria < 80% of reference	5
Partially Supported	Exceeds chronic criteria < 51 to 80 % of reference	3
Not Supported	Exceeds chronic criteria ≥ 50 % reference	1
Indicators of sediment quality criteria for aquatic life use		
Supported	Mean of any parameter does not exceed any Sediment Concentration of Concern	5
Partially Supported	Mean of ≥ 1 parameter exceeds Sediment Concentration of Concern	3
Not Supported	Mean of parameter exceeds Sediment Quality Criterion	1
Indicators of tissue quality for aquatic life and wildlife health		
Supported	Mean of any parameter does not exceed any Tissue Quality Criterion	5
Partially Supported	Mean of any 1 parameter exceeds Tissue Quality Criterion	3
Not Supported	Mean of > 1 parameter exceeds Tissue Quality Criterion	1
INDEX OF PHYSICAL QUALITY		
Indicator of stream channel stability (Level III channel classification by Rosgen 1996)		
Supported	Pfankuch rating = GOOD or EXCELLENT	5
Partially Supported	Pfankuch rating = FAIR	3
Not Supported	Pfankuch rating = POOR	1

Table 18. Decision Matrix and Values Assigned to the Indices of Biological, Chemical, and Physical Quality Using Comparison with a Reference Site and Comparison with Criteria (adapted from NMED 1998). ~ Continued.

Decision	Criteria for Decision	Value Assigned
Habitat quality for aquatic invertebrates (Rapid Bioassessment Protocol [RBP])		
Supported	RBP score > 80% of reference site	5
Partially Supported	RBP score > 50 to 80% of reference site	3
Not Supported	RBP score ≤ 50% of reference site	1
Habitat quality for adult brook trout (using a Habitat Suitability Index [HSI])		
Supported	HSI score > 80% of reference site	5
Partially Supported	HSI score > 50 to 80% of reference site	3
Not Supported	HSI score ≤ 50% of reference site	1
Habitat quality for juvenile brook trout		
Supported	HSI score > 80% of reference site	5
Partially Supported	HSI score > 50 to 80% of reference site	3
Not Supported	HSI score ≤ 50% of reference site	1
Habitat quality for brook trout fry		
Supported	HSI score > 80% of reference site	5
Partially Supported	HSI score > 50 to 80% of reference site	3
Not Supported	HSI score ≤ 50% of reference site	1
Habitat quality for brook trout eggs		
Supported	HSI score > 80% of reference site	5
Partially Supported	HSI score > 50 to 80% of reference site	3
Not Supported	HSI score ≤ 50% of reference site	1

Table 18. Decision Matrix and Values Assigned to the Indices of Biological, Chemical, and Physical Quality Using Comparison with a Reference Site and Comparison with Criteria (adapted from NMED 1998). ~ Continued.

Decision	Criteria for Decision	Value Assigned
Habitat quality for longnose dace		
Supported	HSI score > 80% of reference site	5
Partially Supported	HSI score > 50 to 80% of reference site	3
Not Supported	HSI score ≤ 50% of reference site	1
The Habiat Quality Index (HQI as per Binns [1978])		
Supported	HQI score > 80% of reference site	5
Partially Supported	HQI score > 50 to 80% of reference site	3
Not Supported	HQI score ≤ 50% of reference site	1

Table 19. Benthic Invertebrate Community Metrics (Determined using data collected by Ford-Schmid [1999]) from Four Sites in the Canyon Streams Studied for the LANL Water Quality Assessment, 1996-1997.

Parameter	Site VA 2.6	Site PA 9.0	Site SA 7.64	Site LA 13.0[a]
Date Collected	22-Jul-1994	12-May-1997	20-Mar-1996	25-Feb-1997
Canyon	Valle	Pajarito	Sandia	Los Alamos
Density (number per $meter^2$)	3,100	2,589	1,962	10,914
Richness (number of taxa)	33	25	10	42
Community Tolerance Dominance Quotient (CTQ_d)	91.4	80	99.5	71.4
EPT[b] Index	6	10	3	18
EPT/(EPT + Chironomidae)	0.66	0.84	0.99	0.25
Percent Dominant Taxa	20	21	52	32
Community Loss	0.91	1.16	3.80	0
Percent of Reference				
Density	28	23	17	100
Taxa Richness	78	59	23	100
CTQ_d	78	89	71	100
EPT Index	33	55	16	100
EPT/(EPT + Chiron.)	> 100	> 100	> 100	100
Metric Score				
Density	2	2	0	6
Taxa Richness	4	2	0	6
CTQ_d	4	6	4	6
EPT Index	0	0	0	6
EPT/(EPT + Chiron.)	6	6	6	6
Percent Dominant Taxa	2	4	0	2
Community Loss	6	4	4	6
Biological Condition				
Total of Metric Scores	24	24	14	38
% of Reference Condition	63 (slightly impaired)	63 (slightly impaired)	37 (moderately impaired)	100 (reference condition)

[a] Reference stream segment for this study, used as reference site for these analyses.
[b] EPT=Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies).

Table 20. Comparison of Maximum Sediment Concentrations Provided by LANL (1998) with Sediment Quality Criteria and Grouped by Watershed and Analyte.

Analyte	Units	Los Alamos	Sandia	Water	Pajarito	Sediment Quality Criteria (Table 8)
Aluminum	mg/kg	7,140	7,100	21,000	15,000	580,300
Arsenic	mg/kg	**65.0**[a]	1.1	2.4	3	39
Barium	mg/kg	264	299	247	220	
Beryllium	mg/kg	0.6	0.6	1.3	0.4	
Boron	mg/kg	33.2	20	25	7.7	
Cadmium	mg/kg	0.8	4	4	1.8	7
Chromium	mg/kg	15	12	12	14	176
Copper	mg/kg	6.8	5.6	12	6.5	146
Iron	mg/kg	22,000	18,300	16,000	16,000	32,500
Lead	mg/kg	28	20	20	139	189
Manganese	mg/kg	400	350	390	620	1,096
Mercury	mg/kg	**2.0**	**0.1**	**0.1**	**0.3**	0.002
Molybdenum	mg/kg	2	2	2	5.5	
Nickel	mg/kg	14.9	11	6.3	11.4	51
Selenium	mg/kg	**68**	0.4	0.5	0.5	
Silver	mg/kg	**7.5**	**8**	2	2	2.7
Strontium	mg/kg	41	29	95	19	
Uranium	mg/kg	12	4.1	3.7	5.6	
Vanadium	mg/kg	42	43	24	25	
Zinc	mg/kg	93	77	47	386	562

[a] Bolded values are above the Sediment Quality Criterion (or considered elevated as was selenium).

Table 21. Descriptive Statistics (Mean ± Standard Deviation) for Elements Dissolved in Canyon Waters (N=40, 10 from each stream) Collected for the Los Alamos National Laboratory Use Study, and Water Quality Standards for New Mexico.

Element (µg/L)	Los Alamos	Sandia	Pajarito	Valle	Fisheries[a]		Livestock watering	Irrigation	Water Supply
					Acute	Chronic			
Aluminum	**877 ± 461**[b]	**184 ± 91**	**3,690 ± 4,234**	**798 ± 504**	*750*[b]	*87*	5000	5000	
Barium	25.6 ± 3.9	26.3 ± 6.6	49.1 ± 15.8	**3,332 ± 843**					*1000*
Beryllium	0.3 ± 0.1	0.3 ± 0.1	0.4 ± 0.2	0.2 ± 0.1	130	5.3			
Boron	ND	60.1 ± 11.1	ND	27.2 ± 29.0			5000	750	
Cadmium	**1.8 ± 1.2**	**2.6 ± 1.0**	**2.1 ± 0.7**	**2.1 ± 1.0**	*1.8*	*0.7*	50	10	10
Chromium	3.2 ± 2.8	9.1 ± 2.6	4.5 ± 2.2	9.5 ± 14.6	980	120	1000	100	50
Copper	2.2 ± 1.6	(6.7 ± 2.1)[b]	4.1 ± 2.2	3.3 ± 2.1	9.2	6.5	500	200	
Iron	275 ± 136	375 ± 153	1,532 ± 1,773	430 ± 246		*1000*			
Magnesium	3,254 ± 155	5,415 ± 1,142	3,703 ± 674	5,364 ± 247					
Manganese	4.5 ± 4.2	46 ± 16	11.6 ± 7.8	29.9 ± 29.0					
Molybdenum	ND	88.5 ± 91.8	ND	ND				1000	
Nickel	3.9 ± 2.7	6.6 ± 2.8	6.0 ± 2.2	16.4 ± 30.7	790	88			
Strontium	67.8 ± 7.7	82.2 ± 27.9	72.0 ± 10.2	133.1 ± 11.6					
Vanadium	2.7 ± 2.4	11.7 ± 2.7	5.4 ± 2.9	4.0 ± 2.9			100	100	
Zinc	5.9 ± 2.3	27.2 ± 7.0	10.5 ± 5.0	7.0 ± 2.7	65	59		2000	

[a] For standards that are dependent on hardness, a default hardness value of 50 was used in the derivation of the standard above.
[b] In the row, bolded values are greater than the standards that are italicized. Copper was not elevated when a site-specific hardness was used.

Table 22. Descriptive Statistics* (Mean ± Standard Deviation) for Elements Dissolved in Canyon Waters Collected for the LANL Water Quality Assessment along with Water Quality Criteria for New Mexico (NMWQCC 1995).

Element (µg/L)	Los Alamos	Sandia	Pajarito	Valle	Fisheries[a]		Livestock watering	Irrigation	Water Supply
					Acute	Chronic			
Aluminum	**877 ± 461**[b]	**184 ± 91**	**3,690 ± 4,234**	**798 ± 504**	*750*[b]	*87*	5,000	5,000	
Barium	25.6 ± 3.9	26.3 ± 6.6	49.1 ± 15.8	**3,332 ± 843**					*1,000*
Beryllium	0.3 ± 0.1	0.3 ± 0.1	0.4 ± 0.2	0.2 ± 0.1	130	5.3			
Boron	ND	60.1 ± 11.1	ND	27.2 ± 29.0			5,000	750	
Cadmium	**1.8 ● 1.2**	**2.6 ± 1.0**	**2.1 ± 0.7**	**2.1 ± 1.0**	*1.8*	*0.7*	50	10	10
Chromium	3.2 ± 2.8	9.1 ± 2.6	4.5 ± 2.2	9.5 ± 14.6	980	120	1,000	100	50
Copper	2.2 ± 1.6	6.7 ± 2.1[b]	4.1 ± 2.2	3.3 ± 2.1	9.2	6.5	500	200	
Iron	275 ± 136	375 ± 153	**1,532 ± 1,773**	430 ± 246		*1,000*			
Magnesium	3,254 ± 155	5,415 ± 1,142	3,703 ± 674	5,364 ± 247					
Manganese	4.5 ± 4.2	46 ± 16	11.6 ± 7.8	29.9 ± 29.0					
Molybdenum	ND	88.5 ± 91.8	ND	ND				1,000	
Nickel	3.9 ± 2.7	6.6 ± 2.8	6.0 ± 2.2	16.4 ± 30.7	790	88			
Strontium	67.8 ± 7.7	82.2 ± 27.9	72.0 ± 10.2	133.1 ± 11.6					
Vanadium	2.7 ± 2.4	11.7 ± 2.7	5.4 ± 2.9	4.0 ± 2.9			100	100	
Zinc	5.9 ± 2.3	27.2 ± 7.0	10.5 ± 5.0	7.0 ± 2.7	65	59		2,000	

[a] When a criterion was dependent on hardness, then the default hardness value of 50 was used in the derivation of the criterion.
[b] In the row, bolded values were greater than the criteria that are italicized. See text for why copper does not exceed criteria.
* Note mean and standard deviation computed on the 10 samples from each stream.

Table 23. Concentrations of Explosive Compounds in Water Collected From Valle Canyon and Water Screening Benchmarks for Aquatic Life and Drinking Water.

Compound[a] (µg/L)	Valle Range (N=3)	Water-Screening Benchmark for Acute Effects	Water-Screening Benchmark for Chronic Effects	Human Health-Drinking Water
RDX	13.2 - 542 (mean = 221)	1,400[b]	190[b]	0.3[c]
HMX	5.6 - 172 (mean = 78)	3,800[b]	330[b]	Not determined
4,2,6-DNT	0.5 - 48.6 (mean = 22.9)	Not determined	Not determined	0.05[c]
2,4,6-DNT	1.1 - 22.5 (mean = 13.1)	350[b]	20[b]	0.05[c]

[a] See Table 5 for chemical names and abbreviations.
[b] Talmage *et al.* 1999.
[c] USEPA 1999, IRIS database search on June 27,2000, using carcinogenic endpoints.

Table 24. Mean Concentrations (µg/g, dry weight) in Canyon Sediments Collected for the LANL Water Quality Assessment Compared to Thresholds of Concern.

Chemical[1]	CANYON				THRESHOLDS OF CONCERN			
	Los Alamos	Sandia	Pajarito	Valle	SQC[2]	Background[3]	SAL[4]	SAL/SQC[5]
Ag	0.1	0.6	0.8	0.5	2.7	3.0	380	139
Al	3,774	4,504	4,239	4,546	580,300	15,400	78,000	0.1
As	0.8	0.9	1.8	1.1	39	0.8		
Ba	35.1	55.6	64.2	1,022	40	127	5,300	133
Be	0.8	0.6	0.6	0.6		1.3		
B	1.5	2.0	1.2	1.6		64	5,900	
Cd	0.09	0.31	0.25	0.23	6.7	0.4	38.0	5.7
Cr	3.7	114.0	4.3	4.5	176	10.5	210	1.2
Cu	2.7	9.8	5.8	23.6	146	11.2	2,800	19.2
Fe	4,355	7,957	7,140	8,250	32,500	13,800		
Hg	<0.12	0.07	<0.10	<0.10	0.002		23	14,663
Mg	468	777	626	808		2,370		
Mn	153	269	380	399	1,096	543	390	0.4
Mo	0.3	1.9	0.4	0.4		3	380	
Ni	2.9	3.7	7.4	5.8	51	9.4	1,500	30
Pb	10.6	12.1	19.1	20.8	189	19.7	400	2.1
Se	0.3	0.2	0.2	0.3		0.3	380	
Sr	8.6	9.3	8.0	8.4		20	46,000	
V	5.28	8.38	11.97	9.54		19.7	540	
Zn	21.4	71.4	19.5	45.0	562	60.2	23,000	41
PCBs	<0.001	0.14	<0.002	0.03	0.35			
DNB	<0.03	<0.03	<0.03	<0.03	0.3			
HMX	<0.03	<0.03	<0.03	0.60	0.2			
RDX	<0.03	<0.03	<0.03	0.56	0.7			
TNT	<0.03	<0.03	<0.03	0.10	4.6			

[1] See Table 5 for abbreviations and chemical names, "<" = less than.
[2] Consensus-based Sediment Quality Criteria (see text and Table 8).
[3] Background Concentration in Canyon Sediments (per Ryti *et al.* 1998).
[4] Los Alamos National Laboratory Screening Action Level (per LANL 1998a).
[5] Ratio of SAL-to-SQC. A Ratio >1 indicated the SAL was likely unprotective of aquatic life and the environment (see text).

Table 25. Mean (and Standard Deviation) of Texture (Sand, Silt, Clay), Moisture, and Total Organic Carbon Content in Sediment Samples Collected for the LANL Water Quality Assessment 1996-1997.

Canyon Stream Segment	SAND (%)	SILT (%)	CLAY (%)	TOC (%)	MSTR (%)
Los Alamos	86.3 (7.4)[A]	9.1 (4.3)[A]	4.6 (4.8)[A]	1.2 (0.6)[A]	34.6 (8.3)[A]
Sandia	78.1 (11.4)[A]	16.0 (9.2)[A]	5.8 (2.8)[A]	0.8 (0.3)[AB]	25.0 (5.1)[A]
Pajarito	88.1 (7.8)[A]	8.3 (7.7)[A]	3.5 (0.8)[A]	0.4 (0.3)[B]	25.8 (5.3)[A]
Valle	86.3 (4.7)[A]	9.0 (3.0)[A]	4.7 (1.8)[A]	0.5 (0.3)[AB]	28.0 (7.9)[A]

For each column, superscript letters in common were not significantly different ($p \leq 0.05$, using a One Way Analysis of Variance)
TOC = Total Organic Carbon Content
MSTR = Moisture Content

Table 26. Comparison of Elements in Invertebrates Collected for the LANL Water Quality Assessment, and Reported in New Mexico.

Element (µg/g dry weight)[a]	Caddisfly Nymphs (*Hesperophylax sp.*) collected on LANL		Failing 1993 (*Hesperoperla pacifica*)	Lynch *et al.* 1988 (Mix of invertebrates)	Simpson and Lusk 1999 (Mix of invertebrates)	Popp *et al.* 1996 (Mostly stoneflies)	General Dietary Level of Concern for Fish and Wildlife[b]
	Caddisflies (without their cases)	Caddisflies (with cases on)	Comanche Creek	Red River (Upstream of Mine)	mainstream of the San Juan River	Villanueva Creek	
Al	249	2,806	252		3,310		>1,000
As	1.1	1.8			1.3		> 30
Ba	382	230			62.5		--
Be	0.03	0.3			0.1		> 3
B	3.4	1.6			4.5		> 30
Cd	0.5	0.3	0.4	1.9	0.3	1.3	> 0.5
Cr	16.8	12.4			2.9	2.1	> 10
Cu	17.2	5.7	73.1	43.0	23.3	11	40 - 80
Fe	533	5,156			2,070		>1,000
Pb	1.6	9.1		0.5	2.7	1.6	> 100
Mg	1,608	742			1,443		>10,000
Mn	412	967	79.5	240	261		> 1,000
Mo	14.7	1.5		2.8	0.7		> 30
Ni	10.6	5.3		7.1	2.3		> 300
Se	1.4	0.04			4.8		> 3
Sr	17.8	9.5			83		>5,000
V	1.6	10.7			5.9		> 30
Zn	169	49	397	320	117	239	> 180

[a] See Table 5 for abbreviations and chemical names.
[b] Based on NRC 1980, Eisler 1985, Eisler 1986a, Eisler 1987, Eisler 1993, Eisler 1994, and USDOI 1998.

Table 27. Elemental Concentrations in Fathead Minnow Caged in Streams for the LANL Water Quality Assessment, Compared with Concentrations in Fish Tissues Collected Nationwide and Regionally.

Element (µg/g wet weight)[a]	LANL Water Quality Assessment Whole-body Caged-Fish (*Pimephales promelas*)		Fresquez *et al.* 1999 (Fish Fillets from the Rio Grande above and below the LANL)		Schmitt *et al.* 1999 (Whole Fish Collected Nationwide)	General Dietary Level of Concern - Predatory Wildlife[b]
	Prior to exposure (baseline)	after 2 months exposure	Maximum Background (above LANL)	Maximum (below LANL)	the 85[th] percentile of geometric means	
Al	0.4	43.5				> 200
Ba	2.7	30.8	0.5	1.4		--
B	0.4	0.7				> 30
Cd	0.1	0.1	0.1	0.2	0.04	> 0.1
Cr	1.7	2.2	0.1	0.3		> 5
Cu	1.1	1.4	0.9	0.7	1.7	> 25
Fe	27.7	53.7				> 500
Mg	301	295				>3,000
Mn	0.8	5.8				> 400
Hg	0.02	0.03	0.3	0.2	0.2	> 0.1
Mo	0.1	0.2				> 10
Ni	1.1	1.2	1.1	0.9		> 50
Se	0.4	0.5	0.3	0.5	0.7	> 0.8
Sr	9.1	9.1				>2,000
V	0.2	0.3				> 10
Zn	41.8	38.6			31.7	> 40

[a] See Table 5 for abbreviations and chemical names.
[b] Based on NRC 1980, Eisler 1985, Eisler 1986a, Eisler 1987, Eisler 1993, Eisler 1994, and USDOI 1998.

171

Table 28. Raw Habitat Suitability Index Scores for Various Life Stages of Brook Trout in Each Canyon Stream Segment Studied for the LANL Water Quality Assessment, 1996-1997.

Variable Number⇒		***V1***	***V2***	***V3***	***V4***	***V5***	***V6***	***V7***	***V8***	***V9***	***V10***
SITE	***Trout Life Stage***	***Summer High Temperature***	***Average Maximum Temperature***	***Minimum Dissolved Oxygen***	***Average Thalweg Depth***	***Riffle Flow***	***Percent Instream Cover***	***Average Gravel Size***	***Percent Large Substrates***	***Percent Riffle Substrates***	***Percent Pools***
Los Alamos	Adult	1	NA[a]	1	0.5	NA	1	NA	NA	0.6	0.7
Los Alamos, BR[b]	Adult	0.9	NA	0.7	0.2	NA	0.7	NA	NA	0.6	0.3
Los Alamos, DE[c]	Adult	1	NA	1	0.5	NA	1	NA	NA	0.6	0.7
Sandia	Adult	0.9	NA	0.7	0.55	NA	0.7	NA	NA	0.45	0.8
Pajarito	Adult	1	NA	1	0.3	NA	1	NA	NA	0.8	0.55
Valle	Adult	1	NA	0.75	0.05	NA	0.95	NA	NA	0.6	0.45
Los Alamos	Egg	1	1	1	NA	0.95	NA	0.95	NA	0.6	0.7
Los Alamos, BR	Egg	0.9	0.9	0.7	NA	0.6	NA	0.55	NA	0.6	0.3
Los Alamos, DE	Egg	1	1	1	NA	0.5	NA	0.95	NA	0.6	0.7
Sandia	Egg	0.9	0.7	0.7	NA	0.6	NA	0.55	NA	0.45	0.8
Pajarito	Egg	1	1	1	NA	0.35	NA	0.55	NA	0.8	0.55
Valle	Egg	1	1	0.75	NA	0.5	NA	0.95	NA	0.6	0.45
Los Alamos	Fry	1	NA	1	NA	NA	NA	NA	1	0.6	0.7
Los Alamos, BR	Fry	0.9	NA	0.7	NA	NA	NA	NA	1	0.6	0.3
Los Alamos, DE	Fry	1	NA	1	NA	NA	NA	NA	1	0.6	0.7
Sandia	Fry	0.9	NA	0.7	NA	NA	NA	NA	1	0.45	0.8
Pajarito	Fry	1	NA	1	NA	NA	NA	NA	1	0.8	0.55
Valle	Fry	1	NA	0.75	NA	NA	NA	NA	1	0.6	0.45
Los Alamos	Juvenile	1	NA	1	NA	NA	1	NA	NA	0.6	0.7
Los Alamos, BR	Juvenile	0.9	NA	0.7	NA	NA	0.9	NA	NA	0.6	0.3
Los Alamos, DE	Juvenile	1	NA	1	NA	NA	1	NA	NA	0.6	0.7
Sandia	Juvenile	0.9	NA	0.7	NA	NA	0.9	NA	NA	0.45	0.8
Pajarito	Juvenile	1	NA	1	NA	NA	1	NA	NA	0.8	0.55
Valle	Juvenile	1	NA	0.75	NA	NA	1	NA	NA	0.6	0.45

Table 28. Raw Habitat Suitability Index Scores for Various Life Stages of Brook Trout in Each Canyon Stream Segment Studied for the LANL Water Quality Assessment, 1996-1997 ~ *Continued.*

Variable Number⇒		*V11*	*V12*	*V13*	*V14*	*V15*	*V16*	*V16a*				
SITE	*Trout Life Stage*	*Bank Vegetation Score*	*Summer Bank Stability*	*pH*	*Estimated Baseflow*	*Pool Class*	*Percent Fines in Riffles*	*Percent Fines in Pools*	*Life Stage Score*	*Other Factors Score*	*HSI*	*Final HSI*
Los Alamos	Adult	1	ND[d]	1	1	0.45	0.7	NA	0.66	0.91	0.77	0.77
Los Alamos, BR	Adult	1	ND	1	1	0.3	0.9	NA	0.35	0.88	0.56	0.20
Los Alamos, DE	Adult	1	ND	1	1	0.45	0.7	NA	0.66	0.91	0.77	0.77
Sandia	Adult	1	ND	1	1	1	0.95	NA	0.70	0.86	0.78	0.78
Pajarito	Adult	1	ND	1	1	0.3	0.95	NA	0.50	0.97	0.69	0.30
Valle	Adult	1	ND	1	1	0.3	0.6	NA	0.26	0.86	0.48	0.05
Los Alamos	Egg	1	ND	1	1	NA	0.7	0.2	0.57	NA	0.57	0.57
Los Alamos, BR	Egg	1	ND	1	1	NA	0.9	0.45	0.53	NA	0.53	0.53
Los Alamos, DE	Egg	1	ND	1	1	NA	0.7	0.2	0.46	NA	0.46	0.46
Sandia	Egg	1	ND	1	1	NA	0.95	0.5	0.55	NA	0.55	0.55
Pajarito	Egg	1	ND	1	1	NA	0.95	0.5	0.46	NA	0.46	0.46
Valle	Egg	1	ND	1	1	NA	0.6	0.15	0.42	NA	0.42	0.42
Los Alamos	Fry	1	ND	1	1	NA	0.7	NA	0.77	0.91	0.83	0.83
Los Alamos, BR	Fry	1	ND	1	1	NA	0.9	NA	0.53	0.88	0.68	0.68
Los Alamos, DE	Fry	1	ND	1	1	NA	0.7	NA	0.77	0.91	0.83	0.83
Sandia	Fry	1	ND	1	1	NA	0.95	NA	0.88	0.86	0.87	0.87
Pajarito	Fry	1	ND	1	1	NA	0.95	NA	0.73	0.97	0.84	0.84
Valle	Fry	1	ND	1	1	NA	0.6	NA	0.59	0.86	0.71	0.71
Los Alamos	Juvenile	1	ND	1	1	0.45	0.7	NA	0.72	0.91	0.81	0.81
Los Alamos, BR	Juvenile	1	ND	1	1	0.3	0.9	NA	0.50	0.88	0.66	0.30
Los Alamos, DE	Juvenile	1	ND	1	1	0.45	0.7	NA	0.72	0.91	0.81	0.81
Sandia	Juvenile	1	ND	1	1	1	0.95	NA	0.90	0.86	0.88	1.00
Pajarito	Juvenile	1	ND	1	1	0.3	0.95	NA	0.62	0.97	0.77	0.30
Valle	Juvenile	1	ND	1	1	0.3	0.6	NA	0.58	0.86	0.71	0.30

[a] Not applicable to the HSI model for this life stage.
[b] BR = Below the Los Alamos Reservoir.
[c] DE = Habitat measurements during electrofishing survey. See text.
[d] Not determined and this variable is optional for the brook trout HSI model. See Raleigh 1982.

Table 29. Raw Habitat Suitability Index Scores for Adult Longnose Dace in Each Canyon Stream Reach and Stream Segment Studied for the LANL Water Quality Assessment, 1996-1997.

Variable Number⇒	*V1*	*V2*	*V3*	*V4*	*V5*	*V6*	*HSI*
SITE[a]	*Riffle Flow*	*Riffle Depth*	*Percent Riffle*	*Percent Large Substrates*	*Summer High Temperature*	*Percent Cover*	
Upper Reach Los Alamos	0.75	0.25	1	0.6	0.65	1	0.25
Lower Reach Los Alamos	0.6	0.4	1	0.3		1	0.30
Los Alamos Segment	0.675	0.325	1	0.45	0.65	1	0.28
Los Alamos, BR[b]	0.95	0.25	1	0.6	1	0.65	0.25
Los Alamos, DE[c]	0.25	0.2	1	0.3	0.65	1	0.20
Upper Reach Sandia	0.45	0.2	1	1	1	0.75	0.20
Lower Reach Sandia	0.25	0.2	1	1		1	0.20
Sandia Segment	0.35	0.2	1	1	1	0.875	0.20
Upper Reach Pajarito	0.15	0.2	1	0.6	0.6	1	0.15
Lower Reach Pajarito	0.1	0.15	1	1		1	0.10
Pajarito Segment	0.125	0.175	1	0.8	0.6	1	0.13
Upper Reach Valle	0.3	0.2	1	0.6	1	1	0.20
Lower Reach Valle	0.3	0.2	1	0.45		1	0.20
Valle Segment	0.3	0.2	1	0.525	1	1	0.20

[a] See Figures 8 through 11 for location of habitat reaches in canyon stream segment studied.
[b] BR = Below the Los Alamos Reservoir.
[c] DE = Habitat measurements made during electrofishing survey. See text.

Table 30. Comparison of the Brook Trout HSI Model Parameter Ranges with Habitat Associations Reported by the New Mexico Department of Game and Fish (NMDGF 1998) and "Good-Excellent" Habitat Features Reported by Binns (1978) in the Habitat Quality Index (HQI).

HSI Parameter	*Code*	*HSI Range*	*HSI = 1.0*	*HSI = 0.0*	*NMDGF 1998*	*HQI*
Max. Temp. - adult	V1	0 - 30 °C	10 - 16 °C	0; 24 - 30 °C	<15 - 21 °C	10.5 - 21.1 °C
Max. Temp. - embryo	V2	0 - 20 °C	4 - 12 °C	0; 20 °C	<15 - 21 °C	NS[a]
Min. Dissolved Oxygen	V3a	3 - 9 mg/L	6.5 - 9.0 mg/L	3.0 mg/L	< 5 - >7 mg/L	NS
Min. Dissolved Oxygen	V3b	3 - 9 mg/L	9.0 mg/L	3.0 - 5.0 mg/L	5 - >7 mg/L	NS
Mean Depth	V4	0 - 60 cm	30 - 60 cm	0 - 12 cm	< 30 - 300 cm	NS
Mean Flow	V5	0 - 100 cm/sec	30 - 60 cm/sec	0; 90 - 100 cm/sec	15 - 76 cm/sec	30 - 91 cm/sec
Percent Cover	V6j	0 - 40%	14 - 40 %	N/A[b]	NS, some required	NS
Percent Cover	V6a	0 - 40%	22 - 40 %	N/A	NS, some required	41 - >55%
Substrate Size	V7	0 - 10 cm	2.5 - 6.0 cm	0.0 cm	2.0 - 256 cm	NS
Covered Substrate	V8	0 - 20%	8 - 20 %	0 %	NS	NS
Dominant Substrate	V9	N/A	Class A	N/A	Gravel (Class A)	NS
Percent Pools	V10	0 - 100 %	35 - 65 %	N/A	Preferred	NS
Percent Bank Vegetation	V11	0 - 300 %	150 - 300 %	N/A	NS	NS
Percent Bank Stability	V12	0 - 100 %	75 - 100 %	N/A	NS	76 - 100 %
Max/Min pH	V13	4.0 - 10.0	6.5 - 8.0	4.0; 9.5 - 10.0	NS	NS
Estimated Base Flow	V14	0 - 100 %	50 - 100 %	0 %	NS	26 -55 %
Pool Class Rating	V15	N/A	≥ 30% 1st Class	N/A	1st Class	NS
Percent Fines in Riffles	V16	0 - 60 %	0 - 15 %	N/A	NS	NS

[a] None stated or quantified.
[b] Not applicable to HSI model for this life stage.

Table 31. Summary Results and Values Assigned for the Index of Biological Quality used in the Development of the Water Quality Index.

Biological Survey Results (and Value Assigned)	Valle	Pajarito	Sandia	Los Alamos
Fish Species	0 (1)	0 (1)	0 (1)	2 (5)
Shellfish Species	1 (5)	1 (5)	0 (1)	1 (5)
Aquatic Insect Taxa	33 (3)	25 (3)	10 (1)	42 (5)
Invertebrate Community Biological Condition Index	24 (3)	24 (3)	14 (1)	38 (5)
Surface Water Toxicity				
96-hour fish survival	98 (5)	93 (5)	95 (5)	93 (5)
7-day invertebrate survival	0 (1)	100 (5)	90 (5)	100 (5)
7-day invertebrate reproduction	0 (1)	21 (3)	21 (3)	35 (5)
Caged Fish Bioassay				
Corrected 96-hour survival (flood effects removed)	99 (5)	99 (5)	96 (5)	94 (5)
Corrected 2-month survival (flood effects removed)	94 (5)	73 (5)	93 (5)	77 (5)
2-month, average grams gained (flood effects removed)	1.4 (5)	1.7 (5)	1.8 (5)	1.5 (5)
Sediment Pore Water Toxicity				
7-day invertebrate survival	100 (5)	100 (5)	78 (5)	90 (5)
7-day invertebrate reproduction	31 (3)	32 (3)	13 (1)	41 (5)
Index of Biological Quality	42	48	38	60
% Index of Biological Quality Compared to the Reference Site	70	80	63	100

Table 32. Summary Results and Values Assigned for the Index of Chemical Quality used in the Development of the Water Quality Index.

Summary Results of Water Quality Criteria Exceeded (and Value Assigned)	Valle	Pajarito	Sandia	Los Alamos
Aquatic Life Acute Criteria	Al[a] (1)	Al (1)	_(5)	Al (1)
Aquatic Life Chronic Criteria	Al, RDX, HMX (1)	Al, Fe (1)	Al (3)	Al (3)
Dissolved Oxygen as mg/L	<6 (3)	< 6 (3)	<5 (1)	< 6 (3)
Temperature in Celsius	> 20 (3)	< 20 (5)	> 20 (3)	< 20 (5)
Conductivity as mS/cm	< 1.5 (5)	< 1.5 (5)	> 1.5 (3)	< 1.5 (5)
pH as standard units	> 9 (3)	< 9 (5)	< 9 (5)	< 9 (5)
Turbidity as NTU	> 10 (3)	> 25 (1)	> 10 (3)	> 10 (3)
Phosphorus	> 0.1 (3)	> 0.1 (3)	> 6.3 (1)	> 0.1 (3)
Ammonia as Nitrogen	< 1.0 (5)	< 1.0 (5)	< 1.0 (5)	< 1.0 (5)
Sediment Quality Criteria Exceeded (Value Assigned)				
Sediment Concentration of Concern Criteria	Al (3)	Al (3)	Al, Cr, PCB (1)	Al (3)
Sediment Quality Criteria	HMX, TNT (1)	_(5)	_(5)	_(5)
Tissue Quality Criteria Exceeded (Value Assigned)				
Tissue Quality Criteria	_(5)	Cr (3)	Cr, PCBs (1)	Cr (3)
Index of Chemical Quality	33	37	31	41
% Index of Chemical Quality Compared to Reference Site	80	90	76	100

[a] See Table 5 for abbreviations and chemical names.
[b] _(5) = Did not exceed any criteria, value of 5 assigned.

Table 33. Summary Results and Values Assigned for the Index of Physical Quality used in the Development of a Water Quality Index

Physical Characteristic (and Value Assigned)	Valle	Pajarito	Sandia	Los Alamos
Stream Channel Stability (per Rosgen 1996)				
Pfankuch Rating	FAIR (3)	FAIR (3)	POOR (1)	FAIR (3)
Aquatic Life Habitat Quality Model Results				
Rapid Bioassessment Protocol for Invertebrate Habitat	173 (5)	178 (5)	129 (3)	176 (5)
Habitat Suitability Index for Brook Trout Eggs	0.42 (3)	0.46 (5)	0.55 (5)	0.57 (5)
Habitat Suitability Index for Brook Trout Fry	0.71 (5)	0.84 (5)	0.87 (5)	0.83 (5)
Final Habitat Suitability Index for Brook Trout Juveniles	0.30 (1)	0.30 (1)	1.0 (5)	0.81 (5)
Final Habitat Suitability Index for Brook Trout Adults	0.05 (1)	0.30 (1)	0.78 (5)	0.77 (5)
Binn's Habitat Quality Index	17.1 (1)	23.8 (1)	25.3 (1)	68.7 (5)
Final Habitat Suitability Index for Longnose Dace	0.2 (3)	0.2 (3)	0.2 (3)	0.3 (5)
Index of Physical Quality	22	24	28	38
% Index of Physical Quality Compared to Reference Site	58	63	74	100

FIGURES

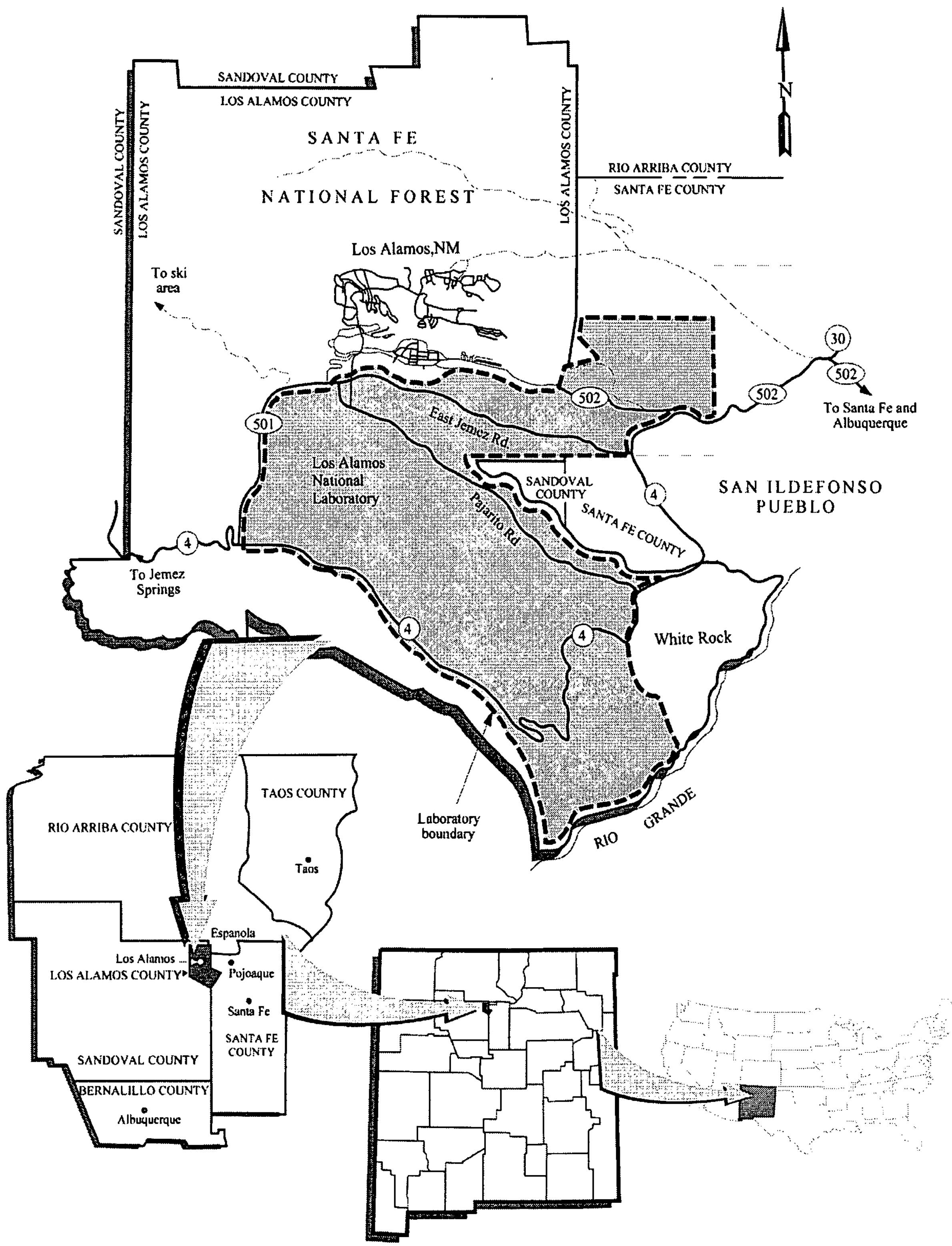


Figure 1. Location of the Los Alamos National Laboratory and Study Area (Source: LANL 1998a).

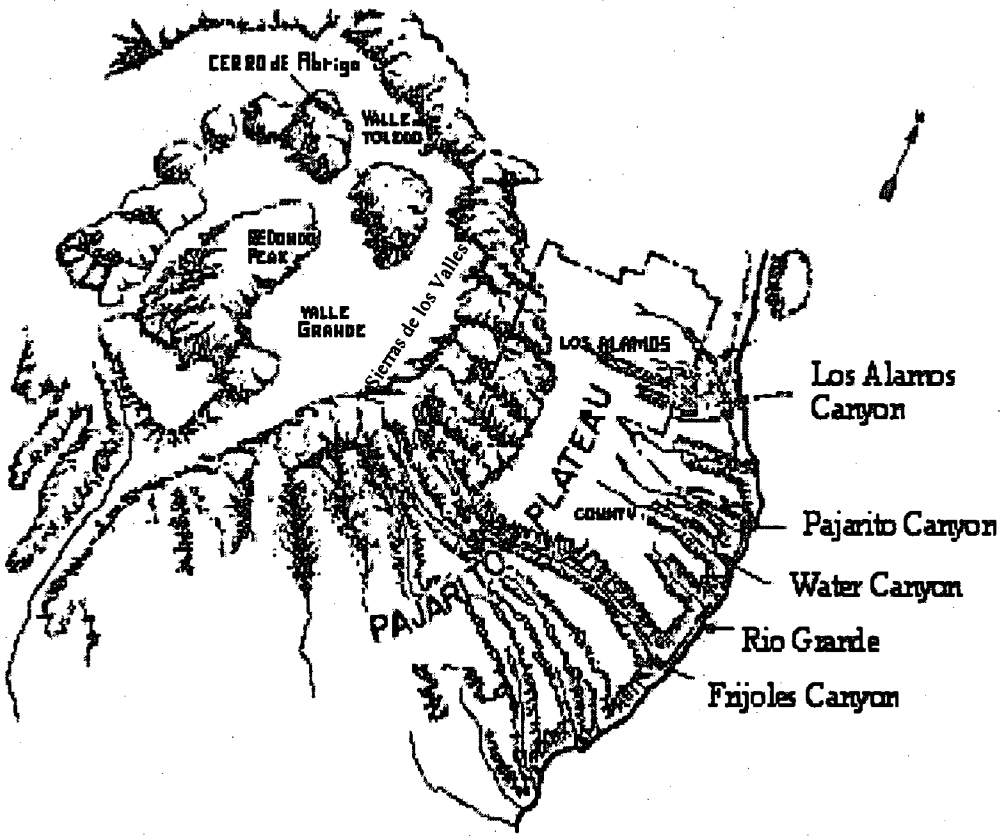


Figure 2. General Location of Several Physiographic Features of the East Jemez Mountains (Source: modified from Ferenbaugh *et al.* 1994).

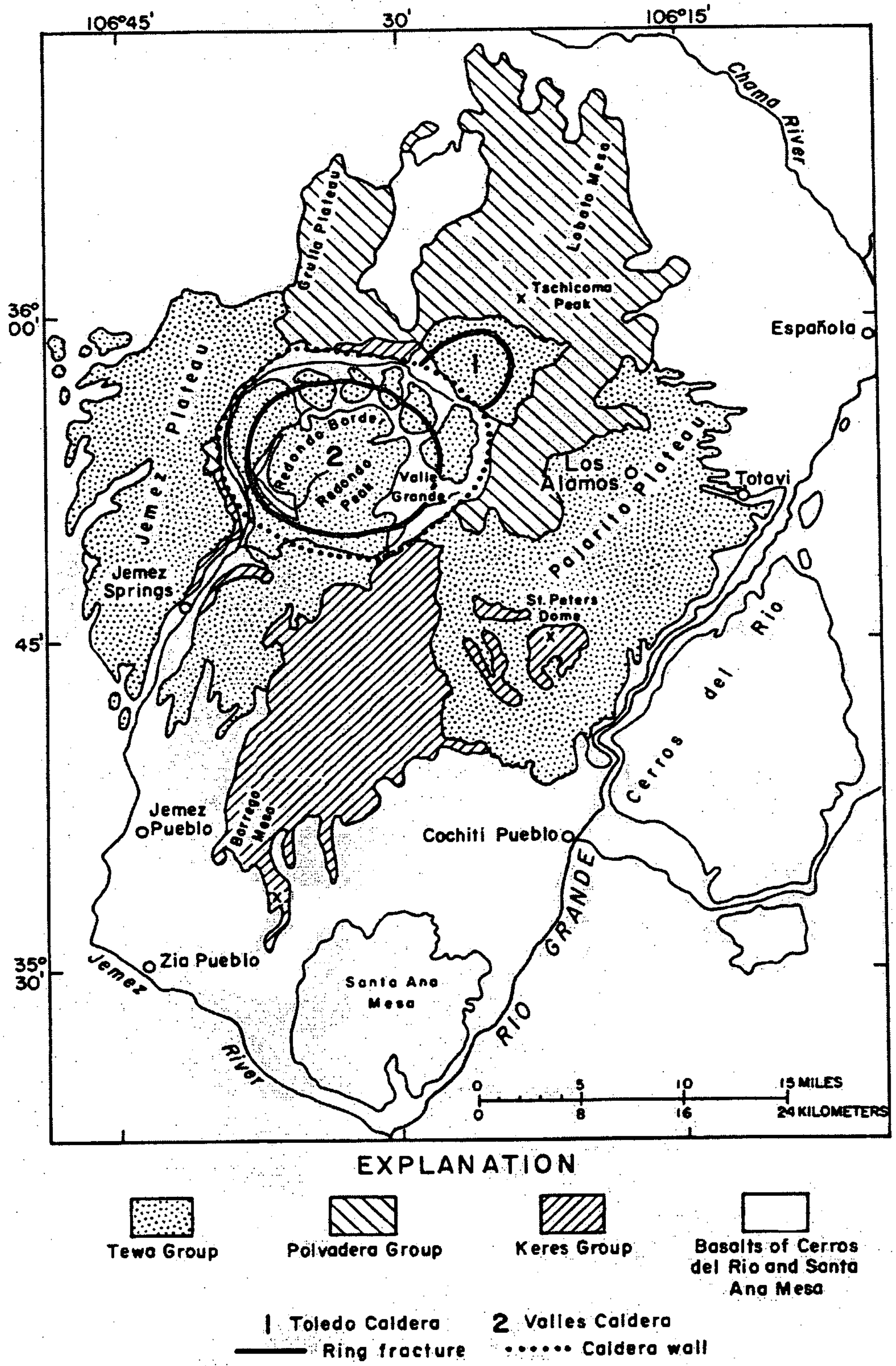


Figure 3. Surface Geology and Location of the Pajarito Plateau. (Copyright by the New Mexico Geological Society; Kudo 1974).

181

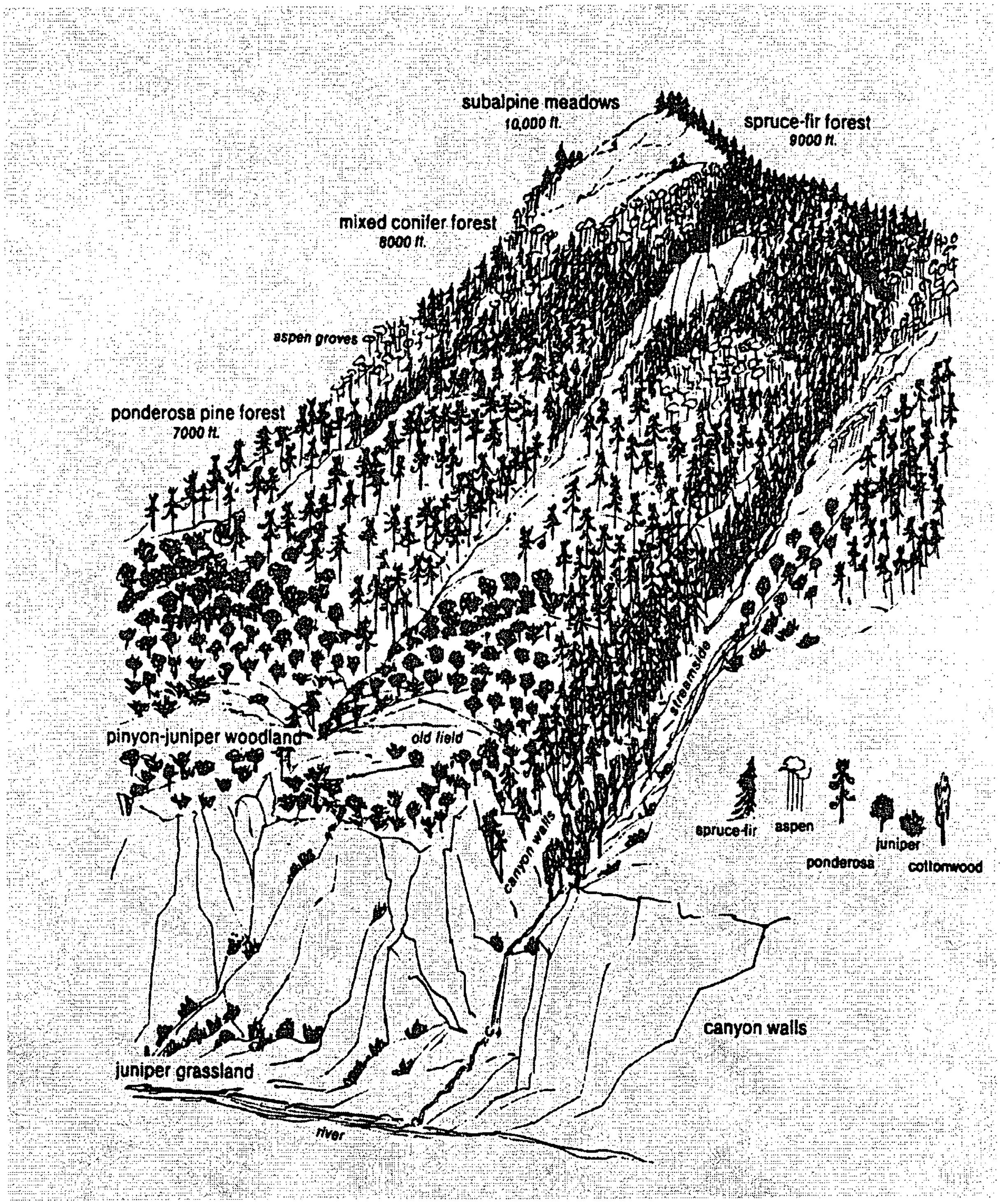


Figure 4. Depiction of Plant Communities of the Pajarito Plateau (Source: Travis 1992).

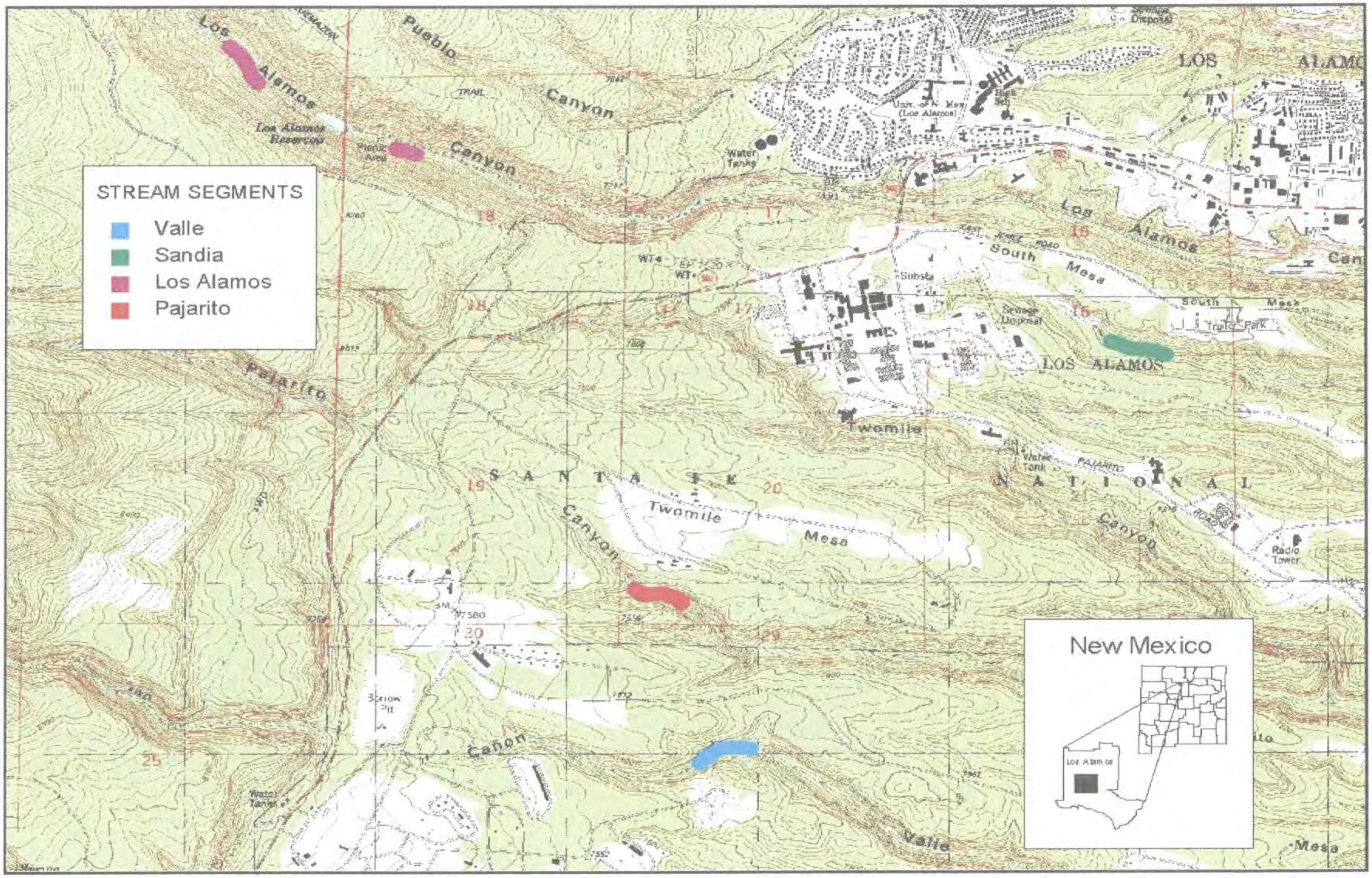


Figure 5. Location of Los Alamos, Sandia, Pajarito and Valle Canyon Stream Segments Studied

183

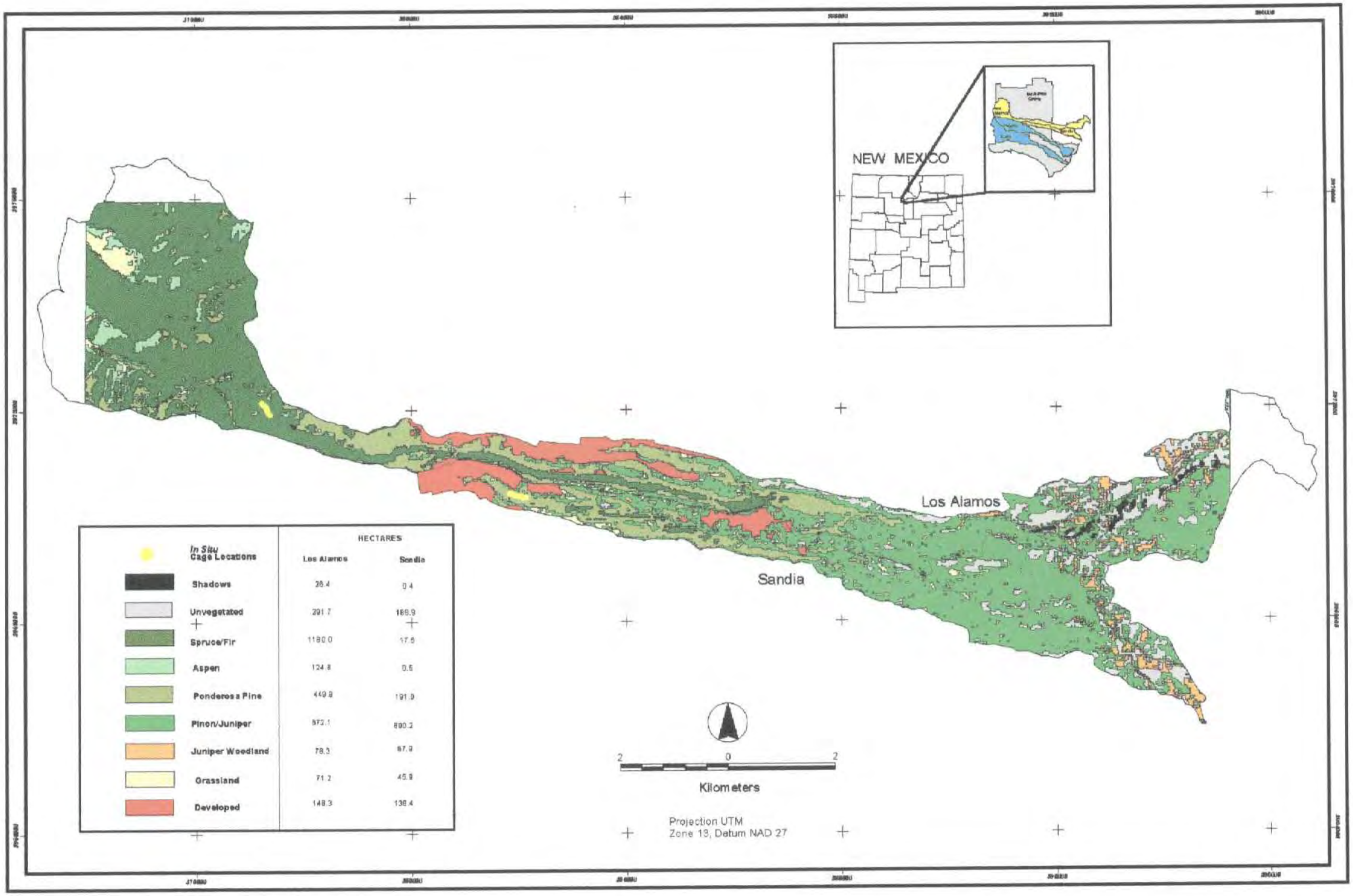


Figure 6. Land Cover of Los Alamos and Sandia Canyons (Source: Koch *et al.* 1997) and Cages Locations within Streams Studied.

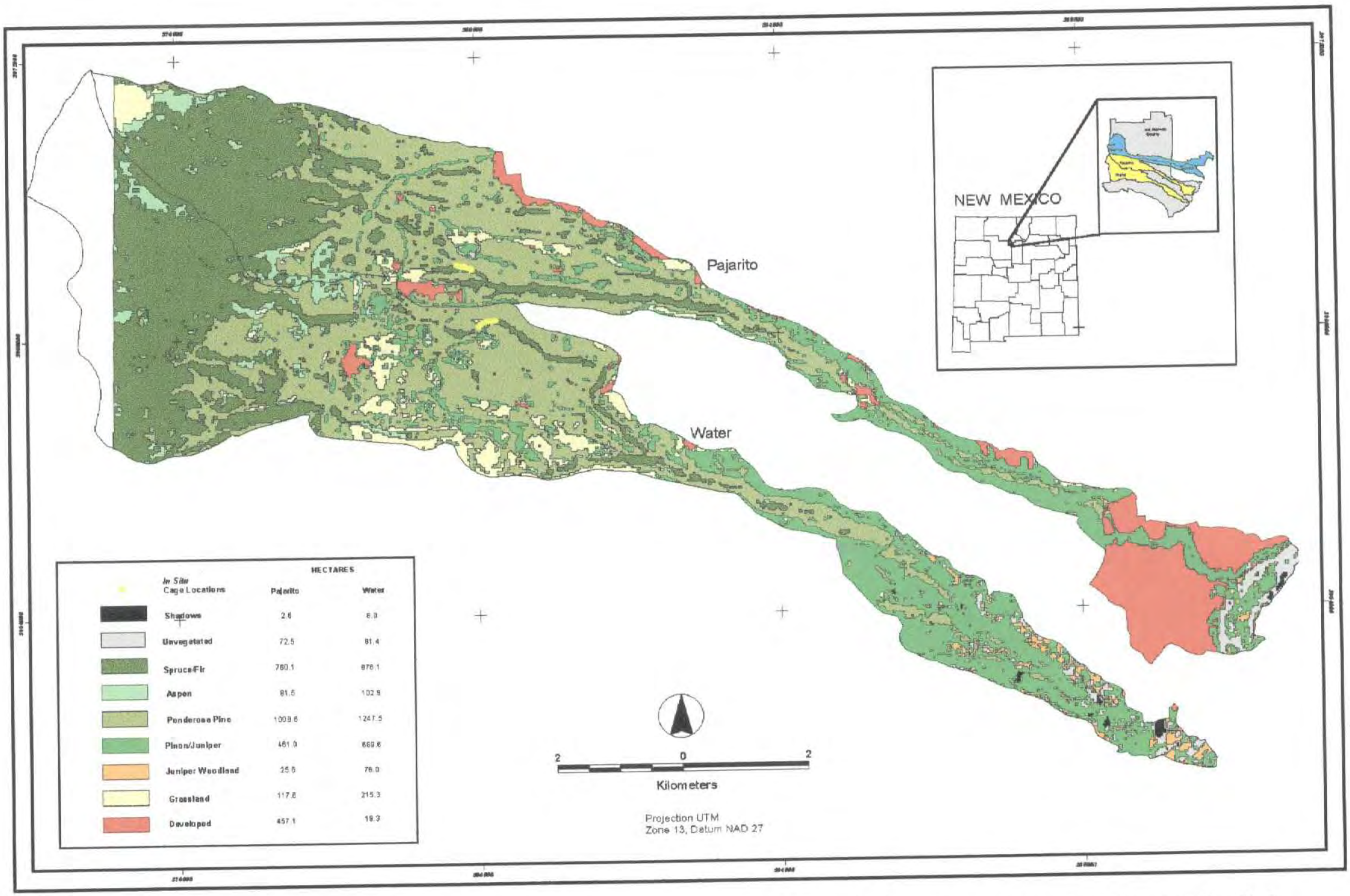


Figure 7. Land Cover of Pajarito and Valle Canyons (Source: Koch *et al.* 1997) and Cages Locations within Streams Studied.

185

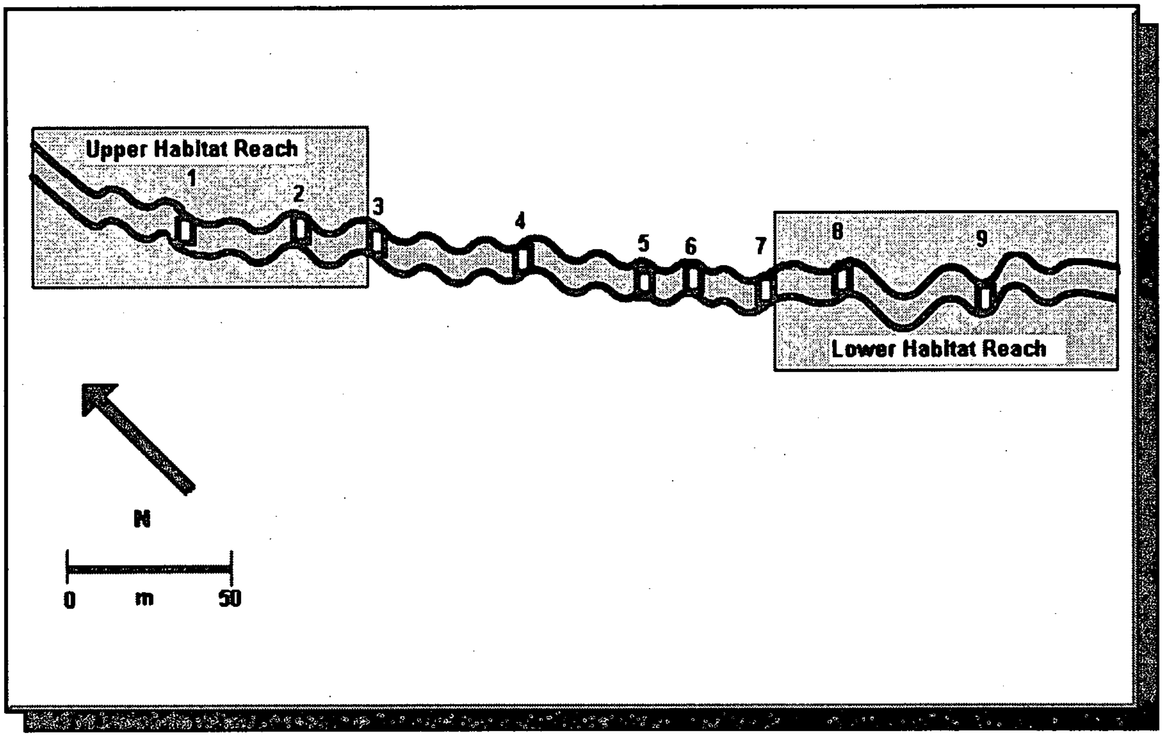


Figure 8. Depiction of Cage Locations and Habitat Evaluation Reaches in the Los Alamos Canyon Stream Segment.

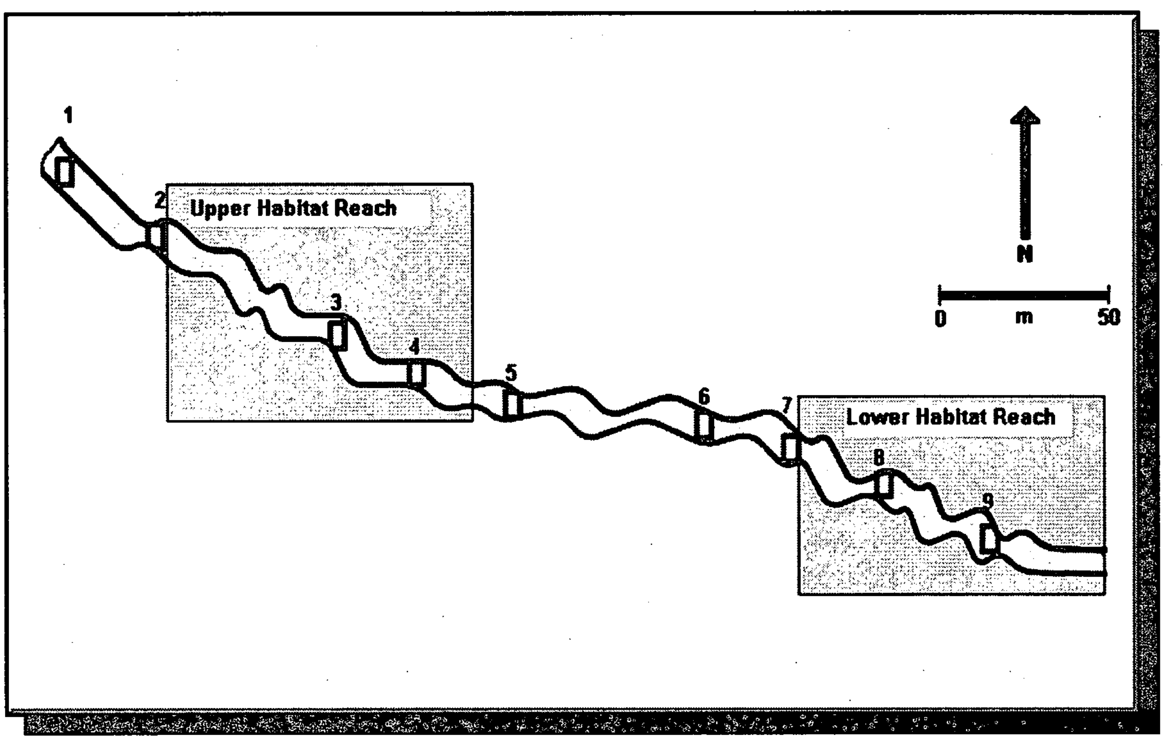


Figure 9. Depiction of Cage Locations and Habitat Evaluation Reaches in the Sandia Canyon Stream Segment.

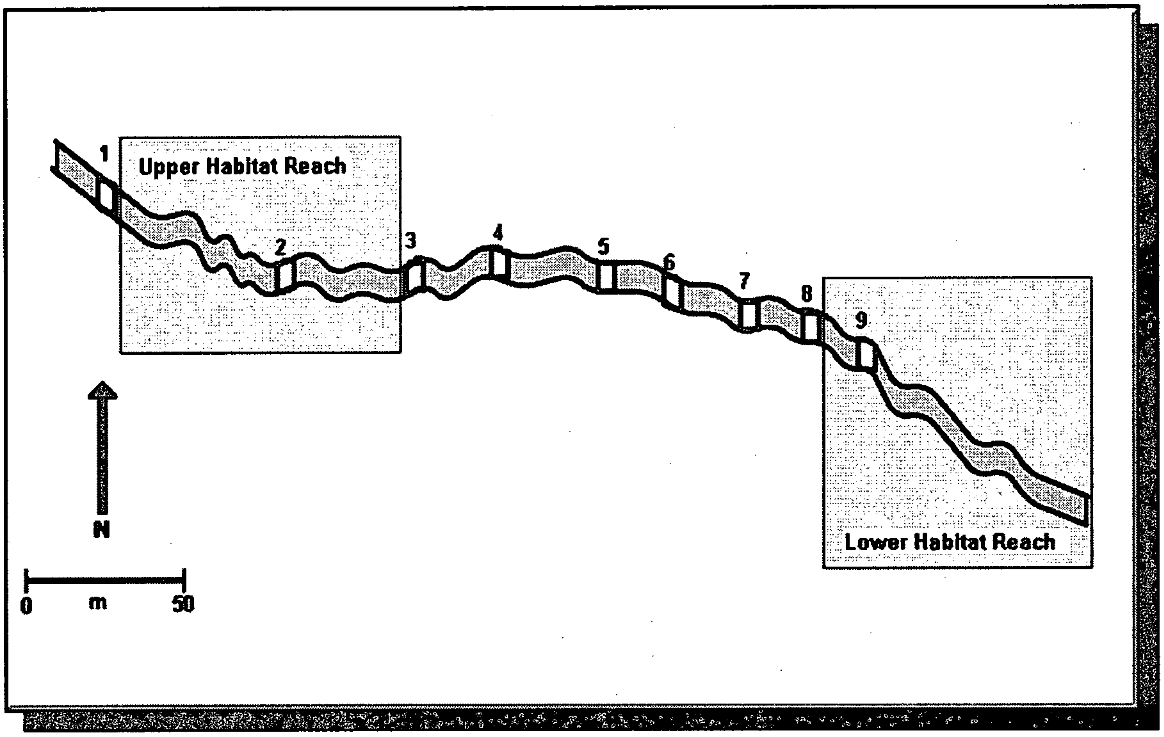


Figure 10. Depiction of Cage Locations and Habitat Evaluation Reaches in the Pajarito Canyon Stream Segment.

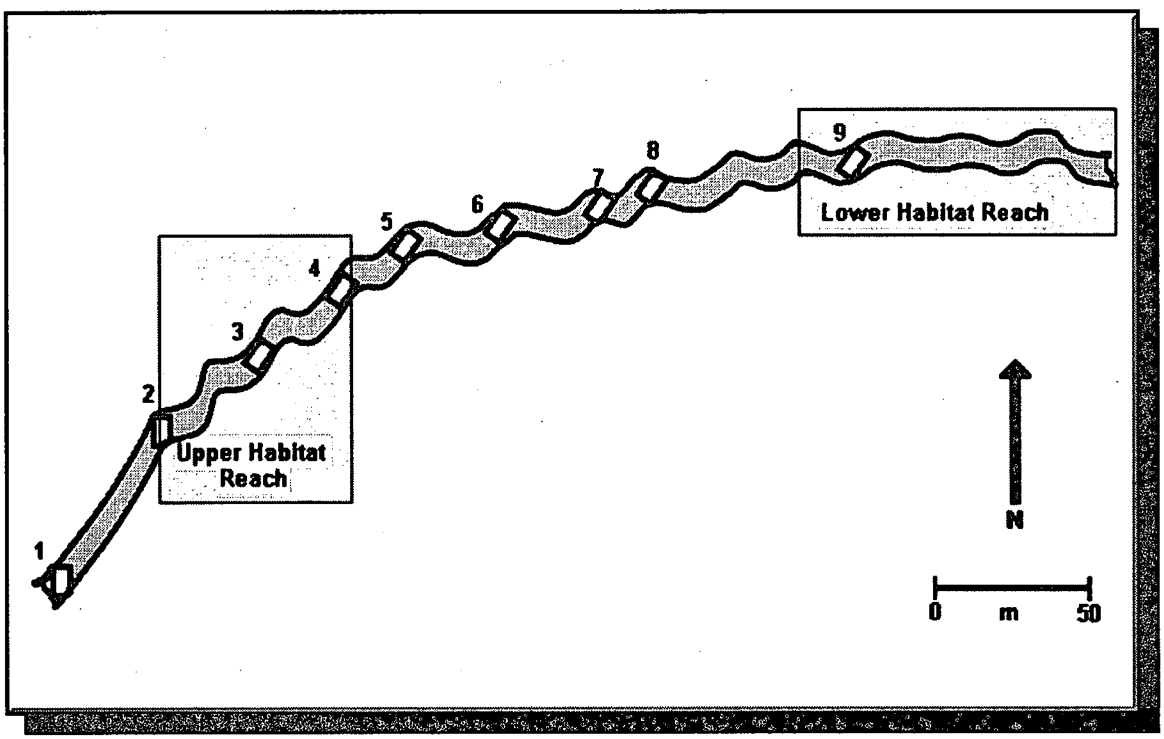
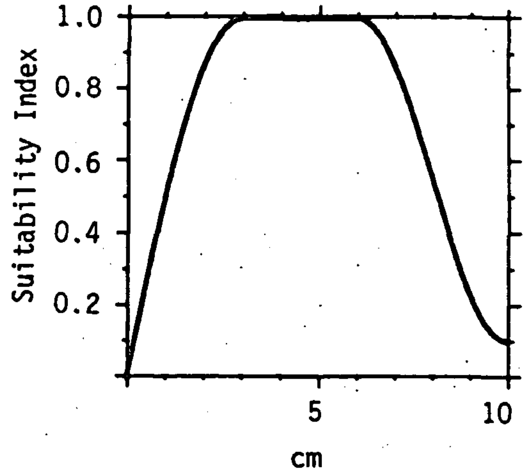


Figure 11. Depiction of Cage Locations and Habitat Evaluation Reaches in the Valle Canyon Stream Segment.

Figure 12. Example of a Suitability Index for Substrate (at right), and Habitat Variables (below) that are Components of the Brook Trout Habitat Suitability Index Model (Raleigh 1982).



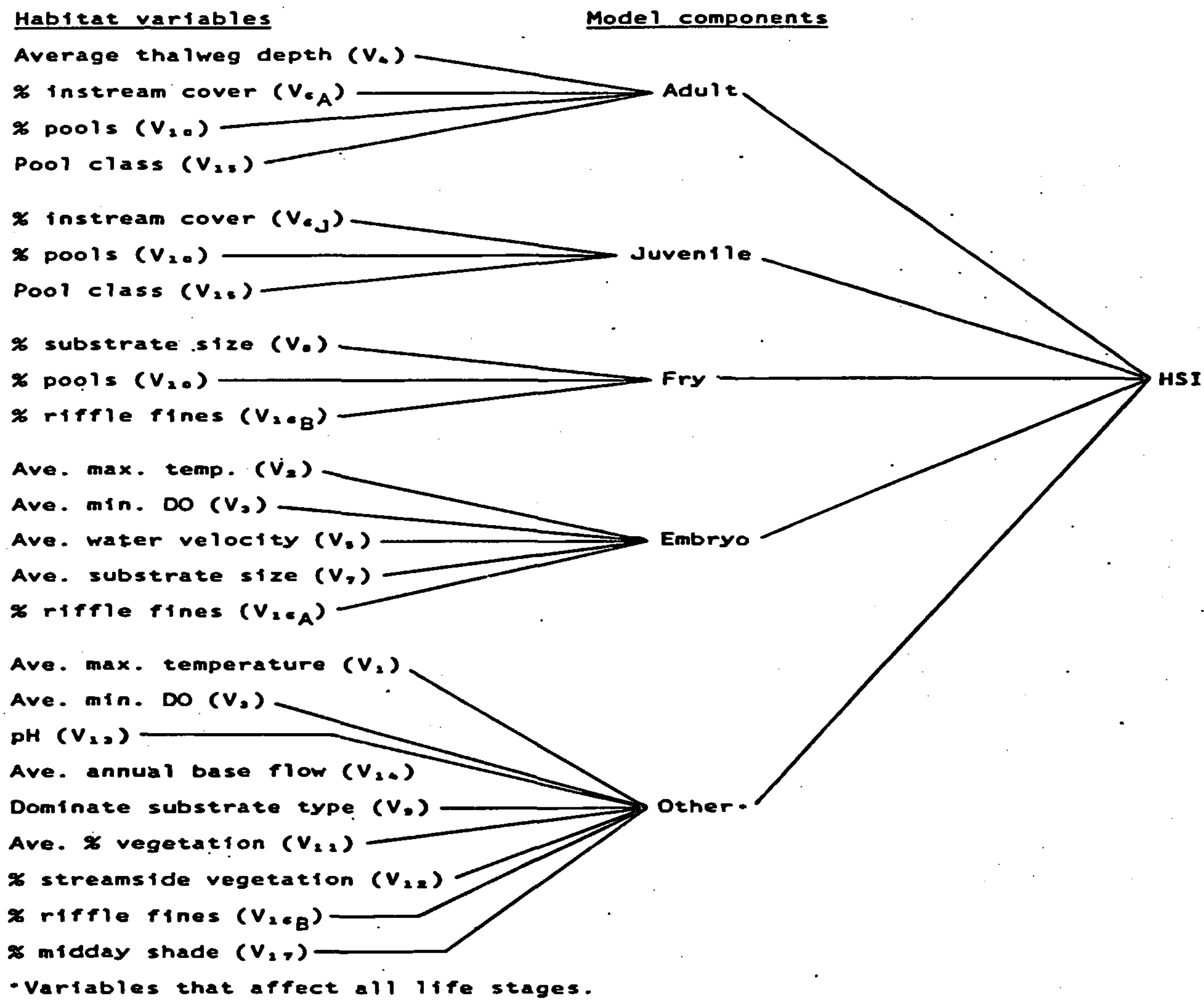


Figure 13. Habitat Variables That Are Components of the Longnose Dace Habitat Suitability Index Model (Edwards *et al.* 1983).

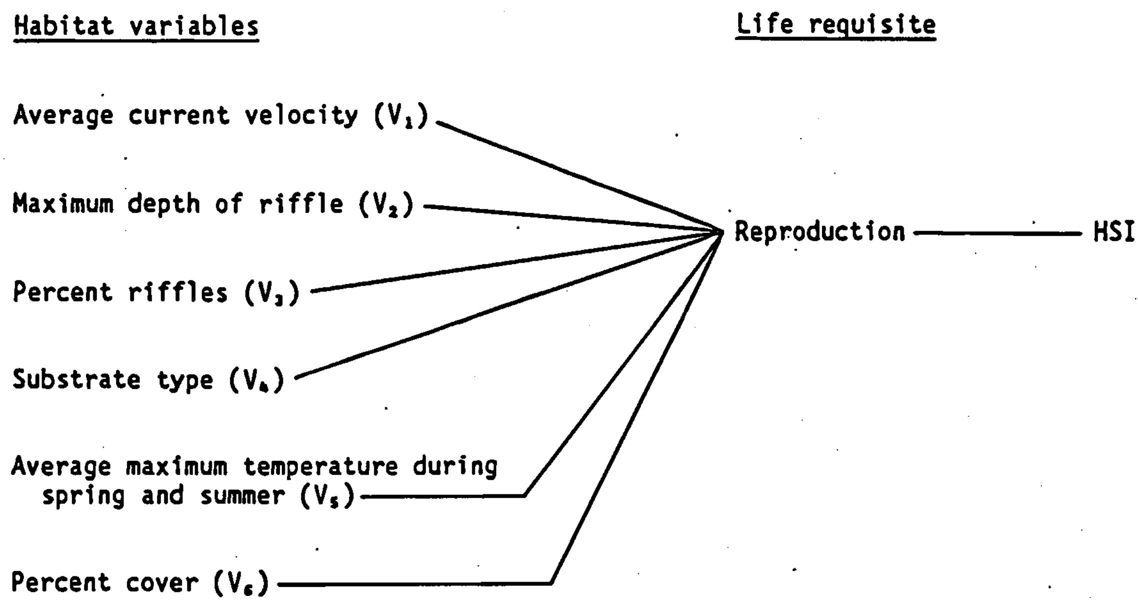


Figure 1. Habitat variables included in the riverine model for longnose dace.

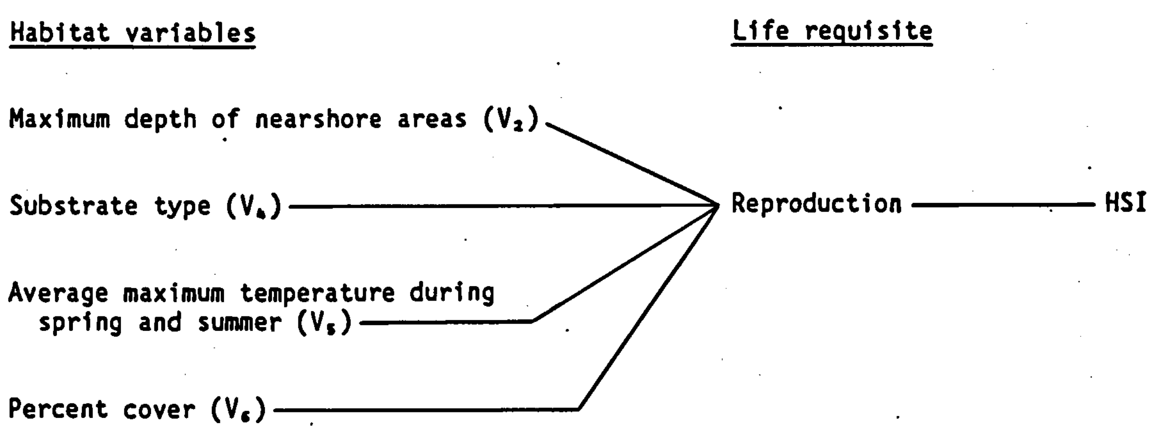


Figure 14. Stream Channel Geomorphological Classification Developed by Rosgen (1996) Used to Evaluate the Long-term Stability of a Stream.

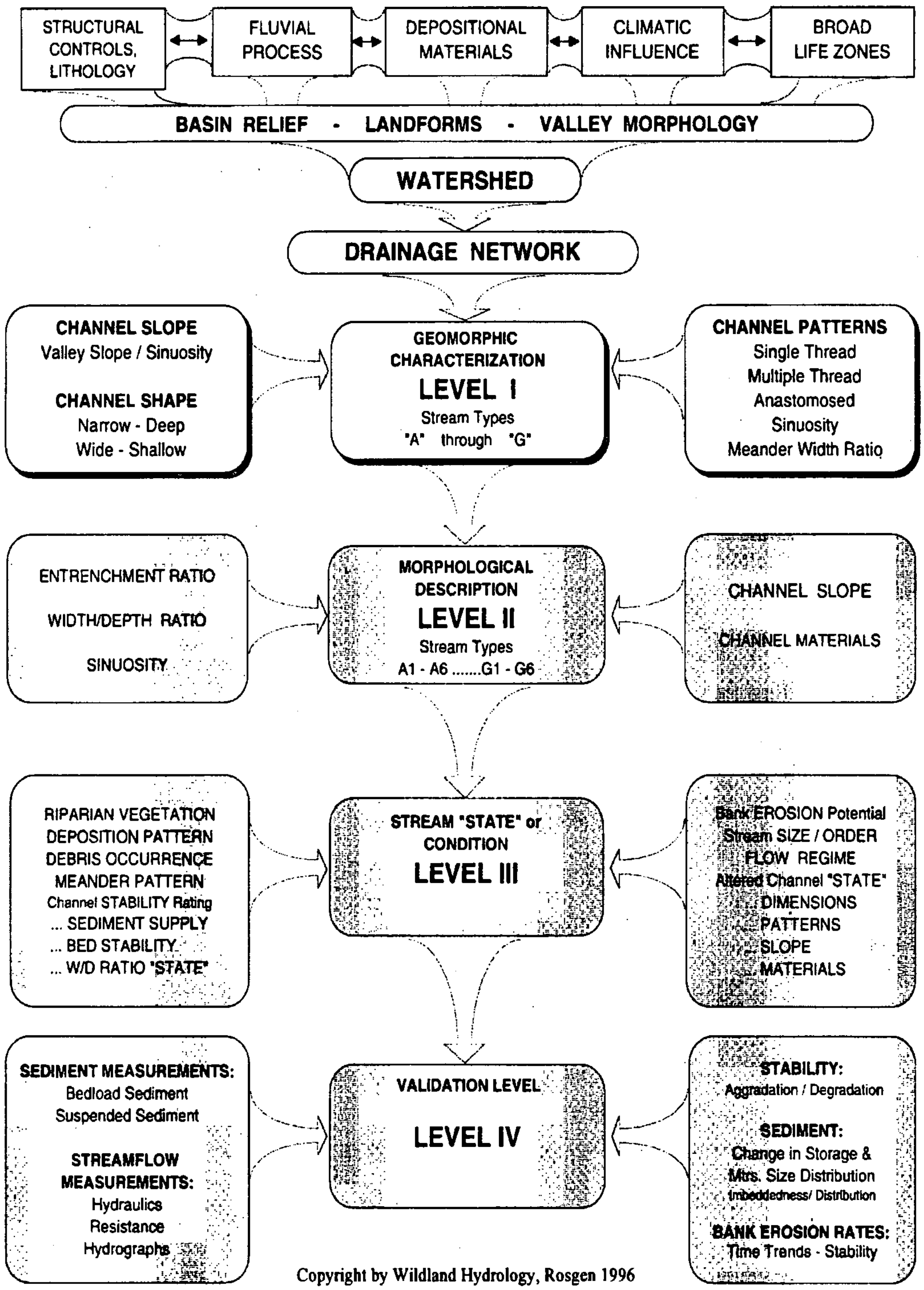
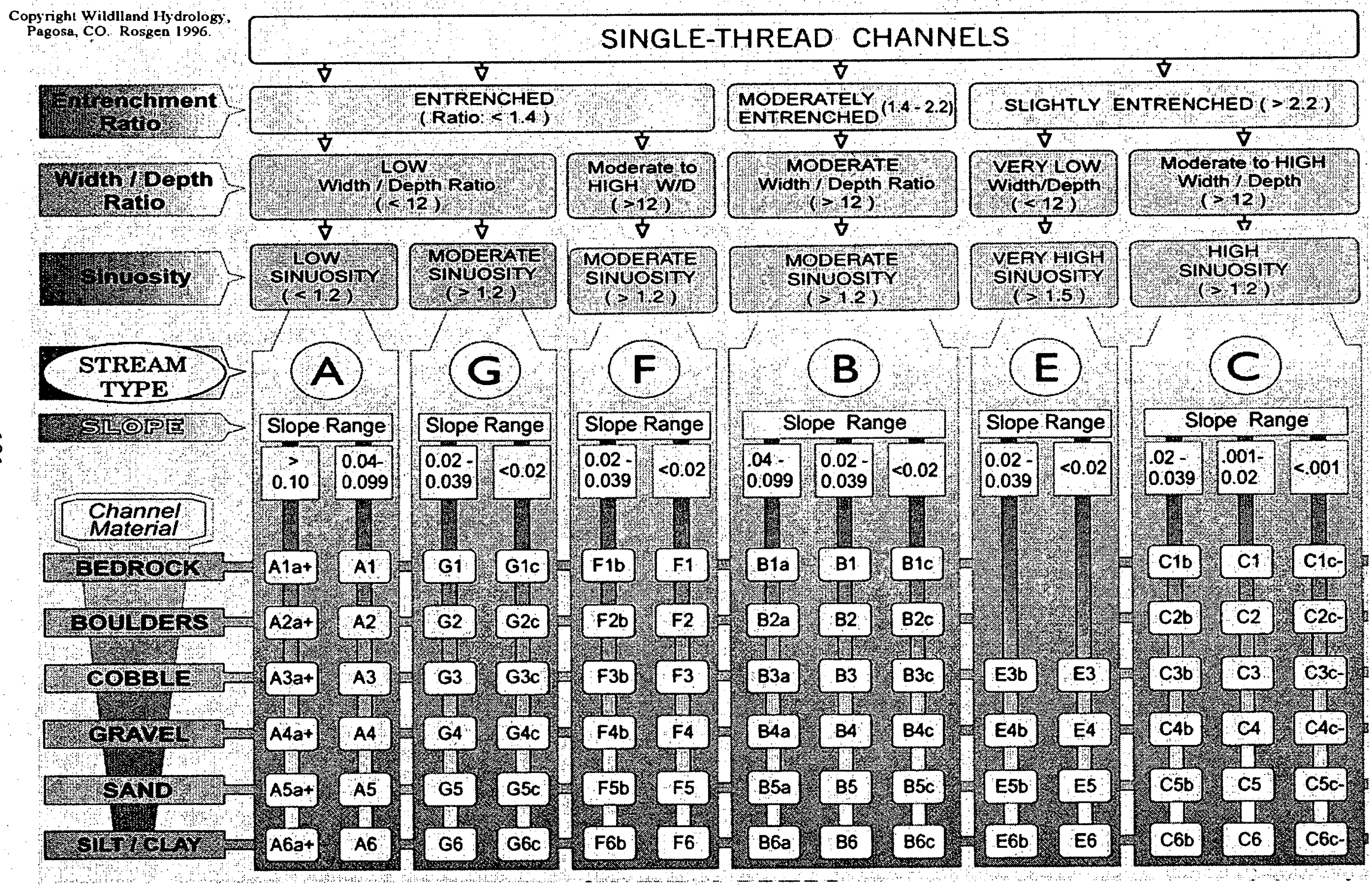


Figure 15. Rosgen (1996) Level II Stream Channel Morphological Classification.



191

Figure 16. Rosgen (1996) Level III Stream Channel Classification.

CHANNEL STABILITY (PFANKUCH) EVALUATION AND STREAM CLASSIFICATION SUMMARY (LEVEL III)

Reach Location____________ Date________ Observers__________

Stream Type ____________

		Category	EXCELLENT	
UPPER BANKS	1	Landform Slope	Bank Slope Gradient <30%	2
	2	Mass Wasting	No evidence of past or future mass wasting.	3
	3	Debris Jam Potential	Essentially absent from immediate channel area.	2
	4	Vegetative Bank Protection	90%+ plant density. Vigor and variety suggest a deep dense soil binding root mass.	3
LOWER BANKS	5	Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio <7.	1
	6	Bank Rock Content	65%+ with large angular boulders. 12"+ common.	2
	7	Obstructions to Flow	Rocks and logs firmly imbedded. Flow pattern without cutting or deposition. Stable bed.	2
	8	Cutting	Little or none. Infreq. raw banks less than 6".	4
	9	Deposition	Little or no enlargement of channel or pt. bars.	4
BOTTOM	10	Rock Angularity	Sharp edges and corners. Plane surfaces rough.	1
	11	Brightness	Surfaces dull, dark or stained. Gen. not bright.	1
	12	Consolidation of Particles	Assorted sizes tightly packed or overlapping.	2
	13	Bottom Size Distribution	No size change evident. Stable mater. 80-100%	4
	14	Scouring and Deposition	<5% of bottom affected by scour or deposition.	6
	15	Aquatic Vegetation	Abundant Growth moss-like, dark green perennial. In swift water too.	1
			TOTAL	

		Category	GOOD	
UPPER BANKS	1	Landform Slope	Bank Slope Gradient 30-40%	4
	2	Mass Wasting	Infrequent. Mostly healed over. Low future potential.	6
	3	Debris Jam Potential	Present, but mostly small twigs and limbs.	4
	4	Vegetative Bank Protection	70-90% density. Fewer species or less vigor suggest less dense or deep root mass.	6
LOWER BANKS	5	Channel Capacity	Adequate. Bank overflows rare. W/D ratio 8-15	2
	6	Bank Rock Content	40-65%. Mostly small boulders to cobbles 6-12"	4
	7	Obstructions to Flow	Some present causing erosive cross currents and minor pool filling. Obstructions newer and less firm.	4
	8	Cutting	Some, intermittently at outcurves and constrictions. Raw banks may be up to 12"	6
	9	Deposition	Some new bar increase, mostly from coarse gravel.	8
BOTTOM	10	Rock Angularity	Rounded corners and edges, surfaces smooth, flat.	2
	11	Brightness	Mostly dull, but may have <35% bright surfaces.	2
	12	Consolidation of Particles	Moderately packed with some overlapping.	4
	13	Bottom Size Distribution	Distribution shift light. Stable material 50-80%.	8
	14	Scouring and Deposition	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	12
	15	Aquatic Vegetation	Common. Algae forms in low velocity and pool areas. Moss here too.	2
			TOTAL	

		Category	FAIR	
UPPER BANKS	1	Landform Slope	Bank slope gradient 40-60%	6
	2	Mass Wasting	Frequent or large, causing sediment nearly year long.	9
	3	Debris Jam Potential	Moderate to heavy amounts, mostly larger sizes.	6
	4	Vegetative Bank Protection	<50-70% density. Lower vigor and fewer species from a shallow, discontinuous root mass.	9
LOWER BANKS	5	Channel Capacity	Barely contains present peaks. Occasional overbank floods. W/D ratio 15 to 25.	3
	6	Bank Rock Content	20-40% with most in the 3-6" diameter class.	6
	7	Obstructions to Flow	Moder. frequent, unstable obstructions move with high flows causing bank cutting and pool filling.	6
	8	Cutting	Significant. Cuts 12-24" high. Root mat overhangs and sloughing evident	12
	9	Deposition	Moder. deposition of new gravel and course sand on old and some new bars.	12
BOTTOM	10	Rock Angularity	Corners and edges well rounded in two dimensions.	3
	11	Brightness	Mixture dull and bright, ie 35-65% mixture range.	3
	12	Consolidation of Particles	Mostly loose assortment with no apparent overlap.	6
	13	Bottom Size Distribution	Moder. change in sizes. Stable materials 20-50%	12
	14	Scouring and Deposition	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	18
	15	Aquatic Vegetation	Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick.	3
			TOTAL	

Source: Rosgen 1996, Copyright Wildland Hydrology, Pagosa, CO

Figure 16. Rosgen (1996) Level III Stream Channel Classification ~ *Continued.*

CHANNEL STABILITY (PFANKUCH) EVALUATION AND STREAM CLASSIFICATION SUMMARY (LEVEL III)

	Category	POOR	
UPPER BANKS	1 Landform Slope	Bank Slope Gradient 60%+	8
	2 Mass Wasting	Frequent or large causing sediment nearly year long or imminent danger of same.	12
	3 Debris Jam Potential	Moder. to heavy amounts, predom. larger sizes.	8
	4 Vegetative Bank Protection	<50% density, fewer species and less vigor indicate poor, discontinuous and shallow root mass.	12
LOWER BANKS	5 Channel Capacity	Inadequate. Overbank flows common. W/D ratio >25	4
	6 Bank Rock Content	<20% rock fragments of gravel sizes, 1-3" or less.	8
	7 Obstructions to Flow	Sediment traps full, channel migration occurring.	
	8 Cutting	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16
	9 Deposition	Extensive deposits of predom. fine particles. Accelerated bar development.	16
BOTTOM	10 Rock Angularity	Well rounded in all dimensions, surfaces smooth.	4
	11 Brightness	Predom. bright, 65%+ exposed or scoured surfaces.	4
	12 Consolidation of Particles	No packing evident. Loose assortment easily moved.	8
	13 Bottom Size Distribution	Marked distribution change. Stable materials 0-20%.	16
	14 Scouring and Deposition	More than 50% of the bottom in a state of flux or change nearly year long.	24
	15 Aquatic Vegetation	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	4
		TOTAL	

Stream Width ________ x avg. depth ________ x mean velocity ________ = Q ________ cfs

Gauge Ht ________ Reach Gradient ________ Stream Order ________ Sinuosity Ratio ________

Width bkf ________ Depth bkf ________ W/D Ratio ________ Discharge (Q_{bkf}) ________

Drainage Area ________ Valley Gradient ________ Stream Length ________ Valley Length ________

Sinuosity ________ Entrenchment Ratio ________ Length Meander (Lm) ________ Belt Width ________

Sediment Supply
Extreme ________
Very High ________
High ________
Moderate ________
Low ________

Stream Bed Stability
Aggrading ________
Degrading ________
Stable ________

Width/Depth Ratio Condition
Normal ________
High ________
Very High ________

[ ] Stream Type

TOTAL SCORE for Reach E____ = G____ + F____ + P____ =

[ ] Pfankuch Rating

Remarks ____

from table [ ] Reach Condition

CONVERSION OF STABILITY RATING TO REACH CONDITION BY STREAM TYPE*

Stream Type	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6
GOOD	38-43	38-43	54-90	60-95	60-95	50-80	38-45	38-45	40-60	40-64	48-68	40-60
FAIR	44-47	44-47	91-129	96-132	96-142	81-110	46-58	46-58	61-78	65-84	69-88	61-78
POOR	48+	48+	130+	133+	143+	111+	59+	59+	79+	85+	89+	79+

Stream Type	C1	C2	C3	C4	C5	C6	D3	D4	D5	D6
GOOD	38-50	38-50	60-85	70-90	70-90	60-85	85-107	85-107	85-107	67-98
FAIR	51-61	51-61	86-105	91-110	91-110	86-105	108-132	108-132	108-132	99-125
POOR	62+	62+	106+	111+	111+	106+	133+	133+	133+	126+

Stream Type	DA3	DA4	DA5	DA6	E3	E4	E5	E6
GOOD	40-63	40-63	40-63	40-63	40-63	50-75	50-75	40-63
FAIR	64-86	64-86	64-86	64-86	64-86	76-96	76-96	64-86
POOR	87+	87+	87+	87+	87+	97+	97+	87+

Stream Type	F1	F2	F3	F4	F5	F6	G1	G2	G3	G4	G5	G6
GOOD	60-85	60-85	85-110	85-110	90-115	80-95	40-60	40-60	85-107	85-107	90-112	85-107
FAIR	86-105	86-105	111-125	111-125	116-130	96-110	61-78	61-78	108-120	108-120	113-125	108-120
POOR	106+	106+	126+	126+	131+	111+	79+	79+	121+	121+	126+	121+

**Generalized relations ... need additional Level IV data to expand data base for validation.*

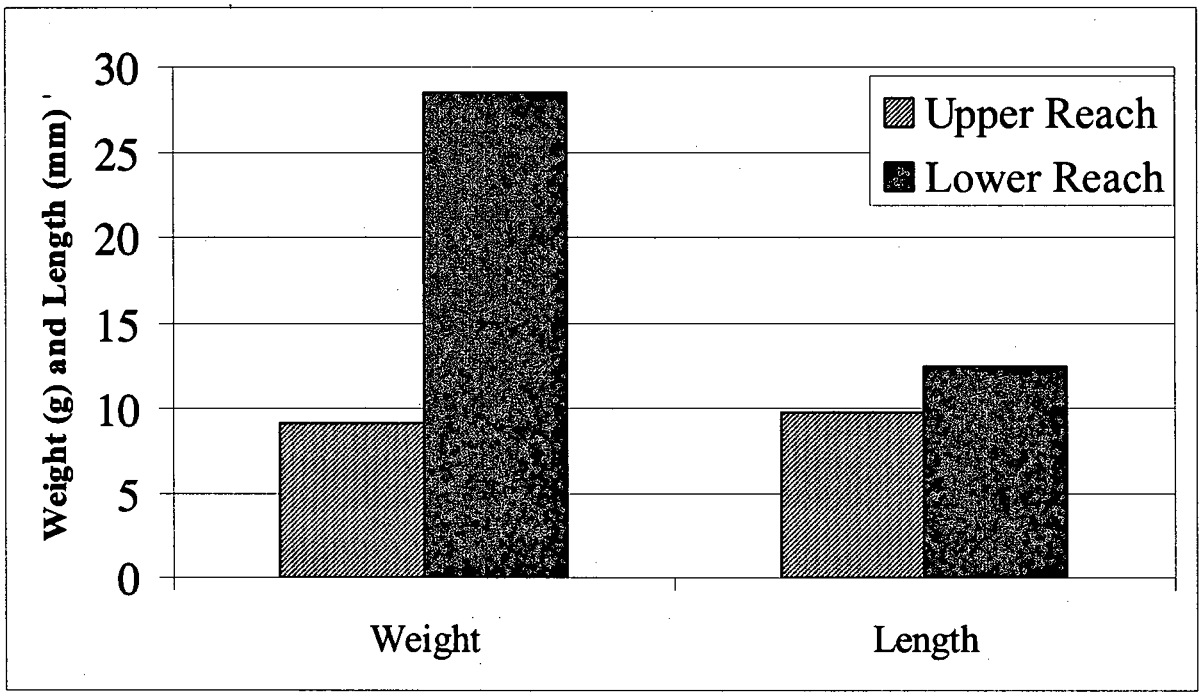


Figure 17. Mean Weight and Length of Trout Captured in Los Alamos Canyon During October 1997.

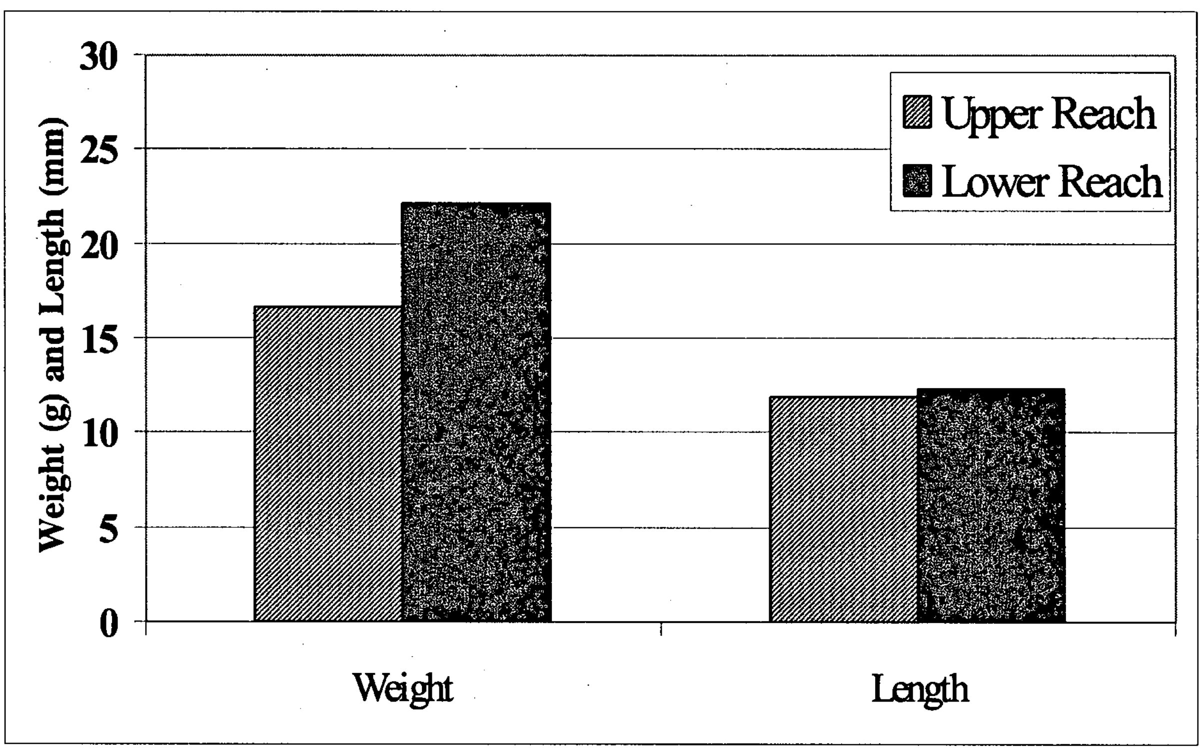


Figure 18. Mean Weight and Length of Trout Captured in Los Alamos Canyon during December 1998.

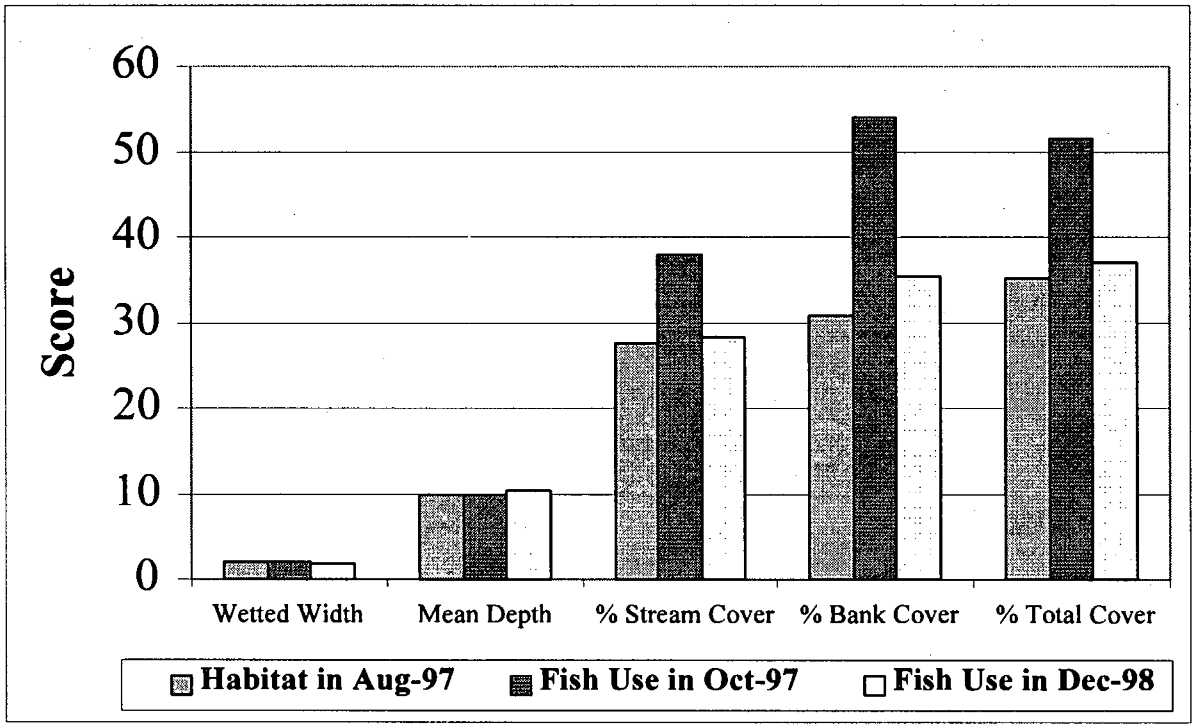


Figure 19. Comparative Values for Various Habitat Parameters Corresponding to Locations Where Fish were Captured (October 1997 and December 1998) Versus Randomized Habitat Quantification (August 1997) in Los Alamos Canyon.

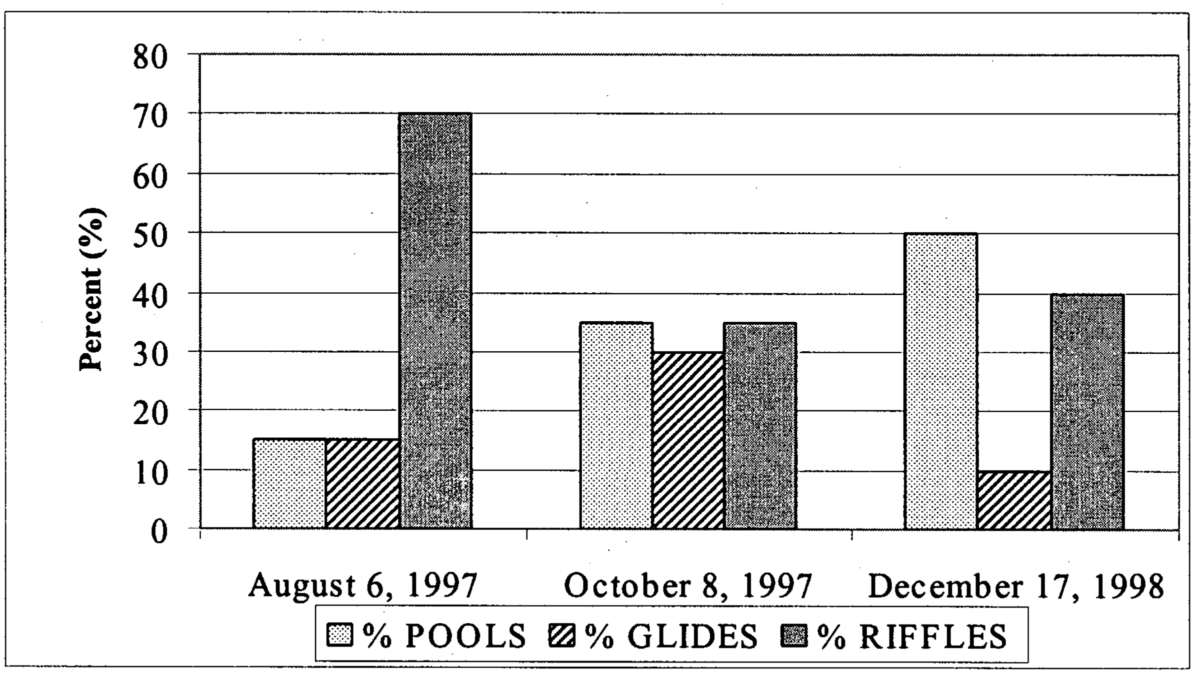


Figure 20. Comparative Habitat Type Percentages Corresponding to Locations Where Fish Were Captured (October 1997 and December 1998)Versus Randomized Habitat Quantification (August 1997) in Los Alamos Canyon.

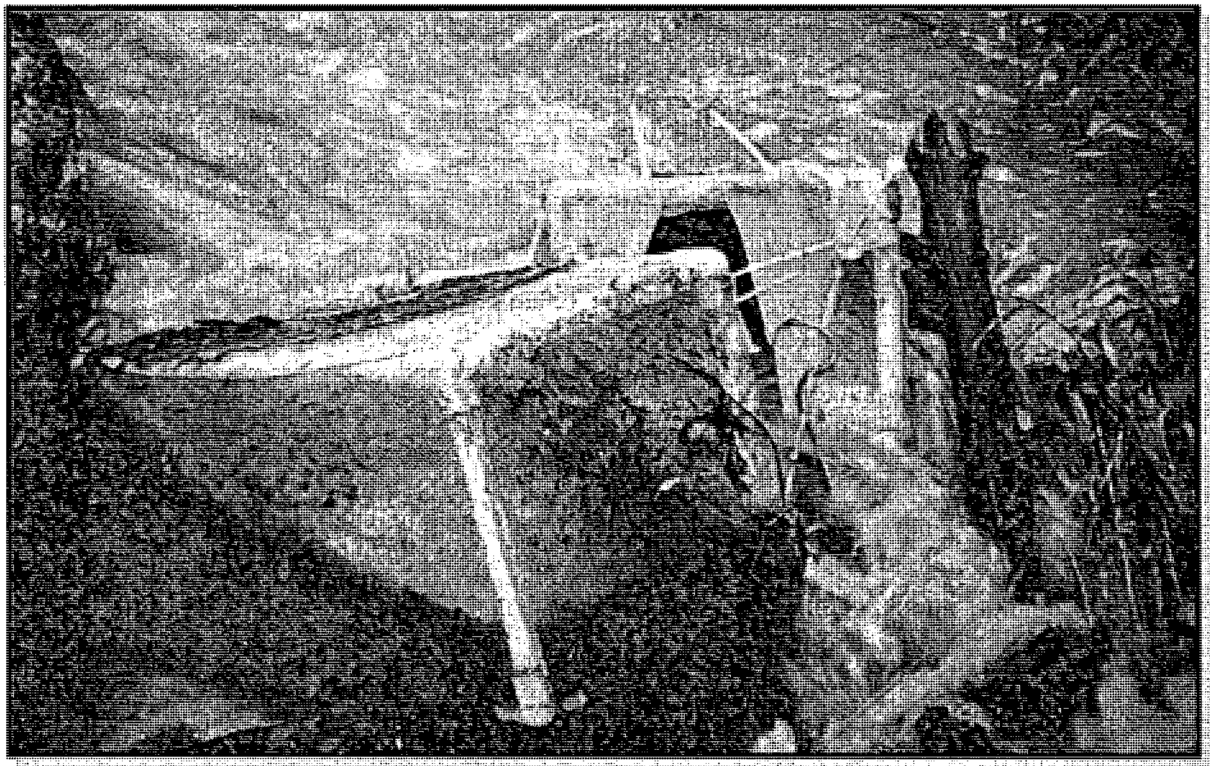


Figure 21. August Floods Affecting *In Situ,* Caged-Fish Bioassays in Sandia Canyon.

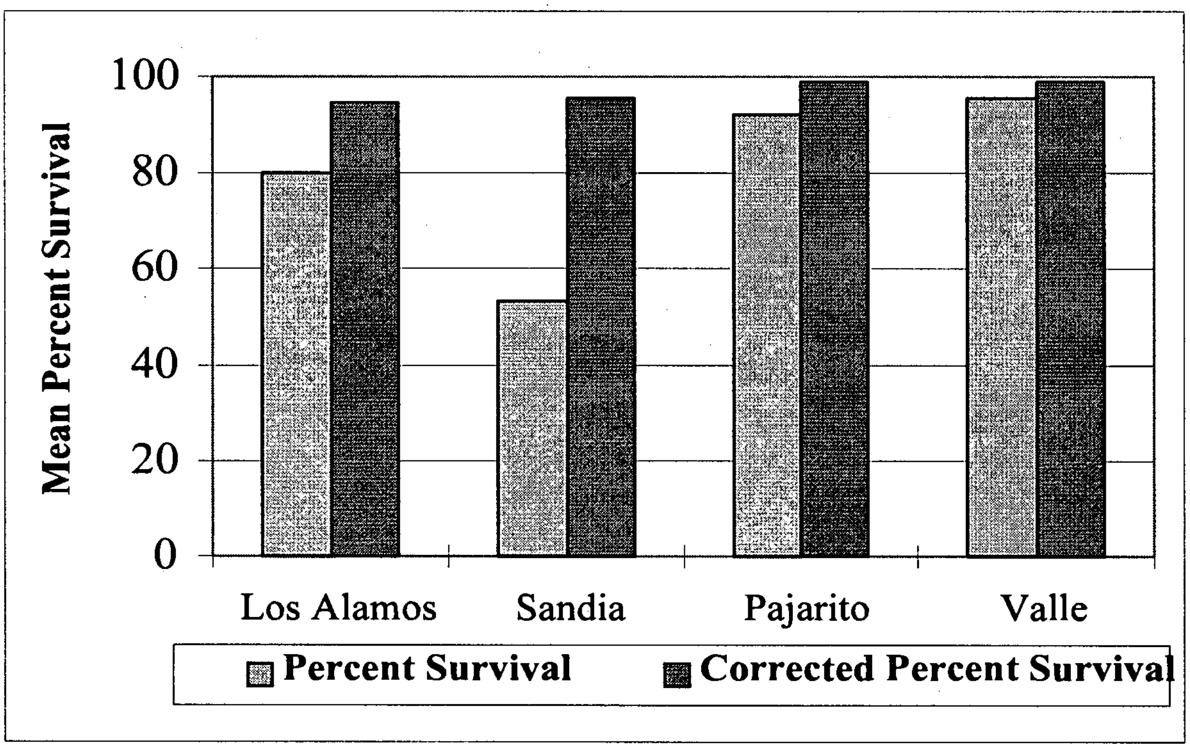


Figure 22. Percent Mortality During the 96-Hour, Caged-Fish Bioassay and Corrected for Mortality Attributed to Floods or Escaped Fish.

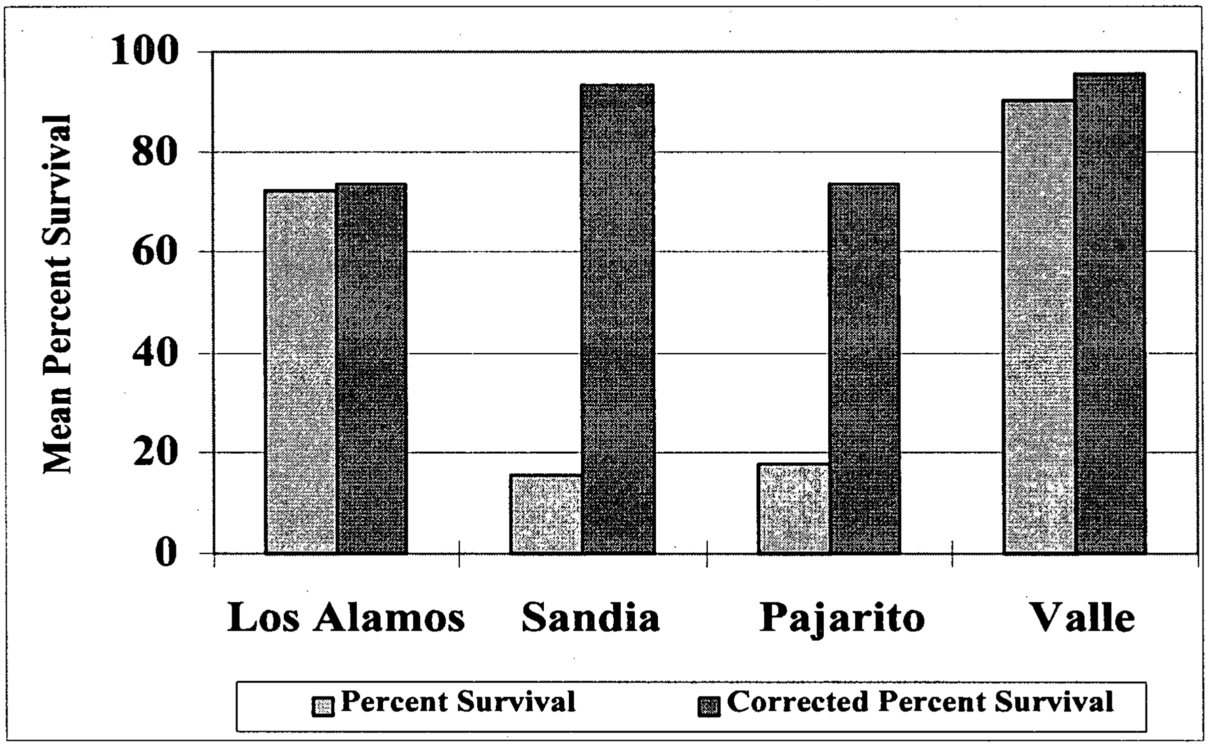


Figure 23. Percent Mortality During the 2-Month, Caged-Fish Bioassay and Corrected for Mortality Attributed to Floods, Vandalism, or Escaped Fish.

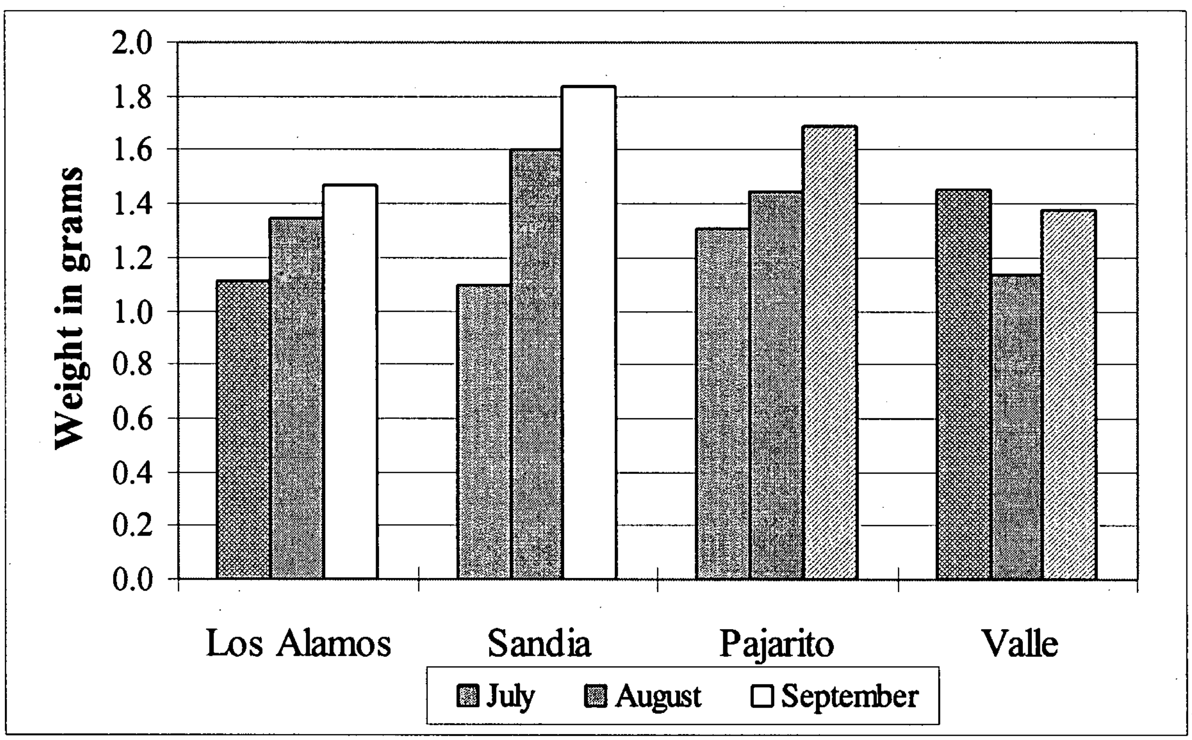


Figure 24. Average Weight Gain of Caged Fish During Two Months Exposure to Canyon Stream Segments.

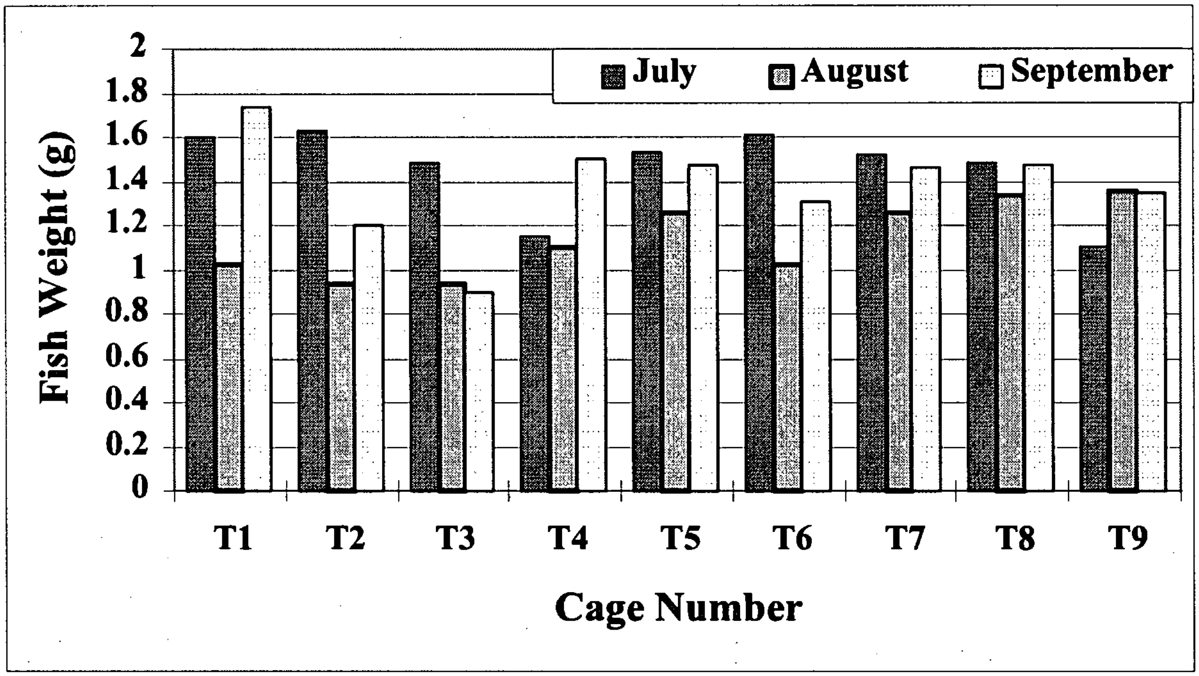


Figure 25. Average Weight Gain of Caged Fish, in Each Cage, During 2-Month Exposure to the Valle Canyon Stream Segment.

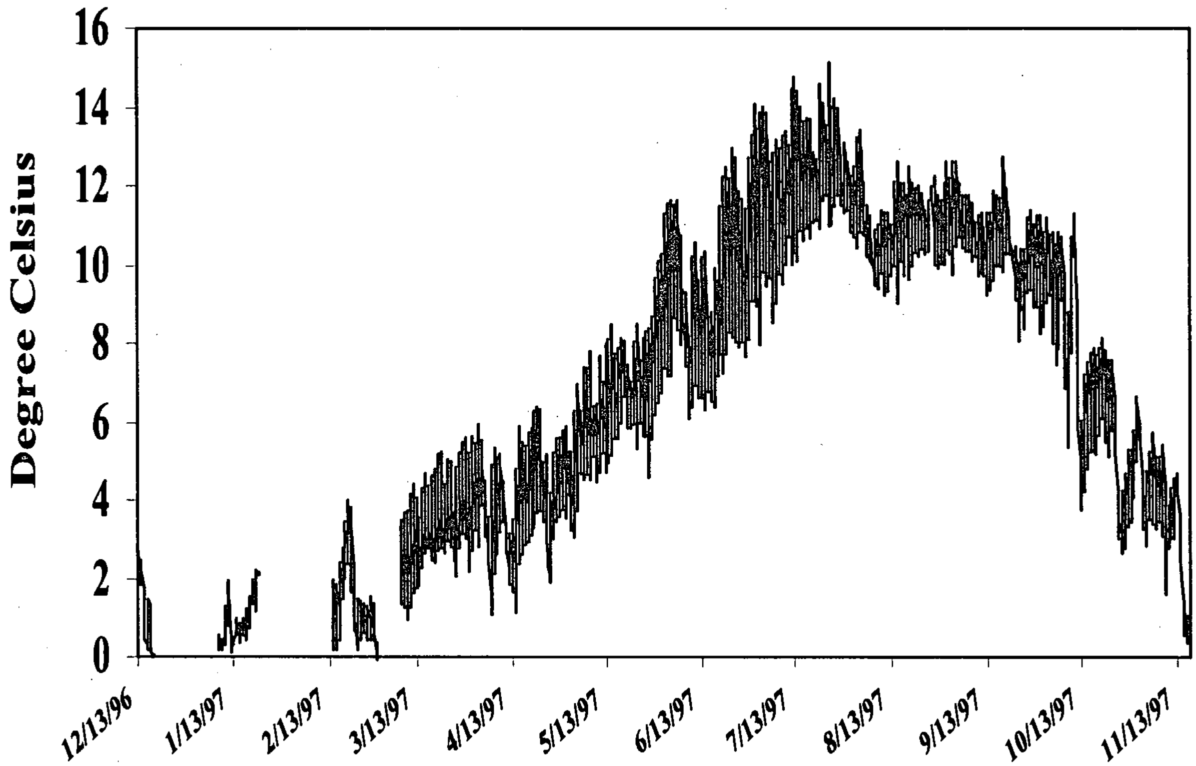


Figure 26. Water Temperature (°C) in the Los Alamos Canyon Stream Segment, 1996-1997.

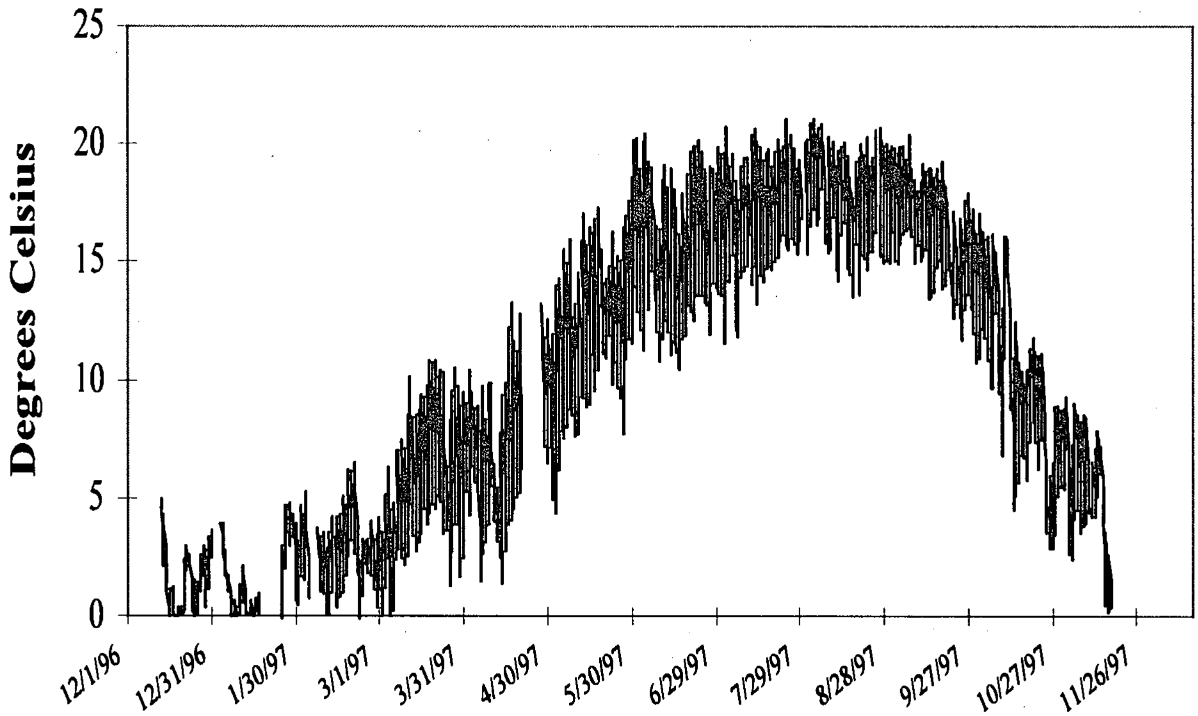


Figure 27. Water Temperature (°C) in the Sandia Canyon Stream Segment, 1996-1997.

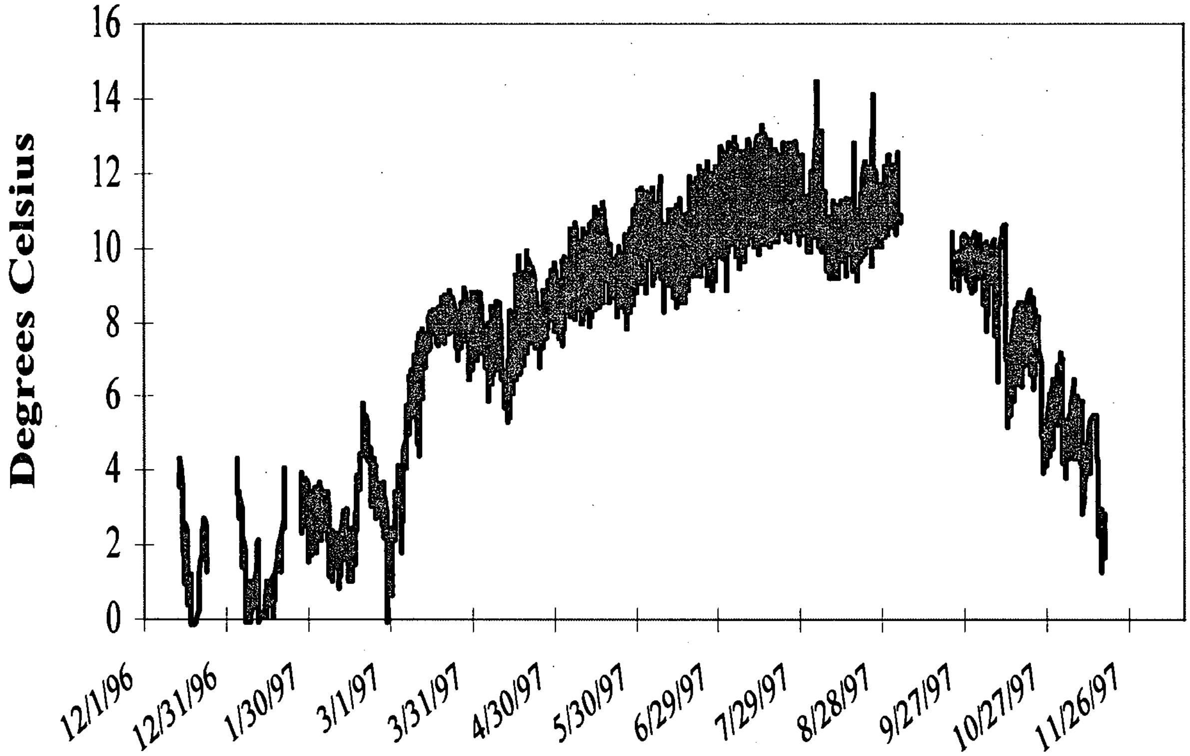


Figure 28. Water Temperature (°C) in the Pajarito Canyon Stream Segment, 1996-1997.

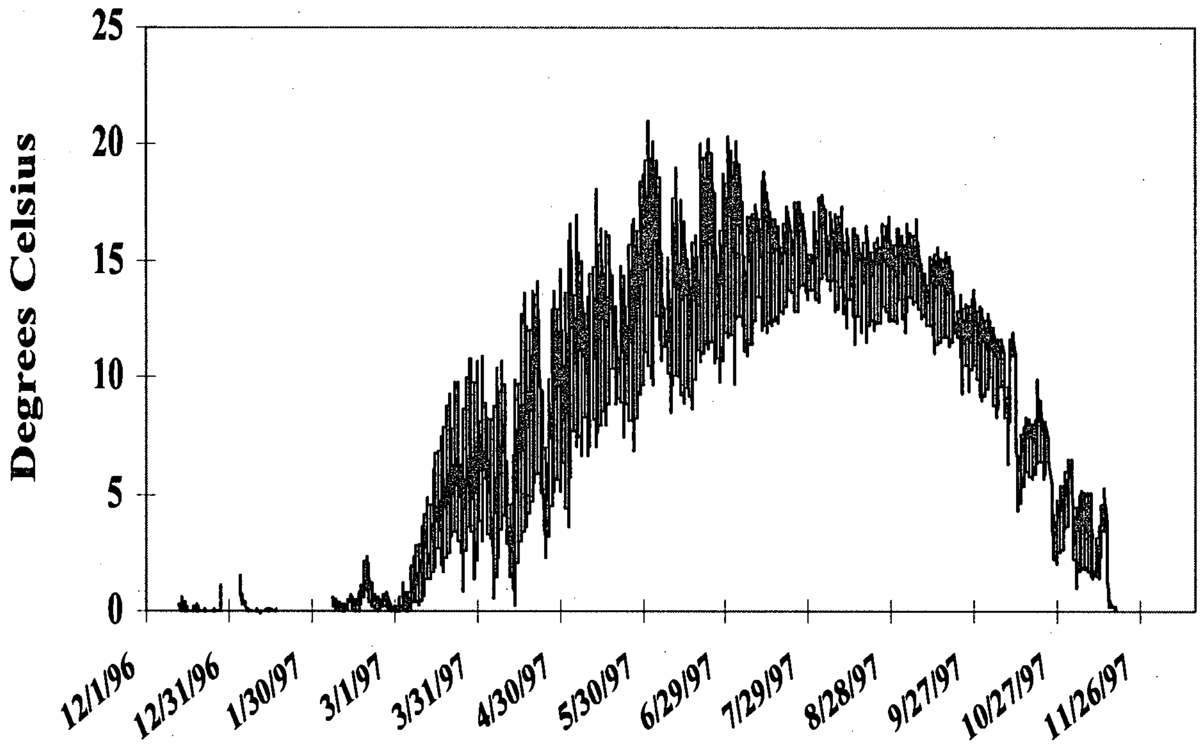


Figure 29. Water Temperature (°C) in the Valle Canyon Stream Segment, 1996-1997.

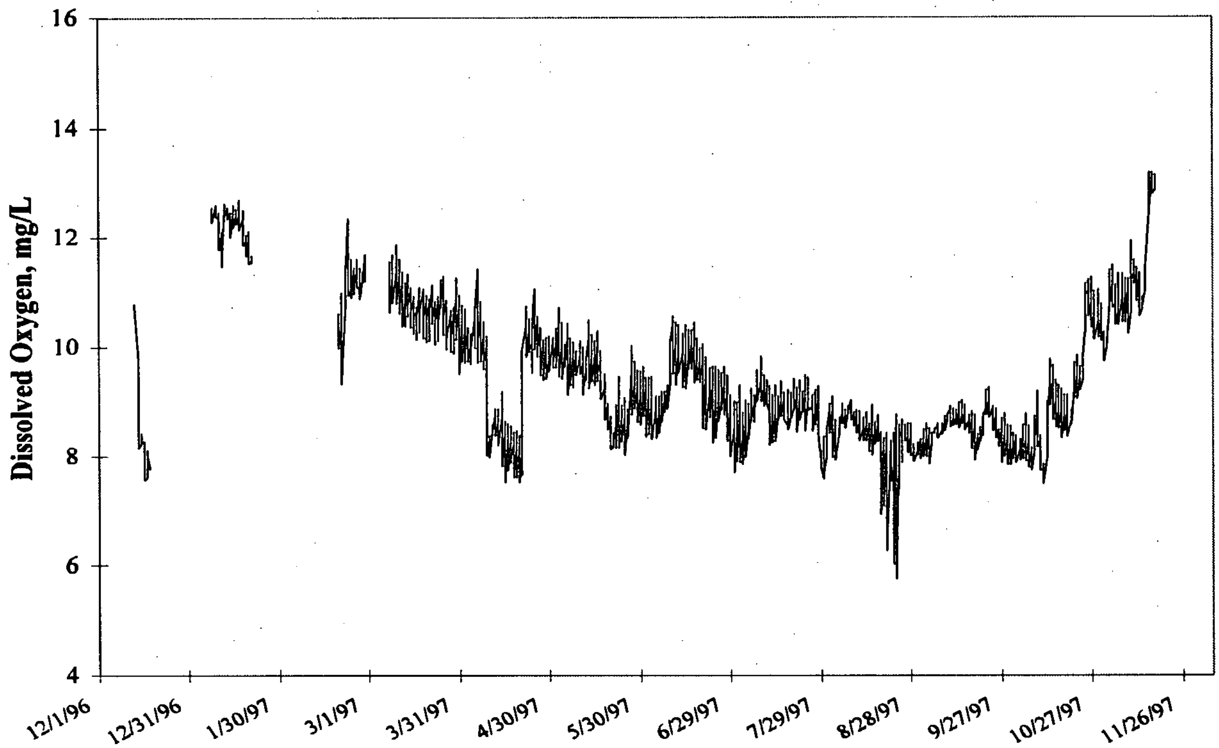


Figure 30. Dissolved Oxygen (mg/L) in the Los Alamos Canyon Stream Segment, 1996-1997.

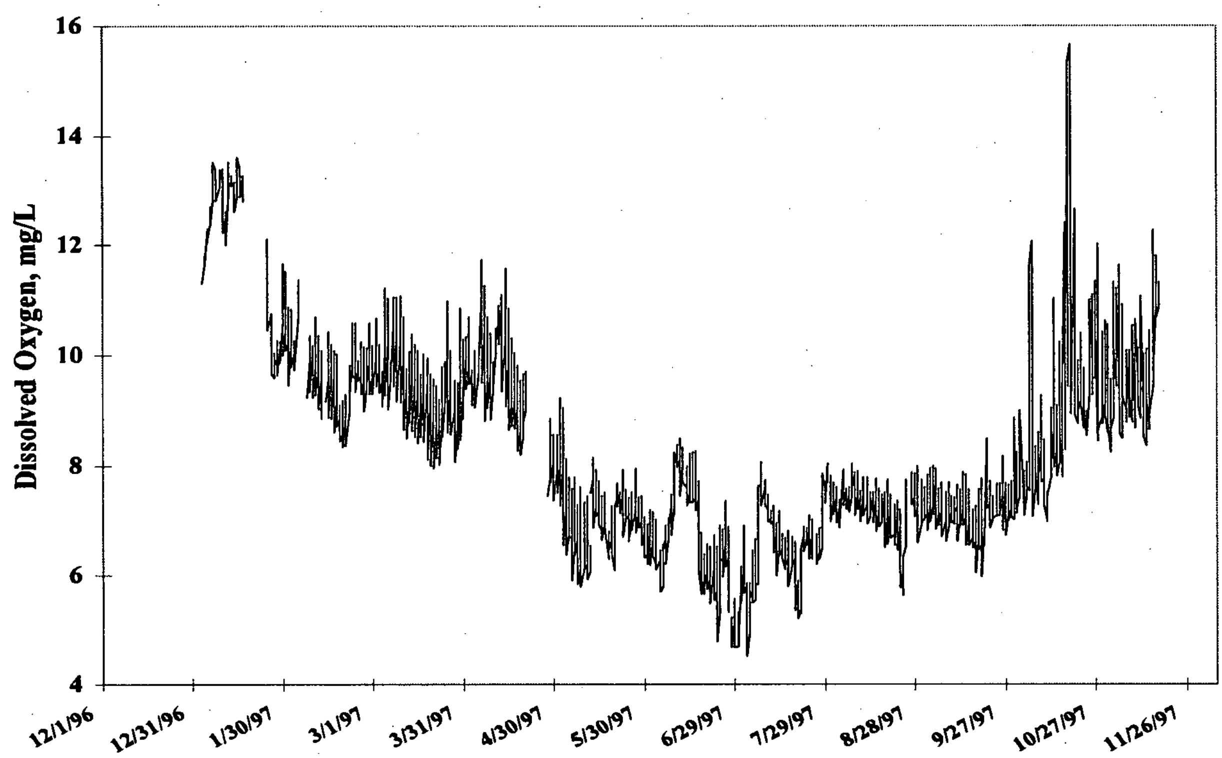


Figure 31. Dissolved Oxygen (mg/L) in the Sandia Canyon Stream Segment, 1996.1997.

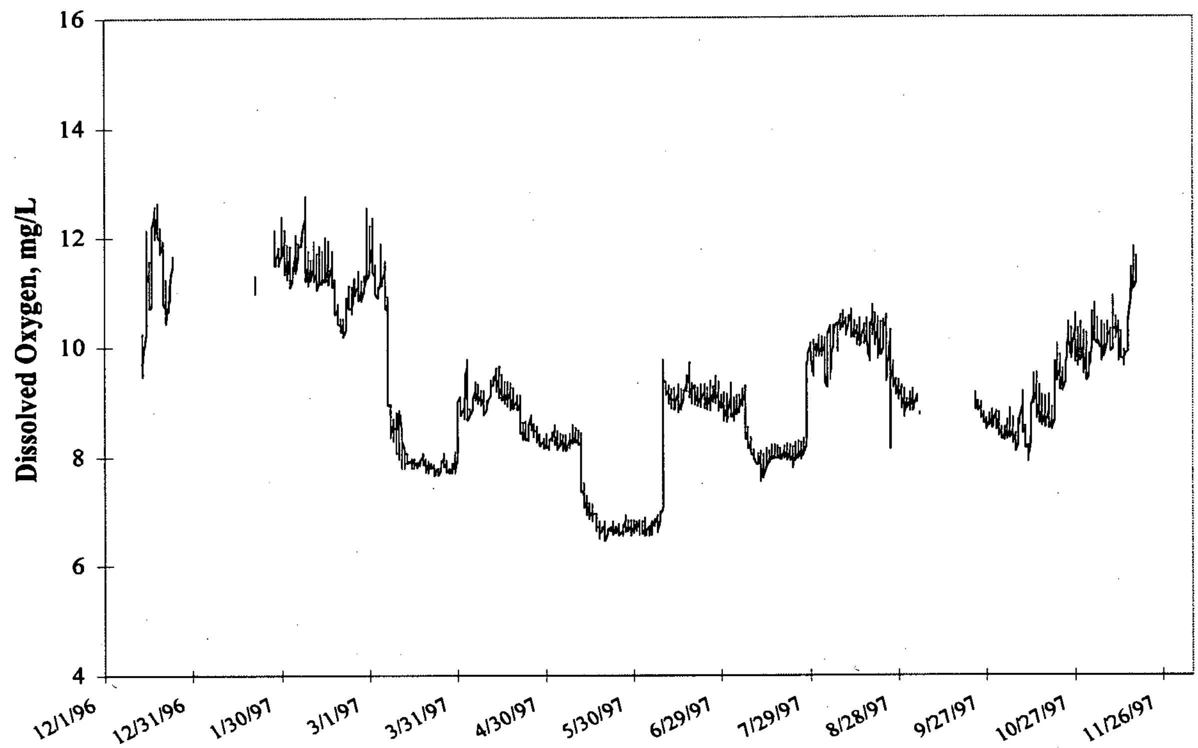


Figure 32. Dissolved Oxygen (mg/L) in the Pajarito Canyon Stream Segment, 1996-1997.

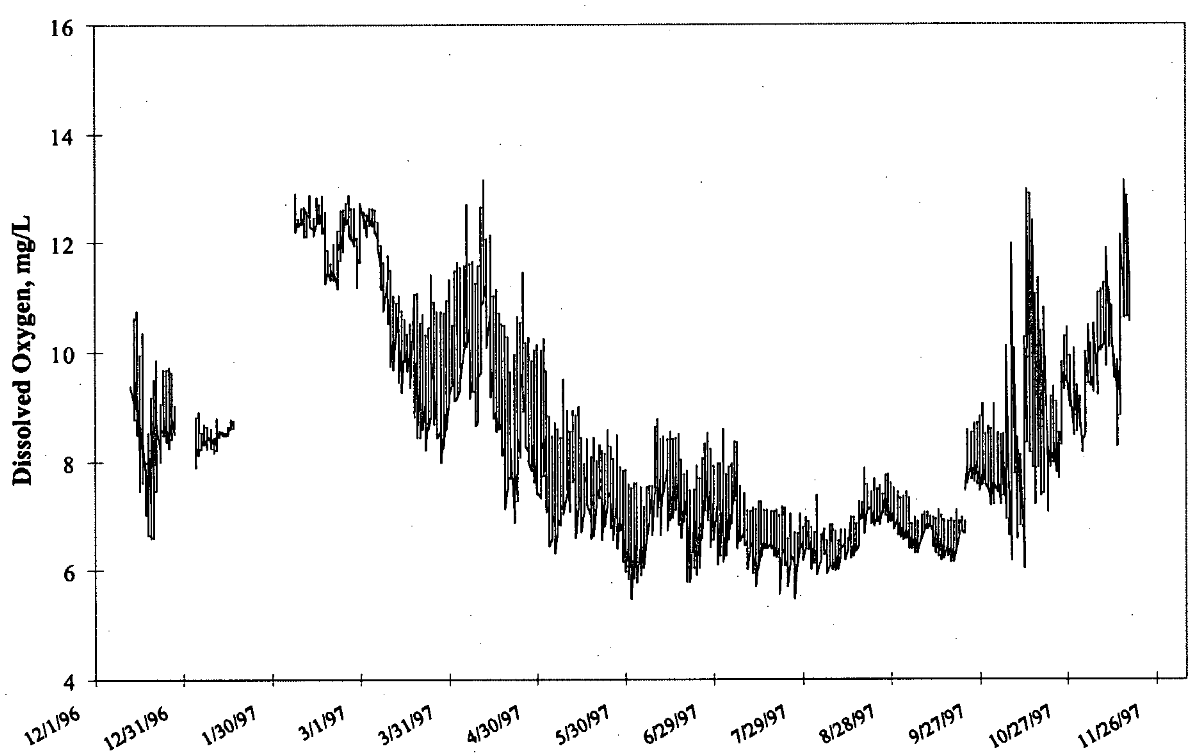


Figure 33. Dissolved Oxygen (mg/L) in the Valle Canyon Stream Segment, 1996-1997.

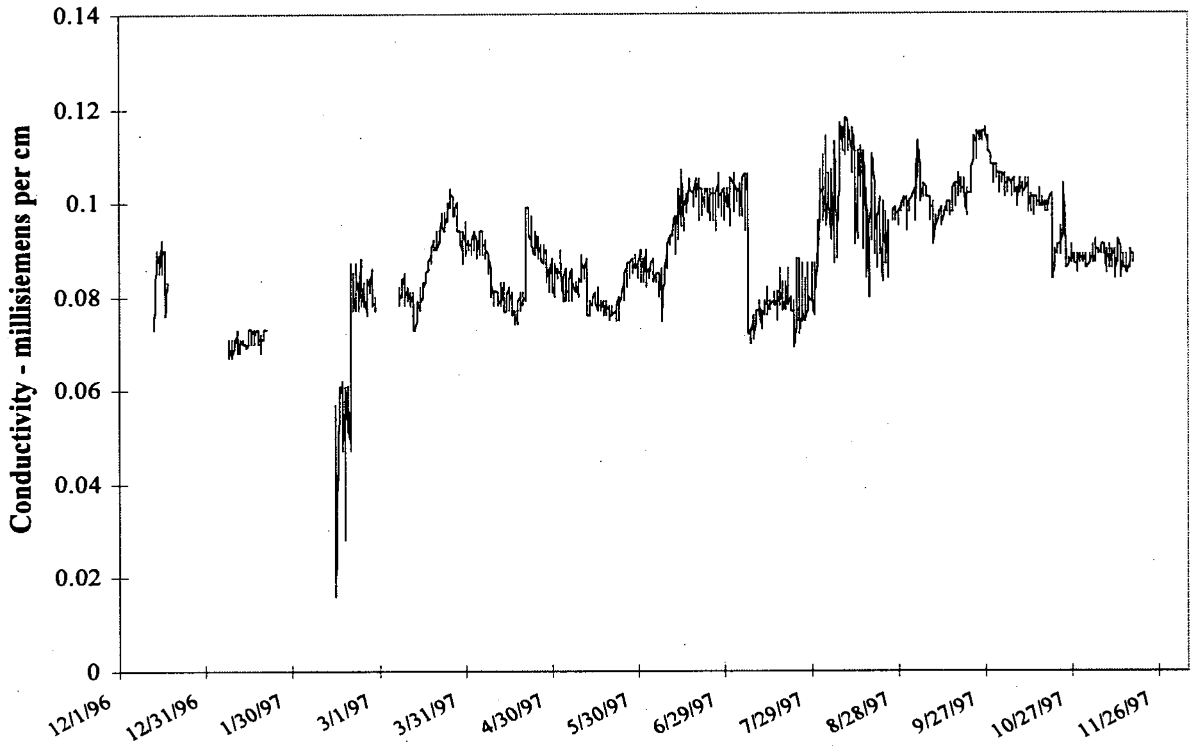


Figure 34. Conductivity (mS/cm) in the Los Alamos Canyon Stream Segment, 1996-1997.

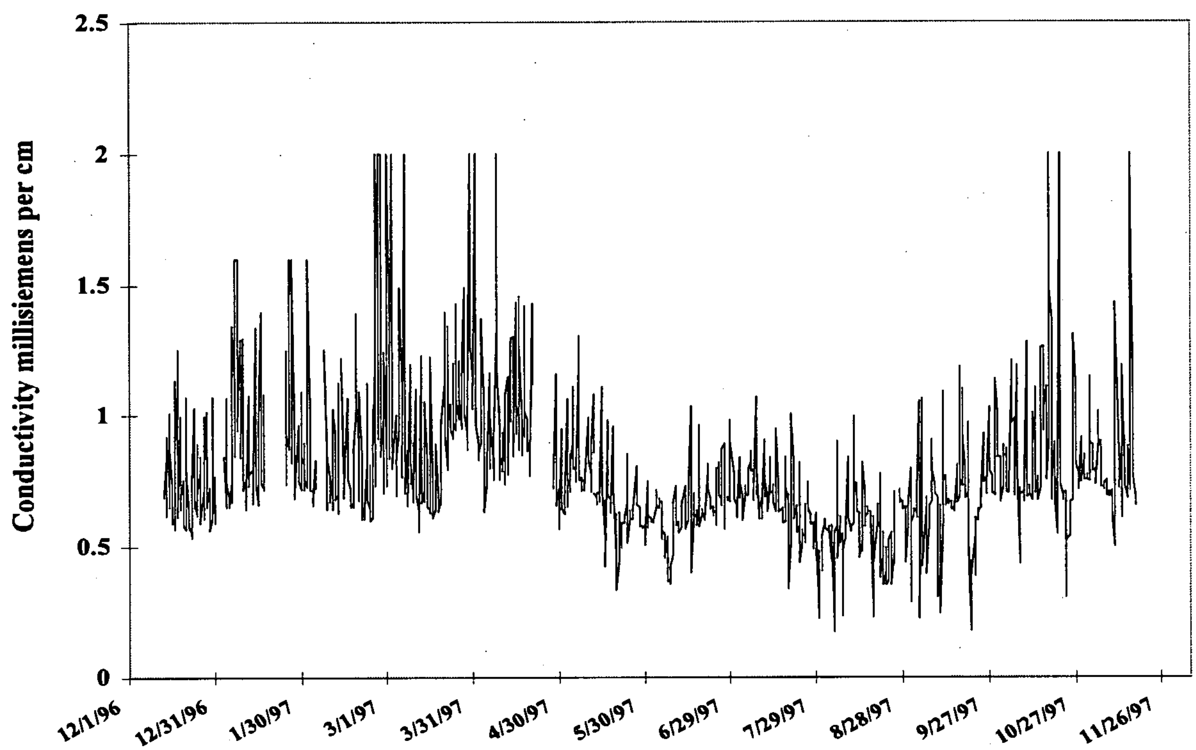


Figure 35. Conductivity (mS/cm) in the Sandia Canyon Stream Segment, 1996-1997.

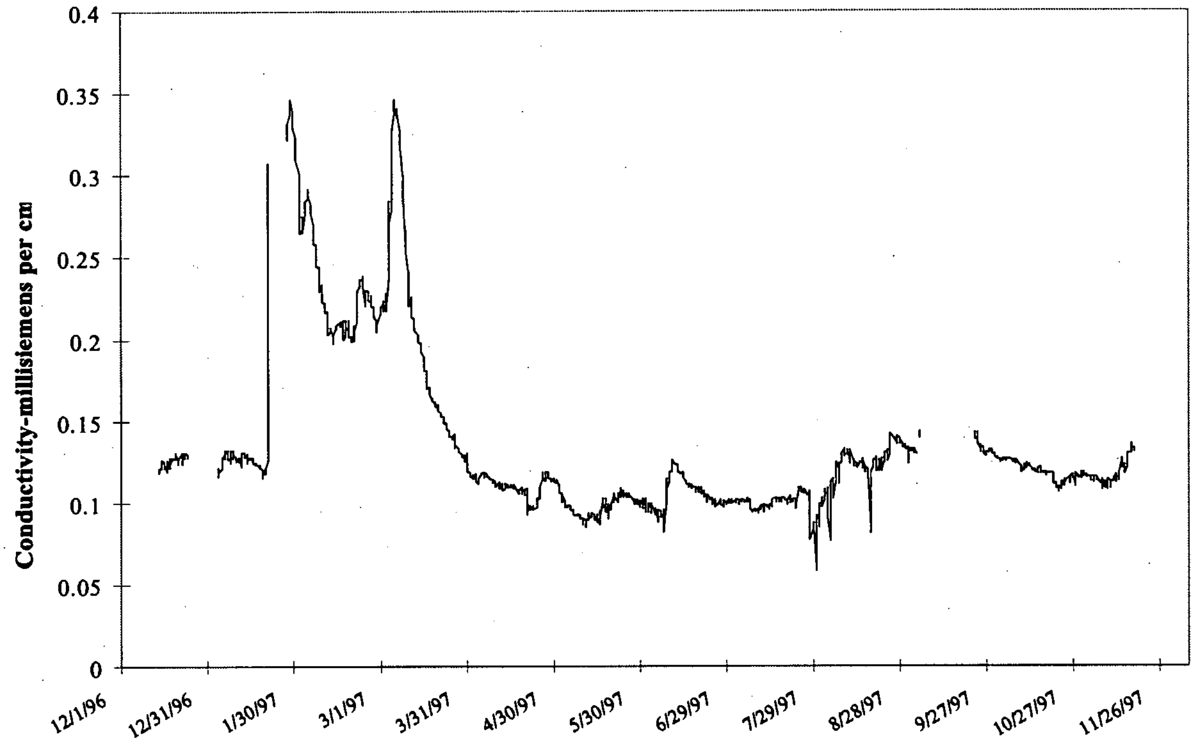


Figure 36. Conductivity (mS/cm) in the Pajarito Canyon Stream Segment, 1996-1997.

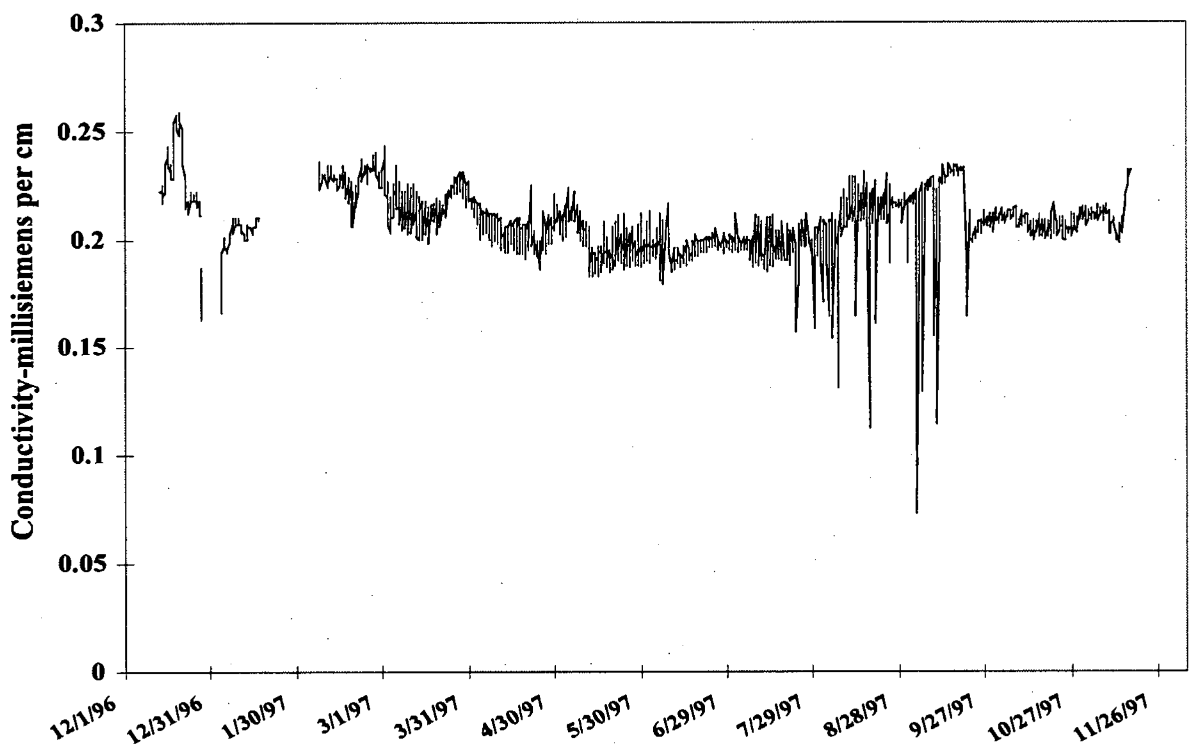


Figure 37. Conductivity (mS/cm) in the Valle Canyon Stream Segment, 1996-1997.

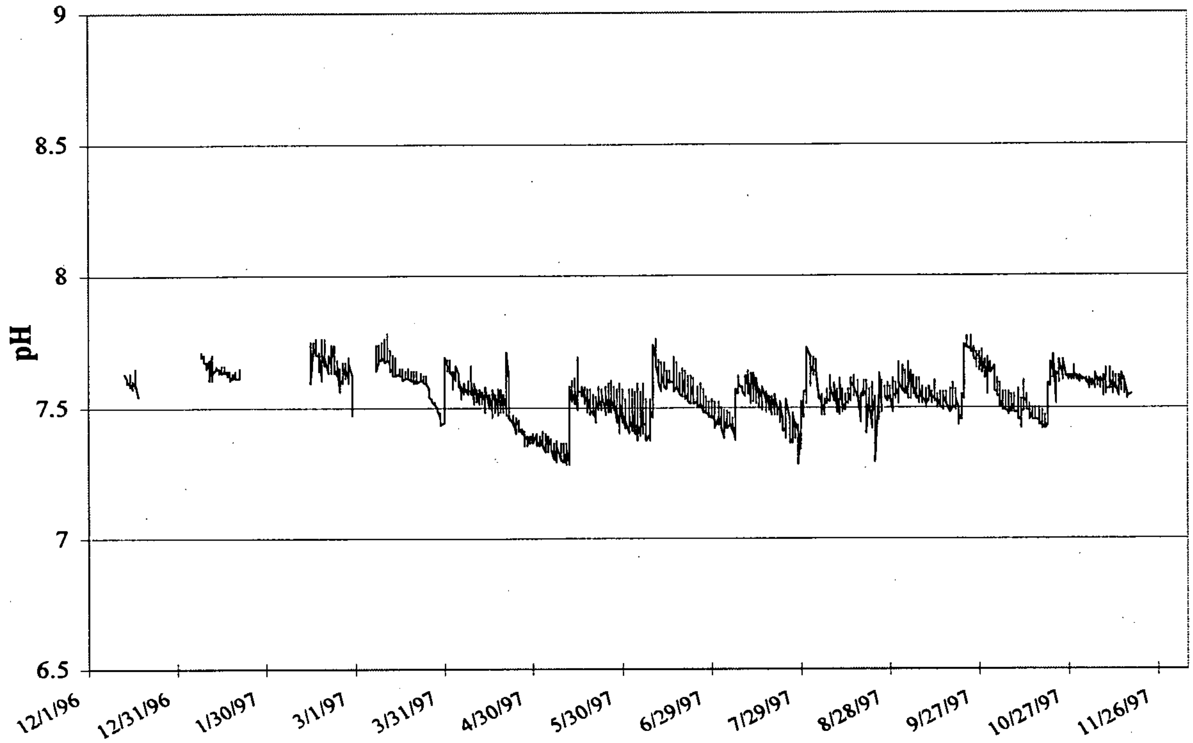


Figure 38. The pH in the Los Alamos Canyon Stream Segment, 1996-1997.

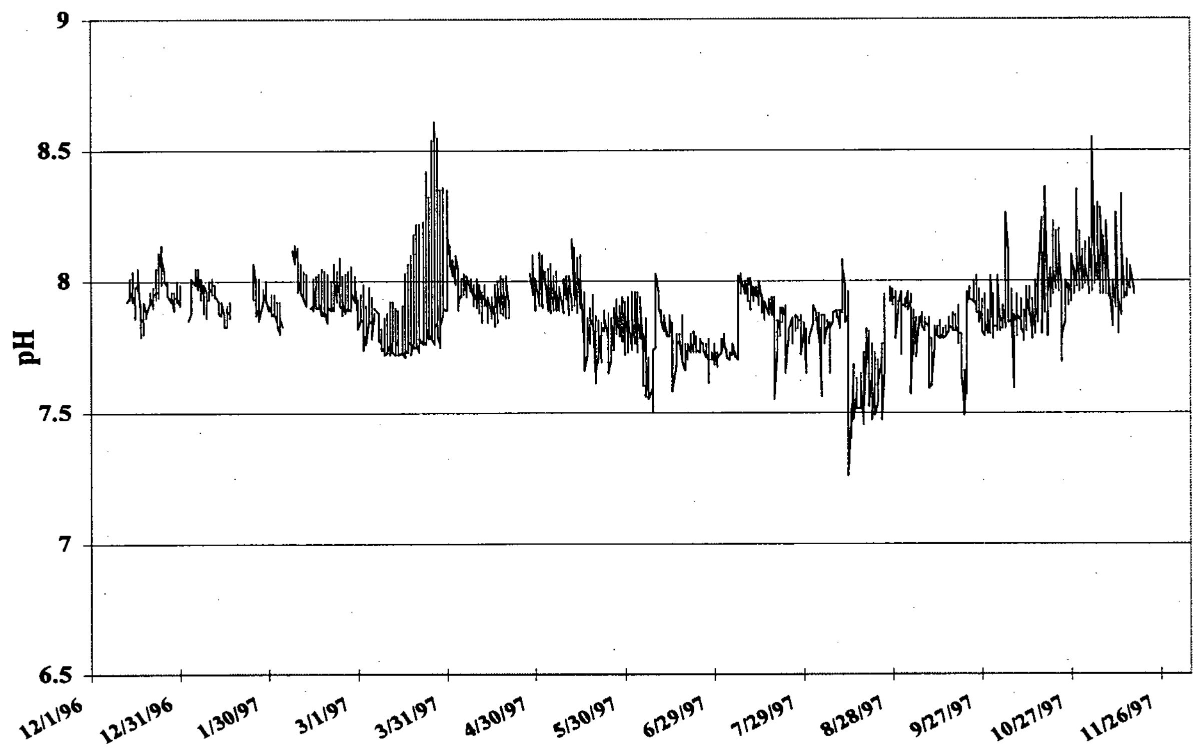


Figure 39. The pH in the Sandia Canyon Stream Segment, 1996-1997.

205

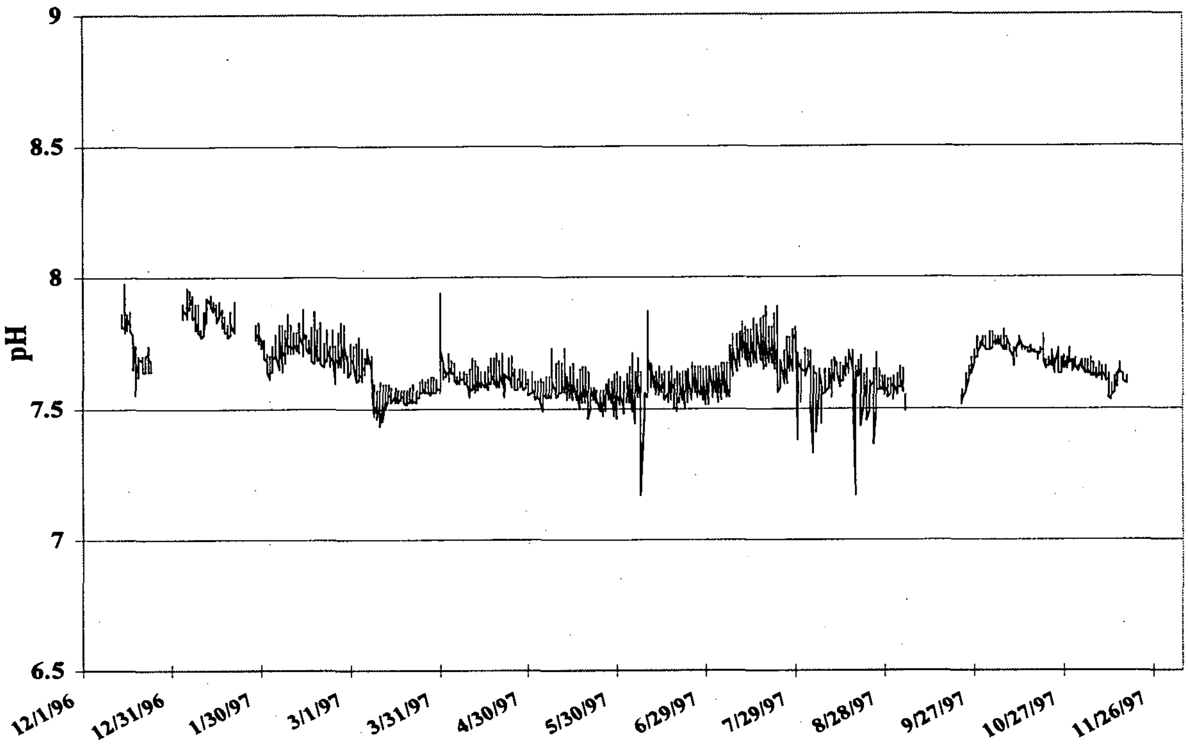


Figure 40. The pH in the Pajarito Canyon Stream Segment, 1996-1997.

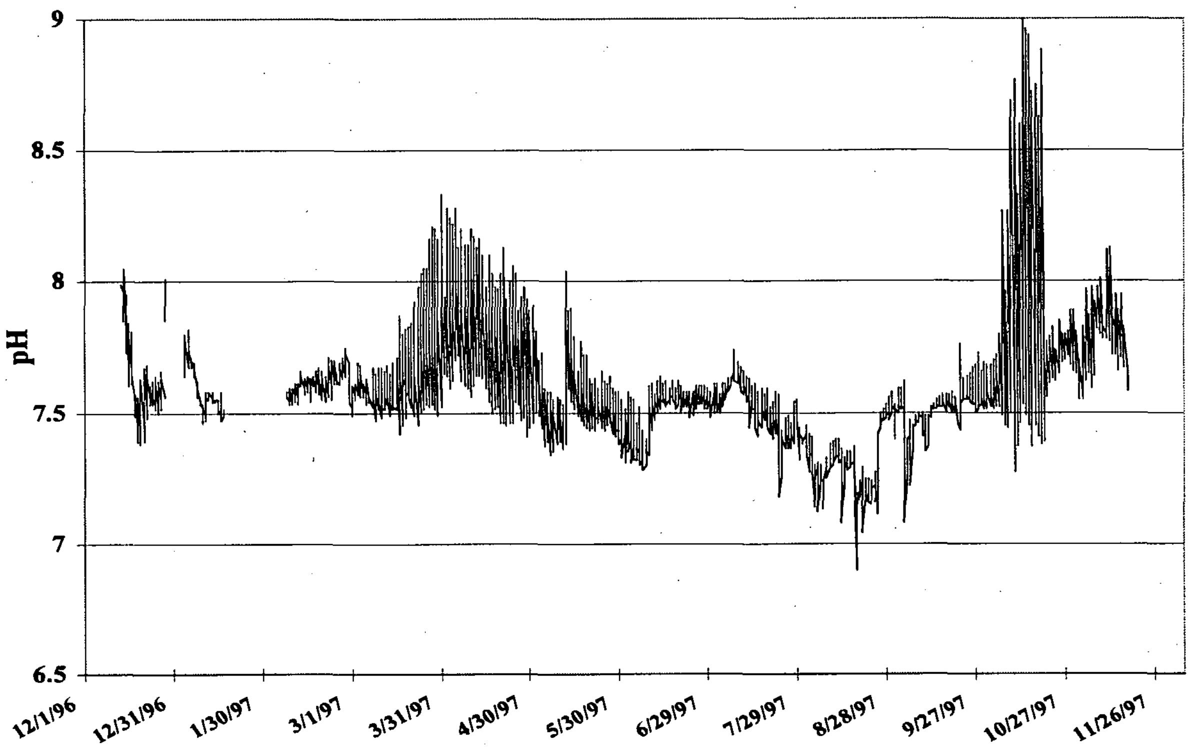
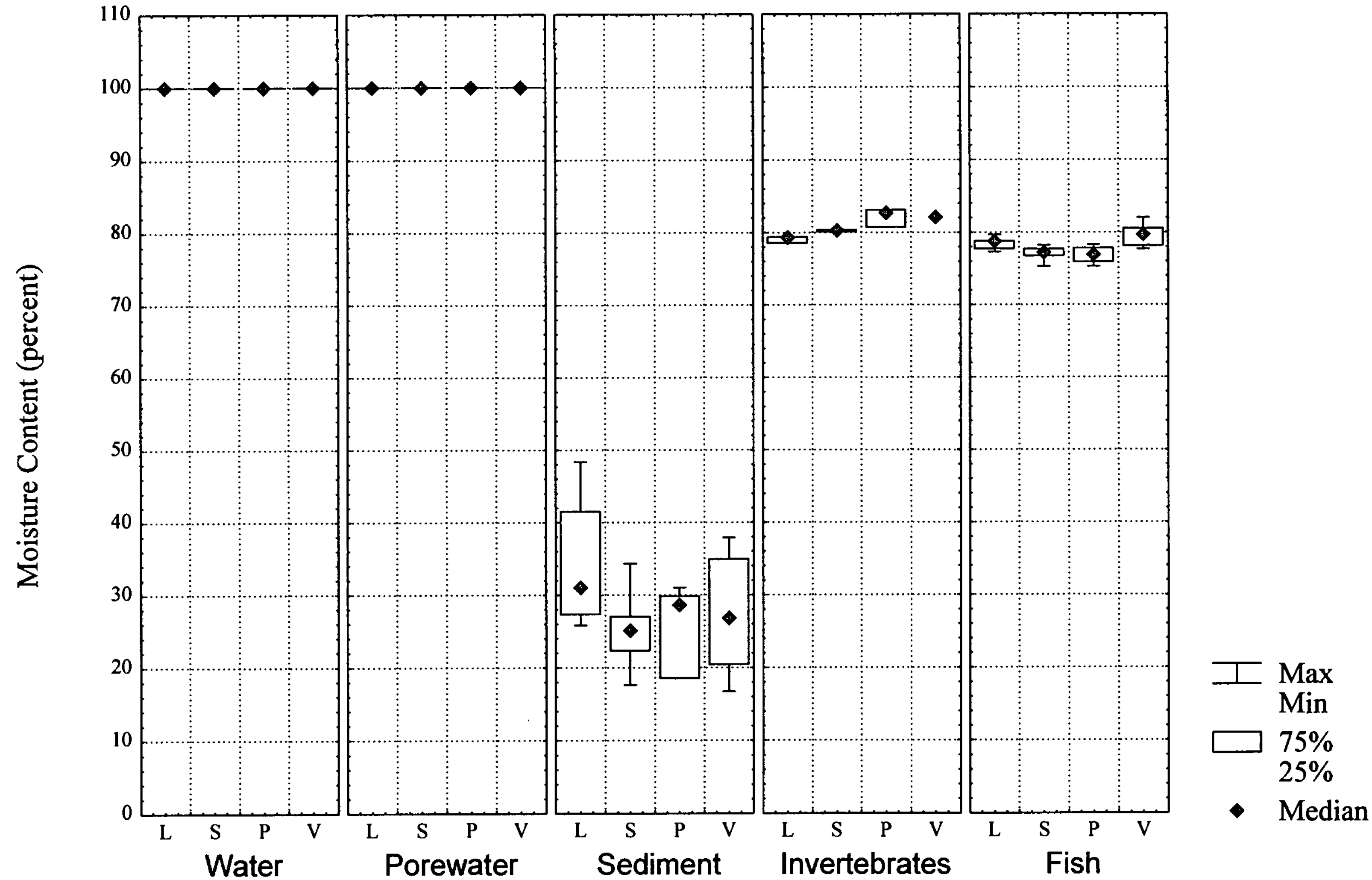


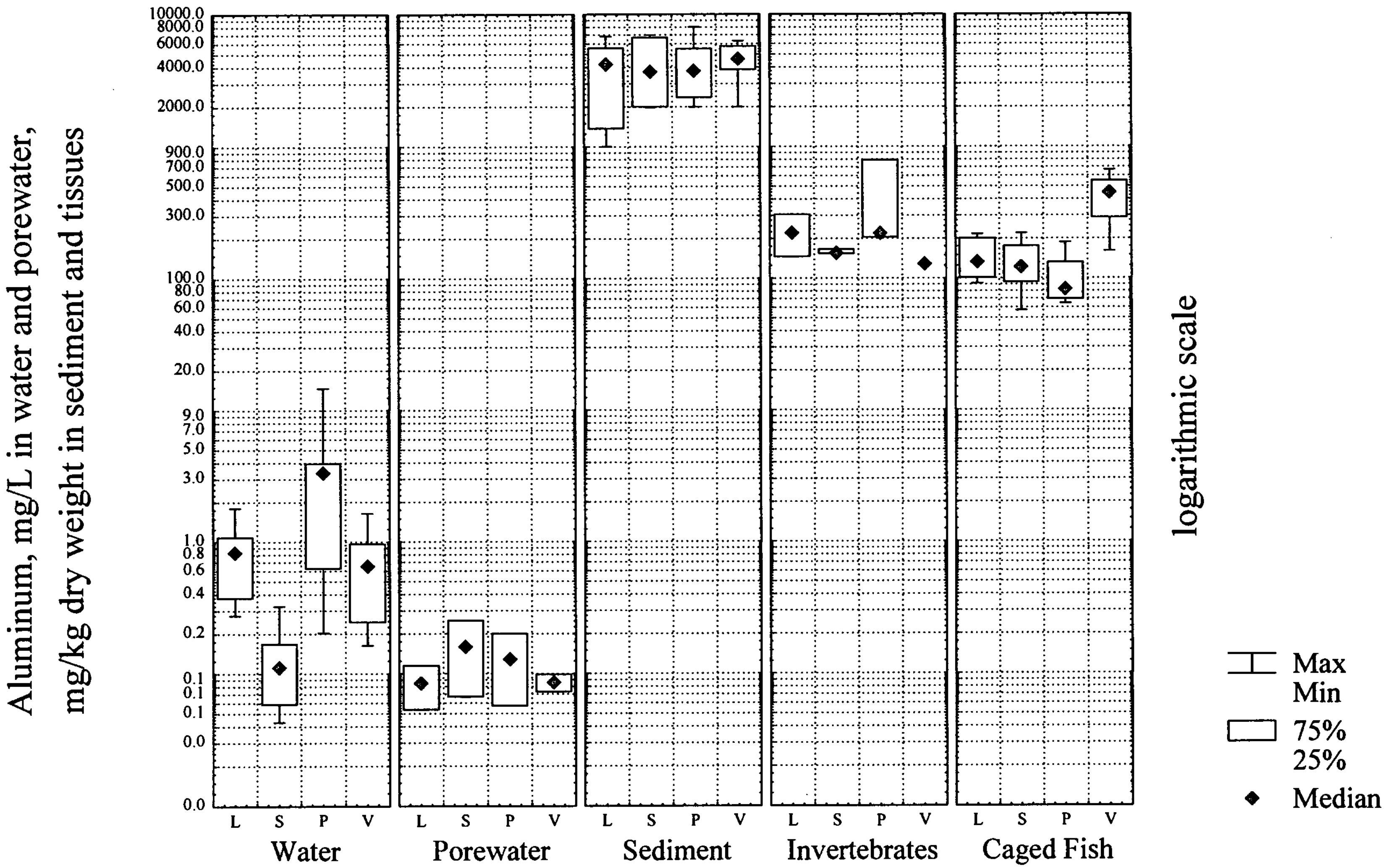
Figure 41. The pH in the Valle Canyon Stream Segment, 1996-1997.

Figure 42. Moisture Content of Environmental Samples.



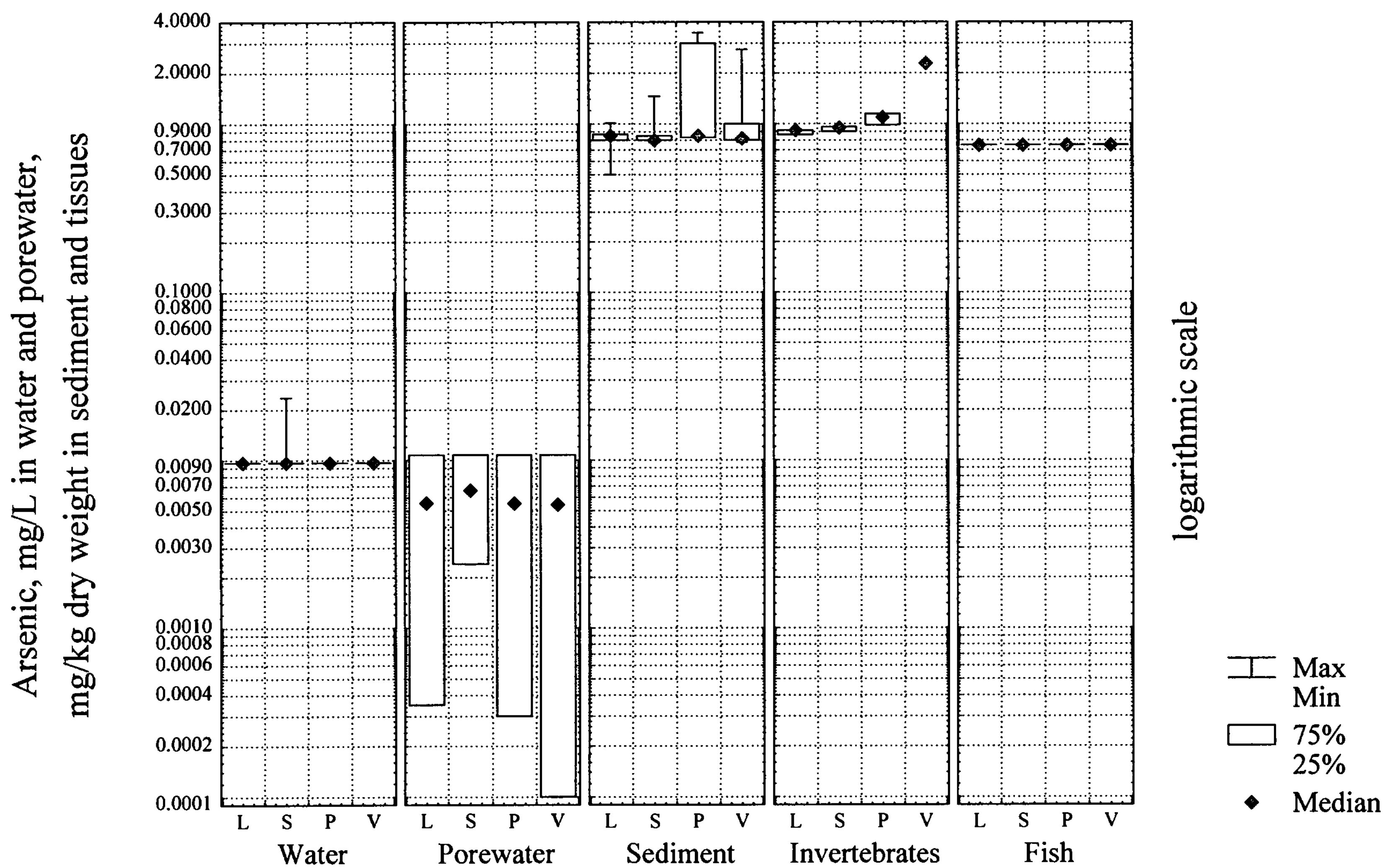
Canyon: L = Los Alamos S = Sandia P = Pajarito V = Valle

Figure 43. Aluminum in Environmental Samples.



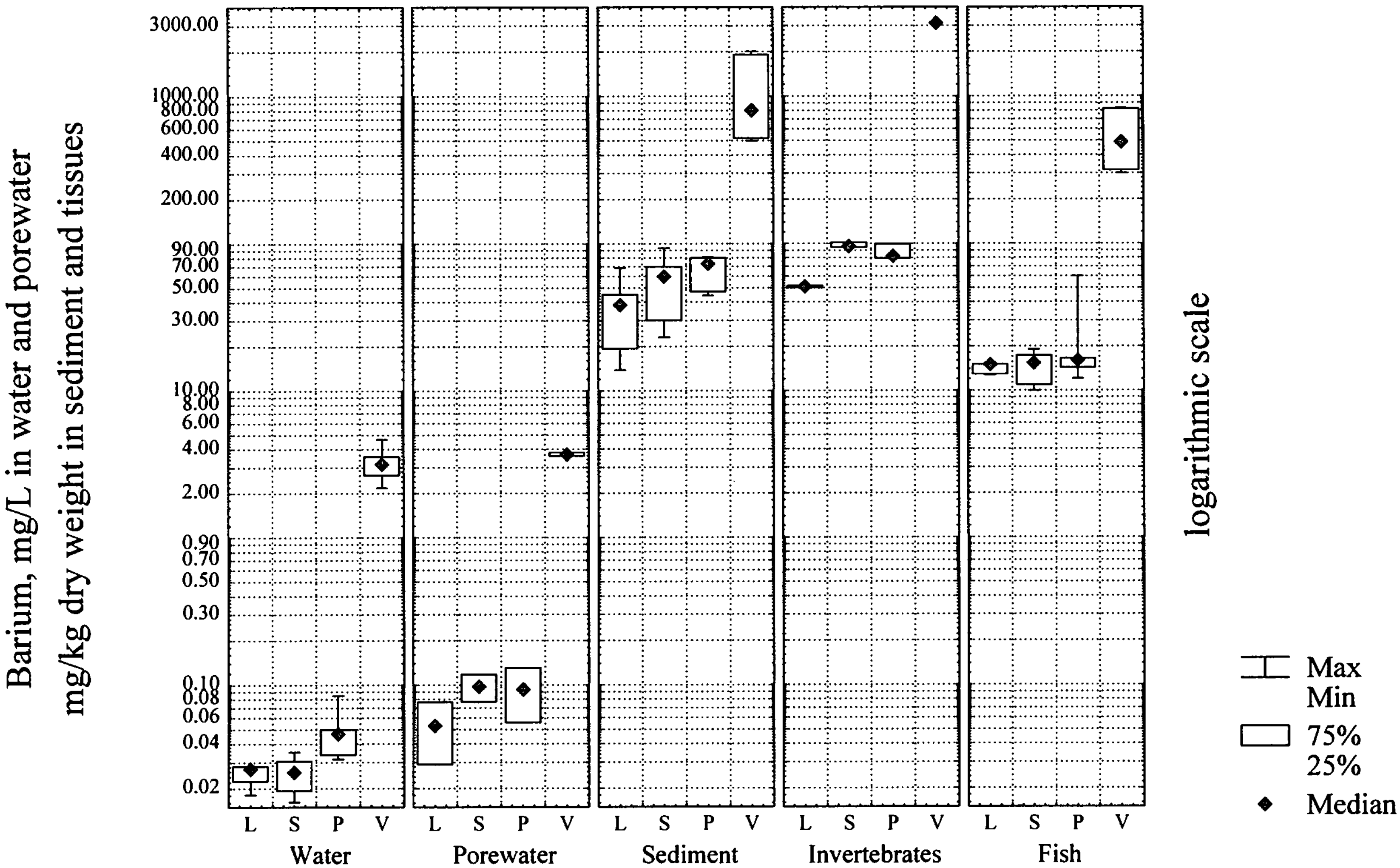
Canyon: L = Los Alamos S = Sandia P = Pajarito V = Valle

Figure 44. Arsenic in Environmental Samples.



Canyon: L = Los Alamos S = Sandia P = Pajarito V = Valle

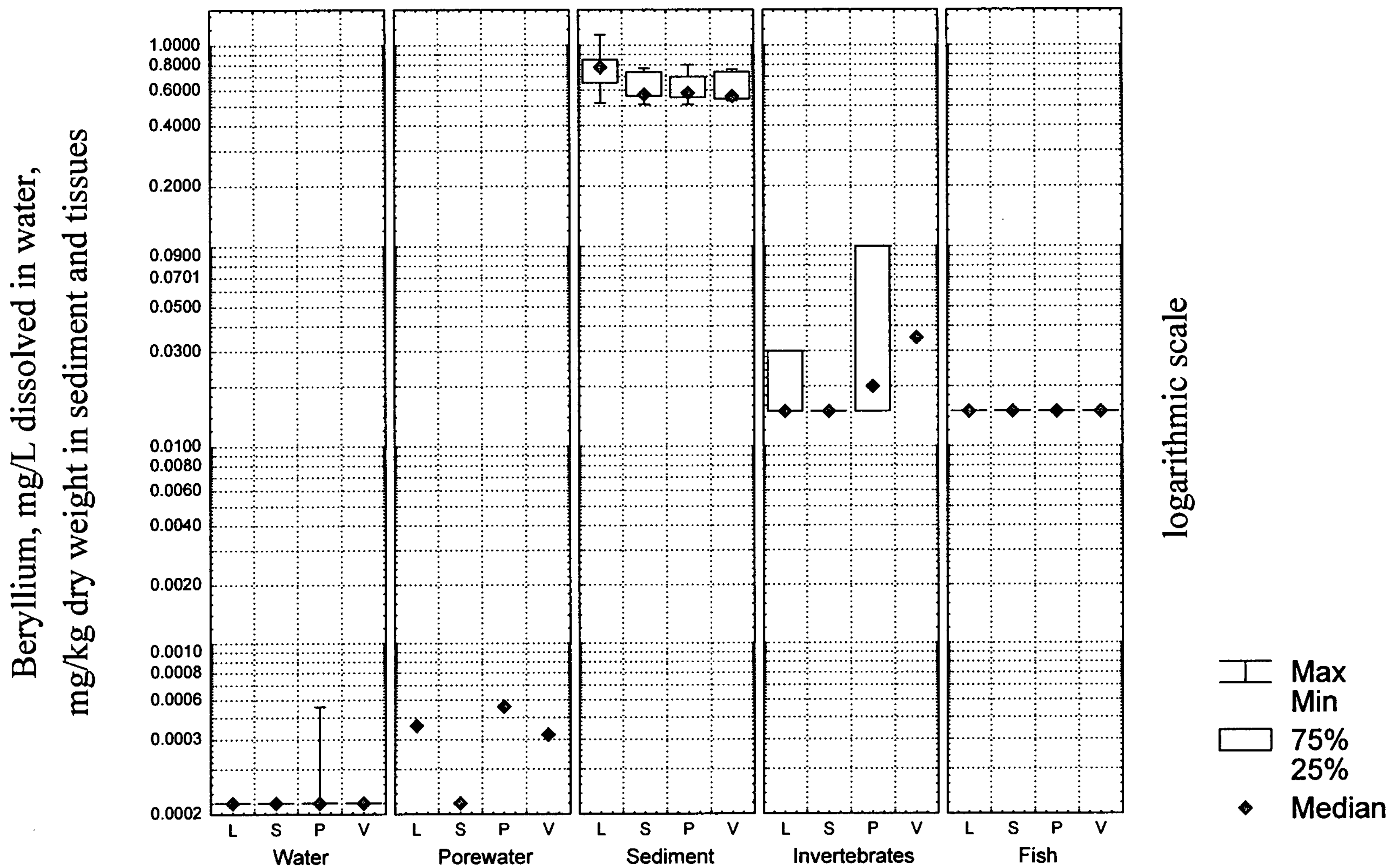
Figure 45. Barium in Environmental Samples.



Canyon: L = Los Alamos S = Sandia P = Pajarito V = Valle

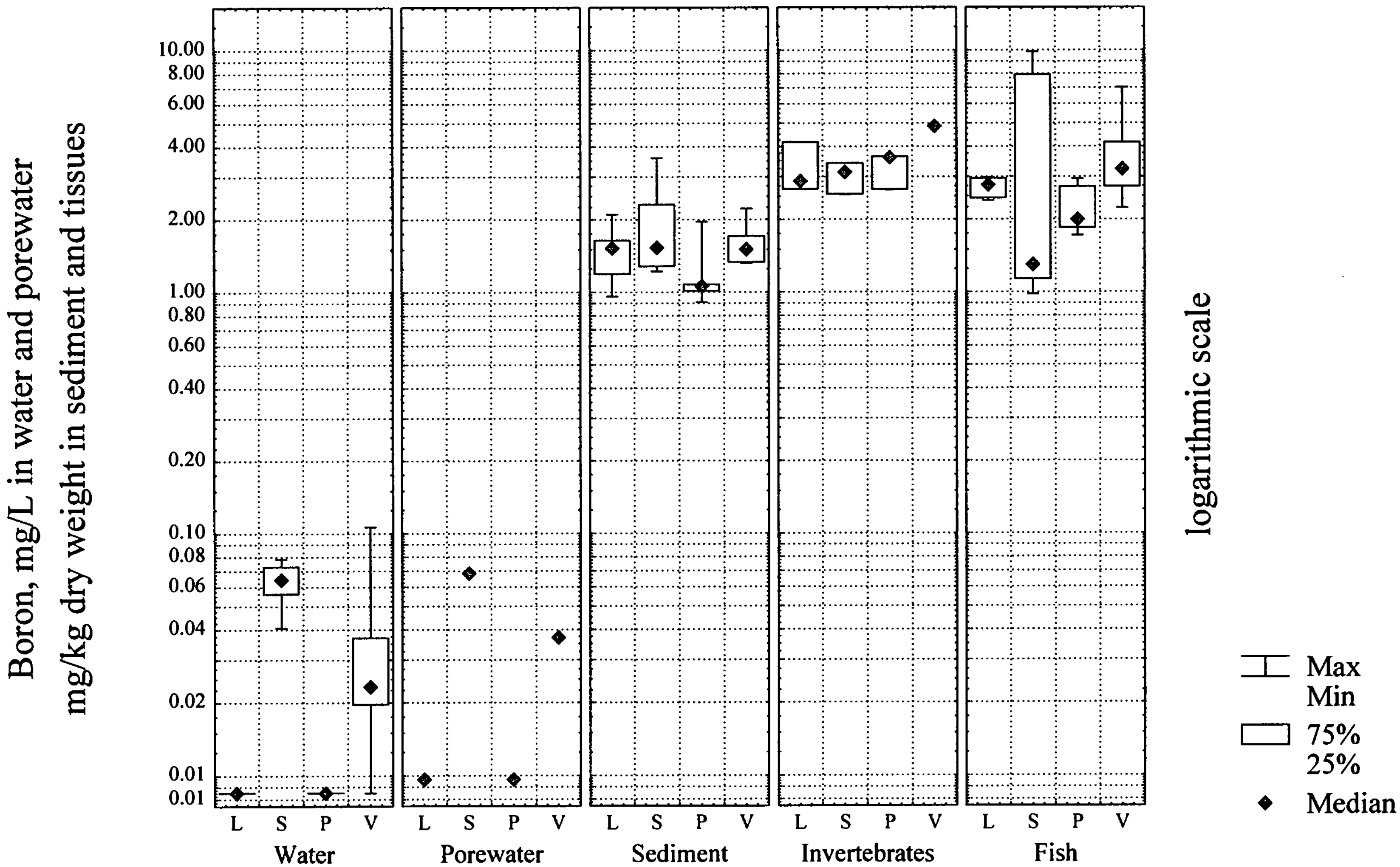
211

Figure 46. Beryllium in Environmental Samples.



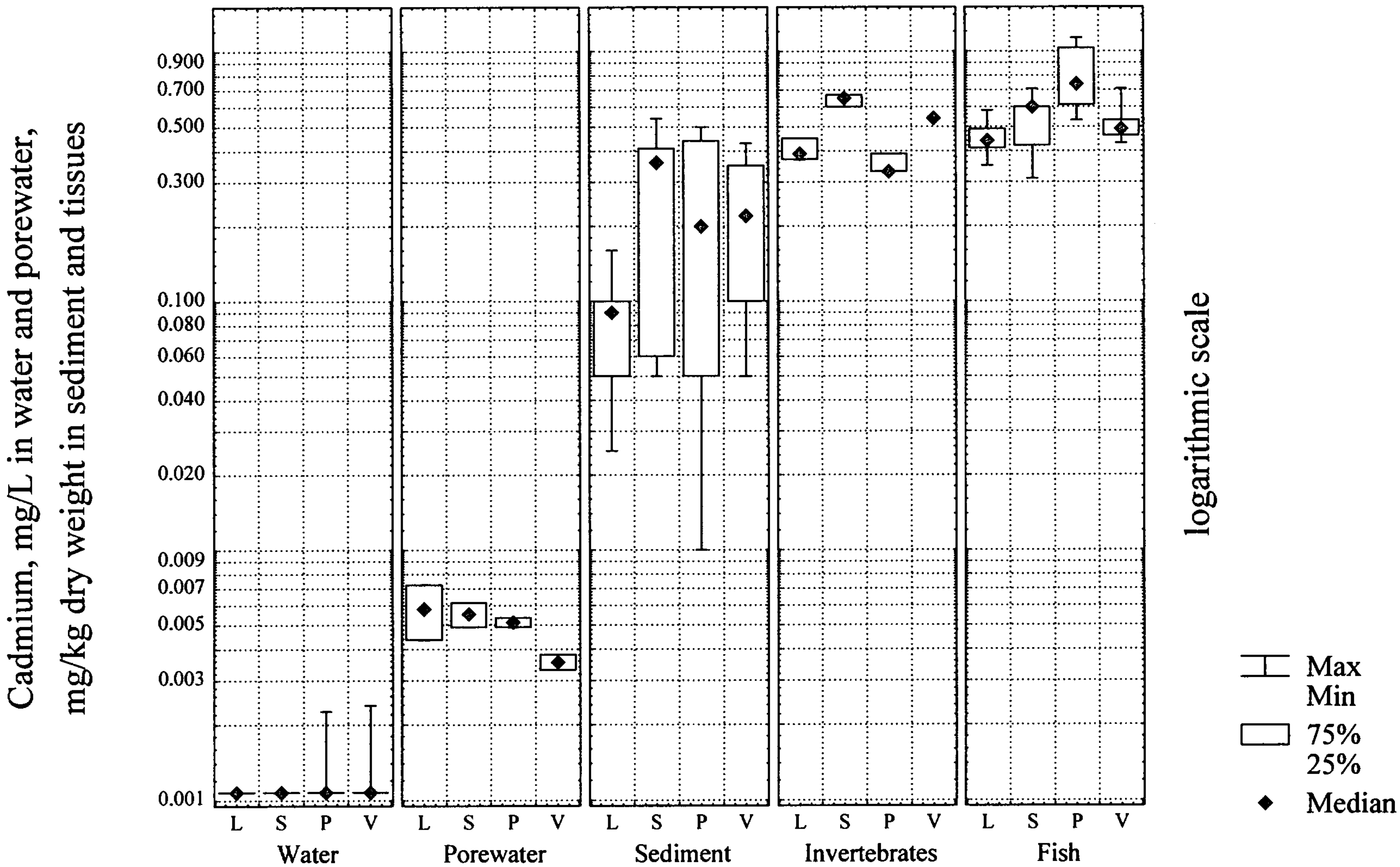
Canyon: L = Los Alamos S = Sandia P = Pajarito V = Valle

Figure 47. Boron in Environmental Samples.



Canyon: L = Los Alamos S = Sandia P = Pajarito V = Valle

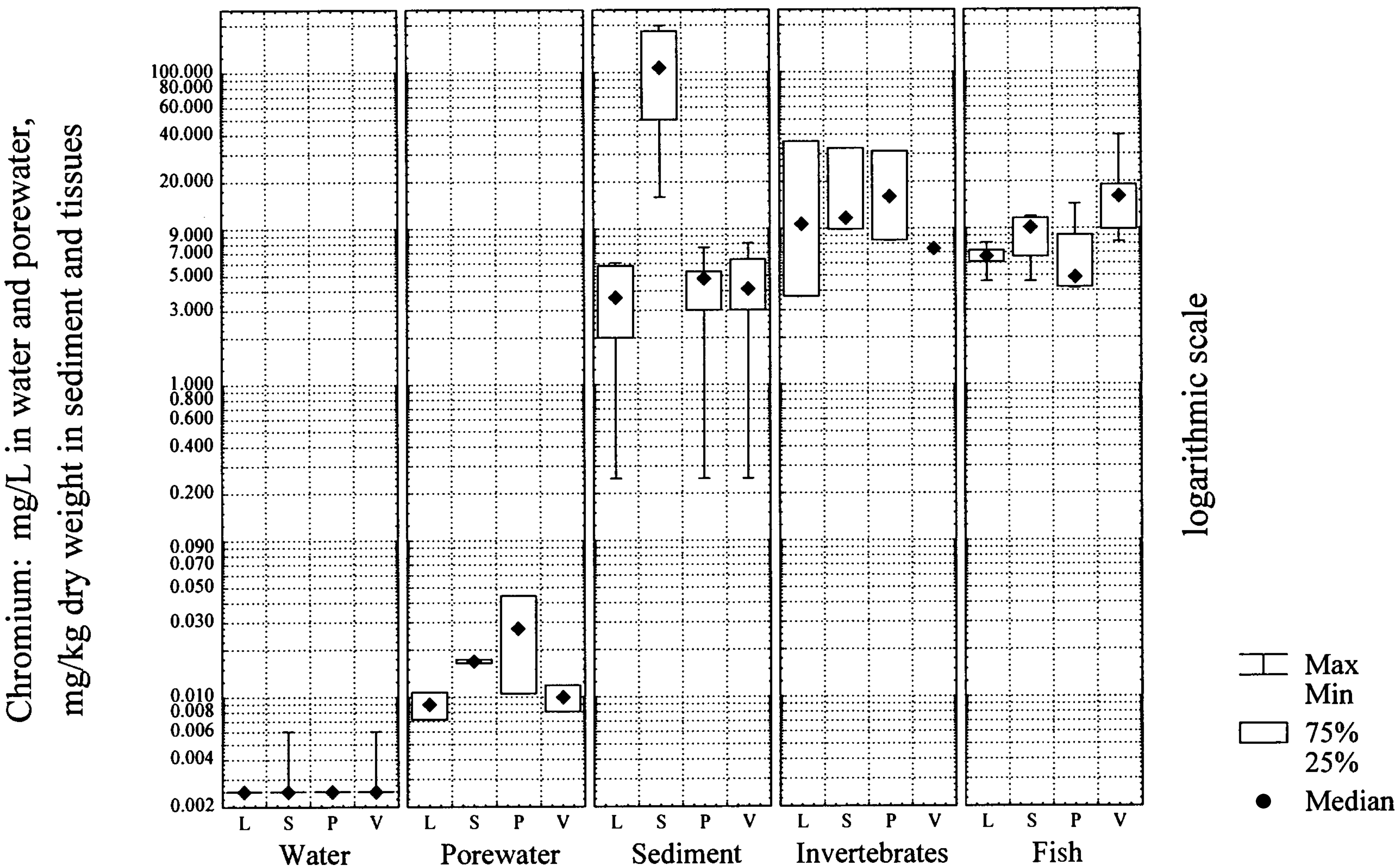
Figure 48. Cadmium in Environmental Samples.



Canyon: L = Los Alamos S = Sandia P = Pajarito V = Valle

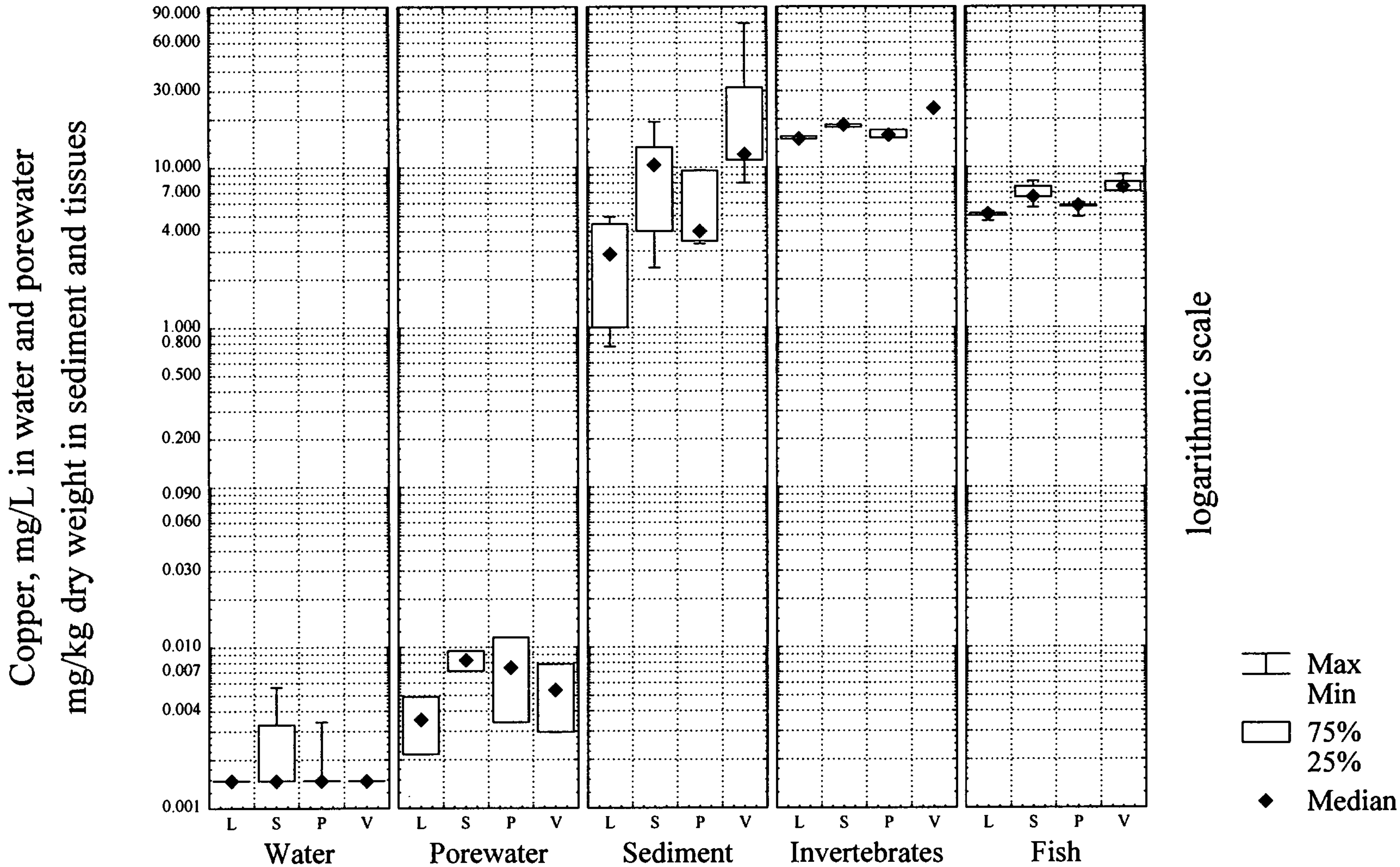
213

Figure 49. Chromium in Environmental Samples.



Canyon: L = Los Alamos S = Sandia P = Pajarito V = Valle

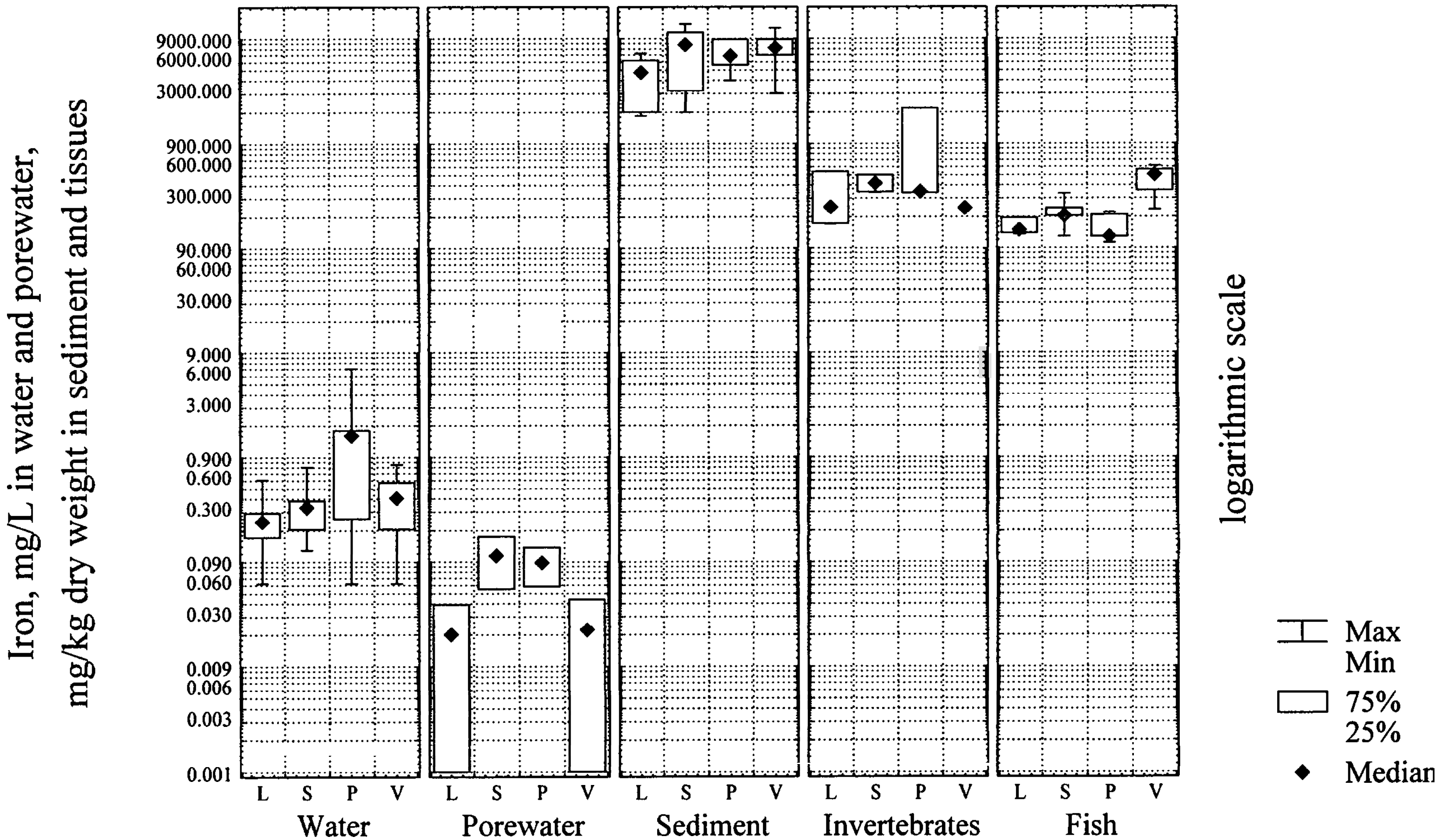
Figure 50. Copper in Environmental Samples.



Canyon: L = Los Alamos S = Sandia P = Pajarito V = Valle

Figure 51. Iron in Environmental Samples

Los Alamos National Laboratory Use Study - 1996-1997



Canyon: L = Los Alamos S = Sandia P = Pajarito V = Valle

216

217

Figure 52. Lead in Environmental Samples.

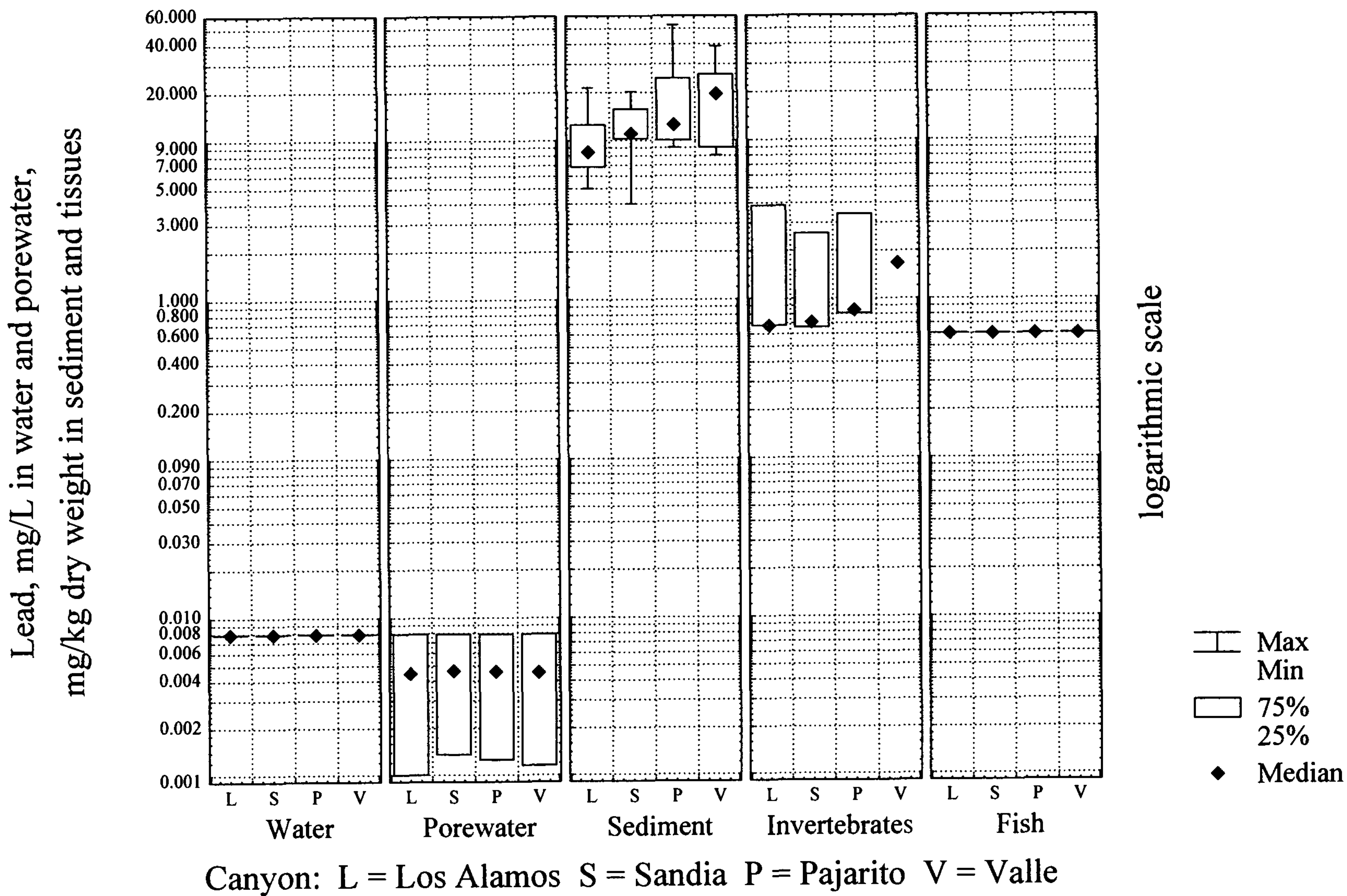
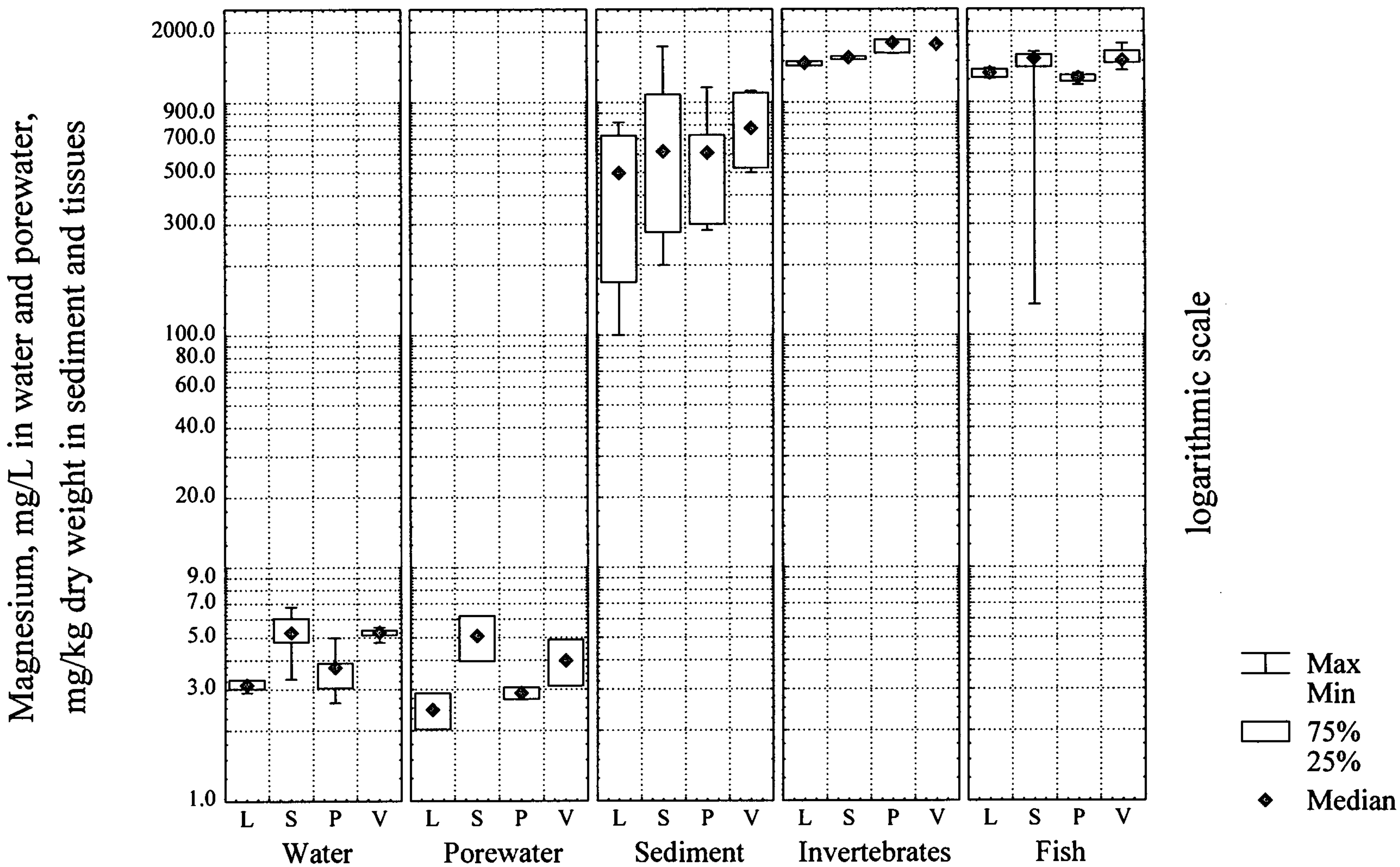
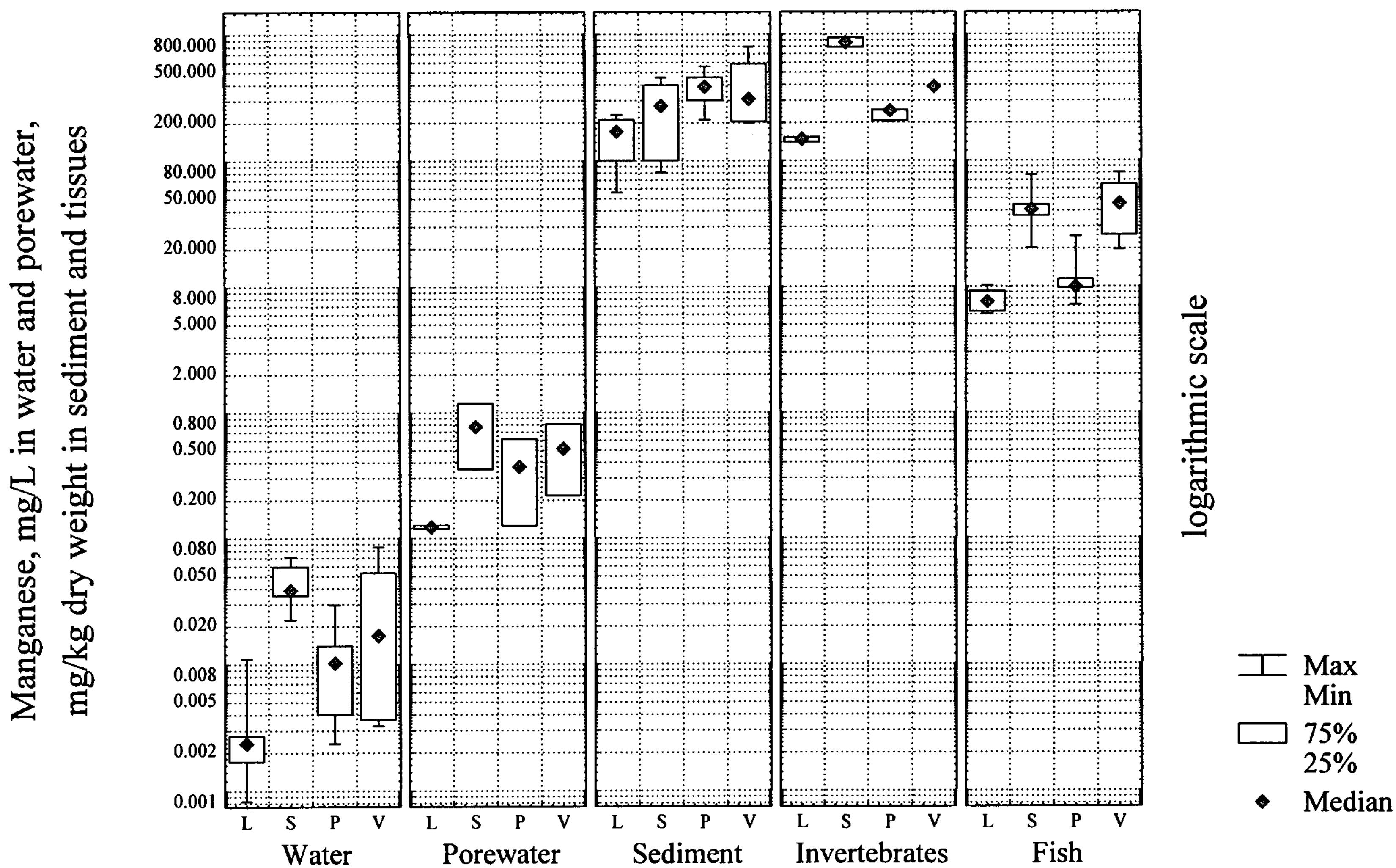


Figure 53. Magnesium in Environmental Samples.



Canyon: L = Los Alamos S = Sandia P = Pajarito V = Valle

Figure 54. Manganese in Environmental Samples.



Canyon: L = Los Alamos S = Sandia P = Pajarito V = Valle

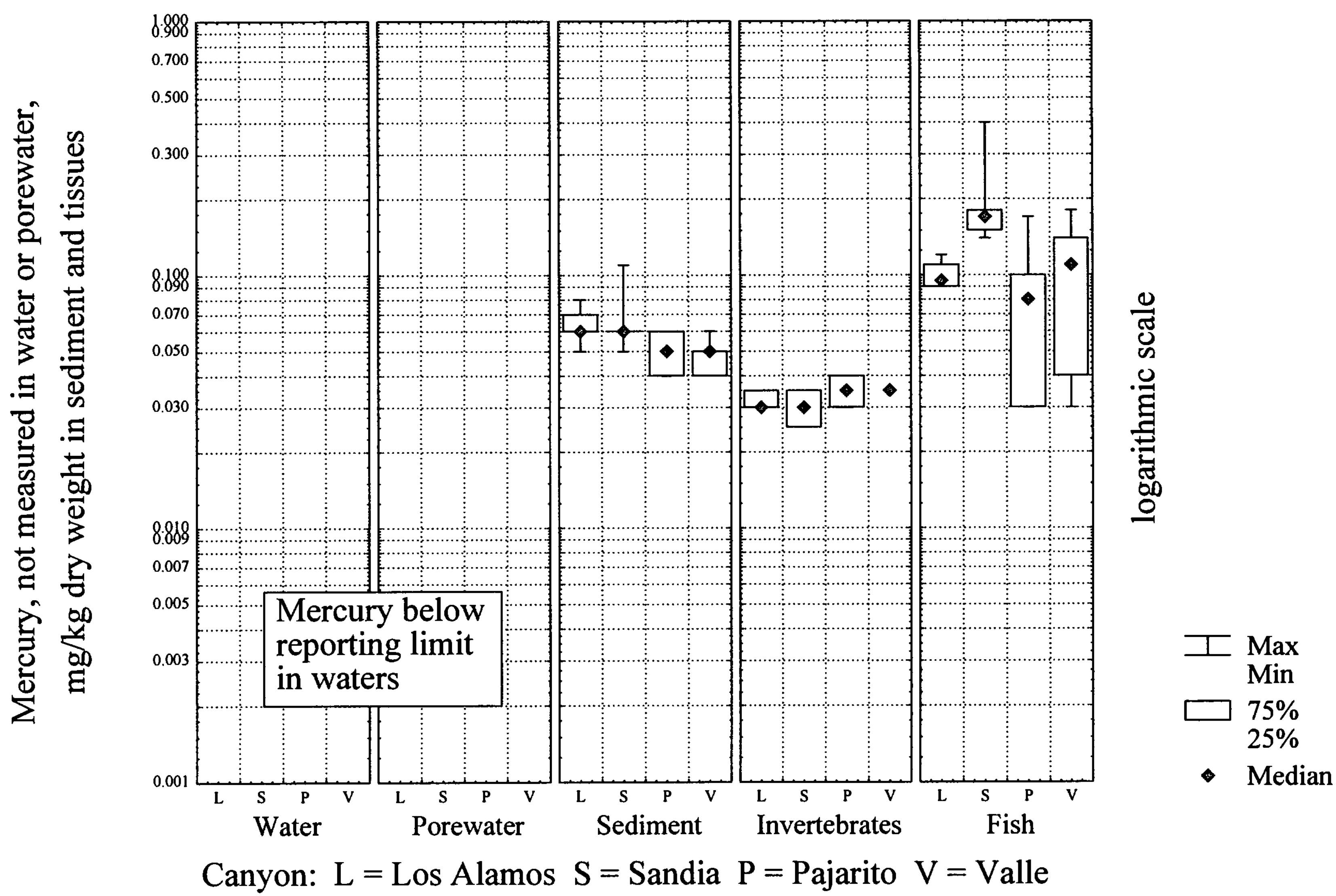
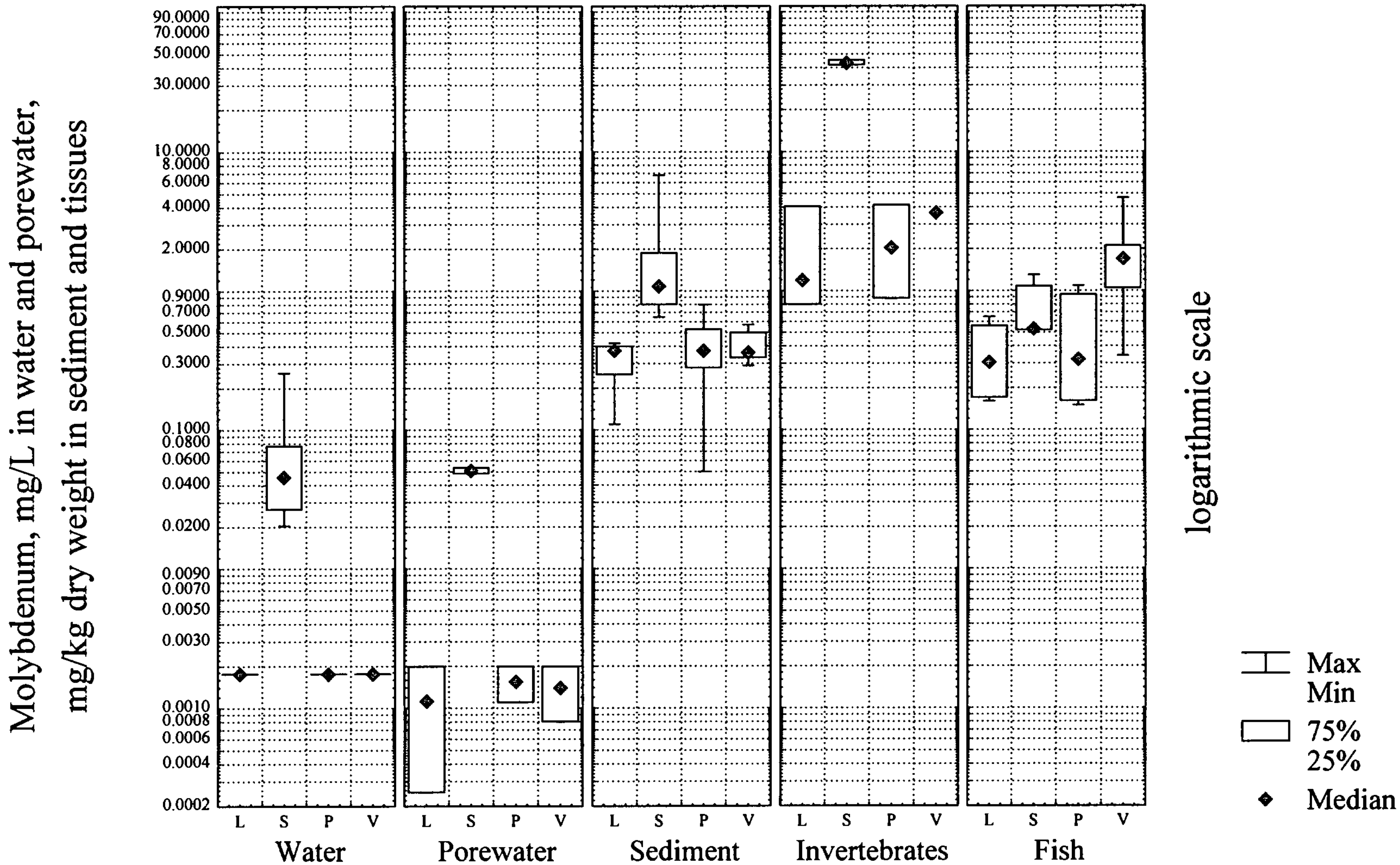


Figure 55. Mercury in Environmental Samples.

Figure 56. Molybdenum in Environmental Samples.



Canyon: L = Los Alamos S = Sandia P = Pajarito V = Valle

222

Figure 57. Selenium in Environmental Samples.

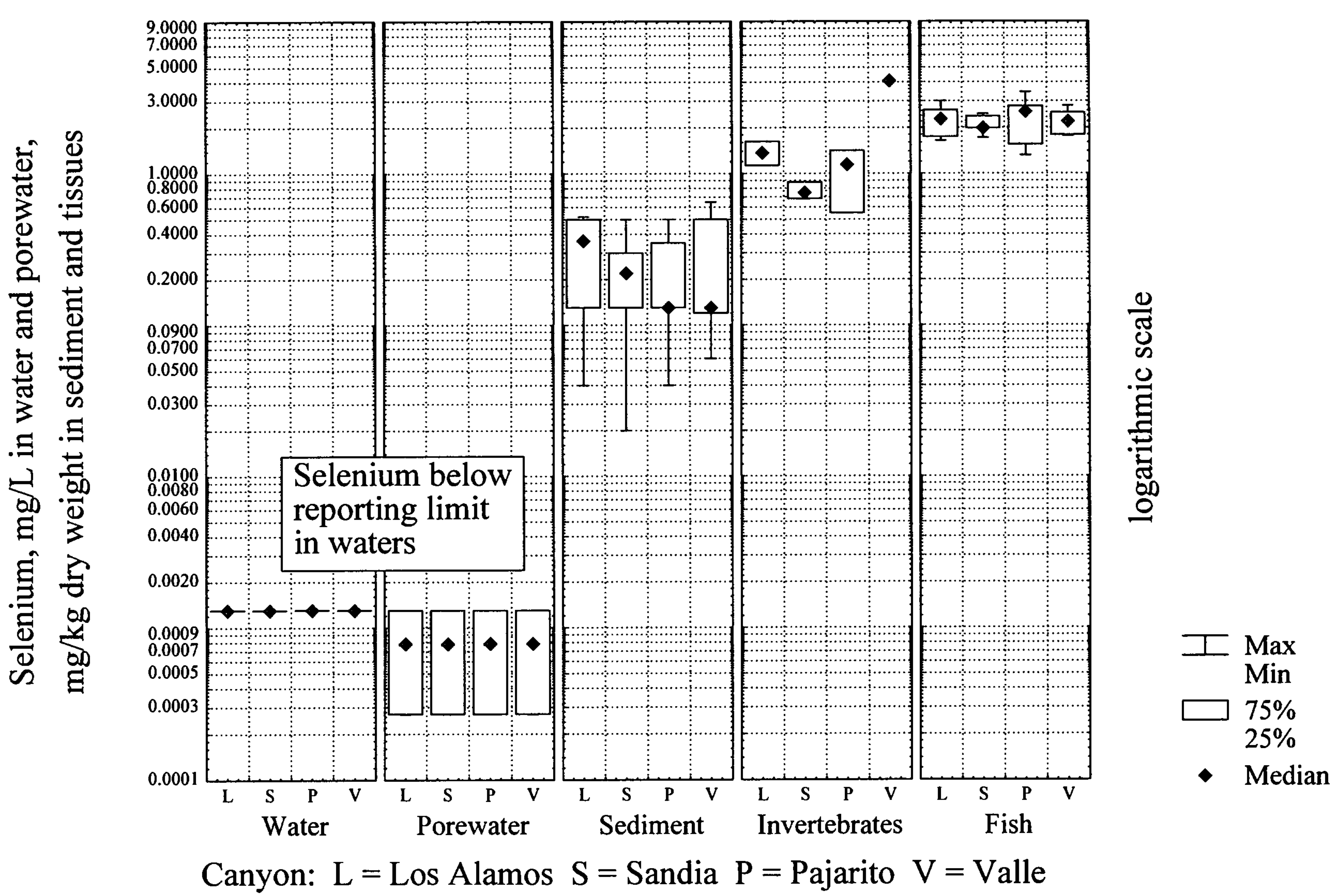
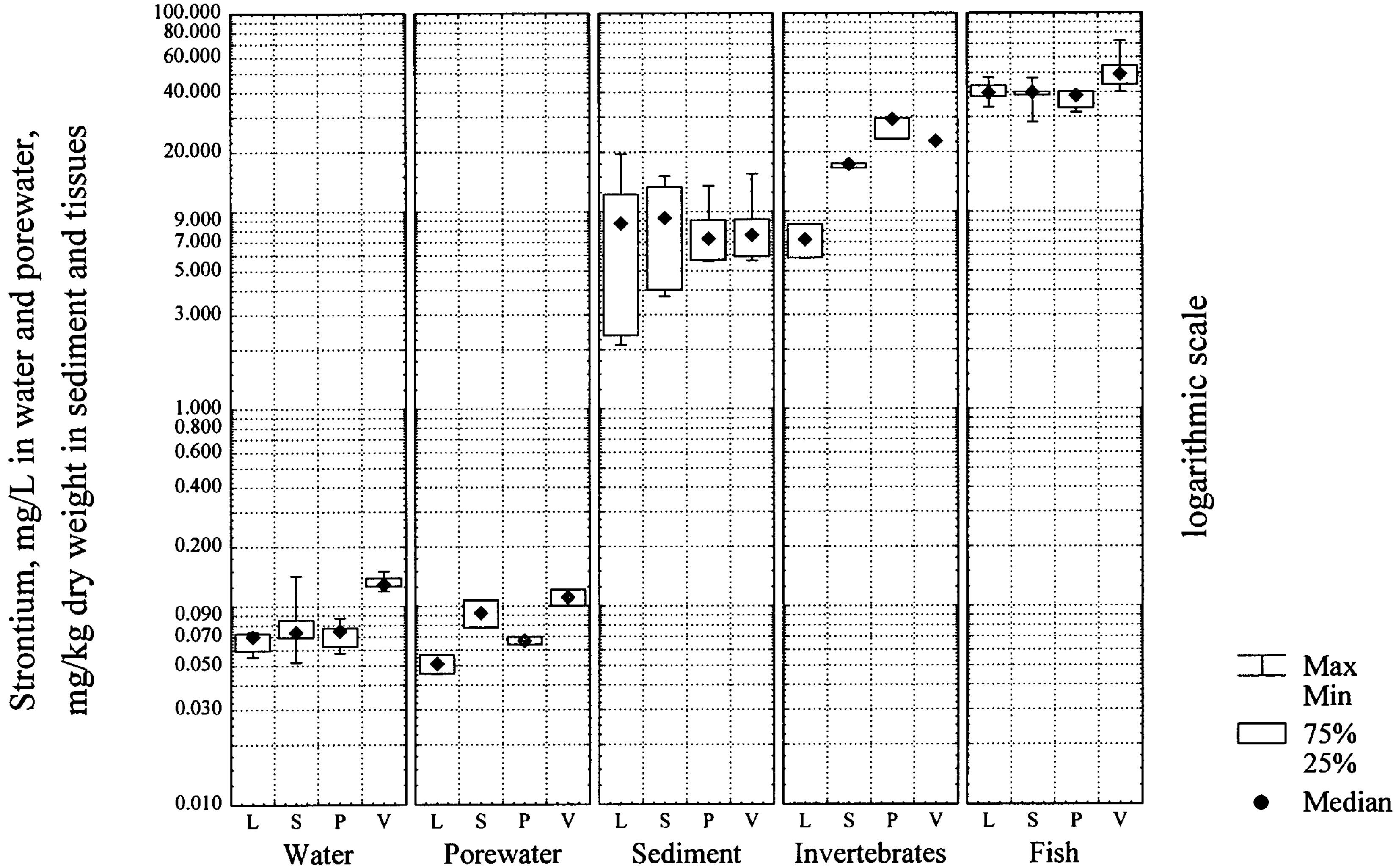


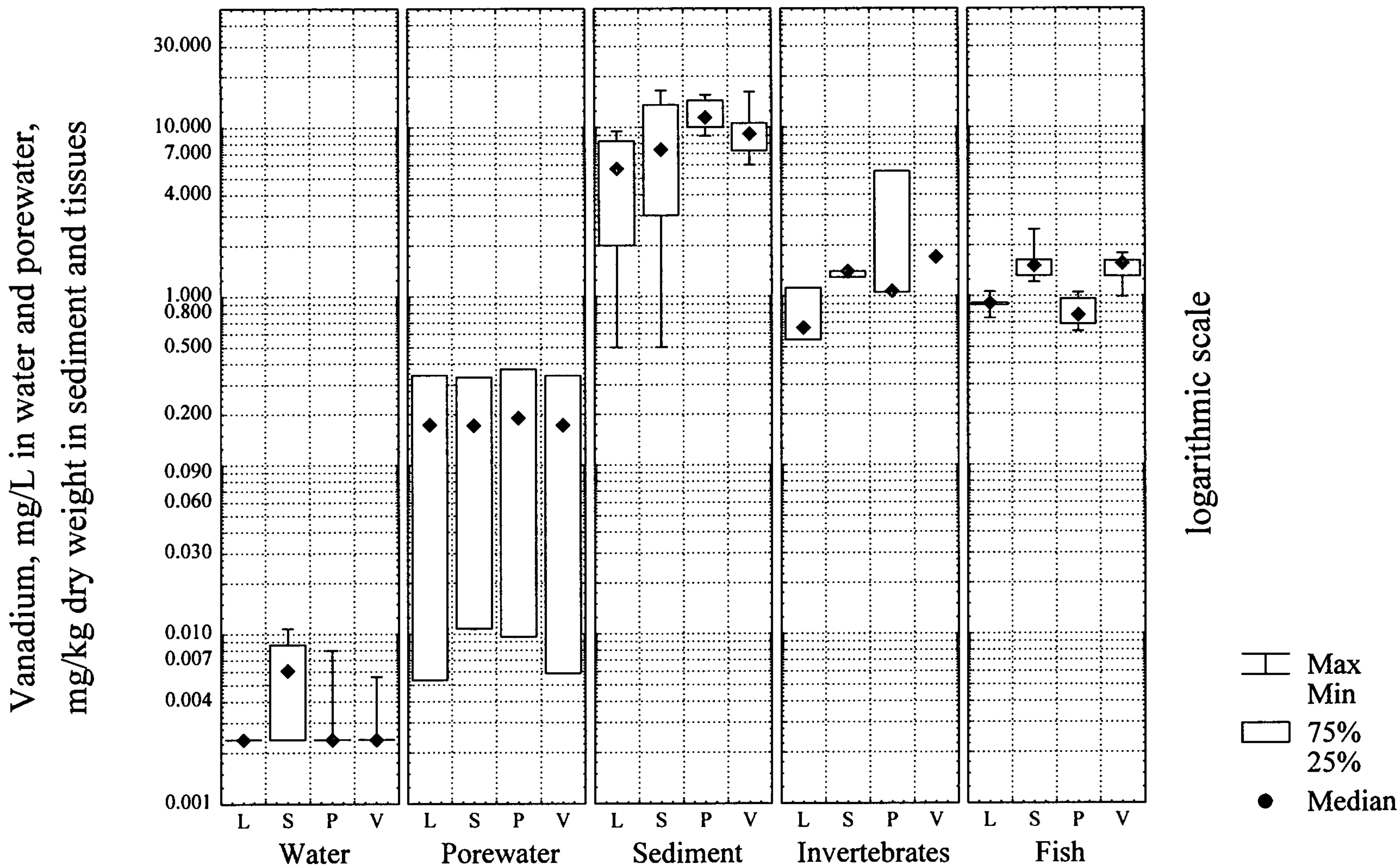
Figure 58. Strontium in Environmental Samples.



Canyon: L = Los Alamos S = Sandia P = Pajarito V = Valle

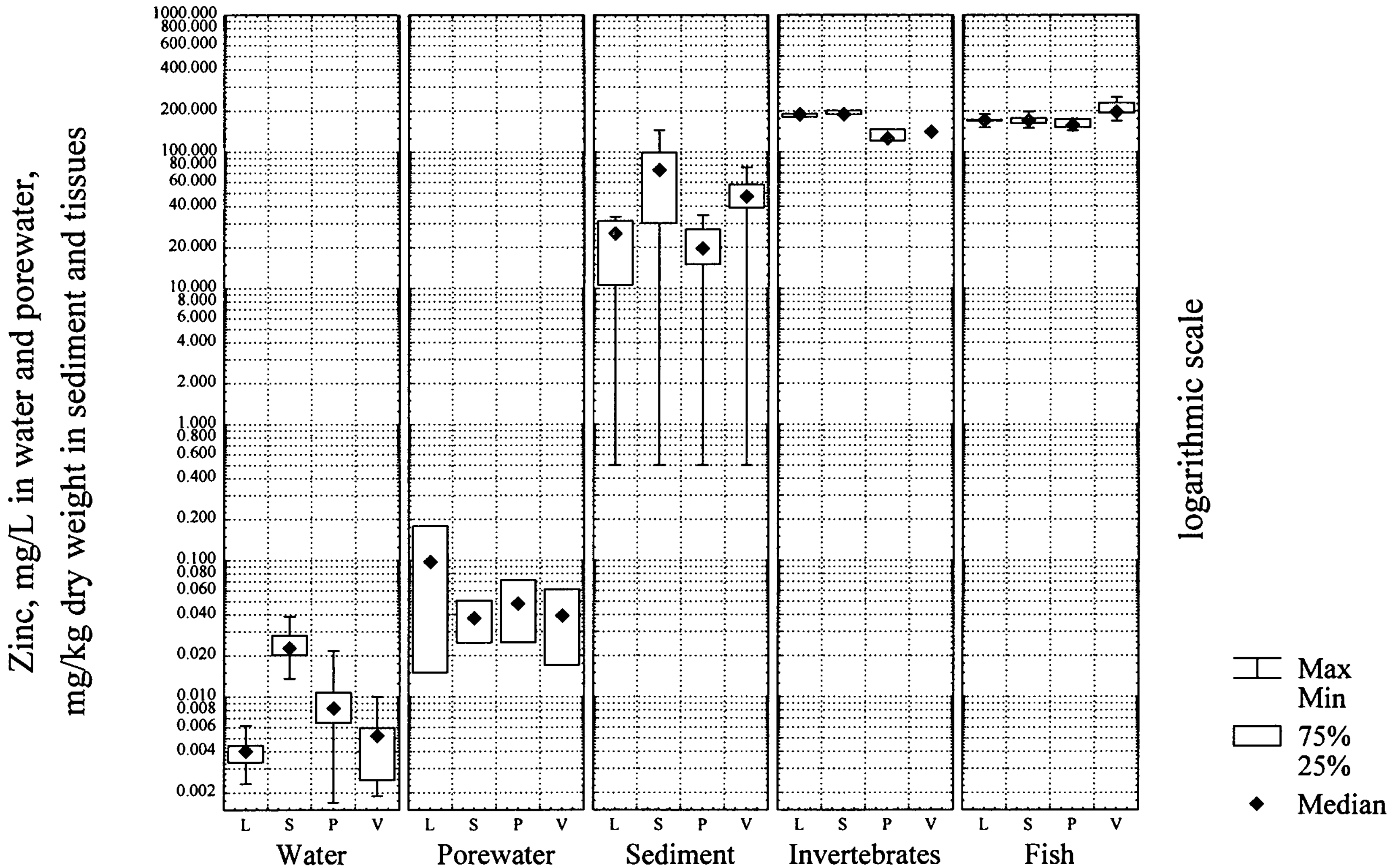
224

Figure 59. Vanadium in Environmental Samples.

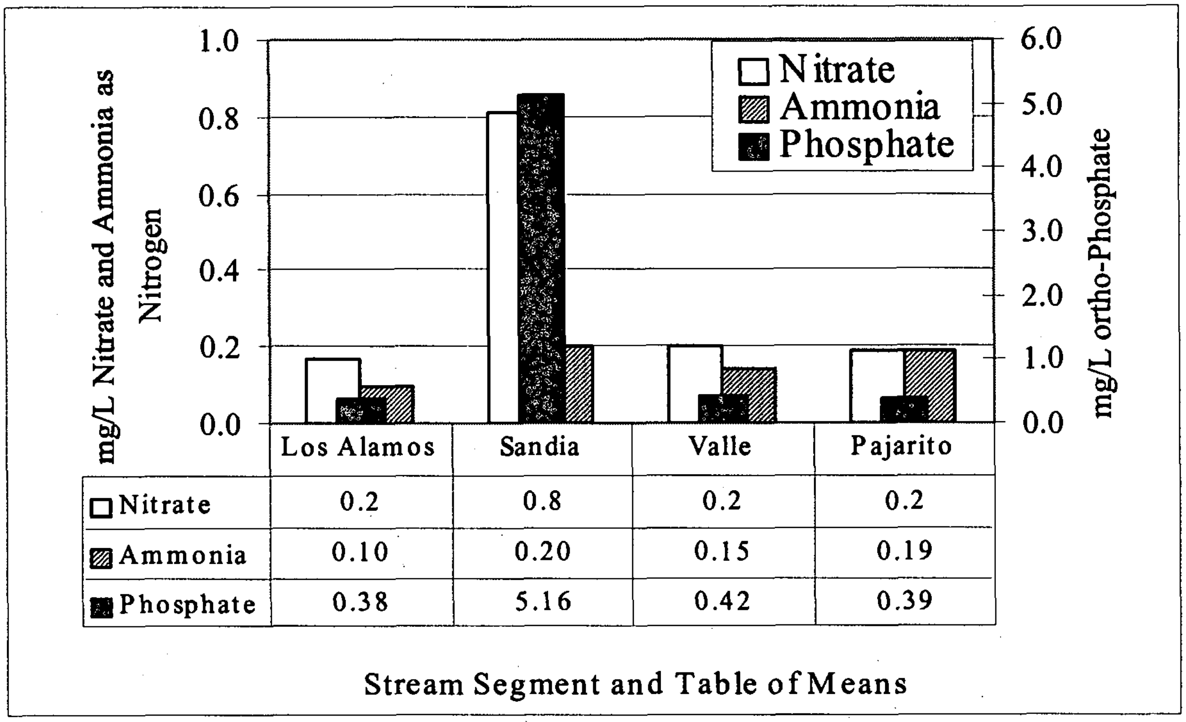


Canyon: L = Los Alamos S = Sandia P = Pajarito V = Valle

Figure 60. Zinc in Environmental Samples.

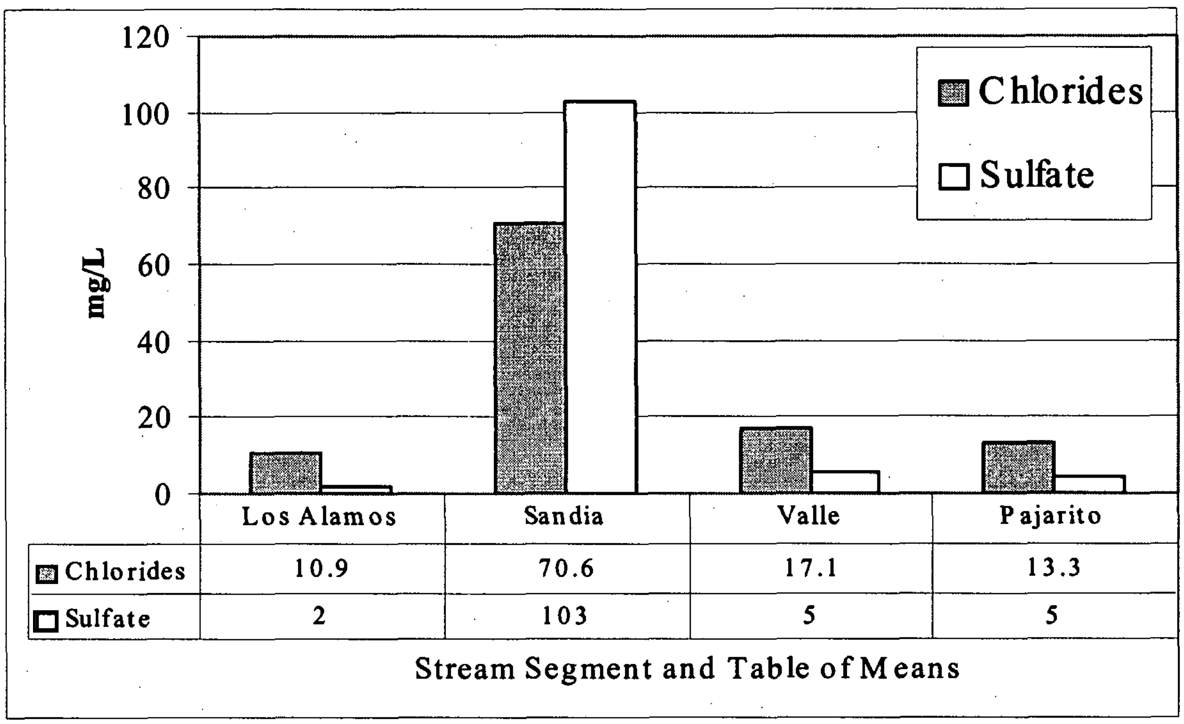


Canyon: L = Los Alamos S = Sandia P = Pajarito V = Valle



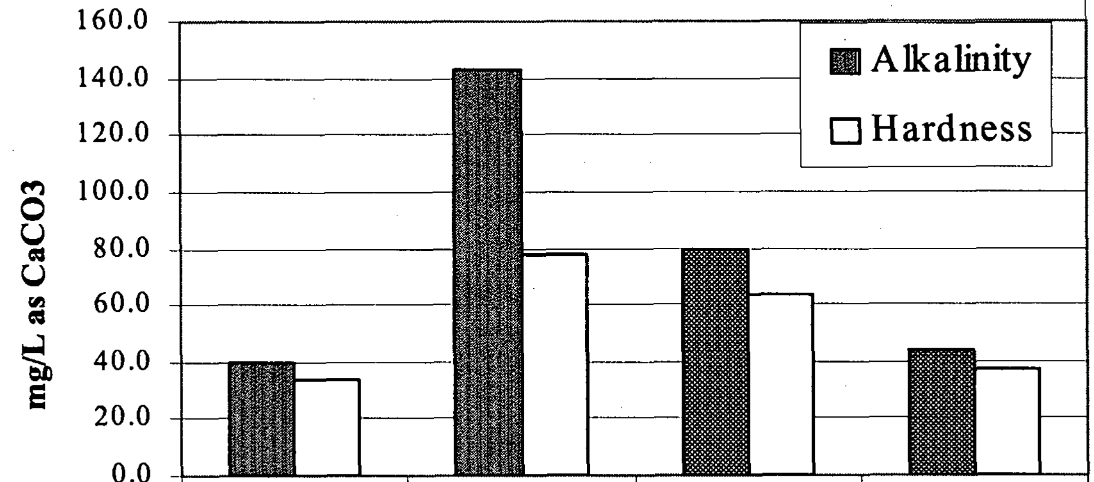
	Los Alamos	Sandia	Valle	Pajarito
Nitrate	0.2	0.8	0.2	0.2
Ammonia	0.10	0.20	0.15	0.19
Phosphate	0.38	5.16	0.42	0.39

Figure 61. Average Nutrient Content (Nitrate/Nitrite and Ammonia as Nitrogen, and Phosphorus as Ortho-Phosphate) of Canyon Stream Segments, 1997.



	Los Alamos	Sandia	Valle	Pajarito
Chlorides	10.9	70.6	17.1	13.3
Sulfate	2	103	5	5

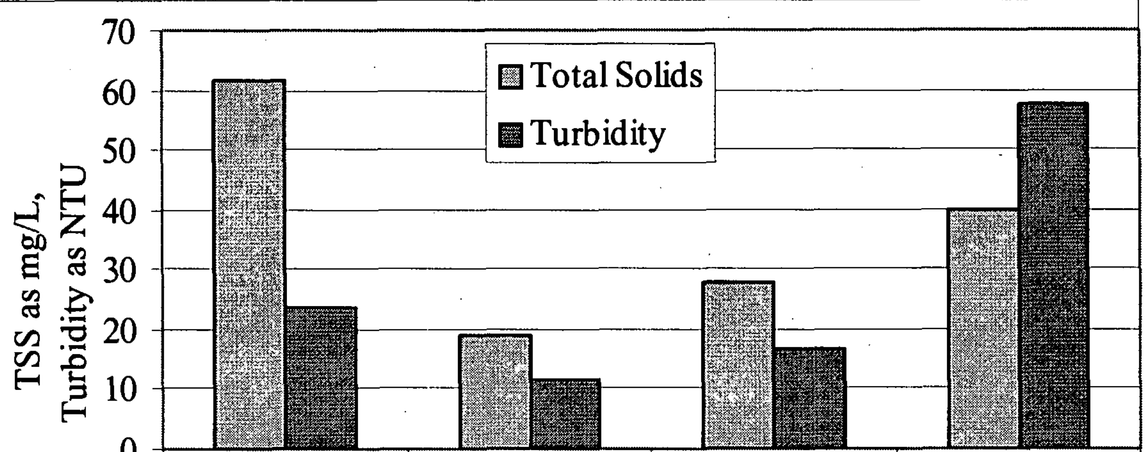
Figure 62. Average Chloride and Sulfate Content of Canyon Stream Segments, 1997.



	Los Alamos	Sandia	Valle	Pajarito
Alkalinity	39.4	143.1	79.5	43.8
Hardness	33.6	78.0	63.7	37.1

Stream Segment and Table of Means

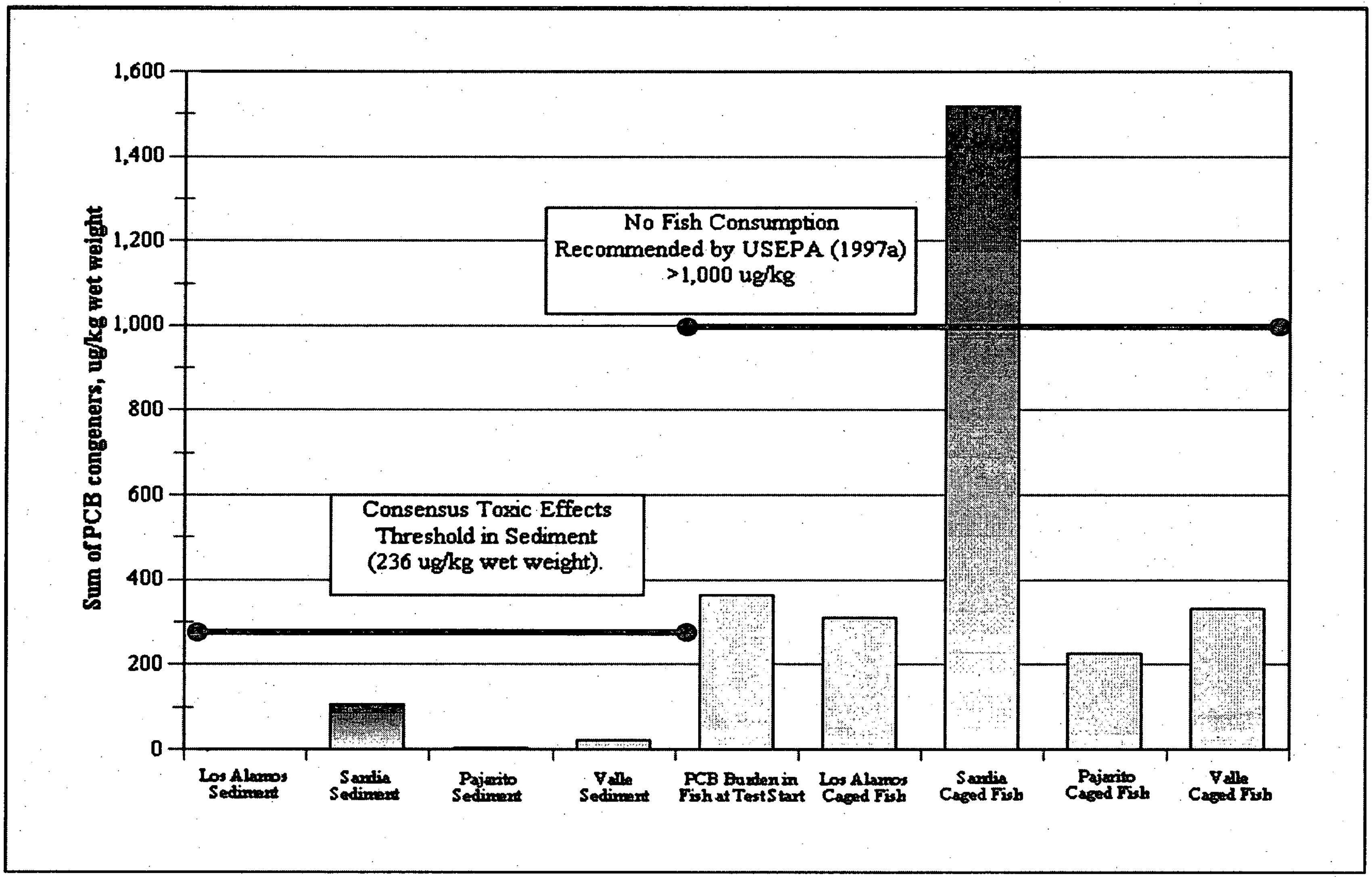
Figure 63. Average Alkalinity and Hardness (mg/L as $CaCO_3$) of Stream Segments, 1997.



	Los Alamos	Sandia	Valle	Pajarito
Total Solids	62	19	28	40
Turbidity	23.7	11.8	16.7	57.6

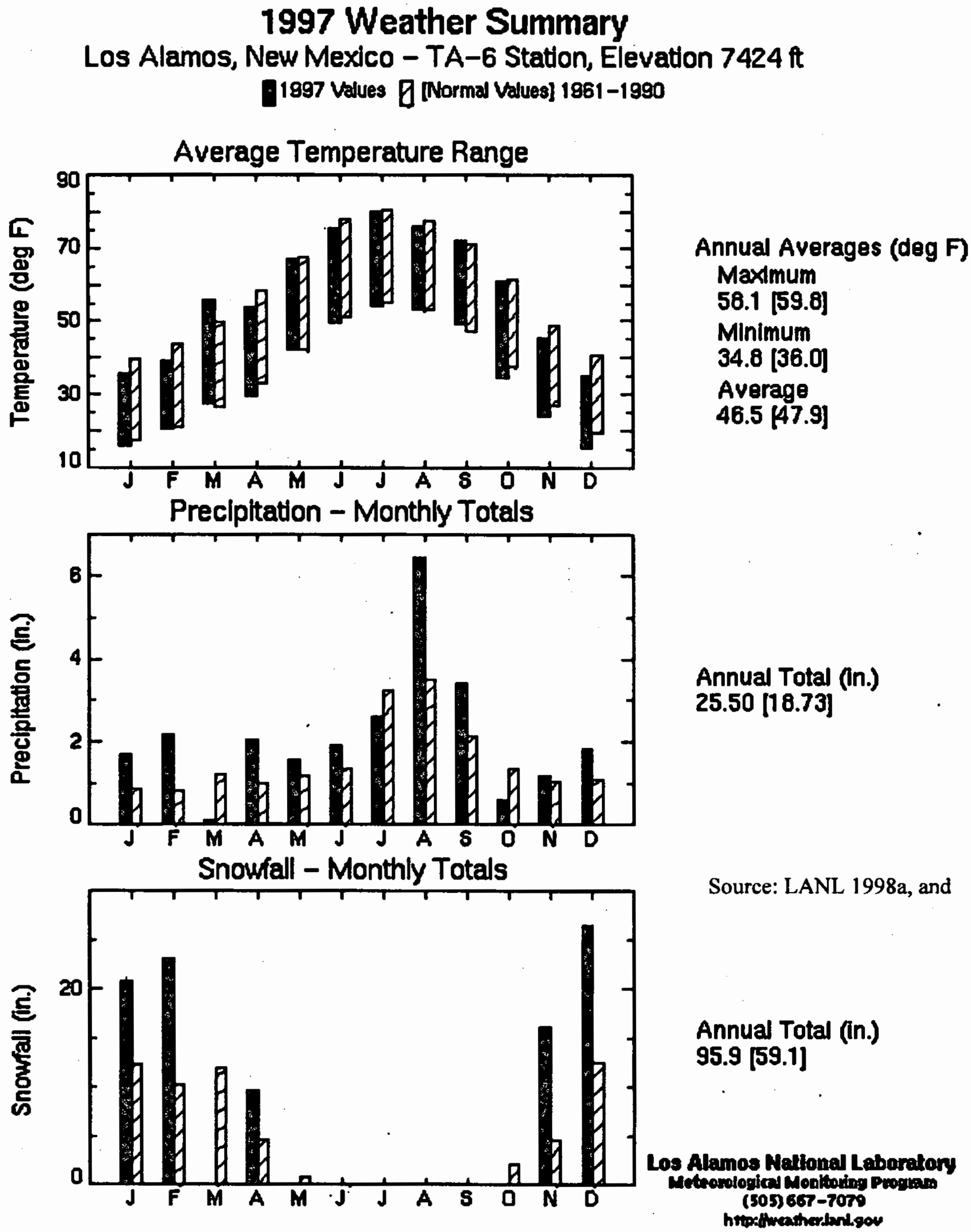
Stream Segment and Table of Means

Figure 64. Average Turbidity (NTU) and Total Suspended Solids (mg/L) of Canyon Stream Segments, 1997.



228

Figure 65. PCB congeners in Sediment and Caged Fish Collected for the Use Study Compared with Thresholds of Concern.



Source: LANL 1998a, and

Figure 66. Summary of Precipitation and Air Temperature (°F) in 1997 at Technical Area 6 of the Los Alamos National Laboratory. (This Weather Station was near to the Stream Segments Evaluated During the Use Study).

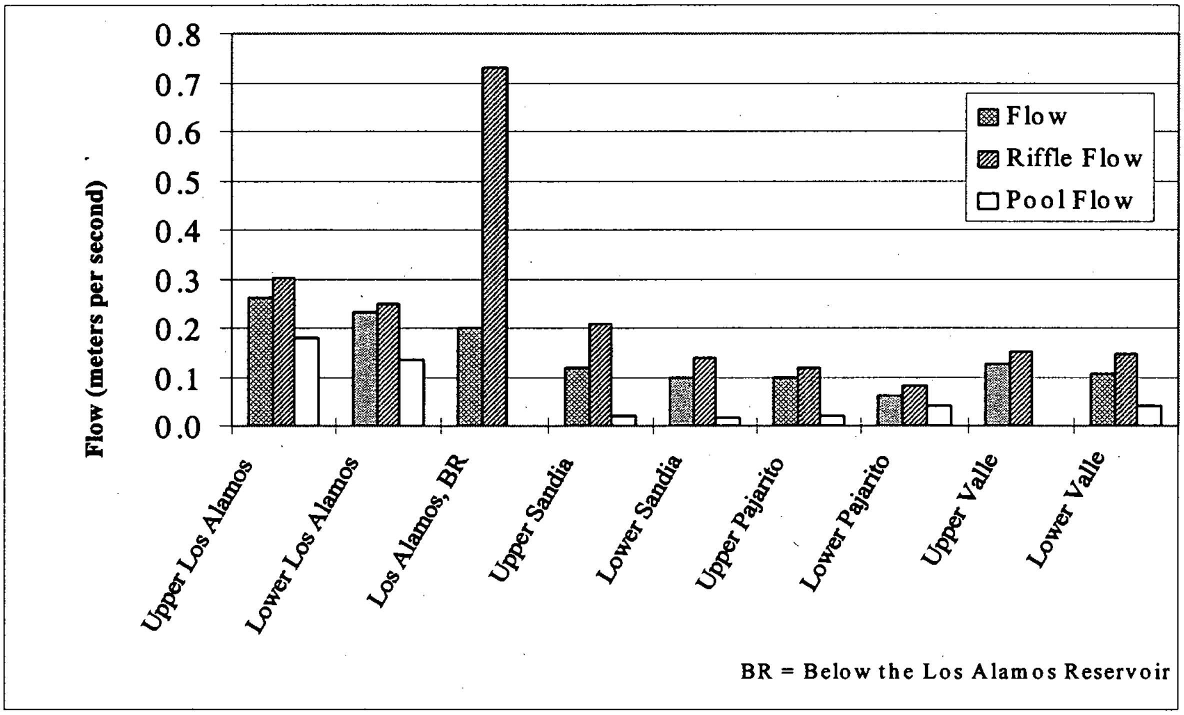


Figure 67. Average Stream Flow, Average Flow in Riffle Habitats, and Average Flow in Pool Habitats, Measured for Each Stream Reach in 1997.

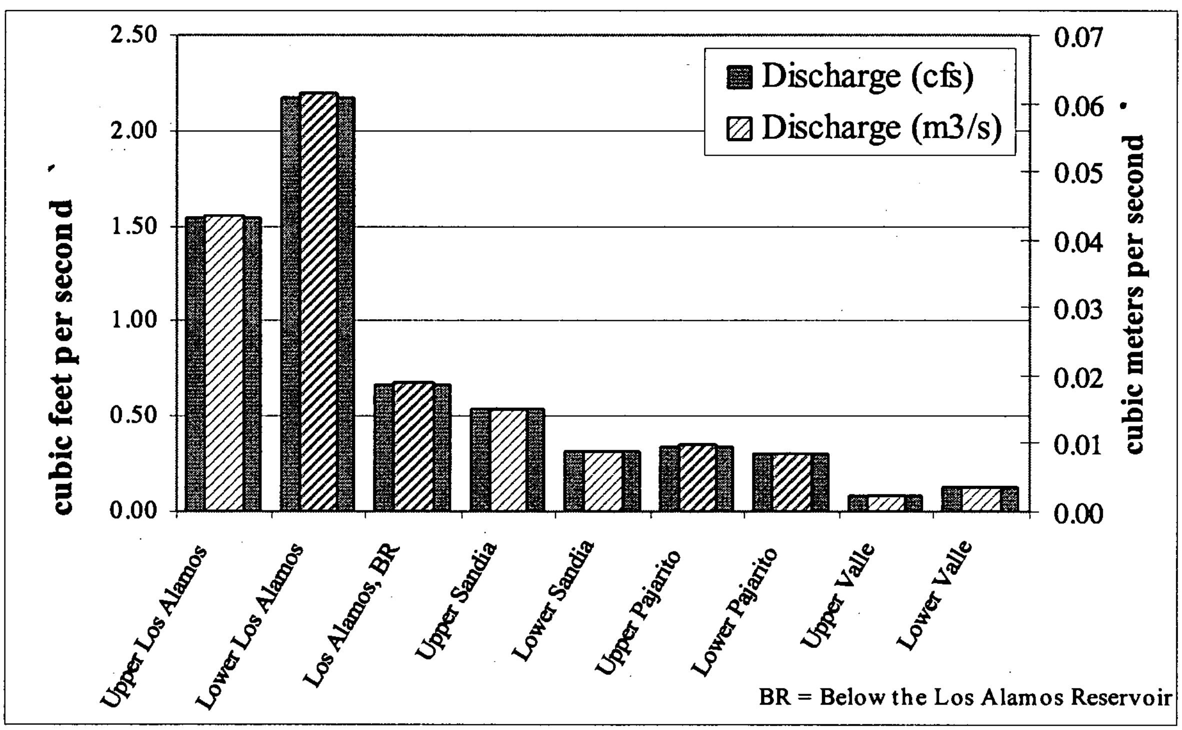


Figure 68. Average Stream Discharge (in cubic feet per second [cfs] and cubic meters per second [m3/s]) Measured for Each Stream Reach in 1997.

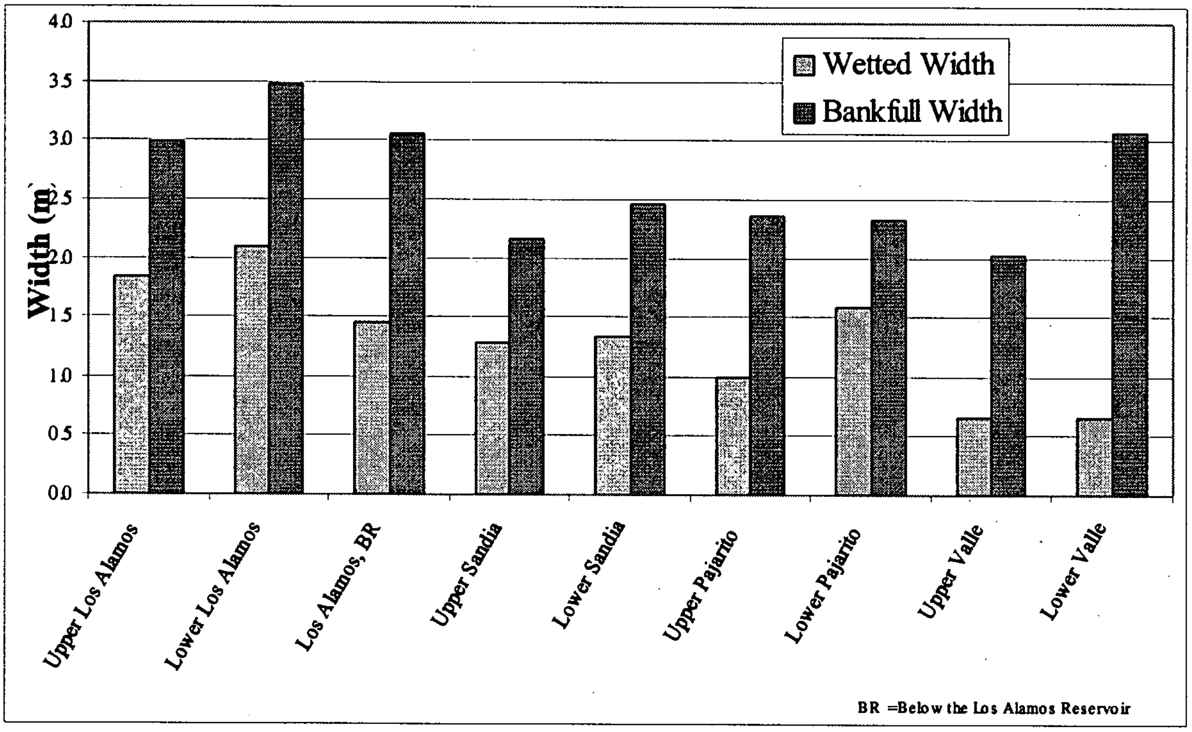


Figure 69. Average Wetted Width and Average Bankfull Width for Each Stream Reach.

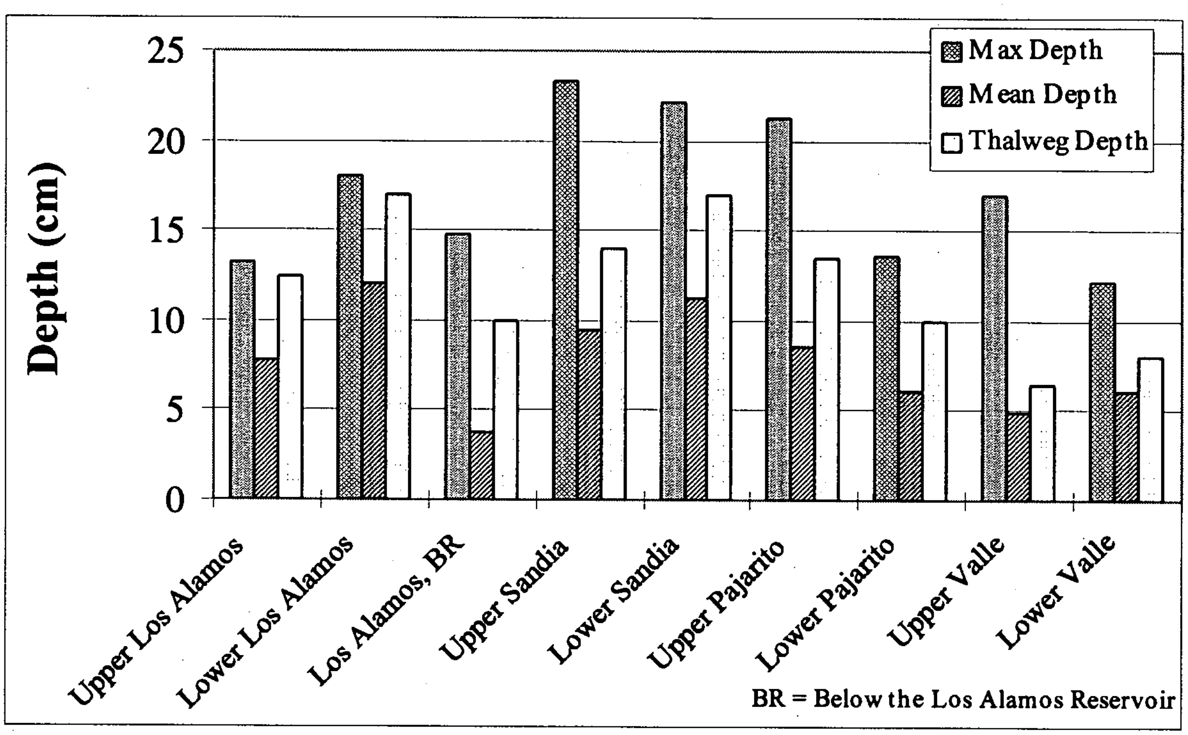


Figure 70. Mean, Maximum, and Thalweg Depth of Each Stream Reach Measured in 1997.

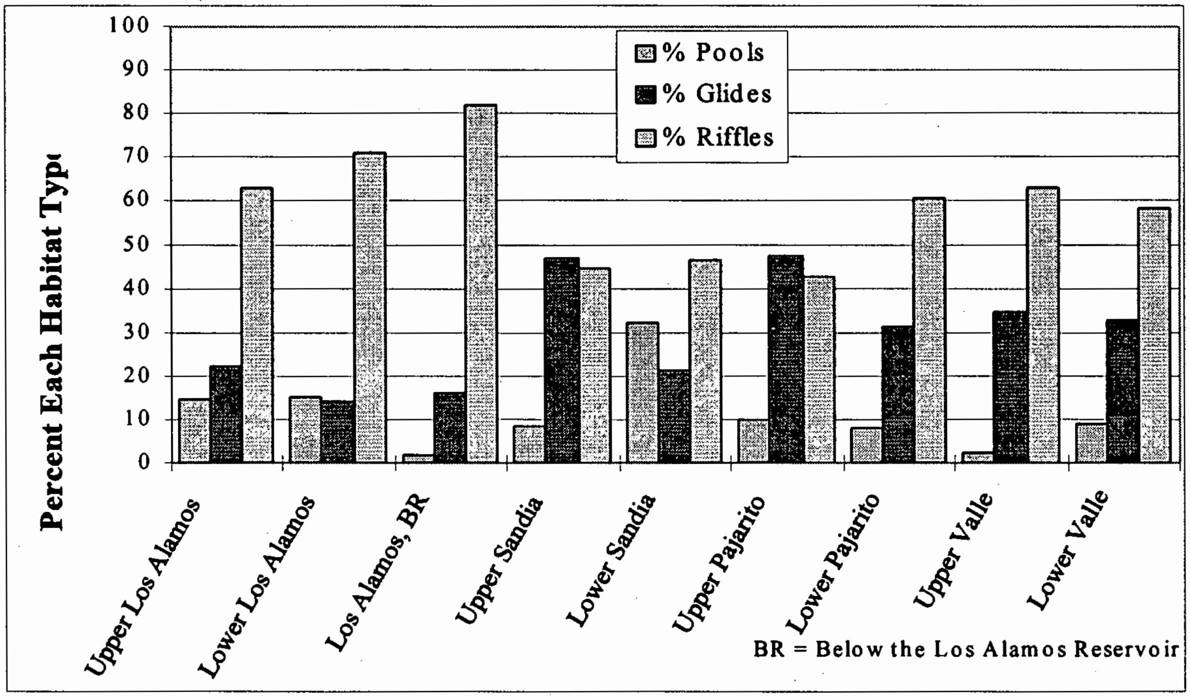


Figure 71. Percentage of Pools, Glides, and Riffles (expressed as a percentage of total wetted stream area) for Each Stream Reach Measured in 1997.

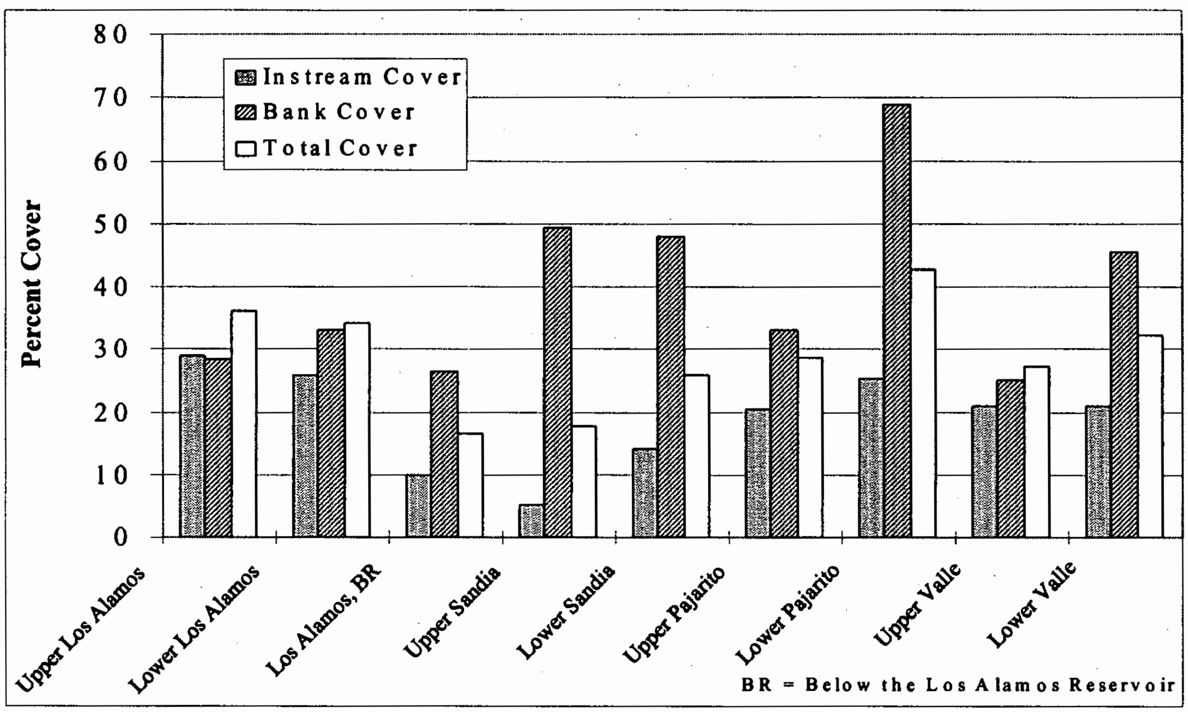


Figure 72. Percentage of Instream Cover, Bank Cover, and Total Cover (expressed as a percentage of the total wetted stream area) for Each Stream Reach in 1997.

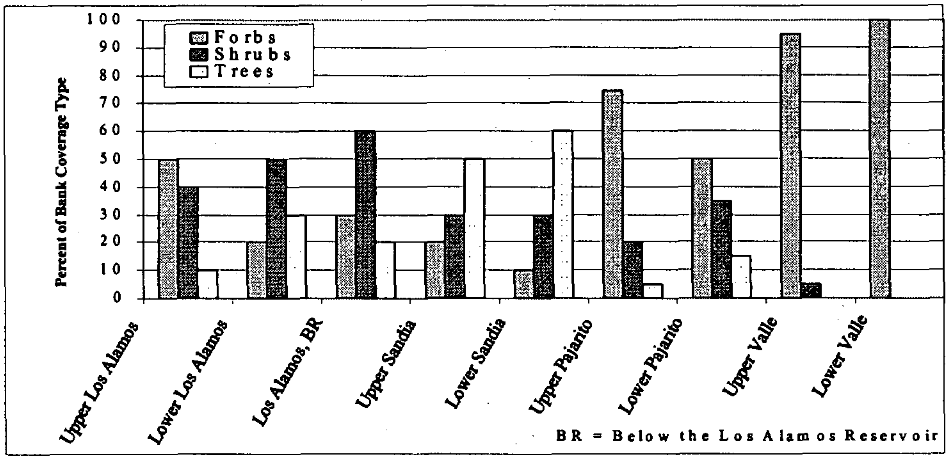


Figure 73. Percentage of Bank Cover Types (Forbs, Shrubs, or Trees) for Each Stream Reach Measured in 1997.

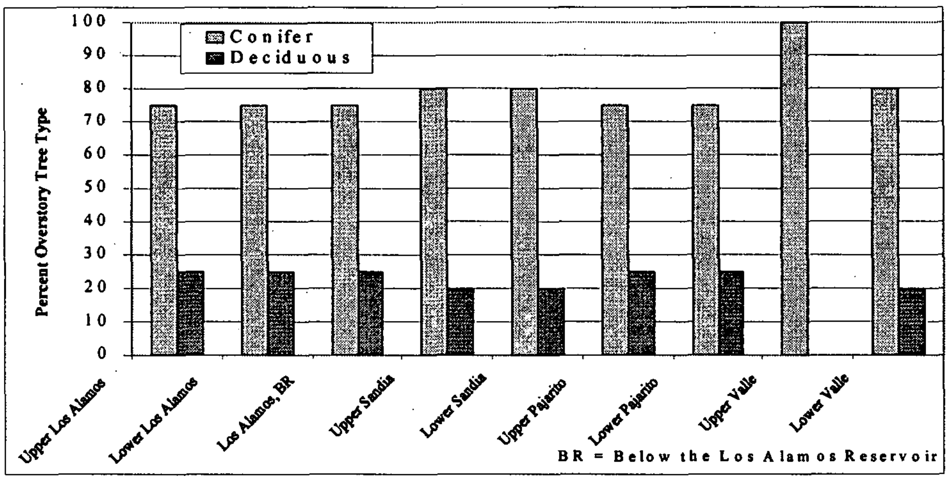


Figure 74. Percentage of Overstory Cover (expressed as a percentage of total riparian area) in the Form of Coniferous and Deciduous Trees for Each Stream Reach in 1997.

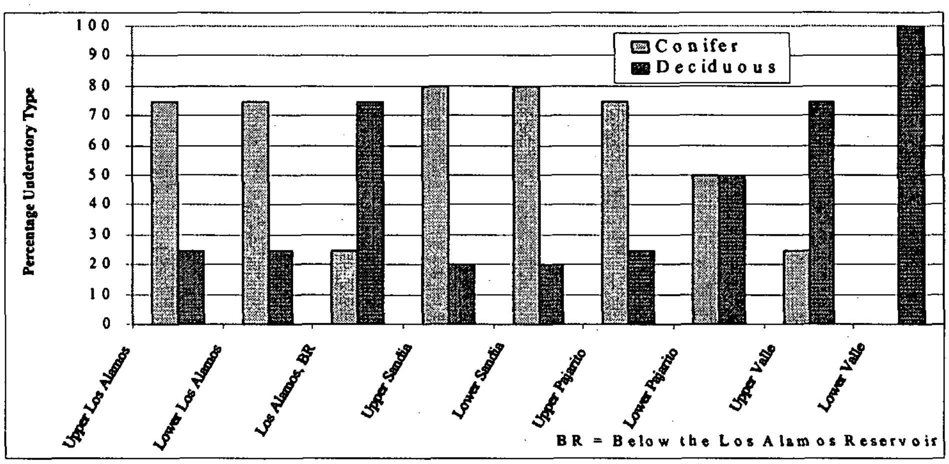


Figure 75. Percentage of Understory Cover (expressed as a percentage of total riparian area) in the Form of Coniferous and Deciduous Trees for Each Stream Reach in 1997.

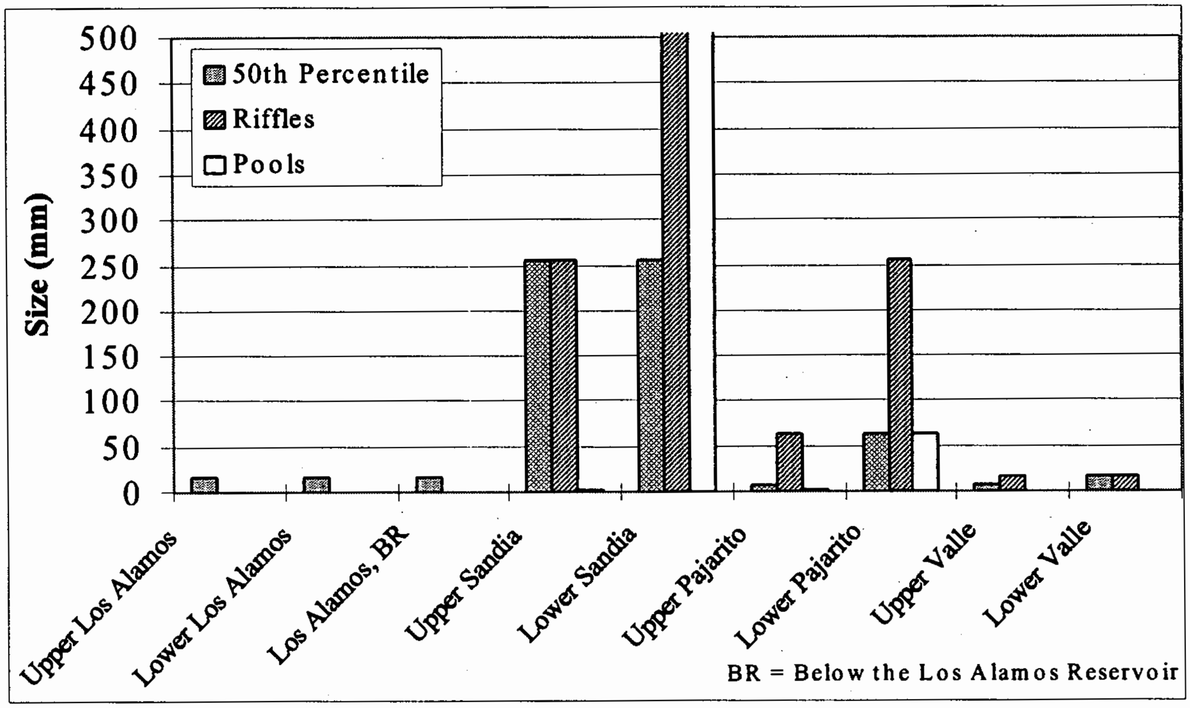


Figure 76. Stream Substrate Size Characteristics in Riffles, in Pools, and the 50th Percentile Distribution of Substrate Sizes for each Stream Reach Measured in 1997.

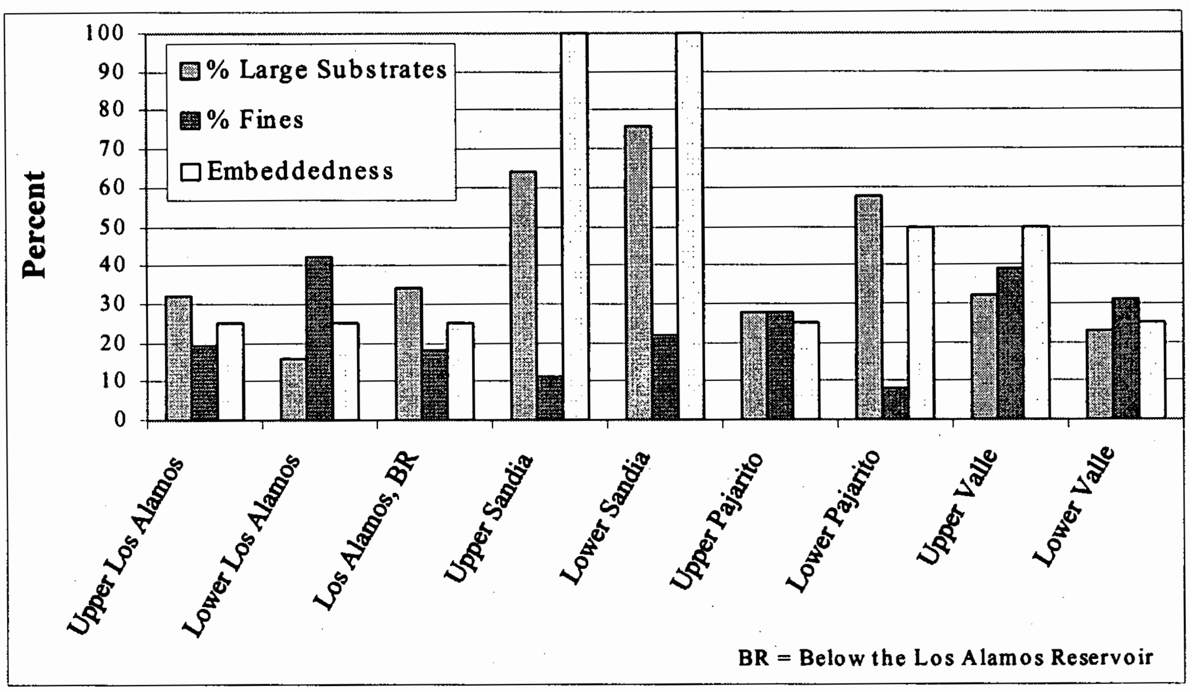
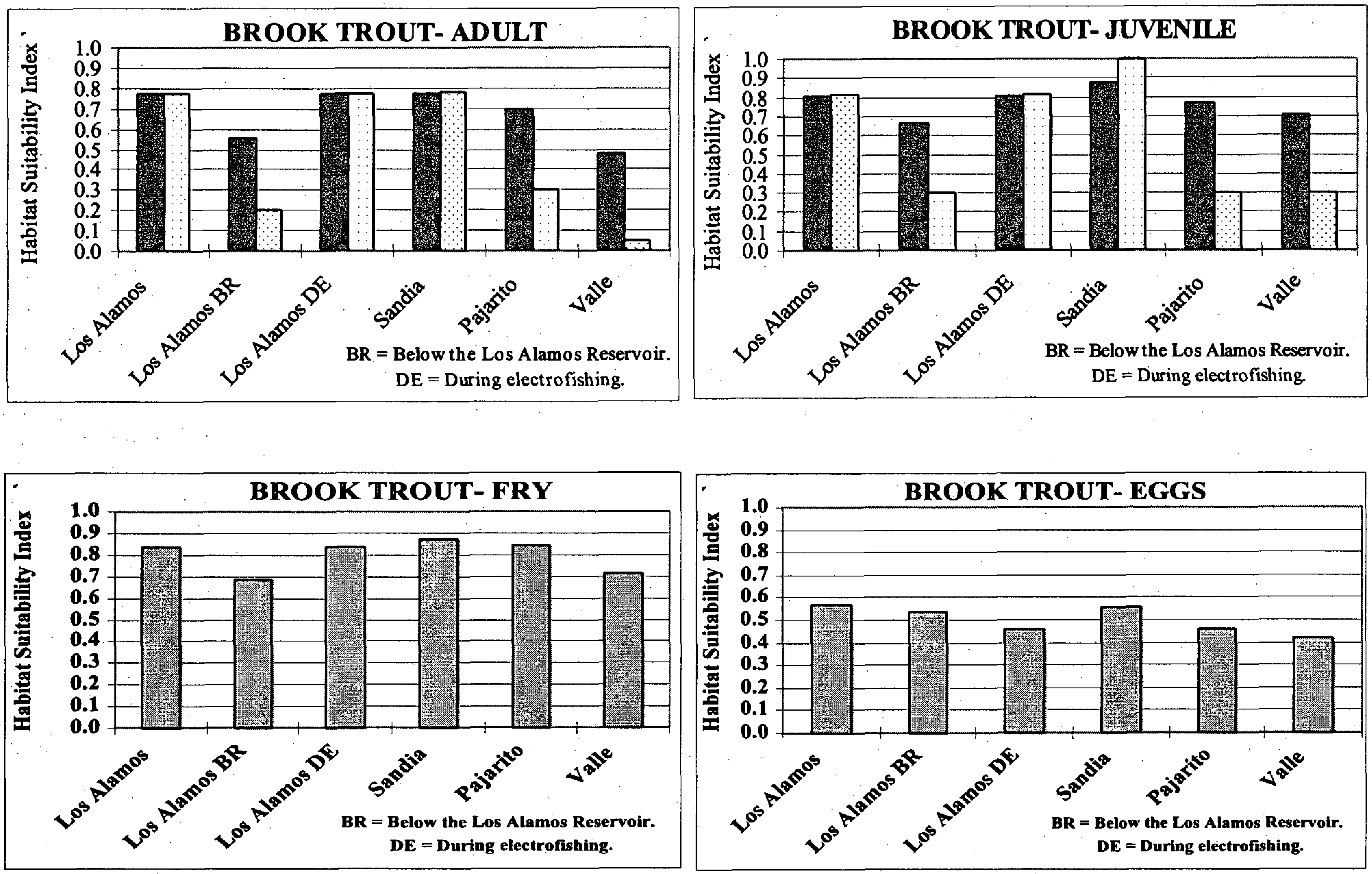
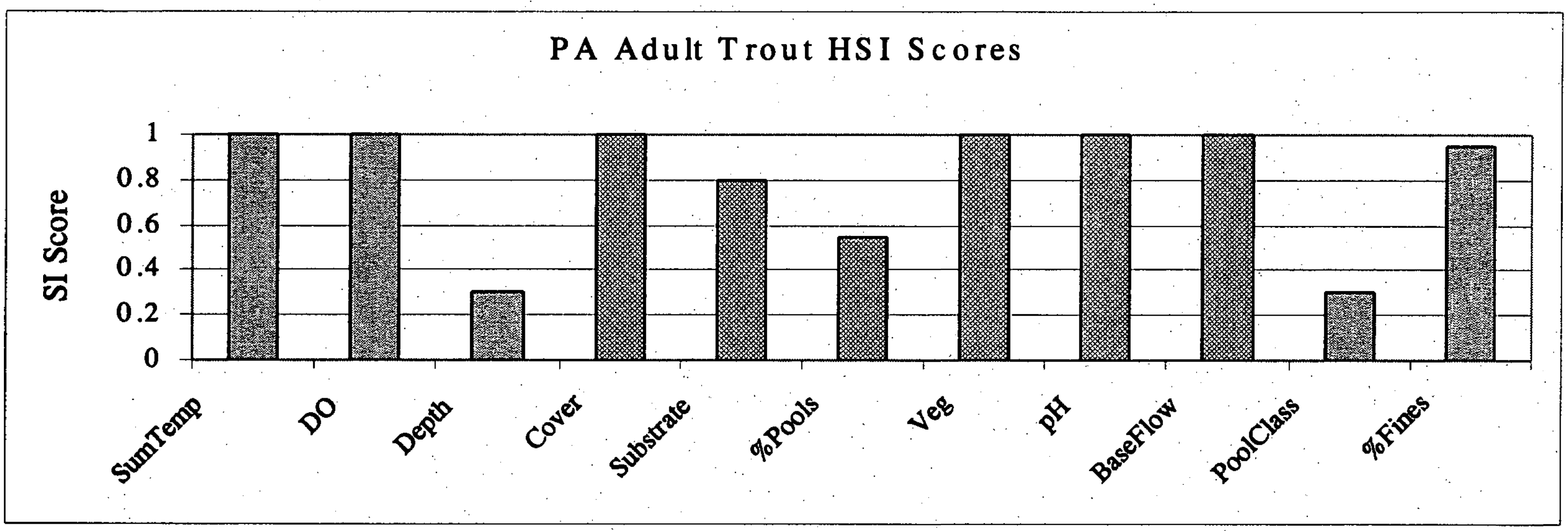


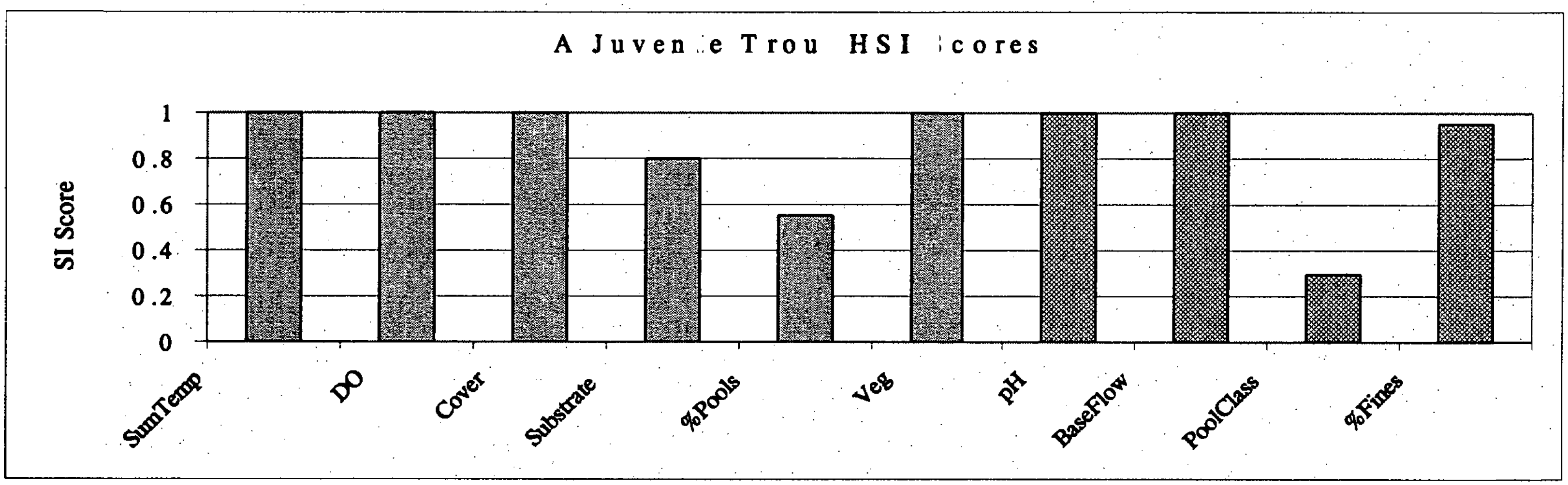
Figure 77. Stream Substrate Characteristics Expressed as Large and Fine Substrates as well as Percent Embeddedness of Large Substrates by Fines for Each Stream Reach.

Figure 78. Mean Habitat Suitability Index (HSI) Scores for Each Stream Segment for Adult, Juvenile, Fry, and Eggs of Brook Trout. For Illustrative Purposes, Adult and Juvenile Graphs Include Two Sets of Bars. Closed Bars Reflect the HSI Scores Before Water Depth and/or Pool Quality were Considered. Open Bars are the Final HSI Scores.



235





236

Figure 79. Mean Individual Habitat Suitability Scores (SI) for the Brook Trout HSI Model, Measured in Pajarito Canyon (PA) in 1997.

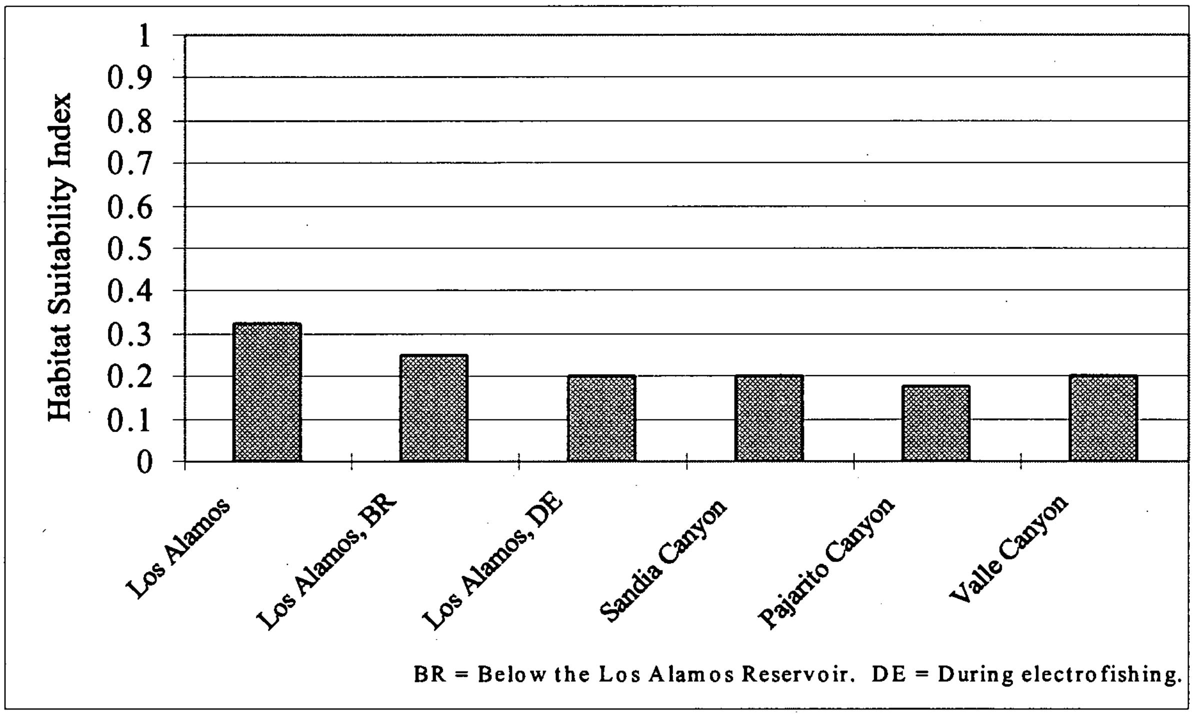


Figure 80. Overall Longnose Dace Habitat Suitability Index for Canyon Streams in 1997.

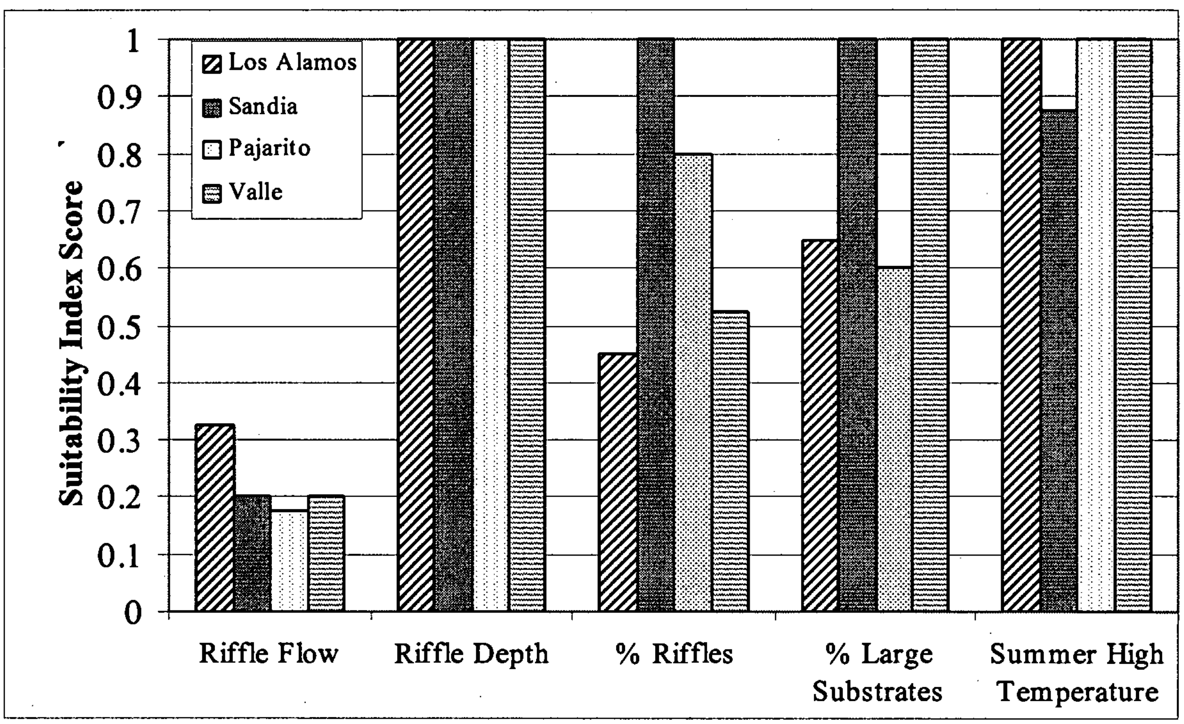


Figure 81. Mean Individual Habitat Parameter Scores for the Longnose Dace Suitability Index Model for Each Stream Reach Measured in 1997.

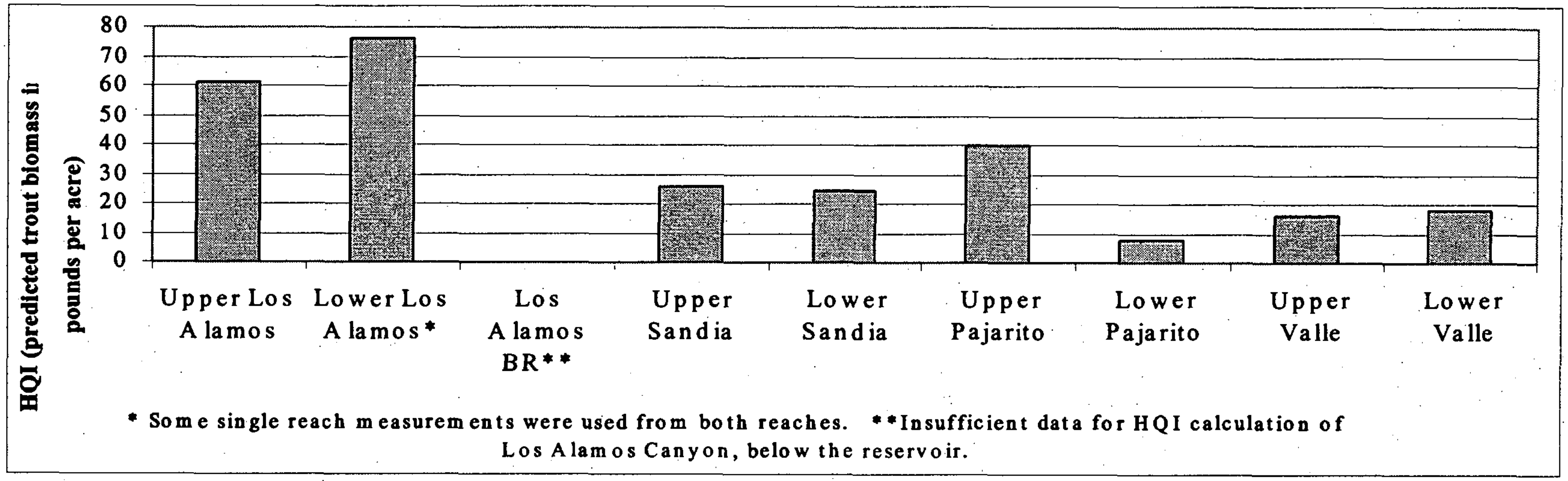


Figure 82. Predicted Trout Biomass (*i.e.*, Standing Crop Density) using the Habitat Quality Index (HQI) for Each Stream Reach.

238

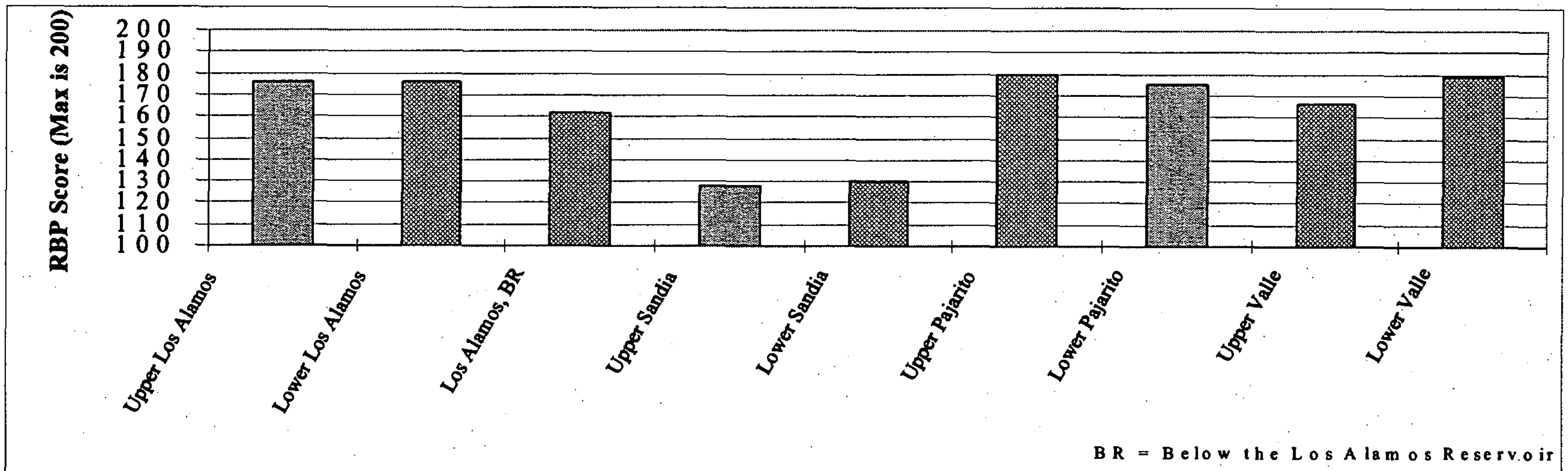
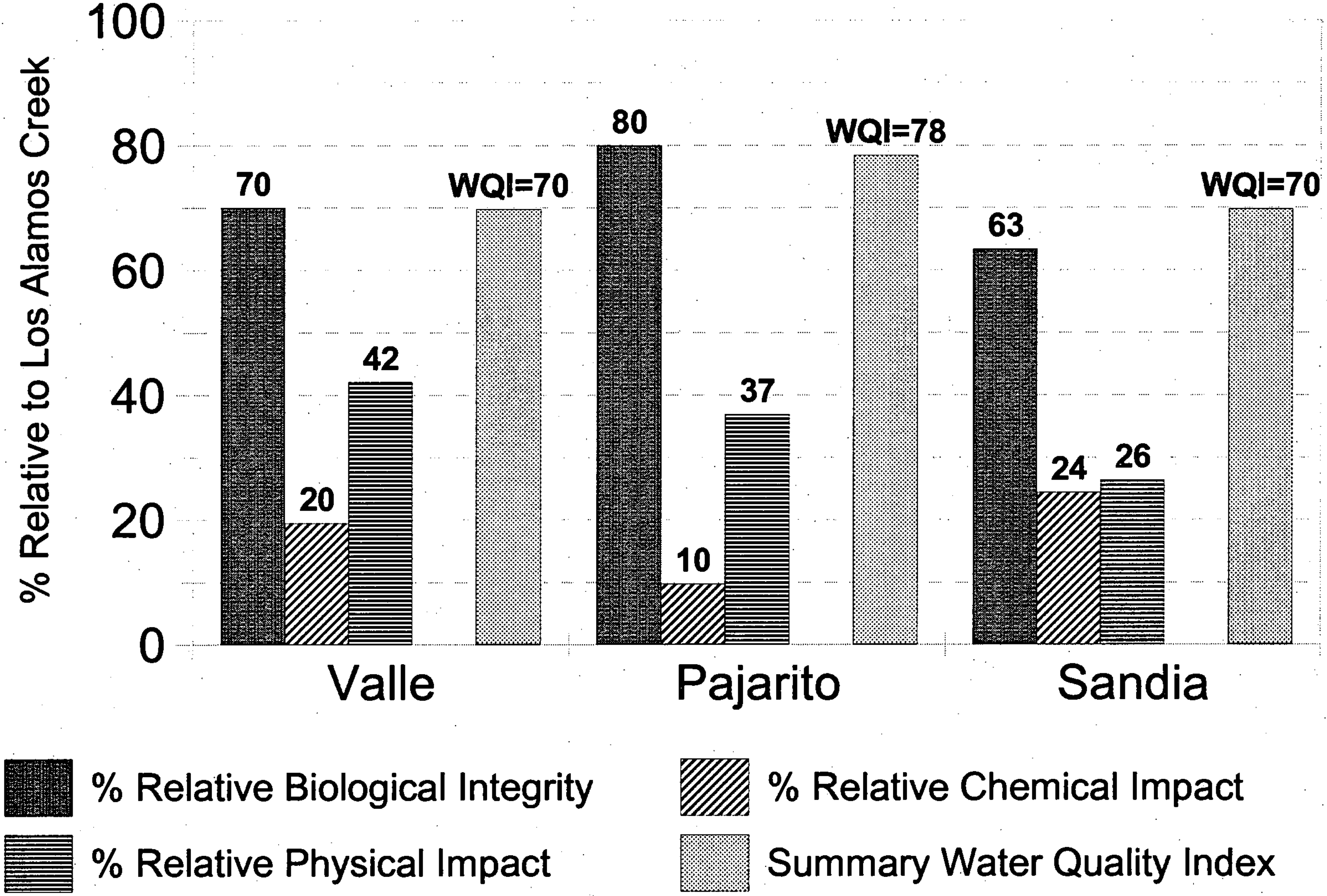


Figure 83. Rapid Bioassessment Protocol (RBP) Scores of Invertebrate Habitat Suitability for Each Stream Reach in 1997.



239

Figure 84. Relative Biological Integrity, the Percent Chemical and Physical Impact, and the Water Quality Index (WQI) for Valle, Pajarito, and Sandia Canyon Stream Segments Compared to Los Alamos Canyon Stream Segment as a Reference Site.

ATTACHMENT A AND APPENDICES
(See Enclosed CD-ROM)

Cover photograph of the Valle Canyon Creek on the Los Alamos National Laboratory and Use Study Activities
FWS Photographs

- Environmental significance and nature of the toxicity.
- Past compliance record or history.
- Cost of monitoring relative to financial capabilities.
- Number of monthly samples used in developing the permit limitation.
- The frequency of intermittent discharges.

Samples should be evenly spaced throughout the year so that seasonal variability can be ascertained.

8.3 Analytical Methods

The permit writer must specify the analytical methods to be used for monitoring. EPA's Office of Science and Technology's Clean Water Act Analytical Methods Website <www.epa.gov/waterscience/methods/> contains information about analytical methods.

The standard conditions of the permit [§§ 122.41(j)(4) and 122.44(i)] require that, when available, permittees use test procedures specified in Part 136 <www.epa.gov/waterscience/methods/basic.htm>. The analytical methods contained in Part 136 are established for conventional, toxic (priority), and some nonconventional pollutants. Without analytical methods for a parameter, the permit writer should specify the analytical method to be used. There are also procedures to apply for approval of alternative test methods in accordance with § 136.4.

While Part 136 identifies the analytical methods approved for use in the NPDES program, additional methods information is available through the National Environmental Methods Index (NEMI) <www.nemi.gov/>. NEMI is a Web-based, searchable clearinghouse of methods supported by the U.S. Geological Survey and EPA's Office of Water. NEMI contains summaries of more than 1,100 methods and describes them by their performance characteristics and their regulatory status, relative cost, detection level, detection level type, accuracy, precision, spiking level, instrumentation, lab equipment, and the *greenness* of analytic methods. Permit writers might find that information useful in comparing the features of Part 136 methods that will be used for assessing compliance with the calculated effluent limitations.

When establishing effluent limitations for a specific parameter (based on technology or water quality regulatory requirements), it is possible for the value of the calculated limit to fall below the method detection limit (MDL) and the minimum level (ML) established by the approved analytical method(s). Regardless of whether current analytical methods are available to detect and quantify the parameter at the concentration of the calculated limitation, the limitation must be included in the permit as calculated.

In some instances, there might be two or more approved Part 136 analytical methods available for the analysis of a parameter. In such cases, the permit should determine whether there is a need to select one of the approved methods and to include a requirement in the permit mandating the use of only the selected method. That approach might be necessary where an effluent limit is established at a level that is quantifiable by one approved method but is below the ML of another approved method.

Such a situation often occurs where a permit contains a WQBEL for mercury. To clarify the EPA's position with respect to effluent monitoring for mercury, EPA developed a memo *Analytical Methods for Mercury in National Pollutant Discharge Elimination System (NPDES) Permits*[12] <www.epa.gov/npdes/pubs/mercurymemo_analyticalmethods.pdf>.

ELECTRONIC CODE OF FEDERAL REGULATIONS

e-CFR data is current as of June 16, 2021

Title 40 → Chapter I → Subchapter D → Part 122 → Subpart A → §122.2

Title 40: Protection of Environment
PART 122—EPA ADMINISTERED PERMIT PROGRAMS: THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
Subpart A—Definitions and General Program Requirements

---

§122.2 Definitions.

The following definitions apply to parts 122, 123, and 124. Terms not defined in this section have the meaning given by CWA. When a defined term appears in a definition, the defined term is sometimes placed in quotation marks as an aid to readers.

Administrator means the Administrator of the United States Environmental Protection Agency, or an authorized representative.

Animal feeding operation is defined at §122.23.

Applicable standards and limitations means all State, interstate, and federal standards and limitations to which a “discharge,” a “sewage sludge use or disposal practice,” or a related activity is subject under the CWA, including “effluent limitations,” water quality standards, standards of performance, toxic effluent standards or prohibitions, “best management practices,” pretreatment standards, and “standards for sewage sludge use or disposal” under sections 301, 302, 303, 304, 306, 307, 308, 403 and 405 of CWA.

Application means the EPA standard national forms for applying for a permit, including any additions, revisions or modifications to the forms; or forms approved by EPA for use in “approved States,” including any approved modifications or revisions.

Approved program or *approved State* means a State or interstate program which has been approved or authorized by EPA under part 123.

Aquaculture project is defined at §122.25.

Average monthly discharge limitation means the highest allowable average of “daily discharges” over a calendar month, calculated as the sum of all “daily discharges” measured during a calendar month divided by the number of “daily discharges” measured during that month.

Average weekly discharge limitation means the highest allowable average of “daily discharges” over a calendar week, calculated as the sum of all “daily discharges” measured during a calendar week divided by the number of “daily discharges” measured during that week.

Best management practices (“BMPs”) means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of “waters of the United States.” BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

BMPs means “best management practices.”

Class I sludge management facility means any POTW identified under 40 CFR 403.8(a) as being required to have an approved pretreatment program (including such POTWs located in a State that has elected to assume local program responsibilities pursuant to 40 CFR 403.10(e)) and any other treatment works treating domestic sewage classified as a Class I sludge management facility by the Regional Administrator, or, in the case of approved State programs, the Regional Administrator in conjunction with the State Director, because of the potential for its sludge use or disposal practices to adversely affect public health and the environment.

Bypass is defined at §122.41(m).

Combined sewer overflow (CSO) means a discharge from a combined sewer system (CSS) at a point prior to the Publicly Owned Treatment Works (POTW) Treatment Plant (defined at §403.3(r) of this chapter).

Combined sewer system (CSS) means a wastewater collection system owned by a State or municipality (as defined by section 502(4) of the CWA) which conveys sanitary wastewaters (domestic, commercial and industrial wastewaters) and storm water through a single-pipe system to a Publicly Owned Treatment Works (POTW) Treatment Plant (as defined at §403.3(r) of this chapter).

Concentrated animal feeding operation is defined at §122.23.

Concentrated aquatic animal feeding operation is defined at §122.24.

Contiguous zone means the entire zone established by the United States under Article 24 of the Convention on the Territorial Sea and the Contiguous Zone.

Continuous discharge means a “discharge” which occurs without interruption throughout the operating hours of the facility, except for infrequent shutdowns for maintenance, process changes, or other similar activities.

CWA means the Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972) Public Law 92-500, as amended by Public Law 95-217, Public Law 95-576, Public Law 96-483 and Public Law 97-117, 33 U.S.C. 1251 *et seq.*

CWA and regulations means the Clean Water Act (CWA) and applicable regulations promulgated thereunder. In the case of an approved State program, it includes State program requirements.

Daily discharge means the "discharge of a pollutant" measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurement, the "daily discharge" is calculated as the average measurement of the pollutant over the day.

Direct discharge means the "discharge of a pollutant."

Director means the Regional Administrator or the State Director, as the context requires, or an authorized representative. When there is no "approved State program," and there is an EPA administered program, "Director" means the Regional Administrator. When there is an approved State program, "Director" normally means the State Director. In some circumstances, however, EPA retains the authority to take certain actions even when there is an approved State program. (For example, when EPA has issued an NPDES permit prior to the approval of a State program, EPA may retain jurisdiction over that permit after program approval, see §123.1.) In such cases, the term "Director" means the Regional Administrator and not the State Director.

Discharge when used without qualification means the "discharge of a pollutant."

Discharge of a pollutant means:

(a) Any addition of any "pollutant" or combination of pollutants to "waters of the United States" from any "point source," or

(b) Any addition of any pollutant or combination of pollutants to the waters of the "contiguous zone" or the ocean from any point source other than a vessel or other floating craft which is being used as a means of transportation.

This definition includes additions of pollutants into waters of the United States from: surface runoff which is collected or channelled by man; discharges through pipes, sewers, or other conveyances owned by a State, municipality, or other person which do not lead to a treatment works; and discharges through pipes, sewers, or other conveyances, leading into privately owned treatment works. This term does not include an addition of pollutants by any "indirect discharger."

Discharge Monitoring Report ("DMR") means the EPA uniform national form, including any subsequent additions, revisions, or modifications for the reporting of self-monitoring results by permittees. DMRs must be used by "approved States" as well as by EPA. EPA will supply DMRs to any approved State upon request. The EPA national forms may be modified to substitute the State Agency name, address, logo, and other similar information, as appropriate, in place of EPA's.

DMR means “Discharge Monitoring Report.”

Draft permit means a document prepared under §124.6 indicating the Director's tentative decision to issue or deny, modify, revoke and reissue, terminate, or reissue a “permit.” A notice of intent to terminate a permit, and a notice of intent to deny a permit, as discussed in §124.5, are types of “draft permits.” A denial of a request for modification, revocation and reissuance, or termination, as discussed in §124.5, is not a “draft permit.” A “proposed permit” is not a “draft permit.”

Effluent limitation means any restriction imposed by the Director on quantities, discharge rates, and concentrations of “pollutants” which are “discharged” from “point sources” into “waters of the United States,” the waters of the “contiguous zone,” or the ocean.

Effluent limitations guidelines means a regulation published by the Administrator under section 304(b) of CWA to adopt or revise “effluent limitations.”

Environmental Protection Agency (“EPA”) means the United States Environmental Protection Agency.

EPA means the United States “Environmental Protection Agency.”

Facility or activity means any NPDES “point source” or any other facility or activity (including land or appurtenances thereto) that is subject to regulation under the NPDES program.

Federal Indian reservation means all land within the limits of any Indian reservation under the jurisdiction of the United States Government, notwithstanding the issuance of any patent, and including rights-of-way running through the reservation.

General permit means an NPDES “permit” issued under §122.28 authorizing a category of discharges under the CWA within a geographical area.

Great Lakes Basin means the waters defined as “Great Lakes” and “Great Lakes System” as those terms are defined in §132.2 of this chapter.

Hazardous substance means any substance designated under 40 CFR part 116 pursuant to section 311 of CWA.

Indian country means:

(1) All land within the limits of any Indian reservation under the jurisdiction of the United States Government, notwithstanding the issuance of any patent, and, including rights-of-way running through the reservation;

(2) All dependent Indian communities with the borders of the United States whether within the originally or subsequently acquired territory thereof, and whether within or without the limits of a state; and

(3) All Indian allotments, the Indian titles to which have not been extinguished, including rights-of-way running through the same.

Indian Tribe means any Indian Tribe, band, group, or community recognized by the Secretary of the Interior and exercising governmental authority over a Federal Indian reservation.

Indirect discharger means a nondomestic discharger introducing "pollutants" to a "publicly owned treatment works."

Individual control strategy is defined at 40 CFR 123.46(c).

Interstate agency means an agency of two or more States established by or under an agreement or compact approved by the Congress, or any other agency of two or more States having substantial powers or duties pertaining to the control of pollution as determined and approved by the Administrator under the CWA and regulations.

Major facility means any NPDES "facility or activity" classified as such by the Regional Administrator, or, in the case of "approved State programs," the Regional Administrator in conjunction with the State Director.

Maximum daily discharge limitation means the highest allowable "daily discharge."

Municipality means a city, town, borough, county, parish, district, association, or other public body created by or under State law and having jurisdiction over disposal of sewage, industrial wastes, or other wastes, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of CWA.

Municipal separate storm sewer system is defined at §122.26 (b)(4) and (b)(7).

National Pollutant Discharge Elimination System (NPDES) means the national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under sections 307, 402, 318, and 405 of CWA. The term includes an "approved program."

New discharger means any building, structure, facility, or installation:

(a) From which there is or may be a "discharge of pollutants;"

(b) That did not commence the "discharge of pollutants" at a particular "site" prior to August 13, 1979;

(c) Which is not a "new source;" and

(d) Which has never received a finally effective NPDES permit for discharges at that "site."

New source means any building, structure, facility, or installation from which there is or may be a "discharge of pollutants," the construction of which commenced:

(a) After promulgation of standards of performance under section 306 of CWA which are applicable to such source, or

(b) After proposal of standards of performance in accordance with section 306 of CWA which are applicable to such source, but only if the standards are promulgated in accordance with section 306 within 120 days of their proposal.

NPDES means "National Pollutant Discharge Elimination System."

Owner or operator means the owner or operator of any "facility or activity" subject to regulation under the NPDES program.

Permit means an authorization, license, or equivalent control document issued by EPA or an "approved State" to implement the requirements of this part and parts 123 and 124. "Permit" includes an NPDES "general permit" (§122.28). Permit does not include any permit which has not yet been the subject of final agency action, such as a "draft permit" or a "proposed permit."

Person means an individual, association, partnership, corporation, municipality, State or Federal agency, or an agent or employee thereof.

Pesticide discharges to waters of the United States from pesticide application means the discharges that result from the application of biological pesticides, and the application of chemical pesticides that leave a residue, from point sources to waters of the United States. In the context of this definition of pesticide discharges to waters of the United States from pesticide application, this does not include agricultural storm water discharges and return flows from irrigated agriculture, which are excluded by law (33 U.S.C. 1342(l); 33 U.S.C. 1362(14)).

Pesticide residue for the purpose of determining whether an NPDES permit is needed for discharges to waters of the United States from pesticide application, means that portion of a pesticide application that is discharged from a point source to waters of the United States and no longer provides pesticidal benefits. It also includes any degradates of the pesticide.

Point source means any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural storm water runoff. (See §122.3).

Pollutant means dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials (except those regulated under the Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 *et seq.*)), heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water. It does not mean:

(a) Sewage from vessels; or

(b) Water, gas, or other material which is injected into a well to facilitate production of oil or gas, or water derived in association with oil and gas production and disposed of in a well, if the well used either to facilitate production or for disposal purposes is approved by authority of the State in which the well is located, and if the State determines that the injection or disposal will not result in the degradation of ground or surface water resources.

NOTE: Radioactive materials covered by the Atomic Energy Act are those encompassed in its definition of source, byproduct, or special nuclear materials. Examples of materials not covered include radium and accelerator-produced isotopes. See *Train* v. *Colorado Public Interest Research Group, Inc.,* 426 U.S. 1 (1976).

POTW is defined at §403.3 of this chapter.

Primary industry category means any industry category listed in the NRDC settlement agreement (*Natural Resources Defense Council et al.* v. *Train,* 8 E.R.C. 2120 (D.D.C. 1976), *modified* 12 E.R.C. 1833 (D.D.C. 1979)); also listed in appendix A of part 122.

Privately owned treatment works means any device or system which is (a) used to treat wastes from any facility whose operator is not the operator of the treatment works and (b) not a "POTW."

Process wastewater means any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, byproduct, or waste product.

Proposed permit means a State NPDES "permit" prepared after the close of the public comment period (and, when applicable, any public hearing and administrative appeals) which is sent to EPA for review before final issuance by the State. A "proposed permit" is not a "draft permit."

Publicly owned treatment works is defined at 40 CFR 403.3.

Recommencing discharger means a source which recommences discharge after terminating operations.

Regional Administrator means the Regional Administrator of the appropriate Regional Office of the Environmental Protection Agency or the authorized representative of the Regional Administrator.

Schedule of compliance means a schedule of remedial measures included in a "permit", including an enforceable sequence of interim requirements (for example, actions, operations, or milestone events) leading to compliance with the CWA and regulations.

Secondary industry category means any industry category which is not a "primary industry category."

Secretary means the Secretary of the Army, acting through the Chief of Engineers.

Septage means the liquid and solid material pumped from a septic tank, cesspool, or similar domestic sewage treatment system, or a holding tank when the system is cleaned or maintained.

Sewage from vessels means human body wastes and the wastes from toilets and other receptacles intended to receive or retain body wastes that are discharged from vessels and regulated under section 312 of CWA, except that with respect to commercial vessels on the Great Lakes this term includes graywater. For the purposes of this definition, “graywater” means galley, bath, and shower water.

Sewage Sludge means any solid, semi-solid, or liquid residue removed during the treatment of municipal waste water or domestic sewage. Sewage sludge includes, but is not limited to, solids removed during primary, secondary, or advanced waste water treatment, scum, septage, portable toilet pumpings, type III marine sanitation device pumpings (33 CFR part 159), and sewage sludge products. Sewage sludge does not include grit or screenings, or ash generated during the incineration of sewage sludge.

Sewage sludge use or disposal practice means the collection, storage, treatment, transportation, processing, monitoring, use, or disposal of sewage sludge.

Silvicultural point source is defined at §122.27.

Site means the land or water area where any “facility or activity” is physically located or conducted, including adjacent land used in connection with the facility or activity.

Sludge-only facility means any “treatment works treating domestic sewage” whose methods of sewage sludge use or disposal are subject to regulations promulgated pursuant to section 405(d) of the CWA and is required to obtain a permit under §122.1(b)(2).

Standards for sewage sludge use or disposal means the regulations promulgated pursuant to section 405(d) of the CWA which govern minimum requirements for sludge quality, management practices, and monitoring and reporting applicable to sewage sludge or the use or disposal of sewage sludge by any person.

State means any of the 50 States, the District of Columbia, Guam, the Commonwealth of Puerto Rico, the Virgin Islands, American Samoa, the Commonwealth of the Northern Mariana Islands, the Trust Territory of the Pacific Islands, or an Indian Tribe as defined in these regulations which meets the requirements of §123.31 of this chapter.

State Director means the chief administrative officer of any State or interstate agency operating an “approved program,” or the delegated representative of the State Director. If responsibility is divided among two or more State or interstate agencies, “State Director” means the chief administrative officer of the State or interstate agency authorized to perform the particular procedure or function to which reference is made.

State/EPA Agreement means an agreement between the Regional Administrator and the State which coordinates EPA and State activities, responsibilities and programs including those under the CWA programs.

Storm water is defined at §122.26(b)(13).

Storm water discharge associated with industrial activity is defined at §122.26(b)(14).

Total dissolved solids means the total dissolved (filterable) solids as determined by use of the method specified in 40 CFR part 136.

Toxic pollutant means any pollutant listed as toxic under section 307(a)(1) or, in the case of “sludge use or disposal practices,” any pollutant identified in regulations implementing section 405(d) of the CWA.

Treatment works treating domestic sewage means a POTW or any other sewage sludge or waste water treatment devices or systems, regardless of ownership (including federal facilities), used in the storage, treatment, recycling, and reclamation of municipal or domestic sewage, including land dedicated for the disposal of sewage sludge. This definition does not include septic tanks or similar devices. For purposes of this definition, “domestic sewage” includes waste and waste water from humans or household operations that are discharged to or otherwise enter a treatment works. In States where there is no approved State sludge management program under section 405(f) of the CWA, the Regional Administrator may designate any person subject to the standards for sewage sludge use and disposal in 40 CFR part 503 as a “treatment works treating domestic sewage,” where he or she finds that there is a potential for adverse effects on public health and the environment from poor sludge quality or poor sludge handling, use or disposal practices, or where he or she finds that such designation is necessary to ensure that such person is in compliance with 40 CFR part 503.

TWTDS means “treatment works treating domestic sewage.”

Upset is defined at §122.41(n).

Variance means any mechanism or provision under section 301 or 316 of CWA or under 40 CFR part 125, or in the applicable “effluent limitations guidelines” which allows modification to or waiver of the generally applicable effluent limitation requirements or time deadlines of CWA. This includes provisions which allow the establishment of alternative limitations based on fundamentally different factors or on sections 301(c), 301(g), 301(h), 301(i), or 316(a) of CWA.

Waters of the United States or *waters of the U.S.* means the term as it is defined in §120.2 of this chapter.

Whole effluent toxicity means the aggregate toxic effect of an effluent measured directly by a toxicity test.

(Clean Water Act (33 U.S.C. 1251 *et seq.*), Safe Drinking Water Act (42 U.S.C. 300f *et seq.*), Clean Air Act (42 U.S.C. 7401 *et seq.*), Resource Conservation and Recovery Act (42 U.S.C. 6901 *et seq.*))

[48 FR 14153, Apr. 1, 1983, as amended at 48 FR 39619, Sept. 1, 1983; 50 FR 6940, 6941, Feb. 19, 1985; 54 FR 254, Jan. 4, 1989; 54 FR 18781, May 2, 1989; 54 FR 23895, June 2, 1989; 58 FR 45038, Aug. 25, 1993; 58 FR 67980, Dec. 22, 1993; 64 FR 42462, Aug. 4, 1999; 65 FR 30905, May

15, 2000; 80 FR 37114, June 29, 2015; 83 FR 730, Jan. 8, 2018; 83 FR 5208, Feb. 6, 2018; 84 FR 3336, Feb. 12, 2019; 84 FR 56669, Oct. 22, 2019; 85 FR 22341, Apr. 21, 2020]

Need assistance?

3.2 DETERMINING THE NEED FOR PERMIT LIMITS WITHOUT EFFLUENT MONITORING DATA FOR A SPECIFIC FACILITY

If the regulatory authority so chooses, or if the circumstances dictate, the authority may decide to develop and impose a permit limit for whole effluent toxicity or for individual toxicants without facility-specific effluent monitoring data, or prior to the generation of effluent data. Water quality-based permit limits can be set for a single toxicant or for whole effluent toxicity based on the available dilution and the water quality criterion or the State standard in the absence of facility specific effluent monitoring data. However, in doing so, the regulatory authority must satisfy all the requirements of 40 *CFR* 122.44(d)(1)(ii).

When determining whether or not a discharge causes, has the reasonable potential to cause, or contributes to an excursion of a numeric or narrative water quality criterion for individual toxicants or for toxicity, the regulatory authority can use a variety of factors and information where facility-specific effluent monitoring data are unavailable. These factors also should be considered with available effluent monitoring data. Some of these factors are the following:

- **Dilution**—Toxic impact is directly related to available dilution for the effluent. Dilution is related to the receiving stream flow and the size of the discharge. The lower the available dilution, the higher the potential for toxic effect. If an effluent's concentration at the edge of a mixing zone in a receiving water is expected to reach 1 percent or higher during critical or worst-case design periods, then such an effluent may require a toxicity limit (see discussion in Section 3.3.3). Assessment of the amount of stream dilution available should be made at the conditions required by the water quality standards or, if not specified in the standards, at the harmonic mean flow and the 7Q10 flow. Figure 3-3 (Pg. 57) shows that, whereas a majority of NPDES permittees nationwide discharge to areas during annual mean flow ranging in dilution from 100 to 1,000, the majority of dischargers fall into the 1 to 10 dilution range during low-flow conditions.

- **Type of industry**—Although dischargers should be individually characterized because toxicity problems are site-specific, the primary industrial categories should be of principal toxicity concern. EPA's treatment technology data base generally suggests that secondary industrial categories may have less potential for toxicity than primary industries. However, based on experience, it is virtually impossible to generalize the toxicity of effluents with any certainty. If two plants produce the same type of product, one effluent may be toxic while the other may not be toxic due to the type and efficiency of the treatment applied, general materials handling practices, and the functional target of the compound(s) being produced.

- **Type of POTW**—POTWs with loadings from indirect dischargers (particularly primary industries) may be candidates for toxicity limits. However, absence of industrial input does not guarantee an absence of POTW discharge toxicity problems. For example, commercial pesticide applicators often discharge to POTWs, resulting in pesticide concentrations in the POTW's effluent. Household disposal of pesticides, detergents, or other toxics may have a similar effect. The types of industrial users, their product lines, their raw materials, their potential and actual discharges, and their control equipment should be evaluated. POTWs should also be characterized for the possibility of chlorine and ammonia problems.

- **Existing data on toxic pollutants**—Discharge monitoring reports (DMRs) and data from NPDES permit application forms 2C and 2A may provide some indication of the presence of toxicants. The presence or absence of the 126 "priority pollutants" may or may not be an indication of the presence or absence of toxicity. There are thousands of "nonpriority" toxicants that may cause effluent toxicity. Also, combinations of several toxicants can produce ambient toxicity where the individual toxicants would not. EPA regulations at 40 *CFR* 122.21(j) require POTWs with design flows equal to or greater than 1 MGD and POTWs with approved pretreatment programs, or POTWs required to develop a pretreatment program, to submit the results of whole effluent toxicity tests with their permit applications. These regulations also provide discretion to the permitting authority to request such data from other POTWs at the time of permit application.

- **History of compliance problems and toxic impact**—Regulatory authorities may consider particular dischargers that have had difficulty complying with limits on toxicants or that have a history of known toxicity impacts as probable priority candidates for effluent toxicity limits.

- **Type of receiving water and designated use**—Regulatory authorities may compile data on water quality. Examples of available data include fish advisories or bans, reports of fish kills, State lists of priority waterbodies, and State lists of waters that are not meeting water quality standards. Regulatory authorities should use this information as a means of identifying point sources that discharge to impaired waterbodies and that thus may be contributing to this impairment. One source of this information is the lists of waters generated by states to comply with Section 304(l) regulations at 40 *CFR* 130.10(d)(6); 50 *FR* 23897-98, June 2, 1989:

    1) Waters where fishing or shellfish bans and/or advisories are currently in effect or are anticipated;

    2) Waters where there have been repeated fish kills or where abnormalities (cancers, lesions, tumors, etc.) have been observed in fish or other aquatic life during the last ten years;

    3) Waters where there are restrictions on water sports or recreational contact;

    4) Waters identified by the state in its most recent state section 305(b) report as either "partially achieving" or "not achieving" designated uses;

5) Waters identified by the states under section 303(d) of the Clean Water Act as waters needing water quality-based controls;

6) Waters identified by the state as priority water bodies;

7) Waters where ambient data indicate potential or actual excursions of water quality criteria due to toxic pollutants from an industry classified as a primary industry in Appendix A of 40 CFR Part 122;

8) Waters for which effluent toxicity test results indicate possible or actual excursions of state water quality standards, including narrative "free from" water quality criteria or EPA water quality criteria where state criteria are not available;

9) Waters with primary industrial major dischargers where dilution analyses indicate exceedances of state narrative or numeric water quality criteria (or EPA water quality criteria where state standards are not available) fortoxic pollutants, ammonia, or chlorine;

10) Waters with POTW dischargers requiring local pretreatment programs where dilution analyses indicate exceedances of state water quality criteria (or EPA water quality criteria where state water quality criteria are not available) for toxic pollutants, ammonia, or chlorine;

11) Waters with facilities not included in the previous two categories such as major POTWs, and industrial minor dischargers where dilution analyses indicate exceedances of numeric or narrative state water quality criteria (or EPA water quality criteria where state water quality criteria are not available) for toxic pollutants, ammonia, or chlorine;

12) Water classified for uses that will not support the "fishable/swimmable" goals of the Clean Water Act;

13) Waters where ambient toxicity or adverse water quality conditions have been reported by local, state, EPA or other Federal Agencies, the private sector, public interest groups, or universities;

14) Waters identified by the state as impaired in its most recent Clean Lake Assessments conducted under 314 of the Clean Water Act; and

15) Surface waters impaired by pollutants from hazardous waste sites on the National Priority List prepared under section 105(8)(A) of CERCLA.

16) Waters judged to be impaired as a result of a bioassessment/biosurvey.

The presence of a combination of these factors, such as low available dilution, high-quality receiving water, poor compliance record, and clustered industrial and municipal discharges, could constitute a high priority for effluent limits.

Regardless, the regulatory authority, if it chooses to impose an effluent limit after conducting an effluent assessment without facility-specific monitoring data, will need to provide adequate justification for the limit in its permit development rationale or in its permit fact sheet. A clear and logical rationale for the need for the limit covering all of the regulatory points will be necessary to defend the limit should it be challenged. In justification of a limit, **EPA recommends that the more information the authority can acquire to support the limit, the better a position the authority will be in to defend the limit if necessary.** In such a case, the regulatory authority may well benefit from the collection of effluent monitoring data prior to establishing the limit.

If the regulatory authority, after evaluating all available information on the effluent, in the absence of effluent monitoring data, is not able to decide whether the discharge causes, has the reasonable potential to cause, or contributes to, an excursion above a numeric or narrative criterion for whole effluent toxicity or for individual toxicants, the authority should require whole effluent toxicity or chemical-specific testing to gather further evidence. In such a case, the regulatory authority can require the monitoring prior to permit issuance, if sufficient time exists, or it may require the testing as a condition of the issued/reissued permit.

Under these circumstances, the regulatory authority may find it protective of water quality to include a permit reopener for the imposition of an effluent limit should the effluent testing establish that the discharge causes, has the reasonable potential to cause, or contributes to excursion above a water quality criteria. A discussion of these options is provided later in this chapter.

3.3 DETERMINING THE NEED FOR PERMIT LIMITS WITH EFFLUENT MONITORING DATA

3.3.1 General Considerations

When characterizing an effluent for the need for a whole effluent toxicity limit, and/or an individual toxicant limit, the regulatory authority should use any available effluent monitoring data, together with any information like that discussed under Section 3.2 above, as the basis for a decision. The regulatory authority may already have effluent toxicity data available from previous monitoring, or it may decide to require the permittee to generate effluent monitoring data prior to permit issuance or as a condition of the issued permit. EPA regulations at 40 *CFR* 122.21(j) require POTWs with design flows equal to or greater than 1 MGD and POTWs with approved pretreatment programs, or POTWs required to develop a pretreatment program, to submit the results of whole effluent toxicity tests with their permit applications. These regulations also provide discretion to the permitting authority to request such data from additional POTWs at the time of permit application.